US Army Corps
of Engineers
Alaska District

Replace and Upgrade Dam
Draft Letter Report
Environmental Assessment
and Finding of No Significant Impact

Kake, Alaska

August 2002

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
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KAKE WATER SUPPLY DAM REPLACEMENT AND UPGRADE

LETTER REPORT

KAKE, ALASKA

August 2002

SUMMARY

This report recommends the construction of a replacement dam on Gunnuk Creek in Kake, Alaska. The plan for this project was investigated under the Energy and Water Development Appropriations Act, 2001, as enacted by Section 105 of P.L. 106-377, which states:

"Within available funds under Title I, the Secretary of the Army, acting through the Chief of Engineers, shall provide up to $7,000,000 to replace and upgrade the dam in Kake, Alaska, which collapsed July 2000, to provide drinking water and hydroelectricity."

Kake is in southeastern Alaska at latitude 56°58' north and longitude 133°56' west, on the northwest corner of Kupreanof Island. It is approximately 40 air miles west of Petersburg and approximately 75 air miles southeast of Juneau. Kake is a first class city with a population of about 700. It is a Tlingit village with a fishing, logging, and subsistence lifestyle.

The community of Kake receives its water supply from the impoundment behind a dam on Gunnuk Creek. In July 2000 a log breached the timber dam, creating an emergency water supply need for the community. Since that time the community has constructed a temporary low profile dam upstream from the previous dam and is supplying water, under precarious conditions, for the community. The Alpine Lakes project, intended as a supplemental water source, was brought on line in May 2002. The community strongly desires to get a replacement dam constructed as soon as possible to alleviate fears of inadequate water supply for drinking, fire protection, and industrial and commercial supply including the Gunnuk Creek hatchery, which is an important economic provider for the community and the fishing industry. Without a stable water supply, the hatchery's operations could be greatly impacted, resulting in a significant loss to the region.

The recommended plan calls for the construction of a gravity concrete dam approximately 53 feet upstream from the previous dam, covering an area about 4,750 ft^2, and a spillway height of 17.7 feet. Because the hatchery and bridge downstream are at risk, the dam would be constructed to meet State of Alaska standards for a Class I dam. An intake structure, complete with fish screen and trash rack, would house intake lines for the city, hatchery water supply, and a opening for the future option of hydropower generation. A supply line would also be provided for the operation of a hydroturbine, controlled by a continuous reading stream gauge that would regulate the hydroturbine use when flows in the creek meet or exceed minimum instream flow requirements. The pump house currently in use on the old dam would be replaced with a new 200-ft^2 structure on the new dam to house the existing pumps for the municipal water supply. The dam would also be provided with a crane system for maintenance removal of debris and a low flow outlet to aid in the removal of sediment behind the dam. Access ways and stairs would also be provided to improve maintenance and operation of the dam.

The recommended plan would store 12.6 acre-feet of water in a reservoir. The dam would provide a permanent primary source of water for Kake's municipal and industrial water demand that could be supplemented by the Alpine Lakes water supply project.

In this letter report, several alternative designs and sites were preliminarily evaluated to assess their value as options. Some of the other sites offered reduced hazard classification while increasing the environmental impact and cost. Some of the alternatives reduced impact and cost but could not offer a stable supply to all that relied on the previous dam for water.

The final plan provided for the replacement of the previous dam with a structurally superior design with improved mechanical equipment that would allow for a safer and more efficient operation of the dam. The concrete dam was selected because it was acceptable to the community, who would utilize and maintain the project, would minimize environmental impact, and could be constructed within the funding limits set by Congress. The concrete dam alternative has a total project cost of $6,096,800 and an equivalent annual cost of $399,000. Including the annual operation and maintenance cost of $48,800, the total annual cost is $448,000.

PERTINENT DATA

Recommended Plan (Alternative 4 Concrete Dam)

Reservoir Surface Area (a)	2.1
Reservoir Volume (acre-ft)	12.6
Reservoir length (ft)	1370
Maximum Reservoir Depth (ft)	16.5
Spillway elevation (ft MLLW)	88.96
Watershed Drainage area (mi2)	14.8

Construction Costs

Item	Federal ($)	Non-Federal ($)	Total ($)
Preconstruction, Engineering, and Design and Surveys	476,000	-	476,000
Supervision and Administration	476,000	-	476,000
Construction	5,131,200		5,131,200
LERR Administration	5,000	5,000	10,000
LERR Acquisition[1]	-	3,600	3,600
Total Project Cost	6,088,200	8,600	6,096,800
Annual Project Cost[2]			399,000
Annual Maintenance and Operation Cost[3]		48,800	48,800
Total Average Annual Cost			$448,000
Benefit/Cost ratio			0.18
Net annual Benefits			-368,000

[1]Estimated value of lands for project, Not creditable

[2]Basic assumptions: (1) October 2001 price level (FY 02 CRF 6 1/8%); (2) 50-year project life

[3]O&M costs do not include the cost of operations of the treatment facility or the Alpine Lake project.

CONVERSION TABLE FOR SYSTEM INTERNATIONAL (METRIC) UNITS

Units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To obtain
cubic yards	0.7646	cubic meters
acre	0.4049	hectare
Fahrenheit degrees	*	Celsius degrees
feet	0.3048	meters
feet per second	0.3048	meters per second
inches	2.5400	centimeters
knots (international)	0.5144	meters per second
miles (U.S. statute)	1.6093	kilometers
miles (nautical)	1.8520	kilometers
miles per hour	1.6093	kilometers per hour
pounds (mass)	0.4536	kilograms

To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula:

C = (5/9)(F - 32).

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1.0 INTRODUCTION

1.1. Project Authority

The Energy and Water Development Appropriations Act, 2001, as enacted by Section 105 of P.L. 106-377, directed the Alaska District Corps of Engineers to do the following:

"Sec. 105. Within available funds under Title I, the Secretary of the Army, acting through the Chief of Engineers, shall provide up to $7,000,000 to replace and upgrade the dam in Kake, Alaska, which collapsed July 2000, to provide drinking water and hydroelectricity."

1.2. Study Purpose

The purpose of this study is to prepare a decision document and present recommendations for the replacement and upgrade for the dam that collapsed on Gunnuk Creek in Kake, Alaska. The alternatives, evaluated in this report, would provide for the water supply needs of the community as well as investigate the potential for generation of hydroelectricity. This is a Construction General Project that has a maximum allowable Federal authorization of $7,000,000. Once this decision document is approved and a Project Cooperation Agreement signed, a construction contract would be prepared to implement the recommended plan.

1.3. Project Location and Current Conditions

Kake is in southeastern Alaska at latitude 56°58' north and longitude 133°56' west, on the northwest corner of Kupreanof Island. It is approximately 40 air miles west of Petersburg and approximately 75 air miles southeast of Juneau. Kake is a first class city with a population of about 700. It is a Tlingit village with a fishing, logging, and subsistence lifestyle. Access to Kake is only by water or air. The location and general vicinity of Kake is shown on figure 1.

1.4. Related Reports and Studies

The following studies have examined water supply needs at Kake.

"Alpine Lake Study for the City of Kake," September 1995. Prepared by Montgomery Watson for the City of Kake. The report studied the feasibility of the Alpine Lake project as a supplemental water supply for the City of Kake.

"City of Kake Dam, AK-00144, Kake, Alaska: Periodic Safety Inspection Report, Alaska Dam Safety Program," 1986. Prepared for the Alaska Department of Natural Resources, Division of Land and Water Management by Shannon & Wilson, Inc. and Tryck, Nyman & Hayes. The report detailed the condition of the dam.

"Alpine Lake Water Supply Investigation," January 2001. Prepared for NANA/Dowl Engineers by Michael Baker, Jr. The investigation assessed the drawdown on alpine lakes to determine the lakes capacity and the amount of water the municipality would need.

"NEPA/VE Alternative Assessments Value Engineering/ Requirements Charrette Replace and Upgrade Dam, Kake, Alaska," November 2001. Prepared by Olympic Associates Company for the U.S. Army Engineer District Alaska. The report documents the planning

and design meeting held at the site with the stakeholders. At the meeting objectives and constraints were established and alternatives evaluated.

1.5. Existing Conditions

1.5.1. Historical Background

In 1920, a log crib dam was built on Gunnuk Creek to serve the cannery. It was about 9 feet high and used a gravity-fed 24-inch, wood stave pipeline to provide water to the cannery. The Civilian Conservation Corps replaced the dam and spillway at the original site in 1936. A timber dam was constructed 56 feet downstream from the existing log crib in 1959. The log crib structure was left in place (Sealaska 1986; Alaska DNR 1986).

The timber dam was raised with a spillway height of 88.96 feet MLLW approximately 17.7 feet above the creek bottom on the downstream side of the dam and the wood stave pipe routed into a gate valve at the new dam. Two intakes and sluice pipes allowed for water to pass through the dam. A 36-inch pipe at the base of the right abutment, looking downstream, was reduced to a smaller diameter pipe (enclosed in insulation and a plywood box) and continued downstream to the cannery. The original line was 24-inch wood stave pipe; however, more recent changes may have included a 12-inch polyethylene pipe (Alaska DNR 1986:10). Figure 2 shows the dam in operation, prior to failure.

