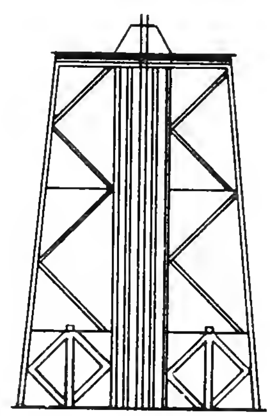
Biological Services Program

FWS/OBS–77/13
March 1978

Environmental Planning for Offshore Oil and Gas

Volume II:

Effects on Coastal Communities



Fish and Wildlife Service

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

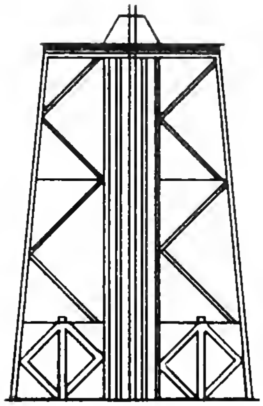
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.

- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staff, who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities, who conduct inhouse research studies.



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Environmental Planning for Offshore Oil and Gas

Volume II: Effects on Coastal Communities

by

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Volume I: Recovery Technology

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Volume III: Effects on Living Resources and Habitats

Volume IV: Regulatory Framework for Protecting Living Resources

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ENVIRONMENTAL PLANNING FOR OFFSHORE OIL AND GAS

FOREWORD

This report is one in a series prepared by The Conservation Foundation for the Office of Biological Services of the U.S. Fish and Wildlife Service (Contract 14-16-0008-962). The series conveys technical information and develops an impact assessment system relating to the recovery of oil and gas resources beyond the three-mile territorial limit of the Outer Continental Shelf (OCS). The series is designed to aid Fish and Wildlife Service personnel in the conduct of environmental reviews and decisions concerning OCS oil and gas development. In addition, the reports are intended to be as helpful as possible to the public, the oil and gas industry, and to all government agencies involved with resource management and environmental protection.

Oil and gas have been recovered for several decades from the Outer Continental Shelf of Texas, Louisiana and California. In the future, the Department of the Interior plans to lease more tracts, not only off these coasts, but also off the frontier regions of the North, Mid- and South Atlantic, eastern Gulf of Mexico, Pacific Northwest and Alaska. Within the set of constraints imposed by the international petroleum market (including supply, demand and price), critical decisions are made jointly by industry and government on whether it is advisable or not to move ahead with leasing and development of each of the offshore frontier areas. Once the decision to develop a field is made, many other decisions are necessary, such as where to locate offshore platforms, where to locate the onshore support areas, and how to transport hydrocarbons to market.

Existing facilities and the size of the resource will dictate which facilities will be needed, what the siting requirements will be, and where facilities will be sited. If the potential for marketable resources is moderate, offshore activities may be staged from areas already having harbor facilities and support industries; therefore, they may have little impact on the coast adjacent to a frontier area. An understanding of these options from industry's perspective will enable Fish and Wildlife Service personnel to anticipate development activities in various OCS areas and to communicate successfully with industry to assure that fish and wildlife resources will be protected.

The major purpose of this report is to describe the technological characteristics and planning strategy of oil and gas development on the Outer Continental Shelf, and to assess the effects of OCS oil and gas operations on living resources and their habitats. This approach should help bridge the gap between a simple reactive mode and effective advanced planning--planning that will result in a better understanding of the wide range of OCS activities that directly and indirectly generate impacts on the environment, and the countermeasures necessary to protect and enhance living resources.

Development of offshore oil and gas resources is a complex industrial process that requires extensive advance planning and coordination of all phases from exploration to processing and shipment. Each of hundreds of system components linking development and production activities has the potential for adverse environmental effects on coastal water resources. Among the advance judgements that OCS planning requires are the probable environmental impacts of various courses of action.

The relevant review functions that the Fish and Wildlife Service is concerned with are: (1) planning for baseline studies and the leasing of oil and gas tracts offshore and (2) reviewing of permit applications and evaluation of environmental impact statements (EIS) that relate to facility development, whether offshore (OCS), near shore (within territorial limits), or onshore (above the mean high tidemark). Because the Service is involved with such a broad array of activities, there is a great deal of private and public interest in its review functions. Therefore, it is most valuable in advance to have some of the principles, criteria and standards that provide the basis for review and decisionmaking. The public, the offshore petroleum industry, and the appropriate Federal, state, and local government agencies are thus able to help solve problems associated with protection of public fish and wildlife resources. With advanced standards, all interests should be able to gauge the environmental impacts of each OCS activity.

A number of working assumptions were used to guide various aspects of the analysis and the preparation of the report series. The assumptions relating to supply, recovery, and impacts of offshore oil and gas were:

1. The Federal Government's initiative in accelerated leasing of OCS tracts will continue, though the pace may change.

2. OCS oil and gas extractions will continue under private enterprise with Federal support and with Federal regulation.

3. No major technological breakthroughs will occur in the near future which could be expected to significantly change the environmental impact potential of OCS development.

4. In established onshore refinery and transportation areas, the significant impacts on fish and wildlife and their habitats will come from the release of hydrocarbons during tanker transfers.

5. A significant potential for both direct and indirect impacts of OCS development on fish and wildlife in frontier areas is expected from site alterations resulting from development of onshore facilities.

6. The potential for onshore impacts on fish and wildlife generally will increase, at least initially, somewhat in proportion to the level of onshore OCS development activity.

The assumptions related to assessment of impacts were:

1. There is sufficient knowledge of the effects of OCS development activities to anticipate direct and indirect impacts on fish and wildlife from known oil and gas recovery systems.

2. This knowledge can be used to formulate advance criteria for conservation of fish and wildlife in relation to specific OCS development activities.

3. Criteria for the protection of environments affected by OCS-related facilities may be broadly applied to equivalent non-OCS-related facilities in the coastal zone.

The products of this project--reported in the series Environmental Planning for Offshore Oil and Gas--consist of five technical report volumes. The five volumes of the technical report series are briefly described below:

Volume I — Reviews the status of oil and gas resources of the Outer Continental Shelf and programs for their development; describes the recovery process step-by-step in relation to existing environmental regulations and conservation requirements; and provides a detailed analysis for each of fifteen OCS activity and facility development projects ranging from exploration to petroleum processing.

Volume II — Discusses growth of coastal communities and effects on living resources induced by OCS and related onshore oil and gas development; reports methods for forecasting characteristics of community development; describes employment characteristics for specific activities and onshore facilities; and reviews environmental impacts of probable types of development.

Volume III — Describes the potential effects of OCS development on living resources and habitats; presents an integrated system for assessment of a broad range of impacts related to location, design, construction, and operation of OCS-related facilities; provides a comprehensive review of sources of ecological disturbance for OCS related primary and secondary development.

Volume IV — Analyzes the regulatory framework related to OCS impacts; enumerates the various laws governing development offshore; and describes the regulatory framework controlling inshore and onshore buildup in support of OCS development.

Volume V — In five parts, reports current and anticipated OCS development in each of five coastal regions of the United States: New England; Mid and South Atlantic: Gulf Coast; California; and Alaska, Washington and Oregon.

John Clark was The Conservation Foundation's project director for the OCS project. He was assisted by Dr. Jeffrey Zinn, Charles Terrell and John Banta. We are grateful to the U.S. Fish and Wildlife Service for its financial support, guidance and assistance in every stage of the project.

William K. Reilly
President
The Conservation Foundation

ENVIRONMENTAL PLANNING FOR OFFSHORE OIL AND GAS

PREFACE

This report is intended to provide the link from primary OCS development to the secondary growth effects it induces and the ecological impacts that may accompany such growth. If used in conjunction with other volumes in this series, the content of the report should enable the reader to examine the full range of impacts on fish and wildlife resources that might be associated with OCS development.

The primary aim of this report is the illustration of procedures used in forecasting community development that accompanies major industrial development, such as OCS development. Forecasting growth is an inexact science at best and no claims are made for its validity nor ability to accurately predict impacts. While uninitiated readers will not be prepared to conduct forecasting after reviewing this report, they should understand which factors are important in predicting community demand, and how these factors interact with each other. The text is designed to emphasize the close relationships between OCS industrial development and community development, on the one hand, and community development and resource conservation, on the other. In this way, the report attempts to close the gap of understanding of the total ecological consequences of OCS industrial development.

The report is presented in four sections that introduce the reader, step by step, to the forecasting process and its connection to impacts on habitat and living resources. The process is presented in simplified format so that the key components stand out distinctly. Examples from published OCS-related studies are included to illustrate the type of discussion and language that the reader will confront in review and evaluation of growth forecasts. An extended list of references has been included for readers who wish to pursue aspects of this topic in greater detail.

Jeffrey Zinn
Senior Associate

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1. INTRODUCTION

1.1 THE NATURE OF DEVELOPMENT

The process of recovering oil and gas from the Outer Continental Shelf (OCS development) requires considerable industrial activity on land as well as at sea. Giant offshore steel platforms must be constructed. Food, fuel, and drilling supplies must be assembled and shipped to the offshore work site, pipelines must come ashore at some point, and storage tanks and pumping stations must be built. The workers from these enterprises need housing and community facilities and services. Many, if not most of these actions, may affect--directly and indirectly--fish and wildlife resources and their habitats.

Within limits, it is possible to forecast the effects of OCS-related actions. A number of established techniques are available, and much of the work may already have been done by planning agencies or industry. To understand these forecasting processes and, especially, their inherent limitations, consider the nature of the development process.

Review of permit applications and other documents routinely submitted to the Fish and Wildlife Service typically begins with consideration of the activity proposed, then the likelihood of disturbances resulting from it, and finally the effects to be expected from those disturbances. This forecasting process can be shown as follows:

ACTIVITIES		DISTURBANCES		EFFECTS
(such as dredging and filling)	→	(such as discharge of spoil)	→	(such as turbidity, sedimentation)

Reviewing OCS development is likely to require additional analysis. The development process can be characterized as a network of items, each flowing from the preceding one. The network begins with "primary (or direct) development": both offshore projects (such as exploratory drilling) and onshore ones, such as the establishment of fabrication yards for OCS platforms. Each of these major projects may require a number of component subprojects, such as navigation improvements or site preparation. Each subproject will result in activities, disturbances, and effects as shown below.

PROJECT	SUB-PROJECTS	ACTIVITIES	DISTURBANCES	EFFECTS
Platform fabrication yard →	Navigation improvement →	Dredging, spoil disposal →	Spoil discharge, dredge spillover →	Turbidity, oxygen depletion
↘	Site preparation →	Clearing, grading →	Soil erosion, loss of cover →	Sedimentation, runoff pollution

Primary development usually creates demand for secondary development. Secondary development has two major components: indirect development, typified by those industrial projects that serve and support the primary projects, often through sub-contracts; and induced development, the construction or expansion of community facilities and services (such as housing, utilities, transportation, schools, recreation and commercial facilities) to serve the added population attracted by employment opportunities in direct, indirect, and induced developments.

With the addition of these secondary developments, which produce environmental effects through the same sort of chain of events as primary development, an example of one portion of the network of items to be aware of in evaluating the potential onshore impact of OCS development now looks like this:

DIRECT PROJECT	SUB-PROJECTS	ACTIVITIES	DISTURBANCES	EFFECTS
Platform fabrication yard →	Navigation improvement →	Dredging, spoil disposal →	Spoil discharge, dredge spillover →	Turbidity, oxygen depletion
↘	Site preparation →	Clearing, grading →	Soil erosion, loss of cover →	Sedimentation runoff pollution
↓				
INDIRECT OR INDUCED PROJECT				
Housing development →	Site preparation →	Clearing grading →	Soil erosion, loss of cover →	Sedimentation, runoff pollution
↘	Solid waste systems →	Filling of wetlands →	Loss of habitat →	Increased BOD

An understanding of secondary development and its effects can help in evaluating the estimates in environmental statements and planning documents related to lease sales or proposed major OCS facilities. Such an understanding can also be of help in the review of permit applications. Applicants often seek permission for actions that appear to be minor (in comparison to a refinery, for example), and for which they provide only simple documentation. Yet "minor" actions may be elements of larger projects that can bring significant secondary development. In commenting on a dredge and fill permit application, for example, it is essential to take note of the potential for secondary development of the project and to predict its effects. Failure to do so can result in resource and habitat damage that could have been avoided.

