

COMMITTEE REPORT

SENATE

FURTHER:

5/19/83

Date: 3/28/84

Mr. President:

The Committee on FINANCE has had SB 272

under consideration and (a majority of the committee) (the committee) reports it back with the following recommendations:

- do pass do not pass
- do pass with attached amendments(s)
- replace with CS for SB 272 (Finance) same title new title
- and recommends DU PASS
- AND attaches a "Letter of Intent" New Fiscal Note
- reports it back without recommendation
- referred to the _____ Committee

MEMBERS SIGNING
DO PASS

MEMBERS HAVING
OTHER RECOMMENDATIONS:

CHAIRMAN

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3-28-84

Original sponsors: Faiks, V. Fischer,
Bennett and Josepshon

Funding Information

General Fund	\$52,056,000
Other Funds	Ø
	<hr/>
	\$52,056,000

1 IN THE SENATE

BY THE FINANCE COMMITTEE

2 CS FOR SENATE BILL NO. 272 (Finance)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 THIRTEENTH LEGISLATURE - SECOND SESSION

5 A BILL

6 For an Act entitled: "An Act making special appropriations for payment as
7 grants to the Municipality of Anchorage for the
8 Eklutna Water Project, to the City of Kotzebue for
9 drilling geothermal wells, to incorporated commun-
10 ities for water and sewer projects, and to school
11 districts for school construction projects; and
12 providing for an effective date."

13 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

14 * Section 1. The sum of \$34,000,000 is appropriated from the general
15 fund for payment as a grant to the Municipality of Anchorage for phase III
16 final design of the Eklutna Water Project, including design of the water
17 treatment plant and lake intake structure; construction of pipeline segment
18 p-2 from Eagle River to Peters Creek and pipeline segment p-3 from Peters
19 Creek to the Eklutna River; and miscellaneous costs of permitting and
20 right-of-way acquisition.

21 * Sec. 2. The sum of \$7,956,000 is appropriated from the general fund
22 for payment as a grant to the City of Kotzebue for drilling exploratory
23 geothermal wells.

24 * Sec. 3. The sum of \$400,000 is appropriated from the general fund
25 for payment as a grant to the City of Akiak for construction of a water
26 and sewer system.

27 * Sec. 4. The sum of \$750,000 is appropriated from the general fund
28 for payment as a grant to the City of Fortuna Ledge for phase II construc-
29 tion of a water and sewer system.

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3-28-84

1 * Sec. 5. The sum of \$1,500,000 is appropriated from the general fund
2 for payment as a grant to the City of Fort Yukon for phase II construction
3 of a water and sewer system.

4 * Sec. 6. The sum of \$1,500,000 is appropriated from the general fund
5 for payment as a grant to the Galena City School District for construction
6 of an elementary addition to Galena School.

7 * Sec. 7. The sum of \$1,450,000 is appropriated from the general fund
8 for payment as a grant to the Iditarod Area School District for construction
9 of an elementary addition to Grayling School.

10 * Sec. 8. The sum of \$2,500,000 is appropriated from the general fund
11 for payment as a grant to the Lower Kuskokwim School District for constuc-
12 tion of an elementary addition to Quinhagak School.

13 * Sec. 9. The sum of \$1,000,000 is appropriated from the general fund
14 for payment as a grant to the Yukon Flats School District for construction
15 of a new school in Stevens Village.

16 * Sec. 10. The sum of \$1,000,000 is appropriated from the general fund
17 for payment as a grant to the Yukon/Koyukuk School District for construction
18 of a secondary addition to Manley Hot Springs School.

19 * Sec. 11. The appropriations made by this Act shall be disbursed in
20 accordance with AS 37.05.315-317.

21 * Sec. 12. This Act takes effect immediately in accordance with AS 01.-
22 10.070(c).

EKLUTNA STATUS REPORT

March 27, 1984

In the 1983 bond election Anchorage voters supported Eklutna Water Project bonding by a 3-to-1 margin. The \$55 million bonding authorization will contribute Anchorage's 25 % share of total Eklutna project cost.

Gov. Sheffield before the Alaska State Chamber of Commerce in Sitka Sept. 29, 1983 said he would work to secure funding for this vitally needed project.

The project is on schedule and within budget. Bids for the P-1 segment (Ship Creek to Eagle River) construction were opened March 15.

The Municipality's \$51 million request for Eklutna will keep the project on schedule. Funding at the \$34 million level will threaten continuity of the project in late 1985/early 1986. Without funding by the 1984 Legislature the project will be delayed.

Significant underfunding of Eklutna in 1984 will result in added costs during construction estimated at \$6 million to \$8 million per year. Delays now mean completion delays. If funding delays completion of the project until 1989, water shortages may occur.

170,400 Alaskans will reside in the Eklutna service area in 1985. By 2024 the number of residents will increase to 449,200. Based on 150 gallons per capita per day (GPCD) usage, water requirements are:

YEAR	AVERAGE	MAXIMUM
1985	26 million	46 million
2025	67 million	117million

Present water supplies (Ship Creek and wells) provide 24 million gallons per day and 22 million gallons per day respectively. Demand will exceed supply in 1988.

FUNDING SUMMARY (in \$ millions)

1982	1983	1984	1985	1986
\$13.6	\$22.5	\$51.0	\$47.0	\$31.0
(approp.)	(approp.)	(request)	(request)	(request)
		\$17.0	\$15.0	\$23.0
		(bonds)	(bonds)	(bonds)



Municipality of Anchorage
Water and Wastewater Utility

PROJECT
EXECUTIVE
SUMMARY

JANUARY 1984

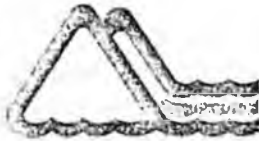
James M. Montgomery, Consulting Engineers, Inc.

In association with

QUADRA Engineering, Inc.

Ott Water Engineers, Inc.

Sverdrup/SPCM



EKLUTNA WATER PROJECT

Phone: (907) 279-2461 • 237 E. Fireweed Lane, Suite 201 • Anchorage, AK 99503

Dear Reader:

If you desire additional information about the Eklutna Water Project, please contact one of the following:

Charley L. Bryant
Project Manager

William H. Blackmer
Program Manager

Sarah Barton
Public Involvement

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INTRODUCTION

This document summarizes the salient information about the Eklutna Water Project, a major water resource development for the future. It has been written so that interested citizens and affected parties can be knowledgeable about the project. The most commonly asked questions are answered in this summary, the project's history is traced, a description of the project is given, recent project activities are described, future activities are given, and project funding is detailed.

Not all information on the project can be contained in a document this size. If unanswered questions arise about any aspect of the project, interested parties should contact the Eklutna Water Project office.

NEED FOR PROJECT

The need for an additional water source was determined based on projections of future service area populations, estimates of per capita water use, and expected capacities of existing and planned water supplies.

Since there is a large variance in the previous population projections for the Municipality that have been made by others, it was decided to utilize the Municipality's Community Planning Department's projections for the purposes of the Eklutna Water Project. Those projections have been made for the Anchorage Bowl and the Northern Communities through the turn of the century. Extrapolating the population projections to the end of the project planning period, the project team has determined that the service area population will be about 449,000 in the year 2025. Of that total, 385,000 are expected to reside in the Anchorage Bowl while the remaining 64,000 are expected to live in the communities of Eagle River, Birchwood, Chugiak, Peters Creek, and Eklutna. These population projections are shown in Table 1 by five-year increments.

TABLE 1
 EKLUTNA WATER PROJECT
 SERVICE AREA POPULATION PROJECTIONS

Year	Anchorage Bowl	Northern Communities	Total E'WP Service Area
1985	149,600	20,800	170,400
1990	179,700	26,200	205,900
1995	209,700	31,600	241,300
2000	239,800	37,000	276,800
2005	269,900	42,400	312,300
2010	298,800	47,800	346,600
2015	327,600	53,200	380,800
2020	356,400	58,600	415,000
2025	385,200	64,000	449,200

The area to be served by the Eklutna Water Project is divided into two service areas, that of the Anchorage Bowl, and that of the Northern Communities. The Anchorage Bowl service area includes the region south of the military bases to Turnagain Arm just south of Potter Marsh, excluding some Hillside areas which use on-site supply systems. It has been assumed that the military complexes will continue to supply their own water.

The Northern Communities water service area extends from north and east of Fort Richardson to the village of Eklutna, including the communities of Eagle River, Chugiak, Peters Creek, Brichwood, and Eklutna. It is anticipated that Chugach State Park will not receive water and some rural areas will continue to supply their own water.

Data on historic water demands from 1969 to the present showed an average use of 174 gallons per capita per day (gpcd). However, because of the trend of decreasing consumption and accelerated water conservation efforts by the Municipality, an amount of only 150 gpcd was used for project planning purposes. The ratio of maximum day demand to average day demand of 1.75 has been used for the project based on historical information and risk analyses.

The water utility has instituted several measures for conserving water. Education programs are given in schools, flow restricters are continuing to be distributed, and industrial, commercial and multi-family domestic users are now billed for water consumption based on metered usage. Leak detection and repair of distribution systems is ongoing. This program has resulted in measurable water conservation throughout the system. While these methods of water conservation have been effective in limiting use, they do not have the potential of eliminating the need for expansion of the water supply.

Based on the population projections, per capita water demands, and ratios of maximum day to average day demands described in the preceding paragraphs, future water requirements were determined. These requirements are displayed in Table 2.

To meet these water demands, Anchorage will have a supply of about 46 million gallons per day (mgd). This is based on 24 mgd from the Ship Creek Water Treatment Plant after its expansion in 1985 and 22 mgd from wells. However, demand is expected to exceed supply by 1988. Therefore, a new water source must be obtained.

TABLE 2
MUNICIPALITY OF ANCHORAGE
EKLUTNA WATER PROJECT SERVICE AREA
PROJECTED WATER REQUIREMENTS

Year	Average Annual Water Requirements (mgd)	Maximum Day Water Requirements (mgd)
1985	26	46
1990	31	54
1995	36	68
2000	42	74
2005	47	82
2010	52	91
2015	57	100
2020	62	109
2025	67	117

HISTORY OF THE PROJECT

Many alternative sources of supplemental water for the Anchorage water service area have been examined over the past decade.

A report on Anchorage Water Sources (Tryck, Nyman & Hayes, et. al., 1973) examined at least 25 potential water sources, ranging from artificial recharge of Anchorage Bowl aquifers and Cook Inlet desalinization to tapping streams from Portage to Chickaloon. That study recommended offstream storage of Ship Creek water on Fort Richardson as the most feasible solution to Anchorage's water problems.

Military opposition to Tryck, Nyman & Hayes' proposal eventually led to studies performed as part of the U.S. Army Corps of Engineers' Metropolitan Anchorage Urban Study (MAUS) in 1979. The MAUS study reexamined several of the alternatives studied previously, including a different offstream storage site at Ship Creek, groundwater alternatives, and other Ship Creek, Eagle River, Eklutna Lake, and Campbell Creek alternatives. Final MAUS recommendations included development of an Eklutna diversion or an Eagle River dam and reservoir. The Ship Creek storage basin option was eventually eliminated based on military opposition, MAUS findings, and other considerations.

Between the programs mentioned above, and other studies, at least 28 alternative water sources have been considered for an Anchorage area water supply. These are listed below with summarized reasons for rejection or acceptance.

The following streams were rejected as sources primarily because of lack of a suitable storage site, inadequate discharge, high sediment loads, or long or difficult water transmission line requirements: Little Susitna River, Matanuska River, Knik River, Peters Creek, South Fork Eagle River, Campbell Creek, Chester Creek, Rabbit/Indian/McHugh Creeks, Bird Creek, Twenty-Mile River, Portage Lake, Placer River, Six-Mile Creek, Resurrection Creek, and Chickaloon River. Pt. MacKenzie surface and groundwater sources were found to be inadequate, as were Eagle River, Matanuska-Knik and Portage area groundwater sources. Desalinization of Cook Inlet would not be economically feasible, reuse of present sources would be too costly, and additional conservation measures would not be adequate.

Seven other, more apparent, potential sources were gradually narrowed down to one most feasible alternative: tapping the Eklutna drainage. Use of Anchorage Bowl groundwater resources, with or without artificial recharge of the aquifers, was rejected mainly because of already near-capacity development of that source, energy requirements, unknown impacts on present groundwater supplies, and because it offers only a short-term solution.

Use of a dam on Ship Creek, or offstream storage there, was rejected because of high capital costs, adverse environmental impacts, inadequate long-term supply and complex water and land rights problems.

Tests of Eagle River area groundwater supplies indicated that very little water is available. A dam on Eagle River was rejected because of extreme adverse environmental impacts, great capital costs, technical complexity and difficulty of land acquisition.

These latter two sources, as well as the Eklutna drainage, were examined in detail by CH₂M Hill in their 1981-82 Eagle River Water Resource Study.

Eklutna Lake was determined to be the best solution to Anchorage's long-term water supply problems. The lake would be able to supply up to 200 mgd, more than enough to meet Anchorage's anticipated needs in planning year 2025. Potential adverse environmental impacts of this project would be minimal. No geotechnical problems have been identified which would prevent or significantly complicate construction of the project, nor have other difficulties been encountered which would delay completion of the project beyond the time additional water is needed for Anchorage. Although tapping the Eklutna water source would have a high capital cost, its unit cost over the life of the project is the lowest of any alternative examined. The main disadvantages included the high capital cost, water treatment requirements, and the deprivation of power-generating water to the Eklutna powerhouse.

As recommended during CH₂M Hill's study, the potential for Eklutna water was further studied and refined. CH₂M Hill proposed three different alternatives: one tapped the Eklutna Power Plant tunnel upstream of the power plant; one tapped the tailrace after water was used for power generation; and the third proposed pumping

water from Eklutna Lake into Eklutna River, and then taking the water from the river near the lower end of the valley. The CH₂M Hill studies recommended the alternative which would take water from the tailrace because of its relative technical simplicity, and because it would not impact power plant generation.

In continuing efforts to develop a new water supply, the Anchorage Water and Wastewater Utility (AWWU) contracted with the Eklutna Water Project team in November, 1982, to act as the Program Management Consultant. The project team examined an additional means of using Eklutna water as a water source. This is known as Alternative IV and involves diversion of water directly from Eklutna Lake, or the power plant tunnel near the lake, and transmission of the water from there to Anchorage by pipeline. This alternative was found to be superior when environmental, permitting, right-of-way, geotechnical, energy, and cost aspects were considered. This is the alternative finally selected and now being developed as the Eklutna Water Project (EWP).

DESCRIPTION OF THE PROJECT

The Eklutna Water Project will divert water from Alaska Power Administration's (APA) existing tunnel connecting Eklutna Lake with the Eklutna Power Plant (EPP). From there, water will flow by gravity through another tunnel and a buried pipeline down the Eklutna River Valley to a water treatment plant located on a bench above the river. After treatment, the water will flow by gravity through a 23-mile-long buried pipeline through the communities of Eklutna, Peters Creek, Chugiak, Birchwood, and Eagle River, to the distribution system near the expanded Ship Creek Water Treatment Plant (SCWTP). Energy will be recovered from the flowing water at each treatment plant location. This system will supply water to the Anchorage service area, from Eklutna Village to Potter Marsh in South Anchorage. The selected alignment and location of facilities are depicted on Figure 1.

The maximum day design flow in the year 2025 is 70 mgd and the average flow during that year is 41 mgd. Until EWP facilities are completed, an interim booster pump station near the SCWTP will be used to supply Ship Creek water to the Eagle River area.

