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North Slope Borough
Coastal Management Program
Prudhoe Bay Area

ka Consultants, Inc., Anchorage, Alaska, June 1978

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NORTH SLOPE BOROUGH

COASTAL MANAGEMENT PROGRAM

PRUDHOE BAY AREA

prepared for the

NORTH SLOPE BOROUGH

by

ALASKA CONSULTANTS, INC.

JUNE 1978

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I. INTRODUCTION

In recent years, coastal areas of the United States have experienced burgeoning populations and continued development. The results have been reflected in continuing and magnified conflicts among alternative land uses, especially between those of a business and industrial nature and those of an open space, recreation and conservation nature.

In response to these and other overwhelming coastal development activities throughout the United States, Congress passed the Coastal Zone Management Act of 1972. The Act established a system for providing guidance and assistance in developing coastal planning and management programs. Congress placed responsibility with the various coastal states, working with local governments and the public and Federal agencies, to prepare precise plans and actions that would lead to logical and intelligent uses of coastal areas.

A. ALASKA COASTAL MANAGEMENT PROGRAM

The State of Alaska initiated its own coastal management program in 1974. The process of coastal program development began in the Alaska Department of Environmental Conservation and focused on the uses of technical information to promote wiser management decisions. This effort was designed to assist the formulation of resource plans within departments, to assist permit review processes, to provide a basis for making State decisions on resource allocation and to serve as a foundation for resource management policy.

As work proceeded, however, it became apparent that many additional activities, primarily involving coordination of the many Federal, State and local government agencies involved in coastal matters, were needed for the coastal management program formulation process. With this in mind, the Governor, in 1975, transferred responsibility for the coastal management program to his Division of Policy Development and Planning.

At its inception in 1975, the Office of Coastal Management (OCM) recognized the need for local participation and an expanded local role in the coastal management planning process. In 1977, the OCM made a commitment to meet this need by providing local governments an opportunity to develop local coastal management programs tailored to their own particular circumstances and needs. Grant money was made available through the Alaska Department of Community and Regional Affairs on a matching basis for coastal planning and management program development.

Concomitantly, the Alaska Coastal Management Act of 1977 established broad State policy for the development of the overall State management program of which the district programs comprise a significant part. The Act provides that the district programs are to be developed under the guidance of the Alaska Coastal Policy Council according to guidelines and standards developed by the Council and approved by the Legislature. The Standards of the Alaska Coastal Management Program and Guidelines for District Coastal Management Programs were developed in 1977, subject to review and comment by local governments and residents in public hearings around the State, and submitted to the Legislature for approval early in 1978.

B. NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

In the North Slope Borough, the conflicts that originally engendered Federal and State coastal management programs are exemplified by the Prudhoe Bay experience. Just over 10 years ago, the Prudhoe Bay area was, for all practical purposes, one of America's last great wildernesses used by the indigenous Eskimo residents for subsistence fishing and hunting activities. Since that time, the country's largest domestic reserve of oil and gas has been discovered in the area, a road has been built connecting Prudhoe Bay to the rest of North America, and a multitude of oil industry support activities have been located in the area. The prospect of new discoveries of petroleum offshore in Prudhoe Bay and adjacent areas and the possibility of opening the Haul Road to the

North Slope Borough Coastal Management Program Phases

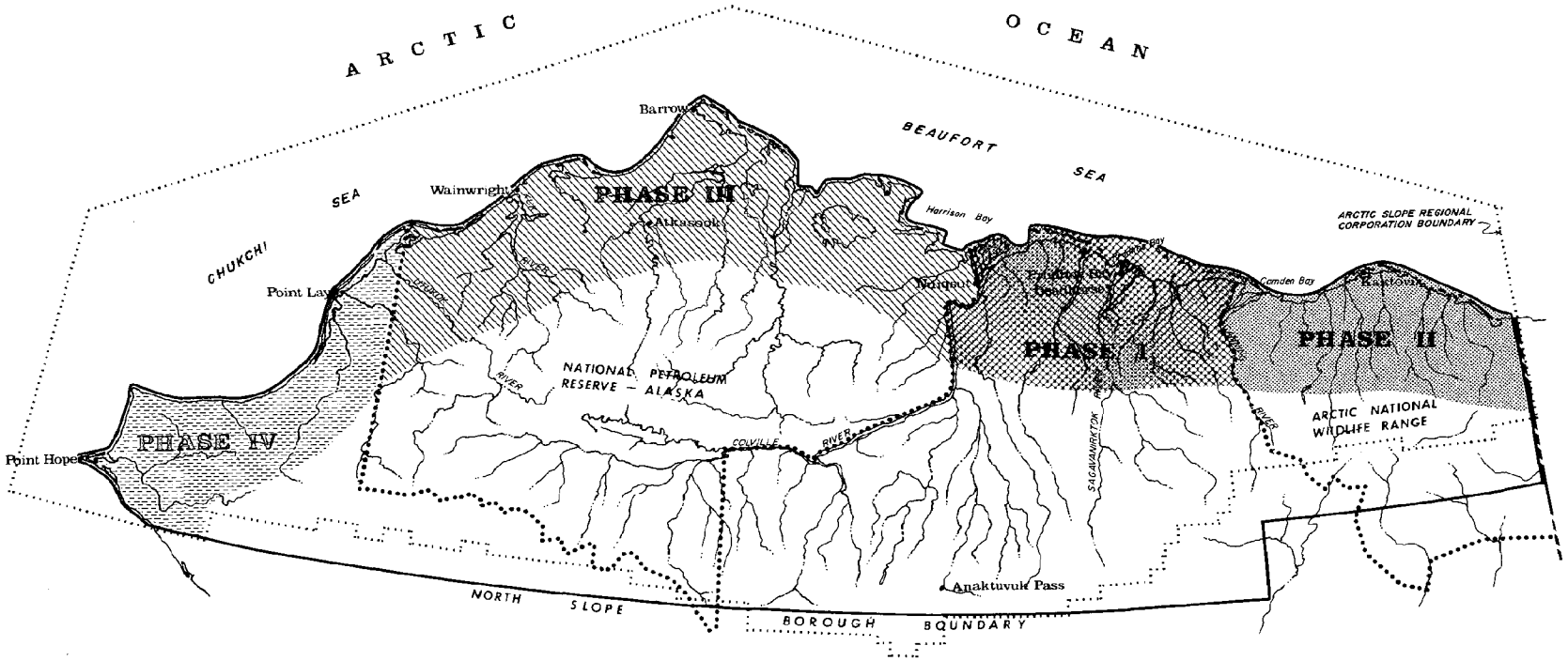


Figure 1

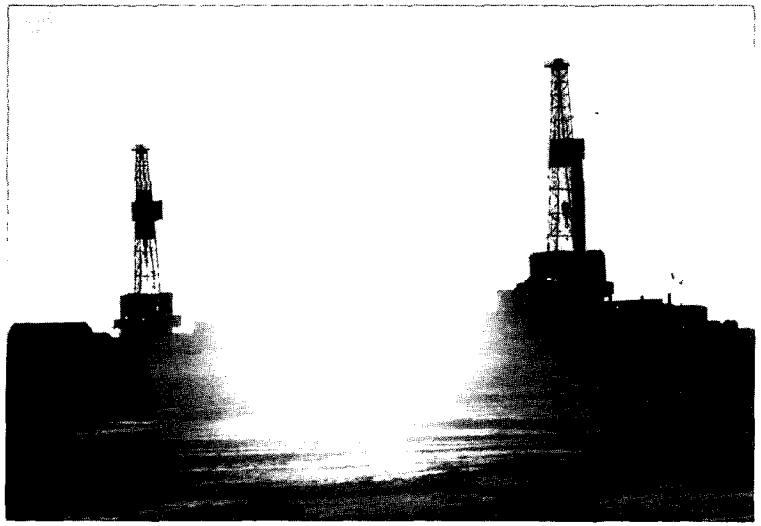
public pose the very real possibility of additional development and degradation of the coastal environment. These actions could prove detrimental to the lands and waters of the coastal area and threaten the subsistence resources which are the basis of the age-old Inupiat culture and economy.

Because of these circumstances, the North Slope Borough has long recognized the need for a coastal management program and has actively participated in the Alaska Coastal Management Program since its inception. It was represented at the Association of Coastal Mayors Workshop, convened by the Department of Community and Regional Affairs in 1976 to consider OCM rules and regulations for the Coastal Energy Impact Program and other coastal management issues, and it is represented on the Alaska Coastal Policy Council. The Borough planning staff has worked closely with the Department of the Interior's Beaufort Sea OCS program and with the NPR-A study team to ensure that Borough coastal management concerns are adequately represented.

The North Slope Borough's concern with the coastal environment extends beyond Borough, State and national boundaries. In response to oil and gas operations offshore Greenland, Canada, the Soviet Union and the U. S., the Borough in 1976 set out to organize the circumpolar Inupiat community to work toward a single set of rules for all Arctic shelf operations as a means of protecting the environmental security of the people of the Borough. The first meeting of the Inuit Circumpolar Conference was held in Barrow in June 1977. The primary focus of this conference was Arctic conservation and environmental protection, with a view toward developing an international Arctic policy. An ICC Interim Committee is writing a charter which will be ratified at the next Circumpolar Conference.

In 1976, in anticipation of the availability of State grant assistance for the development of a district coastal management program, the Borough Planning Department developed an issue paper addressing coastal management in the North Slope Borough. This paper reviewed pertinent sections of the Coastal Zone Management Act of 1972, discussed its relevance to the State and the Borough, and advanced a series of recommendations to involve the Borough in a far-reaching program of the management of its coastal area. It was considered particularly crucial that this program be developed at the local level inasmuch as the Borough's position and actions on a variety of issues affecting its coastal lands and waters transcend the concerns of Congress and sometimes the State. The Borough often conceives itself as being in an obverse position in which it fears a wise and balanced use of the land and water of the coastal area may not be exercised by the Federal and State governments.

The issue paper recommended that because of the size, complexity and importance of coastal management to the North Slope Borough, the development of the coastal management program be considered in four interrelated phases. The first phase would focus on the Prudhoe Bay area, that part of the Borough coast lying between the National Petroleum Reserve-Alaska (NPR-A) on the west and the Arctic National Wildlife Range on the east. This is the coastal area that roughly coincides with imminent State and Federal offshore lease sales and therefore is under the most immedi-



ate pressure from future development. Phase II would include the Arctic National Wildlife Range and adjacent offshore areas and would be based partly on data being developed by the State and Federal governments in preparation for the joint Federal-State OCS Beaufort Sea lease sale. Phase III would include the NPR-A and offshore areas and would depend heavily on material developed by the Department of the Interior's NPR-A land use study. Phase IV would comprise the remainder of the western area of the Arctic coast not included in Phase III. In developing its coastal management program, the North Slope Borough has adopted this approach.

C. PRUDHOE BAY AREA COASTAL MANAGEMENT PROGRAM

Phase I, the Prudhoe Bay Area Coastal Management Program, has been undertaken prior to legislative approval of "Standards of the Alaska Coastal Management Program" and "Guidelines for District Coastal Management Programs." An attempt has been made to monitor changes in the draft standards and guidelines and to reflect these in the Prudhoe Bay Area Coastal Management Program. However, in the absence of definitive standards and guidelines, the elements contained in the Prudhoe Bay Area Coastal Management Program have been based largely on policy guidance contained in the 1977 Coastal Management Act and the Scope of Services governing conduct of the study effort and thus differ somewhat from what might be expected from the standards and guidelines. Following is a brief description of the Prudhoe Bay Area Coastal Management Program.

Chapter II sets forth the North Slope Borough's rationale for determining coastal management boundaries and delineates the specific boundaries for the Prudhoe Bay Coastal Area. Chapter III, Assessment of Planning Activities and Needs, describes various studies being undertaken by the Federal, State and North Slope Borough governments that are relevant to the Borough's Coastal Management Program and relates these specifically to the Prudhoe Bay Area Coastal Management Program. Primary contacts within the various agencies are also identified. In addition, this chapter identifies areas that require further study.

Chapter IV enumerates and briefly analyzes local issues pertinent to coastal management in the North Slope Borough. In Chapter V, lands and waters of the Prudhoe Bay Coastal Area are classified according to their importance to the preservation of fish and wildlife resources and habitat and their suitability for development. Chapter VI, Objectives, Policies and Standards, sets forth the objectives of the North Slope Borough in the management of the Prudhoe Bay Coastal Area, proposes policies or plans of action for implementing these, and describes in general terms existing Federal, State and local government standards available to effectuate North Slope Borough policies for the conduct of activities in the Prudhoe Bay Coastal Area. Strategies for implementing the Prudhoe Bay Area Coastal Management Program are described in Chapter VII.

Chapter VIII, Prudhoe Bay Coastal Area Inventory, describes the natural and man-made environment of the study area and identifies traditional and current use of the land and its resources. In Chapter IX, the Prudhoe Bay Coastal Area is analyzed for its potential to accommodate several different uses—oil and gas development, tourism and recreation, mining, and fish and wildlife. Constraints and conflicts related to each potential use are also identified.

Chapter X, Forecast of Demands, Capabilities, and Impacts, discusses the demands that potential uses would place on the lands and waters of the Prudhoe Bay Coastal Area, assesses the capability of the lands and waters to accommodate these demands, and describes the impacts that are likely to occur as a result of each potential use.

II. Boundaries

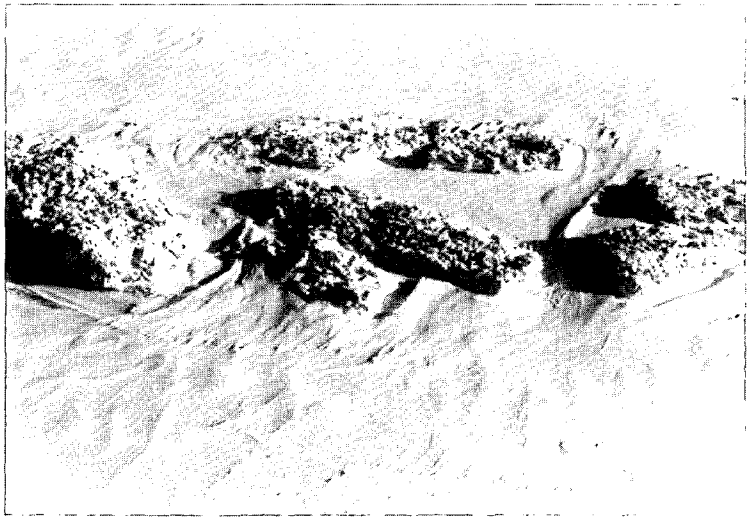
II. BOUNDARIES

The Federal Coastal Zone Management Act of 1972 defines the coastal zone as "the coastal waters (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines . . . and includes islands, in transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends . . . to the international boundary between the United States and Canada and, in other areas, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the use of which have a direct and significant impact on the coastal waters."

The Alaska Coastal Policy Council has adopted initial coastal area boundaries, which may be modified locally by coastal resource districts such as the North Slope Borough. In establishing initial coastal boundaries, the Coastal Policy Council considered work conducted by the Alaska Department of Fish and Game's Marine and Coastal Habitat Management Program which divided the coast into three zones based on biological and physical factors: the zone of direct interaction, the zone of direct influence and the zone of indirect influence. The first zone, that of direct interaction, has both a landward and seaward limit. The landward limit comprises the backshore regions influenced by saltwater intrusion, including the extent of intrusion up river channels. The landward limit of this zone averages 2 to 3 miles inland but extends 60 miles up the Colville River channel. The seaward limit of the zone of direct interaction encompasses the area of shorefast ice and the shear zone. In the zone of direct influence, the boundary includes optimum waterfowl and shorebird nesting habitat and polar bear denning habitat up to 25 and 30 miles inland. Offshore, the zone of direct influence extends into the pack ice to a yet undetermined distance. Consequently, the offshore extent of the indirect coastal zone influence includes all watersheds of rivers flowing into the Beaufort Sea as well as the extent of anadromous fish spawning and the primary influence of a maritime climate on the land. The State of Alaska's standards and guidelines for coastal management program boundaries include the zone of direct interaction and the zone of direct influence but exclude the zone of indirect influence.

The North Slope Borough has extended these State-established boundaries southward to include that area encompassed by the natural physiographic province of the Arctic Coastal Plain. This province provides essential habitat to the region's fish and wildlife which range widely over the Arctic coastal plain during various phases of their life cycle. Because of the potential impact on these resources from development, the southern boundary has been extended to encompass as much as possible of their essential habitat.

In connection with the development of the Arctic Coastal Management Program, there should be undertaken an investigation of both the North Slope Borough's and the State of Alaska's authority offshore beyond the three-mile limit. Nevertheless, it is essential that efforts be made to assure that Borough and State offshore boundaries coincide for purposes of taxation and the enforcement of regulations relating to development.



Phase I of the North Slope Borough Coastal Management Program focuses on the Prudhoe Bay Coastal Area, that part of the Borough coast lying between National Petroleum Reserve-Alaska (NPR-A) on the west and the Arctic National Wildlife Range on the east. The eastern boundary of NPR-A is currently disputed by the State of Alaska and the U. S. Department of the Interior. In 1972, the U. S. Navy which then had jurisdiction over the Reserve asserted that the boundary encompassed the right bank of the Colville River. The State, however, contends that the eastern boundary commences at the peak at the head of the northernmost of the two eastern forks of Midas Creek and runs true north approximately 70 miles until it intersects with the western or left bank of the Colville River, whereupon it follows the left bank via the Nechelik Channel until it intersects with the Arctic Ocean. For the purpose of this program, the western boundary of the Prudhoe Bay Coastal Area will coincide with the State-recognized eastern boundary of NPR-A.

Prudhoe Bay Coastal Zone

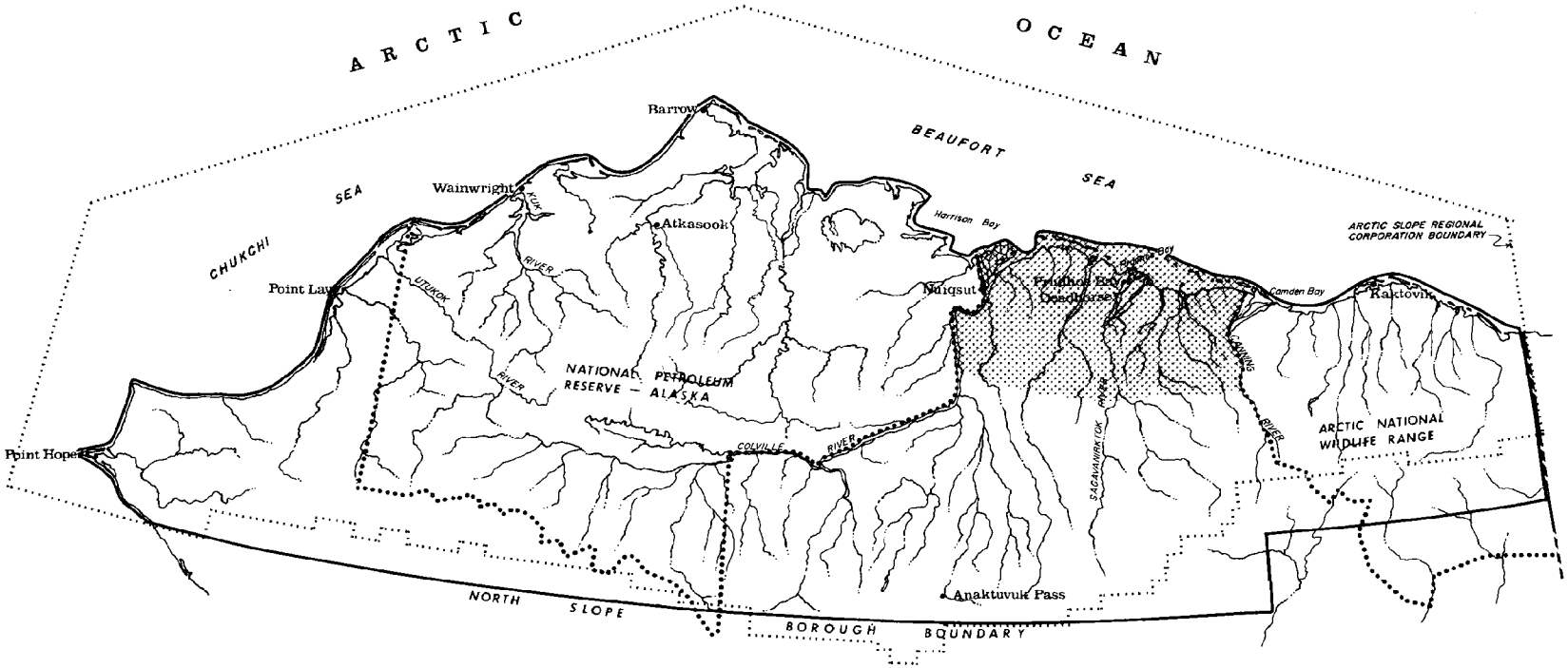


Figure 2

III. Assessment of Planning Activities and Needs

III. ASSESSMENT OF PLANNING ACTIVITIES AND NEEDS

The exploration and development of Prudhoe Bay petroleum resources and the extremely high potential for additional major oil and gas development in the Arctic have engendered a wide variety of planning studies by the Federal, State and North Slope Borough governments. Because petroleum development is so intricately interwoven with coastal management in the North Slope Borough, these studies are particularly relevant to the Borough's Coastal Management Program. These studies have provided much of the data from which the Prudhoe Bay area inventory and analysis have been developed.

The Federal government is currently involved in two major planning efforts on the North Slope—the land use study and plan for the development of oil and gas resources within the National Petroleum Reserve-Alaska (NPR-A) and the Alaska OCS Socioeconomic Studies Program. The Naval Petroleum Reserve Production Act of 1976 directed the Secretary of Interior to "conduct a study to determine the values of, and best uses for, land contained in the Reserve." This study is to take into consideration the Natives who live or depend on such lands, the scenic, historical, recreational, fish and wildlife, wilderness values, mineral potentials and other values in the Reserve and must be completed before any development can take place. The study is being conducted by a study team composed of personnel from the Department of the Interior, the State of Alaska, and the North Slope Borough. Close coordination has been maintained throughout the development of the Prudhoe Bay Area Coastal Management Program with the NPR-A study effort. A number of people involved with this study have been particularly helpful. Mr. William Thomas from the Cultural Heritage and Recreation Service has provided input on wilderness, recreation and scenic values; Mr. William Schneider from the National Park Service has been the contact for information relating to subsistence and cultural and historical values; Mr. Wayne Pichon and others from the U. S. Fish and Wildlife Service have been the source of information relating to fish and wildlife habitat. In addition, Mr. Robert Worl has been the contact for information of a more general nature relating to North Slope Borough participation and the overall progress of the study.

The Alaska OCS Socioeconomic Studies Program conducted by the Bureau of Land Mangement's Alaska Outer Continental Shelf Office is directed toward predicting and evaluating the effects of Alaska OCS petroleum development upon the physical, social, and economic environments within the State. The analysis addresses the differing effects among various geographic units: the State as a whole, the regions within which oil and gas development is likely to take place, and the various communities within these regions. The Beaufort Sea Regional Study is currently in progress, and, when completed will provide the basis for the Federal Environmental Statement relating to Beaufort Sea OCS lease sales. Information developed in the course of this program has contributed to the discussion of the demands, capabilities and impacts of future development activity in the Prudhoe Bay area, the cultural, recreation and historical significance of the land and to the discussion of land and water classification. Primary contacts in the Alaska OCS Office have been Mr. William Civish, Mr. Dean Yoesting, and Mr. Wink Hastings.

State regulations require the completion of a Social, Economic and Environmental Analysis (SEEA) prior to major oil and gas lease sales. The SEEA for the joint Federal-State Beaufort Sea lease sale scheduled for December, 1979 is being coordinated by the Alaska Department of Natural Resources which is charged with the administration of State mineral lease sales. The SEEA will contain input from the State Departments of Community and Regional Affairs, Environmental Conservation, Fish and Game, and Health and Social Services. Material developed by Community and Regional Affairs for inclusion in the SEEA has provided the basis for the physical inventory of the Prudhoe Bay-Deadhorse area and the demography and economy of the study area. Mr. George Cannelos of Community and Regional Affairs and Mr. Patrick

Dobey of Natural Resources have been the points of contact for information relating to this effort.

The *Petroleum Development Study, North Slope Alaska,* conducted by the Department of Natural Resources, is scheduled for completion in the summer of 1978. In the course of this study, several petroleum development scenarios have been run on a computer model that varies a number of parameters including amount, location and timing of oil discoveries, and outputs information such as yearly oil production, work force requirements for each phase of development, and total water and gravel needs. Data from this study have been used to estimate petroleum resources in the study and adjacent areas and to determine demands and impacts on the land and resources given certain levels of petroleum development. Mr. Robert Klein, Department of Natural Resources, has been the main contact point for material relating to this study.

Also in connection with proposed lease sale activity in the Prudhoe Bay area the Alaska Department of Fish and Game (ADF&G) is conducting an environmental survey of the Pt. Thomson area. This survey includes on-site analysis and discussions with local residents and the managers of the Arctic National Wildlife Range. The study will identify ice hazards and the fish and game resources of the area and man's relationship to them. The work will provide the basis for Fish and Game's position vis-a-vis the Pt. Thomson lease sale and lease tract stipulations. In addition, Fish and Game Habitat Protection personnel are involved in the development of lease stipulations for the joint Federal-State Beaufort Sea lease sale. Coordination with these activities has been through Mr. Lance Trasky and Ms. Debra Clausen of ADF&G's Habitat Protection Division.

The Office of Coastal Management, which administers the Alaska Coastal Management Program, is charged with the responsibility of coordinating the activities of the various State agencies participating in the Coastal Management Program. Under the aegis of the Alaska Coastal Management Program, State agencies are involved in identifying geophysical hazard areas and existing facilities and potential needs for a wide variety of activities: recreation, energy, transportation and utilities, fish and seafood processing, timber harvesting and processing, mining and mineral processing, subsistence and cultural resources. The Geological and Geophysical Survey Division of the Department of Natural Resources (James Riehle) developed the material on geophysical hazard areas which has been incorporated in the Borough's Coastal Management Program. The fish and wildlife inventory and information relating to habitat rely heavily on work done by ADF&G as part of the Alaska Coastal Management Program. In connection with this effort, ADF&G has identified potential critical habitat areas on the North Slope and delineated biophysical processes and their boundaries. In addition, the fish and wildlife of the North Slope have been inventoried in detail. Primary contacts in connection with this work were Mr. Rich Cannon, Ms. Debra Clausen, Mr. Ed Klinkhart and Mr. Robert McClain.

Through the development of the Prudhoe Bay Area Coastal Management Program related efforts being undertaken by the North Slope Borough Planning Department have been closely monitored.

The Beaufort Sea Study, Historic and Subsistence Inventory: A Preliminary Cultural Resource Assessment by Jon M. Nielson identified historic and subsistence sites, and wildlife populations and migrations. Material contained in this report provides the basis for the identification of areas of subsistence and cultural importance within the Prudhoe Bay Coastal Area.

The Borough Planning Department has done several studies of the North Slope Haul Road which are reflected in the Prudhoe Bay Area Coastal Management Program. The first, *North Slope Borough: Legal Powers and Options on the Haul Road and Adjacent Federal and State Lands,* analyzes the Borough's choices regarding the Haul Road. A second Borough planning effort, relating to the Haul Road inventories cultural and historical sites in the Haul Road corridor.

A week-long Elders Conference sponsored by the Planning Department brought elders from North Slope villages to Barrow to gather historical and cultural information. Material concerning migration patterns of the bowhead whale which came to light as a result of this conference has been reflected in the Coastal Management Program. Additional information on wildlife resources and migration patterns and traditional land use was obtained during a March 1978 meeting of the Borough Planning Commission in Barrow and a public hearing held in Barrow in February to discuss proposed guidelines and standards for the Alaska Coastal Management Program.

The North Slope Borough's *Arctic Coastal Zone Management Newsletter* published monthly has identified a number of coastal management issues which are addressed in the Program. *Issues Overview* and *Coastal Zone Management Program Considerations* prepared for the Borough by Alaska Consultants, Inc., have also contributed to the identification of coastal management issues and considerations.

All these studies notwithstanding, there remain several issues relevant to coastal area management which, because of the lack of available information warrant further study. Foremost among these are the barrier islands which lie offshore of the Beaufort Sea coast between the Canning and Colville Rivers. Long known as important habitat for bird nesting, feeding and resting, polar bear denning sites and as a protection against coastal erosion from high wave action and ice movement, very little else is known about their function or their vulnerability to development. Some oil exploration has already taken place on Flaxman Island, and the industry is apparently looking to other islands in the chain as possible support bases and drill sites for future offshore activity. Detailed inventory and analysis are required to determine what impact, if any, such activity would have on the islands and the surrounding ecology.

Water and gravel are critical resources on the North Slope. Both are required in large quantities for oil and gas development and both are essential habitat for fish and wildlife. Gravel resources throughout the North Slope Borough should be identified and their extent measured. In addition, analysis should be undertaken to identify possible impacts on fish habitat, in particular, from industrial exploitation of the resource. Exploitation of water sources used by fish for overwintering could lower water levels to such a degree that the water would freeze to the bottom and kill the fish. To ensure that wildlife and industrial use of water do not conflict, additional studies should be undertaken to identify fish wintering spots, on the one hand, and the amount of water that can safely be taken, on the other.

There is presently only limited commercial fishing on the Arctic coast. In its inventory of fish and game resources of northern and western Alaska, the Alaska Department of Fish and Game identified a commercial whitefish operation on the Colville River delta which harvests approximately 3,000 broad and 1,000 humpback whitefish during the summer and 20,000 least and 40,000 arctic cisco annually in the fall. Almost all of these are marketed locally. According to the

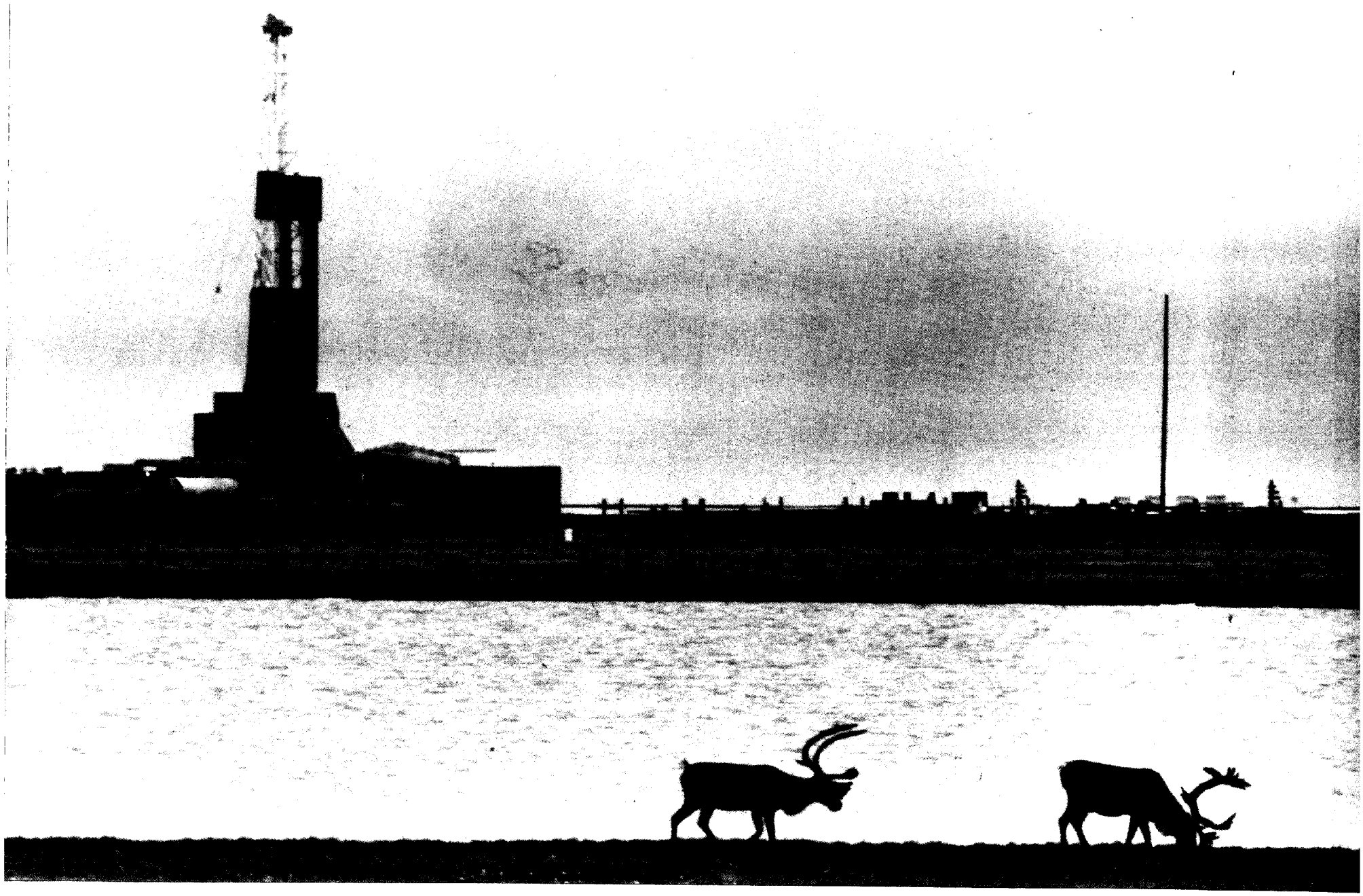
University of Alaska's Environmental Information and Data Center, there appears to be a potential for expanding commercial fishing in the region. Significant additional study will be required, however, to determine the economic feasibility of an expanded commercial operation.

The bowhead whale is the single most important element in the Arctic coastal Eskimo subsistence culture. Bowhead populations are thought to have dwindled to such a degree in recent years that there is a threat to the continued existence of this species. Although there has been a great deal of local, national, and international attention focused on the bowhead recently, relatively little is actually known about population levels or bowhead behavior. While there is little whale hunting east of Point Barrow according to local hunters, the bowhead migrates along the coast in the study area beyond the 6-meter (20-foot) isobath and apparently feeds and calves in the Colville River Delta. Development of a detailed data base on bowhead population and behavior is seen as an essential prerequisite for effective resource management. Effective management will be necessary to ensure the preservation of this important subsistence resource.

There are two distinct caribou herds on the North Slope, the Porcupine which generally occupies the area from the Canning River east to the Canadian border, and the Western herd found west of the Colville River. Although the Porcupine population is currently high and stable, the Western herd has decreased alarmingly in recent years. Relatively isolated as they are from human impact other than subsistence hunting, these herds provide an excellent opportunity to study why and how large caribou populations become depleted. By monitoring the Porcupine and Western herds carefully, it may be possible to learn how population recovery can be facilitated.

During the course of surveys with side-scan sonar, high resolution seismic profile, and the fathometer, the U. S. Geological Survey has delineated a large number of locations on the Beaufort Sea shelf in the Prudhoe Bay Coastal Area

that require further investigation. Located generally in the area between Howe and Narwhal Islands off the mouth of the Sagavanirktok River, these have been designated by the USGS as the "Narwhal Island Boulder Field." This is a large, unique substrata boulder field which appears to have a different species composition from the rest of the Beaufort Sea shelf. Scientists are not certain of the biologic importance of the field to the rest of the area and feel that it should be studied further.



IV. Coastal Management Issues

IV. COASTAL MANAGEMENT ISSUES

The exploration and development of North Slope petroleum resources have raised a number of issues pertinent to coastal management. Primary among these is the conflict between use of the land for development purposes, on the one hand, and its use for the production of wildlife resources, on the other.

The entire North Slope is prime fish and wildlife habitat and harbors a variety of land and water species. For centuries, these have provided the basis for the subsistence economy and culture of the Inupiat people who inhabit the coastal region. From the point of view of local residents, it is imperative that fish and wildlife resources and their essential habitat be protected.

Petroleum development has had both positive and negative impacts. On the negative side is the direct consumption of wildlife habitat by petroleum associated facilities and structures. Indirectly, the consumption of water and gravel resources also may disrupt or destroy habitat. Furthermore, the intrusion of large numbers of people into the region has resulted in increased sport hunting and fishing, thus increasing pressure on wildlife resources.

The introduction of a development culture into the North Slope has raised social and cultural issues as well. There is fear on the part of some older residents that with increased cash income, dependency on subsistence hunting and fishing will lessen. With the need to hunt and fish removed, the old skills required to conduct these activities will be lost, thus destroying the basis of the Inupiat culture.

However, Prudhoe Bay development has brought positive benefits as well. One direct benefit has been the creation of new employment opportunities for Borough residents in the Prudhoe Bay complex. Less obvious but of considerably greater impact are the expanded services and facilities and new employment within traditional communities provided by the North Slope Borough with revenues from Prudhoe Bay oil and gas property taxes.

The opportunity for local employment stems the outflow of young people from the region, a serious problem in the past. Although some older Borough residents might deplore this, the opportunity for local employment for cash wages also provides a buffer when hunting and fishing are lean.

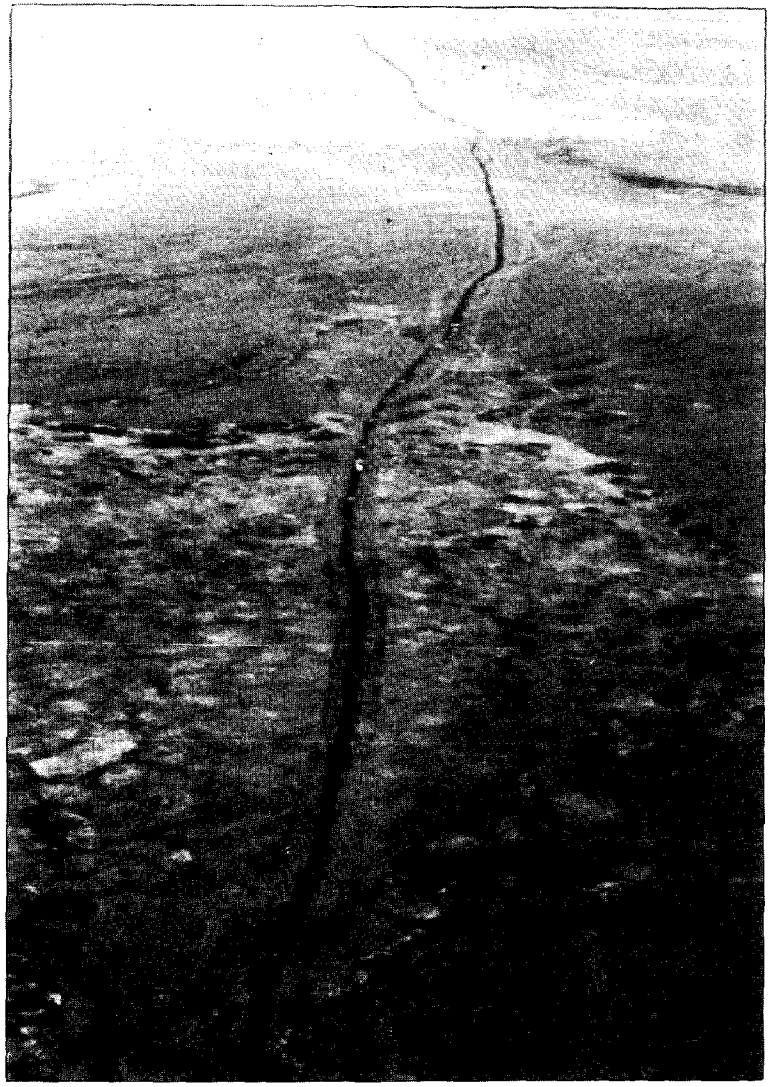
D-2 land designations are currently only tentative and depend upon the decision of the U. S. Congress. The status of other land within the Borough is also undecided at this time. Under AS 29.18.190, a borough or city may select 10 percent of the vacant, unappropriated, unreserved State land located within its boundaries. Thus far, the State and Borough have been unable to resolve the question of just which State land is available for selection, and the Borough has received none of its entitlement. The status of several Native allotments within the Prudhoe Bay area is also subject to question: The State leased the land on which these contested allotments are located to oil companies for exploration and development, ignoring their existence. Allotment holders believe that they can supply proof of occupancy sufficient to satisfy the law and establish their ownership.

Access to the land has long been a hotly contested issue on the North Slope. On the one hand, there is a whole series of issues raised by the possibility of opening the Haul Road to public usage. North Slope Borough residents feel that public usage of the road and the influx of large numbers of people associated with it will put unendurable pressure on habitat and fish and wildlife resources. Borough officials also fear that open access will necessitate the provision of extensive facilities and services by the Borough and will become an economic burden.

While North Slope residents are not in favor of opening the Haul Road to the public, they are concerned about access to subsistence hunting and fishing grounds. Several of the proposed D-2 classifications preclude subsistence hunting and fishing. Furthermore, the establishment of "national interest" enclaves may serve to cut local residents off from traditional subsistence grounds if access through them is not provided.

Finally, there is the issue of local control and participation in Federal and State government actions affecting the North Slope Borough. Centuries of life in the Arctic have made Borough residents eminently knowledgeable in matters concerning the land and its resources, yet the opinion of the Borough is rarely solicited by either the State or Federal governments in important decisions involving the North Slope. Local zoning has been largely ignored by other government agencies and therefore has not been effective.

Many fish and wildlife species inhabiting the North Slope are migratory in nature and spend portions of their life cycle in other regions of the State or in other parts of the world. This is particularly true of birds and sea mammals such as the seal, walrus and whale and some land mammals as well. Since political boundaries are meaningless to migrating species, management according to these lines is ineffective at best. In the polar region, policies and actions of one country vis-a-vis natural resource management or development can have serious impacts on the resources and habitat of neighboring countries. An oil spill in the Mackenzie River delta, for example, would not only have serious impacts on the Alaskan arctic coast and its wildlife resources but could also have wide ranging impacts on wildlife in other parts of the world if sea mammal and bird habitat were affected.



Consistent or at least compatible policies on the part of those countries bordering the Arctic Ocean would greatly enhance the ability to monitor and manage the region's wildlife resources and habitat. The agreement on the Conservation of the Polar Bear is a step in this direction, but it is limited to one species, the polar bear. It is the policy of the North Slope Borough that the entire Arctic Ocean should be similarly managed on an international scale.

