Terrestrial Environmental Specialists, Inc.

ALASKA POWER AUTHORITY

ENVIRONMENTAL SOCIOECONOMIC AND LAND USE ANALYSIS OF ALTERNATIVE ACCESS PLANS FOR THE SUSITNA HYDROELECTRIC PROJECT

by

Terrestrial Environmental Specialists, Inc.
Phoenix, New York 13135

for

Acres American, Inc.
Buffalo, New York 14202

October 1981

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The purpose of this report is to provide environmental input into the selection of an access plan for the Susitna Hydroelectric Project and to recommend an access plan that, from a total environmental standpoint, is judged to have the least impact, both short-term and long-term. This input is provided to Acres American, Inc. and the Alaska Power Authority to be analyzed in conjunction with access plan analysis from engineering and economic standpoints.

Preliminary access route environmental analysis began in March 1980, and still continues. Final access plan impact analysis and mitigation recommendations will be included in the Federal Energy Regulatory Commission application. Initial corridor environmental analysis was largely based on habitat identification, specifically, an attempt at avoidance of large wetland areas. Three generalized corridors emerged for further evaluation: two corridors connecting both dam sites to the west (either the Parks Highway or the railroad at Gold Creek), one on the north and one on the south side of the Susitna River; and one corridor linking the Watana dam site to the Denali Highway on the north. Analysis of these corridors was conducted during 1980. Following the 1980 field season, agency comments were solicited, and public meetings were held to present access options. It was decided in the spring of 1981 to continue impact analysis on the corridors, which were then modified somewhat according to the adjustments and realignments suggested by various sources to reduce potential impacts. Notable among these adjustments were: (1) deletion of the corridor segment that looped around Portage Creek, between the Indian River and Devil Canyon dam site, (2) realignment with alternatives in the Stephen Lake/Fog Lakes area for both the road and railroad plans, and (3) realignment of the northern portion of the route to Denali Highway by moving it to the west away from the Butte Lake area. During the 1981 field season, and following these modifications, the resulting corridors were studied further.

The original corridors plus those adjustments resulting from subsequent suggestions (certain segments have a and b alternatives themselves) can be combined in various ways to provide access to both dam sites. These combinations, called access plans, were further analyzed to select the plan that would result in the least total environmental impact on the area in question.

The eight access plans under current evaluation include seven proposed by R&M Consultants, Inc. in an early 1981 engineering report. Another access plan was added for evaluation by Acres American, in early June 1981. The number of access plans under consideration does not, however, include all possible combinations and permutations of corridor segments. These other possible plans were already ruled out for engineering, environmental, or other reasons.

Because one of the primary effects on construction and operation of the Susitna access route will be the destruction of wildlife habitat, a special section devoted to habitat value analysis has been included in this evaluation report. The proposed route alternatives traverse a wide variety of habitat types, so it was necessary in comparing the access plans, first, to evaluate the relative value, or quality, of the wildlife habitat to be affected by each alternative. The results of this habitat evaluation will then be used in conjunction with other wildlife data to recommend a preferred route.

Several individuals made significant contributions to the preparation of this habitat analysis. Principal investigators for the Alaska Department of Fish and Game submitted life requisite scores for the big game species; Dr. Philip Gipson of the University of Alaska was responsible for the life requisite scores for the furbearer species; Mr. Steven MacDonald of the University of Alaska Museum prepared the scores for the non-game mammal species; and Dr. Brina Kessel of the University of Alaska Museum determined the life requisite scores for the avian species.

Mr. Gregory Konkel of the United States Fish and Wildlife Service provided valuable suggestions in the development of this analysis. Environmental considerations for the report as a whole included plant ecology, wildlife, cultural resources, land use, and socioeconomics. Input into the analysis was provided in part by the University of Alaska (Dr. A. Jubenville, Dr. P. Gipson, Dr. B. Kessel, Dr. E.J. Dixon, Dr. J. McKendrick, Dr. W. Collins); Frank Orth & Associates (Mr. P. Rogers); Alaska Department of Fish and Game (Mr. K. Schneider); and several private consultants to TES, including Dr. F. Banfield, Dr. R. Taber, and A.C. Fazekas. Their contributions are sincerely appreciated.

2. ENVIRONMENTAL ANALYSIS

2.1 METHODS

Any access plan, no matter what the mode or route, will affect the region it traverses. To ascertain the effects of each access plan, experts from various disciplines studied the route's potential consequences for their particular areas of concern. Presented below are the scientific areas considered in assessing each route's effects. These are: vegetation; wildlife, including birds and small mammals, furbearers, and big game; fish; and cultural resources.

Although methods may refer specifically to how analysis of alternative access plans was accomplished, it should be noted that much information in all environmental disciplines has been obtained during the larger study pertaining to the entire area of the upper Susitna River basin and that this information was also used, either directly or indirectly, in the evaluation of the access plans under consideration here.

(a) Vegetation

One-mile-wide corridors were considered for each of the alternative access plans. All mapping was at a scale of 1:63,360 (see accompanying maps). Vegetation was mapped from color infrared aerial photography and field reconnaissance of the routes. Wetland maps were constructed from vegetation maps according to the U.S. Fish and Wildlife Service's wetland classification. The limitations of this classification were described in the 1980 Plant Ecology Annual Report. The area covered by each vegetation type was determined for a mile-wide corridor for each possible alternative access plan. To make the wetland evaluation pertinent to this access plan assessment, each vegetation mapping unit was ranked with respect to the degree of wetness and soil stability.

(b) Wildlife

(i) Birds and Small Mammals

Among the methods for conducting the bird and small mammals portion of the access plan assessment was a one-day raptor survey by aerial reconnaissance of all corridors in early July. A hike along the trail between Devil Canyon and Gold Creek included part of the area touched by several of the proposed access routes. Finally, examination of the avian habitat occupancy levels and habitat preferences of various species contributed to the investigation of a route's suitability in terms of its impact on birds and small mammal populations.

(ii) Furbearers

Methods of furbearer analysis of alternative access plans consisted in part of aerial reconnaissance of all corridors to look for furbearers and their sign and to evaluate various habitats and topographic features important to furbearers along the routes. This input was then considered in conjunction with information previously collected during the larger study of the Susitna Hydroelectric Project, such as preferred habitats and specific denning locations, to assess impacts on furbearers specific to the alternative access plans under consideration.

(iii) Big Game

To assess the various access plans as to the degree of impact they would have on the large game animals in the area, big game principal investigators and others reviewed and made reconnaissance flights over the proposed routes. Included in this group of researchers was a consultant specializing in caribou, since that species is rather sensitive to disturbance and its needs are somewhat unique. This consultant spent three days in early August, 1981 doing reconnaissance overflights of access corridors.

(c) Fish

To assess the impact that the various access routes would have on the area's fish population, researchers studied aerial photographs and topographical maps, conducted a review of pertinent literature, and applied their general knowledge of the effects of road construction on waterways.

(d) Cultural Resources

Because of the vast area under consideration and limited time and resources for sampling, it was impossible to define the probability of archeological site occurrence in a statistically valid fashion for the eight access plans under consideration. Instead, each of the access plans was evaluated for its potential effects on cultural resources, and this was accomplished through analysis of air photos, topographic map analysis, aerial reconnaissance, and limited on-the-ground examination of natural exposures. Use of these methods allowed that zones along each access plan be ranked as exhibiting high, moderate, or low potential for the occurrence of cultural resources. That judgment was made by comparing these areas with others that have been subject to archeological survey and which exhibit similar ecological and geological characteristics.

Archeological sites that have been documented along or adjacent to each corridor were plotted on 1:250,000 scale USGS quadrangle maps; and zones of high, moderate, and low archeological potential were drawn onto topographic maps. Archeological sites reported in the published anthropological literature for the region were also included when applicable.

After the field work was completed, these data were compiled and synthesized for each proposed access plan. Finally, each plan was evaluated for its potential adverse impact on cultural resources.

2.2 CRITERIA FOR EVALUATION

(a) Vegetation

The number of access routes and their combinations present considerable data necessary to select a "best" route for protecting valuable vegetation. The selection was even more difficult since the various values of vegetation are discontinuous throughout the mapping units and the regions encompassing the various access plans. Consequently, there is no real common denominator upon which to base decisions about a route's suitability.

Among the criteria for ranking the proposed access routes was the presence or potential presence of protected plant species. As an extension of the study presented in the 1980 Annual Report, effects upon rare, threatened, and endangered species were examined along each corridor. Work done in 1980 indicated that several such plants would occur on well-drained calcareous sites. This information allowed each corridor to be searched for probable habitats. No such sites were found in proximity to any of the access plans. Based upon that finding and on field observations by Dr. John Koranda, an authority on Alaskan botany, a concern for rare or endangered plants became irrelevant to the access route portion of the Susitna Hydroelectric Project.

Another concern in ranking the various access plans was the increased number of fires that result when a region becomes more accessible to human use. Except for threats to human life and property, however, fire can be a positive ecological force, rejuvenating vegetation, improving certain wildlife habitats, and releasing soil nutrients. According to field evidences of old burns and restricted tree ages, fire has long been a natural part of the ecosystems in this area. According to Johnson, frequent naturally-occurring fires in northern boreal forests of Northwest Canada, prevent, except in rate instances, climax community

development (Johnson, E.A. 1980. Fire recurrence and vegetation in the lichen woodlands of the Northwest Territories, Canada. In: Stokes, Marvin A. and John H. Dietrict, (Tech. coord.). Proceedings of the Fire History Workshop, October 20-24, 1980, Tucson, Arizona. Gen. Tech. Report RM81, Rocky Mtn. Forest and Range Exp. Sta. USDA-Forest Service, Ft. Collins, Colorado, pp. 110-114). The occurrences of burning seem to be related to weather patterns and climatic changes. The same may be said for the upper Susitna basin; hence, any increased burning resulting from fires of human origin would probably be insignificant to the overall scheme of nature.

In view of the limited damage to vegetation that increased fires will cause and in the absence of any rare or endangered plant species, other criteria became most pertinent in evaluating the proposed access plans. These were: 1) total acreage of each vegetation type affected within a mile-wide corridor (Table 1), 2) wetlands, and 3) probable solifluction.

Wetlands are important considerations because of their high ecological value. Wetlands provide habitat for a large number of wildlife species and are a critical link in the hydrological cycle.

Solifluction problems relate to soil instabilities and to degree of slope. One way to predict whether a site will suffer from soil slippage is to note the presence, at lower elevations, of alder and bluejoint reedgrass. At higher elevations, tall shrub sites, in general, are a clue to potential solifluction problems.

(b) Wildlife

(i) Birds and Small Mammals

To determine the consequences that a proposed access plan would have for birds and small mammals along the plan's route, researchers used the following criteria:

- numbers of species affected and their density along an access route or in an area (Table 2)
- types of habitat encountered by a proposed plan
- existence of raptor habitats along a particular route
- existence of wetlands on or near a planned access route
- degree to which a route will facilitate public access to a sensitive area.

(ii) Furbearers

In evaluating the eight access plans for their potential impact to furbearers in the region, the following criteria were used:

- the degree to which the route will increase public access to valuable furbearer habitat. The differences in access permitted by railroad and highway were also noted.
- the fragility of the animal habitat involved
- the types of furbearers that would be affected by a proposed route. Of particular concern are beaver, mink, river otter, fox, and marten.
- the proximity of a proposed route to waterways and lakes

The latter criterion incorporates several related concerns. First, the filling of a wetland simply eliminates a habitat. Second, the process of construction disturbs a habitat--to a greater or lesser degree, depending upon the furbearer species in residence and the types of construction involved. Finally, vehicles using access routes near or through furbearer habitat will likely collide with valuable animals.

(iii) Big Game

The big game investigators used the following criteria to determine the potential effects of a proposed route on resident and migratory big game species:

- the increased public access afforded by the route to big game habitats and the resultant disturbance of animals using those areas.
- the effects of a proposed route on caribou, in particular, a species which may be more vulnerable to disturbance than most other big game species
- the proximity of the route to denning sites of wolves and bears.

(c) Fish

A major concern of the fishery investigation was the extent to which streambeds would be disturbed, banks eroded, sediment washed downstream, and other negative effects incurred with the construction of necessary crossings. These same questions apply to roads built in the vicinity of streams, lakes, or ponds. Such disturbances could be serious, especially during fish spawning and rearing periods.

Similarly, increased public access to lakes, ponds, and streams along the proposed routes is a critical problem for fish populations. Easier access, either of a temporary sort during construction periods or of a permanent nature through established roads, will increase fishing pressure. Those species that experience slow growth in the climate types found throughout the Susitna study area suffer particularly when fishing pressure becomes excessive. Several game fish, including salmon, grayling, lake trout, rainbow trout, and Dolly Varden, are especially threatened by improved access to their habitats.

Sheer numbers alone, however, were not the only consideration when looking at the planned crossings and the access they would facilitate. Each stream or lake to be crossed was assessed for its fishery potential. Disturbance of fish habitat deemed highly valuable was of greater concern than was the disruption of less valuable waters.

With these points in mind, fisheries experts evaluated the access plan alternatives according to the following criteria:

- the number of stream or lake crossings that the route required
- the fishery potential of the water being crossed (e.g. resident, anadromous)
- the potential for increased public access created by the particular plan
- the effects, in particular, on anadromous fish habitats

(d) Cultural Resources

The following criteria were implemented to define zones of high, moderate, and low archeologic potential:

- high archeological potential -- Areas designated as exhibiting high archeologic potential are those for which, in similar areas, previous research has documented a comparatively high frequency of site occurrence relative to the size of the area under consideration. Such locales include lake and stream margins and junctions, kettle and kame topography, natural topography constrictions that tend to funnel and concentrate the movements of large mammals, overlooks, esker systems, etc. Occasionally, a number of these ecological factors occur in a single locale, tending to make this area the focus of repeated used throughout the prehistoric past. Such spots discovered within the study area are ranked as "high potential" for archeological site occurrence.

- moderate archeological potential -- Zones of moderate archeological potential are areas in which archeological sites are likely to occur, but the frequency of site occurrence is anticipated to be low in relation to the size of the area. A likely site would be, for example, an area of rolling topography with occasional knolls or terraces, possibly affording either a view of the surrounding terrain or a dry, well-drained spot for a campsite. Another example of areas classified as having moderate archeological potential are slopes

along drainage systems upon which occasional terrace remnants occur which may contain archeological sites.

- low archeological potential -- Regions of low archeological potential are those areas in which few, if any, archeological sites may be expected to occur. Such areas are steep slopes that afford little or no suitable setting for camps or hunting and areas of low relief containing few, if any, ecological attributes attractive to human beings. These areas are often extensive muskeg/tussock bogs. Also included in these zones are areas that have been subject in the recent past to such destructive geologic processes as river erosion, landslides, mudflows, and others.

Table 3 lists mileage of each of these potential areas within the various access plans. Although there are known sites occurring along each access plan, the numbers are not used as evaluation criteria in this report. It is assumed that many more sites exist and will be discovered during preconstruction surveys.

2.3 DESCRIPTION OF ENVIRONMENTAL RESOURCES

The eight alternative access plans, each of which is designed to provide access to both the Devil Canyon dam site and the Watana dam site from an existing transportation corridor, are made up of several segments of possible corridors in the upper Susitna River basin. Five geographical locations define the beginning/end points of these segments and are as follows: Parks Highway south of Hurricane, the Gold Creek area, Devil Canyon dam site, Watana dam site, and the Denali Highway (Figure 1). Two different segments can connect the two dam sites, one on the north side of the Susitna River and one on the south side. Therefore, there are a total of five different corridor segments that can be combined to produce the eight alternative access plans currently under consideration. Each of these plans is briefly described in the impact assessment section as is the mode of transportation (road or railroad) which characterizes the actual route.

The following is a brief description by corridor segment, of the environmental resources of the project area as those resources pertain to the impact assessment of the alternative access plans (See Table 4 for summary).

(a) Parks Highway to Gold Creek

This segment parallels the Indian River and contains primarily forested habitat types. The slopes along the sides of this valley are covered with spruce habitats, deciduous habitats, and a mixture of spruce and deciduous forest. Near Gold Creek, there are several stands of balsam poplar along the river. Also along the river, mostly west of the railroad, are numerous wet areas, some of which occur as a result of topographic factors and others that have been created by the activities of beavers. Human dwellings are also found in many areas adjacent to the river and the railroad.

The major big game species in this area are moose and probably black bears. The area is not frequented by either Dall sheep or caribou. Wolverines may be present in low numbers, but because of the human

activity in the area, they are unlikely to occur often along this segment. The same is probably true for brown bears and wolves, which are precluded from using this area to any appreciable degree by the presence of permanent dwellings and associated human activity.

There are numerous beaver dams and lodges in wet areas adjacent to the river. Muskrats are also found in these areas. Some pine marten, river otters, and red foxes are likely to frequent the river valley, although the beaver is probably the most abundant furbearer in the area.

The vegetation cover types that predominate along this segment are productive for avian species, especially the mixed spruce-birch forest on the valley slopes. Stands of balsam poplar are also very productive for birds and thus represent important habitat for this group.

A large proportion of this corridor segment passes through areas of high and moderate archeological potential, primarily because the route goes through a natural mountain pass.

(b) Gold Creek to Devil Canyon Dam Site

This segment of the proposed access route extends east from Gold Creek to the Devil Canyon dam site along the south side of the Susitna River. This area is characterized mostly by forested habitat types. The majority of the route is covered with either closed or open mixed forests. These vegetation types are usually a combination of birch and white spruce. Relative to other cover types, these two categories represent very good wildlife habitat. Interspersed among these forested areas are wet sedge grass habitats, which are also good wildlife habitat and which are located on flat benches that occur along this segment. A narrow dirt road parallels portions of the proposed access route in this area.

Black bears and moose are the predominant big game species in this area. Although detailed survey work has not been conducted along much of this segment, it does not appear that moose are particularly abundant, and it is assumed that black bears are of moderate abundance based on data collected in other forested portions of the river basin. Although it is likely that brown bears, wolverine, and wolves utilize this segment, there is no evidence to suggest that they are abundant.

The wet areas on the side benches support beaver, especially where suitable birch forests adjoin these areas. The productive forest conditions probably support a population of pine marten, and where streams occur, it is likely that mink and river otter are present. It is also possible that red foxes make some seasonal use of this area, but data collected in other portions of the basin indicate a preference for habitat types at higher elevations.

This segment traverses deciduous forests which have been found to represent some of the best habitat for bird species. The proposed route does not encroach upon nesting habitat of cliff-nesting raptors.

This segment of the route contains small isolated segments of high and moderate archeological potential. However, since the area is largely forested, indirect impacts resulting from increased access may be minor because of the low visibility from the proposed route.

(c) Devil Canyon to Watana (North Side)

The access route segment that extends west from Devil Canyon to the Watana dam site on the north side of the river is composed of a fairly well interspersed mixture of spruce, tall shrub, mixed low shrub, birch shrub, and tundra vegetation types. Much of these vegetation types are of medium to low value as wildlife habitat. As a result, this segment is of less value to big game species than some of the other segments. Black

bears are scarce, except at each end of the segment where the route approaches the forested areas along the river. Black bears will move close to this segment during late summer to forage on ripening berries as long as tree cover is nearby. Brown bears are more common here than black bears. Wolverine are also abundant in this portion of the upper basin. Moose are not overly abundant in this region.

This segment does not traverse any significant furbearer concentrations. Red foxes have several den sites in the general vicinity, but other species of furbearers are not common in this area.

In general, this area does not support many birds. Several species utilize the types of habitat found here, but the total avian productivity is not as great as in forested habitats along the river.

This segment contains substantial amounts of high and moderate archeological potential area, particularly at high elevations in open habitats; it also contains a number of documented archeological sites.

(d) Devil Canyon to Watana (South Side)

The segment from Devil Canyon to the Watana dam site on the south side traverses a highly interspersed mixture of wildlife habitat types. Those comprising the majority of this area include the tundra types (mat and cushion, and sedge shrub), tall shrub (alder), mixed low shrub, birch shrub, and both open and woodland spruce. Individually, these habitat types are of moderate value to wildlife; however, their extensive interspersion serves to increase their collective value.

This segment is characterized by considerable numbers of big game animals. One of the highest concentrations of moose found in the upper basin occurs in this area. In addition, two wolf packs and numerous

wolverines use this area. Brown bears are also present, and at least some move through this area to and from the salmon run on Prairie Creek. The eastern portion of this segment, near the Fog Lakes, has been commonly used by members of the Nelchina caribou herd, especially during the summer months. Although black bears appear to be less numerous here than in other portions of the upper basin, they do move up to the open shrub habitats during late summer to feed on ripening berries.

A great deal of furbearer activity has been noted along this segment, probably caused, in part, by the high degree of habitat interspersion that exists here, in conjunction with the numerous streams and lakes distributed throughout this region. Because of a low incidence of forested habitat, there are fewer marten in the area, except where open spruce types are found, particularly those spruce areas that are located closer to the river valley. Beaver and muskrat have been observed along this segment.

In general, the abundance of avian species is probably lower along this segment than in forested areas. Many of the cover types are not particularly important to birds. There are, however, several cliff-nesting raptors using the cliffs of tributaries adjacent to this segment.

A fairly large amount of high and moderate archeological potential area is found along this segment, especially in the Stephan Lake, Fog Lakes, and Fog Creek areas.

