

ENVIRONMENTAL EFFECTS OF PETROLEUM DEVELOPMENT
ALONG THE ALASKAN NORTH SLOPE

by 4589

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B. A., Texas Christian University, 1968

A MASTER'S THESIS

submitted in partial fulfillment of the
requirements for the degree

MASTER OF ARTS

Department of Geology and Geography

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

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ACKNOWLEDGEMENTS

The author wishes to thank Dr. David Kromm, under whose direction and supervision this study was undertaken, for his unending patience, guidance, and helpful suggestions. To Robert B. Weeden, an Alaska Conservation Representative, go many thanks for the numerous unpublished materials he provided. Dr. A. R. Thompson of the University of Alberta provided several documents which were indispensable to the study. The author is especially grateful to his wife, Donna, whose typing abilities were essential, and without her dedication and understanding this thesis would never have been completed.

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CHAPTER I

INTRODUCTION

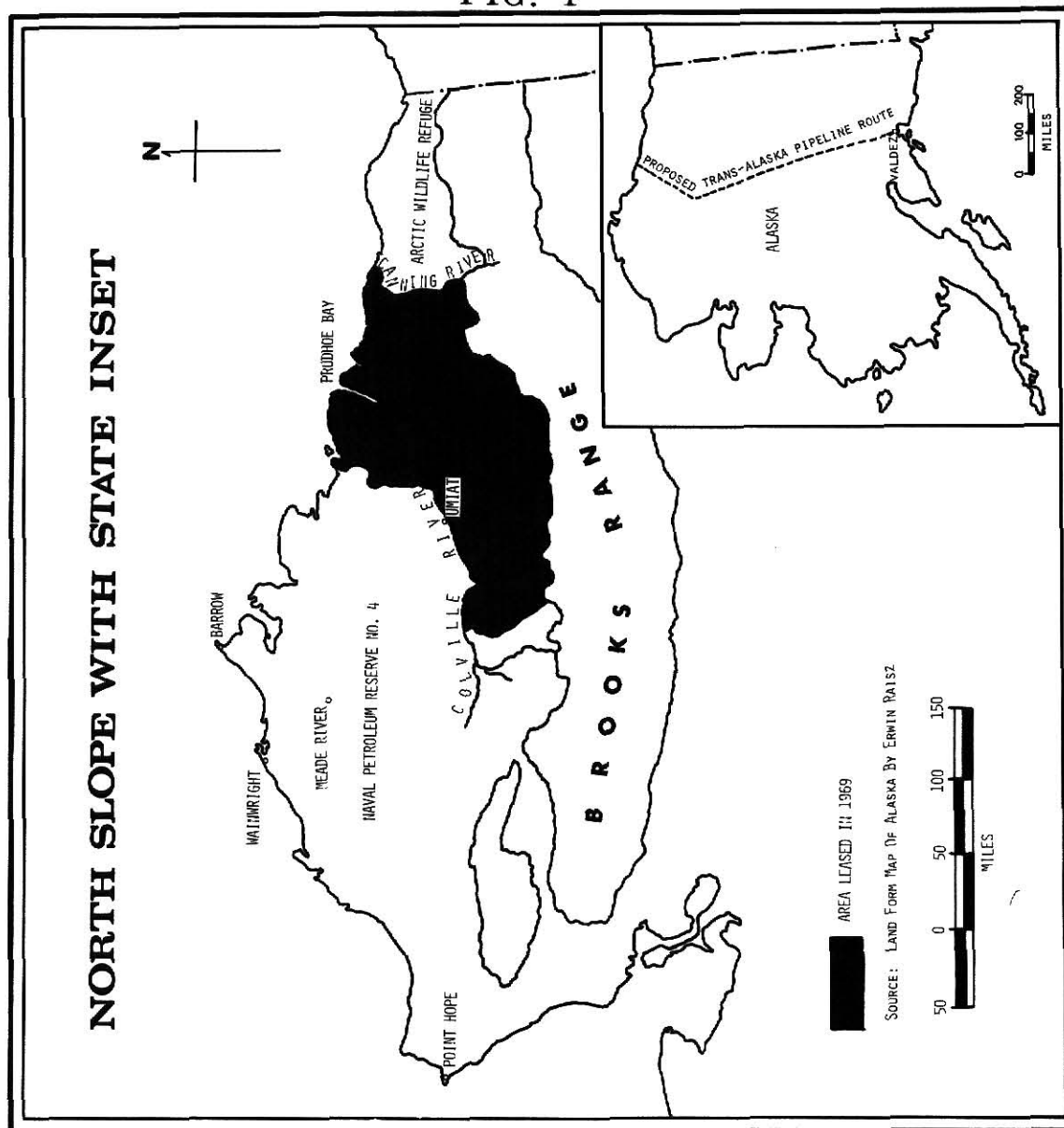
On September 10, 1969, an oil lease sale was held in Anchorage, Alaska. On that day Alaskans, who had earned a total personal income of a little over one-billion dollars in 1968, received and accepted bids from oil companies for slightly over \$900,000,000 in lease payments and bonuses on state lands near Prudhoe Bay¹ (see Figure 1). Although expectations of continued income from future lease sales and from gas and oil production suggest the post-statehood search for revenue is over, other problems have presented themselves. One of these is related to the types of natural environmental² changes Alaskans can expect to occur within the petroleum development region of the North Slope³ and along the projected Trans-Alaska Pipeline route. The effects of rapid development may create problems which in the long run might be more serious than those solved by the sudden influx of capital. The state of Alaska in conjunction with the federal government will soon be forced into a decision. They can permit the oil companies working in the North Slope to continue routine operations on a competitive basis, which will in all

¹Robert Weeden, "Man in Nature: A Strategy for Alaskan Living" (paper read at Tundra Conservation Conference, October, 1969, Edmonton, Alberta).

²Within this thesis the terms "natural environment" and "environment" shall be synonymous. The "natural environment" is defined as all the air, water, land, vegetation, and wildlife which exists in the study region.

³The North Slope consists of all the Alaskan land area north of the Brooks Range.

FIG. 1



probability lead to adverse environmental alterations, or they can delay existing operations until ecological studies have been completed on the area, and a master plan drawn up detailing how different aspects of petroleum development will alter the environment. Once that master plan is available, all parties involved in petroleum development will know ahead of time the possible consequences of each developmental activity.

Both sides of the question have been stated and restated recently by the conservationists and the oil companies. Throughout the United States and Canada many interested groups have identified, discussed, and evaluated environmental changes which may occur along the North Slope.⁴ Oil companies continuously announce that they will adversely affect very little, but that they are bringing numerous economic assets to the region and the state. Many conservationists are concerned about the possible misuse of the land's resources and the absence of environmental legislation which would protect the affected areas from needless degradation.

PURPOSE OF THE STUDY

The purpose of this inquiry is to objectively describe and analyze natural environmental changes occurring and expected to occur along the Alaskan North Slope because of petroleum development which may adversely affect the value of this land for man's future use and enjoyment. This thesis discusses only changes which may result from petroleum development.

⁴There were at least four relevant conferences held in 1969 including: The Alaska Science Conference held at the University of Alaska in August, 1969; the Tundra Conservation Conference which met at Edmonton, Alberta, in October, 1969; the Eleventh Biennial Wilderness Conference held in March, 1969; and the Canadian Conference on Permafrost which met in Ottawa, Ontario, in September, 1969.

The specific objectives of this thesis are to determine how these expected changes could affect the land, wildlife, vegetation, and life patterns of the Eskimo. Although the effects of human activity on the natural or aesthetic beauty of an area usually leads into value judgments on the part of a writer, the effects of petroleum development on this area's natural appearance will be considered.

JUSTIFICATION OF THE STUDY

Since George Perkins Marsh authored Man and Nature in 1864, many geographers have investigated the question of how man influences his environment. Mr. Marsh, an outstanding geographer, intended in his text to depict, "how man has changed the earth."⁵ His idea, that man has a significant effect on his natural environment was accepted readily in Europe,⁶ where the negative effects of man's ignorance of nature had already led to severe resource misuse and environmental deterioration. During the early 1870's U.S. Forestry Commissioner Franklin B. Hough became one of the first Americans to publicly acclaim Marsh's work. He knew that the forest resources in the United States were being rapidly depleted and that a book like this could make people aware that man's effect on his environment was not insignificant. Commissioner Hough and the few others who saw the significance of Man and Nature in the 1870's and 1880's were unable to build sufficient support for a national movement. Marsh's text, though avidly read throughout Europe, was ignored by Americans until the 1930's, whenever the United States was beginning to

⁵ George Perkins Marsh, Man and Nature, ed. David Lowenthal (Cambridge: Harvard University Press, 1965), p. xix.

⁶ Ibid., p. xxii.

experience too many floods and too much erosion.

The generation of the 1930's rapidly became aware of the delicate balance which exists between man and his environment. As the years passed, more and more people began to see how industrialization and population growth could change the natural environment. One of the results of this new environmental awareness was the "Marsh Festival," a conference which drew over eighty scholars from numerous disciplines.⁷ Their subject was the effect of man on his environment and the result was a book entitled, Man's Role in Changing the Face of the Earth. The basic theme of both these texts was that man is now adversely altering the natural environment which supports him. We are changing the air we breathe, the water we drink, the food we eat and the chemical makeup of our own bodies. The central theme of this thesis is that man is adversely affecting the environment of the Alaskan North Slope through petroleum development.

Many scholars, including geographers, have incorporated man-land relationships into their works. Several books have been written by geographers and published which dealt with the principle, man the modifier.⁸ Various articles by geographers have also dealt with this subject including Dr. E. C. F. Bird's, "The Impact of Man on the Gippsland Lakes, Australia." This article by Dr. Bird was, "intended as an illustration of the type of geographical inquiry which seeks to determine the effects of human interference as a

⁷Ibid.

⁸Some geography books which emphasize the "man the modifier" principle are: Joseph Hoyt, Man and the Earth (Englewood Cliffs: Prentice-Hall, 1967), pp. 3-56; Philip Wagner, The Human Use of the Earth (New York: Free Press of Glencoe, 1960), Guy-Harold Smith (ed.), Conservation of Natural Resources (New York: John Wiley and Sons, 1965).

basis for planning the utilization and conservation of a region's natural resources."⁹ In their research, numerous geographers have investigated the effects of man on his environment.¹⁰ Continuing in that tradition, this thesis examines the affects of man's petroleum activities on the Alaskan North Slope.

The area of petroleum development within the North Slope was chosen as the study region because the Slope represents one of our last frontiers, and the development is occurring there now. The North Slope is currently being modified by man's petroleum discoveries. Therefore, an objective review of occurring and expected changes should be useful to policy makers in deciding how the region may be best utilized. A review of the environmental effects of the petroleum industry's development is worthwhile for two reasons. First, the oil industry will bring the initial changes to the region. Therefore, if any environmental changes are observed, and they can be attributed to the oil industry, those same changes might be avoided by future petroleum developers. Also, petroleum development and its possible effects will be reviewed because it is the only industry presently involved.

LOCATION AND DESCRIPTION OF THE STUDY REGION

Within Alaska the land sloping from the northern foothills of the Brooks Range to the Arctic Ocean is called the North Slope. The North Slope

⁹S. R. Eyre and G. R. J. Jones (eds.), Geography as Human Ecology (London: Edward Arnold Ltd., 1966), p. 56.

¹⁰Some geographic articles dealing with the principle, "man the modifier," are: Arthur Doerr and Lee Guernsey, "Man as a Geomorphological Agent: The Example of Coal Mining," Annals of the Association of American Geographers, XL (March, 1956); E. Ketchum, "Air and Water Pollution in the Iron and Steel Industry," Journal of Geography (December, 1967); R. Nelson and J. Byrne, "Man as an Instrument of Landscape Change: Fires, Floods, and National Parks," Geographic Review (April, 1966).

supports soils, vegetation, wildlife, and a population typical of most areas of the world which are designated as tundra.¹¹ The specific area examined in this study is located within the North Slope, and consequently within the tundra. The southern boundary of the study region corresponds to the northern foothills of the Brooks Range between 146° and 151° west longitude. The Arctic ocean forms the northern or poleward extreme, while the eastern border follows the Canning River from the point it leaves the Brooks Range foothills until it reaches the Arctic Ocean. Following a river also, the western margin is defined by the Colville River valley between the Brooks Range foothills and the Arctic Coast. The eastern and western river boundaries are not arbitrary, as the valleys delimit the extent to which the oil companies can legally explore and develop, since the Naval Petroleum Reserve No. 4 lies west of the Colville,¹² and east of the Canning is the Arctic National Wildlife Range. Neither the Naval Petroleum Reserve nor the Wildlife Range are legally available for petroleum development by private companies.

Most of the North Slope is a lowland plain with such slight relief that it is sometimes difficult for the unaided eye to judge which way the land is inclined. In some areas a very slightly rolling topography does occur.

¹¹Sir Dudley Stamp (ed.), A Glossary of Geographical Terms (London: Longmans, Green and Co., 1966), p. 465. Within this book tundra is defined as, "one of the level or undulating treeless plains characteristic of Arctic regions in both hemispheres. The tundras mark the limit of aborescent (tree like) vegetation; they consist of black mucky soil with a permanently frozen subsoil, but support a dense growth of mosses, and lichens, as the reindeer moss, the dwarf cespitase herbs and shrubs; often showy flowered."

¹²Naval Petroleum Reserve No. 4, as shown on Figure 1, represents a vast federally owned tract of land set aside by the Congress of the United States in 1938. This land was to serve as a petroleum reserve and future fuel source. It was to be developed by the Navy.

These sections, often minutely elevated, display features such as polygons, stone nets, and garlands.¹³ Individual mounds or small hills several feet high, called pingos, result from the squeezing of layers of unfrozen soil between frozen topsoil and the underlying permafrost.¹⁴ Pressures may be so great that when release comes, a hill is formed. Numerous lakes and swamps are scattered throughout the North Slope creating wide expanses of water in the summer and ice accumulations in the winter. It may seem unusual that an area such as the North Slope, which averages 5 to 12 inches of precipitation annually, would develop hundreds of marshes and lakes, but a low rate of evaporation throughout the year plus the inability of water to percolate down beyond the ever-present permafrost results in irregular surface drainage. Over two-thirds of the precipitation occurs in the five-month period from July to November. Less than a third of the total precipitation falls between December and June, and that in the form of snow.

Besides receiving most of the precipitation, the summer months are also significant because the recorded temperatures of the warm season dictate the criteria used to define a tundra climate. Specifically, the warmest month must neither average less than 32° nor higher than 50° Fahrenheit in order to

¹³Oscar J. Ferrians, Jr., Reuben Kachadoorian, and Gordon W. Greene, Permafrost and Related Engineering Problems in Alaska, U. S. Geological Survey Professional Paper No. 678 (Washington, D. C.: U. S. Government Printing Office, 1969), pp. 8-12.

