SUSITNA HATCHERY

SITING STUDY

Prepared for

THE ALASKA POWER AUTHORITY
AND
ACRES AMERICA INCORPORATED

November 1982

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DEC 6 1982

December 3, 1982

Mr. Bill Wilson
University of Alaska
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Dear Bill:

Enclosed is a draft copy of the Kramer, Chin and Mayo, Inc. Susitna Hatchery Siting Study for your information. Comments are not requested at this time.

Sincerely,

Larry

Lawrence L. Moulton
Project Manager

LLM/jj

cc: R. Fleming, APA
J. Hayden, Acres
T. Trent, ADF&G

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INTRODUCTION

Background

The Susitna River extends approximately 275 miles from the glaciated peaks of the Clearwater Mountains, 90 miles south of Fairbanks, to Cook Inlet 25 miles west of Anchorage. Its drainage is approximately 19,400 square miles. Native populations of chum, coho, Chinook, pink, sockeye, steel-head, and non-anadromous species occupy the mainstem and its tributaries up to the rapids at Devils Canyon. Recent observations of Chinook and chum suggest the possibility that salmonids are located throughout the basin.

The river has three major tributaries and a number of smaller ones. Both the mainstem and its tributaries vary in characteristics from well defined, plunging channels to braided streams. Salmon spawning occurs both in the smaller tributaries and in the many sloughs which are present in both the mainstem and the large tributaries. Ice cover persists throughout the river system for approximately six months each year.

The Parks Highway provides vicinity access to the central portion of the Susitna Basin and portions of the Chulitna River, one of the major tributaries. Several small access roads have been constructed to the river itself, primarily to provide recreational access. The transmission corridor for the proposed hydroelectric projects may provide additional access as would the relocation of the Capital to the Willow area. These developments similarly would increase the availability of power in the basin which is generally limited to the Parks Highway south of Talkeetna.

The proposed hydroelectric dams at Watana and subsequently Devils Canyon could impact anadromous species in terms of access to spawning grounds and unusual temperature regimes as far as 50 miles downstream of the dams. A variety of options for mitigating and compensating for these potential impacts is being considered. As part of this package, this report summarizes the findings of a reconnaissance siting study for a compensatory hatching and early rearing facility for Chum salmon.

Objective

This report summarizes a four-month study. Its focus was:

- establish biological and physical criteria for the facility
- identify the existence of suitable sites
- conceptualize a state-of-the-art facility
- provide budgetary guidelines in terms of both capital and operation and maintenance costs

Because of the short performance period of this study and the alterations in the Susitna Basin which may occur prior to hatchery construction, it is not an objective of this study to select the "best" or "optimal" site. Rather, the objective is to determine the availability of a feasible site or sites. The commitment to a compensatory hatchery and its exact location must be based on a range of considerations beyond the scope of this study.

The quidelines for the production capacity of the facility have been established at 30,000 adult chum returning to the proximity of the hatchery. It has also been established that the runs produced by the facility should not create additional fishery problems in the river system and Cook Inlet in terms of harvest management, genetics, disease, and competition with native stocks.

Methodology

The method utilized for the identification and subsequent evaluation of potential sites consisted of both review of written descriptions and discussions with individuals familiar with the sites. An initial identification of sites in the Susitna Basin and upper Cook Inlet was conducted by the Alaska Department of Fish and Game (ADF&G) in 1979. This study, conducted over a two-year period, identified 24 sites within the region. Of these, 15 were within the Susitna system drainage basin. After review of the background documents on sites, eight appeared generally feasible for a chum program. One additional site affording groundwater potential was also identified. All nine sites were inspected by an engineer and biologist. Sites were inspected from the ground and via aerial surveillance. Because a single visit during even the most clement of weather provided insufficient information which to base detailed design decisions, the site evaluation team considered previous experience in constructing and operating hatcheries in similar environments. The information available from ADF&G on water chemistry and indiginous fish population and conversations with staff members was of great assistance during the evaluation process.

The sites were analyzed in relation to a set of physical and biological criteria developed in the initial phase of the study. The criteria, contained in Chapter 2 of this report, are consistent with current fish culture practices in Alaska for salmonid hatcheries.

Discussions were held with State staff in regards to pathology, genetics, and harvest management to ensure that recommendations developed in the study are reflective of the State's management and operational guidelines.

COMPENSATORY HATCHERY CONCEPT

The Production Program

The primary objective of this compensatory facility is to ensure the continued return of no less than 30,000 adult chum salmon to the Susitna River without adversely impacting natural stocks. The prodgeny from this number of adults, under normal conditions of natural spawning in the river would yield approximately 190,000 adults assuming a typical escapement of 33 percent and an ocean survival of 1 percent. At present, the harvest pressure in upper Cook Inlet is targeted at 67 percent. Thus at this level of fishing, 30,000 adults will return annually to the river system to maintain the run.

If, however, a hatchery is utilized for the production of juveniles, the survival which can be anticipated from egg to release greatly exceeds that realized under average natural conditions. Therefore, only a portion of the annual return of 30,000 adults is necessary to maintain the run. The following table compares the survival rates at various critical stages in both hatchery bred and naturally spawned fish.

As shown in Table 1, utilizing the hatchery concept, approximately 27,000 fish would be available annually for target fisheries, surplus sales at the hatchery, or to provide donor eggs for enhancement projects elsewhere.

Table 1

Chum Salmon Survival Criteria

Stage	Hatchery Production	Natural Production
Returning Adults	30,000	30,000
Females Spawned	3,000	15,000
Eggs Obtained	6,600,000	30,000,000
Eggs Eyed	5,940,000 (90%)	--
Eggsack Fry	5,643,000 (95%)	--
Buttoned Fry	5,361,000 (95%)	--
Smolts	5,093,000 (95%)	10,890,000 (33%)
Marine Survival	102,000 (2%)	108,900 (1%)
Commercial Harvest	68,340 (67%)	72,963 (67%)
Spawner Escapement	33,660 (33%)	35,937 (33%)
Surplus	27,000	5,937

Sur mort egg 67% ↓ smolt 99% adult ↓ escapement ≈ 0.1%

Eggs taken in the late summer and early fall will be placed in incubator units for eyeing and hatching. Dependent upon temperature, hatching will occur during the later weeks of winter. Upon hatching, fry will be transferred to rearing units. Releases will be made directly from the hatchery, if possible. To increase the survival of the smolts released, juveniles will remain in the hatchery environment several months after hatching until reaching the size of about 600 per pound. Timing of the release will coincide with ice breakup on the river and the outmigration of wild stocks in the river.

The release of juveniles will occur in late spring and the peak return of adults will be in the late summer and early fall. Thus operation of the facility will essentially be year-round. Figure 1 illustrates a typical annual operating schedule for a chum hatchery in the Susitna Basin.

Figure 1

Production/Facility Program

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Activity		SPAWN				INCUBATE			REAR		RELEASE	
					Eye		Hatch					
Facility		RACEWAYS				ZENGER TYPE INCUBATORS			RACEWAYS			
		15,000 cf			15 trays		36 trays		15,000 cf			
Water (gpm)*		1200-2400			240		240		1200-2400			

*Based on ambient water temperature.

As previously mentioned, there is a potential for a surplus adult return to the hatchery based upon the increased survival of hatchery reared fish. A plan for disposing of these either through a fishery, or egg transfers and carcass sales will have to be developed.

FACILITY COMPONENTS

In order to meet the production program outlined in the foregoing paragraphs, there are certain basic components required for any hatchery facility. These are:

- Adult Capture and Holding
- Egg-Take/Spawning
- Incubation
- Rearing
- Water Supply System
- Various Support Functions

Adult Capture and Holding

To develop and maintain a broodstock, it is necessary to capture adult fish returning to the hatchery and hold them until they are suitable for spawning. Generally, capture and holding requires a fish weir or diversion fence in the stream near the hatchery, a fishway to the holding area, and some tanks or ponds for holding.

Where the stream also supports native stocks, the fish weir must be designed carefully to avoid adverse impacts to those stocks. Most commonly a removable weir is installed for only that time that the hatchery stocks are returning. ADF&G has developed a typical weir that is fabricated with aluminum or wood tripods that support a fence comprised of aluminum frames and conduit or tubing. With chum salmon in Alaska, one-inch tubing on two- to three-inch centers has been found to be suitable for diversion of adults.

Various types of fishways have been used in the past few years. Traditional experience in the Pacific Northwest has been that chum salmon will not pass through Denil-type or "steep-pass" fishways. At various chum hatcheries around Alaska, this has not been found to be true. KCM has successfully used Denil-type fishways with a 1:6.5 gradient at a chum facility, and it is likely that a similar fishway would be suitable for a hatchery in the Susitna study area.

The holding ponds are usually most economically used for both adult holding during spawning and fry rearing during the spring. Consequently, adults are often held in raceways that are designed for rearing with modifications for holding. Common modifications include:

- An upwelling water supply during holding to minimize attempts by adults to "migrate" further upstream.
- Provision for or installation of a crowding system in the raceways.
- Piping for sorting and distribution of fish by sex and ripeness.
- Alternative outlet configurations to allow adults to be directed into raceways.

Egg-Take/Spawning

Early in the broodstock development period, the egg-take and spawning operation generally begins with little or no specialized facilities. Temporary bleeding racks and tables are constructed and the eggs and milt are taken in plastic buckets. The eggs are then fertilized, water hardened, treated chemically, and placed into incubators for eyeing.

The basic requirements for the spawning/egg-take operation are a water supply and drain system, sinks or tables for the process, and an enclosed space out of direct sunlight and other weather conditions.

Incubation

There are presently several methods of salmon incubation utilized in the state of Alaska, all of which have proponents and detractors. The concepts common to most incubators are:

- o An upwelling water flow that should be as uniformly distributed as possible.
- o Some type of real or synthetic substrate (gravel, PVC saddles, etc.).
- o Modular sizing of units, usually having capacities from 100,000 to 500,000 eggs per unit.

Incubation is usually a two-step process consisting of initial eyeing without substrate followed by hatchery incubation with substrate. The eggs are usually sorted and counted between eyeing and hatching although with some incubators some hatchery operators are attempting to eliminate this step.

The three most common types of incubators used in Alaska today are:

- o Heath trays
- o "Zenger Boxes"
- o Cylindrical fiberglass units

Heath trays are relatively small compared to the latter two and not used as commonly for chum salmon as Zenger Boxes and cylindrical units such as

R-30s and R-48s. There are many differences of opinion on the use and cost-effectiveness of different types of incubators, and it is probably best to involve operating personnel in decisions regarding incubator selection. Generally, if the people using the incubators are involved in the selection and have confidence in the incubators, they will be more successful than if the operating personnel feel that an incubation system was forced upon them.

For preliminary facility sizing, an incubation room capable of holding eight five-tray stacks of Zenger Boxes or eight R-48s will be used. A water requirement of 240 gpm will be used.

The incubation system may be the most important part of the facility. It is the process during which most egg mortality occurs and the process that can require the most manual labor if the system is not operating properly. Many hours have been spent at some hatcheries cleaning substrate and removing eggs from incubators that were improperly designed and/or operated. Since the eggs are in the incubators for the longest time of any process, a smooth running incubation system can be the difference between a successful facility and a less-than-successful one.

Rearing

The length of rearing time required will vary with water temperature. Most chum salmon hatcheries in the state that do not have the capability to control water temperatures have fry emerging from the incubators earlier than desirable. This is usually the result of 10- to 12-degree C water temperatures in the early fall which expedite the incubation process sufficiently that fry begin to emerge as early as January and February. Since the receiving waters usually have inadequate food for the smolts until April or May and may be ice covered, the fish must be held in rearing facilities and fed for several months.

Clearly, the earlier the fry emerge, more rearing volume and operational costs are required. For purposes of this preliminary study, it is assumed that the fry will be reared to about 600 fish per pound. This many vary slightly with water temperatures and release timing, but it is probably a reasonable assumption for most of the alternative sites considered.

Using the criterion, a rearing volume of 5,000 cubic feet and a peak flow of 1,200 gpm has been determined. ADF&G commonly use higher densities and higher flows than this, so to provide for some flexibility during design and some contingencies for each site, a volume of 5,000 cubic feet with a flow of 2,400 gpm will be used. Various configurations of rearing tanks have been used with square "Swedish ponds" and rectangular raceways the most common.

Water Supply System

Based on the preceding discussions, the water supply should meet the following requirements:

- o 240 gpm during incubation
- o 2,400-gpm peak during rearing
- o Variable temperature desirable

In addition to the above, the water quality parameters listed in Table 2 should be met.

Obviously, the water system will require components to regulate flows during the various operations. If a pumped water supply system is used, various size pumps with standby capacity should be used. Also, a headbox system is necessary to distribute flow to the incubators and inside raceways without affecting flow to other components.

