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# SUSITNA HYDROELECTRIC PROJECT
## AQUATIC MITIGATION REPORT SERIES

## ACCESS, CONSTRUCTION AND TRANSMISSION
## AQUATIC MITIGATION PLAN

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## Preface

This report represents one volume of a three volume report series on aquatic mitigation planning for the proposed Susitna Hydroelectric Project. These volumes are:

1. Access, Construction and Transmission Aquatic Mitigation Plan

2. Impoundment Area Fish Mitigation Plan

3. Middle River Fish Mitigation Plan

A primary goal of the Alaska Power Authority's mitigation policy is to maintain the productivity of natural reproducing populations, where possible. The planning process follows procedures set forth in the Alaska Power Authority Mitigation Policy for the Susitna Hydroelectric Project (APA 1982), which is based on the U.S. Fish and Wildlife Service and Alaska Department of Fish and Game mitigation policies. Mitigation planning is a continuing process, which evolves with advances in the design of the project, increased understanding of fish populations and habitats in the basin and analysis of potential impacts. An important element of this evolution is frequent consultation with the public and regulatory agencies to evaluate the adequacy of the planning process. Aquatic mitigation planning began during preparation of the Susitna Hydroelectric Project Feasibility Report (1981) and was further developed in the FERC License Application (1983). A detailed presentation of potential mitigation measures to mitigate impacts to chum salmon that spawn in side sloughs was prepared in November 1984. It is expected that the three reports in the present report series will also continue to evolve as the understanding of project effects is refined.

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# 1. INTRODUCTION

The Access, Construction and Transmission Aquatic Mitigation Plan (ACT) is a component of the fisheries mitigation plan for the Susitna Hydroelectric Project proposed by the Alaska Power Authority (APA). The ACT contains an evaluation of the aquatic impacts associated with the construction and operation of the access roads and transmission lines. Potential impacts on the aquatic environment from the construction of the proposed Watana and Devil Canyon dams and related facilities are also identified. The impacts discussed for mitigation planning in this volume are based on information presented for the three stage development of the proposed Susitna Hydroelectric Project. Stage 1 involves construction of the Watana dam, access roads and related facilities; during Stage 2, the Devil Canyon dam and facilities will be built. Stage 3 construction will increase the crest elevation of the Watana dam. The ACT presents the mitigation measures which will be utilized during and after the construction of the access roads, transmission lines, dams and related facilities to maintain the productivity of the aquatic populations. The APA intends to incorporate the final mitigation documents in the specifications for bids and the contract documents.

## 1.1 General Description

The proposed Watana and Devil Canyon dams are located approximately 140 miles (225 km) north of Anchorage in the upper Susitna River Basin. The basin is bounded by the Talkeetna Mountains to the southeast and the Alaska Range to the north and west (Figure 1). The Watana dam will be sited between River Mile (RM) 184 and RM 185; the Devil Canyon dam will be built 32 miles (53 km) downstream at approximately RM 152 of the Susitna River.

The proposed dams are in the northern portion of Southcentral Alaska. The climate is typical of the transition zone, with annual temperatures averaging about $35^{O}$F. Winter extends from October to May with temperatures occasionally dropping below $-50^{O}$F. Summers are correspondingly short and frequently rainy. Tundra is the dominant vegetation although stands of coniferous and deciduous trees exist in areas protected from wind and at lower elevations. Isolated areas of permafrost occur near the dam sites.

The hydrologic resources in the vicinity of the dams include small, clearwater streams, lakes and the Susitna River, a large, glacial-fed river. The Susitna River is similar to many unregulated northern glacial rivers with high, turbid summer flows and low, clearer winter flow. In the spring, runoff from snowmelt and increased glacial contributions cause a rapid increase in flow and suspended sediment concentration. Turbidity in the mainstem is reduced in the fall when glacial contributions to the headwaters of the Susitna River decrease. The surface waters in the basin are predominantly of the calcium bicarbonate type with low dissolved solids concentrations; the water is chemically acceptable for most uses (Balding 1976). Clearwater streams are prevalent on the bluffs bordering the Susitna River. The hydrologic regimes of the streams are typical of the subarctic, snow-dominated flow regime, in which a snowmelt flood in spring is followed by generally moderate flow through the summer, with flows peaking after rainstorm events. From October to April, low flows occur when freezing temperatures reduce surface water contributions. A general overview of the chemical characteristics of streams in the project provided measurements of pH ranging from 6.0 to 7.5 and percent dissolved oxygen saturation ranging from 72 percent to 99 percent (Sautner and Stratton 1984). Most of the lakes in the basin are small and shallow although a few larger and deeper lakes exist. The lakes generally have higher summer water temperatures than the streams; lake-water temperatures may reach 65°F (Balding 1976).

The aquatic resources are varied in the general area of the dams and transportation corridors. The numerous clearwater streams and lakes support an abundant fish population. The fish species in close proximity to the access and transmission line corridors and dam sites have been studied since 1981 (ADF&G 1981, 1983, Sautner and Stratton 1984). Arctic grayling, Dolly Varden and sculpin are known to inhabit many of the clearwater streams (Sautner and Stratton 1984). In larger streams, whitefish, longnose sucker and burbot have been observed (Sautner and Stratton 1984). Populations of Arctic grayling and Dolly Varden in selected streams in the vicinity have been estimated (ADF&G 1981, 1983, Sautner and Stratton 1984). The fish species observed within nearby lakes include Arctic grayling, Dolly Varden, burbot and lake trout (Sautner and Stratton 1984). The Susitna River in the vicinity of the damsites provides overwintering habitat for many fish species such as Arctic grayling and Dolly Varden and is used as a migration corridor by resident and anadromous fish (ADF&G 1983). A few chinook salmon migrate upstream within Devil Canyon to spawn in tributary mouths (Barrett et al. 1985). However, Devil Canyon blocks the upstream passage of other fish species.

### 1.2 Impact Assessments

Although details of construction activities for the three stage development of the proposed Susitna Hydroelectric Project have not been prepared, the general type and schedule of activities which will occur during construction and operation of the dams are assumed to be similar to those identified in the FERC License Application (APA 1983a); therefore, the potential effects of these activities upon the aquatic environment can be assessed. Potential aquatic impacts consist of changes to habitat and/or direct effects on aquatic organisms. Arctic grayling and Dolly Varden were selected as the evaluation species for potential construction impacts (APA 1983b). All life stages of these species are abundant in the habitats in the clearwater streams and lakes in the vicinity of the access and transmission corridors and dam facility sites (Sautner and Stratton 1984). Arctic grayling have high human use value as sport fish and both species are sensitive to water quality degradations and instream disturbances. Mitigation plans focusing on the potential impacts which are identified for the evaluation species are expected to maintain the integrity of aquatic habitats and the natural productivity of other aquatic species that utilize similar habitats. Table 1 summarizes the anticipated impacts.

### 1.3 Mitigation Plan

The mitigation plan reflects the intent of the APA to maintain the productivity of the natural aquatic population (APA 1982). The policies of the U.S. Fish and Wildlife Service (USFWS) and the Alaska Department of Fish and Game (ADF&G) were used to develop this approach to mitigation (USFWS 1981, ADF&G 1982). The mitigation plan will be developed and implemented in stages as shown in Figure 2. APA projects will avoid potential impacts where feasible. If unavoided, impacts will be minimized, rectified, reduced or compensated. These mitigation options will be analyzed in the hierarchical scheme depicted in Figure 3.

During construction of the access roads, transmission lines, dams and facilities, many potential impacts will be avoided or minimized by adherence to the APA's Best Management Practices Manuals (BMPM's). These manuals have been prepared in coordination with the resource management agencies to provide guidelines and recommendations for environmentally acceptable construction practices. Federal and state regulations have been identified within the BMPM's. The BMPM's will be included in the bid specifications for the design and construction of the Susitna Hydroelectric Project. Contractual documents will specify that construction activities conform with the BMPM's.

The BMP manual on Erosion and Sedimentation Control (APA 1985a) provides guidelines and techniques to avoid or minimize potential construction impacts on the aquatic environment. Construction activities which may result in erosion or sedimentation impacts, such as vegetation clearing and borrow excavations, are discussed and general guidelines are presented for the planning, design, construction and maintenance phases of a project. The manual describes alternative site-specific methods to reduce erosion and sedimentation and prevent water quality degradations.

The potential aquatic impacts associated with appropriating water will be avoided or minimized by adherence to the BMP manual on Water Supply (APA 1985b). Although the actual plans, designs and installations will be dictated by site-specific conditions, the manual depicts the environmental guidelines and regulatory requirements for water withdrawal.

The BMP manual on Liquid and Solid Waste (APA 1985c) will be utilized to avoid or minimize potential impacts from waste disposal on aquatic organisms. The manual presents various waste management techniques. The collection, treatment and disposal of liquid wastes at project sites will conform to techniques described in the manual to avoid or minimize water quality degradations. Solid wastes will be handled, stored and disposed according to manual guidelines to minimize environmental impacts.

The BMP manual entitled Fuel and Hazardous Materials (APA 1985d) contains guidelines to avoid or minimize potential aquatic impacts from such materials.

These materials have the potential to cause significant adverse effects on the aquatic environment. Regulation requirements and management strategies described in the BMPM will be utilized to safely handle and store these materials with a minimum of adverse effect.

Potential impacts from spill accidents will be minimized through the use of the Oil Spill Contingency Planning BMP manual (APA 1985e). Adverse impacts from spills of petroleum products will be minimized by site-specific spill contingency plans specifying procedures to detect and contain spills. The cleansing and restoration of contaminated areas are also described in the manual. The manual confirms the APA's intent to notify and cooperate with the applicable regulatory agencies in the event of a spill.

Potential impacts associated with most construction, access and transmission line activities will be avoided or minimized through adherence to the BMPM's; residual impacts will be rectified, reduced or compensated. The APA is committed to restoring or rectifying affected aquatic habitat if possible. Monitoring activities will verify the reductions in aquatic impacts over the duration of the project. Compensation measures have not been proposed. Table 1 presents the mitigation measures which will avoid, minimize, reduce or rectify potential impacts.

Monitoring and maintenance are integral features of the mitigation process. Monitoring will increase the flexibility of the mitigation plan and verify that the expected level of mitigation has been achieved. Unrecognized aquatic impacts and inadequate mitigation measures may be identified and corrected through monitoring and maintenance activities. Construction monitoring, conducted by an on-site Environmental Field Officer (EFO), will assure conformance with the BMPM's, regulatory permits and license stipulations. Operational monitoring will verify that long-term impacts do not cause significant degradation in the aquatic resources of the region.

## 1.4 Agency Recommendations

The mitigation plan is intended to be responsive to resource management agency recommendations. Recommendations have been identified from agency comments on the License Application (APA 1983b, 1983c) and from the APA's Responses to Comments on the License Application (APA 1984). The ACT plan reflects these recommendations, which emphasize avoidance and minimization of potential aquatic impacts. Table 2 summarizes the comments including the dates and reasons for the comment submittal from each agency. All comments pertaining to the construction and maintenance of the access and transmission line corridors and the dams and related facilities are addressed within the plan.

Additional comments from the resource management agencies are expected following circulation of the draft ACT Plan. These comments and recommendations will be discussed with agency representatives and used to develop the continuing project mitigation plan.

## 2 - ACCESS CORRIDORS

Access to the sites of the Watana and Devil Canyon dams is needed for construction and maintenance activities. Figure 4 depicts the access corridors to the Watana and Devil Canyon dam sites. The Watana dam site will be accessed by road from the Denali Highway. During Stage 1 construction, the closest railroad facility will be located in Cantwell at the junction of the Denali and Parks highways, approximately 60 miles (97 km) from the Watana dam site. During Stage 2, the Devil Canyon dam site is anticipated to be accessed by a combination of railroad and road. The Devil Canyon road will be built from the Watana access road to the Devil Canyon dam site. A railroad spur and terminal facility is expected to be constructed from Gold Creek. Secondary roads will be constructed to access the construction camps, villages, related facilities, borrow and disposal sites. The Stage 3 development of the Watana dam will utilize access corridors established during the previous stages of construction.

Construction and maintenance of the access road network will impact the aquatic resources of the region. Many of these impacts are expected to be relatively short in duration. Construction activities such as clearing and culvert installation may temporarily decrease water quality in streams and disrupt existing habitat. Long-term aquatic impacts will also occur during access construction and operation. A minor loss of aquatic habitat will occur at the site of culverts and low water stream crossings. Unrestrained instream activities could block fish migrations resulting in a long-term impact to the aquatic resources. The most significant impact anticipated is increased sport fishing pressure on unexploited fish populations as the access corridors will increase the accessibility of waterbodies in the vicinity.

Mitigation will avoid, minimize, rectify, and reduce the potential aquatic impacts identified for access construction and operation (Figure 3). Many adverse impacts associated with construction activities can be avoided or minimized through environmentally careful construction practices. Best Management Practices Manuals (BMPM's) have been prepared by the APA to ensure that environmentally acceptable construction methods are utilized by their contractors. The BMPM's provide guidelines to minimize erosion, maintain water quality, avoid oil contamination, and manage liquid and solid wastes. Instream construction will be restricted during the sensitive periods of Arctic grayling and Dolly Varden spawning (Figure 5). Management policies may minimize the impacts from increased sport fishing pressure. Monitoring activities throughout construction and during maintenance of the access roads will verify that activities are conducted with a minimum of adverse environmental impacts. Compensation for aquatic impacts will not be necessary unless a major oil spill occurs.

## 2.1 - Impact Analysis

### 2.1.1 Cantwell to Watana

#### (a) Description

The section of the Denali Highway from Cantwell to the intersection with the Watana access road, a distance of 21.3 miles (35.5 km), will be upgraded by improving one bridge, topping the road with more gravel, and straightening road curves. Any needed realignment should be possible within the existing easement. In addition, 6 miles (10 km) of the road will be paved from the railhead facility at Cantwell to a point 4 miles (7 km) east of the junction of the Parks and Denali highways. Paving will avoid the problem of excessive dust and flying stones in the community of Cantwell.

Within the section to be upgraded, the Denali Highway crosses several small tributaries of the Nenana River including Edmonds Creek and tributaries to the Jack River. The Jack River system contains Arctic grayling and the Nenana River system in this region supports several other species of resident fish (Table 3).

The Watana dam site will have road access from Milepost 114.5 of the Denali Highway (APA 1983a). The road will run approximately 44 miles (73 km) south to the dam and construction campsites (Figure 4). The northern portion of the route will traverse 19 miles (31 km) of high, rolling, tundra-covered hills. The road will cross small streams including Lily Creek, Seattle Creek, Brushkana Creek, and additional unnamed creeks (Table 4). These northern streams, which are part of the Nenana River drainage, contain Arctic grayling, Dolly Varden, sculpins, and probably other resident species. The southern 25 miles (40 km) of the road will cross and parallel Deadman Creek, a tributary of the Susitna River. Deadman Creek contains Arctic grayling, Dolly Varden, and other resident species (Table 4). The Arctic grayling population of Deadman Creek is estimated at 510 fish per mile reach near the access corridor (Sautner and Stratton 1984). The access corridor lies within 1 mile (1.6 km) of Deadman Lake which contains Arctic grayling, Dolly Varden, lake trout, humpback whitefish, round whitefish, burbot, and sculpin (Sautner and Stratton 1984). Arctic grayling appear to dominate in numbers.

Watana access construction is scheduled to begin in early spring of 1990 and continue until late fall of 1991 (Figure 6). A snow and ice road may be constructed during the winter of 1989-90 for heavy equipment access to permit construction to proceed from both ends of the access road. Instream activities, including the installation of bridges and culverts, are expected to occur in the openwater season of 1990.

Prior to actual road construction, the corridor will be cleared; minimal impacts at stream margins will be assured by adherence to the BMPM (APA 1985a). The Watana access corridor will not require extensive clearing activity until heavily vegetated terrain is encountered within 3 miles (5 km) of the construction campsite; thick brush will be removed at the crossings of the three Deadman Creek tributaries nearest the Susitna River. Trees and large brush impeding overburden removal will be cleared by equipment ranging from hand-held chainsaws to hydro-axes. Trees and brush will be felled into the access corridor and away from waterbodies. Overburden and cleared material will be stockpiled at specific disposal sites, left in place or burned. Coniferous vegetation may be chopped by hydro-axes and broadcast; piles of coniferous slash will be burned within the first year after cutting. Deciduous vegetation may be piled at corridor margins. The length of haul of substandard materials will be minimized by allowing overburden and cleared vegetation to be disposed in side borrow excavation trenches. Clearing near the impoundment area may utilize disposal sites within the permanent inundation area. The amounts of cleared vegetation are expected to be small and are not likely to raise hydrogen sulfide concentrations in the reservoir. Additional disposal sites, if necessary, will be located away from floodplains and wetlands and the disposal sites will be bermed to avoid increased sediment and organic contributions to nearby watersheds.

The Watana access road will be constructed of gravel and have a crown width of 24 feet (7.3 m). Road construction will predominantly use side borrow techniques in which needed borrow material will be excavated by scraping trenches directly alongside the road. Thus, construction activity will generally be confined to a narrow strip, 50 ft (15 m) to 70 ft (21 m) each side of the road centerline. This technique will minimize the requirements and associated impacts of large borrow pit excavations. The majority of the borrow material for the access roads is estimated to be available from side borrows; the remainder is expected to be obtained from borrow sites D and E (Figure 7). These borrow areas will be utilized predominantly for camp, village and dam construction (Section 3.1.1). A mining plan, as required by 43 CFR Part 23 will be prepared for each site prior to the removal of material. A permit application for activities at Borrow Site E will be submitted to the ADF&G (AS 16.05.870).

The access road stream crossings will be located perpendicular to the stream, preferably in a straight stretch (Lauman 1976) with low gradient and narrow, stable banks that do not require cutting or excessive stabilization. Vehicle barriers or guardrails will be installed at sites where there appears to be a greater risk of accidents.

Stream crossings will require the installation of culverts or bridges. Prior to the commencement of construction activities, permit applications for stream crossing structures will be submitted to the ADF&G as required by AS 16.05.870. Culverts will be designed in adherence to the Drainage Structure and Waterway Design Guidelines (Harza-Ebasco 1985a) and the ADF&G velocity criteria to allow fish passage during flood flows and critically low flows. For a specified length of culvert, the water velocity criteria (Table 5) dictates the size of culvert.

Drainage structures will be routinely maintained to ensure fish passage. Accumulated debris at culvert openings will be removed. Appropriate control measures will be undertaken as a part of routine maintenance to ensure that beaver dams do not interfere with fish passage needs.

Construction activities will utilize water for gravel washing, fill compaction and dust control. Water will be withdrawn from available sources along the access corridor. Streams or lakes not supporting fish will be utilized preferentially. Prior to water withdrawal, the ADF&G and ADNR will be consulted for approval and permitting of water removal sites. Water intakes will be screened as described in the BMPM on Water Supply (APA 1985b). Water will be treated to conform to ADEC/USEPA standards prior to discharge. Water utilized for gravel washing will be channeled through settling ponds.

(b) <u>Potential Impacts</u>

Potential impacts on fisheries resources may result from alterations in the physical characteristics of the aquatic habitat and/or direct effects on aquatic organisms. Impacts identified for access road construction and maintenance are presented in the anticipated order of occurrence and consider both types of potential effects.

o <u>Clearing</u>

Potential impacts from the clearing phase of construction include minor water quality degradations and some loss of aquatic habitat at stream crossings. Degradations of fish and aquatic habitat will be avoided by adherence to the following guidelines (APA 1985a):

Vegetated buffer zones will be retained at stream margins until instream construction is necessary;

Cleared areas near streams and lakes will be stabilized to prevent soil erosion into the water body;

Cleared material will be removed from water bodies to prevent blockage of fish movements, deposition of organics on substrates, and increased localized erosion;

Clearing of streamside vegetation will be minimized to prevent loss of fish habitat, reduction in availability of food organisms, and instream temperature variations; and

Stream banks will be promptly graded, mulched, and revegetated to minimize erosion.

Cleared material will be treated in accordance with BMPM guidelines on Liquid and Solid Waste Management (APA 1985c). Cleared material will be removed from the streams to approved construction disposal sites and salvaged, or burned onsite. Coniferous vegetation may be cut by hydro-axes and strewn on the corridor margins. Piled coniferous slash will be burned within one year. Deciduous slash in small quantities may be left at the margins of the corridor.

Construction disposal sites that contain cleared slash and substandard materials (overburden) will be located in the reservoir permanent inundation area or in excavated side borrows away from waterbodies. Additional disposal sites are not expected to be necessary. Disposal sites will be located and configured so that neither high streamflows during breakup nor rainfall runoff will wash silty material into streams. Large disposal sites in the reservoir area will entail constructing runoff control structures, surrounding the disposal site with berms, or channeling runoff through containment and settling ponds. Disposal sites are discussed in greater detail in Section 3.1.1. Figure 8 illustrates the locations of the disposal sites in the reservoir impoundment zone. Incremental impacts from access corridor cleared debris disposal are expected to be negligible.

Some loss of habitat due to cover removal is expected to occur in the 44 ft (12.9 m) wide road corridor at stream crossings. Changes of this magnitude are not great enough to adversely affect fish and other aquatic organism populations in the streams. Mitigation beyond adherence to the specified BMPM's (APA 1985a, 1985c) is not likely to be necessary.

o Stream Crossings and Encroachments

Adverse impacts associated with stream crossings during road construction will be avoided or minimized through adherence to the BMPM guidelines presented in the manual on Erosion and Sedimentation Control (APA 1985a). Some permanent loss of habitat will occur in the immediate vicinity of the stream crossing. Temporary impacts on aquatic organisms from water quality degradations and substrate alterations due to stream crossing activities are expected to be generally short in duration. Potential migration barriers will be avoided by scheduling instream activities during non-sensitive aquatic periods.

Any instream activity associated with upgrading of the Denali Highway will have potential impacts similar to those resulting from new construction. The BMPM techniques (APA 1985a) will be followed to minimize temporary impacts from culvert extensions, bridge work or road straightening.

Fish may avoid habitat experiencing excess suspended sediment levels. The drainages crossed by the access road are clearwater streams inhabited primarily by Arctic grayling and Dolly Varden. Water quality in these streams will be sensitive to increases in turbidity and suspended sediments. The BMPM (APA 1984a) techniques and the ADF&G guidelines will be followed to minimize aquatic impacts from substrate alteration and local turbidity and suspended sediment increases downstream of points of entry for heavy equipment. Residual losses associated with substrate alteration in the stream crossings are anticipated to be minor relative to the magnitude of the remaining unaffected substrate. Residual impacts may include the short-term deposition of small amounts of silt over spawning areas and benthic production areas. Subsequent high water events are expected to remove any deposition. Displaced aquatic organisms are expected to return to previously utilized habitat when suspended sediment levels revert to natural levels upon cessation of instream activity.

Instream use of equipment will be limited to the installation of stream crossing structures and vehicles will be maintained to avoid water quality degradations from fuel, hydraulic fluid, or antifreeze leakages. Water degradations from vehicle leakages are not expected to be significant if activities are conducted as described.

Stream crossings at streams having documented fish or fish habitat at, or upstream from, the construction site will be designed to pass fish. Figures 9 and 10 illustrate the locations of sensitive fish habitat that may be effected by construction of the Watana access road along the planned alignment. The evaluation species used in developing design criteria for stream crossings in the project area is Arctic grayling. At stream crossings where fish passage will be maintained, bridges or large culverts may be constructed.

Bridges will be installed where streamflows are large. Bridges are expected to be located at stream crossings 5.8, 12.0, 13.7, and 27.5 miles from the Denali Highway. On smaller systems where fish passage is required, open-bottom arch, multiplate elliptical or oversized circular culverts will be installed to maintain the natural streambed (Joyce et al. 1980a; Lauman 1976). Multiplate elliptical and oversized circular culvert inverts will be set below the streambed elevation to a depth of at least one-fifth their diameter to avoid perching. Culverts will be armored to minimize erosion at the outlet. Natural stream substrate will be placed over the entire bottom length of the culverts. Open-bottom arch culverts will be preferentially utilized to maintain natural substrate (APA 1985a). Permanent aquatic habitat alteration is expected at the stream crossing where culverts are installed. However, the alteration is not expected to significantly affect stream aquatic populations if installation proceeds as described above.

Only at those stream crossing sites without fish or fish habitat at, or upstream from, will the design of the crossing be based solely on hydrologic and hydraulic criteria. From this figure, only the streams crossed at corridor miles (CM's) 10.7, 11.7, 18.0, 23.0, 23.7, 24.8, 28.5, 37.2 and 37.8, as measured from the Denali Highway (Table 4), do not appear to have fish or fish habitat upstream from the crossing site.

Stream diversions may be needed during construction. Open-bottom arch culverts can be installed without stream diversions. When culverts other than open-bottom arches are used, streams will be diverted around the work area and back into the natural stream channel until the crossing is completed. On small systems, the stream may be flumed. Diversion or fluming will reduce the amount of siltation downstream from the construction area. Diversion will be accomplished in accordance with ADF&G criteria (Table 6). Channel stabilization will proceed immediately after the resumption of normal flow to shorten the duration of turbidity impacts in accordance with the BMPM entitled Erosion and Sedimentation Control (APA 1985a).

Arctic grayling and Dolly Varden migrations to spawning areas could be impacted by instream disturbances. Arctic grayling likely migrate from overwintering habitats, such as Deadman Lake, to spawning habitat in tributaries following spring breakup. Stream-resident Dolly Varden feed predominantly during the summer months in small headwater streams and are believed to remain in these streams for spawning in late August to October. Dolly Varden are expected to migrate to lakes or deeper pools for overwintering. Figure 5 presents the migration and spawning periods; instream activities during the spring and late fall could alter or block these migrations. Instream activities will be restricted during Arctic grayling and Dolly Varden spawning. Figure 11 illustrates the restricted periods for streams crossed by the Watana access road.

o <u>Fill Placement</u>

The potential impacts of fill placement on aquatic habitats will be minimized through the proper construction techniques detailed in the BMPM (APA 1985a). Potential impacts include habitat loss through fill placement and increased suspended sediment levels. Residual impacts of fill placement are expected to be negligible.

Fill utilized in stream crossing construction is not expected to cover significant amounts of habitat previously used by fish. The access road is aligned outside the flood plain except at the site of stream crossings. The impact on aquatic habitat will therefore be minor.

Sheet flow blockages, resulting in ponding on one side of the access road and drying on the other side, will be prevented. Culverts and drainage structures will be installed under the fill to maintain the integrity of the road and the water drainage patterns which contribute to wetlands along Deadman Creek.

Proper stabilization techniques as outlined in the BMPM (APA 1985a) will be observed to minimize erosion and reduce suspended sediment and turbidity contributions to waterbodies. Fill with high organic and/or fines content will not be utilized. Fills and cuts will be stabilized to prevent erosion and revegetated as construction is completed.

o <u>Borrow Sites</u>

Few impacts are anticipated from borrow excavations as the construction techniques presented in the BMP manual on Erosion and Sedimentation Control (APA 1985a) will be followed to avoid sheet flow blockages and increased sediment and petroleum contamination. The majority of the fill material for road construction will be obtained using side borrow techniques. The remainder of the material will be excavated from borrow sites D and E. (Figure 7).

Borrow excavations will adhere to the BMPM (APA 1985a) in order to minimize sediment and petroleum product contributions to waterbodies within the drainage. Buffer zones will be maintained at stream margins. Runoff control structures will be installed at borrow sites and turbid water will be channeled through stilling ponds prior to discharge in adherence to BMPM guidelines (APA 1985a). Flocculants will be used, if necessary, to settle fine sediments. Discharged water will conform to water quality standards of the ADEC (18 AAC 70) and the USEPA. Erosion will also be minimized by excavating material according to the gravel removal guidelines of the USFWS (Joyce et al. 1980b). Residual impacts are discussed in greater detail in Section 3.1.1 and include the conversion of riparian and upland habitat to lake habitat at Borrow Site E.

Borrow Site D is located on a sloped bench approximately 1500 ft above the Susitna River at the proposed site of the Watana construction facilities at an elevation of 2300 ft (700 m). Borrow activities, conducted in accordance with the BMPM techniques (APA 1985a), at this site are not expected to impact aquatic resources in the vicinity. Runoff control structures such as berms and settling ponds will minimize turbidity increases to Tsusena and Deadman creeks.

Borrow Site E is located in the floodplain of the Susitna River at the mouth of Tsusena Creek. Removal of gravel is expected to be confined to the inactive channel floodplain; instream activities are expected to be restricted to a crossing of Tsusena Creek. Berms will be constructed to prevent turbid water contributions to Tsusena Creek. Buffers will border Tsusena Creek and the Susitna River. Surface runoff and water used in material washing will be circulated through sediment settling ponds and reused in material washing. Excavations will occur in aliquots and rehabilitation by contouring and removing man-made objects will follow cessation of activities in each aliquot. Potential impacts on aquatic organisms will include temporary degradations of habitat due to increases in turbidity and noise disturbances. A long-term impact is expected as a deep pit will be excavated during gravel removal. Section 3.1.1 details anticipated impacts; mitigative measures are described in Section 3.2.1.

- <u>Water Removal</u>

The BMPM guidelines for Water Supply (APA 1985b) and the ADF&G water removal criteria will be followed to avoid or minimize potential impacts including fish entrainment, habitat dewatering and increases in suspended sediment levels. BMPM adherence will insure that minimal residual impacts are incurred.

Water removal along the access corridor will preferentially utilize shallow lakes without fish such as the lakes located at 13 and 40 miles (21 and 64 km) from the Denali Highway; in streams, no more than 20 percent of the instantaneous flow will be removed at any time. Under frozen conditions or in cases where the average annual stream flow is unknown, 10 percent of the flow at the time of water removal will be used as the maximum withdrawal flow. All water intakes will be screened and sized according to ADF&G intake design criteria to prevent fish entrapment, entrainment, and impingement (APA 1985b).

The ADF&G criteria state that: (1) all intakes should be screened; (2) openings in the screen should not exceed 0.04 sq in; and (3) water velocity at the screen should not exceed 0.1 ft/sec (0.03 m/sec) in anadromous fish streams or .5 ft/sec (.15 m/s) in non-anadromous fish supporting streams or lakes.

o <u>Operation and Maintenance Activities</u>

During road construction and operation, impacts to the aquatic habitat from accidents involving transport vehicles, including those carrying petroleum products, will be avoided if possible. The access road will be designed without hazardous curves and hills. Traffic control signs and guardrails will be installed where needed. Dust will be controlled in summer and ice will be sanded in winter.

An Oil Spill Contingency Plan will be developed prior to the beginning of construction activities in accordance with the BMP manual on Oil Spill Contingency Planning (APA 1985c) to minimize water quality impacts should a spill occur. Residual impacts from an accidental fuel spill may cause short-term reductions in water quality within the watershed as small amounts of petroleum products are expected to enter the water. An accidental spill, if located adjacent to fish habitat, would likely severely injure or kill fish directly impacted by the petroleum products. Following a major spill, an assessment of the aquatic losses would be conducted by the Environmental Field Officer (EFO) described in Section 2.2.2. Appropriate site-specific mitigative measures would be negotiated in consultation with the resource management agencies.

The BMP manual on Fuel and Hazardous Materials (APA 1985b) provides guidelines to prevent petroleum products from contaminating water in the area during refueling or storage. Activities associated with petroleum storage or transfer will only be allowed in bermed areas. Spillage will be transported by local runoff to a collection area and treated prior to release into water bodies.

The access road will be properly maintained so that road operation impacts on aquatic habitats will be minor. Gravel displaced during road operation or maintenance activities will be removed from wetlands. Maintenance will include removal of culvert and bridge debris to maintain fish passage.

The greatest long term source of adverse impacts upon fish populations is likely to be increased fishing pressure resulting from improved access to streams and lakes. As stated in Section 2.1.1, the Watana access road will cross Brushkana, Lily, Seattle, and Deadman creeks as well as other small, unnamed streams. These clearwater streams are inhabited by Arctic grayling and Dolly Varden. Deadman Creek, in particular, is known for its large and abundant population of Arctic grayling. The reach of Deadman Creek between the falls and Deadman Lake is considered prime Arctic grayling habitat. By subjecting this stream to increased fishing pressure, many of the larger, older fish will be removed from the population, altering the age structure and possibly reducing reproductive potential (Schmidt and Stratton 1984). A similar impact may occur in other grayling streams.