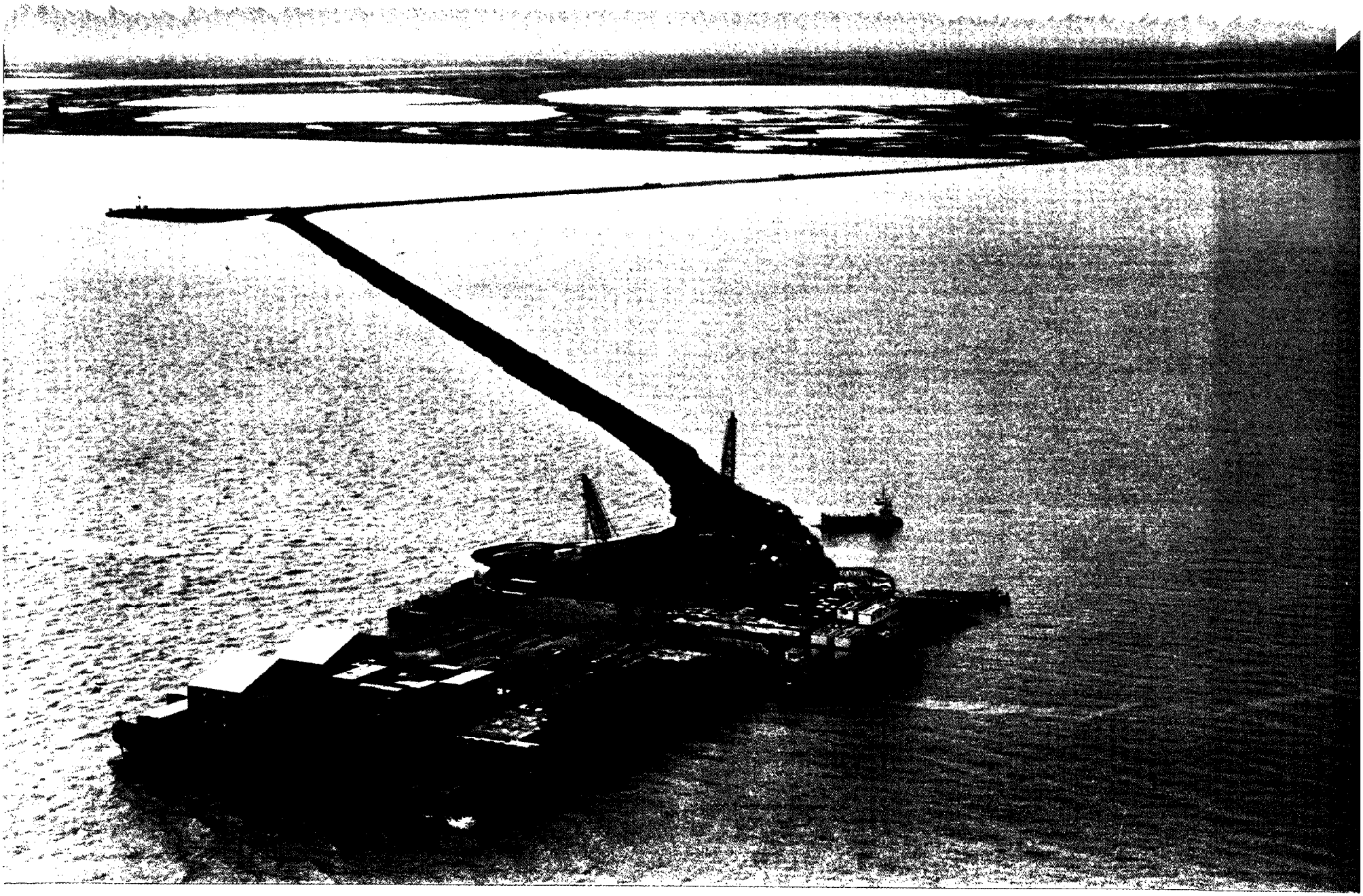
Proposals under Section 17(d)(2) of the Alaska Native Claims Settlement Act of 1971 presently under consideration by the U. S. Congress raise a number of coastal management issues. The legislation proposes a variety of land classifications within the North Slope Borough: wild and scenic river, wildlife refuge, national park, national preserve, wilderness area. Each of these is associated with a different and sometimes conflicting habitat management philosophy. The wild and scenic river classification is designed to preserve waterways in their primitive condition, thus no habitat enhancement of any kind is allowed. (Interestingly enough, the designation of rivers within the study area as wild and scenic would in a sense accomplish just the opposite of the goal. The rivers are wild and scenic, but classifying them as such would attract numbers of boating enthusiasts and thus destroy their virgin character.) Similar provisions against habitat enhancement apply to wilderness and national preserve classifications.

On the other hand, habitat enhancement is allowed in national parks and wildlife refuges. Development of tourist facilities and services is also allowed in national parks. Resource development is allowed under certain conditions in a wildlife refuge. If these classifications become fact, adjoining lands will be managed with entirely different policies: Habitat enhancement will be precluded in some, encouraged in others. Human usage will be stimulated in some, discouraged in others. Furthermore, each classification is the management responsibility of a different government agency, sometimes with conflicting goals and objectives.

The coastal area of the North Slope Borough is seasonal habitat for two endangered animal species: the peregrine falcon and the bowhead whale. The bowhead is important to local residents because it forms the mainstay of their diet and the basis of their subsistence culture.

Although increased cash has enabled the Eskimo to make modern substitutions for many of the traditional items historically obtained from the bowhead, for example, fuel, and modern technology has significantly altered hunting techniques, subsistence hunting of the whale and other sea mammals remains an integral element in the culture of the region.

Both the bowhead whale and the peregrine falcon, because of the precarious state of their existence, have international significance. In this context, the potential impact of petroleum development becomes even more serious and raises the question whether any development should be allowed. Certainly if development is allowed, the protection of endangered species must be assured.



V. Classification of Lands and Waters

V. CLASSIFICATION OF LANDS AND WATERS

The purpose of the Coastal Management Program from the perspective of the North Slope Borough is to safeguard its interests as comprehensively as possible. Of primary interest to the Borough are the fish and game resources on which the subsistence economy and culture of the local residents depend. Thus, the overall thrust of the Coastal Management Program is to protect these resources. Aside from the overall policy of protecting the region's fish and wildlife, however, there is substantial benefit to be gained by the Borough from the development of the region's petroleum resources. Petroleum development provides a tax base which enables the Borough to provide its residents with important facilities and services and at the same time to increase local employment. Therefore, petroleum development will be allowed but only where it does not threaten important subsistence resources and their habitat.

To ensure that development takes place with the least possible impact on fish and wildlife resources and habitat, lands and waters in the study area have been classified into areas according to their importance to the preservation of these resources, on the one hand, and their suitability for development, on the other hand. Within the study area lands and waters fall into four classifications depending upon their importance as wildlife habitat: (1) conservation areas where habitat is of such sensitivity that no development is allowed; (2) seasonal conservation areas where habitat is extremely vulnerable during the ice-free season and therefore is protected from development during that time; (3) areas which merit special attention within which development activity is allowed with utmost concern for wildlife habitat; and (4) sensitive habitat which is generally not as productive as in preceding classifications but nevertheless important to protect the region's overall ecosystem.

Areas which seem suitable for petroleum development have been designated the zone of preferred development. These fall into two classifications: the industrial development zone which is appropriate for permanent, long-term facilities and services and petroleum development zones which appear appropriate for more temporary support activity required for oil and gas exploration and development.

A. CONSERVATION AREAS

Conservation areas are areas of particular environmental importance in which development of any kind, except pipeline crossings and activities of overriding national interest, would be entirely inappropriate. However, stream clearing and wildlife enhancement activities will be encouraged in these areas. Within the Prudhoe Bay Coastal Area, those lands and waters classified as conservation areas include the entire reach of the Colville and Canning Rivers and their associated delta systems and Howe Island at the mouth of the Sagavanirktok River.

The Colville and Canning Rivers provide important fish spawning and overwintering habitat and are thus susceptible to severe degradation from water and gravel removal and from snow cover removal during winter. The Colville River delta is perhaps the most productive bird habitat on the entire North Slope. Because it is one of the first ice-free water bodies in spring, it serves as an important bird staging area during spring and fall migration. Both the Canning and Colville deltas provide important bird nesting habitat and are used heavily by anadromous fish for summer feeding. In addition, these two deltas have been identified by wildlife experts as prime polar bear denning habitat. The Colville delta, and to a lesser extent the Canning River delta, may also serve as whale and seal feeding and calving grounds.

Located at the mouth of the Sagavanirktok River between Heald Pt. and Foggy Island, Howe Island is a little more than a mile long and 300 yards wide. It is completely tundra covered and contains a number of small ponds. Until 1971, Howe Island was apparently used sparingly as a nesting spot by lesser Canada geese, pintails, old squaw, eiders, and a few shorebirds. Beginning in 1971, however, the island has been

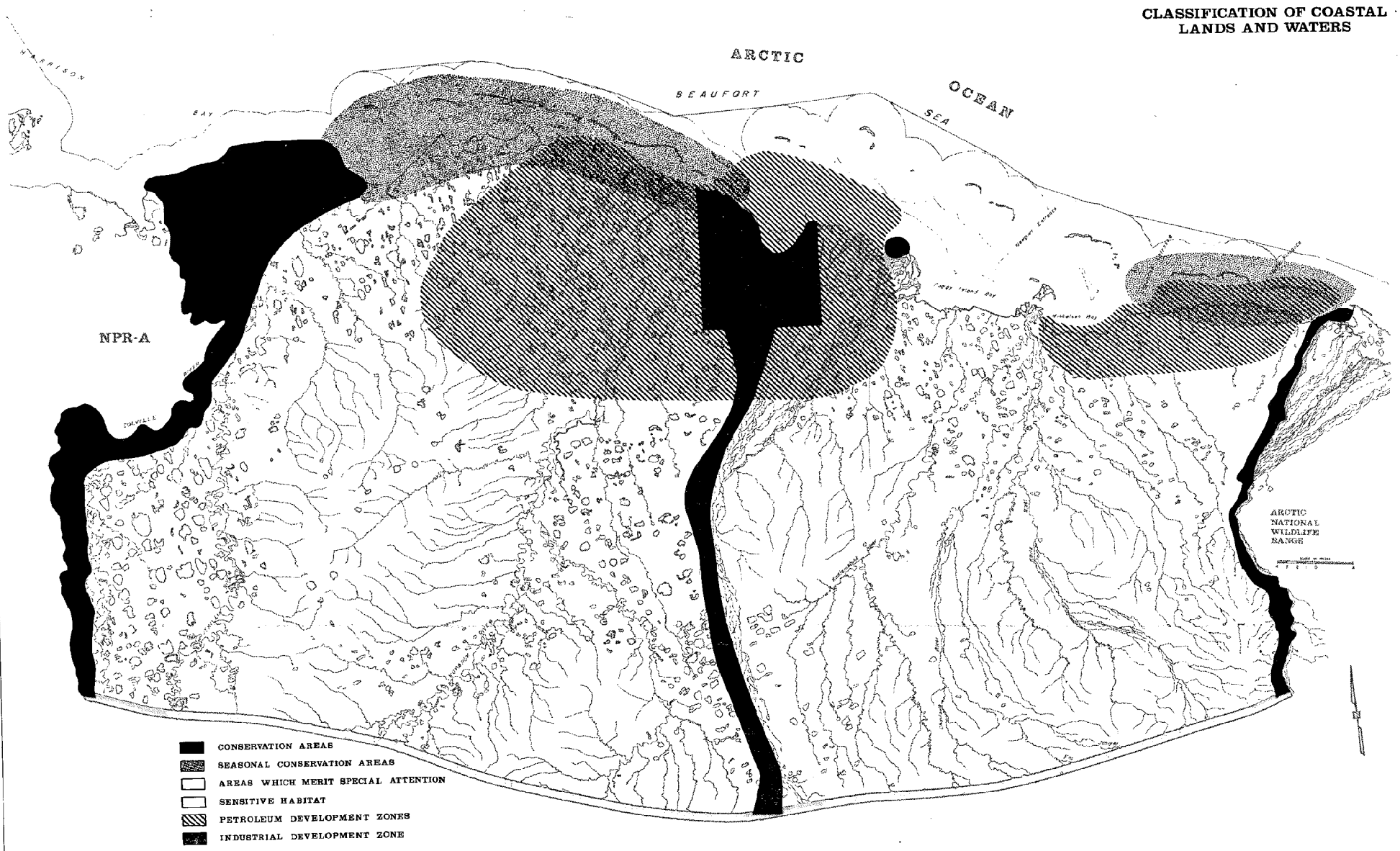
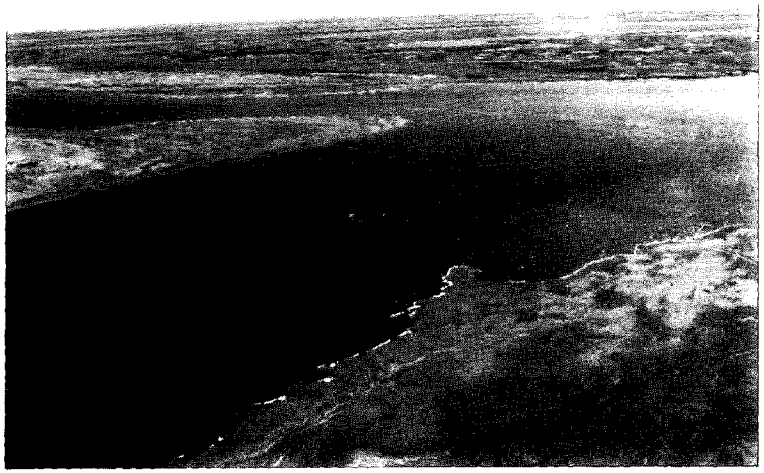

CLASSIFICATION OF COASTAL LANDS AND WATERS
ARCTIC
OCEAN
BEAUFORT
SEA
HARRISON
BAY
NPR-A
ARCTIC NATIONAL WILDLIFE RANGE
CONSERVATION AREAS
SEASONAL CONSERVATION AREAS
AREAS WHICH MERIT SPECIAL ATTENTION
SENSITIVE HABITAT
PETROLEUM DEVELOPMENT ZONES
INDUSTRIAL DEVELOPMENT ZONE

Figure 3

the chosen nesting habitat for a colony of snow geese. This is the first snow goose colony recorded in the area and the only one identified in the entire State of Alaska. For this reason, the island is considered appropriate for the special protection afforded by classifying it a conservation zone.

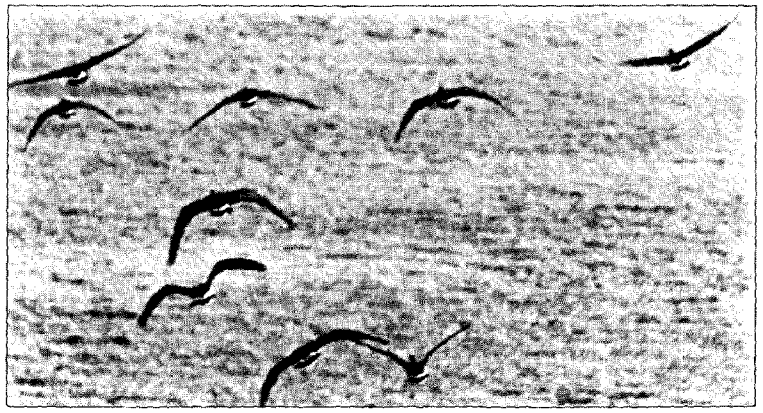
Land use on the North Slope has traditionally revolved around the availability of subsistence resources. Thus, it is not surprising that heavy concentrations of sites with historic and cultural significance have been identified in those areas where fish and game resources are most abundant and accessible. Within the study area, graves and the remains of cabins, sod houses and ice cellars are particularly prevalent along the Colville River and two main channels of the delta, the Nechelik and the Kupigruak. Sites of historic and cultural significance will be protected from disruption from structures or development activity by specified distances of separation. Historic and cultural sites within the study area continue to be heavily used today for subsistence hunting and fishing purposes.



B. SEASONAL CONSERVATION AREAS

Many species of fish and game found on the North Slope are migratory in nature, and thus certain habitats are extremely sensitive seasonally. Primary among these are the complexes comprised of the nearshore barrier islands, their associated lagoons, and the mainland coastal wetlands adjacent to them. From break-up to freeze-up, roughly May to October, these provide the nesting, moulting and post-breeding habitat for a wide variety of migratory bird species. Anadromous fish from the region's major streams feed in the protected lagoon systems during the season of open water, and seals and whales feed and calve there. Local whalers have identified an additional bowhead feeding and calving ground offshore from the Colville River delta beyond the 6-meter isobath. The U. S. Fish and Wildlife Service locates peregrine falcon nesting habitat generally east of the Kuparuk River 15 to 20 miles inland from the coast. As they are intensely used only seasonally, consonant with the time of open water, these lands and waters have been classified as seasonal conservation areas. During the time when these are critical wildlife habitat, no development activity should be allowed.

The seasonal conservation areas abound with sites of historic, cultural, and subsistence significance. As in the conservation zones, these sites will be protected from intrusion at all times by a specified distance of separation.



C. AREAS WHICH MERIT SPECIAL ATTENTION

Although fish and game habitats are most sensitive in those lands and waters classified as conservation and seasonal conservation areas, river drainages, coastal wetlands, nearshore waters and the barrier islands throughout the Prudhoe Bay Coastal Area provide important nutrient input for the entire area and thus are considered "areas which merit special attention." Within the areas designated areas which merit special attention, utmost concern for habitat protection should be exercised.

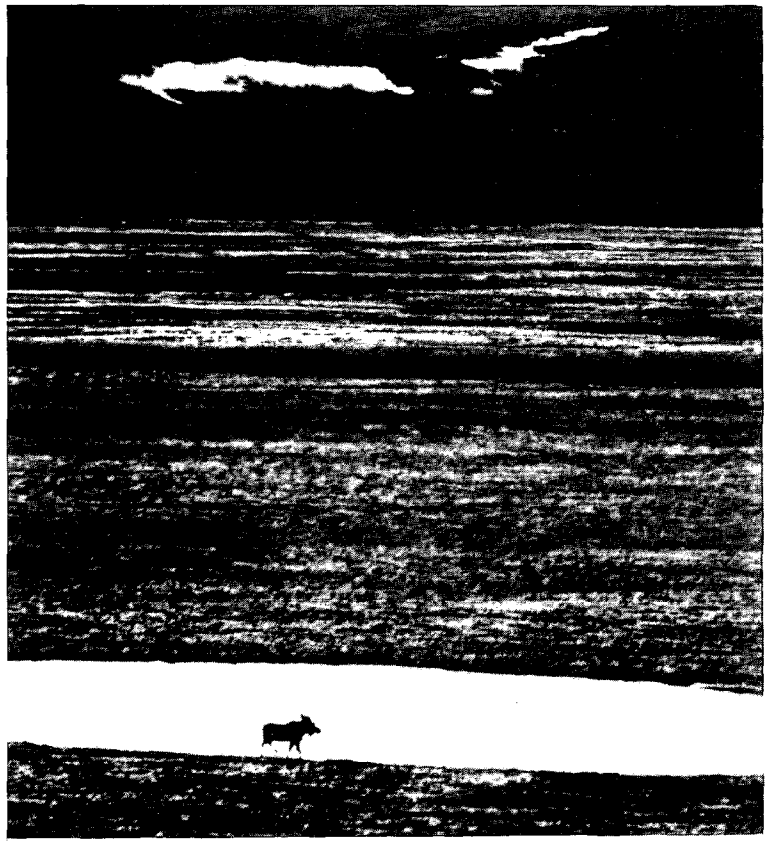
The Colville, Canning and Sagavanirktok River drainages provide overwintering and spawning habitat for fish and the willow vegetation common to these same drainages supports a small moose population. Coastal wetlands of the study area are used to some extent as nesting, feeding and moulting grounds by large numbers of migratory birds. Nearshore waters associated with the mainland coast and the barrier islands are feeding grounds for migratory birds. The coastal area between the Canning and the Colville Rivers, including the barrier islands, is apparently prime denning habitat for polar bears.

Underwater surveys by the U. S. Geological Survey have identified a large number of locations in the area between Howe and Narwhal Islands off the mouth of the Sagavanirktok River that require further investigation. Designated by the U.S.G.S. as the "Narwhal Island Boulder Field," this is a large, unique substrata boulder field which appears to have a different species composition from the rest of the Beaufort Sea shelf. Scientists are not certain of the biologic importance of the field to the rest of the area and feel that it should be studied further.

Although not as important culturally or historically as areas designated as conservation or seasonal conservation zones, the areas which merit special attention include some sites of historic and cultural significance and continue to be used for subsistence purposes. These should be protected from development activity on a site specific basis.

D. SENSITIVE HABITAT

Although not currently highly productive for fish and game or heavily used for subsistence hunting and fishing, the area classified as sensitive habitat does apparently harbor a resident caribou population and at certain times of the year is used by wolves, grizzly bears, ptarmigan and other coastal plain animals which spend significant portions of the year in the northern foothills of the Brooks Range. Relatively speaking, however, human activity is likely to have less impact on fish and game populations and traditional land use in this area than in any other in the Prudhoe Bay Coastal Area.



E. ZONE OF PREFERRED DEVELOPMENT

The zone of preferred development has been chosen on the basis of its compatibility with fish and wildlife resources and subsistence land use, the location of existing oil and gas development, and anticipated future demands for facilities and services insofar as these can be determined at this time. These are areas within which oil and gas development would seem likely to be most appropriate and within which such development should be encouraged. Zones of preferred development fall into two classifications—the industrial development zone where long-term, permanent development is allowed and the petroleum development zone within which only temporary structures and support facilities are allowed.

The industrial development zone is synonymous with the existing Prudhoe Bay/Deadhorse complex and the Pipeline/Haul Road utility corridor. In order to minimize additional impact and to avoid the unnecessary duplication of facilities and services, permanent development within the Prudhoe Bay Coastal Area should be limited to this already developed area.

The petroleum development zones are much larger in area than the industrial development zone and are designed to accommodate temporary activity related to anticipated new petroleum development. No permanent development will be allowed in these areas except such essential structures as platforms, pipelines, and pump houses.

VI. Objectives, Policies and Standards

VI. OBJECTIVES, POLICIES AND STANDARDS

A. BACKGROUND

There can be little question that the life supporting habitat and the subsurface resources are the critical elements in the development of coastal management objectives, policies and standards within the North Slope Borough generally and the Prudhoe Bay area in particular. The habitat, of course, supports the fish and wildlife populations. These populations provide subsistence for the resident Inupiat and the process involved in the Inupiat's susbsistence pursuits forms the basis of Inupiat culture. On the other hand, the subsurface resources have resulted in petroleum development. This development provides jobs, business opportunities and tax revenues for North Slope Borough residents. These revenues are used to improve local public facilities and services. The improvements are carried out by resident Inupiats who receive income for their labor. This process, in turn, results in a higher standard of living for the North Slope Borough permanent resident population. Therefore, the basis of Inupiat culture and the means for the Inupiat to subsist and prosper are vested in the prudent management of the lands and waters of the Borough and the resources therein.

Regarding the people of the North Slope Borough, the only permanent long-term residents have been the Inupiat. There are residents other than Eskimos, however, these residents are essentially transient and can be classified within four broad categories. The first are residents whose purpose for being within the Borough is associated with providing services to the local Eskimo population. Employment-produced income which supports these residents is forthcoming principally from Federal, State and local government units and to a lesser extent the Native corporations. The second group is associated with military complexes. The third group is the scientific community who is studying the Arctic. And the fourth group is associated with natural resource extraction principally of oil and gas resources.

Although considered residents, few of these people can be considered permanent residents of the North Slope Borough. Most governmental employees providing services on the North Slope remain a limited number of years. Those associated with the military either directly or by contract normally are rotated after a year or two at their station on the North Slope. Individuals in the scientific community generally remain only on a project basis or until their field data are collected or, in other instances, seasonally migrate to the north for research of limited duration. And the employees of the oil and gas industry on the North Slope are rotated from their base camp outside the North Slope on a still shorter basis.

During the last population estimate on July 1, 1977, for Alaska State revenue sharing, there were 9,163 people in the Borough. Of this number an estimated 3,612 lived in the permanent Borough communities. The total population of the Borough on July 1, 1976 was estimated at 12,614, with a total of 3,630 residing in the permanent communities. A Borough population count during September 1973 listed 3,333 residents within the permanent communities. Thus, during the period of Prudhoe Bay petroleum development, the Borough communities grew at an average rate of approximately 2.5 percent per year. This is a modest rate of growth considering that the Prudhoe Bay petroleum-related employment counted as population increased from an estimated 253 in September 1973 to 8,801 in July 1976.

The community composition is approximately 85 percent who are essentially life-long Inupiat residents and 15 percent other residents who are generally white people who have moved to the Borough for employment in the public service area. This immigration to the Borough communities has resulted in large part from the Borough's assumption of new areawide powers in recent years, the upgrading of health services in this area and the increase in Arctic research as a result of national interest in petroleum production. Overall, however, the community population in the Borough is quite stable with only a relatively small amount of growth.

The cultural base of the Inupiat of the North Slope is largely vested in the subsistence pursuits of the people. It is important to recognize that the incomes of the people of the North Slope are supplemented by subsistence activities. In many cases this is not essential from the perspective of obtaining sufficient nutrition. However, subsistence is essential if this Inupiat culture is to survive. The esteem accorded the captain for his skill and bravery; the sharing of the catch on a community basis; the provisions for the old, the infirm, the ill and the needy from the catch; the camaraderie and brotherhood fostered in the hunt; the passing of legends from generation to generation; and the total reliance upon Inupiaq as the language of the hunt; are all basic to the Inupiat culture which prizes the abilities of people to survive in the Arctic and from this evolves the sophisticated personal relationships, the generous sharing of time and property and other elements appreciated in so-called "village living."

The economic base of the Inupiat of the North Slope Borough is vested in the natural resource extraction industries, principally the petroleum industry in the Prudhoe Bay area. This industrial sector has provided the residents of the Borough with greater opportunity for employment and with increased business opportunities both through village and regional corporation enterprises and as individual entrepreneurs. It has also provided a source of tax revenues which in turn create employment and business opportunities while providing needed facilities and services to the people.

As a result of natural resource extraction, the Borough has been afforded the opportunity of raising the level of living of its people. And this industry sector can only be considered basic to the continued improvement of future living conditions in this harsh environment. Threats to the continuation of natural resource development in the North Slope Borough are threats to the social and economic well-being of the people of the North Slope Borough.

Estimates by Federal and State agencies concerned with the assessment of natural resources indicate the existence of large quantities of subsurface resources beyond those discovered and in the process of development in the Prudhoe Bay area such as other petroleum resources, coal, phosphates and other minerals. However, despite this storehouse of mineral resources, the costs associated with development are extremely high. Therefore, the discovery of major deposits is required at this time before production is considered or deposits of a smaller scale must be located close to existing transportation systems thereby reducing costs before production would be contemplated. Even drastic increases in value over time due to increased scarcity may not result in the development of the resources if costs of production increase at a similar rate. Furthermore, substitutes for these resources may be developed and employed. Technology, in general, becomes a two-edged sword in this case. It may serve to reduce costs of development in the Arctic, permitting commercial development on the one hand. On the other hand, it may provide substitutes for these Arctic resources. For example, in 1978, there is no development of the Beluga coal fields which are large, quality subbituminous deposits at tidewater near Anchorage. The increased demand for coal is being filled through increased production of the established eastern coal region and the open pit mining of new western deposits. The potential supply from these areas certainly looks as though it will extend in time to a point where alternate sources of power may be developed and provide reasonably low-cost energy.

Given this admittedly pessimistic scenario, it would be sheer folly to impose policies which would prohibit development of the few potential commercial deposits which may exist aside from the present Prudhoe Bay field. Therefore, a policy is mandated that will enable the exploration, designation and development of what in all likelihood will be a relatively small number of commercial deposits of nonrenewable petroleum resources. These resources are scarce in the quantities, at the grades and in the locations which make them commercial. And in terms of the most complete commercial extraction only relatively small amounts of the

land's surface will be disturbed and temporarily occupied.

Nevertheless, this does not imply either rapid development or uncontrolled development. Unquestionably, no development should take place in areas such as those of irreplaceable habitat, extremely scenic and aesthetically pleasing areas, historic sites and other such areas of concern within the Borough. However, regarding natural resource development in most of the remainder, it is more a question of enforcing standards resulting in development of the highest quality with concern for the environment in the broadest sense.

On the other hand, it is well understood by the permanent inhabitants of the North Slope Borough that the fish and wildlife and the environment required for their maintenance, and hopefully their enhancement, must be protected to insure a perpetual harvest for subsistence uses and the maintenance of the Inupiat culture.

This has become an increasingly formidable task since the Inupiat is expected to exercise the utmost prudence not only to insure his own perpetual taking but to insure the continued maintenance or enhancement of fish and wildlife for the remainder of the United States as well as other nations.

Since the basis of the Inupiat culture is vested in subsistence gathering activities his claim to this renewable resource must be of a higher order than any other user. However, despite this legitimate primary claim to the resource, it is fully realized that no one will gain with the deterioration of the stocks or with extinction at the extreme. Therefore, it is of great interest to the Inupiat and a policy of the North Slope Borough to insure a safe environment for the optimum propagation of the fish and wildlife for subsistence uses as well as for the benefit of other peoples. At the same time, there must be allowances for prudent development of petroleum resources under strict regulation. No longer will the Inupiat bear the burden of fish and wildlife conservation through a return to the nondevelopment policies which were replete with poverty and privation for many if not most. The call is for prudent multiple use development of excellence.

B. OBJECTIVES

The North Slope Borough objectives in the management of the Prudhoe Bay Coastal Area are as follows:

1. To value and have valued by others the long-term needs of fish and wildlife above all competing uses.
2. To enforce sound management of all fish and wildlife resources and the environment upon which the fish and wildlife and man depend.
3. To effect management on the basis of total ecosystems.
4. To use Borough regulatory powers, to enter into agreements and to generally promote the protection of fish and wildlife habitat regardless of jurisdiction.
5. To compel management plans and actions to perpetuate and enhance the habitat to obtain optimum fish and wildlife populations.
6. To insist upon the protection of endangered and threatened species.
7. To preserve the traditional Inupiat lifestyle and culture by maintaining unimpaired subsistence use and access to all lands and waters and the fish and wildlife which inhabit them and by preserving the historic resources of the Inupiat culture.
8. To permit competing uses only when assured that the effects will neither result in decreased productivity of fish and wildlife resources within the ecosystems nor the loss of endangered or threatened species.
9. To support competing uses only to the extent that they contribute to the health and well-being of the permanent residents of the North Slope Borough and fulfill the intent and spirit of self-determination as embodied in the Alaska Native Claims Settlement Act.

C. POLICIES

The policies or plans of action in the Prudhoe Bay Coastal Area for carrying out the objectives of the Coastal Management Program are tailored toward the perpetuation and

enhancement of wildlife and wildlife habitat, while at the same time recognizing the existence of competing uses and the necessity of accommodating these in the future. However, policies relating to competing uses call for outright avoidance, severe limitation, stringent requirements and regulation and actions to overcome their effects. Since the following policies have broad effects in most cases, it should be understood that their influence extends beyond the categories in which they are placed.

1. Siting of Major Public and Private Facilities

- The location of all facilities will be on a site specific basis by permit so as to avoid unnecessary dispersal of facilities as well as to provide a means of protecting areas meriting special attention such as archeological and historic sites, hunting and fishing camps and grounds, and areas of exceptional habitat.

- Sand and gravel borrow pits must be located on a site specific basis. This mining should not take place during portions of the year when there would be substantial harm to the environment such as the silting of rivers and streams. Mining should not take place on the beaches or offshore unless no alternatives exist and only then when it can be demonstrated that the shoreline dynamics are not to be altered.

- Transportation facilities should be multimodal to the maximum extent possible thus enabling utility and transportation modes to be placed in a single corridor. The number of corridors should be minimized through cooperative long-term planning efforts.

- Airports and helicopter pads should be located so that there is a minimum of impact upon migrating wildlife, breeding grounds and nesting areas. Furthermore, air routes and altitudes should be designated and maintained to minimize disruption of wildlife.

- It is the Borough position that energy development such as the Prudhoe Bay production and the upcoming gas pipeline should be the top priority use in the Haul Road utility corridor. Uses such as tourism facilities, sport hunting and fishing resorts and remote subdivisions should definitely be discouraged at this time.

- Future related energy development such as that contemplated in the Beaufort Sea area, NPR-A and regional corporation lands should also be considered a prime use for the Haul Road. However, such development should continue to pay its own way as far as road development and maintenance are concerned.

- In keeping with its policy to minimize land use through the joint use of facilities and the concentration of development, the Borough policy is to limit access to the land. This position is critical regarding ingress and egress along the Pipeline Haul Road. It is the Borough policy that all traffic should pass through the Borough with an absolute minimum of stops or impact on adjacent lands and resources within the Prudhoe Bay Coastal Area.

- Solid waste disposal on the barrier islands, artificial islands or at sea should not be permitted nor should there be any disposal in the rivers or lakes which support or are capable of supporting fish and wildlife.

- Any major lease sales resulting in the addition of facilities in the Prudhoe Bay Coastal Area should submit a plan of such activities with the proposed optimum location of facilities prior to any development.

- Archeological and historic sites and sites of cultural significance such as fishing and hunting camps are to be avoided in the siting of any facilities. No activity is to be permitted in known sites and a thorough investigation of proposed sites for any proposed development should be undertaken prior to construction. These sites are generally small and present little problem in working around them.

- It is Borough policy that the joint use of sites and facilities, including existing facilities, should be encouraged to the maximum extent possible. Included in the facilities under consideration should be the shore-based production facilities, pipelines, freshwater storage areas, material sites, airfields, roads, disposal sites, and transportation corridors.

- Although areas subject to flooding as a result of a 100-year flood have not been precisely identified, there appears to be little question that the Prudhoe Bay/Deadhorse complex is in the floodplain of the Sagavanirktok River. In order to promote the public health, safety and general welfare of the Borough and to protect the environment, the loss of life and property, the disruption of commerce and governmental services and the impairment of the tax base, facilities shall in location, design, construction and operation be protected against flood damages.

- No permanent residential settlement or new towns should be located in the Prudhoe Bay Coastal Area. The practice of maintaining camps for employees who are shuttled into the area for work periods then outside to their permanent residence is viewed by the Borough as the best means of limiting the impact of people upon the environment. Permanent residential development would increase the consumption of wildlife habitat, pollution and competition for limited subsistence resources. The major private and public facilities created by this activity should be confined to the Prudhoe Bay/Deadhorse area.

- Long-term structures or facilities for administration, operations or residence should be located in the Prudhoe Bay/Deadhorse area. No long-term facilities other than pipelines, pump houses, and other structures or facilities absolutely necessary to the operations of petroleum fields should be located outside this area.

- Major shoreline use and facilities such as docks, barge landing areas and service bases will be confined to Prudhoe Bay. Safety of offshore personnel is deemed by the Borough as the only exception meriting consideration for shoreline locations. The prime areas of consideration in this regard are viewed as being the DEW Line stations which are no longer in use.

- Upon consideration of flooding, soils, and other characteristics, there shall be a concentration of facilities in the Prudhoe Bay/Deadhorse area sufficient to take advantage of the economics of utilities such as piped sewer and water, power and other infrastructural elements such as existing roads and communications.

2. **Management of Valuable Commercial, Recreation, and Subsistence Resources**

- Since the entire offshore area nominated for oil and gas leasing has been classified by the Borough Coastal Management Program as an area which merits special attention, severe use restrictions should be established on a seasonal basis for all tracts leased.

- The Borough has a vital interest in preserving from destruction or detrimental impact those sites or areas of historic, architectural, archeological and general cultural significance identified in *Beaufort Sea Study—Historic and Subsistence Site Inventory.* Many of the sites shown on USGS 1:250,000 maps in this report could meet National Register criteria. However, many sites require interpretation in far greater detail to guarantee that historic preservation and environmental requirements are completely met. Especially important to the coastal Inupiat and the North Slope Borough are the barrier islands from Thetis Island to Icy Reef. If there is to be compatible development offshore, these sites must be held inviolate. Therefore, identification, study and interpretation of these sites in detail must be carried out prior to lease sales so that conflicts will be avoided.

- Areas deemed irreplaceable habitat which support abun-

dant fish and wildlife populations and which should be totally removed from surface use are Colville River and its delta, the Canning River and its delta, and Howe Island which is a part of the Sagavanirktok River delta. The Colville River delta is the most productive waterfowl area on the North Slope, an anadromous fishery and a site of polar bear denning. The Canning River delta is also an important area for waterfowl and anadromous fish. And Howe Island is the only identified snow goose breeding ground in Alaska. Not only should there be no surface use in these areas but a sufficient buffer area should be maintained to exempt these areas from other forms of disturbance such as noise pollution. In addition, no activity should be permitted in known sites of archeological and historic importance or in sites of cultural significance such as fishing and hunting camps.

- The area from the Colville River delta to Egg Island which includes Simpson Lagoon and Gwydyr Bay is an important seasonal feeding ground for anadromous fish and whales, a polar bear denning area and a waterfowl area. It is unquestionably an area of exceptional habitat. The Borough recommends that this area not be considered for oil and gas leasing until safe development is demonstrated in other offshore areas and then only on a seasonal basis.

- The area enclosed by the Maguire Islands and Flaxman Island is also an important seasonal feeding ground for anadromous fish, whales and some waterfowl. This is an area of exceptional habitat and the Borough recommends that it not be considered for oil and gas leasing until safe development is demonstrated in other offshore areas and then only on a seasonal basis.

- The Borough views public land ownership as being an extremely important means of avoiding and mitigating undesirable impacts. Lease agreements may provide controls unavailable by other means. Therefore, except for Native Allotment claims and where provided for under the terms of the Alaska Native Claims Settlement Act, the Borough desires that no land be sold or conveyed in fee to private parties in this area.

- To further strengthen local control of development in the Prudhoe Bay Coastal Area, the North Slope Borough has actively pursued land selections in the immediate vicinity of Prudhoe Bay and Deadhorse.

- Aggressive management of fish and wildlife and their habitat should not be abandoned simply because petroleum development exists in the area. The Borough believes that management and programs of habitat improvement should be more intensive during this period of habitat consumption and fish and wildlife disruption.

- Petroleum development producing a nonrenewable resource will perhaps occupy portions of lease sale areas for only a relatively short period of time. Although this period may be a substantial part of our lives, it is still temporary. Therefore, the permanent long-range values

of the area should receive emphasis.

- All lands upon termination, cancellation or abandonment of leases should be returned as closely as possible to their natural state. This would include artificial islands, causeways and roads which should be removed after their use has ended.

- The quantities of land or the number of tracts to be leased during lease sales should be capable of being closely monitored. The areas should be of the scale to allow the responsible authorities to thoroughly enforce and manage the stipulations of lease sale contracts and general authorities under law.

- Lands beyond the barrier islands except those capable of being explored and produced from the barrier islands should not be leased at this time. The technology required to safely explore, develop and produce from artificial islands, drillships, rigs or platforms beyond the barrier islands needs to be demonstrated before such risk-taking ventures should be allowed.

- Exploration, development and production drilling should be permitted to locate only on a site specific basis onshore and on the barrier islands and from artificial islands. Thus, potential spills or blowouts at the wellhead would result in the oil flowing upon the surface (land, ice or snow) where it could be impounded and cleaned up rather than chancing a spill in the Beaufort Sea. By reason, the danger of subsea or underwater escapement of oil is simply not worth the chance, especially where endangered marine species are involved. A spill could conceivably destroy food sources of the bowhead whale and other endangered species. If no alternate habitat or source of food was available, the consequences could be tragic.

- A separate plan of operations should be submitted for development/production phases. However, implicit in lease sale contracts is the intent to produce hydrocarbons. If allowable means of transporting petroleum from offshore fields as written or implied in lease sale contracts are later barred for environmental reasons, claims would undoubtedly be filed by lessees. Or, environmental objections would be subjugated by economic considerations. Therefore, it is viewed by the Borough as being extremely important that the means of transporting petroleum to shore or from offshore loading systems and the effects of these transportation modes be thoroughly investigated prior to sales.

- Despite extensive experience in petroleum exploration, development, production and transportation in the Prudhoe Bay Coastal Area, many new considerations are posed by proposed offshore activities. The Borough views increased knowledge of the following factors as being critical to successful petroleum exploitation with a minimum of environmental disruption: barrier reefs or former barrier islands, the so-called Narwhal Island boulder field, underwater permafrost, the effects of oil spills in the cold Beaufort Sea waters and an oil spill contingency plan considering these effects, the effects of artificial islands and causeways upon the marine environment, effects of this environment upon subsea pipelines, especially new methods such as installation of casing by directional drilling for emplacement of carrier pipe, and the effects of subsea gravel mining on the marine environment.

- A thorough set of stipulations dealing with noise pollution, erosion, silting, gravel extraction, water usage and waste disposal should be included in lease sale stipulations. The Borough considers strict regulation in these matters to be invaluable to the protection of the Prudhoe Bay Coastal Area environment.

- Although not promulgated by the State of Alaska, the studies as required in the Oil and Gas Pre-Leasing Procedures (11 AAC 81.210-430) regarding social, economic and environmental analyses of proposed lease

sales is viewed by the Borough as being essential prior to any lease sale by the State. 11 AAC 81.040 permits the Director of the Division of Lands or his designee to exempt the proposed joint Federal/State Beaufort Sea lease sale from any and all requirements of sections 210-430. Considering the complexities involved in this frontier area and the presence of endangered species, the Borough believes an exemption of these studies not to be in the best interest of the Borough and the State.

- Environmental training in the broadest sense should be undertaken in all areas. In addition to archeological, geological and biological considerations, the program should consider the historic, social, and cultural aspects of the North Slope and its residents. In this way a greater appreciation and respect for the Inupiat and their values may be gained by those working for the petroleum industry on the North Slope and in the Prudhoe Bay Coastal Area in particular.
- The Borough considers a field training program as required by 18 AAC 75.310 Contingency Plans to be of great importance. Borough staff observations of recent oil spills indicate that failures in techniques and equipment could have been detected and corrected as a result of field training exercises prior to actual oil spills.
- An inventory should be undertaken quantifying the life of the coastal habitat including the number of marine organisms and the amount of biomass prior to a lease sale. Furthermore, dollar values should be estimated. Also included should be the fair market value and utility/rent value of beach and shoreline property and the shoreline properties of the estuaries. These quantities and values agreed upon by the lessees and the lessors and should then be included in the stipulations of the lease sale contract to provide a basis for calculations of environmental loss or damage which might occur. This is looked upon by the Borough as a deterrent to careless practices resulting in pollution, as spurring clean-up actions if a spill results, and as a means of quicker recovery from environmental loss or damage.
- Lands consumed in the conduct of petroleum exploration, development, production and transportation should be valued as to the loss of fish and wildlife habitat. Funds compensating the State or Federal government for this loss should then be expended within the region for habitat improvement, thereby mitigating the loss of habitat. The Borough views this as a deterrent to unnecessary consumption of space (habitat) as well as a means of avoiding the loss of fish and wildlife resources.
- The existence of habitat which is capable of producing plentiful wildlife is essential to the preservation of Inupiat subsistence economy and culture. Since the maintenance of these is of paramount importance to the people of the Borough, it is Borough policy to strictly limit any activities which would inhibit habitat production. Conversely, the Borough believes that whenever possible habitat enhancement programs should be strongly encouraged.
- Recreation and tourism are both activities whose development directly infringes on wildlife supporting habitat and which threaten to compete for subsistence resources. To minimize their adverse impact, facilities and services supporting these activities should be confined to already developed areas.
- It is Borough policy to discourage land classifications such as Wild and Scenic River and National Park which would serve in the long run to encourage increased tourist and recreation use of the land.

3. Intergovernmental Coordination

- The Borough views participation in all governmental activities directly affecting the lands and waters of its coastal area as a primary means of attaining its goals. It is the policy of the North Slope Borough to actively and

willingly participate in planning, policy development and regulatory activities within the North Slope Borough. Thus, the North Slope Borough calls for the fullest opportunity allowable under law to participate and coordinate activities with other governmental entities.