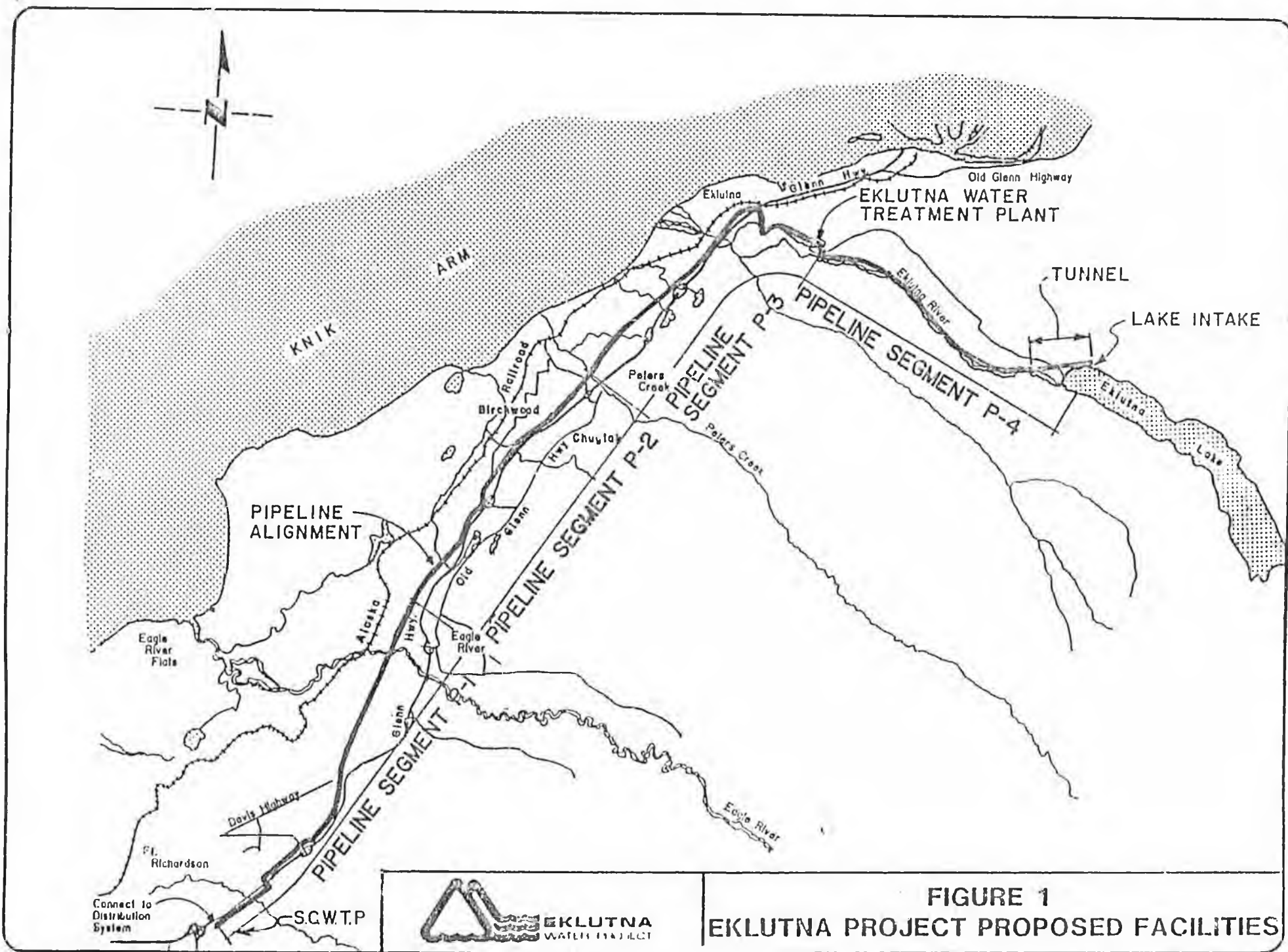


FIGURE 1
EKLUTNA PROJECT PROPOSED FACILITIES



Connect to Distribution System
 SCW.T.P.

Diversion of Eklutna Lake water involves tapping the 9-foot diameter tunnel to the Eklutna Power Plant. The new 7-foot diameter tunnel will connect this existing tunnel with a new pipeline located in the Eklutna River bed below the dam at the downstream end of Eklutna Lake. The new tunnel will be over one mile in length. Connection to the existing tunnel will be precisely planned and carefully executed so as to minimize disturbance to EPP. A gate house will be constructed near the connection of the two tunnels. The top of the gate house will be the only visible evidence of a diversion for the EWP. Downstream of the diversion tunnel, water will be conveyed in a buried 54-inch pipeline which will be constructed along the Eklutna River bed (pipeline segment P-4) to an energy recovery station at the Eklutna Water Treatment Plant (EWTP) which will be located above the river bed at about 620 feet elevation. Generating capacity of this station will be approximately 1.0 MW. It is estimated that in the year 2025, this energy recovery station will produce over eight million KWH per year with water diverted from Eklutna Lake.

The Eklutna Water Treatment Plant will be designed to use either conventional treatment or direct filtration to achieve the desired water quality. Conventional treatment entails rapid mixing, flocculation, sedimentation, and filtration. During most of the year direct filtration, which bypasses the sedimentation basins, is feasible. It is also preferable because it requires a lower coagulant dosage and reduces the amount of sludge.

Pilot water treatment plant studies have been conducted in three phases using water from Eklutna Lake during all the seasons. The first phase, which investigated treatability of Eklutna Lake water during winter, determined that good quality water could be produced using conventional treatment or direct filtration. Phase 2 examined treatability of lake water during spring transition/early summer conditions using direct filtration. The third phase of the pilot plant studies examined treatability of lake water during the expected period of highest turbidity in the fall. The findings of the whole program are that Eklutna Lake water, with its sometimes high concentrations of glacial flour, is treatable and that direct filtration will be possible most of the year, with conventional treatment being utilized during periods of high turbidity.

A treated water reservoir will be constructed at about elevation 600 feet, just downstream of the EWTP. The purpose of the reservoir is to absorb normal diurnal

fluctuations in water demand while maintaining a relatively constant flow through the EWTP. This reservoir will have an initial capacity of 10 to 15 million gallons.

Pipeline segments P-3 and P-2 extend from the treated water reservoir to Eagle River. P-3 begins at the reservoir, running down the slope to a crossing of Glenn Highway near the community of Eklutna. From there it crosses the river, and parallels Glenn Highway a short distance on the northwest side. It then follows the APA powerline easement and residential streets to its end in Peters Creek. The P-2 segment begins at that point, crosses Peters Creek, parallels the APA powerline easement and local streets, then parallels the Glenn Highway to Chugiak High School. It skirts the high school, crosses through the Lake Ridge Terrace Subdivision along residential streets, then parallels the APA powerline easement again to Artillery Road.

This 54-inch buried pipeline will have seven turnouts for delivery of water to northern communities along the route of pipeline segments P-2 and P-3.

Construction and permanent easements must be acquired along the pipeline alignment. Most of the property along P-2 and P-3 is owned by Eklutna, Inc. Other property owners include: Alaska Division of Parks, Fort Richardson Military Reservation, Alaska Department of Transportation and Public Facilities, Federal Highway Administration, Alaska Railroad, various utilities, native corporations, and approximately 50 private property owners. Permits and/or easements will be obtained from these owners before construction takes place.

A geotechnical study concluded that no major construction problems will be encountered along P-2 and P-3. Crossings of wetlands and streams, however, are specific environmental concerns. Construction schedules and procedures have been designed to minimize disturbance of existing biological and hydrologic regimes of wetlands. Special water management, trench, and backfill techniques will also be employed. The proposed alignment was moved in several cases to avoid designated wetlands. Impacts caused by stream crossings will be mitigated by construction practices such as timing, temporary diversions and bank stabilization. Crossing plans and mitigation means will be approved by the Alaska Department of Fish and Game.

Pipeline segment P-1, the first to be constructed, will extend generally parallel to the Glenn Highway from the vicinity of the SCWTP to a powerline easement, then roughly parallel with and adjacent to that easement as far as Artillery Road near Eagle River. The pipeline will vary between 54 and 48 inches in diameter, decreasing closer to the SCWTP. A 24-inch pipeline will also be constructed along Artillery Road to connect with the existing Eagle River water supply system.

Property owners or agencies with jurisdiction in the P-1 segment include: The U.S. Army Corps of Engineers and the Bureau of Land Management, the Alaska Department of Fish and Game, the Alaska Department of Transportation and Public Facilities, the Municipality of Anchorage, and several utilities. Permits, approvals, and/or letters of non-objection must be obtained from each of these agencies for their respective areas of jurisdiction. This permitting and approval process is almost complete for pipeline segment P-1.

A booster pump station/energy recovery station will be constructed upstream of the SCWTP. Until the entire pipeline is completed and supplying water from Eklutna Lake, this station will pump as much as 4.5 mgd from the SCWTP to Eagle River. Only the booster pump portion will be constructed as part of the P-1 phase, but the facility will be designed so it can be expanded and modified easily for energy recovery. After the entire project is complete, conversion to an energy recovery station will take place. The capacity of this generating station will be about 500 kw.

Lake level and storage records are available from 1946 to the present. Annual inflow over the past 30 years has averaged 210 mgd, varying between 150 and 290 mgd. Approximately one-half of this inflow comes from glacial melt, the other half coming from runoff. Lake level is generally lowest in late spring and highest in early fall. The EWP will not impact lake levels, because all water used by EWP will be diverted from that which normally flows to the Eklutna Power Plant.

The Eklutna Power Plant currently withdraws all the inflow except for infrequent spills. When the EWP comes on line, water diversions for domestic uses will reduce the EPP supply approximately 6 to 8 percent; by the year 2025 that will increase to 21 percent. The water project will decrease the amount of energy generated by the EPP, by that same 6 to 21 percent during the period from 1988 to 2025. However, the 1.5

MW energy recovery facilities constructed as part of the EWP will recover about 45 percent of the EPP deprived energy.

The Municipality of Anchorage Water and Wastewater Utility has reached an agreement with the Alaska Power Administration for an equitable method of replacing energy taken from the EPP by the EWP.

PROJECT SCHEDULE

All Eklutna Water Project facilities should be completed by mid-1988 pending availability of sufficient funding. Dates of completion of each pipeline segment and of the other facilities are shown in Figure 2.

Bids will be received for the first pipeline segment (P-1) in March, 1984, and construction is expected to start in June. That pipeline segment will be completed in the summer of 1985.

STATUS OF THE PROJECT

Many studies and other activities have been performed by the Eklutna Water Project team in the past year. These activities, are separated by task and listed below.

- o A Management Plan for Design and Construction was completed in June 1983. (Task 2)
- o The Preliminary Water Supply Master Plan Update report was completed in April, 1983. (Task 3)
- o The Alternative IV Evaluation (tapping the lake directly) was completed in April, 1983. (Task 4)
- o A Regional Geotechnical Report was completed in September, 1983. (Task 5)

- o Pilot Plant Summary Reports have been completed for all three phases of the study. A summary and conclusion report for the entire study will be completed within the next few weeks. (Task 7)
- o Several reports have been produced as part of ~~the~~ Public Involvement task. These speak to alternative sources of supply, project funding, and the project as a whole. This Executive Summary is also part of the Public Involvement program. (Task 9)
- o The Environmental Information Document was completed in June, 1983. This document was the basis of permit support. (Task 10)
- o Several reports have been completed under the First Technical Advisory Committee/Value Engineering task, which reviewed the pipeline segment P-1 alignment and lake diversion alternatives. (Task 11)
- o The Predesign Report - Pipeline Segment P-1 was drafted in April, 1983, and for segments P-2, P-3 in October, 1983. Work is underway on the predesign report for P-4. (Task 12)
- o Two preliminary studies for the lake diversion were completed in 1983. The draft of the predesign report for the lake diversion will be completed in January, 1984. (Task 13)
- o The Second Technical Advisory Committee/Value Engineering task is partially completed. In October, 1983, the first session of this task reviewed the tunnel, P-4 alignment, and pipeline in general. The second session, to be held in March, 1984, will review the water treatment plant and look at the tunnel again. The following document has been produced: Value Engineering Study - 2nd Session. (Task 16)
- o The Initial Design Report Pipeline Segment P-1 was completed in July, 1983. The draft of a similar report for pipeline segment P-2 will be completed in February, 1984. (Task 18)

- o Water rights are currently in the process of being secured through negotiations with the APA. Legislation will be introduced in Congress in February to secure water rights. (Task 23)
- o A document on Eagle River Water Supply and Energy Recovery was produced in July, 1983. (Task 24)
- o Bids were received in November, 1983, for the prepurchase of valves for pipeline segment P-1. Plans and specifications for the construction of P-1 were 95% complete in 1983. This contract will be advertised in January, 1984. (Task 52)
- o Ground surveys for final design of the pipeline segment P-2 were made in 1983. (Task 53)
- o Ground surveys for final design of pipeline segment P-3 were completed in 1983. (Task 54)

In addition to the numerous studies made and documents produced, several permitting and environmental activities have been performed and completed. The U.S. Army Corps of Engineers Section 404 Permit which will allow crossing of wetlands was acquired in November, 1983, for the entire pipeline. The Alaska Department of Environmental Conservation Certificate of Reasonable Assurance (protecting water quality) was obtained. The Alaska Coastal Management Plan Consistency Determination was also accomplished. The Alaska Department of Fish and Game Title 16 Anadromous Fish Protection Permit was granted for the four stream crossings made in segments P-1 through P-3. The Municipality of Anchorage Urban Beautification Commission and the Planning and Zoning Commission have approved plans for the Ship Creek Interim Booster Pump Station.

A right-of-way grant must be obtained from the Bureau of Land Management (BLM) for the entire project. The BLM has joint jurisdiction (with the U.S. Army Corps of Engineers) over the Fort Richardson land, and also serves as the lead/coordinating agency for other landholders and utilities along the alignment. The required letters of non-objection have been received from affected parties, and the right-of-way grant for the entire pipeline is expected to be received early in March, 1984.

ACTIVITIES DURING 1984

Many activities key to the progress of the project will take place during 1984. For the P-1 segment, the contract for supply of the large valves was awarded on January 3. Advertisement for bid of construction contracts will take place on January 31, and bids will be received on March 15. Construction of this segment will begin in June. The P-1 segment will be further divided into four schedules to maximize opportunities for bidding by local contractors.

Final design of P-2 is expected to be complete in July and the construction contracts for that segment will be awarded in the fall of 1984. Final design of P-3 will be complete in October, and will be advertised for bids in November. Easements for both segments will be acquired during spring and summer of 1984.

Pipeline segment P-4 will continue through the predesign and initial design phases during 1984. The predesign report will be completed in October. Initial design will be finished in December. The consultant for final design will be selected during the summer.

Initial design of the lake diversion will be completed during the summer of 1984. The final design consultant also will be selected during the summer, and final design will commence in the fall.

The predesign report for the Eklutna Water Treatment Plant will be completed in April, 1984. Initial design will be finished in September. The final design consultant will be selected during the summer, with final design beginning in the fall.

Water rights to Eklutna Lake water will be acquired in 1984. Application for these rights will be filed with DNR, Land and Water Management, in January. A bill amending the APA's enabling legislation will be introduced before the U.S. Congress in February.

PROJECT FUNDING

Construction of the Eklutna Water Project will require a total expenditure of \$220 million. This figure was estimated in late 1982 and, after a year of planning and

Design still represents a viable estimate for completion of the project in 1988. Funding must be obtained in a timely manner in order to maintain costs at the \$220 million level.

Initial appropriations for the project have been received from the State Legislature, and continued support from that source will be required through the years 1984 to 1986. In 1982, \$13.7 million was appropriated and \$22.5 million was appropriated in 1983.

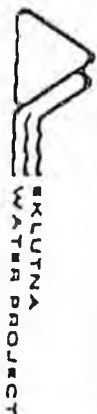
NOVEMBER
In November of 1983, public approval was received with over 75% favorable vote for sale of \$55 million in bonds to help fund the project. These bonds will be sold on an as-needed basis. As a result of these bond sales, usage charges will increase by approximately 40 percent over present rates, or by about \$5.40 per household per month. This increased rate will not be charged until water is actually supplied. No increase in charges will result from the portion of the project funded by legislative appropriations.

Three quarters of the total funds will be requested from the State Legislature, and one quarter of the funds will be obtained from the Municipality through bond sales. In order for the project to proceed on schedule, the following additional funding will be required. In October, 1984, \$68 million will be required, \$51 million of which will be requested from the Legislature. In 1985, a total of \$62 million is needed, including \$47 million from the Legislature. In 1986, the funding required for completion of the project will be \$54 million, which will necessarily include a legislative appropriation of \$30.8 million.

A bar chart depicting funding needs and activity periods is included as Figure 3.