During road construction, several thousand workers will be in the area between the Denali Highway and the Watana damsite (Section 3.1). A survey of construction workers on the Terror Lake Hydroelectric Project indicates that workers lack sufficient leisure time to participate frequently in recreational activities such as fishing (Harza-Ebasco 1985b). During construction at Terror Lake from 1983 to 1984, 57 percent of the project personnel had not fished within ten miles of the project site. 23 percent reported fishing less than 10 times and 8 percent had fished more than 25 times. 10 percent of the project personnel did not respond to the survey evaluating recreational usage of areas near the project site. However, access will be opened to the public following the completion of construction of the Susitna dams. Although this area has been a recreational area in past years, it has not experienced a large influx of people. Unless controlled, this influx will increase fishing pressure on the streams and lakes in the area. The effects of such an increase in pressure were modeled by Schmidt and Stratton (1984). The finding was that the trophy-sized Arctic grayling presently in the creek could only be maintained if a catch-and-release policy was implemented. Allowing a harvest would lead to a population dominated by smaller fish. Alternative management policies may be the only method to lessen these effects of increased pressure. These policies are the jurisdiction of the Alaska State Board of Fisheries (AS 16.05.251); however, APA will provide the Board with project information needed to formulate policy decisions.

### 2.1.2 - Watana to Devil Canyon

#### (a) Description

The planned Devil Canyon access road will traverse high tundra throughout most of its length. Dense shrub vegetation and trees are encountered downstream of Devil Canyon when the access road approaches the Susitna River crossing. The terrain has gentle to moderate slopes allowing road construction without deep cuts except in the case of several stream crossings. Access construction and maintenance will be conducted in the same manner as the Watana access road (Section 2.1.1).

Construction will begin and is expected to finish in 1995 as shown in Figure 12. The Susitna River will be crossed by a high level suspension bridge with an overall length of 1,790 ft (550 m) at approximately RM 150. The Susitna River crossing will link the rail spur from Gold Creek to the construction camps. Bridges are also expected to be installed at streams located 2.2, 8.0, 15.7 and 22.4 miles from the junction with the Watana access road.

The Devil Canyon access road is planned to depart from the Watana access road at mile 38.5 and cross Tsusena Creek 2.2 miles (3.5 km) and Devil Creek 22.4 miles (35.5 km) from the Watana access road junction (Figure 4). The road will cross numerous small streams between Tsusena and Devil creeks and parallel Swimming Bear Creek for approximately 6 miles (9.5 km). Tsusena Creek contains Arctic grayling, Dolly Varden, sculpin and other species; Devil Creek contains sculpin and Dolly Varden (Sautner and Stratton 1984). The road will approach within 1300 ft (400 m) of Swimming Bear Lake, which supports a population of Dolly Varden (Sautner and Stratton 1984) and cross the Devil Creek tributary draining from Swimming Bear Lake. This tributary is used by Dolly Varden for spawning and rearing during the open water season (Sautner and Stratton 1984). The access road will encroach on the Devil Creek flood plain for almost 1 mile (1.6 km) and parallel Devil Creek for 5 miles (8 km). Between the Devil Creek crossing and the Susitna River, the road will cross three tributaries to Devil Creek that provide habitat for Dolly Varden and sculpin (Table 7). The access corridor encounters the High Lake Complex approximately 28 miles (45 km) from the Watana junction. These lakes contain rainbow trout, Dolly Varden and sculpin (Sautner and Stratton 1984). Figures 13 and 14 illustrate the sensitive aquatic habitat encountered by the Devil Canyon access corridor.

(b) Potential Impacts

Potential impacts identified for the Denali Highway to Watana access road (Section 2.1.1) are also applicable to the Devil Canyon access road. Additional impacts are discussed further.

- <u>Clearing</u>

  The Devil Canyon access corridor will encounter dense brush and trees and will require more vegetation clearing with chainsaws and hydro-axes than the Watana access corridor. Similar measures will be undertaken to prevent increased erosion. A need for additional mitigation is not anticipated if clearing proceeds according to the BMPM techniques (APA 1985a).

- <u>Stream Crossings and Encroachments</u>

  All construction will adhere to the BMPM techniques (APA 1985a) to avoid or minimize aquatic impacts from access road stream crossings and encroachments. Surface runoff along the Devil Canyon access road encroachment on the Devil Creek floodplain will be drained through culverts designed to maintain surface water contributions to wetland habitat (Harza-Ebasco 1985a). Additional impacts are not expected due to the encroachment.

  The access road will cross the Devil Creek tributary draining from Swimming Bear Lake. This tributary provides the only documented spawning and rearing habitat for the lake population of relatively large Dolly Varden, up to 375 mm in length, which are believed to overwinter in Swimming Bear Lake (Sautner and Stratton 1984). Instream activities during the fall may disturb Dolly Varden spawning and impact the lake population. The deposition of silt, due to instream activities, onto gravel containing embryos could reduce embryo survival with a subsequent reduction in year class strength. Instream activities will be restricted during sensitive periods for streams supporting Arctic grayling and/or Dolly Varden as shown in Figure 15.

- <u>Fill Placement</u>

  Fill placement in the Devil Creek floodplain will follow BMPM techniques (APA 1985a) to prevent draining wetlands.

Revegetation will proceed as fill is stabilized. Residual impacts are expected to be negligible.

o Borrow Sites

Fill for the Devil Canyon access road will be obtained predominantly through side borrow techniques. Borrow Sites D and E may also be used; the potential impacts are described in Section 2.1.1.

o Operation and Maintenance Activities

Increased fishing pressure on lakes and streams in the vicinity of the access road is expected to be the greatest long term adverse impact on the fisheries resources. Swimming Bear and Devil creeks contain numerous Arctic grayling and Dolly Varden. The High Lake complex also contains rainbow trout. The population composition is expected to be altered by the reduction or elimination of older-age classes (Sautner and Stratton 1984).

### 2.1.3 - Secondary Roads

#### (a) Description

The secondary roads are anticipated to be short in length and not require stream crossings. Short spur roads will be needed to reach the material borrow and disposal sites which are not located adjacent to the access corridors. Access to and within the construction camps and villages will also require the construction of secondary roads. The locations and alignments of these auxiliary access roads are illustrated in Figures 8 and 16.

#### (b) Potential Impacts

Potential impacts on aquatic habitats from the construction, operation and maintenance of the secondary roads are not expected to be significant as stream crossings or encroachments are not expected. The BMPM techniques (APA 1985a) will be applied to avoid or minimize potential aquatic impacts. Erosional and clearing impacts identified for the Watana access road (Section 2.1.1) are relevant for secondary roads.

### 2.1.4 Railroad from Gold Creek to Devil Canyon

#### (a) Description

A railroad spur of the Alaska Railroad is planned from Gold Creek to Devil Canyon for Stage 2 development. The railroad access corridor will depart from the existing railroad at Gold Creek and proceed north and east to the construction campsite. It will remain on the south side of the Susitna River. The railroad will cross Gold Creek, which contains excellent fish habitat (Sautner and Stratton 1984) and is known to support pink and chinook salmon (ADF&G 1981, 1983; Barrett et al. 1984)). Several tributaries that enter the Susitna River between Gold Creek and Jack Long Creek will be crossed; the tributaries contain Arctic grayling, chinook salmon, and sculpin (Sautner and Stratton 1984) (Table 7). These tributaries may be an important source of clear water for Slough 19, which is a spawning area for salmon. The access corridor closely parallels Slough 20 which is utilized by adult pink, chum and chinook salmon (ADF&G 1981, 1983, Barrett et al. 1984). The railroad will then parallel Jack Long Creek for approximately 4 miles (6.5 km). The railroad will be located within the floodplain and cross three tributaries of Jack Long Creek. Jack Long Creek contains small numbers of pink, coho, chinook, and chum salmon, rainbow trout, Arctic grayling and sculpin (ADF&G 1981, 1983; Barrett et al. 1984; Sautner and Stratton 1984). One of the tributaries appears to be accessible to fish and may be utilized by adult or juvenile salmon (Sautner and Stratton 1984). The railroad terminus and turnaround at Devil Canyon will be located adjacent to the upper reaches of Jack Long Creek.

#### (b) Potential Impacts

Potential impacts resulting from the railroad access construction, operation and maintenance will be similar to those impacts identified for the Watana access road (Section 2.1.1). Additional site specific impacts are discussed further.

- Clearing

Construction of the railroad access corridor will require extensive hardwood tree clearing. BMPM clearing techniques (APA 1985a) will be utilized to avoid or minimize impacts on the aquatic resources from turbidity and siltation increases. Material will be removed from streams to prevent fish blockages.

- Stream Crossings or Encroachment

Bridges and culverts will be installed according to BMPM guidelines (APA 1985a) to maintain fish passage and to prevent turbidity and sedimentation impacts on sloughs and clearwater streams. Large volume streams, such as Gold Creek, will require bridges. Encroachments into floodplains will occur along Slough 20 and Jack Long Creek. As described in Section 2.1.1, culverts will be installed to continue surface runoff contributions to wetlands.

Instream activity during summer and fall may cause salmon to avoid spawning habitat in Gold and Jack Long creeks. Instream activities will predominantly be restricted to early or midsummer to avoid resident and anadromous spawning periods (Figure 15) as explained in Section 2.1.1.

- Fill Placement

The BMPM (APA 1985a) techniques will be utilized to avoid detrimental impacts on the aquatic resources associated with fill placement near sloughs and streams. Along Slough 20 and Jack Long Creek, fill will be stabilized to prevent sediment influx to the clear water. Temporary increases in suspended sediments may impact sight feeding fish, such as Arctic grayling. However, Arctic grayling successfully migrate through the turbid mainstem during summer months (ADF&G 1983). Residual impacts from fill placement are expected to be negligible so long as suspended sediment increases are short in duration.

- o **Borrow Sites**

Borrow material for railroad fill will be obtained from Borrow Site G. Borrow Site G will be extensively used for the Devil Canyon dam construction and will be located at the confluence of Cheechako Creek and the Susitna River upstream of the Devil Canyon dam site (Figure 17). Gravel removal is expected to be confined to the channel margins. The USFWS Gravel Removal Guidelines (Joyce et al. 1980b) and the BMP Manual on Erosion and Sedimentation Control (APA 1985a) will be applied to excavation activities. Buffers will isolate the excavation from Cheechako Creek and the Susitna River. Aggregate washing water will be channeled through settling ponds and reused. As the borrow site will be permanently inundated by the Devil Canyon reservoir, rehabilitation will not be necessary. Borrow Site G is discussed in greater detail in Section 3.1.2. Incremental impacts from excavations for railroad access construction will be negligible.

- o **Operation and Maintenance Activities**

The railroad access corridor may allow increased fishing pressure on southside streams and sloughs between Gold Creek and Devil Canyon. The populations in these streams are small, however, and are not expected to attract significant pressure.

## 2.2 - Access Mitigation

Mitigation of potential impacts during access roads and railroad construction will be achieved primarily by adherence to the BMPM construction techniques (APA 1985a). Erosion will be minimized by utilizing proper clearing and soil stabilization procedures as outlined in the BMPM on Erosion and Sedimentation Control (APA 1985a). Revegetation will be scheduled to proceed in segments immediately after portions of the roads or railroad are completed. Streams will be crossed following BMPM guidelines (APA 1985a) in order to minimize impacts.

Scheduling of construction activities is another means of mitigation that would avoid or minimize adverse impacts to fish and aquatic habitats. Movements of vehicles through streams during periods of peak Arctic grayling and Dolly Varden migration will be avoided. Figure 5 illustrates these migration periods. Instream and streambank construction will be minimized at streams containing sensitive habitat during peak migration periods to allow successful passage of the majority of the population to spawning or overwintering habitat. Figures 11 and 15 present the restricted periods for the streams crossed by the access corridors.

Potential impacts were identified in Section 2.1; Section 2.2.1 discusses these impact mechanisms and the mitigation measures that will be applied during and after access construction. Those sources of impact considered to have greatest potential for adverse effects to the aquatic environment are given highest priority. Measures to avoid, minimize, rectify and reduce impacts are discussed. Continued monitoring of the construction facilities and activities will ensure that impacts to the aquatic environment are avoided or minimized. Monitoring (Section 2.2.2) can identify areas that may need rehabilitation or increased maintenance efforts and areas where previous mitigation measures are inadequate and remedial action must be taken. Costs associated with all phases of maintenance and monitoring are outlined in Table 8.

### 2.2.1 Impact Mechanisms and Mitigation Measures

#### (a) Increased Fishing Pressure

##### (i) Impact Mechanism

The sport fishing pressure on the local streams and lakes will substantially increase. The access roads will allow fishermen to reach areas previously unexploited.

##### (ii) Mitigation

During the construction phase, access to the streams will be limited by closing roads to unauthorized project personnel and the general public. The Alaska Board of Fisheries will be provided information needed to develop management policies. Some watersheds, such as the Deadman Creek/Deadman Lake system, are expected to require special management considerations if current stocks are to be maintained (Schmidt and Stratton 1984). These regulations may take the form of reduced seasons or catch limits, imposition of maximum or slot size limits, or control of fishing methods. Since public health regulations will not allow sport-caught fish to be stored or prepared at public food service facilities, the project policy will be that all fishing done by project personnel and contractors be restricted to catch-and-release.

(b) Stream Crossings and Encroachments

(i) Impact Mechanism

During construction, fish are likely to avoid areas disturbed by equipment operated in or near streams. Spawning and overwintering migrations may be interrupted.

(ii) Mitigation

Construction activities in streams supporting fish populations will be scheduled, if possible, to avoid fish migration periods (Figures 11 and 15). Access road construction will continue for approximately 1.5 years at Watana and 1 year at Devil Canyon (Figures 6 and 12). However, during these time periods, instream activities near utilized fish habitat will be coordinated to minimize conflict with identified migration periods.

Spawning migrations and movements to and from overwintering areas by evaluation species occur during several time periods throughout the year (Figure 5). Arctic grayling migrate from lake overwintering habitat to spawning habitats following spring breakup. Spawning appears to end in mid June. Arctic grayling feed in streams and lakes during the summer prior to migrating to lakes in the late fall for overwintering. Stream-resident Dolly Varden predominantly feed in small headwater streams during summer and remain in these streams for spawning in late August to October. Dolly Varden may migrate to lakes for overwintering. By restricting instream activities during fish migrations, impacts to the fish resources in the region can be minimized. Bridges, culverts, and other drainage structures will be installed during the summer months before, between and after Arctic grayling and Dolly Varden spawning periods. Activities not involving instream construction will continue throughout the year. Figures 11 and 15 present the periods during which instream activities will be restricted for specified streams along the access corridor.

The USFWS recommended scheduling clearing activities during winter to minimize aquatic impacts. Because of the difficulties inherent in wintertime construction, current plans do not limit clearing to the winter. However, restricting instream construction during aquatic environmentally sensitive periods is expected to minimize aquatic impacts.

(c) Water Quality

(i) Impact Mechanism

Temporary degradations in water quality caused by increased turbidity, sedimentation and petroleum contamination may change the species composition and reduce the productivity of the system (Bell 1973, Alyeska Pipeline Service Company 1974).

(ii) Mitigation

The primary mitigation measures that will be used to minimize degradations in water quality are: (1) erosion control measures such as runoff control, stilling basins and revegetation will be employed as outlined in the BMP Manual on Erosion and Sedimentation Control (APA 1985a); and (2) the time period of the construction activity will be minimized so that degradation in water quality is a short-term, non-reoccurring problem. Therefore, water quality degradations from access construction and operation are not expected to significantly impact the fisheries resources. Further mitigation is not expected to be required.

(d) Oil and Hazardous Material Spills

(i) Impact Mechanism

Spills of oil and other hazardous substances into streams can be toxic to fish and their food organisms.

(ii) Mitigation

A Spill Prevention Containment and Countermeasure Plan (SPCC) will be developed as required by EPA (40 CFR 112.7) prior to the initiation of construction. The BMP manual on Oil Spill Contingency Planning (APA 1985e) will be used to avoid potential impacts.

Equipment refueling or repair will not be allowed to take place in or near floodplains unless adequate provisions have been made to contain petroleum products. Waste oil will be removed from the site and disposed using ADEC/USEPA-approved procedures. Fuel storage tanks will be located away from waterbodies and within lined and bermed areas capable of containing 110 percent of the tank volume. Fuel tanks will be metered to account for all outflow of fuel. All fuel lines will be located in aboveground or ground surface utilidors to facilitate location of ruptured or sheared fuel lines.

Vehicle accidents, although impossible to totally prevent, can be minimized by constructing the roads with properly designed curves to accommodate winter driving conditions. The roads will have adequate traffic signs and guardrails. During the winter, difficult stretches will be regularly cleared and sanded. In summer, dust will be controlled with water.

State law requires that all spills, no matter how small, be reported to ADEC (18 AAC 70.080). Personnel will be assigned to monitor storage and transfer of oil and fuel and to identify and clean up spilled oil and other hazardous material.

All personnel employed on the project, especially field personnel, will be trained to respond to fuel spills in accordance with an approved oil spill contingency plan. The BMPM Oil Spill Contingency Plan includes:

- Guidelines to follow for a training program for involved personnel.

- Actions to take as a first line of defense in the event of a fuel spill.

- Persons to contact in the construction organization and in state agencies.

- Records to keep during an oil spill and cleanup operation.

Oil spill containment equipment will be located onsite and adequate to handle the largest potential spill. Personnel will be trained in the operation of the equipment, and the equipment will be inventoried and tested regularly to make sure it is in proper working order in the event of an emergency (Bohme and Brushett 1979; Lindstedt-Siva 1979).

Impacts from an unavoidable major spill will be assessed by the Environmental Field Officer (EFO). Appropriate site-specific mitigation measures will be negotiated in consultation with the involved resource management agencies.

(e) Borrow Sites

(i) Impact Mechanism

Removal of material may result in erosion, siltation and increased turbidity. Borrow sites located in floodplains may impact waterbodies through increased ice buildup from groundwater overflow and alteration of fish habitat. Fish may become trapped in excavations within the floodplain.

(ii) Mitigation

Adverse impacts on aquatic habitats will be avoided or minimized by application of the BMPM guidelines. The predominant source of borrow material will be alongside the access road. Minimal impacts to the aquatic resources are expected from side-borrow activities.

Borrow Site D (Figure 17) will be used predominantly for the access road construction. Overburden at the site will be stockpiled for later use in contouring and replanting the borrow area. Berms or dikes will contain surface runoff to reduce the discharge of highly turbid water into Deadman Creek. Turbid water will be channeled through settling ponds.

Soil stabilization measures will be undertaken to limit erosion of exposed slopes as described in the BMP manual on Erosion and Sedimentation Control (APA 1985a).

Borrow Site E is located at the confluence of Tsusena Creek and the Susitna River. Small amounts of borrow for access road construction will be excavated from Borrow Site E. Impacts associated with Site E will be minimized by adherence to the BMPM and as explained in section 3.1.1. Erosion will be reduced by stockpiling materials outside the floodplain and retaining buffers between the excavations and the active channels. Dragline operations in the active channel will be avoided if possible.

Material washing operations will use recycled water. This water will not be discharged into adjacent streams or lakes unless the effluent conforms to ADEC and USEPA standards for turbidity and suspended solids (18 AAC 70.020). Settling ponds and stilling basins will be used to improve water quality.

The borrow sites will be rehabilitated after excavations have ceased. The sites will be revegetated to reduce erosion. Borrow Site E will be shaped and contoured to enhance fish habitat as described in Section 3.2.1. Man-made objects will be removed from the sites to the greatest extent possible. Rehabilitated areas will be monitored to verify the effectiveness of grading, revegetation and other mitigative measures.

### 2.2.2 Monitoring

Monitoring is recognized as an essential project mitigation feature that will provide for a reduction of impacts over time. Monitoring will be conducted during project construction and operation:

- To insure that environmentally acceptable construction practices, as defined by the bid specifications, required permits and the BMPM's, are being employed on the project

- To evaluate the effectiveness of the operation and maintenance of mitigation features

- To recommend changes in construction practices or mitigation features to further avoid, minimize, or reduce impacts

Monitoring of the access road construction will verify that proper construction practices, as detailed in the BMP manuals, are being followed. This monitoring activity will cover all aspects of the access road construction and maintenance.

Construction of the Watana access road is presently scheduled to begin in January 1989. From that time until completion of all access roads, an Environmental Field Officer (EFO) will be present at the sites. On a daily basis, the EFO will visit areas where construction is occurring. The EFO will be responsible for compliance with regulatory requirements and permits. The EFO will be a member of the APA staff and will report to the APA's resident engineer and construction manager.

Once construction has begun, onsite changes in permit stipulations may be needed because of accidents or changes in construction techniques. If a variation is required, the EFO will notify APA's construction manager who will contact regulatory agencies to amend permits or authorize field actions that were not specified in the permits. The construction manager will report permit violations, issue monthly status reports to the resource agencies. The construction manager will also be responsible for notifying the appropriate agencies prior to the commencement of a major construction activity so that the regulatory agency may request a site inspection.

Long-term operational monitoring will be conducted to evaluate the effectiveness of the mitigation plan. Arctic grayling populations will be studied (Harza-Ebasco

1985c) to evaluate the effectiveness of management plan designed to minimize the impact caused by increased fishing pressure in lakes and streams. The access road will be periodically monitored as part of the maintenance schedule. Chronic erosion sites will be identified and corrected; culverts will be inspected for debris blockages that could prevent fish passage.

The monitoring program costs outlined for the project are estimated in Table 8.

# 3 - CONSTRUCTION

The proposed three-stage development of the Susitna Hydroelectric Project will entail construction at two dam sites. Construction on the Stage 1 development of the Watana dam is scheduled to begin in 1990 (Figure 6). Site preparation is expected to start in 1989 and will include camp and village development. The four turbines are scheduled to be on-line for power production in 1997. The Stage 2 development, to be initiated in 1995, will involve the construction of the Devil Canyon dam and temporary camp facilities. In 2002, Stage 3 construction will raise the crest elevation and increase the generating power of the Watana dam. The additional two turbines in the Watana dam are expected to be on-line in 2008 (Figure 6).

The construction activities will affect the aquatic resources in the vicinity of the sites. Changes in nearby waterbodies and fish habitat will result; a loss of habitat will occur at the dam sites. Borrow site excavations will disturb aquatic habitat at the mouths of Tsusena and Cheechako creeks. Water quality degradations, including increased sediment levels, hydrocarbons and wastewater effluent contributions may temporarily decrease aquatic habitat quality. Fish will be directly affected as migration barriers will be created by dam construction.

Mitigation of these impacts in order to preserve the aquatic resources will be primarily accomplished by proper adherence to the construction techniques presented in the BMPM (APA 1985a, 1985b, 1985c, 1985d, 1985e). Additional mitigative measures, such as borrow site rehabilitation, will rectify the impacts associated with dam and camp construction. Monitoring will verify that construction activities follow the BMPM and that water quality is not significantly degraded.

## 3.1 - Impact Analysis

### 3.1.1 Watana Dam and Facilities

The proposed Watana dam and related facilities will be constructed at RM 184 on the Susitna River between Deadman Creek (RM 187) and Tsusena Creek (RM 182) (Figure 4). The Susitna River is a large glacier fed river, turbid during summer and clear during winter. The dam site is probably occupied by burbot, sculpins, and longnose sucker during the open water season and by these species and Arctic grayling during winter (ADF&G 1981, 1983).

Tsusena Creek is a clearwater stream with a drainage area of 144 square miles (373 $km^2$). A waterfall approximately 3 miles upstream of the confluence with the Susitna River blocks upstream fish passage. Dolly Varden and sculpin are present above the falls on Tsusena Creek (Sautner and Stratton 1984). Arctic grayling, Dolly Varden, and sculpin utilize the habitat available in lower Tsusena Creek (Sautner and Stratton 1984) and burbot and round whitefish have been observed near its confluence with the Susitna River (ADF&G 1981, 1983). The Arctic grayling population in the mouth of Tsusena Creek and in the clearwater plume which extends into the Susitna River was estimated at 1,000 fish (ADF&G 1981). Although excellent habitat is present within the lower reaches of the creek, few Arctic grayling appear to utilize this area for summer rearing (ADF&G 1983).

Deadman Creek, a meandering, clearwater tributary of the Susitna River, supports Arctic grayling of trophy size, Dolly Varden and sculpin (Sautner and Stratton 1984). A turbulent section prevents upstream fish passage approximately 0.6 miles (1 km) from the mouth of Deadman Creek. In 1981 and 1982, approximately 980 and 730 Arctic grayling were estimated to inhabit the reach downstream from the fish barrier during summer (ADF&G 1981, 1983). Burbot and longnose sucker have been observed near the creek mouth (ADF&G 1981). The creek has a drainage basin area of 175 square miles (453 $km^2$).

(a) Description

The Watana dam will be an earthfill structure located between RM 184 and RM 185 of the Susitna River. The Stage 1 development of the Watana dam will be built to a crest elevation of 2025 ft (617 m) with a maximum normal reservoir elevation of 2000 ft (610 m). One outlet facility structure and two power intakes will be designed to discharge a 50-year flood before the spillway overflows (Figure 8). The powerhouse will have four power generating units.

During Stage 3, the Watana dam will be raised to a crest elevation of 2205 ft (672 m) (Figure 18). The maximum normal reservoir elevation will be increased to 2185 ft (666 m). The concrete spillway, outlet facility structure and the two power intakes will be raised. A third power intake and two additional power generating units will be constructed. Upon completion of the Stage 3 development, the dam will be approximately 0.75 mile (1.3 km) wide, 0.75 (1.3 km) mile long and 885 feet (267 m) high. Over 62 million cubic yards (47,500,000 $m^3$) of material will be used to construct the dam.

Clearing will be necessary at the dam site and in the impoundment area. Cover vegetation will be removed at the site of the dam and construction camp and village facilities. In the reservoir area, trees will be cleared annually to the expected water level of inundation to reduce debris accumulation at the dam water intakes. Cleared material will be stockpiled or burned at specified disposal sites upstream of the Watana dam site (Figure 8) that will be subsequently inundated.

Prior to construction of the Stage 1 main fill structure, the diversion tunnels and cofferdams will be completed and the river diverted through the tunnels. Heavy equipment will be brought to the cleared site. Construction material will be stockpiled in the project area. Fill material from the borrow pit sites and usable material from excavation of the diversion tunnels will also be stockpiled. Blasting will be necessary during diversion tunnel construction and borrow excavations. During Stage 1 construction, rockfill for the dam will be obtained from tunnel and channel excavations. Water required for construction purposes will be withdrawn from the Susitna River.

The two cofferdams will dewater the construction area of the main dam. One cofferdam will be built upstream from the damsite and the other downstream (Figure 8). The upstream cofferdam will be approximately 800 feet (242 m) long and 450 feet (136 m) wide; the downstream cofferdam will be 400 feet

(121 m) long and 200 feet (60 m) wide. Water blocked by the upstream cofferdam will be diverted into two 38 foot (11.5 m) diameter concrete-line tunnels about 4100 feet (1240 m) long. The cofferdams will be constructed during a two-year period (1990-1991) and will remain in use until reservoir filling begins. At that time, the downstream cofferdam will partially be removed; the upstream cofferdam will be inundated by the reservoir.

Gravel mining and material sorting will be required for construction of the dam and related facilities. During Stage 1 development, approximately 10 million cubic yards (7.5 million $m^3$) of material will be excavated from Borrow Site E between RM 180 and RM 182 along the north bank of the S itna River at the confluence of Tsusena Creek (Figure 7). Material around Tsus a Creek and the mainstem of the Susitna River will be removed. Depending material quality and quantity, the borrow sites will be scraped or pit excavated. Prior to material removal, a mining plan will be formulated in accordance with 43 CFR Part 23; review and approval by concerned state a federal resource managing agencies will be required. A pit excavation is expected at Tsusena Creek. Gravel will be excavated, washed, and stockpilc during spring, summer and fall. Winter excavation is not proposed. The gravel will be washed at the borrow sites; wash water will be channeled through settling ponds and reused. Effluent from the settling ponds will conform to the ADEC/USEPA standards.

Excavation of 1 million cubic yards (0.75 million $m^3$) of gravel material wi be needed for the Stage 3 development of the Watana dam. The upstream regions of Borrow Site E (Figure 19) are not expected to be inundated by t Devil Canyon reservoir, which has a normal operating elevation of 1455 ft (443 m) to 1405 ft (428 m), with the drawdown occurring from June to Au t. Additional gravel material in the downstream area of the borrow site will t exposed during drawdown and will be available for excavation during construction of the Stage 3 raising of the Watana dam. Excavation to remo the needed amounts of material may necessitate the use of cofferdam structures and/or dragline operations.

Overburden, vegetation and unusable material from construction sites will be removed to selected disposal sites upstream from the dam site within the area of permanent inundation (Figure 8). Haul roads will be constructed to these sites (Section 2.4.1). The reservoir area will be cleared of large trees prior to inundation.

Housing of project personnel will be needed at the Watana site. During Stage 1 construction of the Watana dam, facilities to house a maximum of 2625 people are anticipated. The facilities will be located adjacent to the construction site to simplify transportation to and from the camps. Two campsites have been selected: the construction camp near Deadman Creek will be located approximately 2 miles from the dam, and the construction village will be within a mile of the site. Each development will occupy approximately 170 acres (68 ha). Approximately 1510 people are expected to be housed in the Watana construction camp and village during Stage 3 development. A permanent townsite encircling a 25 acre (10 ha) lake (Figure 8) will be developed at the construction village site for personnel who will operate and maintain the dam while the construction camp will be dismantled and the site restored.

The construction camp will contain the management offices, hospital, recreation hall, warehouses, communications center, bachelor dormitories, and other necessary facilities. The wastewater treatment plant will be located within the camp boundaries approximately 2,000 ft (610 m) from Deadman Creek. It is anticipated that the camp, excluding the treatment plant, will be dismantled, at the end of the Stage 1 development of the Watana dam construction. The camp will be rebuilt and utilized during the Stage 2 construction at the Devil Canyon Dam site. Upon completion of the Devil Canyon dam, the Watana construction camp will be reassembled for the Stage 3 development.

The construction village will be built during the Stage 1 development and will be upgraded to a permanent town. The construction village will be made up of 320 temporary housing units and an additional 240 lots with utilities furnished. The temporary housing units will be used primarily for workers who are accompanied by families and will be removed to the Devil Canyon site when construction of Stage 1 Watana is complete. The permanent town will be built to house the families of employees who will form the operation and maintenance team for Watana. The town will contain a hospital, a school, gas station, fire station, store, recreation center, and offices, as well as residences.

Construction uses for water will require withdrawal from waterbodies in the vicinity of construction activities. The Susitna River will be the source for water to be utilized in dam construction. Water will be utilized throughout the construction process in activities such as concrete production, aggregate washing and dust control. Concrete batching and wastewater generated by the production of concrete for the tunnel lining, spillway and powerhouse construction and grouting will be collected and treated in settling ponds prior to discharge. Concrete wastewater pH levels are high (10 +) and will be neutralized prior to discharge. A water appropriation permit application will be filed with the ADNR as required by AS 46.15.070. In addition, the ADF&G and the ADEC will be consulted for approval and permitting of water withdrawal.

Water for camp and village use will be withdrawn from Tsusena Creek and wastewater will be piped to the treatment plant near Deadman Creek. The Tsusena Creek intake will be located 6 miles (10 km) upstream from its confluence with the Susitna River. The water will be treated to conform with the primary and secondary requirements of the ADEC/USEPA for domestic use in the construction camp and village. An estimated 1.5 cfs will be needed during peak demand periods. Wastewater will receive secondary treatment prior to discharge into Deadman Creek. The wastewater outfall will be located in a turbulent section of Deadman Creek approximately 1.5 miles (7.5 km) upstream of its confluence with the Susitna River; thorough mixing is expected rapidly. The sewage treatment system will serve both the construction camp and village and will later be used for the permanent town. The sewage treatment plant will include a biological treatment lagoon to provide secondary treatment. A mechanical aerator will maintain biological activity in the lagoon during the winter. Solid wastes will be disposed in a lined, bermed and capped sanitary landfill situated between the camp and village.