¹⁴For an excellent discussion and definition of permafrost see the first few pages of Oscar J. Ferrians, Jr., Reuben Kachadoorian, and Gordon W. Greene, Permafrost and Related Engineering Problems in Alaska, U. S. Geological Survey Professional Paper No. 678 (Washington, D. C.: U. S. Government Printing Office, 1969).

be classified as tundra.¹⁵ All recording points along the North Slope meet this criteria. The winter months of the Arctic Slope seldom have average temperatures below -25°F, although occasionally the readings may be lower. Exaggerated stories and uninformed reports have seemingly produced a pseudo-climate for tundra areas in general which simply does not exist. In fact, Vilhjalmur Stefansson, a noted Arctic explorer, believes that the Dakota winters rival or exceed the severity of those in the tundra.¹⁶

Winds, especially in the winter, are often very strong and may continue for days at a time. Often these winds moving onto the land from the Arctic Ocean greatly affect the sensible temperature, creating uncomfortable working conditions when the temperature is only near zero. According to Thomas McKnight, without the chilling breezes a temperature of -30°F does not present unpleasant working conditions for most men.¹⁷

The North Slope has few well developed soils with most being low in plant food, leached of mineral constituents, and fairly viscous during the short summer season.¹⁸ As a result of former glaciation there is a considerable accumulation of morainic materials and rewashed glacial deposits, most of which are classed as azonal soils. Underlying virtually the entire surface of the study region is permafrost. This natural phenomenon occurs where

¹⁵ Glenn T. Trewartha, Arthur H. Robinson, and Edwin H. Hammond, Physical Elements of Geography (New York: McGraw Hill Book Co., 1967), p. 188.

¹⁶ John Hodgdon Bradley, World Geography (New York: Ginn and Company, 1945), p. 43.

¹⁷ C. L. White, E. J. Foscutt, and T. L. McKnight, Regional Geography of Anglo-America (Englewood Cliffs: Prentice-Hall, 1964), p. 477.

¹⁸ Earl B. Shaw, Anglo-America (New York: John Wiley and Sons, 1959), p. 48.

winters are longer than the periods of summer thaw, with soil freezing to a depth of several hundred feet. The depth to which the soil freezes and thaws depends upon the slope of the land, water content of the soil, soil type, snow cover, vegetation, and the temperature, with the last being the most important.

Many regard the North Slope as a cold and forbidding area, perpetually covered with ice and snow, where no plant life can exist. Yet as far north as land reaches numerous species of flowering plants grow besides lower forms of plant life, such as mosses, lichens, algae, and fungi. As an adaptation to the short summer, almost all truly Arctic plants are perennial and develop the next year's flowering buds before the onset of winter.¹⁹ Usually the Arctic summer is too short for an annual species to complete its cycle. Most of the perennial plants require several years from germination to the first flowering, and many do not depend entirely on seed production for their propagation, but are protected against unfavorable seasons by various means of vegetative reproduction.²⁰ Besides providing beauty, the various plants form the basis for the annual life cycle of the North Slope. These delicate and primitive plants furnish food for the herbivores directly, who, in turn, give sustenance to the carnivores. For instance, the caribou feeds on many of the mosses and in turn is preyed upon by the Arctic wolf.

One of the most important animals associated with the study region is the barren-ground caribou or wild reindeer. During the summer, the caribou migrates from the Alaska interior or taiga up to the North Slope region. It is so well equipped physically for the severe climates of the North, that it has been stated, "a good caribou coat makes a blizzard slide off a caribou as water

¹⁹Ibid., p. 49.

²⁰Ibid.

slides off a duck's back."²¹ This hearty, valiant beast is a vital factor for the survival and economy of hundreds of native Eskimos located throughout the North Slope including the study region. Usually following close behind the migrating caribou herds are the Arctic wolves. The wolves, who are the principle predators of this region, seldom attack healthy caribou and usually attack only the old or weak stragglers. Almost as widely dispersed as the wolf is the Arctic hare, which grows a white coat in winter and brown in summer, both for environmental concealment or camouflage. The natural enemy of the hare is the Arctic fox which has a reputation of being more of a prolific breeder than the hare, though the total number seems to follow a five-year cycle.²² There are also a significant number of wolverines.

The snow owl, ptarmigan, gyrfalcon, raven and snow bunting constitute most of the permanent feathered residents of the study area.²³ However, numerous waterfowl arrive each summer to raise their young and enjoy the seclusion of the area. Numerous hatches of insects, especially mosquitoes, provide food for the waterfowl. The permafrost freezes to ground level in winter and thaws out in the summer leaving about 18-24 inches of soggy top soil. As the precipitation cannot move vertically, it therefore must either move laterally or remain at the surface. Thus numerous small pools appear which provide havens for mosquitoes and other insects.

Possibly even more important than the caribou to certain coastal Eskimo tribes is the marine life of the near-by Arctic Ocean. Seals and walrus both provide food and pelts, thus constituting a much more dependable

²¹Russell Smith and M. Ogden Phillips, North America (New York: Harcourt, Brace and Company, 1942), p. 765.

²²White, Foscue, and McKnight, op. cit., p. 480.

²³Ibid.

resource than the nomadic caribou.

POPULATION AND SETTLEMENT

For the entire North Slope, a region of approximately 100,000 square miles, there are only about 4,000 people, and the density of one person per 25 square miles is a little greater than that recorded in much of the Canadian Tundra.²⁴ Most of the people are either Eskimos or an Eskimo-white mixture who depend on hunting, trapping, fishing and trading to exist. Some have recently worked for fisheries and in government projects, however "when jobs are scarce, they suffer; they do not want to go back to their old ways of living and they are not fully prepared for the new."²⁵ In other words, if an Eskimo is somehow drawn from the environment which produced him into an environment modified by petroleum development, he may find a situation he is unable to cope with satisfactorily. His new arena calls for substantial living adjustments, coupled with a partial severing of cultural ties. Consequently, if his newly found occupation is short lived he may have great difficulties in readjusting to his former way of life.

The larger Eskimo villages along the Slope are Barrow, Point Hope, Wainwright, Umiat, and Meade River. Though not recorded as incorporated places in the 1960 census, each of these settlements has a population of less than 500 persons.²⁶ Barrow, with a population of nearly 400, ranks as the largest village because of its small military base. Since it has an airstrip

²⁴Shaw, op. cit., p. 60.

²⁵Ibid., p. 54.

²⁶Donald J. Bogue and Calvin L. Beale, Economic Areas of the United States (New York: Free Press of Glencoe, 1961), pp. 521-522.

which serves as an unloading point for airfreight shipped to Prudhoe Bay, Umiat is also significant. The other villages are only important as local trading centers. Only the small developing settlement near Prudhoe Bay and Umiat are located in the study region, and Umiat is on the far western edge.

CHAPTER II

PETROLEUM DEVELOPMENT AND ENVIRONMENTAL EFFECTS OBSERVED IN OTHER AREAS

An excellent method for predicting environmental change in a given area is to observe conditions in other areas which have similar natural environments. This method allows the observer to suggest, with reasonable certainty, what will occur in a specified area given a certain set of circumstances. This only applies if another area has already been studied in which similar circumstances were applicable. For instance, suppose a large fire had scorched an area in 1960, and, after ten years of observations, some aspects of the natural environment of that area had still not recovered. One could forecast that a similar fire, in a like area, could produce the same prolonged environmental retardation observed in the burned region. On the other hand, if there had never been a fire in an area similar to the region now being studied the long range effects of such a fire would be unknown, and prediction would be much more speculative.

This writer feels the above method will be quite useful in this study. The Slope represents the virgin area, while all analogous environments throughout the world which have experienced petroleum development could be summed up as the scorched areas. But no environment similar to the North Slope has experienced petroleum development on the scale planned for the study region. On a much smaller scale there was petroleum development in Norman Wells, Canada, in 1943 and 1944 in a similar environment.

NORMAN WELLS CANOL PROJECT²⁷

During World War II, a crude oil pipeline was constructed which connected the small Canadian Norman Wells oil field with a refinery in Whitehorse, Northwest Territory. Developed for defense reasons, the Norman Wells Canol Project was considered by many to be one of the greatest engineering feats of its kind in North America²⁸ (see Fig. 2). But this "feat" managed to move only 4,000 barrels of crude oil per day at best,²⁹ so the scope of that project has little similarity in scale to either the oil fields of the study area or the Trans-Alaska Pipeline System. Containing recoverable reserves of from five to fifty billion barrels of crude oil, the developers of the study region plan to pipe out between 500,000 to two million barrels of crude oil daily.³⁰

The Norman Wells Canol Project pipeline was not completed until February 16, 1944, and the first crude was delivered to the refinery at Whitehorse shortly before the war ended. Both the line and the refinery at Whitehorse, 360 miles from Norman Wells, were abandoned shortly afterward. Today Norman Wells produces around 1300 barrels of crude per day, most of which is transported by boat up the Mackenzie River to Hay River, Providence, Resolution, Fort Simpson, McPherson, and Good Hope. Because of its size and brief existence, the pipeline and associated activity did not produce many

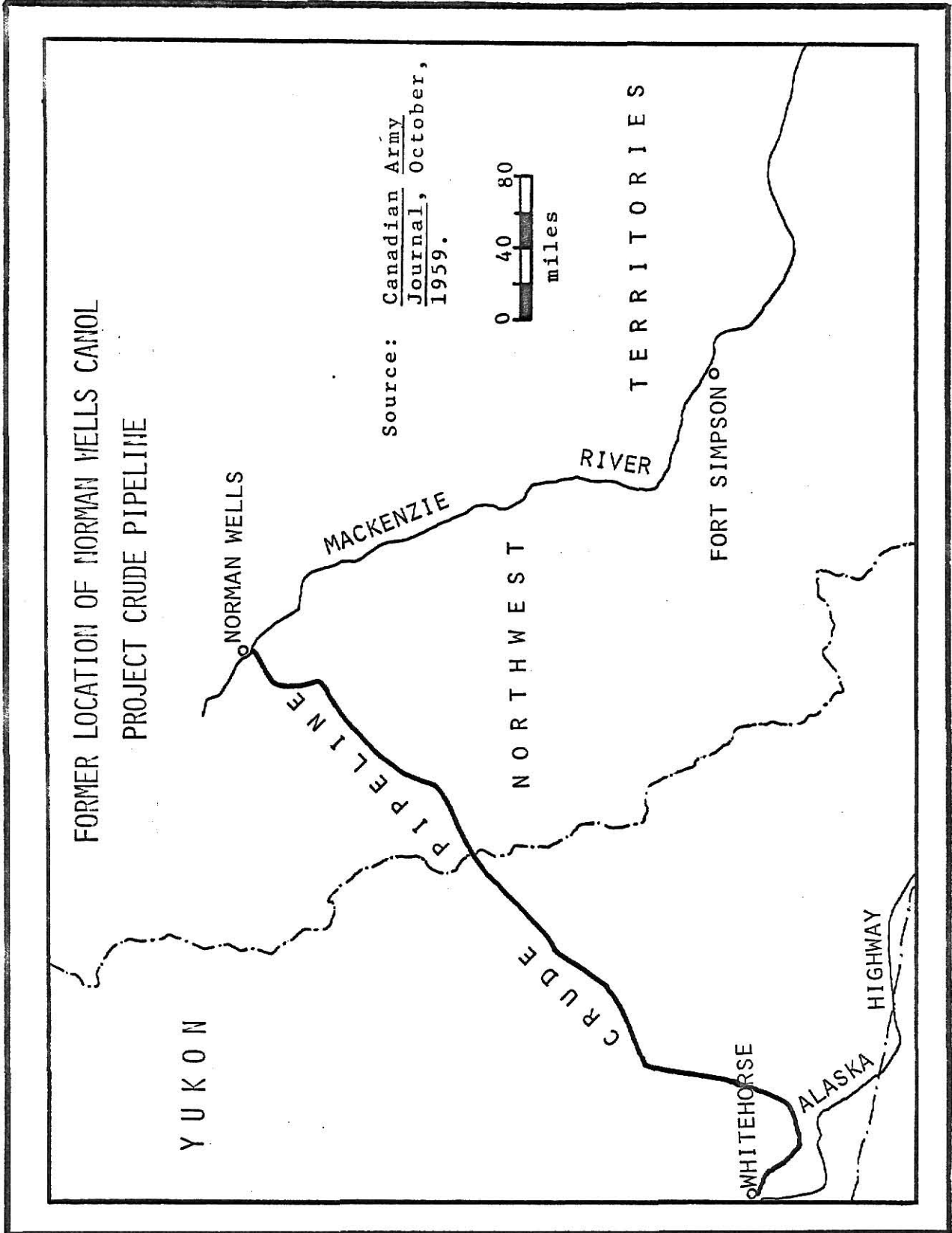
²⁷The word "Canol" is an abbreviated form for the phrase "Canadian Oil."

²⁸J. R. Liss, "The Norman Wells Canol Project," Canadian Army Journal (October, 1959), p. 126.

²⁹Ibid.

³⁰William Smith, "Oil: Yes or No? Da or Nyet?" The New York Times, November 30, 1969.

FIG. 2



environmental alterations which might be forecast for the study region.

There were some cases recorded involving the subsidence of ground due to the destruction of the vegetative cover. In one case, there was subsidence of nearly 10 feet where the vegetative cover had been removed, in comparison to 12 to 18 inches where the plant cover was unharmed.³¹

ENVIRONMENTAL EFFECTS AND PETROLEUM DEVELOPMENT IN NON-ANALOGOUS REGIONS

Since no similar areas, other than Norman Wells, have experienced petroleum development, direct comparisons cannot be made with our study region. But, if the restriction concerning a similar environment is removed, there are numerous areas where there has been extensive petroleum development resulting in environmental changes. Parts of Southern Alaska and the study region are similar since both have petroleum reserves, and the Cook Inlet, in particular, has already undergone much of the development, which the North Slope can expect. Even though environmental changes observed in Cook Inlet cannot be predicted for the Slope, one can assume that the same catalysts which produced change in the Inlet will exist within the study region. This will be true, however, only if the same development procedures are used along the Slope.

The Inlet has experienced petroleum development on a large scale since 1957. Just in the month of June, 1969, oil and gas production was

³¹Russell Hemstock, "Impact of Petroleum Activities on Arctic Ecology" (paper read at 20th Alaska Science Conference, August, 1969, College, Alaska).

valued at over 15 million dollars.³² This petroleum came from one fully developed major oil field, a partially developed oil field, two large natural gas fields, and eight unevaluated or smaller natural gas fields.³³

Various aspects of petroleum development have had an effect on the Inlet's environment. Geophysical exploration, the first step in petroleum development, immediately produced visual impact on the environment of Cook Inlet as tracks cut by exploratory vehicles were usually raw and unfinished.³⁴ Those tracts were in this condition because the exploratory vehicles did not travel on existing gravel roads, but went wherever the geologists wished to perform their geophysical and seismic tests. Therefore, the vehicles crossed existing vegetation, often leaving ruts as well as crushed plants in their paths. In addition, little or no cleanup of trash has been attempted by the exploration crews operating these vehicles.³⁵ The combination of numerous interlacing trails and occasional trash dumps detracts from the natural appearance of Cook Inlet.