(e) Watana Dam Site to Denali Highway

Most land along this segment is covered by birch shrub and willow shrub habitats. Wet sedge grass, mixed low shrub, mat and cushion tundra, and sedge shrub tundra are also commonly found here. Chiefly as a result of the extensive presence of willow shrub and wet sedge grass types, this area is of great value to wildlife, particularly big game species. The presence of Deadman Creek and several lakes serves to enhance that value for wildlife.

Moose and caribou are probably the most numerous big game species in the area. The large amount of willow shrub provides excellent forage for moose. In addition, this access corridor traverses an area that has historically been utilized by a portion of the Nelchina caribou herd. This herd has a total distribution of about 20,000 square miles in south-central Alaska. The herd's distribution is bounded by four mountain ranges: the Alaskan Range to the north, the Wrangell Mountains to the east, the Chugach Mountains to the south and the Talkeetna Mountains to the west. It is also increasingly restricted by human developments on its borders along highway and railroad routes.

The estimated total population of the Nelchina herd in 1981 is approximately 19,000 animals, including several subherds. The Nelchina herd is of importance to sport and subsistence hunters because of the size and proximity to population centers in south-central Alaska. Its population has fluctuated from a peak of approximately 70,000 in 1962/63 to a low of about 9,000 animals in 1972. Alaskan game officials propose to maintain the herd through hunting restrictions and regulated harvesting at approximately the current population level of 20,000.

Historically, virtually the entire Nelchina caribou herd has spent portions of the summer, fall, and late winter in the area around Butte Lake and the hills to the south. The corridor skirts the western edge of this area. A small subherd of approximately 1,000 animals appears to reside permanently in this portion of the upper basin. Calving by this subherd has been documented in the region, and although the calving appears to be highly dispersed, the presence of a permanent subherd with calving activities and frequent use by major segments of the entire herd suggest that this area is quite important to caribou.

Beaver and muskrat are fairly common in wet areas along Deadman Creek. They appear to be associated with lakes and wet sedge grass cover types. Red foxes are also common, and a denning center occurs within the one-mile corridor.

The lack of forested habitats renders this area of less value to birds than the region along the river valley. One pair of bald eagles, however, has been documented nesting along Deadman Creek within the one-mile corridor of the proposed access route.

Almost the entire length of this segment is either of high or moderate archeological potential. Numerous sites were documented during a brief reconnaissance. In addition, this area is almost wholly open terrain; therefore, the potential for secondary impacts resulting from increased access by humans is increased.

2.4 IMPACT ASSESSMENT

The following section describes potential impacts associated with construction and operation of the proposed access plans. Because of the scale of maps available and because the final alignment of the road or railroad has not been determined, impact assessment was conducted on the entire one-mile wide corridor. According to R&M Consultants, Inc., the actual construction right-of-way will be no greater than 200 feet with the actual road no greater than 50 feet wide. Because of this, it may be possible during final centerline studies to locate the route within the corridor so as to minimize environmental effects. This would include, where possible, avoiding wetlands, unstable areas, and areas known to be important wildlife habitat.

The vegetation acreages contained in the impact assessment refer to the entire one-mile wide corridor. Actual road or roadway construction will require a maximum width of 200 feet. Using this figure, actual acres of vegetation to be removed for both road construction and local borrow pits have been calculated. These figures, supplied by R&M Consultants, appear in parentheses following the mile-wide vegetation acreage figures.

The impact section also discusses mitigation only in general terms. Section 2.6 contains more detailed information on mitigation techniques that, if utilized, will reduce the impacts discussed below.

(a) Access Plan 8

This plan is a road beginning at a railroad near Gold Creek and proceeding to Devil Canyon dam site on the south side of the Susitna River. At the dam site, it crosses the river and continues to the Watana dam site on the north side of the river (Figure 2).

(i) Vegetation

Access Plan 8 is the best choice in terms of minimal potential destruction of vegetation. Plan 8 is shorter than any of the other plans; only 30,279 acres of vegetation are within the mile-wide corridor mapped (860 acres to be removed). It also presents the least difficulty with wetlands disturbance (Table 5).

The only major drawback to Access Plan 8 is a possible problem with soil slippages on the north-facing slopes of canyons. Those geomorphic processes are major factors in creating alternating spruce forests and alder thickets. The presence of these thickets along segments of Access Plan 8 is a clue to potential solifluction problems.

(ii) Birds and Small Mammals

Of all the plans proposed, Access Plan 8 is the optimum route in terms of reducing impacts to birds and small mammals. The route involves only a single access point at Gold Creek, rather than the additional point of origin at the Denali Highway, as is the case with some other routes. Plan 8 also uses the north side route between the two dam sites, thus avoiding the sensitive area around Stephan and the Fog Lakes, and traverses the shortest distance through productive avian habitat. Finally, this routing avoids the more important raptor sites on the south side of the river west of Stephan Lake and the wetlands around Stephan and Fog Lakes important to both birds and small mammals.

(iii) Furbearers

Access Plan 8 ranks second in order of preference in terms of its anticipated impact on furbearers. Because it begins at Gold Creek instead of the Parks Highway, the plan minimizes access; vehicles will have to be shipped by rail to Gold Creek, so the result is a closed highway system. Access Plan 8 avoids productive furbearer habitats around Stephan Lake, Fog Lakes, and Fog Creek. The area crossed north of the Susitna River between Devil Canyon and the Watana dam site is relatively unimportant to furbearers.

(iv) Big Game

Access Plan 8 is preferable to other routes in its avoidance of important big game habitat. The major attraction of this access plan is its northern leg between the Devil Canyon dam site and the Watana dam site, thereby avoiding important habitat on the south side of the river. The route also goes through areas that appear to be heavily used by wolverine and bears. The proposed route is higher, however, than most heavily used black bear habitat, except in the vicinity of Tsusena Creek and the Watana site. Moreover, it is lower than most known brown bear dens. Although this is a major concern, this area (Tsuena-Watana) will be disturbed anyway with the construction of the Watana Dam. Portions of this area are important moose habitat, specifically the regions around Devil Mountain and the mouth of Tsusena Creek.

Although the proposed route intersects several caribou north-south trails in the Devil Creek area, caribou traffic appears to be rather light and impacts should not be severe. In any case, Access Plan 8, with its northern segment, is much preferable to any route that traverses the Stephan Lake-Fog Lakes area.

(v) Fish

Access Plan 8 is the second best alternative of the routes being considered in terms of its potential impact on fisheries. First, a north-side route between Devil Canyon and the Watana site is preferable to any of the southern routes because there are simply fewer fish habitats here to be affected by road construction or increased access. In addition, no new crossings of anadromous streams are involved and the effects on resident fish populations should be minimal.

(vi) Cultural Resources

Access Plan 8 is second only to Access Plan 2 for minimizing effects upon cultural resources, specifically archeological sites. Twelve archeological sites have been documented along or adjacent to this route, ten of which were discovered during the course of this evaluation. Access Plan 8 is virtually identical to Plan 2 between Gold Creek and Devil Canyon; however, from an area immediately north of High Lake and extending to the proposed Watana dam site, it traverses an area largely treeless and ecologically diverse. This region also lacks appreciable soil deposition. These factors make cultural resources highly visible and highly vulnerable to any surface-disturbing activities. For these reasons, secondary adverse effects on cultural resources in this region are expected to be severe.

In addition, some of Access Plan 8 route, particularly that section extending east from High Lake, passes through areas of high potential for archeological site occurrence. By avoiding the southern Stephan Lake area, Access Plan 8 becomes a desirable route, but because of the anticipated adverse effects for cultural resources described above, it is less desirable than Plan 2.

(b) Access Plan 2

This plan is totally a railroad access beginning near Gold Creek and connecting both dam sites by rail on the south side of the river (Figure 3).

(i) Vegetation

For its impact on vegetation, Access Plan 2 stands in the middle of the route rankings, with 2b holding a slight advantage over 2a. The corridor of Access Plan 2a will involve 37,610 acres of vegetation; 2b contains 37,591 acres. With the lowest acreage, that for Plan 8, at 30,279 and the highest, for Plan 7b at 66,648, the mileage affected by Access Plan 2 falls in the mid-range (approximately 640 acres to be removed). Plan 2 ranks in the high middle for wetlands (Table 5), primarily because of the

southern segment between the two dam sites, and in the low middle for anticipated solifluction problems. In light of the problems that increased public access generates for vegetation, Access Plan 2, relying on railroad instead of vehicular road, is attractive and preferable to highway construction.

(ii) Birds and Small Mammals

A railroad brings fewer people into an area than a vehicular road allows, so ordinarily a plan involving a railroad would be preferable to other routes. Access Plan 2, which uses a railroad, also, however, traverses the southern route between the two dam sites. That route is detrimental to birds and small mammals, especially in the Stephan Lake and Fog Lakes area, and generally goes through more productive forest habitats and wetlands than any northern route does. Included in the routing, too, is some valuable raptor habitat along cliffs near an unnamed drainage.

An advantage to Access Plan 2, besides its being a railroad, is that it originates at Gold Creek. This origin reduces the impact to valuable bird and small mammal habitat created by routes that begin at the Parks Highway.

Of the two alternatives for Access Plan 2, 2a is preferable to 2b from an avian standpoint. This route remains approximately 2 miles farther from Stephan Lake and from water body (WB) 105 (See Bird and Small Mammal Annual Report for locations of water bodies), which has a bald eagle nest at its southwest end and which also seems to attract swans. Segment 2b contains no nests. (Ten were spotted on 10 October 1980; three adults were seen in late July 1981. No evidence exists of breeding, however.) Plan 2a would cross closer than 2b to the head of Fog Creek, thereby avoiding some potential cliffnesting habitat. Alternative 2a would go closer to WB 103 and WB 104, but neither appears to support many waterbirds.

(iii) Furbearers

Access Plan 2 is the preferred route from a furbearer standpoint. The major advantage to furbearers is that this plan utilizes a railroad instead of a highway. It thereby reduces public access to the Susitna Valley and the furbearer habitat around Stephan and Fog Lakes. Train traffic may also lessen the disturbance to animals because the traffic is not continuous but, rather, periodic.

Access Plan 2, is preferable to all others, too, because of the sensitive areas it avoids--the Denali Highway region, the route from Denali to the Watana site, and the area between the Parks Highway and Gold Creek.

(iv) Big Game

Access Plan 2 presents some of the same problems for big game that it does for other wildlife, that is, the southern route between the two dam sites includes important habitat. The upper Prairie Creek, Stephan Lake, and the Fog Lakes regions support one of the largest year-round moose concentrations. Any access route intersecting this habitat will reduce the ability of the area to support moose populations. At least two wolf packs, substantial numbers of wolverine, and bears also inhabit the area. This plan also cuts across a midsummer migratory route for bears moving from the Susitna River to Prairie Creek to feed on salmon. This has the potential for bear-human conflicts.

The advantage of Access Plan 2 is its use of railroad instead of highway. Disturbance from traffic may be less continuous, and the secondary effects of improved public access would be substantially reduced if a railroad were used. It would also greatly restrict all-terrain vehicles' making new trails along the south bank of the Susitna River. Thus, in all respects, increased public access would be limited, so the effect on wildlife caused by hunters and sportsmen pursuing big game would be tempered.

While Access Plan 2 poses some serious problems for wildlife in general, it is the preferred route for minimizing disturbance of caribou. It almost completely avoids areas important to the Nelchina herd except in the Fog Lakes region and effectively circumvents terrain frequented by the small Chunilna subherd of approximately 300 animals.

(v) Fish

Access Plan 2 is rated the most acceptable when using the criteria for impact on fish populations. A railroad permits far less access than a road does, so lakes in the region covered by Plan 2 would probably not be subject to increased access. As far as effects upon these lakes are concerned, 2a is preferable to 2b.

A plan involving a railroad, such as Access Plan 2, would limit access to all sensitive fisheries habitats, but it would also have another advantage. Railroad crossings will be permanent and less subject to erosion than the stream and lake crossings built for highway traffic.

Plan 2 enters sensitive habitat of resident fisheries around Stephan and Fog Lakes via its southside segment, but again, a railroad would limit access to these locations and the effect would thus be attenuated. Moreover, Plan 2 calls for no new crossings of anadromous streams, and that feature of the plan further reduces the negative aspects of increased access.

(vi) Cultural Resources

Access Plan 2 is the best choice for reducing negative effects on important archeological sites. The route covers the least number of miles of high potential area and includes much less terrain with any archeological potential--high, medium, or low--than all other routes except Plan 8.

Archeological sites do exist along the route, particularly in the vicinity of Stephan Lake and the Fog Lakes. Much of the route, however, skirts relatively steeply sloping valley margins along which few, if any, archeological sites are expected to occur. In addition, much of the route is forested, which reduces both site visibility and future off-road vehicle traffic as well as the secondary adverse impact to sites from recreators and artifact collectors. The railroad will further diminish access by the public, and that feature adds to the appeal of this plan.

Access Plan 2b is slightly preferable to 2a in that it traverses slightly less terrain of high archeological potential. Seven previously documented sites occur along 2a, while six known sites are adjacent to 2b. No "new" archeological sites were discovered along this access plan during the course of this assessment, and while 2b is a slightly better route, both plans are roughly equivalent.

(c) Access Plan 5

Access Plan 5 is a road beginning at the Parks Highway south of Hurricane, going through Chulitna Pass, then south along Indian River, crossing the Susitna River near Gold Creek. From Gold Creek, the route is south of the Susitna River to Devil Canyon dam site, there crossing the river and proceeding east to the Watana dam site on the north side of the river (Figure 4).

(i) Vegetation

Because of its length, Plan 5 would disturb more vegetation than would some of the other access plans (1037 acres to be removed).

In the Susitna basin, tall shrub types occur frequently between Devil Canyon and Watana and especially on the westernmost one-third of the northside segment. Access Plan 5 includes this segment and, consequently, is rated poorly because vegetation suggests solifluction problems that could make restoration of these areas difficult.

The route from Hurricane to the Devil Canyon site passes close to or through valuable wetlands. Access Plan 5, which includes this segment, thus falls short of the optimum route by crossing this sensitive terrain.

Another drawback to Access Plan 5 is also related to its northside segment. The northern portion of the Susitna basin is a favorite moose and caribou hunting area. With their use of off-road vehicles, hunters often unnecessarily damage vegetation and soils here (Sparrow, S.D., F.J. Wooding and E.H. Whiting. 1978. Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska. J. Soil and Water Conservation 33(1):20-27.) In light of that problem, opening of the Susitna basin to more vehicular use could increase those damages.

(ii) Birds and Small Mammals

The primary difficulty with Access Plan 5 in terms of birds and small mammals is the route segment between Hurricane and Gold Creek. The wetlands in this area probably support more mammals than birds (both beaver and cow moose with calves have been seen here), but both wildlife groups will be disturbed. This disturbance should not increase mortality to the point of being detrimental to the overall populations.

A second problem with this plan is that it will allow increased public access deep into the sensitive wildlife habitats of the Susitna River basin. Any such encroachments will have a negative, although minor, impact on the birds and small mammals residing there.

(iii) Furbearers

Access Plan 5 ranks third in order of preference in terms of its anticipated impact upon furbearers. One positive feature of this route is that, while the area between the Parks Highway and Gold Creek has a number of private residences, furbearer sign is still abundant here, even adjacent to these dwellings. Moreover, private landowners wishing to retain an abundant local wildlife may regulate both the access to trapping sites and the number of animals harvested. Thus, even if a road were constructed, local pressure could continue to limit the harvest of furbearers.

Another advantage to this route is that it employs the north segment between the two dam sites; that region is relatively unimportant for furbearers.

The disadvantages of Access Plan 5 to the furbearer population are: (1) the route has the potential to provide almost unlimited access into the Susitna Valley from the Parks Highway and Gold Creek upstream to the Watana Damsite; and (2) there are productive furbearer habitats (primarily wetland areas utilized by beaver) along the entire stretch from the Parks Highway and Gold Creek. Aerial reconnaissance and vegetation mapping indicates it may be possible to locate the road to avoid most of these wetland areas.

(iv) Big Game

Access Plan 5, while not the best choice for the protection of big game, does present some advantages over several other routes. The segment of the route between the Parks Highway and the Devil Canyon site follows primarily north-facing slopes and, therefore, is less likely to affect both moose and bears. This segment is likely to affect caribou since the proposed route intersects several caribou north-south trails in the Devil Creek area. However, caribou traffic appears to be rather light here. There may be problems with bears along this segment, particularly in the spring, when brown bears emerge from dens, and in late summer, when black bears concentrate near timberline. These problems would likely be human-bear conflicts .

Portions of the northern route between Devil Canyon and Watana, primarily the area of Devil Mountain and the mouth of Tsusena Creek, are important summer moose habitat. Construction through this area will reduce its attractiveness to moose. The route also goes through areas that appear to be heavily used by wolverine and bears. The proposed route is higher, however, than most heavily used black bear habitat, except in the vicinity of Tsusena Creek and the Watana site, and lower than most known brown bear dens, thereby reducing impacts to these species.

(v) Fish

Access Plan 5 includes constructing bridges over both the Indian and the Susitna Rivers. In addition, the road would run close to the Indian River. Construction activities in and around both rivers could affect salmon populations, which are known to utilize these areas for spawning and/or migration during spring and summer months. Additionally, with improved access, the Indian River fisheries would be subject to increased fishing pressure. Northside access from the Devil Canyon dam site to the Watana site, as provided by Access Plan 5, is preferable to a southern route, mainly because there are fewer fish habitats to be affected by road construction or increased access. This stretch would allow increased access to some lakes in the High Lake and Tsusena Creek areas.

Thus, the assessment of Access Plan 5 from a fisheries point of view is similar to that for birds and small mammals: the route is neither the worst nor one of the three best; instead, it falls somewhere in the middle of the choices available.

(vi) Cultural Resources

The limited examination of surface exposures along all the access plans resulted in the discovery of twenty-two previously undocumented archeological sites. Some of these sites occur along the route of Access Plan 5. From the region immediately north of High Lake and extending to the proposed Watana dam site, Access Plan 5 traverses an area that is largely treeless, ecologically diverse, and lacking in appreciable soil deposition. These factors make cultural resources highly visible and highly vulnerable to any surface disturbing activities. For these reasons secondary adverse effects to cultural resources are expected to be severe. Additionally, that section of Access Plan 5 that extends east from the vicinity of High Lake passes through areas of high potential for archeological site occurrence. Access Plan 5, then, is less desirable than some of the other alternatives available.

(d) Access Plan 1

Access Plan 1 is a road beginning at Parks Highway south of Hurricane going through Chulitna Pass, then south along Indian River, crossing the Susitna River near Gold Creek. From Gold Creek, the route is south of the Susitna River to both the Devil Canyon and Watana dam sites (Figure 5).

(i) Vegetation

Access Plan 1, with its a and b options in the Stephan Lake area, falls within the middle of the route plans' ranking. The estimated number of acres within the corridor of Access Plan 1, while not the highest figure, was between 39,493 and 40,290, depending upon whether 1b or 1a, respectively, was selected (approximately 1,085 acres to be removed). These figures are substantially higher than the 30,279 acres within the Access Plan 8 corridor.

Access Plan 1 also presents major solifluction problems. The south side route between Devil Canyon and Watana presents steep slopes and, in addition, commonly supports tall shrub types that readily invade exposed soils on solifluction sites. These areas pose difficult restoration problems and should normally be avoided.

(ii) Birds and Small Mammals

The route from Hurricane to Devil Canyon passes close to or through wetlands that support both birds and mammals. Access Plan 1, then, is less desirable in terms of its effects on area wetlands than some other routing options. From an avian standpoint, 1a is preferable to 1b between Devil Canyon and the Watana site. Plan 1a is situated approximately two miles farther away than is 1b from relatively productive Stephan Lake and from Water Body (WB) 105. The latter hosts a bald eagle nest at its southwest end and seems also to attract swans. This lake is within the one-mile corridor. Ten were spotted on 10 October 1980; three adults were seen in late July 1981. No evidence of breeding exists here, however.

Plan 1a, by crossing closer to the head of Fog Creek than 1b does, avoids some potential cliff-nesting habitat that 1b would encounter. While 1a also passes closer than does 1b to WB 103 and WB 104, neither water body appears to support many waterbirds. The one-mile corridor of Access Plan 1 crosses productive forest habitat, and contains and comes close to raptor habitat and to major wetlands. For these reasons, 1 is not the optimum route, but if it were implemented, 1a would be preferable to 1b.

(iii) Furbearers

Access Plan 1 will allow virtually unlimited access to the Susitna Valley from the Parks Highway and Gold Creek upstream to the Watana dam site. The area between the Parks Highway and Gold Creek has a number of private residences now, but furbearer sign is abundant, even adjacent to these dwellings.

Access Plan 1 would involve a negative impact to productive furbearer habitat by following a route south of the Susitna River between the two dam sites. Both 1a and 1b would encounter productive furbearer habitat around Stephan Lake, the Fog Lakes, and/or Fog Creek.

Thus, while Access Plan 1 is not the worst route, it falls in the ranking because of the effects that the southside segment would have on furbearer species.

(iv) Big Game

Access Plan 1 presents a peculiar problem in terms of big game considerations. While the plan is one of the least desirable when all big game needs are evaluated, it is second in order of preference from the point of view of caribou disturbance.