- The North Slope Borough policy in regard to fish and wildlife management can be summed up as one of active participation in a cooperative management system of excellence with an overriding priority for subsistence uses. The Borough views the Alaska Eskimo Whaling Commission as a beginning. Although this Commission was formed for the local self-regulation of a single endangered migratory subsistence species, its formation was encouraged by the Federal government and it is actively cooperating with State and Federal officials in the management of this vital resource.
- Since the petroleum industry, especially in its offshore operations, is extremely complex with innumerable variables presented during the exploration of each lease sale area and during the development and production phases after the location of commercial quantities, the Borough views a close working relationship between industry and government as a means of satisfactory and mutually beneficial site location and protection of the environment. The Borough realizes that severe limitations exist in planning where the location of the petroleum finds are not known. Thus, once the deposits are defined, the development of plans must begin anew with a whole series of alternate means of developing, producing and transporting the product. Most often this involves the consideration of adjacent and nearby finds. Thus, once lease sale contracts are entered into, there must be a degree of flexibility during the production and development phases. To assure maximum protection of the environment, the Borough must maintain a close, ongoing relationship with the industry.
- In order to facilitate the sound environmental practices required by lease sale contracts, Federal and State laws and local ordinances, a joint office should be established to coordinate and expedite the processing of all governmental permits and project reviews. Such a "one stop shopping center" concept is seen by the Borough as providing a more coordinated, responsive and empirical approach to the management of lands and waters after lease sales. From the industry's viewpoint, it would serve to avoid duplication and time and effort consumed in locating and dealing with numerous seemingly autonomous governmental units. Furthermore, this approach, which would be a part of the lease sale stipulations, is seen as being more logical if extended to include existing and potential petroleum basins or petroleum provinces rather than individual lease sales. The entire Beaufort Sea area both onshore and offshore and both Federal and State lands and waters appear amenable to this approach.
- The Borough views agreements among the circumpolar nations regarding the environmental protection of the Arctic Ocean to be in the best interest of all nations. Thus, the Borough will continue its efforts toward the realization of an Arctic Oceans policy with other governmental units.
- The exploration and development of energy resources both onshore and offshore in the frontier Arctic areas of Alaska, Canada, Greenland and the Soviet Union are viewed by the North Slope Borough as being potentially detrimental to the fragile Arctic environment. As a means of environmental protection, the Borough will attempt to effect intergovernmental coordination resulting in an international Arctic coastal management program and a cooperative environmental impact assessment protocol.
- It is the North Slope Borough's view that rules of operation for the exploration, development and production of petroleum of neighboring Arctic Ocean nations

be at least as stringent as those in Alaska. To insure the safe development of petroleum resources in the Arctic, a common set of rules for onshore and offshore development must be formulated and agreed upon. Coordinated, unified intergovernmental activity is viewed as being necessary to initiate such an agreement.

D. STANDARDS

The standards or the rules to be applied in carrying out the North Slope Borough policies for conducting activities on the lands and waters of the Prudhoe Bay Coastal Area cannot be formulated prior to the development of the basic tools of implementation. Although the coastal management program enables the formulation of goals and policies, the development of standards requires carrying out a basic program of comprehensive planning culminating in the enactment of codes and ordinances in which the standards are embodied. Or Borough standards can evolve through agreements with other units of government where standards are jointly developed. However, if the North Slope Borough is to develop confidence in and understanding of its position regarding standards and their enforcement, it must go through the process of developing standards independently prior to negotiations.

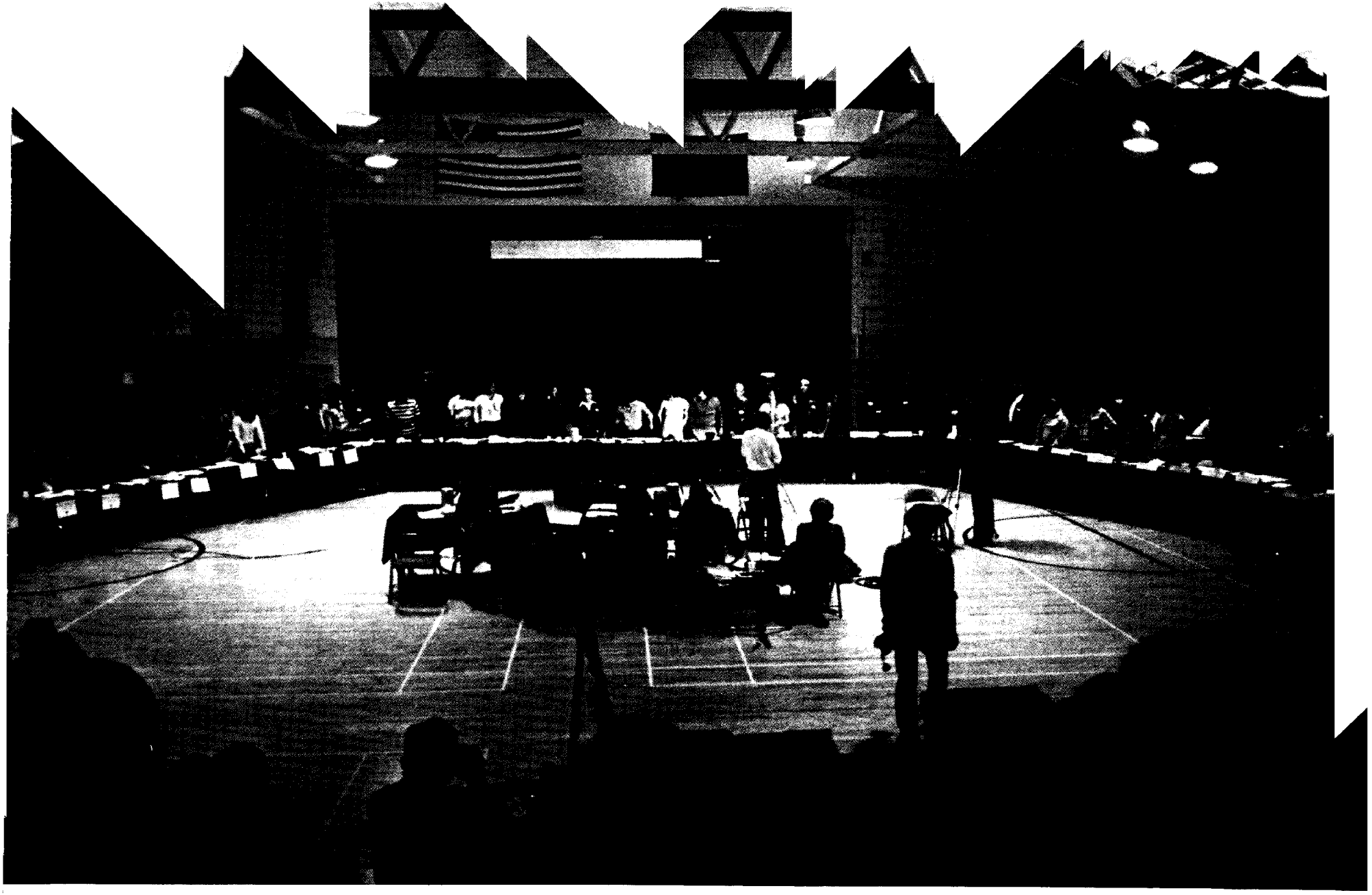
It should not be interpreted that there are no standards being applied to development in the Prudhoe Bay Coastal Area. A wide range of standards in the form of regulations are being applied by Federal agencies such as the Environmental Protection Agency, the U. S. Fish and Wildlife Service, the U. S. Army Corps of Engineers, the Office of Pipeline Safety, the Occupational Safety and Health Administration, and many others, while State agencies such as the Department of Environmental Conservation, the Department of Fish and Game, the Department of Transportation and Public Facilities, the Department of Natural Resources, and others have their own standards which overall vary from those applied by the Federal government.

However, it is reasonable to assume that these standards, although embodying in part the Borough's policies, are not structured to attain Borough goals. It is the standards developed at the local level which must guide Federal and State regulatory and enforcement authority toward the attainment of local goals.

The development of reasonable, yet effective standards in the Prudhoe Bay Coastal Area is not an easy task due to the nature of the petroleum industry whose land uses and activities overshadow all other effects upon the environment. This is a large, dynamic and complex industry which as it moves offshore poses even greater threats to the environment.

To counter these threats to the environment, codes and ordinances are required which prevent surface development in specific areas, limit development on a seasonal basis in other areas, and severely regulate activities in all areas where development is allowed. This requires the legal enforcement of standards based upon contingency plans and these plans and the standards to be applied must have a degree of flexibility which makes them amenable to changes or unforeseen occurrences.

Even during limited lease sales, vast areas are leased for exploration. Within these areas, the location of commercial petroleum deposits, if any, are unknown. Speculation as to quantities and locations can be made and contingency plans can be drawn. However, if commercial finds are realized and defined, changes in the development plan may be required. Quantities and location may force the consideration of alternate means of developing, producing and transporting the product. The alternative may prove to be more or to be less environmentally damaging or disruptive. Or new technologies may provide environmental safeguards unknown in the past. Thus, the standards drawn must be rigid enough to effectively control the use of the lands and waters of the Prudhoe Bay Coastal Area yet they must be sufficiently flexible to respond to change.



VII. Implementation Strategies

VII. IMPLEMENTATION STRATEGIES

During the formative years of North Slope Borough organization and development from its inception on July 1, 1972 to date, the Borough has depended in large part on Federal and State agencies' pursuing the legislative mandate of numerous pieces of legislation tailored to protect the environment. Borough actions were reserved to investigation of particularly damaging or disruptive events as reported by inhabitants of the Borough and to intercession in behalf of these residents with State and Federal officials in an attempt to rectify such situations. As development activities increased with the trans-Alaska pipeline construction, the Prudhoe Bay oil field development, the exploration of areas adjacent to the Prudhoe Bay field and the accelerated exploration of NPR-A, reports of environmental damage and disruption increased dramatically.

The Borough witnessed a large consumption of productive habitat, the disruption of fish and wildlife migrations, damage to overwintering fish populations and other impacts of oil and gas exploration and development. Blowouts while drilling offshore from the Mackenzie River delta in Canada heightened the concern for the environment in the North Slope Borough. And announcements of proposed lease sales in the Beaufort Sea were seen to threaten the very existence of the bowhead whale which is an endangered species and paramount to the subsistence and culture of the coastal Inupiat of the North Slope Borough. Furthermore, not to be omitted by this general plight is the inland Inupiat of Anaktuvuk Pass who along with their coastal relatives foresee the opening of the Haul Road to the general public as being damaging and disruptive to the wildlife resources. They are especially concerned with the disruption of the caribou herds and fear increased direct competition for this scarce subsistence resource.

Clearly, the protection of the environment by the local governmental unit, the North Slope Borough, was mandated by the permanent residents of the Borough. Perhaps the most successful undertakings were legislative when, for example, the Borough played a major role in the transfer of NPR-A from Navy to Interior with strong regulatory, study and classification requirements designed to protect the environment. In the area of archeological, historic, and cultural sites, the Borough has provided invaluable identification and information for the protection of these sites. These policies and the adoption of a zoning ordinance for the Haul Road provide a basis for the control of development along this route. The Borough Capital Improvements Program for the Prudhoe Bay area seeks to consolidate development of major private and public facilities and to connect them to one common utility system. Borough/State cooperation in study efforts such as the *Social Analysis of the Beaufort Sea Lease Sale* welcomed Borough input.

However, despite the individual efforts of some Federal and State agencies, the North Slope Borough feels largely ignored. Decisions are often made which directly affect the Borough without even notification being sent to the Borough or without a solicitation for its inputs. Borough reports, some compiled almost exclusively from local sources, are often ignored. Borough ordinances directly applicable to land use and development are often dismissed. In summary, except in rare circumstances, the North Slope Borough finds itself a foreign party to much planning, policy development and regulation within its own corporate limits and the Borough does not see the tangible results as being development of excellence with the utmost concern for the environment.

A. FEDERAL AND STATE CONSISTENCY WITH LOCAL PLANS AND ORDINANCES

The State's police power delegated to the North Slope Borough extends to all lands within the Prudhoe Bay Coastal Area. This includes Federal and State lands as well as privately owned properties. However, the extent of control may be limited.

In the area of land use development and environmental protection, local control and planning have been relied upon

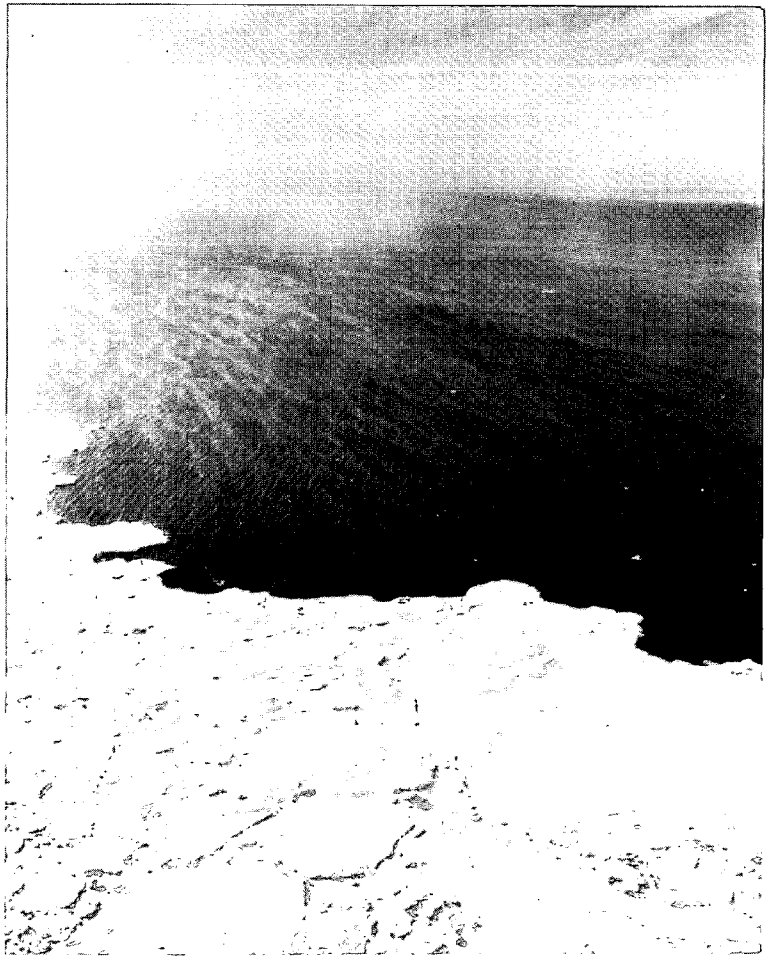
by the State and Federal governments throughout the nation. This is especially evident within the realm of public welfare where such Federal legislation as the National Environmental Policy Act of 1969 and the Environmental Quality Improvement Act of 1970 recognize the importance of both State and local governments. Furthermore, the primary responsibility for the enhancement of the national environment through control of pollution, water and land resources, transportation, and economic and regional development is seen to rest with State and local governments.

Of course, Federal authority over its lands is well established. It may be proprietary or legislative in nature and stems from the "Property Clause" of the U. S. Constitution, Article 1, Section 3, Clause 2, and the Supremacy Clause, Article VI, Clause 2, respectively. However, in particular cases courts have held that States and local units of government delegated State authority may exercise control over Federal lands to the extent that regulation would not be inconsistent or clearly frustrate Federal policies and programs.

Federal jurisdiction over Federal property in laws enacted by the Congress may be determined by express or implied intent to allow or not to allow State or local laws to be applied. Recent legislation such as the Federal Land Policy and Management Act of 1976 calls for public and State/local government consultation and participation in BLM's development of land use plans for public lands. This legislation further calls for the land use plans of the Secretary to be consistent with State and local plans to the maximum extent he finds consistent with Federal law and the purposes of the Act. However, although the extent of consistency with local plans is not well spelled out, it is clear that local authority has not been totally preempted.

Somewhat differently than the Federal Land Policy and Management Act of 1976, the Coastal Zone Management Act of 1972, as amended (16 USC 1451 et seq.) seeks consistency for Federal activities with States and their local governmental units while excluding Federal lands from the coastal area. Subsections 307(c)(1) and (2) provide assurances that all Federal activities including development projects directly affecting the coastal area are undertaken in a manner consistent to the maximum extent practicable with approved State coastal management programs.

Thus, with local representation on the Alaska Coastal Policy Council charged with the development of standards and with the approval of district management programs, the local



governmental unit is afforded the opportunity to have Federal and State actions and activities in the coastal area consistent with local government management plans.

The Alaska Statutes, Section 35.30.020, more clearly calls for consistency with local government plans and ordinances as follows: "A department shall comply with local planning and zoning ordinances and other regulations in the same manner and to the same extent as other landowners." Although this provision is applicable to all State-owned land in the Prudhoe Bay Coastal Area, department means only the Department of Transportation and Public Facilities and the University of Alaska.

The North Slope Borough is committed to undertaking the development of plans and ordinances to exercise the powers of land use planning and control required by the State of home rule boroughs and required to implement the Prudhoe Bay Coastal Area Management Program. However, since well in excess of 90 percent of the lands and waters of the Prudhoe Bay Coastal Area are in the ownership of the State and Federal governments, the Borough plea for adherence to local plans and ordinances must be by virtue of the doctrine of Federal and State consistency.

B. LOCAL PLANS AND ORDINANCES

The basis for the development of reasonable and effective standards in carrying out the policies set forth by the Borough to attain its objectives in the Prudhoe Bay Coastal Area is vested in the traditional land use controls of local government.

1. North Slope Borough Land Use Plans

As a part of its planning program, the Borough will develop a comprehensive development plan which will consider a range of physical, social and economic factors and which will include plan elements for land and water use, facilities and transportation. This comprehensive plan will be a structure plan (a general regional plan) for the Borough with the detailed plans for each separate community to be undertaken as demanded.

This basic document is needed to assemble, inventory and analyze basic information regarding traditional use, fish and wildlife, economic, financial, cultural and other data. Pursuing one factor may be at the cost of others, thus there are inherent conflicts which may require alternative plans or the clear establishment of priorities. This plan is required as a basis for zoning both by State law and North Slope Borough code (19.04.010) and will be completed as soon as possible.

Since a major portion of the Borough comprehensive development plan must necessarily be concerned with oil and gas activities and facilities, a comprehensive land use plan for the Prudhoe Bay/Deadhorse area will be undertaken concurrently with the Borough comprehensive development plan. Although comprehensive in intent, the plan would emphasize the means of obtaining a more concentrated development of facilities and uses in the Prudhoe Bay/Deadhorse area so that common roads, utilities, airports and other facilities could be realized without substantially reducing wildlife habitat in the area. This plan will then form the basis for a zoning and floodplain ordinance, subdivision regulations, and building codes in the Prudhoe Bay/Deadhorse area.

2. Zoning Ordinance

If the objectives of the Prudhoe Bay Coastal Area Management Program regarding the siting of facilities in an orderly manner and the prudent use of lands and waters are to be carried out, zoning provides a principal means of implementation.

Given the objectives and the policies of the North Slope Borough's Coastal Management Program for the Prudhoe Bay area and the Boroughwide elements of:

1. a relatively stable permanent community population composed in large part of indigenous peoples with lands set aside for any conceivable community expansion,

2. the basis of the Inupiat culture of the North Slope Borough being vested in subsistence pursuits,

3. natural resource extraction providing the present and future economic base for an improved standard of living and,

4. the need for environmental safeguards to protect the habitat nurturing subsistence resources,

the following zoning scenario is envisioned.

Outside of the village selections under Section 12(a) of the Alaska Native Claims Settlement Act, the only pertinent land uses within the North Slope Borough are either related to mineral resource extraction (petroleum) or subsistence gathering activities (hunting and fishing). Within the Section 12(a) village selection areas are a variety of land uses normally associated with small Alaska communities. But, since population growth in the permanent Borough communities is not a major factor and lands available through the Alaska Native Claims Settlement Act are sufficient to accommodate any conceivable population growth, it is doubtful there will be encroachment of the villages upon the remaining Borough lands outside the village selections.

Therefore, the Borough envisions that all lands (and waters) within the North Slope Borough, including the Prudhoe Bay Coastal Area, with the exception of the village selections under Section 12(a) will be zoned by the Borough as a wildlife enhancement zone. The uses allowed in this zone would be all activities contributing to the perpetuation and enhancement of wildlife and wildlife habitat and subsistence activities. Uses allowed on a conditional basis and requiring a conditional use permit to insure sound environmental location and practices would be oil and gas extraction and related activities and tourism and recreation.

This zoning would allow subsistence hunting and fishing without impairment. No permits would be required and access would not be limited as to time and route. In essence, those activities which have been conducted on the lands and waters of this area since the arrival of the Eskimo would be encouraged to continue. The extraction of oil and gas, on the other hand, would require permits from the Borough based upon the fulfillment of specified conditions. Tourism and recreation and related development would also require permits from the Borough based upon the fulfillment of specified conditions.

3. Subdivision Regulations

North Slope Borough subdivision regulations are to be applied to the Prudhoe Bay/Deadhorse area. In order to foster efficient development requiring minimum road lengths and utility linkages and thus habitat consumption, any further subdivision of this area should be regulated by subdivision ordinance. However, subdivision regulations as with zoning ordinances and building codes must consider the effects of flooding and thus a flood hazard ordinance dealing with floodplains.

4. Building Codes

The Uniform Building Code with amendments will be adopted and applied immediately to the Prudhoe Bay/Deadhorse area where construction has proceeded to date without the assurance of sound construction for all facilities. Unquestionably, most facilities which are intended to be used throughout the period of petroleum production are built to high standards. However, facilities exist that would not meet any code and this is viewed as a threat to the public health, safety and general welfare especially where flooding is a possibility. Of course, the Uniform Building Code must be severely amended to take into consideration the needs and the difficulties involved in Arctic construction and possible flood conditions.

5. Flood Hazard Ordinance

Within the Prudhoe Bay Coastal Area, there are areas subject to periodic flooding. These areas could potentially cause

serious damage to property, disrupt communications and government services, result in extraordinary public expenditures, impair the local and State tax base and cause widespread pollution. Foremost among the areas of concern must be the floodplain of the Sagavanirktok River. Some petroleum-related development has taken place within the known floodplain. However, the extent of this floodplain during a so-called "100-year flood" is unknown. Thus, it appears to be a prudent act to undertake a hydrological study of the Sagavanirktok River to determine the extent and intensity of flooding in the Prudhoe Bay Coastal Area, especially the Deadhorse area. If flooding which would cause damage were forecast to take place there, the area then would be designated as a flood hazard area and a flood hazard ordinance would be developed and enacted by the Borough. Such an ordinance would assure that safe construction would take place in the future. As an alternative, the ordinance could be tied to any of the ordinances in the affected area such as the ordinances dealing with zoning, subdivision and building codes.

6. Capital Improvements Program

The North Slope Borough Capital Improvements Program is an ordered, long-term schedule for acquiring and building public facilities deemed to be needed by the Borough. In the Prudhoe Bay Coastal Area the Capital Improvements Program has been used to overcome water, sewer and waste disposal problems in the Prudhoe Bay/Deadhorse area. However, the current Capital Improvements Program calls for the completion in 1978 of a complex consisting of a solid waste incinerator and sewage treatment plant and a water reservoir to accommodate foreseeable future demands.

This program is in keeping with Borough policies regarding the concentration of facilities permitting common piped utilities in the Deadhorse area. Should other projects of environmental protection be identified requiring outlays of public capital, they will be included in the Capital Improvements Program and the Capital Improvements Program ordinance for adoption by the Borough Assembly.

C. COOPERATIVE AGREEMENTS

If the Borough does not reinforce or in some cases establish its presence, it will abdicate its powers to the State and Federal governments in the areas of planning, policy development and regulation of its lands and development thereon. Thus, the Borough will have little assurance of meeting its objectives. Although the Borough must establish this standing with land use policies and controls over development through the use of its police powers as well as taxation, spending and eminent domain, the ultimate means of attaining Borough goals could be through cooperative agreements.

1. Cooperative Management Agreements

The Prudhoe Bay Coastal Area with the Arctic National Wildlife Range abutting to the east, NPR-A recommended as the North Slope Wildlife Refuge in current Section 17(d)(2) legislation adjacent to the west and the proposed Borough zoning point toward a cooperative management agreement as the most effective means of attaining Borough goals in the Prudhoe Bay Coastal Area as well as throughout the Borough.

The proposed Borough zoning would undoubtedly be facilitated by a cooperative management agreement among the Federal government, the State of Alaska, the North Slope Borough and the Arctic Slope Regional Corporation as the largest private landowner in the North Slope Borough. Administratively, such an agreement would have to guarantee the participants a voice in the planning, policy formulation and regulation of these lands and waters.

Of course, such a cooperative management agreement could not be realized without significant effort and substantial accord on such matters as subsistence priorities and oil and gas extraction. Then, upon reaching an agreement on substantive issues, the assignment of responsibilities and the development of procedures for actively administering the substance of the agreement would have to be worked out.

It is within the context of such an agreement that the Borough believes the people of the North Slope can play a significant role. The participation of local residents in the processes of inventorying wildlife, improving wildlife habitat, monitoring the effects of development and regulating actions on the lands and waters would be a distinct asset to all groups concerned.

There can be little question that the Alaska Eskimo Whaling Commission developed and successfully implemented a regulatory program to enforce the quota on bowhead whales established by the International Whaling Commission. Without the accord developed by local whaling captains for village quotas and their self-imposed regulatory procedures, it is doubtful the prudence and restraint exhibited by the Eskimo whalers during this past spring whaling season would have been forthcoming. This provides an example to regulatory agencies of the virtue and the value of direct local participation.

2. Coordinated Permit and Project Review Procedure

The North Slope Borough foresees the establishment of a formal office to coordinate and expedite the processing of all governmental permits and project reviews as being essential. If the sound environmental practices required in lease sale contracts, Federal and State laws and local ordinances are to be facilitated, then a single Federal, State and Borough office is required. Such a "one stop shopping center" concept is seen as providing a more coordinated, responsive and empirical approach to the management of lands and waters after oil and gas lease sales.

However, this approach which should be a part of the lease sale stipulations is seen as being more logical if the coordinated permit and review procedure would be extended to include the whole of an existing and/or potential petroleum basin or petroleum province. Thus, the Borough recommends this approach be implemented not only for the proposed joint Federal/State Beaufort Sea Lease Sale, but that it be implemented immediately to facilitate ongoing onshore development. Therefore, this single office would be the focal point of government-industry contact for permits and project review for the entire Beaufort Sea area, both onshore and offshore.

D. LAND OWNERSHIP

The ownership of lands by a local public authority can provide controls unavailable by other means. And barring maladministration of these public lands, leasing policies provide an effective way of avoiding or mitigating undesirable impacts while enforcing safe, well planned development. But, since the lands in the Prudhoe Bay Coastal Area are almost exclusively owned by the State and Federal governments, this option is not currently open to the Borough and any Borough control on these lands would depend upon the exercise of Federal and State consistency.

However, the North Slope Borough has selected State lands in the more intensely developed Prudhoe Bay/Deadhorse area under Section 29.18.190 of the Alaska Statutes. This section allows the Borough to select 10 percent of the vacant, unappropriated, unreserved State land within its boundaries. Although this portion of the Borough land selection was denied by administrative discretion, legal action brought by the Borough is pending before the State Superior Court. The conveyance of this State land to the Borough would provide an added dimension in controlling future development in this most densely developed area. And it is the Borough intention to pursue gaining title to this land.

E. INDUSTRY/BOROUGH COOPERATION

The North Slope Borough has sought the advice of the petroleum industry in the Prudhoe Bay area regarding Borough planning and development activities. It has also informed the petroleum industry regarding its plans and programs and it has received similar information from the industry. This mutual exchange of information and renderings of assistance which has somewhat languished lately will be intensified.

It is fully recognized by the Borough that if plans and standards of performance are to be required and ordinances developed and enacted for the Prudhoe Bay area, a close working relationship will be required with the petroleum industry to assure that the regulations developed are reasonable and effective, not punitive and unworkable. Thus, it is the intention of the Borough to more fully utilize the knowledge and expertise available through the Industrial Representatives Advisory Committee to the North Slope Borough Planning Commission.

F. BOROUGH COMMENT AND CONSULTATION

A variety of Federal and State programs will be beyond the direct control of local ordinances or the degree of control possible through local ordinances will be limited. However, comments or consultation of leasing or permit issuing agencies is often required or sought from the Borough. This process provides the Borough with the opportunity to obtain information regarding proposed development or activity and it also provides the Borough the opportunity to advance its views.

Although there can be no guarantee that Borough views will influence the decision-making, well reasoned, well prepared, timely responses reflecting Borough goals based upon Borough plans, programs and ordinances can contribute toward influencing agencies and attaining Borough objectives. The Borough views the information it receives and its responses as being extremely important where petroleum or petroleum-related activities or development are concerned since the dynamics involved in this industry's operations require constant reappraisal.

VIII. Prudhoe Bay Coastal Area Inventory

VIII. PRUDHOE BAY COASTAL AREA INVENTORY

The Prudhoe Bay Coastal Area inventory describes the natural and man-made environment of the Prudhoe Bay Coastal Area and traditional and current use of this by local residents, industry and nonresident visitors. Particular emphasis has been placed on identifying subsistence resources and habitat that are susceptible to impact from development.

A. CLIMATE

The climate of the Arctic coastal plain differs significantly from other parts of the State. Temperatures are relatively colder both summer and winter and an almost constant wind produces a chill factor which makes the temperature lower than that registered on the thermometer. Although lakes and streams cover the coastal plain, the annual precipitation is sufficiently low to classify the zone arid. From November to January cold temperatures and wind, combined with continual darkness, often make outdoor activity difficult and sometimes impossible.

1. Temperature

For nine months of the year, from September to June, temperatures in the region are below freezing. February is the coldest month with an average daily temperature of -12°F at Barter Island and Barrow, the two stations closest to the study area. July and August, which have average daily temperatures of about 45°F, are the two warmest months; however, even during these two months, there are days with temperatures below freezing. Of more significance to humans than the air temperature, however, is the wind chill temperature. A body that is warmer than the air will lose heat until the body and air temperature are equalized. The rate of loss of body heat is dependent on barriers to heat loss such as insulation and clothing. If heat is lost at a rate greater than the body can replace it, hypothermia can result. Wind accelerates this process at a measurable rate.

2. Wind

The most striking characteristic of the wind on the Arctic coast is its persistence. At Barrow, according to the U. S. Weather Service, there is a no-wind condition only 1.3 percent of the time. A calm condition is present 4.4 percent of the time at Barter Island to the east of the study area. Wind decreases appreciably inland from the coast. At Umiat, 90 miles from the coast on the Colville River, there is no wind about 18 percent of the time.

At Barter Island, from May to December, the prevailing winds are east-northeast and average from 10.6 to 19.5 knots per hour (12.2 to 22.5 miles per hour). From December to April there is a secondary prevailing wind from the west averaging from 15.4 to 19.5 knots per hour (17.7 to 22.5 miles per hour). At Barrow, the year-round prevailing wind is from the east-northeast and averages from 12.4 to 17.5 knots per hour (14.3 to 20.2 miles per hour).

As has been mentioned previously, the chill factor created by wind is an extremely important consideration for human beings living and working on the Arctic coastal plain. It also plays a crucial role in determining the navigability of the Chukchi and Beaufort Seas during their short ice-free season. If an easterly wind prevails from August to October when the Chukchi and Beaufort Seas are normally open, the ice is moved away from the coast and maritime traffic is possible. A prevailing westerly wind during these same months moves the ice toward shore and can seriously impede or prevent shipping operations.

3. Precipitation

With an average annual precipitation of from 4 to 6 inches, the Arctic Slope is considered an arid zone. In general, April is the driest month at Barrow and Barter Island. Barrow receives, in April, an average of 0.17 inches of its total precipitation and Barter Island receives just 0.11 inches during this same month. August, on the other hand, is the wettest month at both stations. Barrow receives nearly an

inch or 21 percent of its 4.89-inch average annual precipitation in August, and slightly more than an inch or 14 percent of Barter Island's average annual precipitation of 7.05 inches falls during August.

B. PHYSICAL SETTING

1. Geomorphology and Stratigraphy

The area encompassed by the Prudhoe Bay Coastal Area is located within a physiographic province, the Arctic Coastal Plain. The Arctic Coastal Plain is generally featureless, tundra-covered terrain rising gradually from the Arctic shore to a maximum elevation of 600 feet along its southern boundary with the Arctic Foothills province. The area is covered by thousands of lakes, meandering rivers and streams and numerous permafrost features.

Quaternary and recent consolidated deposits such as silt, clay, sand and gravel up to 45 meters thick comprise most of the Beaufort Sea coastal plain. These deposits overlie late Mesozoic sediments, conglomerate and shale and Tertiary beds of conglomerate, sandstone and siltstone. Paleozoic rocks thin out from the Brooks Range and are deposited conformably against the Barrow Arch which runs approximately parallel to the Beaufort Sea coast in the study area. In addition, Mesozoic rocks (the Jurassic and Triassic beds) which also thin out from the Brooks Range were deposited conformably on top of these. On the north side of the Arch, the older rocks forming the Arch were truncated by erosion prior to the deposition of the Cretaceous.

Many widespread fault systems and an angular unconformity truncate progressively older rock units. These stratigraphic and structural conditions created favorable traps along the Barrow Arch for development of oil and gas. The producing oil field at Prudhoe Bay is atop the Barrow Arch which is 8,000 to 10,000 feet deep at that location.

2. Soils

Soil formation is affected by the parent material, climate, vegetation, topography, drainage and time. The parent material is the rock or unconsolidated deposits which determine the chemical and mineral composition of the soil. The weathering of the parent material and the action of climate and plant and animal life slowly change the parent material into soil. On steep slopes, a portion of the rainfall runs off leaving less to support plant life. However, the gently sloped lands found in the study area have more water and promote better plant growth. If lowlands are poorly drained, then swamps will form. In the Prudhoe Bay Coastal Area, most soils are formed under poor drainage. The wet soil of the Arctic Coastal Plain thaws to a maximum of 18 inches in the summer and the underlying permafrost prevents good drainage. The texture of the soil, whether it be sandy, loamy, or clayey, depends upon the parent material and is determined by the proportion of different sized particles in the soil.

3. Permafrost

Permafrost is any earth material that remains frozen over several years. A layer of permafrost as much as 1,800 feet (550 meters) thick underlies the entire Prudhoe Bay Coastal Area. Between the ground surface and the permafrost is a shallow layer of earth that thaws to a maximum of 18 inches in summer and freezes completely during the winter. Called the active layer, this earth accumulates water from rain and snow and ice melt. The underlying permafrost prevents the infiltration of water and forces surface drainage creating a liquid environment. This, in turn, promotes the development of the marsh and tundra typical of the region. This vegetative mat insulates and preserves the permafrost and increases its depth. Disruption to the vegetative mat impairs its insulative effect and causes the permafrost to thaw which results in subsidence and erosion.

Permafrost also underlies much of the sea floor in the Beaufort Sea shelf although its eastward extent and distribution are not known. However, on the basis of bathymetry, general subsea permafrost distribtuion can be estimated. In areas of grounded fast ice, usually associated with less than 2

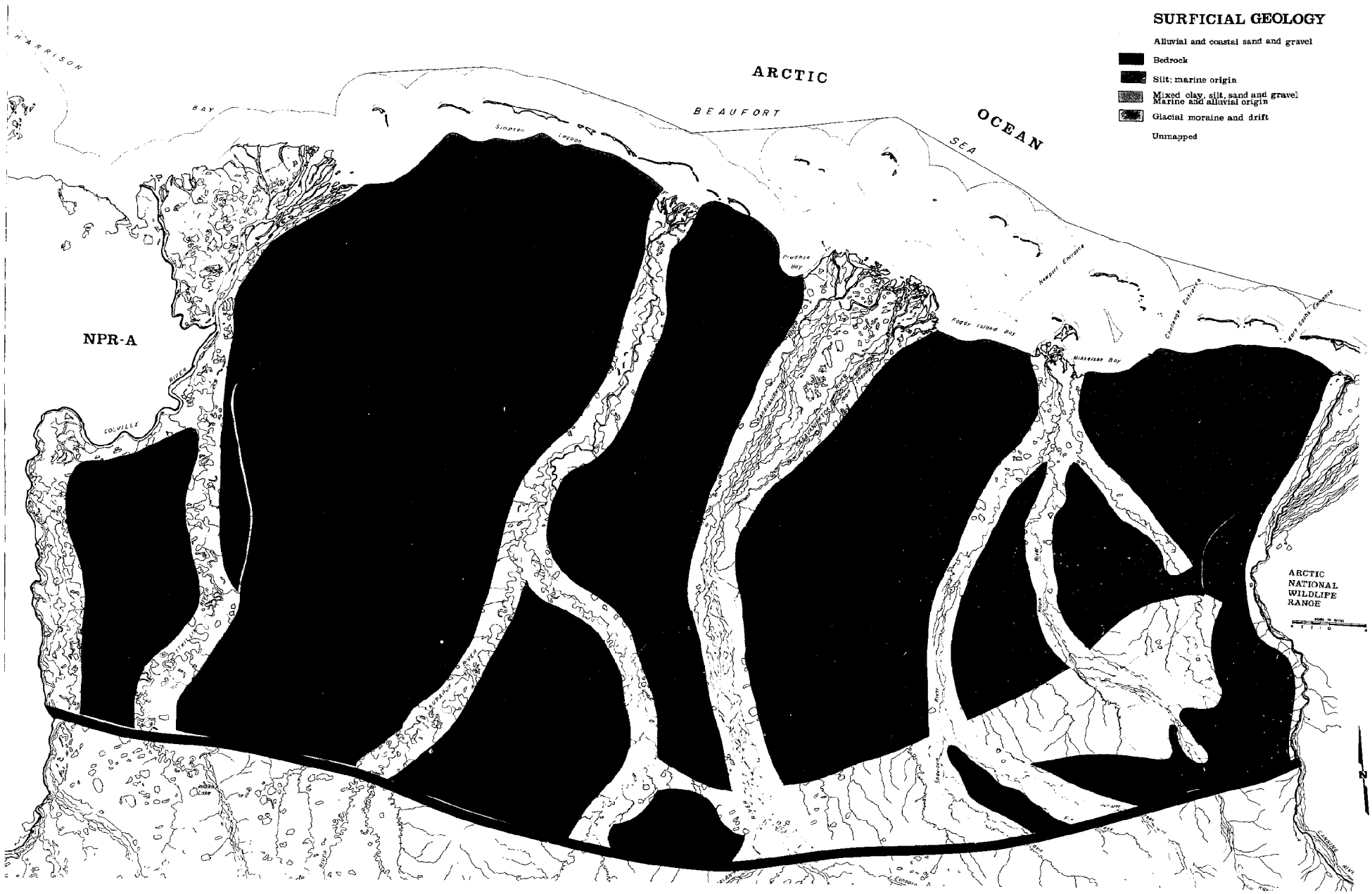

SURFICIAL GEOLOGY
Alluvial and coastal sand and gravel
Bedrock
Silt; marine origin
Mixed clay, silt, sand and gravel
Marine and alluvial origin
Glacial moraine and drift
Unmapped
ARCTIC
BEAUFORT
SEA
OCEAN
HARRISON
BAY
Simpson
Lagoon
Prudhoe
Bay
Newport Entrance
Foggy Island Bay
Mikkelsen Bay
NPR-A
COLVILLE
RIVER
ARCTIC
NATIONAL
WILDLIFE
RANGE
N

Figure 4

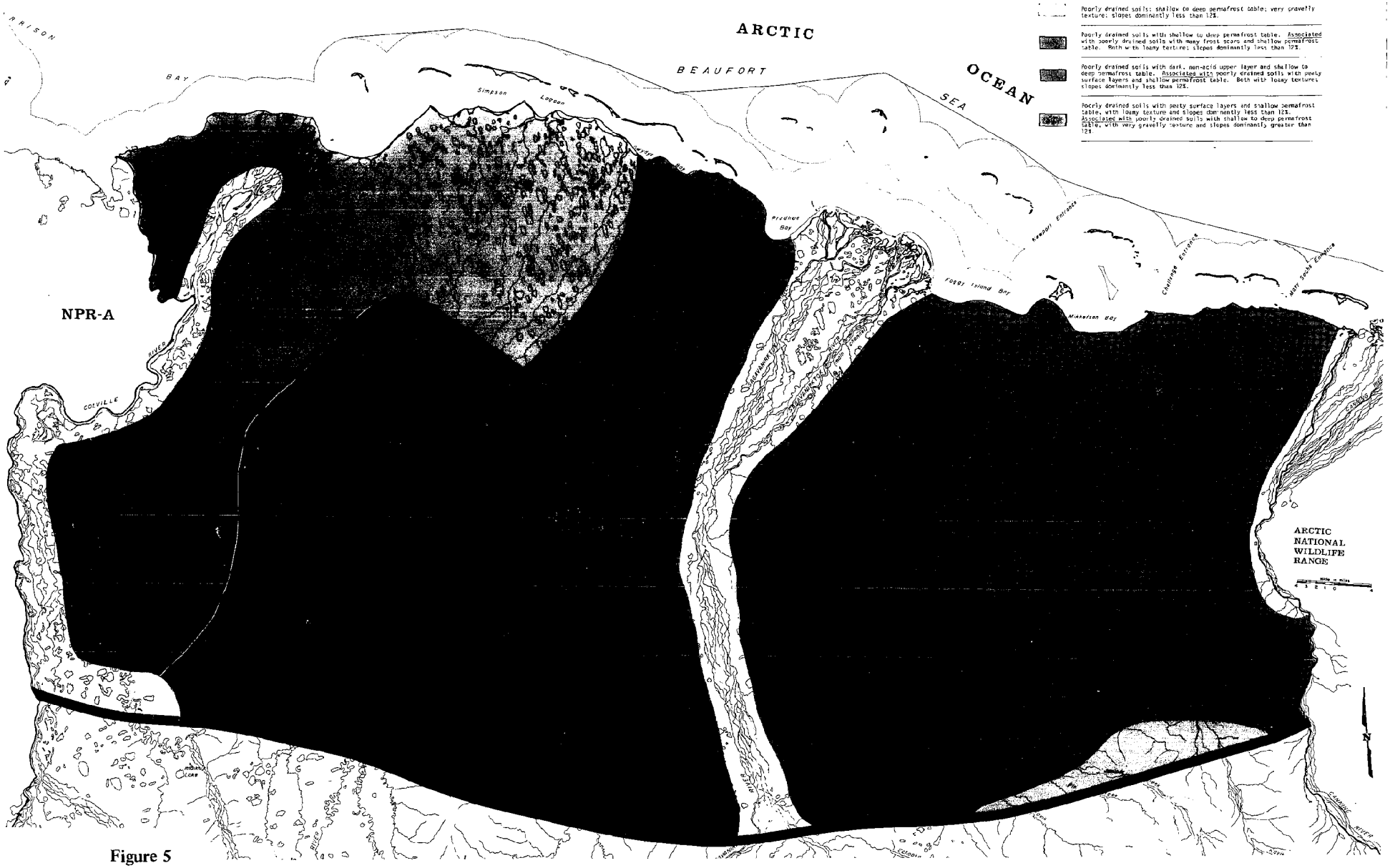

SOILS
Poorly drained soils with peaty surface layer; shallow permafrost table; loamy texture; slopes dominantly less than 12%. Associated with poorly drained, fibrous peat.
Poorly drained soils with peaty surface layer; shallow permafrost table; loamy texture; slopes dominantly less than 12%.
Poorly drained soils; shallow to deep permafrost table; very gravelly texture; slopes dominantly less than 12%.
Poorly drained soils with shallow to deep permafrost table. Associated with poorly drained soils with many frost scars and shallow permafrost table. Both with loamy textures; slopes dominantly less than 12%.
Poorly drained soils with dark, non-acid upper layer and shallow to deep permafrost table. Associated with poorly drained soils with peaty surface layers and shallow permafrost table. Both with loamy textures; slopes dominantly less than 12%.
Poorly drained soils with peaty surface layers and shallow permafrost table, with loamy texture and slopes dominantly less than 12%. Associated with poorly drained soils with shallow to deep permafrost table, with very gravelly texture and slopes dominantly greater than 12%.
ARCTIC
BEAUFORT
SEA
OCEAN
BAY
Simpson
Lagoon
Prudhoe
Bay
Foggy Island Bay
Mikkelsen Bay
Newport Entrance
Challenge Entrance
NPR-A
COLVILLE
RIVER
ARCTIC
NATIONAL
WILDLIFE
RANGE
N

Figure 5

meters (6 feet) of water depth, ice-rich permafrost will be found. Offshore Prudhoe Bay, thick unbonded (nonice-rich) layers of permafrost have been recorded in water depths greater than 2 meters (6 feet). Since the entire Alaskan Beaufort Sea shelf was exposed during the last glacial age and was susceptible to permafrost formation, relict ice-bonded permafrost probably exists out to the 90-meter (290-foot) isobath. It should be noted that these estimates are very rough. The actual extent of the permafrost is unknown.