Support Functions

The following support functions are most commonly required at a chum salmon hatchery:

- Shop and garage space
- Laboratory
- Office
- Employee restrooms
- Employee lunch room (kitchen)
- Storage
- Freezer space (portable vans are often used)
- Bunkhouse and/or apartment
- Permanent residences at remote sites

Table 2

ADF&G Water Quality Standards for Fish Health

Alkalinity	at least 20 ppm as CaCo(3)
Aluminum	0.01 mg/1
Ammonia	0.02 ppm
Arsenic	0.05 mg/1
Cadmium	0.0005 ppm (100 ppm alkalinity) 0.005 ppm (100 ppm alkalinity)
Chromium	0.03 ppm fish and other aquatic life
Carbon Dioxide	0.1 mg/1
Copper	0.006 ppm (100 ppm alkalinity) 0.03 ppm (100 ppm alkalinity)
D.O.	8.0 ppm
Fluoride	0.5 mg/1
Hydrogen Sulfide	0.003 ppm
Iron	0.1 mg/1
Iron Bacteria	(includes Sphaerotilus sp.) - prefer water with a lack of enough nutrients to inhibit growth.
Lead	0.02 ppm
Magnesium	15 mg/1
Manganese	0.01 mg/1
Mercury	0.2 mg/1
Nitrogen	110% total gas pressure (103% nitrogen gas)
pH	6.5 - 8.0
Silver	0.003 mg/1 (fresh water) 0.003 mg/1 (salt water)
Sulfur	1.0 mg/1
Temperature	0 - 15 degrees C
TDS	400.0 mg/1
TSS	80.0 ppm (25 JTU's)
Zinc	0.005 mg/1
No petroleum or petroleum derivatives	
Nitrate	1.0 mg/1
Nitrite	0.1 mg/1
Ni	0.01 mg/1
HCN	0.005 mg/1
K	5.0 mg/1
Background radiation count (info only)	
Sa	0.01 mg/1
Na	75.0 mg/1
Salinity	5.0 ppt
Sulfide (-2)	50.0 mg/1
U	0.1 - 0.00 mg/1
V	0.1 mg/1
Ba	5.0 mg/1
Zr	0.1 mg/1

Siting

Biological Considerations:

Chum salmon presently comprise approximately _____ percent of the total annual number of returning salmonids. Their catch contribution, is primarily to the Cook Inlet commercial fishery. Only a small fraction is taken by the in-river sports fishery. Dependent upon the goals of the compensation program, it may be desirable to locate the hatchery outside of the Susitna basin in order to allow target fisheries on the stocks and thus reduce the surplus to the hatchery. If the hatchery stock is mixed with wild stocks the harvest pressure must equal that needed to protect other stocks and the surplus cannot be avoided. One of the foremost decisions in siting the hatchery from a biological standpoint is the decision on whether the objective of the program is to maintain river runs of Chum salmon at present levels, or whether the goal is to maintain the current level of contribution to the commercial fishery.

Biological considerations pose the greatest uncertainty in the siting of a successful hatchery facility. Not only does the location have to have a water supply of high quality, the conditions between time and release and subsequent adult returns must be supportive of at least average rates of survival.

The latter conditions are at best difficult to predict in areas where there are historical data on hatchery operations within the locale. Such history is unavailable for Susitna. Compounding it is the fact that within Alaska there is little historical information on which to predict the success of upriver hatcheries.

One obvious siting potential is that of locating the compensation hatchery at the dam site where access, power, community services, etc would be readily available. However, the upstream dam construction will preceed the Devil's Canyon Dam by several years this delaying the opportunity for hatchery operation until the second phase of hydroelectric plant development.

The intent and requirement of this compensating facility is to avoid adverse impacts on wild stocks. This includes not only chum salmon but other indigenous stocks of salmonids. Some of the impacts that must be minimized are:

- Improper smolt release timing, i.e. hatchery smolts outcompeting wild smolts for available food.
- Introduction of disease from donor stocks to wild stocks.
- Over-harvest of wild stocks in commercial fishery including incidental catch of coho and Chinook.

Physical Considerations

Within the Upper Cook Inlet Region, there are numerous sites that, from the standpoint of engineering feasibility, could support the construction of a salmon incubation and/or rearing facility. However, there are various types of sites that appear much more practical or cost-effective than others. In order to describe the available sites in an organized manner, the following constraints or parameters will be used:

- Accessibility to roadways
- Accessibility to electrical power
- Type of water supply (lake, stream, or groundwater)
- Other factors such as soil conditions, land ownership, etc.

Accessibility to Roadways

Roadway access can be an extremely important factor in determining the feasibility of a site. Over the past several years, numerous hatcheries have been constructed throughout the state and more data on operational experience is being gathered each year. One simplified way to categorize hatcheries is remote or nonremote; with a nonremote hatchery being one that can be reached by ground transportation throughout the year.

Nonremote hatcheries have several obvious advantages as well as some not-so-obvious ones. Clearly, construction costs and direct operational costs are lower at sites that have vehicular access. Delivery of materials and equipment by boat or airplane is costly and, in some cases, limited by weather conditions. Both during construction and operation, logistics become major factors in the feasibility of the project. A not-so-obvious problem with remote sites is morale and employee turnover. Because the staff at a hatchery is relatively small most of the year, it is not possible to provide all community-type activities at remote sites. Employees with families and school age children are usually not able to accept assignments at remote sites. Those people that do work at remote sites often find extended assignments difficult or unacceptable. ADF&G does not have sufficient duration of experience for statistically valid comparisons of turnover, but anecdotal evaluation would probably support the conclusion that employees do not stay at remote facilities as long as at nonremote facilities. Of course, retraining costs and the possibility of operational problems or failures increase with employee turnover.

Accessibility to Power

Even if a site is located on an existing roadway, if it is not near an existing electrical power system, construction and operational costs increase substantially. Though the major energy requirement at a hatchery is usually pumping process water, even hatcheries with gravity flow throughout the process water system have significant energy requirements for lighting, heating, and ventilation.

Independent generation of power, either with diesel engines or hydroelectric plants, is utilized at several remotely located hatcheries in the state. Clearly, diesel generation has a high continuing cost associated with it and presents an opportunity for serious problems if fuel deliveries are delayed or equipment breakdowns occur. Experience with small hydro plants is limited, but mechanical problems have occurred at some hatchery projects.

Type of Water Supply

There are three basic types of water supplies available: lakes, streams, or groundwater. Lake and stream supplies can be gravity flow or pumped and groundwater, of course, is usually pumped. Any of the three types are feasible and have been used successfully at hatcheries. Each does present different advantages and disadvantages.

Lake supplies are probably the most versatile and reliable. Intakes can be installed at different depths to obtain different temperatures, and variations in turbidity is usually not as great a problem as on streams. The entire intake system can be installed at sufficient depth to avoid freezing problems. One possible biological problem with lake supplies is that lakes often support numerous native stocks and disease transmission to the hatchery can occur.

Stream intakes may have less pipe length than lake intakes, but they usually have numerous disadvantages. The possibility of freezing and flooding are the greatest disadvantages. Surface intakes are usually difficult and costly to design, construct, and operate. Where a well-defined channel exists such as in bedrock canyons, diversion structures can usually be installed successfully. However, they may require heating or other maintenance to assure continuous year-round flow. Where well-defined channels do not exist, such as the gravel bottom, braided channels common in the study area, installation of a suitable surface intake can be extremely costly and possibly not practical. It should be noted that sub-surface intakes along streams, such as infiltration galleries, are technically feasible but require near ideal gradations of the existing gravel deposits to function.

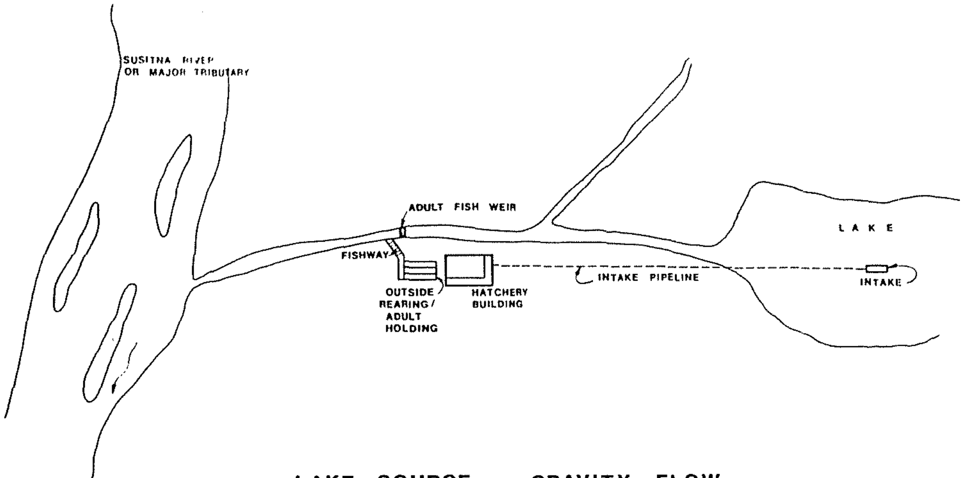
Well water usually offers many of the advantages of lake supplies, (low turbidity, minimal freezing problems) but does have the disadvantages of pumping costs and little opportunity to vary temperature. Before any site is selected that relies on groundwater for a supply, detailed testing is required to ensure the quantity and quality of the water.

Other Factors

There are several other physical factors that can determine the feasibility of a specific site. Most salient among these are probably soil conditions, and land ownership; but economic and social constraint can also be important. For example, there may be local opposition to a hatchery at a specific site or the land may have uses with higher local priorities. These items have not been investigated in detail in this evaluation but they should be considered for any recommended site(s).

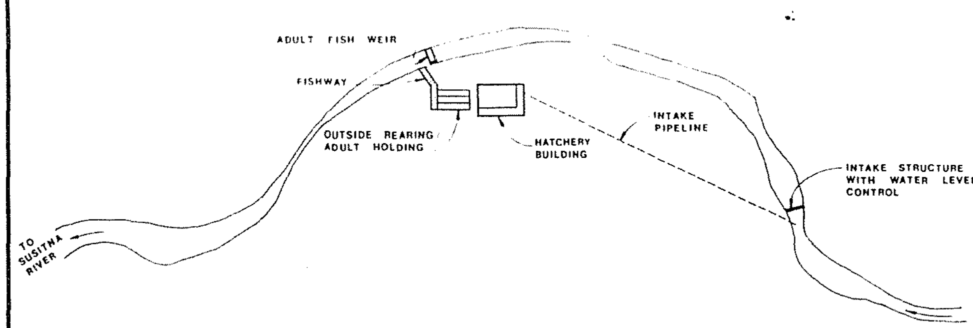
Poor soil conditions can add substantially to construction costs. Floodplain or muskeg areas may require large amounts of fill or other foundation improvements before construction. No subsurface investigations were performed in this study, but surficial observations were made at sites visited.

Land ownership may or may not cause problems with the sites evaluated. Most ownership in the area is state or private with some native corporation land and state or federal park land. Specific site ownership is stated.



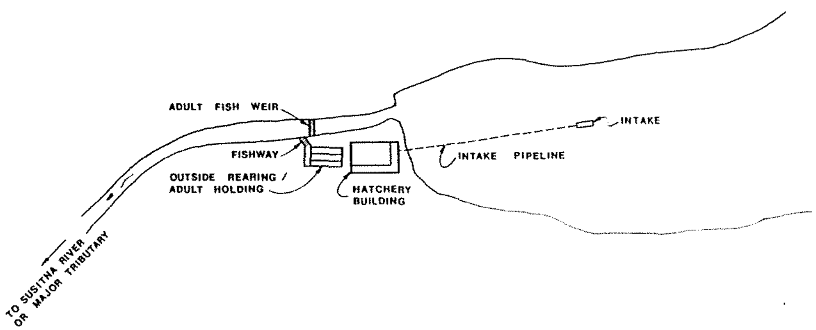
LAKE SOURCE - GRAVITY FLOW

(TYPICAL - LARSON LAKE)



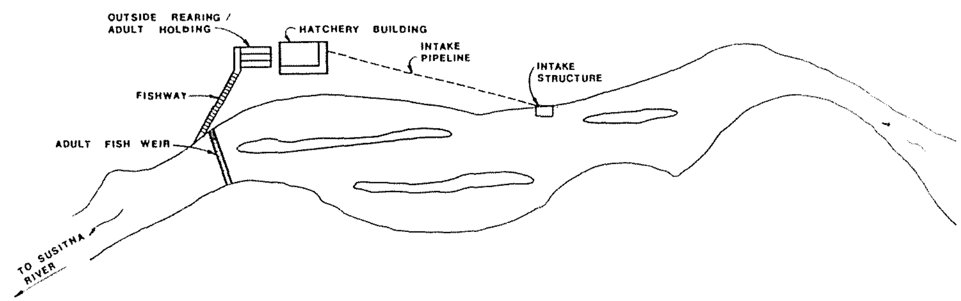
STREAM SOURCE - GRAVITY FLOW

(TYPICAL - WILLOW CREEK)