Hazardous wastes will be temporarily stored onsite in a bermed and lined area and then removed for disposal. Waste oils containing trace metals require handling as a hazardous waste under 40 CFR 261-265. Solvents and other chemicals of concern, including antifreeze, hydraulic oil, grease and paints, are also toxic to aquatic life and will be stored in the hazardous waste area. Vehicles will be maintained to prevent antifreeze, hydraulic fluid and fuel from contaminating nearby water. Fuel will be stored and used in large quantities during construction. Fuel tanks will be surrounded by containment dikes capable of containing 110 percent of the tank capacity. Fuel storage areas will be lined with impermeable materials to prevent fuel contamination of groundwater. Vehicle fueling will be restricted to areas where runoff will be collected. Oily water runoff from the dam site and surface runoff at the vehicle maintenance areas, shops and related facilities will be collected and treated. All fuel spills will be reported to the ADEC as required by law. The contractor's Spill Prevention, Containment and Countermeasure plan (SPCC) will be developed and personnel trained prior to the initiation of construction as described in Section 2.1.1.

A 2500 foot (758 m) temporary airstrip will be built approximately 1 mile (1.6 km) from the damsite at the 2200-2300 foot (667-697 m) level. The airstrip will later be upgraded to a permanent airstrip which will be 6000 feet (1818 m) long.

(b) Potential Impacts

The construction of the Watana dam and camps will have a number of effects on the Susitna River, nearby tributaries and their biota. Some effects will be the direct result of construction activities, while other effects will result from alteration of the river environment during construction. Impacts will vary in duration and overall extent, some being temporary or localized while others will be permanent or more widespread.

o Cofferdams and Diversion Tunnels

The first major phase of Stage 1 dam construction involves placement of the two cofferdams and the permanent dewatering of 0.75 mile (1.3 km) of riverbed at the damsite. Fish normally using this stretch are anticipated to move into adjacent habitats. The effects on population size are expected to be minor. The dewatered area will eventually be totally covered by the Stage 3 Watana dam; thus, the effect will be a permanent but relatively minor loss of aquatic habitat. The Stage 1 dam will cover approximately 300 ft (91 m) less riverbed on the downstream side (Figure 18), than the Stage 3 dam.

Upstream fish movements through this reach will be permanently blocked when the Stage 1 development occurs. Arctic grayling seem to predominantly return to the stream utilized in previous migrations from the mainstem (ADF&G 1983). However, some Arctic grayling are expected to migrate to other streams upstream and downstream along the Susitna River (ADF&G 1983). For example, Arctic grayling tagged at Deadman Creek have been recaptured at Tsusena and Fog creeks (ADF&G 1981, 1983). The permanent upstream fish passage blockage between Deadman and Tsusena creeks is not expected to cause major degradation in the aquatic resources as migration appears to occur in both the upstream and downstream directions. Interstream movements from Deadman Creek will remain possible in the upstream direction; from Tsusena Creek, interstream movements will remain possible downstream.

The cofferdams will impound water and raise water levels upstream from the damsite. During the summer, a flood event equal to the once-in-50-year flood will cause a water level of 1536 feet (465 m), thus causing backwater effects for several miles upstream. To avoid ice problems in the diversion tunnel during the winter, a control gate will be partially closed to create a head pond approximately 50 feet (15 m) deep. The water will be ponded to an elevation of 1470 feet (445 m) affecting about 0.5 mile (0.8 km) of river upstream from the cofferdam. This backwater impoundment will provide additional mainstem habitat which is expected to be used by overwintering resident species.

The tunnel diversions during the Stage 1 dam construction will impact fish in the vicinity. Arctic grayling and other resident fish overwinter in mainstem habitat, and physical conditions within the head pond will provide substantial overwintering habitat. Fish residing in the impoundment upstream from the tunnels may be entrained into the flow and transported downstream from the damsite. If river transport mechanisms move rocks and other materials into the tunnels, or if the tunnel walls are not smooth, fish may be damaged through abrasion while being transported downstream. Water velocities within the tunnels will act as a barrier to upstream fish passage.

Experiments with fish transport indicate that fish are adversely affected when exposed to velocities in excess of 9.0 ft/sec (2.7 m/sec) (Taft et al. 1977). Tunnel velocities are expected to exceed 18 ft/sec (5.4 m/sec) during much of the summer (APA 1983c). However, little impact on populations is expected since relatively few resident fish are believed to occupy the mainstem area immediately upstream from the tunnels during the summer. As water levels increase during the winter months, entrance velocities into the tunnels are expected to be in excess of 20 ft/sec (6 m/sec) (APA 1983c). Overwintering fish in the head pond are likely to be entrained into the tunnels, and would likely result in fish mortality.

Several agencies (ADF&G and USFWS) suggested that a grating at the intake of the diversion tunnels would avoid fish entrainment. However, the installation of a fish screen would have temporary value since the habitat within the impoundment is expected to be poor and most fish are likely to seek alternative habitat. The cost associated with the construction and maintenance of a screen does not appear justifiable relative to the small number of fish potentially transported downstream.

Habitat immediately downstream of the diversion tunnels will be impacted by the high discharge velocities at the downstream end of the tunnels.

The high velocities will deter fish from using the area immediately downstream from the tunnels (Bates and Vanderwalker 1964; Stone and Webster 1976) during dam construction and operation. Gravels, sands and silts will be scoured from the immediate area of the tunnel outlet, and suspended sediment levels will initially increase. This increase is expected to be negligible relative to the naturally turbid summertime water conditions of the mainstem. However, during the winter, sediment transport is anticipated to increase above natural winter levels. Scouring of the glacial till in the channel bed would predominantly cause an increase in bed load and the turbidity of the river is expected to remain low.

o <u>Borrow Activities</u>

Impacts associated with borrow activities include habitat alterations and temporary reductions in habitat quality from water quality degradations caused by increases in suspended sediments and hydrocarbons. A long-term aquatic impact is expected due to the excavation in the vicinity of the mouth of Tsusena Creek. The volume of material to be removed will result in a large pit that will become filled with water. This pit will be rehabilitated to produce increased lentic habitat replacing lost riparian and upland habitat as described in Section 3.2.1. Other aquatic impacts from gravel removal operations may be avoided or minimized by adherence to the BMPM on Erosion and Sedimentation Control (APA 1985a). Gravel removal activities will conform to the Gravel Removal Guidelines of the USFWS (Joyce et al. 1980b).

At Borrow Site E, the installation of a stream crossing structure at Tsusena Creek will introduce small amounts of hydrocarbons and suspended sediments into the creek. To avoid or minimize hydrocarbon contamination, fuel utilized in borrow activities will be stored and equipment refueled in a bermed and lined area. Accidental petroleum spills will be avoided or contained according to the BMP Oil Spill Plan detailed in Section 2.1.1 (APA 1985c).

The Stage 2 development will change the quality of the aquatic habitats with the rehabilitated Borrow Site E. The operation of the Devil Canyon dam will impound a reservoir to a maximum normal operating elevation of 1455 ft (443 m). The reservoir will partially inundate Borrow Site E as shown in Figure 19. Following inundation, the water quality of the rehabilitated pit will reflect the reservoir water quality characteristics. The productivity in the Devil Canyon reservoir is expected to be poor because of high turbidity levels, cool temperatures and low nitrogen and phosphorus nutrient levels. However, fish utilization around the areas of tributary inflow, such as at the mouth of Tsusena Creek, is expected to be higher than elsewhere in the reservoir. A detailed description of the water quality and habitat availability in the reservoir is contained in Exhibit E, Chapter 2 of the License Application (APA 1983c).

During the Stage 3 development of Borrow Site E, temporary increases in suspended sediment levels and instream disturbances may cause fish to avoid habitat in the vicinity of the mouth of Tsusena Creek. The additional gravel excavations, even though conducted in accordance with the BMPM (APA 1985c) and the USFWS Gravel Removal Guidelines (Joyce et al. 1980b), may increase suspended sediment levels in the Devil Canyon reservoir; relative to the expected reservoir turbidities, the sediment contribution is not expected to significantly degrade the water quality. Borrow activities may temporarily disturb fish utilizing habitat at the mouth of Tsusena Creek. The sites of gravel excavation will be rehabilitated following the cessation of material removal.

Excavation, in accordance with the BMPM on Erosion and Sedimentation Control (APA 1985a), is not expected to have significant aquatic impacts at upland sites such as Borrow Site D and Quarry Site A. Suspended sediment increases at all borrow sites will be avoided or minimized by retaining buffers at stream margins, collecting runoff and monitoring settling pond effluents. Buffer zones of uncleared vegetation or overburden will reduce sediment contributions to streams and lakes. Runoff will be channeled away from waterbodies providing aquatic habitat to minimize erosional impacts. The effluent discharged from the settling ponds will be monitored and the ponds will be dredged when the water quality approaches the ADEC/USEPA standards.

- Fill Placement

The movement and usage of fill materials for the cofferdams and the main dams will be conducted according to BMPM guidelines (APA 1985a) to avoid or minimize turbidity and siltation impacts at the dam site and construction camps. During the transport, storage and placement of the fill material used in construction, material spills will be avoided to prevent impacts to adjacent water bodies including the mainstem Susitna River. Runoff control structures will be installed to channel surface runoff into settling ponds prior to discharge to the Susitna River. The placement of fill material during cofferdam construction will raise suspended sediment levels downstream. However, the cofferdams will be constructed during the summer and the resulting increase in suspended sediments relative to the natural summer conditions is not expected to significantly affect the aquatic resources downstream. Residual increases in mainstem turbidity are expected to be negligible.

- Water Removal

All water removal operations will adhere to the BMPM guidelines (APA 1985b) in order to avoid or minimize potential impacts. All water intakes will be screened and sized according to the ADF&G intake design criteria to prevent fish entrapment, entrainment or impingement. Since low volume pumps equipped with proper intake screens will be used, it is expected that the number of affected fish will be low.

In accordance with the BMPM (APA 1985b), a maximum of 370 cfs will be withdrawn from the Susitna River during the open water season; under frozen conditions, 10 percent of the flow at the time of withdrawal, an expected volume of 200 cfs, will limit the withdrawal quantities. These maximum withdrawal quantities are expected to exceed the volumes required for construction. The potential for dewatering of habitat in the Susitna River is negligible.

The estimated 1.5 cfs which will be needed to meet peak domestic use demands in both the construction camp and construction village presents less than a one percent reduction in Tsusena Creek flow during the average open-water season, and little impact is expected to result from decreases of this magnitude. A maximum reduction of approximately 8 percent is expected during the winter period; overwintering Dolly Varden, Arctic grayling and sculpin which may be present in deep pools downstream of the intake are not likely to be adversely affected by the water withdrawal.

Installation of the water withdrawal structure will follow the BMPM guidelines (APA 1985b). Turbidity and suspended sediment levels will increase temporarily during installation of the water intake system. Impacts associated with this instream activity will be short in duration and will cause negligible impacts to the aquatic resources if proper construction practices are used.

- <u>Liquid and Solid Waste Management</u>

Liquid and solid wastes will be managed in accordance with the BMP techniques outlined in the manual on Liquid and Solid Waste Management (APA 1985c) to minimize water quality degradations. Wastewater from construction and domestic activities will be monitored to verify conformance with ADEC/USEPA standards and the wastewater disposal permits. Potential aquatic impacts are not expected from the collection and disposal of solid wastes in conformance with the BMPM (APA 1985c). Residual impacts from waste disposal will not significantly affect the aquatic habitat or the productivity of the aquatic system. All necessary permit applications for discharge will be obtained from the ADEC, USEPA, ADNR and PHS and include the ADEC wastewater and waste disposal permits, a Federal Water Quality Certification and a National

Pollutant Discharge and Elimination System Permit.

Aquatic impacts on the Susitna River from wastewater generated during construction activities are not expected. The wastewater will be treated and neutralized prior to discharge. During the Stage 1 development, the construction wastewater will be discharged into the Susitna River; mixing is expected to occur rapidly in the large, swift river. During the Stage 3 development, the effluent discharged into the river will be introduced into the Devil Canyon reservoir. The effluent quantities will be insignificant relative to the reservoir volume.

The BMP manual on Liquid and Solid Waste Management (APA 1985c) will be applied to avoid impacts on fish habitat located downstream from the effluent outlet into Deadman Creek. Secondary treatment will avoid many of the problems associated with primary treatment, such as decreased dissolved oxygen and increased biochemical oxygen demand (BOD) and bacterial counts (Warren 1971). If disinfection is required, an additional lagoon will be needed to provide the residence time to reduce the total residual chlorine to the USEPA chlorine standard of 2 mg/l for salmonids. Arctic grayling, the primary species in Deadman Creek, are considered to be very sensitive to alterations in water quality. The effluent BOD and the concentration of total suspended solids (TSS) are both estimated to be 30 mg/l, levels which conform to water quality standards set by the Clean Water Act (USEPA) and the ADEC Wastewater Disposal regulations (18 AAC 72). The treated wastewater will introduce increased levels of phosphorus and nitrogen into Deadman Creek. A large increase in production in Deadman Creek is not expected as the wastewater outfall in Deadman Creek will be located in a turbulent section and thorough mixing is expected rapidly. The maximum effluent discharge from Watana camp is expected to be 1.5 cfs; the 1 in 20 year, 30-day low flow for Deadman Creek is estimated to be 27 cfs (APA 1983c). Following mixing, at this low flow, the BOD and TSS levels in the effluent will be diluted to approximately 2 mg/l.

Nitrogen and phosphorus loadings will be similarly diluted. The water quality in Deadman Creek is thus not expected to be significantly degraded by the effluent contributions.

The diluted effluent is not expected to degrade the water quality in the Watana reservoir by a measurable amount. During Stage 1 dam construction, the effluent from the wastewater treatment plant will rapidly become mixed with the water in Deadman Creek; maximum dilution is expected before Deadman Creek enters the impoundment created behind the cofferdams. During the Stage 1 operation, the maximum normal reservoir elevation will be 2000 ft (610 m). The outfall will be approximately 100 ft (30 m) upstream along Deadman Creek from the reservoir at this elevation. Although complete mixing of the effluent may not occur in the 100 ft (30 m) reach of creek, the large volume of the reservoir is likely to assimilate the effluent completely and water quality degradations in the impoundment are expected to be undetectable. The effluent outlet will be inundated during the Stage 3 operation of the Watana dam. The effluent is not expected to significantly degrade the water quality in the Stage 3 Watana reservoir.

o Disposal Sites

Adherence to the BMPM guidelines (APA 1985a) for disposal of material will avoid or minimize adverse impacts on the aquatic resources. Runoff control berms will minimize turbid water contributions to nearby streams and lakes. Disposed material will be covered with a layer of coarse gravel or shot rock to minimize erosion. Suspended sediment increases will be temporary. Residual aquatic impacts are not expected.

The disposal sites will be partially inundated upon Stage 1 Watana reservoir filling. Turbidity may increase locally during inundation; however, relative to the large volume of water in the reservoir, turbidity increases will be insignificant.

During the Stage 3 development of the Watana dam, overburden, vegetation and unusable material from the dam site will be stockpiled until disposal in the specified disposal area on the north bank of the Susitna River (Figure 8). Disposal will take place during the drawdown cycle of the Stage 1 reservoir; the reservoir will reach a minimum normal elevation of 1850 ft (564 m) approximately in April. Quantities of disposal material for the Stage 3 development will be less than quantities from the Stage 1 development. Residual aquatic impacts are not expected if activities conform to the BMPM on Erosion and Sedimentation Control (APA 1985a).

o <u>Clearing</u>

Clearing of vegetation will utilize the BMPM techniques (APA 1985a) to minimize erosional impacts on nearby waterbodies. Increases in local runoff may occur due to clearing activities and cause erosion, increased turbidity, and increased dissolved solids (Likens et al. 1970; Bormann et al. 1970; Pierce et al. 1970). Residual aquatic impacts from clearing activities will not require additional mitigation beyond adherence to the BMPM (APA 1985a).

Increases in suspended sediment contributions to nearby waterbodies will be avoided or minimized. Vegetation at stream margins will be hand cleared. Vegetated buffer zones will be maintained to the greatest extent practicable as the removal of bank cover will reduce fish habitat, may increase the exposure of fish to predators, and lead to a decrease in fish populations (Joyce et al. 1980a). Suspended solids and siltation increases will be minimized through soil stabilization procedures. Increased turbidity generally reduces visibility and decreases the ability of sight-feeding fish such as Arctic grayling and Dolly Varden to obtain food (Hynes 1966), thus effectively reducing feeding habitat. There is a considerable amount of literature that deals with the effects of siltation on fish (Shaw and Maga 1943, Cordone and Kelly 1961; Iwamoto et al. 1978), particularly the effect on spawning and incubation. A general conclusion reached by a review of the literature (Dehoney and Mancini 1982) is that the greatest adverse impact of siltation is on immobile eggs and on relatively immobile larval fish. In general, siltation can cause significant losses of incubating eggs and fry in redds, particularly by interfering with oxygen exchange and waste removal. Areas of ground water upwelling flow would likely be affected to a lesser extent than other areas because silt would tend to be prevented from settling. Resident fish in the vicinity of Watana Dam, including Dolly Varden, Arctic grayling, and round whitefish, may be affected by siltation. However, increases in suspended sediments are anticipated to be temporary; suspended sediment levels will return to natural levels following cessation of construction activities in accordance with the BMPM techniques (APA 1985a).

o <u>Fuel and Hazardous Materials</u>

The BMP manual on Fuel and Hazardous Materials (APA 1985d) outlines handling and storage requirements to avoid hazardous waste impacts. Accidental oil spills will be avoided or contained by adherence to the BMP manual on Oil Spill Contingency Planning (APA 1985e). Adherence to these guidelines will avoid or minimize potential impacts associated with fuel and hazardous material usage as described in Section 2.2.1. Residual aquatic impacts are expected to be minor during typical construction activities; accidental spills of material will have greater impacts on the aquatic environment and require additional mitigation.

Waterbodies in close proximity to the construction sites may receive small amounts of hydrocarbons. By providing proper drainage facilities, ponding areas, and if necessary, pump stations to pump contaminated water to the treatment facility, most oily and silty water will be prevented from reaching Tsusena and Deadman creeks. The lake at the village site will be more susceptible to intrusions of oily water. Runoff control measures such as trenches alongside roadways will collect runoff to avoid impacts to the lake. The water quality is not expected to be detectably impacted by the hydrocarbons in such small quantities.

An accidental spill, however, would severely affect the aquatic biota in nearby creeks and lakes.

o Blasting

Current construction plans do not require instream blasting. Blasting is planned for areas 500 feet (150 m) or more from streams. A review of the effects of blasting on aquatic life (Joyce et al. 1980a, Teleki et al.) indicates that effects from such blasting would probably not be lethal to aquatic organisms (at least with charges of less than 200 kg of TNT). The transmitted shock waves from the blasting may disturb fish and perhaps temporarily displace them from areas near blasting activity. This type of behavior is well documented for a variety of noise sources (Vanderwalker 1967; Latvaitis et al. 1977; USEPA 1976). Secondary effects of blasting, including increased turbidity and siltation caused by loosened soils and dust, will be avoided by adherence to the BMPM (APA 1985a). Instream blasting will adhere to the ADF&G standards (Table 9) for the Susitna River. The location and amount of blasting planned during the Watana dam construction is not expected to significantly impact fish. Quarry activities are expected to be distant enough to have negligible impacts.

o Recreational Impacts

Construction and operation of the dam and camps will result in increased access to an area previously exposed to minimal fishing pressure. The areas expected to sustain the heaviest harvest pressure would be those stretches of Deadman and Tsusena Creeks and the Susitna River that are easily accessible from the camps and the damsite. The resident fish populations are thought to be at their maximum level, i.e., they are at their carrying capacity (ADF&G 1981). Studies to date have indicated a relatively high percentage of "older" age group fish (up to 9 years) (Sautner and Stratton 1984). Sportfishing will inflict heaviest impacts upon larger, older fish and would likely result in a change in the age distribution of the population (Schmidt and

Stratton 1984). However, increased fishing pressure is likely to result from the construction of the access road (Section 2.2.1) and construction of the dam will not incrementally increase fishing pressure significantly.

### 3.1.2 Devil Canyon Dam and Facilities

The Devil Canyon dam will be situated on the Susitna River at RM 152 approximately 2 miles (3 km) downstream from the Cheechako Creek confluence (RM 154) and represents Stage 2 of the Susitna Hydroelectric Project. The high velocities in the Susitna River are believed to deter fish from utilizing habitat at the dam site (ADF&G 1981). Fish are usually prevented from migrating upstream of Devil Canyon because of the high water velocity. However, a relatively small number of chinook salmon have been observed upstream of the Devil Canyon dam site (ADF&G 1981, 1983, Barrett et al. 1985). A maximum of 46 chinook salmon per year were observed upstream of the Devil Canyon dam site between 1981 and 1984 (ADF&G 1981, 1983; Barrett et al. 1985).

Cheechako Creek is a clearwater stream supporting Arctic grayling, Dolly Varden and probably sculpin (Barrett et al. 1984). A few chinook salmon are known to utilize the lower reaches of Cheechako Creek; between 1981 and 1984, a maximum of 29 chinook salmon were observed in Cheechako Creek (ADF&G 1981, 1983, Barrett et al. 1985). During the low summer flows associated with the operation of Watana dam, chinook salmon are likely to pass the Devil Canyon dam site.

#### (a) Description

The Devil Canyon dam will be located at RM 152 of the Susitna River, approximately 32 miles (53 km) downstream from the Watana dam site. At the Devil Canyon dam site, the Susitna River is confined to a canyon approximately 600 feet (180 m) deep and 200 to 400 feet (60 to 120 m) wide at river level. During the Stage 2 development of the Susitna Hydroelectric Project, a thin concrete arch dam will be built at the downstream end of Devil Canyon and connect to an earth/rockfill saddle dam that will be constructed at the south end of the arch dam to provide closure of a low area at the south abutment. The dam foundation will cover about 90 ft (27 m) of river bottom. Construction of the dam will require excavation in the river channel. The reservoir behind Devil Canyon will cover 7800 acres (3120 ha) and will be about 32 miles (53 km) long and not more than 0.5 mile (0.8 km) wide.

The concrete dam and foundation will be 646 feet (195 m) high with a crest elevation of 1463 ft (446 m) and a crest length of 1650 feet (500 m). An estimated 2.7 million cubic yards (2,052,000 $m^3$) of concrete will be needed to construct the arch dam. The saddle dam will be 950 feet (287 m) across and 245 feet (74 m) high with a crest elevation of 1472 ft (449 m) and will require about 1.2 million cubic yards (912,000 m) of earth and rockfill material. Gravel for filler material and for concrete aggregate will be required.

Material for filter material and for concrete aggregate will be obtained from the Susitna River at the dewatered dam site, Borrow Site G and Quarry Site K. Borrow Site G is located at the confluence of Cheechako Creek and the Susitna River. A pit excavation is expected at Borrow Site G. Quarry Site K is approximately 400 ft higher in elevation and 1.5 miles (2 km) upstream from the mouth of Cheechako Creek. The locations of sites G and K are shown in Figure 17; other borrow sites may be utilized if material quantities are not adequate at sites G and K.

As with the Watana dam, the Devil Canyon dam will have an underground powerhouse, intake structure, outlet works, and main and emergency spillways. A 39 foot (11.8 m) diameter tailrace tunnel will convey the turbine discharge approximately 1.3 miles (2.2 km) downstream from the arch dam.

During construction of the dam, the river will be blocked above and below the construction site by cofferdams. The flow will be diverted into a 30 foot (9 m) diameter horseshoe tunnel, 1490 feet (451 m) long, and discharged back into the river channel. The upstream and downstream cofferdams will be about 400 feet (120 m) long and 200 to 400 feet (60 to 120 m) wide (Figure 16).

During construction of the Devil Canyon dam, housing will be required for 1900 persons. The construction camp and construction village will be located between 1.7 and 3.4 miles (2.8 and 5.6 km) southwest of the dam site (Figure 20). The camp will include bachelor dormitories, cafeteria, warehouses, offices, hospital, and recreational buildings. The village will contain housing for 170 families and will include a school, stores, and a recreation area. The camp will be approximately 0.5 mile (0.8 km) from the village. Both developments will be more than 700 feet (210 m) above the Susitna River and more than 4000 feet (1200 m) from the edge of the canyon. Water, sewage, and solid waste disposal facilities will be shared by both developments. Water will be withdrawn from the Susitna River and effluent from a secondary treatment system will be discharged into the Susitna River downstream of the water intake.

The southern boundary of the camp and the village approach within 200 ft (60 m) of the upper reaches of Jack Long Creek. Arctic grayling, rainbow trout, slimy sculpin, chinook, pink, chum and coho salmon are known to utilize Jack Long Creek (Sautner and Stratton 1984). A small unnamed creek, which enters the Susitna at RM 150, drains a series of lakes 3000 feet (900 m) to the east of the camp. The creek is paralleled by the sewage outfall line for 1000 feet (300 m) or about 20 percent of its length. The unnamed creek and lakes appear to provide Arctic grayling habitat. A few chinook salmon, Arctic grayling, and Dolly Varden are found in the lower reaches of Cheechako Creek (ADF&G 1983).

As at the Watana dam (Section 3.1.1), fuel and hazardous materials will be stored and utilized onsite. The fuel storage area will be located in a lined and diked area on the south side of the construction camp approximately 300 feet (91 m) higher in elevation and 1500 ft (460 m) away from Jack Long Creek.

Both the camps and the village are temporary developments to be dismantled and removed when the Stage 2 construction of the Devil Canyon dam is completed. Permanent personnel responsible for operations of the Devil Canyon dam will live at the Watana town. No airstrip will be built; air access will be provided by the permanent runway at Watana.

(b) Potential Impacts

The adverse impacts upon the aquatic resources at the Devil Canyon dam site are expected to be similar, but of lesser magnitude, to those at the Watana site (Section 3.1.1). Impacts from construction at Devil Canyon will be primarily restricted to the dam site. Temporary impacts resulting from the camp and village construction and operations are expected to be limited to the area immediately surrounding the construction site.

- Cofferdams and Diversion Tunnel

  Upon completion of the cofferdams and diversion tunnel, the dam site will be dewatered as at the Watana dam (Section 3.1.1). Because the turbulence at the site is believed to deter fish from utilizing the aquatic habitat in the canyon, dewatering will likely have a minor impact upon availability of suitable aquatic habitat.

  The cofferdams will create a permanent upstream migration barrier to fish in Devil Canyon. Under natural conditions, most fish species are unable to migrate upstream through the canyon due to high water velocities. In 1981 through 1984, chinook salmon were observed spawning in four tributaries and tributary mouths upstream of the dam site. However, few chinook salmon utilize this reach of river (21 to 46 fish observed per year) (ADF&G 1981, 1983, Barrett et al. 1985) and therefore the loss of chinook salmon spawning habitat upstream of the damsite is expected to be minor.

  Fish migrations downstream will remain possible although high mortality is likely if fish are abraided by the tunnel walls. Under natural conditions, fish may migrate downstream though Devil Canyon. The extent of downstream fish migration is assumed to be small. Fish migrating downstream after construction of the cofferdams may be entrained into the diversion tunnel. Entrained fish are likely to be damaged by contact with tunnel walls.

During the winter the division tunnel will be partially closed to impound a head pond to prevent ice problems; the impoundment may provide overwintering habitat for Arctic grayling. However, overwintering fish are likely to become entrained into the tunnel and transported downstream. The impoundment is not expected to provide substantial fish habitat.

o Borrow Sites

The greatest impacts during construction of the dam and related facilities are likely to be associated with gravel mining and processing in Borrow Site G. However, all borrow activities will be conducted in accordance with the BMPM techniques (APA 1985a) to avoid or minimize potential aquatic impacts. Suspended sediment contributions to the Susitna River from gravel mining will be controlled in order to minimize adverse impacts to fish. The effects of gravel mining on aquatic systems have been discussed in Section 3.1.1. Potential migration barriers to fish in Cheechako Creek will be avoided. Residual impacts due to borrow or quarry activities are not expected to cause a long term degradation in the aquatic populations.

Vegetated buffer zones will be maintained around waterbodies in the vicinity. The sites will be bermed. Turbid runoff will be collected and circulated through sediment ponds prior to release into clearwater streams. Blasting in the quarry site is not expected to adversely affect the aquatic resources of the region. Fish passage will be maintained through Cheechako Creek and instream activities will be restricted during the migration and spawning periods of Arctic grayling and Dolly Varden as shown in Figure 5. Borrow Site G will be permanently inundated by the Devil Canyon reservoir.

- Disposal Sites

  Disposal sites will be located in accordance with the BMPM guidelines (APA 1985a) to avoid or minimize impacts on the aquatic organisms as described in Section 3.1.1. Runoff control structures will be installed to avoid increases in turbidity or organic contributions to waterbodies in the vicinity. Disposal sites will be situated upstream from the dam site (Figure 16) and will be permanently inundated during reservoir filling. Prior to inundation, disposed material will be stabilized with a riprap cover to minimize erosional impacts. Residual impacts on the aquatic resources of the area from operation or inundation of the disposal sites are expected to be negligible due to the large volume of the reservoir.

- Water Removal

  Water removal will be conducted as described in Section 3.1.1 to avoid impacts to fish. Water for construction and camp use will be withdrawn from the Susitna River. Required withdrawal discharges are expected to be insignificant relative to the Susitna River discharge.

- Liquid and Solid Waste Management

  To minimize water quality degradations, all process waters will be treated prior to discharge to the Susitna River. Wastewater from the construction camp will be collected and treated in the Devil Canyon sewage treatment plant. The treated effluent, less than 1 cfs, will not significantly degrade the waste assimilative capacity of the Susitna River and is expected to have no significant effect on the aquatic environment. Water used in the concrete batching process, storm drainage, and oily water runoff from the construction camp will be collected and treated in settling ponds prior to discharge. Required drainage facilities and retention ponds, as specified in the BMP manual on Water Supply (APA 1985b), are expected to avoid impacts to Jack Long Creek from uncontrolled runoff from the camp area. Residual increases in sediment levels are not expected to adversely affect spawning habitats in Jack Long Creek or the unnamed creek nearby.

- Fuel and Hazardous Materials

Impacts associated with the handling and storage of fuel and hazardous materials were described in Section 3.1.1. The BMP manual on Fuel and Hazardous Materials (APA 1985d) will be followed to avoid adverse impacts on the aquatic organisms in Jack Long Creek and other nearby waterbodies. The BMP Oil Spill Contingency Planning manual (APA 1985e) will be utilized to avoid or contain accidental petroleum spills.

- Blasting

Construction of the arch dam and the saddle dam will require excavation in the dewatered river channel at the damsite. Excavation by blasting or by mechanical means may result in the introduction of materials into the Susitna River that would be carried downstream. It is unlikely that the damsite itself is located in a stretch of the Susitna regularly inhabited by fish; therefore, it is expected that the excavation and blasting required at the damsite would not disrupt fish populations. However, the ADF&G blasting guidelines (Table 9) will be applied.

- Recreational Impacts

As with the Watana dam, the most significant long-term impact associated with the Devil Canyon dam will be the increase in fishing pressure. The camp and village at the Devil Canyon site will house 1900 workers for several years. As a result of the improved access and higher population, streams and lakes in the vicinity will be subjected to increased fishing pressure as described in Section 2.1.1. This area has not been heavily utilized for sport fishing in the past.

The habitats most likely to be affected by increased fishing include

Cheechako Creek, unnamed creeks and lakes, Jack Long Creek, and to a lesser extent, the Susitna River and Portage Creek, which enters the Susitna River on the opposite side of the Susitna River from the camp and village.

## 3.2 - Construction Mitigation

Mitigation of potential impacts associated with the construction of the Watana and Devil Canyon dams and facilities will be achieved primarily by adherence to the BMPM construction practices. The BMP described in the Erosion & Sedimentation Control Manual (APA 1985a) will be followed to minimize turbidity and siltation impacts. The BMP manual on Water Supply (APA 1985b) will be utilized to minimize impacts associated with water withdrawal. Activities involving wastewater, petroleum products and hazardous materials will conform to the relevant BMPM (APA 1985c, 1985d, 1985e) to avoid or minimize potential impacts on the aquatic resources in the vicinity.