The southern leg of Plan 1, which runs between the Devil Canyon dam site and the Watana site along the south side of the Susitna, raises serious concerns for big game specialists. The upper Prairie Creek, Stephan Lake, and Fog Lakes areas support one of the largest

year-round moose concentrations in the region. Construction in this area will reduce the habitat available to the moose and increase hunting mortality. In addition, at least two wolf packs, substantial numbers of wolverine, and some bears, especially brown bears, inhabit the area. This route also cuts across a midsummer migratory route for bears moving from the Susitna River to Prairie Creek to feed on salmon, increasing the potential for bear-human conflict. Taking into account all of these characteristics, one sees that Access Plan 1a is slightly preferable to 1b because 1a avoids passing close to Stephan Lake.

While caribou, too, regularly use the area, particularly around the Fog Lakes, the rest of the route traverses a region seldom visited by caribou and would, therefore, cause the animals minimum disturbance. An additional important factor is that it appears that caribou have used the area around Access Plan 1 only when the Nelchina herd has been at peak numbers. It seems unlikely, then, that they will use this part of the Susitna basin again, unless their numbers rise considerably at some future time. An increase of this sort is not, at present, anticipated.

Plan 1 has another drawback of concern to big game specialists. The route would open up access for all-terrain vehicles to the southern side of the Susitna River. Incursion of these vehicles beyond the Fog Lakes and Watana Mountain areas is unlikely, but should this occur, it would represent a threat to the main calving grounds of the Nelchina herd in the Kosina Creek and Oshetna River drainages. Thus, while Plan 1 itself is advantageous to the protection of caribou, the possible secondary effects of the route could have a negative impact on these animals.

(v) Fish

Because it involves a combination of negative consequences to both anadromous and resident fish species, Access Plan 1 is the least acceptable route design. The plan calls for bridges over both the Indian and the Susitna Rivers. In addition, the road at the west end

of the route would run close to the Indian River. Construction activities in and around both rivers could affect salmon populations, which are known to utilize these areas for spawning and/or migration. Sound construction practices and siltation control should reduce impacts to fisheries and fisheries habitat. This route would also subject the Indian River fisheries to increased fishing pressure.

Of even graver concern is the segment between Devil Canyon and Watana. The southern route would increase access to Stephan and the Fog Lakes as well as to Fog Creek. Fishing pressure would increase for grayling, lake trout, rainbow trout, and Dolly Varden. Very little difference in impact on fisheries exists between 1a and 1b. Segment 1b may allow for slightly more access to Stephan Lake and perhaps for this reason, is a slightly less desirable alternative.

(vi) Cultural Resources

The criteria used to determine the potential for archeological site occurrence point to Access Plan 1 as the third best choice for dam site access. Plan 1 will likely encounter less terrain of high archeological potential than five of the other alternatives. Certain sites exist along the Devil Canyon to Watana segment, particularly in the vicinity of Stephan Lake and the Fog Lakes. The seriousness of such encounters is lessened, however, because much of the route is forested. This characteristic reduces both site visibility and future off-road vehicle traffic as well as the secondary adverse impact to sites from recreators and artifact collectors.

(e) Access Plan 4

Access Plan 4 consists of a railroad between Gold Creek and the Devil Canyon dam site on the south side of the Susitna River. A separate link by road connects the Watana dam site to the Denali Highway (6).

(i) Vegetation

Access Plan 4 ranks as the second best choice with respect to its effect upon vegetation, with 4a slightly preferable to 4b. In terms of acreage, the corridor of Plan 4a contains 35,987 acres, while 4b contains 37,242 (approximately 975 acres to be removed).

Plan 4a will encounter fewer wetlands than any of the other proposed options with the exception of Access Plan 8. Again, 4a ranks slightly higher than 4b in this regard.

Plan 4 fares equally well when solifluction criteria are applied, again ranking close to Plan 8 in this regard. Plan 4a supersedes 4b in this category also. One reason for the plan's high marks is that the rating system indicated a preponderance of tall shrubs sites--warning signs for unstable soil properties--between Devil Canyon and Watana. Since Access Plan 4 does not provide for any link between the two dam sites, this critical area is avoided entirely.

The northern portion of the Susitna basin is a favorite moose and caribou hunting area. As a result, the vegetation and soils here are often seriously damaged by drivers of off-road vehicles pursuing game (Sparrow, Wooding, and Whiting, 1978). Opening of the Susitna basin to further vehicular use could increase that damage, and Plan 4 will increase the opportunity for that type of destructive travel.

An advantage of Access Plan 4 is its use of the railroad, which limits public access to the area, especially since the line originates at Gold Creek and not the Parks Highway. Since the railroad is not planned for the sensitive Denali segment, however, its effectiveness is somewhat attenuated.

(ii) Birds and Small Mammals

One attractive feature of Access Plan 4 is its use of the railroad. A railroad brings fewer people into an area than a vehicular road allows, so ordinarily a plan involving a railroad is preferable to other modes.

There is also some advantage to the route in that it begins at Gold Creek rather than at the Parks Highway. That point of departure reduces the area of habitat, especially wetlands, encountered.

The portion of the route to the Denali Highway from Watana should have minimal impact to birds and small mammals. This is because the habitat is primarily tundra and/or shrublands, which generally support less productive and less avian communities than the forests.

The negative aspects of Access Plan 4 include its use of two access points, one at Gold Creek, the other at the Denali Highway. As a consequence, more avian and small mammal habitats will be affected than with any "single access" plan.

In terms of the Denali segment, Plan 4a is preferable to 4b between the Watana dam site and the highway because the former route would avoid raptor habitat, in particular a bald eagle nest in a cottonwood along Deadman Creek, present within the one-mile corridor of 4b.

(iii) Furbearers

The use of the railroad will minimize access from the Parks Highway and eliminate the continuous disturbance to and increased destruction of furbearers that vehicle traffic brings.

Another positive feature of this plan is that the lack of a connecting road between the two dam sites will eliminate disruption of valuable furbearer habitat south of the Susitna River around Stephan Lake and the Fog Lakes.

The serious disadvantage to Access Plan 4 is the inclusion of the road between Denali Highway and the Watana dam site. The fragile tundra through which this road passes is already abused by off-road vehicles. Improved access in this area will compound the damage, with negative results for the good furbearer habitat here. Vulnerable beaver/muskrat populations and fox denning sites along this route may be affected.

Furthermore, the Denali Highway, which is presently closed during the winter, will have to be upgraded to a year-round road. This action will not only provide increased access into the upper Nenana Valley, but it will also mean that furbearer resources in both the Susitna and Nenana drainages will be affected, in terms of increased trapping mortality and potential habitat destruction.

(iv) Big Game

Access Plan 4's use of a railroad is a positive feature because it reduces the access to valuable big game habitat compared to what a road would afford. The presence of an access route through wildlife habitat does not, alone, disturb the animals. What does disturb them is noise, traffic, hunting and other activities resulting from increased access. Since little or no hunting will occur from railroad lines, the effect of this increased access is somewhat offset by its being a railroad, not a highway.

While a railroad is preferable to a road, it will still affect the game in the region. Moose and black bear will avoid the route, whether railroad or highway, by approximately one-half mile in timbered to one-mile of open terrain on either side. The avoidance-zone estimates double for wolves and wolverines.

The access routes will have two effects on brown bears: conditioned to fear the sound of an engine, they will avoid any route, whatever the mode, and they will be inhibited by a route lying across their migration path. Whether or not this will affect the population is unknown.

The Denali Highway-Watana segment of Access Plan 4, however, is likely to lead to disruption of the animals, especially caribou, that frequent the area. It will also tend, at its southernmost end, to open up access into the Stephan Lake-Fog Lakes area.

This proposed Denali road passes through an area that has frequently been used either by major portions of or by the entire Nelchina herd, and includes the calving and summer ranges of the northwestern subgroup of that herd. This subherd is believed to number approximately 1000 animals. The alpine tundra of the Deadman and Brushkana Creek valleys is the center of its summer distribution.

Construction of the access road would likely not cause significant impacts. Removal of the habitat and disturbance would not be major. However, presence and operation of the road may be more detrimental to caribou.

The proposed access road also lies across the caribou's late summer migration route toward Butte Lake and Gold Creek. Massive caribou trail patterns as well as a few bulls have been spotted in this area. Furthermore, the proposed route parallels a traditional spring migration route southward toward the Susitna River.

Direct effects upon this group of caribou would include: the disturbance of cows and calves during the route's construction period, the disturbance to caribou migration caused by road traffic, and the possibility of increased caribou mortality rates as a result of road kills. Of these, impacts to migration are not expected to be severe, for caribou will cross roads. Females do exhibit affinity to traditional calving grounds and interference with these areas could be significant.

Of greater importance, however, are the indirect consequences for this caribou group that will result from easier access to its range. An access road across the tundra between the Nenana and Susitna river valleys will encourage all-terrain vehicles to push a network of unplanned trails throughout this subherd's range. The effect will be additional disturbance of the entire group and higher losses of individual animals as they encounter vehicles, campers, and hunters. Thus, there is a chance that this route could lead to partial abandonment of important caribou habitat. A possible mitigation technique for this impact is heavy patrol by regulatory agencies and enforcement of hunting regulations.

(v) Fish

Access Plan 4 falls in the middle of the ranking as far as effects upon fish are concerned. The railroad leg of the plan, between Gold Creek and Devil Canyon, is a particular advantage. It will not increase access to any of the area's lakes, nor does it call for new crossings of anadromous streams.

The lack of a link between the two dam sites is likewise, a positive feature, if only because it reduces the number of fish habitats that will be disturbed. The road south from Denali Highway to Watana, though, is an objectionable aspect to the plan. Not only will the road permit access to fish habitat along its path, but it will also facilitate access to important fisheries areas at its southern end, namely Stephan Lake, the Fog Lakes, and Fog Creek. Alternative 4a is slightly better than 4b because it passes farther from Deadman Creek and necessitates fewer stream crossings.

(vi) Cultural Resources

Access Plan 4 ranks rather well in terms of the number of miles it will cover that include sites with any archeological potential. Moreover, the railroad feature tempers this ranking because it will limit public access and its concomitant damage to sites by recreators and artifact collectors.

On the other hand, and primarily because Plan 4 includes the Denali segment, the route ranks less well in terms of the number of miles of high potential sites it could encounter. A total of fifteen archeological sites have been documented along this leg--twelve along or adjacent to 4b and nine along or adjacent to 4a. Of the fifteen sites now known and documented, twelve were only discovered during the field survey portion of this assessment.

Virtually the entire length of the Denali segment of this plan passes through treeless topography, and many deflated areas also occur here. Along much of the route, glacial drift is covered by a thin veneer of loess in areas of high topographic relief. These factors combine to make archeological sites highly visible and easily disturbed. It is reasonable to assume that, as a result of these characteristics, sites along this route will experience the secondary adverse effects created by off-road vehicles and artifact collectors, among others.

Of the two alternatives for the Denali segment, 4a would encounter fewer archeological sites and is, therefore, preferable to 4b.

(f) Access Plan 6

This plan consists of a railroad between Gold Creek and the Devil Canyon dam site on the south side of the Susitna River. A roadway connects the Watana dam site to the Denali Highway, and a service road on the north side of the Susitna River links the two dam sites (Figure 7).

(i) Vegetation

Access Plan 6 rates very poorly in terms of the anticipated impact on vegetation along its route. Alternative 6a's corridors will encompass 58,586 acres; 6b includes 59,819 acres (approximately 1570 acres to be removed). Of that acreage, a great deal will consist of valuable wetlands, enough to commit Plan 6 to a low rating in that regard.

With respect to solifluction, Access Plan 6 also rates poorly. One feature of the plan that amplifies its low solifluction score is the north-side service road linking the two dam sites.

The northern portion of the Susitna basin is a favorite moose and caribou hunting area. As a result, vegetation and soils are already being damaged by off-road vehicle travel (Sparrow, Wooding, and Whiting, 1978). An access road from the Denali Highway will probably increase this traffic drastically and result in greater damage to vegetation.

(ii) Birds and Small Mammals

Access Plan 6 includes the positive feature of a railroad between Gold Creek and the Devil Canyon dam site. A railroad brings fewer people into an area than a vehicular road allows, so ordinarily, a plan involving a railroad would be preferable to other routes. Plan 6, however, also calls for a road from the Denali Highway to Watana. The result of Plan 6's utilizing two access points is that more avian and small mammal habitat will be affected than with any "single access" plan.

Other than increasing unwanted access to important habitat, the Denali segment will have less of a negative impact on birds than some other routes would. The habitat here is primarily tundra and/or shrubland, which generally support less productive and less diverse avian communities than forests do. There are also few wetlands along this route.

Another advantage to Access Plan 6 is that its use of a northside service road instead of any route on the Susitna's south side will result in its encountering much less habitat important to birds and small mammals.

If Access Plan 6 is selected, 6a is preferable to 6b in order to circumvent a bald eagle nest in a cottonwood along Deadman Creek.

(iii) Furbearers

With respect to furbearer habitat, Access Plan 6 combines the advantages of Access Plan 2's railroad with the disadvantages of the Denali Highway access.

The railroad feature between Gold Creek and Devil Canyon reduces potential impacts to furbearers. Disturbance from construction traffic would be less continuous and secondary effects of improved access would be substantially reduced with a railroad.

Another advantage to Access Plan 6 is that the planned northside service road will go through an area relatively unimportant to furbearers. A southside route, on the other hand, would seriously affect productive habitats around Stephan Lake, the Fog Lakes, and Fog Creek.

These positive features of Plan 6 are counterbalanced, however, by the Denali segment. By providing access to the fragile alpine tundra/lake/stream complex here, the route will bring impact to aquatic furbearers inhabiting the areas of Deadman Mountain, Deadman and Big Lakes, and upper Deadman Creek. This impact will likely be due to increased trapping mortality and habitat disturbance.

In addition, the Denali Highway, which currently remains closed in winter, will have to be upgraded. Thus, with Access Plan 6, furbearer resources in both the Susitna and Nenana drainages will be affected by this route.

(iv) Big Game

The railroad access included in Access Plan 6 is much preferable to a vehicular road for lessening negative effects on wildlife populations. A railroad provides controlled access and, in this case, will restrict all-terrain vehicles' making new trails on the south side of the Susitna River.

Plan 6's northside service road intersects several north-south caribou trails in the Devil Creek area, but caribou traffic here appears to be light; impacts, therefore, should not be significant. Furthermore, the mountain ranges to the north will discourage excessive all-terrain vehicle penetration.

Portions of this northside segment in the Tsusena Creek area are important moose habitat, however, and go through areas that appear heavily used by wolverine and bears. The proposed route is higher than most black bear habitat, except in the vicinity of Tsusena Creek and the Watana dam site, and it is lower than most of the known brown bear dens. There may be some problems with bears here, particularly in spring, when brown bears emerge from dens, and in late summer, when black bears concentrate near the timberline. These problems could likely relate to minor disturbances and possible bear-human conflicts, but should not be significant.

The presence of an access route through wildlife habitat does not, of itself, disturb the animals here. Traffic, hunting and other activities associated with a road and increased access adds to the disturbance. Bears, having been conditioned to fear the sound of an engine, will avoid the route and will be inhibited by a road lying across their migration route. Moose will avoid the route by approximately one-half mile in timbered areas to one mile in open terrain. The avoidance zone for wolves and wolverines is double that of the moose zone. The road from the Denali Highway to the Watana dam site is likely to involve all these problems and, in addition, may severely disrupt the caribou population.

The proposed Denali road passes through an area that has frequently been used either by major portions of or by the entire Nelchina herd, and includes the calving and summer ranges of the northwestern subgroup of the that herd. This subherd is believed to number approximately 1000 animals. The alpine tundra of the Deadman and Brushkana Creek valleys is the center of this herd's summer distribution.

The proposed road also lies across the caribou's late summer migration route toward Butte Lake and Gold Creek. Massive caribou trail patterns as well as a few bulls have been spotted in this area. Furthermore, the route parallels a traditional spring migration route to the Susitna River.

The direct effects upon this group of caribou will include: the disturbance of cows and calves during the route's construction period, a disturbance and an impediment to caribou migration caused by road traffic, and the likelihood of increased caribou mortality rates as a result of road kills. Of these, impacts to migration are not expected to be severe, as caribou will cross roads. Females do exhibit affinity to traditional calving grounds and interference with these areas could be significant.

Of greater importance, however, are the indirect consequences for this caribou group that will result from easier public access to its range. A road across the tundra between Nenana and Susitna river valleys will encourage all-terrain vehicles to push a network of unplanned trails throughout this subherd's range. The effect will be additional disturbance of the entire group and higher losses of individual animals as they come in contact with vehicles, campers, and hunters. Thus, there is a chance the utilizing of this access plan could lend to partial abandonment of important caribou habitat. A method to mitigate this would be through heavy patrol by regulatory agency personnel.

(v) Fish

Access Plan 6 is one of the less desirable plans when considering fishery concerns. The railroad leg of the plan, between Gold Creek and Devil Canyon is, however, one of the plan's advantages. It will not increase access to any of the area's lakes, nor does it call for new crossings of anadromous streams.

Another of the advantages of this plan is the northside service road, which if a link is required, is preferable to a southern connection. North side access simply involves fewer fish habitats than will be affected by road construction or increased access on the south side of the Susitna.

The Denali Highway-to-Watana road is the major drawback to Plan 6. Not only will the road permit access to fish habitat along its path, but it will also facilitate access to important fisheries areas at its southern end, namely Stephan Lake, the Fog Lakes, and Fog Creek. Alternative 6a is slightly better than 6b because it passes farther from Deadman Creek and necessitates fewer stream crossings.

(vi) Cultural Resources

Access Plan 6 is a poor choice in terms of the potential archeological sites it is expected to encounter. It includes nearly the highest number of miles of possible sites of high potential and ranks in the middle of mileage figures for sites with any site potential. The railroad feature of Plan 6 tempers this low ranking somewhat because it will limit public access and its concomitant damage to sites by recreators and artifact collectors.

On the other hand, the Denali segment promises difficulties in terms of cultural resources. A total of fifteen archeological sites have been documented along this leg--twelve along or adjacent to 6b and nine along or adjacent to 6a. Of the sites now known and documented here, twelve were only discovered during the field survey portion of this assessment.

Virtually the entire length of this route passes through treeless topography, and many deflated areas also occur here. Along much of the route, glacial drift is covered by a thin veneer of loess in areas of high topographic relief. These factors combine to make archeological sites highly visible and easily disturbed.

It is reasonable to assume that, as a result of these characteristics, sites along this route will experience the secondary adverse effects

created by off-road vehicles and artifact collectors, among others. Of the two alternatives for the Denali segment, 6a will encounter fewer archeological sites and is, therefore, preferable to 6b.

The proposed northside service road between the dam sites compounds the already negative characteristics of Plan 6. From an area immediately north of High Lake and extending to the Watana site, the road traverses an area largely treeless and ecologically diverse. The region also lacks appreciable soil deposition. All these factors make cultural resources highly visible and highly vulnerable to surface-disturbing activities. For these reasons, secondary adverse effects to cultural resources may be severe. In addition, this section of the route also passes through areas of high potential for archeological site occurrence. All these aspects considered, Plan 6 is likely to have severe consequences for cultural resources in the Susitna valley.

(g) Access Plan 3

Access Plan 3 consists of a roadway from the Parks Highway, through Chulitna Pass to Gold Creek and on to the Devil Canyon dam site along the south side of the Susitna River. A separate link connects Watana dam site by road to the Denali Highway (Figure 8).

(i) Vegetation

Access Plan 3 ranks rather unfavorably in terms of its impact on vegetation. The corridor of plan 3a will involve 42,825 acres of vegetation, and Plan 3b will include 44,058 acres (approximately 1,244 acres to be removed), both of which figures are markedly higher than the low of 30,279 acres (Plan 8).

Both routes fall in the mid-range for wetlands encountered, with 3a being preferable to 3b. Plan 3 did rank rather highly in minimum acres of tall shrubs, an indication that this route would encounter fewer problems with solifluction than would some of the other routes.

A serious drawback to Access Plan 3 is the segment extending north from the Watana dam site to the Denali Highway. That leg includes much caribou range, which is already subject to damage by off-road vehicles. The Denali segment also contains a large amount of willow range for moose and outranked all other segments in that respect. An access road through this area will not only damage the vegetation in the immediate vicinity of the road but will also allow the additional destruction of valuable plants caused by off-road vehicle travel.

(iii) Birds and Small Mammals

Access Plan 3 utilizes two access points, one at the Parks Highway and the other at the Denali Highway, with the result that more avian and small mammal habitats will be affected than with any "single access" plan.

The route from Hurricane to the Devil Canyon site passes near or through wetlands that support both birds and mammals. Beaver, for example, have been seen in the area as well as cow moose with calves.

One positive aspect of Access Plan 3, at least from an avian standpoint, is the Denali segment. The habitat here is primarily tundra and/or shrublands, which generally support less productive and less diverse avian communities than the forests. For this segment, Plan 3a is preferable to 3b since the former avoids raptor habitat, in particular a bald eagle nest in a cottonwood along Deadman Creek, which is within the one-mile-wide corridor of Access Plan 3b.