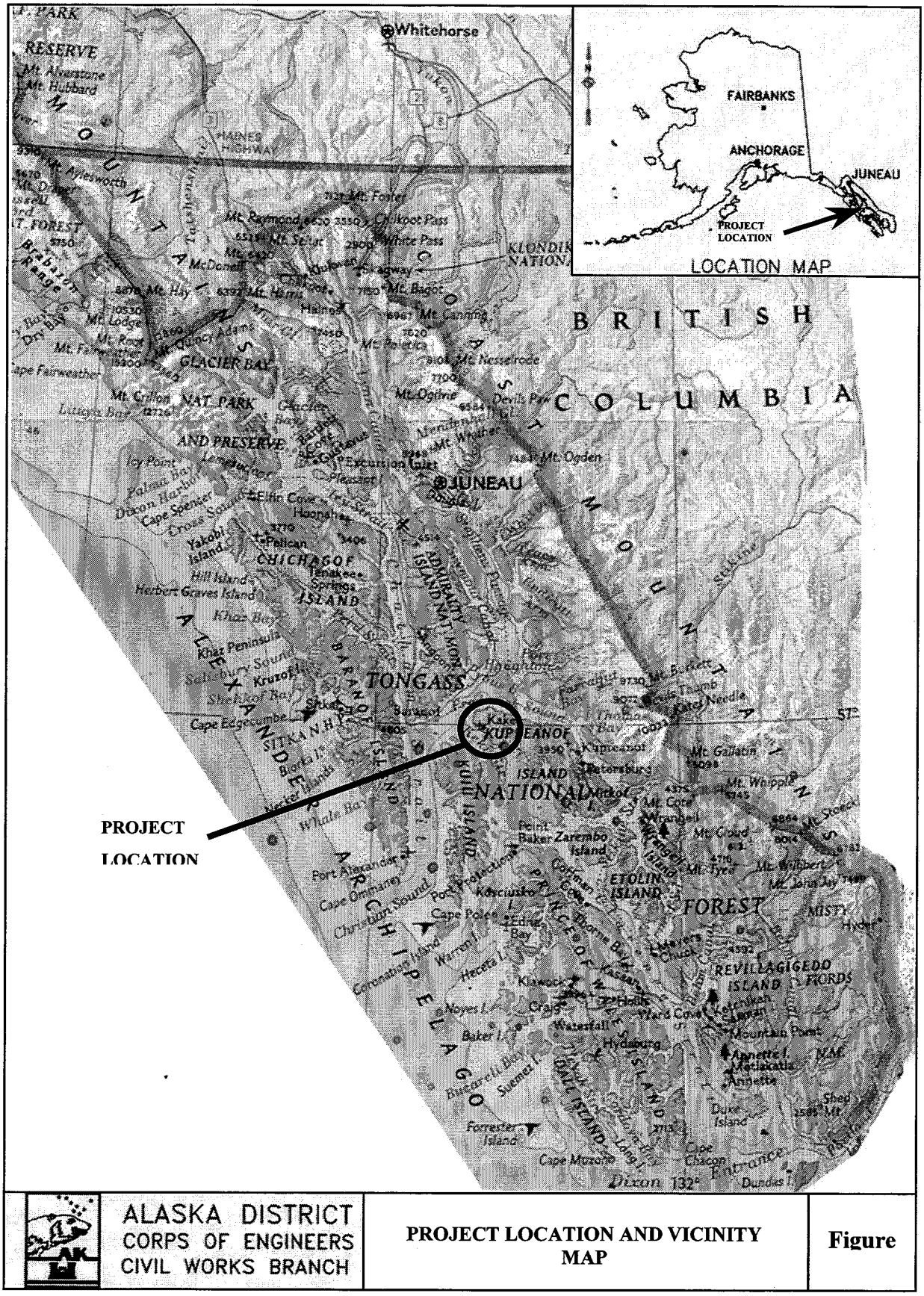


Figure 1. Vicinity Map of Kake

Replace and Upgrade Dam, Kake Alaska

The timber dam provided an impound area from which two electrically driven 20 horsepower pumps delivered water to the municipal treatment plant and storage tank. The water surface elevation at the pump intakes was about 89 feet MLLW, and the elevation of the treated water storage tank overflow was about 246 feet. Each pump delivered 250 gallons per minute (gpm) when operated singly. In addition to the pumps there was a hydroturbine below the impoundment that used water flow from the impoundment for energy to pump about 250 gpm to the water treatment and storage facility.

The Public Health Service has reported that a flow of 5,200 gpm is required to operate the hydroturbine, of which 250 gpm are delivered to the treatment facility and the remainder is discharged into Gunnuk Creek downstream of the hydroturbine. The City of Kake, historically, used the electrically driven pumps to supply about 85 percent of the water for city consumption; however, the hydroturbine was rarely used for a variety of reasons including:

- insufficient flow in the creek to operate the hydroturbine.
- concerns about freezing in hydroturbine during the winter.
- concerns about depriving the hatchery of water during the summer.
- increased silt load on the treatment plant when water is pumped by the hydroturbine.

Figure 2. Dam prior to failure

Gunnuk Creek hatchery operating downstream from the dam has two permits to appropriate water from the impoundment. A 10 inch pipe has provided gravity fed water supply to the hatchery from the impound of the dam. The permits have allowed the hatchery to draw up to 2.5 cfs from the stream.

In 1970, the City of Kake hired an engineer to "de-silt" the dam by using high-pressure hoses and flushing the material downstream into Gunnuk Creek. The idea was abandoned due to inadequate funds and concerns that the silt would affect the fish habitat downstream. The next year a pump, storage tank, and chlorinator were installed. Twenty thousand cubic yards of silt and gravel were removed from the reservoir in 1983. An access road was constructed to allow for silt removal. (Sealaska 1986; Alaska DNR 1986).

In July 2000 a log breached the timber-constructed dam (see figure 3). After the dam failure the State of Alaska required additional demolition of the dam to minimize the danger from additional failure and damage downstream. Figure 4 shows the condition of the dam after the removal of the additional structure. This is essentially the present condition.

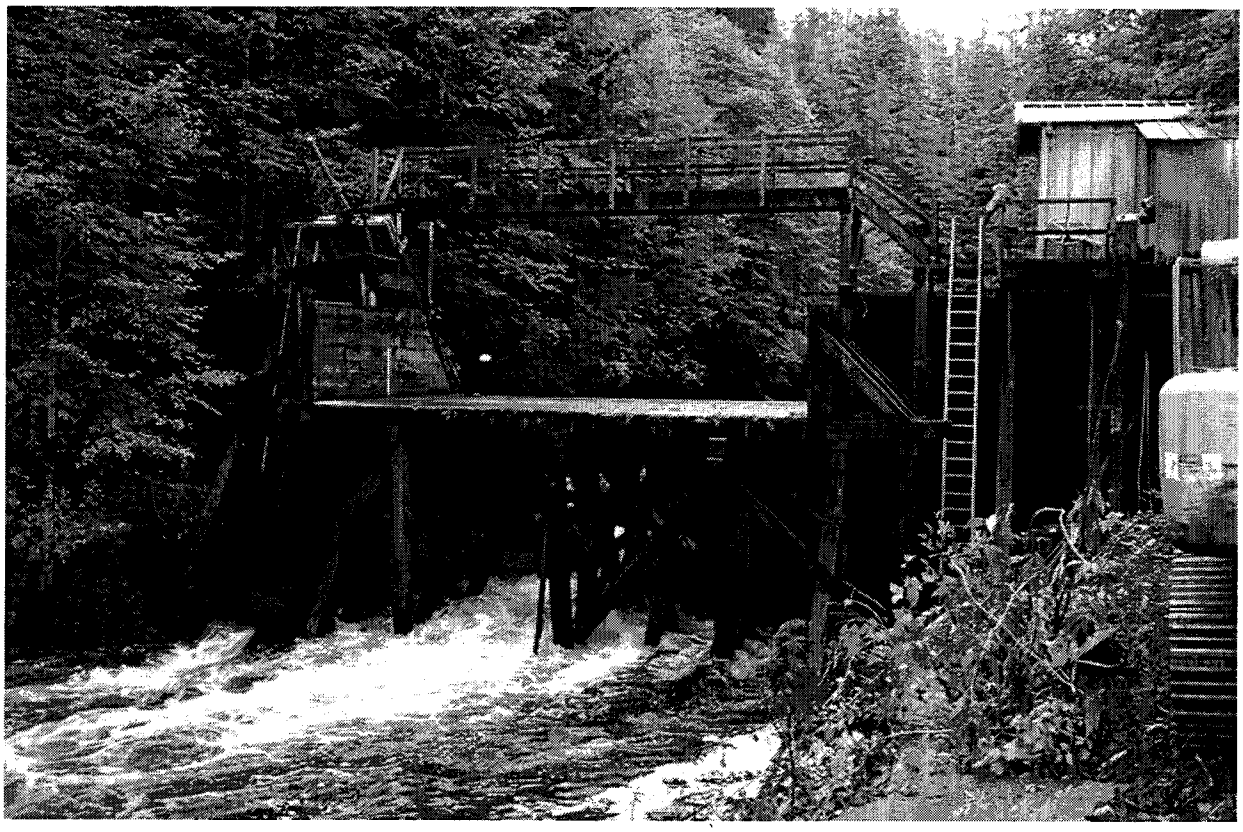


Figure 3. Dam after failure

1.5.2. Kake Water Supply Requirements

In 1995 the City of Kake conducted a study, referred to as the "Alpine Lake Study" (Montgomery Watson, 1995) to evaluate the potential for developing additional water supply sources for supplementing the existing municipal water system. The study evaluated the existing water supply needs and projected the future water demand for the City of Kake. According to records provided by the Kake municipal water treatment plant, water demand, historically, averaged between 530,000 gallons per day (gpd) and 330,000 gpd. The report calculated an annual average daily consumption by the City at 400,000 gpd.

Kake Tribal Fisheries cold storage is planning to expand their operations with the addition of 2 canning lines within the twenty-year projection period. The water usage for the canning lines is estimated to be about 600,000 gpd during July through September for a six to eight week period. Some of this need could be supplemented with seawater. Because the duration that the canning lines run is relatively short and seasonal a future water demand of 200,000 gpd was used in the Alpine Lake study as a reasonable estimate for the canning lines use over the next twenty years that would be supplied by the municipal system.

Gunnuk Creek Hatchery draws water from the creek for its operations. The current hatchery water demand is 1,260,000 gpd throughout most of the year but diminishes greatly between the months of April and August. The Gunnuk Creek Hatchery is planning to expand their operations within the projection period with the introduction of a coho smolt program during the summer months. This hatchery expansion would not significantly increase their average

Figure 4. Existing condition of dam

daily consumption except during the summer months when the flows from the creek are annually at their lowest.

The Alpine Lake Study estimated that Kake would experience a growth of population and water consumption of about 25 percent over the next twenty years. Increasing the current 400,000-gpd water consumption by 25 percent results in a projected 500,000-gpd water demand within 20 years. Including the 200,000 gpd for the cannery lines and 1,260,000 gpd for the hatchery, the total projected average daily water demand for Kake would be 1,960,000 gpd.

1.5.3. Current Water Supply Projects

Immediately after the failure of the dam, a temporary makeshift water supply system with two six-inch pipelines with electric pumps was installed on the downstream of the dam to pump water for the city water plant. The system could not be considered an adequate supply for the city and could not meet the needs for the hatchery. The emergency system can be seen in figure 4.

The City of Kake and the Kake Nonprofit Fisheries Corporation have constructed a temporary low profile dam to draw water for the hatchery and the city. The intake structure is sited approximately 1,500 feet upstream of the previous dam site and feeds two 10-inch water lines that supply water to the city and the hatchery. Figure 5 shows the low profile dam and intake structure. Permit stipulations state the system is not to draw water from the creek when the instream flows below the dam are below 11 cubic feet per second (cfs). The structure is also to be removed in its entirety upon completion of a permanent dam (estimated to be 2003). The low profile dam was completed in June of 2001 and is the only functioning supply for the city as of the writing of this report. The water supply for the city from this system still remains precarious with concerns about low instream flows and the possibility of icing during the winter months that may interrupt the steady supply needed by the city and the hatchery.

The City of Kake has also attempted to construct an infiltration gallery immediately downstream of the dam. The system has experienced technical difficulties and is not operational. Figure 6 shows the infiltration gallery structure.

A $3.1 million project to pipe water from nearby Alpine Lake to Kake was completed in May of 2002. Alpine Lake is within the Gunnuk Creek watershed. The lake is high enough to provide gravity flow through the existing treatment plant and into the treated water storage tank. With the inlet submerged in the lake the water would be conveyed through a 10-inch pipeline following existing roads for a total distance of about 31,000 feet. The project was a result of the 1995 report prepared for the City of Kake to find a supplemental water source for the municipal water system. The Lake contains a useable supply of 1950 acre-feet of water that could yield 2.7 cfs for a period of 365 days. An assessment for the Alpine Lake project was completed in January 2001 for the possible draw down that could be expected from withdrawal of water from Alpine Lake and determine what magnitude of sustained withdrawal the lake could support. The assessment reported the findings of the new water balance model and estimated the maximum sustainable water withdrawal rate would be between 700,000 and 1,000,000 gpd which is short of the 1,960,000 gpd needed by the community.