LAKE SOURCE - PUMPED FLOW

(TYPICAL - BYERS LAKE, FISH LAKE,
REDSHIRT LAKE)



STREAM SOURCE PUMPED FLOW

(TYPICAL - MONTANA CREEK, GOOSE CREEK)

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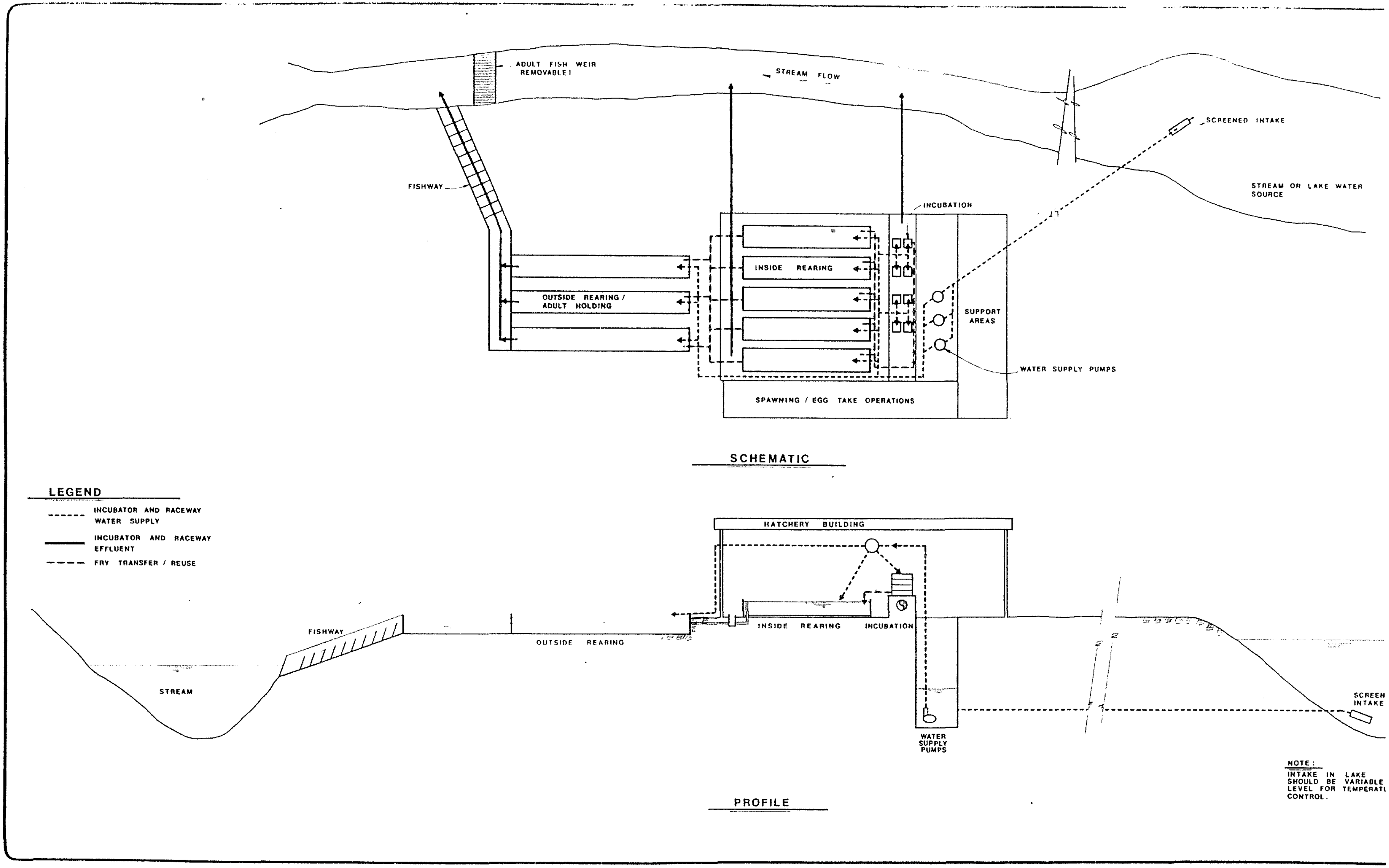

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SUSITNA HATCHERY SITING STUDY

TYPICAL HYDRAULIC SCHEMAIC & PROFILE (PUMPED WATER SUPPLY)

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SITE ANALYSES

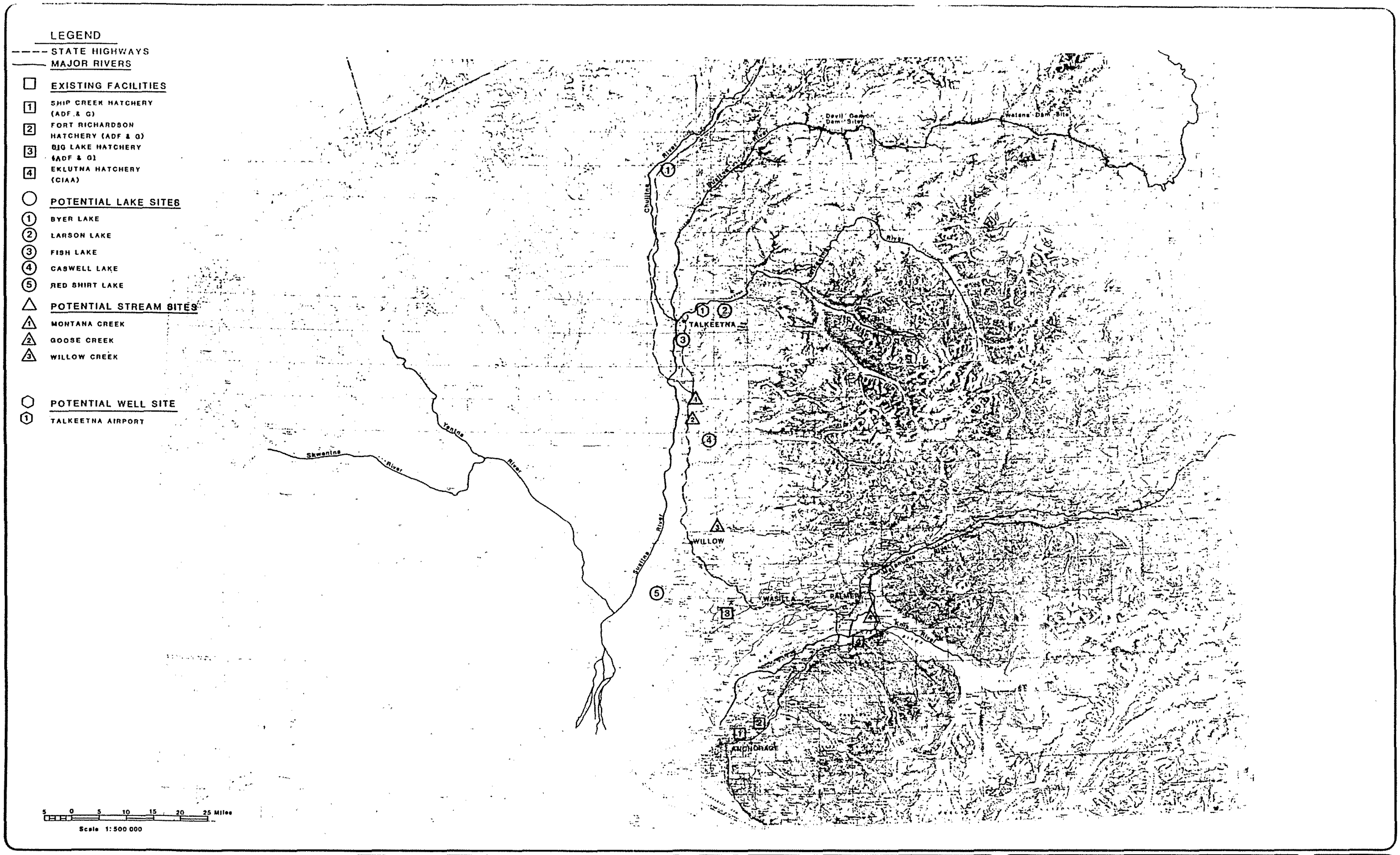
Overview

More than a dozen sites were inspected during this study within the Susitna Basin in adjacent area in upper Cook Inlet. The bases of site identification included previous hatchery siting efforts by ADF&G staff, existing hatcheries, and sample sites in areas currently accessible by road. Of the sites visited, nine generally met siting criteria. The locations of each of these is indicated in Figure 1.

It should be pointed out that these are not necessarily the optimal or best sites in the watershed. They are generally feasible sites that are typical of the different types of water supplies, remoteness conditions, etc., available within the basin. It is possible that comparable sites with similar characteristics are available, but these sites are the most prominent considered within the time frame of this study.

No sites were considered in the western half of the Susitna watershed or on river systems other than the Susitna. The former was due to remoteness considerations as most of the sites west of the river would require extensive road or power extensions or be planned on an entirely self-sufficient basis.

The potential of expanding an existing facility was also considered. No hatching or rearing stations presently exist on the Susitna itself or its tributaries. However, there are facilities within the upper Cook Inlet region which were considered.



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SUSITNA HATCHERY
SITING STUDY

SITE LOCATION MAP

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If sites outside of the Susitna watershed are considered that are several stream sites such as the Little Susitna River and Bodenburg Creek that ADF&G have already investigated as potential sites. In addition, there is a 20 million egg chum hatchery now under construction at Eklutna. This is a private non-profit hatchery owned by the Cook Inlet Aquaculture Association. If a site outside the watershed is considered for a compensatory facility, expansion of the Eklutna hatchery would be a possibility.

Most of the sites can be considered remote in terms of immediate access to community services, utilities, schools, etc. Some have no road access. For security, provisions will have to be made at the facility for staff housing, and in sites where no road access is available, additional storage will have to be provided.

The sites can be divided into three broad categories by water source: lake, stream/spring, and well. Dependent upon site conditions, general facility concepts can be defined for each site type. Following is a brief description of the sites reviewed. All maps are at a scale of 1 inch = 1 mile, and site locations are schematic only.

LAKE WATER SOURCE

Five potential lake shore sites were identified: Byers Lake, Larson Lake, Fish Lake, Lake Caswell, and Redshirt Lake. Of these, only Larson Lake affords the possibility of a gravity water supply system. The others would require pumping.

STREAM/SPRING WATER SOURCE

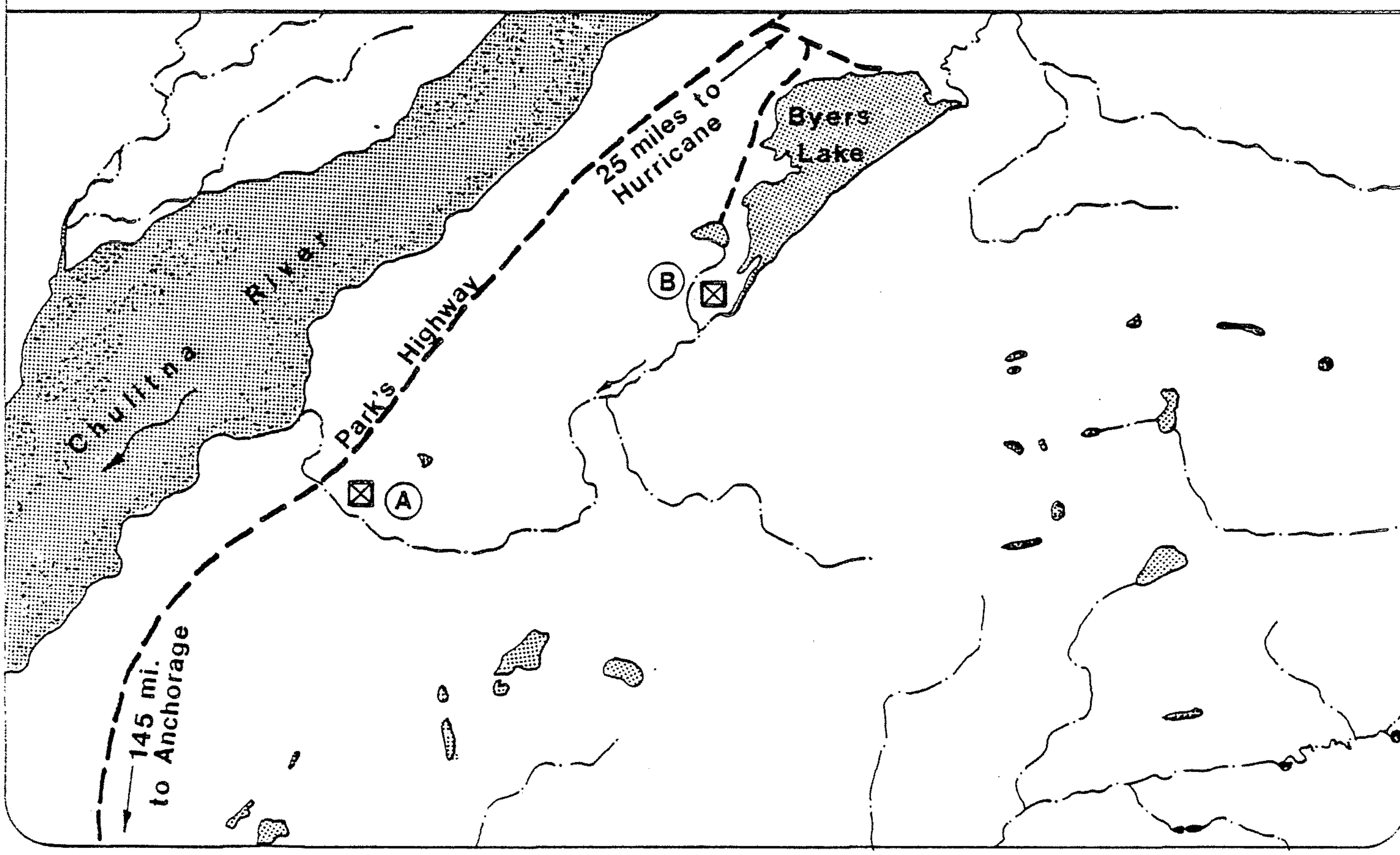
Three sites were identified with the potential for developing a water source from either a creek, stream, or spring. Only those sites which afforded reasonable safety from flooding and iceflow conditions were considered practical. Water supply intake locations in both confined channels and braided stream beds were considered. The sites are Montana Creek, Goose Creek, and Willow Creek.