1.2 THE FORECASTING PROCESS

How much secondary development will a particular OCS-related facility stimulate? What kinds of development? Where? Finding answers to these and other questions in a specific case requires a forecast methodology that goes through a sequence of analyses and estimates. Some steps in that sequence involve non-quantitative analysis of the specific facility and and its proposed location. Others involve the application of a factor ("ratio" or "multiplier") derived from experience with growth responses in a locality, a region, or perhaps for the whole nation.

The estimating process is subject to a number of limitations that should be kept in mind; three are especially important. First, forecasts of the kind and amount of secondary development and its effects rarely can be precise. This is particularly true for major projects, such as refineries or for lease sales, which may affect large areas. Uncertainties usually are unavoidable, so rough approximations are the rule, not the exception. The approximations in one case may prove to be fairly accurate; others may prove to be way off base. Nonetheless, approximations seem the best available way to forecast the consequences of major facilities, including effects on living resources.

Second, the processes used to forecast secondary development are limited by their selected regional boundary. Whichever process is chosen, it will be confined to a defined study region. The size and shape of the chosen region can enormously influence the resulting apparent effects of the proposed OCS activity. As one study put it [1]:

> The choice of 'region' is crucial to the measurement of impact. What may be dramatic change in economic activity for a small town may be trivial for a state and infinitesimal for a nation.

The regions chosen for forecasting potential impacts of OCS lease sales are typically large, because OCS oil and gas recovery operations can affect a large area, and the forecasting process must consider the full range of impacts. Also, certain impacts beyond the regional boundaries are recognized in the analysis; for example analyses of proposed leases along the Atlantic coast have recognized services provided from established industry bases along the Gulf Coast.

There is considerable disagreement over what are the appropriate regional boundaries for a study. One study of a mid-Atlantic lease sale, for example, analyzed impact within a region including "southern New Jersey, the New York City-Newark Metropolitan area, Philadelphia and surrounding counties, and the two northernmost counties of Delaware" [2]. A different study of the same lease sale established a region that included "the coastal zones (up to 150 miles inland) of North Carolina, Virginia, Delaware, Maryland, Pennsylvania, and New Jersey, and the New York City metropolitan area and Long Island" [2]. A third analysis covered coastal counties in "New York, New Jersey, Delaware, Maryland, Pennsylvania and Virginia" [2].

Definition of regional boundaries also strongly affects studies of OCS-related facilities such as platform fabrication yards, refineries, or combinations of several inter-connected facilities. For such major facilities, the region may be very large. One study suggested that [1]:

> In general, the area should be large enough to include the major fiscal impact--those associated with industrial activity, with its employees, with the supporting activities generated, and with their employees. For practical purposes, it is probably sufficient to limit the study area to one that includes 80 to 90 percent of the commuting pattern.

Regardless of the boundaries selected, the processes to be discussed in this volume provide no help in predicting the location of the proposed development within the region. Rather, these processes estimate the kinds and amounts of development that will occur somewhere within the study region. An important question about both primary and secondary developments is their siting flexibility.

A third limitation to this type of estimation process is that, in the absence of specific proposals, it is important to consider whether particular OCS-related facilities are likely to be built at all. One measure of this factor can be called the feasibility threshold. It is related to five basic variables that affect the decision of industry to build new facilities: the extent of the oil and gas "find"; distance from established company bases; available labor supply; transportation costs; and the existence of onshore infrastructure. An onshore facility is more likely to be built if the find is large, if the OCS area is a long way from existing company bases, if skilled labor is available locally, if the cost of transporting the needed items from other bases is high, and if other industrial support services already are available in the area.

The answers from the forecasting process, though directly useful for some purposes, often require further interpretation in order to provide direct guidance on issues that arise during permit reviews. For example, the reviewer needs to know whether development is likely to affect a particular resource or habitat. What can be done about this insufficiency? Detailed development planning is one possibility, but time and money often are unavailable for such studies, and even they may be able to provide only partial answers. In many such cases, the best approach is to analyze the resource to be protected rather than the proposed development. Then it will be possible to determine the sorts of disturbances that might threaten that resource and identify the kinds of secondary development that might cause those disturbances.

2. FORECASTING EMPLOYMENT AND POPULATION

2.1 SOME COMMONLY USED PROCEDURES

Processes of varying sophistication are used to forecast OCS development-related activities and their effects, including those of secondary development. The more complex analyses, typified by those in environmental impact statements prepared for OCS lease sales and proposed major facilities, often use one or more of the following: input/output analysis, the Harris model, or development scenarios.

2.1.1 Input/output Analysis

The purpose of input/output analysis is to provide an accounting system to trace the flow of goods, services, and money from one sector of the economy to all other sectors. It does this by describing the interrelationships among all the sectors within a specific region at a specific time and expressing these interrelationships as mathematical coefficients. Thus, if one sector of a regional economy generates a certain amount of activity, the effects of that activity on other sectors can be estimated by applying the coefficients for those sectors to the numbers describing the known activity.

For OCS-related forecasting, selection of the region to be considered, and use of coefficients appropriate to that specific region may be the most important considerations. Economic structure varies considerably within the country, making the use of national coefficients for industrial classifications potentially misleading. For example, coefficients for the marine mining sector, which includes offshore petroleum development, are significantly different for Louisiana, which has a well-developed offshore industrial base, than for the United States as a whole.

The result of an input/output analysis indicates the demand an industrial activity will exert on other sectors of the economy, but does not indicate employment requirements or induced community effects.

2.1.2 Bureau of Land Management Analysis

The Bureau of Land Management has used a sophisticated economic model, known as the Harris Model, to examine the need for new industrial facilities in a region. The model uses industrial interrelationships to portray ties among the industries of a defined region; like input/output analysis, it does not directly indicate induced community effects. Among the basic items considered in using the model are population movements, demand for products, costs of production and transportation, and industrial input/output coefficients (from input/output analysis) [2]. These are used to predict changes in production activities resulting from hypothetical oil and gas finds. The model thus compares changes in industrial interrelationships with and without discovery. Predicted changes are used to forecast such items as employment, earnings, population movements, and overall personal income and expenditures. The forecasts prepared in this way for one year may then be used in preparing forecasts for succeeding years. This incremental process, a component of many economic models, has some practical limits, most notably an increase in the uncertainty of the forecasts as time passes.

2.1.3 Scenarios

Scenarios are the most popular tool for predicting offshore and onshore OCS-related development and its impact. Of published OCS studies, well over half use scenarios.

Scenarios are descriptions of anticipated future situations that would result from assumed changes in specified components. For example, siting of oil or gas facilities near a community (the assumed change) would probably result in population growth, new political problems, and increased requirements for community services and facilities (the future situation). The accuracy of the scenario (how many people? which political problems? what facilities?) necessarily depends on the accuracy of estimates of the assumed changes.

OCS lease sales--actions with potential for far-reaching effects over large areas--have been common subjects for scenarios. These may include assumptions for resource quantities; leases, sales, and lease productivity; industry procedure; and material availability (see Example 1). Many published OCS studies have contained from two to four alternative scenarios based on assumptions associated with no discovery of oil, a low find, a medium find, and a high find.

Scenarios are used to project change over time. They may be used to picture a sequence of events at varying magnitudes which might include the number of drilling rigs and production platforms employed in each of several consecutive years, the length of time required to complete a single exploratory well, and the predicted development pattern of onshore support facilities (see Example 2).

Scenarios can be made at many levels of complexity. In OCS studies, they range from verbal descriptions based on a few broad assumptions, to sophisticated computer models where they may be combined with input/output analysis or other economic models, such as the Harris model.

The need to use scenarios suggests a major problem in planning for OCS-related development: it is impossible to precisely predict development patterns and impacts based on a resource of unknown quantity and characteristics. In addition, oil and gas each require different

EXAMPLE 1. Assumptions Underlying an OCS-Development Scenario (Source: Reference 3)

Decisions for Delaware applied the following assumptions in predicting onshore impacts:

1. Two lease sales will be held roughly two years apart; one late in 1975 and one in mid-1977.

2. In each sale, 4,000,000 acres will be offered and 2,000,000 will actually be leased.

3. Each sale will result in production of 500,000 barrels a day; a total of 1,000,000 barrels per day from the entire Mid-Atlantic region.

4. Because the Baltimore Trough is a group of relatively simple structures, it is estimated that only 150 exploratory wells will be required to verify the production from each lease sale.

5. It is estimated that one platform will be required for every four lease blocks and that an average of 36 wells will be drilled per platform. Each will produce 1,000 barrels per day.

6. It is estimated that from 45 to 60 days will be required to drill a well to reach the hydrocarbon—bearing geologic structures.

7. The fundamental unit for estimating population and economic impact is the number of drill rigs and from that the size of the mining labor force. An average of 60 men per rig is assumed. To determine the size of directly and indirectly associated labor force, two multipliers are added to mining manpower. A third multiplier is then used to convert the sizeable labor force to a total population...as will be seen in calculation details the multipliers applied to the mining manpower in this study are 2.0 to determine the directly associated labor force; 3.0 to determine the indirectly associated labor force; and 4.0 to arrive at an estimated total population.

In addition to these seven basic assumptions, other detailed assumptions indicate that 150 exploratory wells will be drilled in a 7-year period and approximately 42 production platforms will be required to develop the entire Baltimore Trough. Development plans also include the estimated number of active rigs, crew boats, work boats, and helicopters required each year between 1976 and 1986, details about logistics of port capabilities, and other needs.

EXAMPLE 2. One Scenario's Estimate of Non-Construction Jobs Resulting from a Proposed Mid Atlantic Lease Sale. (Source: Reference 4)

	Cumulative Exploratory			Cumulative Development			Platform		Oil bbl/d	Gas cf/d	Onshore Base		Pipeline Terminal		Gas Processing Plant		Service Support	Office	Total
	Wells	Rigs	Employ	Wells	Rigs	Employ	Employ	No.	(10^3)	(10^6)	Employ	No.	Employ	No.	Employ	No.	Employ	Employ	Employ
1976	20	8	904														23		927
1977	60	8	904														98	21	1023
1978	110	10	1130														174	21	1325
1979	160	10	1130	20	3	195					136	1					174	21	1656
1980	210	10	1130	60	7	455					136	1	17	1	49	1	174	21	1982
1981	260	10	1130	125	10	650	112	7	70	55	136	1	31	2	98	2	261	42	2463
1982	300	8	904	205	13	845	176	11	140	110	136	1	51	3	147	3	261	42	2562
1983	340	8	904	300	15	975	272	17	220	380	272	2	68	4	196	4	261	84	3032
1984	380	8	904	405	15	975	368	23	300	165	272	2	68	4	196	4	348	84	3215
1985	420	8	904	510	15	975	432	27	380	2190	408	3	68	4	290	6	348	84	3509
1986	460	8	904	605	13	845	496	31	465	2740	408	3	68	4	384	8	348	126	3579
1987	480	4	452	685	13	845	544	34	600	3290	408	3	68	4	384	8	348	126	3175
1988	500	4	452	755	10	650	592	37	740	3825	544	4	68	4	384	8	261	126	3077
1989	520	4	452	820	10	650	640	40	740	4385	544	4	68	4	384	8	261	126	3125
1990	540	4	452	850	5	325	672	42	740	4385	544	4	68	4	384	8	261	126	2632
1991	550	2	226	870	5	325	688	43	685	3290									
1992	560	2	226	880	2	130	704	44	600	2185									
1993	565	1	113						465	1095									
1994	570	1	113						300	1095									
1995	575	1	113						245	1095									
1996									165	875									
1997									110	765									
1998									70	660									
1999									40	550									
2000									40	435									

technologies and related onshore support, resulting in different combinations of onshore effects and impacts. Even for a single lease sale, differing assumptions can create enormous variation among estimates of the timing and rate of production, as shown in Figure 1.

2.2 OUTLINE OF A SAMPLE FORECAST

A better appreciation of how forecasting methods work in practice can be gained from working through a sample. The following process (Figure 2) has been somewhat simplified for clarity, but contains the major elements of a working procedure. A brief description of the process is followed in the next section by consideration of each of its elements.

Initial steps in the process focus on OCS-generated employment within the region under study:

1. Direct employment is estimated first. This consists essentially of workers required for any of the 15 OCS-related activities described in Volume I. (A more detailed definition is given in Section 2.3.1, where direct employment is considered more fully. Also Appendix A presents direct employment data for these important OCS-related facilities.)