4. Surface Water

Although the Prudhoe Bay Coastal Area is covered by numerous rivers, streams, lakes and marshes, continuous permafrost and ice resulting from the cold winter temperatures severely limit the availability of surface water on a year-round basis. Surface water is readily available during the region's short summer both for human and industrial use. The only sources of water during the region's long winter are melted ice and snow or the few large rivers such as the Canning, Colville, and Sagavanirktok which are fed by groundwater wells and maintain flows year-round and the deeper lakes which do not freeze to the bottom. These same rivers and lakes are used by fish for overwintering.

The major rivers of the study area are the Canning, the Kavik-Shaviovik, the Sagavanirktok, the Kuparuk-Toolik, and the Colville. With a drainage area of 24,000 square miles and a length of approximately 400 miles, the Colville is the largest of these. The Sagavanirktok drains an area of 5,546 square miles and extends approximately 166 miles; the Kuparuk drains 3,649 square miles and is 183 miles long; and the Canning River drains 2,256 square miles and is 117 miles long. Although most rivers and streams in the Prudhoe Bay Coastal Area are frozen to the bottom from December to May, the Colville, Sagavanirktok and Canning Rivers maintain limited flows during these months.

The extent of flooding depends upon the amount of accumulated snow and the time of melting. Floods occur when, prior to river ice break-up, melted water overflows the ice, sometimes for several miles on each side of the frozen channel bed. If river ice break-up occurs after the period of peak flooding, ice jams may significantly increase the height of the water and cause extensive flooding. Local flooding may also occur during the winter when water from rivers or springs bursts through the surface of the ice and overflows the channel. When this overflow freezes, aufeis, which resembles an ice mound or thick ice sheet, is formed. When it occurs, aufeis buildup can disrupt river crossings such as roads, bridges or pipelines.

There are two types of lakes in the Arctic region: glacial lakes and thaw lakes. Glacial lakes, formed from melting glaciers, are generally found in foothills and mountains close to the source of the glacier, consequently there are few lakes of this type in the study area. Thaw lakes, however, are quite common in the Prudhoe Bay Coastal Area. These are produced by the pooling of melted snow and ice in slight depressions, augmented during summer by the thaw from underlying permafrost. As this process continues over time, the lake deepens and widens. The larger thaw lakes (0.62 to 1.2 miles in surface area) tend to be elongated and oriented

10 to 15 degrees west of true north. Thaw lakes shallower than 6 to 8 feet usually freeze to the bottom during winter. Although the larger lakes may not freeze entirely, they usually contain impurities from frozen layers and thus are not potable.

The permafrost of the Prudhoe Bay Coastal Area prevents subsurface drainage and thus severely limits the availability of ground water. The only potential year-round source of ground water is the unfrozen alluvium located beneath large, deep rivers and lakes which do not freeze entirely during the winter. Here, the surface water bodies create a warming effect which thaws the surrounding alluvium. The alluvium aquifers underlying rivers generally have better quality water and greater storage potential than those underlying lakes because the movement of the river water continuously recharges them.

5. Coastal Erosion and Relief

A unique feature of the Beaufort Sea coast is that it is frozen fast and is therefore protected from erosion during 8 to 9 months of the year. Nevertheless, the shoreline in the Prudhoe Bay Coastal Area is retreating rapidly. The permafrost is highly susceptible to thermal erosion effects. During the summer, the soil above the permafrost thaws, making it weak and highly susceptible to slumping. In addition, the surface water has a warming effect on the underlying permafrost. These two factors in combination with wave and current action break down the ice bonding in the permafrost and undercut coastal banks and bluffs to form "thermo-erosional niches." These niches make the overhanging bluff increasingly unstable and eventually it collapses. The slumped soil affords temporary protection from direct wave attack, thus retarding coastal retreat.

In 1972, P. V. Sellmann of the U. S. Army's Cold Regions Research and Engineering Laboratory developed three different coastal classifications on the Arctic coast: river deposition, wave erosion, and marine deposition. River deposition coasts characteristically are river deltas and sometimes have near-shore barrier islands facing them. They are formed from river deposits accumulated over years. River deposition coasts extend the shoreline seaward and generally have low relief (0 to 4 meters).

Wave erosion coasts are exposed directly to the open ocean and consist of bedrock sea cliffs or poorly consolidated permafrost. The cliffs are wave straightened and have a nearly continuous appearance. They are generally less than 11 meters high and are subject to erosion from wave action. Marine deposition coasts are shaped by sea waves and currents and are in the process of active buildup from these forces. In general, these coasts are fronted by nearshore barrier islands and spits roughly parallel to the coast but separated from them by a narrow body of water usually less than 5 kilometers wide. The barriers afford some protection from the ocean pack ice, waves and currents. Marine deposition coasts have a generally low relief of less than 4 meters.

Beaufort Sea coastal relief or sea cliff height can be classified in three categories. Low coastal relief is less than 2 meters in height; moderate coastal relief ranges from 2 to 5 meters; and high coastal relief is greater than 5 meters in height. Because of the ongoing coastal retreat process and the generally flat terrain of the area, coastal relief is dependent upon the elevation of the adjacent land surface relative to sea level. Low relief is associated with barrier islands and spits, deltas of river deposition coasts and sea cliffs along low sections of the tundra surface.

Moderate relief is distinguished by sea cliffs along wave erosion coasts and marine deposition coasts. These cliffs contrast with the flat tundra surface and are undergoing moderate erosion. Some cliffs of moderate relief are steep and uniform in appearance, while others are irregular as a result of erosion and permafrost thawing. High relief coasts generally consist of steep, sheer sea cliffs of relatively uniform appearance. Normally found along wave erosion coasts, these cliffs are subject to only moderate erosion because of the protection afforded by bedrock and large ramps of snow and ice.

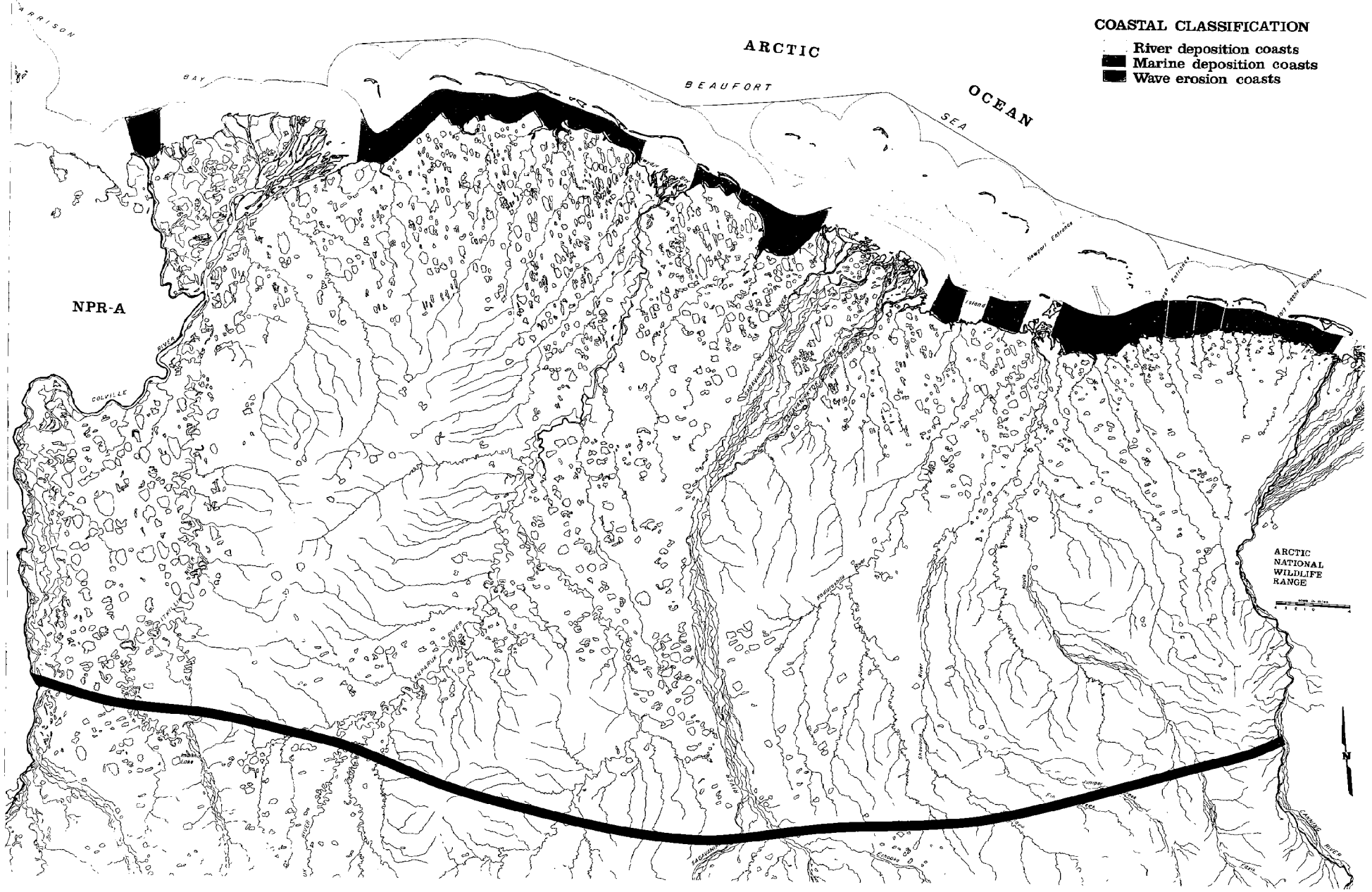

COASTAL CLASSIFICATION
River deposition coasts
Marine deposition coasts
Wave erosion coasts
ARCTIC
BEAUFORT
SEA
OCEAN
HARRISON
BAY
NPR-A
COLVILLE
RIVER
ARCTIC
NATIONAL
WILDLIFE
RANGE
N

Figure 6

6. Waves, Currents and Tides

Wave generation in the Beaufort Sea is significantly limited by the almost continuous presence of ice. During the short summer months when the nearshore areas are ice free, most wave action is from the northeast since that is the direction of the prevailing winds. Floating ice and barrier islands partially protect the coast from wave action and consequent erosion.

Wave size is dependent upon wind velocity and the extent of open water for the wind to blow across. Heaviest wave action occurs in September and October when wind is strongest and the nearshore area is usually free from ice. In the Beaufort Sea, waves generally have a duration of from two to three seconds and are less than 50 centimeters or 20 inches high. During severe storms, however, waves of one to three meters and lasting from five to ten seconds have been recorded by the Coastal Studies Institute of Louisiana State University.

Sensitivity of coastal areas to storm surges and waves is directly related to coastal relief. Areas with low relief (less than 2 meters in height) are vulnerable to frequent storm surges and frequent flooding from waves. Zones of moderate relief, from 2 to 5 meters in height, are subject to infrequent storm surges and quite frequent storm wave flooding. The zone of high relief (from 5 to 8 meters in height) is vulnerable only to infrequent high storm waves of three meters or more. The zone of very high relief (greater than 8 meters) is free from storm surge or wave flooding danger.

Shallow water, the ice pack and barrier islands limit currents in the Prudhoe Bay Coastal Area. The Beaufort Sea gyre, an anticyclonic (clockwise) gyre centered midway between the Arctic coast and the North Pole dominates the surface current of the Beaufort Sea. This current carries the ice pack in a westerly direction along the continental shelf at the rate of from three to ten kilometers a day. Nearshore, between the barrier islands and the coast, the current is wind related and therefore highly variable over short periods of time.

Along the Prudhoe Bay coast, the lunar tides are weak and have a minor effect on sea level. The mean range of sea level from these tides is less than 15 centimeters or 6 inches. In the absence of strong tides, other factors, such as wind and atmospheric pressure, become unusually significant. Meteorological tides or storm surges resulting from atmospheric low pressure and westerly winds, have caused the sea level to rise as much as three meters (10 feet) according to the Coastal Studies Institute of Louisiana State University.

7. Ice

The Beaufort Sea is icebound for at least nine months of the year, but break-up and freeze-up vary greatly from season to season. Break-up has been observed as early as June 13 but generally occurs early in August. Freeze-up has occurred as late as October 25, but the average freeze-up is the first week in October.

Leads in the Beaufort Sea are associated with break-up. Beginning in June, there are scattered leads along the Arctic coast from Cape Lisburne to Barrow. At about this same time, a lead begins to form at the mouth of the Mackenzie River and extends westward along the Alaskan coast to about the Colville River delta by mid- or late July. These are the routes used by whales and seals migrating northward and eastward. The area of coast from Barrow eastward to the Colville delta is normally the last to break up because of the prevailing wind flow.

The existence of open water in the Beaufort Sea is dependent upon the winds. Easterly and southerly winds hold the ice pack offshore, while northerly and westerly winds force the floes in the direction of the shore. Even when the main body of ice recedes from the coast, however, drifting floes and bands of fast ice occur in the inshore waters.

Beaufort Sea ice can be classified in three major zones: grounded fast ice, generalized fast ice, and pack ice. Grounded fast ice, which extends from the shore seaward to the 30-

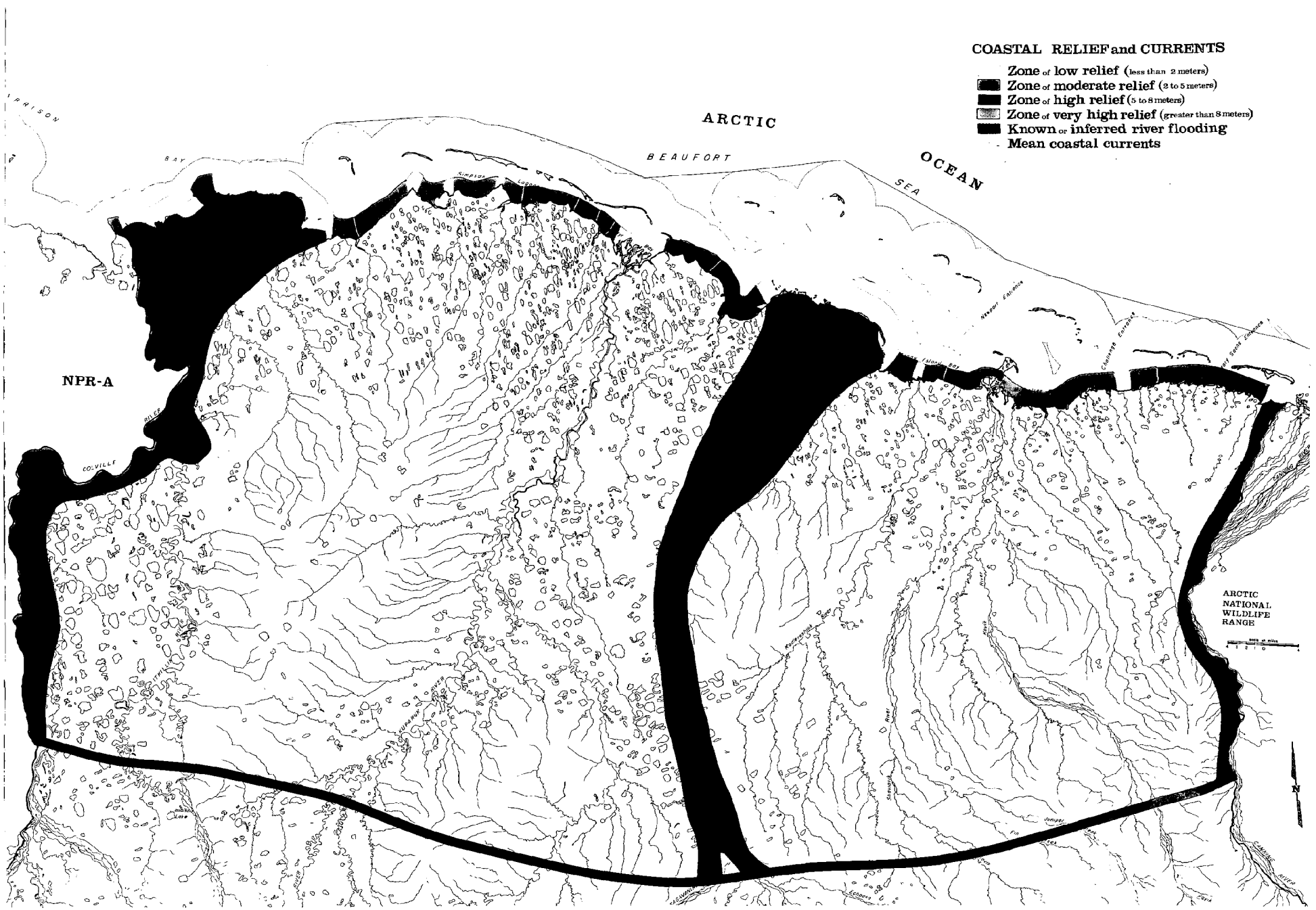

COASTAL RELIEF and CURRENTS
Zone of low relief (less than 2 meters)
Zone of moderate relief (2 to 5 meters)
Zone of high relief (5 to 8 meters)
Zone of very high relief (greater than 8 meters)
Known or inferred river flooding
Mean coastal currents
ARCTIC
BEAUFORT
SEA
OCEAN
NPR-A
ARCTIC NATIONAL WILDLIFE RANGE
N

Figure 7

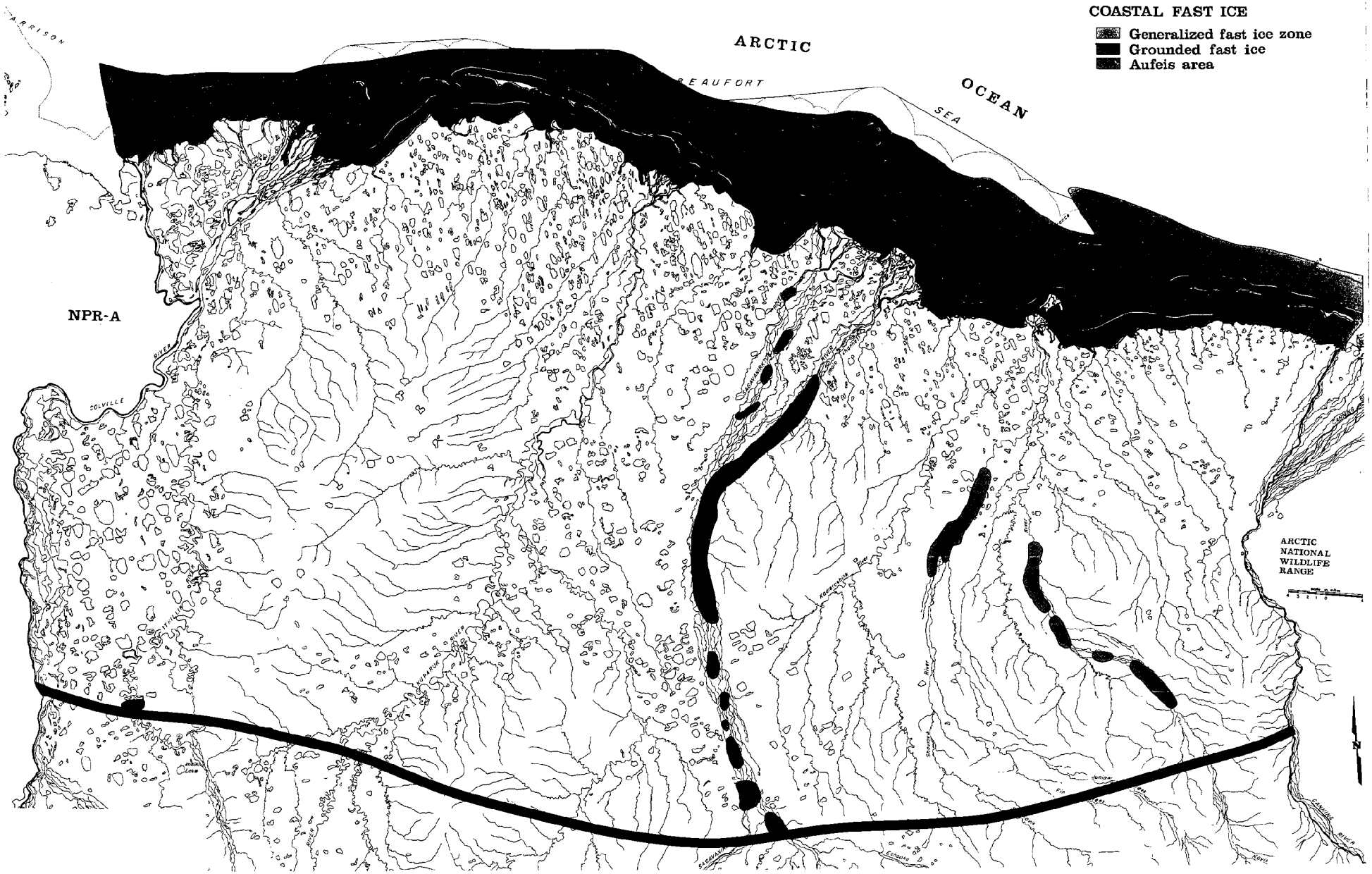

COASTAL FAST ICE
Generalized fast ice zone
Grounded fast ice
Aufeis area
ARCTIC
OCEAN
SEA
NPR-A
ARCTIC
NATIONAL
WILDLIFE
RANGE

Figure 8

to 60-foot isobath and reaches a maximum depth of 6 feet by the end of winter, is seasonal and relatively little deformed. Its extent seaward depends upon the shoreline configuration, water depth, the time of year and pressure exerted by pack ice. Near shore, where water is less than six feet deep, the freezing continues into the sediments of the ocean bottom, thus binding the ice to it. It is nearly static throughout winter.

Generalized fast ice extends from the outer limit of the grounded fast ice to the shear zone which separates it from the pack ice. Generalized fast ice is extremely dynamic. It constantly produces large, linear leads which freeze and form new ice susceptible to deformation by pressure from the pack ice. The area between the generalized fast ice and the pack ice, the shear zone, is subject to great stress from penetration by pack ice. This action produces ridges and ice hummocks as high as 13 feet and protuberances which often extend to the sea floor and may gouge it as the shear ice moves.

Beyond the shear zone is the constantly moving pack ice. Sixty to seventy percent of the pack consists of large, multi-year floes from 6 to 12 feet thick. First-year ice, generally less than 8 feet thick, and leads constitute the remainder of the pack.

The Beaufort Sea pack ice also contains "ice islands" which have broken off from Ellesmere Island or other ice shelves in the Canadian Arctic and have moved westerly with the prevailing winds. Ranging from 30 to 100 meters (96 to 320 feet) thick, these ice islands sometimes become grounded in the shallow waters of the Beaufort Sea. When subjected to pressure from the ice pack, they may gouge the sea bottom.

C. VEGETATION AND WILDLIFE

1. Vegetation

Terrestrial vegetation throughout the Arctic Coastal Plain is relatively uniform. It consists principally of tundra, a word used to describe the vast, nearly level, treeless plains typical of Arctic regions. Much of the tundra of the Arctic Coastal Plain resembles grassland, and except for willows and birch found along some river and stream banks, never grows above a foot tall. Depending upon moisture and slope, the species composition varies. The tundra which dominates the study area is generally described as wet. Moist tundra characterizes the foothills region of the Brooks Range, and alpine tundra occurs in the mountainous areas or along well-drained rocky ridges. Wet tundra covers nearly 80 percent of the Arctic Coastal Plain, while moist tundra comprises the remaining 20 percent.

Wet tundra soil thaws to about 30 centimeters during summer. Because of the impermeability of permafrost, water from melted snow and ground ice is trapped on the surface in poorly drained lowlands and floodplains and provides a wet environment in which vegetation thrives. Sedges and moss are the predominant wet tundra species, but cottongrass, herbs, heather and small willows are also present.

Moist tundra is characteristic of the southern coastal plain and foothills and the better drained areas within the study area. Cottongrass tussocks ranging from 6 to 10 inches (15 to

25 cm) high predominate, and mosses and lichens are found in the moist channels between tussocks. Other plants typical of a moist tundra environment are such small shrubs as dwarf birch and willows and herbs like cloudberry and bistort.

Well-drained gravel, sand, and silt found along the floodplains of the major rivers in the study area provide appropriate soil for the growth of high brush. The plants of this community include willows, mosses and lichens and such herbs as dwarf fireweed and lupine.

The most conspicuous habitat feature of the moist coastal tundra is the extensive wetlands which cover 50 to 75 percent of the coastal plain in the study area. In spring, water from rapidly melting snow flows over frozen surfaces and fills numerous shallow thaw lakes and ponds, streams and rivers. As summer progresses, standing water disappears from some depressions, nevertheless, the percentage of surface area covered by wetlands remains high.

Carsen and Hussey (1962) divided the Arctic Coastal Plain into eastern and western sections on the basis of the size and shape differences of thaw lakes, with the Colville River forming the boundary between the two. In the eastern section, which includes the Prudhoe Bay Coastal Area, wetlands generally range from about 3 meters to rarely more than 1.6 kilometers in length.

A study of waterbirds and their wetland resources at Storkersen Point conducted by Bergan et al (1977) described these wetlands in 8 classifications on the basis of size, depth, vegetation and water chemistry. It should be noted, however, that these do not include incised and braided streams, their deltas and associated nonfluvial wetlands. Although the area encompassed by this study does not include the entire Prudhoe Bay Coastal Area, the apparent geological and vegetational homogeneity of the coastal plain in this area would indicate that it is fairly representative of the region.

Class I, Flooded Tundra, comprises roughly 29 percent of the total wetlands in the area. Flooded Tundra is characterized by shallow waters formed during spring thaw when meltwater overflows stream basins or is trapped in vegetated tundra depressions. In June, these basin depths rarely exceed 10 centimeters in depth; however, by August, surface water is absent or only a few centimeters deep. Plants tolerant of periodic flooding cover all or most of Flooded Tundra.

Class II, or Shallow-Carex, accounts for 21 percent of the total wetlands. These are shallow ponds with a gently sloping shore zone surrounded by and usually containing emergent Carex-aquatilis with a central open water zone. Water depths range from 10 centimeters to 30 centimeters in June to considerably less in August.

Class III, Shallow-Arctophila, accounts for 4 percent of the total. These include ponds or pools in beaded streams containing Arctophila fulva in the central zone and shoreward stands of A. fulva or Carex aquatilis. Maximum depths of Class III wetlands range from 20 to 50 centimeters.

Class IV, Deep-Arctophila, comprises 11 percent of the total wetlands. These are wetlands of either large pond or lake size that lack emergents in the central zone and contain stands of Arctophilia fulva near shore. Maximum water depths exceed 30 centimeters.

Class V, Deep-Open wetlands account for 5 percent of the total and are characterized by large deep lakes that have abrupt shores, sublittoral shelves and a deep central zone. The maximum depth of Class V wetlands is 1.1 meters. A. fulva is absent or present in less than 5 percent of the shoreline.

Class VI, Basin-Complex, accounts for 17 percent of the total in the area. They are large, partially drained basins that may contain nearly continuous water in spring. Later in summer water levels recede, leaving a pattern of green Carex-aquatilis and open water where Arctophila fulva may grow along the margins of deeper pools or throughout shallow pools. In late summer, Class VI wetlands are characterized by stands of

Alopecurus alpinus and Dupontia fischeria growing on a moss substrate.

Class VII, Beaded Stream wetlands account for 5 percent of the total. These are small, often intermittent streams consisting of a series of channels formed in ice wedges and linked to pools that develop at ice wedge intersections. The relationship between water depths and aquatic plants appears to be similar to those in ponds and lakes. In spring, Beaded Streams may flood surrounding lowlands, thus creating Class I Flooded Tundra, but by mid-July, waterflow is usually confined to stream channels and beads and flow may be intermittent.

Class VIII, Coastal Wetlands, comprises 3 percent of the total in the study area. These are aquatic habitats that occupy low areas bordering the Beaufort Sea and within a zone directly influenced by sea water. Coastal wetlands vary from lagoons confluent with the sea to ponds periodically inundated by high wind tides. They are brackish or subsaline and have a characteristic vegetation dominated by Carex subspathacea and Puccinellia phryganodes at basin margins and on adjacent flats.

Although the ice-free season is short, wetlands play an extremely important role in the overall ecosystem of the study area. They provide the principal attraction for the many water-related birds which visit the area seasonally. According to Bergman et al., the aquatic invertebrates that characterize these wetlands appear to be a major food source for breeding and young waterfowl and to provide an essential nutrient source for laying female ducks and shorebirds.

2. Wildlife

a. Fish

The extreme climate of the North Slope region does not provide a suitable environment for many species of fish commonly found in warmer waters of the State. The presence of ice in the Beaufort Sea for nearly nine months of the year and the unpredictability of break-up limits the presence of such species as salmon which migrate from open ocean waters. Rivers are usually free from ice only four or five months of the year. During the winter months, all but the largest of the rivers freeze to the bottom, thus limiting suitable spawning and overwintering spots. The shallow lakes which abound on the Arctic Coastal Plain present similar limitations as they also freeze to the bottom during winter. Consequently, suitable fish habitat is limited to those deeper lakes which do not freeze to the bottom and to the region's

three major rivers, the Canning, the Colville, and the Sagavanirktok, which, since they are fed by groundwater springs, maintain some running water year round.

All these factors notwithstanding, the Prudhoe Bay Coastal Area contains large numbers of several fish species. Of these, the whitefish is the most widely distributed in the region's rivers and lakes. Five species of whitefish are found here: the round whitefish, the broad whitefish, the humpback, and the least and arctic cisco. All except the "resident" round whitefish are anadromous and outmigrate to summer feeding grounds in the river deltas and nearshore salt water during the summer months, returning to the rivers in early fall to spawn and overwinter.

The arctic char is also widely distributed in the lakes and rivers of the North Slope. In the eastern Arctic, the Sagavanirktok and the Canning Rivers and to a lesser extent, the Colville River, which provide running water year round, appear to provide the most suitable habitat for this fish. Arctic char are both anadromous and resident. The latter are most often lake dwellers, spawning and overwintering in the lakes in which they reside. Anadromous arctic char inhabit the flowing waters of rivers during the freshwater periods of their life. They outmigrate during May and June to nearshore feeding grounds and return to the rivers in September and October to spawn and overwinter, typically in gravel-bottomed stream beds near groundwater springs.

A third widely distributed fish in the study area is the arctic grayling. Found predominantly in streams and higher elevation lakes of the North Slope, this fish seldom leaves the fresh water although it is found in deltas during break-up when these are primarily fresh water. Arctic grayling spawn in May and June and fry are reared in the calm shallow waters of lakes and flowing systems. They overwinter in deeper lakes, deep pools in rivers, and near groundwater springs.

Other fish identified in the Prudhoe Bay Coastal Area but present in lesser numbers are the arctic lamprey, the dog and humpback salmon, the Dolly Varden and lake trout, sheefish, smelt, capline herring, pike, blackfish, sucker, the freshwater, tom, and Siberian cod, the flounder, sculpin, and the stickleback.

There is presently only limited commercial fishing in the Prudhoe Bay Coastal Area. According to the Alaska Department of Fish and Game, there is a commercial whitefish operation in the Colville River delta which harvests approximately 3,000 broad and 1,000 humpback whitefish annually during the summer and 20,000 least and 40,000 arctic cisco annually during the fall. Most of these are sold locally.

b. Land Mammals

The North Slope in general does not provide a suitable habitat for most large terrestrial mammals primarily because the severe coastal climate does not favor the growth of trees and brushy willows on which these animals typically depend for food. Dependent as they are on the existence of trees and larger brushy willows, most large land mammals found in the North Slope region are located in the foothills and upper reaches of the Brooks Range.

Only four large land mammals—the moose, the caribou, the grizzly bear, and the polar bear—are found in appreciable numbers on the coastal plain. Although there are two significant herds of caribou on the North Slope, according to the Alaska Department of Fish and Game (ADF&G), the Western herd typically goes no further east than the Colville River and the Porcupine herd is generally associated with that area from the Canning River east to the Canadian border. Members of the North Slope Borough Planning Commission report that the absence of caribou in the study area is a recent phenomenon and is directly attributable to development activity at Prudhoe Bay. These same sources recall significant caribou population in the region in years past.

The Canning, Colville and Sagavanirktok Rivers all provide the dense willow vegetation stands required by the moose for

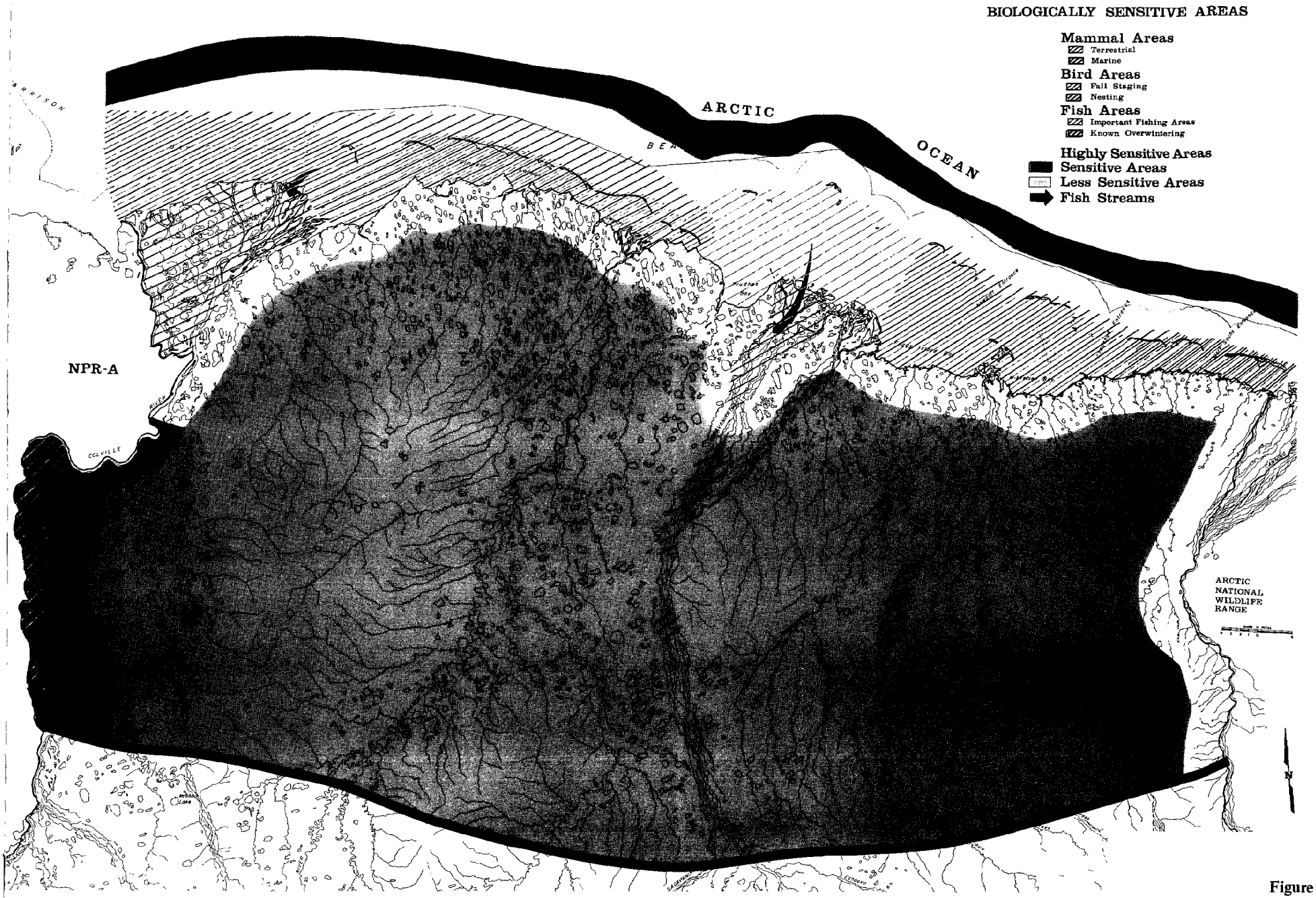

BIOLOGICALLY SENSITIVE AREAS
Mammal Areas
Terrestrial
Marine
Bird Areas
Fall Staging
Nesting
Fish Areas
Important Fishing Areas
Known Overwintering
Highly Sensitive Areas
Sensitive Areas
Less Sensitive Areas
Fish Streams
ARCTIC
OCEAN
NPR-A
COLVILLE
ARCTIC
NATIONAL
WILDLIFE
RANGE
N

Figure 9

habitat. According to the ADF&G there is a current population of from 1,000 to 1,400 moose in the North Slope region and almost all of these are found along the Colville and Canning Rivers. Approximately 75 moose are harvested here annually, primarily by sportsmen from outside the region.

The grizzly bear is distributed throughout the North Slope. Within the Prudhoe Bay Coastal Area, the grizzly is found in the spring in the major river valleys where they search for carrion or prey on ungulates. In the summer, they disperse from the valley bottoms to high in the alpine areas. In the fall, if there is a good crop of soapberry, they may again be concentrated in the willow stands in the river valley. The grizzly breeds from May to mid-July and dens from October to April or May. Cubs are born in the den in January or February. According to the ADF&G, critical habitat for grizzly bears on the North Slope consists of large areas which are undeveloped and sparsely inhabited. Important habitats are the valley bottom riparian willow stands, poorly drained areas where horsetail grows abundantly and the riverbeds. Although there are no statistics for the study area itself, ADF&G estimates the grizzly population of Unit 26 (the North Slope) to be from 500 to 700. This is based on an aerial survey of the Canning River drainage which found an average of one bear per 50 square miles. The ADF&G estimates an annual Unit 26 harvest of up to 35 grizzlies. The sport harvest has averaged 12 bears annually since 1961. The resident sport use accounts for 20 percent of the harvest, nonresident guided hunters for 75 percent and domestic or local use, 5 percent.

There are two distinct populations of polar bear in Arctic Alaska. One of these, the north population, numbering about 2,500 animals, ranges along the Arctic coast and on sea ice north of the coast from the Canadian border to Point Lay. One of the most critical habitats to the welfare of polar bears is the area used for denning. According to the ADF&G, some of the most intensive denning on the Arctic coast occurs from the Colville River east to the Canadian border which includes the Prudhoe Bay Coastal Area. This area, including the offshore islands, is approximately 50 miles wide and includes a corridor of land extending about 25 miles from the coast and the strip of adjoining shorefast ice. The shorefast ice extends from the shore outward to the moving ice and includes offshore islands. Some denning also takes place on the drifting sea ice. Dens typically are located in cut banks and gullies where drifting snow accumulates and affords some protection. While pregnant females are denning from November until March, males come ashore in search of carrion and other food. Both sexes return to the ice in spring to feed on seals. Most of this activity is concentrated where currents keep the ice in motion causing open leads or newly frozen leads where seals congregate.

Since 1972 the Marine Mammal Protection Act has limited the harvest of polar bear to Natives for subsistence purposes. Prior to passage of the Act, hunters took approximately 260 bears annually; since that time, however, only 50 to 60 bears have been harvested annually by Natives. The meat is eaten and skins are used for garments, mainly as mukluks and mittens, and as parka ruffs.

c. Furbearers and Small Game

Of the eleven economically important land furbearers found regularly within the State of Alaska, only five are present in significant numbers on the Arctic Slope. These are the red fox, the arctic fox, the wolf, the weasel, and the wolverine. With the exception of the arctic fox, however, these are sparse on the coastal plain and are concentrated primarily in the foothills of the Brooks Range because the topography and permafrost on the coastal plain limit available denning habitat.

The arctic fox is the only furbearer on the coastal plain which occurs in sufficient numbers to be the subject of intensive trapping. It is found on the coastline, the open tundra, rocky beaches and also, like the polar bear, on the sea ice many miles from shore. The arctic fox breeds in spring and dens in elevated, well-drained soils found in association

with pingos, riverbanks, sand dunes and old lake shores, all of which serve as sources for granular fill material for human use.

Arctic foxes feed on rodents (especially the lemming), hares, and to a lesser extent on birds and eggs. Dependent as they are on lemmings as a food source, the fox population undergoes extreme fluctuations consonant with the rise and fall of the lemming population. In off years, when the lemming population is low, foxes are forced to depend more heavily on the maritime environment. In these years, in particular, the fox depends heavily on beach carrion and leftovers from polar bear kills. Thus, the marine environment is also an important habitat.

According to the ADF&G, Game Management Unit 26 accounts for roughly 40 percent of the State's average annual arctic fox harvest of 2,369. Most of these are trapped by local residents of the coastal villages from Wainwright to Kaktovik and are either sold to local stores, fur buyers or tourists or are utilized for subsistence purposes.

Although small game animals like the squirrel, porcupine, the hare and the ptarmigan and grouse are all found on the North Slope, only the arctic ground squirrel and willow ptarmigan are abundant on the coastal plain. The arctic ground squirrel ranges from sea level to high in the Brooks Range. Its meat is eaten by local residents and the fur is used for parka ruffs. The willow ptarmigan is found most often in the 2,000 to 2,800-foot elevation of the Brooks Range foothills where it breeds, but in the fall females move to lower elevations and become a food source for local residents.

d. Marine Mammals

The Bering and Chukchi Seas, and to a lesser degree the Beaufort Sea, comprise some of the most biologically productive areas in the Northern Hemisphere. Nutrient-rich water from the Yukon River distributed northward by prevailing currents provides the nutritional support for a myriad of marine organisms. Although these waters do not usually extend east of Barrow, the Colville and Mackenzie Rivers contribute significant nutritional material to the Beaufort Sea.