WELL WATER SOURCE

One site was identified with the potential of groundwater development. This site, within the community of Talkeetna, was selected primarily for its proximity to transportation networks and utilities. Because of its remoteness from the Susitna and its tributaries, a release, recapture location would have to be established for the salmon produced at the facility.

FACILITY EXPANSION

There are four salmon hatcheries in the Susitna vicinity. Three State facilities are at Big Lake, Ship Creek, and Fort Richardson. A private, nonprofit chum hatchery is under construction at Eklutna. The Big Lake Station is presently near capacity in terms of both water and rearing volume and has a history of disease problems. The Eklutna facility affords considerable opportunities for expansion. Non of these sites would result in any salmon directly into the Susitna River.



SITE ① - BYER'S LAKE

Kramer, Chin & Mayo, Inc.
Consulting Engineers · Architects · Applied Scientists
[illegible] West [illegible] Street, Juneau, Alaska 99801
Phone (907) [illegible]

SITES

Byers Lake

Byers Lake is a 325-acre lake within the boundaries of Denali State Park. The 40-square-mile drainage area of the lake is forested with a few recreational cabins located on privately owned land. The lake outlet is Byers Creek which flow approximately five miles to the Chulitna River. The Chulitna River joins the Susitna in the vicinity of the community of Talkeetna.

Byers Lake has been the focus of several hatchery siting investigations by ADF&G, primarily for sockeye enhancement. Detailed stock assessments of sockeye are currently being conducted. Past salmon population surveys have recorded the presence of pink, chum, sockeye, coho and Chinook salmon in the area as well as resident populations of trout, sucker, whitefish, and burbot. There is insufficient information on the availability of chum in numbers required for brood stock for a hatchery project.

The average lake depth is approximately 70 feet. Ice forms during winter months. Historical limnological information collected by ADF&G suggest the lake is well mixed during most of the year. Temperatures range from 0 degrees C at the surface and 3 degrees C mid-depth to bottom during winter months. Late spring and summer temperatures average 6 degrees C. Temperatures as high as 17 degrees C have been recorded at the surface during summer months. Byers Creek temperatures appear to be closely correlated with air temperatures. It has been observed to have ice cover as early as November.

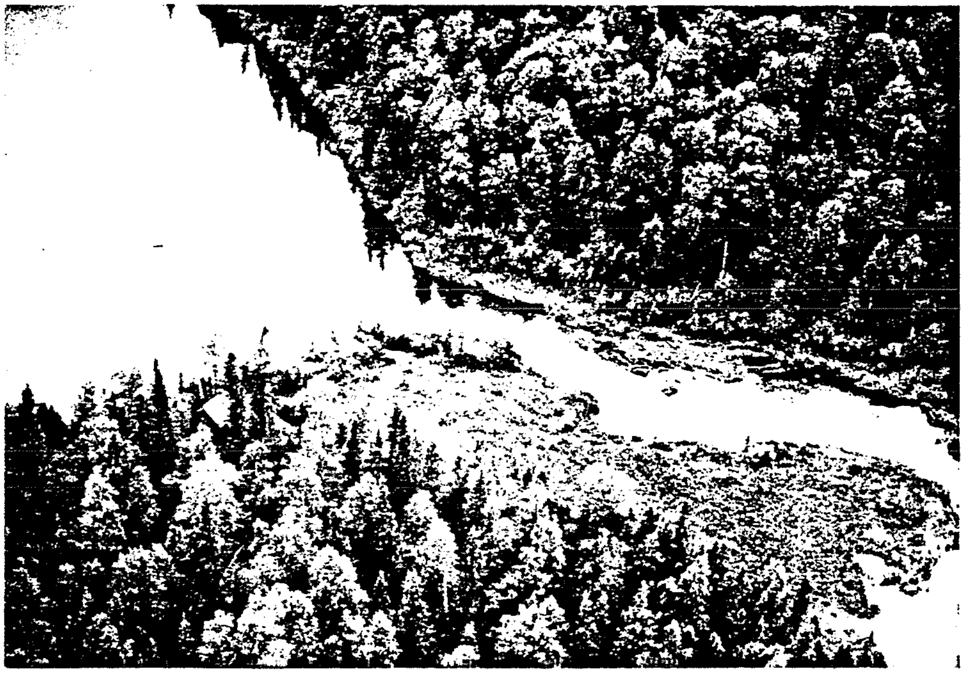
The discharge from Byers Lake has been measured at 4.5 cfs in early spring to 250 cfs in June. The pH is approximately 7.5 with Secchi disk readings ranging from 3 to 11 meters.

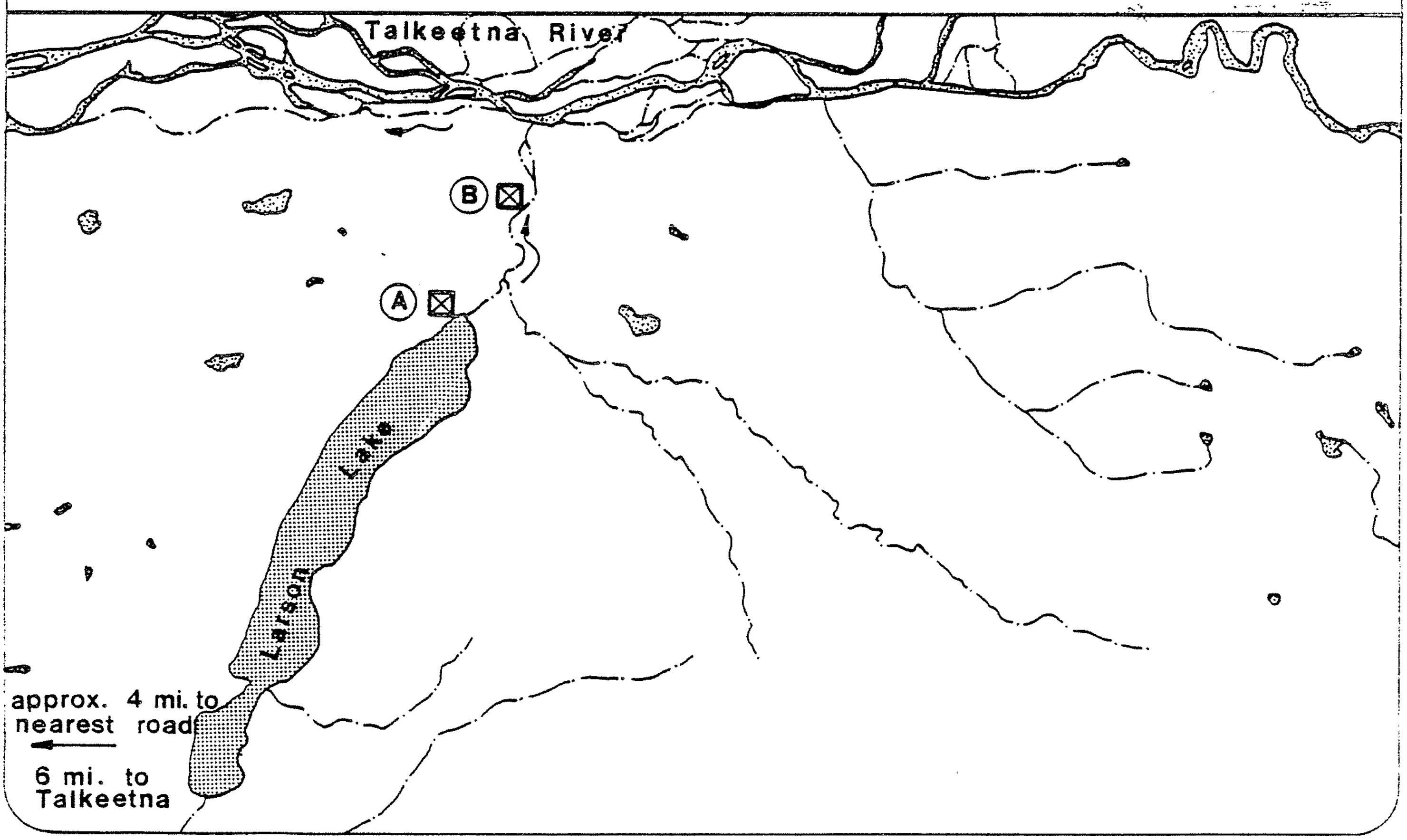
Early studies by ADF&G failed to detect any significant presence of pathogenic organisms of concern to fish culturists. In general, they found water quality satisfactory for a hatching and rearing operation.

There are several sites on the lake shore and Byers Creek which are suitable for hatchery construction. Site "A", as shown on the preceeding map is located close to the Park's Highway. ADF&G has considered this as a potential hatchery site in the past. Water development at this site would either have to be a well, pumped, or gravity flow from the creek. There is no groundwater data on which to evaluate well cost or water quality. During winter months, low water temperatures in Byers Creek and ice formation may make operation of a creek supply troublesome. A supply to this site from the lake would permit gravity operation, but a pipeline of approximately four miles would be required.

Near the lake outlet, area "B", there are several locations which would permit construction. Road access is close by. An intake could be placed at a depth in the lake which would provide a suitable temperature regime. There is a potential for utilizing pens for rearing in place of raceways.

The most significant negative aspects of sites in this area include the lack of power and the potential for the establishment of major sockeye populations in the lake at a future date. The nearest power is 26 miles away at Hurricane.





SITE ② - LARSON LAKE

Kramer, Chin & Mayo, Inc.
Consulting Engineers, Architects, Applied Scientists

Larson Lake

Larson Lake is located seven miles east of Talkeetna in the Talkeetna watershed. The area is presently remote affording no road or boat access. However, their plans for a residential development in the area which could make available both access and power in the future. The land sales for this development will transfer some of the land in the Larson Lake vicinity to private ownership.

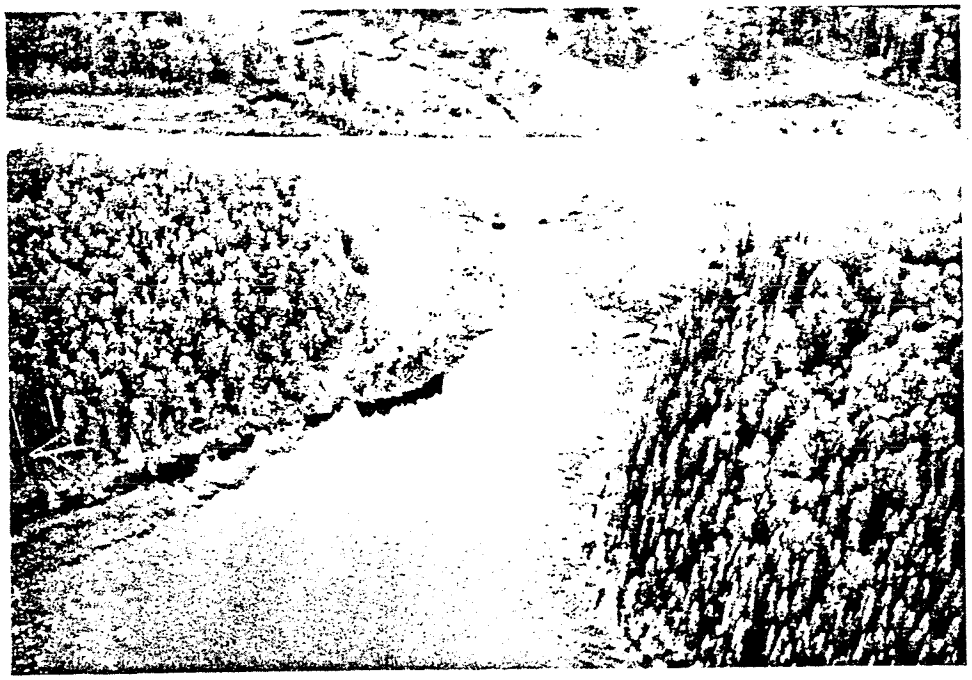
The Lake is approximately 450 acres with a maximum depth of 148 feet. The watershed is forested. The Lake drains via a creek which flows about 1.5 miles into the Talkeetna River. A discharge a 15 cfs was estimated. The creek is utilized by sockeye, pink, coho and chum salmon. Sockeye spawning along the Lake shoreline was observed during the study. There are few suitable areas for spawning in the system, thus limiting the production potential of the lake and creek for wild salmon. There are resident populations of trout and other species.