2. Indirect employment is estimated next. This consists of support services, often contracted to vendors instead of being performed directly by oil company employees. Equipment repair services are an example (see Section 2.3.2).

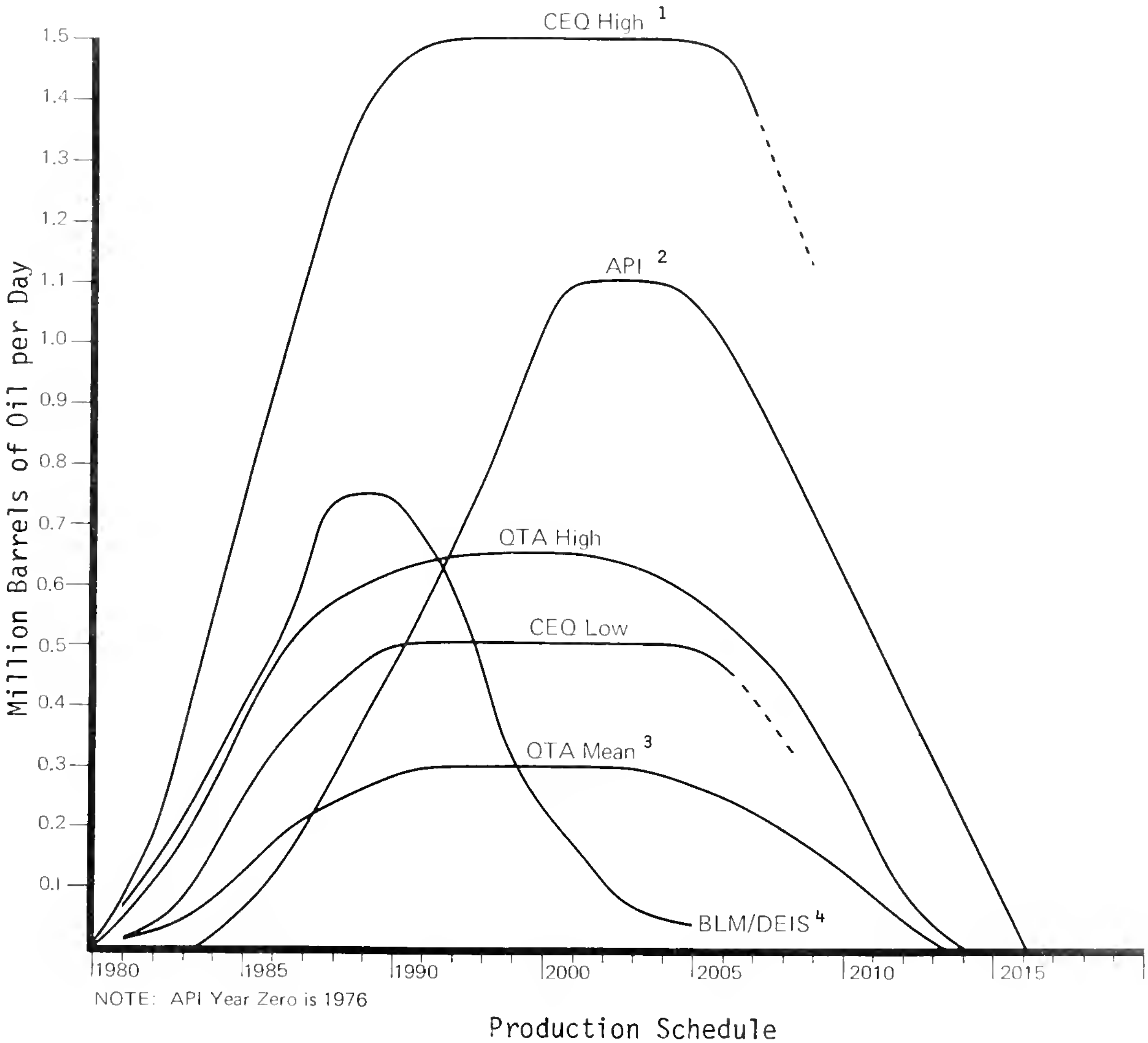
3. Induced employment is the third employment category to be estimated. This consists of employment stimulated by the spending of wages earned in direct and indirect employment. It is a broad category which might include, for example, a doctor or a supermarket checker (see Section 2.3.3).

4. Total employment estimates are then obtained by adding together the estimates for direct, indirect, and induced employment (see Section 2.3.4).

Once total employment has been estimated, the next steps seek to derive the total added population that the study region is likely to experience:

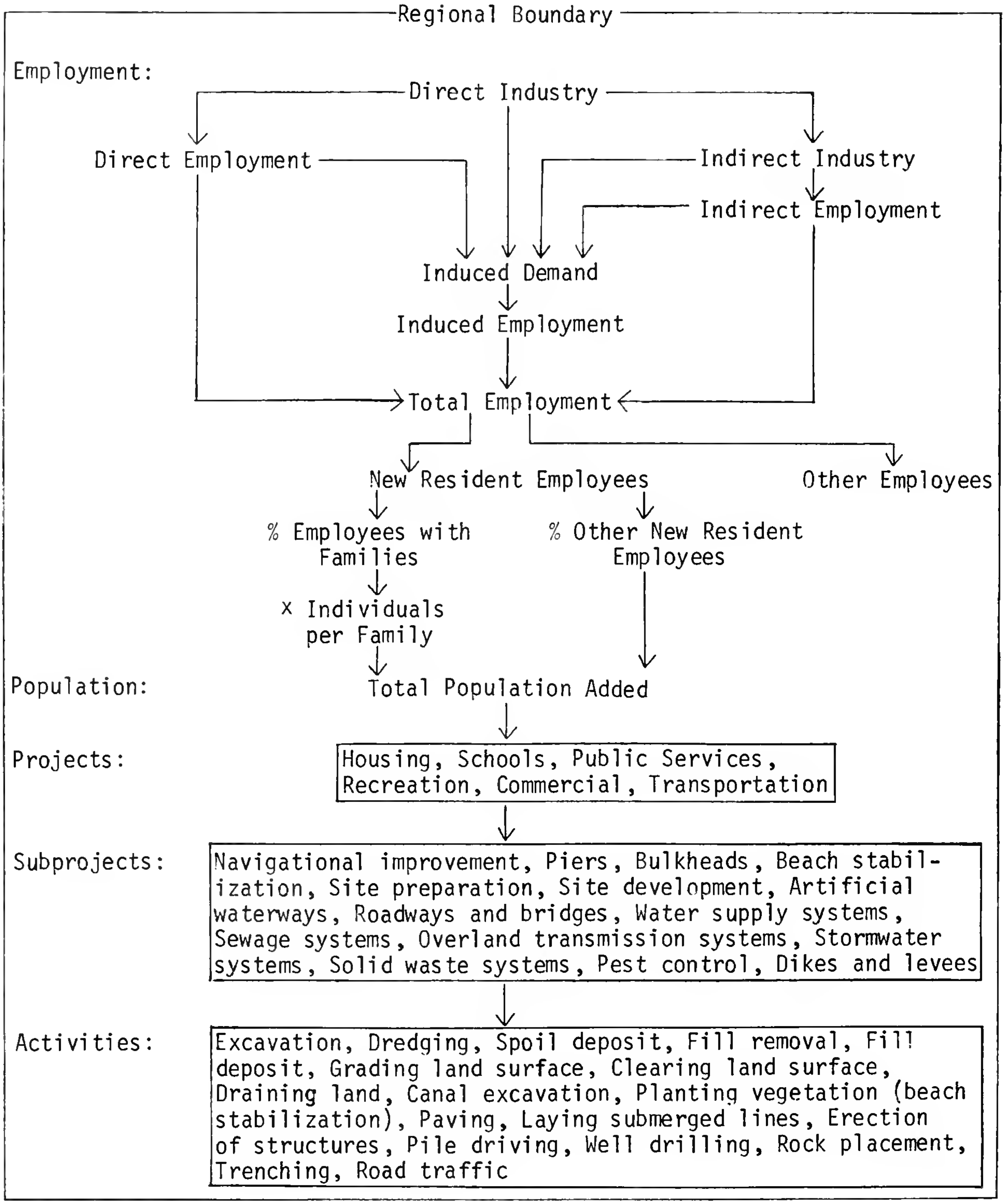
1. New resident employees. The first of these steps is to estimate the number of OCS-related employees who will be new residents of the region, as distinguished from employees who already live there, and employees who continue to reside elsewhere (see Section 2.3.5).

Figure 1. A comparison of estimated OCS production schedules for the Mid Atlantic Lease Sale. (Source: Adapted from Reference 2).



[1] CEQ - Council on Environmental Quality: Reference 13.
[2] API - American Petroleum Institute: Reference 9.
[3] OTA - Office of Technology Assessment: Reference 21.
[4] BLM/DEIS - Bureau of Land Management/Draft Environmental Impact Statement: Draft version of Reference 15.

Figure 2. A simplified process for forecasting development.



2. Families. The next step is to estimate how many of the new resident employees will bring families, as distinguished from those who are single or are not living with their families. A multiplier is then used to estimate the number of people in the new resident families (see Section 2.3.6).

3. An estimate of total population added is then obtained by combining (1) the estimated number of new resident employees without families, and (2) the estimated total population of new resident families (see Section 2.3.7).

The next step in the process is to estimate the demands of the total added population for public and private facilities such as homes, businesses, schools, and recreation facilities (Section 3). All facilities in this group are termed projects.

The final step is consideration of environmental alterations that might result from initiating the forecasted public and private facilities (see Section 4). For convenience of analysis, discussion of this work is divided into the subprojects involved, such as bulkhead construction. The subprojects are carried out through activities which can cause environmental disturbances, which may in turn have effects on fish and wildlife resources and their habitats. Major types of subprojects and the potential disturbances they may cause are reviewed further in this report. A more detailed discussion is provided in Volume III of this series.

2.3 WORKING THROUGH A SAMPLE FORECAST

Forecasting impacts depends on accurate estimation of the numbers of people employed and total population added. Many of the factors involved in these elements are considered in greater detail in this section. Consideration of the physical facilities to be required is taken up in a later section.

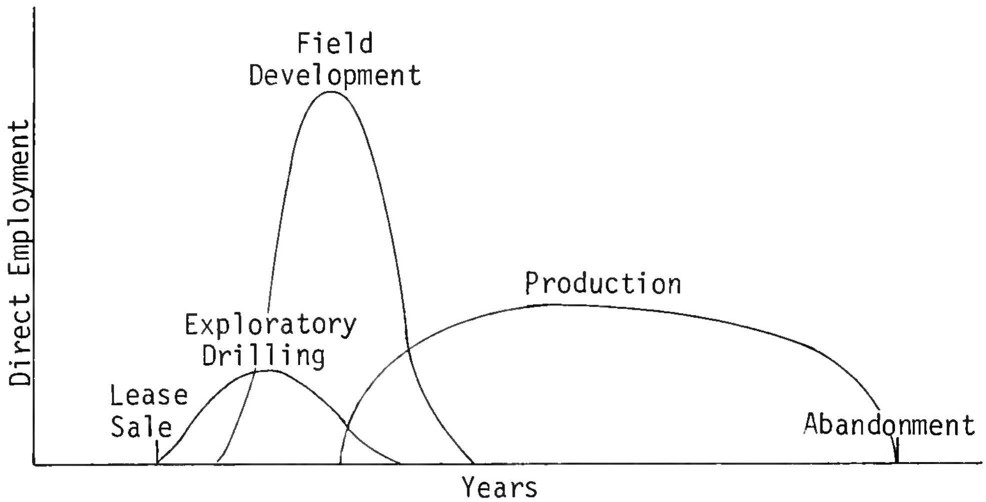
2.3.1 Direct Employment

Direct employment is defined as [5]:

> ...workers employed by oil companies and drilling contractors who are immediately and totally involved in OCS activities including operation of exploratory and development rigs and production platforms, and essential onshore functions such as manning processing plants, generally coinciding with direct hire or direct contract. Thus, direct employees include offshore and some onshore employees.

Direct employment is typically greatest during the field development phase of offshore oil and gas recovery, because facilities construction requires a large labor force (Figure 3). Later, when oil and gas production becomes the primary activity, employment typically declines rapidly.

Figure 3. The general pattern of direct employment during different phases of OCS development. (Source: Adapted from Reference 7)



Industrial facilities related to OCS oil and gas development can be broken down into 15 categories (Figure 4). Estimates of total direct employment should be based on consideration of each category, although not all types of facilities may be built or in operation at any one time or in any given region. Since such estimates are also critical to forecasts of secondary development, a profile of each facility is presented in Appendix A.

