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WATER RESOURCES PLANNING IN ALASKA

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ABSTRACT: The State of Alaska does not have a state water plan nor a comprehensive list of water resources planning-related activities. In the absence of either of these, this paper describes the organization of water resources planning and management by the state resource agencies, and presents a brief outline of what might be included in a state water plan. The primary focus of the paper is to describe major planning-related efforts that are being conducted by the state resource agencies.

INTRODUCTION

Water resources planning in the State of Alaska is neither comprehensive nor well coordinated. While there are many types of water resources planning that have been completed or are underway, the state does not have a comprehensive state water plan.

In many respects, Alaska does not share common characteristics with other western states that have lead to state water plans. Water resources in Alaska are generally abundant, though not evenly distributed seasonally or geographically. The state contains more than 40 percent of the Nation's surface water resources, but some streams freeze completely or have periods of low flow during the winter and early spring. Conversely, ice-jam floods are common on some rivers during spring snowmelt and summer floods have caused extensive damage on other streams. Average runoff for the state is about 25 inches, but varies from as much as 300 inches in Southeastern Alaska to only 4 inches in some Arctic coastal areas.¹

The state has a population of less than one-half million people, mostly concentrated in a few urban areas. Many cities, towns, and villages provide public water supply, but there are no local water districts in the state. In fact, some parts of the state have no local government.

Water resources data including surface and groundwater supply, precipitation, and water quality is limited. During water year 1988, the U.S. Geological Survey collected water discharge data at 85 gaging stations, 66 crest-stage partial recording stations, 13 lakes, water quality data at 24 gaging stations, and water levels for 26 observation wells statewide.²

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To date, there are few instances of over-appropriation. Major water uses include public water supplies, fish processing, forest products, mining, and oil and gas exploration and development. Agricultural water use is very small. Hydroelectric power generation, fish hatcheries and placer mining are important non-consumptive uses of water. Instream water use for fish habitat maintenance, recreation, and navigation and transportation are important water uses in the state.

Finally, few major federal water projects have been constructed for water use in the state. There are no Bureau of Reclamation projects, very few Corps of Engineers projects, and only two federal hydroelectric projects.

Since Alaska does not have a state water plan, this paper outlines what might be included in a state water plan for Alaska, and describes some parts of a plan that already exist.

WATER RESOURCES ADMINISTRATION

The majority of water resources administration and planning conducted by the state is done by the Departments of Natural Resources (DNR) and Environmental Conservation (DEC). Within DNR, water resources responsibilities are housed in two divisions. The Division of Land and Water Management is responsible for managing and adjudicating water rights, including surface and groundwater for diversionary and instream uses (AS 46.15); administering the state's dam safety program (AS 46.17); preparing land use plans, including water resources, for state lands (AS 38.04.065); and determining navigability for state title for submerged lands (AS 38.05.127). The Division of Geological and Geophysical Surveys (DGGS) is responsible for collecting, analyzing, and distributing data for surface and groundwater and water quality (AS 41.08.017 and .020). The Division manages the state's well log and water use programs and is beginning a statewide water quality data base.

The Department of Environmental Conservation is responsible for protecting water quality in the state (AS 46.03 - AS 46.09). Water pollution control responsibilities cover point and nonpoint pollution sources including maintaining regulations for water quality standards, reviewing wastewater system and subdivision plans, certifying residential septic systems, permitting wastewater disposal from municipalities and industrial facilities, evaluating the effects of nonpoint sources on water quality, protecting public drinking water, providing water and sewage disposal facilities in second class cities in the state, regulating oil pollution control, managing the underground storage tank program, regulating solid waste and hazardous wastes, managing the Superfund program, regulating pesticide use, and coordinating with other agencies in coastal zone management.

In addition to these two agencies, a number of other state

agencies have water resources management and planning responsibilities. The Department of Fish and Game (DFG) is responsible for protecting fish habitat (AS 16.05). The Department of Community and Regional Affairs administers floodplain management for insurance purposes. (AS 44.47). The Alaska Energy Authority in the Department of Commerce and Economic Development is responsible for hydroelectric power development (AS 44.83). Finally, the Division of Emergency Services in the Department of Military and Veterans Affairs is responsible for coordinating protection of life and property during emergencies such as river flooding or dam failures (AS 26.23.040). Figure 1 shows a generalized state agency organization chart emphasizing these water resources agencies.

A STATE WATER PLAN FOR ALASKA

A state water plan for Alaska would likely be a dynamic process that evolves over time, rather than a single document. However, there is value in having a document that summarizes the elements of the plan and how they are developed. Such a plan might have the following contents.