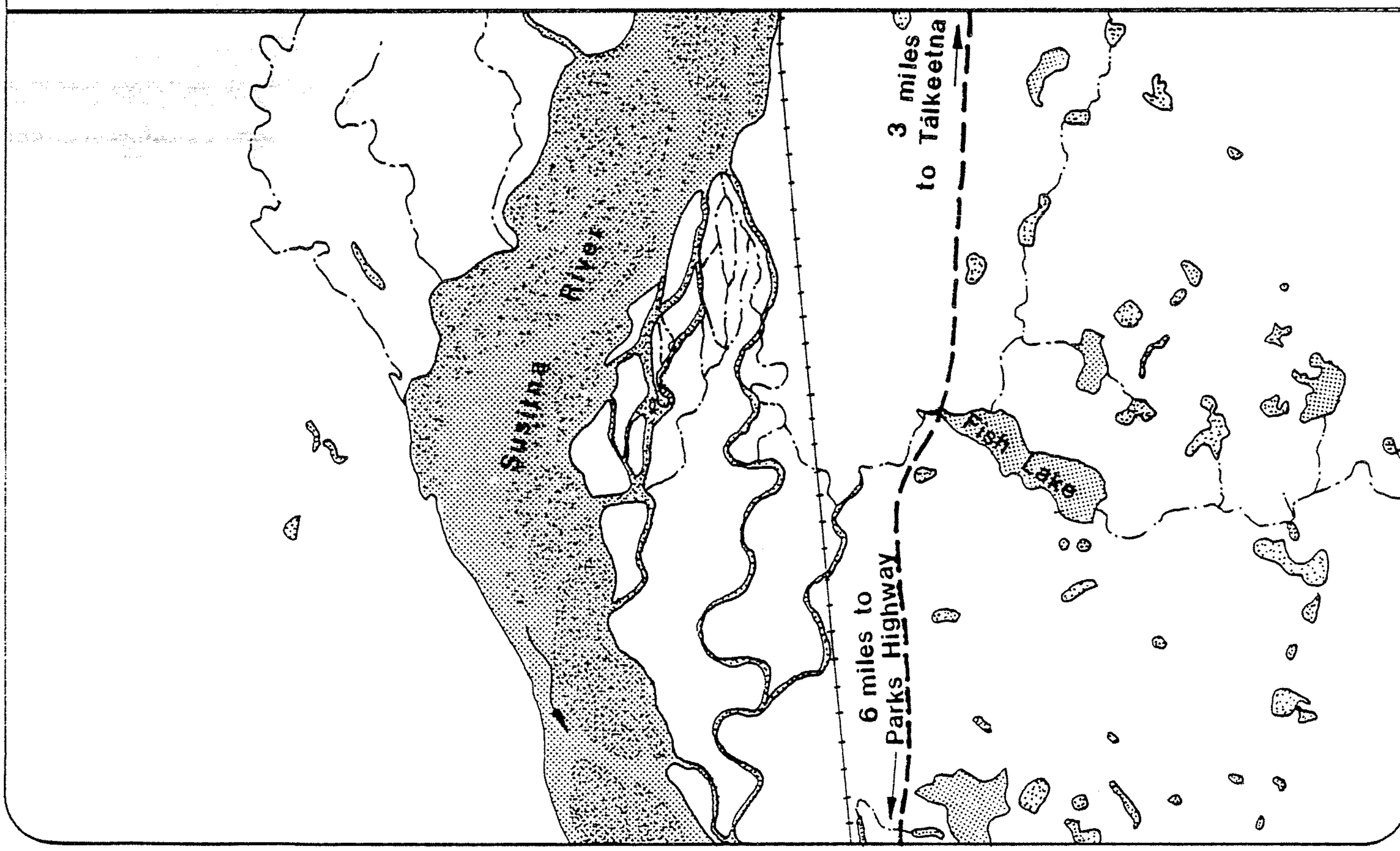
Like Byers Lake, ADF&G is interested in enhancing the sockeye population through a hatchery program. They have conducted some water quality investigations and have found conditions "favorable." Water temperatures during early September range between 15 degrees C at surface to 4.5 degrees C at 50 feet. The pH averages 7.

Two potential hatchery sites have been identified. The area "A" is adjacent to the lake near the outlet. It would require a submerged intake in the lake and a pumped supply. Alternatively, there may be a possibility to develop a groundwater supply. Both of these alternatives would require power which would have to be generated onsite, given current conditions, or a power line would have to be extended from Talkeetna. Power is approximately six miles away. Road access to the south end of the lake is approximately four miles away.

Site "B" is located along the lake discharge creek. A site in this vicinity would offer the potential of a gravity water supply if a pipeline is extended from the lake to the site. Such a supply concept could provide more temperate water to the station than would be available from the creek itself. The amount of discharge in the creek and water temperatures during the winter months are unknown.

The Talkeetna River has a chum population which could be used in developing a brood stock for the hatchery.





SITE 3 - FISH LAKE

Kramer, Chin & Mayo, Inc.
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124 West Fifth Street, Juneau, Alaska 99801
Phone (907) 586-6400

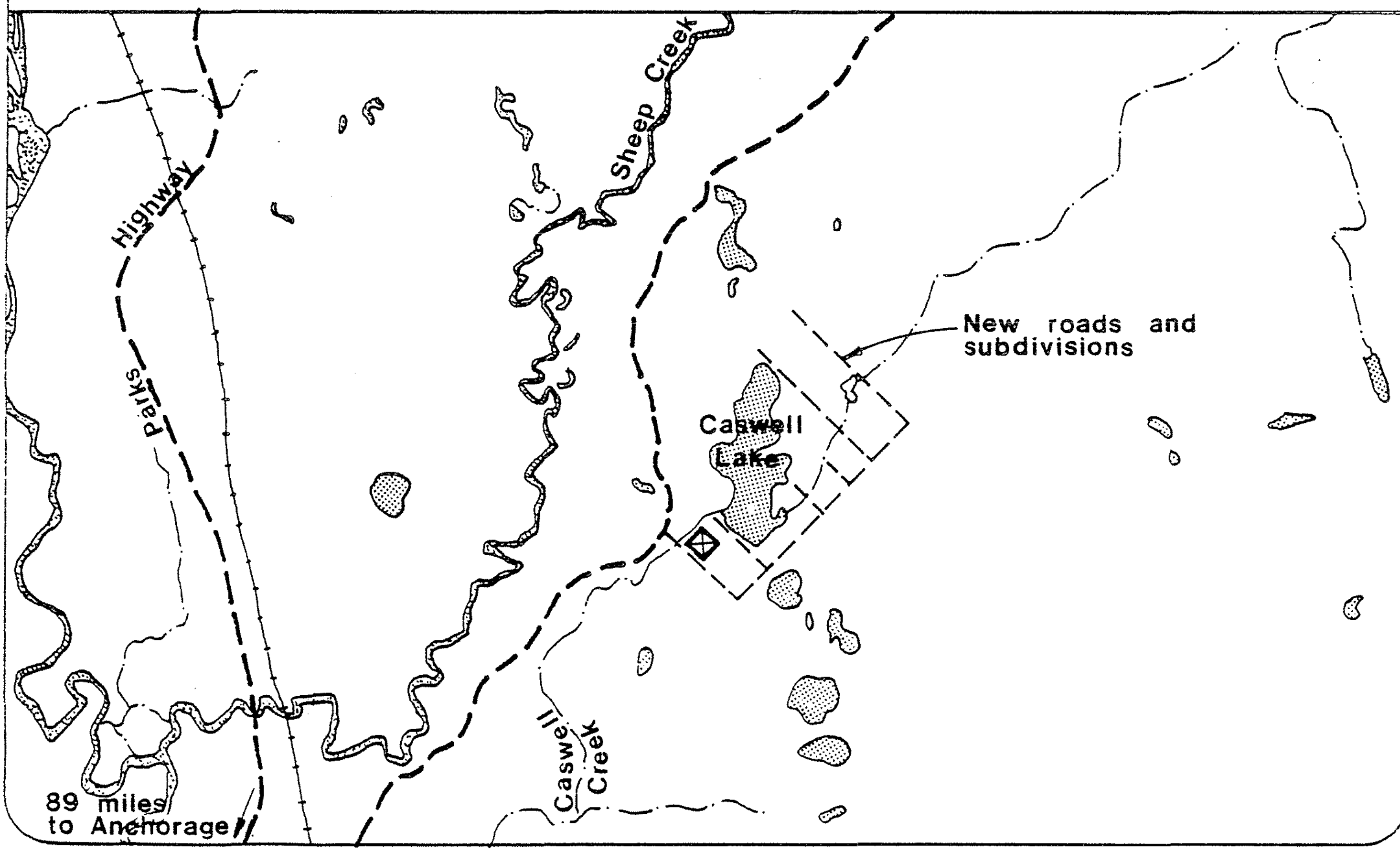
Fish Lake

Fish Lake is approximately two miles from the Susitna River in the vicinity of Talkeetna. It is approximately 154 acres, averaging 35 feet in depth. Discharge from the lake was estimated at 10 cfs in early fall. The lake is bordered by both State- and privately owned property. The Parks Highway passes across the lake outlet and power is available. Access roads are located around the lake for the residential developments.

Use of the Lake and its discharge and supply streams by coho, sockeye, and pink salmon has been documented by ADF&G.

Water quality measurements taken by ADF&G suggest the lake is poorly buffered. The significant water quality parameters appear to be within the criteria established for hatcheries. However, more detailed measurements would have to be taken throughout the year to confirm this generalization given the development which has occurred along the lake shore and its watershed.

The best location for a hatchery would be near the lake outlet. However, security fencing would be a necessity given the facility's accessibility. A submerged intake in the lake would be required to provide a pumped water supply. Water temperature information during the winter months is not available.



SITE ④ - CASWELL LAKE

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Caswell Lake

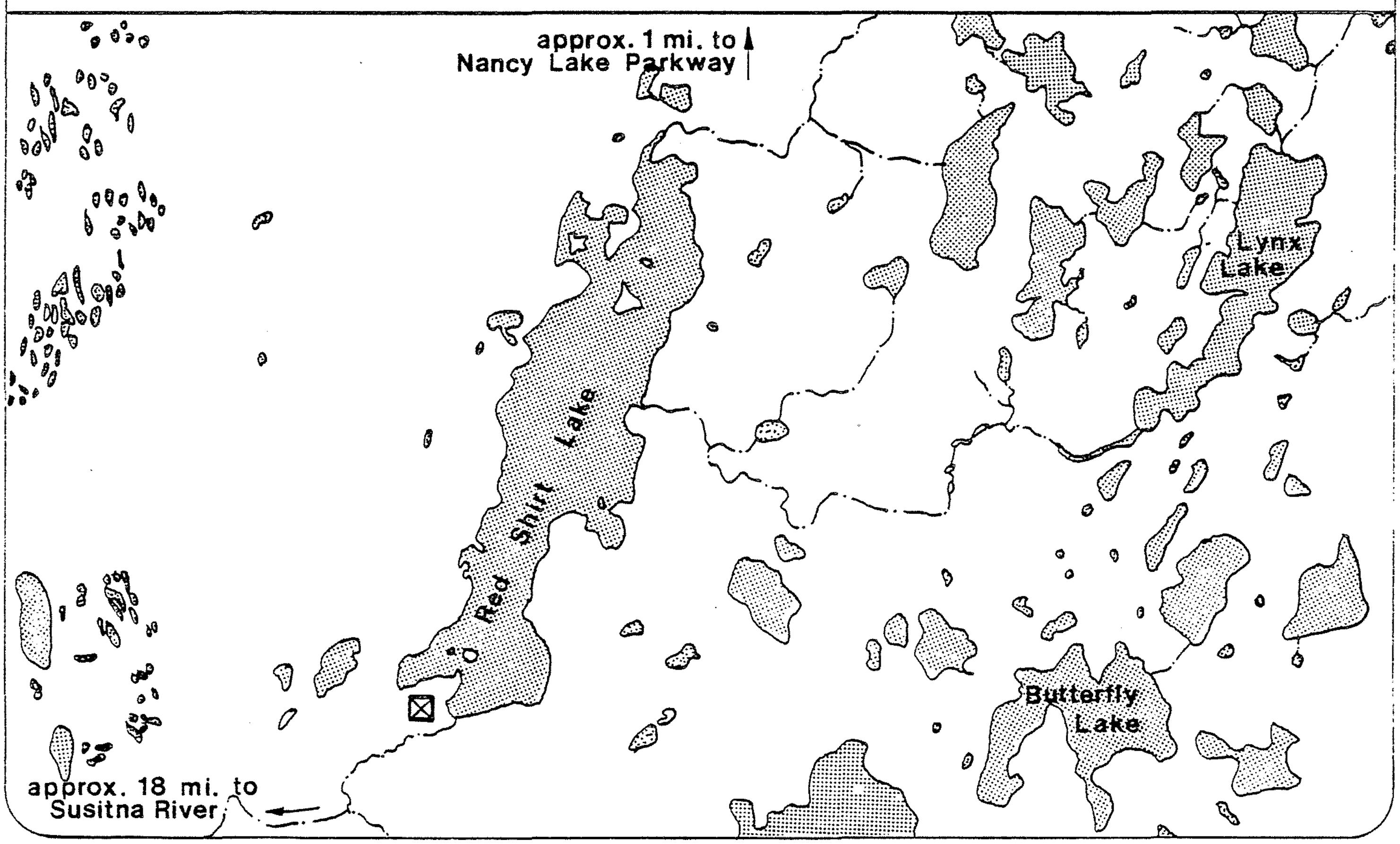
Caswell Lake is located just off the Parks Highway, approximately 90 miles north of Anchorage. There are several smaller lakes in the vicinity. The 154-acre Caswell Lake drains via Caswell Creek into the Susitna River. The area has been subdivided and considerable development has occurred within the lake's watershed. Access is readily available around most of the lakeshore.