After geophysical exploration ended in the Inlet, a well site was planned and heavy equipment was moved into place. Intense activity was associated with moving the heavy rigging into place, and usually the three or four acres of vegetation surrounding the well site were trampled and crushed. But in the Cook Inlet area, this well site, if abandoned, will rejuvenate itself in all aspects except tree cover in only a few years.

³²Charles Evans, "Environmental Effect of Petroleum Development in the Cook Inlet Area" (paper read at 20th Alaska Science Conference, August, 1969, College, Alaska).

³³United State Geological Survey, Mineral and Water Resources of Alaska (Washington, D.C.; U.S. Government Printing Office, 1964), p. 49.

³⁴Evans, loc. cit.

³⁵Ibid.

Blowouts have also been recorded in Cook Inlet, including one gas well which ran wild for nearly a year.³⁶ In the Kenai National Moose Range near Cook Inlet, petroleum development has proceeded only under strict surveillance by the Department of the Interior. Yet, even with this strict surveillance, a blowout occurred in the Moose Range which discharged large quantities of sand and drilling mud into nearby Beaver Creek.³⁷ Fortunately this incident occurred when the stream was ice covered, otherwise the salmon producing capacity of Beaver Creek could have been permanently destroyed.³⁸ The Kenai National Moose Range has suffered from very little adverse environmental change because of existing regulations which strictly govern petroleum activities. Those regulations, entitled "Geophysical Operation Procedures," specifically regulate all petroleum operations within the Moose Range (see Appendix B).

Oil spills have been a problem at Cook Inlet. In 1968 alone, there were 26 spills recorded at onshore and offshore drilling sites.³⁹ Onshore spills are a fire hazard and potential danger to the wildlife. One spring day in 1969, a pipeline ruptured in the Swanson River. Had the incident occurred during the darkness of night, rather than during the daytime, the Swanson could have been permanently destroyed as a productive salmon-rainbow trout area.⁴⁰ The trout would have been killed because an oil surface significantly reduces the high oxygen content necessary for these fish to survive. There were eleven other onshore pollution incidents involving pipelines with

³⁶Evans, loc. cit.

³⁷Ibid.

³⁸Michael Frome, "Hickel and the Arctic," Field and Stream, XXIV (November, 1969), p. 16.

³⁹Evans, loc. cit.

⁴⁰Ibid.

the Inlet between January 1966 and May 1969.⁴¹ Offshore, there were six reported occasions when tankers pumped their oil ballast into the Inlet, and one ruptured tanker poured 1,700 barrels of crude oil over an estimated 1,000 square miles of the same waters.⁴² Another tanker spill brought death to approximately 2,000 sea birds in November, 1967.⁴³ Tanker spillage also accounted for significant amounts of oil in the Inlet's water nineteen per cent of the time between June 1966 and April 1968.⁴⁴ If the aforementioned incidents occurred in and around Cook Inlet where only around 190,000 barrels of crude were shipped daily in June 1969, one can only speculate at what might happen along the Trans-Alaska Pipeline route and near the Valdez terminal, where, possibly by 1972, from 500,000 to 2,000,000 barrels of crude will be shipped daily?

In general, Cook Inlet has avoided significant adverse environmental alterations. The streams remain unpolluted, the animals plentiful, and the appearance of the land and vegetation in nearly all areas is unspoiled. Good fortune alone did not produce this favorable situation. Cook Inlet, and especially the Kenai Moose Range, is under strict surveillance. Petroleum development is both closely observed and regulated. Even so, some incidents have occurred, and some effects are visible. Hopefully, the effects observed in the Inlet will not occur along the North Slope, but if similar incidents did occur their effects would be vastly different.

⁴¹Ibid.

⁴²Ibid.

⁴³Ibid.

⁴⁴Ibid.

CHAPTER III

POTENTIAL EFFECTS OF PETROLEUM DEVELOPMENT IN THE STUDY REGION

This chapter of the thesis probes the problem of how petroleum development will affect the environment along the North Slope. As of April 1970, over 60 wells had been drilled along the slope.⁴⁵ Therefore signs of environmental change should be appearing in the study region if those changes are going to occur. Activity has been intense, and if this development is to significantly affect or alter any aspect of the natural environment of the study region, those changes should be increasingly more obvious. In order to fully discuss any effects petroleum company activities may have on the natural environment, a systematic outline of oil field procedures will be given. As each phase is listed, an analysis will be made of any accidents which have been recorded. The analysis shall point out how the particular incident has and may affect the environment. In general, it is observed that the further we proceed in the developmental stages the greater the likelihood for environmental alteration.

GEOLOGICAL RECONNAISSANCE

The initial exploratory survey is termed geological reconnaissance and is mostly performed from helicopters or light aircraft. Since little of the activity of this first phase has contact with the tundra surface there

⁴⁵Alaskan Department of Natural Resources, Division of Oil and Gas February Report (Anchorage: State of Alaska, 1970), p. 1.

are no appreciable environmental effects. There have been numerous occasions in which reconnaissance helicopters were used in "running down" a wolf or grizzly bear.⁴⁶ These tactics are employed whenever an animal is attracted too close to the camp trash deposits. The animal in turn could die from shock, but more commonly he will run until completely exhausted.

GEOPHYSICAL RECONNAISSANCE

Following geological reconnaissance is geophysical reconnaissance, which involves moving men and machines first along widely spaced lines and later at closer intervals to observe and record data on probable oil bearing areas.⁴⁷ Although it has proven expensive, all geophysical reconnaissance could be performed by helicopters rather than tracked vehicles. In addition, hovercraft or air cushion vehicles have been tried and may be especially useful in the summer when even the slightest contact with the surface may destroy the vegetation and bring about local subsidence.⁴⁸ More common than either helicopter or hovercraft unfortunately are trucks, tractors, sleighs, and tracked vehicles.

In relation to geophysical reconnaissance, some incidents have been recorded which lead this writer to believe that the study region's environment has already been adversely affected by this phase of development. For example, Russell Hemstock, Arctic Coordinator of Imperial Oil Company, states, "some of the geophysical [reconnaissance] work in the past has been

⁴⁶ Alaskan Conservation Society, Alaska Conservation Review, X (Winter, 1970), p. 6.

⁴⁷ Hemstock, loc. cit.

⁴⁸ "CITGO Initiates Hovercraft Use in North Slope Exploration Work," Fairbanks Alaska Daily News-Miner, July 21, 1969, p. 6.

done without due regard to the environment and has resulted in disturbance or destruction of the [tundra's] organic cover resulting in subsidence in those areas where soil ice content is high."⁴⁹ The "subsidence" and "destruction" mentioned by Hemstock refers to the fact that a single passage by tracked or heavy, wheeled vehicles over permafrost underlain tundra can kill existing vegetation. The destruction of the vegetation will be followed by the formation of deep ruts like those shown in Figure 3. As scars caused by these tracks are most likely during the spring or summer, movement of tracked vehicles and exploration should be restricted to the winter months. Even then, tracked vehicular movement and the rough trails needed for geophysical exploration mobility are recommended only within areas of extensive snow cover, which acts as an insulator to protect the delicate ecological carpet.⁵⁰ Were movement restricted to snow covered areas the vegetative cover would remain unmolested, and no unsightly ruts would occur because of subsidence. If the movement of these vehicles is not restricted to snow blanketed areas, then the imprints will grow more and more numerous along the Slope. The depth of those indentations will vary from area to area depending on soil type and ice content, but ruts have already formed with a maximum depth of 50 feet.⁵¹ Since the recuperative powers of the land in this area are minimal, it may take a century for these scars to heal themselves naturally.

EXPLORATORY DRILLING

Exploratory or wildcat drilling follows geophysical exploration. Since the odds are approximately ten to one against finding a producing well,

⁴⁹Hemstock, loc. cit.

⁵⁰Ibid.

⁵¹"Oil Under the Ice," Petroleum Gazette, March, 1970, p. 16.

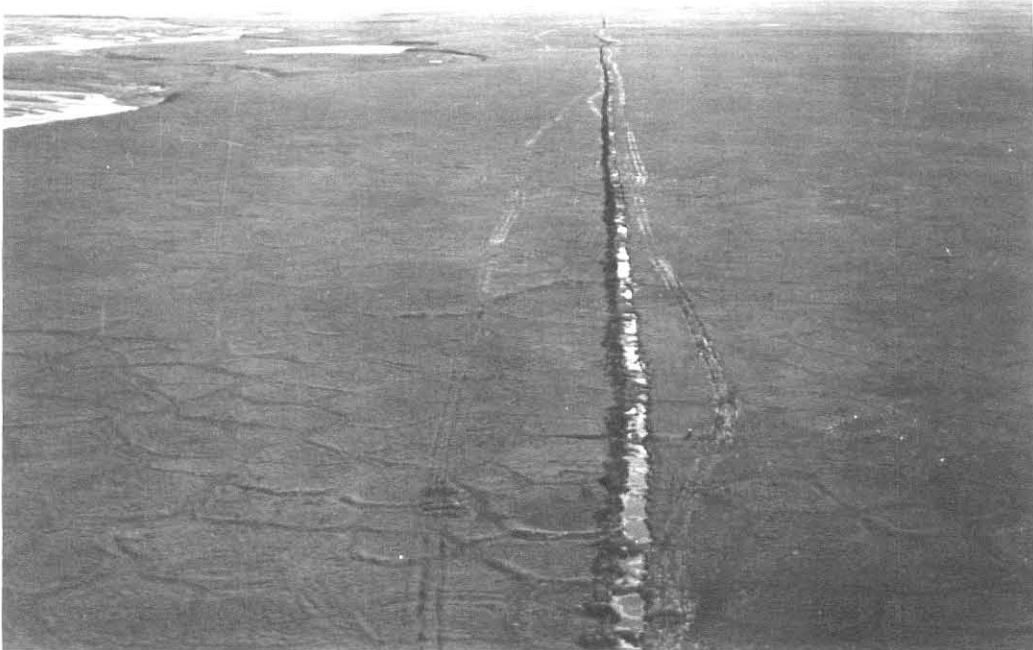


Fig. 3. Oblique photograph of tractor trail near Canning River, North Slope. Photo courtesy Department of the Interior.

the development costs of each exploratory well must be minimized by the oil companies. But in the study area, whenever you try to reduce cost you increase the possibility for environmental alteration. This principle seems to especially hold true during the development stages. In order to reduce costs, only a small amount of insulating fill is used around the drilling rig and work area to protect the tundra surface. That fill, normally river gravel, is scarce and expensive to haul, and since the majority of the exploratory wells are dug in the winter, the tundra surface is used for a road bed. If that tundra surface has a sufficient cover of ice or snow there is little surface damage. The study region, however, receives little precipitation, and most of the travel to and from exploratory sites is not across snow or ice. Some of the first winter roads were prepared by clearing off the snow and vegetative cover with a bulldozer, thereby allowing vehicles to travel across the exposed permafrost table itself.⁵² Figure 4 depicts the type of road surface which results from use of a bulldozer, and the texture of the surface cover one can expect in the summer after vegetation removal.

Following abandonment, the three to four acre site normally required for each exploratory well is usually severely eroded because of bulldozing, heavy traffic, and insufficient surface insulation. If sufficient fill were placed on the surface before significant activity began, most of the environmental damage to the site would be avoided. As it is, gullies and scars resulting from minimized cost may exist for over a century. In regard to the problems caused by vehicular movement to and from exploratory sites, various solutions seem possible. The simplest answer is to not travel across tundra vegetation with surface contact vehicles unless there is some kind of

⁵²Hemstock, loc. cit.

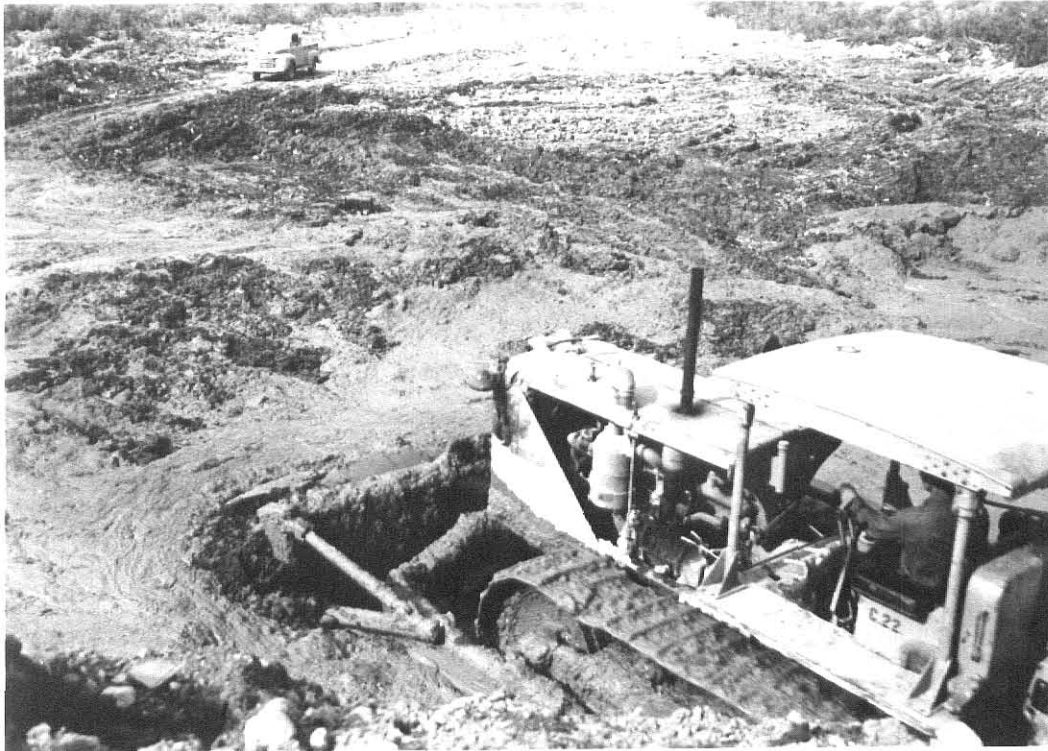


Fig. 4. Thawed sediments flowing around blade of bulldozer. Ice-rich permafrost in the lake silts exposed in a cut during the construction of the Richardson Highway two miles north of Paxson. Photo courtesy Department of the Interior.

protective covering such as ice, snow, or gravel fill. The use of helicopters and light planes should be increased, especially in the summer. More air cushioned vehicles should be introduced for year round use.⁵³ Surface vehicles, especially tracked, should be used only in the winter, and even then, unless they cross on ice, snow, or gravel road, they will damage the surface.

PERMANENT PRODUCTION INSTALLATION

If an exploratory well becomes a producer, a permanent installation is established for petroleum production. Consequently, more elaborate camp facilities are needed along with greater volumes of machinery, pipelines, and other equipment. This permanent installation demands large quantities of fill material to insure against subsidence of the drilling rig as well as to provide for semi-permanent roads, building padding, and perhaps an airstrip.⁵⁴ Without sufficient fill, road, building, and airstrip foundations will either suffer from severe erosion or discontinuous subsidence (see Figures 5-7). The cost of moving gravel fill from southern Alaska to the Slope is exorbitant, resulting in the tapping of local supplies of gravel. The North Slope has very little gravel except in the stream beds which occur along the entire Arctic coast at about ten mile intervals.