- Goals and objectives

- Policy statements

- Resource inventories

- Specific resource elements

 - Water supply

 - Water use, water rights, and water demand

 - Water quality

 - Conservation

 - Public trust uses, including instream flow

 - Water resources protection, including critical water management areas, riparian, and wetlands protection

 - Fisheries

 - Hydroelectric power development

- Future directions and recommended action

WATER RESOURCES PLANNING IN ALASKA

While Alaska does not have a comprehensive state water plan,

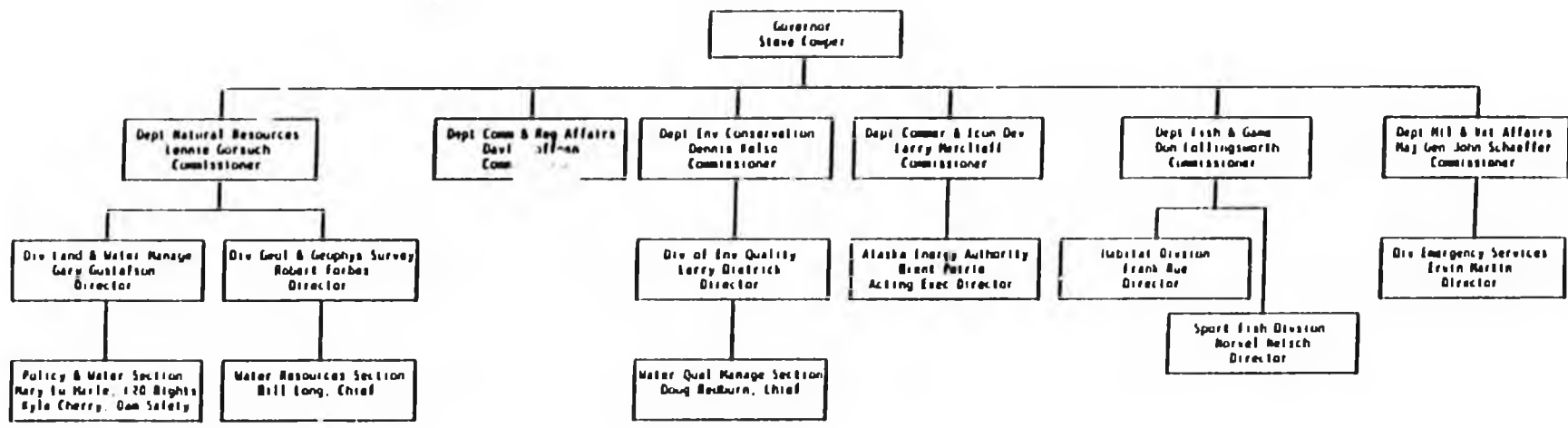


Figure 1

there is some water planning-related activity that is being done.

State Policies

As in other states, Alaska has much of its water resources policy set out in the state constitution, statutes and regulations. In addition there are other policy documents such as interagency cooperative agreements and policy directives, such as the water management policy for state lands on the North Slope. Other policy statements are found in Attorney General's Opinions, state agency department orders and operating procedures, and administrative and executive orders issued by the Governor.

Land Use Planning

There are two major land planning efforts that are authorized by state law. While both of these are land use plans, they also include water resources planning to varying degrees. The Department of Natural Resources develops land use plans for state lands and coastal management districts develop coastal management planning documents.

State Land Use Plans

Approximately 28.5 percent of the land in Alaska is in state ownership. The Department of Natural Resources is responsible for land use planning on state lands under the authority of AS 30.04.065 and 11 AAC 55.010-280. There are three main types of planning efforts for state lands; area plans, management plans, and recreational river plans. All of these efforts include some water resources planning, however the emphasis varies depending on the geographic area and the nature of land and water use issues within each planning area. Water resources issues that are commonly addressed include compiling information on existing water rights; identifying streams and lakes that need instream flow protection for fish and wildlife and recreation; riparian and wetlands protection; navigability determinations; water quality issues; and floodplain management for state lands scheduled for sale. Little water resources inventory or assessment is done with regard to water supply or water use. More recent plans include a water resources element, or chapter, in the plan.

The planning process for all three types of state plans includes three public meetings to receive public input into the plan. Some plans also have advisory boards composed of user group representatives, government officials, and private citizens. All of the plans have interagency planning teams. The state land planning process includes the following eight steps.