Discharge from the lake has been recorded to range between 40 and 140 cfs. One hundred cfs appears to be a representative average annual discharge. Because of the development which has occurred in the lake vicinity, early reports by ADF&G of satisfactory water quality conditions must be verified.

The system reportedly supports sockeye and coho salmon. Resident freshwater species are also present. Observations during this study indicate that there is a possibility that blockage of the Caswell Creek may occur periodically due to debris and beaver dams. Caswell Creek is essentially a meadow creek which meanders for approximately eight miles through muskeg. Blockages occurring during migration periods could jeopardize the success of a hatchery facility.

The site which appears most desirable is located along the creek, approximately 1/4 mile downstream from the lake. An access road crosses the creek at this point. Water could be withdrawn directly from the creek or from the lake.

Although there is a gaging station on the creek, temperature data are unavailable for the winter months. Temperatures and flow conditions during the winter months must be reviewed prior to recommending this site.



SITE ⑤ - RED SHIRT LAKE

Kramer, Chin & Mayo, Inc.

Red Shirt Lake

Red Shirt Lake is a large, shallow lake within the Nancy Lake State Recreation Area. This lake is supplied by a series of smaller lakes and ponds within the system. The lake is 20 feet in average depth and is approximately 1,200 acres in surface area. The outlet, Fish Creek, enters the Susitna at approximately river mile 12. It is a meandering stream with many beaver dams. The creek channel appears well defined. Fish Creek is approximately 12 miles in length.

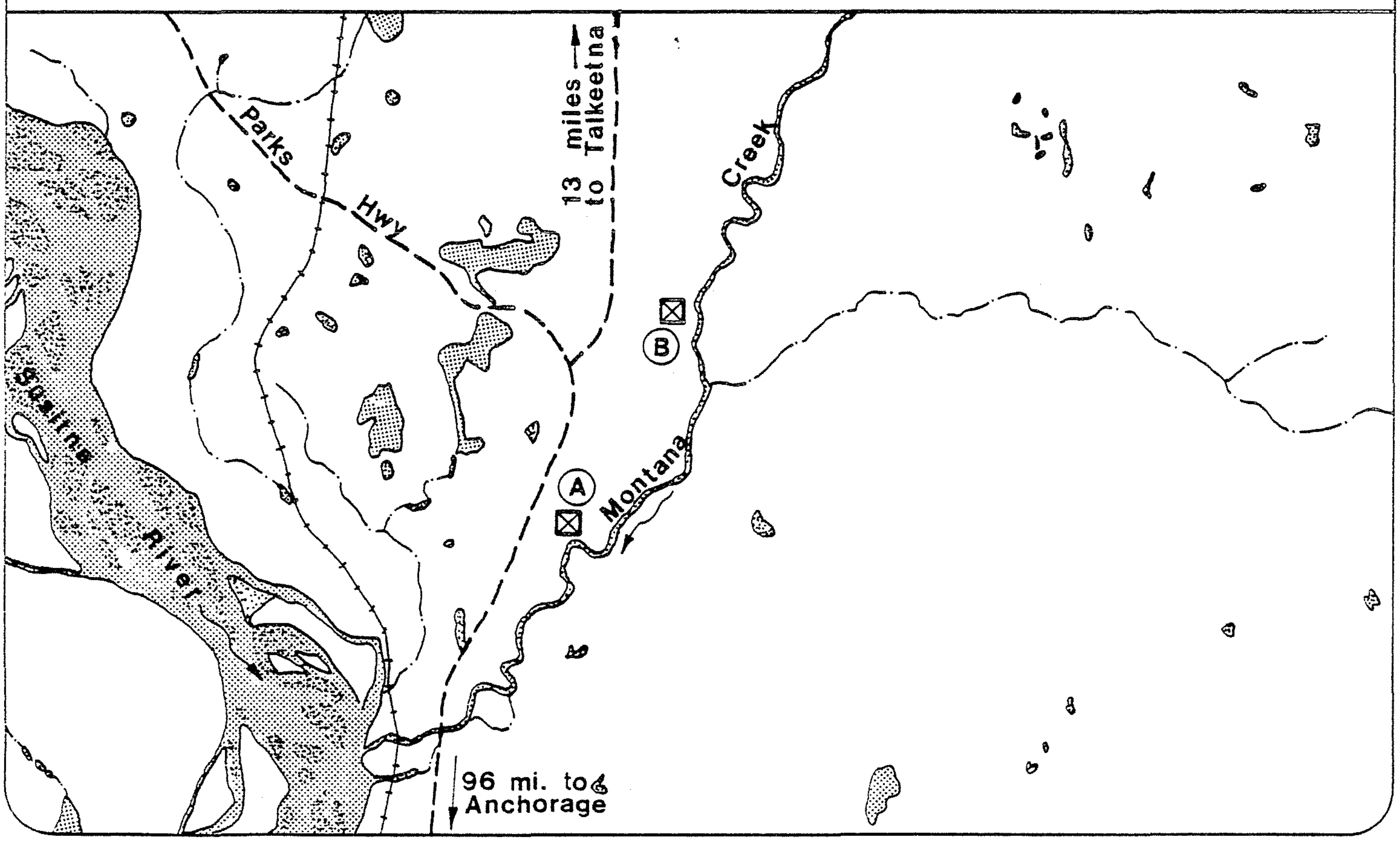
Road access is available to within 1-1/4 miles of the upper end of the lake. Several cabins are located along the lake shore. No power is available.

The lake and stream presently support sockeye, coho and Chinook salmon. There are also resident trout populations. Evidence of beaver activity within Fish Creek may have a negative impact on salmon usage of the system.

Water temperature in September ranged from 24 degrees C at surface to 10 degrees C at 30 feet. No information on winter conditions is available. The discharge during September was estimated at 20 cfs.

The State Hatchery at Big Lake is within 10 air miles of the Red Shirt Lake site. Winter temperature conditions can be predicted to be similar. No investigation of pathogens within the system has been reported.

A site near the lake discharge would provide the best opportunity for a hatchery operation. Caswell Lake water could be extracted from a wet well or from the creek directly. A submerged intake in the lake is also a possibility.



SITE 1 - MONTANA CREEK

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Montana Creek

Montana Creek is a tributary to the Susitna River, entering approximately 15 miles south of Talkeetna. "Creek" is somewhat of a misnomer as the mean discharge as recorded by the gaging station is over 1,200 cfs. However, the discharge varies greatly during the year. The watershed of Montana Creek drains the 160-square-mile area southeast of Larson Lake.

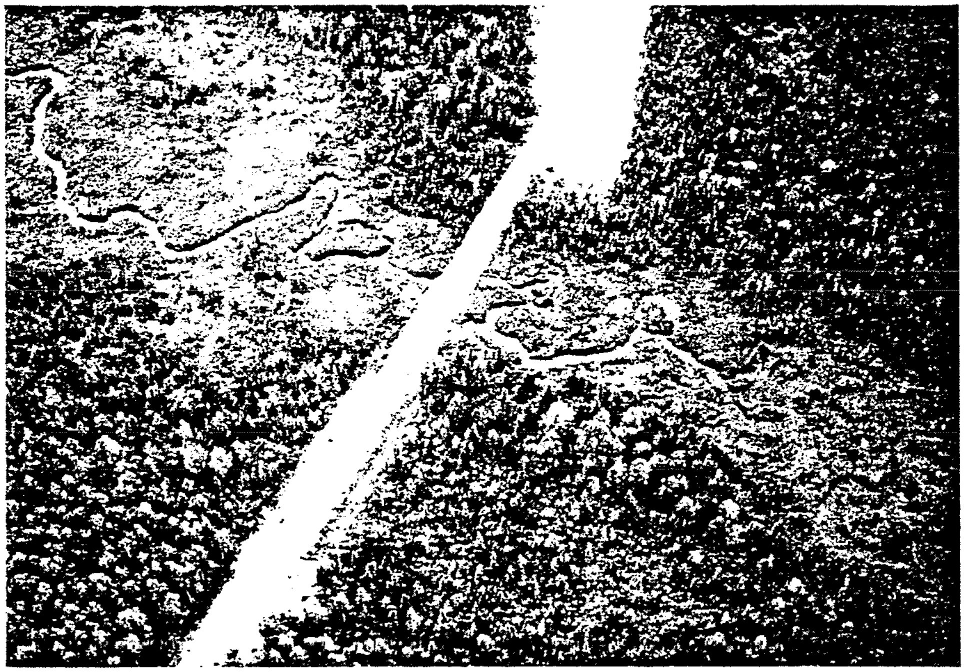
Montana Creek forks into three tributaries eight miles above its confluence with the Susitna. Little development has occurred above the forking. Road access is available at several location in the lower portion of the creek. Some State-owned land is available in this vicinity. Much of the upper portion of the creek is in private or borough ownership.

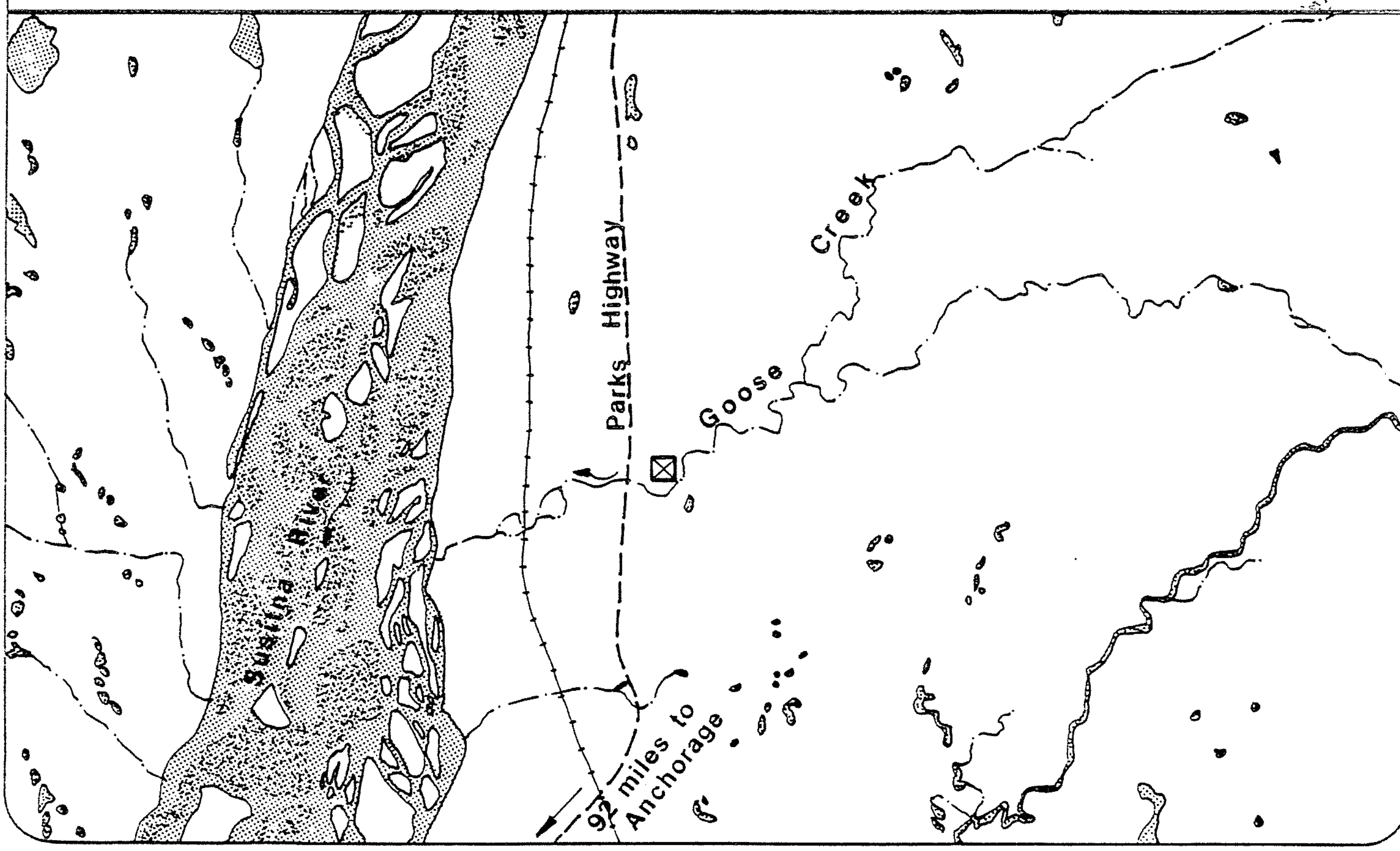
The clear waters of the creek support chum salmon as well as pink, coho, and Chinook. Trout and grayling are also present. There is insufficient information on chum populations to verify a sufficient brood stock for a hatchery.