Potential impacts are identified in Section 3.1. Section 3.2.1 contains a discussion of the impact mechanisms and the mitigation measures that will be applied during and after construction. Those mechanisms considered to have the greatest potential for adverse impact to the aquatic environment are discussed first. Avoidance, minimization, rectification and reduction of impacts are discussed. Costs associated with the rehabilitation of Borrow Site E are presented in Table 8; no other direct mitigation costs have been evaluated as adherence to the BMPM (APA 1985a, 1985b, 1985c, 1985d, 1985e) is the primary means of mitigation.

Continued monitoring of the construction facilities and activities will ensure that impacts to the aquatic environment are avoided or minimized. Monitoring can identify areas that may need rehabilitation or maintenance and areas where previous mitigation measures are proved inadequate and remedial action is necessary. Monitoring of construction is discussed in Section 3.2.2. Costs associated with construction monitoring are outlined in Table 8.

### 3.2.1 Impact Mechanisms and Mitigation Measures

#### (a) Borrow Sites

##### (i) Impact Mechanism

Removal of floodplain gravel at Borrow Sites E, G and other potential sites (Figures 7 and 17) can cause increased erosion, siltation, increased turbidity, increased ice buildup caused by ground water overflow, fish entrapment, and alteration of fish habitat.

##### (ii) Mitigation

Gravel removal in the floodplains of the Susitna River will be conducted in accordance with the USFWS Gravel Removal guidelines (Joyce et al. 1980b) and the BMPM on Erosion and Sedimentation (APA 1985a). Buffers will be retained between the sites and any active channels. The buffers will consist of vegetated strips and/or dikes designed to prevent erosion and subsequent increases in turbidity. At Tsusena and Cheechako creeks, buffers will be maintained between the active channel and the excavations. Fish passage will be maintained through Tsusena, Cheechako and all other fish supporting creeks affected by borrow activities. The borrow areas will be subdivided into aliquots; each aliquot will be cleared and excavated prior to the commencement of borrow activities in adjacent aliquots. Rehabilitation of the disturbed aliquot will proceed concurrently with borrow activities in adjacent aliquots. Rapid rehabilitation will assist in reducing erosional impacts to the aquatic resources.

Material washing operations will use recycled water and will not discharge into adjacent clearwater streams. Water containing suspended sediments will be circulated through settling ponds and reused. Settling ponds may be maintained by dredging fine materials which will be removed from the floodplain and used in site renovation. Settling ponds will be cleared when the effluent approaches the ADEC/USEPA standards. Upon closure of the borrow site, the water will be discharged from the settling ponds into the Susitna River. All effluents will conform to ADEC/USEPA standards (AS 46.03.100; 18 AAC 70.020; 18 AAC 72.010).

Overburden and unsuitable material will be stockpiled for return to the removal area for contouring and revegation efforts. Material will be stockpiled outside the floodplain to avoid impounding flow at higher stages resulting in material erosion. If insufficient space exists away from the floodplain, material may be stockpiled and armored to prevent erosion.

Rehabilitation at Tsusena and Cheechako creeks will proceed both concurrently with borrow activities and following closure of the site. Stockpiled overburden will be replaced at upland aliquots. Exposed slopes will be stabilized and contoured to blend with surrounding features and topography. Revegetation and fertilization of the disturbed areas will assist in minimizing erosion. All man-made objects will be removed following site closure. Settling ponds will be dewatered of the clear surface water and silt will be broadcast, removed to approved disposal sites, left in place with a riprap covering or piled in the nonflooded sections of the site.

The pit excavation at Borrow Site E will be rehabilitated to provide fish habitat. A rehabilitated borrow pit can provide fish rearing and overwintering and increase the availability of Arctic grayling and Dolly Varden (Joyce et al. 1980a). Spoil materials will be used to provide a diversity of water depths and bank slopes to create a variety of fish habitats. A mean depth of 8 ft (2.5 m) or greater will be needed to assure survival of overwintering fish. The pit will have a relatively long and narrow shape with an irregular shoreline aligned longitudinally in the floodplain.

Spoil and overburden will be used to construct islands and peninsulas. An outlet channel will be provided at the downstream end of the pit to enable fish movement between the mainstem and the pit and the unnamed creek will contribute directly to the pit. Tsusena Creek will remain independent of the pit by maintaining a buffer of vegetation between the excavation and the active channel of the creek. Figure 21 details a rehabilitated pit excavation that may be appropriate for Tsusena Creek.

Borrow site G will be inundated following dam completion; rehabilitation will consist of stabilizing slopes to minimize erosion and removing man-made objects. Revegetation will not be necessary. Settling ponds will not be dewatered.

(b) Water Quality

(i) Impact Mechanism

Temporary degradations in water quality caused by increased turbidity, sedimentation and petroleum contamination may change the species composition and reduce the productivity of the system (Bell 1973, Alyeska Pipeline Service Company 1974).

Discharge of camp effluents may result in increased nutrient loading. Concrete batching plants produce highly alkaline effluents. Wastewater may have a higher temperature than natural waters.

(ii) Mitigation

The primary mitigation measures that will be used to minimize degradations in water quality are: (1) employing BMPM erosion control measures including runoff control, stilling basins and revegetation (APA 1985a); and (2) maintaining vegetated buffer zones.

Disposal sites will be constructed so that neither runoff during breakup nor rainfall will wash silty material into streams. This may entail runoff control structures, surrounding the disposal site with berms, or channeling runoff through containment ponds. Prior to site inundation, the overburden and slash will be stabilized with gravel or riprap fill. Turbidity increases, water quality degradations, and other impacts are not expected due to disposal site inundation (Section 3.1.1).

The natural vegetation is a major factor in preventing erosion (Alyeska Pipeline Service Company 1974). Clearing will be confined to the minimum area and level necessary. Cleared material will be removed to approved disposal sites, salvaged, or burned onsite. Revegetation of cleared areas will proceed as rapidly as possible following the termination of construction activities.

All wastewater will be treated to comply with ADEC/USEPA effluent standards (AS 46.03.100; 18 AAC 70.020; 18 AAC 72.010). The concrete batching effluent will be neutralized and treated prior to discharge into the Susitna River to avoid impacts related to pH and toxic substances. Secondary treatment will be utilized to reduce the concentration of suspended solids and biochemical oxygen demand (BOD) of the wastewater. The effluent will retain relatively high concentrations of nitrogen and phosphorus. Wastewater will be retained in settling ponds until effluent temperatures approximate instream temperatures.

(c) Susitna River Diversions

(i) Impact Mechanism

The diversion tunnels and the dams will act as barriers to successful fish migration. Chinook salmon will not be able to utilize spawning habitat upstream of the dam site. Fish passing downstream through the diversion tunnels are expected to be lost because of impacts with tunnel walls. During summer, relatively few fish are present in the vicinity of the tunnel entrance. During winter, resident fish are expected to be entrained into the intake and passed downstream.

(ii) Mitigation

Due to the relatively small impact on the aquatic resources, no direct mitigation is proposed. The loss will be included in the compensation for lost reservoir habitat that will take the form of acquiring public access and undertaking habitat improvement outside the project area (Jennings and Moulton 1985).

(d) Oil and Hazardous Material Spills

(i) Impact Mechanism

Spills of oil and other hazardous substances into streams are toxic to fish and their food organisms.

(ii) Mitigation

Mitigation for oil and hazardous material spills is described in Section 2.2.1 and will be conducted in accordance with the BMPM on Oil Spill Contingency Planning (APA 1985e); compensation for a major spill will be determined following consultation with the resource management agencies.

(e) Clearing the Impoundment Area

(i) Impact Mechanism

Impoundment area clearing may accelerate erosional contributions to the Susitna River.

(ii) Mitigation

Clearing will be scheduled annually as close to reservoir filling as is feasible. Vegetation will be cleared to the elevation of the high water level anticipated for each year of filling. Disturbance to the vegetative mat will be avoided. Erosion control methods described in the BMP manual on Erosion and Sedimentation Control (APA 1985a) will be employed wherever needed to minimize erosion. No additional mitigation will be required.

(f) Increased Fishing Pressure

(i) Impact Mechanism

The sport fishing pressure on the local streams and lakes will increase due to the presence of the construction workers.

(ii) Mitigation

The mitigation of the aquatic impact from increased fishing pressure has been previously discussed in Section 2.2.1. Variations are not expected.

### 3.2.2 - Monitoring

Monitoring is recognized as an essential project mitigation feature that will provide for a reduction of impacts over time. Monitoring will be conducted throughout project construction:

- To insure that the environmentally careful construction practices detailed in the BMPM's (APA 1985a, 1985b, 1985c, 1985d, 1985e) are being employed on the project to avoid or minimize impacts;

- To verify and evaluate the effectiveness of the operation and maintenance of mitigation features; and

- To recommend changes in construction practices or mitigation features to further avoid, minimize, or reduce impacts.

Construction monitoring will consist of monitoring construction activities to verify that proper construction practices are being followed and that project facilities are being properly maintained. This monitoring activity will cover all project facilities, including camp and village construction, material removal, washing operations for dam construction, reservoir clearing, abandonment, and rehabilitation activities.

As described in Section 2.2.2, the APA will assign at least one member of its staff to be an Environmental Field Officer (EFO) responsible for compliance with regulatory requirements and permits. During and after construction activities, the EFO will review the designs and verify that the activity is in compliance with the BMPM's permit and license stipulations. If a discrepancy with existing stipulations is observed and if a variance was not requested prior to implementing the activity, a certificate of non-compliance will be issued and all responsible parties will be notified.

The monitoring program will include water quality and borrow site monitoring. Deadman Creek will be monitored to detect degradations in water quality from increased phosphorous or nitrogen (Harza-Ebasco 1985c). The water quality monitoring program will also investigate dissolved oxygen levels downstream of the effluent outlet (Harza-Ebasco 1985c). Borrow sites will be monitored during construction and after rehabilitation. Settling pond effluents will be monitored to assure compliance with ADEC/USEPA standards. Tsusena and Cheechako creeks will be monitored for fish blockages. Impacts identified through the monitoring program will be assessed and rectified following negotiation with the resource agencies.

## 4 - TRANSMISSION LINES

Power generated at the Watana dam and the Devil Canyon dam will be delivered to power utilization regions by transmission lines. Construction will occur throughout the three stages of development (Figure 22). The transmission lines will be built from the Watana dam along the access road to the Devil Canyon dam site and continue along the railroad spur from Gold Creek (Figure 23). At Gold Creek, the transmission lines are planned to converge with the Anchorage-Fairbanks Intertie currently extending from Willow to Healy (Figures 24, 25 and 26). The route south of Willow will be extended to Point MacKenzie where a submarine cable will cross the Knik Arm. The terminus of the southern section will be the University substation in Anchorage (Figure 27). The northern section will be extended from Healy to Ester near Fairbanks (Figures 28 and 29). The transmission corridor from Anchorage to Fairbanks will be 330 miles (530 km) long.

Potential aquatic impacts associated with the transmission line construction and maintenance will be similar to those identified for the access corridor (Section 2.1). In general, impacts are anticipated to be short in duration and confined to the construction phase. Short-term aquatic impacts will occur where the transmission lines cross resident and anadromous fish streams. The transmission line corridor will increase the accessibility of these streams and nearby lakes and may lead to increased fishing pressure; this long-term impact is probably the most significant potential aquatic impact associated with transmission line construction.

Mitigation of potential transmission line impacts will also be similar to the mitigation of the access road impacts (Section 2.2). Mitigation of short-term potential impacts during construction will be accomplished primarily by adherence to the construction practices presented in the APA BMP manuals (APA 1985a, 1985b, 1985c, 1985d, 1985e). Mitigation of impacts resulting from increased accessibility may include restricting usage of the maintenance road.

### 4.1 - Impact Analysis

#### 4.1.1 - Watana to Gold Creek

(a) Description

From the Watana dam site to Gold Creek, a distance of 37 miles (60 km), two parallel sets of towers will be built during Stage 1 construction; the towers will require a 285 foot (87 m) wide right-of-way through tundra and occasionally dense vegetation. The transmission lines will consist of a series of steel towers approximately 1300 ft (393 m) apart. The towers will be x-framed guy towers, capable of supporting three conductors. The transmission towers will be spaced so that structures are not located within currently active stream channels and are removed from floodplains to the best extent practicable.

In the right-of-way, trees and shrubs within 20 ft (6 m) of the conductors and trees within 55 ft (16.5 m) of the tower centerline will be cleared as well as any other trees or shrubs that may hamper construction or pose a threat to the completed line. The selective clearing will retain low shrubs and grasses in order to minimize erosion. Revegetation in the corridor will be allowed to proceed so long as the integrity of the lines is not endangered and vehicles are able to follow the cleared area associated with the lines. Where vegetation is dense between the Susitna River crossing and Gold Creek, cleared vegetation will be hauled to a designated area and salvaged or burned. Deciduous vegetation may be piled at the corridor margins; coniferous slash may be chopped with a hydro-axe and broadcast in the corridor. Piled coniferous vegetation will be burned within the first year after cutting. Clearing activities are scheduled to occur from 1992 to 1993.

The transmission line construction will necessitate stream crossings by heavy equipment such as hydro-axes and drill rigs. Streams and lakes potentially impacted are previously identified in Sections 2.1.2 and 2.1.4 since the transmission corridor will closely parallel the Devil Canyon dam access road and the railroad spur connecting Devil Canyon to Gold Creek (Figure 23). Temporary bridges may be installed depending on the stream size and passage requirements. For small streams with low gradients and gradual banks, low water crossings may be used. All crossings will be designed to provide adequate fish passage (Harza-Ebasco 1985a).

The towers will be supported by a variety of foundations designed for soil conditions at each site. Driven steel pilings and steel grillage foundations will be preferentially utilized although cast-in-place concrete piles will occasionally be necessary. Buffers of at least 100 ft (30 m) between active stream channels and the sites of driven piles will be retained to avoid increased sedimentation from soil vibration in the channel during pile driving. Waste concrete will be disposed at designated sites away from streams and lakes. Concrete batch water will be neutralized prior to discharge.

Ground access will be provided in transmission line corridors for periodic maintenance and repair of lines, towers and conductors. Within the transmission line corridor, a 25 ft (7.5 m) wide trail will be cleared; the trail will be suitable for flat tread, balloon tire vehicles. The maintenance trail will remain clear of vegetation and will be accessed using secondary trails from the Devil Canyon access road and railroad. Stream crossings in the corridor will be minimized by clearing secondary trails to the sections of the corridor trail separated by major streams. Vegetation or man-made buffers between the corridor trail and the stream will discourage stream crossings. Along the Watana to Gold Creek corridor, a secondary trail will connect each tower to the road or railroad access corridor. The secondary trails will not be maintained by the APA.

(b) Potential Impacts

Potential aquatic impacts from Stage 1 construction of the transmission line from Watana to Gold Creek are similar to those of the Devil Canyon access road (Section 2.1.2) and the railroad spur (Section 2.1.4). Impacts discussed in these sections are generally applicable to transmission line construction. Variations or alterations in impacts are discussed further.

o Clearing

Residual impacts from transmission line clearing from the Watana dam site to Gold Creek will include minor water quality degradations and small amounts of aquatic habitat loss from cover removal. Clearing activities will conform to the BMPM on Erosion and Sedimentation Control (APA 1985a) to avoid or minimize the potential clearing impacts which are expected to be similar though of less significance than clearing impacts for the Devil Canyon road and railroad access (Section 2.1.1).

As described in Section 2.1.2, adherence to the BMPM construction techniques (APA 1985a) will minimize potential impacts associated with clearing. At transmission line stream crossings, clearing may remove overhanging vegetation that provides cover for fish. Fish may not utilize the available habitat if cover is not available. This habitat loss is expected to be temporary and minor relative to the total amount of available habitat. BMPM techniques (APA 1985a) will be followed at cleared vegetation stockpiling, salvaging or burning sites to prevent surface runoff from contributing ash or organic materials to streams and lakes as described in Section 2.1.1.

o Stream Crossings and Encroachments

During transmission line construction, instream activities will be conducted according to the BMPM guidelines (APA 1985a) to avoid or minimize impacts to the aquatic resources. Residual impacts from stream crossings consist of temporary habitat losses, which are not believed to be of significant magnitude to require mitigation. Mitigation for a major petroleum spill is presented in Section 2.2.1.

Instream activities will be limited to the installation of necessary stream crossing structures designed to provide adequate fish passage (Harza-Ebasco 1985). Stream crossings at major fish supporting streams will be avoided by utilizing the alternative access secondary trails from the access road and railroad to Devil Canyon. Instream use of equipment will be required to be short in duration and avoid environmentally sensitive periods for the designated streams (Figures 11 and 15).

o Operation and Maintenance Activities

All maintenance activities will be conducted in accordance with the BMPM (APA 1985a) and significant impacts are not expected to occur. Some localized habitat disruptions could occur when maintenance vehicles need to cross wetlands and streams to repair damaged lines or towers. Streams may be forded to make repairs if the temporary bridges or culverts are removed after construction is complete. Aquatic habitat in the immediate vicinity of the crossing could be affected. In addition, there may be increases in suspended sediments and sedimentation in downstream reaches. However, maintenance activities in remote areas are expected to utilize helicopter transportation.

In the longer term, the transmission line corridor and maintenance road may increase fishing pressure on lakes and streams in the vicinity. Because the vegetation will be kept relatively low, hikers and all terrain vehicles will be able to use the transmission corridor as a trail. In winter, snow machines will also be able to traverse these cleared areas. Between Watana and Devil Canyon, access may be increased marginally beyond that provided by the nearby Devil Canyon access road. The corridor and maintenance track between Devil Canyon and Gold Creek paralleling the railroad spur would marginally improve access to tributaries and sloughs of the Susitna River and may slightly increase the fishing pressure on these habitats.

### 4.1.2 Devil Canyon to Gold Creek

#### (a) Description

The Stage 2 construction on the Devil Canyon dam will add two transmission lines to the transmission corridor from Devil Canyon to Gold Creek. This will result in an arrangement of four parallel sets of towers extending for 8 miles (13 km) along this segment of the lines. The corridor will be widened to 515 ft (157 m). Additional clearing along the corridor will be necessary as described in Section 4.1.1.

(b) Potential Impacts

The potential impacts associated with installing two additional transmission lines in the Devil Canyon to Gold Creek corridor will be identical to those impacts identified in Section 4.1.1. Disposal sites from stage one clearing will be utilized. Significant new impacts are not expected with this incremental addition.

### 4.1.3 Willow to Healy

(a) Description

The transmission lines will join the Anchorage-Fairbanks Intertie at Gold Creek. The Anchorage-Fairbanks Intertie, which connects Willow to Healy, is being built as a separate project and is expected to be completed in 1985 (Figures 24, 25 and 26). During Stage 1 construction, the Susitna Hydroelectric Project will add another line of towers from Gold Creek to Willow within the same right-of-way; the Stage 2 Devil Canyon construction will include building an additional transmission line in the Intertie corridor from Gold Creek to Healy. A third transmission line will be constructed from Gold Creek to Willow to transport power following Stage 3 development at Watana (Figure 22). The Intertie corridor for the Stage 3 development will be cleared to a width of 285 ft (87 m) from Gold Creek to Healy and 400 ft (120 m) from Gold Creek to Willow. The impacts will be similar to those experienced during Intertie construction. The Environmental Assessment Report for the Intertie (Commonwealth et al. 1982) discusses the expected environmental effects of transmission line construction in this segment. Fish streams that will be crossed include the Nenana River, Talkeetna River, Chunila Creek, Susitna River, and the Kashwitna River. A total of 77 streams will be crossed (Table 10).

The majority of streams crossed by the transmission lines along the Intertie route are utilized throughout the year by anadromous and resident species (Table 10). Anadromous fish include chinook, sockeye, coho, pink, and chum salmon; resident species include Arctic grayling, Dolly Varden and rainbow trout.

Construction will proceed in a similar manner to the construction of the Intertie transmission lines. Experience gained from the previous construction will be applied and is likely to result in a shortened construction period. Access established during construction of the Intertie will likely be utilized. During construction, heavy equipment will cross small streams. Temporary bridges or culverts may be installed to minimize impacts to aquatic organisms. The majority of stream crossings will utilize log stringer and temporary bridges. Small headwater streams without fish populations will be forded. These streams are identified in Table 10 and are located at the approximate mile post (AMP) 79, 90.5, 91.5, 92.5, 94, 117.5 and 137.5 as measured from the Willow substation. Large streams in the transmission corridor will not be crossed by equipment; sections of the transmission line separated by major streams and rivers will be accessed from existing roads such as the Parks Highway. Construction where secondary roads to the site would be long and cross many streams is expected to utilize helicopter transportation in a similar manner to construction along the Anchorage-Fairbanks Intertie.

(b) Potential Impacts

The potential impacts of constructing additional transmission lines in the Anchorage-Fairbanks Intertie corridor are expected to be similar, but less significant than the impacts associated with the original construction activities. Impacts identified for transmission line construction in Section 4.1.1 are applicable. Additional site specific impacts are discussed further.

o Clearing

The additional clearing required for the installation of the second and third transmission line will be conducted using BMPM techniques (APA 1985a). Sites previously selected during construction of the Intertie for vegetation broadcasting, stockpiling and/or burning will be utilized. Residual impacts are not expected if the BMPM (APA 1985a) techniques are followed.

- Stream Crossings and Encroachments

  Access provided during Intertie construction will be used. Any instream activities will follow BMPM guidelines (APA 1985a) to avoid significant increases in suspended sediments, sedimentation, or petroleum contamination. Aquatic organisms in nearby habitat will be temporarily disturbed.

- Operation and Maintenance Activities

  The operation and maintenance of additional transmission lines in the Intertie corridor are not likely to increase aquatic impacts beyond the existing level of impact.

### 4.1.4 Healy to Ester

#### (a) Description

The transmission line corridor will be extended from Healy to Ester (Figures 28 and 29) during construction of the Stage 1 Watana dam. A second transmission line will be added to transport power during the Stage 2 development of the Devil Canyon dam. When the two transmission lines are installed, the corridor will have a 285 ft (87 m) width. The Nenana River is crossed 2.75 and 58.75 miles (4.4km and 94.5 km) from the Healy substation. The line will turn north after crossing Dry Creek at AMP 4.75 and roughly parallel the Parks Highway for the greatest part of its length. The line will end at the Ester Substation (AMP 94.25). Clearing and construction will proceed as described for the Watana to Gold Creek section (Section 4.1.1). The streams crossed by the northern leg are listed in Table 11. Streams of the Nenana Basin that are accessible and have appropriate spawning habitat support spawning runs of resident species such as Dolly Varden, round whitefish and Arctic grayling. A number of interconnected lakes lie in the Nenana Basin. Fish found in the lakes include Arctic grayling, whitefish, lake trout, and burbot.

(b) Potential Impacts

Impacts in the Healy to Ester segment will be similar to impacts identified for the transmission line construction of other segments (Section 4.1.1). Additional impacts specific to this segment of the transmission line are discussed below.

- Clearing

  Impacts to aquatic organisms from clearing activities are likely to be minor as the BMPM on Erosion and Sediment Control (APA 1985a) will be followed. Large amounts of clearing are not anticipated as much of the vegetation is tundra. Cleared vegetation will be broadcast or removed to selected sites and stockpiled or burned. Ash and other organic material will be prevented from entering streams or lakes.

- Operation and Maintenance Activities

  The corridor from Healy to Ester will follow the route of the Parks Highway; access will therefore be available previously and the aquatic resources are not expected to be incrementally impacted by the operation and maintenance of the transmission lines.

### 4.1.5 Willow to Anchorage

(a) Description

The transmission corridor from Willow to Anchorage (Figure 27) will be established during the Stage 1 development of the Susitna Hydroelectric Project. The Willow substation is located approximately 0.5 miles (0.8 km) north of Willow Creek. Proceeding first west then south, the lines will be routed between the Susitna River and the Nancy Lake area, passing within 0.75 miles (1.3 km) of the Susitna River. The lines will cross several Susitna River tributaries, including Fish Creek at AMP 18 as measured from the Willow substation. The Little Susitna will be crossed at AMP 26. Few streams are crossed between the Little Susitna River and the Knik Arm at AMP 44. The Knik Arm, which is approximately 2.5 miles (4.1 km) wide at the transmission line crossing, will be crossed by a submarine cable system. The Knik Arm switching station will be located between Sixmile Creek and Eagle River. From there the transmission lines will bypass Otter Lake and cross the Alaska Railroad and Fossil Creek. The the corridor will parallel the Glenn Highway for about 2 miles (3 km). Ship Creek will be crossed at AMP 75 and the lines will traverse the Chugach Foothills before terminating at the University substation near the corner of Tudor and Muldoon roads. Table 12 presents a list of the streams to be crossed by the transmission lines.

Construction of the two transmission lines from Willow to Anchorage during Stage 1 development will be similar to previous construction (Section 2.1.1). A third transmission line will be installed from Willow to the Knik Arm crossing during Stage 3 development. Details of the installation of the cable under Knik Arm are to be developed during final design. The Knik Arm is primarily a migration route for anadromous species that utilize the Knik and Matanuska River drainages. The anadromous species include five species of Pacific salmon, Dolly Varden, eulachon, and Bering cisco. Benthic organisms and other resident species are sparse because of the excessive amounts of fine glacial sediments on the sea floor. Alteration of this area from the cable installation and operation is unlikely and effects upon resident or anadromous species are expected to be minor. The presence of an operating cable under the Knik Arm should not affect fish populations.

(b) Potential Impacts

Potential impacts associated with the transmission lines from Willow to Anchorage are similar to impacts previously discussed (Section 4.1.1). Additional site specific information is provided. Impacts during construction are expected to be more severe than impacts connected with maintenance activities.

- Operation and Maintenance Activities

  Increased fishing pressure will likely result from construction of the transmission lines from Willow to Anchorage. The transmission corridor is likely to experience heavy usage by ATV's and snowmachines due to the close proximity of dense population areas such as Willow and Wasilla. Access by road is available to the Nancy Lake region. The corridor will also roughly parallel an existing tractor trail from the Little Susitna to the Susitna River. However, an increase in fishing pressure on both resident and anadromous species may be expected at sloughs of the Susitna River West of the Nancy Lakes region. Fish Creek, other Susitna River tributaries and the Little Susitna River may also be more heavily utilized. Fishing pressure increases may have a moderate impact on the fish resources of the region.

## 4.2 - Transmission Corridor Mitigation

Mitigation of potential impacts during transmission line construction and maintenance will be achieved primarily by adherence to the BMPM construction techniques (APA 1985a, 1985b, 1985c, 1985d, 1985e). Proper clearing and soil stabilization procedures will be followed as outlined in the BMP manual on Erosion and Sedimentation Control (APA 1985a). Shrubs and small trees will be allowed to revegetate the transmission corridor; the access trail will be kept clear for maintenance needs. Streams will be crossed utilizing BMPM procedures (APA 1985a) in order to minimize impacts. Instream activities required for transmission line construction will be scheduled for mid-summer months to the greatest extent feasible to avoid the biologically sensitive spawning and overwintering migrations.

Potential impacts of the transmission line construction and maintenance were described in Section 4.1. Impact mechanisms identified and the corresponding mitigation measures to be applied during and after construction are discussed in Section 4.2.1 and are similar to those discussed in Section 2.2.1. Mechanisms believed to have the largest potential impacts to the aquatic environment requiring mitigation are considered first. Impact avoidance, minimization, rectification and reduction are discussed. Adherence to the BMPM techniques (APA 1985a) is the primary mitigation measure.

Monitoring of the transmission line through the construction and maintenance phases will assist in avoiding or minimizing impacts to the aquatic resources. As described in Section 2.2.2, monitoring will be used to identify rehabilitation or maintenance requirements for mitigation measures. Inadequate mitigation measures may be identified and remedied by monitoring efforts and additional measures. Costs associated with all phases of construction monitoring are outlined in Table 8.

### 4.2.1 Impact Mechanisms and Mitigation Measures

#### (a) Stream Crossings

##### (i) Impact Mechanism

During construction and maintenance activities, suspended solids and petroleum contamination may be increased. Siltation of downstream reaches may occur. Fish are likely to avoid areas disturbed by equipment operated in or near streams.

##### (ii) Mitigation

Instream activities will be minimized during the periods of peak fish movement as described in Section 2.2.1. Previously installed temporary bridges or culverts will be utilized if available. During the remainder of the open water season the duration of instream activities will be minimized as suggested by the BMP manual on Erosion and Sedimentation Control (APA 1985a). The use of helicopters will avoid much of the potential instream disturbances in remote areas.

Spawning and overwintering migration disturbances are not expected if instream activities are minimized during sensitive spring and fall months (Figure 5).

(b) Water Quality

(i) Impact Mechanism

Temporary degradations in water quality, including increased suspended solids, sedimentation and petroleum contamination, could alter species productivity (Bell 1973, Alyeska Pipeline Service Company 1974).

(ii) Mitigation

The primary mitigation measures that will be used to minimize water quality degradation from transmission line construction are (1) adhering to the BMPM (APA 1985a) guidelines; (2) employing erosion control measures such as runoff control, stream bank stabilization and revegetation; and (3) minimizing the time necessary to complete instream activity so that water quality degradations are short-term and non-reoccurring events.

Additional mitigative measures are not expected to be needed.

(c) Increased Fishing Pressure

(i) Impact Mechanism

Sport fishing pressure on local streams and lakes will likely increase. The transmission line corridor will allow fishermen to reach areas previously unexploited.

(ii) Mitigation

Section 2.2.1 presents the recommended mitigation for increased fishing pressure impacts. Modifications to current seasons and catch limits may be necessary to maintain current stocks, particularly along the Willow to Anchorage transmission corridor.

(c) Oil and Hazardous Material Spills

(i) Impact Mechanism

Spills of oil and other hazardous substances into streams are toxic to fish and their food organisms.

(ii) Mitigation

Mitigation for oil and hazardous material spills is described in Section 2.2.1 and includes the preparation of a Spill Prevention, Containment and Countermeasure Plan (SPCC) as required by EPA (40 CFR 112.7) prior to construction commencement.

(d) Water Removal

(i) Impact Mechanism

Fish fry and juveniles can be impinged on intake screens or entrained into hoses and pumps when water is withdrawn from water bodies for miscellaneous uses during construction.

(ii) Mitigation

The construction and maintenance activities will require small amounts of water which will be withdrawn as described in Section 2.2.1 to avoid significant impacts. Barren lakes will be used preferentially as a water source during transmission line construction.

### 4.2.2 Monitoring

Monitoring will verify that proper construction practices, as detailed in the BMP manuals (APA 1985a, 1985b, 1985c, 1985d, 1985e), are being followed during transmission line construction and maintenance. During transmission line construction, monitoring will be conducted to verify compliance with regulations and permits obtained from the ADEC, ADF&G, ADNR and Corps of Engineers (COE). The Environmental Field Office (EFO) will provide guidance on permit compliance relative to daily activities as described in Section 2.2.2.

After the construction phase, the transmission lines will be periodically monitored as part of the maintenance schedule. Chronic erosion sites will be identified and corrected; stream crossings will be inspected to prevent fish passage blockages. Costs associated with the monitoring program are estimated in Table 8.