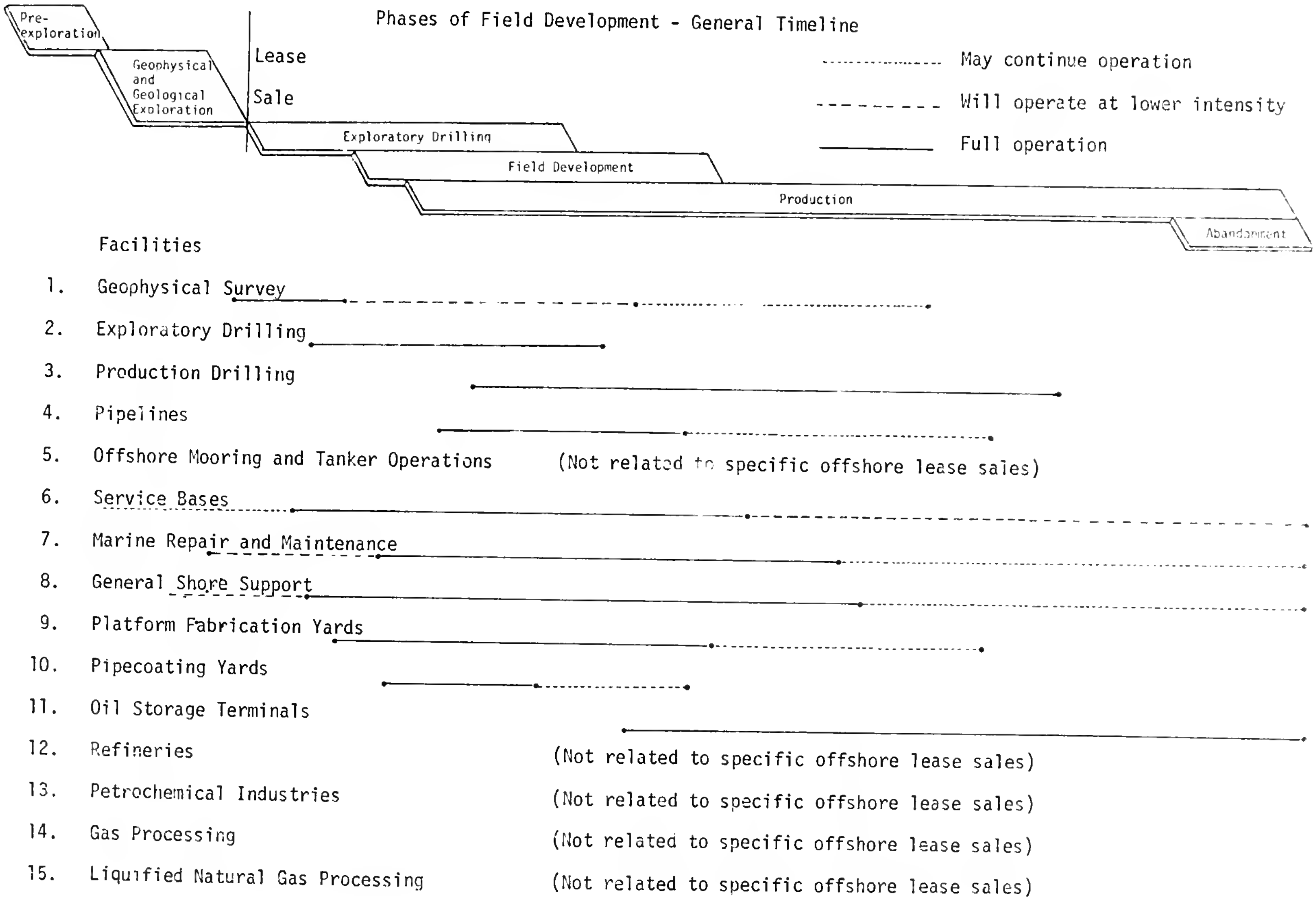
Employment statistics are subject to considerable variation for seemingly similar facilities, so overall averages should be viewed with a healthy skepticism. For example, a regasification plant (at which liquefied natural gas is returned to its original gaseous state) in Georgia provided a peak of 600 construction jobs, while one of similar size in Maryland provided 900 jobs.[6].

2.3.2 Indirect Employment

Indirect employment is defined as [5]:

> ...necessary support services which are not direct hire jobs, which may be contracted directly and are often

Figure 4. Relationships of phases of OCS field development to facility operations. (Source: Adapted from Reference 8)



> sub-contracted. These jobs would include some supply vessel crews and other transportation functions, some welding services, catering, contract supply and inspection services, equipment supply, metal and repair. Indirect employment would also include major suppliers to petroleum field operations, e.g., machinery, paint, gaskets and seals, and electrical apparatus, whose products are used by other industries as well.

Current OCS facility studies usually include estimates of indirect employment. Indirect employment is derived from estimates of direct employment by applying a ratio based on other experience in the same industry or experience in the same region. For example, a 5:1 ratio means one indirect job is estimated for every five direct ones.

State, regional, or local planning officials can often provide background data and analyses that are useful in evaluating the particular ratio chosen. Also, state agencies responsible for coordinating economic development can often provide ratios based on the state's experience; these may be available as statewide averages, regional averages, or for specific industrial sectors.

A number of factors affect the amount of indirect employment in specific cases. Those factors include the scale of the OCS operation, the presence of established support services in the study region, and the availability of such services in other areas nearby. Example 3 illustrates the consideration of several factors in the October 1975 study, Mid Atlantic Regional Study: An Assessment of the Onshore Effects of Offshore Oil and Gas Development [9].

2.3.3 Induced Employment[1]

Induced employment is defined as [5]:

> ...generated by the initial and subsequent rounds of OCS spending/related wages earned by direct and indirect employees (offshore and onshore) who reside within the regional economy of the study area.

Induced employment is accordingly very diverse and may occur in both public and private sectors. Examples include doctors and school teachers, store clerks and policemen.

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[1]Indirect and induced employment are sometimes lumped together as "secondary" employment. BLM environmental statements are among the OCS studies that use the "secondary employment" concept.)

EXAMPLE 3. A Discussion of Indirect Employment
(Source: Reference 9)

The number of indirect jobs at an OCS facility are small relative to the number of direct workers. Few of the principal products required for OCS operations are manufactured in large quantities within the study area. According to data provided in the U.S. Input-Output Table (U.S. Office of Business Economics, 1969), major direct and indirect suppliers of petroleum production include the inorganic chemicals, petroleum refining, primary steel, electrical apparatus, gaskets and seals, oil field machinery and paint industries. Of these industries, the study area has significant chemicals and electrical apparatus production facilities and a petroleum refining complex in Gloucester County. However, these firms are but a small fraction of the number of suppliers located in Louisiana and Texas, near current offshore production areas. According to industry sources, Mid Atlantic OCS operations can be supplied from Gulf Coast enterprises, so that the expansion of the study area capability with respect to the above mentioned direct and indirect suppliers should not be necessary. We have assumed that such expansion will not take place.

Those products useful to, but not exclusively utilized by OCS facilities can be purchased from firms in the study area and from companies in the large manufacturing sectors of the New York City and Philadelphia areas. These latter areas can readily compete for purchase orders with study area establishments.

Since industries in the study area will probably provide only a small portion of the above supplies required for OCS operations, we have assumed that two indirect jobs will be created for every ten jobs at OCS facilities.

In OCS facility studies, induced employment is typically estimated by applying a multiplier to the total of direct and indirect employment. An illustrative discussion of use of a multiplier is included in Example 4, from the 1975 study mentioned above. (Note that ratios and multipliers are not equivalent forms of notation.)

A hypothetical example illustrating indirect and induced employment calculations may be helpful. This example is based on three assumptions: (1) a hypothetical industry directly creates 500 jobs; (2) for every five direct jobs, one indirect job will be created; the indirect employment ratio is thus 5:1; (3) for every ten direct and indirect jobs, eight jobs are induced; the induced employment multiplier is thus 0.8. The resulting calculation is as follows:

Direct employment	500
Indirect employment (at 5:1 ratio)	100
Direct plus Indirect	600
Induced employment (at multiplier of 0.8)	480
Total Employment	1,080

The ratio may be stated as a multiplier so that it directly produces total employment rather than induced employment. In this example, the resulting multiplier would be 1.8 (600 x 1.8 = 1,080). The final result, of course, is the same.

EXAMPLE 4. Discussion of the Induced Employment Multiplier (Source: Reference 9)

We have assumed that for every 10 direct and indirect OCS jobs to be held by residents of the study area, there will be a total of 18 jobs; thus, eight jobs will be induced. This multiplier of 1.8 was derived from a study performed for the U.S. Economic Development Administration (Management and Economic Research, Inc., 1967). This study determined, from other available studies, that a relatively large, integrated area could be assumed to have an income multiplier of 1.8 while small areas generally experience greater leakage of funds and can thus be assumed to have a multiplier of 1.3.

The 1.8 multiplier appears reasonable, but is low relative to factors used in several other studies related to OCS development (U.S. Council on Environmental Quality, 1974; Gulf South Research Institute, 1974; Goodman, 1975). The relatively lower multiplier appears to more accurately reflect the incremental effects of job creation within metropolitan areas. Multipliers that are derived from economic base or input-output data assume that the creation of additional jobs would lead to induced employment in roughly the same ratio as the existing ratio of induced to basic employment in the area. This characterization ignores some basic issues. First, jobs induced by an increase in direct and indirect jobs are most often a function of income and population. To the extent that direct and indirect jobs will be absorbed by the existing population, the ratio of additional induced to additional basic jobs would be less than the existing basic-induced job ratio. . . .

The multipliers used to estimate induced employment vary greatly among OCS studies (Table 1). The variation reflects a variety of assumptions, base conditions, and other factors, including the following:

-- The size of the region under study. Smaller multipliers are associated with smaller regions because a smaller percentage of necessary services is likely to be available within the region.

-- The presence or absence of needed facilities and services in the region. Smaller multipliers are associated with regions having limited industrial development, such as many rural areas, where only a small percentage of induced demand can be accommodated within the region.

-- The types of industries and skills available in the region. Larger multipliers are associated with regions where needed services and skills are available.

-- The availability of needed facilities and services in adjacent or nearby regions. Smaller multipliers are associated with regions where nearby locations outside the study region already offer the necessary support.

2.3.4 Total Employment

Total employment is obtained by adding together the estimates for direct, indirect, and induced employment.

2.3.5 New Resident Employees

After total employment has been estimated, the next step is to estimate the number of anticipated jobholders who will move into the study region. In approaching this question, studies sometimes divide employment into three categories: local hire, new-resident hire, and non-resident hire [5].

The new residents are of special interest in analysis of secondary development. They are the employees who move into the study region and require housing and other private and public services. They are the group most likely to create demands for new facilities.

The other employees are likely to cause less impact. The non-residents presumably generate most facility demands where they live, which is by definition outside the study region. And the employees who already lived in the region before they got their OCS-related job (i.e., those hired locally) are also unlikely to create major new demands. Unless the new job permits a major change in their living standard, these employees will probably continue to use the same facilities they were using before they got an OCS-related job.

Table 1. Examples of Multipliers Used in OCS Studies

Study	Multiplier	Comment
Florida Impact of Offshore Oil Development(10). An analysis of the potential effects of OCS off the west coast of Florida.	1.68	Multiplier from a 1973 U.S. Chamber of Commerce Study, "What New Jobs Mean to a Community."
Mid Atlantic Regional Study (9) An analysis of the onshore effects of OCS activities in the Mid Atlantic states	1.8	
Economic and Social Impacts of Oil in the Gulf of Alaska (11). A study, prepared for the Gulf of Alaska Offshore Operations Committee, that looks at likely coastal effects of future offshore activity.	1.86	Coastal communities in Alaska, derived by the State of Alaska
Offshore Revenue Sharing (12) An analysis of offshore operations in Louisiana, with implications drawn for frontier area.	2.087	Obtained using 1970 census data and the Standard Industrial Classification (SIC) system.
OCS Oil and Gas (13). An analysis of the onshore effects of OCS activities in several U.S. coastal areas.	2.2	
Environmental Assessment (14). A study of the effects of proposed offshore leases on Southern California.	2.2	
Decisions for Delaware (3). A study of the effects of proposed Mid Atlantic OCS sales.	3.0	
Final Environmental Statement, OCS Sale No. 40., (15) Analysis of the effects and impacts of the proposed Mid Atlantic lease sale.	4.3	A maximum employment multiplier obtained by an analysis of the high recoverable resource estimates.