⁵³Cities Service Oil Company used two hovercraft in their 1969 summer exploration work. These vehicles could travel at speeds up to 60 miles per hour, and carry 14,000 pounds of equipment. Fully loaded, these hovercraft can operate for seven hours of uninterrupted service.

⁵⁴In order to determine what constitutes sufficient fill, various structural engineering procedures are available. The 1959 U. S. Geological Survey Bulletin number 1083-A, pages 1-36, by H. H. Lachenbruch thoroughly describes, in engineering terms, why the fill is needed and how much is necessary.

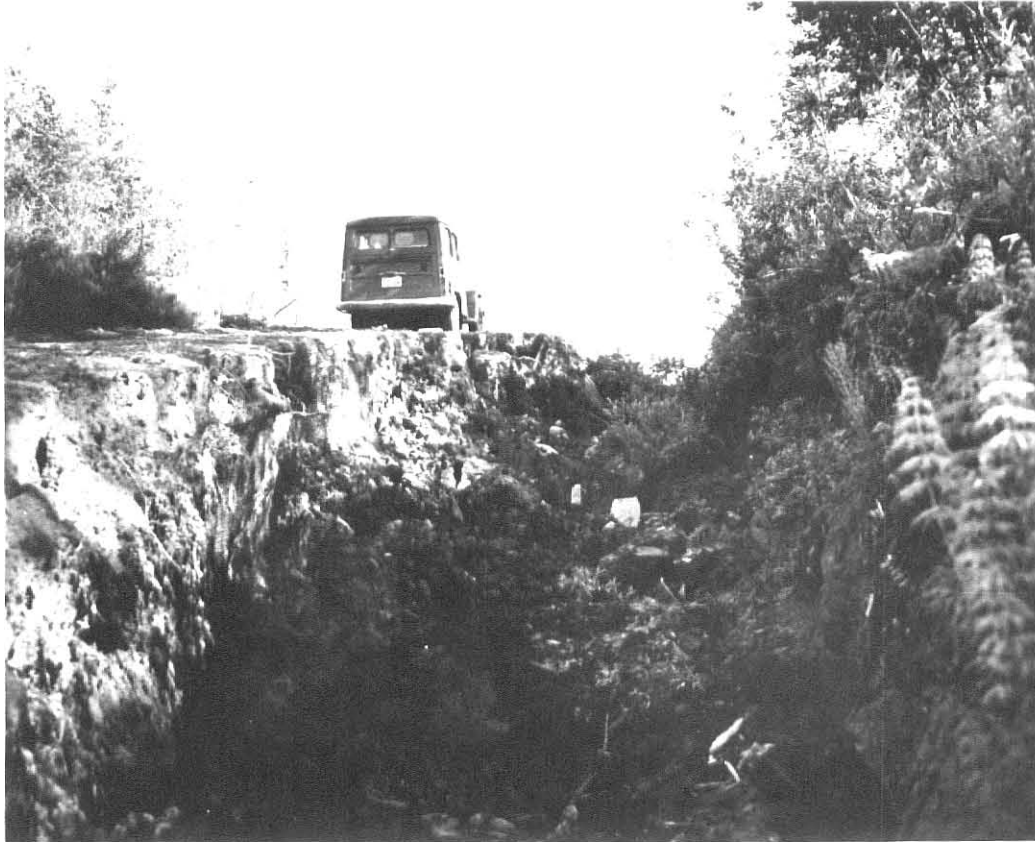


Fig. 5. Old Sheep Creek Road northwest of Fairbanks. After construction, the surface drainage thawed the permafrost in the underlying loess deposits. Photo courtesy Department of the Interior.



Fig. 6. Slump block of fine grained highway fill material at Simpson Hill, on the Richardson Highway. Centerline of road formerly lay over exposed part of sheared culvert. Note bulldozer tracks on slump block surface, which are a continuation of those at road level on right side of photograph. Photo courtesy Department of the Interior.



Fig. 7. Gravel road near Umiat showing severe differential subsidence caused by thawing of ice-wedge polygons in permafrost. Photo courtesy Department of the Interior.

Removal of gravels from the local streams within the study area could easily prove injurious to the environment. At Prudhoe Bay the gravel from the bed of the Sag River was used to provide fill for most of the nearby camps and some of the drilling sites, and the Sag River has been literally dug out of existence.⁵⁵ It was formerly a spawning ground for salmon and Arctic Char, but, without the gravel, a muddy torrent now flows where once there was a clear stream. The silt laden water will be deadly to either of the fish which have gone through their reproductive process in those waters for many past centuries. At Sagwon, a small camp south of Prudhoe Bay, more than 500,000 yards of gravel have been removed from nearby streams for fill purposes,⁵⁶ and local lakes are also used as a source for fill material in this area.⁵⁷

The effects of full scale gravel removal from lakes and streams in the study region could be very important to the wildlife, and the natives. The streams, without the gravel base, become silt laden and cannot support the fish or the vegetation they had in the past. In turn, the animals which relied on those streams in the late spring, summer, and early fall for nourishment will probably have to go elsewhere. Eskimos, who drank the water, caught and ate the fish, and stalked the wildlife will have to search for other sources. The beauty of the area and its attractiveness for sportsmen will be diminished. Of course, if all the streams along the Slope were to be "dug out" or destroyed, people who never visited the region will not know what they missed. Visitors in years to come may wonder why anyone worked to preserve these muddy streams, or the silt laden lakes, or the barren de-vegetated, de-flowered tundra.

⁵⁵Frome, op. cit., p. 21.

⁵⁶Ibid.

⁵⁷Hemstock, loc. cit.

These lakes and streams could be affected by activity other than gravel removal. Dr. Edgar Wayburn, Vice-President of the Sierra Club, reported that one oil well was drilled and spudded in the middle of a frozen river channel without the drilling crew's knowledge.⁵⁸ Seen by Dr. Wayburn in the first few months of 1969, that well, along with its oil sump, was probably destroyed by spring waters rushing down from the Brooks Range. What actually occurred when the spring brought its water over the site is unknown to this writer. If, however, a producing well was washed out in a stream the oil pollution and environmental damage along the entire lower stream course could be very severe.

TRANSPORTATION

The final major stage in petroleum production will involve the movement of the crude oil from the well site, to a local terminal, and finally to a tanker port such as Valdez, Alaska, the proposed terminus for the Trans-Alaska Pipeline.⁵⁹ Gathering pipelines will carry the crude from the various producing fields to storage tanks near Prudhoe Bay. From Prudhoe the oil will either move in ice breaking tankers to the eastern United States, or it

⁵⁸Edgar Wayburn, "Conservationists Concern About Arctic Development" (paper read at 20th Alaska Science Conference, 1969, College, Alaska), p. 5.

⁵⁹The northwest passage tanker route will not be discussed by this writer for the following reasons: (1) I do not believe it will be as economically feasible as the Trans-Alaska Pipeline, (2) In order to develop that route, conservationists within Canada would have to be convinced there is little chance for oil pollution in their northern waters, (3) The Alaskan government would rather have the Trans-Alaska Pipeline along with the money and employment it will bring, and (4) It would have little influence on the North Slope environment. It should be noted that, though estimates vary considerably, it would cost less to ship crude from the Slope to Chicago if it went via tanker through the Northwest Passage. Tanker use would be about 25¢ a barrel less than it would cost to ship using the Trans-Alaska Pipeline.

will move via the Trans-Alaska Pipeline south to Valdez. This thesis will only examine the environmental affects the pipeline may have on its proposed route.⁶⁰

The Trans-Alaska Pipeline, if constructed, would connect Prudhoe Bay and Valdez, a distance of some 800 miles.⁶¹ Though the exact route has not been planned or approved, the pipeline will have to cross the Brooks Mountain Range, the Yukon River, probably the Alaskan White Mountains and the Alaska Range, before it terminates in Valdez. Consequently, the 48" diameter pipeline will cross rough terrain and encounter severe climatic variations.

Even though this pipeline has not been built, it is the most likely choice of transportation available at this time. Pipe built in Japan has already arrived in Alaska, and one of the last major tasks which remains is the planning of the exact route. The Secretary of the Interior has given his permission for the construction of the pipeline, but the precise route has not been submitted by the Trans-Alaska Pipeline System. Until an exact route is approved, the location of the pipeline and the access roads, as well as their definite environmental effects, will be unknown.

Before the first section of the pipeline can be placed in the ground, access roads will have to be constructed. They can be constructed so that

⁶⁰ Builders of the 48" diameter pipeline expect to move two million barrels of crude a day from the Slope to Valdez. Therefore at maximum capacity, every mile of that pipeline would contain approximately 2,500 barrels of crude. By comparison, a 24" diameter pipeline over 800 miles in length would hold only around 450 barrels of crude per mile. The smaller pipeline is half the diameter of the Trans-Alaska pipeline but its carrying capacity is only 1/5 as much. Consequently, the pollution capacity of the larger line is five times as great as the smaller line.

⁶¹ The phrase, "if constructed" is inserted because some oil companies, like Continental Pipeline, feel the pipeline should run from Prudhoe Bay to Edmonton via the Mackenzie River Valley.

the road will remain usable for a long period without subsidence occurring. Subsidence will not occur if sufficient fill, which acts as an insulator between the surface and the contact point of tracked vehicles, is used. Insufficient fill leads to severe erosion and subsidence as shown in Figures 5, 6, and 7. If subsidence is to be avoided, roads which cross permafrost areas must be insulated with a protective padding. An adequate covering of gravel for the hundreds of miles of access roads may prove very expensive. In a project such as the Trans-Alaska Pipeline, which is scheduled to cost approximately one billion dollars, economizing efforts may well keep access road construction costs at a minimum. As we have already seen, when you attempt to reduce cost in areas such as the study region and the planned pipeline route, you often maximize environmental damage. Poorly constructed roads could be visually repelling for many years, although with a sufficient outlay of funds those same roads could be permanent surfaces making pipeline repair simple and opening up a great deal of the central part of the state of Alaska and the North Slope to travelers.

If the Trans-Alaska Pipeline System owners either decide, or are coerced into constructing an all weather semi-permanent road system with sufficient insulation, then a great deal of fill material will be needed. But if that fill is removed from the interior rivers, streams, and lakes, it might be better to leave the roads without an insulating cover. Removal of gravel from a stream or lake nearly always leads to adverse environmental effects such as those discussed earlier.

The possible effects of pipeline construction on the natural environment of the study region including the Trans-Alaska Pipeline route to Valdez are myriad. This would be the largest pipeline ever built, and a number of the engineering problems have not been solved. In fact, there is still

discussion going on as to how the line should be built. Basically three alternatives exist: (a) place the pipeline underground for the entire 800 miles, (b) set the entire line on pilings, or (c) use a combination of below ground line and pilings. The effects on the environment will be directly related to the type of construction which is used. Placing the entire line beneath the surface should have very little direct effect on the people or the wildlife which inhabit the course of the planned line. Neither caribou mobility nor the movements of the Eskimos should be hampered. The surface appearance, however, would be changed for a distance of 25 to 30 feet either side of the pipeline. The altered surface would be sunken, de-vegetated, and in summer, quite mushy. The removal and replacement of the vegetation and permafrost during construction would create such a surface.

The pipeline could be placed entirely on pilings between Prudhoe Bay and Valdez. Above the ground, on pilings, the pipeline would not be subject to permafrost's seasonal thaw and refreezing. But an above ground pipeline will experience a much broader range of temperatures than would an underground line. To withstand temperatures ranging from 90 degrees Fahrenheit to minus 70 degrees Fahrenheit, insulation of the highest quality is needed. Otherwise, the oil will cool and reach a molasses-like consistency. The cooler and more viscous the oil, the greater the chance for pipeline rupture. In addition, whenever pilings are used there will be danger from frost heaving (see Figures 8 and 9). Frost heaving involves the vertical refreezing of the earth's top few feet in the winter. This refreezing action pushes objects

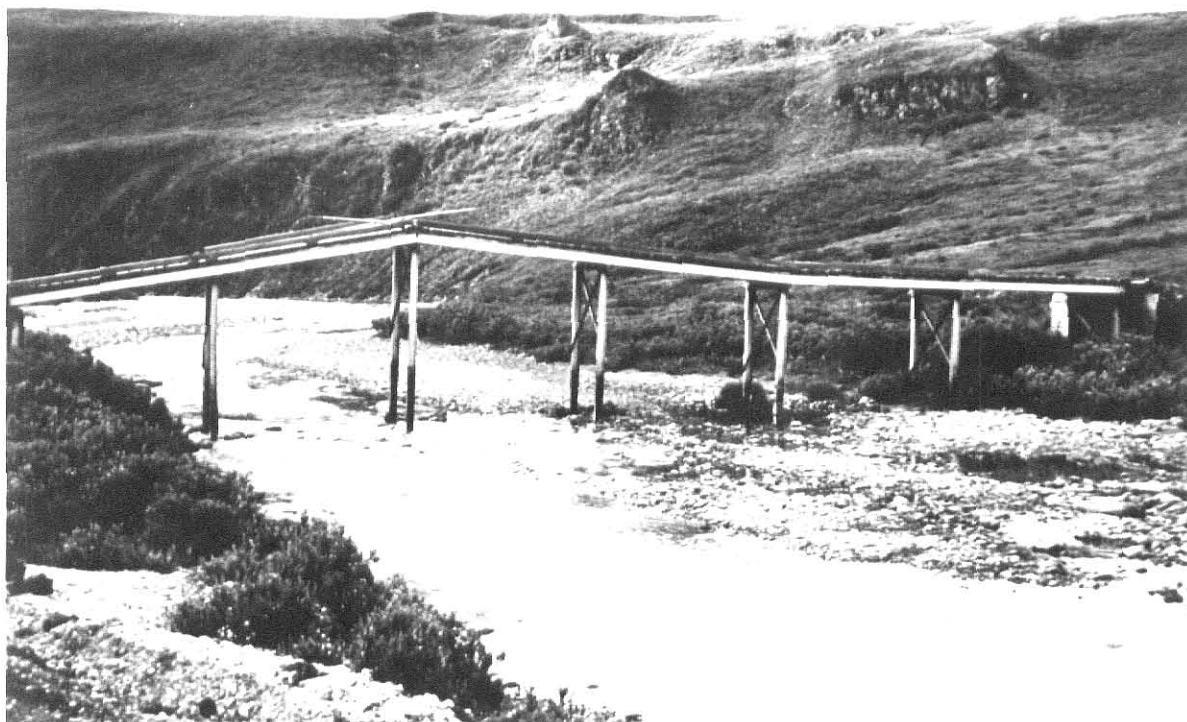


Fig. 8. Frost heaved steel-pile bridge spanning North Fork River on the Kougarok Highway, Seward Peninsula. Photo courtesy Department of the Interior.



Fig. 9. Frost heaved piling of bridge spanning outlet of Clearwater Lake, southeast of Big Delta. Piles are wooden. Photo courtesy Department of the Interior.

toward the surface.⁶² One piling, either poorly inserted or not placed deep enough, could lead to a ruptured pipeline.