The waters of the Arctic Ocean support a wide variety of marine mammals at some time during their annual cycle. Principal among these are the walrus, four species of ice-associated phocine seals (ringed, bearded, harbor, and ribbon) and four whale species—the bowhead, grey, minke and beluga. To some extent all these are seasonally migratory, usually moving north in the spring in search of food and then retracing their path in winter. Although the distribution and numbers of marine animals shift continuously, the Bering Sea supports more animals in winter and the Chukchi Sea is more intensively used during the summer. The Beaufort Sea is a relatively less productive environment for sea mammals but nevertheless supports significant numbers.

(1) Whale. Although a number of different whale species have been sighted in Arctic waters, only two, the bowhead and the beluga, are numerically or culturally significant in the Beaufort Sea. The bowhead, in particular, has been prized for centuries by the Arctic coastal Eskimo. At the present time, there are no quantitative data available on the numbers of bowhead or beluga whales which migrate in shore leads from the Bering Sea into the Chukchi and Beaufort Seas nor is much known about the behavior of these animals once they arrive at their summer feeding and calving grounds located there.

At least two resident beluga populations have been identified in Alaska. One, of approximately 300 to 400 animals, is localized in the Cook Inlet. The other is resident in Bristol Bay and numbers perhaps 1,000 to 1,500. Belugas begin a northward migration to Arctic waters in April, traveling in large herds. Once through the Bering Straits, the animals follow open leads along the Siberian and Arctic coasts. By May and June some of these have reached the eastern Beaufort Sea and the pack ice around Banks Island. Although the precise movements of the beluga within the study area

are not known, they are generally believed by local inhabitants to be present seasonally in the entire nearshore reach from the Colville River to the Canning River. Unlike the bowhead which is not found in water depths less than 6 meters, the beluga is found in extremely shallow water close to shore and in river estuaries. The fall return migration begins in September preceding freeze-up since belugas cannot maintain breathing holes in thick ice and generally do not swim long underwater. Belugas are hunted during both the spring and fall migrations, but more heavily during the former. The ADF&G in 1974 estimated that Alaskan Eskimos utilized at least 200,000 pounds of beluga annually and estimates the annual Bering Sea-Arctic Ocean beluga harvest at from 100 to 300 whales. It is not known, however, how many of these are harvested in the Beaufort Sea east of Barrow.

The bowhead population was decimated by intensive commercial whaling during the nineteenth century and has never fully recovered. Although there has been no commercial whaling since 1915 and the species has been protected from all but subsistence hunting by Alaskan Natives by the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, their numbers apparently remain dangerously low. In response to this situation, the International Whaling Commission (IWC) in 1977 imposed stiff quotas on the taking of bowhead whales. In 1977, the IWC estimated the bowhead population to range from 800 to 1,200, with 1,000 the most likely figure. However, a population count conducted by the National Oceanic and Atmospheric Administration (NOAA) during the 1978 spring bowhead migration, counted 2,264 bowheads. More than 1,700 whales were actually seen. Thus, according to NOAA, the bowhead population appears to be in better shape than the IWC estimated.

Like the beluga, the bowhead whale begins its northward migration from the Bering into the Chukchi and Beaufort Seas in April and May. Its arrival at Barrow normally varies by two weeks depending on ice conditions. Bowheads are reportedly at Banks Island in the Canadian Arctic by mid-May and have been observed there all summer, but there is no precise information on their activity in the western Beaufort Sea during this time. At a 1978 Elders Conference conducted by the North Slope Borough Commission on History and Culture held to document traditional land use and subsistence values, elders reported an apparent westward movement over the past two years of the bowhead breeding habitat. The elders reported unusual numbers of bowhead breeding and calving in the area between Kaktovik and Herschel Island, far west of the usual habitat near Banks Island. The elders speculate two possible explanations for this movement: a population growth or habitat displacement caused by Canadian Beaufort Sea oil and gas operations.

Although very little whaling actually takes place in the study area, except off Kaktovik during the fall migration, the bowhead migrates through the area beyond the 6-meter (20-foot) isobath. According to local whalers, the bowhead feeds and calves offshore from the Colville River Delta, beyond the 6-meter isobath.

(2) **Seal.** There are three species of ice-related seals found in the study area: the bearded seal, the harbor seal, and the ringed seal. The ringed seal has a high and stable population of over one million in the Chukchi and Beaufort Seas alone and is the most widely distributed ice-inhabiting seal of Arctic and subarctic Alaska. Most ringed seals inhabit areas of shorefast ice in winter and migrate north with the retreat of the ice pack in spring and summer. Recently, ringed seal harvests by Alaskan hunters have been about 5,000 annually, well below the annual recruitment of the population. Although this species is present in the region year round, most hunting takes place in the spring and summer when weather conditions are better.

The bearded seal rarely ventures far from sea ice. In late winter and early spring, they are found from the southern edge of the ice pack in the Bering Sea north to the solid cover of the polar ice pack. As the pack moves northward in spring, the bearded seal follows and by late summer is found along

the southern edge of the pack. Fall brings a reversal of this process. The total Bering Sea-Arctic Ocean bearded seal population is estimated to be relatively stable at 200,000, and the present annual harvest by Soviet and Alaskan hunters is about 4,000, approximately 1,500 of these by residents of northwest Alaska.

Harbor seals are found seasonally along the entire northern Alaska coast. Prior to parturition in late winter, the entire population occupies the southern edge of the polar ice pack. As break-up progresses, most follow the ice pack north, gradually moving toward land, including the offshore islands, where they rest and feed intermittently. With the approach of winter, they usually precede the ice pack south.

The annual harvest of the harbor seal by Americans and Soviets is 7,000 or less, about evenly split between the two countries. Total population is estimated at from 200,000 to 250,000 animals. About half the harvest occurs during spring when the animals are moving north, the remainder during the southern migration in September and October.

(3) **Walrus.** Following a significant decline in population as a result of heavy commercial hunting during the nineteenth century, the Bering, Chukchi, Beaufort and East Siberian Seas' walrus population has undergone significant regeneration over the past half century. Today, the entire population is estimated at roughly 200,000 animals, close to its level prior to the advent of commercial hunting. The walrus winters in the central and northwest Bering Sea many miles from the Alaskan mainland. They begin their northern migration in late March and April and reach the northern Chukchi Sea by mid-July. Most then move west to the Siberian coast, but some also disperse along the southern polar ice cap in the Chukchi and Beaufort Seas. In September and October they begin moving south again to the Bering Sea.

The annual retrieved harvest of walruses by Alaskans has recently averaged about 1,600 animals, most of these by residents of Bering Sea villages. Residents of Arctic Alaska harvest only about 100 walrus according to the ADF&G. This relatively small harvest stems partly from the Arctic Eskimos' preference for whale meat and partly because walrus disperse widely in the northern Chukchi and Beaufort Seas and are not always accessible.

e. **Birds**

The Arctic Coastal Area and the adjacent seas are inhabited by approximately 163 bird species. Most of these are present only seasonally, however. Some species come here specifically to nest, others to feed, and still others migrate through the region on their way to and from breeding grounds in other areas of the Alaskan, Canadian and Soviet Arctic. Though some few species such as the snow bunting may arrive in the region in early April, most do not arrive until early May; fall migration begins as early as August, but most do not leave until September and some species are known to remain until early November.

Most waterfowl and shorebird species found in the study area are coastal migrants. As many as one million eiders migrate east along the Beaufort Sea coast in early May, and two-thirds of the species bound for the Canadian Arctic islands migrate along this route as well. As many as one-tenth of the world's whistling swans nest within one to five miles of the Arctic coast; major concentrations of these are found within the study area at Prudhoe Bay and at the mouths of the Colville and Canning Rivers. The only known nesting colony of snow geese within the State is found within the study area on Howe Island in the delta of the Sagavanirktok River.

Average densities of 1,400 birds per square mile are found as far as 50 to 60 miles inland from the coast, while even greater densities per square mile of waterfowl and shorebirds occur along the coast and adjacent inshore waters. Fluctuations in these densities occur with food availability and weather conditions.

The onshore areas provide nesting habitat for most birds in the study area but a few species such as the plover, sandpiper,

and eider use the offshore islands. Onshore habitats consist primarily of the wetlands, coastal sedge meadows, sea beaches, cutbanks along streams and rivers and old beach lines. Approximately 24 species of birds nest in the onshore areas of the Prudhoe Bay Coastal Area: eleven of these are swimming birds such as loons, ducks and geese and four others are species of sandpiper.

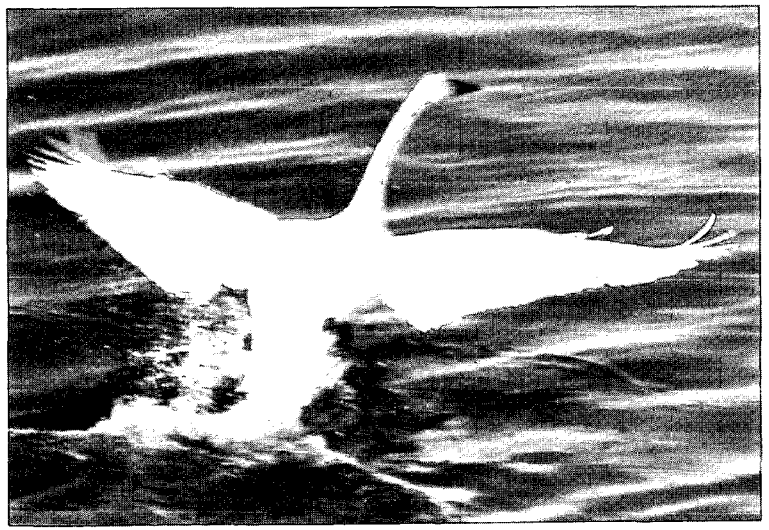
Black-bellied plovers, jaegers, and glaucous gulls occasionally use water areas there. Lapland longspurs and snow buntings are the only songbirds commonly present. Although they don't nest here, common visitors to the onshore area include snow geese, common eiders, arctic terns, snowy owls and ravens.

Brackish inshore waters or lagoons between the mainland and barrier islands are rich in nutrients and invertebrate organisms. These areas are extremely important as a source of food for both onshore and island nesting populations and for the millions of waterbirds which utilize the onshore areas as a major migration route in spring and fall. In addition, old squaws and Canada geese depend upon the onshore areas for moulting.

The coastal islands serve as a barrier to drifting pack ice and provide shallow ice-free feeding and resting areas for waterfowl, gulls and terns. Because they also tend to contain summer coastal runoff, the islands harbor lagoons of varying salinity and high productivity. With the exception of Cross and the Niakuk Islands, Beaufort Sea barrier islands support very low numbers of breeding birds. Cross Island has a significant number of breeding common eiders and the Niakuk Islands have large concentrations of glaucous gulls. The greatest use of the islands, however, occurs during the postbreeding season when many land species move to the coast. Beginning in mid-July, old squaws concentrate in bays near the islands where they feed and moult. Later in the month they are joined by juvenile red phalaropes, juvenile Sabine's gulls, arctic terns and other shorebirds.

Twenty-one species have been observed in the offshore areas of the Beaufort Sea. Sixteen of these breed on either tundra or offshore islands. Eiders, scoters, old squaws, phalaropes and gulls are the most conspicuous offshore birds, but loons, jaegers, alcids and arctic terns are also common. Although birds are sometimes found many miles from shore on the pack ice, most don't stray beyond 5 miles of the mainland or barrier island coast. As a result of studies conducted by the Bureau of Land Management in connection with the joint Federal/State OCS lease sale scheduled for December 1979, a number of the offshore islands within the study area have been designated as important bird nesting grounds. Pingok, Cross, Niakuk and Duck Islands are considered by the BLM to have high bird nesting importance, while Flaxman, Pole, Howe, Egg and Thetis Islands are considered to have medium nesting importance.

The Prudhoe Bay Coastal Area is the seasonal home of the peregrine falcon, an endangered species. Although Federal law protecting endangered species does not allow specific identification of the bird's nesting habitat, U. S. Fish and Wildlife biologists locate these generally east of the Kuparuk River about 15 to 20 miles inland from the coast. The



peregrine falcon ranges as far as the coast to feed on nesting shorebirds. Like most bird species found on the North Slope, the peregrine falcon is only a seasonal visitor and spends the winter in South America.

D. PETROLEUM RESOURCES

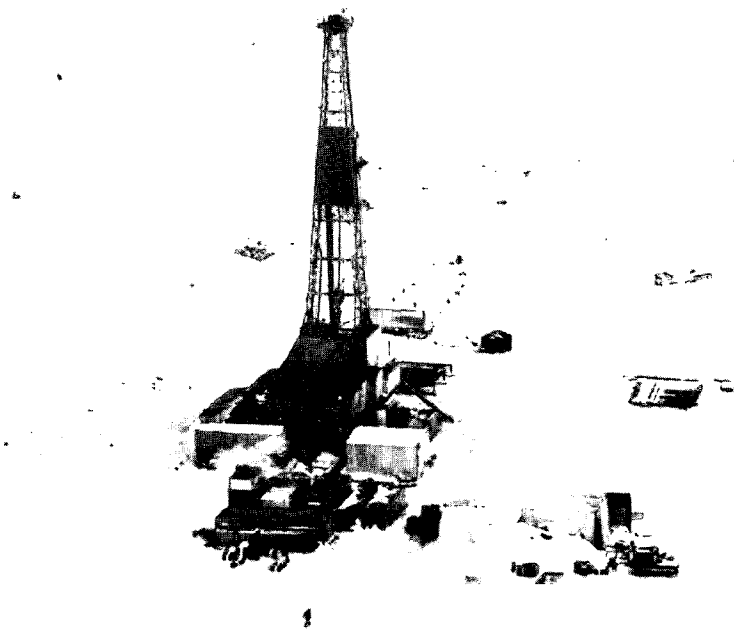
The single most important factor in the economy of the Prudhoe Bay Coastal Area is its oil and gas resources. Although a number of oil seeps on the North Slope were known to Native Eskimos and early arctic explorers, modern interest in oil and gas in the region dates to 1901 when the first geologic traverse was undertaken. Sufficient positive data as to potential resources had been acquired by 1923 to cause President Harding to establish Naval Petroleum Reserve No. 4. This designation was changed in 1976 to National Petroleum Reserve-Alaska or NPR-A when the Department of the Interior took over its management.

Following the establishment of NPR-A, the U. S. Geological Survey undertook considerable reconnaissance surveys in the 1920's and 1930's. In 1944, spurred by the pressure of World War II, the Navy began a vigorous exploration and drilling program in NPR-A which, after the war, was continued until 1953 under private contract. This effort resulted in the discovery of nine oil and gas fields, none of which contained commercially recoverable quantities.

Prior to 1958, Federal land on the North Slope, with the exception of NPR-A, was closed to mineral leasing for many years. Leasing was restored in 1958, however, and in that year 3.4 million acres were offered on a noncompetitive basis. Between 1958 and 1966, when the leasing program was suspended because of Native protest, BLM leased 5 million acres of a total 22.3 million acres offered for lease. Although no Federal lands on the North Slope were leased after 1966, the program was not officially terminated until 1969.

In 1959 when Alaska became a State, it received title to all tide and submerged lands and, in addition, acquired the right to select about 102 million acres statewide. Thus far it has selected over 4 million acres on the North Slope, almost all located on the Arctic Coastal Plain between NPR-A and the Arctic National Wildlife Range. Significant portions of this have been offered for oil and gas leasing in four sales held in 1964, 1965, 1967, and 1969. It was on land obtained during the three earliest leases (1964, 1965, and 1967) that Atlantic Richfield in 1968 drilled the so-called Prudhoe Bay "discovery" well. The 1969 lease sale was held after the announcement of the discovery.

Additional sales are planned in the area in the future. Two of these are offshore leases sales. The first is a joint State/Federal lease sale scheduled for December 1979. This lease area is located offshore between the Canning and Colville Rivers and encompasses most of the area within the three-mile limit and some adjacent Federal tracts. The second



offshore sale will take place in 1982, but the specific area to be leased has not yet been announced. Two onshore sales are also planned. The first is scheduled for October 1978 and will involve land east of Pt. Thomson on the study area's eastern boundary. The second sale is scheduled for April 1981 and will include previously unleased acreage in the Prudhoe Bay area.

Since the discovery of the Prudhoe Bay field in 1968, the Beaufort Sea region has been the subject of heightened interest on the part of the petroleum industry. This has been reflected in increased exploration activity both in the study area and also in the adjacent National Petroleum Reserve-Alaska and the Arctic National Wildlife Range with increased demands for additional lease acreage.

Thus far, this interest has certainly been justified. The main reservoir (Sadlerochit) at Prudhoe Bay is estimated to contain 9.6 billion barrels of recoverable oil and 25 trillion cubic feet of gas, the largest known petroleum reserve in North America. In addition to the Sadlerochit formation, however, other pools in the area of unknown extent are apparently capable of producing oil. Atlantic Richfield Company is currently undertaking a production test on the Kuparuk River formation of the Prudhoe Bay field. According to the Alaska Division of Oil and Gas Conservation, this pool is estimated to contain 1 billion barrels of recoverable oil.

It is difficult to estimate how much additional oil will be discovered in the area. The U. S. Geological Survey in 1975 estimated that there are from 5 to 16 billion barrels of oil and 14 to 49 trillion cubic feet of gas on the entire North Slope, but these estimates of undiscovered resources are not broken down by area. A study conducted by the Alaska Department of Natural Resources in 1977 estimated the area's undiscovered resources to contain from 0.5 to 1.5 billion barrels of oil and from 1.5 to 5 trillion cubic feet of gas.

The U. S. Geological Survey estimates that the undiscovered recoverable oil and gas resources are from 0 to 7.6 billion barrels of oil and from 0 to 19.3 trillion cubic feet of gas between the 0 to 200-meter isobaths in the Beaufort Sea from Barrow east to Demarcation Point on the Canadian border. However, because of present technological limitations these estimates must be scaled down to the 20-meter (60-foot) isobath. Approximately 60 percent of the Beaufort province lies within the 20-meter isobath. Estimates of from 0 to 4.6 billion barrels of oil and from 0 to 11.6 trillion cubic feet of gas are obtained by allocating 60 percent of the overall estimates.

Data on petroleum resources in some areas adjacent to the study area are limited. For example, the U. S. Department of the Interior is currently exploring the NPR-A, but estimates of the resources there vary greatly. In 1976, the Federal Energy Administration estimated the NPR-A to contain 5 billion barrels of oil and 14.3 trillion cubic feet of gas, but current estimates place this closer to only 1 billion barrels. Oil exploration is not currently allowed in the Arctic National Wildlife Range, but resource experts consider the area to have a high hydrocarbon potential. Onshore exploration of adjacent land would appear to have minimal impact on the Prudhoe Bay district. All support for NPR-A exploratory activities are contained within NPR-A, and since exploration is not presently allowed in the wildlife range, there will be no impact from this direction at least in the near future.

Future impact on the Prudhoe Bay area from NPR-A or wildlife range development activity will depend on two factors: The size and location of future discoveries and the route and type of system developed to transport the resources. The Department of the Interior is in the process of evaluating the best procedures for the development, production, transportation and distribution of NPR-A petroleum resources. At the same time, a special Interior Department task force is studying the best use for land within and adjacent to NPR-A for such values as subsistence, scenery, historic, recreation, fish and wildlife and wilderness. Results of these studies will be presented to the Secretary of Interior in 1979 and he will, in turn, make a recommendation to

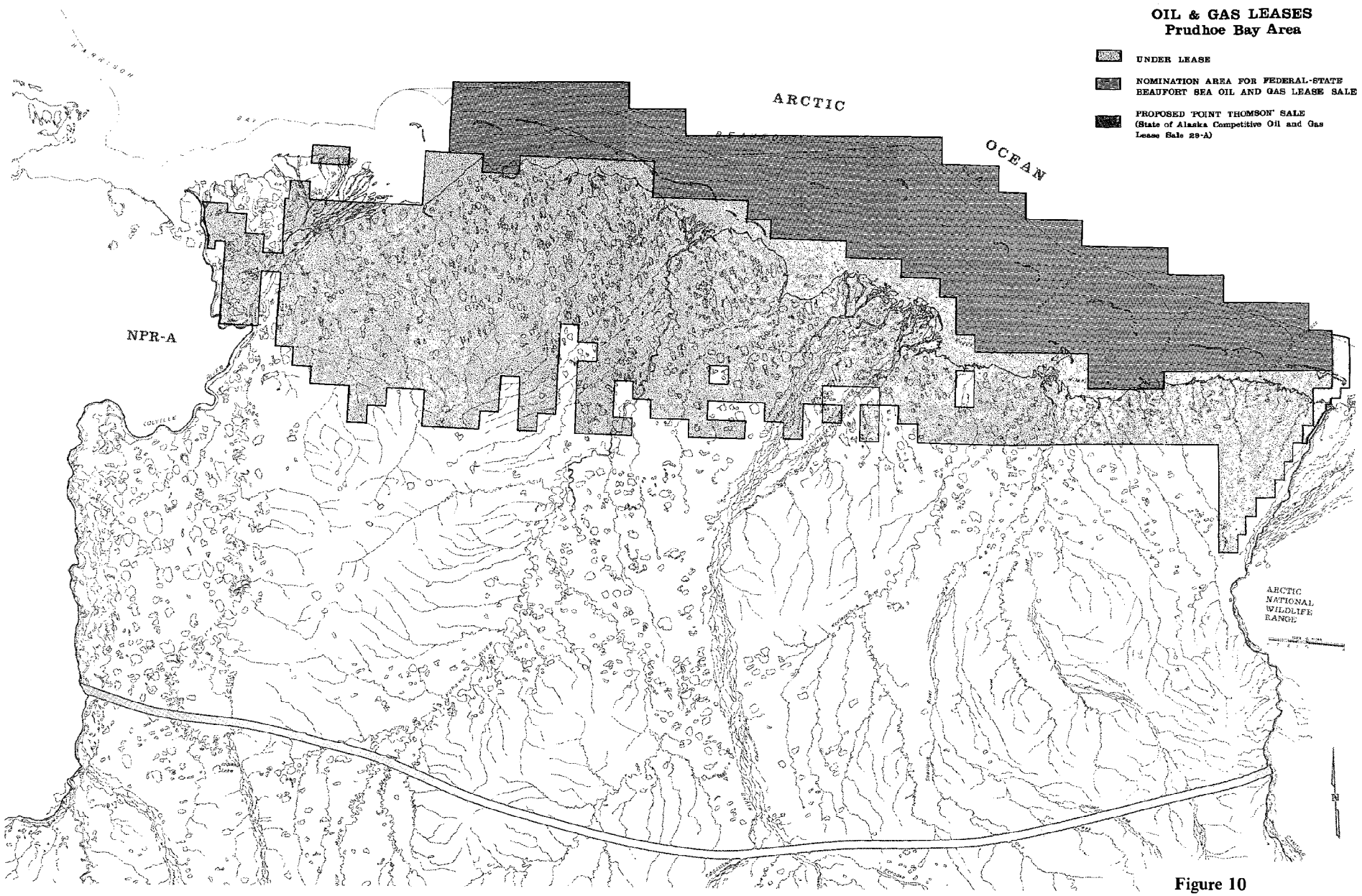

OIL & GAS LEASES
Prudhoe Bay Area
UNDER LEASE
NOMINATION AREA FOR FEDERAL-STATE BEAUFORT SEA OIL AND GAS LEASE SALE
PROPOSED 'POINT THOMSON' SALE (State of Alaska Competitive Oil and Gas Lease Sale 29-A)
ARCTIC
OCEAN
NPR-A
ARCTIC NATIONAL WILDLIFE RANGE
N

Figure 10

Congress as to the future use of NPR-A. The impact of development of NPR-A will depend to a large extent upon the decision made by Congress as to the disposition of NPR-A. Potential impacts from wildlife range development depend upon if and when it is opened to exploration and development.

E. RECREATION AND CULTURAL RESOURCES

1. Cultural Significance

Although there is currently no permanent Native population living within the study area, the land has in the past been the site of numerous temporary settlements and seasonal hunting and fishing camps. Recent archeological and historical studies undertaken by the North Slope Borough and the Federal government have identified hundreds of old grave sites, sod hut and ice cellar outlines, and a wide variety of artifacts which give ample testimony to the historical and cultural significance of the land. These are identified and described at some length in an inventory published recently by the North Slope Borough. Additional inventories in NPR-A and within the study area are being prepared by the National Park Service.

A number of cultural and historic sites identified by the North Slope Borough and the Federal government appear to be of sufficient significance to merit National Historic Register status, and appropriate documentation is being prepared to make a determination of their eligibility. For other identified sites, there are not enough data available to make such a determination and additional study is required. Both "registered" and potentially eligible national historic sites have full protection under Federal law if they are on Federal land or if they may be impacted either directly or indirectly by Federal action. Within the Prudhoe Bay Coastal Area, most land is State owned and thus registered historic sites located there are the responsibility of the State.

Within the study area sites of historic and cultural significance are heavily concentrated along the entire coast, the barrier islands, and the river valleys, particularly the Colville River. In general, these coincide with those areas where subsistence resources have been most abundant. Although these locales continue to be used today on a seasonal basis for their subsistence resource value, subsistence use of the land there is less intense now than it has been in the past.

Within the Prudhoe Bay Coastal Area there is one State of Alaska Historic Site and one entrant in the National Register of Historic Sites. This is the former campsite of explorer/geologist Ernest de Koven Leffingwell located on Flaxman Island off the Canning River delta. Leffingwell mapped the Arctic coast from 1907 to 1914 and conducted some of the first significant scientific studies on permafrost. In addition, he named the Sadlerochit Formation which has since become famous as the main reservoir of the Prudhoe Bay oil field.

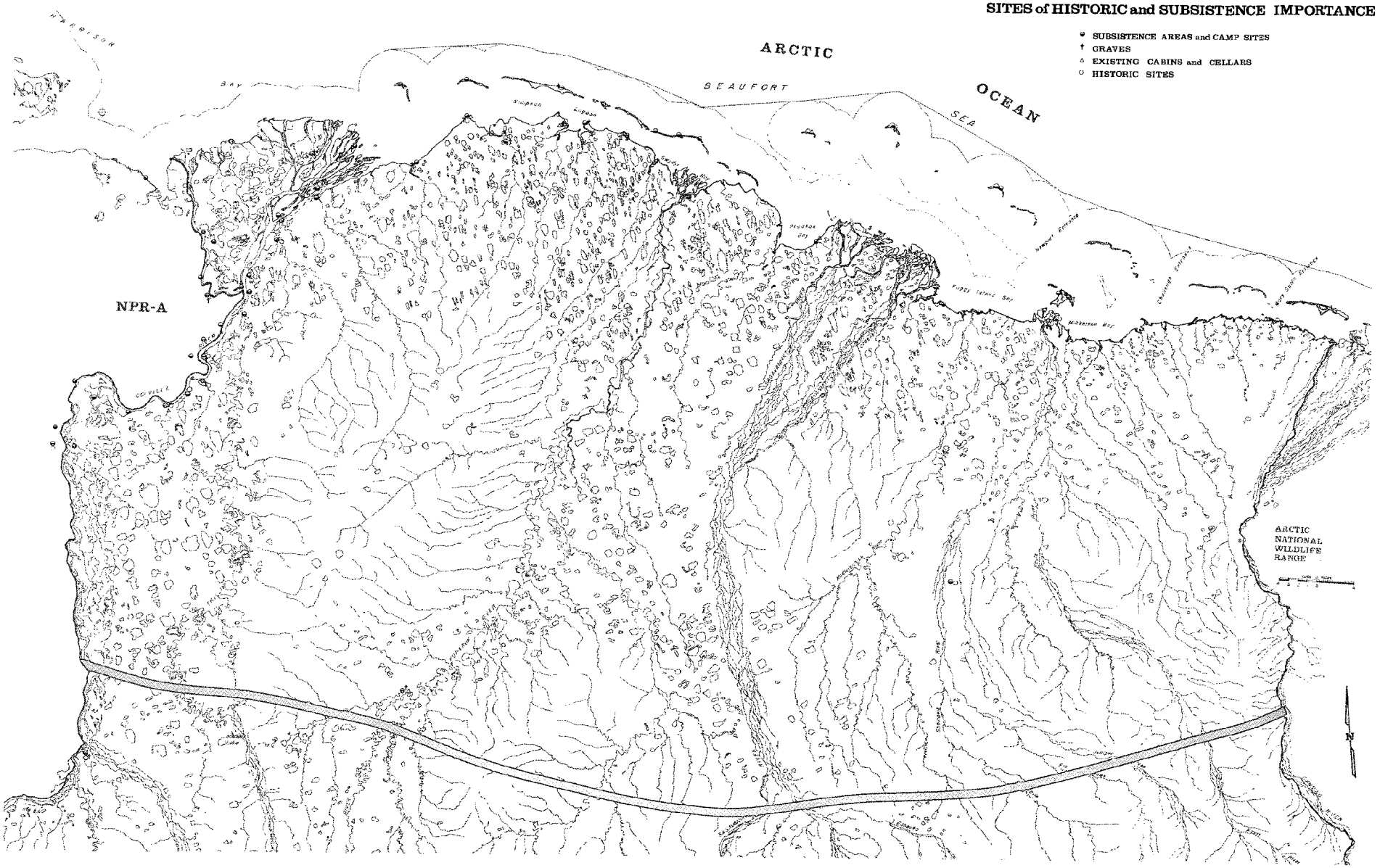

SITES of HISTORIC and SUBSISTENCE IMPORTANCE
SUBSISTENCE AREAS and CAMP SITES
GRAVES
EXISTING CABINS and CELLARS
HISTORIC SITES
ARCTIC
OCEAN
BEAUFORT
SEA
HARRISON
BAY
NPR-A
ARCTIC
NATIONAL
WILDLIFE
RANGE
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Figure 11

2. Recreation Resources

At the present time, there are no recreational facilities in the Prudhoe Bay Coastal Area outside those provided by the oil industry and NANA at Prudhoe Bay and Deadhorse. The absence of facilities does not indicate that the area lacks recreational significance, but rather that the remoteness of the region from major population centers and the limited facilities and access have kept use pressure at a minimum. Even with these limitations, however, there is some existing conventional recreational use of the land both by residents of Prudhoe Bay/Deadhorse, the Barter Island DEW Line station, and nonresidents who fly in from outside. As residents of Prudhoe Bay/Deadhorse are not allowed to possess firearms, their use of the area's resources is limited to fishing.

According to the Alaska Department of Fish and Game (ADF&G), a number of nonresident hunters and sport fishermen visit the Prudhoe Bay Coastal Area annually. Data generated from harvest ticket report forms which are required submittals from "successful" hunters indicate that there were from 50 to 100 nonresident caribou hunters in the region during 1977. This number would undoubtedly have been higher had the ADF&G not imposed strict "bag limits" and a permit system in Game Management Unit 26, which includes the study area, as a means of protecting the dwindling Western Arctic caribou herd. Although moose are not generally prevalent on the Arctic Coastal Plain, they are found in some numbers in the Colville River valley, the western boundary of the Prudhoe Bay Coastal Area. ADF&G estimates that there were 23 nonresident moose hunters in Game Unit 26 during the 1977 moose hunting season. It is assumed that most, if not all, of these were in the Colville area.

Although there are no accurate figures on the number of sport fishermen using the area, Atlantic Richfield officials report that some Prudhoe Bay and Deadhorse residents do fish in their limited free time, particularly in the Sagavanirktok and Kuparuk Rivers and along the coast in the Prudhoe Bay environs. A guide service, located in the Colville River delta about 20 miles north of Nuiqsut, transports sport fishermen to rivers and lakes within the study area in its two planes.

A task force headed by the Heritage Conservation and Recreation Service (formerly the Bureau of Outdoor Recreation) has expended considerable effort during the past year developing the wilderness scenery and recreational potential element of the overall NPR-A land use plan. While its findings relate specifically to the NPR-A, some of these can be applied generally to the Arctic Coastal Plain which comprises much of the Prudhoe Bay Coastal Area. The Heritage Conservation and Recreation Service considers the study area to have significant resources available to provide a variety of recreational activities. The flat topography and the low vegetation prevalent in this region are particularly conducive to sightseeing and wildlife and waterfowl viewing. Although hiking is made difficult in summer by mosquitos and swampy soil conditions, there is potential for such sports as cross-country skiing and snowmobiling in late winter and early spring when days are longer and temperatures have moderated.

Although the Heritage Conservation and Recreation Service has not yet assessed the boating potential of any rivers within the study area, it has studied portions of the Colville and considers the river to have significant wilderness scenery and recreational potential. Segments of the Colville have been included in the Administration's D-2 proposal as part of the National Wild and Scenic River System, and H.R. 39 as passed by the House of Representatives proposes that all rivers within NPR-A, including the Colville, be included in the Wild and Scenic River System. The Heritage Conservation and Recreation Service and the State of Alaska will study the potential of the Sagavanirktok River during the summer of 1978. The State has asked the Service to study the wild and scenic potential of the Canning River, but at this time, there are no definite plans to do so.

3. Scenic Resources

Probably the greatest attraction of the Prudhoe Bay Coastal Area is its primitive condition and the wide variety of unique Arctic geological and ecological phenomena that exist there. Although oil and gas development and the trans-Alaska pipeline have degraded the pristine quality of the Prudhoe Bay area and the pipeline corridor, the impact of this development has been quite restricted and large portions of the study area remain untouched by industrial development. In an attempt to ensure protection of the unique ecological and biological features of the Arctic lowland from intrusion by development, the National Park Service in 1974 initiated a program to identify unique examples of tundra environment to be included in the Natural Landmark Program.

In connection with this effort, the Park Service identified 16 geographic locations within the study area as appropriate for nomination as Natural Landmarks. It is the opinion of the Park Service that all of these contain geological or ecological values of such distinction as to be of national significance. Nine of the proposed landmarks illustrate geological themes and the remaining seven represent ecological themes.

The Putuligayuk Plains (1) provide an excellent example of a flat interior plain. They are characterized by permafrost landforms including pingos, high- and low-centered polygons and braided streams. As the majority of the plains lie in the trans-Alaska pipeline utility corridor, they are in some jeopardy because of their proximity to the pipeline.

The 15,000-acre Foggy Island Bay site (2) illustrates a raised coastal plain. The land surface is nearly flat, contains thermokarst and oriented lakes and abundant polygons and ice wedge cracks. The land in the Foggy Island Bay area is owned by the State of Alaska and has been leased to numerous oil companies, and some exploratory drilling has taken place.

Rising 500 to 600 feet above the surrounding lowlands, the gravel-covered Franklin Bluffs (3) are a spectacular landmark. Composed of exposed bedrock, weathering has created in the bluffs brilliant hues of red, pink, yellow, orange and white. In addition to their scenic value, the Franklin Bluffs contain important falcon and hawk aeries. The site is in some jeopardy due to the proximity of the trans-Alaska pipeline and Haul Road.

The White Hills (4) are a 500- to 600-foot plateau so named for the white pediment gravel and light-colored bedrock which characterize them. The plateau affords an impressive panoramic view of the Arctic Coastal Plain and from the eastern side, some spectacular badland topography. There has been exploratory drilling for petroleum off the eastern boundary, and the White Hills themselves are potentially vulnerable to oil exploration.

The Sagavanirktok River (5) provides a classic example of a braided stream. Included in this 51,840-acre site are three or four main channels that flow on a three mile wide floodplain in an intricately braided network. Although the river at this location has probably suffered irreparable damage from pipeline and Haul Road construction, the National Park Service, nevertheless, considers it to have a high degree of national significance.

The Kadleroshilik River (6) is significant as an example of pingo development. This site encompasses more than 30 pingos and numerous closed depressions that will probably undergo future pingo development, as well as abundant high- and low-centered polygons, thermokarst lakes and thaw pits. This area has a delicate ecological balance and the Park Service recommends that it be set aside while it is still relatively unspoiled.

The Toolik River Pingo Field (7) contains approximately 60 pingos in various states of development. Most of these are on the alluvial floodplain of the Toolik River with the highest about 100 feet above the surrounding plain. Polygonal ground, braided streams, thermokarst and oxbow lakes and sand dunes are also prevalent. The State of Alaska has leased this area for oil exploration. There are exploratory oil wells nearby and the pingo field is in some jeopardy from possible future exploratory activity.

	LANDMARK	LANDFORM/UNIQUE FEATURES
1	Putuligayuk Plains	Plains, lakes and lakeshores, permafrost
2	Foggy Island Bay	Raised coastal plain, permafrost, lakes and lakeshores, sea and seashores
3	Franklin Bluffs	Gravel pediment plateau
4	White Hills	Gravel pediment and bedrock plateau
5	Sagavanirktok River	Braided channel
6	Kadleroshilik River	Pingos, polygons, beaded streams, plain
7	Toolik River Pingo Field	Pingos, polygons, plains, river systems
8	Shaviovik River Pingo Field	Pingos, polygons, plains
9	Ishukpak Bluff	Fold, fault, river system
10	Franklin Bluffs & the White Hills	Tertiary formations, unique flora, microtopography, falcon aeries
11	Beechey Mound Area	Coastal topography, waterfowl nesting area, pingos, polygons, oriented lakes
12	Colville River Delta	Deltas, seashores and islands, lakes and lakeshores, eolian. Large arctic delta with unique fish populations, waterfowl, dunes and tidal flats
13	Cross Island	Offshore island on Arctic coast, polar bear denning sites, waterfowl nesting, marine strands
14	Flaxman Island	Island, eolian. Site of explorer's cabin and camp, location of erratic boulders, waterfowl
15	Kadleroshilik Mound	Large mature pingo
16	Colville River Bluffs	Bluffs along middle course of braided river, falcon aeries, moose habitat, willow tree growth, coal deposits, Petroleum Reserve campsite

Source: U. S. Department of the Interior, National Park Service.

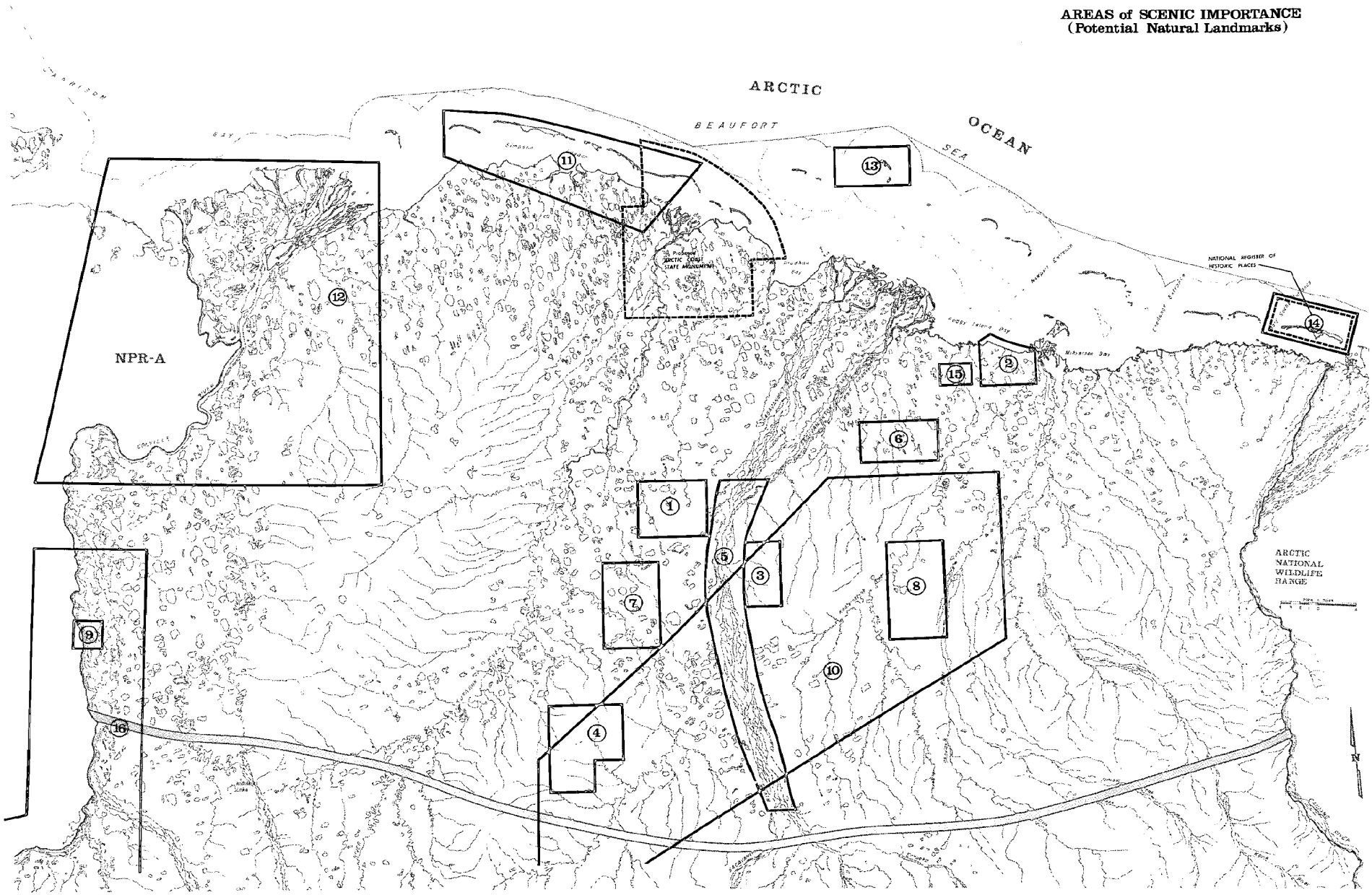
AREAS of SCENIC IMPORTANCE
(Potential Natural Landmarks)
ARCTIC
BEAUFORT
SEA
OCEAN
NPR-A
NATIONAL REGISTER OF HISTORIC PLACES
ARCTIC NATIONAL WILDLIFE RANGE
1
2
3
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Figure 12

The Shaviovik River Pingo Field (8) provides additional good examples of pingos and high- and low-centered polygons and has several braided streams in advanced stages of development.

The Ishukpak Bluff (9) is a noted example of the effect of the movement of the earth's crust. Black and white beds emphasize the folding and faulting of the strata. The bluffs host falcon and hawk aeries; the river flats are characterized by aquatic and wet sedge tundra and tussock tundra occurs on the river bluffs.

The Franklin Bluffs/White Hills site (10) includes all or portions of four previously identified sites: Franklin Bluffs, White Hills, the Sagavanirktok River, and the Shaviovik River Pingo Field. In addition to the already described unique features of these sites, this proposed landmark hosts a variety of animal life. Falcons and hawks nest on the bluffs, and golden eagles, swans and jaegers have also been observed in the area. Caribou move through the area in summer and can frequently be seen in small groups on the gravel bars within the riverbeds. Wolf tracks are abundant and grizzly bears are sometimes seen. The well-drained Franklin Bluffs support a variety of vegetation types which contrast with the uniform sedge tussock tundra predominant on the upland surface of the Arctic lowland. The Park Service considers this potential landmark to have a high degree of national significance and deems it extremely vulnerable because of its proximity to the pipeline.

The major features of the Beechey Mound Area (11) are offshore islands, pingos and coastal tundra. The northernmost island of the Return Island group and the Jones Islands, which are included in the site, are less than 20 feet above mean sea level and present good examples of Arctic beach. Beechey Mound and several other pingos in the area were used by early explorers as navigational aids. The littoral tundra provides suitable habitat for waterfowl. During the summer, swans, loons, and a variety of shorebirds are present and large numbers of eider ducks migrate up and down the coast during spring and fall. Although the site has scenic value, it may not warrant national significance.