Sites "A" and "B" on the preceding page are typical of potential locations within the lower reaches of the creek. Both have road access.

Detailed winter temperatures and information on icing and flooding is not available. However, observations during this study indicate that any construction within the floodplain, including a water intake structure, would be in jeopardy during winter months and operational problems could be incurred.

Water quality investigations by ADF&G during autumn months indicated the creek is generally satisfactory for a hatchery operation. Similar measurements would have to be taken after ice breakup to confirm conditions, particularly in regard to turbidity and solids.





SITE 2 - GOOSE CREEK

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Consulting Engineers, Architects, Applied Scientists
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Phone (907) 586-6400

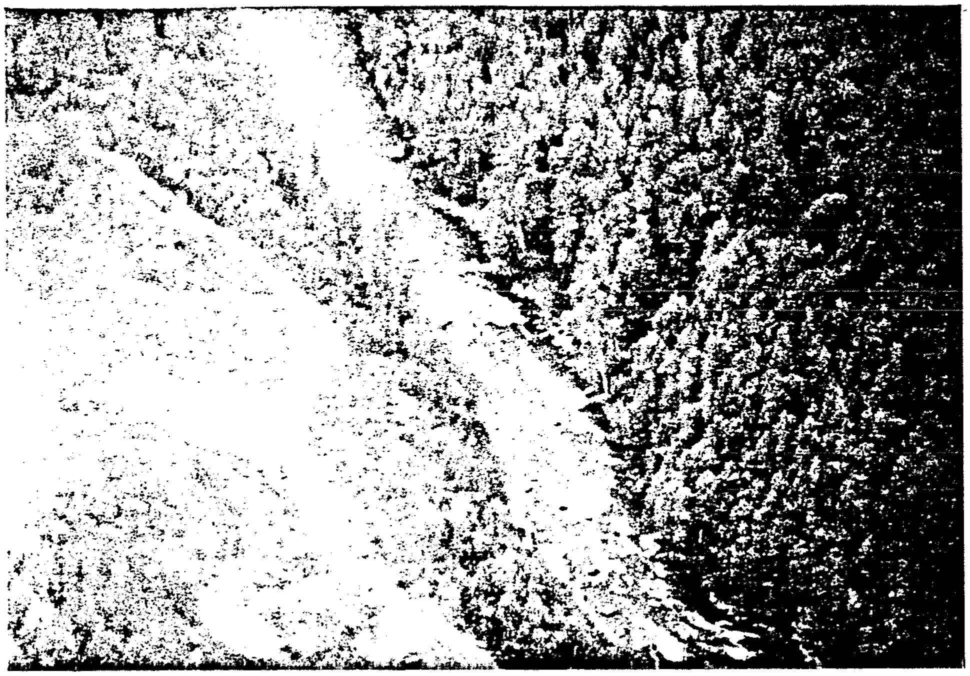
Goose Creek

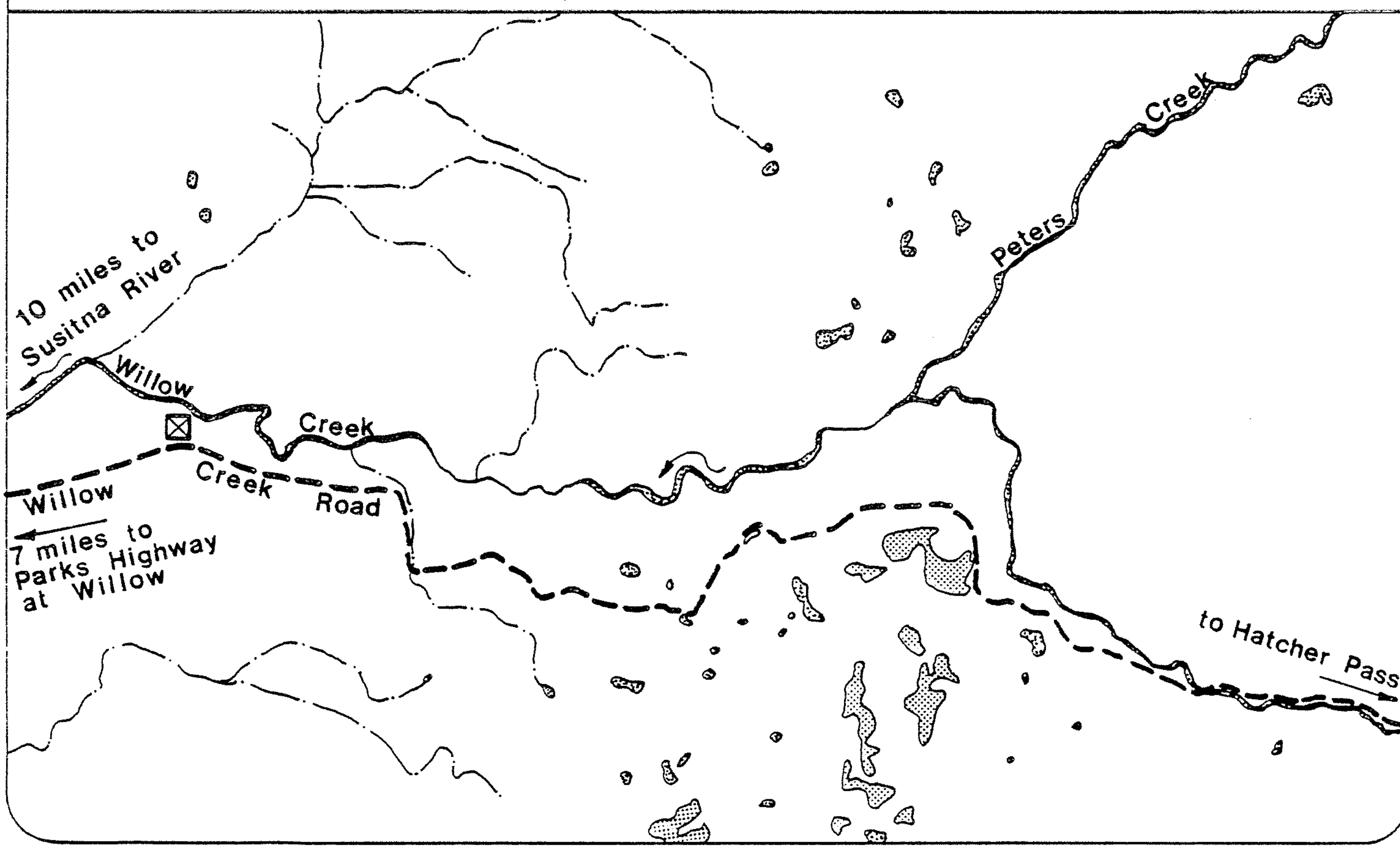
Goose Creek basically parallels Montana Creek, entering the Susitna approximately four miles below the discharge of Montana Creek. Similarly, its headwaters are located in the Talkeetna Mountains but the drainage area of Goose Creek is only 15 square miles. A major portion of the present flow in the creek is from Sheep Creek, to the south, which was rechanneled during flooding in 1971. No discharge information after this rechannelization has been recorded.

Power and access conditions to the creek are generally similar to the Montana Creek situation, previously described. Flooding threats are very evident making any development within reasonable distance to the creek extremely vulnerable.

Salmon presently utilize the system. Chum are present as are populations of Chinook, pink, and coho.

A potential hatchery site was identified by the study team as shown on the preceeding map. Its selection was based primarily upon proximity to road and power. Building evaluations would have to be carefully determined to avoid flooding.





SITE 3 - WILLOW CREEK

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Consulting Engineers, Architects, Applied Scientists
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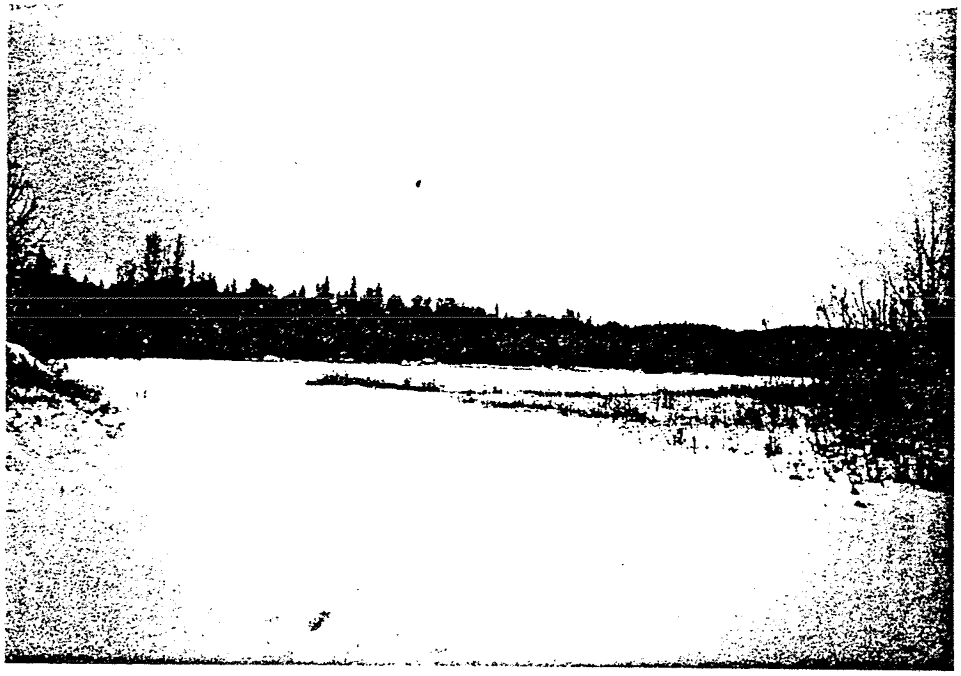
Phone (907) 586-6400

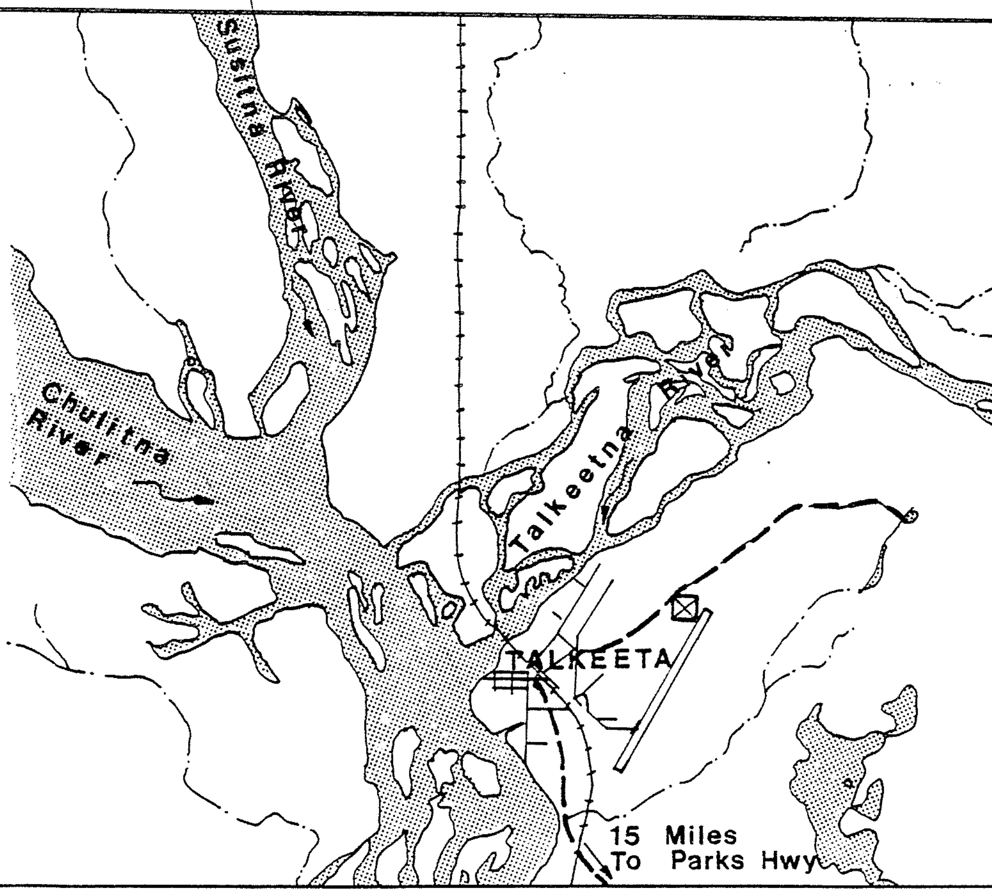
Willow Creek

A few miles north of the community of Willow, Willow Creek, and its tributary, Peters Creek, flow towards the Susitna River. The creek passes over varied terrain over much of its 40-mile length. One steep, narrow canyon exists near Willow. Immediately downstream of the canyon, there is a potential hatchery site. It is shown on the vicinity map. This site affords both road access and a potential for a gravity water supply. Below this point, the floodplain is quite large and annual channel changes are evident.