A combination of pipeline above and below ground would probably cause the least disruption. Wherever the line passed over finely textured soils with high water and ice content, it could be constructed on pilings, partially avoiding erosion and subsidence resulting from ditch digging in continuous permafrost areas. In addition, the Trans-Alaska Pipeline System could gather data concerning caribou migrations and thus find out where the pipeline and the caribou are most likely to meet. At those points the line could be placed underground. Thus probable problems might be avoided before they occurred.

One final aspect which must be considered is the question of what affect a pipeline oil spill would have on the environment. Besides possible engineering difficulties, the destructive powers of unpredictable earthquakes should be considered. Tremors of various magnitudes are not uncommon, especially in Southern Alaska, and even a minor earthquake along the route could easily shear even the strongest of pipelines. The engineering problems of the pipeline are enormous, and the solutions that exist are either theories or textbook examples, which, in most cases, have never been tested. If a spill occurred from a pipeline on pilings the crude oil would kill the vegetation where there was contact. The loss of the vegetation would, in turn, remove the insulation the plant cover provided resulting in a mushy, uneven surface in the summer and a frozen muskeg in the winter. The

⁶²T. L. Pewe and R. A. Page, "Frost Heaving of Piles with an Example from the Fairbanks Area, Alaska," U. S. Geological Survey Bulletin No. 1111-I, 1963, p. 352. It should be noted that Pewe and Page have done extensive theoretical work dealing with the effects of frost heaving on pilings. However, even they admit that with each change in soil type a new test would have to be performed to determine the depth the piling should be inserted.

topographic location of the spill would, of course, dictate the exact effects. A spill or rupture from a pipeline at a river crossing could create havoc for all the fish and wildlife associated with the river or stream in the downstream stretches. Salmon, trout or other fish which came in contact with the oil would almost certainly perish. Any fowl, whose feathers became coated with the crude oil, would be unable to fly and eventually either drown or freeze. Any animals, whose instincts did not prevent them from drinking those polluted waters, could be internally poisoned. The entire ecosystem, which centered on that once clear stream or river, would be effected by a pipeline rupture at a river crossing.

POSSIBLE EFFECTS ON THE ESKIMO

Environmental alterations produced by petroleum development will have two effects on the Eskimo. Development will modify the environment resulting in changes in the life style of the natives. Once environmental modification is widespread, another adjustment will be required. That adjustment will either call for adoption of our non-traditional economic and social system, or removal to permanent reservations. Many of the younger Eskimos would reportedly favor a different social and economic system, even if adverse environmental alterations do not occur. The majority of the older Eskimos would prefer to continue in their traditional patterns.⁶³

Changes Produced by Environmental Alterations

The coastal Eskimos, who predominate along the North Slope, depend on

⁶³James Lotz, "Land Problems and People Problems--The Eskimo as Conservationist" (paper read at the Tundra Conservation Conference, October, 1969, Edmonton, Alberta).

the tundra and adjacent waters for sustenance. If the resources contained in that environment are negatively altered, the life patterns of the coastal Eskimo will be affected. A reduction in the number of animals, fish, fresh water, and unspoiled areas will occur as petroleum development proceeds.

Since much of the petroleum development is planned for the areas along the coast of the Slope, animals such as walrus, seals, and polar bears will become less abundant. These animals, like the grizzly bear in areas further south, do not easily accept the noises, smells, and actions of man. Therefore they leave rather than adapting. Once they depart, the natives may find it difficult to live from their trapping abilities. Some Eskimos, who act as guides during the hunting season, would be partially deprived of employment. In most cases, the Eskimo would have to relocate if he wished to continue in his traditional patterns.

Animals found further inland would also become fewer in number. The caribou, wolf, fox and arctic hare provide both food and furs. Yet these animals would probably diminish in number as they have in other tundra areas where various types of development have occurred.⁶⁴ Polluted streams and lakes, created by petroleum development, may reduce the fresh water fish populations, as well as the quality of the drinking water supply. Without the caribou, whose migrational patterns may be vastly altered due to above ground pipeline construction, and the other animals mentioned, the Eskimo's ability to live off the land would be hindered. Relocation could provide a temporary solution for those natives wanting to continue life in the form they

⁶⁴Charles Grubben, "Paper Concerning the Rights of Indigenous Peoples in the Canadian Arctic" (paper read at the Tundra Conservation Conference, October, 1969, Edmonton, Alberta).

have practiced for centuries.

As long as the Eskimos have the alternative to relocate in a similar environment, there need be no significant changes in their life patterns. Changes will occur only when he can no longer move, or be moved to, areas which have an analogous natural environment. Some will choose to remain in regions near petroleum development. Those natives, and they may represent a large per cent of the total, will be accepting change voluntarily. Most of those who initially volunteer to accept the training and education required for transition will come from the younger Eskimos.

Change Resulting from the Elimination of Traditional Habitat

Once extensive development along the North Slope has occurred, the Eskimo will be unable to find an environment similar to what he had known. At that period in time, he will either adopt a non-traditional social and economic system, or he may be allowed to form some type of Eskimo reservation. For those that choose to adopt a new system, various alternatives should exist. He should be permitted, and possibly given aid and assistance, if he chooses to leave the Slope entirely to find work in Fairbanks, Anchorage, or any other area. For those that prefer more gradual change, some form of transition should be provided. They could be trained in certain skills, taught the English language, and provided with food, shelter, and clothing during the process.⁶⁵ The crucial point is that the Eskimo should be given

⁶⁵The problem which may arise is that the Eskimo may not view this aid in transition as anything more than welfare. Some anthropologists, including Jim Lotz from the Canadian Research Center at Saint Paul University, feels, "there is evidence that the Eskimo sees the white newcomers who shower benefits on them merely as another resource in the ecology--a new cow to be milked, a presence to be courted or avoided." Lotz, loc. cit.

as much assistance as is needed to make the transition. In addition, all those natives who choose to continue traditional patterns of life should be given an opportunity to do so.

Reports concerning the Eskimos in Tuktoyaktuk, Northwest Territory, illustrate the problem. In Tuktoyaktuk, development of part of the Dew Line in 1955 adversely changed the environment. Seismic blasting and road construction caused many of the animals to leave and for the Eskimos trapping became progressively less productive. The Eskimos also blame seismic blasting in their harbor for the disappearance of fish and whales. Creeks were dammed and their streams began to silt up, thereby affecting the quality of the drinking water. The Eskimos at Tuktoyaktuk saw their once productive environment quickly reduced to a non-productive, semi-sterile region. These natives, however, decided to remain in their homes and attempt to survive. For the widowed, blind, and sick there were requests for food. As for the healthy, they requested to keep their own small plots of land, to receive some type of education and training, and that industries like fur shops and fish canneries be located in their region to provide employment. Tuktoyaktuk offers proof that a changed environment reduces the ability of the Eskimo to survive. When that survival is threatened, the Eskimo wants and deserves another opportunity to live. Whether that life is within another similar environment, or within the white man's social and economic systems is insignificant. What is significant is that he be allowed to choose the alternative he prefers.

MAKING A DECISION

Whenever mankind decides to utilize an area such as the North Slope, he must attempt to insure that that utilization produces the greatest possible good for humanity. All alternative uses should be weighed carefully before approval for any type of development is given. In relation to the study region, the variables we must consider before making a decision include:

(1) it is one of the last unpolluted, unspoiled areas available within the borders of the United States, (2) the vegetation and wildlife population contained are unlike any other found in the United States, except for the remainder of the Slope, (3) it probably possesses the greatest oil reserves in existence in America today, and (4) this region provides a home for the Eskimo.

Once one perceives this area not as a bleak, cold, barren wilderness, but as a vibrant, beautiful, living ecosystem as yet unspoiled by mankind, a rational decision can better be reached. That utilization decision, though influenced by public demands, will be made by our federal and the Alaskan state governments. They may allow development to proceed unharnessed and unregulated or, they could terminate petroleum development completely, without exception. Or, as advocated by this writer, they can allow oil development to proceed under a strict set of regulations and comprehensive surveillance. The final governmental decision will have far reaching effects. If it is decided to terminate permanently all petroleum activities along the Slope, there could be economic repercussions for the state of Alaska and the United States. Expected capital from development would not be forthcoming, jobs would not be created, and most significantly, Alaska's plans for new roads, hospitals, and schools would be frustrated. Conversely, unregulated

development would probably bring the capital, jobs, schools, highways, and hospitals, but at the cost of the North Slope's natural environment and the Eskimo's way of life. The final choice can allow for development and environmental conservation. With the advent of needed regulations and adequate surveillance, Alaska can have her capital, jobs, and roads, while preserving her natural environmental heritage.

This country, especially the Alaskan state and federal governments, must make a decision. Should the oil companies be permitted to do what they wish within the North Slope, or should this area be saved for the present use of all its inhabitants, thus maintaining the existing environment, or can a compromise be reached between conservationists and the oil industry, which will allow for development and conservation with minimal adverse change? It is my feeling a workable compromise can and must be found. With that objective in mind, the next chapter will discuss what is needed with regard to regulations and how that compromise can be achieved.

CHAPTER IV

LEGISLATION AND THE STUDY AREA

Since our knowledge concerning the effects of present and future petroleum development in the study region is somewhat speculative, it is difficult to ascertain what regulations or legislation are needed to cope with future situations. As our knowledge of the soil, water, and air, which exists at the surface in the North Slope expands, so will our understanding of the effects of our activities on that part of the environment. Today we know very little about how our actions will, over a long period, affect an area like the study region. Consequently, it would be to the advantage of this region's environment, if petroleum activities proceeded with caution. Perhaps a general guideline for man's use of the North Slope, as well as all the natural world, based on existing knowledge could be as follows: The disturbance of any natural environment should not exceed the minimum needed to accomplish human goals.⁶⁶

If minimum disturbance is to be our goal in regions easily disrupted by man's influence, then there must be uniform actions by all groups concerned. As pointed out earlier, minimum expenditures in the study region will probably lead to maximum damage. Thus, unless all oil companies involved in petroleum production are required by law to follow similar developmental procedures, competition will necessitate minimum expenditures resulting in maximum environmental damage. For instance, if City Service Oil Company uses hovercraft

⁶⁶Raymond Dasman, An Environment Fit for People (New York: Public Affairs Committee of the Conservation Foundation, 1968), p. 5.

for geophysical exploration both summer and winter, then the other operating companies should not be allowed to use tracked vehicles for their geophysical exploration. This would force the other companies to either use hovercraft or terminate an important aspect of their exploratory work. Efficient regulation, coupled with comprehensive surveillance, could maintain a relatively unspoiled environment for future scientific study, the use of the present inhabitants, and for eventual recreation purposes. The profit margins of the oil companies may be reduced initially, but additional investment now could create a better public image as well as preserving a unique natural environment.

This writer espouses the idea that there can be both development and conservation of the existing natural environment. Oil production will lead to a more viable economic base in Alaska and permit her to become a highly valued and productive member of the United States. And with adequate regulations the environment of the Slope could remain in tact for future scientific study, and as a home for the Eskimo. Development and conservation are not mutually exclusive. It is the task of the federal government and Alaskan state government, as well as the oil companies involved, to insure that existing regulations will be properly enforced and obeyed. Furthermore, needed regulation should be provided by the legislatures whenever a need arises. A discussion of existing and suggested regulation follows.

EXISTING REGULATIONS

In a discussion of existing legislation designed to regulate petroleum development in the study area it is clear that the "development

ethic"⁶⁷ is favored, and that environmental conservation is considered as an afterthought.

Development Ethic

Dr. A. R. Thompson defines the development ethic as follows:

Any enterprise that an individual or corporation initiates or prosecutes for profit is presumed to be in the best interest of society. Society may impose restrictions on the conduct of the enterprise, and may even prohibit it, but the onus is on those who advocate restrictions to justify them, and the restrictions won't be justifiable if they would render the enterprise unprofitable unless serious matters of public health and welfare are at stake.⁶⁸

In other words, businessmen should regard conservation legislation with fear only if their profit is entirely removed from an undertaking. This writer agrees with the idea that there must be profit, but most businessmen actually fear regulation because they wish to make the greatest gain possible. They are not happy when profit is reduced. It is this philosophy of maximum profit which has produced most of our existing legislation. Therefore, the public must accept the existing regulations or create new legislation with a different orientation. For instance, if more harm than good seemed possible for the study region because of shortsighted or restricted petroleum policies, then we should prohibit petroleum activities until that oil can either be removed without detrimental environmental effects, or it is a necessity for the United States' economic well-being. Laws which empower us to prohibit or restrict petroleum activities regarded as harmful, even though profitable, could reverse the present situation. If this reversal occurred burden of

⁶⁷ A. R. Thompson, "A Conservation Regime for the North--What Have the Lawyers to Offer?" (paper read at Tundra Conservation Conference, October, 1969, Edmonton, Alberta), p. 2.

⁶⁸ Ibid.

proof would switch to the developer. Then any enterprise which wished to remain in operation would either have to find ways of avoiding harmful effects, possibly reducing their profit, or they could and should cease to exist. This writer feels most oil companies would limit profits, before they would terminate operations. This would mean increased cost to the consumer, but eventually the public is going to have to begin paying for a cleaner, healthier, more wholesome environment.

The second aspect of existing applicable legislation is centered on the notion that ideas of environmental protection have been written into legislation only as secondary considerations, not as the primary motive for a bill. Only in recent years have politicians, lawyers, and economists begun to introduce broad environmental considerations into proposed legislation and academic papers. Following is an excerpt from a cost-benefit study done by two economists which reveals how the environment may be included in such studies.

Great progress has been made in the last few years in developing a conceptual framework in which to measure the economic value of recreation, scenery, open space, clean air, and the like; and there have been heroic attempts to assign actual dollar values to certain of these goods within limited assumptions. It is unlikely, however, that such methodologies, let alone the shadow prices they develop, will achieve general consensus in the immediate future. Except for the most narrowly commercial aspects of these goods (tourism, the cost of water treatment, etc.), formal cost benefit analysis is unlikely to play a central part in the decision making process for resolving these conflicts.⁶⁹

Some economists, lawyers, and businessmen are beginning to subscribe to a philosophy other than the development ethic, but these people are still few in

⁶⁹R. Tussing and J. Erickson, Mining and Public Policy in Alaska (College: Institute of Social, Economic and Government Research, University of Alaska, 1968), p. 15.

number. Their efforts and those of other interested citizens will have to create legislation to supplement or replace the laws in existence today. The work yet to be accomplished is enormous, since the existing legislation applicable to environmental conservation, in relation to the North Slope on both the federal and state levels, is limited.

In our federal system there are a number of divisions of power between federal and state governments, and within Alaska, the administrative jurisdiction over petroleum holdings is extremely fractured. Briefly, the situation which exists in Alaska today in regard to land use jurisdiction is as follows. In 1959, when Alaska became a state, 99.8 per cent of its 365 million acres were owned by the federal government. Alaska, however, upon entering the union was given a patrimony of 100 million acres to be selected over a twenty-five year period. Consequently, Alaska has the opportunity to select that 100 million acres from her highest valued acreage. Though the huge Naval Petroleum Reserve No. 4 will remain out of reach, Alaska has already brought the oil productive lands of the Kenai Peninsula into state ownership. But surveying the land is slow, and in June, 1967, federal public lands still comprised 95 per cent of Alaska's total land area. The obvious conclusion is, that for the long term, as well as for the present, development of petroleum lands in Alaska will require close cooperation between state and federal administration.