Estimating the percentage of new resident employees is common in environmental studies of OCS development. Selected examples are shown in Table 2. As the table suggests, the estimated percentages of new-resident employees can vary widely from place to place and from time to time. Indeed, different studies of the same lease may include different estimates, as shown in Example 5.

Table 2. Percentages of New-Resident and Other Employees During Successive Phases of Field Development, as Estimated in Selected Studies (Source: Modified from Reference 5)

Study	Exploration Phase		Development Phase		Production Phase	
	New[1] %	Others[2] %	New %	Others %	New %	Others %
1. BLM: Final Environmental Statement on OCS Sale 35, (Volume 2, p. 365)	85	15	35	65	20	80
2. Industry Input-California; Western Oil and Gas Association Offshore Operations Committee, 10-75. (Unpublished)	31	69	39	61	12	88
3. Industry Input - Mid Atlantic; Gulf Offshore Operations Committee, 1-75. (Unpublished)	38	62	57	43	6	94

[1]New resident employees
[2]All others (including employees who already live in the region and those who continue to live elsewhere).

2.3.6 Families

Some of the new resident employees will bring families into the region being studied. In forecasting community effects, it is important to estimate the number and size of new resident families, since they will enlarge and diversify the population under study. Some studies estimate the number of households--including one-person households--instead of estimating numbers of families. Because of the varied presentation of family or household data, it is important to determine the precise definition of terms.

EXAMPLE 5. Differing Estimates of New Resident Employees in Two Studies of the Mid Atlantic Lease Sale. (Source: Reference 2)

	API			BLM/DEIS		
	Local Hire (%)	New Resident (%)	Non-Resident (%)	Local Hire (%)	New Resident (%)	Non-Resident (%)
Exploratory Rig	37	40	23	37	40	23
Development Rig	37	40	23	43	57	-
Platform	94	6	-	94	6	-
Operations Base	82	18	-	82	18	-
Onshore Office	38	62	-	38	62	-
Pipeline Terminal	76	24	-	76	24	-
Gas Processing Plant	76	24	-	63	37	-
Rig Support	62	38	-	62	38	-

The percentage of employees with families varies widely from place to place and from time to time. Among influential factors are:

-- The character of the study region. A smaller percentage of resident families is likely to be attracted to areas, such as parts of Alaska, where living conditions are different from those to which most American families are accustomed.

-- The stage of facility development (construction or operation). A higher percentage of single people is usually associated with facility construction than with operation. Longer term positions are more likely to attract a higher percentage of employees with families.

-- The type of facility. The employees who operate some types of OCS facilities, notably exploratory rigs and pipelaying barges, customarily migrate from job to job. If these employees have families, they customarily leave them near a fixed home base.

-- The employment cycle at the facility. Facilities with an "on again, off again" employment pattern typically attract a higher proportion of single people. One example of such a facility is a pipe coating yard, which may operate intensively for several months and then close down until more orders are received. Facilities offering long-term, continuous employment attract a higher percentage of employees with families.

Once the expected number of new families has been estimated, that number is multiplied by average family size to determine the total population of those families. If a study has estimated the number of households instead of the number of families, a different multiplier will be used. The multiplier will be substantially lower, since many households may have only one person.

Recent studies of energy development have estimated family size at from 3.0 to 3.7 people [9, 16]. The figure used may be an average for the locality or region, or the national average may be used. The national average family size was 3.58 in 1970, 3.39 in 1976 [17]. Table 3 shows some figures used in OCS studies; Example 6 is a discussion of family population in an OCS-related study.

Table 3. Family Size Estimates in Selected Studies

Study	Multiplier	Comment
Florida Coastal Policy Study (10) An analysis of the onshore effects of OCS development off the west coast of Florida	3.55	Families are 0.69 times total employment, and population is 2.45 times total employment; family size is 2.45 ÷ 0.69, or 3.55.
Brown and Root Impact Study (18) A study of the effects of a platform fabrication yard on a rural area of coastal Virginia	3.5	Virginia average 3.57, Northamampton county average 3.6, and national ratio 3.5. National average selected.
Mid Atlantic Regional Study (9) An analysis of the onshore effects of OCS activities in the Mid Atlantic States	3.0	
Rapid Growth (16) Discussion of the effects of rapid population growth and decline on rural communities	3.7	

EXAMPLE 6. Family Population from the Anticipated Work Force in an Impact Study of a Platform Fabrication Yard. (Source: Reference 18)

Some Brown & Root employees would be part of families, others would be unmarried. Marital and family status of the Brown & Root workers living and working in Northampton County is assumed to be the same as the general Virginia population under 65. In 1970, 77 percent of the Virginia population under 65 were in families. The remaining 23 percent lived alone or in rooming houses and other group quarters.

Using these same proportions, Brown & Root would have 694 workers in families and 206 single individuals. The 694 workers in the families are assumed to comprise 625 separate family households because of the possibility of both husbands and wives working.

Approximately 150 of the 206 individuals are assumed to be living alone. The remaining 56 are assumed to be living in rooming houses or boarding with local families.

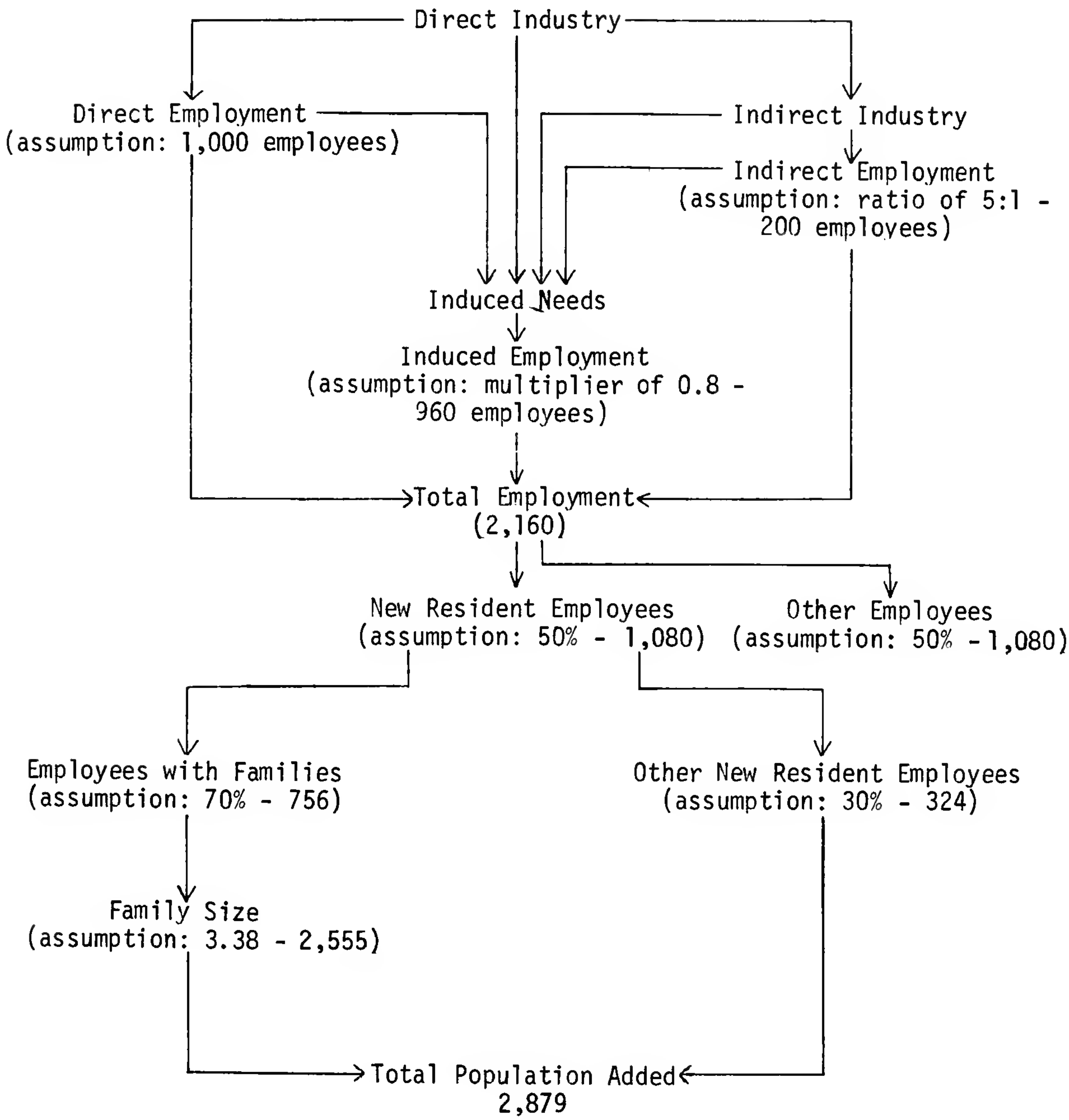
Applying the same assumptions to the 200 workers in the industries supported by Brown & Root would mean an additional 138 families and 46 single individuals, 33 of whom will be living in separate households.

In 1970, the Commonwealth of Virginia contained 3.57 persons per family unit; Northampton County contained approximately 3.6 persons per family. Based upon a national ratio of 3.5 persons per family, an additional 2,923 residents, distributed among 763 family units and 250 individuals would be expected in Northampton County. Northampton County population would then total approximately 16,000 - a 15 percent increase over 1970 and close to the county's 1950 level.

2.3.7 Total Population Added

Total population added is obtained by adding the estimated number of new resident employees without families, and the estimated total population of new resident families. An example of the calculations required to determine total population added is presented in Figure 5. This example applies the format laid out in Figure 2. It is based on a hypothetical direct employment of 1,000 workers. Assumptions and resultant numerical values are noted for each step. It is critical to remember that the ratios, multipliers, and factors all vary widely, and therefore numerical estimates will also vary greatly.

Figure 5. Hypothetical calculation illustrating the steps required to derive total population added.



3. COMMUNITY FACILITIES

Total population added to the region under study becomes the basis for the next step in the forecasting process: determining the potential demand for public and private community facilities.[1] The location, design, construction and operation of community facilities can affect fish and wildlife and their habitats. Facilities may, for example, require substantial land areas; their construction may require grading or other land alterations; they may produce runoff. Among the facilities that may have such effects are: housing, public utilities and services, transportation, schools, recreation and commercial establishments. These six are discussed in this section. Other facilities such as police and fire stations and medical and social service may also cause environmental effects, although they do so less frequently or on a smaller scale than the foregoing facilities.

Planning agencies for the locality, state, or region likely already have detailed analyses of facility needs or are preparing them. Even in the absence of such analyses, invaluable information and standards may be obtained from these agencies. These contacts, as well as the information they can make available, should help in understanding the planning process used by public agencies, applicants, and others. Of course that process is often concerned with many impacts besides those that affect living resources and their habitats; many of these broader impacts are deliberately omitted from this discussion.

3.1 HOUSING

Assessing housing demand is difficult because of the interplay between housing demand and supply. In simple terms, housing demand is a function of the individual household's income (ability to pay for housing), the total number of units demanded by these households, and the price required for each unit of housing.

Additional variables also play a significant role in this demand-supply interplay, including: family size and stage in the family cycle (that is, number and age of children); the local vacancy rate; the condition and nature of existing housing; the capabilities of the housing construction industry in the area; and the loan criteria used by local lending institutions.

Family size and stage in the family cycle are important indications of the type of housing required for households moving into the community.

[1]This discussion considers only facilities needed to serve added population. It does not include the facility needs of industry.

Preference will vary among single family, multifamily, and mobile units, as well as rental and purchase units.

The existing condition and the vacancy rate of community housing not only indicate the availability of housing, but also lead to initial estimates of the demand for new construction. Many communities' vacancy rates hover around 5 percent. If the percentage is higher, absorption of some additional population without new construction or inflation of housing costs is more likely.

Residential space needs for the new population can be estimated. One widely used planning reference lists residential density standards (Table 4). These densities can be compared with any estimates of new housing demand to determine the approximate area required.