Significant chum populations have been recorded in the system, suggesting a sufficient brood source. Pink, Chinook, and coho are also present in significant numbers.

If the state capitol is relocated to Willow, alterations to the watershed may affect a hatchery located along Willow Creek. The major potential impact would be the use of Willow Creek as a water supply for the community. Sewage discharge is als a possibility. A major community development would also make security a necessity. However, a highly visible project near the legislative center may have other benefits.





SITE 1 - TALKEETNA AIRPORT

Kramer, Chin & Mayo, Inc.
Consulting Engineers, Architects, Applied Scientists
124 West Fifth Street, Juneau, Alaska 99801
Phone (907) 586-6400

Talkeetna Airport

Presently, ADF&G, F.R.E.D. Division, is evaluating the enhancement potential of the upper Susitna River should the hydroelectric projects not proceed. As one alternative, an incubation facility downstream of Devil's Canyon, with remote fry plants upstream, is under consideration. A site near the Talkeetna Airport has been identified because of its proximity to air, rail, and road transportation systems.

Road and power are accessible although power extension would be required. The Talkeetna River is approximately 1/2 mile away, but the channel is braided and it appears that a surface intake could be a difficult installation. ADF&G is considering well water as a source. Further studies would be required to verify the adequacy of groundwater supplies; disposal alternatives have not been investigated. Groundwater disposal may be feasible for an incubation facility but a compensatory hatchery would require a discharge to the Talkeetna River suitable for attracting and collecting returning adult fish.

COST ESTIMATES/SCHEDULE

Physical Facility

There are several components that are common to a compensatory facility located at any of the sites described. These include:

- Hatchery Building Incubation area (1,000 square feet)
  Rearing area (3,600 square feet)
  Support area (2,400 square feet)
- Inside Process (Mechanical)
- Outside Raceway Piping
- Fish Diversion Weir in Stream
- Fishway

In addition to the above components, there are additional items that may or may not be required at some sites or will vary in size with the site selected. These include:

- Sitework
- Intake Structure Lake Stream
- Pump Station or Gravity Supply
- Access Road Length
- Power Extension or Onsite Generation

Cost Estimates

Table 3 summarizes preliminary cost estimates for components common to all sites considered. It should be pointed out that these are 1982 construction cost estimates without contingencies, administration, design, or other project overhead costs included.

Table 4 illustrates the total costs associated with construction at each site. It should be emphasized that all cost estimates are preliminary in nature and, as such, are only considered accurate within approximately +30%. Consequently, these estimates should not be used as a basis for comparison of individual sites, but rather to determine the magnitude of the project as described herein. Clearly, some sites are more favorable than others and should be investigated in more detail.

Another item that Table YY illustrates is the costs associated with remoteness relative to road and power access. Obviously, the costs of developing sites such as Larson Lake and Red Shirt Lake could be reduced substantially if they were now roaded or the costs of access roads were shared with other development in the area. Where the cost of power extensions appeared excessive, onsite generation was used. As pointed out earlier, both roaded development and onsite power generation would increase the operational costs of the project.

Development Schedule

Figure 2 illustrates an estimated time frame for the development of the project. This is a best estimate at this time, based on past experience of hatchery projects. There are several unknowns which could either delay or expedite the project, primarily the permit and public involvement process.

If a site is selected with little local opposition and consistent with permitting agency plans, it is possible that some elements of the work could be shortened. However, this would be the exception rather than the rule for hatchery projects in Alaska.

Table 3

Estimates of Probable Construction Costs,
Components Common to Most Sites

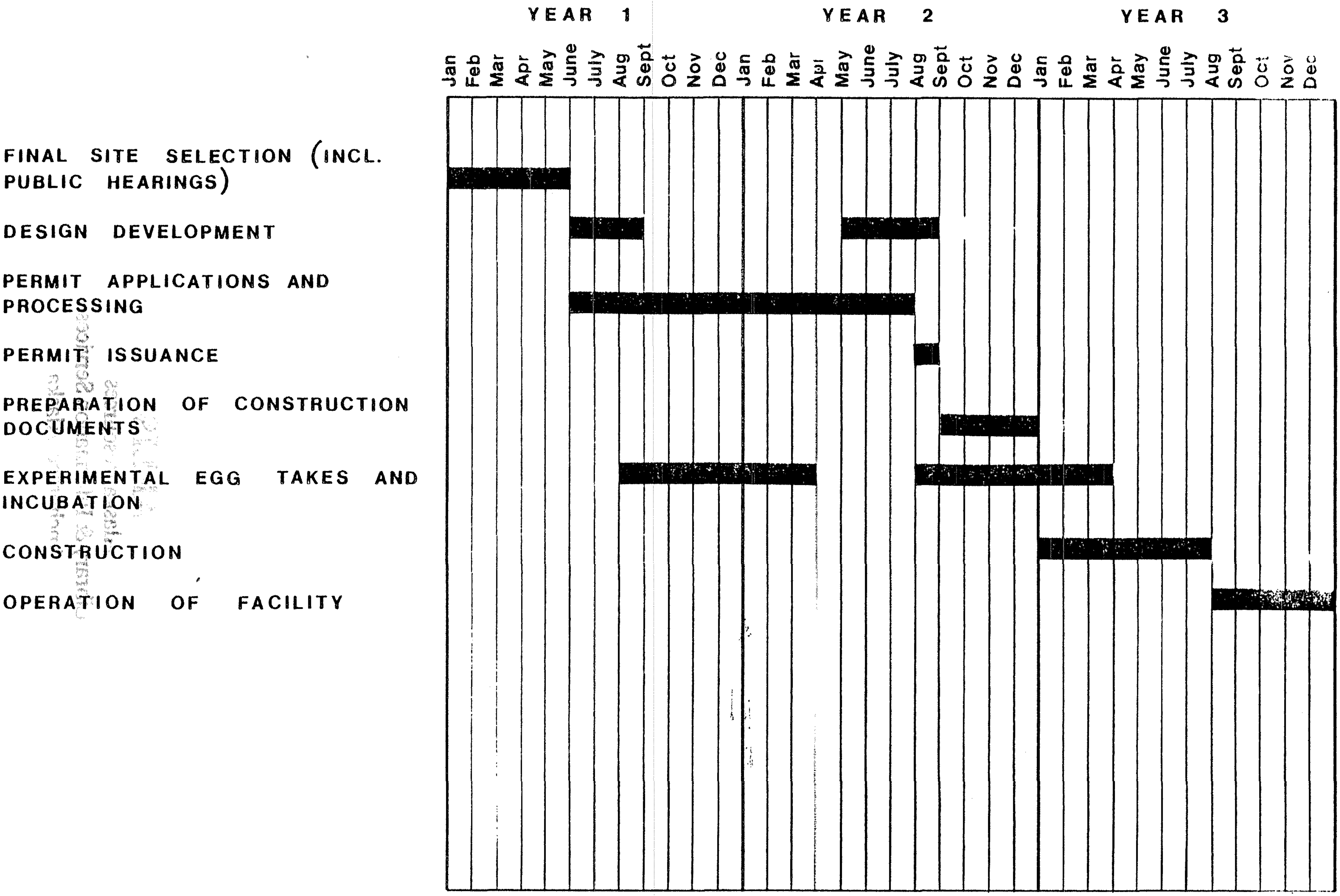
COMPONENT	QUANTITY	UNIT COST	TOTAL COST	SUBTOTAL
Hatchery Building				
Incubation	1,000 SF	$ 75.00	$ 75,000	
Rearing	3,600 SF	75.00	270,000	
Support	2,400 SF	75.00	180,000	
				$525,000
Inside Process				
Incubators	8 ea.	3,000.00	24,000	
Raceways	5 ea.	8,000.00	40,000	
Piping	Lump Sum	36,000.00	36,000	
				$100,000
Outside Rearing				
Piping	Lump Sum	20,000.00	20,000	
Raceways	3 ea.	20,000.00	60,000	
				$ 80,000
Fish Weir	Lump Sum	50,000.00	50,000	
				$ 50,000
Fishway	Lump Sum	35,000.00	35,000	
				$ 35,000
TOTAL				$790,000

Table 4

Summary of Construction Costs

COMPONENT	BYERS LAKE-A	BYERS LAKE-B	LARSON LAKE-A	LARSON LAKE-B	FISH LAKE	CASWELL LAKE	REDSHIRT LAKE	MONTANA CREEK	GOOSE CREEK	WILLOW CREEK	TALKEETNA AIRPORT
COMMON FACILITIES											
COST ($)	790000	790000	790000	790000	790000	790000	790000	790000	790000	790000	790000
SITEWORK											
COST ($)	25000	75000	75000	75000	25000	25000	75000	25000	25000	25000	25000
REMARKS	FLAT	MARSHY	MARSHY	STEEP	FLAT	FLAT	MARSHY	FLAT	FLAT	FLAT	FLAT
INTAKE STRUCTURE											
COST ($)	175000	175000	175000	175000	175000	175000	175000	350000	300000	175000	100000
TYPE	CREEK	LAKE	LAKE	LAKE	LAKE	LAKE	LAKE	RIVER	RIVER	CREEK	WELLS
INTAKE PIPELINE											
COST ($)	200000	40000	80000	400000	40000	160000	120000	80000	40000	320000	200000
LENGTH (FEET)	2500	500	1000	5000	500	2000	1500	1000	500	4000	2500
PUMP STATION											
COST ($)	GRAVITY	110000	110000	GRAVITY	110000	110000	110000	110000	110000	GRAVITY	50000
ACCESS ROAD											
COST ($)	25000	150000	1050000	1050000	25000	5000	1550000	100000	75000	75000	25000
LENGTH (FEET)	500	3000	21000	21000	500	100	31000	2000	1500	1500	500
POWER EXTENSION											
COST ($)	150000	150000	150000	150000	12500	325000	150000	50000	37500	37500	62500
LENGTH (FEET)	ON-SITE	ON-SITE	ON-SITE	ON-SITE	500	13000	ON-SITE	2000	1500	1500	2500
SUBTOTAL	1365000	1490000	2430000	2640000	1177500	1590000	2970000	1505000	1377500	1422500	1252500
GENERAL CONTRACTOR											
OH & P (15%)	204750	223500	364500	396000	176625	238500	445500	225750	206625	213375	187875
SUBTOTAL	1569750	1713500	2794500	3036000	1354125	1828500	3415500	1730750	1584125	1635875	1440375
DESIGN & CONSTRUCT											
CONTING (30%)	470925	514050	838350	910800	406238	548550	1024650	519225	475238	490763	432113
TOTAL CONSTRUCTION	2040675	2227550	3632850	3946800	1760363.	2377050	4440150	2249975	2059363.	2126638.	1872488.
PROJECT OVERHEAD,											
ADMIN (25%)	510169	556888	908213	986700	440091	594263	1110038	562494	514841	531659	468122
TOTAL PROJECT	2550844	2784438	4541063	4933500	2200453	2971313	5550188	2812469	2574203	2658297	2340609

** INCLUDES DISCHARGE PIPELINE TO TALKEETNA RIVER



PROPOSED PROJECT DEVELOPMENT SCHEDULE