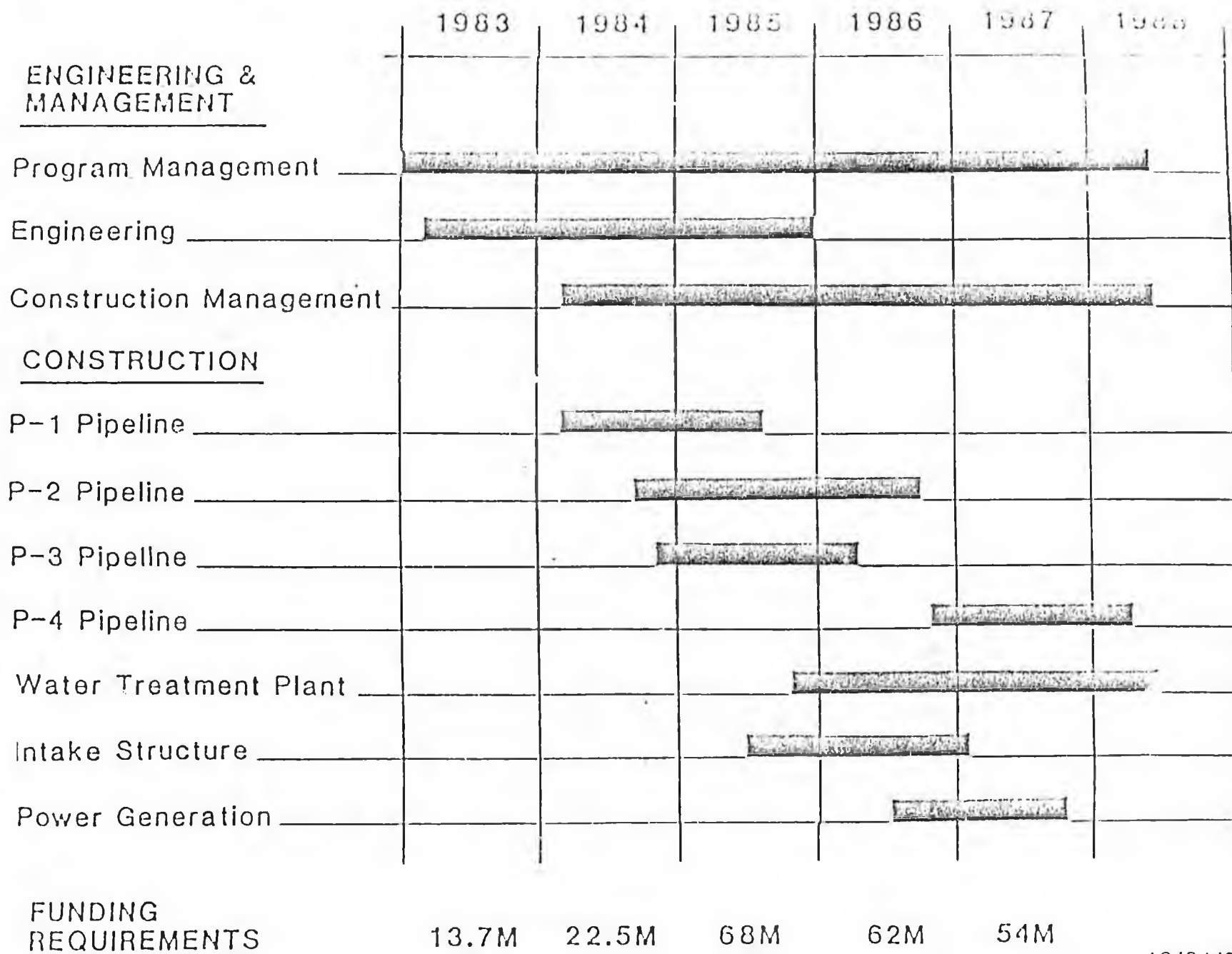
PROGRAM MANAGEMENT STRUCTURE

The Municipality of Anchorage Water and Wastewater Utility executed a contract in November, 1982, with James M. Montgomery, Consulting Engineers, Inc. (JMM), which placed that company in the principal role of Program Management Consultant for the Eklutna Water Project. JMM has overall responsibility for planning and design of the project, as well as supervision of construction. In addition to overall responsibility,



EKLUTNA
WATER PROJECT

BAR CHART OF ACTIVITIES



10/31/83

FIGURE 3

MM has primary responsibility for designing the project facilities. Three associate firms are in charge of other key aspects of the project and numerous other local firms are involved with the project.

QUADRA Engineering, Inc. is responsible for Geotechnical, Surveying, and Engineering Support for the project. QUADRA is assisted in that role by Woodward-Clyde Consultants, Inc., which is performing seismic studies.

Ott Water Engineers, Inc. is conducting the Environmental, Permitting, and Public Involvement programs, which includes obtaining necessary permits, rights-of-way and easements. Assisting with securing of Eklutna Lake water rights is the legal firm of Burr, Pease, and Kurtz. R. W. Beck and Associates, Inc. is a special consultant relating to energy replacement matters.

Sverdrup/SPCM, Inc. is responsible for Planning and Control tasks of the project, and Construction Management. In the latter responsibility, they are assisted by Triad Engineering, Inc. with consultation regarding construction practices. Sverdrup is also performing engineering for the lake diversion and tunnel.

Coffman Engineers, Inc. is conducting corrosion studies and is performing final design of the corrosion control system.

Three additional local firms have been retained for final design of segments of the pipeline. Tryck, Nyman and Hayes, Inc. is performing final design for segment P-1; DOWL Engineers, Inc. for segment P-2; and URS Engineers, Inc. for segment P-3. Other local firms will be added to perform final designs of the following facilities as the project progresses: Eklutna Water Treatment Plant, lake diversion, pipeline segment P-4, treated water reservoir, and energy recovery stations at Eklutna and Ship Creek.

The Anchorage Water and Wastewater Utility (AWWU) is the overall project administrator for the Eklutna Water Project. In that capacity, AWWU provides general direction to the consultants and makes detailed reviews of their work. AWWU has placed a full time project manager in the Eklutna Water Project office to more easily manage the large amount of work being performed on the project.

This management team has kept the project on schedule and within budget.

AKIAK - WATER AND SEWER FACILITIES (VSW)

400.0

Village Safe Water has identified Akiak as having one of the most serious water problems in the State. Residential wells are producing water which exceeds water quality standards for iron by as much as 27,000%. USPHS began drilling wells for individual homes, and, while early test results showed relatively "good" water during the early stages of the drilling program, recent water analysis has shown many wells are producing unacceptable water.

FORTUNA LEDGE WATER/SEWER SYSTEM - PHASE II

Fortuna Ledge

1,000.0

The City of Fortuna Ledge proposes to construct 10,600 linear feet of water transmission line and 15,100 linear feet of sewer main to serve the 119 lots included in the new residential subdivision area. Water and sewer study plans also provide for a lift station and water works building modifications. The proposed water and sewer extension will utilize an existing system which appears capable of handling the additional load.

Cost estimates for the water and sewer system are based on 1984 dollars and using local labor and equipment.

EXHIBIT A
MARSHAL MASTER PLAN
JUNE 1983
ESTIMATED WATER & SEWER COSTS
119 LOTS
LOCAL LABOR AND EQUIPMENT

WATER

10600 Lin. Ft. 4" Arctic Pipe Installed @ \$50 =	\$530,000
Modifications in Water Works Building	<u>50,000</u>
	580,000
20% Contingencies & Engineering	<u>116,000</u>
	\$696,000

SEWER

15100 Lin. Ft. 6" Arctic Pipe Sewer Installed @ \$70 =	\$1,057,000
Lift Station	<u>45,000</u>
	1,102,000
20% Contingencies & Engineering	<u>220,400</u>
	\$1,322,400
 Total Estimated Installed Cost	 \$2,018,400 =====

CITY OF FORT YUKON

CAPITAL BUDGET

FOR

WATER AND SEWER IMPROVEMENTS PHASE II
(ANGEL POND SUBDIVISION)

WATER SYSTEM:

Main Line 13,500 ft 6" insulated @ \$69.00/lf	931,500
Hydrants 13 @ \$3500	45,500
House Services to 66 lots @ \$4000/lot	264,000
New booster pump and building	100,000

Construction Cost	1,341,000
Engineering	180,000
Administration and Legal	220,000
Contingency	250,000

Water Project Estimated cost	\$ 1,941,000

SEWAGE DISPOSAL:

Subsurface Disposal 66 units @ \$7500 ea	495,000
Engineering and layout	15,000
Administration and Legal	44,000
Contingency	40,000

Sewer Project Estimated Costs	\$594,000

TOTAL REQUEST FOR FORT YUKON WATER AND
SEWER PROGRAM PHASE II \$2,535,000

Galena Elementary School Program

CONCEPTUAL COST ESTIMATE

A cost estimate has been prepared based upon the information contained in the "Design Criteria" section of this document. This estimate is based upon the premise that the new building will be located as shown on the site plan (2-3), and that construction will begin in 1984.

Listed below is a summary of the construction furnishings and equipment costs for Galena Elementary School. The costs per square foot of the building average \$213.

DIVISION 1	GENERAL CONDITIONS	\$	536,000
DIVISION 2	SITE WORK	\$	47,000
DIVISION 3	FOUNDATION WORK	\$	344,000
DIVISION 5	METALS	\$	10,000
DIVISION 6	CARPENTRY	\$	269,000
DIVISION 7	MOISTURE PROTECTION	\$	221,000
DIVISION 8	DOORS & WINDOWS	\$	82,000
DIVISION 9	FINISHES	\$	265,000
DIVISION 10	SPECIALTIES	\$	36,000
DIVISION 11	EQUIPMENT	\$	8,000
DIVISION 12	FURNISHINGS	\$	250,000
DIVISION 15	MECHANICAL	\$	434,000
DIVISION 16	ELECTRICAL	\$	278,000
MARKUPS 17	OVERHEAD & PROFIT	\$	370,000
TOTAL		\$	3,150,000



Budget

INTRODUCTION

The following is a construction budget which is based on a cost of \$250/square foot. This was determined as follows:

- Average bid at Nikolai in 1983 was \$262/square foot. This school is of similar construction and built for the Iditarod Area School District.
- 8% escalation to summer of 1984 = \$282/square foot
- Reduction due to size of Grayling and accessibility = \$250/square foot

BUDGET

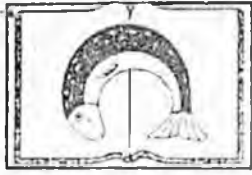
2,900 square foot (remodeled) X \$125/square foot =	\$250,000
12,538 square foot X \$250/square foot =	<u>\$3,147,000</u>
Subtotal	\$3,397,000

Project Overhead and Other Costs

Administration Cost	7.25%	\$246,282
Design Costs	8.00%	\$281,951
Furnishing and Equipment Costs	8.00%	\$271,760
Art	1.00%	<u>\$33,970</u>
Subtotal		\$4,230,963
Project Contingency	5.00%	<u>\$211,548</u>
Project Total		\$4,442,511

This project could be funded by a direct grant from the state. The grant could be supplemented by funds available from the federal government. These funds are available to those school sites being omitted by the Bureau of Indian Affairs education program.

To begin construction in 1984 and finish before June of 1985, which is the date the B.I.A. will curtail its sponsorship of the elementary program, would should begin immediately. This would insure the state of not occupying the B.I.A. school which has never been required to meet local building codes. If the state were to occupy the school additional funding would have to be found to upgrade the existing B.I.A. school to current fire/life safety codes.



QUINHAGAK

Village Profile

Quinhagak is located on the mouth of the Kanektok River. The population is an estimated 340 (1980). Two school sites exist; an elementary school with current K-8 enrollment of 85, and a high school with 9-12 enrollment of 56. Total enrollment 141.

Building Data

Building 203 is a two-classroom school/quarters of wood frame construction consisting of 4,233 square feet built in 1963 and relocated in 1979. Building 204 houses storage and two standby generators in a wood frame structure of 1,332 square feet built in 1963 and relocated in 1979. Building 206 is a two-classroom wood frame structure of 2,844 square feet constructed in 1968 and relocated in 1979. Building 208 is a classroom/quarters wood frame structure of 2,880 square feet constructed in 1979. The school is of one-hour construction containing 9,480 square feet built in 1979.

Summary Diagram

1A

UPGRADE OF EXISTING ELEM SCHOOL (7,877 SQ. FT.) + 20 YEAR LIFE CYCLE

1B

ADDITION OF 7,877 SQ. FT. TO HIGH SCHOOL + 20 YEAR LIFE CYCLE

2A

REMODEL OF EXISTING ELEM SCHOOL (7,877 SQ. FT.) & ADDITION OF 3,423 SQ. FT. + 20 YEAR LIFE CYCLE

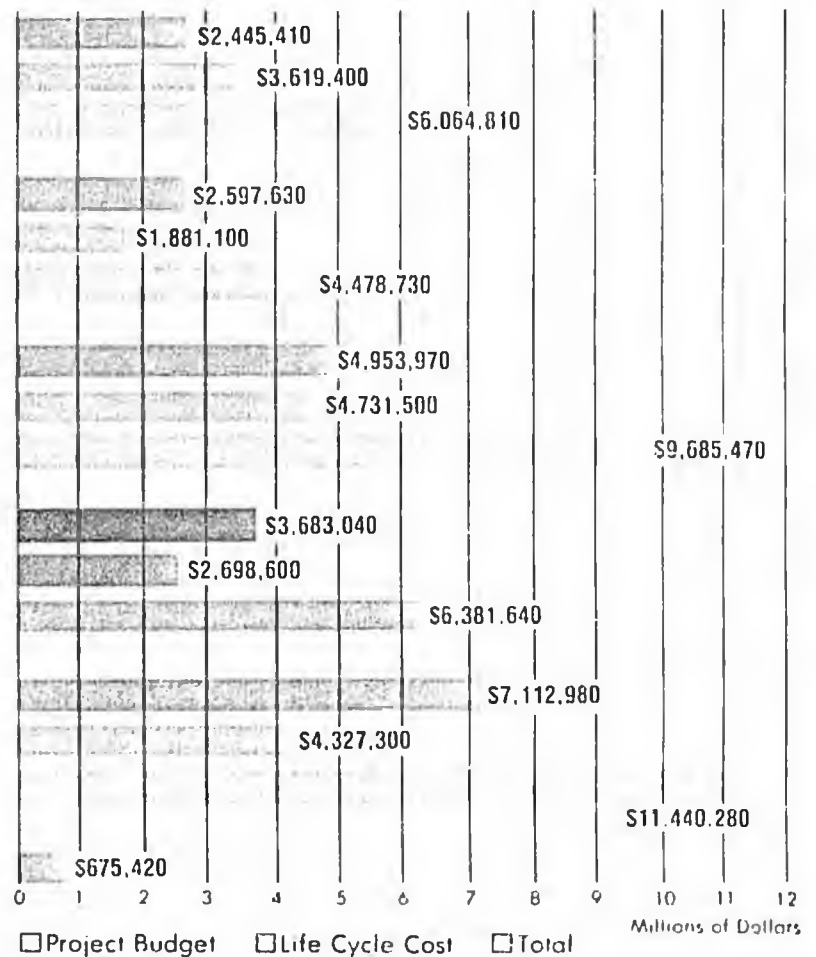
2B (Recommended)

ADDITION OF 11,300 SQ. FT. TO HIGH SCHOOL + 20 YEAR LIFE CYCLE

3

REMODEL OF EXISTING HIGH SCHOOL (9,480 SQ. FT.) & ADDITION OF 18,120 SQ. FT. + 20 YEAR LIFE CYCLE

PREVIOUS BIA STUDY



Recommendation

Alternate 2B would provide a new building which addresses the educational goals of the district as well as provides common use of staff and facility without the inherent problems of operating four separate buildings for a 20 year cost 5.5% more than Alternate 1A. Alternate 2B should be pursued.

CAPITAL IMPROVEMENT PROJECT



Priority Rank 2 of 11

Project: Stevens Village, New Elementary/High School

Capital Request: \$2,800,000

PROJECT DESCRIPTION AND PUBLIC BENEFITS

Stevens Village is on the north bank of the Yukon River, 10 miles east of the Elliot Highway crossing and about 50 miles west of Beaver. This is a traditional Native village, settled in the late 1800's. Income here is obtained from construction work, railroad work, river transportation work, and fishing.

There were secondary age students attending Mt. Edgcombe School. With the closing of that facility, Stevens Village school has been impacted.

Two teachers, a teacher aide, and 16 students, grades K-12, are presently housed in a 800 square foot former BIA school, circa 1960. Conditions are already extremely overcrowded and with the addition of students returning from Mt. Edgcombe, the situation has become very difficult.

There is no room at the present site to remodel and expand the present building. The project must be relocated and a new site has been selected with the cooperation of the Village Council.

The present school is energy inefficient. There have been waste water and sewage disposal problems at each spring thaw due to the small site and inadequate space for a sewage disposal system large enough to accommodate school needs. Department of Environmental Conservation had intimated possible school closure if sewage continues to contaminate village and school property due to inability of frozen soils to disperse waste water underground.

Finally, the school does not meet minimum space requirements mandated by the Tobeluk ("Hootch") Decree.

We propose a combined K-12 facility to include an elementary classroom, a secondary classroom, a vocational shop, a multipurpose room, kitchen, and mechanical area to total 6,210 square feet.