1. Public meetings are held to learn of local problems, interests, and concerns about state lands and water.

2. Information about natural resources (oil and gas, minerals, fish, water, forests, soils), existing land uses and ownership, and economic and social characteristics is gathered, mapped and analyzed.
3. Different land and water use options are developed using public comments, resource information, and state policy.
4. Public meetings are held to review plan alternatives.
5. Public comments are reviewed, conflicts are resolved, a preferred alternative is selected, and a draft plan is written.
6. Public hearings are held on the draft plan.
7. Changes to the draft plan are made based on public comments. Final plan recommendations are developed.
8. The Commissioner of the Department of Natural Resources adopts the final plan. The plan then guides the state's land and water management decisions.

Area plans are developed for large regional areas of state land. Management plans are written for smaller areas such as the Hatcher Pass recreational area and the Matanuska Valley Moose Range, both located north of Anchorage. Figure 2 shows the status of area planning for the following state lands.

The Bristol Bay Plan was adopted in 1984 and covers 13 million acres of state-owned and state-selected land.

The Copper River Basin Plan was adopted in 1986 and covers 3.3 million acres of state-owned and state-selected land.

The Haines/Skagway Plan was adopted in 1979 and covers 400,000 acres of state-owned and state-selected land. It was superseded by the Alaska Chilkat Bald Eagle Preserve Management Plan in 1985 and the Haines State Forest Management Plan in 1986.

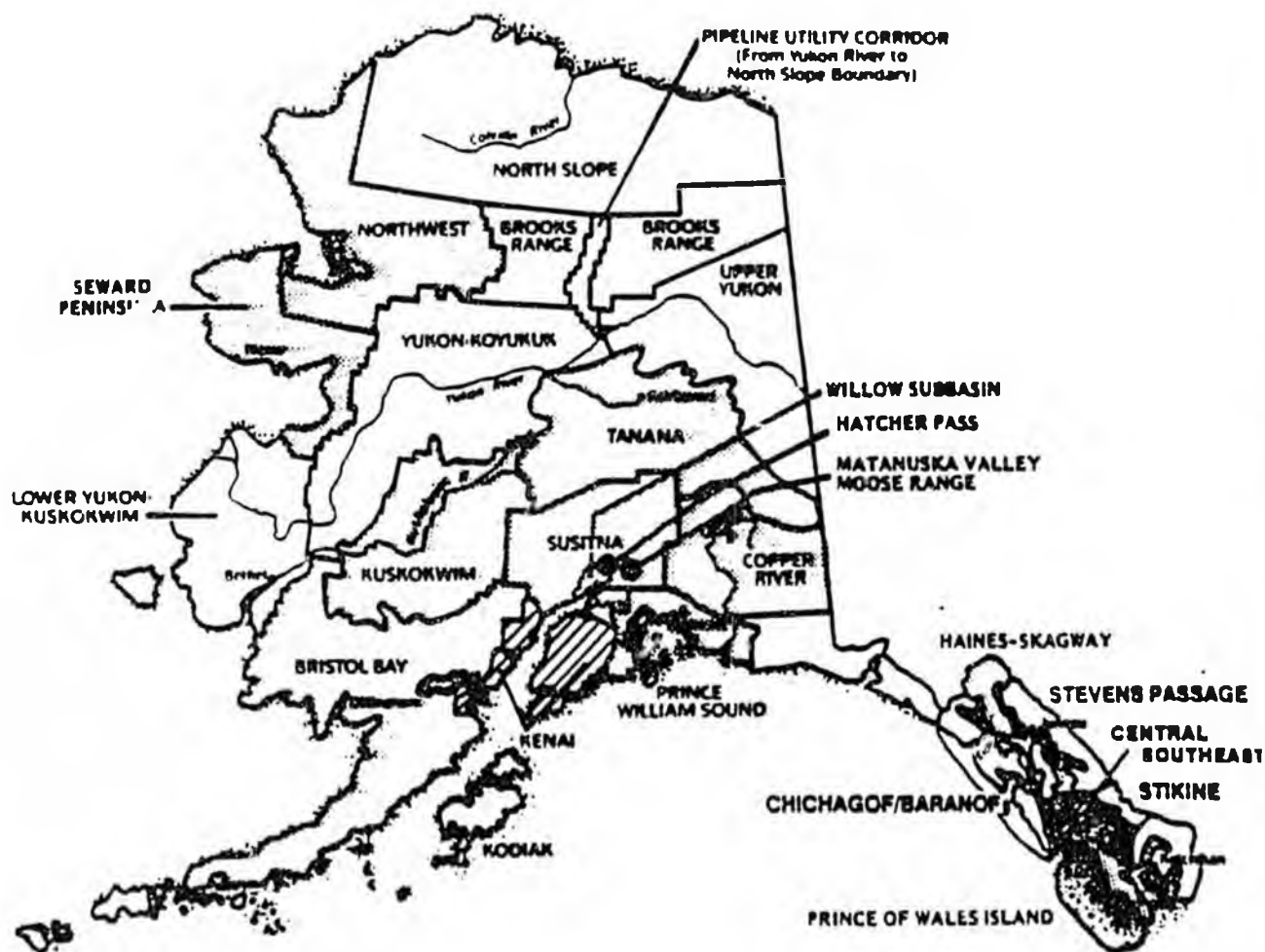
The Kuskokwim Basin Plan was adopted in 1988 and covers 16 million acres of state-owned and state-selected land.