Table 4. Net Residential Density Standards
(Source: Reference 19)

Dwelling Unit Type	Density of Units per Net Acre: Desirable	Density of Units per Net Acre: Maximum
One- and two-family		
One-family unit detached	5	7
One-family semidetached or Two-family detached	10	12
One-family attached (row) or Two-family semidetached	16	19
Multifamily		
2 story	25	30
3 story	40	45
6 story	65	75
9 story	75	85
13 story	85	95

3.2 PUBLIC UTILITIES AND SERVICES

In assessing the demand for utility services, the demand for each service (water, sewers, solid waste, and electricity) must be determined. Table 5 shows demand figures used in selected environmental studies. After demand is estimated, it should be compared to the capacity for the existing water, sewer, solid waste, and electric service systems and facilities in the study region.

3.3 TRANSPORTATION

Assessment of transportation needs (mainly roads and highways) is extremely difficult; needed information on local road travel is frequently unavailable. Highway transportation is measured by average daily traffic and peak hour volumes which are then compared to highway capacity. Increased population and industrial activity can cause congestion as the capacity of a highway, a constant, is attained or exceeded. The capacity of a highway is expressed in a number of vehicles passing a point each hour.

Highway congestion typically results from two changes in travel patterns. One is congestion around new industrial or commercial facilities where vehicles congregate. Second is congestion around new supporting development stimulated by highway access.

Transportation projects typically consist of expanding and improving portions of existing facilities. Short sections of highways may be constructed in new locations. Typical projects include widening two-lane highways to four lanes, straightening curves, constructing turning bays, or improving traffic signals. The usual goal of these projects is to improve the smoothness and rate of traffic flow.

Example 7 is a discussion of local transportation from one of the few studies made to date of the impact of a proposed major OCS-related onshore facility (a platform construction yard) on a community. Cape Charles, Virginia, is a fishing and agricultural center on the eastern shore of Chesapeake Bay, near the southern end of the Delmarva Peninsula.

3.4 SCHOOLS

Determining the impact of added population on school demand requires:

1. An estimate of elementary, junior high, and high school age children by location. The national average figure for all school children per household is 0.63 [23].

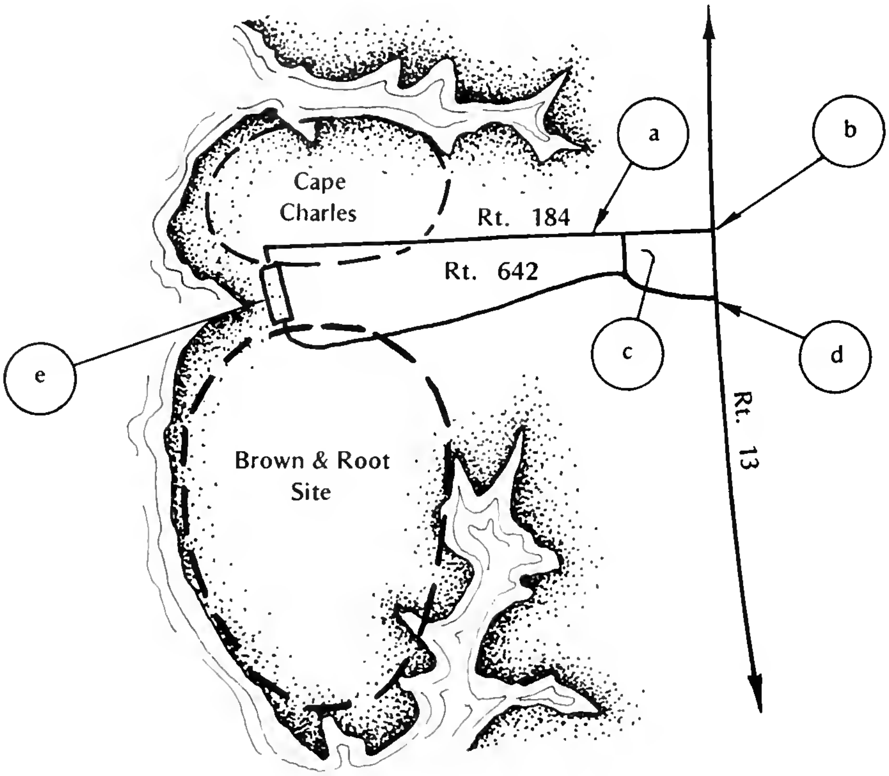
2. Application of these estimates to local or state standards for school area and classroom size. Alternatively, school acreage needs may be estimated by reference to widely used planning standards (Table 6).

Table 5. Factors Used to Estimate Public Service Demands in Selected Environmental Studies.

Study	Factors			
	Water (domestic)	Sewage (domestic)	Solid Waste	Power
Hampton Roads Energy Company (20). An Analysis of the economic impact of a proposed refinery on the Portsmouth, Virginia area.	100 gals/ person/day	100 gals/ person/day	3 tons per 1000 people per day	
Brown and Root Impact Study (18). A study of the effects of a platform fabrication yard on a rural area of coastal Virginia.	170 gals/ person/day	120 gals/ person/day		750 KHW per person per per month
New Use Demands on the Coastal Zone and Offshore Areas (21). An analysis of the effects of offshore development, including oil and gas, nuclear power, and deepwater ports, on New Jersey and Delaware.	152 gals/ person/day	120 gals/ person/day	6 lbs. per person per day	
OCS Oil and Gas (13). An analysis of the onshore effects of OCS activities in several U.S. coastal areas, prepared for the Council on Environmental Quality		120 gals/ person/day	6 lbs. per per person per day	0.006 MW per person per month
Application of a Procedures Manual (22). Assessing the socioeconomic impact of a coal-fired electrical generating plant in rural Wyoming.	180 gals/ person/day	100 gals/ person/day		
Final Environmental Statement, OCS Sale No. 40 (15). Analysis of impacts and effects of a proposed lease sale off the Mid Atlantic States.			3.306 lbs. per person per day	

EXAMPLE 7. Local Transportation Discussion from the Brown and Root Impact Study, 1975. (Source: Reference 18)

Brown & Root Access



Route 642 is a narrow, high crowned, two lane road with pavement width of approximately 16 feet. The road is adequate for present traffic volume which averages 750 cars per day.

Route 184 is a wider three lane highway with the center lane for turns. Average daily traffic on Route 184 is approximately 3,700 vehicles.

With the opening of Brown & Root, a morning and evening rush hour peak of 1,500 vehicles should be expected. Average daily traffic on Routes 184 and 642 would increase by 3,500 to 4,000 vehicles. Most of the additional traffic would be between the Brown & Root site and U.S. 13, however, considerable traffic between the site and Cape Charles should also be anticipated.

To accommodate this additional traffic, several improvements to the road system would be required.

Example 7, continued.

a. Upgrading of Route 184 to 4 lanes between U.S. 13 and Route 641. This is necessary to accommodate traffic turning on to and off of U.S. 13 and on to Route 641. Paving and construction cost of the additional lane excluding right-of-way acquisition, moving of utilities, etc. would be approximately $102,000.

b. Improvements to the U.S. 13/Route 184 intersection including additional turning lanes on U.S. 13 and improved traffic control would cost approximately $50,000.

c. Widening and Upgrading of Route 641 to three lanes. These improvements would cost approximately $40,000 plus right-of-way acquisition, moving of utility lines, etc.

d. Reconstruction and Improvement of Route 642 from the Brown & Root site to U.S. 13. Three lanes of traffic and improvements to the U.S. 13 intersection are needed. Construction costs would be approximately $955,000.

   A detailed engineering study should be conducted to examine the feasibility of moving the Route 642 alignment south of the Cape Charles cemetery and the Delmarva Power and Light Company office on U.S. 13.

e. Improved Access into Cape Charles along Route 642. The present bridge over the Penn Central rail yard carries approximately 1,250 vehicles per day. Increased traffic between the Brown & Root site and the town would cause backups and congestion. Construction of a parallel bridge or construction of a new wider bridge with improved bridge approaches woulc cost approximately $750,000. (Other improvements then recommended)

Total highway construction improvements to provide proper flow of traffic in the Cape Charles vicinity are estimated at $2,022,000. Highway improvement costs are normally a state responsibility. However, the state has an established highway needs program which exceeds available funding and therefore might not be able to make these needed improvements for many years. In similar cases, the state has asked the local jurisdictions to fund all or part of the necessary improvements.

Table 6. School Acreage Needs (Source: Reference 19)

Type of School	Minimum Acreage	Desirable Minimum Acreage	Preferred Acreage Range
Elementary	5	5 + 1/100 ultimate enrollment	10-25
Junior High	10	10 + 1/100 ultimate enrollment	25-50
Senior High	20	20 + 1/100 ultimate enrollment	40-100

Examples of educational service demand figures used in OCS and energy development environmental studies are shown in Table 7.

3.5 RECREATION

Demand for recreation facilities should be considered both for the community as a whole and for each neighborhood. The demand for community-wide facilities (such as major natural parks and public golf courses), can be determined by applying the expected population increase to the suggested standards (Table 8). These standards can be compared to the facility standards used in one OCS study (Example 8).

Similarly, estimates of the demand for neighborhood recreation facilities are based on estimates of the population increases for each neighborhood. This can be done by assuming that the population of each neighborhood will grow by the same percentage as the whole community, but this overlooks both varying market forces and any efforts by the community to manage its growth. Then, neighborhood recreational demand can be derived from Table 8 or Example 8.

3.6 COMMERCIAL FACILITIES

Forecasting the demand for and supply of commercial facilities is extremely difficult. As with other induced demands, consultation with state, regional or local planners is likely to be the best way of gaining useful information. If all else fails, a very rough approximation of space needs for new commercial facilities can be derived by applying total population added to the data in Table 9. An analysis of demand/supply and location variables is essential before an even approximately accurate determination of commercial impact can be made.

Table 7. Factors Used to Estimate Educational Service Demands in Selected Environmental Studies

Study	Factor	
	Number of new students	Classroom size
Boomtown Growth Management (24). A study of rapid energy-related growth in rural Wyoming.	275 students per 1,000 new residents	25 students per classroom
Mid Atlantic Regional Study (9). An analysis of the onshore effects of OCS activities in the Mid Atlantic states.	0.75 students per new resident worker	23 students per classroom
OCS Oil and Gas (13). An analysis of the onshore effects of OCS activities in several U.S. coastal areas, prepared for the Council on Environmental Quality.	0.25 students per person	1,000 students per school
Brown and Root Impact Study (18). A study of the effect of a platform fabrication yard on a rural area of coastal Virginia.	22 students per 100 population	
Hampton Roads Energy Company (20). An analysis of the economic impact of a proposed refinery on the Portsmouth, Virginia area.	262.5 students per 1,000 population	
New Use Demands on the Coastal Zone and Offshore Areas (21). An analysis of the effects of offshore development including oil and gas , deepwater ports and nuclear power, on New Jersey and Delaware.		23.3 students per classroom

Table 8. Recreational Facility Needs (Source: Reference 19)

Type of Facility	Acre/ Person	Standard Size/ Acres	People/ Minimum Size	People/ Maximum Size
Playground (neighborhood)	0.00125	5-10	4,000	8,000
Local park (neighborhood)	0.001	2 or more	2,000	2,000 or more
Recreation center	0.00125	15-20	12,000	16,000
Playfield	0.00125	10-30	8,000	24,000
Major natural parks	0.0025	100	40,000	40,000
Public golf course	1 hole/3,000	150	54,000	54,000

EXAMPLE 8. Recreation Standards Used in the Brown and Root Impact Study, 1975 (Source: Reference 18)

Recreation Facility Standards

Recreation Facility Standards for Towns

Type of Facility	Service Area	Standard	Provided By
Play Lots	neighborhoods and small developments	(as needed)	towns or developers
Neighborhood Parks	neighborhoods and large developments	2.5 acres/1,000 town people	towns or developers
Town Parks	towns	2.5 acres/1,000 town people	towns
Water-oriented Parks	county-wide	2.5 acres/1,000 county people	county
Inland Parks	county-wide	2.5 acres/1,000 county people	county
Boat Landings, Fishing Piers	county-wide	1 landing and pier/1,000 county people	county

Recreation Facility Standards for Rural Areas

Type of Facility	Service Area	Standard	Provided By
Water-oriented Parks	county-wide	2.5 acres/1,000 county people	county
Inland Parks	county-wide	2.5 acres/1,000 county people	county
Boat Landings, Fishing Piers	county-wide	1 landing and pier/1,000 county people	county

Table 9. Typical Characteristics of Neighborhood Shopping Centers[1] (Source: Reference 25)

Population Served	Floor Area Required (Sales)	Customer Parking Area	Circulation Service, etc.	Total	S.F./ Family
800 Families 2,500 Persons	16,000	32,000	12,000	60,000 1.4 acres	75
1,600 Families 5,000 Persons	28,800	57,600	36,400	172,800 4 acres	100

[1]This shopping center should include food market, bakery shop, drugstore, stationery store, restaurant, barber shop, beauty parlor, laundry and dry cleaning store, hardware store, service station.