<u>Costs:</u>	Planning and architectural	\$ 270,000
	Site Development	70,000
	Construction	2,228,000
	Legal	10,000
	Administration	22,000
	Equipment	200,000
	Total Project Cost	\$2,800,000

YUKON/KOYUKUK SCHOOL DISTRICT - MANLEY HOT SPRINGS SCHOOL 1,000.0

This is a direct appropriation to the Yukon/Koyukuk School District through the DOE. Manley Hot Springs currently has a high school consisting of 960 square feet of classroom space and 556 square feet of supplementary space. The school district is requesting an additional 5,700 square feet of secondary space.

COST ESTIMATE

GEOTHERMAL WELL-KOTZEBUE, ALASKA

<u>Medium Depth Well</u>	6,000 to 8,000	
Pre Stand by		100,000
Moving & Rig up & Down		210,000
Day Work		675,000
Overhead		100,000
Camp & Catering		195,000
Post Standby		100,000
Extra Labor Rental		103,000
	SUBTOTAL	1,483,000

Other Drill Costs

1. Raw Materials		600,000
2. Service Contractors		
a. Drill Consultant		50,000
b. Wellsite Geologist		20,250
c. Mud Logging		55,200
d. Wire Surveys		180,000
e. Cont. Service		200,000
f. Carting		29,300
g. Shooting & Perforating		70,000
h. Csg Inspection		18,000
3. Other Direct Cost (fuel, water, ect)		500,000
	SUBTOTAL	1,722,750
4. Build Location Permafrost Bed		750,000
5. By/Air Rig Transport in & out		4,000,000
	TOTAL	7,955,750

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KOTZEBUE GEOHERMAL PROJECT

Final Report

Summary of Project Tasks and Findings

February 1981

Prepared For
The State of Alaska
Division of Energy & Power Development
338 Denali
Anchorage, Alaska 99501

Energy Systems, Inc.
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Anchorage, Alaska 99502

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ALASKA POWER AUTHORITY

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FINAL REPORT--KOTZEBUE PROJECT

Introduction

This report summarizes work done by Energy Systems Inc. on the Kotzebue Geothermal Project for the State of Alaska Department of Commerce and Economic Development, Division of Energy and Power Development. The work reported covered the period July 1, 1980 to Feb 1, 1981. The work was done in fulfillment of two contracts, BRU Kotzebue Geothermal, 08-71-7-500 and A7N 81-525, CC 08-1582.

The first section of this report lists the tasks contracted for item by item and summarizes the work done. Reference is made to four items that were completed as part of the contract tasks: geological and geophysical data for the Kotzebue Selawik Basin, "Kotzebue Geothermal Project: Currently Available Information and Report of the Advisory Group Meeting", "Geologic Analysis of Geothermal Energy at Kotzebue", and a proposal to the Department of Housing and Urban Development on behalf of the City of Kotzebue to study the district heat prospects at Kotzebue. These four items are bound separately and are referred to as appendices A, B, C and D respectively. Reference should be made to them for a more detailed description of the results of the tasks performed, and described below.

Task 1

An energy needs analysis for the City of Kotzebue including electrical power and fuel demands to the year 2000. This task will take existing projections from a recent needs analysis by the Alaska Power Authority and put it in a form for presentation at the geothermal meeting in Task 3. Potential local use geothermal applications will be projected under the assumption that if the geothermal resources were developed geothermal energy availability would stimulate commercial development to some degree.

Three independent estimates of energy use at Kotzebue were located, analyzed, and compared. No significant commercial uses of geothermal energy were identified, either in the literature or in discussion. The most beneficial application was determined to be space heat. The possibility of space heat was further examined by conceptually designing a district heat system, with a geothermal heat source, and estimating the cost of heat obtained from it. The estimated cost of the geothermal heat was too high, but the district heat portion of the system looked moderately promising. A summary of this work can be found on pp. 34 to 42 of Appendix B.

Task 2

Research currently available geological and geophysical information for the Kotzebue-Selawik Basin. This information shall be put in a form for oral, visual and written presentations on the geological possibility of developing geothermal resources.

Mr. Arlen Ehm, consulting geologist, was hired to carry out this task. The raw information is included in Appendix A, and a summary of it with some analysis is given on pp. 24-28 of Appendix B. A bibliography is on pp. 45-46. A more detailed, and up-to-date, analysis of this data is given in Appendix C. Appendix A was supplied to the Department of Commerce and Economic Development, Division of Energy and Power Development, in only one copy because of its voluminous nature.

Task 3

Organize and host an interdisciplinary meeting of geothermal experts to develop a work plan for the development of the Kotzebue project and the expenditure of the State appropriation. This meeting will be held at or around the Geothermal Resource Council Annual Meeting in mid-September 1980 unless otherwise agreed upon.

A list of geothermal experts and people involved in the Kotzebue geothermal project was compiled by Energy Systems Inc. with the help of the Division of Energy and Power Development. The people contacted included representatives of the City of Kotzebue, the NANA Corporation, the University of Alaska Geophysical Institute, the State Division of Geological and Geophysical Surveys, the Alaska State Legislature, the Alaska Power Authority, Universities with relevant geothermal programs, National Laboratories with Geothermal Programs, and the US Geological Survey. These people were contacted by phone and it was determined that a meeting on September 12, 1980, immediately following the meeting of the Geothermal Resources Council would be feasible. In many cases people on the list could not attend, and it was necessary to find alternates. In the end a suitable advisory group was assembled, with Dr. William Ogle of Energy Systems Inc. as chairman. It also proved advantageous to hold a preliminary meeting in Anchorage to allow more local experts to attend.

Arrangements were made for the meeting in Salt Lake City. Information that had been uncovered in Tasks 1 and 2 and at the meeting in Anchorage was mailed to the advisory group for their review prior to the meeting. It was also organized into viewgraphs suitable for presentation to the group. The members of the advisory group generously donated their time at no cost to the State of Alaska. Their advice and aid was quite helpful. The final composition of the advisory group is on p.10 of Appendix B. Notes of this meeting are on pp.11-33 of Appendix B.

The basic conclusion from the meeting was that the geothermal prospect did not look as promising as first thought, but also that the possibility of direct use or use through heat pumps could not be ruled out. The district heat portion of the project looked moderately promising. Specific recommendations were to get additional (proprietary) geological data from NANA and Chevron, and to apply to the Department of Housing and Urban Development for funds to look at district heat in greater detail.

Task 4

A written final report detailing the task findings, the preliminary ideas broached at the meeting in Task 3 and possible cost and impacts of the different elements of the work plan will be required. The state geothermal development plan Kotzebue section is the preliminary plan to be critiqued at this meeting.

Appendix B is the written report. Pages 4-8 summarize the ideas presented at the meeting. Page 9 gives some conclusions and recommendations for future work. On pp. 28 and 29 is a critique, by Mr. John Reeder, of the Kotzebue section of the State's geothermal implementation plan. Pages 11-44 contain a lot of information relevant to developing a plan for further geothermal work at Kotzebue, including drilling costs and estimates of the cost of a district heat system.

After the advisory group meeting, and acting on conclusions and recommendations coming from that meeting, the Division of Energy and Power Development extended its contract with Energy Systems Inc. to perform tasks 5 to 10, outlined below.

Task 5

Request from Northwest Alaska Native Association information pertinent to determining depths at Kotzebue equivalent to depths observed in the Nimiuk Point and Cape Espenberg wells, and to the salinity, specific gravity, and dissolved solids in the water from these wells.

Arlen Ehm wrote a letter to the NANA corporation requesting the required information and detailing the need for that information. NANA forwarded the request to the Chevron Resources Company, which generously allowed Mr. Ehm to view the requested material in San Francisco. The formation water chemistry information is shown in Fig.17 of Appendix C and the equivalent depths to basement at Kotzebue is Fig.19 of Appendix C.

This information is crucial to determining the feasibility of geothermal energy at Kotzebue.

Task 6

Obtain further information on what data and information could be obtained by electrical geophysical methods at Kotzebue. Design same and cost out.

The results of Task 5 were such that task 6 was no longer relevant. The seismic depth to basement obtained in Task 6 is far more reliable than what could be obtained by any electrical method, and the 2000 ft. depth to basement obviates the need for the information on salinity. Thus it was decided to determine the cost of drilling a 2000 ft. well at Kotzebue.

Battelle Pacific Northwest Laboratories was drilling similar wells at Eethel. We asked their contractor and Battelle themselves

to estimate the cost of a 2000 ft well at Kotzebue. Both estimated that the cost would be about \$350,000, including mobilization and demobilization. However, the contractor contacted would only do the job on a time and materials basis, and he has never drilled that deep with the rig he anticipated using on the job. He did not think the anticipated depth would be a problem, however, as long as a slim-hole is used.

Task 7

Integrate information obtained in tasks 5 and 6 with previously obtained gravity surveys, well logs, surface geology maps, and other pertinent information to formulate the best estimate presently obtainable of subsurface temperature, permeability, pressure, and porosity at Kotzebue.

The information requested in the above task is given in the report that is Task 8. The geological information gives a fairly complete picture of the subsurface geology at Kotzebue relevant to determining the feasibility of using geothermal energy there. Of course, no amount of information could ever be sufficient for answering every conceivable question.

The depth to impermeable basement at Kotzebue is about 2000 ft. The probability of finding sufficiently permeable rocks below 2000 ft. is very low. The temperature at 2000 ft. depth is predicted to be low (105F to 135F). Above the basement, the rocks would have permeable zones that would produce adequate volumes of water. Of course, this water would be at a temperature below 135F. The downhole pressures would not be sufficient to bring the water to the surface. In general, the only feasible way to determine pumping requirements is to drill a well and test it. The water would have a lot of dissolved solids. Drilling costs would be low in comparison to the costs usually quoted for petroleum wells in the area because there is little point in drilling below 2000 ft, and the formations are easy to drill, both because of the sedimentary rocks and because no extraordinary downhole pressures are anticipated. A truck mounted rig could be used.

Task 8

Write a report on the geology of the Kotzebue Selawik basin as it applies to the utilization of geothermal energy, including figures that summarize the surface geology (rocks and faults), regional geology, temperature profiles from the Cape Espenberg and Nimiuk Point wells, lithologic sections, electric logs, etc.

Mr. Arlen Ehm compiled the requested information in the report titled "Geologic Analysis of Geothermal Energy at Kotzebue", which is Appendix C to this document.

Task 9

Answer H.U.D. solicitation for district heating for the village of Kotzebue. The work plan for this solicitation will be an economic scoping study considering wind, coal, wood, geothermal, and waste heat separately and in conjunction with each other for the most economical district heating system for the village.

An outline of the proposal was constructed by Energy Systems Inc. John Beebee of Energy Systems and Don Markle of the Division of Energy and Power Development traveled to Kotzebue and discussed the draft of the proposal with as many people who would participate in it as possible. In particular, Gene Moore, the City Manager of Kotzebue, was most helpful in setting up the District Heat Working Group, suggesting changes in the management plan of the proposal, and getting background information and letters of support. The proposal was sent to HUD on January 16, 1981. Appendix D is a partial copy of the proposal. Complete copies were sent to HUD, the City Manager of Kotzebue, and the Division of Energy and Power Development. Missing from the copy given in Appendix D is "Appendix B" of the proposal, which is essentially the same as Appendix B attached to this report.

Task 10

Work in conjunction with the City of Kotzebue and the Mauneluk Native Association to form a District Heating System Association for Kotzebue.

After some discussion, it was decided that the City Manager's suggestion of using the City Council as the core of the District Heat Working Group called for in the HUD proposal was most satisfactory. The composition and duties of this group can be found in Appendix D of this report, p.3. Since the Department of Commerce and Economic Development contemplated participating financially in the project, representatives of the Alaska Power Authority and the Division of Energy and Power Development were added. This should be a useful advisory group in beneficially expending the remainder of the geothermal project appropriation.

Findings and Recommendations

The general conclusion of the geothermal advisory group meeting was that geothermal energy was not likely to be an economical source of heat for Kotzebue, but that district heat might be feasible. The specific recommendations were that further data be sought from Chevron and NANA and that HUD should be approached for funds for a more detailed study of district heat. The Division of Energy and Power Development followed these recommendations. The geological information obtained from Chevron clearly reinforced the conclusion that geothermal energy would not be feasible at Kotzebue. The conclusion is based on several interrelated facts that are described in greater detail in Appendix C. (1) The depth to impermeable basement at Kotzebue is only about 2000 ft. (2) The temperature at 2000 ft. will be too low (105F-135F) for direct use. (3) The formation pressures are too low to push the water to the surface

(4) Pumping will be required to get adequate volumes of water to the surface, and this pumping will be expensive. (5) The water is so saline that it must be passed through a heat exchanger and reinjected. (6) Higher temperature water cannot be economically produced from the Nimiuk point well and transported to Kotzebue, both because of the pumping cost and because of the pipeline cost. (7) Because of the high cost of diesel generated electricity at Kotzebue heat pumps would not be advantageous, either if used individually or in a central installation. (8) The hot dry rock technique of energy extraction would require drilling wells that would be too expensive to deliver energy at a cost competitive with the anticipated cost of oil.

Of course, the geological parameters are predictions, based on data and assumptions that are explained in detail in Appendix C. The best method for verifying these predictions of temperature, permeability, porosity, and formation pressure is to drill a well at Kotzebue, and test it. Such a well, to a depth of 2000 ft, would probably not cost less than \$350,000. The \$350,000 cost is based on using a rig that has not drilled to 2000 ft, must drill a 4 in. or less diameter hole, and it assumes that there are no hole problems. To be certain of getting the results desired, it would be necessary to anticipate expenses that would be much greater than \$350,000. Other than verifying the geological predictions, such a hole could be used to locate aquifers suitable for thermal energy storage, to gather subsurface water quality data, and would be of interest simply as a source of subsurface information at Kotzebue.

The recommendation that district heat be examined more closely is based on a feasibility study done in preparation for the advisory group meeting. This study, which used general costs for components of district heat systems and experience by the Public Health Service in constructing the present water and sewer system, predicted that the cost of delivering 1.16×10^3 btu per year was \$1.1 million per year, or \$9.48 per million btu. (This cost includes an allowance for retrofitting house heating systems, but does not include the cost of heating the water.) This estimate was based on using low temperature geothermal water, which resulted in mains that were larger than necessary for higher temperature water. Also, due to the danger of subsidence around the geothermal wells it was necessary to transport the water from over a mile out of town, which added considerably to the cost. The present cost of fuel for oil heat is about \$14.80 per million Btu.

Since Kotzebue presents some rather difficult engineering problems for a district heat system, both in soil conditions and the need for extreme system reliability, it is felt that pursuing the district heat option will require a detailed feasibility study, as outlined in the proposal, Appendix D. The total cost of this study was estimated to be \$185,500, of which the City of Kotzebue would provide \$10,500, the State of Alaska would provide \$120,000, and HUD would supply \$55,000. The cost of the contract for a detailed study of the district heat system is \$135,000. The remaining costs were for administration and to fulfill HUD goals.

In fulfilling this contract, Energy Systems Inc and the Division of Energy and Power Development had considerable contact with

the City of Kotzebue. In particular, the City Council agreed to serve as an advisory group on the proposed district heat study. This group could be asked to help direct how the remaining funds in the Kotzebue geothermal appropriation should be spent.

Further study of the district heat option, as outlined in appendix D, pp. 1-18, would be a useful application for the funds.

The proposed district heat study, and the geothermal study reported in appendices B and C, could be considered parts of an integrated space heat study for Kotzebue. Other possible sources of heat that might be examined as part of such an integrated study are the direct use of coal in home furnaces and distributing low btu gas from coal to the city.

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KOTZEBUE GEOTHERMAL PROJECT

**Analysis of Currently Available Information
and
Report of Advisory Group Meeting**

October 1980

Prepared For
The State of Alaska
Division of Energy & Power Development
338 Denali
Anchorage, Alaska 99501

Energy Systems, Inc.
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Anchorage, Alaska 99502

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ALASKA POWER AUTHORITY

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ACKNOWLEDGEMENT

The following individuals donated time and effort to reviewing the Kotzebue project. We are grateful to them and to the organizations who supported them. Also, a proposal submitted by Dr. Robert Forbes of the University of Alaska Geophysical Institute to the San Francisco Operations Office of the Energy Research and Development Administration (Ref. 18), was the first expression of the possibility of using geothermal energy at Kotzebue.