Existing Federal Regulations

As of March 1, 1970, there were only two sections of existing federal legislation, found by this writer, which provide some protection for the environment. Section 3107 of Title 43 of the Code of Federal Regulations

authorizes exploration for oil and gas on federal lands.⁷⁰ This section provides for the posting of a \$5,000 bond for each oil or gas development project. That bond will be forfeited unless there is, "full and faithful compliance with all of the terms and conditions of the regulations in this subpart."⁷¹ Also contained within here is a brief reference to "additional measures" taken to "rehabilitate the land."⁷² Those few words, though conservation oriented, do not carry much weight because they are not specific. Part 211 of Title 30 of the Code of Federal Regulations prescribes oil and gas operating procedures. Regulation ss.221.32 provides a single remark, identifiable as a conservation measure, designed to protect the environment. Regulation ss.221.32 states:

Pollution and surface damage. The lessee (of federal lands) shall not pollute streams or damage the surface or pollute the underground water of the leased or other land. If useless liquid products of wells cannot be treated or destroyed or if a volume of such products is too great for disposal by usual methods without damage, the supervisor must be consulted, and the useless liquids disposed of by some method approved by him.⁷³

Existing State Regulations

The state of Alaska has regulatory power over all state lands, and it shares regulatory power with the federal government over all federal lands. Existing state regulations are mainly oriented toward development, rather than a compromise between conservation and development. Nearly any mention of conservation in Alaskan legislation refers only to preserving the oil and not the natural environment which contains the oil. Existing Alaskan oil and gas regulations provide for the following:

⁷⁰Thompson, op. cit., p. 8.

⁷¹Ibid.

⁷²Ibid., p. 6.

⁷³Ibid.

- 2062. Fire hazard. Any rubbish or debris that might constitute a fire hazard shall be removed to a distance of at least 100 feet from the well, all tanks and separators. All waste oil shall be burned or disposed of in a manner to avert creating a fire hazard.
- 2108. Location clean-up. The operator shall clean up the location and level the pits within one year of the plugging, unless an extension of time is granted by the Committee. All loose debris shall be buried or burned and the location left in a clean and generally level condition. These requirements shall be limited to onshore operations.
- 2155. Earthen reservoirs. Oil or oil field waste shall not be stored or retained in earthen pits or open receptacles except on permission of the Committee.
- 2161. Disposal of brine and other wastes. Salt water shall be disposed of, with the permission of the Committee, in any manner which will not contaminate fresh water sources or endanger other natural resources.⁷⁴

There are two cases in Alaskan law where the regulatory scheme was designed especially to preserve the natural environment in wildlife reserves. In the first case, the discovery of oil in the Kenai Peninsula in southern Alaska threatened the forests, as uncontrolled running of seismic lines could have resulted in damage. Therefore the Federal Bureau of Sport Fisheries and Wildlife set up their "Geophysical Operating Procedures" to protect the Kenai National Moose Range. The following sample provisions indicate the exacting requirements of those procedures.

- Geophysical operations using tracked or large-wheeled vehicles may be conducted from December 1 through March 31 provided snow and ice cover are sufficient to protect wildlife resources.
- Scarring of ground and removal of other vegetative cover is prohibited.
- Moss and grass removal is not permitted in open muskeg.
- Streams may be crossed only at approved sites.⁷⁵

⁷⁴ A. R. Thompson, "A Conservation Regime for the North--What Have the Lawyers to Offer?" (paper read at Tundra Conservation Conference, October, 1969, Edmonton, Alberta), pp. 9-10.

⁷⁵ The Geophysical Operation Procedures are available in Appendix B.

The other case applies in a more general sense to all Alaskan Wildlife Refuges, establishing stipulations which must be followed by a lessee if his oil and gas leasing rights are subject to the Mineral Leasing Act, 1920.⁷⁶

A perusal of Appendix C will increase the readers' knowledge of the types of regulations which have been established. Regulations, like these, are needed for the study region even though it is not a wildlife refuge. The stipulations, presented in Appendix C, provide a comprehensive scheme to deal with erosion, pollution, fire precautions, mobile equipment, drilling operations, and surface restoration. Failure to comply with these stipulations is grounds for lease cancellation.

In addition to the state and federal regulations outlined above, there has been one recent attempt by the federal government to regulate the construction of the Trans-Alaska Pipeline. A Department of the Interior group called, "The Federal Task Force on Alaskan Oil Development" led by Russell Train, an undersecretary to Walter Hickel, prepared what are entitled, Trans-Alaska Pipeline System Stipulations. The Stipulations were established, "to draw up guidelines that will provide exacting environmental protection during the construction and operation of the Trans-Alaska Pipeline."⁷⁷ They provide

⁷⁶The statute compromised the claims of conservationists, who would have closed the public domain to all forms of private exploration and the claims of westerners who saw in rapid development of mineral resources the chief means of stimulating and sustaining the economics of the western states. The compromise opened the minerals to the developer, but it ended the free patent system and substituted a leasing system which would continue with the government as owner of the minerals with partial control over the lease operations and a continuing financial interest in the form of rentals and royalties.

⁷⁷United States Department of the Interior, Trans-Alaska Pipeline System Stipulations (Department of the Interior, Washington, D. C., 1969), p. 1.

a comprehensive plan which could protect a natural environment, while allowing for development. No apparent aspect of possible environmental degradation is left to chance as far as these guidelines are concerned. The Stipulations require the consent of an "authorized officer" before any developmental action takes place. An "authorized officer" may be the Alaska State Director, a member of the Bureau of Land Management, or some person designated by the federal or state government to work with a particular project. That authorized officer must give his consent to the "permittee," meaning any individual, company, partnership, corporation, joint venture, association or any other business firm engaged in the construction, operation or maintenance of the pipeline, before legal activities can be performed in the field. But in nearly all cases, the permittee provides the authorized officer with two or three plans for proposed work. The authorized officer will then hopefully choose the alternative which will do the least damage to the environment now and in the future. The problem is that the permittee, who is most likely trying to build at the least expense to himself, outlines all phases of the operation, and the authorized officer may very well be choosing only the least damaging alternative. Both parties, however, will have fulfilled their obligation under the existing Stipulations. This problem could be remedied if the governmental agencies, who are hopefully interested in environmental protection, prepared the various plans. The companies could then choose from two or three alternatives, each of which should produce acceptable environmental alteration. Larger federal and state appropriations for additional manpower would be required if the government was going to do the research, but the result should be more desirable than what we can expect from private oil company plans.

NEEDED REGULATIONS

As we have seen, the existing regulations which apply to the North Slope and the pipeline route are not extensive. Two small sections in the Code of Federal Regulations, four sections in the Alaska State Oil and Gas Regulations, two special procedures applying directly to wildlife refuges, and the Trans-Alaska Pipeline Stipulations, comprise the existing controls which can be used to protect the natural environment of the study region. But they are inadequate. The small section in the Code of Federal Regulations is too general, the two cases applying to wildlife refuges in Alaska are not applicable to the North Slope, the Trans-Alaska Pipeline System Stipulations have numerous loopholes, and the sections in the Alaskan Oil and Gas Regulations discussed apply entirely to the conservation of the oil and not the environment. More state laws like those applying to wildlife refuges are needed to protect areas such as the North Slope. Specific legislation on both the federal and state level which provides regulation directly applicable to environmental protection should be created and soon.

In the very near future, both the Alaskan and federal governments should establish regulations forbidding development to proceed until all possible environmental repercussions have been analyzed. Policy must take into account the Eskimo, the wildlife, the natural beauty, and the potential of the study region. If these regulations do not appear soon, an entire area's way of life could be irreversibly altered. Those possible alterations do not have to occur, but preventative legislation was needed yesterday, and tomorrow could be too late.

CHAPTER V

SUMMARY

This thesis was prepared to determine how the present and planned petroleum activities, for the North Slope of Alaska, will affect the natural environment. After considering the data presented with respect to environmental effects on analogous area, environmental changes observed along the North Slope, and existing environmental regulations, this writer feels that unless major steps are taken in regard to existing legislation, there will be serious environmental changes along the slope due to petroleum development. Large expanses of tundra vegetation will be denuded; some species of animals especially wolves, bears, and caribou may rapidly decrease in numbers because of their inability to cope with the sudden increase in foreign elements; the aesthetic beauty of the region will be severely reduced; and the life of the natives will be negatively altered.

Geographers are concerned with various activities on the surface of the earth, and the primary result of all man's activities has been to constantly change the very environment which provides him so abundantly. When it lies within man's power to keep from furthering those negative environmental alterations, that power should be exercised. The adverse effects, which man may have on the study region because of petroleum development, can be prevented before they have an opportunity to occur if we create the legislation needed which would reflect new values.

Regulations, which could prevent on a large scale what has already begun on a smaller scale, can be prepared. The legislation providing those

regulations can only be created through due process, but this does not mean that we should proceed with petroleum development in the study region until those regulations are drawn up. The Department of the Interior could be instrumental in delaying all petroleum activities until the possible repercussions of those activities have been studied by environmental scientists. Then preventative measures could be written into law at both the state and federal levels. In April of 1970, the secretary of the Department of the Interior told the student body of Kansas State University that he would like to see all the lands of the United States cataloged depending on how they could best be utilized. The Secretary of the Interior pointed out that Santa Barbara, California, would not have been used for petroleum development. He has an opportunity to catalog, at least unofficially, the entire Alaskan North Slope as an area which might serve a better purpose if left unspoiled. That choice may not be realistic due to the great monetary value of the oil reserves present. He could, however, delay further industrial activity until specific environmental legislation is passed which will provide for development as well as preservation.

The Secretary of the Interior cannot delay those activities forever, and unless the needed legislation is quickly forthcoming the oil industry will undoubtedly be permitted to continue without needed restrictions. In order to obtain needed legislation the public of the United States must let the federal government know what it wants. Recently, citizens interested in a better environment for the United States have initiated a popular and growing movement. They want a cleaner, more wholesome environment for future generations. If change is what we really want, we should continue to question industrial pollution and advocate environmental protection. The North Slope

of Alaska represents an arena where the people can make their voice heard.

If the proper steps are taken in congress, both the people and industry can be satisfied. If these steps are not taken quickly, then industry will have won another round, and another parcel of the United States and the world will have its environment adversely changed to meet the needs of economic growth.

SELECTED REFERENCES

A. BOOKS

- Bradley, John H. World Geography. New York: Ginn and Company, 1945.
- Carter, George F. Man and the Land. New York: Holt, Rinehart and Winston, 1968.
- Darling, F. Fraser and John P. Milton (eds.). Future Environments of North America. Garden City: Natural History Press, 1966.
- Devos, Anthony, Norman Pearson, P. L. Silveston, and W. R. Dryman (eds.). Pollution Reader. Montreal: Harvest House, 1968.
- Eyre, S. R. and G. R. J. Jones (eds.). Geography as Human Ecology. London: Edward Arnold Ltd., 1966.
- Herfindahl, Orris C. and Allen V. Kneese. Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water, and Air. Baltimore: Johns Hopkins Press, 1965.
- Hoyt, Joseph B. Man and the Earth. Englewood Cliffs: Prentice Hall, 1967.
- Marsh, George P. Man and Nature, ed. David Lowenthal. Cambridge: Harvard University Press, 1965.
- Marsh, George P. Man and Nature; or Physical Geography as Modified by Human Action. New York: Scribner, Armstrong, and Company, 1864.
- Shaw, Earl B. Anglo-America. New York: John Wiley and Sons, 1959.
- Smith, Guy-Harold. Conservation of Natural Resources. New York: John Wiley & Sons, Inc., 1965.
- Smith, J. Russell and M. Ogden Phillips. North America. New York: Harcourt, Brace, and Company, 1942.
- Stamp, Sir Dudley (ed.). A Glossary of Geographical Terms. London: Longmans, Green and Company, 1966.
- Strahler, Arthur N. Introduction to Physical Geography. New York: John Wiley & Sons, Inc., 1965.
- Thomas, William L. (ed.). Man's Role in Changing the Face of the Earth. Chicago: University of Chicago Press, 1956.

Trewartha, Gleen T., Arthur H. Robinson, and Edwin H. Hammond. Physical Elements of Geography. New York: McGraw-Hill Book Company, 1967.

Wagner, Philip. The Human Use of the Earth. New York: Free Press of Glencoe, 1960.

White, C. Langdon, Edwin J. Foscue, and Tom L. McKnight. Regional Geography of Anglo-America. Englewood Cliffs: Prentice-Hall, 1964.

Zimmermann, Erich W. World Resources and Industries. New York: Harper and Row, 1951.

B. PUBLICATIONS OF GOVERNMENT, LEARNED SOCIETIES AND OTHER ORGANIZATIONS

Brown, R. J. E. Proceedings of the Third Canadian Conference on Permafrost 14 and 15 January 1969. Associate Committee on Geotechnical Research. [Ottawa: National Research Council of Canada, 1969].

Dassmann, Raymond. An Environment Fit for People. Conservation Foundation. [New York: Public Affairs Committee of the Conservation Foundation, 1968].

Department of Natural Resources. Division of Oil and Gas Report. State of Alaska. [Anchorage, Alaska: State of Alaska Department of Natural Resources, March, 1970].

Federal Water Pollution Control Administration. Federal Water Pollution Control Act - Oil Pollution Act. U. S. Department of the Interior. [Washington, D. C.: Government Printing Office, 1967].

Ferrians, Oscar, Jr., Reuben Kachadoorian, and Gordon Green. Permafrost and Related Engineering Problems in Alaska. U. S. Geological Survey Professional Paper No. 678. [Washington, D. C.: U. S. Geological Survey, 1969].

Tussing, Arlon R. and Gregg K. Erickson. Mining and Public Policy in Alaska. Institute of Social, Economic and Government Research Report No. 21. [College, Alaska: U. S. Department of Commerce, 1969].

U. S. Department of the Interior. Trans-Alaska Pipeline System Stipulations. [Washington, D. C.: Department of the Interior, 1969].

U. S. Geological Survey. Mineral and Water Resources of Alaska. [Washington, D. C.: U. S. Government Printing Office, 1964].