Another advantage to Access Plan 3 in general is that it does not provide for a link between the two dam sites. The result of this feature is that sensitive habitats, especially those south of the Susitna between the sites, are avoided entirely.

(iii) Furbearers

Access Plan 3 is a poor choice of access route from the standpoint of furbearers. The plan involves productive wetland areas between the Parks Highway and Gold Creek. In addition, the valuable and sensitive tundra

areas adjacent to the Denali Highway will be affected by increased access. Along the route from the Denali Highway to the Watana Dam, particularly the area south of Deadman Mountain, are beaver and muskrat populations and fox denning sites. These animals would be vulnerable to increased trapping pressure if a road were constructed.

(iv) Big Game

Access Plan 3 is a poor choice when big game criteria are applied. The chief reason is the Denali segment, which will disturb caribou use of the area. The proposed road would pass through an area that has been frequently used either by major portions of or by the entire Nelchina herd, and includes the calving and summer ranges of the northwestern subgroup of that herd. This subherd is believed to number approximately 1000 animals.

The alpine tundra of the Deadman and Brushkana Creek valleys is the center of the herd's summer distribution. Three small groups of cows and calves were seen during a reconnaissance flight on August 8, 1981. The Denali segment of Access Plan 3 also lies across the late summer migration route of caribou toward Butte Lake and Gold Creek. Massive caribou trail patterns as well as a few bulls were spotted in this region. The proposed road also parallels a traditional spring migration route southward toward the Susitna River.

The direct effects upon this group of caribou should Access Plan 3 be implemented would include: a disturbance to cows and calves during the road construction period, a disturbance and possible impediment to caribou migration as a result of increased traffic in the area, and the possibility of direct mortality from road kills. Of these, impacts to migration are not expected to be severe, as caribou will cross roads. Females do exhibit affinity to calving grounds and interference with these areas could be severe.

Of greater importance than these factors, however, are the indirect consequences to this group of caribou of freer access to its range. An access road across this alpine tundra would provide the opportunity for all-terrain vehicles to push a network of unplanned trails throughout this

subherd's range. This new access would cause disturbance and increased mortality to these caribou from their contact with vehicles, campers, and hunters. Thus, there is a chance that utilization of this route could lead to partial abandonment of important caribou habitat. A method by which this could be mitigated would be through heavy patrol by regulatory agency personnel.

(v) Fish

Access Plan 3 requires constructing bridges over both the Indian and the Susitna Rivers. In addition, the access road itself would run close to the Indian River. Construction activities in both rivers could affect salmon populations, which are known to use these areas for spawning and/or migration. Furthermore, with improved access, the Indian River fisheries would be subjected to increased fishing pressure.

The Denali segment is a negative feature, also, when considering fish habitats, partly by virtue simply of the added length and partly because it opens up additional fisheries areas to more use.

(vi) Cultural Resources

Plan 3 ranks in the low middle range in terms both of the number of miles of high potential it is likely to encounter and the number of miles of possible sites of any potential.

The segment of Plan 3 extending south from the Denali Highway to the proposed Watana dam site is a major drawback to this route. A total of fifteen archeological sites have been documented along this leg. Twelve sites are located along or adjacent to 3b, and nine sites appear along 3a. Of the fifteen sites now known and documented, twelve were discovered during the field survey portion of this assessment.

Virtually the entire length of this route passes through treeless topography, and many deflated areas also occur here. Along much of this northern extension, glacial drift is covered by a thin veneer of loess in areas of high topographic relief. These factors combine to make archeological sites highly visible and easily disturbed because they are not deeply

buried. Based on these observations, it is reasonable to assume that if Access Plan 3 were select Access Plan 3, then, is one of the least desirable from an archeological perspective. If chosen, however, route 3a would probably encounter fewer archeological sites than would 3b and, consequently, would be preferable.

(h) Access Plan 7

Access Plan 7 consists of a roadway from the Parks Highway, through Chulitna Pass to Gold Creek, and then east to the Devil Canyon dam site along the south side of the Susitna River. The Watana dam site is linked by road to the Denali Highway, and the two dam sites are connected by a service road on the north side of the Susitna River (Figure 9).

(i) Vegetation

From the perspective of vegetation concerns, Access Plan 7 is the worst choice. It will affect the greatest number of acres of all the routes: 65,424 acres are contained in the 7a corridor and 66,648 in 7b (approximately 1,840 acres to be removed).

Plan 7 also has the lowest rating of all the routes for wetlands encountered, indicating all of the hazards associated with construction plus all the negative effects upon wetlands vegetation that a road creates.

The incorporation of a northside service road into Access Plan 7 renders it susceptible to increased solifluction problems. Tall shrub types that indicate probable soil slippage occur most frequently on the westernmost one-third of the northside segment. So Access Plan 7 is rated poorly in terms of potential solifluction.

Plan 7 also does poorly when the vegetation needs of moose and caribou are considered. The northern portion of the Susitna region is already a favorite moose and caribou hunting area, and the Denali segment of the route will open that area to further such use. Vegetation in this area is already abused by off-road vehicles, and the damage will increase if access is improved.

(ii) Birds and Small Mammals

Access Plan 7 is the worst option in terms of birds and small mammals. Like Plan 3, it utilizes two access points, one from the Parks Highway and one from Denali Highway. The long length of the plan will result in disruption of more avian and small mammal habitats.

This drawback is exacerbated by the northside service road connecting the two dam sites. While the northern route is preferable to the southern route, the service road feature renders Plan 7 the longest of any of the proposed plans. In general, the more acreage a route covers, the more each individual species and all the varieties of species will be adversely affected.

Access Plan 7 includes, too, the segment from Hurricane to the Devil Canyon site, which passes near or through important wetlands areas. Beaver have been seen here as well as cow moose with calves. If the road is placed on upland areas within the one-mile wide corridor, these impacts will be reduced.

Route 7a is preferable to 7b between Denali and the Watana site, since 7a would avoid raptor habitat; in particular, a bald eagle nest in a cottonwood along Deadman Creek, which is within the one-mile corridor of Plan 7b. The tundra/shrubland habitat crossed from Watana to the Denali Highway is not considered highly productive avian habitat.

(iii) Furbearers

As far as furbearer habitat is concerned, Access Plan 7 incorporates most of the negative features of all the other plans. As a result, it is ranked as the poorest choice.

First, productive furbearer wetland habitat exists between the Parks Highway and Gold Creek along the Indian River, Salmon Creek, Summit Lake, and Pass Creek. Plan 7 includes all of these areas. If the road is placed in upland areas present within the one-mile-wide corridor, impacts to furbearers will be reduced.

Second, the route could provide almost unlimited public access from the Parks Highway to the Denali Highway. Next, the route from the Denali Highway to the Watana dam site will be particularly harmful by providing access to the fragile alpine tundra/lake/stream complex inhabited by aquatic furbearers around Deadman Mountain, Deadman and Big Lakes, and Upper Deadman Creek. A red fox denning complex south of Deadman Mountain within the one-mile corridor and numerous red fox foraging areas are likely to be negatively affected.

Finally, the Denali Highway will have to be upgraded to a year-round road, thereby providing increased access into the Upper Nenana Valley as well as the Susitna drainage. The Denali Highway is presently closed during winter. Thus, furbearer resources on both the Susitna and Nenana drainages will be affected by this route, in terms of increased access.

(iv) Big Game

Access Plan 7 poses potential negative impacts to big game.

The route segment between the Parks Highway and Devil Canyon follows mainly north-facing slopes and, therefore, is less likely to affect moose and bears than another alignment might be.

Plan 7 calls for a service road on the north side of the Susitna River between the two dams. Portions of this area, specifically Devil Mountain and the mouth of Tsusena Creek, are important moose habitat. This section of the route also goes through areas that appear heavily used by wolverine and bears. The proposed route is higher than most heavily used black bear habitat, though, and is lower than most of the known brown bear dens, thereby reducing the potential for impacts to these species.

This part of the route arouses relatively little concern, then, except in the vicinity of Tsusena Creek and the Watana site, which both black bears and moose frequent. Part of this area will obviously be disturbed anyway with the construction of the Watana Dam itself. In any case, a northern route between the dam sites is preferable to a southern route, which would invade valuable habitat around Stephan and the Fog Lakes.

The Denali Highway segment of Access Plan 7 is of particular concern to big game specialists. The proposed road will pass through an area that has frequently been used either by major portions of or by the entire Nelchina herd, and includes the calving and summer ranges of the northwestern subgroup of the Nelchina caribou herd. This subherd is believed to number approximately 1000 animals. The alpine tundra of the Deadman and Brushkana Creek valleys is the center of the herd's summer distribution.

The Denali segment of Plan 7 also lies across the late summer migration route of caribou toward Butte Lake and Gold Creek. Massive caribou trail patterns--as well as a few bulls--were observed in this region. The proposed road also parallels a traditional spring migration route southward to the Susitna River.

The direct effects upon this group of caribou should Access Plan 7 be implemented include: a disturbance to cows and calves during the road construction period, a disturbance and possible impediment to caribou migration as a result of increased traffic in the area, and the possibility of direct mortality from road kills. Of these, impacts to migration are not expected to be severe as caribou will cross roads. Females do show affinity to traditional calving grounds and interference with the areas could cause major impacts.

Of greater importance than these factors, however, are the indirect consequences to this group of caribou of freer access to its range. An access road across this alpine tundra would provide the opportunity for all-terrain vehicles to push a network of unplanned trails throughout this subherd's range. This new access would cause disturbance and increased mortality to these caribou from their contact with vehicles, campers, and hunters. Thus, there is a chance that this route could lead to partial abandonment of important caribou habitat.

The road will affect other species as well. Moose and black bear will avoid the route by approximately one-half mile in timbered areas to one mile in open terrain on either side. The avoidance-zone estimates double for wolves and wolverines. Brown bears will be affected in two ways: conditioned to fear the sound of an engine, they will avoid any route, and they will be inhibited by a road lying across their migration paths.

(v) Fish

Access Plan 7 is one of the two least desireable route options in terms of fish habitat. First, it calls for bridges over both the Indian and Susitna Rivers, with the road itself running close to the Indian River. Construction activities in both rivers could affect salmon populations, which are known to utilize these areas for spawning and/or migration. Also, with improved access here, the Indian River fisheries will experience increased fishing pressure.

Plan 7's inclusion of a Denali segment adds to the route's disadvantages. In combination with the Parks Highway segment, this northern leg promises that Plan 7 will open up the entire Susitna Basin to increased fishing pressure and to stream and lake disturbance. Alternative 7a is slightly preferable to 7b because it is located farther from the Deadman Creek region and has fewer stream crossings than 7b.

The only positive feature of Access Plan 7 is its northside service road between the Devil Canyon and Watana dam sites. There are fewer fish habitats to be disturbed by road construction and increased access here than along the southern Stephan Lake-Fog Lakes leg.

(vi) Cultural Resources

From the vantage point of cultural resources, Access Plan 7 is the worst option. Alternative 7b ranks first among all routes and alternative 7a second for number of miles of high potential; they rank second and third, respectively, for total number of miles with any anticipated archeological potential.

One of the difficulties with the plan is its service road on the north side of the Susitna River between the two dam sites. From an area immediately north of High Lake and extending to the proposed Watana site, the route traverses terrain largely treeless and ecologically diverse. This region also lacks appreciable soil deposition. These factors make cultural resources highly visible and highly vulnerable to any surface-disturbing activities. For these reasons, secondary adverse effects to cultural resources may be severe. In addition, much of the route traversed by the proposed service road passes through areas of high potential for archeological site occurrence.

The segment of Plan 7 extending south from the Denali Highway to the proposed Watana dam site is a major drawback to this route. A total of fifteen archeological sites have been documented along this leg. Twelve sites are located along or adjacent to 7b, and nine sites appear along 7a. Of the fifteen sites now known and documented, twelve were only discovered during the field survey portion of this assessment.

Virtually the entire length of this route passes through treeless topography, and many deflated areas also occur here. Along much of this northern extension, glacial drift is covered by a thin veneer of loess in areas of high topographic relief. These factors combine to make archeological sites highly visible and easily disturbed because they are not deeply buried.

Based on these observations, it is reasonable to assume that if Access Plan 7 were selected, the secondary adverse impact to cultural resources, particularly from off-road vehicle traffic and artifact collectors, would be extensive.

Access Plan 7, then, is the least desirable from an archeological perspective. If chosen, however, Route 7a would probably encounter fewer archeological sites than would 7b and, consequently, would be preferable.

2.5 HABITAT VALUE COMPARISON

(a) Introduction

Because one of the primary effects of construction and operation of the Susitna access route will be the destruction of wildlife habitat, a special section has been included with this evaluation to assess these impacts. The proposed route alternatives traverse a wide variety of habitat types, so it was necessary in comparing the routes, first, to evaluate the value, or quality, of the wildlife habitat that would be affected by each alternative. The results of this habitat evaluation will then be used in conjunction with other wildlife data to recommend a preferred route.

(b) Methods

In a situation such as addressed in this effort, there is no single, well established, accepted method of determining habitat value. There are techniques available that could be applied to specific species or groups of species, but to deal with the total realm of wildlife species over such a large area in a detailed quantitative fashion is impracticable from a cost and time standpoint. The decision was thus made to utilize an approach that is primarily subjective but does include, to the greatest extent possible, the data already collected on the Susitna studies as well as the professional opinions of the principal investigators familiar with the species and the area.

Two different analysis procedures were utilized, with the results of both procedures applied to the comparison of access plan alternatives. The foundation of both approaches was the same and was based on work conducted by the U. S. Fish and Wildlife Service for use on the proposed Alaska natural gas pipeline corridor (Konkel, G., J. Clarke, L. Halpin, P. Marten, J. Murk, B. Polmer, L. Shea, and R. West. 1981. An evaluation of wildlife habitats within the Alaska Natural Gas Pipeline Corridor. U. S. Fish and Wildlife Service, Habitat Evaluation Project, Anchorage, Alaska). The basis of the approach described

herein, as well as the USFWS approach, is the use of vegetation cover types in defining habitat types; in other words, the terms "habitat" and "cover type" are used interchangeably. Following is a step-by-step description of the procedures used in this analysis. Since there is a danger, when dealing with a procedure that is based upon both quantitative data and subjective opinion, to forget the assumptions upon which the resulting numbers are based, the explanations include frequent warnings and emphases concerning the manner in which the results were obtained. These should be kept in mind when reviewing the results of this analysis.

(i) Determination of Life Requisite Scores

The first step in the analysis entailed determining the value of each cover type to each wildlife species. This process was accomplished by listing, for each cover type, the wildlife species that inhabit or utilize on a regular basis that particular cover type. The value of that cover type to each species was then estimated for seven life requisite categories. The seven categories were as follows: 1) value as food in spring/early summer, 2) value as cover in spring/early summer, 3) value as food in late summer/fall, 4) value as cover in late summer/fall, 5) value as food in winter, 6) value as cover in winter, and 7) value for reproduction activities. In each of these seven categories, a score ranging from 0 to 3 was assigned for each species in each cover type. A score of 3 indicated that the particular cover type was of high value for that particular species in the indicated category, a score of 2 indicated medium value, a score of 1 indicated low value, and a score of 0 indicated that the cover type was of no value.

The determination of the life requisite scores was conducted by the appropriate principal investigators responsible for each species or group of species. At this point, it should be noted that the life requisite scores were determined by several different means, including the review of data collected in the course of the Susitna studies, pertinent literature, and the experience and professional opinions of the investigators. Thus, the scores vary in their degree of subjectivity, depending on the amount of reliable information available. Obviously, the scores for those species that have been intensively studied, and for which a good data base is thus available, will be more reliable than the scores for species about which very little is known of their habitat needs. Therefore, the reliability of the life requisite scores in reflecting habitat value is highly variable, a consideration that should not be ignored when applying the results of this analysis.

(ii) Determination of Cover Type Scores

In determining the habitat value of the cover types, two options were identified, and both were utilized and applied to the comparison of access plan alternatives. The first approach is fairly simple and is basically the same as that used by the U. S. Fish and Wildlife Service (Konkel, et al. 1981). This approach involves summing the total life requisite scores for all species within a cover type to produce a total cover type score (Table 6). The resulting cover type scores were influenced entirely by the numbers of species using the cover type and the value of the cover type to those species. All species and the life requisite values for those species were considered of equal value; no allowance was given to any real or perceived differences in the value of one species over another species. The figures resulting from the computation of these cover type scores were converted to a relative basis, with the highest scoring cover type designated as 1.00 and all other cover type scores altered proportionately less than 1.00.

The second technique for computing the cover type scores requires the weighting of the species life requisite totals to give some species more influence in the total cover type score than other species. The premise in this case is that some species are worthy of more consideration than others when analyzing an access plan. The objective of this weighting process is to develop some index which would, first, reflect the differences in importance of various species. The index could then be used to alter the life requisite totals so that those cover types important to key species would earn higher scores than the cover types of little value to these species.

The determination of the weighting factor was based largely on the approach used by the U. S. Fish and Wildlife Service in their Habitat Evaluation Procedure [U. S. Fish and Wildlife Service. 1980. Habitat Evaluation Procedures (HEP), ESM 102. Division of Ecological Services, Washington, D. C.]. The weighting factor was referred to as a Relative Value Index (RVI). The first step in generating a RVI is to select criteria. Five evaluation criteria were chosen and their relative weights determined by means of a pair-wise comparison. The five criteria are described below with their relative weights identified in parentheses.

- Ecological Importance (0.30) - based on the contribution of a species to nutrient cycling and energy flow.
- Consumptive Value (0.30) - the value of the species to subsistence and sport hunting and trapping.
- Non-consumptive Value (0.13) - the value of a species for non-consumptive uses such as bird watching, photography, aesthetic value, or as an attraction to tourists.
- Vulnerability to Habitat Destruction (0.07) - the potential for a population existing within the project vicinity to be negatively affected by habitat destruction from the proposed action.

- Vulnerability to Disturbance Resulting From Human Activity (0.20)- the potential for a population existing within the project vicinity to be negatively affected by human activity associated with the proposed action.

Each criterion was then applied to each species, and a value ranging from 1 to 100 was assigned to indicate the extent to which that criterion applied to the species. This number (1-100) was then multiplied by the weight of the criterion, and all five products were totaled to produce a relative value score for each species. Next, these scores were converted to an index by assigning a value of 1.00 to the highest score and converting all other scores to a comparable value less than 1.00. The result of this process was a Relative Value Index for each species.

The RVIs were then applied to the life requisite scores as computed for each cover type. As a result, the scores of high value species, i.e., those species with a high RVI, were reduced very little, while the scores of low value species (low RVI's) were lowered considerably. These adjusted scores were totaled to produce a score for each cover type.

At this point, two sets of cover type scores were available for use, one set based on unweighted habitat value (no RVI) and one set based on weighted habitat value (with RVI). In both cases, the scores were converted to a relative value by assigning a 1.00 score to the highest figure and converting the others to a comparable value less than 1.00.

(iii) Comparison of Access Plans

Following the calculation of the relative cover type values, the acreage of each cover type within each access plan was determined. These acreages were adjusted by applying the relative cover type values for the appropriate cover types. The adjusted acreages were totaled to provide a total adjusted score for each access plan. For example,

if a particular plan included 10,000 acres of a cover type with a relative value of 1.00, the adjusted score remained 10,000. If that plan included 10,000 acres of a cover type with a relative value of 0.75, the adjusted score would be 7,500. In other words, the more acreage of high value cover types contained within a plan, the less the adjusted score deviated from the initial acreage. Conversely, plans with a high proportion of low value cover type acreage were reduced more. For comparative purposes, this process was conducted for both sets of cover type scores, the weighted set and the unweighted set.

(c) Results and Discussion

The results of this analysis were useful in determining the relative habitat value of the vegetation cover types (Table 6). With minor exceptions, however, the comparison did not influence the ranking of the access plans with respect to their impact on wildlife habitat. The differences in the lengths of the plans and the corresponding differences in acreage were so great as to overwhelm the differences in habitat value of the cover types contained within each plan. There were two basic reasons for this result. First, many of the cover types were very similar in their relative value as habitat. Very few cover types were notably different from the cover type ranked above or below. In other words, a fairly smooth continuum evoked from the highest value to the lowest.

The second factor responsible for reducing the ranking effectiveness of this comparison was the length of the proposed access plans and the high degree of cover type heterogeneity within each access corridor. To quantify this heterogeneity, an interspersion index was calculated for each plan. This index consisted of counting the number of times the centerline crossed a cover type boundary. Of the fourteen plans, the highest index figure was 2.1 cover type crossings per mile (plans 2a and 2b) and the lowest was 1.7 (plans 3b and 4b). The other plans

fell between these two figures and in total indicated that all plans traversed a highly heterogeneous cover type pattern.

Table 7 illustrates the ranks of the plans based on simple acreage, unweighted adjusted scores, and weighted adjusted scores. In only one case did the rank of a plan shift as a result of using a different approach. Otherwise, the habitat comparison resulted in a ranking identical to that based on acreage. Thus, there is no justification for choosing a long access route in the hopes of avoiding valuable habitat. In fact, when all the variables were considered, Access Plan 8 surfaced as the best choice from the standpoint of least impact on wildlife habitat. Plan 7b is the worst choice on this basis.