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INTRODUCTION - DESCRIPTION OF TASKS

The Alaska Legislature appropriated \$600,000 to the Alaska Power Authority for a Kotzebue geothermal project. The Alaska Division of Energy and Power Development, on behalf of the Power Authority, contracted with Energy Systems, Inc. to gather together the existing information on the energy needs at Kotzebue, to research currently available geological and geophysical information for the Kotzebue-Selawik Basin, and to organize and host an interdisciplinary meeting of geothermal experts to help develop a plan for the Kotzebue project. (In addition to the meeting called for in the contract, it proved necessary to also hold a preliminary meeting in Anchorage). This is Energy Systems' written report on the tasks above.

William Ogle of Energy Systems was Chairman of both meetings. John Beebee compiled this report. Robert Henson contributed Figure 2. Arlen Ehm, consultant geologist, compiled and reviewed the geologic data. Linda Ibarra prepared the manuscript.

HEATING NEEDS AT KOTZEBUE

We located two guesses of heating oil use in Kotzebue. They are compared in Figure 2, p. 35. The study by Retherford, Assoc., Reference 1, estimated the amount of residential space heating by assuming 467 houses, 900 sq.ft. each, R-11 insulation, 2 air changes per hour, 16,039 degree days. They came up with residential heating use of $.91 \times 10^{11}$ Btu/year. No estimate was given for use by commercial and public buildings.

The draft study by Louis Berger and Associates, Reference 2, had an estimate of residential fuel oil consumption based on a house to house survey by the Mauneluk Association and the Alaska Public Forum. The survey found that in January the average house used 2.21 drums (55 gal per drum) of oil. This was projected, based on degree days, to heating needs for the entire year. Heating requirements for commercial and public buildings were estimated by trying to find actual consumption figures for buildings of the same type, reducing these to consumption per square foot, and then projecting this on the basis of square footage. Louis Berger and Associates' estimate was $.72 \times 10^{11}$ Btu per year for residential and commercial space heating combined.

The mayor of Kotzebue, Mr. Royal Harris, estimated that Kotzebue uses about 1.2 million gallons of oil per year for space heat, based on the fuel dealer's sales. Converted to Btu's at 65% efficiency that is about 1.1×10^{11} Btu/year.

We think the actual space heating need for Kotzebue is between $.72 \times 10^{11}$ Btu per year and 1.1×10^{11} Btu per year. Other than for space heat, we could

not identify any planned major uses for low temperature energy at Kotzebue.

Figure 2 also shows electric energy consumption and cost. Only about half as much electric energy is consumed as is used for space heating. Using the rule of thumb that a diesel electric plant produces about as much usable heat as electricity, there presently isn't enough surplus heat from that source to heat all of Kotzebue, especially since part of it is already used to heat the culinary water. The actual generation cost is around \$.13 per Kw-hr. This means that diesel electric energy for downhole pumps, fan-coil heat exchangers, or heat pumps is very costly.

According to the Retherford Study, Reference 1, the Kotzebue electric association has had an annual load growth of 10% per year. Some of this (7%) is due to population increase and part is due to higher consumption per person. We note that the number of people per house (5.5) is high, and that the houses are small (under 1000 sq.ft., average). Thus there is a substantial incentive for more or larger houses. On the other hand, conservation measures have had a strong effect. We have guessed (Figure 3) that the total oil used for space heat will grow 7% per year. The current (Sept. 1980) cost of oil for space heat is about \$1.22 per gallon plus a delivery charge. Figure 3 also shows what we guess Kotzebue might spend for heat in the coming years.

FEASIBILITY OF DISTRICT HEAT

In preparation for the meeting, we did a small feasibility analysis for district heat, which is outlined in Figures 4,5 and 6, pp. 38, 39 & 40. There are several engineering problems that would have to be solved in a more detailed analysis:

1. How do you deal with Kotzebue soil conditions? Possible solutions are shallow burial, burial in a concrete culvert, placing the system above ground.
2. Do you use a one pipe or a two-pipe system?
3. What kind of system backup do you use?

From our analysis, based on what we infer to be the subsurface temperatures at Kotzebue, we find that the wells must produce 1500 gallons per minute. A 750 gpm geothermal well is unusually good, though not very unusual. A key problem is the cost of pumping so much water out of the well. The annual electric energy cost for the pumps would cost no less than \$205,000, based on our present view of downhole pressures and permeability, and present generating costs in Kotzebue.

Our estimate, outlined in Figures 4, 5 and 6, is that the total annual cost of geothermal district heat would be about \$2,500,000.

The above annual cost is based on an estimate of \$7,590,000 for the district heat system and \$12.5 million for the wells. If the wells were located closer to the center of town, which is feasible only if fears of subsidence could be overcome, the cost of the district heat system could

be reduced to \$6,000,000. With the most optimistic reasoning, well costs could be reduced to \$4,000,000, using a truck mounted rig. Thus, the lowest imaginable cost for the system is \$10,000,000. Thus the capital cost alone (ignoring operating and maintenance) would be \$943,900 per year (\$10,000,000 amortized at 7% for 20 years). My conclusion is that the lowest conceivable cost of geothermal district heat is similar to the present cost of oil, so that economics alone do not justify geothermal, but since the district heat system without geothermal might be useful, an effort should be made to further refine the feasibility analysis of district heat.

GEOLOGIC ASSESSMENT

From the geological information compiled by Arlen Ehm, References 4 to 15 and Figure 10, p. 44, we come to the following conclusions:

1. We can probably find a formation at 6-8000 ft. depth below Kotzebue that will produce saline water (2 x seawater) at 160-178°F.
2. The downhole pressure may be sufficient to bring the water to a static level 250-500 ft. below the surface.
3. The data indicates thick sections of high porosity under Kotzebue, but the only way to determine well production rates is to drill a well at Kotzebue and pump it.

All of this is based on extrapolations from the Nimiuk Point and Cape Espenberg wells, and general geologic reasoning. The best available data to supplement these predictions is the seismic data owned by Chevron and NANA. Water analysis data from the Nimiuk and Cape Espenberg wells would also be useful. If seismic data is not available, electrical methods are the only way to verify the presence of saline water and the depth to equivalent basement with the budget available.

RECOMMENDATIONS

1. Request seismic and water chemistry information from NANA and Chevron.
2. Integrate this information with the geological data in the references to obtain the best possible prediction of what a geothermal well at Kotzebue would produce.
3. Get more information on what electrical and magnetic geophysical techniques will show.
4. Apply to HUD for funds to do a district heat scoping study for Kotzebue including geothermal, coal, and heat pump energy sources.

EDITORS NOTE

The following are notes of the advisory committee meeting. The headings refer to the person who was leading the discussion. The paragraphs following are a summary of the discussion, not a verbatim transcript. The notes were reviewed with a tape recording of the meeting to be sure the relevant points were included.

Participants

<u>Name</u>	<u>Organization</u>
John Beebee	Energy Systems, Inc.
William E. Ogle	Energy Systems, Inc.
Keith E. Brown	New Mexico Energy Institute
Gay Hammer	Eng. & Econ. Research, Inc.
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Arlen Ehm	Geological Consultant/Energy Systems, Inc.
Jack Howard	Lawrence Berkeley Laboratory
Gene Wescott	University of Alaska-Geophysical Institute

NOTES

ALASKA STATE DIVISION OF ENERGY AND POWER DEVELOPMENT

KOTZEBUE ADVISORY PANEL MEETING

September 12, 1980
Salt Lake City, Utah

Energy Systems, Inc. - William Ogle

The purpose of the meeting is to determine what to do with the \$600,000 appropriated for the Kotzebue Geothermal Project. The question is pretty open - we could "return" the money to the State or go all out on drilling a well.

Division of Energy and Power Development - Don Markle

The purpose of the appropriation is to develop a local energy source. The program started when Chevron drilled two wells, at Nimiuk Point and Cape Espenberg, for petroleum. There seemed to be a normal gradient geothermal resource. (The wells didn't seem to show petroleum and were abandoned.) Bob Forbes, of the University of Alaska Geophysical Institute, who is unfortunately not able to be here today, and some others submitted a proposal to look into the possibility of using the geothermal waters. That was 4 years ago. The proposal was turned down by the Department of Energy, but was resubmitted by the City of Kotzebue 2 years ago. It was turned down again.

Kotzebue is the regional center for the northwest Arctic region, in the sense that state social services for this region are centered there, and supplies are landed there and distributed.

The State of Alaska has a "policy" of trying to put oil revenues into renewable resource projects. Senator Frank Ferguson asked the State Division of Geological and Geophysical Surveys for figures on what a normal gradient geothermal project would cost. They recommended \$6 million, primarily for a well. The other alternative was \$60,000 for a feasibility study. The upshot was a \$600,000 appropriation for a Kotzebue geothermal project. Its an odd amount of money. We could design a district heat system for geothermal or coal, and return the balance to the State. We could use it as leverage for participating in federal programs like the user coupled drilling program.

Now that the State has an energy institute, which is presumably responsible for research and development of this sort, could the management of the project change? The answer is probably no.

Could the \$600,000 be redirected to the Pilgrim Springs Project? The answer is no, but there is \$250,000 in the Energy Center appropriation for the Pilgrim Springs project. Incidentally, since some of the people at this meeting helped us with that project, I can say that project is a success - there seems to be a good resource there. We are waiting on roads and leases before proceeding further. We also have a project at Unalaska, looking into the possibility of electricity. There is a "district heat" prospect at Tenakee Springs. The University of Alaska is compiling a geothermal atlas for the State.

City of Kotzebue - Gene Moore

Kotzebue has about 2500 people who live on 294 acres located on a spit 3 mi. long and 3600 ft. wide in Kotzebue Sound, 30 mi. N of the Arctic circle. The Corporate limits include 26 1/2 sq. mi. It is the regional center for 10 villages dependent on Kotzebue for hospitals, schools, fuel, and transportation. The region is about the size of Ohio. The population is 84% (approximately) Inupiat Eskimo. The economic mainstay is government. Kotzebue swells in population in summer, to 4-5000, as people come in to fish. Kotzebue has a 5 acre campground to accommodate them. Kotzebue influences the region. It has the only airport that can handle jets. (It is 1 hr. and 10 min. to Anchorage by jet.) Supplies mostly come on 4 barges between July and September. The barges have to dock 13 miles off-shore and lighter goods ashore. This adds 25% to the cost of goods.

People work when it is available, but the economy is mostly subsistence. Officially, 22% of the working population is unemployed. The real figure is higher. The total region has about 5000 people.

There has been a lot of building going on in Kotzebue. There have been 20 new homes, a 29 unit apartment complex, a \$2,000,000 human services complex, and a new school. We will be building a larger skills center.

People are enthused about geothermal, peat, and coal. The coal is about 60 miles across the water, near Deering.

Some people have personal gardens, and there is a little research into commercial grain and potato growing.

The Public Health Service built a water and sewer system, over a 17 year period. They started with plain uninsulated plastic pipe in the ground. It

eventually failed due to freezing problems. The system was rebuilt and rebuilt again. The water is heated to 47°F at the source and it is sent 8000 ft. to the treatment plant, at which point it is about 32°F. The water circulates constantly through 4 loops. Waste heat from the power plant is used to heat it. The sewer system is based on gravity, with force mains. A lagoon is used for treatment. The sewer system has an infiltration problem.

Northwest Alaska Native Association (NANA) - Don Argetsinger

NANA is a native regional corporation. It has 5000 shareholders, and \$65 million in assets. It has title to 2 1/2 million acres. The regional corporation merged with all the village corporations except Kotzebue (the Kikitagarmiut Inupiat Corporation). Except for the case of Kotzebue, NANA owns both the surface and the subsurface estate. NANA is involved in a number of businesses, mostly related to oil. In the region, it has a hotel in Kotzebue, reindeer herds and a jade plant.

By agreement with NANA Chevron drilled the two wells to be considered here, in 1975. Chevron and NANA share the information. Chevron is obligated to do further work when NANA gets all land entitlements - in the next few weeks. They must look at a certain number of acres in a given time frame. NANA needs the consent of the villages it merged with when exploration takes place on their lands. NANA has 8 or 9 employees in Kotzebue, and the local corporations have some more. All villages are second class cities. NANA probably owns the Deering coal but not the Hope coal.

Mauneluk Association - Jeff Smith

Mauneluk is a village non-profit corporation. It is quasigovernmental, but has no government authority. It is a contractor for government services like planning and health, manpower studies and training. It is funded mainly by the State and Federal governments. It has 80 direct employees, and 150 indirect employees through the Community Employment Training Act. It administers \$8 million in grants.

Mauneluk is doing a vegetation mapping study and is involved in a regional strategy plan for economic development, coastal management, etc.

If there was a district heat system in Kotzebue, it would be a municipal utility. The electric association is an REA coop.

The Kikitagarmiut Corporation is the Kotzebue village profit corporation.

Energy Systems, Inc. - John Beebee

Energy Systems estimated space heating fuel needs at Kotzebue and made a preliminary assessment of District heat.

Figure 1 shows Kotzebue, as it appeared in 1978. The city is only 10 feet above sea level, making subsidence a serious consideration. The Public Health Service installed a water system. The mains are shown as dashed lines. There are four loops, mostly 4 in. diameter pipe in 12 in. casing, with insulation between. There are about 500 connections to the system at present. (There are 467 houses). The pipe is shallowly buried. Once the water reaches the treatment plant, it is heated by means of waste heat from the diesel-electric power plant. We don't know what portion of the heat from the diesels is used. The water system, as it

exists today, including the collection works, cost \$5 million. However, it is hard to set an exact figure, because the sewer and water were built together, and parts of the system were reconstructed, over a 17 year period.

Don Clemson at EG&G has been looking at the possibility of circulating 100°F water by means of water mains and using it for both heating and culinary purposes by means of heat pumps. Since Kotzebue has a circulating system, it might be well worth looking at. A rough calculation shows that a lot of the heat could be supplied by the diesel electric generators. At this temperature expansion is not a problem, but the 4 in. diameter sounds too small, for Kotzebue. Also, the heat pumps would have to work off of diesel electricity at \$.22 per kw-hr. Nobody in Kotzebue heats with electricity. A permafrost engineer would have to look to see if the higher temperatures would be a problem. In the Soviet Union there are some installations where treated 140°F water is piped to the houses and used for heating and sanitary purposes, and then cooled for cold water.

I am not sure how the engineers will handle the permafrost problem. Although the permafrost is not bad at Kotzebue, the effect of adding a lot of heat to the ground is hard to predict. There is a military installation 3 miles south of Kotzebue, a radar site with about 100 employees. They have a central heat supply with above ground distribution. The feasibility of above ground or surface level utilidors would have to be looked at. Some of the sewer mains are pretty deep, 10-15 ft. Below 5 ft. you have to use a jackhammer or thawing all year.

Figure 2 shows some figures on oil use at Kotzebue. We compared a study by Retherford Associates and one by Louis Berger and Associates, and then chose the figures we liked best. The conclusion is that Kotzebue seems to use about .875 million gallons of oil per year for space heat. The Mayor, Mr. Royal Harris, who is manager of the fuel supply, estimates 1.2 million gallons were used in the past year, and that consumption is more or less level. It is hard to favor either figure. The .875 million gallon figure is based on a house to house survey of oil use by the Mauneluk Association, and estimates for commercial buildings by square footage. It was not able to take wind chill effects into account. The 1.2 million gallon estimate is based on records of fuel sales, and hence does not account for the fuel after it leaves Arctic Lighterage, the fuel dealer. It also appears that some of the difference may be accounted for by leaks.

Fuel at the dealer costs \$1.22/gal, but in many cases there is a delivery charge that must be added. Also note that the cost of electricity is around \$.20 per kw-hr to residential users. The actual cost of generation alone is around \$.13 per kw-hr, and this is charged to large users, consumption over 10,000 kw-hr/mon.

Houses in Kotzebue are pretty well insulated--6 in. thick walls. The houses are small, 600 to 900 sq. ft. for a family of 4 to 6. People have trouble paying their fuel bill. Water and sewer cost \$60 per month per residence, but this doesn't completely cover system operation and maintenance. Most houses burn the oil in a space heater, but commercial buildings and new apartments have hydronic heat, using a very small

circulation pump.

It is easy to forget, when talking about \$20 million district heat systems, that over the years you may pay this for oil. Figure 3 shows our estimate of what Kotzebue will pay for space heat based on oil in the coming years. The main points are that they are presently paying about \$1 million per year for space heat, but with a 4% per year increase in population, a 3% increase in per capita consumption, and a 5% (above inflation) per year increase in oil prices, they will spend \$20 million (1980 dollars) for oil between now and 1990.