The Northwest Area Plan was adopted in 1989 and covers 10 million acres of state-owned and state-selected land in the Bering Straits region, the Northwest Arctic Borough, and the far western segment of the North Slope Borough.

The Prince of Wales Island Plan was developed in two parts and adopted in 1985 and 1988. This plan is for 30,000 acres of state-owned and state-selected uplands and about one million acres of adjacent tidelands and submerged lands. The plan

Alaska Department of Natural Resources

AREA PLANS



AREA PLANNING STATUS

- Completed area plans
- Area plans in progress
- Not scheduled for area plans at this time

addresses such issues as land offerings, log transfer and storage facilities, floating camps, floathomes, sea-farming, and state selections from the Tongass National Forest.

The Prince William Sound Plan was adopted in 1988 and covers 850,000 acres of state-owned and state-selected uplands and most of the tidelands and submerged lands in Prince William Sound.

The Susitna Area Plan was adopted in 1985 and covers 9.5 million acres of state-owned and state-selected land.

The Tanana Basin Plan was adopted in 1985 and covers 12.5 million acres.

The Kenai Area Plan is underway and will cover state land within the Kenai Peninsula Borough with the exception of lands that have been legislatively designated for refuges, critical habitat, and other special use areas. The plan will be complete in 1991.

The Central Southeast Plan will cover the area from the Cleveland Peninsula north to Frederick Sound. It will include the Stikine River and there will be a shorelands river management component. The plan will be complete in 1991.

In 1988, the Alaska Legislature passed the Recreation Rivers Act, AS 41.23.400-510. This act establishes six recreation rivers in Southcentral Alaska, including the Little Susitna River, Deshka River, Talkeetna River, Lake Creek, Talachulitna River, and Alexander Creek. The rivers are to be managed to maintain and enhance land and water in the river corridors for recreation; manage, protect, and maintain fish and wildlife on a sustained yield basis; continue recreation and economic uses; multiple use management of upland activities to mitigate potential adverse effects on water quality and stream flow; and provide access for recreation uses. The Department of Natural Resources is responsible for developing a plan and managing the river corridors. A planning team composed of state, federal, and local government representatives has been formed. In addition, an advisory board of 13 user group representatives has been established. The plan will be complete in December, 1990, and will address the following issues:

- * How to manage recreation activities and facilities, such as campsites, restrooms, garbage, boating, and trail use.
- * What measures are needed to protect fish and wildlife habitat.
- * What measures are needed to protect water quality and ensure adequate stream flow in the rivers to protect the purposes of the Recreation Rivers Act.

- * How to manage transportation facilities and resources.
- * Where commercial facilities, such as lodges and campgrounds, will be allowed.
- * Guidelines for resource use, such as timber harvest for personal use and small material sales, and if new mining claims will be permitted on uplands.
- * Document illegal activities such as trespass cabins and long term camps and develop management options to resolve unauthorized uses of state land.

The Recreation Rivers Act mandated that instream flows be reserved to protect the purposes of the recreation rivers. Unfortunately no funds were appropriated to do this work. Three of the rivers have stream gage data, and a cooperative effort among state and federal agencies is underway on a limited basis to establish stream gages on the ungaged rivers and to collect miscellaneous discharge and water quality data to quantify instream flows for these rivers.

Coastal Management Planning

Coastal management planning is a result of both the Federal Coastal Zone Management Act of 1972, and the Alaska Coastal Management Act of 1977. The Alaska Coastal Management Act establishes a process to resolve controversies over how to use or not use the land and waters of Alaska's coast through development and use of district coastal management plans. The Act also established a 16 member Coastal Policy Council composed of state and local elected officials. The Council developed standards and guidelines for district coastal management programs which have been adopted as regulations, 6 AAC 85.010-110. The statutes and regulations of the Department of Environmental Conservation relating to air, land, and water quality are also incorporated into the coastal management program.