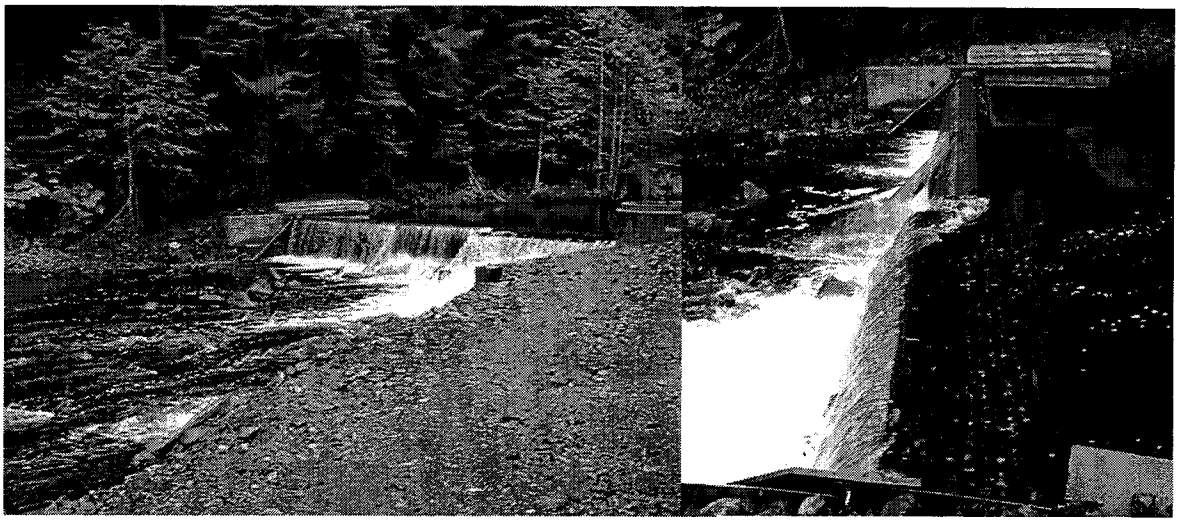


Figure 5. Low profile dam (Current water supply)

1.5.4. Expected Future conditions

The Alpine Lake Project was completed in May 2002. However, the Alpine Lake source alone does not provided sufficient water to meet the projected water supply needs and requirements for the City of Kake. The original intent of the Alpine Lakes Project was to provide an additional source to increase the capacity of the City of Kake's water supply system with Gunnuk Creek as the primary source. Together, both the Gunnuk Creek and Alpine Lakes sources would provide sufficient capacity to meet City's projected daily water demand of 1,960,000 gpd. Without the replacement of the dam on Gunnuk Creek, the City of Kake water supply system will not have sufficient capacity to supply projected water requirements. The lack of sufficient water supply will have significant economic impacts to the community and in particular the canneries and Gunnuk Creek Hatchery.

Figure 6. Infiltration System

2.0 PLAN FORMULATION

2.1. Planning Criteria

2.1.1. Engineering Criteria

The alternatives considered should be adequately designed to provide long-term water supply for the community, be maintainable/operable by the City of Kake, and be adequately designed so as not to create a hazard to infrastructure or people downstream from the project. Alternatives should also consider the potential to generate hydropower or utilize hydropower to supply energy needed to pump the water to the treatment facilities.

2.1.2. Economic Criteria

All alternatives considered to meet project needs should be presented in quantitative terms where possible. Though economic feasibility is not required, the project should be incrementally analyzed to ensure the alternative selected as the recommended plan provides the maximum project benefit while adhering to the engineering, economic, environmental, and social criteria.

2.1.3. Environmental Criteria

Environmental considerations include (1) the need to evaluate the water requirements of the hatchery and fish and wildlife using the water habitat, (2) minimizing disruption of the area's

natural resources, and (3) using measures to protect or enhance existing environmental values.

2.1.4. Social Criteria

The planning process must bear in mind that the community of Kake has not had a reliable source of water since July 2000. Because of this and the urgency expressed by the community, some of the options that could yield better results from an engineering standpoint could adversely impact the community due to the amount of time and money required to sufficiently design and evaluate the potential impact on the environment. Alternatives must provide water to sustain the non-profit Gunnuk Creek Hatchery, which assists in sustaining the salmon fishery. The hatchery is essential to the economy of Kake by providing employment and livelihood for hatchery workers, fishermen, and fish processing workers. Alternatives considered must minimize adverse social impacts and must be consistent with state, regional, and local land use and development plans, both public and private. The selected alternative must be acceptable to the non-federal sponsor.

2.1.5. Federal Funding Limits

The project is to be constructed at Federal expense with the City of Kake responsible for the operation and maintenance of the project. The existing authorization sets a Federal cost limit of $7,000,000 for the project.

2.2. Alternatives Considered

The first process in the development of alternatives was the consideration of different creeks with the potential for providing the water supply and potential hydropower for the City of Kake. The creeks in the vicinity of Kake that were preliminarily evaluated were: Unnamed Creek (northwest of Gunnuk Creek, Gunnuk Creek, Sitkum and Jenny Creeks (below their confluence), Slo Duc Creek, Cathedral Falls Creek, and Hamilton Creek. Figure 7 shows the location of the creeks considered.

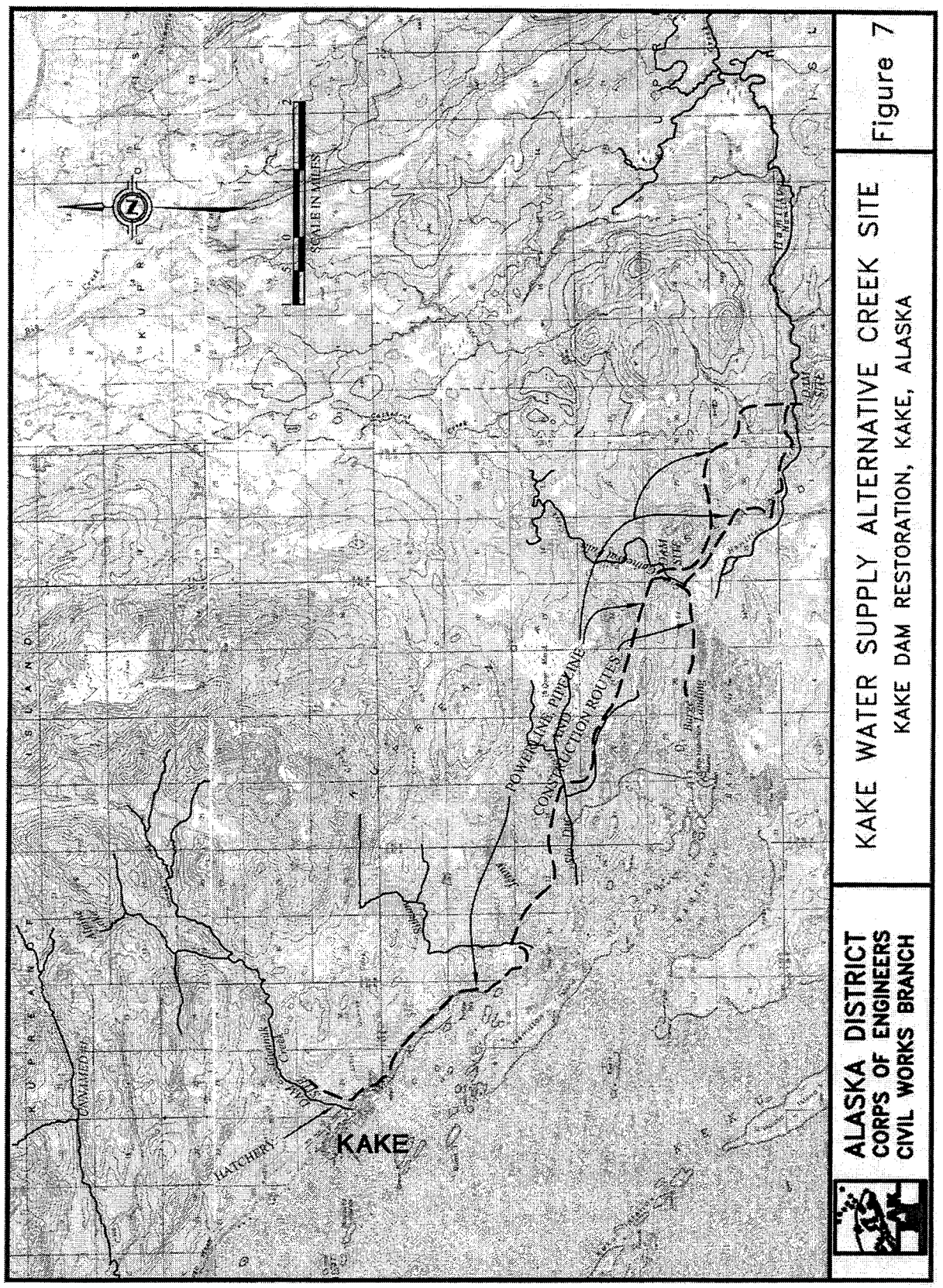


Figure 7. Alternative Project Sites Loc/Vic Map

The average annual water flow is directly related to drainage area and precipitation. The low flow period of July/August from other creeks needs to be the same or more as Gunnuk Creek to be considered reasonable alternatives based on supply. Based on basin area, Unnamed Creek, Slo Duc Creek, Sitkum and Jenny Creeks were eliminated from further consideration. The remaining creeks were considered taking into account fish species, safety classification, and other factors that would have to be evaluated if these sites were to be developed. A comparison of the sites is provided in table 1.

Table 1. Alternative Creek Sites Comparison

Creek Sites	Fish species	Drainage areas (sq. mi.)	Average Annual Flow (cfs)	Mean July Low (low flow month) (cfs)	Length of new waterline and power line (mi.)	Length ofaccess road from barge landing (mi.)
Unnamed Creek NW of Gunnuk	DV, CO, P, CH	12.3				
Gunnuk Creek	DV, SH, CO, CH, P, CT	15	99	39	0	0
Sitkum and Jenny Creeks below confluence	CO, CH, P	12.6				
Slo Duc Creek	CO, P	5 - 6				
Cathedral Falls Creek	CT, CO, CH, P	27	156	35	Waterline-12.5 Powerline- 9.0	2.4
Hamilton Creek	CO, P, CH, SH, CT	61	390	64	Waterline-17.1 Powerline- 13.1	6.4

DV = Dolly Varden, CO = coho, P = pink, CH = chum, SH = Steel head, CT = cutthroat trout

Gunnuk Creek (existing dam site). Gunnuk Creek is a clear water creek draining from a watershed area of approximately 15 square miles discharging to marine waters. The watershed is mountainous and forested. Nearly one-third of the watershed has been logged using clear-cut methods over the past decade. Numerous branches of the creek form a relatively dense network of watercourses between steep slopes. Gunnuk Creek flows through a steep-walled canyon characterized by several steep waterfalls. Alpine lake is the largest of several ponds and lakes within the Gunnuk Creek watershed. It lies on the northern edge of the watershed and has a nominal surface elevation of 596 feet. During the planning and design meeting it was presented that a study performed previously for the community investigating potential for hydropower in the vicinity of Kake found Gunnuk Creek to have the greatest potential though not a very substantial source.

Flow data for Gunnuk Creek have been collected continuously at the Gunnuk Creek Hatchery since late 1986. Montgomery Watson reviewed the compiled data. Mean flow over the period of record is 68.1 cfs. Flow is highest in the late fall and winter months, and falls to a minimum during July and August when mean flows for the month have dropped below 7 cfs. Minimum flows on record are 4.11 cfs during the summer and winter low flow periods. Winter low flows occur when periods of very cold temperatures prohibit snowmelt. Summer low flows occur due to relatively long periods without rainfall. Water within the Gunnuk Creek watershed is of high quality. Turbidity in the creek is monitored by the city and the hatchery to insure that quality is maintained.