Using the figures already developed, on energy use for space heat, and estimates what geothermal wells will produce, we made a small feasibility study for district heat, shown in Figures 4,5, and 6. We used 158°F for the well temperature, vs. the 162°F measured bottomhole temperature in the Nimiuk well. By using a two pipe system things could be arranged so that all houses get an approximately equal supply temperature. This was about the absolute minimum temperature for a district heat system. A 40°F drop from 150°F requires a large heat exchanger, or one that uses a lot of electricity, in the houses. A 400 watt fan running all year would consume over \$770 worth of electricity.

For planning the geothermal wells, we need 1500 gpm flow. This is usually two or three wells.

Salinity of the geothermal water is predicted to be twice seawater, and hence you need a flat-plate heat exchanger at the wellhead.

The Public Health Service estimates a cost of \$60-70 per foot for 4 in. diameter mains in a 12 in. aluminum jacket, buried, with a normal

number of fittings. I assumed cost increased linearly with diameter, and that one-way lines cost 75% as much as dual lines. The resulting costs are similar to estimates in the literature for pipes laid in downtown Stockholm and eastern U.S. cities, though obviously in these places a lot of money is spent displacing existing utilities and breaking pavement.

The City of Kotzebue finds it costs about \$35 per foot, with an average number of fittings, for materials and labor, for the 4 in. diameter Arctic pipe. This is an awful lot lower than ESI's estimate. With a district heat system, there would be a lot more cutting and filling, and possibly a concrete culvert, to keep heat from leaking into the ground, and to keep traffic from breaking the system. Also, with such a low supply temperature you may need a 2 pipe system. It is hard to figure out the cost of dealing with the permafrost, or how to best deal with it. A more detailed study needs to be done to determine the cost more reliably, but even it couldn't nail down things like contractor contingency fees.

As will be seen later, when Arlen talks about the geology, it looks like the pump setting depth will be at least 1000 ft. This is a problem, because pumping an average of 660 gpm against a 1000 ft. head is going to use at least \$205,000 per year in electricity. The well cost, \$5,000,000 per well, is based on commonly quoted figures for petroleum wells in the bush. There doesn't seem to be any logical reason why the wells should cost this much. The 2 1/2 wells assumes 2 production and one injection well. Similar wells at Raft River cost \$1 million each,

and there are some on the East Coast that cost \$600,000.

A 250 HP pump would require an 8" casing.

As can be seen, our estimate gives a total annual cost for geothermal district heat for Kotzebue of \$2,500,000. Fuel for space heat in Kotzebue now costs about \$1,000,000 per year.

The last figure (Figure 7, p. 41) shows some other considerations for Kotzebue district heat. The most outstanding advantage of district heat is that it can use a variety of heat sources. In the case of Kotzebue, waste heat from a coal fired electric plant might be worth looking at. Geothermal district heat is extremely capital intensive. It would create about the same number of local jobs it would displace in fuel sales. It is, however, a local source of heat.

Do you need some sort of backup heat for the geothermal system? The diesel exhaust heat is a good topping source. Perhaps by using waste heat or auxiliary boilers you could reduce the size and cost of the mains and household heat exchangers. Perhaps, but the cost of the mains goes up linearly with diameter, while the energy carrying capacity goes up with the square. Thus it is cheap to oversize the mains, within limits.

Comparison with Reykjavik, a successful geothermal heating system, shows that Kotzebue has a much lower heat density, and the supply temperature is lower. Thanks to Battelle, I did find a couple of geothermally heated towns in Iceland with heat densities similar to Kotzebue.

Energy Systems, Inc. - William Ogle

I did a parametric study, based on alternative well costs and depths to John's.

Looking at Figure 8, p. 42, the well depth affects the supply temperature, the flow rate required, the probable number of wells, and the pumping cost, as well as the cost per well. I assumed you could get 400-500 gpm per well. Note that there is a depth at which the cost is minimum (around 6000 ft.).

The first column shows well depth in feet. The second column shows the predicted bottomhole temperature. The gradient used is the measured gradient for the Nimiuk well. The third column shows the useful temperature drop, assuming a reject temperature of 110°F. It would be hard to use water below this temperature without heat pumps. The fourth column shows the average system power, in megawatts. The fifth column shows the required amount of water. The sixth column shows different assumptions for pump setting depths. The next column is the number of wells, rounded off to an integral number. The eighth column, headed Y\$, is the cost for the first 4000 ft. of drilling. I assumed that after this the cost was only half as much. If we don't think optimistically the answer is too obvious. The ninth column, Z\$, is the estimated cost of the district heat system. There is a funny sort of economics being discussed in Alaska, in which oil revenues are invested for capital equipment for utilizing renewable energy resources, and the cost of that equipment is not considered in computing the cost of that energy. Thus I looked at the case where the district heat system costs nothing. The tenth column is the 30 year amortization rate. (The Alaska Power Authority has 8.5% money.) The current

cost of oil heat in Kotzebue is around \$12.62 per MBtu, or \$.043 per kw-hr. It can be seen that no geothermal district heat system can match this price, except by postulating a 6 MW average power (vs 2.2 MW at present), 8.5% money, and a district heat system costing half as much or less per Btu delivered than as estimated by John. It also assumes the well costs already explained.

It seems that both the well cost, and the district heat cost are obstacles to an economic system. The figures for cost per kw-hr span the range of estimated future oil costs, and only in optimistic cases are they as low as the present cost of oil. If you played the game for 20 years you might break even. You need something more than economics to justify the system.

Discussion of District Heat

Wood is an alternative for the villages around Kotzebue. There are six villages that can harvest wood at \$50-65 a cord, at sustained yield. This is vs. \$125 per 55 gal drum of oil. (Though wood stoves are 15% less efficient). Mauneluk is developing a wood management plan for these villages. People are returning to wood heat. The money stays in the community. Coal is being looked at seriously. There is no active mining now, but in the past it was used for whaling vessels and mining. You get tired of chopping wood and stoking the fire.

One advantage of district heat is that it can be supplied by waste heat.

There are lots of other fuels for district heat. The wells look bad. The pumps are 2000 ft. down. They would be hard to maintain.

Would the salinity of the water cause problems with the heat exchanger?
No, you can use a flat-plate exchanger and disassemble it once in awhile for cleaning.

The projected electricity use by downhole pumps is comparable to what would be used by household heat pumps working off of 110° water delivered by the present water system. The cost of household heat pumps would be about \$1.7 million. This would probably overload both the electrical distribution system and the water supply system.

Within 3 days the Department of Housing and Urban Development is going to announce funds for scoping studies of geothermal district heat systems. Eric Peterson is the person at the Division of Geothermal Energy to contact. After the scoping study is done, HUD will provide \$2-300,000 for design. In fact, the whole system can be designed using HUD money. Do scoping studies on all the options. You should also look for ways to reduce the size of the mains.

The town of Pagosa Springs, Colorado, has gone a long way in getting a geothermal district heat system and in inducing people to connect. The town has a local advisory committee that has developed local enthusiasm. Fred Eberling has worked with them. Local improvement districts can also be used to induce people to connect. What are the Alaska statutes on local improvement districts?

How did the Public Health Service induce people to connect? They didn't tell them what it cost! It was much more convenient to have public water and sewer. It is easier to turn a tap than to chop and

melt ice. People would have connected even if they had known the cost. District heat is no different. If it is more convenient and available, people will connect.

There is a fish coop in Kotzebue. They are thinking about a freezing plant.

Can money be spent on regional projects? There is an unexplored geothermal resource south of Ambler, in the Purcell Mountains, that may have electrical potential. Flows of a thousand gpm are reported. It is 150 miles from Kotzebue.

Arler Ehm - Geological Consultant

I'll go over the regional geology, the well tests, and something about what it means about temperatures, depths, and costs for geothermal energy.

The Kotzebue geologic province is bounded on the north and south by mountains, representing faulting and thrusting. To the north of Kotzebue the surface rocks and mountains are predominantly sedimentary, to the south they are more igneous and clastic. The Baldwin Peninsula, on which Kotzebue lies, is in the Hope Basin, a geologically recent (tertiary and cretaceous) basin, a straightforward petroleum province. There is no similarity between the geology of the Seward Peninsula and Kotzebue.

The best indication of what is under Kotzebue comes from the Nimiuk Point well, 17 miles SE of Kotzebue. The only probable difference between Kotzebue and Nimiuk is the thickness of the volcanic rocks (see

Figure 10, p. 44) and the depth to "basement". The temperature gradient is slightly higher than normal, as in the entire North Slope of Alaska.

The olivine basalt, at about 6000 ft. in the Nimiuk well, was extruded into water, where it cooled immediately and has been cooling ever since. For geothermal, we would be looking for intrusive rocks. The relationship between the basalt and the underlying carbonates and schist is unknown. The basalt, schists and carbonates below 6000 ft. do not represent the basement for the Hope Basin. There are additional sediments at depth greater than the well. The sandstones penetrated by the well, from approximately 300-6000 ft., have around 35% porosity and are probably very permeable. Beyond the bottom of the well the porosity and permeability probably decline. There probably isn't much water or fracture permeability below 6000 ft. The carbonates below 6000 ft. are mid Paleozoic. The petroleum targets were in the Tertiary section. The petroleum company stopped drilling both wells in the schists, dolomites, and limestones, of probable paleozoic age. They evidently thought they wouldn't find hydrocarbons or porosity at greater depth. The well was tested in the 3755-3537 ft. interval, and a column of salt water and drilling fluid rose 2190 feet in the drill stem (to within about 1350 ft. of the top of the hole). (See Figure 10).

The Cape Espenberg well, 40 miles SE of Kotzebue, Figure 10, was tested from a zone that included sandstone, clastics, and carbonates. We can't say which zone produced the water, but saltwater rose from 8000 ft. to within 500 ft. of the surface. Again, the pressure buildup

suggests the column of saltwater and mud is a true indicator of the formation pressure. The three tests above in the well seem to be mechanical failures. We would expect to get water from each zone tested.

There is a correspondence between the geological sections in the Cape Espenberg and Nimiuk Point wells. The volcanic section, which is 40 ft. thick in the Nimiuk well, is 3000 ft. thick in the Espenberg well. The "basement" schists are around 6150 ft. in the Nimiuk well and at 8200 ft. in the Cape Espenberg well.

The electric logs for the two wells, self potential and resistivity, indicate that the formations encountered by the wells are saturated with salt water, and have thick sections of high porosity, 20-35%. They are good geothermal wells (except for pressure) but poor petroleum wells.

There are three sources of temperature measurement. Everytime a sonde is put into the hole maximum reading thermometers are taped on. A complete temperature profile is made after the well drilling has been completed. A temperature guage is placed at the top of the tested formation (in the fluid stream) during drill stem tests.

The process of drilling cools the rock. The mud must be left in the hole 60-70 days before it reaches temperature equilibrium. Drilling activities cool the rock by means of mud invasion and other convection, more rapidly than conduction can rewarm it. Not enough water is produced in the drill stem tests to get water far from the well bore.

The temperature gradient seems about normal for sedimentary rocks. The two wells have about the same measured bottomhole temperature (162°F) but the Nimiuk Point well is 6311 ft. deep, vs. 8373 ft. for the Cape

Espenberg well. The Nimiuk Point well has a relatively higher gradient at the bottom. I guess you would have to add 18°F to the measured bottomhole temperatures (162 and 163°F) to get the true formation temperature. Apparently the "basement" itself, rather than its depth, determines the temperature at depth. But this is a generalization. There seems to be little vertical water convection. Apparently, there isn't much connection with the sea. The rock is saturated with ancient formation water.

How much water can we get? There is no real information. The only way to find out is to pump test. We have high porosity, but permeability and longevity cannot be predicted. There is apparently lots of water, but it must be tested. If the formations extend unbroken, as we expect, water would flow into the well from all of Hope Basin.

The gravity map shows a high at Espenberg and a low at Nimiuk, but the depth to equivalent "basement" is greater at Espenberg than Nimiuk. Kotzebue itself is a small local "high". Apparently the gravity measurements are influenced by the density of the surface rocks. The equivalent depth to "basement" at Kotzebue is an important piece in the puzzle, because apparently the temperature gradient is more strongly influenced by the formation than its depth, and we need to know how deep to drill. We also need to determine that the formations encountered at Nimiuk and Espenberg are continuous. The most unambiguous source of this information, other than a well, is the seismic data that was collected by NANA and Chevron. Because of the mutual confidentiality agreement, between

NANA and Chevron, we will have to make a written request to both. Purchasing the raw seismic data or reacquiring it is prohibitively expensive. There is seismic data for sale, but you have to buy it all, you can't get pieces of it. There undoubtedly is a seismic line near Kotzebue, because wells like the Nimiuk well are almost always drilled at an intersection of seismic lines. Because of the agreement between NANA and Chevron, other companies are not interested in the area. We also need the water chemistry information.

Vic Mittach estimates he could drill a 6000-8000 ft. production well at Kotzebue, using a truck mounted rig, for \$800,000 to \$1.2 million. This is with a 6 in. casing. The rig is limited by the casing weight. Kotzebue is a relatively easy drilling situation. The rig itself costs \$2 million to \$6 million. A 250 HP downhole pump requires an 8 in. diameter casing. At Raft River, the 250 HP pump did not give adequate flow. They had to use a 600 HP pump, which required 13 5/8 in. diameter casing.

State Division of Geological and Geophysical Surveys - John Reeder

In our paper ("Alaska Geothermal Implementation Plan," Reference 17) we tried to envision how a geological and geophysical investigation of Kotzebue should be conducted. The printed investigation was for a convective system, which we now realize is not the case. Hence our plans do not fit the site.

It is hard to detect an aquifer at great depth, by any technique. It isn't impossible to detect a saltwater aquifer at depth. We are

looking at a structural approach. We need the seismic information most of all. We should also locate aeromagnetic data. Shallow temperature gradient holes will not do any good, because of the permafrost. They must be at least 1000 ft. deep. If the "basement" is shallower than 4000 ft, we may as well give up. I have reservations about trying to drill a well with an inadequate budget. We may spend too much money and not get a good well.

In this case, the geology is known well enough that you pretty much have to decide whether you are going to drill a production well or not. To find what you need to know, you have to make a pump test. The difference between an exploratory well and a production well, particularly the cost, would be pretty small.

With a small drilling rig you can afford to test as you drill.

It seems that most of the relevant additional geological information can be obtained from Chevron.

University of Alaska Geophysical Institute - Gene Wescott

I looked at the resistivity data from the Nimiuk Point well and used it to calculate the results that can be expected using magnetotellurics. The model I used is shown below.

<u>Depth</u>	<u>Resistivity</u>
0	
300'	1000 Ω -m
700'	20 Ω -m
	.8 Ω -m

From 0-300 ft. we have $1000\Omega\text{-m}$ sediments, from 300-700 ft. we have $20\Omega\text{-m}$ sediments, and thereafter the resistivity is $.8\Omega\text{-m}$.

The base of permafrost should be easily detected by dipole-dipole or audio frequency magnetotellurics. We will probably see the "basement," assuming they are dense rocks that are not salt-water saturated. The technique should show the limestone layer, if it is present. The error in depth to the limestone, assuming 6000 ft. depth, would be $\pm 5\%$. The cost would be about \$50,000. The survey would have to start at the Nimiuk Point well. Since Kotzebue is not, probably, a series of pancake layers, we would have to use a 2-dimensional interpretation. We can also use the phase data in the interpretation. The best stratigraphic information can be obtained from a seismic survey, but if that can't be obtained, the only way to get the information, with a \$600,000 budget, is magnetotellurics. It will show presence or absence of saltwater at depth before you drill a \$2,000,000 well.

In the past, magnetotelluric results have been so ambiguous that it wouldn't stop you from drilling a well. It would sure make you pause, though, if the magnetotelluric results showed an absence of saltwater at interesting depths.

Are we being misled because there are wells with warm water at Cape Espenberg and Nimiuk Point? There wasn't any geothermal interest in Kotzebue until the wells were drilled. Could Kotzebue be totally different? Yes, and that is another argument for looking at the seismic data. Kotzebue is of critical interest, because it is a case study of a normal gradient system. If geothermal won't work at Kotzebue, there are a lot of other sedimentary areas where it won't work.

It would cost a lot to reopen the Nimiuk Point well. It wasn't entirely cased. Thus, there is cement in an open hole.

Discussion

We should look at the demographic changes in Kotzebue, and also the potential of conservation, wood heat, heat pumps, and a dual purpose (heat, electricity) coal fired plant. There is a coal study being done by James and Moore. Kotzebue wants to do something to change its dependence on oil.

A consideration in any design for a district heat system is whether it is supplied with coal or geothermal. There are different design factors.

Senator Ferguson needs to know whether geothermal is feasible or not. We seem to be spending some of the \$600,000 to make the non-geothermal options look better.