Each district program must address ten program elements: (1) needs, objectives, and goals, (2) organization, (3) boundaries, (4) resource inventory, (5) resource analysis, (6) subject uses, (7) proper and improper uses, (8) policies, (9) implementation, and (10) public participation. Water dependent and related uses and activities which must be covered by the plan include coastal development, geophysical hazard areas, recreation, energy facilities, transportation and utilities, fish and seafood processing, timber harvesting processing, mining and mineral processing, and subsistence.³ Twenty five coastal management districts have plans in effect and seven more are being developed

Water Resources Inventories

There are a number of programs that inventory, store, and report data on water supply and use, dams, water quality and fisheries habitat. These data are frequently used by planners, resource managers, industry, and the public. Listed below are some of the major inventories that the state resource agencies maintain or participate with federal agencies in maintaining.

Alaska Water Resources Evaluation Five-Year Plan

The DNR Division of Geological and Geophysical Surveys (DGGS), in cooperation with the U.S. Geological Survey (USGS) and the U.S. Army Corps of Engineers has developed a report of statewide water resources data collection and hydrologic studies called the Alaska Water Resources Evaluation, or AWARE Plan. The document is a summary of current and proposed (through 1994) plans for basic hydrologic data collection in Alaska by these and other state, federal, and local agencies. The plan's goal is to provide water resources information to government agencies, industry and the public to promote the use and management of the state's water resources. The plan is organized by regions of the state and describes data collection programs for surface water, groundwater, and water quality. It describes programs of the USGS, Water Resources Division; the National Weather Service; the U.S. Army Corps of Engineers; the U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service; the National Park Service; and the U.S. Fish and Wildlife Service. State programs described include the Department of Natural Resources Division of Geological and Geophysical Surveys and Division of Land and Water Management; the Department of Community and Regional Affairs; the Department of Fish and Game; the Department of Environmental Conservation; and the Division of Governmental Coordination in the Governor's Office. Water resources programs undertaken by the Matanuska-Susitna Borough are also included.⁴

Water Well Logs

The DNR Division of Geological and Geophysical Surveys has developed and maintains a computerized water well log inventory called WELTS, or Well Log Tracking System. Approximately 16,000 well records are contained in WELTS which are commonly received from well drilling contractors and through the state's water rights program. The inventory is used by DGGS hydrologists in hydrogeological investigations, by planners, by DNR water rights adjudicators, and by homeowners and realtors. The system is cross indexed to water rights case file numbers and to USGS locational numbers. The well log information is also transferred to the USGS Ground-Water Site Inventory database.⁵

Water Use Data

DNR's Division of Geological and Geophysical Surveys also operates the Alaska Water Use Data System, or AWUDS. Water use data are collected primarily from the Division of Land and Water Management water rights program, which requires water meter records from all permitted water uses greater than 30,000 gallons of water per day. The 1988 water use summary will include approximately 225 water use points. The emphasis of the program has been on collecting public water supply water use data. This was expanded in 1988 to include water use by hydroelectric power generation sites and state fish hatcheries. Plans for 1989 include collecting water use data from the Kenai-Nikiski area and possibly from North Slope industrial water users.⁶

Groundwater Quality Data

The Division of Geological and Geophysical Surveys in DNR has prepared a report recommending a plan to collect and store groundwater quality data in Alaska. There is presently no coordinated system for storing this information. Groundwater quality data are collected for various regulatory programs within the Department of Environmental Conservation and during investigations by the USGS and military installations in the state. With the exception of the USGS, the majority of these data are not stored or generally available for systematic retrieval. The report concludes that the National Water Information System maintained by the USGS is the recommended data management system to manage groundwater data in Alaska. The DGGs in cooperation with the USGS is beginning a large scale pilot project to test the system.⁷

Water Rights - Land Administration System

The Department of Natural Resources has developed a data base to store and track land and water case file information. The system is called the Land Administration System (LAS). Within this system is the water subsystem which is devoted to storing water rights information, locating prior appropriators to give public notice during adjudications, and printing various letters and documents, such as notices, permits, and certificates of appropriation. The system stores all information contained in the application, including customer name, identification number, and address; location including latitude and longitude and the legal description of points of diversion and use; type of use which is identified by a standard industrial code (SIC) number; source of water; and quantity of water. Because the system was designed to primarily store and retrieve data, there is limited capability to manipulate data. The system is one of the most comprehensive in the state and contains approximately 21,240 water rights case files.