Fish species found in the creek include Dolly Varden, stealhead, coho, chum, pink, and cutthroat trout. The falls below the dam appear to be a natural barrier to pink and chum

salmon. Steelhead and coho have been observed in the pool below the dam indicating some fish can migrate past the falls in certain hydrologic conditions. Surveys were conducted during the study period for this project to investigate the barrier falls in Gunnuk Creek and to observe habitat quality above the dam site. The surveys indicated the available habitat below the dam site is fully utilized. There is limited spawning pools and substrate. The creek bed above the dam is composed of shallow riffles for several miles. This is not suitable habitat for salmon rearing and spawning. The creek canyon is very steep-walled with several waterfalls. The second set of falls approximately 1.8 miles upstream of the dam site is a very steep effective barrier for all fish species in Gunnuk Creek.

Because there are existing structures and individuals that reside in the potential floodway below the existing dam, construction of a dam on Gunnuk Creek would have to meet the requirements for a Class 1 dam, the highest risk classification.

The hatchery is one of the downstream structures and uses the water from the creek for its operations. The hatchery needs to utilize Gunnuk Creek waters and has 2 permits to appropriate water from the impoundment from the dam totaling 2.5 cfs.

Cathedral Falls Creek. Cathedral Falls Creek possesses abundant water flow with an average annual flow of 156 cfs from a drainage area almost twice the size of Gunnuk Creek, but would require significant infrastructure development for delivery into Kake. Approximately 12.5 miles of pipe would be required to convey the water from the creek northwest to the existing water treatment facility. Power would also need to be run approximately 9 miles to pump the water from the creek. The remoteness of this site does allow the construction of a dam without the risk to life or property downstream making the permit and design requirements less demanding.

Fish species found in the creek include coho, chum, pink, and cutthroat trout. Cathedral Falls Creek has barrier waterfalls approximately 0.7 miles from sea outlet. The trail leading to the beautiful waterfalls is popular with hikers. Locals use this area for recreation. Because of the falls, there is limited coho salmon habitat.

The environmental impact to gain access to the creeks as well as the impact to the undisturbed creek habitats was not considered justifiable. In order to develop a water supply system at Cathedral Falls Creek, a significant amount of study would have to be performed to evaluate the impacts, requiring time that was not available to pursue due to local concerns about the stability of their existing water supply.

In locating a water supply project on Cathedral Falls Creek, the water demand for the hatchery would still be unmet. This would require a relocation of the hatchery operations or an additional permanent system at Gunnuk Creek for a continuous water supply. Because of the environmental impact and the remaining water supply need for the hatchery, this site was eliminated for further consideration.

Hamilton Creek. Hamilton Creek possesses the largest potential water flow with an average annual flow of 390 cfs from a drainage area four times the size of Gunnuk Creek. Use of this creek would require significant infrastructure development for delivery into Kake. Approximately 17.1 miles of pipe would be required to convey the water from the creek northwest to the existing water treatment facility. A power line would also need to be run about 13.1 miles to provide the energy required to pump the water from the creek. The

remoteness of this site does allow for the construction of a dam without the risk to life or property downstream making the permit and design requirements less demanding.

Fish species found in the creek include coho, chum, pink, steelhead, and cutthroat trout. Salmon and steelhead populations have not been studied, however, local knowledge of the creek indicates a healthy population of steelhead as well as the other salmon species.

Like Cathedral Falls Creek, Hamilton Creek was not considered justifiable due environmental impacts to the creek habitat. In order to develop a water supply system at Hamilton Creek, significant study would be needed to evaluate the impacts: A study of this magnitude would require considerable time that was not available due to local concerns about the stability of their existing water supply.

In locating a water supply project on Hamilton Creek, the water demand for the hatchery would still be unmet. This would require a relocation of the hatchery operations or an additional permanent system at Gunnuk Creek for a continuous water supply. Because of the environmental impact and the remaining water supply need for the hatchery, this site was eliminated for further consideration.

Because of the preexistence of the dam on Gunnuk Creek, the location of the hatchery and the municipal water treatment facility, along with local preference for a permanent water supply system to be reconstructed on Gunnuk Creek, it was concluded to focus evaluation of alternatives to the Gunnuk Creek watershed. To help in determining a plan that would meet the planning criteria in an expedient timeframe, a design meeting was held in Kake for several days with participants from State agencies, the community, the hatchery, and the design team. The different design alternatives were discussed and evaluated. The following presents information gathered for the alternatives as a result of the design meeting.

2.2.1. Alternative 1: Alpine Lake Project

The Alpine Lake water supply line could be considered the no Federal action plan. All alternatives considered would assume the Alpine Lake project would be used to supplement the water supply needs for the community. The project was brought on line in May of 2002. The project is fed from an inlet submerged in the lake. The water is conveyed through a 10-inch pipeline, following existing roads, for a total distance of about 31,000 feet. The elevation of the lake is high enough to provide gravity flow through the existing treatment plant and into the treated water storage tank for the municipality. The project is a result of the Alpine Lake Study prepared for the City of Kake to find a supplemental water source for the municipal water system. The estimated maximum sustainable water withdrawal rate would be between 700,000 and 1,000,000 gpd. This quantity is approximately half of the communities projected water demand of 1,960,000 gpd. The hatchery operation must continue to rely on the temporary low profile dam as its source of water. The higher pressures causing higher gas saturation and colder temperatures of the water from the Alpine Lake system could be fatal to the fish stock production of the hatchery. Because this alternative does not address all of the community's water supply needs the community does not consider it an acceptable solution by itself.

2.2.2. Alternative 2: "Gabion" Dam Modified to be Permanent

The existing temporary "gabion" dam is in operation now and provides the water for the community as well as the hatchery. Figure 5 shows the existing structure that consists of a weir made from concrete sections placed together in the stream with screened intake

structure, low flow outlet, and flushing channel. Two 10-inch pipes convey the water to the existing water treatment facility and to the hatchery downstream. The permit for the dam stipulates that the dam is temporary and must be removed in its entirety when the new permanent dam is constructed. The alternative considered would modify this structure to ensure it would withstand flow conditions subjected to during the life of the project. Further modification would be required for the intake structure to comply with requirements for an effective fish screening. The project would also require armoring with riprap the existing pipeline downstream of the intake structure to ensure the pipe would be secure from expected flows and possible damage from debris during the project life. The pump house at the existing dam would also require removal and reconstruction to make its function more efficient and permanent.

The concern with this alternative is its ability to provide a steady supply of water throughout the year. At present there is a stream flow maintenance requirement of 11 cfs that must be met before the hatchery can withdraw water under its two permits to appropriate water from the creek. The City of Kake appears to be allowed to appropriate its 5 cfs without this requirement. Low flows can occur during the summer due to relatively long periods without rainfall. Mean monthly flows during July and August have dropped below 7 cfs. Winter low flows occur when periods of very cold temperatures prohibit snowmelt. Minimum flows on record are 4.11 cfs during summer and winter low flow periods. During these periods there would be no supply available for the hatchery because the gabion structure offers essentially no storage and the storage supplied by Alpine Lakes is not suitable for hatchery use.

This alternative does offer a reduced risk from a dam safety perspective. Because impound behind the dam is minimal, there is not much risk of damage to life or property downstream in the event of failure. This alternative also offers a lesser impact to the environment because of the lack of an impound area and reduced barrier for fish migration upstream. There is, however, less surety that a constant supply of water would be available for the hatchery due to low flows or potential freezing problems at the intake structure.

2.2.3. Alternative 3: Infiltration System

An infiltration gallery could be designed much like the one presently being constructed by the City of Kake. Figure 6 shows the system by the existing dam site. The system would be used by the city and the hatchery when flows are high enough to allow withdrawal of water from the creek. Additional protection would have to be designed into the system to protect it from damage that could occur during high flow events. The existing system is experiencing problems such as siltation in the water lines, and mechanical and electrical malfunctions. The connection to the treatment facilities from the infiltration system would need to be reconstructed, and removal of the existing pump house and other mechanical systems would need to be upgraded to better convey the water to the treatment facilities and hatchery.

Because this system offers no storage of water, it would not be able to supply water during low flow periods. In addition, use of this system would require extensive operations supervision and would incur high electrical costs to pump the water to the municipal treatment facility.

2.2.4. Alternative 4: Replacement Dam

The proposed dam would essentially serve the same function as the previous timber dam except it would provide for a much larger spillway for the predicted maximum flood, provide for greater stability, and provide more efficient operation and maintenance. A geotechnical

investigation conducted at the proposed site concluded that the site was suitable for construction of the proposed dam. Spillway height and impoundment pool would be essentially the same in height, area, and volume. Several types of dams are often considered for similar situations:

- rockfill dam
- concrete faced rockfill dam
- concrete gravity dam
- RCC gravity dam

Rockfill Dam. Rockfill dams are typically structures with an impervious core surrounded by filter layers and shell layers. These structures are economical to build if a suitable location exists to construct a spillway and outlet facilities can be conveniently configured. The topography of the project site offers no options to locate a spillway to pass the required flow.

Concrete Faced Rockfill Dam. There are numerous examples where a rockfill dam was faced with concrete to provide impermeability. The concrete facing is on the upstream face. There are rockfill dams where concrete overflow protection is placed on the downstream face to serve as a spillway surface. This is usually done to rehabilitate existing dams that require improvements for spill situations. It is not usually done for new dams.

A concrete structure is well suited for this narrow canyon where significant flows are possible. All these flows must be routed over the structure. The structure can be constructed of either conventional concrete or a combination of conventional concrete and roller compacted concrete.

Concrete Gravity Dam. Less than 4,000 yd^3 of conventional concrete is required to construct the project. Standard design sections are envisioned for this type of dam. The standard features include a stilling basin, end sill, training walls, main dam, spillway crest, parapet walls, and intake tower. The use of standard forming systems, waterstops, and surface treatment is necessary. This type of construction can be done at this site and with the available resources during the available construction season.

Roller Compacted Concrete (RCC) Gravity Dam. The use of roller compacted concrete is usually the material of choice for constructing a concrete gravity dam. The material is economical to produce and can be placed very rapidly. Its use for Kake Dam would require the concurrent use of conventional concrete or pre-cast concrete elements to provide durability to the exposed surfaces. The relatively low volume of RCC to construct this structure, the restricted site, and the remote location reduces the advantage of the use of RCC for this project.

3.0 COMPARISON OF ALTERNATIVES

3.1. Physical Comparison of Alternatives

All alternatives have a common objective, which is to provide a stable water supply for the community of Kake, without exceeding the Federal limit of $7,000,000. A comparison of the

alternatives is shown in table 2. The values in the table are for comparison of alternatives and are not used to determine the best overall alternative.

The Alpine Lake alternative was not included in the table because it is not considered an acceptable alternative by itself. The Alpine Lake project would not replace the function of the dam for meeting the hatchery's water supply. Also the Alpine Lake project is considered a supplemental source of water for the community.

Table 2. Comparison of Alternatives

Scale of 0-5: 5 = best, 4 = good, 3 = fair, 2 = poor, 1= worst, 0= Not Acceptable	Alternative 2 (Gabion Dam)	Alternative 3 (Infiltration Gallery)	Alternative 4 (Dam Replacement)
Supply City Water Demand	4	3	5
Supply Hatchery Water Demand	3	2	5
Dam Safety Hazard	3	4	1
Maintenance/ Operation	2	1	2
Fish Habitat Compatibility	2	3	1
Minimizes Disruption of Natural Resources	2	3	1
Protects Enhances Environmental Values	2	3	1
Cost to Construct	3	2	1
Cost to Operate	2	2	2
Time to implement	3	3	2
Storage capacity	0	0	4
Potential to produce Hydropower	0	0	3
Social acceptability	0	0	5
Provides Benefits	3	2	4

All of the alternatives have limitations on their ability to provide a stable water supply that included the hatchery. Only the dam alternatives could offer an impoundment that would serve as a buffer during low flow periods. Also only the dam alternative would offer the potential for producing hydropower though it was determined that the amount that could be developed would not significantly contribute to the community it could generate some electricity to subsidize some of the communities needs. Therefore it was determined not to pursue development of the hydropower now but an intake would be stubbed into the design of the dam for possible future development.