In spite of past overoptimism about the value of magnetotellurics, there has been, in the past 9 months, some serious progress in 3 dimensional interpretation of the results. We ought to get together with another expert on magnetotellurics to get a better grip on what results we can expect. It seems like good insurance to do an electrical survey before drilling a \$4,000,000 well.

We will pursue the HUD solicitation. District heat looks good for Kotzebue. John Reeder will contact Art Grants about some other seismic data.

A heat flow well might help by giving information on conductivity and temperature gradient. But what does it mean in a water filled medium? A well at Kotzebue is not a rank wildcat, it is a stepout wildcat. A slimhole won't allow you to pump test, which is the most important thing you will need to do. The petroleum industry does not use slim holes. If they found something interesting, they would not be able to pursue it without a bigger rig.

If we can't make normal gradient geothermal energy work at Kotzebue, we can't make it work anywhere. Maybe, but remember that the district heat system was as big a factor, economically, as the wells. If Kotzebue was one big building, things would look a lot different.

Some Tentative Conclusions

No-one has said the whole thing is ridiculous.

We need to get the seismic and water chemistry information. After that is done, we ought to integrate it with the logs and surveys we already have. We may then want to go one step up and use electrical methods.

The projected heat distribution costs are sufficiently attractive that some effort should be made to reduce their uncertainty, and other heat supplies, particularly coal, should be considered, as well as some more detailed consideration of the engineering problems. We should get together again to consider the results.

The Department of Housing and Urban Development should be contacted about funding a scoping study for district heat, and some of these other

options should be integrated into the study.

After the above things have been done, we had better do a little more talking.

If the economics seem to work out after the above is done, there seems to be no other step except to find a way to drill a hole.

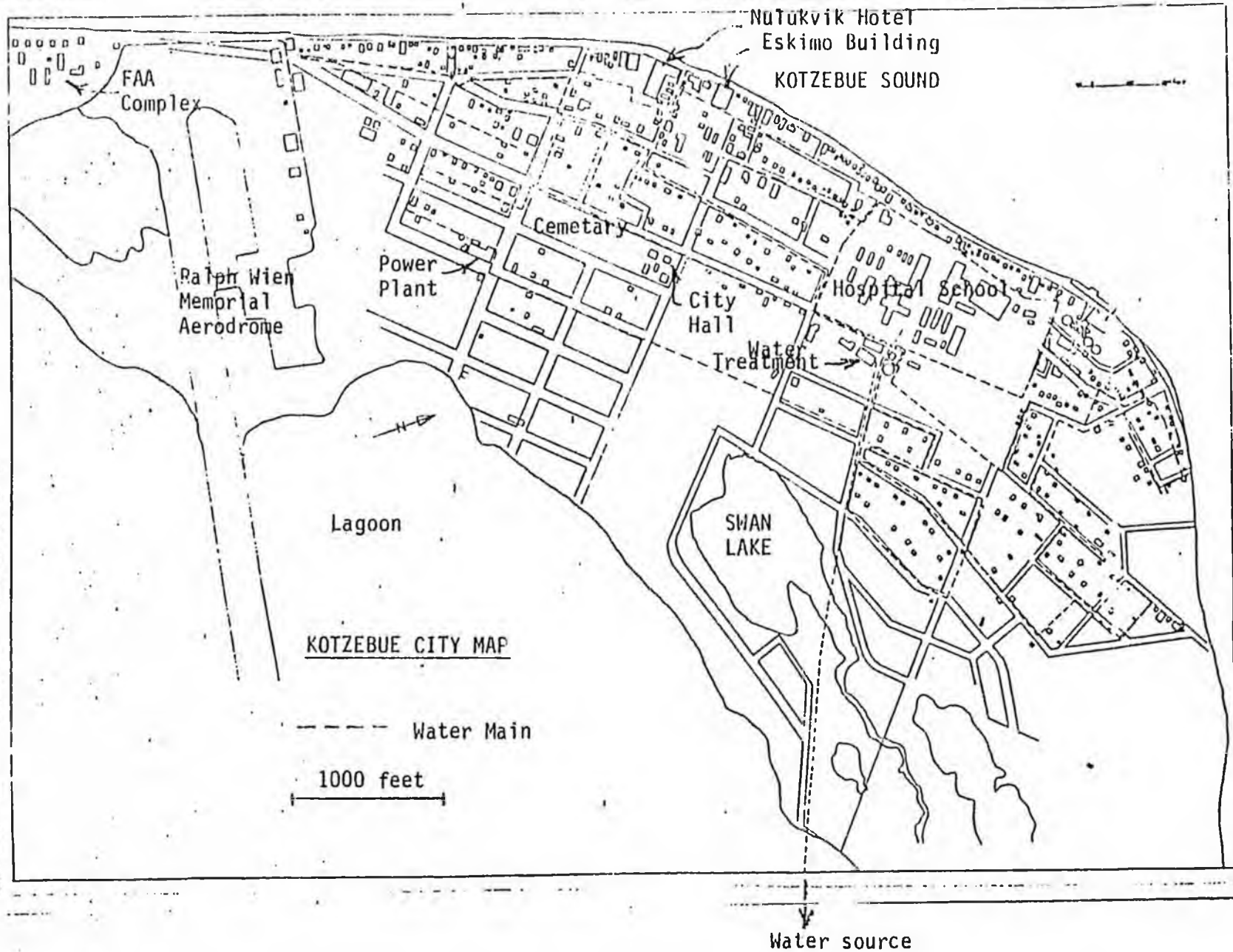


Figure 2
KOTZEBUE, ALASKA

1980 ANNUAL ENERGY INVENTORY

	<u>Retherford(1)</u>	<u>Other Studies</u>	<u>ESI Analysis</u>
Residential Space Heating	0.91x10 ¹¹ BTU(13)	0.37x10 ¹¹ BTU(5)	0.37x10 ¹¹ BTU(8)
Commercial Space Heating	-----	0.35x10 ¹¹ BTU(5)	0.35x10 ¹¹ BTU(9)
Total Oil Space Heating	1.1x10 ⁶ Gal(2)	0.875x10 ⁶ Gal(5)	0.875x10 ⁶ Gal(5)(14)
Electric Energy	4x10 ¹⁰ BTU	3.7x10 ¹⁰ BTU(5) (25% Efficiency)	4x10 ¹⁰ BTU(1)
Total Oil Used for Electrical	1.16x10 ⁶ Gal (25% Efficiency)	1.088x10 ⁶ Gal(5)	1.16x10 ⁶ Gal(1) (25% Efficiency)
Total Oil Consumption	2.26x10 ⁶ Gal(2)	2.786x10 ⁶ Gal(5)	2.04x10 ⁶ Gal
Fuel Cost for Electrical Generation	\$1.16x10 ⁶ (3)	\$1.237x10 ⁶ (6)	\$1.32x10 ⁶ (10)
Residential Cost of Electricity	18.2¢/KWh(4)	24¢/KWh(7)	20.26¢/KWh(11)
Cost of Residential Heating Oil	\$1.1x10 ⁶ (3)	-----	\$0.546x10 ⁶ (12)
Total Fuel Cost Space Heating	-----	-----	\$1.07x10 ⁶ (10+12)

- (1) R.W. Retherford Assoc., "Assessment of Power Generation Alternatives for Kotzebue", June 1980.
- (2) Does not include commercial space heating requirements (schools, jail, hospital, business).
- (3) \$1.00/Gal from Ref. (1).
- (4) Retherford uses 18.2¢/KWh for all electrical usage (therefore, \$2.148x10⁶/yr).
- (5) Louis Berger & Associates, Inc. "Western and Arctic Alaska Transportation Study-Fuel Consumption Working Paper", July 1980. Based on Mauneluk house-to-house fuel use survey and building square feet to 60% efficiency.
- (6) Ref. (5) and Arctic Lighterage records of \$1.137/Gal.
- (7) 24¢/KWh est. by Division of Energy and Power Development, "1979 Community Energy Survey", (therefore, \$2.6x10⁶/yr).
- (8) Based on 467 residences and .0573 gal/deg-day/residence for 16039 deg-days.
- (9) Ref. (2) for oil consumption of 427,000 Gal.
- (10) Arctic Lighterage Records of contract fuel at \$1.137 per gallon.
- (11) 20.26¢/KWh for 467 residences at 448 KWh/mo usage-Supplied by Kotzebue Electric Association records (\$0.51x10⁶).
- (12) Arctic Lighterage Cost of non-contract fuel at \$1.22/Gal.
- (13) Based on 467 houses, 900 SF each, R-11 insulation, 16,039 deg. days.
- (14) Arctic Lighterage estimates 1.2 million gallons were used for space heating in 1980.

Figure 3

HEATING OIL COSTS

- (a) 1980 fuel cost is \$1.22/gal.
- (b) Oil cost per gallon increases at 5% (1) per year.
- (c) 1980 heating oil required = 0.875 million gal.
- (d) Total oil use for heat increases 7% (2) per year.
- (e) 1980 dollars.

<u>Year</u>	<u>Cost/Gal.</u>	<u>M Gal.</u>	<u>Cost(M\$)</u>	<u>SUM</u>
1981	\$1.28	0.936	\$1.20	1.20
1982	1.35	1.0	1.35	2.55
1983	1.41	1.07	1.51	4.06
1984	1.48	1.15	1.70	5.76
1985	1.56	1.22	1.90	7.66
1986	1.64	1.31	2.15	9.81
1987	1.72	1.41	2.43	12.24
1988	1.80	1.5	2.70	14.94
1989	1.89	1.61	3.04	17.98
1990	1.99	1.72	3.42	21.40
1991	2.09	1.84	3.85	25.25
1992	2.19	1.97	4.31	29.56
1993	2.30	2.11	4.85	34.41
1994	2.42	2.26	5.47	39.88
1995	2.54	2.41	6.12	46.00
1996	2.66	2.58	6.86	52.86
1997	2.80	2.76	7.73	60.59
1998	2.94	3.04	8.94	69.53
1999	3.08	3.25	10.00	79.53
2000	3.24	3.48	11.28	90.81

After 20 years, total heating oil expenditure is $\$180 \times 10^6$

- (1) Review of Price Projections for Traditional Space Heating Fuels, Johns Hopkins University, Applied Physics Laboratory, GEMS-007, QM-80-070, MCGER-80-001, APRIL 1980.
- (2) Assessment of Power Generation Alternatives for Kotzebue, Robert W. Retherford Associates, June 1980. The Retherford study argued a 7% per year increase in the number of consumers.

Figure 3 (Cont.)

In (b) above, the assumption of a 5% increase per year for residential fuel costs is supported by the renormalized price projections made by the Energy Information Administration and reported in the Johns Hopkins University publication. Projections were made for every fifth year from 1979-2000. All projections indicated increases between 2% and 8% per year and were made before the energy supply problems and price increases of 1979. Thus, they are definitely too conservative. Readjusted scales appear to support an 8% to 15% increase. However, projections are not intended to predict actual prices prevailing at a future date, but to indicate "overall" trends. Therefore, this analysis was made for an assumption of 5% real growth.

The problem in (d) above, of estimating the growth in numbers of consumers was solved by reasoning that:

1. The Alaska Department of Labor shows that the Kotzebue population has increased by 4% per year since 1970.
2. Kotzebue presently has about 5.5 people per residence, with houses around 900 square feet. It is assumed the first number will decrease, the second number will increase, and that conservation measures will have a strong effect.

Figure 4

ESTIMATE OF POTENTIAL
FOR DISTRICT HEAT

Estimate for 1980 heating requirements: $.72 \times 10^{11}$ Btu

Use a figure of 1.16×10^{11} Btu to size the mains.

This figure was chosen rather arbitrarily and is a compromise between the estimated 1990 demand of 1.41×10^{11} Btu and the 1980 demand of 72×10^{11} Btu. A more detailed analysis would have to consider how many houses can economically be connected to the system.

Record F degree day = 117

Average F degree day = 44

97.5% of the degree days are less than 101

Use a peak to average ratio of 2.3

Average use = 1.16×10^{11} Btu/yr \div 365 days/yr \div 24 hrs/day =
 1.32×10^7 Btu/hr.

Peak use = 1.32×10^7 Btu/hr \times 2.3 = 3.03×10^7 Btu/hr.

Assume a sendout temperature of 150°F for the mains.

Assume a useful temperature drop of 40°F.

These last two assumptions are based on the expectation of getting a 158°F geothermal supply. The 40°F temperature drop in the district heat system would require very large radiators and heat exchangers. On the other hand, assuming a more reasonable 20°F drop results in larger mains and higher pumping costs. It would be very advantageous to the system if nature provided 200°F water. The power of the system is controlled primarily by the water sendout temperature rather than by varying the flow.

$$3.03 \times 10^7 \text{ Btu/hr} = 1 \text{ Btu/lb/F}^\circ \times 62 \text{ lbs/ft}^3 \times 40^\circ\text{F} \times Q \text{ (ft}^3\text{/sec)} \times \\ 60 \text{ min/hr} \times 60 \text{ min/sec.}$$

$$Q = \text{peak fluid flow} = 3.39 \text{ ft.}^3\text{/sec.}$$

A flow of 3.39 ft.³/sec. = 1,523 gpm. This corresponds, at 6 ft/sec. flow velocity, to a main with an inside radius of 5.09 in. We will assume a 10 in. diameter main.

Kotzebue has a water distribution system at present. The water is collected at the reservoir and heated just enough to ship it 8000 ft. into town. Here it is heated further with waste heat from

Figure 5

the power plant and distributed to the customers through 4 loops, with lengths of 7,500 ft, 10,000 ft, 11,000 ft, and 12,000 ft. The water in the loops circulates constantly. The 4 in. diameter pipe is inside a 12 in. casing, with insulation between. Such pipe, with a normal number of fittings, installed, cost \$60-70/ft. The pipes are shallow buried, to minimize the heat they add to the ground, which has permafrost. The system, including collection site, cost about \$5,000,000.

For this analysis of a district heat system, I will assume that the mains are layed out like the water system, with the wells at the site of the water collection system. This is the basis for estimating the piping requirements.

8000 ft of 2-way 10 in. main at \$200/ft =	\$1,600,000
40,500 ft of 1-way 6 in. main at \$100/ft =	4,050,000
Heat exchanger 1500 gpm =	120,000
400 house connections at \$1000 each =	400,000
400 house heating system retrofits at \$1000 each =	400,000
Miscellaneous buildings, circulation pumps, controls, etc. at 5% =	330,000
Engineering at 10% of cost =	690,000
Cost of district heat system =	7,590,000
2 1/2 wells at \$5,000,000 per well	12,500,000

This is based on 2 wells, each 6,000 ft deep and capable of producing 70°C water at a combined flow of 1500 gpm. It is assumed we need one 3,000 ft injection well.

2 downhole pumps, 250 HP each at \$400/HP =	\$200,000
---	-----------

This is calculated by assuming each pump must produce $3.39 \div 2 = 1.7$ cu ft/sec against a 1000 ft head at 75% efficiency. If P is the pump power in HP, then $P = 1.7 \text{ ft}^3\text{sec} \times 1000 \text{ ft} \times 62 \text{ lbs/ft}^3 \div 550 \text{ ft-lbs/sec-HP} \div .75 = 255.5$ HP

Total cost of wells and pumps =	\$12,700,000
Total cost of system =	20,290,000

Cost of system amortized for 20 years at 7% =	1,915,000/yr.
Operation and maintenance (5% of District heat net) =	380,000/yr.
Cost of electricity for downhole pumps at \$.125/kw-hr =	205,000

Assume that, on the average, there is 250 HP on line:

$C = \$.125/\text{kw-hr} \times 250 \text{ HP} \times .75 \text{ kw/HP} \times 24\text{hr/day} \times 365 \text{ day/yr} =$	\$205,000
---	-----------

Total annual cost:	\$2,500,000
--------------------	-------------

Figure 6

It appears that if the District heat system had gone on line today, with all of the favorable characteristics above, and replaced all of the oil used today for heating, and if it could expand to meet the future demand, then it would provide heat competitive with oil in 1987-1988.

Figure 7

OTHER FACTORS AFFECTING A KOTZEBUE DISTRICT HEAT SYSTEM

1. Permafrost, high water table, and poor soils (compared to the outside world). The system must be insulated from the ground.
2. Likelihood of extremely low temperatures at a time of system failure. The system must be protected from freezing.
3. The ratio of peak to average demand is over 2.
4. There are about 16000 F degree days.
5. There is a low heat density. See comparison below with Reykjavik.
6. Most residences must be retrofitted for hot water heat.
7. High cost of electricity (\$.125/kwh for large users) must be considered in system design.
8. The elevation of Kotzebue is only about 10 feet above sea level. Subsidence would be intolerable.
9. There is a lot of local concern about fish and wildlife, and this probably means spent brine must be reinjected.
10. District heat would provide the opportunity to use other locally available fuels, most notably coal.
11. Geothermal district heat would create a few local jobs, but it is definitely capital intensive.