Review of the acreages, the unweighted scores, and the weighted scores reveals very few differences among Access Plans 4a, 4b, 2b, 2a, 5, 1b, 1a, and 3a. The only notable difference arises with Access Plan 3b. If Plan 8 is not selected, it then makes little difference, from the standpoint of impact on wildlife habitat, which of the above mentioned plans is chosen.

Continuing down the ranking, Plans 6a and 6b are considerably different from the plans ranked above them and are certainly inferior selections. There is also a large gap between Plans 6a and 6b and Plans 7a and 7b. Selection of either of these plans would result in far more habitat destruction and impact on associated wildlife than with any other plan. This is especially true if 7a and 7b are compared to some of the high ranking plans, such as 8 and 4a.

Although the results of this exercise do little to aid in the selection of an access plan, they will be most useful when considering mitigation for other access route decisions. For example, it is anticipated that some fine-tuning of the actual right-of-way will take place following the selection of a plan. Referring to the cover type rankings will suggest route changes that will avoid high value habitat and, where a

choice exists, result in the disturbance of only cover types of lower habitat value. Likewise, subsequent decisions concerning the acquisition of borrow material for construction of the access road can utilize the results of this analysis, along with the vegetation maps, to select borrow areas with low habitat value rather than areas of great importance to wildlife.

2.6 MITIGATION

In the environmental analysis of a major project such as the Susitna Hydroelectric Development Project, of which the access route is only a portion, negative effects on various vegetation types, wildlife species, and cultural resources are inevitable. Mitigation opportunities must therefore be used whenever possible to decrease potential negative impacts. Avoidance, as a type of mitigation, is perhaps the best or most appropriate method to be considered in the selection of an access plan. The Impact Assessment (Section 2.4) allows such avoidance by analyzing and thereby isolating that plan which presents the potential for the fewest negative consequences of access. In addition, final centerline surveys will be conducted to avoid waterways, important wildlife habitats and other sensitive areas wherever possible. With that in mind, the following are some general guidelines for impact mitigation for any access plan chosen.

(a) Vegetation

On any of the access plans chosen, areas of potentially severe solifluction problems, such as those indicated by the presence of tall shrub communities or alder thickets, should be avoided by skirting around these vegetation types and their associated landforms. Solifluction could be mitigated by fertilizing and seeding slopes to grasses to stabilize them. In addition, use of rip rap, mulch, netting, terracing and other techniques can be utilized to stabilize areas prior to regrowth of vegetation. After construction, managed revegetation will be necessary in areas of rough terrain, that is, those with more steep slopes exposed. While caribou range should be avoided as much as possible, caribou do, in some instances, seek out roads in order to feed on vigorous roadside plants. Reclamation of all temporarily disturbed areas by replacing topsoil and stabilizing slopes with planted vegetation will partially mitigate negative impacts on vegetation.

(b) Birds and Small Mammals

Permanent habitat removal or destruction as a consequence of any access

route is a direct impact on that area's birds and small mammals and cannot be mitigated. Temporarily disturbed areas, such as will be created during the construction stage of the access route or, in some cases, borrow areas, can be recontoured and revegetated to make them available for use by some avian and small mammal species, if not the same ones that previously inhabited those areas. This will partially mitigate the disturbance to those areas.

(c) Furbearers

(i) General

- Construction should avoid closely paralleling and/or obstructing waterways and lakes. These sites often provide important cover, den sites, and foraging areas for furbearers, especially beavers, muskrats, mink, and river otters.
- For crossing small streams and wet areas, bridges rather than culverts should be used, where practical, to avoid problems with beavers damming culverts.
- During the period April through June, furbearers den and produce young. Construction should be avoided in wetland areas and in stands of white spruce at this time of year.

(ii) Segment Specific

In the route segment between the Parks Highway and Gold Creek, in order to minimize the destruction of additional furbearer habitat, the road should be kept above the waterways whenever possible and should closely follow the existing railroad.

In the route segment between Gold Creek and Devil Canyon, any road or railroad should be built on the ridge to the south, above the creeks, streams and small marsh areas that parallel the proposed route. The existing primitive road may be harmful to furbearers because it crosses and closely parallels waterways that are used by aquatic furbearers.

In the route segment between Devil Canyon and Watana on the north side of the Susitna River, construction should be avoided in the area around High Lake and other lakes during the period April through June to minimize disturbance to foxes denning near these lakes.

In the route segment between Devil Canyon and Watana on the south side of the river, alternative "a" near the rim of the Susitna Canyon and alternative "a" south of Fog Creek should be followed to avoid concentrations of marten, beavers, and muskrats.

In the route segment between the Watana dam site and the Denali Highway, in the vicinity of Deadman Mountain, the "a" alternative should be used. Near the southern end of the mountain, the road should be kept on the ridge to the west of Deadman Creek at an elevation of 3200 feet or higher. This alignment will avoid fragile aquatic furbearer habitat as well as a red fox denning center.

(d) Big Game

Some steps can be taken to reduce the effects on big game of any of the access plans chosen. Direct animal mortality resulting from road kills may be decreased by early instructional sessions for construction workers. Alaskan authorities will have to design and enforce controls to keep behavior disruptive to big game at a minimum.

Of perhaps more concern, however, is the increased access to the upper Susitna basin to the general populace. Ultimately it will be the responsibility of Alaskan government agencies to control wildlife disturbance, particularly the incursion of all-terrain vehicles. Without controls, caribou in particular, may be severely impacted, especially by those plans that provide access via large expanses of open country, such as the area between the Susitna River and Denali Highway.

(e) Fish

Proper construction during non-critical times of the year can eliminate or reduce construction impacts. It is also imperative that the proper type of stream crossing facility be constructed at the respective site. These

should include bridges and properly installed culverts. Low water crossings have been found to be a failure in association with the Alaska oil pipeline construction. Properly built low water crossings can be used for occasional, light, vehicular traffic. They are not, however, intended for the movement of heavy equipment for construction purposes.

Control of siltation could mitigate impacts to spawning areas. Use of siltation control devices and prompt restoration and revegetation of disturbed areas on creek and river banks will reduce impacts to fish populations.

(f) Cultural Resources

Those responsible for route selection should take into consideration the cost of mitigating adverse effects on cultural resources as a very real factor in attempting cost analysis for construction purposes. They must also consider the potential for encountering cultural resources in borrow sources and the access roads to them. Finally, it should be noted that whatever route is selected, adverse effects upon cultural resources can be mitigated. Three options can be considered: 1) avoidance (minor realignment of the route); 2) preservation; and 3) investigation (conservation of information through adequate study of the resources, which may include systematic excavation). Combinations of the three mitigation options may be recommended.

2.7 CONCLUSIONS

On the basis of the environmental impact assessment as documented in this report and the mitigation options available, the best access plan from an environmental standpoint alone is Access Plan 8. By originating at a railhead, Gold Creek, to which there is currently no road access, this plan will limit, to a large extent, the potential impacts associated with easy public access. Although a road from Gold Creek may allow more access than a railroad (Access Plan 2), this disadvantage is overshadowed by the advantage of the northside connection between the two dam sites. This northside connection avoids the potential consequences possible to waterfowl, raptors, furbearers, and some big game species associated with the southside connection, which skirts deep gorges and the highly productive areas near Stephan Lake, the Fog Lakes, and other lakes and wetlands.

A road connection from Gold Creek to the Parks Highway could have potential effects on anadromous fish using Indian River and the Susitna River and on furbearers, and it passes through large areas of wetlands and other sensitive vegetation communities. This segment also seems superfluous to minimum access needs for construction and maintenance.

The road segment connecting the Watana dam site to the Denali Highway has the potential to impact big game, particularly portions of the Nelchina caribou herd; furbearers; vegetation communities; and cultural resources. This segment poses the least potential impacts to birds and small mammals. All plans that incorporate this segment also include a connection to the west, either by road or railroad. In one plan (Access Plan 7) there is a complete road connection between the Parks Highway and the Denali Highway. Any of these plans could increase access to such an extent that certain animal subpopulations may be seriously jeopardized.

Table 2.1

Estimated Acreages for Each Vegetation Mapping Unit in One-Mile Wide Corridors for Proposed Access Plans

Access Plan

Habitat Type	6	2a	2b	9	3a	3b	4a	4b	8a	8b	5a	5b	7a	7b
Sedge shrub tundra	1573	622	622	1573	683	683	24	24	1573	1573	22	22	1571	1571
Mat and cushion tundra	2566	2090	2090	2566	1636	1636	4022	3835	6563	6376	4016	3851	6557	6370
Sedge grass tundra	160	106	106	160	61	61	2238	1903	2398	2063	2238	1903	2398	2063
Wet sedge grass	1130	1269	1203	225	491	441	2928	1734	2928	1734	2025	831	2025	831
Open black spruce	43	3035	3071	43	3338	3561	43	43	43	43	418	418	418	418
Woodland black spruce	29	2285	2736	29	2413	2810	126	126	155	155	126	126	155	155
Open white spruce	1838	3648	3980	782	3119	3349	1108	1108	1838	1838	89	89	819	819
Woodland white spruce	1125	3317	1372	796	4315	3285	329	329	1125	1125	---	---	796	796
Closed birch forest	611	943	792	184	649	677	582	582	636	636	135	135	189	189
Open birch forest	528	497	820	118	88	194	497	497	528	528	88	88	119	119
Closed balsam poplar	1027	1027	1027	---	461	461	1027	1027	1027	1027	461	461	461	461

Table 2.1 (Cont.)

Habitat Type	6	2a	2b	9	3a	3b	4a	4b	8a	8b	5a	5b	7a	7b
Open balsam poplar	731	138	138	731	29	29	138	138	731	731	29	29	622	622
Closed mixed forest	7623	7399	7857	6071	6758	7210	6707	6707	7623	7623	5948	5948	6864	6864
Open mixed forest	3463	4039	4238	909	2526	2405	3600	3600	3600	3600	1526	1526	1526	1526
Closed tall shrub	2154	734	734	1984	1229	1229	517	517	2154	2154	426	426	2063	2063
Open tall shrub	1610	1875	1875	1610	1921	1921	---	---	1610	1610	---	---	1610	1610
Birch shrub	7110	2592	1939	7047	2951	2485	6773	6277	13,819	13,323	6709	6213	13,755	13,259
Willow shrub	723	495	576	723	485	508	9226	12,193	9949	12,916	9226	12,193	9949	12,916
Low shrub	3880	2997	2841	3880	3121	3055	1743	2078	5623	5958	1743	2078	5623	5958
Grassland	25	25	25	---	115	115	25	25	25	25	115	115	115	115
Disturbed	194	194	194	71	179	179	194	194	194	194	179	179	179	179
Rock	82	82	82	82	105	105	424	230	424	230	447	253	447	253
River	593	510	510	451	624	624	510	510	593	593	---	---	83	83
Lake	244	351	625	244	313	568	44	381	265	602	21	358	242	579
TOTAL	39,182	40,290	39,493	30,279	37,610	37,591	42,825	44,058	65,424	66,648	35,987	37,242	58,586	59,819

Table 2.2

Avian Habitat Occupancy Levels,
Upper Susitna River Basin,
1981

Avian Census Plot	No. Species (No. Breeding Species)	Density (No. territories/10ha)	Biomass (Grams/10ha)	Species Diversity(H')
Cottonwood Forest	21 (16)	60.9	3653	2.55
Mixed Forest II	22 (13)	34.6	1836	2.07
Mixed Forest I	18 (14)	41.8	1709	2.47
Paper Birch Forest	18 (10)	38.1	1814	2.05
White Spruce Scattered Woodland	23 (16)	43.8	1775	2.29
Black Spruce Dwarf Forest	23 (13)	24.8	1166	2.43
Low-medium Willow Shrub	14 (6)	45.4	1413	1.56
White Spruce Forest	18 (8)	15.7	1059	1.83
Medium Birch Shrub	10 (5)	32.5	952	1.48
Tall Alder Shrub	15 (10)	12.5	888	2.05
Dwarf-Low Birch Shrub	11 (6)	10.6	355	1.29
Alpine Tundra	8 (7)	3.9	211	1.73

Table 2.3

Mileage for Each Access Plan in Terms of High, Moderate and Low Potential to Contain Archaeological Resources

Plan	Approximate Number of Miles				Rank[1] Based On:	
	High Potential	Moderate Potential	Low Potential	Total	Total Miles	Miles of High Potential
1a	24-1/2	9	26-1/2	60	9	10
1b	24	8-1/2	29-1/2	62	8	11
2a	17	9	32	58	11	13
2b	15	8-1/2	29	52-1/2	13	14
3a	39	14-1/2	15	68-1/2	7	5
3b	36	20	13	69	6	6
4a	28	12-1/2	14-1/2	55	12	9
4b	29	18	12	59	10	8
5	32	6	22	60	9	7
6a	44	15-1/2	27-1/2	87	5	4
6b	45	21	25	91	4	3
7a	55	17-1/2	28-1/2	102	3	2
7b	56	23	26	105	2	1
8	23	4	18	45	14	12

1. High numbers represent top choices.

Table 2.4
Environmental Inventory/Constraints - Access Corridor Segments

	Parks Highway to Gold Creek	Gold Creek to Devil Canyon Damsite	Devil Canyon to Watana (Northside)	Devil Canyon to Watana (Southside)	Watana to Denali Highway
Vegetation	Passes close to or through valuable wetlands.	Largely forested area, few large areas of wetlands.	Severe potential solufluction problems in westernmost portion of this segment, as indicated by tall shrub habitat types.	Important wetlands in Stephan and Fog Lakes area.	Relatively minor expanses of area in wetlands, or areas with potential solufluction problems.
Birds and Small Mammals	Valuable bird and small mammal habitat along Indian River, and through wetlands of the Chulitna Pass area.	Forested areas along Susitna River are highly productive habitat for birds and small mammals.	Relatively unproductive habitat for birds and small mammals.	Segment goes through relatively productive forest habitats, and near productive water bodies, such as Stephan Lake, for waterfowl. Also traverses near occupied and potential cliff-nesting raptor habitat along tributaries.	Segment travels through relatively unproductive avian habitat. Bald eagle nest tree along Deadman Creek, little other raptor habitat nearby.
Furbearers	Productive furbearer habitat, particularly beaver, along this segment.	Fairly productive forested habitat for aquatic furbearers.	Relatively unimportant to furbearers except red fox denning area around High Lake.	Productive furbearer habitats around Stephan Lake, Fog Lakes, and Fog Creek.	Good furbearer habitat. Beaver, muskrat population throughout area and numerous fox denning sites in area of Deadman Mountain.
Big Game	Area used primarily by moose and probably black bears.	Predominant big game species in this area are moose and black bear.	Moderately important for big game species, segment is lower than most brown bear den sites: segment intersects north-south caribou trails, but caribou use appears to be light.	Important big game (especially caribou and moose) habitat in Stephan/Fog Lakes areas.	Likely to lead to severe disruption of big game, particularly caribou of the Nelchina herd and upper Susitna and Nenana subherd.

Table 2.4 (Cont.)

	Parks Highway to Gold Creek	Gold Creek to Devil Canyon Damsite	Devil Canyon to Watana (Northside)	Devil Canyon to Watana (Southside)	Watana to Denali Highway
Fish	Potentially severe disturbance to salmon in Susitna River and Indian River fisheries.	Little potential impact to anadromous species.	Few fish habitats, either streams or lakes, near this proposed segment.	Potentially severe impacts to resident fisheries in Stephan and Fog Lakes areas.	Provides access to resident fisheries habitat along route, numerous stream crossings.
Cultural Resources	Considerable portion of segment goes through areas of high and moderate potential for cultural resources.	Relatively little potential for impacting areas of high potential for cultural resources.	A large proportion of this segment traverses areas of high potential for cultural resources. This treeless area, ecologically diverse, also lacks appreciable soil deposition - this makes cultural resources visible and vulnerable to surface disturbing activities.	Documented sites in Stephan and Fog Lakes areas, high and moderate potential for additional cultural resources in these areas. However, topographic constraints to access in western portion could limit impacts in this area.	Large proportion of length passes through areas of high archeological potential, secondary impacts due to increased access could be severe because of largely treeless topography and good visibility.
Approximate # River/Creek crossings	River - 1 or 2 (Indian River) - 1 (Susitna) Creeks - 5	Creeks - 6	Creeks - 12	Creeks - 10	Creeks - 20

Table 2.5

Ranking of Access Plans on the Basis of Total Area of Vegetation, Total Area of Wetlands and Total Area of Solifluction Potential Within the Mile-Wide Corridor

Access Plan Numbers	Rating on the Basis of:(1) Acreage Affected	Wetlands	Solifluction
5	9	9	10
1a	7	8	5
1b	8	7	6
8	14**	14**	12**
2a	10	11	5
2b	11	12	5
3a	6	6	8
3b	5	5	7
7a	2	2	2
7b	1	1	1
4a	13*	13*	11*
4b	12	10	9
6a	4	4	3
6b	3	3	4

(1) High numbers represent top choices
** First choice
* Second choice

Table 2.6

Relative Value of Vegetation Cover Types as Wildlife Habitat

Unweighted Values		Weighted Values	
Cover Type	Relative Value	Cover Type	Relative Value
open mixed forest	1.00	wet sedge grass	1.00
closed mixed forest	0.98	open mixed forest	0.95
wet sedge grass	0.92	open white spruce	0.94
woodland white spruce	0.91	willow shrub	0.92
open white spruce	0.84	lake	0.90
balsam poplar	0.80	closed mixed forest	0.88
lake	0.77	mixed low shrub	0.88
open black spruce	0.74	woodland white spruce	0.87
woodland black spruce	0.72	open black spruce	0.82
closed birch forest	0.72	birch shrub	0.80
willow shrub	0.71	tall shrub	0.77
open birch forest	0.70	woodland black spruce	0.76
mixed low shrub	0.70	sedge grass tundra	0.76
sedge shrub tundra	0.65	sedge shrub tundra	0.75
sedge grass tundra	0.64	closed birch forest	0.66
birch shrub	0.60	river	0.66
tall shrub	0.55	mat & cushion tundra	0.64
grassland	0.53	balsam poplar	0.62
mat & cushion tundra	0.53	open birch forest	0.60
river	0.44	rock	0.44
rock	0.28	grassland	0.42