Dam Safety Inventory

The Alaska Dam Inventory is also maintained as part of the water subsystem in LAS. It contains information on approximately 200 dams in the Corps of Engineers inventory format. At the present time all known dams in the state are included in the inventory, even those not jurisdictional under AS 46.17, the Alaska Dam Safety Act. When the upcoming federally required inventory is done, only jurisdictional dams will be entered on the inventory. A separate inventory is planned to be maintained for non-jurisdictional dams for use with the water rights program under AS 46.15.⁸

Federal Reserved Water Rights Inventory

In 1985, the Department of Natural Resources established the Federal Reserved Water Rights Work Group to coordinate federal and state activities dealing with federal reserved water rights. The group was composed of representatives of the state resource agencies and federal land management agencies. One of the goals of the group was to identify lands that the federal government might claim federal reserved water rights for, and to describe the location, legal history, primary purposes and pertinent authorities establishing the federal land withdrawals. This information was submitted to DNR by the National Park Service for approximately 51 million acres, the U.S. Forest Service for approximately 23 million acres and the U.S. Fish and Wildlife Service for approximately 76 million acres and provides a great deal of information about federal reserved water rights in Alaska. DNR had plans to establish this information on a data base, but budget reductions to this program have limited further work on the project.

Public Water Supply Inventory

The Department of Environmental Conservation maintains a data base of approximately 2500 public water supply systems in the state. The data are submitted by public water suppliers when systems are tested and by laboratories. Data include owner information, source of water, kind of treatment, and testing results. Reports are generated on a quarterly basis and submitted the U.S. Environmental Protection Agency. The system has been in operation about five years, and is currently being updated.⁹

Anadromous Fish Catalog

The Department of Fish and Game (DFG) developed and maintains the "Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fish", which is composed of an atlas and catalog listing documented streams, rivers, and lakes that are used by anadromous fish. The Atlas presents maps showing the location of the anadromous fish waters, the fish species using these waters,

and the life history of the fish species using the waters. Waterways containing anadromous fish are protected by DFG under AS 19.05.870. A fish habitat permit is required from DFG for activities which affect these waterways. Additions to the catalog can be made by DFG personnel, private individuals, or other agencies and changes are made using regulation adoption procedures. The document is divided into six volumes corresponding to the state's six fish and game resources management regions.¹⁰

Alaska Habitat Management Guides

The Department of Fish and Game also maintains the "Alaska Habitat Management Guides". The guides present the best available information on selected fish and wildlife species, describing their life functions and habitat requirements; mapping and discussing their geographic distribution; mapping and discussing the human uses made of the water; and estimating their value to residents of the state. The guides include information about mammals, birds, and fish.¹¹

Instream Flow Reservation Schedule

The State of Alaska has statutory authority to reserve instream flows under the AS 46.15.145. The Department of Natural Resources adjudicates and grants instream reservations. State, federal, and local agencies and private persons and organizations can apply for reservations for fish and wildlife, recreation and park purposes, navigation and transportation purposes, and water quality purposes. In fiscal year 1987, the Department of Fish and Game formally established an instream flow program with the goal of protecting the habitat of sport fish species by reserving instream flows. The program is funded primarily by the Wallop-Breaux federal legislation and is therefore limited to protecting instream flows for sport fish species. Under this program, the DFG quantifies instream flow needs and files applications to reserve water with the Department of Natural Resources. Thus far, DFG has submitted 18 applications, of which six have been granted. The DFG prioritizes and schedules streams needing instream flow reservations after coordinating with the various DFG divisions and the Department of Natural Resources water rights and state land planning programs.¹²

Hydrologic Data Collection

The U.S. Geological Survey in coordination with the state Division of Geological and Geophysical Survey, the National Weather Service, and the Soil Conservation Service are the primary agencies that collect baseline hydrologic data in Alaska. Included are surface water stream gage stations, groundwater stations to collect long term water level records, water quality stations, sediment stations, flood frequency determinations, precipitation gages, and

snow surveys. All of these agencies report and disseminate data for use by planners, managers, industry, and the public.

Water Quality Planning

The Alaska Department of Environmental Conservation, Division of Environmental Quality, undertakes a number of water quality planning efforts. Listed below are two of the most recent water quality planning programs.