## 5 - ACKNOWLEDGEMENTS

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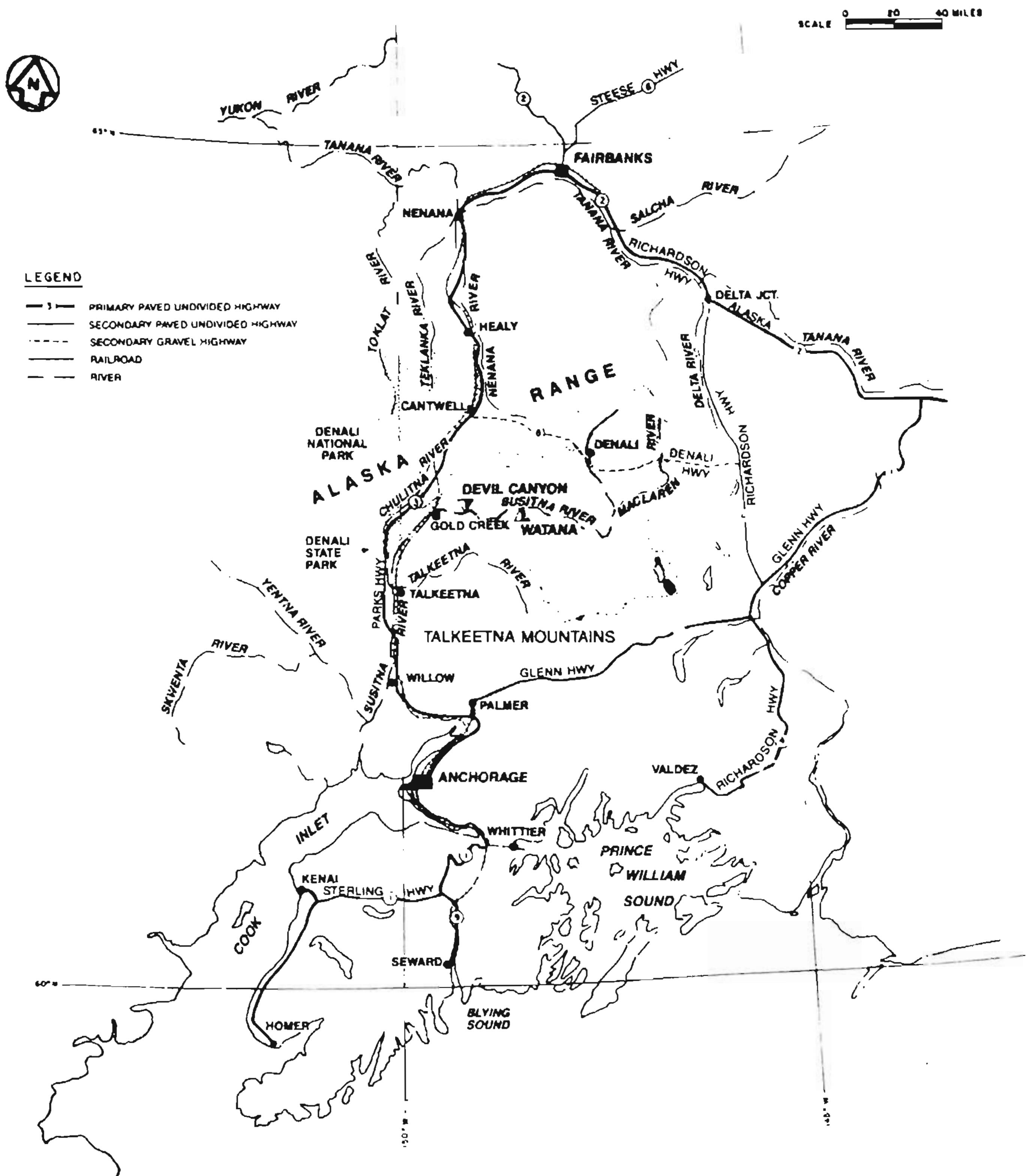
# FIGURES

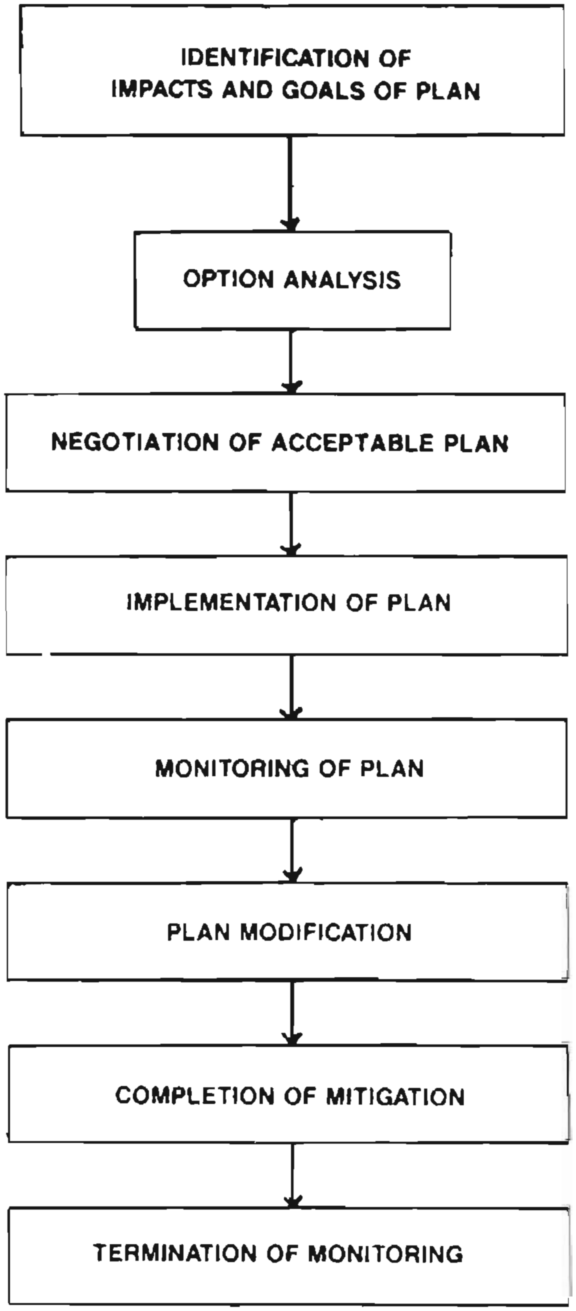



**THE SUSITNA RIVER BASIN AND THE PROPOSED SITES OF THE WATANA AND DEVIL CANYON DAM**

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

Reference: APA, 1983.

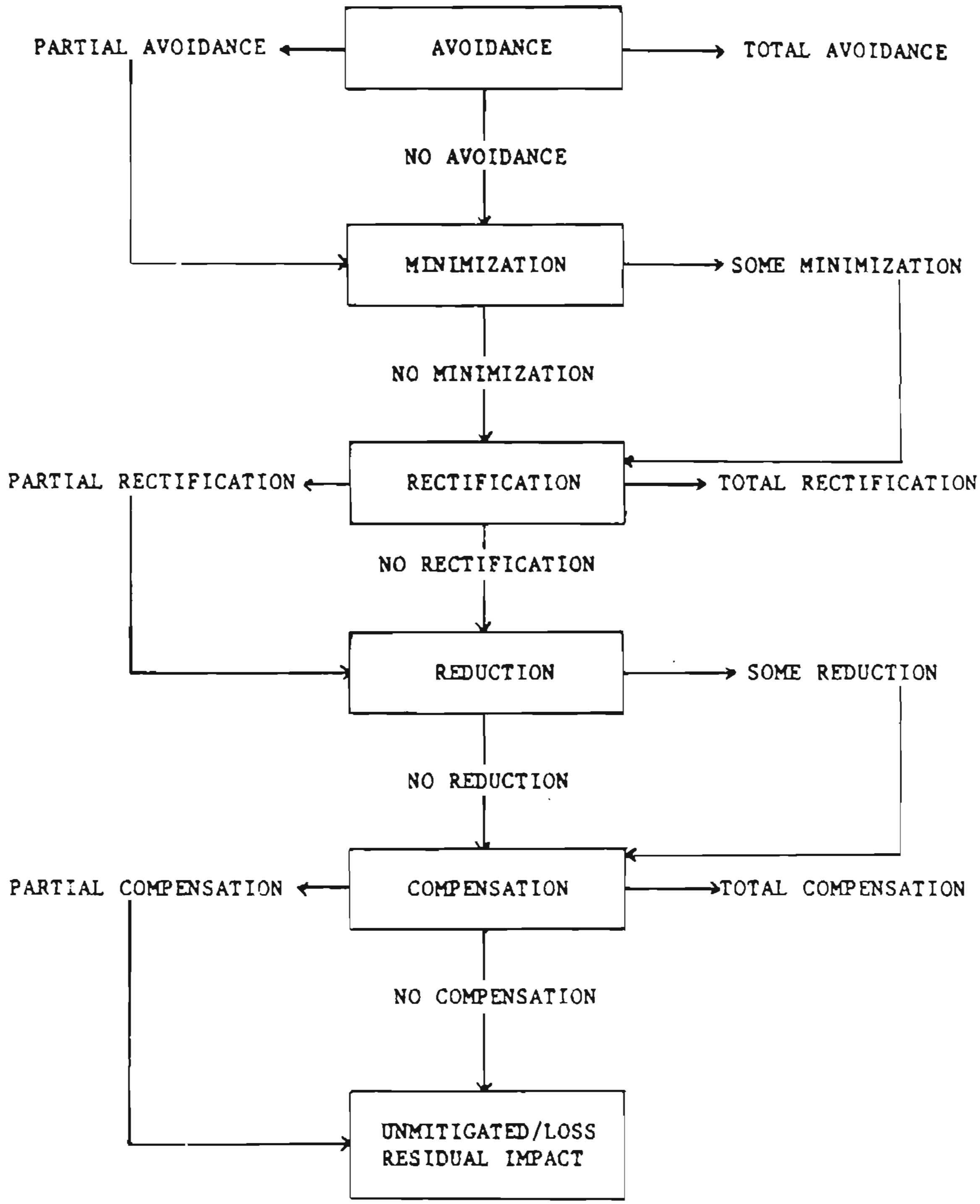
Figure 1




MITIGATION PLAN DEVELOPMENT AND IMPLEMENTATION

Figure 2

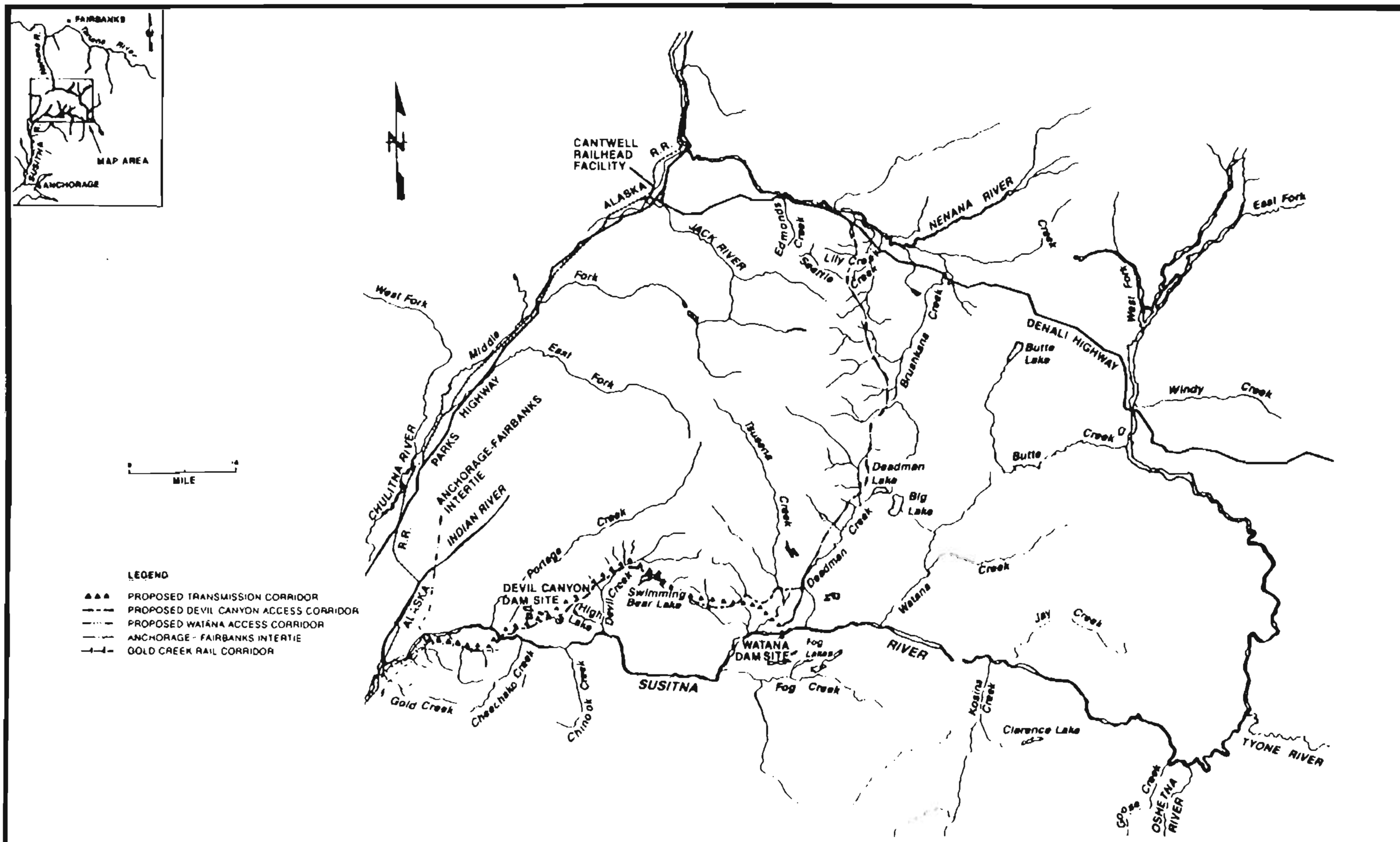
| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |




**OPTION ANALYSIS**

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

Figure 3

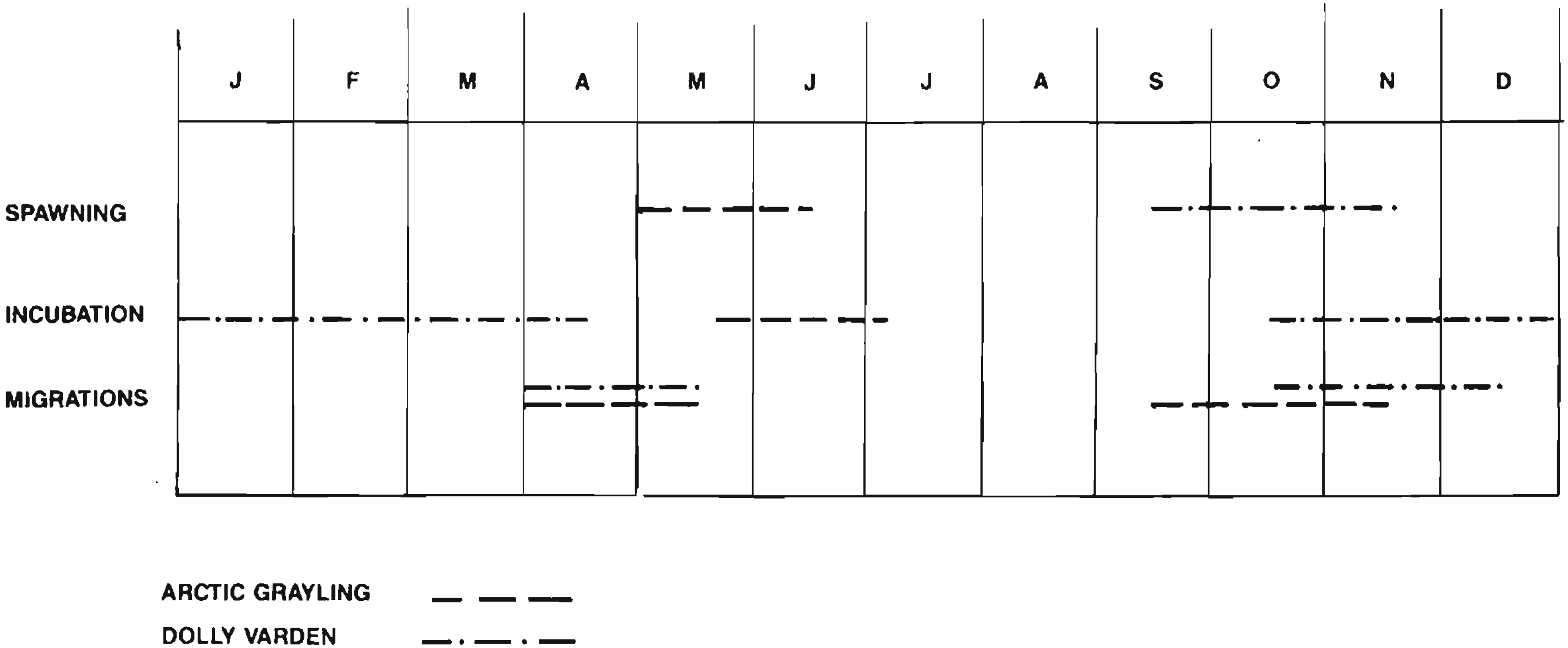



# THE VICINITY OF THE DAM SITES, ACCESS CORRIDORS AND TRANSMISSION LINE CORRIDORS

Reference: Saulner and Stratton, 1984.

Figure 4

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |




MIGRATION AND SPAWNING PERIODS FOR
ARCTIC GRAYLING AND DOLLY VARDEN IN TRIBUTARIES

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Woodward-Clyde Consultants
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

Reference: Morrow 1980
Scott and Crossman, 1973.

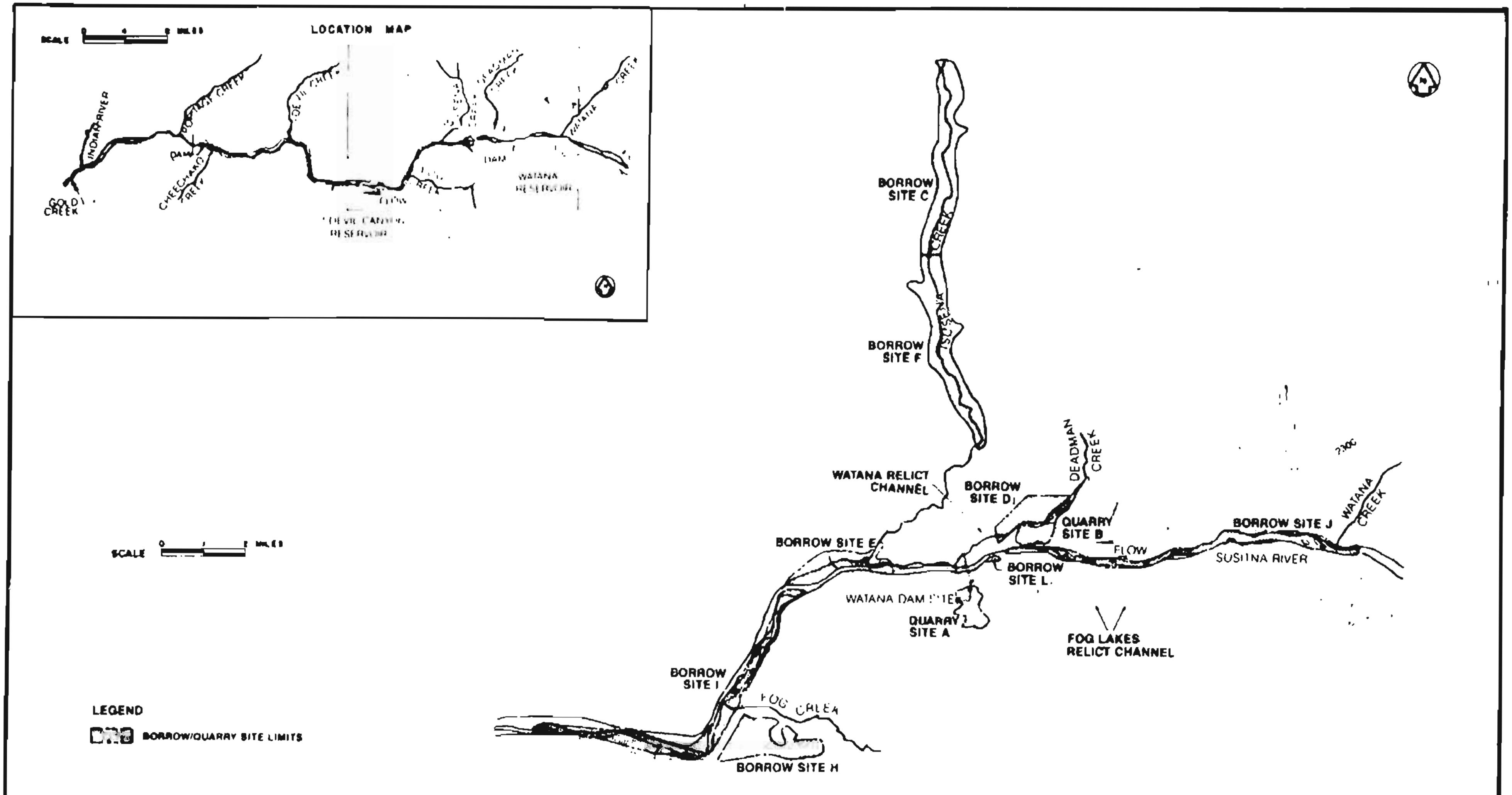
Figure 5

INFORMATION NOT CURRENTLY AVAILABLE

SCHEDULE FOR THE CONSTRUCTION OF THE WATANA DAM AND RELATED FACILITIES

Figure 6

| ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants** AND ENTRIX, INC. | HARZA-EBASCO SUSITNA JOINT VENTURE |




PLAN VIEW OF POTENTIAL WATANA BORROW SITES

Reference: APA, 1983.

Figure 7

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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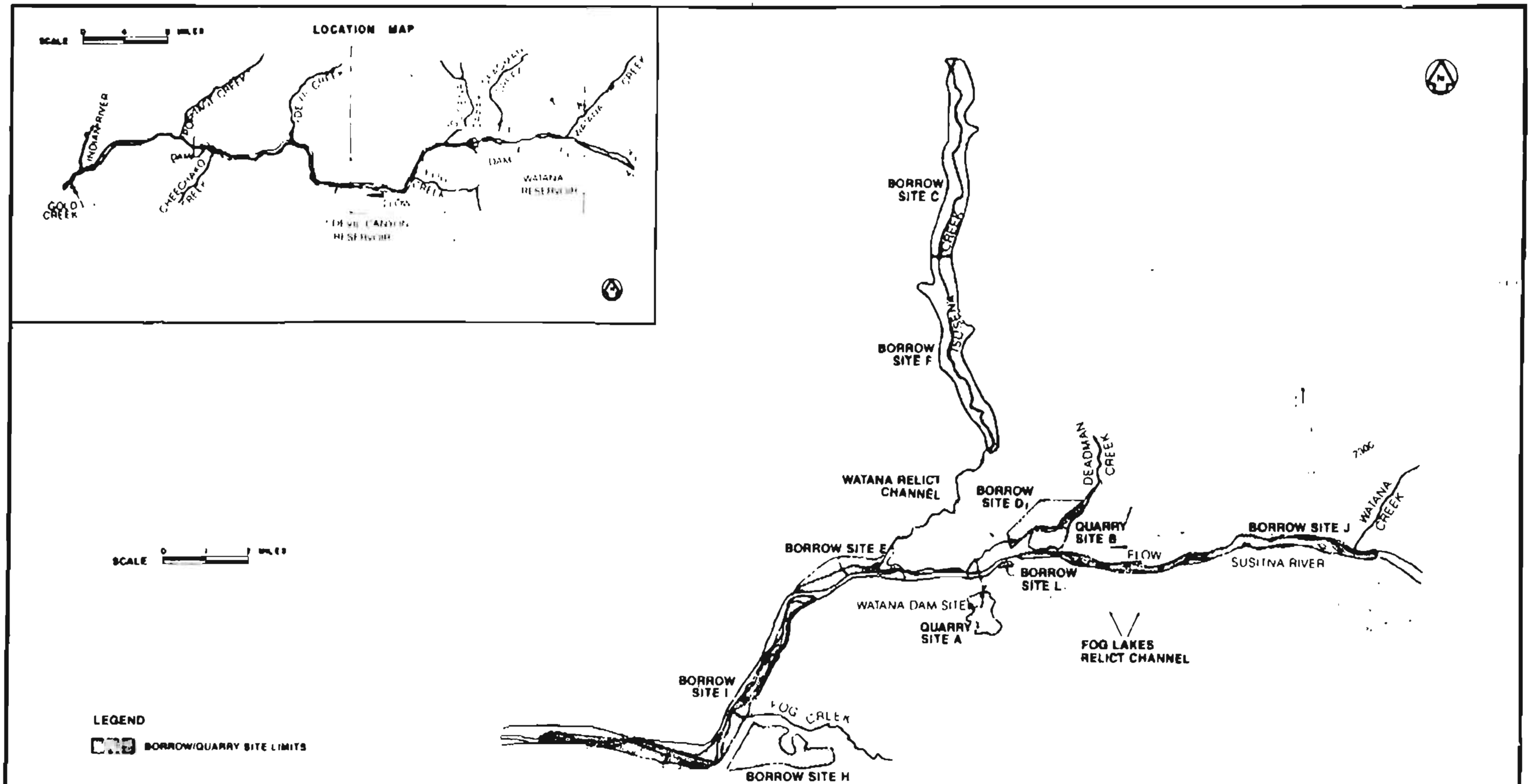


PLAN VIEW OF POTENTIAL WATANA BORROW SITES

Figure 7

Reference: APA, 1983.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| Woodward-Clyde Consultants AND ENTRIX, INC. | HARZA-EBASCO SUSITNA JOINT VENTURE |
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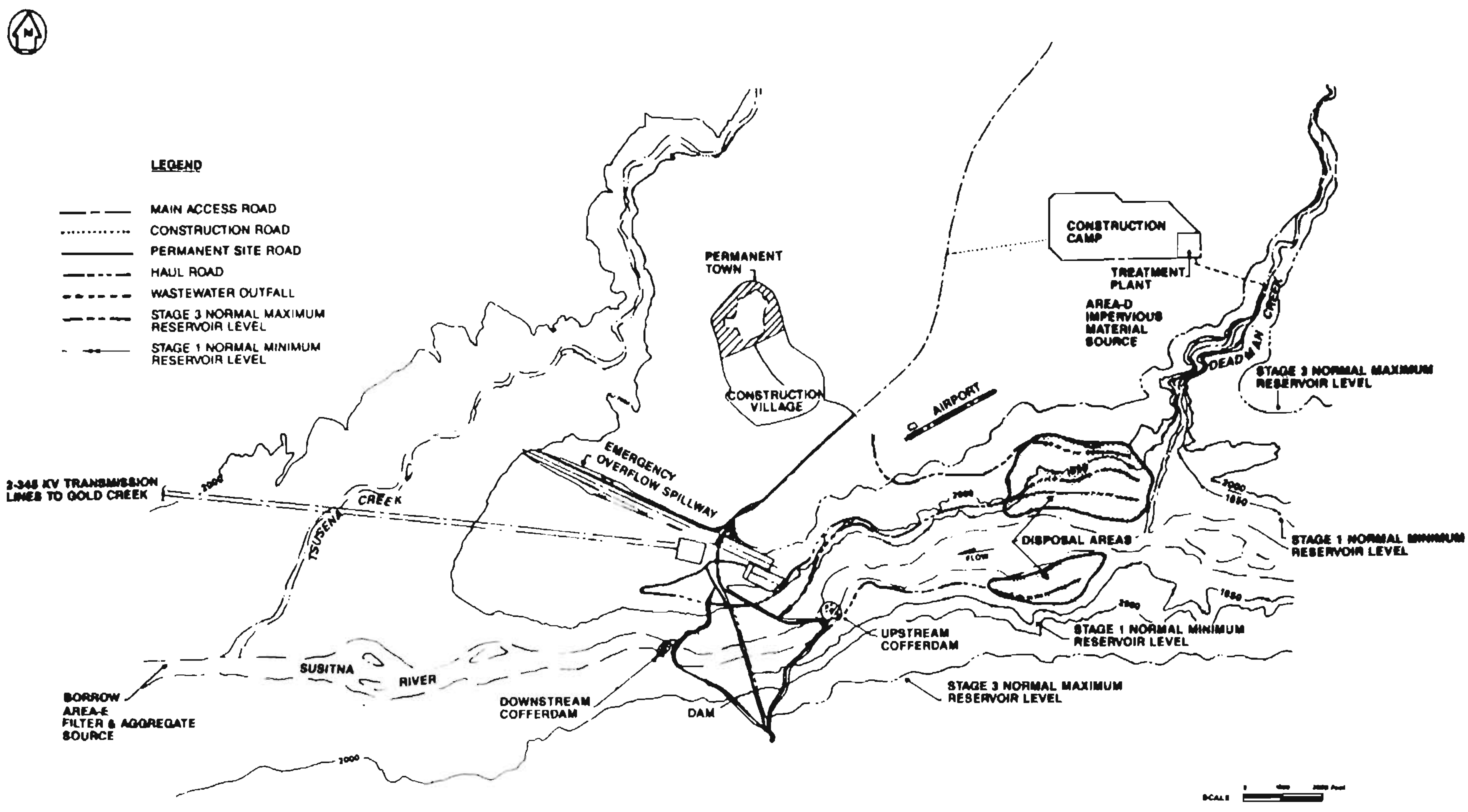



**PLAN VIEW OF THE WATANA DAM, COFFER DAMS, RELATED FACILITIES AND DISPOSAL AREAS**

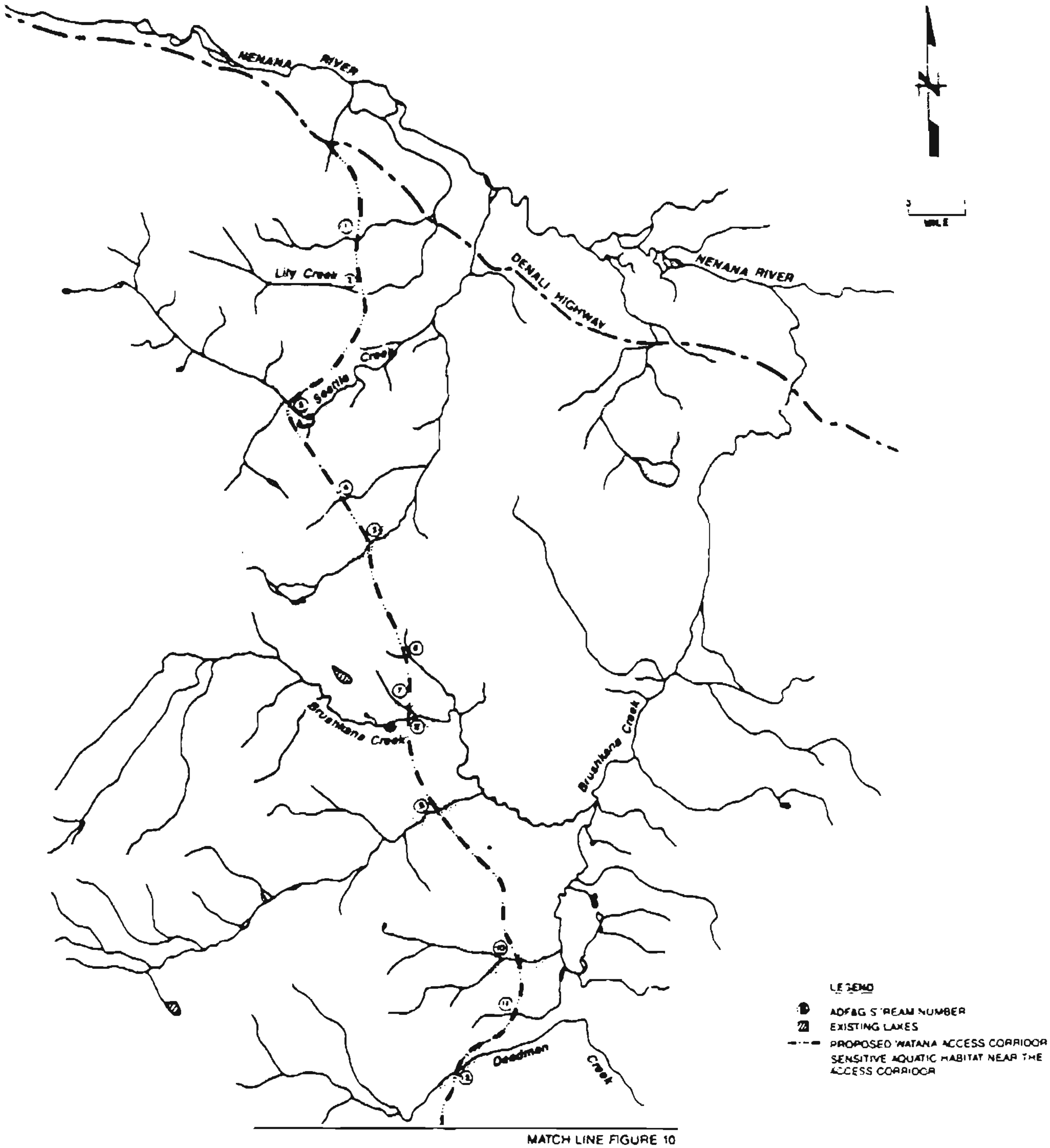
Reference: APA, 1983.