4. POTENTIALS FOR ECOLOGICAL DISTURBANCE

After the demand for new public and private facilities generated by OCS development has been forecast, the next step is to consider the activities that will be necessary to create those facilities. These activities can have adverse effects on fish and wildlife and their habitats.

Housing, utilities, transportation, schools, recreational, commercial, and other projects can most conveniently be analyzed by breaking them down into subprojects. Among the variety of possible subprojects that might be involved, the following often have the most significant impact on living resources in coastal areas (the numbers in parentheses refer to the standardized list of subprojects appearing in Volume III of this series):

- Navigational Improvements (Subproject 1)
- Piers (Subproject 2)
- Bulkheads (Subproject 3)
- Beach Stabilization (Subproject 4)
- Site Preparation (Subproject 5)
- Site Development (Subproject 6)
- Artificial Waterways (Subproject 7)
- Roadways and Bridges (Subproject 8)
- Water Supply Systems (Subproject 9)
- Sewage Systems (Subproject 10)
- Overland Transmission Systems (Subproject 11)
- Storm Water Systems (Subproject 12)
- Solid Waste Systems (Subproject 13)
- Pest Control (Subproject 16)

The reader is referred to Volume III for a detailed discussion of subprojects. Each is briefly reviewed below to provide basic orientation to disturbances resulting from coastal development.

4.1 NAVIGATIONAL IMPROVEMENTS

Most navigation dredging in marine basins that accompany OCS-related community development is required by the expansion of recreational boating. A large increase in population will cause an increase in boating activity which requires navigational improvement. Exactly how much increased boat traffic and marina development, and therefore channel dredging, might be required is difficult to predict. The major potential adverse environmental effects of dredging on coastal water systems are: increased turbidity; sediment buildup; reduction of oxygen content; disruption and removal of productive estuarine bottom and the life it contains; creation of stagnant deepwater areas; disruption of estuarine circulation; increased upstream intrusion of salt water and sediments; obliteration of wetlands; and degradation of oyster beds, coastal regions and other vital areas. These problems can be avoided for the most part through careful planning and attention to the natural processes at work in coastal ecosystems and to the probable effects of dredging.

4.2 PIERS

An increase in piers and docks along navigable waterways may result from the recreational boating demand accompanying increases in population. These piers and docks are built to provide berthing for new pleasure craft docked at marinas or at individual homesites. Uncontrolled proliferation of piers and docks can lead to blockage of circulation, loss of vital areas, accelerated pollution, and a general reduction of carrying capacity. Properly guided, there can be a substantial increase of such facilities without major adverse ecological effects.

4.3 BULKHEADS

An increase in housing, commercial development, or other community growth in coastal areas in response to OCS facilities may cause an increase in bulkheading of property. Bulkheads are built to protect shorelines (usually of protected waters) from erosion, to serve aesthetic purposes, to provide boat-docking convenience, or to hold fill materials deposited for the conversion of low-lying land, wetlands, or water areas to real estate of greater value.

Major environmental objections to bulkheading arise from the loss of coastal marsh (often from dredge filling behind the bulkhead) and other vital habitat areas, the reduction in size of water bodies, the accompanying water pollution, and the interruption of the movement of fresh water into the estuary.

In conformance with recent federal and state regulatory guidelines, bulkheads are typically approved for protection of unvegetated, eroding shorelines within estuaries. Bulkheads designed to permit expansion of real estate acreage by filling shorelines or to provide dock frontage for boats are discouraged.

4.4 BEACH STABILIZATION

The expansion of coastal communities causes expansion of residential, commercial, and transportation projects at the beachfront and an increase of proposals for construction of seawalls, groins, or other stabilization and erosion prevention structures. Any plan that requires the construction of beach stabilization structures is given the closest scrutiny because these stabilization measures are often ineffective, sometimes counterproductive, and typically can be avoided if nonstructural protection measures are used. Solutions include placing structures well inland of the active part of the shore and taking positive action both to prevent the removal of sand from any storage element (dune, ridge, berm, or beach) and to prevent blocking the free movement of sand from any storage element into active transport via such processes as littoral drift. Further protection includes dune and berm management employing such measures as sand fences, and dune grass planting. In this way, structures which obliterate ecologically valuable dune and backbeach habitats can be avoided and the loss of beaches can be prevented.

4.5 SITE PREPARATION

Whenever urbanization occurs, new tracts of land are opened for development. Construction of transportation systems, recreation facilities, homes, schools, public utility works, and commercial sites all require site alteration in one form or another. Many severe ecological problems of new development occur at the stage of clearing and grading the land surface before construction begins. During this clearing and grading, critical wildlife habitats may be lost and stream courses altered. Removing the natural vegetation exposes soils to the erosional forces of wind and water. The unprotected soils may be eroded and washed into tributaries or directly into coastal waters, where they degrade water quality and interfere with biological processes. Site development processes frequently alter the drainage system adversely by filling or draining marshes, bogs, and swamps, and diverting, obliterating or channelizing natural drainageways. Preventive measures include wetland, streambank, and watercourse protection, critical habitat and buffer area preservation, runoff water detention and soil stabilization.

4.6 SITE DEVELOPMENT

A large OCS facility could generate considerable site development activity in a community short on facilities to provide for housing, transportation, recreation, and commercial needs. Site development includes activities that follow clearing and grading; such as, excavating ditches, installation of cables and pipes, paving of surfaces, building bulkheads, and erecting structures. Paved roads, parking lots, sidewalks, and other impervious surfaces decrease the land's ability to retain precipitation, cause surge flows of runoff, and thus adversely alter the quality, quantity, and rate of flow of runoff from any watershed. The adverse impacts of bulkheads, ditches, and transmission lines are discussed in other subprojects.

4.7 ARTIFICIAL WATERWAYS

The land available and desirable for community growth in low-lying coastal communities may require drainage before construction. Many communities that would attract OCS onshore facilities are in low-lying coastal areas with considerable water-soaked land. Drainage of these near-wetlands and wetlands by canals and ditches is often proposed, as is the excavation of lakes or canals and use of the material to fill the adjacent land. Canals may be dug to provide boat channels back into the land, or ditches may be dug to drain land for mosquito control. This variety of activities can accompany housing, recreation, transportation, and all other components of development in low-lying communities.

Whatever the specific reason, canal, ditch, and artificial lake excavation can have serious adverse effects. For example, when the natural flow pattern is disrupted, the water-cleansing function of the vegetation is reduced, and freshwater flow into the estuaries occurs in surges. Moreover, drainage may cause shrinkage of organic soils and subsidence of land and eliminate the critical ecological functions of wetlands. The main solution is to avoid any uses of these lands that require drainage.

4.8 ROADWAYS AND BRIDGES

Increased population and community growth that result from OCS activities encourage construction or improvement of roadways. If enough new traffic is generated, there will be a need for more highways and accompanying bridges in addition to local roads. If this road expansion requires crossing of tidal rivers, bays, or wetlands, there is a high potential for adverse ecological effects. A particular problem is solid-fill causeways that block the upper portions of estuaries; these blockages lead to stagnation and eventually to total deterioration. Supports and abutments can also have a partial stagnating effect on the cutoff portion. Roadways may obliterate wetlands due to the filling for roadbeds and approaches, channeling for equipment access, disposal of spoil, and blocking of wetland tidal flows. Solutions lie in aligning roadways to avoid wetland alteration and in protecting surface water flows.

4.9 WATER SUPPLY SYSTEMS

Communities have two major alternative sources of water: subsurface (groundwater) and surface. In coastal areas, groundwater may be a preferable source either because of a lack of fresh surface water, or the presence of easily accessible aquifers. There are problems involving both recharge and withdrawal of groundwater. Water diversion caused by paved surfaces and altered water drainage may reduce the amount of natural recharge that would replenish groundwater. At the same time, overpumping of groundwater supplies near the shore can lead to the drying out of wetlands and salt intrusion into aquifers. Solutions lie in reducing impervious surfacing and in controlling well sites.

4.10 SEWAGE SYSTEMS

Any increase in population caused by OCS expansion will add to a community's sewage load, increasing the amount of effluent produced. Many coastal water basins receive effluent from sewage plants that contain greater concentrations of nutrients, organic matter, toxic substances, and pathogenic organisms than the basin can assimilate. In low-lying areas with naturally high water tables, liquid waste from septic systems may saturate the soil and cause overflow. This pollution potential from septic tanks is intensified in flood-prone areas, where high tides and storms periodically saturate the soils. The problem can be solved by avoiding the use of septic tanks in low-lying areas and by providing proper levels of sewage treatment and disposal.

4.11 OVERLAND TRANSMISSION SYSTEMS

All aspects of community growth involve transmission systems for electricity, water, sewage, power, and gas. A small OCS-related facility might not be accompanied by any significant secondary expansion in these systems, but a large refinery might require expansion. There are potential problems with transmission systems in the alignment, construction, and, to a lesser extent, in leakage of transmission systems. Like roadways, these systems may obliterate vital ecological areas or degrade them during clearing, excavation, or installation. For example, wetlands have been favorite locations for sewage gravity mains and pipe crossings. A solution is to align routes to avoid critical and vital areas and use appropriate safeguards to prevent ecological disruption during construction.

4.12 STORM WATER SYSTEMS

Increased community facilities creates additional demand for storm sewers because of the build-up of impervious surfaces (roads, parking areas, and roof-tops) in the community. Rainfall in urbanized areas is considered a nuisance and a hazard. The resulting runoff is removed as quickly as possible by construction of storm drains and sewers. In the coastal zone, standard practice has been to pipe runoff directly into surface waters with little or no treatment. Natural subsurface purification is therefore bypassed by channeling contaminants directly into a water body. Runoff may have higher biochemical oxygen demands (BOD) and greater concentrations of various pollutants than domestic sewage. Problem resolution may lie in appropriate detention and treatment of storm waters and, particularly, in the use of alternative, more natural, drainage systems.

4.13 SOLID WASTE SYSTEMS

All elements of OCS associated community growth--transportation, utilities, schools, recreation, commercial, and housing--generate solid wastes. Solid waste disposal may present problems where, because of community growth, available disposal sites become scarce. The location of sanitary landfills is the major consideration. Solid waste landfills that preempt wetlands or other vital habitat areas can do considerable ecological damage. The problem can be avoided by locating such landfills back from the water's edge in appropriate, non-critical, upland sites, where they will not pollute surface waters or groundwater.

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APPENDIX A

Employment and Locational Factors for Direct OCS-Related Facilities

Profiles of 15 major facilities are presented below. Types of employment are described for construction and operation of each facility. Time requirements for construction and operation are also presented. This information is drawn from prior experiences rather than estimated requirements whenever possible.

Each profile also includes a discussion of the coastal dependence and lease dependence of each facility. Facilities that serve more than one lease sale or field have greater flexibility in choice of a site.

A.1. GEOPHYSICAL SURVEYING: Geophysical surveying has little effect on employment in nearby onshore communities. Although some employment positions may be filled locally, most employees on geophysical survey vessels travel with the vessel from job to job.

One form of geological exploration, stratigraphic test drilling, can have greater effect. This process requires the drilling of a well from a drilling rig to attain core samples (but not to test directly for oil or gas). Its employment consequences are similar to those of an exploratory drilling rig.

A.2. EXPLORATORY DRILLING: The three types of drill rigs (jack-up, semi-submersible, and drillship) have somewhat different employment consequences. Estimates of employment per rig range from 113 (for a drillship) to 217 (for a semi-submersible rig) [21, 15].

Employees who work on an exploratory rig typically migrate with the rig from job to job. Their homes are often near the rig's home port, and many of them return home when off duty. If they do take up residence in a distant drilling area, they do so only temporarily and make minimal demands on the community.

Nevertheless, exploratory drilling may have some effects on employment in nearby onshore communities. In one study involving a semi-submersible rig, it was estimated that 80 of 217 employees would be hired locally; that 87 others would maintain temporary local residences during drilling; and that 50 would commute to homes out of the local area while off duty [21]. Local hiring is likely to be principally in the unskilled category.