According to the Alpine Lake Study performed by Montgomery Watson for the City of Kake dated September 1995 there is always more than enough flow in the creek to meet City's municipal water demand, 1.08 cfs. The minimum flow recorded in the creek since September, 1986 is 4.11 cfs according to hatchery records. Table 3 shows the storage in days the dam would provide under various scenarios. The durations shown are based on the projected hatchery demand provided by the hatchery and uses the 100% exceedance flows for each month based on the data provided in the 1995 Alpine Lake study. The city demand used is 1.08 cfs. It should be noted that the records from the hatchery indicate that in 1993 for the months from June through September of that year the stream discharge was 0.0 cfs or missing though the city continued to draw water from the creek during this period. The table indicates the fact that the instream flow requirement greatly reduces the effectiveness of the dam for storage of water. Also shown is that with the project dredged the increased reservoir adds about 30% duration of water supply with the instream flow requirements. If the

instream flow requirement is not applied and if the City water demand is met by the Alpine Lakes project then the hatchery demand could be met by the proposed dam reservoir throughout the year provided that the estimated 100% exceedence flows occur.

Table 3. Reservoir Yields in Days of Water Supply for Various Demands and Conditions

				DREDGED				NOT DREDGED			
	Projected Hatchery use	Mean Monthly Stream Flow	Estimated 100% exceedence Stream Flow	Without instream requirement		With instream reqiurement		Without instream requirement		With instream reqiurement	
				Hatchery + City	Hatchery	Hatchery + City	Hatchery	Hatchery + City	Hatchery	Hatchery + City	Hatchery
Month	(cfs)	(cfs)	(cfs)	(days)	(days)	(days)	(days)	(days)	(days)	(days)	(days)
January	2.2	102	3	All	All	0.61	0.65	All	All	0.44	0.46
February	2.2	71	1	3.65	All	0.52	0.54	2.60	All	0.37	0.39
March	2.4	30	6	All	All	0.84	0.91	All	All	0.60	0.65
April	2.5	84	8	All	All	1.13	1.25	All	All	0.80	0.89
May	1.5	84	7	All	All	1.13	1.25	All	All	0.80	0.89
June	0.4	26	3	All	All	0.74	0.79	All	All	0.53	0.57
July	0.5	10	1	All	All	0.60	0.63	All	All	0.43	0.45
August	1.75	13	1	4.91	All	0.53	0.56	3.51	All	0.38	0.40
September	1.75	62	1	4.91	All	0.53	0.56	3.51	All	0.38	0.40
October	2.0	88	2	11.67	All	0.57	0.60	8.33	All	0.41	0.43
November	2.2	82	8	All	All	1.19	1.32	All	All	0.85	0.95
December	2.2	50	10	All	All	1.90	2.27	All	All	1.36	1.62

Note: *Days represent the duration water demand would be met by the reservoir with the continued input of the 100% exceedence flow. Example: 0.61 days is the amount of time the water demand would be met before the reservoir would empty if the flow did not increase or the water demand was not reduced within time period.*
Mean monthly flows predicted by USDA regression from hatchery precipitation data as presented in the Alpine Lake water study.
Duration calculations neglect evaporation and seepage.

3.2. Environmental Evaluation of Alternatives

Gunnuk Creek is the largest producer of pink salmon of any anadromous stream in the Kake coastal zone district. The natural stock of pink salmon is small, producing about 2,000 to 6,000 spawners annually. There are also natural runs of chum and coho salmon, and steelhead trout. Gunnuk Creek supports only a minimal natural spawning stock of chums. The coho run ranges from 25 to 100 fish annually, and the steelhead run ranges from 10 to 30 fish annually. The falls below the dam appear to be a natural barrier to pink and chum salmon. Steelhead and coho have been observed in the pool below the dam indicating some fish can migrate past the falls in certain hydrologic conditions. Gunnuk Creek provides very limited habitat for anadromous fish. The available habitat below the dam site is fully utilized. There are limited spawning pools and substrate. The creek bed above the dam is composed of shallow riffles for several miles. This is not suitable habitat for salmon rearing and spawning. The creek canyon is very steep-walled with several waterfalls. The second set of falls above the dam site is a very steep effective barrier for all fish species in Gunnuk Creek. Dolly Varden and cutthroat trout are the resident non-anadromous fish species. The abundance of these species has not been studied. Local information indicates the numbers are low. Resident fish that enter waters below the falls are unable to return and are therefore lost to the system. The dam project would include features to protect existing fish habitat but would

not include fish passage structures. Protecting fish habitat would be accomplished by regulating in-stream flow minimums for fish spawning and rearing and by bypassing accumulated sediments at the dam site. Pink and chum salmon habitat in Gunnuk Creek has been determined essential fish habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act. This act mandates that Federal agencies assess the effects of Federal projects on EFH and consult with the Department of Commerce. The activities occurring in Gunnuk Creek, as described in the Proposed Action Section, may have temporary adverse effects to salmon habitat during construction. The effects would not be substantial. Mitigation measures to minimize adverse effects include timing the activities to avoid migration periods.

Bald eagles and American kestrels are the most common birds of prey in the area. Other bird species observed along this coast include belted kingfisher, blue grouse, crows, ravens, sparrows, and jays. No eagles' nests are close to the project site. Large mammals present on Kupreanof Island include black bear, deer, and wolves. Black bear are common along salmon streams in the fall. Deer and wolves are not common in the Kake area because of the heavy logging that has occurred. Furbearers include otter, mink, weasel, and beaver. Beaver inhabit most of the Gunnuk Creek watershed. Bats, field mice, and flying squirrels also occur in the area.

Previous coordination with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for the harbor project in Kake and the Department of Army permit 4-2000-1043, Gunnuk Creek 2 indicated that no species under their jurisdiction other than the humpback whale and the Steller sea lion were common in the Kake project area. The proposed action would not affect these species. The current listing of threatened and endangered species indicates that no other species would be affected by this project. No historic properties were identified during the study that would be affected by the Kake dam project.

3.3. Economic Evaluation of Alternatives

3.3.1. Introduction

This economic evaluation is structured to consider impacts upon the economy resulting from meeting the water demand at Kake. In order to measure these changes, the economic evaluation considers three scenarios: 1) the existing condition; 2) future without-project conditions; and 3) future with-project conditions.

Existing Condition. The existing condition is simply a description of the situation as it currently stands. This condition does not account for any changes in the future and is therefore not a true representation of conditions as they would exist if no action were to result from this study.

Without-Project condition. Even without Corps involvement, the City of Kake would take actions to solve its water supply dilemma. In fact, some of those actions led to the authorization of a Corps project and initiation of this study. Although it may appear that some type of Corps action is a given, the without-project condition is still investigated to establish a baseline to compare the benefits and costs of the Corps project. Therefore, the without project condition represents what would happen in the absence of a Corps project.

With-Project Condition. This study has identified several alternatives as potential solutions for meeting the water supply needs of Kake. The conditions that would exist with each of these alternatives in place represent the with-project condition.

National Economic Development Vs. Regional Economic Development Impacts

In Corps water resource studies, impacts to the economy are typically measured in National Economic Development (NED) and Regional Economic Development (RED) terms. As the names imply, NED impacts are measured by changes to the national economy, while RED impacts are measured by changes to the regional (or local) economy. Project benefits under the NED criteria are based on increases in the net value of national output of goods and services, including the value of goods and services that are and those that are not marketed. Frequently the RED effects of a project are larger than the NED effects, because net gains and losses in one region can be reduced or entirely offset by gains and losses in another region, resulting in lesser impacts to the national economy as a whole.

The objective of most Corps water resource studies is to identify the plan that reasonably maximizes net NED benefits while meeting certain engineering and environmental criteria. This plan is called the NED plan.

3.3.2. NED Benefits of Kake Water Supply

Supplying water to a community for municipal and industrial uses is critical. Particularly important is supplying drinking water as it is not an optional activity. Water is essential for the health and welfare of the community, so the problem becomes determining how best to meet the demand. In a water supply study, the essential premise of each viable alternative is that it would be capable of supplying the minimum dependable yield required by the community. Therefore, it can be concluded that each viable alternative will meet the water supply needs of the community, resulting in approximately the same benefits to the community. For NED purposes, the benefits of water supply are measured on a willingness to pay basis as demonstrated by the most likely, least-costly non-Federal alternative. However, Kake is a small community with a population of less than 10,000 and does not possess the efficiencies of large-scale development. Therefore, the policy for smaller communities will apply to this project and the NED benefit is equal to the cost of the separable M&I facilities plus an appropriate share of the remaining joint cost of the project. In other words, the benefit of the project is equal to the cost of the project.

Commercial fishing activities are given special attention in this evaluation because operations of the hatchery support the local commercial fishing fleet. Salmon fry raised and released by the hatchery eventually return to Gunnuk Creek during the annual spawning runs. Kake has nine local commercial fishing vessels that fish the Gunnuk Creek opening. The local fleet delivers its catch to the local processing plant, Kake Tribal Fisheries, which then delivers the final products to market.

3.4. Existing, Without-Project, and With-Project Conditions

The following paragraphs will describe existing, without-project and with-project conditions. For each condition, water demand, water supply and impacts to commercial fishing will be explained.

3.4.1. Existing Conditions

Water Demand. According to the 1995 report for Kake, total water demand at Kake has historically been 1.66 million gallons per day (gpd).

Water Supply. Immediately after the failure of the dam, in July of 2000, a temporary water supply system with two six-inch pipelines with electric pumps was installed downstream of the failed dam to pump water for the city water plant. The temporary system is not an adequate supply as it does not meet municipal and industrial needs.

The City of Kake and the Kake Nonprofit Fisheries Corporation have constructed a temporary low profile dam to draw water for the municipal and industrial uses. The intake structure is sited approximately 1,500 feet upstream of the previous dam site and feeds two 10-inch water lines that supply water to the city and the hatchery.

Permit stipulations state the system is not to draw water from the creek when the instream flows below the dam are below 11 cubic feet per second (cfs). The structure is also to be removed in its entirety upon completion of a permanent dam (estimated to be 2003). The low profile dam was completed in June of 2001 and is the only functioning supply for the city as of the writing of this report. The water supply for the city from this system still remains precarious with concerns about low instream flows and the possibility of icing during the winter months that may interrupt the steady supply needed for municipal and industrial purposes.

The City of Kake has also attempted to construct an infiltration gallery immediately downstream of the dam. The system has experienced technical difficulties and is not operational.

A $3.1 million project to pipe water from nearby Alpine Lake to Kake was completed in May of 2002. Alpine Lake is within the Gunnuk Creek watershed. The lake is high enough to provide gravity flow through the existing treatment plant and into the treated water storage tank. With the inlet submerged in the lake the water would be conveyed through a 10-inch pipeline following existing roads for a total distance of about 31,000 feet. The project was a result of the 1995 report prepared for the City of Kake to find a supplemental water source for the municipal water system. The Lake contains a useable supply of 1950 acre-feet of water that could yield 2.7 cfs for a period of 365 days. An assessment for the Alpine Lake project was completed in January 2001 for the possible draw down that could be expected from withdrawal of water from Alpine Lake and determine what magnitude of sustained withdrawal the lake could support. The assessment reported the findings of the new water balance model and estimated the maximum sustainable water withdrawal rate would be between 700,000 and 1,000,000 gpd which is short of the 1,960,000 gpd needed by the community.