The bluffs of the Colville River Delta (12) host major concentrations of raptorial birds including falcons, hawks and eagles. The river valley's protected willow thickets serve as a wintering range for some species of birds and the delta's dunes support a large population of Arctic ground squirrels and foxes.

Cross Island (13) lies approximately 11 miles off the Sagavanirktok River delta between the Midway Islands to the west and McClure Island to the east. Although the island does not support a large resident bird population, it does provide a resting place for waterfowl and shorebirds during migration. Polar bear denning sites are also present.

Located off the Arctic coast in the Beaufort Sea, the proposed Flaxman Island Natural Landmark (14) lies just west of the mouth of the Canning River. Although the island is a bird nesting site and a refuge for migrating birds, the primary reason for proposing it as a Natural Landmark lies in its historic significance. As mentioned previously, Flaxman

Island is the former campsite of explorer/geologist Ernest de Koven Leffingwell.

Located approximately three miles inland from Foggy Island Bay, the Kadleroshilik Mound (15), which stands about 200 feet above the surrounding tundra, is one of the largest pingos in the Arctic lowland. The Mound is a roost for predatory birds and has a small population of ground squirrels. There are no apparent dangers to the integrity of the site.

The Colville River Bluffs (16) are unique for both biological and geological reasons. The bluffs contain large aeries of such rare raptorial birds as peregrine falcons and rough-legged hawks. Also within the bluffs there are numerous coal exposures. The river valley supports a relatively large moose population, the only moose in significant numbers in the North Slope region. This site also includes the Ishukpak Bluff described previously. The site's integrity is in no apparent danger.

In addition to the 16 Natural Landmarks within the study area proposed by the National Park Service, the State Division of Parks has proposed the establishment of the Arctic Coast State Monument. Located to the west of Prudhoe Bay on State-owned property, the proposed Monument would afford visitors access to view the natural features and abundant waterfowl of the area in concert with petroleum exploration and development. The State envisions that visitor usage of the proposed Monument would be closely controlled.

In 1977, the Federal-State Land Use Planning Commission undertook to identify natural and landscape features around the State deemed by the public as having high resource merit. As a result of this study, three rivers within the study area, the Canning, Sagavanirktok, and Colville Rivers, have been designated by the Planning Commission as "Scenic Arctic Rivers." In addition, Flaxman Island and its associated lagoon system and Pingok and Spy Islands and their associated lagoon systems are also rated by the public as high resource areas and have thus been designated "Scenic Arctic Barrier Island and Lagoon Systems." At the present time, these designations are solely for resource identification purposes and have no legal connotations; however, they may possibly receive some legislative consideration in the future.

F. POPULATION AND ECONOMY

1. Past Population Trends

Historical patterns of settlement along the Arctic coast were based upon subsistence harvesting of sea mammals. Small bands of coastal Eskimos hunted, fished, and traded with nomadic inland Eskimos who hunted the caribou. Various settlements and seasonal campsites existed in the Prudhoe Bay Coastal Area at one time or another. The 1890 U. S. Census noted "no permanent settlements along the Arctic coast between Point Barrow and the Mackenzie River" but acknowledged the existence of temporary camp and trading sites within the region. In 1919, however, explorer-geologist Ernest de Koven Leffingwell identified two permanent settlements in the Canning-Colville coastal environs. Beechey Point, located 25 miles east of the Colville River, had a

permanent population of 66 in 1919 according to Leffingwell; more recently, in 1939, the U. S. Census identified 12 people living at this settlement. Also in 1919, Leffingwell identified a permanent settlement at the west entrance of Foggy Island Bay, 35 miles southeast of Beechey Point at the mouth of the Sagavanirktok River and named this Brower Village after the trader Charles Brower.

Other historic places in the Prudhoe Bay Coastal Area region identified by the Federal Field Committee for Development Planning in Alaska are Oliktok (west of Beechey Point); Point McIntyre, located between the Kuparuk and Sagavanirktok Rivers; Tigvariak Island, west of Brower Village; and Shinagru, an historic trading center at the mouth of the Canning River.

No permanent settlements have been identified at any of these locations since 1939; however, many of these sites continued to be used during this period as seasonal campsites for hunting and fishing purposes. Historic Native presence here is evident today in the remains of cabins and a number of patented allotments sprinkled throughout the region. As happened with other similar historic settlements along the Arctic coast, residents migrated to larger population centers in the region, notably Barrow, in search of wage employment and government-provided social services such as schools and medical facilities.

Following a period of little or no settlement activity in the Prudhoe Bay Coastal Area during the 25-year period from 1940 to 1965, State-sponsored competitive oil and gas lease sales in 1964, 1965, 1967, and 1969 and attendant exploratory activity brought an influx of population to the Prudhoe Bay area. The discovery well for the Prudhoe Bay field was spudded in 1967, and was officially announced in July 1968. In 1970, according to the U. S. Census, there were 279 people living in the general Prudhoe Bay/Deadhorse area. Five years later, just prior to start-up of construction on the trans-Alaska pipeline, according to figures provided by the industry to the North Slope Borough there were 3,159

people living there, an increase of well over 1,000 percent. At the height of pipeline construction, in July 1976, approximately 8,800 people were living in various camps within the region. From July 1976 to July 1977 population decreased roughly 43 percent, and it is anticipated that population will continue to decrease in the near future as pipeline construction is completed and the operational phase takes over.

2. Population Composition

Historically, influxes of white population into the Arctic coastal region have been exclusively male. During the height of the whaling industry in the late 19th century, the census noted 391 whites residing within the Arctic region, all of these male. This sexual disparity persists today. According to the U. S. Census, the outstanding feature of the population living at Prudhoe Bay and Deadhorse in 1970 was that it was exclusively male.

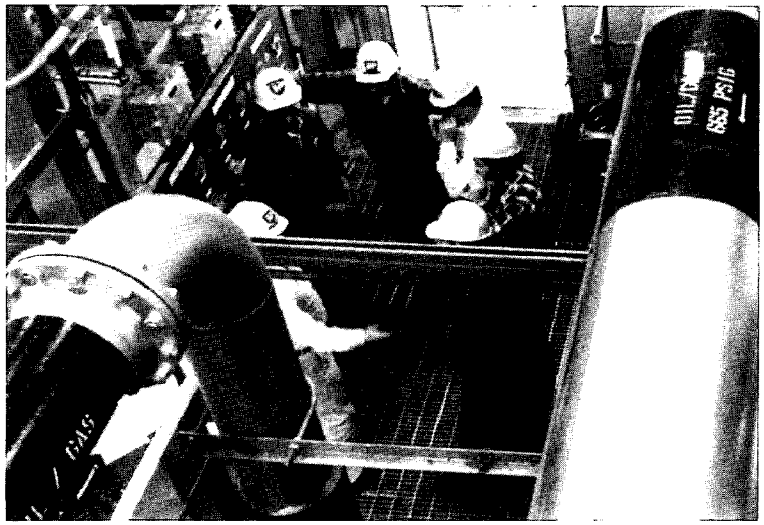
A second peculiarity of the population is that it has a high median age—34.3 years at Deadhorse and 37.2 years at Prudhoe Bay. Neither settlement had any residents under the age of 18 or over 66 since all persons counted lived there for

some work-related reason and thus included only those of working age.

Although there were many more people based in the Prudhoe Bay/Deadhorse area in 1977 than in 1970, and the current population does include some females, overall the characteristics of the population have not changed appreciably. All persons living in camps in the Prudhoe Bay/Deadhorse area are still there strictly for purposes of employment, with dependents living elsewhere in the State or nation. Consequently, the area's population continues to be dominated by males between the ages of 18 and 65.

Alaska Natives made up less than 10 percent of the population at Prudhoe Bay (8.2 percent) and Deadhorse (9.2 percent) in 1970 even though in the North Slope region as a whole they comprised 83 percent of the population. As with females, although the number of Natives working in the area has increased since 1970, they do not account for a significantly greater proportion of the total population.

These "peculiar" features of the Prudhoe Bay/Deadhorse population are likely to continue for at least the next several



years. Construction of the gas pipeline and scheduled offshore oil and gas lease sales promise to bring additional persons with similar age, sex and racial characteristics back to the area.

3. Employment Composition

According to information provided to the North Slope Borough by the oil industry there were, in July 1977, 3,239 people employed in that portion of the Prudhoe Bay/Deadhorse area within the Prudhoe Bay Coastal Area. Included in this count are all those people employed in the Prudhoe Bay industrial complex (including Deadhorse) as well as those located in the two Alyeska Pipeline Company camps within the study area, Franklin Bluffs Camp and Happy Valley Camp.

There is some difficulty in obtaining an accurate sector breakdown from these data as they are in some cases categorized by place of dwelling rather than by activity or employer (although in many cases these are one and the same). For example, the industry reported that there were 448 people living at BP Construction Camp No. 1 in July 1977. One can assume that most of these were involved in construction-related activities; however, the figure also includes some support personnel such as caterers and maintenance personnel. Likewise, the 219 persons identified as living at Deadhorse Camp and associated with NANA Oilfield Services include employees involved in a variety of activities such as transportation, communications and public utilities (ERA Helicopter, Sea-Airmotive, RCA), finance, insurance, and real estate (Alaska Bank of the North), etc. Because the industry does not supply a definitive breakdown by employer, these people have all been placed in the service sector as NANA Oilfield Services is the largest single employer among them. Even with these data limitations, however, some generalizations concerning the Prudhoe Bay/Deadhorse labor force composition can be developed.

In July 1977, the three largest employment sectors were contract construction; transportation, communications and

public utilities; and mining. Contract construction accounted for well over half or 54.8 percent of the Prudhoe Bay/Deadhorse nonagricultural wage and salary employment. Transportation, communications and public utilities together represented nearly 40 percent of the total nonagricultural wage and salary employment. Only two other sectors—service and government—had identifiable employment in July 1977. The service sector had 5.2 percent of the total Prudhoe Bay/Deadhorse employment and State and Federal government together had less than 0.5 percent or 10 employees. There were no local government employees in the area at the time of the July 1977 count.

Overall, the composition of the study area's employment bears some marked similarities to that of the North Slope Borough as a whole, although it is not typical of the employment composition of the Borough's traditional villages. Since well over half of the Borough's population and significantly more than that portion of its employment lives in the Prudhoe Bay/Deadhorse area, Boroughwide employment figures are understandably heavily weighted by the activity at the Prudhoe Bay industrial complex.

Although there are no 1977 employment distribution data yet available for the North Slope Borough, a comparison of July 1977 Prudhoe Bay/Deadhorse figures with those compiled by the Alaska Department of Labor in 1976 for the Borough shows that contract construction was the largest single employer for both. In 1976, 53.9 percent of the Borough's nonagricultural wage and salary employment was in contract construction; in July 1977, 54.8 percent of those living in the Prudhoe Bay industrial complex were employed in contract construction. Similarly 18.3 percent of the Borough's 1976 nonagricultural wage and salary employment was in the mining sector, and 18.6 percent of the Prudhoe Bay complex employment was involved in mining activity. Boroughwide, the service sector represented 6.2 percent of the total nonagricultural wage and salary employment. In the Prudhoe Bay/Deadhorse area, the figure was a slightly lower 5.2 percent.

The most striking difference in employment composition of the two areas is in the government sector. In 1976, 12.9 percent of the North Slope Borough's nonagricultural wage and salary employment was with either the Federal, State or local governments. However, in July 1977, only 0.2 percent of the Prudhoe Bay industrial complex employment was in the government sector, less than 0.1 percent at the State and local level. Boroughwide, 9.4 percent of the total nonagricultural wage and salary employment was at the State and local government level. Mining, like contract construction, was a more significant source of employment at Prudhoe Bay during 1977 than it was Statewide in 1976. In July 1977, roughly 18 percent of the complex's employment was in mining, whereas, Statewide, the mining sector accounted for only 2.3 percent of the total nonagricultural wage and salary employment.

4. Unemployment and Seasonality of Employment

Unemployment does not exist in the Prudhoe Bay/Deadhorse area. All people living in the region do so for job-related reasons, and once their jobs end, they simply leave. Nor do industry population statistics from 1974 to 1977 indicate any definite pattern of employment seasonality. Employment rose steadily in the Prudhoe Bay/Deadhorse area from January 1974 to July 1976 regardless of season. Since January 1976, there has been a steady decrease in employment, but this can be attributed to completion of pipeline construction rather than to seasonal changes in employment patterns.

5. Recent Trends and Changes

There have been two significant changes in Prudhoe Bay/Deadhorse area employment in the past several years. First, employment has decreased steadily since it peaked in the summer of 1976 during the height of pipeline construction. In July 1976, the oil industry identified 8,856 persons living and working the Prudhoe Bay/Deadhorse area. In January 1977, this figure had fallen to 8,270, a decrease of 7 percent.

By July 1977, the figure had fallen to 5,351, a decrease of 56 percent of the July 1976 figure. In January 1978 there were only 3,374 people living and working in the area according to industry spokesmen. There may be additional small decreases in the future, but industry expects employment to remain relatively stable until such time as there is some major new oil and gas development in the area or until start-up of construction on the proposed gas pipeline.

Employment composition statistics reflect the recent switch from pipeline construction to operation. In July 1976, during the height of construction, there were 5,339 employees or 84.7 percent of the area's total employment involved in contract construction. One year later, in July 1977, just after the pipeline became officially operational, 2,322 persons, representing 54.8 percent of the area's total labor force, were classified in contract construction.

Concomitant with this decrease in contract construction employment, there has been an increase in the mining and transportation, communications and public utilities sectors. Although the number of people employed in the mining sector did not change appreciably from 1976 to 1977 (742 persons in 1976 and 787 persons in 1977), the sector's percentage of the total labor force did grow in the one year period. In 1976, mining accounted for 11.8 percent of the total employment while in 1977, it accounted for 18.6 percent of the total.

The switch from construction to operation is even more apparent in the transportation, communications and public utilities sector. In 1976, there were 160 employees in this sector, 2.5 percent of the total labor force. Most of these were employed by aviation and trucking companies supporting the construction effort. In 1977, however, this same sector had about 900 employees, 21.2 percent of the total labor force. Almost all of these were directly involved in the operation of the pipeline, rather than in its support.

The trend toward domination of employment by the mining and transportation, communications, and public utilities sectors is likely to persist at least in the near term. In July 1977, even though the pipeline was officially operational, there was some residual construction activity. According to industry officials, this activity has tapered off since then and will continue to do so in the future. However, the number of employees involved in the mining and transportation sectors is expected to remain constant, thus increasing those sectors' percentage of the total labor force.

6. Income Levels

Reliable figures on income are difficult to develop for the Prudhoe Bay/Deadhorse area because State Department of Labor income statistics are generated on a Boroughwide rather than on an individual community basis. However, given the composition of the Prudhoe Bay/Deadhorse employment, with its heavy concentrations in the mining, contract construction, and transportation, communications, and public utilities sectors as opposed to the limited employment in these sectors in the North Slope Borough's traditional communities, some generalizations can be made about the Prudhoe Bay/Deadhorse area.

Statistics developed by the State Department of Labor show that wage levels in the North Slope Borough were among the highest in the State in 1975 and 1976. The average monthly wage in the region in 1976 was $3,897, which is only slightly lower than the three highest census divisions in the State, Southeast Fairbanks, Valdez-Chitina-Whittier, and Yukon-Koyukuk. All three of these divisions, like the North Slope Borough, were heavily impacted by pipeline construction in 1976. Statewide, the average monthly wage in 1976 was $1,928. This figure, too, was impacted by the high level of construction activity engendered by pipeline construction.

A review of monthly wage levels by industry sector in the Barrow-North Slope census division for 1975, 1976 and the first quarter of 1977 indicates very clearly why Boroughwide wage figures are so high. The average wage in the construction sector in the region was more than $5,000 per month

TABLE 1

NONAGRICULTURAL WAGE AND SALARY DISTRIBUTION
PRUDHOE BAY/DEADHORSE AREA[1]
JULY 1977

Industry Classification	Number	Percent of Total
		%
Mining	787	18.6
Contract Construction	2,322	54.8
Manufacturing	–	–
Transportation, Communication and Public Utilities	901	21.3
Trade	–	–
Finance, Insurance and Real Estate	–	–
Service[2]	219	5.2
Miscellaneous	–	–
Government	10	0.2
Federal	(8)	(0.2)
State	(2)	(0.0)[3]
TOTAL	4,239	100.0

1. Includes the Prudhoe Bay industrial complex, Deadhorse, and Franklin Bluffs and Happy Valley camps.
2. Includes 165 employees of NANA Oilfield Services as well as 64 persons living at NANA's Deadhorse Camp as of July 1, 1977.
3. Represents less than 0.1 percent.

Source: North Slope Borough

TABLE 2

NONAGRICULTURAL WAGE AND SALARY DISTRIBUTION
PRUDHOE BAY/DEADHORSE AREA[1]
1976

Industry Classification	Number	Percent of Total
		%
Mining	742	11.8
Contract Construction	5,339	84.7
Manufacturing	–	–
Transportation, Communication and Public Utilities	160	2.5
Trade	–	–
Finance, Insurance and Real Estate	–	–
Service[3]	55	0.9
Miscellaneous	–	–
Government	10	0.2
Federal	(8)	(0.1)
State	(2)	(0.0)[2]
TOTAL	6,306	100.0

1. Includes the Prudhoe Bay industrial complex, Deadhorse, and Franklin Bluffs and Happy Valley Camps.
2. Represents less than 0.1 percent.
3. Includes residents of NANA's Deadhorse public camp.

Source: SOHIO-BP.

TABLE 3

NONAGRICULTURAL WAGE AND SALARY EMPLOYMENT DISTRIBUTION
NORTH SLOPE BOROUGH
1976

Industry Classification	Number	Percent of Total
		%
Mining	1,271	18.3
Contract Construction	3,738	53.9
Manufacturing	*	*
Transportation, Communication and Public Utilities	316	4.6
Trade	*	*
Finance, Insurance and Real Estate	*	*
Service	445	6.4
Miscellaneous	0	—
Government	892	12.9
Federal	(239)	(3.4)
State	( )	( )
Local	(652)	(9.4)
TOTAL	6,932	100.0

*Employment figures withheld to comply with disclosure regulations.

Source: Alaska Department of Labor.

TABLE 4

NONAGRICULTURAL WAGE AND SALARY EMPLOYMENT DISTRIBUTION
PRUDHOE BAY/DEADHORSE AREA AND STATE OF ALASKA
1976-1977

Industry Classification	Prudhoe Bay/ Deadhorse 1977	Alaska 1976
	%	%
Mining	18.6	2.3
Contract Construction	54.8	17.6
Manufacturing	—	6.0
Transportation, Communication and Public Utilities	21.3	9.2
Trade	—	16.1
Finance, Insurance and Real Estate	—	4.1
Service	5.2	16.2
Miscellaneous	—	.7
Government	0.2	27.6
Federal	(0.2)	(10.5)
State	(0.0)	(8.2)
Local		(8.9)
TOTAL	100.0	100.0

Source: Alaska Department of Labor.

TABLE 5

AVERAGE MONTHLY WAGE
ALASKA CENSUS DIVISIONS
1976

Census Division	Average Monthly Wage
STATE TOTAL	$1,928
Aleutian Islands	$1,499
Anchorage	$1,613
Angoon	$ 899
Barrow-North Slope	$3,897
Bethel	$ 940
Bristol Bay Borough	$1,309
Bristol Bay	$1,142
Cordova-McCarthy	$1,220
Fairbanks	$2,161
Haines	$1,093
Juneau	$1,414
Kenai-Cook Inlet	$1,742
Ketchikan	$1,294
Kobuk	$1,161
Kodiak	$1,287
Kuskokwim	$1,577
Matanuska-Susitna	$1,316
Nome	$1,286
Outer Ketchikan	$ 918
Prince of Wales	$1,493
Seward	$1,178
Sitka	$1,377
Skagway-Yakutat	$1,229
Southeast Fairbanks	$3,956
Upper Yukon	$2,009
Valdez-Chitina-Whittier	$3,932
Wade Hampton	$1,349
Wrangell-Petersburg	$1,290
Yukon-Koyukuk	$4,082

Source: Alaska Department of Labor.

TABLE 6

AVERAGE MONTHLY WAGE BY INDUSTRY SECTOR
BARROW-NORTH SLOPE DIVISION
1975-1977

	1975				1976				1977
	1st Qr	2nd Qr	3rd Qr	4th Qr	1st Qr	2nd Qr	3rd Qr	4th Qr	1st Qr
Total Nonagricultural Industries	$2,654	$2,879	$3,439	$3,310	$3,092	$3,904	$4,311	$4,230	$3,224
Mining	$2,709	$2,662	$2,686	$3,201	$2,924	$2,946	$3,254	$3,162	$3,437
Construction	$3,793	$3,738	$4,337	$4,055	$3,733	$5,103	$5,820	$6,120	$5,158
Transportation, Communications and Utilities	$2,231	$2,745	$2,692	$2,245	$2,889	$2,760	$3,093	$2,502	$2,799
Wholesale Trade	*	*	*		*	*			
Retail Trade	$ 457	$ 428	$ 483	$ 447	$ 612	$ 551	$ 508	*	$ 642
Finance, Insurance & Real Estate	$1,013	$1,038	*	$1,456	*	*	$2,540	$1,564	*
Services	$2,498	$2,282	$2,475	$2,939	$3,060	$3,251	$3,519	$3,094	$2,918
Federal Government	$ 916	$ 885	$ 939	$ 992	$ 668	$1,039	$ 962	$1,078	$ 980
State & Local Government	$ 852	$1,213	$1,442	$1,638	$1,007	$1,746	$1,453	$1,578	$1,426
Miscellaneous & Manufacturing	*	*						*	*

*Figures withheld to comply with disclosure regulations.

Source: Alaska Department of Labor.

after the first quarter of 1976, peaking at $6,120 per month in the fourth quarter of 1976. Essentially all of this activity was located in the study area and was associated with the trans-Alaska pipeline.

Average wage levels in mining, services and in transportation, communications and public utilities in the North Slope Borough were also high when compared with those of other sectors. The average wage in mining exceeded $3,000 per month after the second quarter of 1976 (with a peak of $3,437 per month recorded for the first quarter of 1977). Although some of this employment was in National Petroleum Reserve-Alaska, most of it occurred in the vicinity of Prudhoe Bay. Another reason for the high average monthly wage rates in these sectors is the very large number of hours of overtime logged by employees, particularly in jobs associated with the pipeline.

The salaries recorded for the North Slope census division in trade and government are much lower. Nearly all employment in these sectors, however, is in the Borough's traditional communities rather than in the Prudhoe Bay/Deadhorse area. The highest average monthly wages in trade recorded for the region between 1975 and the first quarter of 1977 was only $642 (in the first quarter of 1977). Average monthly wages in government were higher than those in trade in the North Slope Borough between 1975 and the first quarter of 1977. The average for the Federal government sector was $980 per month in the first quarter of 1977 (down from a high of $1,078 in the fourth quarter of 1976). Again, essentially all employment in the government sector is in the Borough's traditional communities. Less than 0.2 percent of the Prudhoe Bay/Deadhorse area employment is in the government sector, whereas Boroughwide in 1976, 12.9 percent of the total nonagricultural wage and salary employment was in the government sector.

Wages in services jobs also averaged more than $3,000 per month in 1976 (with a peak of $3,519 per month in the third quarter of 1976) although average wage rates in this sector dropped to slightly below $3,000 in the first quarter of 1977. The largest share of these jobs was related to oil and gas development or to pipeline construction activities.

Wage levels in transportation, communications and utilities were slightly below those in mining and services but were still high when compared with all other sectors except for construction. The highest average monthly wage recorded to date in this sector was $3,098 which was reached during the third quarter of 1976. Again, most jobs in this sector were directed toward servicing oil and gas or pipeline activities or associated with the DEW Line stations.

Part of the reason for the very high wage rates in construction, mining, services and transportation, communications and utilities in the North Slope Borough is due to the fact that employers in this sector do not maintain office staffs in the region (or if they do, they are very small). The Alaska offices of most companies in these sectors are based in Anchorage or Fairbanks, or both. As a result, the lower salaries normally paid to clerical and junior technical personnel are not reflected in North Slope Borough figures.

In summary, persons employed at Prudhoe Bay/Deadhorse and along the pipeline enjoy extremely high incomes when compared to those earned in the Borough's traditional communities and even to incomes Statewide. Furthermore, these incomes are not diminished by the high costs of living on the North Slope since all goods and services are provided by the employer and almost all dependents live outside the region.

G. LAND USE AND PUBLIC FACILITIES AND SERVICES

1. General Land Use Patterns

Prior to the arrival of the military in the 1950's and the oil industry in the 1960's, use of the land in the Prudhoe Bay Coastal Area was entirely subsistence oriented. Most of this was concentrated along the coast, the barrier islands, and major rivers where subsistence resources were most likely to

be plentiful. These same general subsistence land use patterns persist today.

Physical development in the study area is limited to the oil and gas-related facilities at Prudhoe Bay and Deadhorse, the pipeline Haul Road which supports these, and a number of widely scattered small gravel airstrips built by industry to support oil and gas exploration. In addition, there are three DEW Line stations along the coast—Oliktok, Pt. McIntyre, and Flaxman at Bullen Point. Of these, only Oliktok is presently an active station.

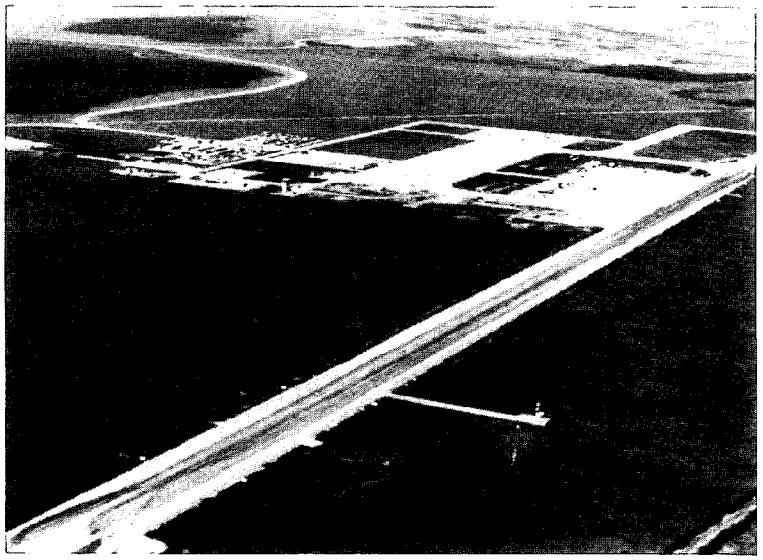
The Prudhoe Bay area is an industrial enclave located in an otherwise nonindustrial area. Because of the size of the field, development is necessarily dispersed widely. In all, this industrial area occupies more than 400 square miles, more land, in fact, than that occupied by the Borough's eight traditional communities and numerous military installations. Within the Prudhoe Bay complex are oil production facilities, living accommodations for workers, and a wide variety of support services.

Sixteen companies are involved in the development of the Prudhoe Bay field. To avoid duplication of facilities, however, these companies entered into an agreement which assigns the field operation to the two companies with the largest interest: Atlantic Richfield Company operates the eastern section of the field and BP (Sohio) manages the western portion. Although each has constructed similar facilities in their respective management areas, some facilities are common. These include the central compression plant, the central power plant, port facilities and an airstrip.

Many specialized services are not carried out by ARCO and BP (Sohio) but are instead contracted to other firms. Although camp facilities for some of these firms are located close to operations, most are located near the Deadhorse Airport on land leased from the State Department of Transportation and Public Facilities.

2. Facilities and Services

The Prudhoe Bay/Deadhorse complex is not an organized political unit of government but rather a private industrial development located primarily on State-owned land within the North Slope Borough. It pays taxes to the Borough, is subject to its areawide powers and, in theory, is dependent upon it for the provision of certain services. In fact, however, the Borough has been required to provide only limited services to the complex. As a result of an agreement between the oil companies and the North Slope Borough shortly after incorporation in 1972, Prudhoe Bay has remained a private industrial complex responsible for providing its own services. Until recently, all services at Deadhorse have been provided by the service companies located there; however, in 1976 because of recurring problems with the subdivision's solid waste, sewage and water supply systems, the Borough created a utility service area at Deadhorse and assumed responsibility for the provision of sewage and solid waste disposal and for the water supply. The ASRC has also applied to the Public Utilities Commission to take over the Deadhorse telephone exchange currently operated by RCA Alascom.



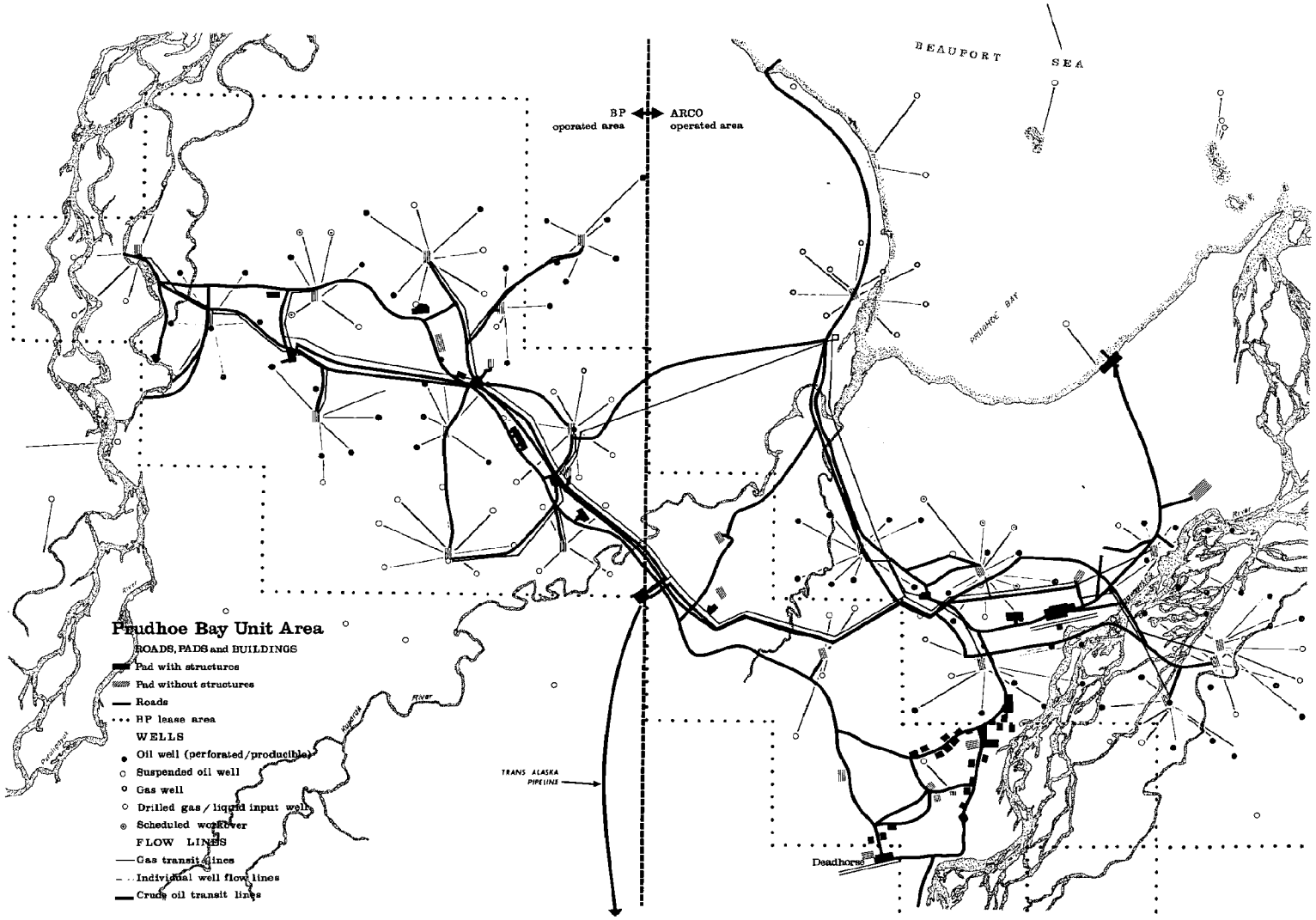


Figure 13 scale 1" = 4000'

Alaska Consultants, Inc.


LAND USE
TRANSPORTATION and OIL RELATED ACTIVITIES
RUNWAY and TAXI WAYS
DEADHORSE AIRPORT
N

Figure 14

State and Federal government facilities in the area are also limited. The State of Alaska owns and operates the Deadhorse Airport, and the Federal Aviation Administration operates a flight service station there. Although the North Slope Haul Road is currently operated and maintained by the Alyeska Pipeline Service Company, the road is scheduled to be taken over by the State in October 1978 and will become part of the State highway system. The State administration has recommended that the road be closed to all but industrial and commercial tour bus traffic during the period of gas pipeline construction and that maintenance be the responsibility of the users. The State of Alaska also has a trooper stationed at Deadhorse. The following is a detailed description of both private and public facilities and services at Prudhoe Bay and Deadhorse.

Preliminary projections developed by both the Federal and State governments in connection with the joint Federal/State Beaufort Sea lease sale indicate that future oil and gas exploration and development will probably engender employment levels lower than those accommodated by Prudhoe Bay and Deadhorse during the height of pipeline construction. Thus existing facilities and services should be adequate to accommodate future development.

a. Public Safety

Police protection at Prudhoe Bay/Deadhorse is provided by an Alaska State Trooper who rotates every two or three months out of Fairbanks. The police station, located near the Deadhorse Airport, is equipped with a holding cell, where prisoners are held only until transportation to more adequate facilities in Fairbanks can be arranged. The trooper is supported by a four-wheel drive truck outfitted with local communications and emergency medical equipment.

To supplement this service, the Prudhoe Bay operators contract additional private security guards who cooperate closely with the State Trooper. Usually retired policemen or military, these security guards have special commissions from the State Department of Public Safety which empower them to make arrests. They do not, however, have the authority to carry weapons.

Responsibility for provision of fire protection service within Prudhoe Bay and Deadhorse lies for the most part with the companies operating there. Alyeska Pipeline Service Company is responsible for safety and fire protection of the trans-Alaska pipeline and the one pump station within the Prudhoe Bay Coastal Area. Pump Station No. 1 is outfitted with a range of equipment specifically designed to combat fires resulting from oil and gas combustion. The station has two built-in, fixed fire protection systems—a halon system and a combination water/foam system. In addition, a number of hand portable and wheeled extinguishers are also available. There are two fire trucks at the station outfitted with a 1,250-gallon water tank, 500 pounds of dry chemical, 125 gallons of A3F foam and a 300-gallons-per-minute pump. One of these trucks is available under a mutual aid agreement to supplement BP (Sohio) and Atlantic Richfield's fire fighting capabilities.

In addition to fire trucks, the pump station also has a portable twin-engine unit equipped with 450 pounds of dry chemical and 200 gallons of premixed light water. This is usually mounted on the back of a pickup truck, but when required, can be readily picked up by helicopter and flown to another location.

A full-time safety and fire protection specialist is responsible for the maintenance and operation of fire protection equipment at Pump Station No. 1. This individual is also responsible for organizing and training the station's fire brigade. According to Alyeska safety officials, existing equipment is adequate to protect the pump stations.

Responsibility for management of the Prudhoe Bay field is divided between BP (Sohio) and Atlantic Richfield Company. Each has its own personnel and fire protection equipment designed to meet the needs of its particular operation. These

differ in specifics, but both companies have systems which meet guidelines established by the National Fire Protection Association for the types of fires most likely to occur in this environment. Thus only one of the two companies' systems is described here.

BP (Sohio)'s fire station is located close to its base operations center. The company's safety engineer and three safety technicians who are responsible for maintaining both fixed and mobile fire protection equipment are housed here. A 20-man fire brigade, assigned to each 7-hour shift and equipped with electronic pagers is spread throughout the complex and can be called immediately in the event of a major fire. The entire brigade receives weekly training and all brigade members are trained annually at special fire fighting courses given at Texas A & M University. Mobile equipment stationed at the firehouse includes a fire truck equipped with a 750 gallons per minute pumper, a 2,000 gallon water tank, 400 gallons of 3F foam and 1,500 pounds of dry chemical. A water truck has a 2,000 gallon capacity and a 500 gallons per minute pneumatic pumper.

In addition to mobile equipment, each of the company's major facilities has a built-in fire protection system. The central power station has four, 4 ton carbon dioxide systems for its turbines, several halon systems, and a 20,000 gallon water tank with pumps powered by elevation and air pressure for each pair of turbines.

The three gas gathering centers are similarly equipped. Each has a 433,000 gallon circulating system with two, 15,000 gallons per minute pumps, one electric and one diesel. System outlets are located in each module within the gathering centers. Each gathering center also has standard foam application systems and is equipped with water curtains between modules. Fire detection systems are varied, depending upon the particular activity involved and the type of fire danger associated with it.

The company's three housing complexes have elaborate fire detection systems. In addition, these buildings have automatically closing doors which would serve to contain fires within specific areas and there is halon protection throughout. Water for fire fighting comes from two sources—the 30,000 gallon swimming pool and the building's potable water source which has a 30,000 gallon reserve at all times. An additional 80,000 gallon water tank equipped with two 500 gallons per minute pumps is now under construction at the fire station.

Responsibility for fire protection at Deadhorse Airport lies with the airport's owner and operator, the State Department of Transportation and Public Facilities. Fire fighting equipment includes one three-quarter ton "quick response" vehicle equipped with dry chemicals and one large tank truck with a pumper. Lacking an organized fire department, operation of the equipment is left to the airport manager and employees.

b. Health

Health services at Prudhoe Bay/Deadhorse are limited to those provided by the two managers of the oilfield—Atlantic Richfield and BP (Sohio)—and to the Emergency Medical Treatment Service provided by the State Trooper stationed at Deadhorse. Atlantic Richfield has a well-equipped clinic at its main base camp staffed full time by a physician and two physicians' assistants provided under contract by a clinic in Fairbanks. BP (Sohio) has two medical facilities, one at its base operations camp and one at its Construction Camp No. 2. These are staffed by a licensed physicians' assistant or nurse practitioner who has a direct telephone connection to a doctor in Anchorage.

The service companies all have first aid rooms where minor injuries and illnesses can be treated. In the event of more serious medical problems, however, they rely on the medical facilities of either BP (Sohio) or Atlantic Richfield, whichever firm it is under contract to. Under an agreement among Atlantic Richfield, BP (Sohio) and the service companies, ARCO's physician serves all personnel at Prudhoe Bay. All patients with serious illnesses or injuries are evacuated to hospitals in either Fairbanks or Anchorage.

c. Recreation

Recreation facilities within the Prudhoe Bay Coastal Area are limited to those provided by the oil industry at its camps within the Prudhoe Bay complex and by NANA Oilfield Services at its Deadhorse "public camp." Oil company recreation facilities are closed to all but company employees and their guests, while those of NANA are open to the public.

Compared to the facilities available in most of the Arctic's traditional villages, facilities available to people living in the Prudhoe Bay camps are lavish. British Petroleum (Sohio) has three camps in the Prudhoe Bay area. The base camp is equipped with a full gymnasium, including basketball and handball courts, a swimming pool and saunas, an indoor track, and a fully equipped exercise room. In addition, the camp has a theater which shows scheduled movies and, on occasion, live entertainment brought in from outside the region. Employees also have access to a wide range of hobby-oriented and academic classes taught by fellow employees when a particular skill is locally available or by imported specialists when it is not.

Atlantic Richfield's Prudhoe Bay base camp has a range of recreation facilities similar to that offered by BP (Sohio). This camp has an indoor basketball court which can be converted for volleyball and badminton and has an elevated indoor track over it. The camp also has a fully equipped exercise room, saunas, pool tables and other table games. A 135-seat theater is included in the complex and is used for both movies and live entertainment. Recreation activities are organized by a full-time recreation director.

Alyeska's one pump station operating within the Prudhoe Bay area has a large recreation area, half of which is devoted to table games such as table tennis and pool, with the other half used as a theater for daily movie shows. The station also has a sauna, a fully equipped exercise room and a commissary where employees can purchase personal items plus books, newspapers and magazines. At Deadhorse, the 240-man public camp operated by NANA Oilfield Services includes a public restaurant, a movie theater, and a bar. A small gift shop caters to summer tourists.

d. Communications

There are several discrete communications systems operating within the Prudhoe Bay industrial complex. RCA Alascom, based at Deadhorse, provides all long distance service via telecommunications satellite. An NC 10, cross-fire switch system with a 400-line capacity provides local service. In February 1978, only about 250 of the 400 available lines were in use. Atlantic Richfield Company and BP (Sohio), each have their own in-house end-radio communications systems. In addition to handling calls inside ARCO and BP (Sohio), these systems also provide access to RCA's Deadhorse exchange and to its long distance service. A separate radio-based "alert" system, designed for use in emergency situations, connects all the various Prudhoe Bay operations and pipeline pump stations.

The ASRC has applied to the Public Utilities Commission to install small telephone exchanges in all of the Borough's villages except Barrow and to take over the Deadhorse exchange currently operated by RCA Alascom. RCA would retain its responsibility for long line service to connect Deadhorse to the State long distance network. As of February 1978, the Public Utilities Commission had taken no action on the ASRC's application.

e. Transportation

At the present time, the Deadhorse Airport is the only public transportation facility in the Prudhoe Bay/Deadhorse area. Owned and operated by the State Department of Transportation and Public Facilities, the airport has a 6,500 foot by 150 foot gravel runway and an adjacent gravel helipad. The runway is scheduled to be paved in 1978. The runway and taxiway have medium-intensity lighting; however, high-intensity lighting will be installed at the airport during the summer of 1978. Navigational aids include a very high-frequency omnirange/distance measuring equipment (VOR/

DME), a glide slope, localizer, direction finder, visual approach slope indicator (VASI), and a nondirectional radio beacon 2 miles northeast of the airport. Airport facilities include a terminal, utility-storage shop, a power plant, and small transient camp. Extensive fueling is also available.

Deadhorse receives scheduled jet service daily from Fairbanks and Anchorage via Wien Air Alaska. Aside from Wien flights, ERA Helicopter and Sea-Airmotive provide scheduled air service out of Deadhorse to Kaktovik and Nuiqsut, respectively. Atlantic Richfield and British Petroleum (Sohio) provide their employees with jet service from Anchorage and Fairbanks to Deadhorse. ARCO charters a Wien 737 aircraft which operates once daily Monday through Friday. BP (Sohio) has leased an Alaska Airlines 727 which operates on a nonscheduled basis.

An airstrip at Prudhoe Bay, owned by the State Division of Lands and operated by Atlantic Richfield Company, is closed to all but oil company traffic. The facility has a 5,500-foot by 150-foot gravel runway with medium-intensity lighting. Navigational aids include two-channel VHF and UHF radio and a communications tie-in with the Deadhorse flight service station. Other small private airstrips are located throughout the Prudhoe Bay area and along the pipeline corridor. These are closed to all but private traffic.

Outside the Prudhoe Bay/Deadhorse area but still within the Prudhoe Bay Coastal Area there are three additional airstrips, all associated with DEW Line stations. Oliktok, located 40 miles northwest of Prudhoe Bay, is an active DEW Line station and has a 4,019 foot long gravel airstrip equipped with medium-intensity runway and taxiway lights and nondirectional beacons and an 85,000 gallon jet fuel storage tank. Pt. McIntyre, which has been abandoned by the Air Force, is located 20 to 40 miles northwest of Prudhoe Bay and has a 1,300 foot by 66 foot gravel runway. Three small buildings and fuel storage facilities remain on the property. A second abandoned DEW Line airstrip commonly referred to as Flaxman is located on Bullen Point just east of Mikkelsen Bay and has a 3,785 foot by 100 foot runway.