C. PERIODICALS

- Alaska Conservation Society. Alaska Conservation Review, X (Winter, 1970).
- Burton, Ian. "The Quality of the Environment: A Review," Geographical Review (July, 1968) 472-481.
- Dickens, H. G. "Construction in Permafrost - Obstacles of Soil and Climate," Canadian Consulting Engineer (January, 1960) 33-37.
- Doerr, Arthur, and Lee Guernsey. "Man as a Geomorphological Agent: The Example of Coal Mining," Annals of the Association of American Geographers (March, 1956) 197-210.
- Frome, Michael. "Hickel and the Arctic," Field and Stream, XXIV (November, 1969) 15-19.
- Ketchum, E. "Air and Water Pollution in the Iron and Steel Industry," Journal of Geography (December, 1967) 481-495.
- Liss, J. R. "The Norman-Wells Canol Project," Canadian Army Journal (October, 1959) 122-126.
- Nelson, J. C. and A. R. Byrne. "Man as an Instrument of Landscape Change: Fires, Floods, and National Parks in the Bow Valley, Alberta," Geographical Review (April, 1966) 226-238.
- "Oil Under the Ice," Petroleum Gazette (March, 1970) 15-21.
- "The Old and the New Aklavik," The Canadian Architect (November, 1956) 23-28.
- Thompson, A. R. "Sovereignty and Natural Resources - A Study of Canadian Petroleum Legislation," Valparaiso University Law Review (Spring, 1967) 284-319.

D. UNPUBLISHED MATERIALS

- Brown, Jerry, Warren Rickard, and Donald Vieter. The Effect of Disturbance on Permafrost Terrain, U. S. Army Corps of Engineers. Hanover, New Hampshire: Cold Regions Research and Engineering Laboratory, 1969.
- Caldwell, Lynton K. "Man and the Environment." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.

- Erickson, Gregg. "Alaska's Petroleum Resource Policy: A Crisis of Direction." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Evans, Charles. "Environmental Effects of Petroleum Development in the Cook Inlet Area." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Frances, Karl E. "Environmental Adaptation and Alaskan Development." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Galloway, J. H. "Petroleum Industry Policies for Protecting the Environment." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Hakkita, Jack O. "The Place of Petroleum in Alaskan Resource Development." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Hemstock, Russell. "Impact of Petroleum Activities on Arctic Ecology." Paper read at the 20th Alaska Science Conference, August, 1969, College, Alaska.
- Lotz, James. "Land Problems and People Problems - The Eskimo as Conservationist." Paper read at the Tundra Conservation Conference, October, 1969, Edmonton, Alberta.
- Thompson, A. R. "A Conservation Regime for the North - What Have the Lawyers to Offer." Paper read at the Tundra Conservation Conference, October, 1969, Edmonton, Alberta.
- Wayburn, Edgar. "Conservationists Concern About Arctic Development." Paper read at the 20th Alaska Science Conference, August, 1969, College Alaska.
- Weeden, Robert B. "Arctic Oil: Its Impact on Wilderness and Wildlife." Paper read at Eleventh Biennial Wilderness Conference, March, 1969, San Francisco, California.
- Weeden, Robert B. "Man in Nature: A Strategy for Alaskan Living." Paper read at the Tundra Conservation Conference, October, 1969, Edmonton, Alberta.

E. NEWSPAPERS

Anchorage Daily News, January 27, 1970.

Fairbanks Daily News Miner, July 21, 1969.

Smith, William. "Oil: Yes or No? Da or Nyet?" The New York Times,
November 30, 1969, p. 1.

APPENDIX "A"

NOTICE TO THE MINERAL INDUSTRY

The Division of Lands is in the process of developing regulations governing exploration activities on state lands. It is the policy of the state to encourage the development of its natural resources under the multiple use concept consistent with the public interest. We believe it is necessary to regulate exploration activities to assure that a maximum of lands can be left open to mineral development under the multiple use concept. The basic purpose of the regulations will be to minimize adverse effects of exploration activities to other uses and thus minimize the need to limit exploration activities. Enclosed is a draft of regulations which we believe will accomplish this purpose. Your review and ideas before we submit the proposals for formal hearing and adoption procedures will be appreciated. We would be glad to meet with groups or individuals to explain and discuss our proposal.

Title II Natural Resources

January 17, 1969

Division I Lands

Chapter ____ Exploration

1. General Provisions and Definitions.

1.11 Purpose.

The purpose of these regulations is to establish procedures for conducting exploration activities on State of Alaska lands which will encourage exploration for leasable, salable, and locatable minerals and, at the same time, minimize adverse effects such activities may have on the lands and their resources.

1.12 Applicability.

These regulations apply to all mineral exploration activities on Alaska State lands including operations on lands under prospecting sites, mining claims, and mining leasehold locations under Parts 604, 605, and 606, of the Mining Rights Regulations, Title 11, Chapter 6. They do not apply to operations under state administered oil and gas leases, coal leases, coal prospecting permits, mining leases, or off-shore prospecting permits by the holder of the permit or lease or his authorized agent.

1.13 Lands Open to Exploration Activities.

All state lands except those specifically closed to exploration activities are open for exploration. Exploration permits may be issued for closed lands at the discretion of the Director where not prevented by law and for units of the State Park System in accord with the State Park Regulations, Chapter 7, Division 1 of Title 11.

1.14 Authority.

The authority for these regulations is contained in AS 38.05.020(b) (1), AS 38.05.285 and AS 38.05.350.

1.2 Definitions.

The following terms shall have the meaning indicated unless the context clearly requires a different meaning.

1.201 "Exploration" means any activity relating to the search for mineral deposits. It includes but is not limited to geophysical operations, construction of roads and trails, excavations and cross-country transit by motorized vehicle over state lands for purposes of finding or gathering information on mineral deposits.

1.202 "State lands" means lands owned or administered by the State of Alaska including lands which have been disposed of with the minerals reserved to the state under AS 38.05.125 and lands on which the state has obtained the mineral interest of the United States of America.

1.203 "Authorized officer" means any person designated by the Director to perform the duties required herein.

1.3 General Stipulations and Restrictions.

All exploration activities authorized by these regulations are subject to the following:

(1) Activities employing wheeled or tracked vehicles will be conducted in such a manner as to minimize surface damage.

(2) Trail widths will be kept to the minimum necessary or authorized by the Director and may not exceed 20 feet. Surface may be cleared of timber, stumps and snags. Due care must be used to avoid scarring or removal of ground vegetative cover.

- (3) Drainage systems shall not be blocked. Cuts or fills causing siltation or accumulation of debris in streams shall be avoided and if they occur must be repaired to the satisfaction of the Director.
- (4) All operations must be conducted so as not to change the character or cause pollution of streams, lakes, ponds, water-holes, seeps, and marshes or damage to fish and wildlife resources.
- (5) Surface damage which may induce soil movement and/or water pollution must be corrected to the satisfaction of the Director.
- (6) Vegetation must not be disturbed within 300 feet of any waters designated in an exploration permit except at stream crossings.
- (7) No explosives may be used within one-fourth mile of designated fishery waters.
- (8) Trails and campsites must be kept clean. All garbage and foreign debris must be eliminated by removal, burning, or burial.
- (9) Existing roads and trails shall be used whenever possible.
- (10) All survey monuments, witness corners, reference monuments and bearing trees must be protected against destruction, obliteration, or damage. The operator must re-establish any damaged or obliterated markers in accordance with accepted survey practice of the Division of Lands.
- (11) The operator shall make every reasonable effort to prevent, control, or suppress any fire in the operating area. Reports of uncontrolled fires must be immediately reported to the fire protecting agency.
- (12) Fill all holes, pits, and excavations except as necessary to verify discovery on prospecting sites, mining claims and leasehold

locations.

(13) No entry may be made on land, the surface of which has been granted or leased by the State of Alaska or on land for which the state has received the reserved interest of the United States until good faith attempts have been made to agree on settlement for damages which may be caused by such entry. If agreement cannot be reached, operations may be commenced on the land only with the specific approval of the Director and after making adequate provision for full payment of any damages which the owner may suffer.

(14) No test hole on lands under mineral lease permit or claim to others will be allowed in excess of 1000 feet.

1.4 Exploration Permits.

A permit is required for all explorations activities on state land which requires any of the following:

- (1) Clearing of surface area, including trails.
- (2) Excavation or sluicing or surface material.
- (3) Test drilling.
- (4) Use of tracked or wheeled vehicles except along established trails or roads except such vehicles as may be designated as exceptions by the Director.
- (5) Use of explosives.
- (6) Cause the discharge of any material including soil into waters.

1.401 Application for Permit.

The application for permit must contain the following information in sufficient detail to allow evaluation of the planned operations effect on the land.

(1) A detailed map showing the location of all activities for which a permit is required including trails, roads, clearing excavations, routes of vehicle travel, test holes, shot points, campsites, and water sources desired.

(2) A description of the proposed operation including approximate depth of all test holes and excavations contemplated, type of equipment that will be used, kind and amount of drilling, mud or other chemical, plan for disposal of garbage and other refuse from the operation.

(3) Any other information that the Director may require. Applications must be submitted in triplicate and must be accompanied by a \$20.00 filing fee.

1.402 Term.

Permits will be granted for any term requested but not to exceed one year. The permit may be extended for any number of consecutive periods, each period not to exceed one year, upon showing of need. Any modifications in the original plan must be indicated. The Director may modify existing stipulations or require additional stipulation in the approval of the extension. Applications for extension must be accompanied by a \$20.00 filing fee.

1.403 Effective Date.

The effective date of the permit shall be the first day of the month following the date on which the permit was signed on behalf of Alaska; provided, however, upon request by the applicant, the permit may be dated the first day of the month in which the permit was signed on behalf of Alaska.

1.404 Terms and Conditions.

Each permit issued is subject to the provisions of Section 1.3 and any provision the Director determines is necessary to assure compliance with these regulations including:

- (1) A bond in an amount determined to be reasonable and sufficient to protect the state's interests.
- (2) A provision for cancellation of the permit upon violation of any terms of the permit.

1.5 Waiver of Conditions.

The Director may waive or alter the requirements of these regulations when he believes it is in the interest of the state, and it is shown to his satisfaction that the requirement will cause unreasonable hardship on the permittee or will prevent adequate exploration.

1.6 Suspension and Cancellation.

Operations under these regulations may be suspended on order of the Director or his authorized officer for a reasonable time to determine if the conditions of the regulations or the permit is being complied with or upon violation of any of the provisions of the regulations or the permit. Any violation may result in termination of the permit or loss of the right to continue exploration.

1.7 Inspection of Operation.

All operations under these regulations are subject to inspection by the Director or his authorized officer.

1.8 Penalty.

Any exploration on state lands done in violation of these regulations shall be considered waste, trespass or injury to state lands under AS 38.05.360.

APPENDIX "B"

GEOPHYSICAL OPERATION PROCEDURES

Kenai National Moose Range

This office is authorized under 43 CFR, Part 3120, Subpart 3120, Sec. 3120, 3-3 (January 1, 1966) to issue Special Use Permits for geophysical operations in the portion of the Kenai National Moose Range open to oil and gas leasing and subject to the following Special Conditions which are a part of the geophysical permit.

SPECIAL CONDITIONS

(1) As used herein:

- (a) The term "Wildlife Resource" and "Wildlife Resources" includes all fish, animals and birds and all vegetable matter including trees, plants, shrubs, grass, muskeg and marsh within, on, under or over the permit area; and all lands, waters and all beds of waters within the permit area and all appurtenances to lands and waters and beds of waters within the permit area, whether natural or constructed;
- (b) The term "authorized officer" means the Refuge Manager of the Bureau of Sport Fisheries and Wildlife and his superior officers in the Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service including the Secretary of the Interior;
- (c) The term "permittee" means the person or concern who is the lessee or optionee of a Federal oil and gas lease within the permit area and who executes this permit. The term "permittee" also includes a person or concern conducting geophysical operations under authority from the

permittee and who has been given written permission from the contracting officer to operate for and in behalf of the permittee herein;

(d) The term "permit area" means the area designated on the map attached hereto;

(e) The term "geophysical operations" means exploration for petroleum and related hydrocarbons only by means of seismograph, gravity meter and magnetometer. It does not mean exploration by core hole or slim hole or by any other operations.

(2) The permittee hereby agrees that he shall:

(a) Comply with all the rules and regulations of the authorized officer and of the Secretary of the Interior;

(b) Prior to the beginning of operations under this permit, properly appoint and maintain at all times during the term of this permit a local agent, employed by the permittee, upon whom may validly be served written orders or notices respecting all matters contained in this permit and to inform the authorized officer in writing of the name and address of such local agent;

(c) Conduct all authorized activities in a manner satisfactory to the authorized officer.

(d) Conduct all authorized activities with due regard for good wildlife resources management and avoid damage to all wildlife resources including damage to improvements, timber, crops, wildlife range and waters, wildlife cover, and the permittee will fill all sump holes, ditches and all other excavations and holes made by him and cover, remove or burn, to the satisfaction of the authorized officer, all debris, and restore the surface of the permit area to its former

condition. The authorized officer shall have the right at all times to enter and inspect the premises, the installations and the operational activities of the permittee within the permit area;

(e) Take such steps as will be necessary to prevent damage to wildlife resources;

(f) Do all in his power to prevent and suppress forest, brush, or grass fires and fires to wildlife resources and to see to it that his employees, contractors, subcontractors and all employees of contractors and subcontractors do likewise;

(g) Maintain adequate equipment to prevent damage to wildlife resources;

(h) Conduct all operations in such manner that pollutants of any nature, including the intrusion of subsurface waters, are not introduced to the refuge lands;

(i) Fill and cover all holes, pits and excavations made by the permittee to the satisfaction of the authorized officer;

(j) Remove all structures and equipment and debris of any nature whatsoever prior to the termination of this permit;

(k) Comply with and see to it that his agents, employees, contractors and subcontractors and employees thereof comply with all Federal, State or Territorial laws relating to hunting, fishing and trapping;

(l) Prevent the erosion of the land, pollution of the water resources and damage to the water shed and do all things necessary to prevent or reduce to the fullest extent the scarring of the land;

(m) Agree to comply with any new requirements imposed by the Secretary of the Interior, or the authorized officer, on the conduct of operations under the terms of this permit in order to give complete protection to

wildlife resources;

(n) Compliance with any new requirements, amendments or modifications of this permit by the authorized officer will be immediate.

(3) The permittee hereby agrees that he shall not:

(a) Construct roads or trails without first obtaining written approval of the authorized officer or construct any facility which might interfere with wildlife resources or drainage;

(b) Modify or change the character of streams, lakes, ponds, water holes, seeps, muskegs and marshes, except by advance approval in writing by the authorized officer, nor shall he in any way pollute streams, lakes, ponds, water holes, seeps, marshes or wildlife resources within the permit area;

(c) Conduct operations under this permit that might tend to damage any wildlife resource or interfere with wildlife concentrations;

(d) Use explosives in fish spawning or rearing areas, nesting areas, lambing grounds, or areas of wildlife concentrations or during periods of intense wildlife activity or at any time or in any manner that might damage any wildlife resources or use explosives or helicopters, airplanes or automotive vehicles in areas that might be periodically closed by the Refuge Manager;

(e) Use any water or water source within the permit area without advance approval in writing from the authorized officer;

(f) Use mobile equipment under such conditions and in such manner as will in the opinion of the authorized officer damage wildlife resources, cause scarring and erosion, or interfere with wildlife resources;

(g) Burn rubbish, trash or other inflammable materials or substances or

use explosives in a manner or at a time when such burning or explosions would constitute a fire hazard. All burning throughout the fire season will be done in conformance with the Bureau of Land Management, U.S.

Department of the Interior regulations and procedures;

(h) Cut timber or brush without first obtaining the written permission of the authorized officer.