Table 2.7

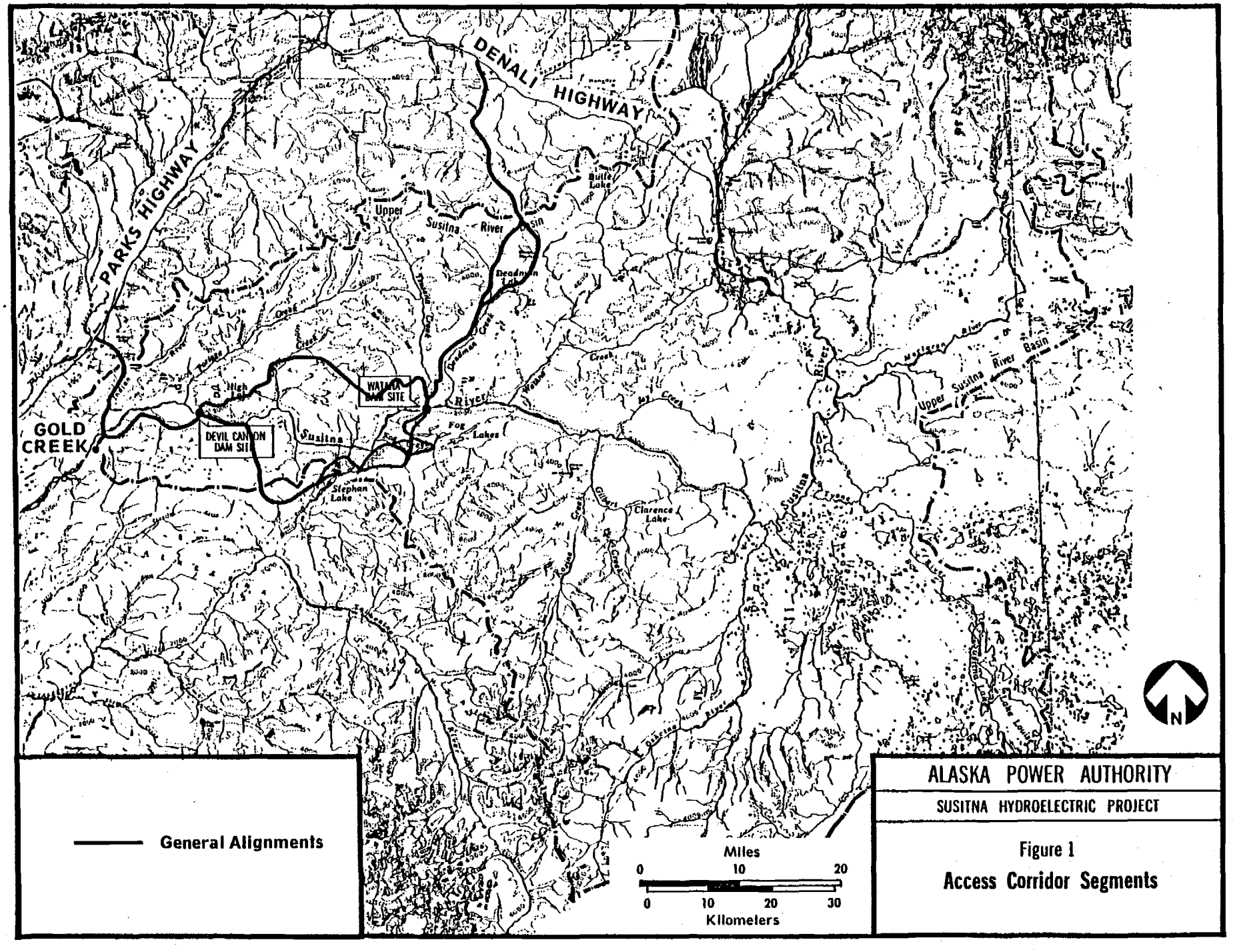
Comparison of Alternative Access Plans

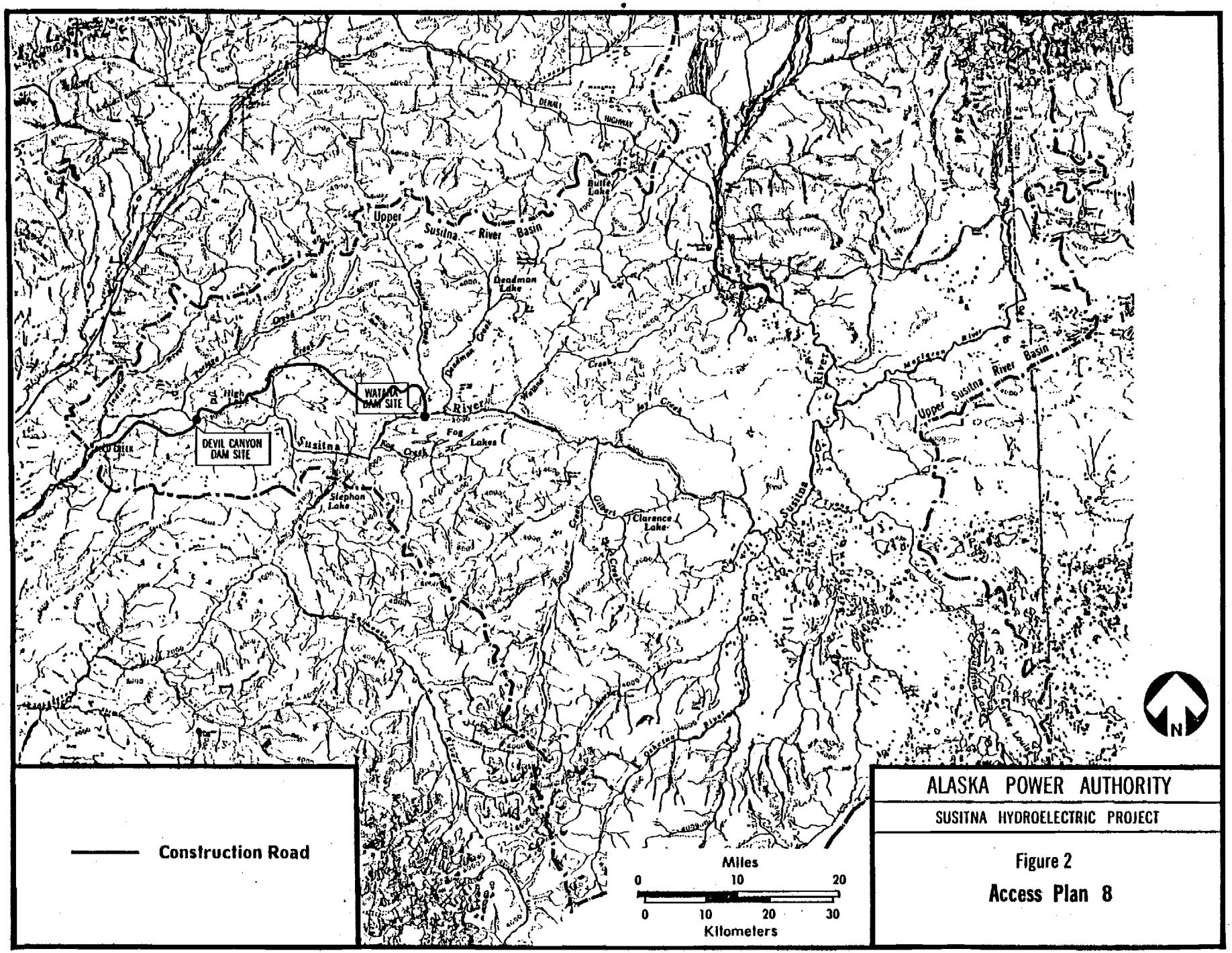
Plan Rank[a]	Based on Actual Acreage	Based on Unweighted Scores	Based on Weighted Scores
1	8 (30,198)[b][c]	8 (21,627)[c]	8 (24,536)[c]
2	4a (35,816)	4a (26,055)	4a (29,954)
3	4b (37,063)	4b (26,901)	2b (31,191)
4	2b (37,412)	2b (29,228)	4b (31,236)
5	2a (37,531)	2a (29,330)	2a (31,327)
6	5 (38,873)	5 (29,551)	5 (31,974)
7	1b (39,339)	1b (31,273)	1b (33,091)
8	1a (40,054)	1a (31,926)	1a (33,544)
9	3a (42,631)	3a (32,008)	3a (35,819)
10	3b (43,864)	3b (32,843)	3b (40,125)
11	6a (58,402)	6a (40,745)	6a (47,952)
12	6b (59,640)	6b (41,584)	6b (49,232)
13	7a (65,224)	7a (46,700)	7a (53,823)
14	7b (66,463)	7b (47,540)	7b (55,105)

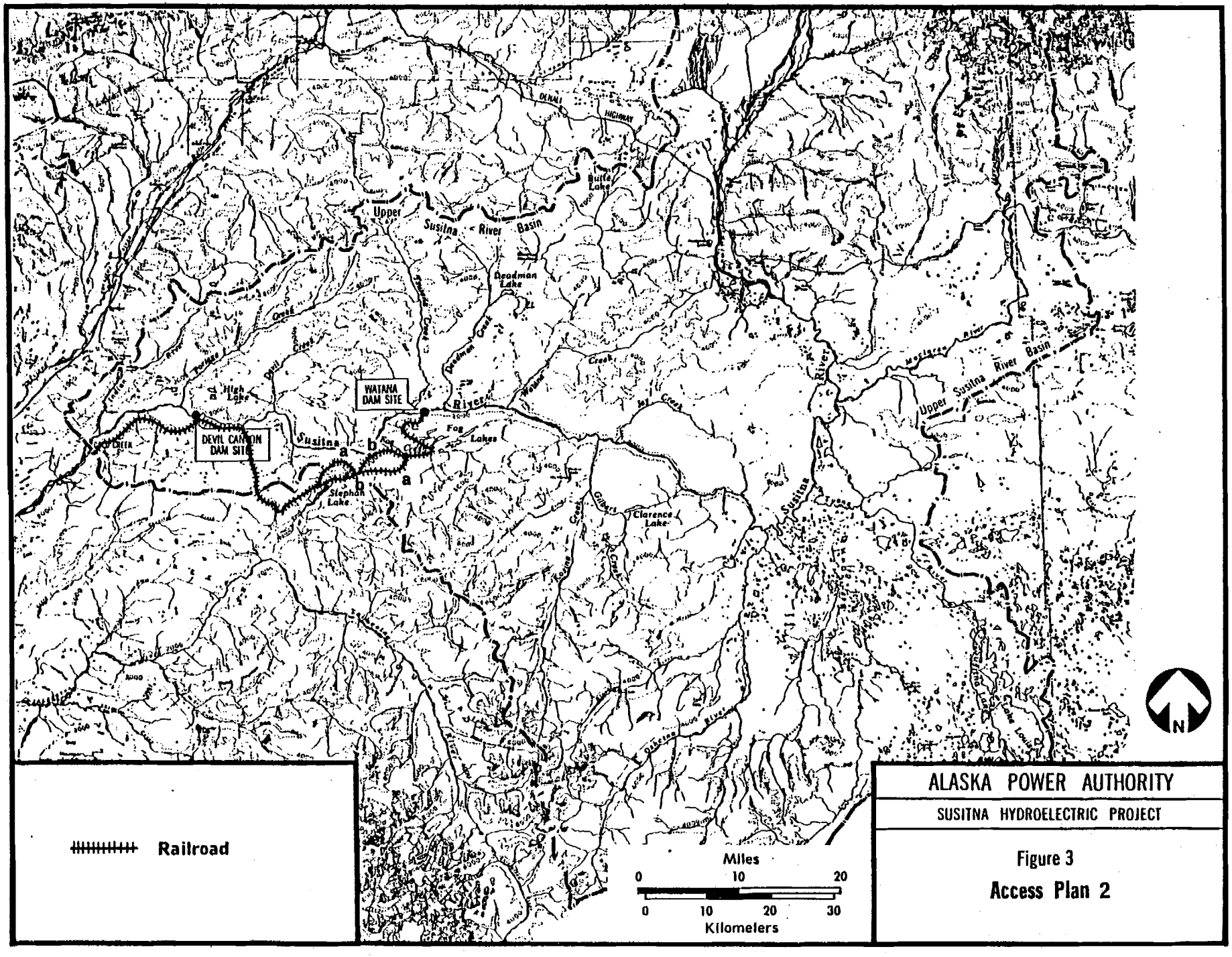
(a) The plans are ranked in decreasing order of preference with number 1 having the least habitat value and thus being the most preferred plan, and conversely number 14 has the highest habitat value and is thus the least preferred choice.

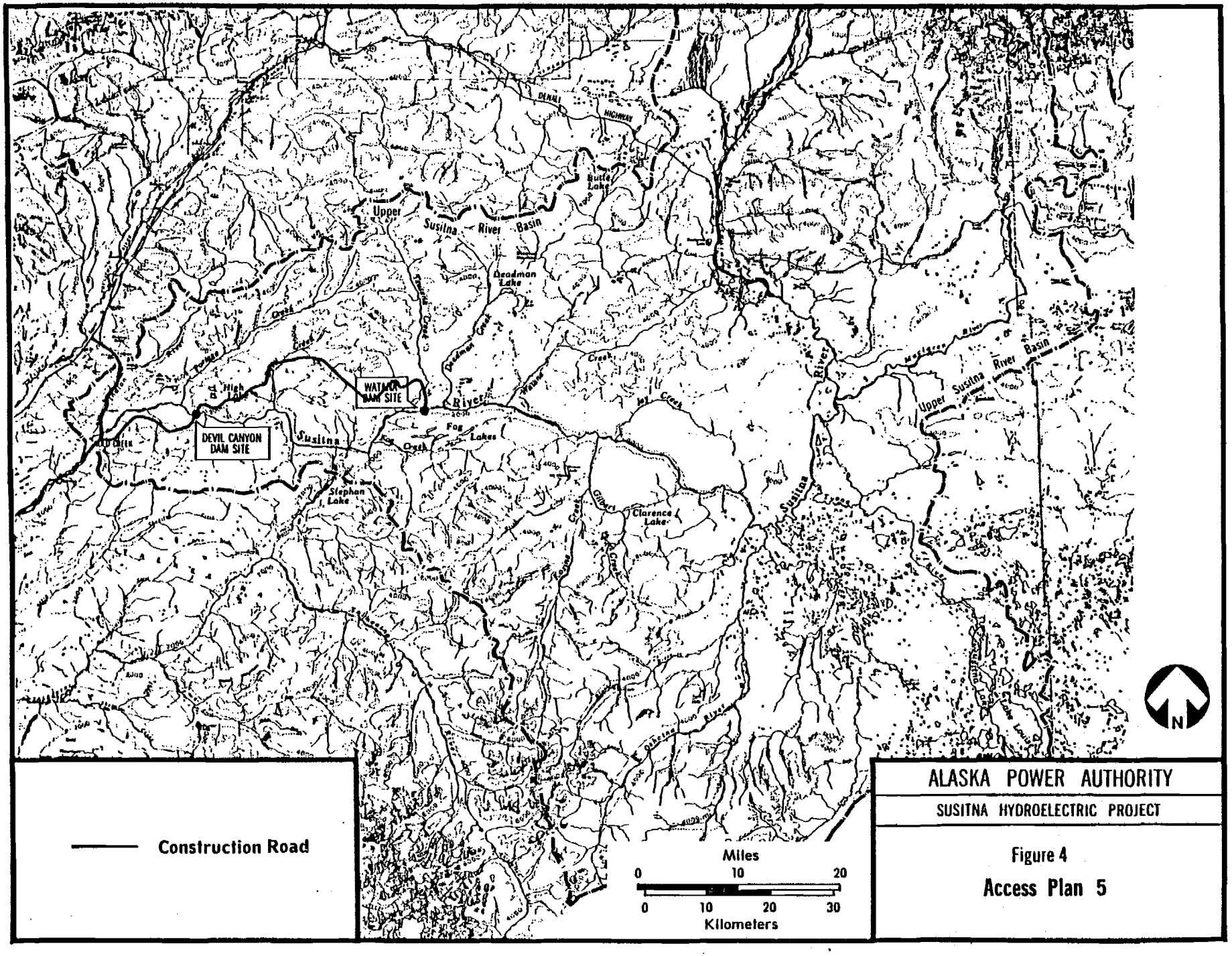
(b) Total acreages deviate from totals in table of vegetation mapping units because cover types such as "disturbed" were not included in the habitat value rankings.

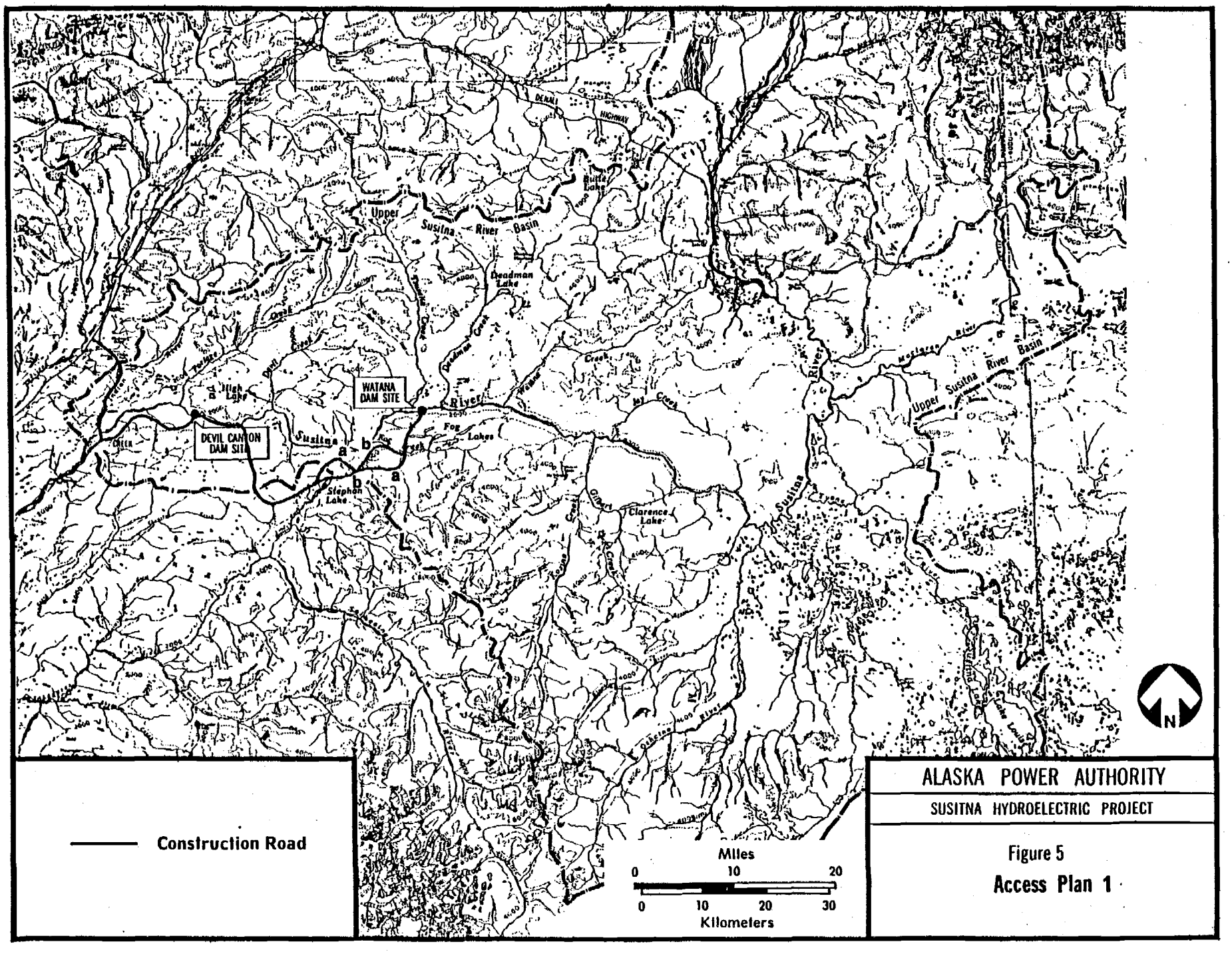
(c) Numbers in parentheses are acreage values. Acreages based on unweighted and weighted scores are adjusted to reflect habitat value.

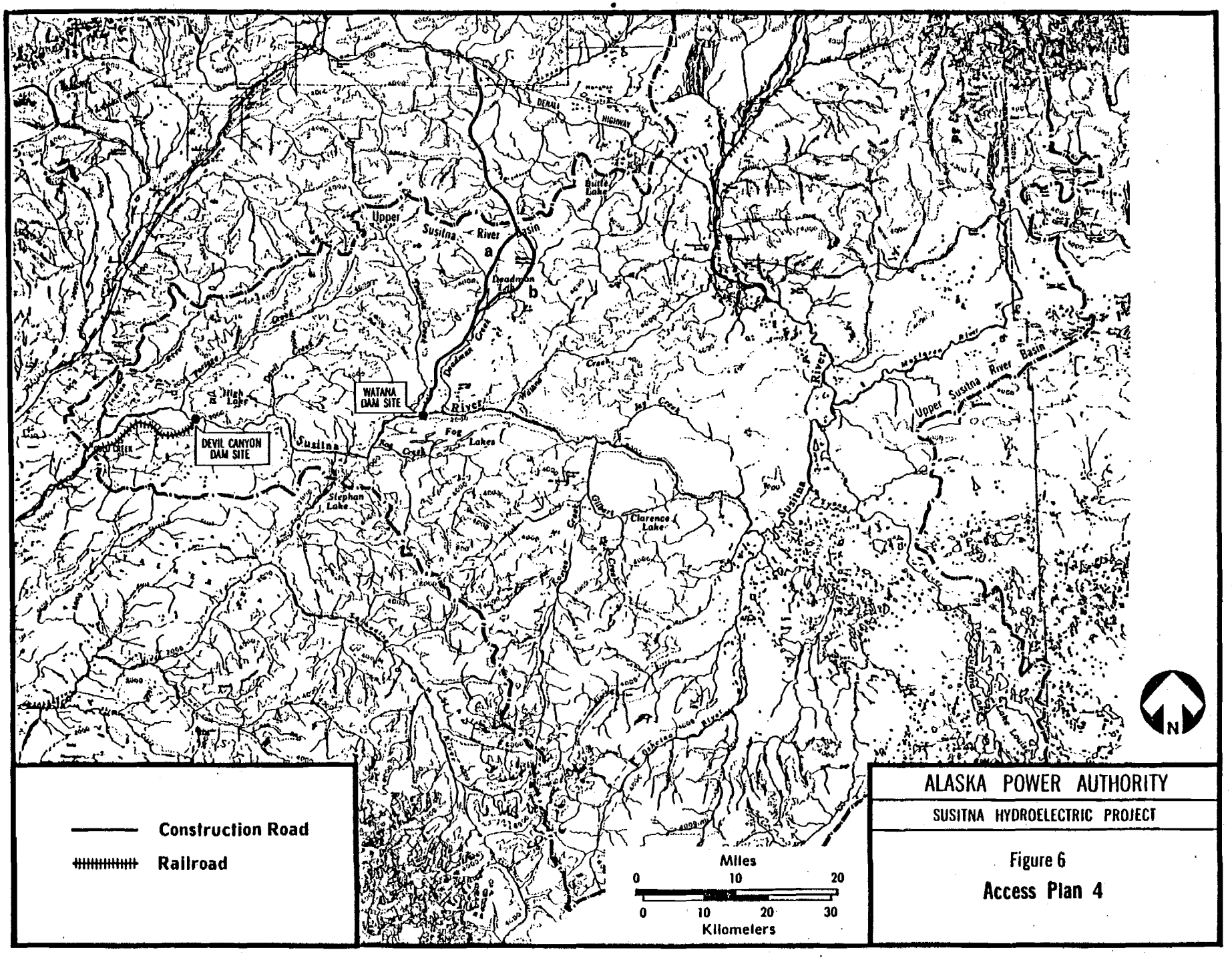

DENALI HIGHWAY
PARKS HIGHWAY
GOLD CREEK
DEVIL CANYON DAM SITE
WATANA DAM SITE
Upper Susitna River Basin
Susitna River
Deadman Lake
Butte Lake
High Lake
Fog Lakes
Stephan Lake
Clarence Lake
Gilbert Creek
Watana Creek
Jay Creek
Tyone River
General Alignments
Miles
0 10 20
0 10 20 30
Kilometers
N
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 1
Access Corridor Segments