Groundwater Quality Protection Strategy

Alaskans depend heavily on groundwater for public water supplies, industrial uses, and to supply baseflow in streams. Recent cases of groundwater contamination in Alaska have prompted an increased concern for groundwater quality protection. The Groundwater Quality Protection Strategy was developed to describe the nature and location of groundwater resources and to describe potential contamination sources and how they are regulated in Alaska. The strategy defines problems, identifies existing programs, and makes recommendations for improving protection of Alaska's groundwater resources. The Strategy discusses 23 separate topics and identifies 74 recommendations to improve groundwater protection. Many of the recommendations can be accomplished by existing regulatory programs with no additional funding. However, some of the recommendations require new regulations and new sources of funding. The recommendations are presented in six groups, including education, data collection and management, planning, control of contamination sources, response and enforcement, and action plan and funding. The draft strategy is complete, and the final document is expected to be published this year.¹³

Nonpoint Source Pollution Control Assessment

The Department of Environmental Conservation is also preparing a nonpoint source pollution control assessment that is required by section 319 of the Clean Water Act. The goals of the assessment are to identify waterbodies which are impaired or threatened by nonpoint source pollution and the pollution sources affecting each waterbody, and to prepare narrative descriptions of the categories of nonpoint source pollution and their impacts on water quality. Nonpoint source categories that are planned to be included in the assessment include timber harvest and related activities, placer mining, oil and gas development, agriculture, urban development, rural sanitation and waste disposal, on-site sewage disposal, fuel and chemical storage and handling, and harbor and boating wastes. The assessment is presently being prepared and will be completed this year. It will be followed by a Nonpoint Source Pollution Control Strategy which will describe programs and activities necessary to control categories of nonpoint source pollution and to reduce nonpoint source pollution in certain

individual waterbodies. 14

CONCLUSION

This paper has presented some of the major water resources planning-related efforts and inventories that are in progress or planned for the near future by the state resource agencies. It is by no means a comprehensive description of planning-related programs in Alaska. A comprehensive list or description of planning-related programs undertaken by the state does not exist. It is hoped that this paper might serve as a starting point for developing a comprehensive list of state water resources planning efforts, which could be used to develop a state water plan for Alaska. A state water plan would benefit the state in collecting baseline hydrologic data, allocating and managing water use, protecting water quality, and protecting life and property resulting from dam failures, flooding, and related catastrophic events.

FOOTNOTES

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ALASKA

Water Supply and Use

Alaska's water supplies might appear to be unlimited because of the large quantities of precipitation received in the State (fig. 1A). Statewide average annual precipitation is about 1,050,000 Mgal/d (million gallons per day), and average annual runoff is about 989,000 Mgal/d. Alaska contains more than 40 percent of the Nation's surface-water resources. Three rivers (the Yukon, the Kuskokwim, and the Copper) are among the 10 largest in the United States. More than 3 million lakes range in area from pond size to about 1,000 mi² (square miles). Also, large amounts of water are stored within two principal aquifers. Environmental conditions, legal restrictions, and technological problems, however, limit the usability of these abundant supplies.

Alaska encompasses a land area of about 586,000 mi², or about one-fifth of the area of the conterminous United States. Climates range from frozen desert in the Arctic Slope basin to maritime rain forest in the Southeast Alaska basin. Average annual precipitation and temperatures range from about 5 inches and 10° F (degrees Fahrenheit) in the Arctic Slope basin to about 300 inches and 45° F in the Southeast Alaska basin. Much precipitation occurs as snow. Glaciers and icefields cover 28,500 mi², or nearly 5 percent of the land (Post and Mayo, 1971) and affect the timing and the quantity of runoff. Many of the rivers are silt laden, are affected by mid-winter overflow icing or ice-jam flooding at spring breakup, or are ice covered much of the year. The occurrence and the availability of ground water are limited by permafrost. The extent and thickness of the permafrost decrease southward from a continuous layer as much as several hundred feet thick in the Arctic Slope basin to areas

that are generally free of permafrost in the South Central Alaska and the Southeast Alaska basins. Because of these conditions, there is no certainty that either surface or ground water will be available at a given time and location.

Several water issues in Alaska result from this variability in the availability and occurrence of the water resource. Additionally, the legal precedents for obtaining water rights cause conflicts. Com-