Commercial Fishing Activities. Kake has nine local commercial fishing vessels that fish the Gunnuk Creek opening.

Summary of Existing Conditions. The temporary system has sustained the water supply needs of the community. However, the long-term impact to the community without a dependable water supply was foreshadowed when the dam was breached. As a result of the dam failure, the hatchery experienced a 15 percent egg and fry mortality due to unfiltered incubation water and the partial reliance upon re-circulated water with the subsequent high levels of ammonia and lowered dissolved oxygen. Production was reduced to 77 percent of

the hatchery's egg capacity in 2001. The result of the loss of production will not be realized until the adults return (4 to 5 year return).

3.4.2. Without-Project Conditions

Water Demand. Based on the 1995 report for Kake, water demand for the City of Kake is projected to rise to 1,960,000 gpd.

Water Supply. There is a back-up water supply currently being constructed at Alpine Lake, within the Gunnuk Creek watershed. The project has a $3,100,000 capital project cost. It is estimated that once in place this back-up system would have a maximum sustainable water withdrawal rate of between 700,000 and 1,000,000 gpd. This would not be sufficient to supply the projected municipal water demand of 1,960,000 gpd. The current temporary system was considered for the permanent water delivery system. This system would require upgrading, electrical pumps, and a filtering system at its present location. However, this system would lack storage capability, resulting in regular water shortages.

As described under existing conditions above, an interruption in water supply requires that water already in the tanks be re-circulated. As the water is re-circulated, the fish gradually deplete the oxygen and ammonia builds up from the fish wastes. Fry survival is reduced by the poor water quality, and ultimately the local fishing industry suffers because fewer fry are released and fewer adult salmon return for the spawn. Depending upon the frequency and duration of each interruption, the impacts could range from reduced fry development to loss of the entire year's production.

Relocation was considered; however, the obstacles would be tremendous, due to the remote location of alternative sites, potential environmental impacts, and other fishery considerations. At best, it would take a number of years to secure the necessary permits for construction/operation at the new site, which in and of itself could force the hatchery out of business. If proper permits were obtained, the remote location would create construction costs that are likely to be 50% higher and operating costs that are 25% greater than existing conditions. Kake Nonprofit Fisheries Corp. and the City of Kake do not have the financial resources for such a move and would be unlikely to obtain financing through the usual source, the State of Alaska's Revolving Fisheries Enhancement Loan Program. That notwithstanding, the cost to relocate the facility would be approximately $4.9 million and annual operating costs would rise by $250,000 annually. Due to these significant financial and political obstacles, the hatchery would be expected to close rather than relocate.

Therefore, under without project conditions it is expected that only the Alpine Lake pump system would be in place to supply water for the community of Kake.

Commercial Fishing Activities. Without the hatchery, the salmon supply for the Gunnuk Creek opening would not exist. Without the local opening, seven of the nine vessels could fish other openings during this time of the season while the remaining two vessels would not, because they are not licensed to fish elsewhere in the state.

Prior to the opening of the Gunnuk Creek Hatchery, the seven commercial vessels that are licensed to fish elsewhere in the state made five trips each to Hidden Falls and one trip to Ketchikan to fish the openings at those locations. Since the hatchery would fail without water supply and would not produce fish, commercial fisherman in Kake report that the commercial vessels that fish the Gunnuk Creek opening would again fish the Hidden Falls and Ketchikan openings.

Summary of Without-Project Conditions. The Alpine Lake water supply system is going to be constructed in 2002 with a project capital cost of $3,100,000, and annualized costs equal to $289,450. This water supply system is not expected to meet the water demand of 1,960,000 gpd.

3.4.3. With-Project Conditions

Water Demand. As described under without-project conditions, the projected water demand for the City of Kake is 1,960,000 gpd.

Water Supply. Typically, a least cost analysis is performed to identify the project alternative that would dependably provide the required water supply. In this study a least cost analysis is not possible because all but one potential alternative have been eliminated on other grounds. Two alternatives that were considered under without project conditions, the Gabion Dam and the Infiltration Gallery, were dropped as potential with-project solutions because they could not provide a dependable water supply. The Rock-Filled Dam and the Concrete Faced Rock-Filled Dam were eliminated because topography precludes construction of a spillway. While a Roller Compacted Concrete dam is possible, the size of the project site limits the effectiveness of this approach. The only remaining alternative is a Concrete Dam constructed using conventional methods.

Commercial Fishing Activities. With the construction of a concrete dam, the nine commercial vessels would be able to continue fishing the Gunnuk Creek opening.

Summary of With-Project Conditions: Concrete Dam. A 23 foot concrete dam would be constructed in 2003 with a project capital cost of $6,832,600. The Alpine Lake water supply system is going to be constructed in 2002 with a project capital cost of $3,100,000. The dam will provide dependable water supply to meet Kake's M&I needs of 1,960,000 gpd. The Alpine system will work in concert with the dam to supplement M&I needs and will serve as a backup to the dam. Hatchery production would be able to resume at 100 percent of egg capacity when the dam is built. Because the dam would allow for full hatchery production, the nine local vessels would be able to conduct normal fishing activities.

3.5. RED Benefits in Kake – Local Jobs

Fish returning to the Gunnuk Creek Hatchery comprise more than 75% of the salmon poundage being processed at the Kake Cold Storage. Nearly 50% of the local seine fleet's income has likewise been generated through the cost recovery harvest of the local hatchery's returning fish in the past three years. It is therefore safe to assume that all of the jobs listed below would be jeopardized by the closure of the hatchery.

Projected 2002 seasonal (6-month)Cold Storage workforce	≈ 120
Year-round Cold Storage jobs	≈ 12
Local fishing (purse seine) jobs	≈ 40
Seasonal (6 to 8 month) hatchery jobs	= 9
Year-round hatchery jobs	= 5

"Other" (clerical/support) jobs	≈ 3
Total employment impact to the community of Kake	**≈ 189**

3.6. Benefit Summary

As discussed in the without-project condition relocation was considered, however, due to significant financial costs and political obstacles the community could not afford to relocate the hatchery. According to policy for NED benefits the project benefit for small communities with a population under 10,000 that are not able to afford an alternative water supply may be considered equal to the cost of the project. Under without project conditions the M&I needs of the community would not be met by the Alpine Lake project because it will lack a dependable water supply.

Table 4 displays the costs and benefits under the with- project conditions. All of the estimated costs and benefits reflect October 2001 price levels. For comparison purposes, all values have been converted to average annual values using the FY 2002 Federal Discount Rate of 6.125 percent.

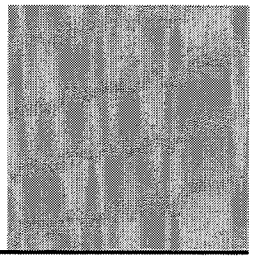
The Alpine Lake water supply system is expected to be in place and the project cost is $3,100,000 with an average annual value of $290,800. The with-project average annual costs equal the average annual NED benefits. The resulting benefit-cost ratio equals 1.0.

The proposed $7,000,000 investment would also produce Regional Economic Development Benefits that are not shown by the NED calculations. The proposed project would protect the community's investment in the hatchery, which is valued at approximately $5,000,000 and would also protect approximately 190 local jobs, equal to almost 1/3 of the local employment. From the regional perspective the proposed capital investment is more than feasible; it is necessary to sustain the local economy, which has already lost 30% of local jobs due to logging restrictions in the National forests.

Table 4. Summary of Project Feasibility

Item	With Project
Project First Cost	
Alpine Water System	$3,100,000
23' Concrete Dam	$6,096,800
Total Project First Costs	$9,196,800
Interest during construction	$125,500
Investment cost	$9,322,300
Annual equivalent (50 years @ 6.125%)	$609,000
Annual operation, maintenance & replacement	$136,600
TOTAL ANNUAL COST	$745,600
TOTAL ANNUAL BENEFITS	$745,000
Net annual benefits	0

Benefit/cost ratio	1.0
Estimated Regional Benefits	
Approximately 190 jobs saved	
$5,000,000 Hatchery investment saved	



4.0 RECOMMENDED PLAN

4.1. Selection of Recommended Plan

During the design meeting, a Value Engineering exercise was undertaken to facilitate the selection of the recommended plan. A baseline design was presented at the meeting. With the input of local participants, agency personnel, design and study personnel, and representatives from the City of Kake, the recommended plan was established. Alternative 4 (concrete dam) was selected as the recommended plan because it provided the most stable source of water for the community, including the hatchery, was technically feasible, socially acceptable, and could be constructed to minimize environmental impact. The other alternatives that created no reservoir were considered unacceptable to the community for various reasons. The reasons given were the risk to the hatchery during periods of low flow, and the assertion that the intent of the language in the authorization was for the repair or replacement of the dam on Gunnuk Creek.

Of major importance in the planning process is the incremental analysis to determine the size of the dam. Survey information had been gathered to facilitate design of a spillway for the dam 17 feet higher than the existing dam spillway. The benefit (increasing the height of the spillway) is the amount of reserve the community would realize during periods of low flow. Alpine Lake provides a large reservoir that, according the report done for the City of Kake, should be capable of meeting their need for the 20 year period forecasted. The hatchery water demand cannot be sustained by the Alpine Lake reservoir. The flow from the creek represents the best source for the hatchery, and by creating as large an impound area as possible, the greater the buffer available for supplying the hatchery's water demand. Another benefit with a larger reservoir is the ability to pump the community's water to the treatment facility using a hydroturbine and reducing costs associated with pumping from the creek. A larger reservoir could also help maintain required instream flows during extremely low flow periods in the creek.

Preliminary estimates for the higher dam exceeded the $7,000,000 Federal limit for funding, putting the burden on the City of Kake to procure the additional funds required to implement the larger reservoir. Additional concern was the impact the higher reservoir would have on habitat. Earlier coordination with regulatory and other responsible agencies had revealed concern about the project if it included a damming of the creek. The previous dam had been constructed prior to the National Environmental Policy Act (NEPA) and other legislation that

regulate construction of dams. In an effort to minimize the impact to habitat, a spillway height equal to the previous dam spillway was chosen. The cost estimate presented for the Value Engineering exercise for replacing the dam at the same height was $5,700,000. This left a little room for increasing the height of the dam but omitted some essential features needed to improve the functionality of the dam. Increasing the height of the dam would not only add cost to the construction but also would increase the cost for the design and study. By maintaining the existing spillway height, the cost of the project and the amount of preparation time required to complete the NEPA requirements was reduced.

Further evaluation during the meeting produced design elements that reduced the estimated cost of the base project presented for the Value Engineering exercise. The resulting plan is illustrated in figures 8 and 9, and described in the following section. Project costs for this plan are shown in table 6.