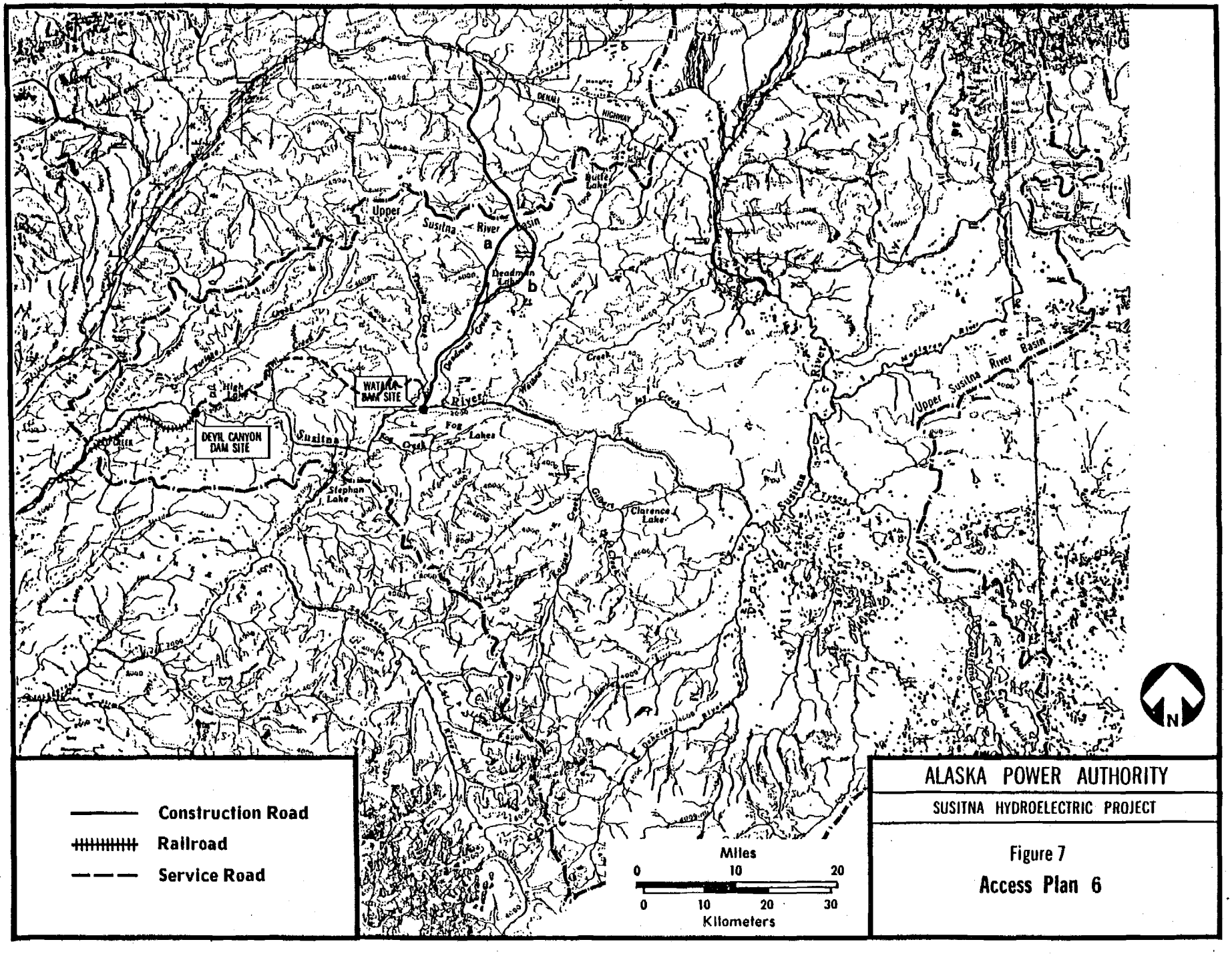

DENALI HIGHWAY
Upper Susitna River Basin
Butte Lake
Deadman Lake
Deadman Creek
WATANA DAM SITE
Watana Creek
Tyone River
Jay Creek
Fog Lakes
Fog Creek
DEVIL CANYON DAM SITE
Susitna River
Stephan Lake
Clarence Lake
Gilmore Creek
Kosina Creek
Oshetna River
Miles
0 10 20
0 10 20 30
Kilometers
N
Construction Road
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 2
Access Plan 8

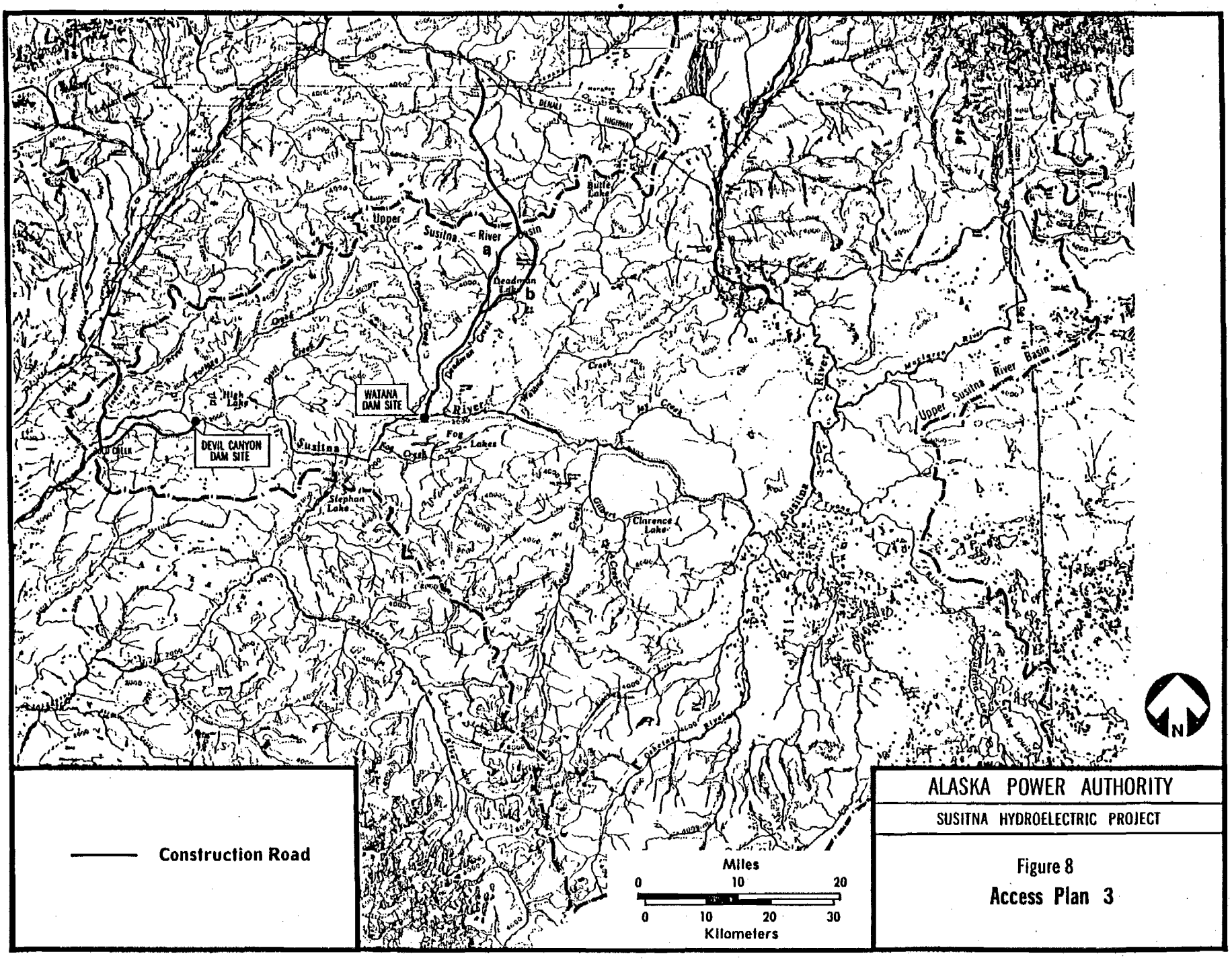

Railroad
Miles
0 10 20
0 10 20 30
Kilometers
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 3
Access Plan 2


DENALI HIGHWAY
Upper Susitna River Basin
Butte Lake
Deadman Lake
Deadman Creek
Tyone River
Tyone Creek
High Lake
WATANA DAM SITE
DEVIL CANYON DAM SITE
Susitna River
Fog Lakes
Fog Creek
Stephen Lake
Clarence Lake
Gilbert Creek
Jay Creek
Watana Creek
Oshetna River
Maclaren River
Upper Susitna River Basin
N
Construction Road
Miles
0 10 20
0 10 20 30
Kilometers
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 4
Access Plan 5


WATANA DAM SITE
DEVIL CANYON DAM SITE
Upper Susitna River Basin
Deadman Lake
Butte Lake
Clarence Lake
Stephan Lake
Fog Lakes
Miles
0 10 20
0 10 20 30
Kilometers
N
Construction Road
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 5
Access Plan 1


Construction Road
Railroad
WATANA DAM SITE
DEVIL CANYON DAM SITE
Upper Susitna River Basin
Deadman Creek
Watana Creek
Fog Lakes
Stephan Lake
Clarence Lake
Butte Lake
Miles
0 10 20
0 10 20 30
Kilometers
N
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 6
Access Plan 4


Upper Susitna River Basin
a
b
Deadman Creek
Butte Lake
DENALI HIGHWAY
WATANA DAM SITE
DEVIL CANYON DAM SITE
High Lake
Fog Lakes
Stephan Lake
Clarence Lake
Gilbert Creek
Watana Creek
Jay Creek
Susitna River
Miles
0 10 20
0 10 20 30
Kilometers
N
Construction Road
Railroad
Service Road
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 7
Access Plan 6



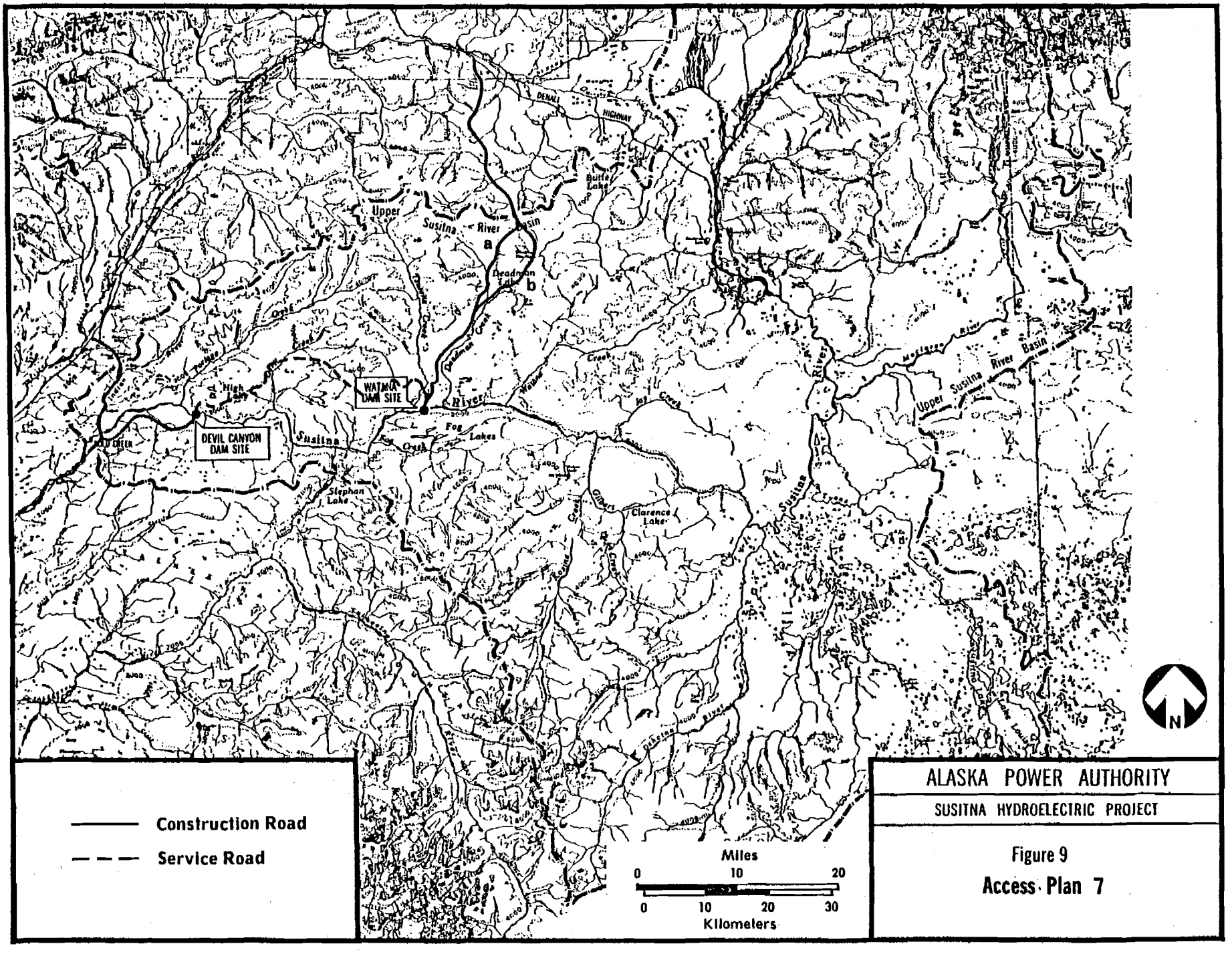
Construction Road

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

Figure 8

Access Plan 3


DENALI HIGHWAY
Butte Lake
Upper Susitna River Basin
a
b
Deadman Lake
Deadman Creek
Tyone River
Tyone Creek
High Lake
WATANA DAM SITE
Watana Creek
Jay Creek
Fog Lakes
Fog Creek
DEVIL CANYON DAM SITE
Susitna
Stephan Lake
Clarence Lake
Gilbert Creek
Oshetna River
Maclaren River
Maclaren River Basin
Upper Susitna River Basin
N
Construction Road
Service Road
Miles
0 10 20
0 10 20 30
Kilometers
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
Figure 9
Access Plan 7

3. SOCIOECONOMIC AND LAND USE ANALYSIS

Each of the eight access plans under consideration contains access routes to both dam sites which tie into the existing transportation network at one or two of the following points: the Parks Highway at Hurricane (road intersection), the Alaska Railroad at Gold Creek (railroad or road junction), and the Denali Highway near Denali (road intersection).

The eight routes can be paired according to shared points of origin, although they vary in alignment or mode from the point of origin to the work sites. For purposes of socioeconomic and land use analysis, the point of origination is the dominant variable, with mode being an important variable and alignment being a minor variable. In general, the effects of each pair will be very similar.

Access Plans 1 and 5 - These plans are both road access options originating at Hurricane, passing through the Devil Canyon site, and terminating at the Watana site. In Plan 1 the road is on the south side of the Susitna River between Devil Canyon and Watana; in Plan 5 the road is on the north side between the two dam sites.

Access Plans 8 and 2 - Both originate at a railhead near Gold Creek, pass by the Devil Canyon site, and terminate at Watana. In Plan 2, the connection is accomplished via a rail line on the south side of the river; in Plan 8, a road runs on the south side of the river from the railhead to Devil Canyon and on the north side of the river from Devil Canyon to Watana.

Access Plans 4 and 6 - Both plans include the initial construction of a road from the Denali Highway to the Watana site followed by the construction of a railroad from the railhead at Gold Creek to the Devil Canyon site. Plan 6 includes the construction of a service road on the north side of the river between Devil Canyon and Watana; Plan 4 does not.

Access Plans 3 and 7 - Both plans include the initial construction of a road from the Denali Highway to the Watana site followed by the construction of a road from near Hurricane on the Parks Highway to the Devil Canyon site. Plan 7 includes the construction of a service road on the north side of the river between Devil Canyon and Watana; Plan 3 does not.

3.1 METHODS

(a) Socioeconomics

The development of access routes to the Watana and Devil Canyon dam sites will affect the economic and social characteristics of the surrounding region, particularly near the junctions between the access routes and existing transportation corridors. The type, magnitude, and location of these effects will vary depending upon which access route is selected, whether a road or railroad is built, and how frequently construction workers commute to the work sites. The severity of the socioeconomic effects of the alternative access routes depends more upon the origin and type of access than on the actual alignment; these details determine which communities in the railbelt region will be affected as well as the extent to which they will feel the impact.

The evaluation of the access plans from a socioeconomic standpoint consisted of assessing the dynamics of socioeconomic change for each plan. This assessment was based on several assumptions. First, housing for workers would be provided on-site, and the families of workers would locate as conveniently as possible to the site. Second, all roads constructed into the Susitna drainage from public roads would also be public and allow access to the sites. Finally, whether a road or railroad is used, it is assumed that the port of entry for project materials would be Anchorage and, possibly, Whittier. Thus, effects from transport of materials would be concentrated in communities located along the Parks Highway.

The preliminary socioeconomic assessment sought to determine qualitatively the level of impact on each socioeconomic category for each access plan and each geographic area. The results of this assessment are shown in Table 8. The level of impact under each plan is designated by labeling the effects as: 5-major, 4-significant, 3-moderate, 2-slight, and 1-negligible.

The following is a summary of the information presented in Table 8. It should be noted that effects on Fairbanks should not vary as a result of differences in the proposed access routes. They will be essentially the same under all plans. Therefore, Fairbanks is not included in the discussion of the variation of effects under different plans.

(b) Land Use

Each access route will be built for construction and operation of the dam facilities. Many of the effects, however, will be related to long-term consequences after construction is complete. The impact on current land use and related activities resulting from emplacement and use of an access route will vary depending upon the location of the route and the mode selected.

Each route was analyzed for its potential land use impact, and Table 9 was constructed to present the anticipated magnitude of these effects on the various land use concerns for the route under consideration. A numerical scale of 1 to 5 has been used, with 5 representing a great impact and 1 a small or negligible impact. The scoring's purpose is to identify only possible impact and to estimate relative magnitude, thus enabling a rudimentary comparison of the access schemes. This information, in combination with analyses provided by other environmental specialists, can be used by those responsible for making the decision as to which access scheme is most desirable.

3.2 CRITERIA FOR EVALUATION

(a) Socioeconomics

Socioeconomic analysis identifies changes in specific characteristics that cover a wide range of social, community, and economic categories. The social and community categories selected for inclusion in the analysis of the proposed access plans constitute some of the criteria upon which an evaluation was based. These are:

- population levels
- racial mix
- culture/way-of-life
- community, social, and political organization
- housing type
- housing availability
- public services
- government expenditures and revenues
- total labor demand
- unemployed labor

The economic categories that served as evaluative criteria are:

- construction
- mining
- agriculture
- forestry
- manufacturing
- commercial fisheries
- oil and gas
- transportation (motor, rail, & port)
- public utilities
- communications
- wholesale trade

- retail trade
- services
- tourism/recreation

Each of the access route plans has been examined in terms of its effects on categories listed above. The effects have been considered for the Parks Highway-Railroad corridor, the Richardson Highway corridor, and Anchorage, Whittier, and Fairbanks. More specifically, the corridors are defined as follows:

- Parks Highway-Railroad corridor - This corridor includes development between Fairbanks and Anchorage. It includes communities in the Matanuska-Susitna Borough and the southeast part of the Yukon-Koyokuk Census Division. Those communities along the Parks Highway, include Healy, Cantwell, Chulitna, Talkeetna, Willow, and Wasilla. This corridor and the surrounding area is termed "Westside."

- Richardson Highway corridor - This corridor includes the Valdez-Cordova Census Area, specifically communities such as Glennallen, Gulkana, Paxson, and others located along the Richardson Highway. This corridor and the surrounding area is termed "Eastside."

(b) Land Use

The land use analysis of each access plan involved assessment of the potential impact of the route on four general land use classes defined as follows:

(i) Land uses inherently associated with site specific activities

This class includes land uses that involve some form of long-term commitment of human resources (e.g., structures) and their concomitant activities. These include the following subclasses: residential,

commercial (primarily recreational), mining, agriculture, and transportation.

(ii) Dispersed and isolated non-site-specific activities

This class incorporates activities that are generally non-continuous and do not involve a commitment of resources at any particular site; these include consumptive recreational or subsistence activities, such as hunting and fishing; riverine activities, such as boating or rafting; and dispersed activities, such as camping, hiking, and photography.

(iii) Resource management activities and related concerns

This category involves consideration of present or potential future activities related to conservation or planned use of the land and resources, including fish and wildlife management, dispersed recreation management, off-road vehicle management, native claims, and land values.

(iv) Natural aesthetics

This category involves consideration of and for the natural land cover type itself as opposed to the uses of or activities on the land; these concerns encompass visual character for both land and water resources; ground cover, specifically flora; land surface integrity; and general natural character.

3.3 DESCRIPTION OF RESOURCES

In the upper Susitna basin, the site of all the proposed access plans, there is little extensive land use. Most of what exists occurs along present rail lines and around the major lakes in the area--High, Stephan, and the Fog Lakes. In these locations, most of the land use resources involve recreational concerns, both of a private, individual nature and of a commercial sort.