Figure 8

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

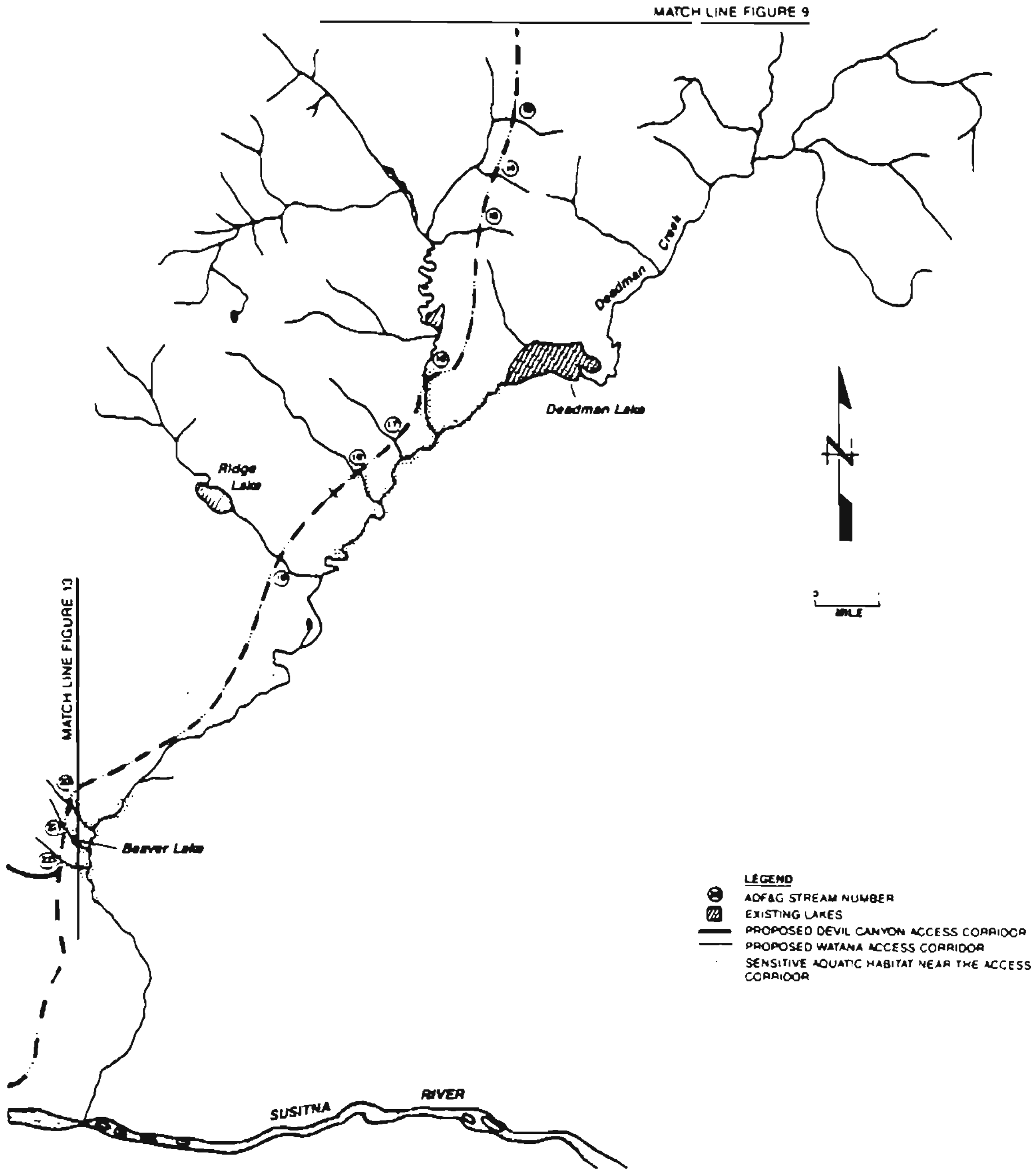



## SENSITIVE AQUATIC HABITAT ALONG THE NORTHERN SECTION OF THE WATANA ACCESS CORRIDOR

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

Reference: Sautner and Stratton, 1984.

**Figure 9**




**SENSITIVE AQUATIC HABITAT ALONG THE CENTRAL SECTION OF THE WATANA ACCESS CORRIDOR**

| ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants** AND ENTRIX, INC. | HARZA-EBASCO SUSITNA JOINT VENTURE |

Figure 10

Reference: Sautner and Stratton, 1984.

| STREAM | CM | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unnamed Creek Nenana System | .3 | | | | | | | | | | | | |
| Tributary to Lily Creek | 2 | | | | | | | | | | | | |
| Lily Creek | 3 | | | | | | | | | | | | |
| Seattle Creek | 5.8 | | | | | /// | /// | | | /// | /// | /// | |
| Tributary to Seattle Creek | 7.7 | | | | | | | | | | | | |
| Tributary to Seattle Creek | 8.7 | | | | | /// | /// | | | /// | /// | /// | |
| Brushkana Creek | 10.7 | | | | | | | | | | | | |
| Tributary to Brushkana Creek | 11.7 | | | | | /// | /// | | | | | | |
| Brushkana Creek | 12.0 | | | | | /// | /// | | | | | | |
| Tributary to Brushkana Creek | 13.7 | | | | | /// | /// | | | | | | |
| Tributary to Brushkana Creek | 16.9 | | | | | /// | /// | | | /// | /// | /// | |
| Tributary to Brushkana Creek | 18.0 | | | | | | | | | | | | |
| Deadman Creek | 19.7 | | | | | /// | /// | | | | | | |
| Tributary to Deadman Creek | 23.0 | | | | | | | | | | | | |
| Tributary to Deadman Creek | 23.7 | | | | | | | | | | | | |
| Tributary to Deadman Creek | 24.8 | | | | | | | | | | | | |
| Tributary to Deadman Creek | 27.5 | | | | | /// | /// | | | | | | |
| Tributary to Deadman Creek | 28.5 | | | | | | | | | /// | /// | /// | |
| Tributary to Deadman Creek | 29.5 | | | | | | | | | /// | /// | /// | |
| Tributary to Deadman Creek | 31.4 | | | | | | | | | | | | |
| Tributary to Deadman Creek | 36.9 | | | | | /// | /// | | | /// | /// | /// | |
| Tributary to Deadman Creek | 37.2 | | | | | /// | /// | | | | | | |
| Tirbutary to Deadman Creek | 37.8 | | | | | /// | /// | | | | | | |

/// = Instream Activity Prohibited

**RESTRICTED PERIODS OF INSTREAM ACTIVITY FOR STREAMS CROSSED BY THE ACCESS CORRIDOR FROM THE DENALI HIGHWAY TO THE WATANA DAM SITE**

Figure 11

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

INFORMATION NOT CURRENTLY AVAILABLE

SCHEDULE FOR THE CONSTRUCTION OF THE DEVIL CANYON DAM AND RELATED FACILITIES

Figure 12

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
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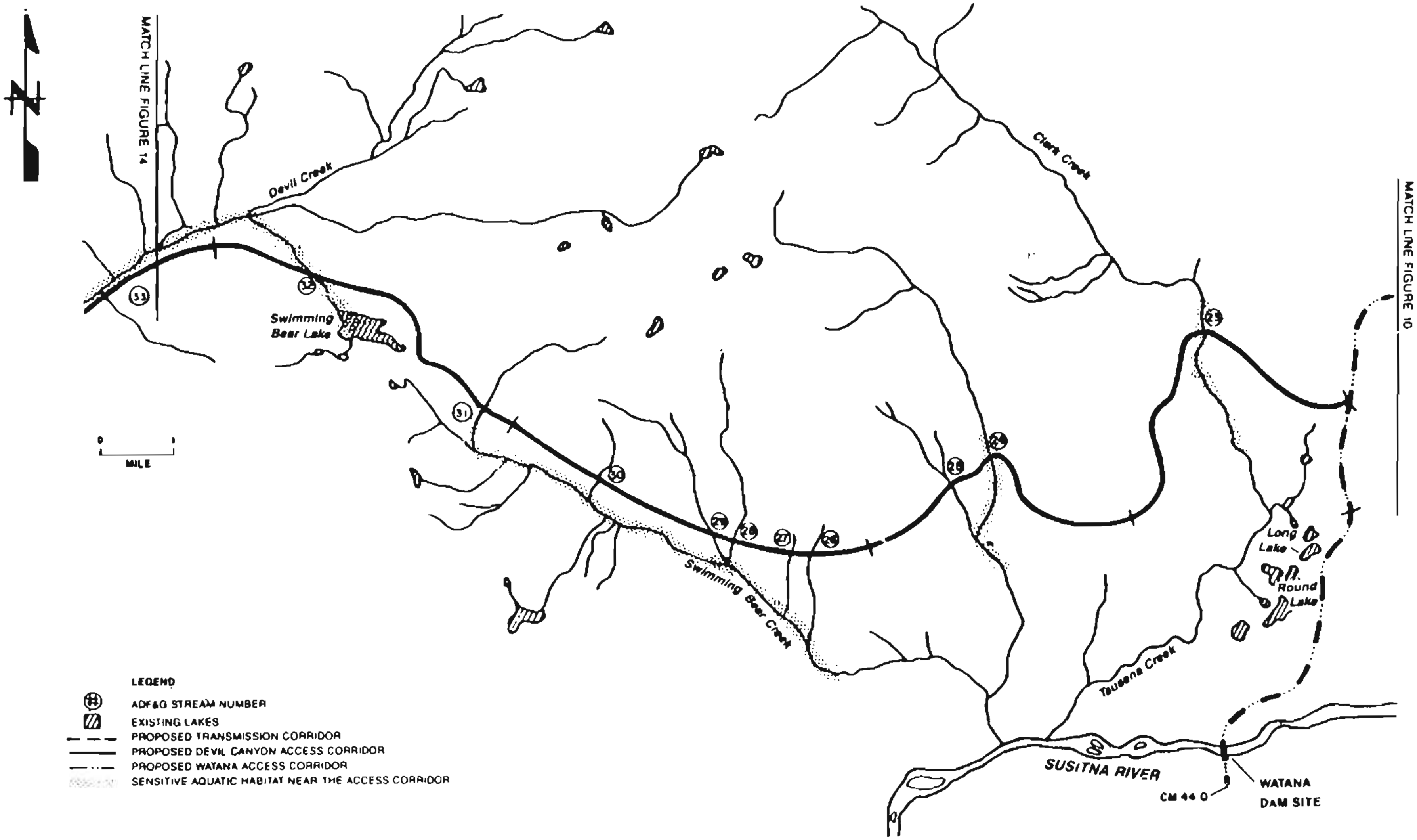
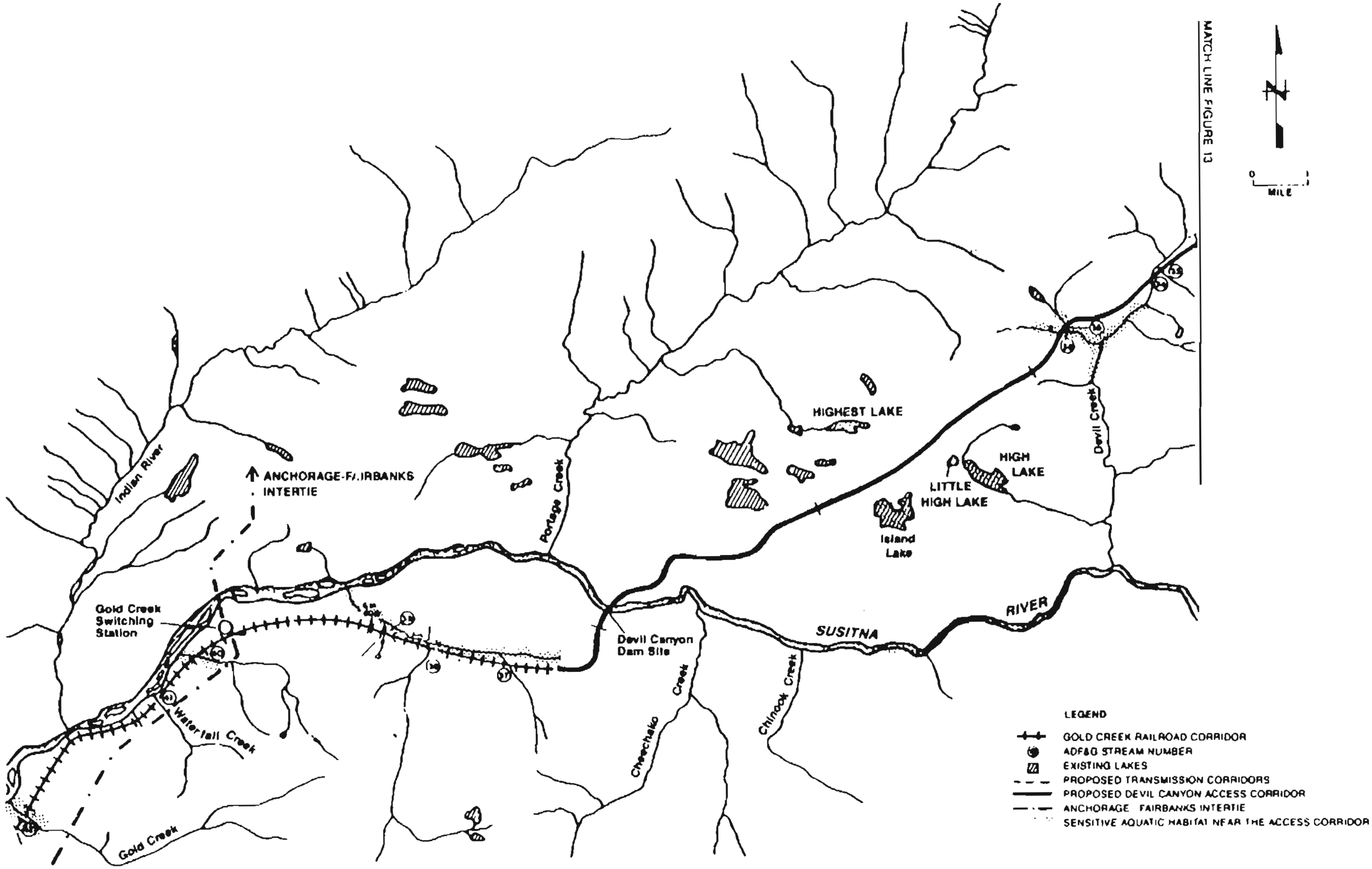



**SENSITIVE AQUATIC HABITAT ALONG THE WATANA AND DEVIL CANYON ACCESS CORRIDORS**

Figure 13

Reference: Sautner and Stratton, 1984.

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |




**SENSITIVE AQUATIC HABITAT ALONG THE WESTERN SECTION OF THE DEVIL CANYON ACCESS CORRIDOR**

Figure 14

Reference: Sautner and Stratton, 1984.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

| STREAM | CM | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tsusena Creek | 2.2 | | | | | /// | /// | | | /// | /// | /// | |
| Tributary to Swimming Bear Creek | 8.0 | | | | | | | | | /// | /// | /// | |
| Tributary to Swimming Bear Creek | 8.7 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 11.1 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 11.4 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 12.0 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 12.4 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 13.9 | | | | | | | | | | | | |
| Tributary to Swimming Bear Creek | 15.7 | | | | | | | | | /// | /// | /// | |
| Tributary to Devil Creek | 18.9 | | | | | | | | | /// | /// | /// | |
| Tributary to Devil Creek | 22.2 | | | | | | | | | | | | |
| Devil Creek | 22.4 | | | | | | | | | | | | |
| Tributary to Devil Creek | 24.3 | | | | | | | | | /// | /// | /// | |
| Tributary to Devil Creek | 24.5 | | | | | | | | | /// | /// | /// | |
| Tributary to Devil Creek | 26.3 | | | | | | | | | | | | |
| Susitna River | 35.1 | | | | | | | | | | | | |
| Jack Long Creek Encroachment | 36.3-39.3 | | | | | /// | /// | | | /// | /// | /// | |
| Tributary to Jack Long Creek | 37.3 | | | | | | | | | | | | |
| Tributary to Jack Long Creek | 38.9 | | | | | | | | | | | | |
| Tributary to Jack Long Creek | 43.3 | | | | | | | | | | | | |
| Unnamed Creek | 43.3 | | | | | /// | /// | | | /// | /// | /// | |
| Unnamed Creek ("Waterfall Creek") | 44.5 | | | | | | | | | | | | |
| Gold Creek | 47.9 | | | | | /// | /// | | | /// | /// | /// | |

/// : Instream Activity Prohibited

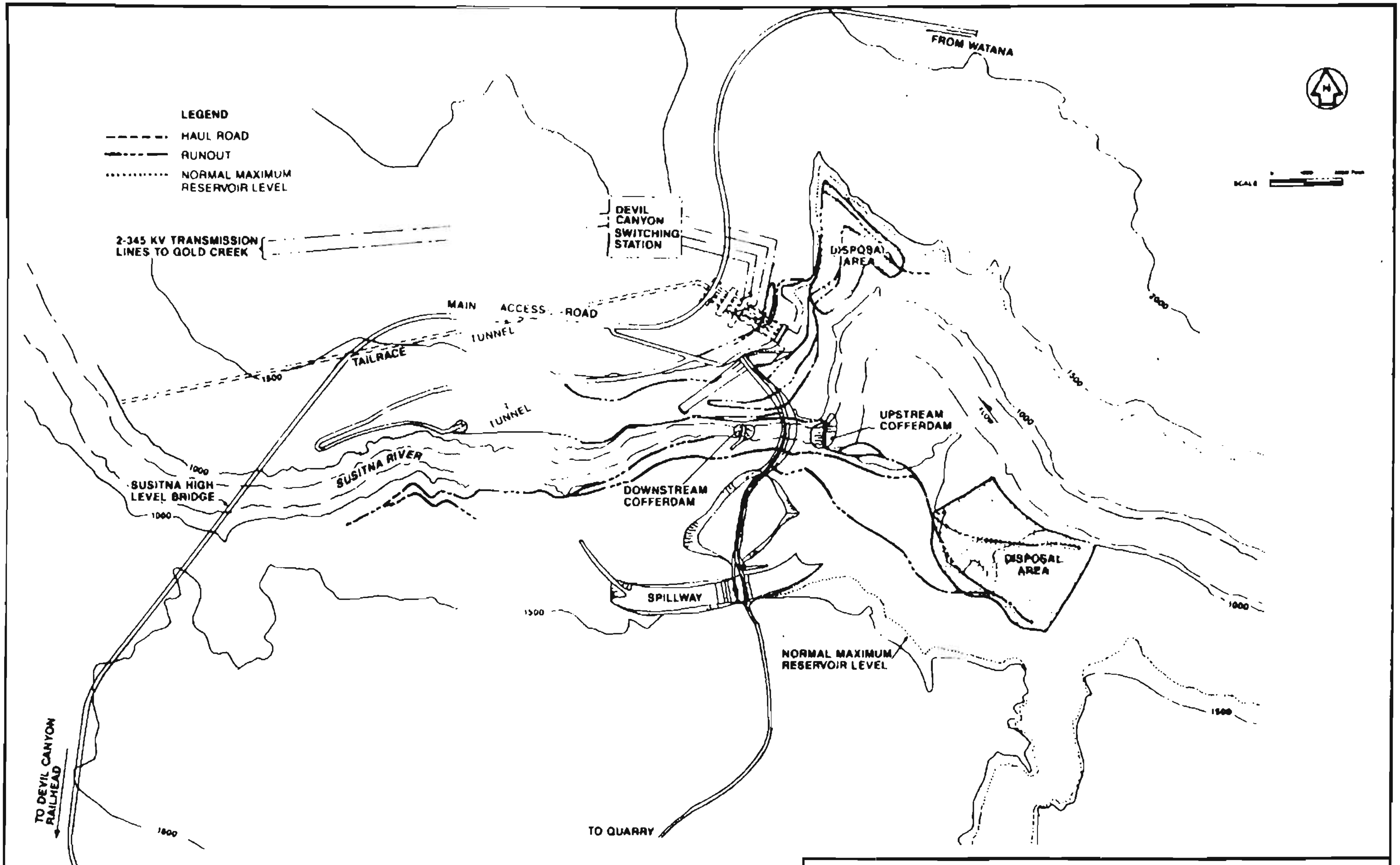
**RESTRICTED PERIODS OF INSTREAM ACTIVITY FOR STREAMS CROSSED BY THE ACCESS AND TRANSMISSION LINE CORRIDORS TO THE DEVIL CANYON DAM SITE**

Figure 15

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

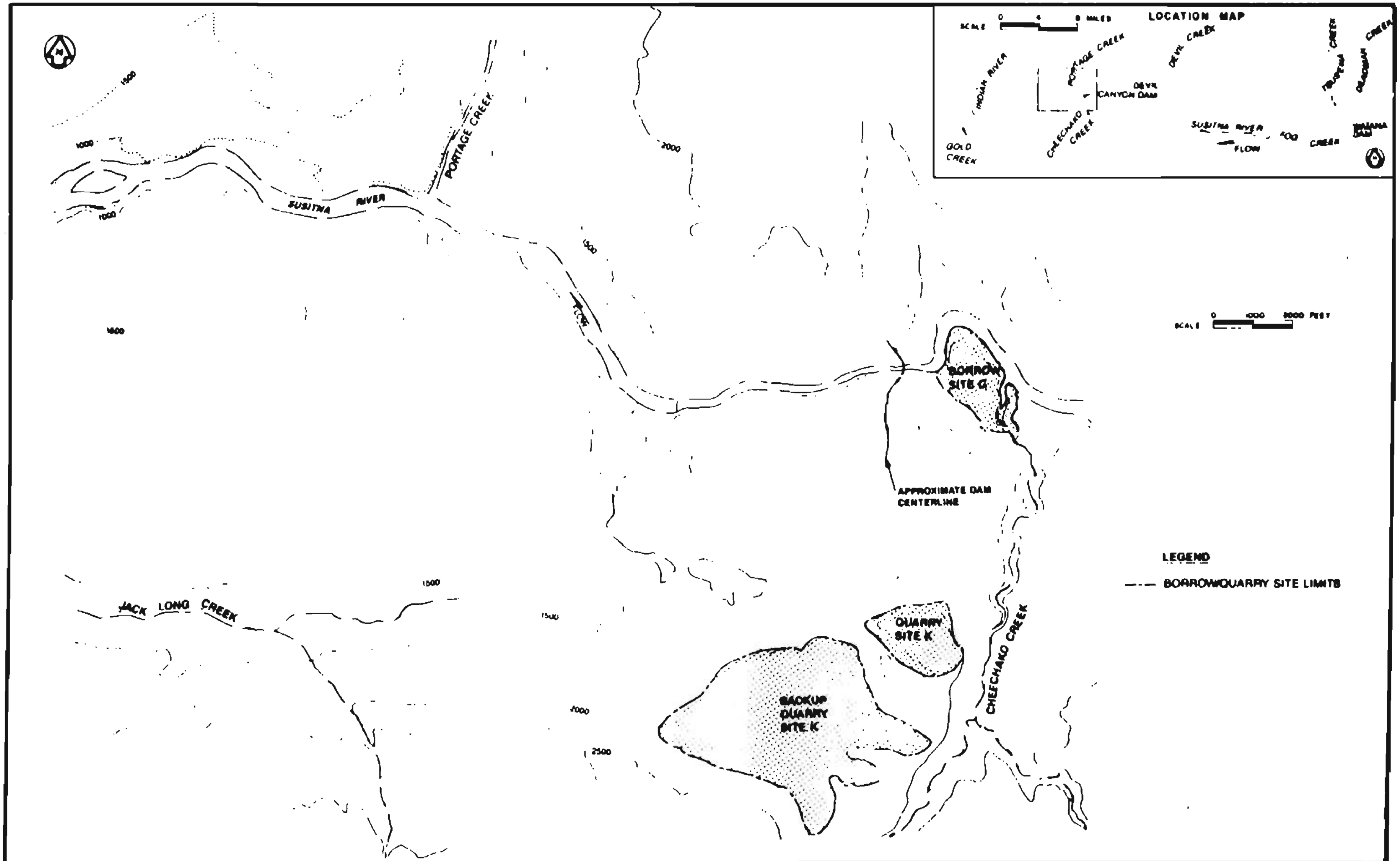



**PLAN VIEW OF THE DEVIL CANYON DAM, COFFER DAMS AND DISPOSAL AREAS**

Figure 16

Reference: APA, 1983.

| | |
|---|---|
| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |




ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

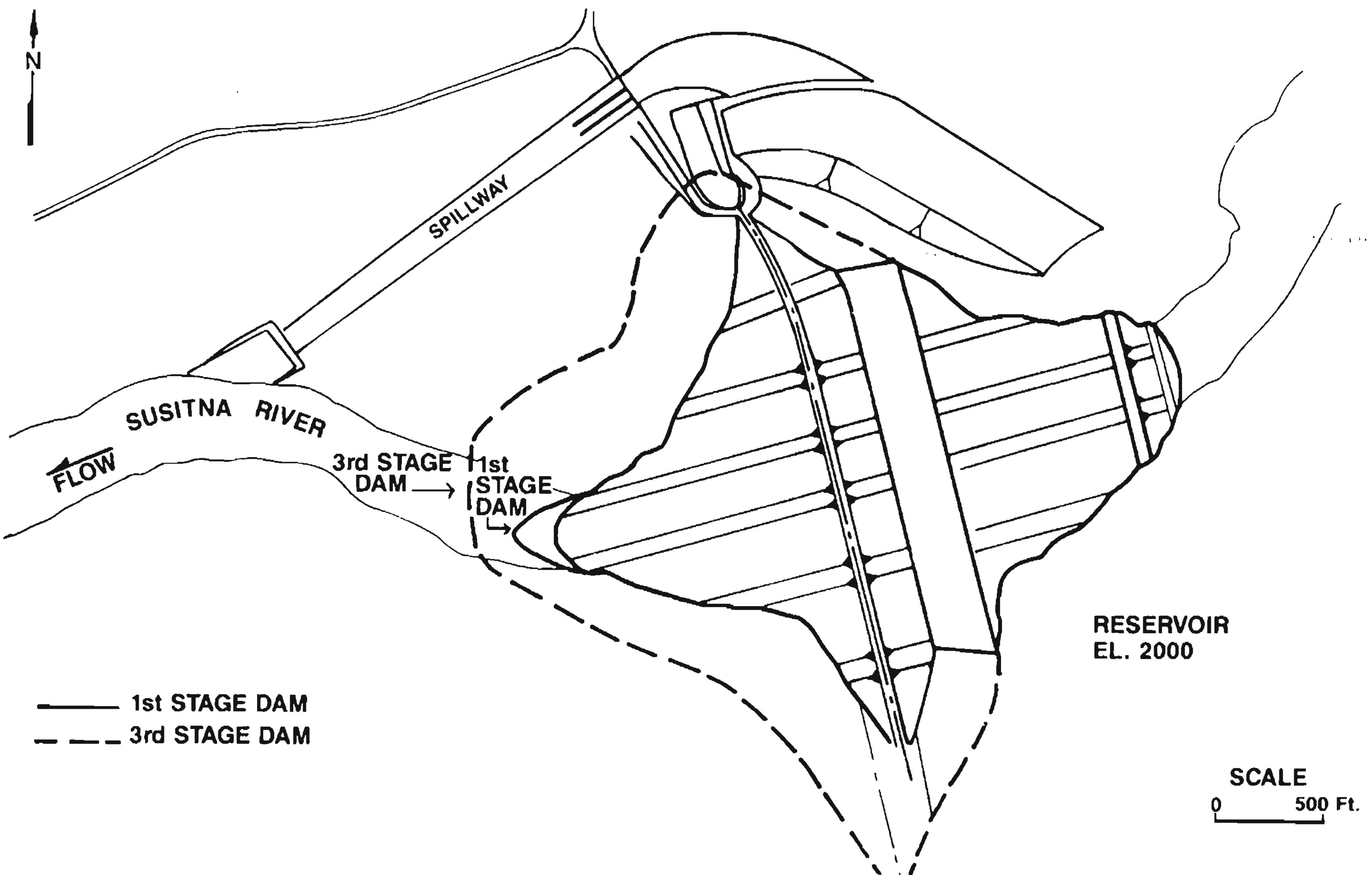
PLAN VIEW OF POTENTIAL DEVIL CANYON BORROW SITE

Figure 17

Woodward-Clyde Consultants
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

Reference: APA, 1983.



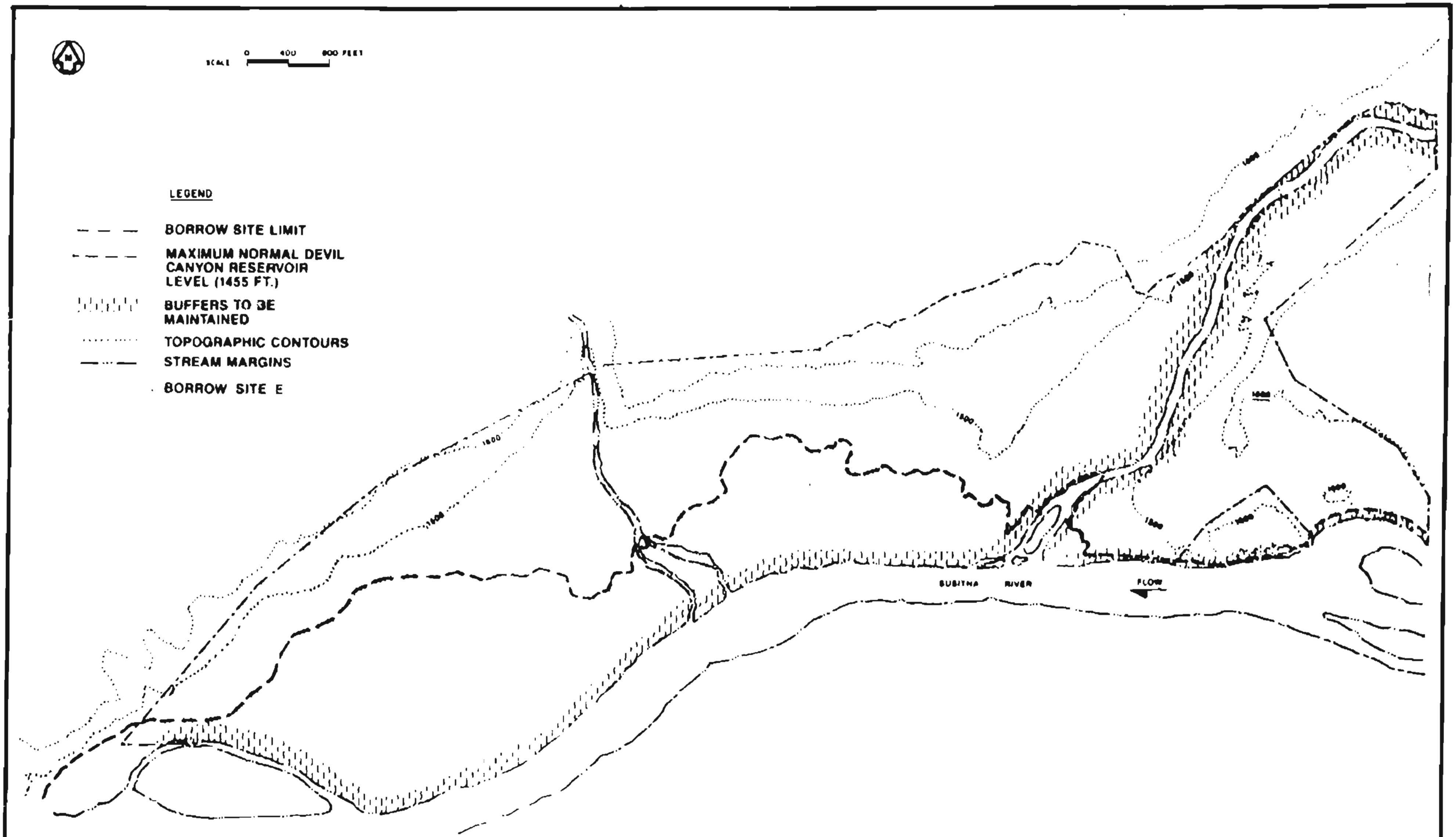

STAGES 1 AND 3 OF THE WATANA DAM

Figure 18

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

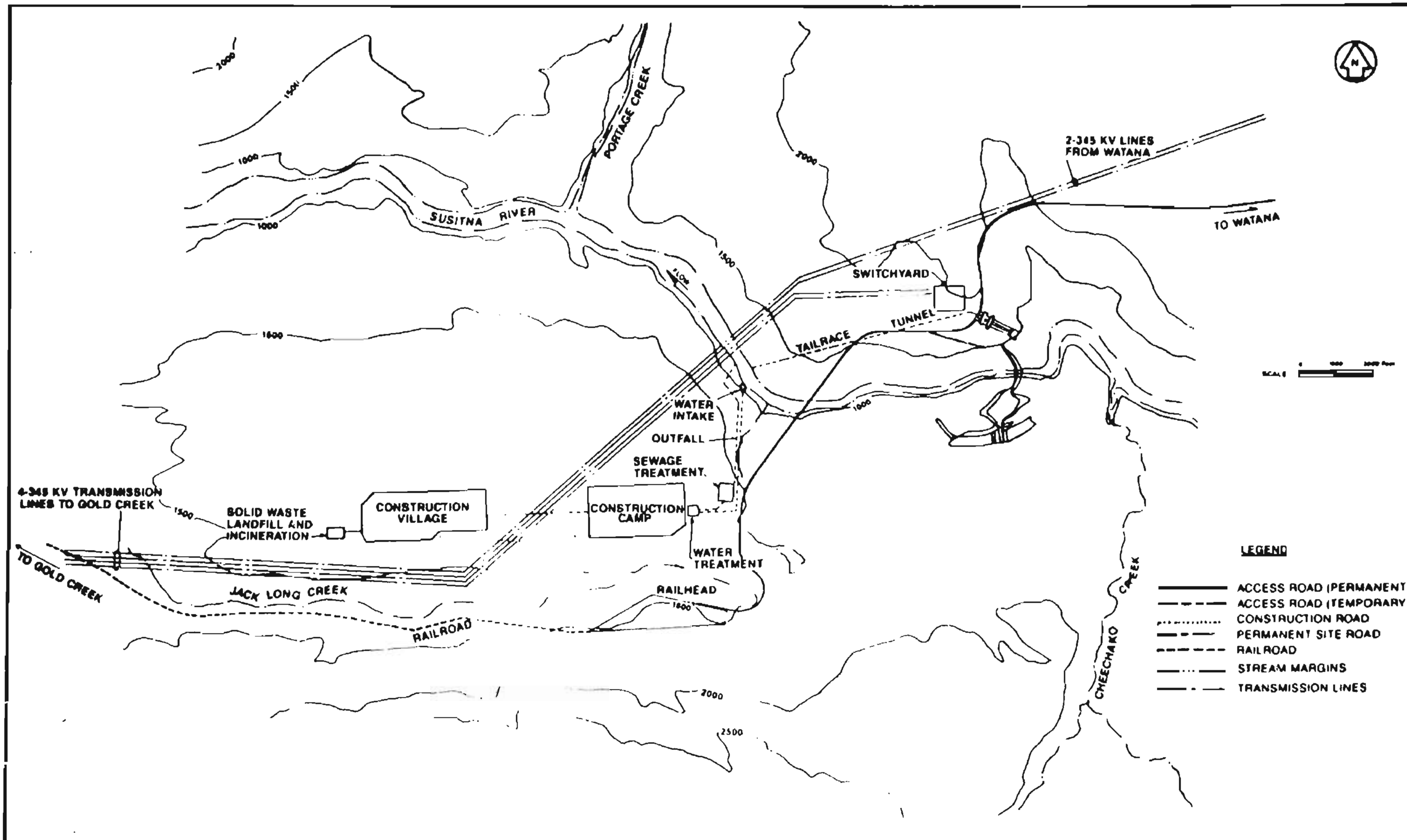



BORROW SITE E

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

Figure 19

Reference: APA, 1983.