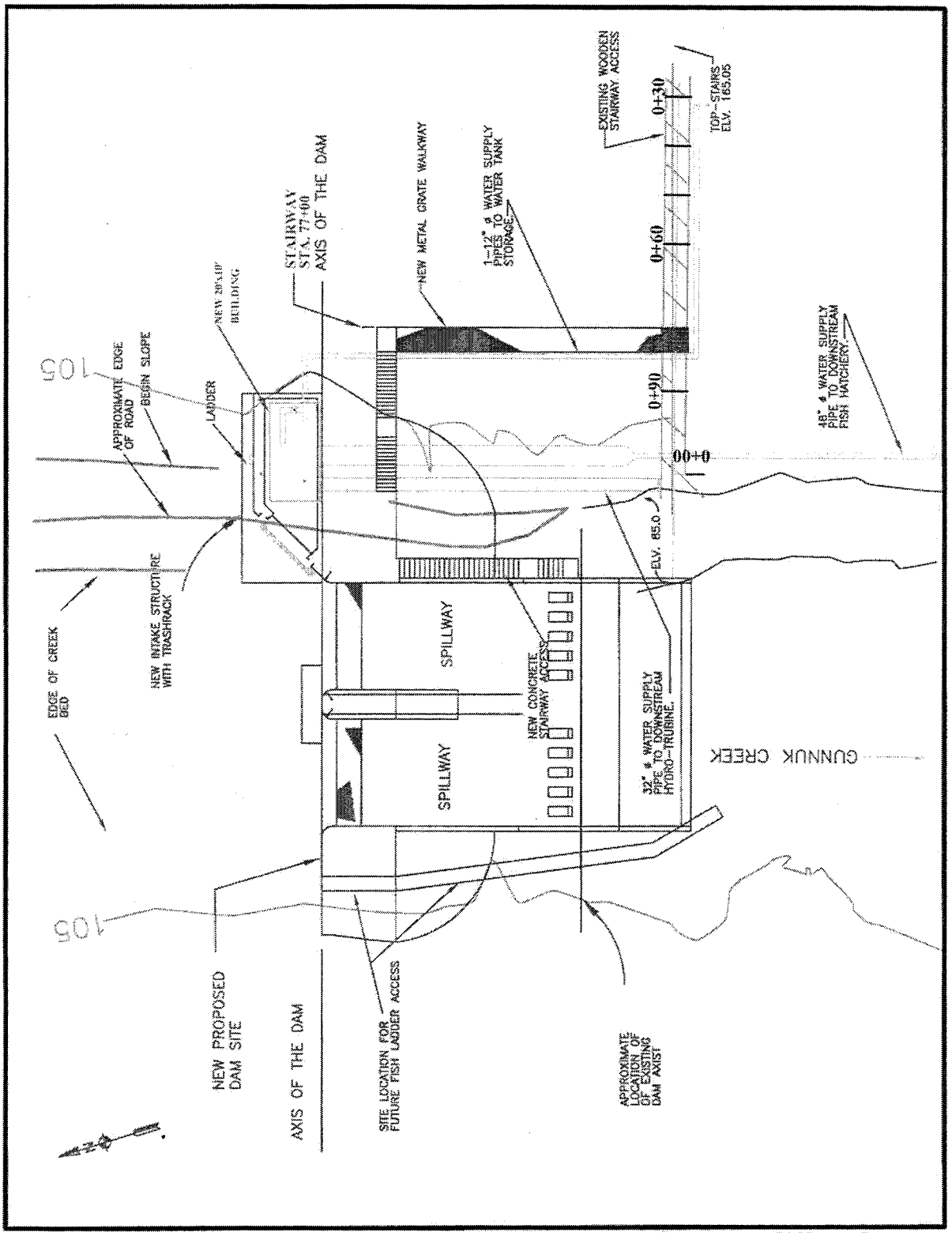


Figure 8. Plan view of Recommended Plan

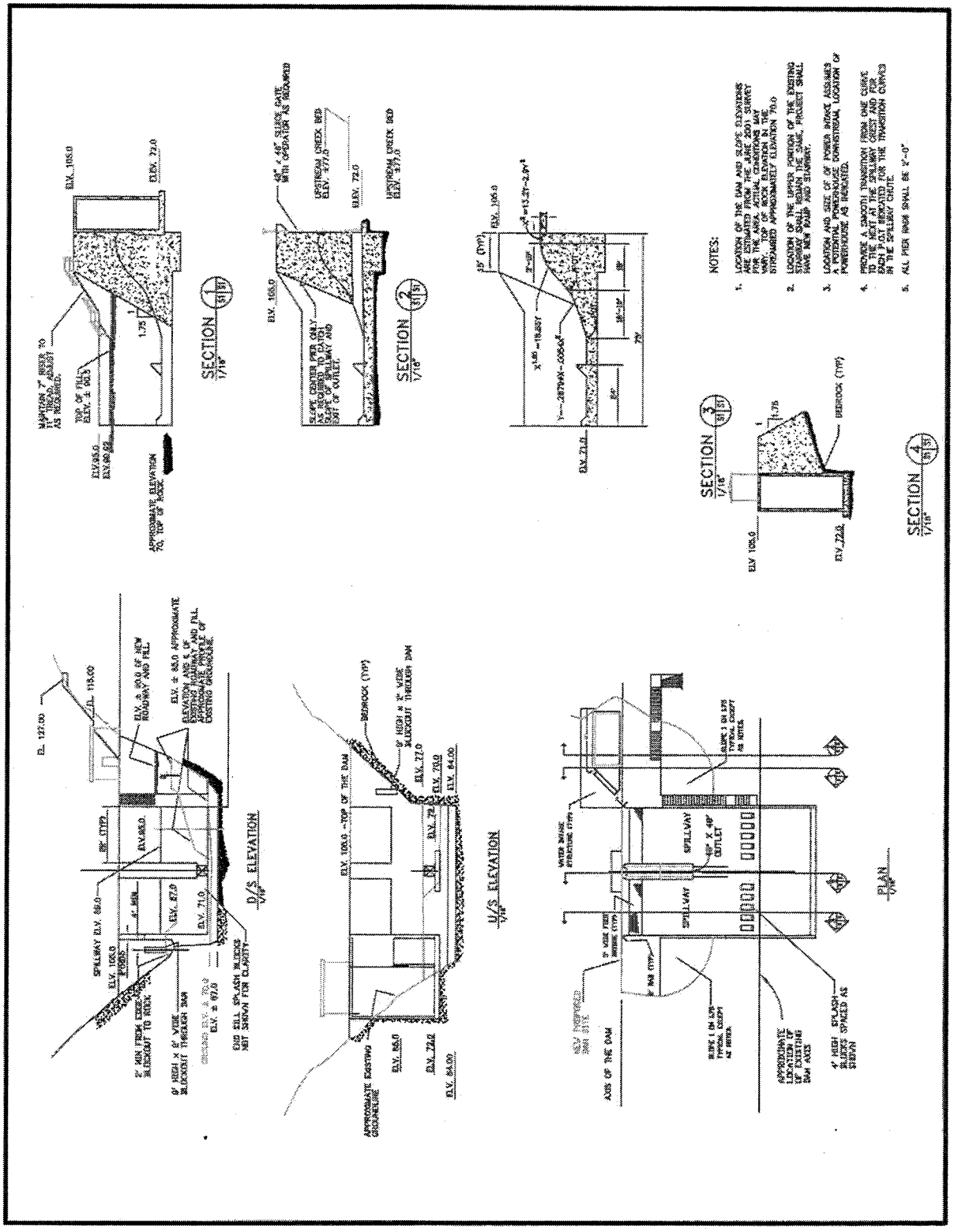


Figure 9. Various Elevation Views of Recommended Plan

4.2. Plan Components

Removal of the Old Dam. The existing dam, infiltration gallery, pump house, stairways, piping, and foundations for the dam would be removed and disposed of at a designated site owned by the City of Kake. Ownership of the materials would be transferred to the City of Kake for their use or disposal. After the project is operational, the temporary "gabion dam" would also be removed and disposed in the same site as the materials from the old dam.

Concrete Gravity Dam. The selected project would propose a construction of a concrete gravity dam on Gunnuk Creek, 53 feet upstream from the old dam that failed in July of 2000. The footprint of the dam including the spillway and intake structures would cover an area of approximately 4,750 ft^2. The height, if the spillway design is approximately 89.0 feet MLLW, would be 18 feet above the creek bottom, basically the same elevation as the previous dam. The spillway would extend horizontally 62 feet from the impoundment area to sill splash blocks at the downstream end of the structure. The impoundment area behind the dam would be 2.1 acres. To provide the area required to pass the maximum probable flow for Gunnuk Creek, the dam will have two 22 foot wide spillways to a height of 105 feet MLLW. An estimated 3,772 yd^3 of concrete would be placed for the construction of the dam. A calculated 978 yd^3 of rock removal may require blasting to key the dam into the surrounding bedrock. The construction of the dam would also be designed to allow for the inclusion of a fish ladder that could be retrofitted at a later date if the hatchery or dam use changed or it there was a need to allow a natural run of salmon upstream of the dam.

Intake Structure. An intake structure on the west upstream side of the dam would allow for the supply lines for the City and the hatchery. A trash rack would cover the 18 foot by 14.6 foot intake structure opening. Behind the trash rack would be placed an intake screen designed to meet requirements as a fish screen and allow for the adequate flow of water for the intake lines.

The intake lines would include one 12 inch diameter lines pumped to the existing treatment facility, one 48 inch diameter line for the hatchery supply, and a 32 inch diameter line for connection to a hydroturbine to facilitate pumping to the city's treatment facility. The hatchery supply line would be necked down to a 10 inch line that would continue down to the hatchery. The larger opening (48 inch) would allow for the potential, future hydropower generation.

The creek was not considered to be a viable source of power generation on a large scale but could provide a limited amount of power that could supplement some of the community's need. It was decided to include the larger intake pipe during the construction of this project and left to the city to develop the energy potential later.

Pump House. A 200 ft^2 pump house would be placed on the top of the dam above the intake structure. The poly-sided structure would house water pumps currently used in the pump house from the old dam.

Dam Access Ways. For the safe operation and maintenance of the dam, existing stairways would be removed and replaced with new stairs for access to the pump house and to the top of the canyon where the treatment facilities are located. A bridge across the spillways would enable access to the other abutment, and a ladder would be placed on the upstream side of the dam to allow access to the impound area for maintenance operations.

Stream Gauge. For operation of the dam, a continuous reading stream gauge would be installed. The gauge would record the flows in the creek and would help meet permit requirements for maintaining minimum flows from the dam reservoir when withdrawing water.

Fill and Excavation. During construction of the project, additional instream work would occur. This work would include the improvement of the fill on the temporary pipes from the gabion dam for use as an access road for construction of the dam. An estimated 1260 yd^3 of material would be placed to upgrade this fill for construction equipment access. This material would be removed along with loose material that has accumulated in the creek bed. Approximately 11,710 yd^3 of material would be removed and placed in the designated disposal site, for use as fill at the treatment facility.

4.3. Construction Considerations

Access Road. Upstream of the dam the two pipes that convey the water from the temporary "gabion dam" were covered the entire length with gravels that were removed from the creek bed to form an access road. The road was a violation of the permit, allowing the temporary dam and pipe system to be constructed. Compensation was agreed to for this violation by the City of Kake. The use of this road, during construction of the recommended plan, would be allowed by regulatory agencies. Access down to the creek would be make possible by a road that was cut to the river in 1983 during a maintenance operation to remove silts and gravels that had accumulated behind the dam. The grade of the road does not meet the Corps of Engineer's safety standards as stated in EM 385-1-1, Section 21.1.07b. To allow the use of this road, without requiring the improvements necessary to meet the grade requirements, a waiver was requested through the Corps of Engineers Safety Office. Costs included in the estimate reflect the prep work and construction safety requirements listed below necessary to use the road with a waiver of the grade requirements. In order to meet grade standards, extensive clearing, excavation, and fill would be required and could result in excessive project costs as well as environmental impacts. Without this waver the cost could increase an estimated $786,000 to prep the access road for construction of the project. To allow for construction using the steeper grade, the following requirements as well as possible other precautions would need to be satisfied by the successful contractor:

- The contractor would provide a safety and health professional on the job site during the work. That individual would have no other duties assigned.
- The contractor would be required to perform and document daily mechanical checks on all vehicles using the road.
- Traffic would be limited to one way, controlled by radio equipped flag people at the top and bottom of the road.
- A "runaway ramp" would be constructed for emergency use by downhill traffic.
- Vehicles with heavier loads would be attached to a dozer (minimum size D-7 Caterpillar or equivalent) to further assist safe decent and ascent of the road.