Obviously, with the introduction of a highway, a railroad, or a combination of these, land use concerns focusing on transportation will also be involved. Furthermore, the communities that exist at the origins of these routes will feel the impact of any new transportation form introduced.

Access will facilitate the influx of people and activity within the basin, affecting both small population concentrations and isolated residences, peripheral commercial and transportation systems, resource utilization and level of recreational activity, visual and aesthetic factors, and the overall character of the area. In addition, these effects will have ramifications for management activities in terms of their extent, adequacy, and need (e.g., fish and game, land, etc.) and will influence changes in land values and development.

(a) Parks Highway to Gold Creek

Access Plans 1, 5, 3, and 7 all include this route segment. The land use resources in this area, to be affected by these access plans, include Pass Creek and the Indian and Susitna Rivers, all of which will require crossings. These access plans will also have a significant impact on Chulitna, Canyon, and Gold Creek, all of which will acquire road access where none previously existed. Two cabins and an unnamed lake are also included in the land use resources here.

(b) Gold Creek to Devil Canyon

All of the access plans include this segment, although some pass through here via railroad while others use a vehicular road. The towns of Gold Creek and Canyon would both experience an impact from access plans here, with the effects on Gold Creek substantially greater than those on Canyon. Both would feel the impact on their land values and on commercial and residential land uses. Some minor stream crossings are also planned for this area.

(c) Devil Canyon to Watana, North Side

In terms of land use concerns, the primary resources to be affected here are waterways and water bodies. Access Plans 5, 8, 7, and 6 will pass within a quarter-mile of both the Susitna River and an unnamed lake. These plans will come within a half-mile of High Lake and partly parallel a several-mile length of Devil Creek.

Other types of resources along this route include High Lake Lodge, which consists of nine buildings; a private cabin; and Tsusena Creek, which will require a significant crossing via a bridge.

(d) Devil Canyon to Watana, South Side

Access Plans 1 and 2 incorporate this segment. The waterways to be affected here include two unnamed tributaries of the Susitna itself and, with Plan 1, a significant crossing and bridge over Fog Creek. These access plans will pass within one-quarter mile of Stephan Lake and will come quite close to the Fog Lakes. All of this area may experience increased off-road vehicle use, especially around the lakes and in the plateau region of the upper Prairie Creek drainage. This use will be limited, however, if Plan 2, using a railroad, is chosen over Plan 1, which calls for a highway.

Finally, access into this area, by whatever means, will affect approximately twelve cabins and the Stephan Lake Lodge, which consists of ten structures. The lodge, in particular, will experience a significant impact.

(e) Denali Highway to Watana

Access Plans 3, 7, 4, and 6--all of which incorporate this segment--will parallel the Deadman Creek drainage and pass close to Deadman Lake. They will also pass within a mile or so of a lake adjacent to Tsusena Butte, so both the butte and the lake will experience some impact. This segment could have a possible effect upon approximately four local cabins and will open up a considerable area to new off-road vehicle use.

3.4 IMPACT ASSESSMENT

(a) Access Plans 8 and 2

(i) Socioeconomics

With access to the sites originating at Gold Creek, all materials, equipment, and labor must move by rail to Gold Creek. Once there, it would continue either by rail or road to both dam sites. There would be a significant impact on Gold Creek itself as well as at Hurricane and Talkeetna, which are the last railroad junctures with highway access to the north and south of Gold Creek, respectively.

In a more general sense, Plans 8 and 2 would also concentrate effects on the Westside, and these would be approximately the same as those for Access Plans 1 and 5 (see below). The differences would occur in those categories affected by the limited access that a rail link affords and in rail-related activities, which would receive additional stimulation. Even though direct access to the work sites would require vehicle access from the railhead at Gold Creek, Access Plan 8 would not have the same results as Plans 1 and 5 (see below). The fact that vehicles can only be brought into the access road by rail will largely limit the vehicles on the road to a set of dedicated project vehicles. Plans 2 and 8 limit public access and recreational use significantly, while Plan 2 has the additional advantage of controlling stops along the access route.

Westside: With Access Plans 2 and 8, there would still be major or significant effects on population levels and total labor demand as well as on housing availability and the construction industry in Westside communities. These effects would be magnified in Talkeetna and near Hurricane because of their locations at rail-highway intersections. There would likely be significant effects on public services, government expenditures and revenues, unemployed labor, public utilities, retail trade, and services. A moderate effect would probably occur in mining,

manufacturing, motor transportation, communications, way-of-life, and community organization. Housing type and other categories would probably be affected slightly or negligibly.

Anchorage/Whittier: The effects of Access Plans 2 and 8 on the Anchorage area would be much the same as with all road access. Construction, port and rail transportation, wholesale and retail trade, and service industries would still feel significant or moderate effects. Changes in unemployed labor, community categories, and most other industries can be expected to be slight or negligible. Whittier, however, would feel moderate effects on employment, retail trade, and services.

Eastside: Most effects resulting from road access would be concentrated on the Westside, not the Eastside. Negligible or, at most, slight effects would result for the Eastside.

(ii) Land Use

The effects associated with Access Plans 2 and 8 are probably the most limited, in that the only access to the interior basin is via rail at Gold Creek. To take either the road or railroad to the dam sites requires using the Alaska Railroad to get to Gold Creek. This approach tends to limit access, while a road, on the other hand, permits the public to drive to the site. Furthermore, use of the railroad to ship materials to a point where materials would be transported to the dam sites would cause less of an impact on communities along the Parks Highway corridor.

(b) Access Plans 1 and 5

(i) Socioeconomics

Generally, the access route impact will be concentrated on the Westside and in Anchorage. They will be more evident on the Westside than in Anchorage, however, since the Westside lies closer to all access route

origins and currently has far less development and activity. The Railbelt corridor will provide access for construction materials, power plant equipment and furnishings, and construction workers as well as for post-construction users of the Susitna Basin (recreators, hunters, fishermen, etc.). The size, composition, and source of the construction work force are major determinants of socioeconomic impact. The majority of available Alaskan construction workers will be based in the greater Anchorage area and, to a lesser extent, in Fairbanks. They will need to commute to the site on some periodic basis. Out-of-state workers who bring their families will wish to locate as close to the site as possible, yet will desire to be near services and shopping such as are found in Anchorage and Fairbanks. Depending on work force scheduling at the site, they will locate anywhere between the junction with the access road and the Anchorage and Fairbanks areas. The majority will probably seek accommodations in the southern portion of Mat-Su Borough.

Westside: Communities in the borough will be called upon to provide increased services. There will be major or significant effects on population levels, housing availability, public services, government expenditures and revenues, total labor demand, and unemployed labor in both the Mat-Su and southeast Yukon-Koyokuk areas. There will also be major or significant effects on construction, motor transportation, public utilities, retail trade, services, and the tourism industry.

There would be moderate effects on culture, the way-of-life, community, political and social organization, mining, communications, and manufacturing industries. Other categories such as housing type, agriculture, forestry, fisheries, oil and gas, wholesale trade, racial mix/ethnicity/religion, and rail and port transportation would feel only slight or negligible effects.

Anchorage/Whittier: With a road from the west, the Anchorage area could anticipate slight or negligible effects on the community and related

categories and in several of the economic base categories. There would be moderate consequences for construction, motor and port transportation, retail trade, and service industries. A significant effect on wholesale trade is possible. Whittier could serve as a shipment point for materials going to the sites by rail. In this case, slight or moderate effects are expected in unemployed labor, retail trade, and services.

Eastside: Most effects resulting from road access of the Parks Highway would be concentrated on the Westside. Only slight or negligible effects would occur in Valdez and communities along the Richardson Highway.

(ii) Land Use

The effects associated with Access Plans 1 and 5 would be substantial on communities along the Parks Highway. There would be significant consequences for existing community land uses, particularly residential and commercial uses. Of all access plans under consideration, this pairing would have the greatest impact on community land uses. In addition, either the north connecting road, for Plan 5, or the south, for Plan 1, would affect lodges in the interior of the basin. One could expect these uses and associated activities to be substantially influenced by the additional access afforded the public.

(c) Access Plans 4 and 6

(i) Socioeconomics

Initially, since the Watana site is to be developed first, these access plans move the origin of access from the Railbelt corridor west of the Susitna drainage to the Denali Highway in the north. This move would attenuate the effects described for Plans 8 and 2 and Plans 1 and 5 up the Railbelt corridor to Cantwell. Access from the Denali Highway lengthens significantly the road distance between most available housing (Mat-Su Borough) and the work site. Thus, most workers would probably

commute to the site in a more organized and routine manner than if they all provided their own transportation to the site or the railhead. More workers might then be concentrated in one area, particularly Anchorage and, to a lesser extent, Fairbanks. The addition of a service road between the Devil Canyon and Watana sites, as included in Plan 6, will create a negligible difference between the two access plans. If it is maintained and opened to the public after completion of the two dams, however, it would increase the usage of the Susitna drainage. This usage would not have any significant consequences outside of the drainage though.

Development of the Devil Canyon site during the second half of the proposed Susitna project will be achieved by access similar to that provided in Access Plan 2. The socioeconomic effects would be delayed and would be, in general, of lesser magnitude than those for Access Plan 2. This is because, in later years, the Westside would be more developed and better able to absorb the impact.

Westside: In the construction of Watana Dam, all goods and materials would come farther up the corridor than under previous plans. Workers' families would also tend to locate in more communities and possibly concentrate in Anchorage. This residency extends the area of impact while increasing the demand for transportation and services. Significant or major effects would be felt on population, culture/way-of-life, community, political and social organization, housing availability, government expenditures and revenues, labor demand, unemployed labor, public services, construction, rail transportation, public utilities, communications, retail trade and services. All other categories would experience moderate to negligible effects.

Anchorage: Wholesale trade would likely experience a significant effect, and moderate effects could be expected in construction, rail and port transportation, retail trade, and services industries. Other categories would be affected the same as under prior plans. As under Plans 8 and 2 Whittier would feel moderate effects on employment, retail trade, and services.

Eastside: Access to Watana from the Denali Highway will tend to spill over on the Eastside and also to generate Eastside tourism. Because they are now so small, communities on the Eastside could then expect moderate effects on various community factors, such as population, way-of-life, housing availability, construction, total labor demand, unemployed labor, and tourism.

(ii) Land Use

Access Plans 4 and 6 promise to create effects similar to those of Access Plans 2 and 8. Goods or people would travel by rail to the Devil Canyon site. This requirement reduces the extent of impact on community land uses along the Parks Highway. Access by road from the Denali Highway to Watana, however, would introduce potential for significant off-road vehicle use in areas where it is now minimal. This effect could result in significant alterations to an area with virtually no existing development or surface-disturbing activities.

(d) Access Plans 3 and 7

(i) Socioeconomics

Initially, this plan is similar to Access Plans 4 and 6 in that it would expand the area of effects on the Westside and induce some moderate effects on the Eastside. During later Susitna development, it is similar to Plans 1 and 5 but with a delay of several years. Again, the service road would have little impact.

Westside: The effects would be largely the same as with Plans 4 and 6. Goods and materials would move farther up the corridor as would workers' families. Significant or major effects would be felt on population, culture/way-of-life, community, political and social organization, housing availability, labor demand, public services, government expenditures and revenues, unemployed labor, construction, motor transportation, communications, retail trade, services, tourism, and public utilities.

Anchorage/Whittier: The effects would initially be the same as those of Plans 4 and 6 and, later, similar to those of Plans 1 and 5.

Eastside: The effects would be essentially the same as with Plans 4 and 6.

(ii) Land Use

Access Plans 3 and 7 provide road access from two directions--the Parks Highway and Denali Highway. The impact on community land uses along the Parks Highway would be somewhat less compared to, as with Plans 1 and 5, a road off the Parks Highway alone. With Plans 3 and 7, there is likely to be greater alteration to interior basin land uses, as access is facilitated for both Anchorage and Fairbanks populations.

3.5 MITIGATION

Mitigation of the effects of an access plan on land use and socioeconomic factors entails choosing a plan which affects the fewest number of variables and/or which affects such variables the least; i.e., that plan likely to produce the least change in existing conditions. Adverse effects can be controlled by limiting public use of the access facility itself and by preventing those restricted users from leaving the access facility to engage in off-road activities. This approach will reduce the geographic extent of the effects of an access road.

Similarly, minimizing the use of the existing transportation network, to which the chosen access road would be connected, will result in fewer changes in areas near the existing network. This process can be accomplished by use of a more restrictive existing mode--i.e., rail--which would receive less general use by the public than a road.

Limiting worker commuter patterns and activity would also tend to reduce the impact along existing networks. This control can be accomplished by providing a fully developed construction community in the project area, thereby reducing the amount of housing, services, and travel required along existing networks.

3.6 CONCLUSIONS

The most significant aspect of the analysis of access route schemes relates not so much to various impacts associated with a given individual scheme but, rather, to the concept of access itself, in any form, to the interior of the Susitna basin. The provision of a means by which the general public can easily and frequently venture inland to an essentially pristine wilderness will likely cause profound alterations on the character of the Susitna area. Such alterations relating to access may be assessed quite distinctly from the emplacement of Susitna hydroelectric facilities themselves.

In terms of socioeconomic effects, Access Plans 3 and 7 and Plans 4 and 6 will cause somewhat greater magnitudes of impact on some socioeconomic variables. With respect to land use concerns, Plans 1 and 5 and Plans 3 and 7 are expected to have a significant impact both on community land uses outside the project area and on land use and activities in the interior basin.

Access Plan 1's south river road from the Devil Canyon site, looping around Stephan Lake to the Watana site is probably the one proposed study route that would have both strong positive and negative impacts on land use, particularly at Stephan Lake and Fog Lakes. From the Devil Canyon site to Stephan Lake, a new land use may emerge: off-road vehicles above timberline. At Stephan Lake and Fog Lakes, whether alternative "a" or "b" is used, the road will also pass close enough, even without formal access, to attract the recreational boater. This proximity will affect the existing lifestyles of the present residents and could have economic impacts on the lodges and guiding businesses. Regardless of the formal/informal access, recreational use of the lakes will occur and will likely conflict with the present residents of and fly-in visitors to Stephan Lake and Fog Lakes. Present users will likely be displaced by new types of users, willing to tolerate higher densities, noise levels, etc.

This road could also open up CIRI lands for possible resource development. This could be seen as a positive step by those interested in tourism, mining, timber, and land ownership changes. It could be viewed with dismay, however, by those native corporations that have different objectives for the use of their lands.

Plans 4 and 6 would likely cause somewhat less of an effect than those above, since direct access from the Parks Highway is precluded. These access alternatives would reduce the impact on community land use patterns in those areas and could concentrate it, instead, on railroad use. The road from the Denali Highway would permit car travel by the public into the interior, but Fairbanks' population is considerably smaller than Anchorage's, so the human use would undoubtedly be less with these plans, especially since access would be more difficult for the latter, larger population. In addition, virtually no development exists along the Denali route, so disruptions to existing land uses would be minimal. There would likely be, however, the introduction of additional off-road vehicle use along this route.

Land use and socioeconomic disciplines establish a somewhat different problem from that offered either by the strict biological sciences or by cultural resources considerations. In all these areas, the route being sought is that which will have the least impact on the area. Consequences of whatever type are viewed as negative and, therefore, to be avoided. With land use and socioeconomics, additional factors must be addressed in the impact of access road alternatives: 1) the potential impact area is larger, may not be geographically explicit (for socioeconomics), and varies depending upon origin and mode being considered; 2) there are a greater number of variables, which may be mutually exclusive, comprising the land use and socioeconomic disciplines; and 3) interpretations of results of analysis of these factors requires consideration of a disparate public's opinion as to whether outcomes are positive or negative; i.e., what may be considered negative by one individual may be viewed quite positively by another. The various access plans will have consequences for both the resident population and for those newcomers arriving with the construction activities, as well as those with land or other economic interests who do not live in the project area.

Access Plans 2 and 8 would create the least amount of impact, all things considered, on land uses both in the interior basin and in adjacent communities. For minimizing alterations to land uses, either would be an acceptable plan. For enhancing access, providing the public with more exposure to the resource base, one of the other plans would be a better selection.

Of the eight alternatives, Plans 1, 5, 2, and 8 would likely cause the fewest overall changes in various socioeconomic factors. Plans 2 and 8 would tend to restrict such changes to economic variables related to rail transportation activities, and in communities through which the railroad passes or in which facilities were placed to facilitate project construction and shipments (e.g., construction of railhead at Gold Creek).

Plans 1 and 5 restrict impacts to a larger defined Westside area, with greater effects on communities situated on the Parks Highway.

All four of the Plans incorporating the Denali segment - 3 and 7 and 4 and 6 - will cause much greater effects on the Cantwell area and Eastside communities, which have smaller populations and less developed infrastructures than westside communities.

Table 3.8

Potential Socioeconomic Impacts of Alternative Access Plans
by Socioeconomic Impact Category

	Anchorage & Whittier								Westside (excl. Anchorage & Whittier)								Eastside							
	Access Plan Number								Access Plan Number								Access Plan Number							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Population levels	2	2	2	2	2	2	2	2	4	4	5	5	4	5	5	4	1	1	3	3	1	3	3	1
Culture/way-of-life	2	2	2	2	2	2	2	2	3	3	4	4	3	4	4	3	1	1	3	3	1	3	3	1
Community, Political,& Social Organization	2	2	2	2	2	2	2	2	3	3	4	4	3	4	4	4	1	1	3	3	1	3	3	1
Housing - Type	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2	1
- Availability	2	2	2	2	2	2	2	2	4	4	5	5	4	5	5	4	1	1	3	3	1	3	3	1
Public Services	2	2	2	2	2	2	2	2	4	4	5	5	4	5	5	4	1	1	2	2	1	2	2	1
Government Expenditures & Revenues	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1
Total Labor Demand	2	2	2	2	2	2	2	2	5	5	5	5	5	5	5	5	2	2	3	3	2	3	3	2
Unemployed Labor	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	2	2	3	3	2	3	3	2
Economic Base																								
Construction	3	3	3	3	3	3	3	3	5	5	5	5	5	5	5	5	2	2	3	3	2	3	3	2
Mining	1	1	1	1	1	1	1	1	3	3	2	2	3	2	2	3	1	1	1	1	1	1	1	1
Agriculture	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Forestry	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
Manufacturing	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1
Fisheries	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oil and Gas	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Transportation-Motor	3	2	3	2	3	2	3	2	4	3	4	3	4	3	4	3	1	1	2	2	1	2	2	1
-Rail	2	3	2	3	2	3	2	3	2	5	2	4	2	4	2	5	1	1	1	1	1	1	1	1
-Port	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 3.8 (Cont.)

	Anchorage & Whittier								Westside (excl. Anchorage & Whittier)								Eastside							
	Access Plan Number								Access Plan Number								Access Plan Number							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Economic Base - (Cont.)																								
Public Utilities	2	2	2	2	2	2	2	2	4	4	5	5	4	5	5	4	1	1	2	2	1	2	2	1
Communications	2	2	2	2	2	2	2	2	3	3	4	4	3	4	4	3	1	1	2	2	1	2	2	1
Wholesale Trade	4	4	4	4	4	4	4	4	2	2	3	3	2	3	3	2	1	1	1	1	1	1	1	1
Retail Trade	3	3	3	3	3	3	3	3	4	4	5	5	4	5	5	4	1	1	2	2	1	2	2	1
Services	3	3	3	3	3	3	3	3	4	4	5	5	4	5	5	4	1	1	2	2	1	2	2	1
Tourism/Recreation	2	2	2	2	2	2	2	2	5	2	4	3	5	3	4	3	2	2	3	3	2	3	3	2
Racial Mix/Ethnicity/ Religion	1	1	1	1	1	1	1	1	2	2	3	3	2	3	3	2	1	1	1	1	1	1	1	1

KEY: 5 - Major
4 - Significant
3 - Moderate
2 - Slight
1 - Negligible

Table 3.9

Potential Impacts and Magnitude of Impacts
of Access Route Plans on
Land Use Variables

LAND USE ANALYSIS CATEGORIES	ACCESS PLANS			
	Plans 1 & 5	Plans 2 & 8	Plans 4 & 6	Plans 3 & 7
1. Land uses and associated site-specific activities				
- Residential: remote, isolated	4	3	4	4
- Residential: community*	3	3	4	4
- Residential lodges (concentrated tourism & recreation)	5	5	2	2
- Commercial: community*	3	2	3	4
- Agriculture	1	1	1	1
- Transportation: Highway	4	1	2	3
Rail	1	5	4	4
- Mining	3	3	3	3
2. Dispersed and isolated activities				
- Extractive: hunting & fishing	5	3	4	4
- Riverine: boating	3	3	3	3
- Camping, hiking, photography, etc.	3	2	2	3
3. Land management activities & related concerns				
- Game management; hunting, fishing, trapping	5	3	4	5
- General land management	5	3	4	5
- Off-road vehicle management	5	2	4	5
- Native claims	4	4	2	4
- Land values	4	2	2	4
4. Natural aesthetics				
- Visual charactersitics: land	4	3	3	4
- Visual characteristics: water	3	2	2	3
- Ground cover: flora	5	2	2	4
- Land surface integrity	4	2	3	4
- General natural character, extensive	4	2	3	4

* The Socioeconomic Analysis deals with more discrete factors relating to communities located near the project area.