A.3. PRODUCTION PLATFORMS: Production platforms operate in three phases: (a) drilling, (b) production, and (c) workover.

(a) Production drilling, when wells are sunk, requires about the same number of employees per platform, performing similar roles, as are needed for each exploratory drill rig. The proportion of local employment, however, is likely to be higher, since the platform is a fixed facility that will be in place for a substantial period.

(b) Production, after drilling is completed, requires only a very small labor force to monitor and maintain the platform and wells. One study, for example, estimated that 16 employees per platform would be needed; others estimated as few as 8 [15, 26]. Because production is a long-term operation, however, the workers are very likely to live in nearby coastal areas.

(c) Workover, which is a process of improving well production, occurs infrequently on a given well but continually in a large field. It may require about as many employees as production drilling, but many are likely to be specialists imported for the occasion.

In estimating the employment consequences of production platforms, it is essential to recognize that there may be a number of platforms within a single lease area (Example 9). The short-term employment consequences of production drilling can be great, since drilling is likely to take place on many platforms simultaneously.

A.4. PIPELINES: The location of pipelines is tied to each offshore field site and (usually) the shortest distance to a landfall and connecting lines. The locational flexibility of pipelines is somewhat limited because of high construction costs but bottom conditions, or environmental decisions, may dictate use of other than the most direct route to shore in some areas. Seafloor pipelines may also be laid to link production platforms with storage and ship-loading facilities offshore and thus avoid landfall altogether.

(a) Construction: Pipelaying barges may employ some 160 to 175 people [10]. Like workers on drilling rigs, most pipelaying workers migrate with the vessel from job-to-job. Perhaps 50 workers would be recruited locally, principally unskilled labor or specialized workers such as welders [10]. If these workers are unavailable locally, pipeline construction is likely to bring new residents to the community. Most pipelines are no more than 200 miles long; a rule of thumb for pipelaying progress is approximately one mile per day. Construction is seasonal, and may take as little as 6 months or as much as 2 years because of such factors as bottom topography, wave conditions, and weather.

EXAMPLE 9. Estimate of Employment Associated with Production Platforms in the Mid Atlantic Lease Area. (Source: Reference 4)

Year	Production Drilling		Production	
	No. of Platforms	Employment	No. of Platforms	Production Employment
1976				
1977				
1978				
1979	8	520		
1980	12	780		
1981	18	1170	8	128
1982	18	1170	14	229
1983	20	1300	20	320
1984	20	1300	26	416
1985	18	1170	32	512
1986	15	975	38	608
1987	10	650	42	672
1988	8	520	45	720
1989	6	390	47	752
1990	4	260	48	768
1991	2	130	49	789
1992	1	65	50	800
1993				800
1994				800
1995				800

A.5. OFFSHORE MOORING AND TANKER OPERATIONS: One type of offshore mooring, known as a single point mooring, is essentially a large buoy connected to a storage/pumping facility by pipeline and to tankers usually by floating hoses. These are the principal components of deepwater ports, such as the proposed LOOP and Seadock installations in the Gulf of Mexico. These large, complex ports include offshore moorings, submarine pipelines, and onshore facilities for storage, transportation, or processing. Offshore moorings may not be dependent upon a particular offshore field or lease sale. They can accommodate tankered oil from all over the world.

Another function of an offshore mooring buoy is to allow tankers to take on oil directly from one or more wells which have subsurface completions (wellhead on the sea floor, with no fixed platform overhead). These facilities have minor employment requirements.

Construction of a deepwater port may take about 2 years. The offshore buoy itself is likely to be built in an existing marine construction yard, away from the port site, thus creating minimal onsite employment. The pipelines will have employment consequences as described above. Onsite employment required to construct a deepwater port may be roughly 1,000 (with a peak force of 1,500) if port facilities alone are built [27].

If storage facilities or refineries are also provided, the employment consequences would be as described in paragraph A.11 (storage) or A.12 (refineries). Deepwater ports, such as those proposed by LOOP or Seadock would require about 300 workers each to maintain, monitor, and operate the facilities, according to one estimate [27].

A.6. SERVICE BASES: These essential facilities, which must be located on the coast, may be temporary or permanent. They usually serve single fields and attempt to locate as close to the lease area as possible.

Temporary service bases support exploratory operations and last only so long as exploration continues. Temporary bases use existing facilities insofar as possible, so any construction is likely to require at most a few months and to provide few jobs. During exploratory drilling, the number of employees depends on the number of rigs being serviced. At one temporary base in Florida, for example, employment was 32, including 12 positions filled by local residents [28].

If exploration leads to commercial production, the temporary base may evolve into a permanent service base, which will remain throughout the life of the production platforms it services. Base size depends on the availability of services from nearby companies: large bases are more likely to be constructed at less developed ports, where fewer such services are available. Construction of a permanent base may take up to a year, with average employment of about 20 and maximum of about 90 [10].

After construction is completed, employment at service bases fluctuates with the level of activity on the production platforms being serviced. One study estimates that employment may be more than twice as great during drilling and workover as during production [28].

A.7. MARINE REPAIR AND MAINTENANCE: Marine repair and maintenance services, located along the coast in developed harbors, are needed throughout the life of oil and gas fields. Although these services are already available in many ports, OCS development brings another customer whose specialized demands and number of vessels may require construction of some additional facilities. Where no marine repair and maintenance facilities are available, oil companies (or contractors) may build them in conjunction with their service base.

Time to construct repair and maintenance facilities will usually be short and the labor force small. The continuing labor force needed to provide repair and maintenance services also will be small. Employees with specialized skills may be brought into the area, while the less skilled workers are likely to be hired locally if available.

A.8. GENERAL SHORE SUPPORT: General shore support is provided by contractors or vendors, who supply specialized services to support OCS development. A few shore support industries are in the "direct" industrial category, but a majority are "indirect" or support industries. Support services are needed throughout the production life of the field, although many individual services are needed for limited periods. (For example, a mud supplier is required only during drilling). While vendors prefer coastal sites, most do not require one. Some vendors serve a single oil and gas field from different facilities, while others serve world-wide markets from one or two locations.

When possible, these companies minimize construction expenditures and employment by using existing facilities. Even so, the total labor force needed to construct or modify facilities for all services may be substantial if a large field is discovered. The size of the labor force providing shore support will depend on the size of the field. Larger fields attract more local facilities for service companies, which would otherwise serve the field from their established facilities. Much of the support labor force will require specialized skills, and accordingly is likely to be hired outside the region and migrate into it.

A.9. PLATFORM FABRICATION YARDS: Platform fabrication yards, which require a coastal site, serve markets around the world. The yards are not constructed until initial platform orders are imminent or signed. Thereafter, a yard is constructed rapidly, using a labor force typically exceeding 500 people. Construction may be completed in less than a year.

Employment during operations fluctuates depending on the size and number of platforms being constructed. Many large orders mean high employment; if there are no orders, the yard may close temporarily. Operators of a large yard now under construction at Northampton, Virginia initially estimated employment of up to 2,000 people, mostly fabricators and welders [18]. Few places in the nation could provide such a large work force of specialized labor without substantial immigration.

A.10. PIPE-COATING YARD: Pipe-coating yards, like platform construction yards, are coastal facilities that are constructed rapidly when the need for them becomes clear, but have an uncertain duration because future demand cannot be known. Pipe-coating yards serve a much smaller market area than platform fabrication yards because of the high cost of shipping the heavy, coated pipe.

Construction of the yard seldom takes more than 6 months. The labor force for construction would probably not exceed 50 workers [28]. During the operational phase, employment fluctuates. A pipe-coating yard may employ up to 200 people for 8 months to process 200 miles of 30-inch pipe. Between orders, a skeleton crew of only 40 to 45 is retained [28]. Although supervisory personnel are likely to be brought into the region, many operating jobs are likely to be held by local residents.

A.11. OIL STORAGE: Oil storage terminals are not necessarily associated with a single OCS lease. They are often built to support a single field or source, but as the source becomes depleted, it may be replaced by other sources, such as imports. Terminals are located along or near the coast.

Storage terminals take about 2 years to construct, the length of time varying with the size of the terminal, the size of the work force, and the staging of construction. According to one estimate, 565 workers would be required to construct a facility capable of handling 250,000 barrels of oil per day [27]. Many of the needed workers are metal fabricators and welders.

Storage terminals operate with a small labor force to monitor and maintain the facility. The facility described above will employ approximately 90 individuals [29]. Major improvements or modifications are contracted out.

A.12. REFINERIES: Refineries are not tied to a single lease or crude oil source. Although a change in the source of crude oil can require major refinery modifications, these are less expensive than constructing a new refinery. They are usually located along the coast or near water bodies to minimize transportation costs and to have large volumes of water available for processing.

During construction, refineries employ the largest labor force of the 15 types of OCS facilities. One study estimates the average labor force to be 1,800 and maximum 2,900 during construction of a refinery with a capacity of 200,000 barrels per day. Approximately 1,000 of these would be skilled labor. Construction takes approximately 3 years [10]. The effect of a labor force of this size on nonmetropolitan communities would be great.

Operating employment estimates for the same refinery range from 550 to 650 [10, 30]. Of the 550, 55 would be in administrative support, 55 in specialized support, and 440 in operation and maintenance. Of this latter total, 396 would be skilled workers [10].

A.13. PETROCHEMICAL INDUSTRIES: Petrochemical plants are closely tied to refineries and their products. As in the case of refineries, petrochemical plant sites are not determined by the proximity to OCS oil or any other specific source but do require substantial supplies of refined oil and a large supply of fresh water.

During a construction period of perhaps 3 years, a primary petrochemical complex would have an average labor force estimated at 1,600 to 1,900 to build a facility producing 1 billion pounds of ethylene per year [9, 26]. Very few locations have a construction force of that size available. Another study estimates the basic construction employment would be 50 percent unskilled, 40 percent skilled, and 10 percent management and administrative [26].

Petrochemical operation is highly automated. The same hypothetical plant employing 1,900 during construction would employ 420 people during operation, of whom 50 would be administrative and 295 skilled [26].

A.14. GAS PROCESSING: Gas processing plants are tied into the productive life of a field (or fields, if more than a single field is connected by pipeline to the facility). These facilities do not require a coastal site.

During a 2-year construction period, a gas processing plant with capacity of 300 million cubic feet per day requires about 300 workers; a plant with capacity of 1 billion cubic feet per day would employ a maximum of 550 [2, 28]. Much of the construction work requires specialized labor skills.

Operation of the plants, which are highly mechanized, requires few employees. The smaller plant (300 million cubic feet per day) would require 21 people, while the larger one (1 billion cubic feet per day) would employ 35 [21, 28].

A.15. LIQUEFIED NATURAL GAS PROCESSING (LNG): LNG plants, like refineries, are tied to a world system of supply. They are located at or near the coast. All the plants existing or anticipated in the United States are regasification plants converting the gas from a liquid state into a gaseous state).

Construction of an LNG plant, with a capacity of a billion cubic feet per day would employ approximately 600 individuals and require about three years [6]. The skills needed for construction are similar to those needed to build a refinery.

To operate an LNG plant with capacity of a billion cubic feet per day requires about 100 employees [6].

APPENDIX B

Additional Literature Sources

In addition to references cited in the text, there are many additional sources of information describing or analyzing the effects of OCS development. The most important works available at this time are listed in this appendix. These sources are grouped into four categories: OCS facilities, OCS lease sales, prior regional experience, and socio economic effects.

OCS FACILITIES: This section includes descriptions of specific facilities prepared by independent analysts. Promotional material prepared by the industry is not included.

OCS LEASE SALES: The National Environmental Policy Act (NEPA) has encouraged or required assessment of environmental effects of entire lease sale areas. This scale of analysis includes large coastal regions within which facilities to support offshore operations may locate. The sources listed review potential OCS operations at this regional scale.

REGIONAL EXPERIENCES: Coastal areas that have experienced offshore oil exploration and production, and related onshore development offer useful lessons to those areas that anticipate similar patterns of enterprise in the future. These sources describe such experiences.

SOCIO-ECONOMIC EFFECTS: Socio economic effects of energy-related development, including location of large facilities in rural areas, has been analyzed in a variety of studies. The sources listed review socio economic effects specific to OCS development along with analagous non-OCS studies.

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