In-Stream Work. During the construction of the recommended project, the work would occur in the creek and creek bed. It is very likely that the access road described in the preceding paragraph would require improvement in some of the sections along the creek.

Excavation of gravels from the creek is proposed for providing protection to the water supply lines buried under the road. The removal of gravels from the creek bed would likely occur, also, during the preparation work for the foundation and for the placement of the concrete. The creek would also be affected during the demolition of the old dam and for the removal of the temporary "gabion" dam.

Work performed in the stream would need to observe certain precautions to minimize impact to the wildlife and habitat downstream from where the work would be performed. Such precautions would include the use of silt barriers and limiting work to periods during the season when increased silts or fines in the creek would not adversely effect spawning or habitat. These "work windows" would be established by the governing agencies in consultation with the hatchery operations.

4.4. Operations and Maintenance

This section summarizes the anticipated operations and maintenance (O&M) measures for the project. Because the recommended project is essentially a replacement of the previous dam, the requirements for operation and maintenance would be similar with the exception of new regulation and upgraded equipment requirements. These new requirements would be provided to the City in the form of an Operation and Maintenance manual before the completion of construction. Additionally, when the Alpine Lakes project comes online, the City would have the opportunity to manage the various systems in a manner that would allow for efficient use of the two reservoirs and alternative power sources. Doing so may increase labor costs but would reduce electrical costs and provide for a greater reserve of water during dry or low flow periods.

Dam Operation. The permits for appropriation of water from the dam have as a requirement minimum in-stream flows that must be observed. The Certification of Appropriation the City of Kake has for the withdrawal of 5 cfs from behind the impound of the dam does not have this requirement. The City's Permit to Appropriate 12 cfs has a stipulation that a minimum of 11 cfs must go over the spillway to withdraw water using the hydroturbine. And it appears the two Permits to Appropriate water that the hatchery own have the same minimum in-stream flow requirements that must be met for the withdrawal of water from the impoundment.

During the study process, State and Federal agencies were brought together to determine in-stream flow requirements for the operation of the dam. At present, there still was no consensus on the new in-stream flow requirements: The hatchery was working with the regulatory agencies to make this determination. Once it is determined what the in-stream flow requirements would be, the City of Kake and the hatchery would need to implement these requirements when operating the dam.

To aid in the reading of in-stream flows, a stream gauge, continuously monitoring the flows, would be used in the project. It would be the responsibility of the city to monitor and maintain the stream gauge. Estimates for the maintenance of the gauge amount to $15,000 annually. To aide in the operation of the hydroturbine, it is recommended that the stream gauge be connected to the hydroturbine system for regulation of the system. Utilizing the hydroturbine as much as possible, would reduce the electrical costs to the city for the pumping of water and allow the Alpine Lakes project to be reserved for low flow periods.

Before the dam can be operated, the city would need to apply and receive a certificate to operate a dam from the State of Alaska. In addition the local sponsor must produce an emergency action plan for operation of the dam and for the area affected below the dam as a result of dam failure or flooding. After operations have been initiated, the city would need to make periodic safety inspection. A professional engineer on the order of every 3 years to continue dam operation would perform these inspections. Estimates are about $5,000 to $10,000 for each inspection. Also, dam operators would need to be trained in dam safety and operations to ensure the safe and efficient use of the water supply system during the various flow conditions anticipated in the watershed.

Dam Maintenance. In addition to equipment maintenance, the city would need to remove debris, as often as necessary, to ensure there are no obstructions in the spillway or intake structures. The sediments that accumulate in the impound area would also require removing. Stipulations, provided from the Department of Fish and Game as well as recommendations from U.S. Fish and Wildlife Service, should indicate the frequency and allowable work periods to perform the removal of accumulated fines and gravels from behind the dam and how they are to be reintroduced downstream from the dam. Coordination with the hatchery would also be required to ensure no adverse impact to their operations. These maintenance procedures have been performed by the City of Kake for the previous dam and similar procedures are anticipated for the new dam operation. All dam maintenance procedures shall be included in the O&M manual for the dam.

4.4.1. Operations And Maintenance Of Water Supply Facilities

The following operation and maintenance costs were supplied by the City of Kake or were taken from the 1995 report for the Alpine Lakes project and are shown in table 5. These include energy costs for pumping water from the reservoir to the municipal treatment facility and the labor costs for the personnel to operate and maintain the previous dam and the temporary structure now supplying water for the community.

The following assumptions were used, under existing and prior conditions, to determine the costs to operate and maintain the dam: (1) 80 percent of the electrical costs are for pumping water; costs are averaged over the period from the supplied information; 66 percent of State subsidized costs for electricity are included. (2) Costs from the 1995 report have been escalated to 2001 dollars.

With-project conditions would be comparable to conditions, prior to the dam failure, because the proposed project would replace a dam with a dam. Operations would essentially be the same with the following differences:

Electricity: Historically, the hydroturbine has been used to pump about 15 percent of the water due to various operation difficulties. Considering the flows needed to operate the turbine and the in-stream minimum flow requirements for withdrawal of water, a minimum flow of 23 cfs is needed to utilize the hydroturbine. Flow duration charts for Gunnuk Creek show that the creek, equals or exceeds 23 cfs, 70 percent of the time annually. Assuming the hydroturbine was used to pump water 50 percent of the time or an increase of 35 percent of the time, the daily average cost for electricity would be $136.47 x .65 = $89.35.

Table 5. O&M Costs Comparisons

	Labor ($/day)	Electricity ($/day)	Stream Gauge ($/yr)	Total ($/yr)
Prior to failure	243.80	136.47	-	138,798
Existing (Current) conditions	341.40	224.64	-	206,604
Future Without-project (Alpine Lakes)[a]		-	-	87,798
Future with-Project (Recommended)	243.80	89.35	15,000	136,600

[a]1995 report assumed an annual savings of $51,000 per year ($139.73 per day) compared to the Prior Conditions.

Table 6. Cost of Recommended Plan (Concrete Dam)

November 2001 price level

	Quantity	Unit	Unit Price	Total Cost
Construction Contract				
Mob/Demob	1	Ea.	$514,000	514,000
Care and Diversion of Water	1	L.S.	$87,000	87,000
Access Road	1,260	yd^3	$29.60	38,000
Bridges	1	L.S.	$19,000	19,000
Earthwork	1	L.S.	$241,000	241,000
Foundation Work	1	L.S.	$137,000	137,000
Embedded Metal Work	1	L.S.	$182,000	182,000
Concrete Dam	1	L.S.	$2,462,000	2,462,000
Associated General Items[1]	1	L.S.	$596,000	596,000
Subtotal				$4,276,000
Construction Contingency			20%	$855,200
Total Construction Contract				$5,131,200
Contract Documents				
Preconstruction, Engineering, and Design			11%	476,000
Supervision & Administration			11%	476,000
Subtotal				$952,000
Contract Award + Construction				$6,085,200
Real Estate Acquisition				$13,600
Intrest During Construction (IDC)				$82,000
Total Project Cost (Contract Award, Construction, IDC, plus Real Estate)				$6,178,800
Annual Cost (6 1/8% at 50 years)				$399,000
Annual Operation and Maintenance				$136,600
Total Annual Cost				$535,600

4.5. Utility Relocations

The utility line from the collapsed dam pump house building will be lengthened to allow for continuous electrical service. There are no plans to relocate any roads. Roads may be contoured and graded to meet safety requirements. A runout ramp and turn out area will be added to the upper road near the temporary gabion dam for safety purposes. No other utility or facility relocations are anticipated for this project.

4.6. Real Estate

The Real Estate Plan and Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability are contained in appendix B attached to this report. The value of lands and related expenses estimated for the project are shown in table 7.

Table 7. Real Estate Costs

Item	Federal	Non-Federal
Lands		$3,600
Administrative, Non-Federal	$5,000	$5,000
TOTAL	$5,000	$5,000

4.7. Consultation Requirements

An environmental assessment was prepared with the finding that the project is not likely to have an adverse effect on the biological resources at Kake.

During the planning phase of this project, coordination with the Office of Dam Safety for the State of Alaska was initiated. This coordination will continue through the development of plans and specifications as well as during construction. The Federal government will need to apply for and receive a certificate to construct the project, and prior to the operation of the dam, a certificate to operate the dam will be required from the State of Alaska.

4.8. Public Coordination

The City of Kake has been an integral part of the study process during the development of this report and its recommendation. The City of Kake has stated their preference for the recommended plan.

4.9. Federal and Non-Federal Costs

This project is a Construction General Project, which currently has a maximum allowable Federal authorization of $7,000,000. The total project cost, including the cost for this letter report, environmental coordination, and for the project cooperation agreement, is $6,141,200. The Federal cost is estimated to be $6,136,200, which includes the cost of $500,000 for preconstruction, engineering, and design, and $5,131,200 for construction of the recommended plan. The non-federal cost is $5,000 the administrative cost of LERR.

Once this decision document is approved and a Project Cooperation Agreement has been signed, a construction contract would be prepared to implement the recommended plan.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The study, documented in this report, indicates that Federal construction of a replacement dam on Gunnuk Creek in Kake, Alaska, as directed be Congress and as described in the recommended plan, is technically feasible, and environmentally and socially acceptable. The City of Kake has indicated its willingness to act as a local sponsor for the project and fulfill all the necessary local cooperation requirements. Thus, it is concluded that the Federal government should proceed with construction of the replacement dam recommended herein.

5.2. Recommendations

I recommend that the replacement dam at Kake, Alaska be constructed, as directed by Congress and generally in accordance with the plan herein subject to modifications deemed advisable by the Chief of Engineers. The estimated total project cost is $6,141,200, which includes the Federal cost of $6,136,200 to construct the recommended plan. The total non-federal cost, which includes the cost of real estate, is $5,000, which is the administrative cost of LERR acquisition.

The recommendation is made with the provision that prior to the start of construction, non-federal interests would agree to the following:

- Provide without cost to the United States all lands, easements, and rights-of-ways, including suitable areas for borrow and disposal of excavated materials, as determined by the Chief of Engineers, necessary for the implementation of the project.
- Hold and save the United States free from damages due to construction of the project, not to include damages due to the fault or negligence of the United States or its contractors.
- Maintain and operate all the works after completion in accordance with regulations prescribed by the State of Alaska and the Secretary of the Army.

The recommendations for the implementation of the water supply project at Kake, Alaska reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect the program and budgeting priorities inherent in the local and State programs of the formulation of a national civil works water resources program. Consequently, the recommendations may be changed at higher review levels of the executive branch outside Alaska before they are used to support funding.

Date _____

Steven T. Perrenot
Colonel, Corps of Engineers
District Engineer

6.0 REFERENCES

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Http:/www.dced.state.ak.us/mra/cf_comdb.htm

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