COMPARISON WITH REYKJAVIK

	Reykjavik	Kotzebue
Population	72,000	2500
Degree days	8700	16000
Area	130,000,000 sq ft	15,000,000 sq ft
Heat consumption	41.2 trillion Btu	.116 trillion Btu
Heat density	31,900 Btu/sq ft	7,733 Btu/sq ft
Peak power/average	2.3	2.6
Geothermal supply temperature	220 F	158 F

Figure 8
Parametric Projections of Geothermal Energy Cost

Well Depth	Temp(F)	DT(F)	Demand Power	Flow(Gal/Min)	Pumping Depth	N ¹	Y(\$) ²	Z(\$) ³	R ⁴	\$/KWH ⁵
4500	119.15	9.155	3000	2234	2000	4	2000000	8000000	.15	.136
5000	128.28	18.28		1119		5				.148
6000	146.53	36.53		560		2				.100
7000	164.78	54.78		373		3				.113
8000	183.03	73.03		280		2				.097
10000	219.53	109.53		187		1				.082
8000	203.03	93.03		220		2				.098
6000	166.53	56.53		362		2			.085	.0995
5500	157.40	47.40		432		2				.104
5000	148.28	38.28		535		2				.070
5500	167.40	57.40		356		2				.067
5000	158.28	48.28		424		2				.065
42 4000	140.03	30.03		681		2				.065
5500	157.40	47.40		356		2				.064
				432		2				.065
			6000	864		2				.037
						3	4000000			.025
						3		16000000		.038
					4500	3				.066
					1000	3				.072
					2000	3				.064
			3000	432	2000	2	2000000	8000000		.052
4000	150.03	40.03		511	2000	2		8000000		.065
5500	157.40	47.40	6000	864		2				.063
			3000	432		3				.032
						2				.051
						2				.037

- (1) Number of Wells
- (2) Well Cost Parameter
- (3) District Heat Cost
- (4) Rate of Return
- (5) Energy Cost

Figure 9

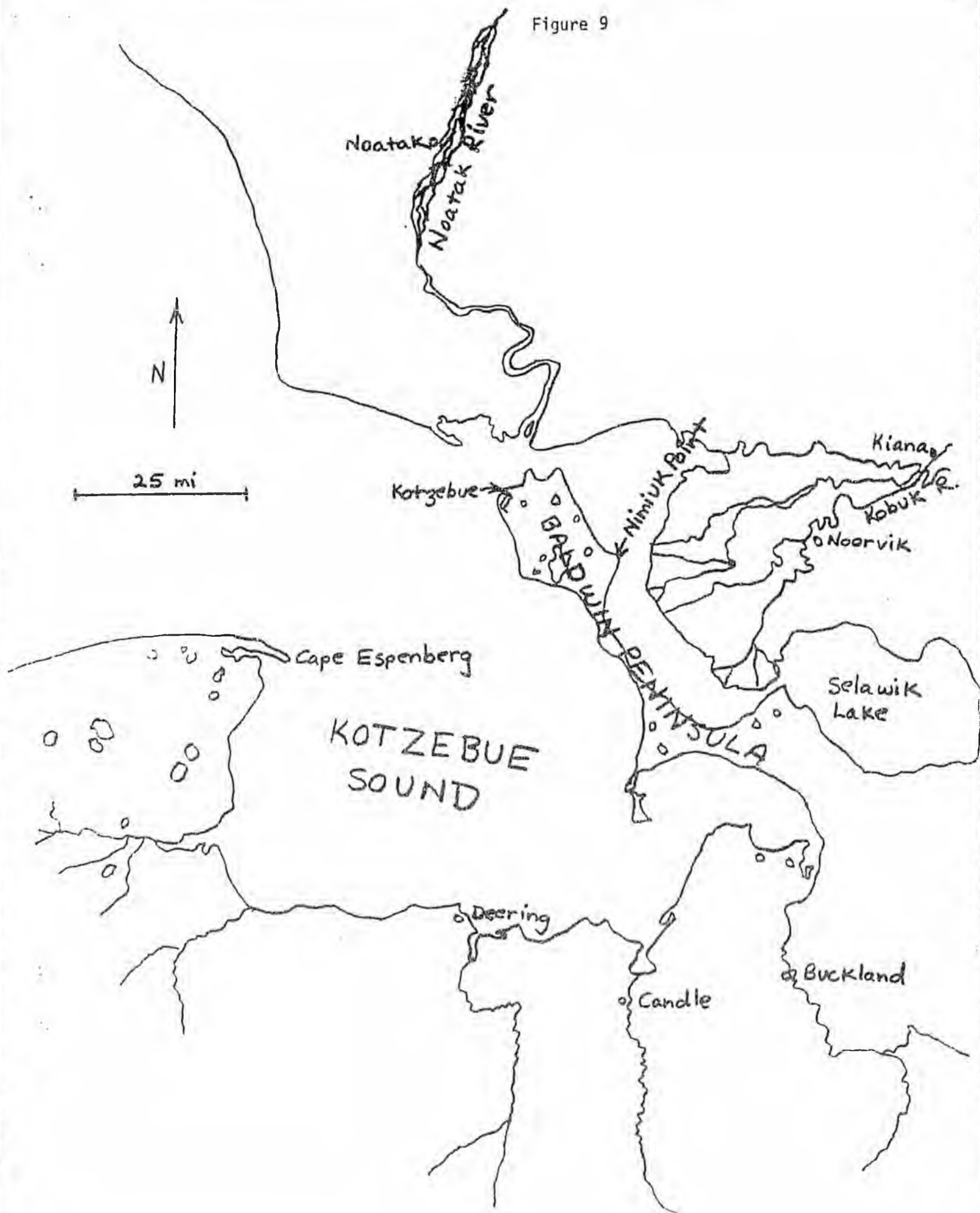


Figure 10

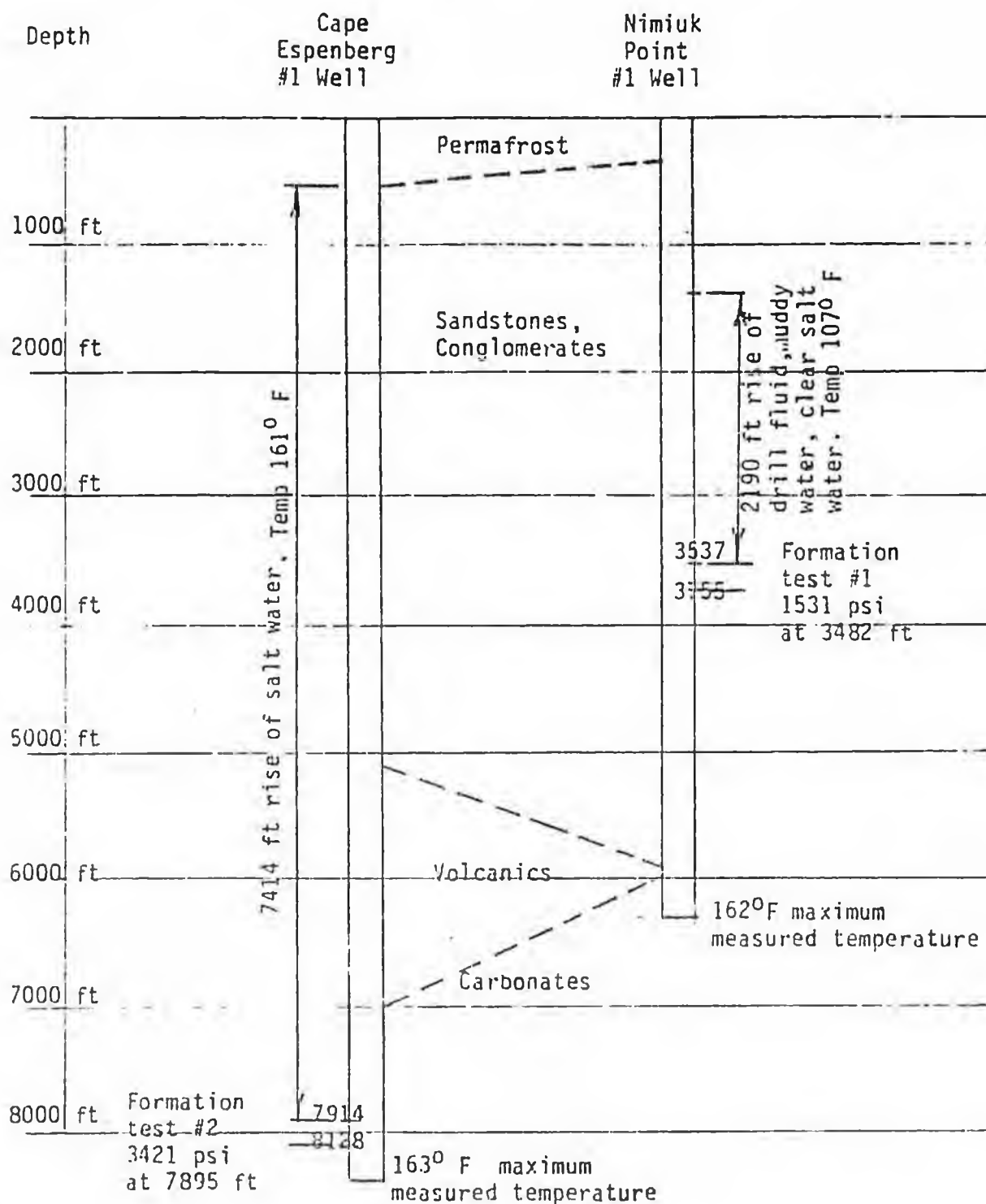


DIAGRAM OF CAPE ESPENBERG AND NIMIUK POINT WELLS, SHOWING GENERAL ROCK TYPES, DEPTHS, AND RESULTS OF FORMATION TESTS. (The well logs show this in more specific detail.)

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Offered: 5/19/83
Referred: Finance

Original sponsors: Faiks, V.Fischer,
Bennett and Josephson

Funding Information
General Fund \$37,400,000
Other Funds -0-
\$37,400,000

1 IN THE SENATE BY THE RESOURCES COMMITTEE

2 CS FOR SENATE BILL NO. 272 (Resources)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 THIRTEENTH LEGISLATURE - FIRST SESSION

5 A BILL

6 For an Act entitled: "An Act making special appropriations for payment as
7 grants to the Municipality of Anchorage for expansion
8 of the Ship Creek Treatment Plant, phase II design
9 and construction of the Eklutna Water Project and the
10 purchase of the Central Alaska Utility; and providing
11 for an effective date."

12 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

13 * Section 1. The sum of \$7,400,000 is appropriated from the general
14 fund for payment as a grant to the Municipality of Anchorage for expansion
15 of the Ship Creek Water Treatment Plant to 24 million gallons per day.

16 * Sec. 2. The sum of \$25,000,000 is appropriated from the general fund
17 for payment as a grant to the Municipality of Anchorage for phase II design
18 of all the Eklutna Water Project and construction of the Anchorage to Eagle
19 River segment of the Eklutna Water Project.

20 * Sec. 3. The sum of \$5,000,000 is appropriated from the general fund
21 for payment as a grant to the Municipality of Anchorage for purchase of the
22 Central Alaska Utility.

23 * Sec. 4. The appropriations made by this Act shall be disbursed in
24 accordance with AS 37.05.315.

25 * Sec. 5. This Act takes effect immediately in accordance with AS 01.-
26 10.070(c).

As (some) Not adopted by (some) the

Folta
3/27/84

Original sponsors: Faiks, V.Fischer,
Bennett and Josephson

<u>Funding Information</u>	
General Fund	\$41,956,000
Other Funds	-0-
	<u>\$41,956,000</u>

1 IN THE SENATE

BY THE FINANCE COMMITTEE

2 CS FOR SENATE BILL NO. 272 (Finance)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 THIRTEENTH LEGISLATURE - SECOND SESSION

5 A BILL

6 For an Act entitled: "An Act making special appropriations for payment as
7 grants to the Municipality of Anchorage for the
8 Eklutna Water Project and to the City of Kotzebue for
9 drilling geothermal wells; and providing for an
10 effective date."

11 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

12 * Section 1. The sum of \$34,000,000 is appropriated from the general
13 fund for payment as a grant to the Municipality of Anchorage for phase III
14 final design of the Eklutna Water Project, including design of the water
15 treatment plant and lake intake structure; construction of pipeline
16 segment p-2 from Eagle River to Peters Creek and pipeline segment p-3 from
17 Peters Creek to the Eklutna River; and miscellaneous costs of permitting
18 and right-of-way acquisition.

19 * Sec. 2. The sum of \$7,956,000 is appropriated from the general fund
20 for payment as a grant to the City of Kotzebue for drilling exploratory
21 geothermal wells.

22 * Sec. 3. The appropriations made by this Act shall be disbursed in
23 accordance with AS 37.05.315.

24 * Sec. 4. This Act takes effect immediately in accordance with AS 01.-
25 10.070(c).

Original sponsors: Faiks, V.Fischer,
Bennett and Josephson

Funding Information

General Fund	\$41,956,000
Other Funds	-0-
	<u>\$41,956,000</u>

1 IN THE SENATE

BY THE FINANCE COMMITTEE

2 CS FOR SENATE BILL NO. 272 (Finance)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 THIRTEENTH LEGISLATURE - SECOND SESSION

5 A BILL

6 For an Act entitled: "An Act making special appropriations for payment as
7 grants to the Municipality of Anchorage for the
8 Eklutna Water Project and to the City of Kotzebue for
9 drilling geothermal wells; and providing for an
10 effective date."

11 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

12 * Section 1. The sum of \$34,000,000 is appropriated from the general
13 fund for payment as a grant to the Municipality of Anchorage for phase II
14 design of the entire Eklutna Water Project and construction of the
15 Anchorage to Eagle River segment of the Eklutna Water Project.

16 * Sec. 2. The sum of \$7,956,000 is appropriated from the general fund
17 for payment as a grant to the City of Kotzebue for drilling exploratory
18 geothermal wells.

19 * Sec. 3. The appropriations made by this Act shall be disbursed in
20 accordance with AS 37.05.315.

21 * Sec. 4. This Act takes effect immediately in accordance with AS 01.-
22 10.070(c).

INDIVIDUALS WISHING TO TESTIFY

REGARDING SB 200 - Sewer

DATE	NAME	TITLE	AGENCY
3/28/84	CHARLEY BRYANT	Project Manager Klutwa Water Project	AWWU Munic. of Hrvch

SENATE FINANCE COMMITTEE

DATE: _____

PLEASE SIGN YOUR NAME, TITLE, AND AGENCY FOR THE RECORD
 THIS SHEET IS FOR ATTENDANCE PURPOSES ONLY

NAME	TITLE	AGENCY
Janet Clark Keel	Budget Analyst	OMB
Sandy Stone	Staff	Zeiks
Harley Bryant	Project Manager EWP	AWR/MofA
Tyler Jones	Legis. Liaison	Munic. of Anchorage
P. Macklin	SEN. RODEY'S STAFF	Legislator

10

Introduced: 4/21/83
Referred: Community and Regional
Affairs, Resources and
Finance

Funding Information
General Fund \$45,400,000
Other Funds -0-
\$45,400,000

BY FAIKS, V. FISCHER,
BENNETT AND JOSEPHSON

1 IN THE SENATE

2 SENATE BILL NO. 272

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 THIRTEENTH LEGISLATURE - FIRST SESSION

5 A BILL

6 For an Act entitled: "An Act making a special appropriation for payment as
7 a grant to the Municipality of Anchorage for expansion
8 of the Ship Creek Treatment Plant and phase II
9 design and construction of the Eklutna Water Project;
10 and providing for an effective date."

11 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

12 * Section 1. The sum of \$10,400,000 is appropriated from the general
13 fund for payment as a grant to the Municipality of Anchorage for expansion
14 of the Ship Creek Water Treatment Plant to 24 million gallons per day.

15 * Sec. 2. The sum of \$35,000,000 is appropriated from the general fund
16 for payment as a grant to the Municipality of Anchorage for phase II design
17 of all the Eklutna Water Project and construction of the Anchorage to Eklutna
18 River segment of the Eklutna Water Project.

19 * Sec. 3. The appropriation made by this Act shall be disbursed in
20 accordance with AS 37.05.315.

21 * Sec. 4. This Act takes effect immediately in accordance with AS 01
22 10.020(f)(1).