Road access to the Prudhoe Bay Coastal Area is provided by the trans-Alaska pipeline Haul Road which connects with the State highway system at the Yukon River and runs parallel to the pipeline to its terminus at Prudhoe Bay. The road was constructed by Alyeska Pipeline Service Company to secondary highway standards and is scheduled to be turned over to the State by Alyeska in October 1978. During construction and the initial operations phase of the pipeline, the Haul Road has been closed to all but industrial traffic and maintenance has been performed by Alyeska. When the road is turned over to the State, however, the State will assume maintenance responsibility and some public usage of the facility may be allowed.

Local service roads within Prudhoe Bay and Deadhorse have been constructed and are maintained by the oil companies and Alyeska. The State will not assume responsibility for these when it takes over the Haul Road. The only port facilities within the study area are those associated with Prudhoe Bay. Constructed initially in 1969 by the oil

companies, these consist of a gravel causeway and four barges placed at its end which serve as an unloading dock. A 25 acre gravel pad adjacent to the dock serves as a storage area. A second dock, 5,000 feet long and 50 feet wide, and associated storage area, were constructed during the winter of 1975/1976. Located more conveniently than the 1969 facility, this new dock has become Prudhoe Bay's primary port facility. Three heavy cranes are available for unloading cargo from barges. Both port facilities are connected to the Prudhoe Bay complex by road.

f. Utilities

There is no central utility responsible for the provision of power, water or sewage and solid waste disposal services in the Prudhoe Bay industrial complex or at Deadhorse. Within Prudhoe Bay, Atlantic Richfield Company and BP (Sohio) provide their own water and sewage and garbage disposal services. The responsibility for provision of electricity and gas utilities is shared jointly by the two companies. BP (Sohio) constructed the central power station and electrical transmission lines, whereas Atlantic Richfield is responsible for conditioning the natural gas used for electrical generation and heating systems for the field facilities and Alyeska Pipeline Service Company's four pump stations north of the Brooks Range.

Lacking a central utility at Deadhorse, service companies located there have in the past been required to provide their own utilities. Prior to 1974, all service companies provided their own electricity and heat generators powered by diesel fuel purchased from Atlantic Richfield's topping plant. In 1974, however, Atwood Enterprises, Inc., formed an electric utility which was, in turn, purchased in 1975 by Arctic Utilities, Inc., a subsidiary of NANA Development Corporation. In January 1978, AUI provided power to Deadhorse Airport and to approximately one-half of the service companies located at Deadhorse.

All service company camps maintain their own package sewage treatment plants and either supply their own water requirements from nearby lakes and rivers or purchase their water from hauling companies.

(1) **Electricity.** As has been mentioned previously, under the provisions of the Prudhoe Bay Unit Operating Agreement, Atlantic Richfield and BP (Sohio) share responsibility for the provision of electricity to the operating companies. BP's central power station has a generating capacity of 100 megawatts (100,000 kw). Power is delivered to the operating facilities through 69 kv transmission lines which traverse the field. ARCO plans to expand the power-generating facility by an additional 40 megawatts in 1980.

The service companies all provide their own power with diesel fuel purchased from Atlantic Richfield's topping plant. At Deadhorse, Arctic Utilities' diesel-powered plant has a generating capacity of 1900 kw. AUI provides power for its own camp and sells excess capacity to the Deadhorse Airport and a number of smaller users in the Deadhorse area. In 1978, AUI plans to expand its generating capacity by 800 kw to accommodate the addition of the North Slope Borough's new central utility.

(2) **Water.** Within Prudhoe Bay, both Atlantic Richfield and BP (Sohio) have developed their own water sources and systems. Atlantic Richfield has a permit to pump 294,000 gallons of water per day from the Sagavanirktok River and 300,000 gallons per day from the Putuligayuk River. During the summer, water is piped directly to the operations center. The winter water supply is held in a 138 million-gallon reservoir which is also filled during the summer from the Sagavanirktok River.

British Petroleum obtains most of its water from the Kuparuk River and Big Lake. The two reservoirs on the Kuparuk River have a combined usable capacity of 42 million gallons while a much smaller reservoir on Big Lake adjacent to its operations center has a 3-million gallon capacity. Styrofoam floats and heated water circulated through the reservoir prevent the water from freezing during the winter.

Most of the water from the service companies at Deadhorse is obtained from Colleen Lake in the floodplain of the Sagavanirktok River near the Deadhorse Airport. NANA Environmental Services has dropped a casing through the reservoir ice through which hoses pump water into tank trucks for delivery to various users. A number of companies, including NANA, Mukluk Freight Lines, and Frontier Equipment, have water-hauling vehicles which can be leased for approximately $85 per hour. There is no charge for the water, but NANA is in the process of applying for a water utility permit which would allow it to impose a tariff for the water as well as the delivery.

(3) **Sewage and Solid Waste Disposal.** Atlantic Richfield and BP (Sohio) each maintain their own separate sewage and solid waste disposal systems. ARCO's operations center and construction camp have binary sewage treatment systems with the effluent piped to a holding lagoon. Overflow from the lagoon flows into the Arctic Ocean. Burnable solid waste is incinerated at each facility; nonburnable waste is hauled by truck to a landfill in a sand dune area east of the base camp. BP (Sohio) has similar facilities for disposing of sewage and solid waste at its camps.

The North Slope Borough under contract to NANA Environmental Services has assumed responsibility for sewage and solid waste disposal within Deadhorse. NANA has a sewage treatment plant at its public camp with a 15,000 gallon per-day capacity, sufficient according to NANA officials to handle more than existing requirements. Sludge from the sewage treatment facility and solid waste are disposed of in NANA's incinerator. NANA's public camp is plumbed into this system; other users are serviced by a 2,000 gallon tank truck which hauls sewage to the treatment facility. Solid waste is also hauled by NANA's trucks to its incinerator.

An additional sewage and solid waste disposal plant is located at the Deadhorse Airport. Owned by the State and operated under contract by NANA, this plant has had a number of operational problems and is not currently in use.

(4) **North Slope Borough Central Utility.** There have been a number of problems with Deadhorse's existing solid waste, sewage and water supply systems. Consequently, in 1976, the oilfield operators and service companies and the State of Alaska requested that the North Slope Borough create a utility service area at Deadhorse and construct a central utility for the subdivision. Construction on the central utility was begun in 1976 and is scheduled for completion in 1978 at a total cost of $18 million, $2.25 million of which will be covered by a grant from the State of Alaska. The facility will include a solid waste incinerator, a sewage treatment and water purification plant and a water storage reservoir available on a contractual basis to facilities within the Prudhoe Bay/Deadhorse area. As these services are already provided by the oil company operators for their own facilities, it is expected that the central utility will be used for the most part by the service companies based at Deadhorse.

IX. Use Potentials, Constraints and Conflicts

IX. USE POTENTIALS, CONSTRAINTS AND CONFLICTS

A. OIL AND GAS DEVELOPMENT

The development of oil and gas resources within the Prudhoe Bay Coastal Area has brought significant benefits to residents of the North Slope Borough. One direct benefit has been the creation of new employment opportunities for Borough residents in the Prudhoe Bay complex. Less obvious but of considerably greater impact, however, are the expanded services and facilities and new employment within traditional communities provided by the North Slope Borough with revenues from Prudhoe Bay oil and gas property taxes.

In about the year 2000, existing Prudhoe Bay oil and gas property is scheduled to begin to depreciate. Assuming no new development has come on line at this time, the Borough's tax revenues and operating budget will be severely constricted. As most employment in the region's permanent communities is generated through Borough spending, employment levels and incomes are likely to suffer.

The possibility of discovering additional commercially exploitable oil and gas reserves within the Prudhoe Bay Coastal Area is extremely high. Development of these would, of course, enlarge the Borough's tax base and provide additional revenues, thus enabling increased latitude in operating and capital improvement expenditures. Future development would also extend further into the future the eventuality of pressure on the Borough's revenues when the Prudhoe Bay field oil and gas reserves run out.

Although the potential for discovering additional exploitable petroleum resources in the Prudhoe Bay Coastal Area appears excellent, there are certain factors which could constrain their development. Primary among these is the consumption of valuable fish and wildlife habitat by the structures, facilities and services required for such development.

Human and industrial activity at Prudhoe Bay/Deadhorse and along the pipeline corridor within the study area have consumed valuable fish and wildlife habitat and have in some cases removed this habitat from production or lessened its productivity. The coastal plain in the vicinity of Prudhoe Bay has historically been the site of caribou breeding and the onshore area between the Canning and Colville Rivers has accommodated a small, but stable, resident caribou herd. According to members of the North Slope Borough Planning Commission development has either forced these animals to other locations or eliminated them entirely.

The expansion of development outside the immediate Prudhoe Bay/Deadhorse area to previously undeveloped onshore and offshore locales raises the very real possibility of additional habitat consumption. Of particular concern are the effects of offshore development on the migration routes, calving and feeding grounds of the beluga and bowhead whale and the barrier islands which provide nesting, feeding and resting habitat for migratory fowl. Nesting and feeding habitat of the endangered peregrine falcon also falls within the study area. These could be seriously impacted from additional development. The extent to which offshore development may impact important wildlife habitat is unknown at this time, but it is likely that concern for its protection will result in strict regulation of offshore petroleum development.

A number of other negative impacts are connected with petroleum development. Gravel is an essential commodity in most construction activities. Although ice roads and pads have to some degree lessened the demand for gravel, it is required for its insulative effects for all permanent structures. Buildings, roads and airstrips must be underlaid with a thick gravel pad to provide insulation from permafrost. An alternative to gravel pads is to elevate the structure so that cold air may flow between it and the ground to maintain the integrity of the soil. If one of these two precautionary measures is not followed, the permafrost will gradually melt and cause the structure to sink. Shortage of gravel in strategic locations will either result in significantly increased costs due to long haul distances or preclude development altogether. Aside from

these economic considerations, however, are the potential effects of gravel removal on fish habitat and stream courses. Removal of gravel from stream banks and beds can disrupt fish spawning grounds and, in addition, cause serious stream siltation.

Water is another essential element in petroleum development. Not only is it required for human consumption, but considerable quantities are necessary for industrial purposes. Water is plentiful during the summer months, but during the winter it is in extremely short supply. What water is available at this time is found in deep lakes and the few large rivers that do not freeze to the ground, the same sites used by fish for overwintering. Extraction of water from these sources during winter can cause them to freeze to the ground and thus destroy overwintering fish habitat. As with gravel, lack of a nearby water supply could prove to be an economic deterrent to petroleum development if water has to be transported over long distances.

Water pollution is another serious constraint to petroleum development. Oil spills resulting from "blow outs" and ruptured pipes pose a serious water pollution hazard on the North Slope where ice and severe climate conditions would make clean-up difficult if not impossible. Furthermore, the technology to prevent such mishaps is extremely costly.

Oil and gas field construction and production and attendant activities such as aircraft flights produce a great deal of noise. This "noise pollution" can seriously disrupt wildlife. Particularly susceptible to disruption from noise are denning polar bears and breeding and nesting waterfowl. Thus, activity which creates high levels of noise pollution may have to be limited during these crucial periods.

Future development would, of course, bring additional people into the region. These would, in turn, necessitate the provision of extensive support facilities and services. Particularly when proliferated, the development of facilities and services is extremely expensive. Although the expense of these has in the past been assumed for the most part by the development companies, the North Slope Borough and the State of Alaska have assumed major financial commitments in connection with Prudhoe Bay development. This detracts from the resources available to the people of the Borough and the State.

The short ice-free season presents several problems for industry operating in the Arctic. First, it severely limits the time available for logistical support by sea and forces industry to rely on other, less efficient and more costly forms of transportation during much of the year. The short summer season also places severe limitations on the time available for operating conventional drilling structures. Since operating conventional structures seasonally is probably uneconomical, industry will most likely find it necessary to design platforms to accommodate various degrees of ice loading.

The short ice-free season is a time of intense activity and conflict on the Arctic coast. Break-up coincides with the northern migration of two important subsistence resources for the coastal Eskimo, the whale and the seal, and is the time when they are most accessible for hunting. Between break-up and the southern migration just prior to freeze-up, these animals feed and calve along the coast and river deltas in the study area. The coastal area is also intensely used by migrating fowl for feeding, nesting, and resting and for fish summer feeding habitat. Maritime activity coincides with animal migration and uses basically the same routes. Construction of offshore rigs and support systems is much easier in the summer and this too could seriously impact important wildlife habitat.

Gouging and scouring by ice poses serious potential hazards to underwater pipelines. In areas where there is a possibility of this action, pipelines either will have to be buried at a depth sufficient to protect them or elevated on causeways. Environmental concerns about causeways, however, would seem to eliminate them as a feasible alternative.

Additional constraints to petroleum exploration and development are presented by potentially hazardous geologic condi-

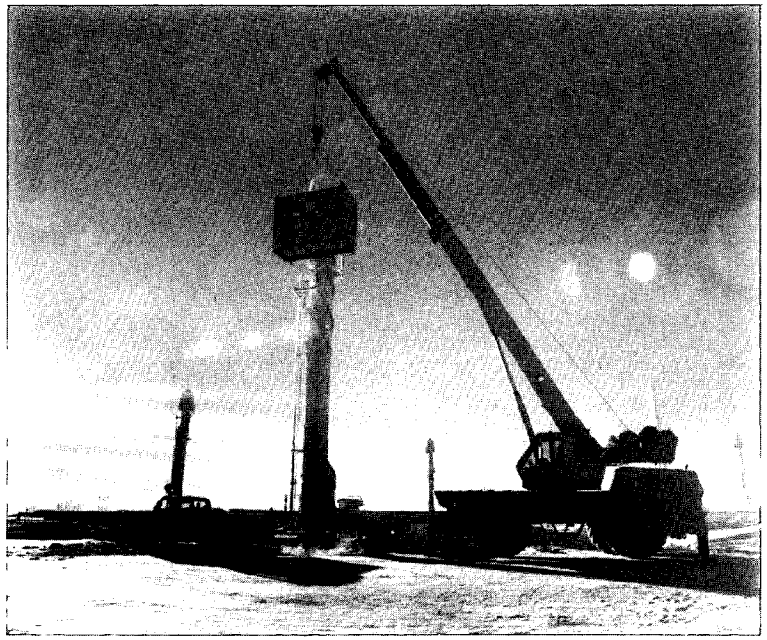
tions. A report prepared by the State of Alaska Department of Natural Resources has identified the Prudhoe Bay area as an "area of particular concern for geologic reasons." According to this report, the location of the channel followed by barge tugs into Prudhoe Bay and to the gravel causeway constructed by Atlantic Richfield shifted relative to the shoreline by as much as 175 meters between 1950 and 1976. Shoaling of the channel is reported during open water season, and nearby Stump Island has also shifted southwestward and grown in area.

Exposed shoreline from Point McIntyre east has been eroded, primarily by thermal erosion of permafrost tundra, at an average rate of 1 meter per year but up to 3 meters a year locally. In addition, the area offshore Prudhoe Bay is thought to be underlain by ground below 0° C. Ice-bonded permafrost is thought to occur just below the seabottom in areas contacted by annual sea ice and at progressively greater depths further seaward of the 2-meter isobath. Over ice flooding and spring breakups on the larger rivers such as the Sagavanirktok are also potential hazards.

Freight barges used the bay entrance channel almost exclusively before the Atlantic Richfield causeway was constructed and now that is heavily used for offloading. The short, open-water season and expense of constructing offloading and storage facilities imply that changes in channel configurations and temporary interruptions in barge access can have serious consequences. Future coastal activities anywhere in the Beaufort Sea must allow for shoreline erosion and natural changes in offshore bathymetry as well as potentially adverse effects of the activities themselves on the rates of such changes. Also, engineering design and construction must allow for potentially adverse effects of melting bonded permafrost, especially settlement and subsequent material erosion, both onshore and offshore.

Without doubt the development of Prudhoe Bay has brought positive and tangible benefits to residents of the North Slope Borough and any future development can be expected to add to these. However, along with positive benefits have come some very real negative impacts which have raised some significant conflicts among residents of the North Slope. As has diminished the number of caribou in the Prudhoe Bay area and expansion of this activity, particularly to the offshore area, may impact the whale and fowl population. Degradation of wildlife resources is of utmost concern to residents of the North Slope for these provide the basis of the subsistence economy. Dimunition of the resources would seriously impair the Inupiat's ability to support themselves from the land.

Aside from the economic considerations associated with the loss of subsistence resources, petroleum development has raised some social and cultural conflicts as well, particularly among older residents of the North Slope's traditional communities. Just as wildlife resources provide the basis of the region's subsistence economy, the pursuit or hunting of these



is the cornerstone of Inupiat culture. There is a fear on the part of older residents that with increased cash income, the dependency on subsistence hunting and fishing will lessen. And with the need to hunt and fish removed, the old skills required to conduct these activities will be lost, thus destroying the basis of the Inupiat culture.

Clearly what is needed to resolve these conflicts is an environment in which both land uses—petroleum development and fish and wildlife production—are mutually compatible. Petroleum development has brought significant benefits to North Slope residents: employment opportunities and income have increased substantially and facilities and services have been greatly expanded in the region's traditional villages. Naturally, Borough residents want to see these benefits continue. Above and beyond their material well-being, however, the Inupiat place tremendous value on the maintenance of their subsistence lifestyle.

B. RECREATION AND TOURISM

At the present time, there is little recreational or tourist use of the land in the Prudhoe Bay Coastal Area. There is, however, potential for a great deal more. In the past, conventional tourism in the study area has been limited to the environs of the Prudhoe Bay complex where some tourist facilities exist. Since 1972, NANA Corporation has conducted a tour bus operation at Prudhoe Bay and Deadhorse. Patronage has risen steadily since the operation began, with the exception of 1977 when it fell slightly.

According to the Alaska Department of Fish and Game, a number of nonresident hunters and sport fishermen visit the Prudhoe Bay Coastal Area annually. Although there are no accurate figures on the number of sport fishermen using the study area, Atlantic Richfield officials report that some Prudhoe Bay residents fish in their free time in the immediate area of Prudhoe Bay as ADF&G regulations allow. A guide service, located on the Colville River delta transports sport fishermen to rivers and lakes within the study area, and charter operators at Barrow and Deadhorse also fly fishermen and hunters into the region.

The Heritage Conservation and Recreation Service considers the study area to have sufficient resources available to provide a variety of recreational experiences. The flat topography and the low vegetation are particularly conducive to sightseeing and wildlife and waterfowl viewing. In addition, there is potential for such sports as cross-country skiing and snowmobiling in late winter and early spring when the weather has moderated.

Although the Heritage Conservation and Recreation Service has not yet assessed the boating potential of any rivers within the study area, it has studied portions of the Colville River and considers the river to have significant wilderness scenery and recreational potential. Segments of the Colville have been included in the Administration's D-2 proposal as part of the National Wild and Scenic River System. The wild and scenic designation would surely attract some recreational boating enthusiasts to the area.

Probably the greatest attraction of the Prudhoe Bay Coastal Area is its primitive condition and the wide variety of unique Arctic geological and ecological phenomena that exist there. The National Park Service has identified 16 geographic locations within the study area as appropriate for nomination as natural landmarks. All of these contain geological or ecological values of such distinction as to be of national significance.

In addition, the Alaska Division of Parks has proposed the establishment of an Arctic Coast State Monument to the west of Prudhoe Bay on State-owned property. The proposed monument would afford visitors access to view the natural features and abundant waterfowl of the area in concert with petroleum exploration and development.

Clearly, the Prudhoe Bay Coastal Area has an abundance of tourist and recreational resources which could serve to attract large numbers of visitors to the region. That these have not

been exploited in the past is due primarily to the remoteness of the region from major population centers, the lack of facilities and services, severe climate conditions for most of the year, and limited access.

Opening the Haul Road to the public could significantly increase tourist and recreational usage of the land adjacent to the pipeline corridor. In response to a mandate issued by the State Legislature in 1977, the Governor in early 1978 announced that the Haul Road would be open year round to industrial traffic to support Prudhoe Bay and gas pipeline construction and to tour bus traffic. In consonance with this policy, the Administration has submitted legislation requesting funds for the establishment of limited support facilities along the road and at Prudhoe Bay.

If this policy becomes fact, some tourist usage of the road will undoubtedly ensue. Impact on the surrounding area will be somewhat limited and controlled, however, as long as tourists are confined to buses and tour groups. Following completion of the gas pipeline, the State will be forced to reassess the question of general public utilization of the road. If the decision is made to open the road to the public, significantly increased exploitation of and pressure on recreational and tourist resources will result.

The existence of significant tourist and recreation resources notwithstanding, from the perspective of the North Slope Borough, there are a number of serious constraints on the development of a tourist and recreation industry in the Prudhoe Bay Coastal Area. Access in the past has been a limiting factor. Opening the Haul Road to the public would, of course, accomplish a great deal to alleviate this problem, but would, in turn, raise additional considerations. Automobile users require a wide variety of facilities and services: fueling and repair services, rest stops, food and lodging facilities, to mention only a few. Maintenance of the road to accommodate the public is a very real economic constraint, but provision of all the required facilities and services would also be costly. Moreover, the facilities required to accommodate tourists would consume additional wildlife habitat.

People generate trash and solid waste, which in turn causes pollution. This is certainly unsightly and, when uncontrolled, damaging to habitat as well. Open access to the region would certainly encourage the use of off-road vehicles. These create noise which would disturb wildlife; they would also damage the delicate tundra surface. Once damaged, tundra is practically impossible to rehabilitate.

Given the large area and harsh climate of the region, insuring the safety of visitors would be a major problem. While this is in theory possible with adequate personnel and equipment, it would be an extremely costly undertaking. Insuring the security of the pipeline would also become a problem with the incursion of large numbers of tourists and recreationists into the region. There is very little distance between the Haul Road and the pipeline itself, and, in fact, the pipeline is readily accessible from the road for most of its length in the study area. The vast distance to be covered would make it almost impossible to assure total security of the pipeline.

Unrestricted tourist and recreation use of the land would raise major conflicts. The most valuable resources of the land from the point of view of the tourist and recreation user are the region's fish and wildlife. These are the same resources prized most highly by the North Slope's Native residents. Boating, hiking, skiing, snowmobiling all would impact to some degree on wildlife habitat and in addition, could impede subsistence hunting and fishing activities. While some visitors would come only to look, many others would come with the express intention of consuming these resources in sport hunting and fishing. This would exert pressure on vital subsistence resources. As many of these are already seriously depleted, the subsistence economy and culture could be endangered.

Petroleum development has, thus far, had little direct adverse impact on the traditional villages of the North Slope, since

people conducting this activity have been largely confined to the Prudhoe Bay enclave. Tourist and recreation users, however, would be widely dispersed and would bring outside visitors into direct contact with local villages. With the exception of Barrow, none of the villages have facilities to accommodate visitors, nor do they wish to provide these.

While tourism and recreation might bring some material benefits to residents of the North Slope in terms of increased employment and opportunities for small commercial enterprises, the costs exacted by expanded tourism and recreational use of the land would seem to far outweigh any possible benefits.

C. MINING

Although mineral fuels such as crude oil, natural gas and coal are extremely abundant in the Prudhoe Bay Coastal Area, the region appears largely unfavorable for metallic mineral deposits. Low-grade phosphate deposits which could be used in the manufacture of commercial fertilizer have been identified on the coastal plain just east of the Canning River, but according to the U. S. Geological Survey, these are not of sufficient quality or quantity to make the mining of them economically viable in the foreseeable future.

The sediment characteristic of the Arctic Coastal Plain is the type generally associated with the presence of uranium. Extensive further exploration is required to determine whether these sediments do, in fact, contain uranium and whether it is of sufficient grade or quantity to warrant commercial exploitation.

Roughly 90 percent of the State's total estimated coal resources of 130 billion tons are located north of the Brooks Range. Although most of the high-grade deposits occur west of the Colville River, significant beds of subbituminous and, to a lesser extent, bituminous coal have been identified in the study area between the Canning and Colville Rivers on the coastal plain. At the present time, the U. S. Geological Survey considers these deposits to have moderate to low importance based on their potential for economic viability and national or local economic need for them.

Despite the widespread presence of natural resources other than petroleum in the Prudhoe Bay Coastal Area, it is doubtful that any of these will be developed in the foreseeable future. Costs associated with mineral development are extremely high. To be economically viable, deposits must be major in scope or located close to existing transportation systems. Even increases in value over time may not make these resources commercially attractive if production costs also increase substantially or if new technology is developed to replace their function.

Economic constraints aside, large-scale mineral development in the Prudhoe Bay Coastal Area would be severely constrained by environmental considerations. Conventional strip or open pit mining consumes large amounts of land and would disrupt vast expanses of delicate tundra surface. This would impinge upon valuable wildlife habitat, and it is highly questionable whether, once disturbed, it would ever be possible to reclaim the land. Extensive mining development would inevitably require a permanent work force which would probably mean the development of new towns and the attendant facilities and services required by these. This would, in turn, consume wildlife habitat.

The constraints and conflicts associated with extensive mining development are similar to those engendered by petroleum development. Impacts on wildlife habitat from petroleum development are temporary if attendant structures are removed and habitat rehabilitated once the resources have been extracted. Open pit and strip mining, however, would permanently remove habitat from production as it is virtually impossible to replace tundra surface once it has been removed. Moreover, with petroleum development the benefits accrued by local residents are extensive. Benefits not only to Borough residents but to the State as a whole from mining are doubtful. The costs related to this activity, on the other hand, are extremely high.

D. FISH AND WILDLIFE

The Prudhoe Bay Coastal Area is highly productive fish and wildlife habitat. Specific fish and wildlife resources and habitat of the region have been discussed in detail in Chapter VIII of this report. In general, however, the area's two major rivers, the Canning and the Colville, and their associated deltas, are particularly fertile wildlife habitat. Anadromous and resident fish are abundant in both rivers. The delta areas are important seasonally for large numbers of breeding, resting and feeding birds. Seals, and to a lesser extent whales, are also found there seasonally feeding and calving. The deltas are also considered prime polar bear denning habitat.

Whales and seals migrate along the coastal area and waterfowl abound seasonally in the nearshore waters, particularly those protected by close-in barrier islands. Shorebirds breed and feed on the barrier islands and to some extent along the coast throughout the Prudhoe Bay Coastal Area. The coastal wetlands are also important habitat to a wide variety of water-related birds. Although the region is not highly productive in terms of large land mammals, there is a substantial moose population in the Colville River valley. In the past, the study area has harbored a fairly stable resident caribou population, but in very recent years this apparently has declined.

For centuries, these resources have provided the basis for Inupiat subsistence and livelihood, and the process associated with the gathering of these resources has provided the context for the people's culture. Although there are currently no permanent settlements within the study area, a multitude of old ruins and gravesites and written records attest to the historical occupation of the Prudhoe Bay Coastal Area. And as would be expected, the remnants of past inhabitants are most prevalent where fish and wildlife are most plentiful.

The presence or absence of a permanent Native population in the region does not mean that the wildlife resource value has declined, but rather that people have moved to centers where services and facilities such as medical assistance and education are more readily accessible. Residents of Barrow, Nuiqsut and Kaktovik continue to fish and hunt seasonally in the Prudhoe Bay Coastal Area. This activity is likely to continue as long as fish and wildlife resources are plentiful.

Fish and wildlife are also important recreation and tourist resources. These presently support some limited sport hunting and fishing by both nonresident visitors and residents of Prudhoe Bay and Deadhorse, although the activity of the latter group is limited to fishing only as allowed by Alaska Department of Fish and Game regulation. Fish and wildlife also have significant scenic value. The flat landscape characteristic of the region makes it possible to see for miles without obstruction and thus provides a particularly good environment for wildlife viewing. Many people visit the region for the express purpose of viewing wildlife in its natural habitat.

The continued healthy production of fish and wildlife resources in the Prudhoe Bay Coastal Area depends on two factors: the preservation of their essential habitat and controlled exploitation of the resources themselves. Develop-

ment of any kind, whether it be petroleum-related, mining, or tourism and recreation, consumes or disrupts habitat and therefore is a constraint to wildlife production. Recreation, in the form of sport hunting or fishing, involving as it does the direct consumption of fish and wildlife resources, poses an additional constraint to wildlife resource production.

Conflict arises when any of these development interests compete for land necessary to preserve wildlife production and the Native subsistence economy and culture which depend upon it. As has been discussed in Section A of this chapter, the resolution of the conflict between development and wildlife resource production depends on the creation of an environment in which both land uses can be conducted compatibly, where benefits to the Borough and its residents outweigh the costs to them.

X. Forecast of Demands, Capabilities and Impacts

X. FORECAST OF DEMANDS, CAPABILITIES AND IMPACTS

The Prudhoe Bay Coastal Area has potential for several uses. Historically, the area has provided a wide variety of fish and wildlife resources which have been the basis of the subsistence economy and culture of local residents. Although currently there are no permanent residents there, the region's resources continue to be used for subsistence purposes. The Prudhoe Bay area's oil and gas potential is extremely high and is currently being exploited. Additional petroleum development is anticipated in the future.

While there is presently only limited recreation and tourism activity in the Prudhoe Bay Coastal Area, existing resources are sufficient to attract large numbers of visitors to the area, given development of access and facilities and services. The study area has mineral resources other than petroleum, however, the existence of these in other, more accessible, areas of the State probably precludes their development in the Prudhoe Bay area in the foreseeable future.

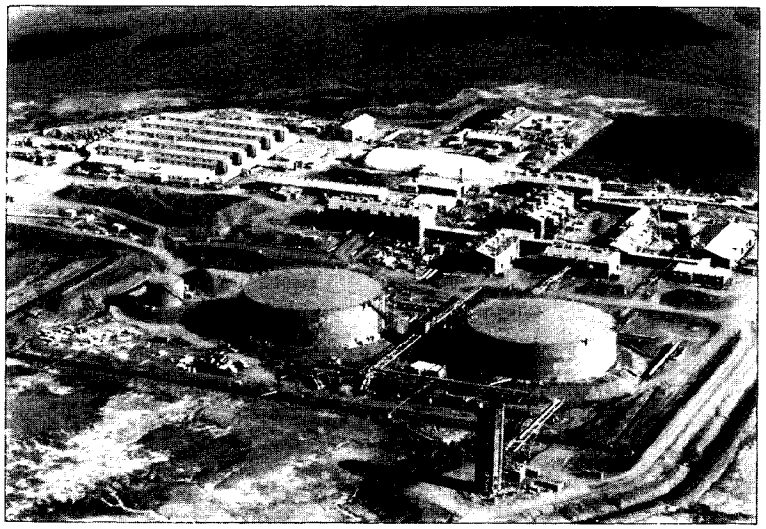
The following sections discuss the demands these potential uses would place on the land in the study area, the capability of the land to accommodate these uses, and their potential impacts.

A. DEMANDS

The discovery of the Prudhoe Bay field has engendered considerable interest in the oil potential of the Arctic in general but especially in the Prudhoe Bay region and adjacent offshore areas. Concomitant with the construction of the trans-Alaska pipeline and production of the Prudhoe Bay field, exploration in the area of Prudhoe Bay has continued, primarily onshore. As a result of this activity, there have been two discoveries recently near the eastern boundary of the study area, on Flaxman Island and at Pt. Thomson. Another discovery in the Kuparuk River formation is presently undergoing tests.

Although it is not possible to anticipate the extent of future discoveries in the area of the joint Federal-State lease sale scheduled for December 1979, this lease sale is of great interest to the oil industry. In addition, industry has expressed considerable interest in the remaining unleased onshore acreage located between the Canning and Colville Rivers. The discovery of commercially developable reserves in any of these areas will require the construction of a variety of facilities as well as additional pipelines to connect with the trans-Alaska pipeline at Prudhoe Bay. Construction of a natural gas pipeline within the trans-Alaska pipeline utility corridor is also anticipated to take place in the next several years. If commercial reserves of oil and gas are found either onshore or offshore the National Petroleum Reserve-Alaska or the Arctic National Wildlife Range, pipelines will be required to connect with the trans-Alaska pipeline. Trunk pipelines from offshore locations would probably run directly to shore and then traverse land to facilities at Prudhoe Bay.

Oil and gas resources are nonrenewable and will not last forever. While they last, they will return significant benefits to local residents of the North Slope Borough in terms of



facilities and services provided from property tax receipts and in increased employment. Of more long-term concern to local residents, however, are the region's fish and wildlife resources, which provide the basis of their subsistence economy and culture. In most instances, oil and gas development is in direct conflict with these resources. Thus, while exploiting the petroleum resources, it is necessary to protect fish and wildlife resources and their habitat to ensure that these remain and flourish when oil activity has finished.

1. Offshore Exploration and Development

The Federal government and the State of Alaska are scheduled to conduct a joint lease sale of tracts for oil and gas exploration and development during December 1979. The lease area is located in the Beaufort Sea between the Canning River on the east and the Colville River on the west and extends from the shoreline to about the 20-meter (60-foot) isobath. Total acreage available for nomination is approximately 650,000 acres, which includes 236 tracts ranging in size from 2,221 acres to 4,914 acres.

In preparation for the pending lease sale, the Department of the Interior has undertaken a study to determine impacts of exploration and development in the Beaufort Sea area. As part of this study, a number of petroleum development scenarios have been created to predict the nature of the development. These scenarios include the proposed State-Federal sale as well as other Federal OCS lands, but only two scenarios are directly related to the study area. The first is the so-called Prudhoe Bay-Large which is estimated to contain 1.9 billion barrels of oil (Bbbl) and 4.75 trillion cubic feet (tcf) of gas. The second is the Canning-Camden scenario which includes two fields which together contain 1.3 Bbbl of oil and 3.25 tcf of gas. A third scenario, Cape Halkett, would also affect the Prudhoe Bay Coastal Area. Even though the oil field is offshore from the National Petroleum Reserve-Alaska, a pipeline from the field would cross the study area.

a. Prudhoe Bay-Large

The Prudhoe Bay-Large field comprises 38,000 acres and lies between the nearshore Stump, Egg, and Long Islands and the outer Midway Island. Water depths range from about 6 meters at Stump Island to a maximum depth of nearly 18 meters, 19 kilometers west-northwest of Midway Island.

In this scenario, leasing is assumed to take place in the winter of 1979-80, with the first three exploratory wells being drilled from two barge platforms and one soil and gravel island in 1981. Two exploratory holes would be drilled each year from 1982 through 1987, except in 1986 when only one hole would be drilled. The field would be discovered in 1982, confirmed in 1983, and construction of development facilities would begin in 1984. Production drilling begins in 1986 and peak production would be reached in 1991 and maintained until 1994. Oil production would be discontinued in 2006 and gas production would end in 2014.

(1) **Facilities.** Platforms, wells and pipelines are the offshore facilities required to develop this field. During the exploration phase, a total of 14 exploratory wells would be drilled from 4 barge-based platforms, 7 soil and gravel islands, and 3 ice islands. During production there would be 253 oil wells, 15 gas wells and 22 development wells drilled over the life of the field from the 1 barge-based platform, 4 soil and gravel islands and 1 gravity island. Offshore pipelines would include 68 kilometers of interplatform connectors for oil and 48 kilometers for gas, plus 6 kilometers of oil and gas trunk lines in twin corridors. Two flow centers would be located onshore if space is available; if not, processing would take place offshore in modular treatment centers on each platform. Two pipelines would carry oil and gas the 15 kilometers to Pump Station No. 1 at Prudhoe Bay where existing transportation and communication networks would be utilized.

(2) **Manpower.** Labor associated with the exploratory phase would include personnel involved in geophysical exploration, platform construction, and drilling. During periods

of open water, geophysical work would be conducted from boats by a crew of 30 and one onshore expeditor. During winter, a mobile crew of 40 and an expediter would work from the ice. Manpower required for construction of exploratory platforms would depend on the type of platform to be constructed: A soil platform would require 171 workers, a barge platform, 50 workers, and an ice island would require 78 workers. Regardless of platform type, each exploratory drill rig would employ 60 on-site workers plus 5 workers located in Deadhorse for field support.

As with exploratory platforms, manpower requirements for development platforms depend upon platform type. Soil platforms are estimated to require 150 workers, while it is estimated that barge, gravity or submersible platforms each would require 80 workers. Development drilling rigs normally require 60 people per rig and an additional 6 platform maintenance personnel. From the point of view of manpower requirements, the major component of the development phase is the construction of oil field facilities. These include roads, flow stations, warehouses, shops, power plant and distribution system, pipelines, operation center and gas conditioning facilities. The height of this activity would occur just prior to production. With the Prudhoe Bay-Large scenario this would occur in 1986 and 1987 when employment is estimated to be 2,750 and 2,529, respectively. When production begins in 1988, employment would stabilize at 1,101 and be maintained at this level throughout the production drilling phase.

Activities undertaken during the operating phase are remedial work, platform operation, and miscellaneous construction. Remedial work includes such activities as casing reperforation and sand removal and would involve a full-time crew of 30. About 20 workers would be required to operate each platform and these would be supported by about 700 workers employed at the operations center, at the power and sewage treatment plants, in catering and in miscellaneous maintenance activities. Miscellaneous construction projects would employ 5 workers. All of these work force estimates would be in addition to the existing personnel at Prudhoe Bay.

b. **Canning-Camden**

The Canning-Camden scenario contains two major reservoirs encompassing 17,000 and 26,000 acres. The Canning field includes the eastern part of the Stockton Islands and the western half of Alaska Island, part of the Maguire Islands. The Camden field is comprised of the eastern portion of Alaska Island, Duchess and North Star Islands, and the western part of Flaxman Island. Water depths range from about 1 meter at the eastern end of Flaxman Island to a maximum of about 75.4 meters at the fields' outer limit beyond the barrier islands.

Canning-Camden leasing is assumed to take place during the winter of 1979-80 and drilling would begin immediately thereafter from a ballasted barge. The Camden field would be discovered in 1981, confirmed in 1982, and discovery of the Canning field would follow in 1983. Construction would be started on the Camden field and the decision would be made to continue processing and transport of this output as well as that previously discovered on State lands.

The Canning field would be confirmed during 1984 and would lead to construction to accommodate both fields. Production drilling would begin in 1990 and peak production would be reached in 1993 and maintained until 1998. Oil production would cease in 2010 and gas production would end in 2015.

(1) **Facilities.** Because of its distance from the Prudhoe Bay complex, some duplication of facilities would be required for this scenario. The two fields would share an airstrip and harbor, but separate construction camps would be built 15 miles apart. During the exploration phase, 18 holes would be drilled from 9 soil and gravel islands, 6 barge platforms and 3 ice islands. A total of 433 oil wells, 12 gas wells, and 75 development wells would be drilled for the two fields from 9 soil and gravel islands, 3 barge platforms and

one gravity island. Offshore pipelines would include 85 kilometers of interplatform connectors for oil and 63 kilometers for gas, plus 10 kilometers each of oil and gas trunk lines. A flow center located onshore opposite the Camden field would serve it and a portion of the production from the nearby State lands. The Canning field flow station located 15 miles west of the Camden flow station, would serve that field and the remainder of the production from State lands. Eighty-seven kilometers of onshore oil and gas pipelines would connect each of the flow stations with Prudhoe Bay. These pipelines would run adjacent to the coast, cutting across drainage areas as far as Foggy Island Bay where they would move inland to connect with Pump Station No. 1. The Canning onshore plant complex would also include a power plant, compressor, and pump station. Following construction, a single base camp located near the harbor would serve both fields.

(2) **Manpower.** With the exception of the development construction phase, manpower requirements and functions would be the same for the Canning-Camden scenario as for the Prudhoe Bay-Large scenario. Manpower requirements for the development-construction phase for Canning-Camden would be significantly less than for the Prudhoe Bay-Large scenario because of the smaller size of the fields. From 1980 to 1984, workers would number about 200. With the advent of construction activities in 1987, employment would rise to 2,048. Employment would fall off until 1990 when it would stabilize for the ensuing five years at about 1,000 workers. Employment would then slowly decline until it would discontinue in 2015. These work force estimates are additional to any other development.

2. Onshore Exploration and Development

Exploration activity on existing onshore leases will increase as more fields are discovered onshore. Petroleum discoveries at Pt. Thomson and Flaxman Island were announced in 1977. For several years the Kuparuk River field has been known to exist and testing of the economic viability of the field is currently taking place. In addition to activity on current leases, the remaining State land in the Prudhoe Bay Coastal Area is desired by the petroleum industry for exploration.

a. Kuparuk River

In addition to the currently producing Sadlerochit formation of the Prudhoe Bay field, there are two other onshore horizons capable of producing oil, the Kuparuk River and Lisburne. There are no current plans to test or develop the Lisburne oil pool, however, Atlantic Richfield Company is currently drilling two test wells in the Kuparuk River formation which is estimated to contain 1 billion barrels of oil. If results are favorable, ARCO will proceed with its 32-well plan in the spring of 1978. Drill pads, an interim bridge across the Kuparuk River and a spine road through the middle of the area to provide access to the wells are already in place and additional facilities will be trucked up the Haul Road in the spring of 1978. The 200-250 worker construction camp, a warehouse and shop are scheduled for completion by July 1978. Permanent housing facilities for approximately 100 personnel will be barged to Prudhoe Bay in 1979; the permanent production facilities will follow in 1980. A pipeline will be built to connect with Pump Station No. 1 at Prudhoe Bay. The Kuparuk is expected to produce between 60,000 and 80,000 barrels per day with initial production scheduled for mid-1981.

b. Pt. Thomson and Flaxman Island

In 1977, Exxon Corporation announced two oil and gas discoveries. One is at Pt. Thomson located on the coast 50 miles east of Prudhoe Bay near the Arctic National Wildlife Range, and the second is eight miles east of Pt. Thomson on Flaxman Island. Confirmation wells are currently being drilled for both discoveries. According to one Exxon official, discovery of 1 billion barrels of recoverable oil would justify the construction of a pipeline to join the field to the trans-Alaska pipeline at Prudhoe Bay.

c. Additional State Acreage

In a survey conducted recently by the Alaska Department of Natural Resources, the oil industry was asked to rank 36 areas of State land according to their petroleum potential and order of preference in which these lands should be leased. The remaining onshore State acreage in the Prudhoe Bay area was ranked fourth in both categories. In April 1978, the State announced a five-year schedule of oil and gas lease sales. The schedule calls for several lease sales within the study area in addition to the previously announced State/ Federal Beaufort Sea sale slated for December 1979. The first, scheduled for October 1978, involves limited acreage in the Pt. Thomson area. A second onshore sale, scheduled to take place in April 1981, will involve major acreage in the Prudhoe Bay area. Sometime in 1982, the State will conduct a second sale in the Beaufort Sea offshore area, but as yet the specific acreage involved has not been identified. Undoubtedly, additional facilities will be required to develop any reserves identified there.