**PLAN VIEW OF THE DEVIL CANYON DAM AND RELATED FACILITIES**

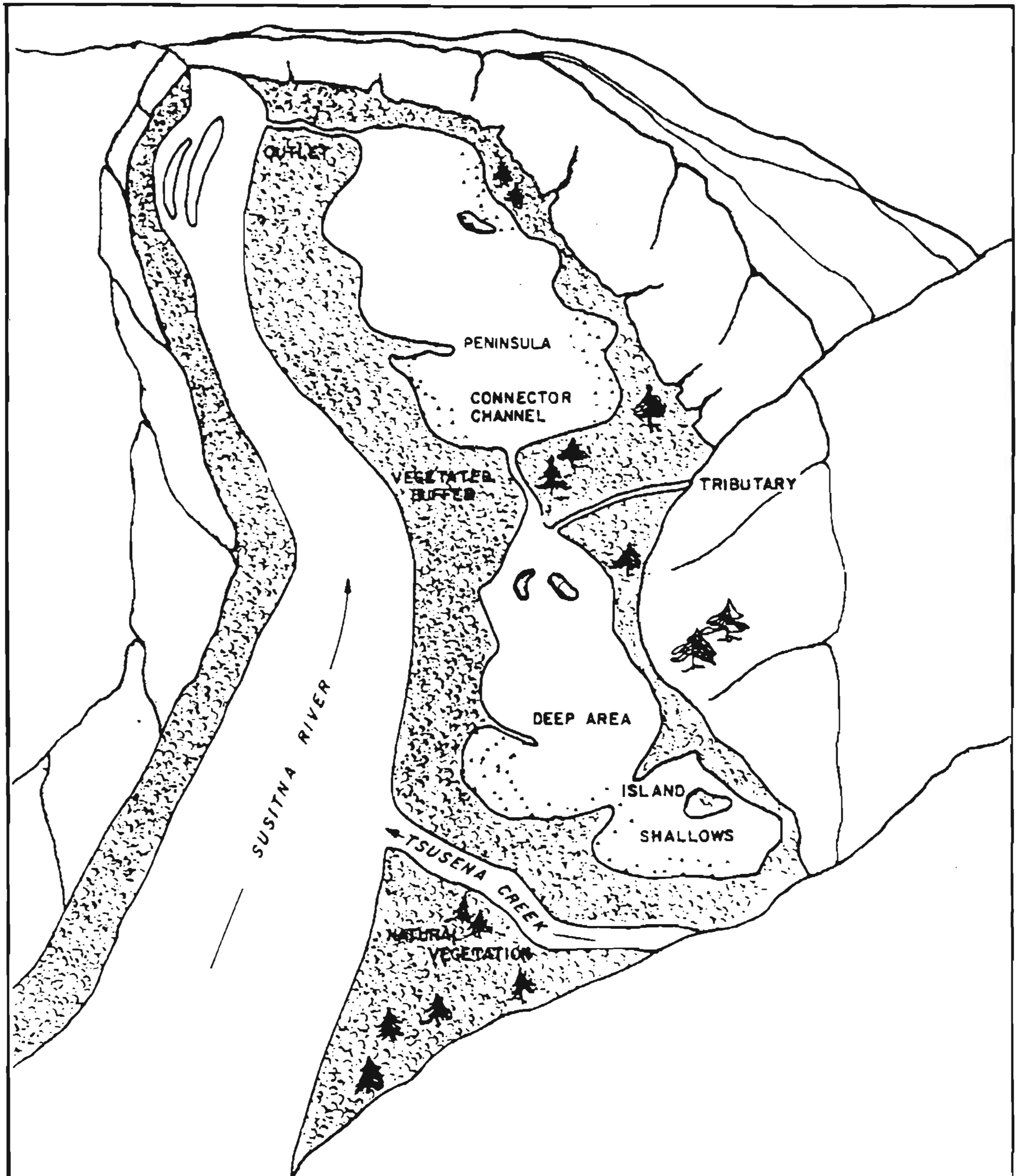
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE

Reference: APA, 1983.

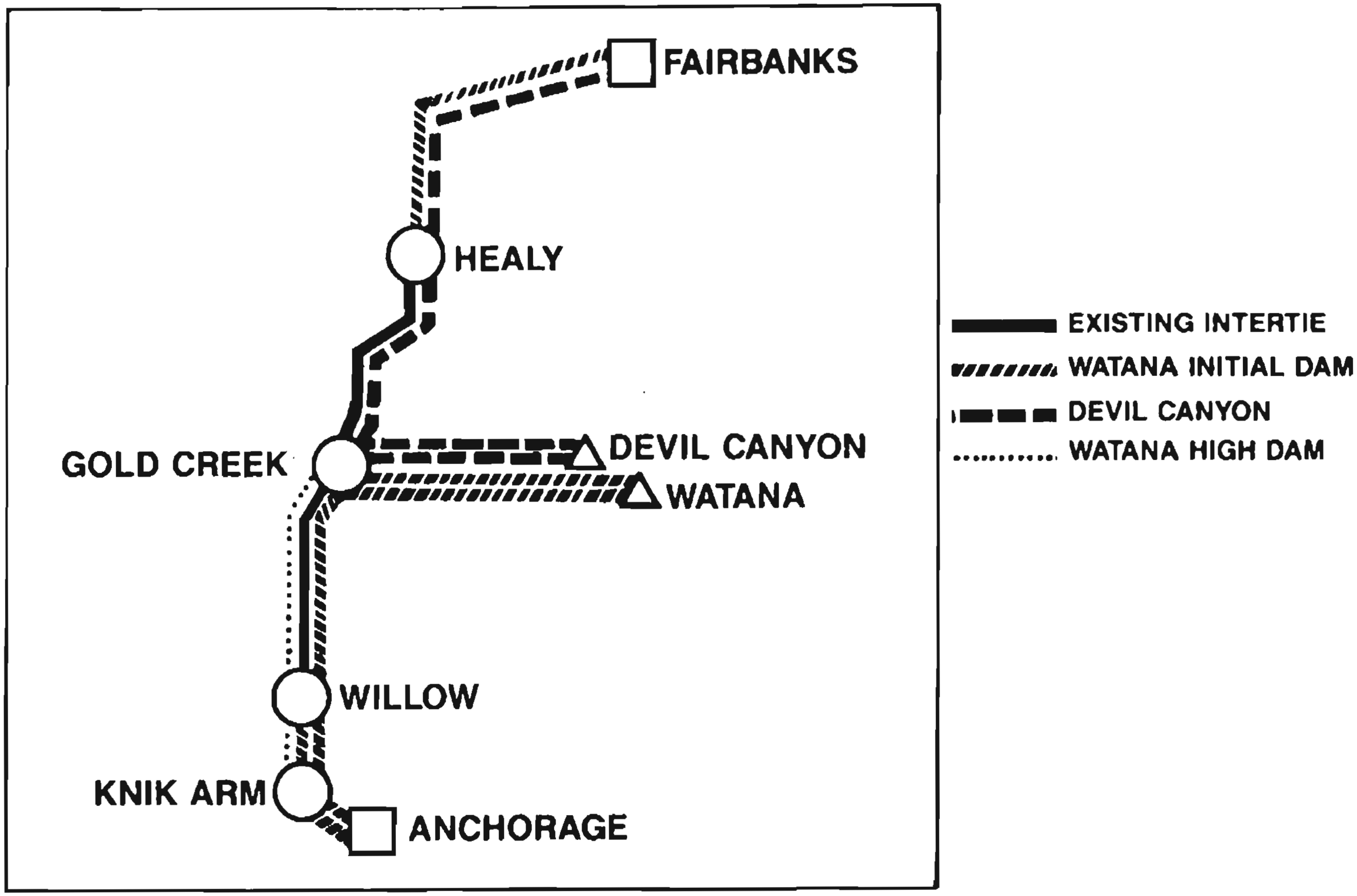
Figure 20




**REHABILITATED BORROW SITE E**

Figure 21

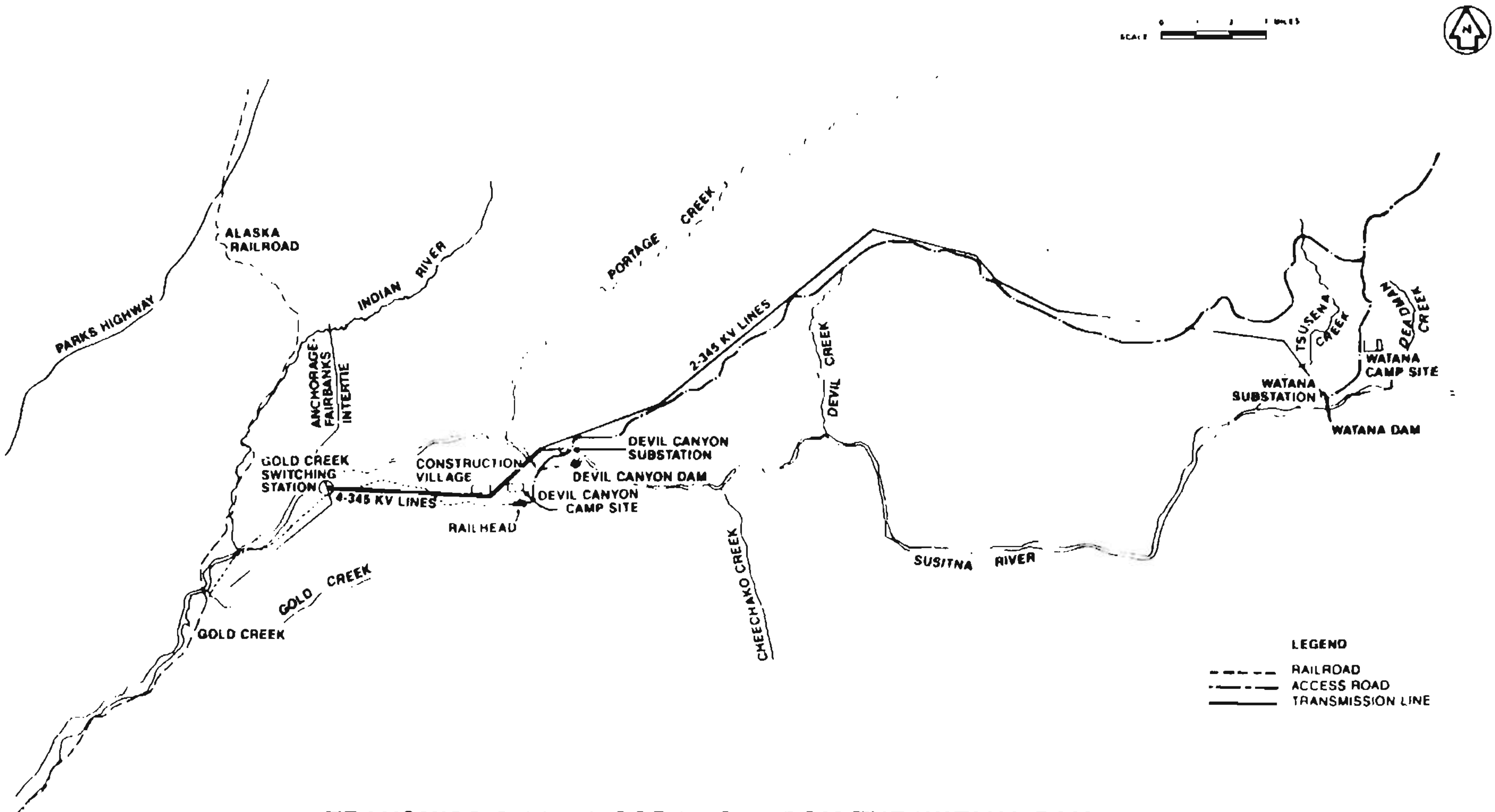
| | | |
|---|---|---|
| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | | |
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE | |




STAGED CONSTRUCTION OF TRANSMISSION LINES

Figure 22

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

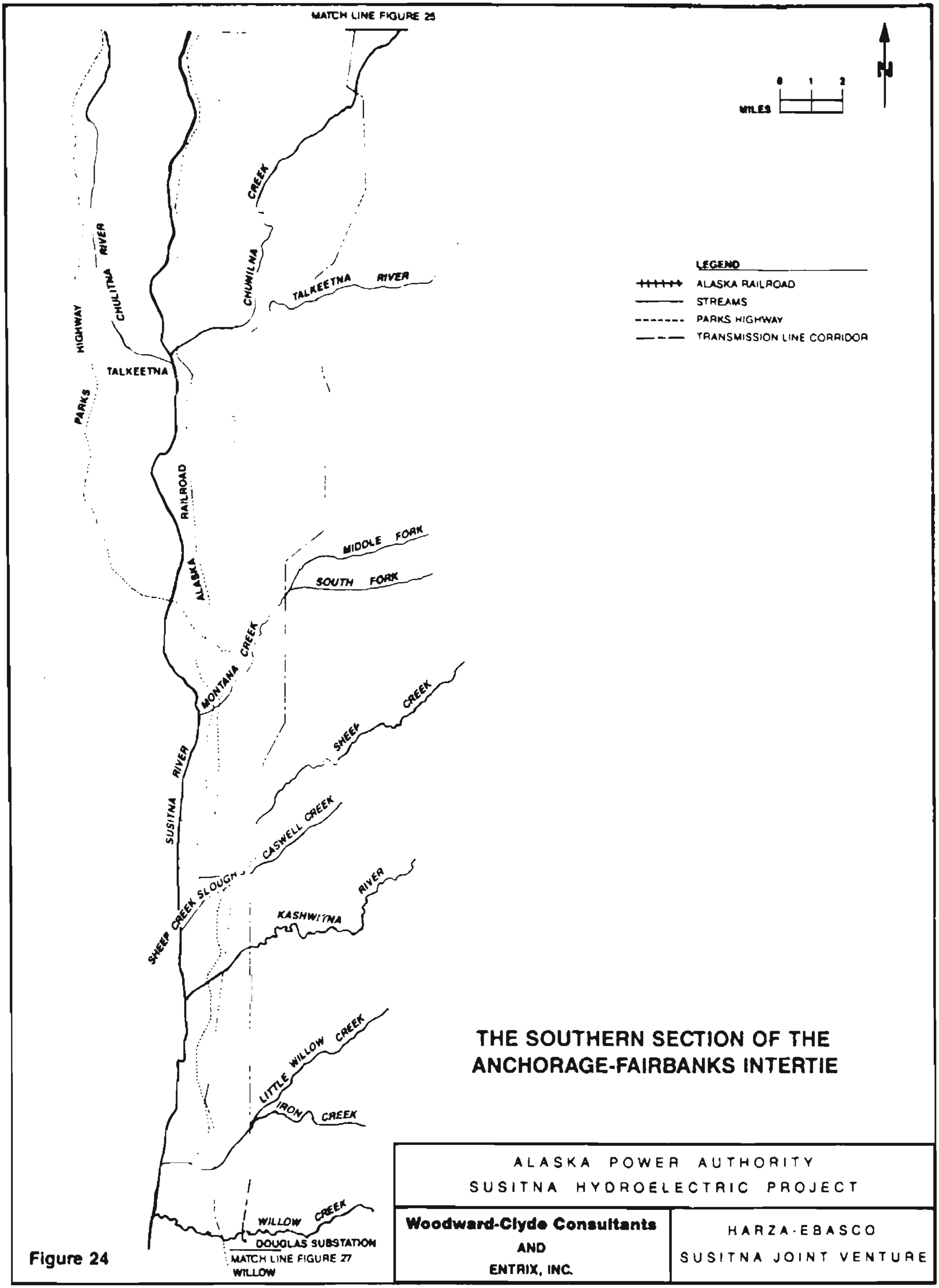



# TRANSMISSION LINE CORRIDOR FROM THE WATANA DAM SITE TO GOLD CREEK

Reference: APA, 1983.

Figure 23

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |



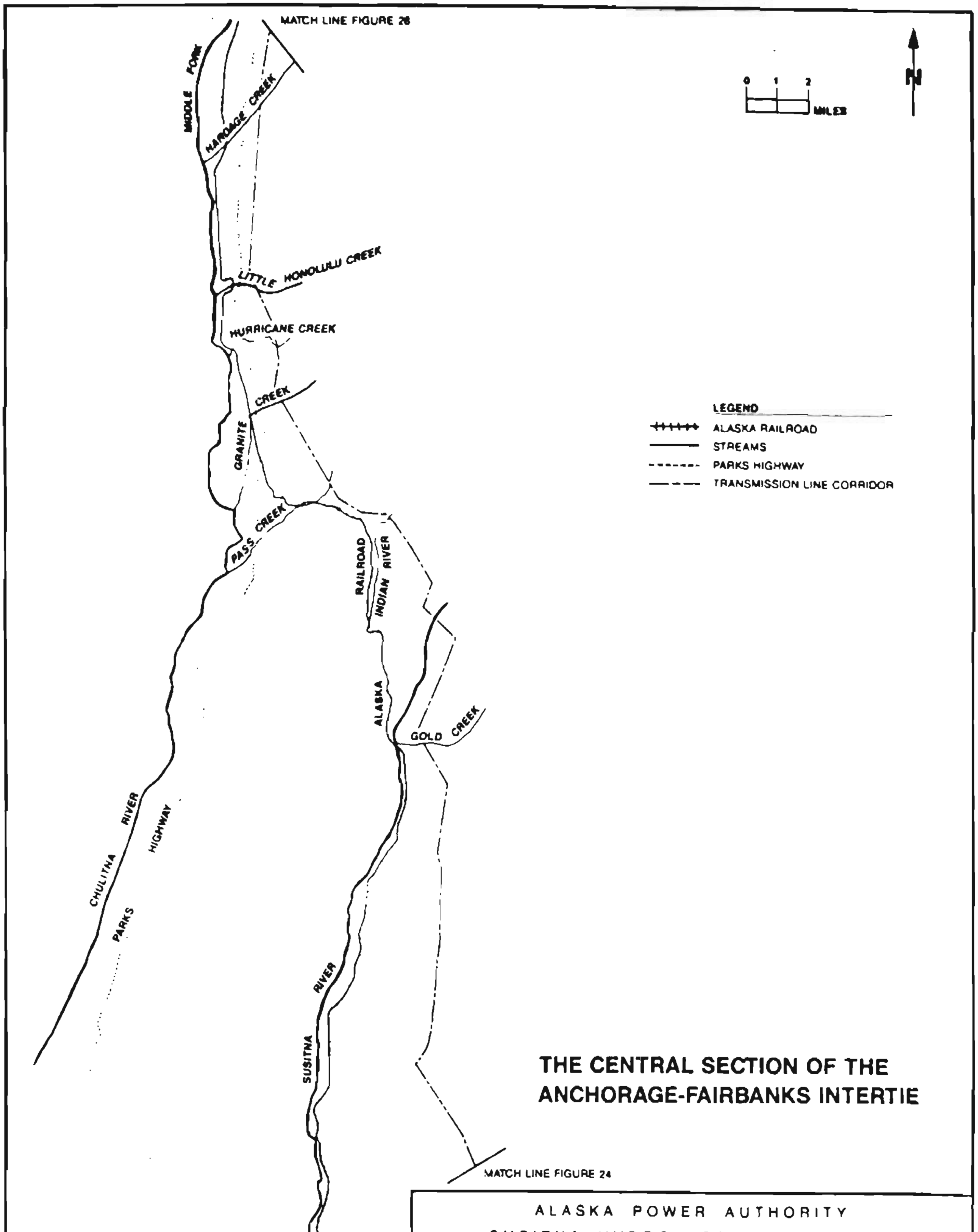

THE SOUTHERN SECTION OF THE ANCHORAGE-FAIRBANKS INTERTIE

Figure 24

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

HARZA-EBASCO
SUSITNA JOINT VENTURE



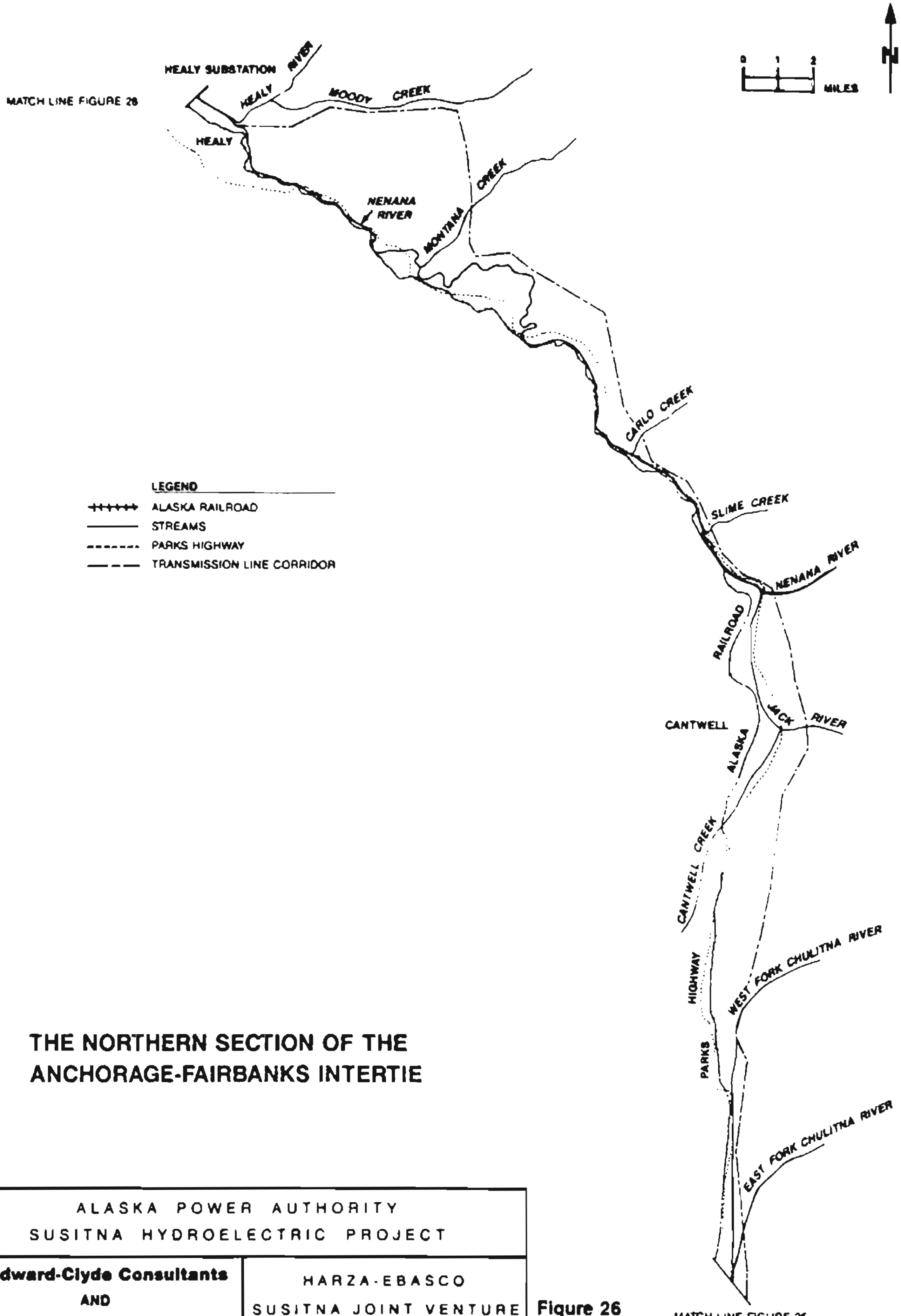

THE CENTRAL SECTION OF THE ANCHORAGE-FAIRBANKS INTERTIE

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Figure 25

**Woodward-Clyde Consultants**
AND
ENTRIX, INC.

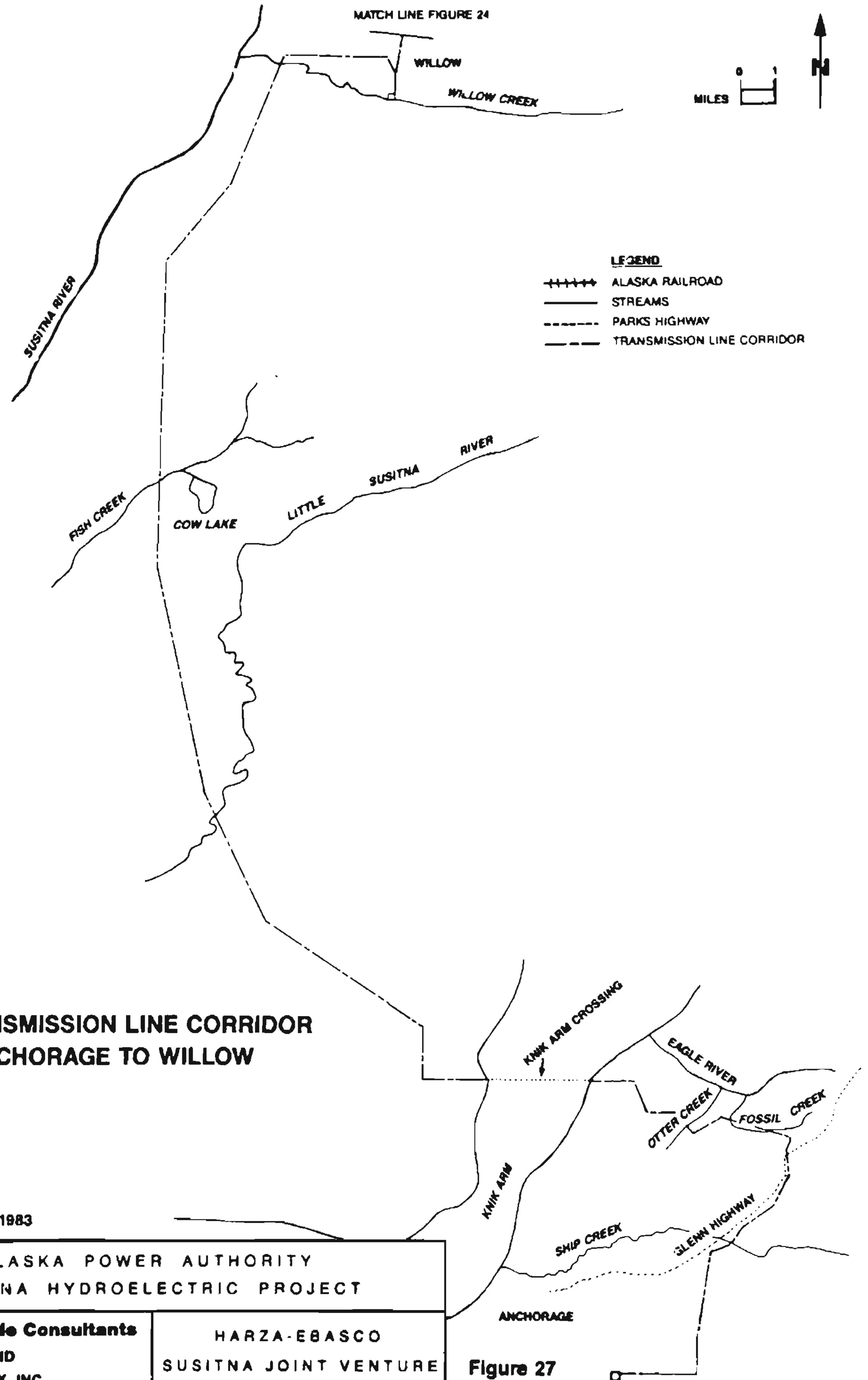
HARZA-EBASCO
SUSITNA JOINT VENTURE




## THE NORTHERN SECTION OF THE ANCHORAGE-FAIRBANKS INTERTIE

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |

Figure 26



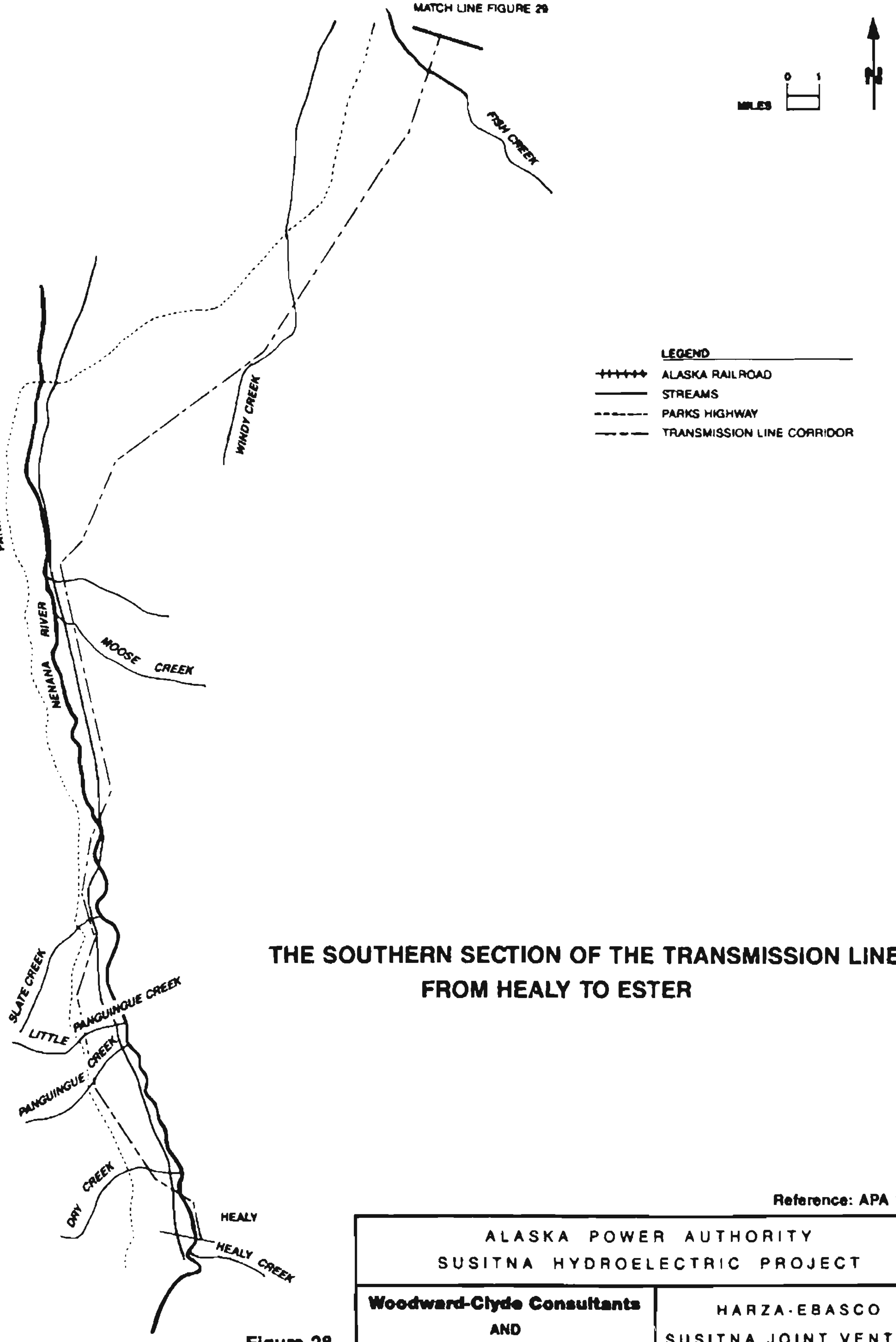

**THE TRANSMISSION LINE CORRIDOR FROM ANCHORAGE TO WILLOW**

Reference: APA 1983

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| | |
|---|---|
| **Woodward-Clyde Consultants** AND ENTRIX, INC. | HARZA-EBASCO SUSITNA JOINT VENTURE |