- (4) The permittee herein recognizes the right of the authorized officer to close certain areas within the permit area to geophysical activity from time to time because of wildlife nesting activities, concentrations of wildlife for feeding purposes, and for other reasons connected with hunting within the permit area and with the conservation of wildlife resources. The permittee herein further recognizes that the migratory nature of wildlife renders it impossible to delineate these closed areas in advance. Therefore, the permittee hereby agrees that he will not conduct geophysical activities within areas which may from time to time in the future be closed by the authorized officer, provided that notice of such closure is posted in a position open to public inspection in the authorized officer's office for the Kenai National Moose Range, and that the office of the permittee's authorized officer is notified thereof in advance.
- (5) The permittee herein recognized that the physical manner by which geophysical operations are conducted under this permit may be changed from time to time by the authorized officer. Therefore, the permittee hereby agrees that he will conduct all his geophysical operations in strict conformance with the regulations of the authorized officer. The regulations of the authorized officer are and will be posted at all times in a

place open to public inspection in the authorized officer's office for the Kenai Moose Range.

- (6) The bond which has been executed by the permittee and his surety to cover the permittee's performance of all the terms of this permit will not relieve the permittee from liability for damages over and above the total amount of the bond unless the surety shall make payment therefore, and the bond will not relieve the permittee from damages over and above the amount of the bond and will not relieve the permittee from the forfeiture and other penalty or damages provisions of this permit.
- (7) The permittee agrees and recognizes that this permit does not alter, change, amend, relieve or eliminate the necessity for the permittee to fully comply with all other Federal, Territorial or State statutes and regulations applicable to the conduct of geophysical operations. The permittee herein further agrees that he will comply with all Federal statutes or regulations pertaining to the obtaining of the consent of the mineral owner, mineral lease offeror, mineral lease holder or mineral lease optionee to the conduct of geophysical operation on lease or mineral acreage within the permit area.
- (8) The permittee herein, recognizes that this permit will be immediately cancelled for violation of any of the terms of this permit. Cancellation will be effective upon notice thereof given to the office of the permittee's authorized officer.

Signature _____
(Permittee)

Date _____
(Title)

RULES AND REGULATIONS OF THE REFUGE MANAGER

1. Prior to submitting a formal geophysical proposal the permittee will meet with the Refuge Manager to discuss the proposal and details of the Special Conditions. Maps showing requested seismic lines will be presented at the discussion.
2. Following the meeting the permittee may submit five (5) copies of a formal geophysical proposal with 1:63,360 scale maps showing in detail the geophysical work planned. The formal proposal will include at least the following information:
 - a. Items involving approval of locations will be shown on 1:63,360 maps.
 - b. The exact routes of travel desired. It is the responsibility of the permittee to choose routes traversable with his equipment.
 - c. The total miles of line in the program.
 - d. The number of shot points.
 - e. The depth of shot holes.
 - f. The size and kind of charge.
 - g. The distance between shot points.
 - h. A diagram showing shot point patterns.
 - i. A diagram showing the number and pattern of geophones.
 - j. The number, kind and size of drills used.
 - k. Kind and amount of drilling mud and other chemicals required for the total program.
 - l. When hydraulic vibrators or other non-explosive methods are to be used, the weight and other descriptions of the equipment must be included.

- m. Water sources desired.
 - n. Kind of vehicles or aircraft, and number of each to be used.
 - o. Campsite locations desired.
 - p. Number and size of trailers and other equipment to be at the camp.
 - q. Sewage disposal plans for the camp.
3. Geophysical operations using airborne equipment may be conducted from December 1 through April 30.
 4. Geophysical operations using tracked or large-wheeled vehicles may be conducted from December 1 through March 31 provided snow and ice cover are sufficient to protect wildlife resources.
 5. Maximum trail width is fifteen (15) feet. Surface of ground may be cleared of timber, stumps and snags.

Scarring of ground and removal of other vegetative cover is prohibited.

No topsoil will be removed in clearing right-of-way. No cuts and/or fills are authorized.
 6. Trails will follow a meander course with a minimum of straight-line cuts. Any necessary straight-line cut will be less than one-half (1/2) mile in length and will avoid hilltop crossings.
 7. Drainage systems may not be blocked.
 8. Moss and grass removal is not permitted in open muskeg.
 9. Streams may be crossed only at approved sites.

Portable bridges or logs will be used on stream crossings where ice strength is questionable or stream banks may be disturbed.
 10. Shot holes must be at least 1/4 mile from any water body that may have fishery value.
 11. Timber or brush will not be disturbed within 300 feet of any lake or

stream, or within 1/4 mile of any special designated waters, except for approved stream crossings.

12. A blind approach must be used at the intersection of a trail and the Moose Range boundary or any road or large stream.
13. In certain areas vehicle travel will be restricted to existing seismic trails.
14. Operations will cease during thawing weather to prevent damage to the ground.
15. Camps will be at locations approved by the Refuge Manager.
16. Shot holes will be promptly plugged using expanding parachute plugs.
17. Trails and campsites must be kept clean. All garbage and debris must be removed from the Moose Range.
18. A progress report must be submitted to the Refuge Manager twice weekly.
19. A bond in the amount of \$10,000 will be posted in favor of the Fish and Wildlife Service.
20. At the completion of the geophysical program all trails must be thickly strewn with trees for a distance of 1/2 mile from their intersection with the Moose Range boundary or any road or large stream.

FAILURE BY THE BUREAU TO ENFORCE ANY OF THE CONDITIONS OR REQUIREMENTS OF THE PERMIT DOES NOT CONSTITUTE A WAIVER BY THE BUREAU OF SUCH CONDITIONS OR REQUIREMENTS.

Permittee

Refuge Manager

Date _____

APPENDIX "C"

STIPULATIONS IN LEASES ON WILDLIFE LANDS

ss. 3120.3 - 3, TITLE 43, CFR

NOTE:

Stipulations. For inclusion in oil and gas leases entered into pursuant to this section relating to oil and gas leases in wildlife refuge, game range, and coordination lands.

Instructions. (1) The following stipulations will be made a part of Interior Department lease forms. These stipulations will be made applicable as terms and conditions of performance by lessees under all oil and gas leases entered into under authority vested in the Secretary of the Interior over game range, coordination or Alaska Wildlife lands pursuant to the order of the Secretary of the Interior published in 23 F.R.227, January 11, 1958.

(2) Should compliance with one or more of these terms and conditions be considered unduly burdensome and unnecessary to the protection of wildlife resources, the lessee may request waiver thereof by letter addressed to the Secretary of the Interior setting forth, in full, the reasons why a waiver is considered necessary. The authority to grant such waivers shall be discretionary and may be exercised only by the Secretary or the Under Secretary of the Interior.

(3) The authorized officer shall (a) approve no plan of operation that contains provisions inconsistent with the stipulations hereinafter set forth; (b) waive no term or condition in a lease; or (c) exercise no discretion vested in him unless he is satisfied the exercise of that discretion will not damage any wildlife resource.

(4) Drilling and production operations under the lease shall be under the

direction of the Geological Survey.

Terms and conditions.

(1) as used herein:

(a) The term "lessee" includes the lessee, heirs and assigns of the lessee and persons operating on behalf of the lessee;

(b) The term "wildlife resources" includes fish and wildlife resources and concentrations, fish and wildlife management operations and range improvements and facilities;

(c) The term "authorized officer" means the State Director of the Bureau of Land Management in the State in which the land is located, and, in Alaska, the Refuge Manager of the Bureau of Sport Fisheries and Wildlife;

(2) The lessee shall:

(a) Comply with all the rules and regulations of the Secretary of the Interior:

(b) Prior to the beginning of operations, appoint and maintain at all times during the term of the lease a local agent upon whom may be served written orders or notices respecting matters contained in these stipulations and to inform the authorized officer in writing of the name and address of such agent. If a substitute agent is appointed, the lessee shall immediately inform the said representative;

(c) Conduct all authorized activities in a manner satisfactory to the authorized officer with due regard for good land management and avoid damage to improvements, timber, crops, and wildlife cover, and fill all sump holes, ditches, and other excavations or cover all debris, and so far as reasonably possible, restore the surface of the leased lands to their former condition and when required to bury all pipelines below plow depth. The

authorized officer shall have the right to enter all the premises at any time to inspect both the installation and operational activities of the lessee;

(d) Take such steps as may be necessary to prevent damage to wildlife;

(e) Do all in his power to prevent and suppress forest, brush, or grass fires and to require his employees, contractors, subcontractors and employees of contractors or subcontractors to do likewise;

(f) Install adequate blow-out prevention equipment;

(g) Construct ring dikes and sump pits to confine drilling mud and other pollutants and make safe disposition of salt water by use of injection wells or such other method as may be approved in the plan of operation;

(h) Cover flare pits in areas of wildlife concentration;

(i) Remove derricks, dikes, equipment, and structures not required in producing operations within 60 days after the completion of drilling;

(j) Comply with and see to it that his agents and employees comply with all Federal, State, or territorial laws relating to hunting, fishing, and trapping;

(k) Commit the lease to any unit plan required in the interest of conservation of oil or gas resources or for the protection of wildlife;

(l) Prior to the conduct of geological, geophysical, or core drilling operations or construction of any facilities, or prior to operations to drill or produce, submit in triplicate for approval in writing by the authorized officer a plan of operation that will include detailed statements indicating the manner in which the lessee will comply with these stipulations together with a statement that the lessee agrees that compliance with these

stipulations and with the approved plan of operations are conditions of performance under this lease and that failure to comply with these provisions (unless they are waived by the Secretary or the Under Secretary of the Interior) will be grounds for cancellation of the lease by the United States. Notwithstanding other provisions in these stipulations, the lessee shall include in any plan of operation specific provisions relating to: The time, place, depth and strength of seismographic shots, maps showing the location of his leases included in the plan, actual and proposed access roads, bunkhouses, proposed well locations, storage and utility facilities, water storage, pipelines and pumping stations, the type of safety equipment that will be employed; the methods to be used to assure the disposition of drilling mud, pollutants, and other debris; the location of facilities in relation to flood levels; and such other specific matters as the authorized officer may require. The plan of operation shall be kept current in all respects and all revisions and amendments submitted to the authorized officer for written approval;

(m) Do all things reasonably necessary to prevent or reduce to the fullest extent scarring and erosion of the land, pollution of the water resources and any damage to the watershed. Where construction, operation, or maintenance of any of the facilities on or connected with this lease causes damage to the watershed or pollution of the water resource, the lessee agrees to repair such damage, including reseeding and to take such corrective measures to prevent further pollution or damage to the watershed as are deemed necessary by the authorized officer;

(n) File the bond required by section 2a (4) of the lease before conducting any operations on the leasehold, and file any additional bond

required by the authorized officer to pay for damages to wildlife habitat, including trees and shrubs, or wildlife improvements;

(o) Agree to respect and comply with any new requirements imposed by the Secretary of the Interior, or the authorized officer, on the operating program as operating experience proves necessary in order to give complete protection to wildlife populations and wildlife habitat on the areas leased.

(3) The lessee shall not:

(a) Construct roads, pipelines, utility lines, and attendant facilities that are either unnecessary or which might interfere with wildlife habitat or resources or with drainage;

(b) Modify or change the character of streams, lakes, ponds, water holes, seeps, and marshes, except by advance approval in writing by the authorized officer, nor shall he in any way pollute such streams, lakes, ponds, water holes, seeps, or marshes;

(c) Conduct operations at such times as will interfere with wildlife concentrations;

(d) Conduct geological or geophysical explorations that might damage any wildlife resource and such operations shall be conducted only in accordance with advance approval in writing by the authorized officer as to the time, manner of travel and disturbances of surfaces and the facilities required for the protection of wildlife.

(e) Use explosives in fish spawning or rearing areas, nesting areas, lambing grounds or other areas of wildlife concentration during periods of intense activity or at any other time or in any manner that might damage any wildlife resources; the pattern size, and depth of seismographic shots shall be submitted to the authorized officer for advance approval in writing and

immediately following the detonation of any seismographic charge, the hole shall be filled or plugged and any surface damage repaired to the satisfaction of the authorized officer;

(f) Without advance approval in writing, use any water or water source controlled or developed by the United States;

(g) Use mobile equipment under such conditions as to permanently damage surface resources, cause scarring and erosion, or interfere with wildlife concentration;

(h) Conduct geological, or geophysical, or core drilling operations or construct roads, bunkhouses or any facilities or drill or produce under a lease until the submittal and approval in writing of a plan of operation pursuant to section (2) (m) supra or deviate therefrom until any revisions or amendments of said plan have been approved in writing by the authorized officer.

(i) Burn rubbish, trash, or other inflammable materials or use explosives in a manner or at a time that would constitute a fire hazard.

ENVIRONMENTAL EFFECTS OF PETROLEUM DEVELOPMENT
ALONG THE ALASKAN NORTH SLOPE

by

CHARLES WAYNE BRADLEY

B. A., Texas Christian University, 1968

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Geology and Geography

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

Since the Alaskan North Slope petroleum discovery, oil companies, conservationists, and governmental representatives at all levels have discussed the possible effects on the environment. This thesis analyzes these possible effects, and determines whether the environment would be adversely influenced. After reviewing analogous petroleum activities, especially those in the Cook Inlet of Alaska, and potential North Slope actions, this writer expects the following unfavorable environmental changes: (1) depletion of existing animal resources such as bears, caribou, wolves, walrus, and seals, (2) the creation of numerous semi-permanent interlacing tractor trails, (3) streams and lakes relieved of their fish populations because of oil spills, and (4) the aesthetic loss due to the general change in the area's appearance. The belief, that there is a good possibility these changes will occur, was reinforced after examining existing regulations which pertain to environmental protection. In Alaska, existing legislation, in most cases, is interested only in the conservation of the oil, and not the environment which contains it. And federal regulations usually are too general.

The development which is expected to create these problems presents itself in various forms. For instance, the construction of the Trans-Alaska Pipeline may result in the destruction of permafrost over the entire 800 miles it will cross. The movement of tracked vehicles may create deep ruts which will remain permanently, reminding man he should think before acting too quickly. Other development which may also negatively effect the environment includes: oil sump pits, gathering pipelines, access roads, and permanent drilling sites.

Petroleum activities will also have an effect on the Eskimos. These natives are closely attached to their natural environment. When changes occur

in the environment, the Eskimo is affected. He depends on the animals for food, and on the streams for clean water and fish. If these resources are reduced or eliminated, the Eskimo will have a smaller resource base and his life's pattern may be changed. The Eskimo may also experience cultural changes produced by his increased contact with petroleum developers.

Unfavorable effects on the environment may be avoided if the oil companies involved would cooperate with ecologists, and follow passive developmental procedures. Passive development means that the procedures followed should be adapted to the environment, rather than adapting the environment to the procedures. The state and federal government should delay activities until environmental scientists have completed their studies. Once completed, the ecologists' findings could be used as a basis for revamping inadequate environmental legislation and in the formulation of new regulations. Unless both government and industry act quickly and positively the Alaskan North Slope will certainly experience adverse environmental change.