3. Pipelines

A third demand that will be placed on the Prudhoe Bay Coastal Area is hydrocarbon transportation. The gas of the Prudhoe Bay field will need to be transported to market as will existing and future discoveries in the study area and future discoveries in neighboring NPR-A and the Arctic National Wildlife Range. A pipeline for Prudhoe Bay gas is scheduled for completion by 1982. Other production will probably be transported by trunk pipelines to connect with the trans-Alaska pipeline or the gas pipeline.

a. Natural Gas Pipeline

A giant gas cap, estimated to contain 26.5 to 30 trillion cubic feet of recoverable natural gas, sits atop the Prudhoe Bay oil field. Assuming an average calendar day throughput of 2.5 to 3 billion cubic feet of natural gas, roughly 24 to 29 years of operation would be required to accommodate Prudhoe Bay gas reserves alone. The Northwest Pipeline Company has been chosen to transport Prudhoe Bay natural gas to market along a route in the study area parallel to the trans-Alaska pipeline. In addition to the gas pipeline itself, the Alcan system will include within the study area a meter station, compressor station, a major staging area, pipe storage yards, primary communications sites and helipads.

Because the gas pipeline will follow the Alyeska Pipeline route so closely, road construction will be minimal and will be limited to access to borrow pits, quarries and other construction material sites. Most facilities will be located next to the existing Haul Road or pipeline work pad. The total additional acreage required by the Alcan project within the North Slope Borough will be approximately 3,500 acres. Over 3,000 acres will be consumed by the 120-foot pipeline right-of-way, the compressor station, stream crossings and access roads. Although not so stated specifically, it is assumed that the remaining 500 acres will be devoted to pipe storage yards, the meter station, the operation and maintenance base and borrow pits.

Alcan's assumption that the natural gas pipeline can be constructed from the Alyeska work pad for the entire 182-mile segment within the North Slope Borough may be overly optimistic. If the routes diverge significantly because of engineering difficulties, the acreage and material requirements would be increased substantially.

It is assumed that pipeline construction will begin one year after project approval and will last five years. Activity during project years two and three would include initial surveying, preparation of support facilities and movement of material. Pipeline construction would take place during the summer of the third and fourth project years. The compressor station will be constructed concurrently with the pipeline and will be completed at the end of the fourth year. Peak employment on the North Slope portion of the line is scheduled for project years three and four and would involve 2,678 and 2,041 workers, respectively. The construction work force declines to 82 in year five.

b. **National Petroleum Reserve-Alaska Pipeline**

Any oil discovered offshore from National Petroleum Reserve-Alaska (NPR-A) will be piped to shore and traverse the Prudhoe Bay Coastal Area to an appropriate pump station at Prudhoe Bay. Any onshore discoveries in northeastern NPR-A would be handled similarly. One of the scenarios developed by the Federal government in connection with the OCS study assumes discovery offshore from Cape Halkett. The pipeline for this field would cross Harrison Bay to Oliktok Pt. in the study area. Since the base camp, harbor and airstrip would be located at Cape Halkett, the only facilities in the study area would be the 41-mile pipeline and associated road from Oliktok Pt. to Prudhoe Bay. Some personnel such as expeditors and field support would be located at Prudhoe Bay.

c. **Arctic National Wildlife Range Pipeline**

The future of oil and gas exploration and development in the Arctic National Wildlife Range is not known. In March 1978 the U. S. House Interior Committee in its deliberations on D-2 legislation approved procedures for Federal exploration of the Range; however, these were not included in the final version of H.R. 39 passed by the House in May 1978. Whether the U. S. Senate will address this issue in its D-2 considerations is not known at this time, nor can it be predicted whether the final legislation will contain provisions for Wildlife Range petroleum exploration. If there is commercial petroleum development in the Wildlife Range at some future date, there may be a requirement for a pipeline from the Wildlife Range to Prudhoe Bay. Since the Canning-Camden scenario road and pipeline would come within 2 kilometers of the Wildlife Range, any Wildlife Range pipeline would likely connect to the Canning-Camden pipeline or be built parallel to it, thus minimizing impacts.

4. Subsistence

Prior to the arrival of western culture on the North Slope in the mid-nineteenth century, the coastal Eskimos were entirely dependent upon the fruits of the land for their existence. Wildlife provided virtually the only food source for these people, and all other necessities of life such as fuel, clothing, tools and weapons were garnered from the natural environment.

Commercial whalers first introduced cash into the local economy in the mid-nineteenth century. Since that time, there has been a dual economy on the North Slope, with dependence on subsistence hunting and fishing rising and falling according to the availability of cash. Having undergone a number of these cash-flexibility cycles the Eskimo has learned that continued existence in the Arctic is dependent upon the ability to harvest the region's renewable resources.

A multitude of old ruins, gravesites, artifacts, and written

records attest to historical human presence in the Prudhoe Bay Coastal Area. Thus, it is apparent that in the past the natural resources of the region have been sufficient to support various levels of population. Although not as heavily used today as in times past, the area continues to support subsistence activity. Today this activity is concentrated in those areas where fish and wildlife are most prevalent, that is along the two major rivers in the study area, the Canning and the Colville, in the nearshore areas where fish, birds and sea mammals are present seasonally, and on the barrier islands. The preservation of these resources, is absolutely essential to ensure their future ability to support a subsistence lifestyle and culture for local residents.

5. Recreation and Tourism

Even though there is great potential for recreational and tourist usage in the Prudhoe Bay Coastal Area, there is currently little demand for these activities. Generally limited to the Prudhoe Bay/Deadhorse area, tourist activities have been rising steadily since tour bus operations around Prudhoe Bay, conducted by NANA Corporation in conjunction with Alaska Tour and Marketing Services, began in 1972. As long as access to the study area is limited to air transport, the demand for tourism will not rise significantly. This is probably also the case for recreational usage. A number of nonresident hunters and fishermen visits the study area annually, however, there are no accurate figures available on the number of people utilizing the study area. Although residents of Prudhoe Bay are not allowed to hunt, some residents fish in their limited free time. Currently, there has been little demand on the Prudhoe Bay Coastal Area for recreational boating. However, if portions of the Colville River are designated as wild and scenic, the demand for that use will increase. The demand for recreational and tourism usage is a function of the accessibility to the region. As long as incoming traffic to the area is restricted to air travel the demand for recreation and tourism will remain limited. On the other hand, if the Haul Road is opened to unrestricted use, there will certainly be a marked increase in demand for recreation and tourism usage of the Prudhoe Bay Coastal Area.

B. LAND CAPABILITY

In this section different aspects of the land's capability to meet the demands previously described will be enumerated.

1. Land Availability

With the exception of several military withdrawals and a scattering of Native allotments, almost the entire Prudhoe Bay Coastal Area belongs to the State of Alaska. As the landowner, the State has the power to lease the land for oil and gas exploration and development and also to issue permits for water and gravel extraction. In addition, as the area is within the boundaries of the North Slope Borough, it is subject to its zoning and regulatory authority. There have been four onshore lease sales of acreage between the Canning and Colville Rivers and soon the offshore area will also be leased for oil and gas exploration. As has been mentioned previously, additional lease sales will take place in the future.

The availability of land for subsistence purposes is not so easily determined. Although the entire Prudhoe Bay Coastal Area is in theory available for subsistence hunting and fishing in accordance with established State and Federal fish and game regulations, subsistence activities can take place only when wildlife resources are present. There are indications that Prudhoe Bay development has adversely affected wildlife resources, most noticeably the fish population in the Sagavanirktok River and caribou which used to be abundant in the Prudhoe Bay Coastal Area. Thus, only to the extent that development activities do not destroy wildlife habitat and resources will the land be available for subsistence activities.

2. Waterfront Access

The discovery of petroleum offshore in the Prudhoe Bay Coastal Area will necessitate construction of a pipeline to shore and then to Prudhoe Bay. Additionally, if the development occurs beyond a certain distance from the Prudhoe Bay

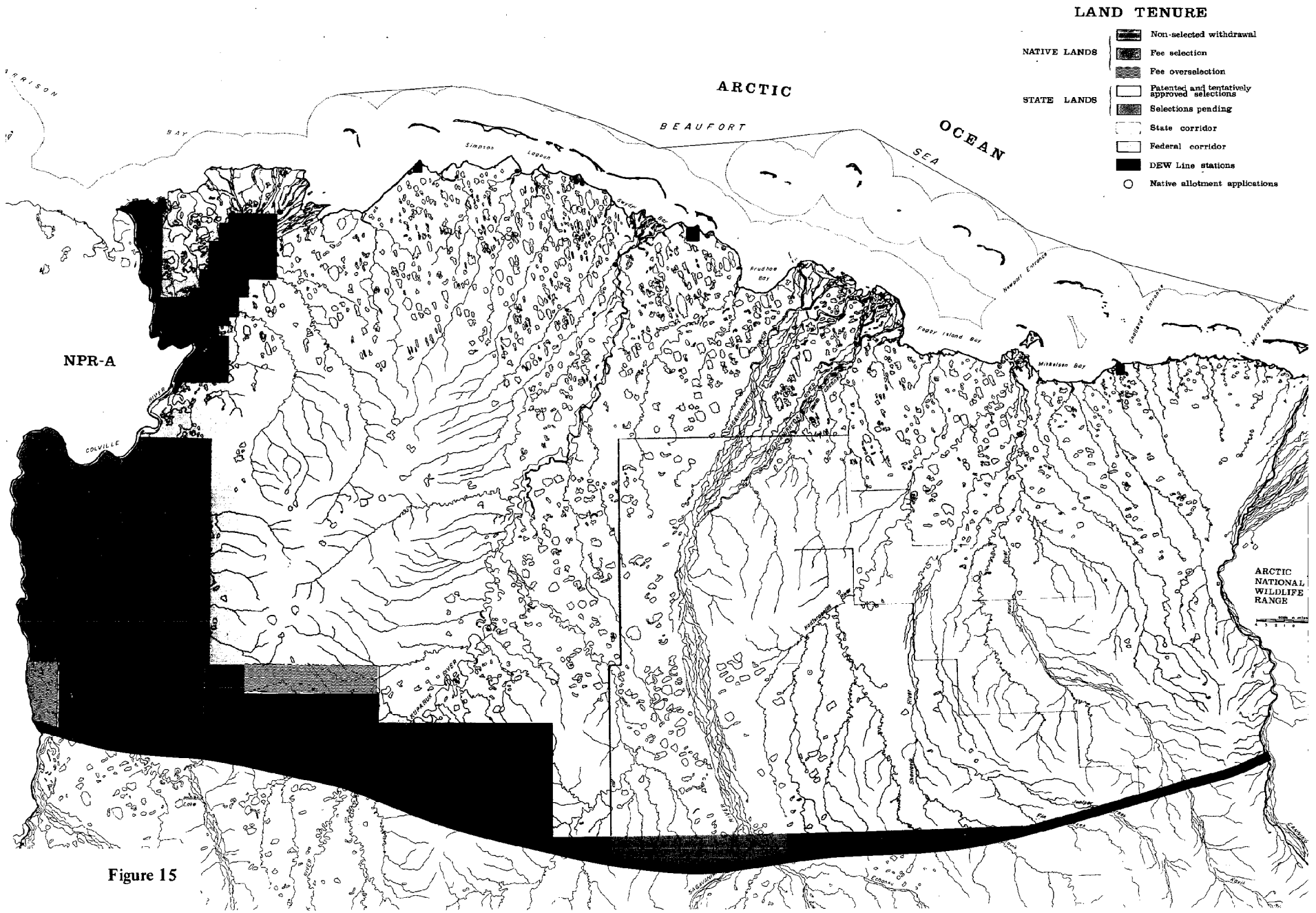

LAND TENURE
NATIVE LANDS
STATE LANDS
Non-selected withdrawal
Fee selection
Fee overselection
Patented and tentatively approved selections
Selections pending
State corridor
Federal corridor
DEW Line stations
Native allotment applications
ARCTIC
BEAUFORT
SEA
OCEAN
NPR-A
ARCTIC NATIONAL WILDLIFE RANGE

Figure 15

port, new port and dock facilities may be required. The capability of the shore to provide for these needs is somewhat limited. Natural wave and thermal erosion of coastal bluffs of the Beaufort Sea is very rapid in some areas. The protection of the pipeline from shoreline erosion at pipeline landfalls is an important design consideration especially for those coasts classified as wave erosion areas. Since the Beaufort Sea is shallow, water depth close to shore is an important locational criteria for port siting. On the Beaufort Sea coast there are few sites capable of accommodating oceangoing vessels. Sites that have been identified by the Arctic Institute of North America as having potential for medium- to deep-draft ports include Pingok Island, Cross Island, Pole Island, Flaxman Island and Konganevik Point.

3. Development Resources

For any development to occur, quantities of water and gravel must be located. Water is required for human consumption as well as various industrial uses and gravel is primarily required for its insulative capacity.

a. Water

North Slope water consumption has historically been limited to domestic use by villages, use by the Naval Arctic Research Laboratory in Barrow and DEW Line sites. The development of the Prudhoe Bay field and construction of the trans-Alaska pipeline has substantially impacted the available water resources in some areas of the Prudhoe Bay Coastal Area as demands have often outstripped supply during the winter months. Since large quantities of water are required in every phase of petroleum development, water availability will continue to be a major concern in Arctic petroleum development. Regulation of water extraction from fish overwintering spots further limits the availability of water during winter.

Water will be required for many purposes, including human consumption, well drilling and secondary recovery. Rates of domestic consumption vary greatly depending upon water availability and transport facilities. Estimates of per capita daily consumption in arctic construction camps range from 10 to 100 gallons per day of fresh water with an average camp usage of approximately 80 gallons per capita per day. The Navy estimates that average water consumption for exploration wells is 25 barrels (42 gallons per barrel) per day. Approximately 600 barrels are required daily for rig operation which includes the mixing of drilling mud and cement, and washing down the rig floor. The water requirements for production wells will be similar to the daily requirements of exploration wells; however, production wells can be drilled in significantly less time than exploratory wells, thus lowering total consumption. In order to maintain pressure and consequently field production, water flooding is often used in secondary recovery efforts. Approximately 7 years after the start of production, water flooding, which requires amounts of water from 3 to 10 times the volume of oil produced, is initiated.

Water needs at Prudhoe Bay are currently being met by the Sagavanirktok, Putiligayuk and Kuparuk Rivers and Big Lake. The largest single use, secondary recovery, has not yet begun. However, this water use will likely not conflict with fresh water sources as sea water will probably be used. Sources for future water needs will depend on the siting of development. A potential supply of water is from the rivers which do not freeze to the bottom during winter, namely the Colville, Sagavanirktok and Canning Rivers.

b. Gravel

Well-drained fill materials required in the construction of roads, buildings, drill pads and airstrips necessitate the location and development of sand and gravel resources in the Arctic. Even greater demands will be placed on these resources by offshore Beaufort Sea development than was required for onshore development because of the need for such facilities as artificial islands and causeways, harbors, and staging areas. As with water removal, there are environmental concerns regarding sand and gravel extraction. These include possible siltation of fish spawning streams and offshore fish

habitats and the acceleration of erosion on beaches, rivers and coastal bluffs, barrier islands and tundra surface.

Gravel requirements for various facilities on the North Slope vary greatly depending on the specific use involved, availability of gravel and the site specific soil conditions. The volume of gravel estimated for offshore exploratory islands in the proposed Federal/State lease sale in the Beaufort Sea ranges from 48,000 to 1,600,000 cubic yards depending on the type, size and depth of the island. Production islands are estimated on an average to require 621,133 cubic yards of gravel while causeways are estimated to utilize approximately 391,000 cubic yards per mile. Approximately 110,000 to 165,000 cubic yards are needed for an all-weather airstrip measuring 5,000 feet by 150 feet. Other facilities utilizing gravel include staging areas/production centers (750,000 to 1,000,000 cubic yards) and drill pads or camps (35,000 to 50,000 cubic yards).

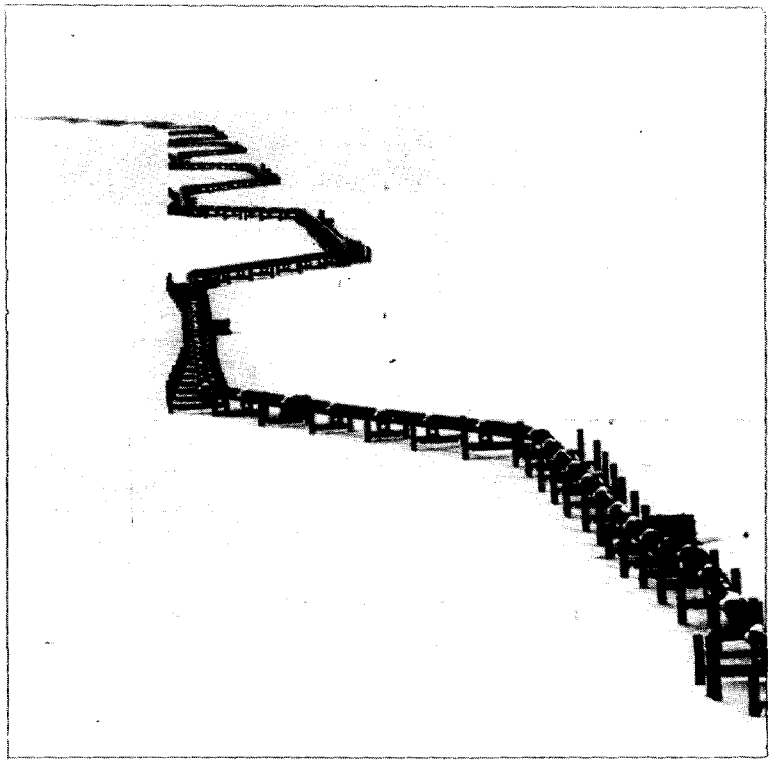
The Sagavanirktok, Putuligayuk and Kuparuk Rivers are current gravel and water sources. The location and quantity of gravel deposits and the environmental effects of extraction will determine possible future gravel removal sites. Additional gravel deposits have been identified in the deltas of the Canning and Shaviovik Rivers as well as beach and subsea deposits offshore.

4. Availability of Oil and Gas Transportation Facilities

At this time the only transportation facility for oil or gas is the trans-Alaska pipeline which is, of course, for oil. The gas pipeline from Prudhoe Bay is planned to be completed by 1982, however, specific design characteristics have not been completed.

a. Trans-Alaska Pipeline Capacity

Although the design capacity of the trans-Alaska pipeline is 2 million barrels per day, oil is currently being pumped through the line at the rate of 1.2 million barrels per day. Alyeska Pipeline Service Company would not increase current capacities until notified to do so by the seven owner companies. At this time there are 8 pump stations each with 2 pumps and 1 reserve pump. In order to bring the pipeline up to its design capacity, an additional 4 pump stations would be required and each of the 12 stations would need 3 pumps and 1 reserve pump. One of the 4 additional pump stations would be located in the study area approximately 20 miles south of Prudhoe Bay. Although no estimate of work force or timing is available, Alyeska officials have indicated that the work force required to increase the pipeline capacity would most likely be housed at the existing pump stations. With additional pump stations and looping of the pipeline, Alyeska officials estimate capacity could reach 4 million barrels per day.



b. Trans-Alaska Pipeline Availability

In its planning studies for the Beaufort Sea lease sale, the Department of the Interior has assumed that the trans-Alaska pipeline would be expanded to its design capacity and would transport 14.9 billion barrels of oil by the year 2010. This production would come from Prudhoe Bay, including Kuparuk (10.5 billion barrels), Flaxman Island-Pt. Thomson (0.4 billion barrels), Canning-Camden (1.3 billion barrels), Prudhoe Bay-Large (1.9 billion barrels), and Cape Halkett (0.8 billion barrels). The yearly summation of output from those fields results in a critical peak period in 1993 when the throughput reaches 1.996 million barrels per day which is close to pipeline capacity. Any additional throughput from other sources could be accommodated by additional pump stations or looping of the pipeline.

5. Fish and Wildlife Resources

The development of the Prudhoe Bay field coupled with the construction of the trans-Alaska pipeline and adjacent Haul Road has removed considerable acreage from productive wildlife habitat. The extraction of water and gravel from nearby lakes, rivers and streams to facilitate that development has also altered fish habitat. Although much land in the Prudhoe Bay Coastal Area has been removed as habitat for fish and wildlife, the area is still capable of supporting a multitude of wild creatures. In Chapter VIII the fish and game of the study area are inventoried and therefore will not be repeated here. The most noticeable effect of those development activities is the removal of the area surrounding Prudhoe Bay as a caribou calving ground. However, there is still a great deal of virgin land remaining in the study area that supports wildlife and fish.

6. Recreation and Tourism Resources

There are two aspects to consider when evaluating the capability of the land to provide for recreation and tourism; whether or not the land has recreation or tourism resources and the ability to provide for the development of the recreation and tourism resources, if they do indeed exist. The Prudhoe Bay Coastal Area has a variety of tourist and recreational resources: fish and wildlife for sport hunting and fishing, unique geologic landforms and wildlife for sightseeing and streams and lakes for recreational boating. However, even though the study area has tourist and recreational resources, the fragile nature of the land during summer when most of those activities would take place, limits the availability of those resources. The Prudhoe Bay Coastal Area is predominantly marshy and wet during the summer. Gravel roads would have to be built to allow vehicular traffic access to the different areas. Increased human activity could drive wildlife out of the area and also could damage the protective topsoil. Recreational hunters and fishermen could also deplete certain areas of their fish and wildlife.

C. POTENTIAL IMPACTS

The potential impacts of the demands that will or may be placed on the Prudhoe Bay Coastal Area are consumption of habitat, disruption of the environment and environmental pollution, and competition for fish and wildlife resources. These potential impacts will be discussed in this section.

1. Consumption of Habitat

Of the demands that will be placed on the study area, only one, subsistence activities, will not remove wildlife habitat. Petroleum development, recreation and tourism will all consume habitat by the siting of facilities, pipelines and new population.

a. Population

Since the entire population of the Prudhoe Bay Coastal Area is there solely to work on petroleum development, population increases and decreases are directly related to the level of activity taking place there. The actual manpower requirements for the various needs described earlier will hinge on the timing of development, the technology employed (for example, type of platform), and the number, size and location of fields.

It is anticipated that personnel of the Prudhoe Bay-Large scenario and those connected with construction of the natural gas pipeline within the study area would be located in the existing Prudhoe Bay/Deadhorse complex. If trunk pipelines were to be built from the National Petroleum Reserve-Alaska and the Arctic National Wildlife Range, part of the construction crew would probably also be located at Prudhoe Bay. The work force required for producing the Kuparuk River oil pool will be located 30 miles west of Prudhoe Bay at the site of development. The Canning-Camden scenario postulates locating the work force in the adjacent onshore area. If new population centers are developed outside of Prudhoe Bay, then duplication of services and facilities will result. This would also increase the consumption of wildlife habitat.

b. Pipelines

Within the study area, the natural gas pipeline will run parallel to the existing oil pipeline. Additional anticipated pipeline construction includes the oil trunk line from the Kuparuk formation to the trans-Alaska pipeline which will run 30 miles due east to Pump Station No. 1. The Prudhoe Bay-Large scenario assumes four miles of both oil and gas offshore lines. These would run from the north-northeast in the vicinity of the Midway Islands and would land just east of Point McIntyre, at which point 9.5 miles of onshore trunk pipelines will run due south across the Putuligayuk River to Pump Station No. 1. In the Canning-Camden scenario there would also be two pipelines—one for oil and the other for gas. Because there would be two separate fields, two offshore trunk pipelines would be necessary. One would run south between the Stockton and Maguire Islands and the other would run between the Maguire Islands and Flaxman Island landing at Bullen and at Point Thomson, respectively.

From Point Thomson the oil and gas pipelines would follow the coast to Foggy Island Bay and then run straight to Pump Station No. 1, a distance of 54 miles. These pipelines could also service the Flaxman Island/Pt. Thomson discoveries and, if extended 6 miles, could also connect to the Arctic National Wildlife Range. The Cape Halkett scenario postulates a pipeline from offshore Cape Halkett, though the eastern Jones Islands to Oliktok Point. From there, the pipeline would follow the coast until it reaches the Kuparuk River where it heads southeast to Pump Station No. 1.

c. Facilities

Exploration for new petroleum resources within the Prudhoe Bay Coastal Area will require very limited new construction because the Prudhoe Bay/Deadhorse industrial complex will most likely be utilized as the staging, supply and communications center. Only after economically recoverable oil is discovered would additional permanent onshore facilities be built. Typically, onshore field development is located as near as possible to the discovery or, for offshore fields, at the closest landfall. Facilities that could be required include an oil/gas/water separating plant (flow station), gas compression plant, base camp, airstrip, dock/harbor, storage area, and access roads.

Facilities for Kuparuk and for the Canning-Camden scenario

and the potential Pt. Thomson/Flaxman Island development will be at the field or at the closest point onshore from the field. The Prudhoe Bay-Large scenario would require separate production/processing facilities, but would utilize the existing airstrip, harbor, and construction housing at Prudhoe Bay. Development of Cape Halkett assumes no facilities in the Prudhoe Bay Coastal Area. Similarly, development of the Arctic National Wildlife Range would probably not require facilities within the study area. Since the natural gas pipeline will run parallel to the trans-Alaska pipeline, new facilities will be limited to the pipeline corridor.

2. Disruption of the Environment and Environmental Pollution

The extent of alteration to the environment from development will determine the potential impacts of that development. The location and quantity of water and gravel extracted and the siting of construction, the noise pollution created by it and obstruction to migration patterns will collectively be the direct effects on the environment.

a. Construction

Gravel mining and road and workpad construction have damaged fish and wildlife habitat throughout the pipeline corridor. Undoubtedly, future pipelines in the study area will cause similar damage. Therefore, the primary objective for construction planning should be to reduce the amount of land consumed by development. The Alaska Department of Fish and Game suggests burying pipelines especially through river deltas and floodplains to lessen the negative impact on habitat. Maximization of all currently existing facilities provides another means of reducing habitat consumption. When new facilities are built they should be removed after they are no longer needed and the area returned to its natural condition. Wildlife would, in time, return to inhabit the area. Artificial islands, may negatively impact the biotic community and, in addition, may constitute a hazard to navigation unless properly charted and marked. To lessen negative impacts, the soil and gravel from abandoned artificial islands should be reused or the islands should be constructed so they are readily demolished by wind and wave action when erosion control materials have been removed.

b. Water Usage

During the summer and fall months, water is abundant on the North Slope. However, during the eight month arctic winters, nearly all rivers, streams and lakes freeze to the bottom. A few pockets of water in deep lakes and large rivers do not freeze and these often become the crowded habitat of overwintering fish. Additional winter sources are found in groundwater present in alluvial aquifers near large rivers and beneath larger lakes which do not freeze to the bottom. Melted ice and snow and deep lakes are the primary sources of community water during winter. In summer, developing groundwater sources below the permafrost is not practical because the permafrost extends from several feet below the surface to depths between 600 to 1,980 feet.

Several ecological problems may be created by removal of water from unfrozen pockets. Partial removal of water supporting aquatic organisms crowds organisms into the remaining confined space and may cause a buildup of the organisms' waste metabolites or a decrease in dissolved oxygen concentration due to the animals' respiratory activities. Removal of only a portion of the water may also dewater marginal gravels which contain developing fish embryos. If all water is withdrawn from an area mortality of some species may occur. Withdrawal of water from fish overwintering pools may over time cause the fish to move to other areas and potentially reduce village winter food sources. For the above reasons, removal of water during winter poses a potential, and often significant, threat to aquatic organisms. Since no comprehensive formula has been developed to protect overwintering organisms, each situation should be investigated individually.

c. Gravel Usage

As has been discussed in previous sections of this report

significant demands will be placed on the sand and gravel resources in the Prudhoe Bay Coastal Area by future petroleum development, especially offshore exploration and production. Most of the gravel for the trans-Alaska pipeline and Prudhoe Bay field construction has been extracted from river floodplains. In the future gravel may be mined both onshore and offshore. Abandoned artificial islands and causeways are the preferred source of fill materials. Other sources in order of preference are open pit terrestrial mines, the sea bottom outside the 5-meter isobath, riverbeds, Beaufort Sea beaches, the sea bottom inside the 5-meter isobath and, finally, the barrier island system.

(1) **Onshore gravel extraction.** Most of the major rivers and streams which originate in the Brooks Range contain sand and gravel. Coastal deposits east of the Colville River are available in beaches, spits and barrier islands. Alterations to stream morphology have a number of effects on the aquatic biology. Fish spawning areas may be eliminated by the destruction or modification of the gravelly channel substrate. A significant impact associated with gravel extraction is siltation. Generally caused by equipment working in or near active channels, siltation is created by excavation in the stream channel, gravel washing or increased erosion of the river channel and adjacent banks. Siltation can reduce fish food organisms, smother spawning gravel beds and adversely affect egg development. These siltation problems can be avoided or corrected by the use of settling basins or diversionary channels to keep equipment out of streams. Long-term site rehabilitation measures such as replacement of topsoil, restoration of pre-mining vegetation and contours and various erosion control procedures can also mitigate siltation damage. Coastal erosion resulting from beach and barrier island borrowing is also a major concern. Although upland borrow sites are recommended there are few suitable sites on the North Slope due to permafrost, geotechnical and resource availability problems.

(2) **Offshore gravel extraction.** East of the Colville River delta, from the shoreline to the 60-foot isobath, the bottom sediments consist mainly of sands and gravels. The mining of offshore sand and gravel is primarily to construct artificial islands for exploration and production of oil and gas. Extraction involves dredging by barge-mounted or land-based clamshell dredges, barge-mounted suction dredges or draglines. Although there is no experience with this type of dredging in the study area, it has been used in the southern Beaufort Sea in Canada. According to Canadian scientists, sediment plumes and increased turbidity associated with dredging and hydraulic fill operations have not seriously impacted planktonic communities, benthic organisms, and fish. There is concern, however, that the artificial island program may have serious effects on Beaufort Sea whale populations. Disturbances from construction activity or the physical presence of islands may cause whales to avoid traditional calving and feeding areas and to alter migration routes.

d. **Noise**

Excessive noise could potentially have a significant effect on the area's wildlife. Noise from construction activities coupled with increased noise from trucks and aircraft can reach unnaturally high levels of noise for the area. Although there are little data on the effects of noise pollution on wildlife, denning polar bears and breeding waterfowl appear to be very susceptible to disruption from noise.

e. **Obstacles to Migration**

When considering obstacles to migration patterns or routes, it is common to refer to roads, pipelines or construction camps as obstacles to migrating land mammals such as the caribou. Although this is a very significant concern, marine inhabitants must also be considered. The effects of artificial islands and causeways on any species from migrating whales to microscopic organisms is largely unknown. Before the erection of permanent structures, studies should be undertaken to determine the migratory patterns of the area. Besides physical barriers of roads or causeways, other factors such as noise or increased boat, truck and airplane traffic could be obstacles to migration routes.

3. Competition for Fish and Wildlife Resources

Although the population of the State as a whole has increased dramatically over the past several decades, there has been relatively little population change on the North Slope outside Prudhoe Bay/Deadhorse. During this same period the level of subsistence hunting and fishing has decreased. Perhaps the most significant cause of this decrease results from the switch from dogs to snow machines as the primary mode of transportation, thus eliminating the necessity to harvest vast quantities of game for dog food. Increased income has also lessened Native dependence on fish and game. Regardless of reduction in levels of subsistence harvest, the preservation of traditional culture and historic patterns of subsistence is of major concern to the people of the Arctic coastal region and given a stable population, long-term subsistence harvest levels should remain at a relatively low and stable level. There are a number of pressures on fish and wildlife resources in the region. Recreational fishermen and hunters are showing increased interest in hunting and fishing in the Arctic and are beginning to compete with local residents for fish and game resources. Activity related to development of Prudhoe Bay has decreased fish populations in the Sagavanirktok River and displaced traditional caribou calving grounds in the Prudhoe Bay area. New facilities, gravel mining, and water collection in connection with onshore development are likely to impact wildlife habitat in the future. The possible impacts on fish and wildlife from offshore development are largely unknown and require extensive additional study.

Bibliography

BIBLIOGRAPHY

Alaska Consultants, Inc., 1976. North Slope Borough coastal zone management program considerations.

_____, 1976. North Slope Borough: Issues Overview.

_____, 1978. Alaska OCS socioeconomic studies program: Beaufort Sea petroleum development scenarios, man-made environment impacts. Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office, Technical Report No. 19.

_____, 1978. Alaska OCS socioeconomic studies program: Beaufort Sea region, man-made environment. Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office, Technical Report No. 8.

_____, 1978. Inuit Circumpolar Conference, June 1977.

Alaska Department of Fish and Game, 1977. A Fish and Wildlife Resource Inventory of Western and Arctic Alaska, Volume 1—Wildlife, Volume 2—Fisheries.

Alaska Division of Policy Development and Planning, 1975. Environmental Assessment: Proposed Beaufort Sea Nearshore Petroleum Leasing (draft). April 4, 1975.

Alaska Office of the Governor, 1978. Standards of the Alaska Coastal Management Program (draft). January 1978.

_____, 1978. Guidelines for District Coastal Management Programs (draft). January 1978.

Alaska Report, 1977. ARCO considers oil probe west of Prudhoe Bay. July 13, 1977.

_____, 1977. Exxon Pt. Thomson wildcat flows 2,300 BOPD, 13 MMCF on test. November 2, 1977.

Anchorage Daily News, 1978. Oil exploration in wildlife range wins approval. March 14, 1978.

American Law Institute—American Bar Association, 1978. Oil spills and the Law. An ALI-ABA course of study prepared by Committee on Continuing Professional Education. April 1978.

Arctic Coastal Zone Management Newsletter, 1978. North Slope Borough, Issue Number 8.

_____, 1978. Haul Road: NSB officials blast public Haul Road use. Issue 10. March 1978.

Arctic Institute of North America, 1973. Arctic Marine Commerce Study. Report prepared by the Arctic Institute of North America for Maritime Administration, U. S. Department of Commerce. August 1973.

_____, 1974. The Alaskan Arctic Coast, A Background Study of Available Knowledge. Anchorage, U. S. Department of the Army, Corps of Engineers, Alaska District.

Bagne, Conrad, 1977. North Slope Borough legal powers and options on the Haul Road and adjacent Federal and State lands. Report submitted to the North Slope Borough Planning Department, November 1, 1977.

Barnes, P. W. and E. Reimnitz, 1974. Sedimentary processes on arctic shelves off the northern coast of Alaska, *in* the Coast and Shelf of the Beaufort Sea, J. C. Reed and J. E. Sater (eds.). Arctic Institute of North America, Proceedings of a Symposium on Beaufort Sea Coast and Shelf Research.

Bergman, R. D., R. L. Howard, K. F. Abraham and M. W. Weller, 1977. Water birds and their wetland resources in relation to oil development at Storkersen Point, Alaska. U. S. Fish and Wildlife Service Resource Publication 129, Washington, D. C.

Carsen, C. E., and K. M. Hussey, 1962. The oriented lakes of Arctic Alaska, J. Geol. 79(4):417-439.

Carter, R. D., C. G. Mull, K. J. Bird, and R. B. Powers, 1977. The Petroleum Geology and Hydrocarbon Potential of Naval Petroleum Reserve No. 4, North Slope, Alaska. U. S. Geological Survey, Open-File Report 77-475.

Clark, John, 1977. Coastal Ecosystem Management. A Technical Manual for the Conservation of Coastal Zone Resources. The Conservation Society, John Wiley and Sons, New York.

Crittenden, Cassetta, Cannon/Hellmuth, Obata & Kassabaum, Inc., 1978. Prudhoe Bay Case Study, Alaska OCS Socioeconomic studies program, Technical Report No. 4. Bureau of Land Management.

Dames and Moore, 1978. Alaska OCS socioeconomic studies program: Beaufort Sea petroleum development scenarios, natural physical environment impacts. Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office, Technical Report No. 21.

Dennis M. Dooley and Associates, 1978. Alaska OCS socioeconomic studies program: Beaufort Sea petroleum development scenarios, transportation impacts. Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office, Technical Report No. 20.

Detterman, Robert L., 1974. The Arctic Lowland Region, Potential Landform and Lifeform Natural Landmarks. U. S. Geological Survey, an administrative report prepared for the National Park Service. November 1974.

E. F. Hutton & Company, Inc., 1977. North Slope Borough, Alaska, general obligation bonds, series H. June 15, 1977.

Federal Register, 1977. Federal consistency with approved coastal management programs. Vol. 42, No. 167, August 29, 1977.

Ferrians, O. J., 1965. Permafrost Map of Alaska. U. S. Geological Survey, Miscellaneous Geologic Investigations Map I-445.

Gavin, A., 1977. Wildlife of the North Slope. Atlantic Richfield Company.

Gibson, K. J., and P. A. Kerschner, 1977. Alternatives for the future, petroleum development study, North Slope of Alaska (draft). Alaska Department of Natural Resources. December 1977.

Grantz, A., et al., 1976. Summary report of the sediments, structural framework, petroleum potential, environmental conditions, and operational considerations of the United States Beaufort Sea, Alaska area. U. S. Geological Survey, open-file report 76-830.

Harden, D. et al., 1977. Distribution and Character of Naleds in Northeastern Alaska. U. S. Geological Survey, Open-file Report 77-91.

Hawley, C. C., 1978. Alaska mineral potential. U. S. Bureau of Mines, Juneau, Alaska.

Hume, J. D., and M. Schalk, 1964. The effects of beach borrow in the Arctic. *Shore and Beach.* April 1964.

_____, 1967. Shoreline processes near Barrow, Alaska: A comparison of the normal and the catastrophic. *Arctic,* 20(2):86-103.

Hume, J. D., and M. Schalk, and P. W. Hume, 1972. Short-term climate changes and coastal erosion, Barrow, Alaska. *Arctic,* 25(4):272-278.

Karlstrom, T.N.V. et al., 1964. Surficial Geology of Alaska. U. S. Geological Survey, Miscellaneous Geologic Investigations Map I-357.

Klein, R. M. et al., 1974. Energy and mineral resources of Alaska and the impact of federal land policies on their availability. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Open-file Report No. 50.

Koranda, John J., and Charles D. Evans, 1975. A Discussion of Sites Recommended as Potential Landmarks in the Arctic Lowland Natural Region, Northern Alaska. April 1975.

Labelle, J. C., 1973. Fill materials and aggregate near Barrow, Naval Petroleum Reserve No. 4, Alaska. Arctic Institute of North America.

_____, 1974. Fill materials and aggregate in the Cape Halkett Region, Naval Petroleum Reserve No. 4, Alaska. Arctic Institute of North America.

Leffingwell, E. DeK., 1969. The Canning River Region, Northern Alaska. U. S. Geological Survey, Professional Paper 109.

Lewellen, R. I., 1970. Permafrost erosion along the Beaufort Sea coast. Published by the author, Box 1068, Littleton, Colorado 80120.

MacCarthy, G. R., 1953. Recent changes in the shoreline near Point Barrow, Alaska. *Arctic,* 6(1):44-51.

Miller, B. M. et al., 1975. Geological estimates of undiscovered recoverable oil and gas resources in the United States. U. S. Geological Survey, Circular 725.

Mull, C. G. and B. A. Kososki, 1976. Hydrocarbon assessment of the Arctic National Wildlife Range, eastern Arctic Slope, Alaska, *in* The U. S. Geological Survey in Alaska: Accomplishments during 1976, K. M. Blean (ed.). U. S. Geological Survey Circular 751-B.

Nielson, J. M., 1977. Beaufort Sea Study—Historic and Subsistence Site Inventory: A Preliminary Cultural Resource Assessment. North Slope Borough.

North Slope Borough, 1977. Proposed land-use management system for the Haul Road and other major highways.

_____, 1977. Adoption of findings and policies on the Haul Road and zoning and subdivision ordinance amendments for the area along the Haul Road and other major highways in the Borough. Resolution Serial No. 77-7.

_____, 1977. Overall economic development program—summary report. June 1977.

Oil and Gas Journal, 1977. Kuparuk development eyed on North Slope. October 3, 1977.

Oil Daily, 1977. Exxon expects spending rise. December 9, 1977.

O'Sullivan, J. B., 1961. Quaternary geology of the arctic coastal plain, northern Alaska. Iowa State University of Science and Technology, Ames, Ph.D. thesis.

Outer Continental Shelf Environment Assessment Program, 1977a. Arctic Project Bulletin No. 13. NOAA-BLM. March 1, 1977.

_____, 1977b. Arctic project No. 14. NOAA-BLM. June 1, 1977.

_____, 1977c. Arctic project bulletin no. 15. Beaufort Sea synthesis report: environmental impacts of OCS development in northern Alaska (Draft). NOAA-BLM. June 1, 1977.

_____, 1977d. Arctic project bulletin no. 16. NOAA-BLM. September 1, 1977.

Pewe, T. L., 1976. Quaternary Geology of Alaska. U. S. Geological Survey, Professional Paper 835.

Potocsky, G. J., 1975. Alaskan Area 25- and 30-day Ice Forecasting Guide. U. S. Naval Oceanographic Office. Special Publication 263.

Reed, J. C., 1958. Exploration of Naval Petroleum Reserve No. 4 and adjacent areas, Northern Alaska, 1944-53, Part 1, History of the Exploration. U. S. Geological Survey, Professional Paper 301.

Reed, J. C., and J. E. Sater, 1974. The coast and shelf of the Beaufort Sea. Arctic Institute of North America, Proceedings of a Symposium on Beaufort Sea Coast and Shelf Research. December 1974.

Reimnitz, E. and P. W. Barnes, 1974. Sea ice as a geologic agent on the Beaufort Sea Shelf of Alaska, *in* the Coast and Shelf of the Beaufort Sea, J. C. Reed and J. E. Sater (eds.). Arctic Institute of North America, Proceedings of a Symposium on Beaufort Sea Coast and Shelf Research.

Resource Planning Associates, 1976. The exploration, development and production of Naval Petroleum Reserve No. 4. Draft Final Report prepared for Federal Energy Administration, Contract No. Cr-05-60579-00.

Searby, Harold W. and Marcelle Hunter, 1971. Climate of the North Slope, Alaska. U. S. Department of Commerce, National Weather Service, Alaska Region, NOAA Technical Memorandum NWS AR-4.

Selkregg, L. L. ed., 1975. Alaska regional profiles—Arctic region. Arctic Environmental Information and Data Center.

Sellmann, P. V. et al., 1972. Terrain and Coastal Conditions on the Arctic Coastal Plain; Arctic Environmental Data Package, Supplement 1. Cold Regions Research and Engineering Laboratory, U. S. Department of the Army, Special Report 165.

Spencer, David L., 1977. The preservation of wildlife habitat in Alaska. Prepared for the Joint Federal-State Land Use Planning Commission for Alaska by the Arctic Environmental Information and Data Center, University of Alaska, Anchorage. June 1977.

Spencer, R., 1959. The North Alaskan Eskimo, A Study in Ecology and Society. U. S. Government Printing Office.

U. S. Fish and Wildlife Service, 1976. Preliminary report—gravel removal studies in selected Arctic and Sub-Arctic streams in Alaska. Office of Biological Services, Washington, D. C.

Wahrhaftig, C., 1965. Physiographic divisions of Alaska. U. S. Geological Survey, Professional Paper 482.

Wilson, W. J. et al., 1977. Winter water availability and use conflicts as related to fish and wildlife in Arctic Alaska—a synthesis of information. U. S. Fish and Wildlife Service.

Wiseman, W. J. et al., 1973. Alaskan Arctic Coastal Processes and Morphology. Coastal Studies Institute, Louisiana State University, Technical Report 49.

Worl, R., 1977. Arctic Slope Socio-Economic Subsistence Complexes. North Slope Borough.

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