**Figure 27**

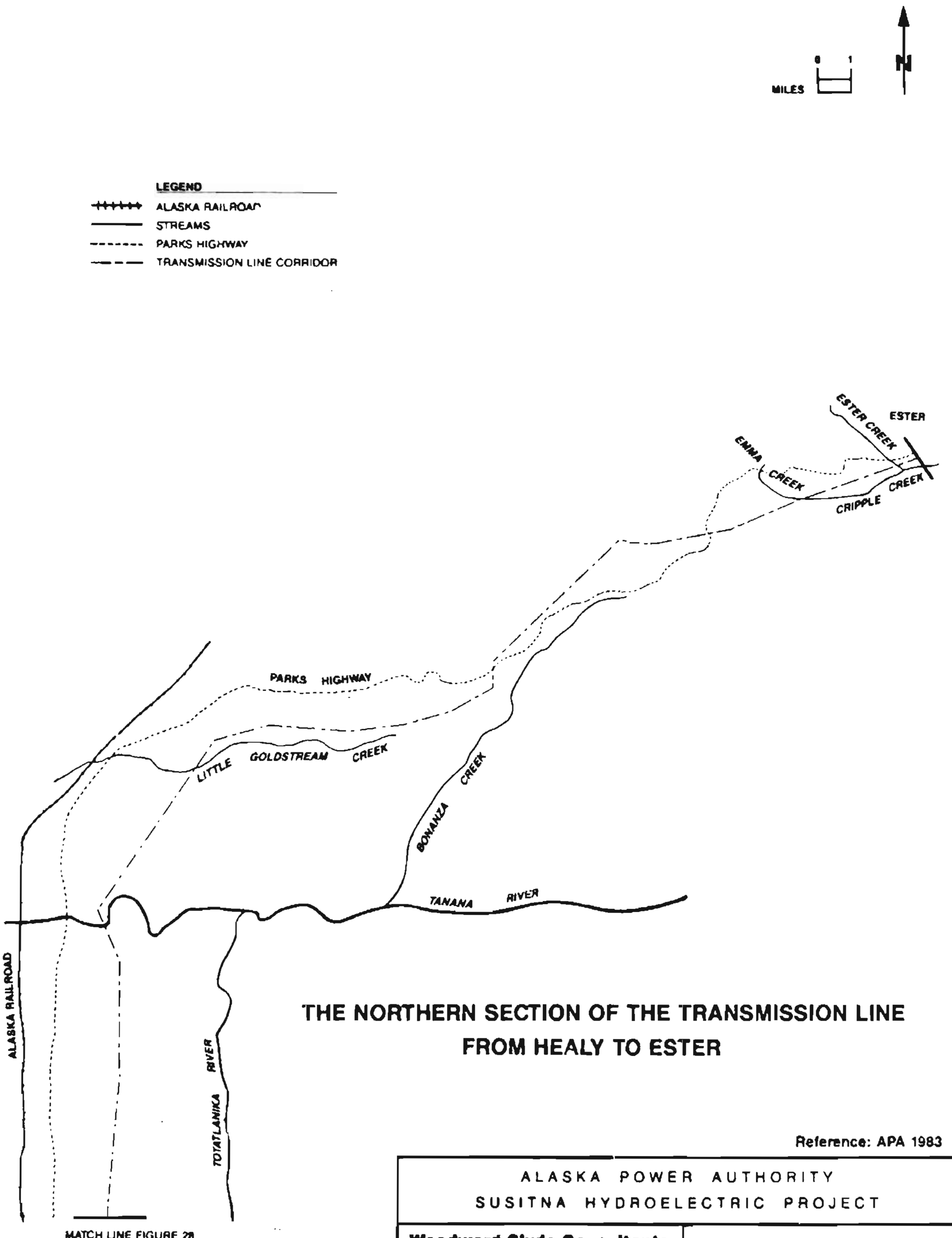



## THE SOUTHERN SECTION OF THE TRANSMISSION LINE FROM HEALY TO ESTER

Reference: APA 1983

Figure 28

| ALASKA POWER AUTHORITY<br>SUSITNA HYDROELECTRIC PROJECT | |
|---|---|
| **Woodward-Clyde Consultants**<br>AND<br>ENTRIX, INC. | HARZA-EBASCO<br>SUSITNA JOINT VENTURE |




## THE NORTHERN SECTION OF THE TRANSMISSION LINE FROM HEALY TO ESTER

Reference: APA 1983

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

| Woodward-Clyde Consultants AND ENTRIX, INC. | HARZA-EBASCO SUSITNA JOINT VENTURE |
|---|---|

Figure 29

TABLES

Table 1. Access, construction, and transmission impact mechanisms and associated mitigation.

| | Best Management Practices Manuals[1] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Impact Mechanisms | 1985a | 1985b | 1985c | 1985d | 1985e | Scheduling of Construction Activities | Project Policy & Modification of current seasons/limits | Water Treatment | Stream Margin Buffers | Rehabi-litation | Monitoring |
| Increased Fishing Pressures | | | | | | | X | | | | X |
| Borrow Site Excavations | X | | | | | X | | X | X | X | X |
| Stream Crossings and Encroachments | X | | | | | X | | | X | X | X |
| Water Quality Degradations | X | X | X | X | X | X | | X | | | X |
| Oil and Hazardous Material Spills | | | X | X | X | | | X | X | X | X |
| Water Removal | X | X | | | | | | X | | | X |
| Clearing | X | | | | | X | | | X | X | X |
| Susitna River Diversions | | | | | | | | | | | |

[1] APA, 1985a. Erosion and Sedimentation Control
APA, 1985b. Water Supply
APA, 1985c. Liquid and Solid Waste Management
APA, 1985d. Fuel and Hazardous Materials
APA, 1985e. Oil Spill Contingency Planning

Table 2. Summary of comments from the resource management agencies pertaining to access, construction and transmission lines.

| Agency | Date | Reason for Correspondence | Comments |
| --- | --- | --- | --- |
| USFWS | 10/5/82<br>1/4/83 | Review of Draft Exhibit E, FERC License Application | (1) Siting of access and transmission line corridors<br>(2) Design of tunnel intakes<br>(3) Scheduling of construction activities |
| ADF&G | 1/13/83 | Review of Draft Exhibit E, FERC License Application | (1) Design of tunnel intakes |
| ADNR | 12/23/82<br>1/28/83<br>2/8/83 | Review of Draft Exhibit E, FERC License Application | (1) Watana camp domestic water supply source<br>(2) Access road usage by non-project personnel<br>(3) Transmission line routing |
| ADEC | 1/21/83 | Review of Draft Exhibit E, FERC License Application | (1) Hazardous material handling<br>(2) Wastewater treatment<br>(3) Concrete production<br>(4) Access road design |

Table 3. Streams crossed by the Denali Highway from Cantwell to the Watana access road junction.

| Stream | Approximate miles from the Richardson Hwy. | Species Present |
| --- | --- | --- |
| Tributary to Jack River | 132.5 | Arctic grayling, (whitefish)[1] |
| Tributary to Jack River | 132 | Arctic grayling, (whitefish)[1] |
| Unnamed Creek (Jack R. System) | 128 | (Arctic grayling, whitefish)[1] |
| Edmonds Creek | 121 | Arctic grayling, northern pike, burbot, whitefish, sculpin |
| Nenana River Oxbow | 119.8 | Arctic grayling, northern pike, burbot, whitefish, sculpin |
| Nenana River Oxbow | 119.5 | Arctic grayling, northern pike, burbot, whitefish, sculpin |
| Tributary to Nenana River | 118 | Arctic grayling, northern pike, burbot, whitefish, sculpin |
| Tributary to Nenana River | 117.8 | Arctic grayling, northern pike, burbot, whitefish, sculpin |
| Unnamed Creek (Nenana R. System) | 114.3 | Arctic grayling, northern pike, burbot, whitefish, sculpin |

[1] (species) can be reasonably expected, but not verified

Reference: ADF&G 1978 Fisheries Atlas. Volume II.

Table 4. Streams to be crossed by the Watana access road (Denali Highway to the Watana dam).

| Stream (ADF&G Survey No.) | Miles From Denali Highway | Species Present | Habitat Condition at Crossing[1] |
|---|---|---|---|
| Unnamed Creek (Nenana System) | 0.3<br>2.0 | (grayling)[2] | ---[3] |
| Trib. to Lily Cr. (1) | 3.0 | Dolly Varden, sculpin | 3 |
| Lily Creek (2) | 3.0 | Dolly Varden, sculpin | 3 |
| Seattle Creek (3) | 5.8 | Dolly Varden, grayling, sculpin | 2 |
| Trib. to Seattle Cr. (4) | 7.7 | Dolly Varden | 4 |
| Trib. to Seattle Cr. (5) | 8.7 | (Dolly Varden, grayling)[2] | 2 |
| Trib. to Brushkana Cr. (6) | 10.7 | (grayling, sculpin)[2] | 4 |
| Trib. to Brushkana Cr. (7) | 11.7 | (grayling, sculpin)[2] | 5 |
| Brushkana Cr. (8) | 12.0 | grayling, sculpin | 1 |
| Trib. to Brushkana Cr. (9) | 13.7 | grayling, sculpin | 1 |
| Trib. to Brushkana Cr. (10) | 16.9 | Dolly Varden, grayling, sculpin | 2 |
| Trib. to Brushkana Cr. (11) | 18.0 | (grayling, sculpin)[2] | 5 |
| Deadman Creek (12) | 19.7 | grayling, whitefish sucker, burbot, sculpin | 5 |
| Trib. to Deadman Cr. (13) | 23.0 | probably none[4] | 5 |
| Trib. to Deadman Cr. (14) | 23.7 | probably none[4] | 5 |
| Trib. to Deadman Cr. (15) | 24.8 | probably none[4] | 5 |

Table 4 (continued)

| Stream (ADF&G Survey No.) | Miles From Denali Highway | Species Present | Habitat Condition at Crossing[1] |
|---|---|---|---|
| Trib. to Deadman Cr. (16) | 27.5 | (grayling, sculpin)[2] | 1 |
| Trib. to Deadman Cr. (17) | 28.5 | probably none[4] | 5 |
| Trib. to Deadman Cr. (18) | 29.5 | Dolly Varden, sculpin | 5 |
| Trib. to Deadman Cr. (19) | 31.4 | sculpin | 5 |
| Trib. to Deadman Cr. (20) | 36.9 | Dolly Varden, grayling, sculpin | 3 |
| Trib. to Deadman Cr. (21) | 37.2 | (grayling, sculpin)[2] | 3 |
| Trib. to Deadman Cr. (22) | 37.8 | (grayling, sculpin)[2] | 3 |

1 1 = excellent, 2 = good, 3 = limited, 4 = marginal, 5 = poor Ratings deduced from information presented in Sautner and Stratton (1984).

2 (species) can be reasonably expected, but not verified

3 --- = not evaluated

4 steep contours on downstream side of road probably preclude fish from this reach

Biological Data Source: Sautner and Stratton 1984

Table 5. Alaska Department of Fish and Game standards for passing Arctic grayling to be used on Susitna Hydroelectric Project stream crossings[1].

| Length of Culvert (feet) | Average Cross-Sectional Velocities at Outlet[2] (ft/sec) |
|---|---|
| 30 | 4.6 |
| 40 | 4.5 |
| 50 | 4.0 |
| 60 | 3.6 |
| 70 | 3.3 |
| 80 | 3.0 |
| 90 | 2.8 |
| 100 | 2.5 |
| 150 | 1.8 |
| 200 | 1.8 |

[1] Each culvert must be installed so that at least 20 percent of the diameter of each round culvert or at least 6 inches of the height of each elliptical or arch type culvert are set below the streambed at both the inlet and outlet of the culvert except when using bottomless arch culverts or to avoid solid rock excavation.

[2] Average cross-sectional velocities at the outlet of the culvert may not exceed the velocities in the table except for a period not exceeding 48 hours during the mean annual flood.

Source: Edfelt 1981 and Title 5 Fish and Game Part 6 Protection of Fish and Game Habitat Chapter 95 - Alaska Department of Fish and Game.

Table 6. Alaska Department of Fish and Game Temporary Stream Diversion Standards

Temporary diversion channels in all streams frequented by fish must be constructed and controlled in the following manner:

(1) The width and depth of the temporary diversion channel must equal or exceed 75 percent of the width and the depth, respectively, of that portion of the streambed which is covered by ordinary high water at the diversion site, unless a lesser width or depth is specified by the department on the permit for activities undertaken during periods of lower flow;

(2) During excavation or construction, the temporary diversion channel must be isolated from water of the stream to be diverted by natural plugs (unaltered streambank) left in place at the upstream and downstream ends of the diversion channel;

(3) The diversion channel must be constructed so that the bed and banks will not significantly erode at expected flows;

(4) Diversion of water flow into the temporary diversion channel must be conducted by first removing the downstream plug, then removing the upstream plug, then closing the upstream end and the downstream end, respectively, of the natural of the diverted stream;

(5) Rediversion of flow into the natural stream must be conducted by removing the downstream plug from the natural channel and then the upstream plug, then closing the upstream and the downstream end, respectively, of the diversion channel;

(6) After use, the diversion channel and the natural stream must be stabilized and rehabilitated as may be specified by permit conditions.

Source: Edfelt 1981

Table 7. Streams to be crossed by the Devil Canyon access road and railroad spur from Gold Creek.

| Stream (ADF&G Survey No.) | Miles From Watana Road | Species Present | Habitat Condition at Crossing[1] |
|---|---|---|---|
| Tsusena Cr. (23) | 2.2 | grayling, whitefish, sucker, Dolly Varden and sculpin | 1 |
| Trib. to Swimming Bear Cr. (24) | 8.0 | Dolly Varden, sculpin | 3 |
| Trib. to Swimming Bear Cr. (25) | 8.7 | probably none | 5 |
| Trib. to Swimming Bear Cr. (26) | 11.1 | (Dolly Varden, sculpin)[2] | 5 |
| Trib. to Swimming Bear Cr.(27) | 11.4 | (Dolly Varden, sculpin)[2] | 5 |
| Trib. to Swimming Bear Cr. (28) | 12.0 | Dolly Varden, sculpin | 3 |
| Trib. to Swimming Bear Cr.(29) | 12.4 | Dolly Varden, sculpin | 3 |
| Trib. to Swimming Bear Cr.(30) | 13.9 | probably none | 5 |
| Trib. to Swimming Bear Cr.(31) | 15.7 | Dolly Varden, sculpin | 2 |
| Trib. to Devil Cr. (32) | 18.9 | Dolly Varden, sculpin | 1 |
| Trib. to Devil Cr. (33) | 22.2 | sculpin | 3 |
| Devil Creek (34) | 22.4 | sculpin | 3 (because of fish barrier) |
| Trib. to Devil Cr. (35) | 24.3 | Dolly Varden, sculpin | 3 |
| Trib. to Devil Cr. Cr. (36) | 24.5 | Dolly Varden | 3 |

Table 7 (continued)

| Stream (ADF&G Survey No.) | Miles From Watana Road | Species Present | Habitat Condition at Crossing[1] |
|---|---|---|---|
| Trib. to Devil Cr. | 26.3 | (Dolly Varden)[2] | ---[3] |
| Susitna River | 35.1 | grayling, Dolly Varden, sculpin, whitefish, burbot, sucker, chinook, coho, pink and chum salmon. | --- |
| Jack Long Cr. Encroachment | 36.3-39.3 | chinook, coho, chum and pink salmon, rainbow trout, grayling, sculpin | --- |
| Trib. to Jack Long Cr. (37) | 37.3 | sculpin | 4 |
| Trib. to Jack Long Cr. (38) | 38.9 | (chinook, coho)[2] | 4 |
| Trib. to Jack Long Cr. (39) | 39.9 | (sculpin)[2] | 4 |
| Unnamed Creek (40) | 43.3 | chinook salmon, sculpin | 2 |
| Unnamed Creek (41) (Waterfall Cr.) | 44.5 | probably none | 4 (because of fish barrier) |
| Gold Creek (42) | 47.9 | chinook, coho, pink salmon | 1 |

1 1 = excellent, 2 = good, 3 = limited, 4 = marginal, 5 = poor Ratings deduced from information presented in Sautner and Stratton (1984).

2 (species) can be reasonably expected, but not verified

3 --- = not evaluated

Biological Data Source: Sautner and Stratton 1984

Table 8. Costs[1] associated with the access, construction and transmission line mitigation and monitoring.

| Description | Capital Costs[2] ($) | Annual Costs[3] |
|---|---|---|
| Borrow Site E Rehabilitation | 65,000 | 0[4] |
| Environmental Monitoring Program | 0[5] | 102,000 |
| (a) Effluent Monitoring | 4,000 | 20,000 |
| Total: | $69,000 | $122,000 |

[1] All costs in 1985 dollars.

[2] Details of cost analysis in Appendix A.

[3] Annual costs are estimated for 20 years of construction activity.

[4] No annual cost expected prior to inundation by the Devil Canyon Reservoir.

[5] Average annual operating costs only are evaluated.

Table 9. Alaska Department of Fish and Game standards for blasting near an anadromous fish stream.

DISTANCE TO ANADROMOUS FISH STREAM MEASURED IN FEET[1]

| Substrate | Explosive Charge Weight in Pounds | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 100 | 500 | 1000 |
| Rock | 50 | 80 | 120 | 170 | 270 | 530 | 1180 | 1670 |
| Frozen Material | 50 | 70 | 110 | 160 | 250 | 500 | 1120 | 1580 |
| Stiff Clay, Gravel, Ice | 40 | 60 | 100 | 140 | 220 | 440 | 990 | 1400 |
| Clayey Silt, Dense Sand | 40 | 50 | 80 | 120 | 180 | 370 | 820 | 1160 |
| Medium to Dense Sand | 30 | 50 | 70 | 100 | 160 | 320 | 720 | 1020 |
| Medium Organic Clay | 20 | 30 | 50 | 70 | 100 | 210 | 460 | 660 |
| Soft Organic Clay | 20 | 30 | 40 | 60 | 100 | 190 | 440 | 620 |

[1] Required distances for charge weights not set forth in this table must be computed by linear intropolation between the charge weights bracketing the desired charge if the charge weight is between one and 1000 pounds; example: for 15 pounds of explosive in rock substrate - required distance =

$$170 \text{ feet} + \frac{15 \text{ lbs}-10 \text{ lbs}}{25 \text{ lbs}-10 \text{ lbs}} (270 \text{ feet}-170 \text{ feet}) = 203 \text{ feet};$$

for charge weights greater than 1000 pounds, the required distance may be determined by linear extrapolation.

Source: Edfelt 1981

Table 10. Streams crossed by the Anchorage-Fairbanks Intertie.

| Stream | Approximate miles from Willow Substation | Species Present |
|---|---|---|
| Willow Creek | .4 | Chinook, coho, chum, pink and sockeye salmon; Dolly Varden; rainbow trout; Arctic grayling; whitefish; (burbot)[1] |
| Rogers Creek | 2.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Iron Creek | 4 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Little Willow Creek | 5 | (Chinook, sockeye, chum, coho and pink salmon; whitefish; Arctic grayling; rainbow trout; Dolly Varden; burbot)[1] |
| Unnamed creeks | 7,8.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| 196 Mile Creek | 10 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| 197 1/2 Mile Creek | 11.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Kashwitna River | 13 | Chinook, coho and chum salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Caswell Creek | 16 | Chinook salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Sheep Creek | 17 | Chinook, pink and chum salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Unnamed Creek | 19.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Goose Creek | 24 | Chinook and pink salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |

Table 10 (continued)

| Stream | Approximate miles from Willow Substation | Species Present |
|---|---|---|
| Unnamed Creek | 27.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Montana Creek | 30 | Chinook, pink and chum salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Unnamed Creek | 34 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Answer Creek | 36.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Unnamed Creek | 41 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Talkeetna River | 45 | Chinook, sockeye, coho, pink and chum salmon; (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Unnamed creeks | 48,50.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Chunilna Creek | 54.5 | Chinook, coho, pink and chum salmon; (Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Tributary of Chunilna Creek | 63 | (Chinook and coho salmon; Arctic grayling; rainbow trout; Dolly Varden; whitefish; burbot)[1] |
| Lane Creek | 63.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Unnamed creeks | 67,70 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Sherman Creek | 70.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Unnamed creeks | 71.5,73 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Gold Creek | 76 | Chinook, coho and pink salmon, Arctic grayling, rainbow trout, Dolly Varden, whitefish, sculpin |
| Unnamed Creek (Waterfall Creek) | 79 | none[2] |

Table 10 (continued)

| Stream | Approximate miles from Willow Substation | Species Present |
|---|---|---|
| Unnamed Creek | 80.5 | Chinook salmon, sculpin |
| Susitna River | 81 | Chinook, sockeye, coho, pink and chum salmon; Arctic grayling; Dolly Varden, whitefish, longnose sucker, burbot, sculpin |
| Tributary of Indian River | 86 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Indian River | 87.5 | Chinook, coho, pink and chum salmon; Arctic grayling; Dolly Varden; rainbow trout; (whitefish, burbot)[1] |
| Unnamed Creek | 90 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish, burbot)[1] |
| Pass Creek | 90.5 | none[2] |
| Unnamed creeks | 91.5,92.5, 94 | none[2] |
| Granite Creek | 94.5 | (Arctic grayling, rainbow trout, Dolly Varden, whitefish)[1] |
| Hurricane Gulch | 96 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Little Honolulu Creek | 98.5 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Unnamed Creek | 100 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Honolulu Creek | 101.5 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Antimony Creek | 103.5 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Unnamed Creek | 105.5 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Hardage Creek | 106 | (Arctic grayling, rainbow trout, whitefish)[1] |
| East Fork Chulitna River | 111.5 | Sockeye, coho and chum salmon; (Arctic grayling; rainbow trout; whitefish)[1] |

Table 10 (continued)

| Stream | Approximate miles from Willow Substation | Species Present |
|---|---|---|
| Fourth of July Creek | 114.5 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Unnamed Creek | 117.5 | none[2] |
| Coal Creek | 118 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Middle Fork Chulitna River | 120 | Sockeye, coho and chum salmon; (Arctic grayling, rainbow trout, whitefish)[1] |
| Unnamed creeks | 122.5,125 | (Arctic grayling, rainbow trout, whitefish)[1] |
| Unnamed creeks | 125.5,126.5, 128 | (Arctic grayling, whitefish)[1] |
| Jack River | 131.5 | (Arctic grayling, whitefish)[1] |
| Unnamed creeks | 133.5,134.5, 136.5 | (Arctic grayling, whitefish)[1] |
| Nenana River | 137 | Arctic grayling, whitefish, burbot, northern pike, sculpin |
| Unnamed Creek | 137.5 | none[2] |
| Slime Creek | 141 | (Arctic grayling, whitefish)[1] |
| Carlo Creek | 145.5 | (Arctic grayling, whitefish)[1] |
| Yanert Creek | 154 | (Arctic grayling, whitefish)[1] |
| Unnamed Creeks | 155,156.5 | (Arctic grayling, whitefish)[1] |
| Montana Creeks | 158 | (Arctic grayling, whitefish)[1] |
| Unnamed Creeks | 159,162.5, 163.5,164.5, 165 | (Arctic grayling, whitefish)[1] |
| Copeland Creek | 168.5 | (Arctic grayling, whitefish)[1] |
| Healy Creek | 172 | (Arctic grayling, whitefish)[1] |

[1] (species) can be reasonably expected, but not verified

[2] Steep contours probably preclude fish
Reference: ADF&G 1978 Fisheries Atlas. Volumes I and II.

Table 11. Streams to be crossed by the transmission line from Healy to Ester.

| Stream | Approximate miles from Healy Substation | Species Present |
| --- | --- | --- |
| Nenana River | 1.5 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, burbot, chum and coho salmon |
| Dry Creek | 3 | (Arctic grayling, whitefish)[1] |
| Panguingue Creek | 6 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, sculpin |
| Little Panguingue Creek | 7.5 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, sculpin |
| Slate Creek | 11.5 | (Arctic grayling, whitefish)[1] |
| Nenana River | 14.5 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, burbot, chum and coho salmon, Inconnu, northern pike |
| Tributary to Moose Creek | 15.5 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Moose Creek | 16 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Tributaries to Nenana River | 18.5,19.5, 21 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Unnamed Creek | 24 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Windy Creek | 30,32 | (Arctic grayling, whitefish, Dolly Varden, burbot, northern pike)[1] |
| Tributaries to Julius Creek | 34.5,35.5, 36,36.5,38.5 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, sculpin |
| Fish Creek | 41 | Arctic grayling, round whitefish, Dolly Varden, longnose sucker, sculpin |
| Unnamed creeks | 43,43.5, 45,46,46.5, 49,49.3,49.7, 50,50.5,51,51.5 | (Arctic grayling, whitefish, Dolly Varden, burbot, northern pike)[1] |

Table 11 (continued)

| Stream | Approximate miles from Healy Substation | Species Present |
|---|---|---|
| Tanana River | 52.5 | Chum, coho and chinook salmon, Inconnu, northern pike, Arctic grayling, whitefish, burbot |
| Unnamed creeks | 55,56 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Tributary to Little Goldstream Creek | 59 | Arctic grayling, whitefish, Dolly Varden)[1] |
| Little Goldstream Creek | 60.5 | Arctic grayling, round whitefish, Black fish, longnose sucker, sculpin |
| Tributaries to Goldstream Cr. | 63,64.5,65.5 66.5,68,68.2, 70 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Little Goldstream Creek | 70.2 | Arctic grayling, round whitefish, Black fish, longnose sucker, sculpin |
| Tributaries to Bonanza Creek | 71,72,72.5 73 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Tributaries to Ohio Creek | 78,78.5,79 80.5,82,83.5, 84 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Tributary to Alder Creek | 87 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Alder Creek | 88 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Emma Creek | 89.5 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Tributary to Emma Creek | 90 | (Arctic grayling, whitefish, Dolly Varden)[1] |
| Ester Creek | 93 | (Arctic grayling, whitefish, Dolly Varden)[1] |

[1] (species) can be reasonably expected, but not verified

References: Letter from Jerry Hallberg (ADF&G Sportfish Div.) to Nancy Heming (Falls Creek Environmental) October 29, 1982.

ADF&G 1978 Fisheries Atlas. Volume II.

Table 12. Streams crossed by the transmission lines from Willow to Anchorage.

| Stream | Approximate miles from University Substation in Anchorage | Species Present |
|---|---|---|
| Ship Creek | 7.5 | Chinook, coho, chum and pink salmon; Dolly Varden; rainbow trout; (Arctic grayling)[1] |
| Fossil Creek | 12.5 | none |
| Otter Creek | 18 | Sockeye salmon, rainbow trout, (Arctic grayling, Dolly Varden)[1] |
| Knik Arm | 20-22 | Chinook, sockeye, coho, chum and pink salmon, eulachon, Bering cisco, Dolly Varden |
| Unnamed Creek | 26 | (Burbot, rainbow trout, whitefish, Dolly Varden)[1] |
| Little Susitna River | 36.5 | Chinook, sockeye, coho, chum and pink salmon; Dolly Varden; rainbow trout; Arctic grayling; (burbot, whitefish)[1] |
| Tributary to Fish Creek | 45 | (Chinook and coho salmon; rainbow trout, burbot, whitefish, Dolly Varden)[1] |
| Fish Creek | 47 | Chinook, sockeye, coho and pink salmon; rainbow trout; (burbot; rainbow trout; whitefish; Dolly Varden)[1] |
| Tributaries to Susitna River | 52,53,58 | (Coho salmon, burbot, rainbow trout, whitefish, Dolly Varden)[1] |
| Willow Creek | 61 | Chinook, coho, chum, pink and sockeye salmon; Dolly Varden; rainbow trout; Arctic grayling, whitefish; (burbot)[1] |

[1] (species) can be reasonably expected, but not verified

Reference: ADF&G 1978, Fisheries Atlas Volumes I and II

# Appendix A

## Detailed Mitigation and Monitoring Costs

This appendix presents the preliminary costs for the mitigation and monitoring program proposed in this volume. Mitigation will predominantly be composed of adherence to the environmentally acceptable construction practices detailed in the BMPM's (APA 1985a, 1985b, 1985c, 1985d, 1985e); no direct costs have been assigned to this mitigation. All costs are evaluated in terms of 1985 dollars. Equipment and personnel are assumed to be available at the sites and not require additional transportation. Effluent monitoring will be conducted throughout the year; laboratory analysis costs are estimated as average annual costs. For the environmental field officer program, capital costs including transportation have been incorporated into the average annual operating costs.

Borrow Site E Rehabilitation

| | |
|---|---|
| Labor | $42,000 |
| Equipment | 17,000 |
| Engineering/Management | 6,000 |
| Total | $65,000 |

Total Initial Costs of Borrow Site E Rehabilitation $65,000
No Annual Costs are anticipated

Environmental Field Officer Program

| | |
|---|---|
| Labor | |
| EFO #1 (20 yrs) | $70,000/yr |
| EFO #2 (7 yrs) | 70,000/yr |
| Equipment | 7,800/yr |
| (a) Effluent Monitoring | 4,000 |
| Laboratory Analysis | |
| (a) Effluent Monitoring | |
| - Stream Crossings | $13,500/yr |
| - Tsusena and Deadman Creeks | 5,000/yr |
| - Settling Ponds | 1,500/yr |
| - Wastewater Treatment Plant | -0-[1] |

| | |
|---|---|
| Total Initial Costs | $ 4,000 |
| Average Annual Costs | $122,000 |

[1] All costs are included in the design and construction of the plant.