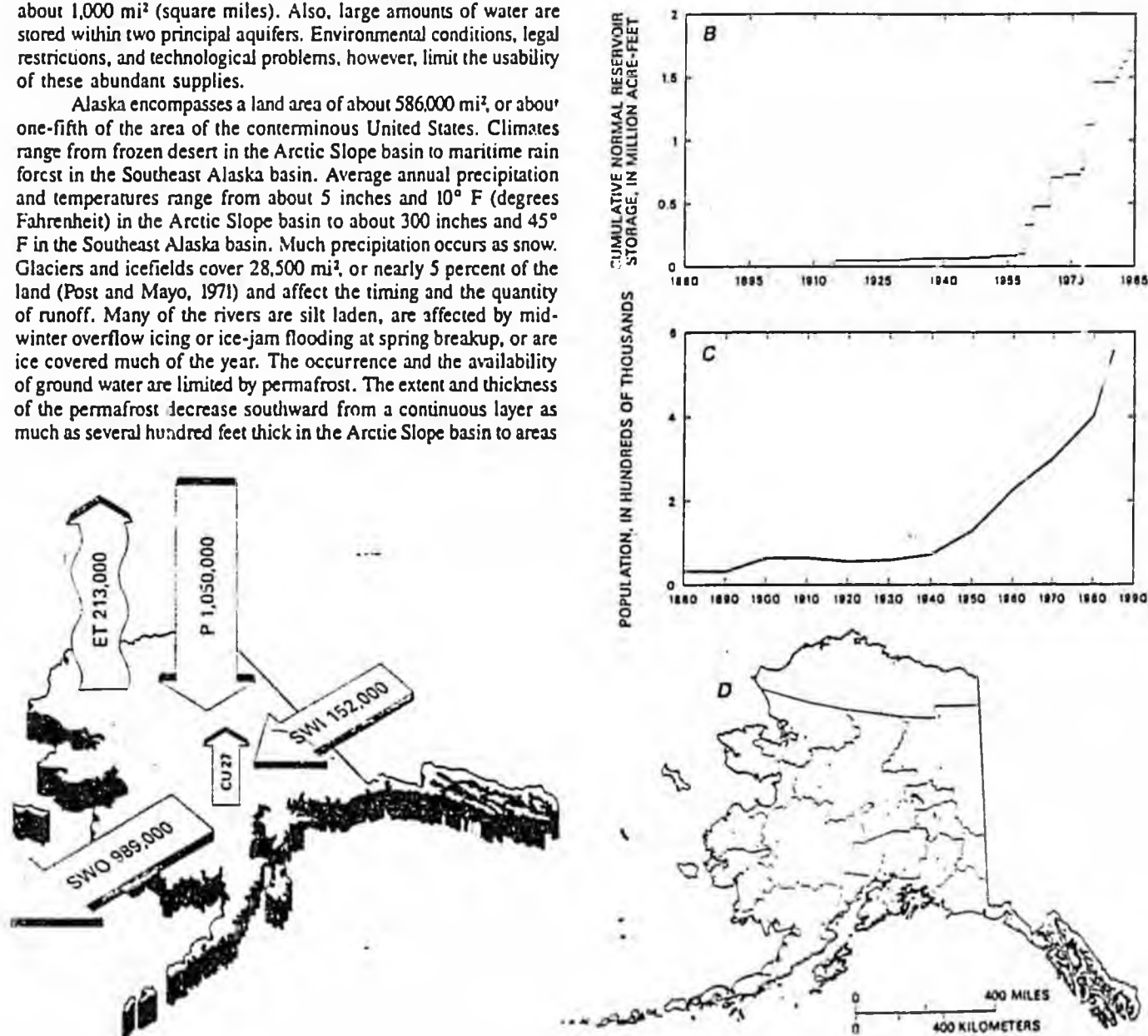


Figure 1. Water supply and population in Alaska. A. Water budget, in million gallons per day. B. Cumulative normal storage of reservoirs with at least 5,000 acre-feet capacity, 1880 to 1985. C. Population trend, 1880 to 1985. D. Population distribution, 1985; each dot on the map represents 1,000 people within a census tract. Abbreviations: CU, consumptive use; ET, evapotranspiration; P, precipitation; SWI, surface-water inflow; SWO, surface-water outflow. Sources: A, R. D. Lamke (U.S. Geological Survey, written commun., 1985). B, U.S. Army Corps of Engineers, 1981. C, D, Compiled by U.S. Geological Survey from U.S. Bureau of the Census data.

petition for limited surface-water resources exists among industry, fish hatcheries, recreation, and fish and wildlife habitat demands. Ground-water-rights issues primarily involve public supply in basins where surface water is scarce. Currently (1987), the Arctic Slope, the South Central Alaska, and the Southeast Alaska basins are the focus of these issues.

HISTORY OF WATER DEVELOPMENT

In 1914, the first large reservoir was constructed to provide power for the mining and the timber industries in the Southeast Alaska basin. Since then, 19 additional reservoirs that have storage capacities greater than 5,000 acre-ft (acre-feet) have been built for electric power generation and public supplies. Of these 20 reservoirs, 13 are in the Southeast Alaska basin, 6 are in the South Central Alaska basin, and 1 is in the Yukon basin. These reservoirs contain a cumulative capacity of about 1.78 million acre-ft (fig. 1B).

The first significant increase of Alaska's population occurred during the gold rushes of the late 1800's (fig. 1C). Postwar migration and homesteading increased the population during the late 1940's and 1950's. Population growth during the 1960's and 1970's can be attributed to the development of oil fields in Cook Inlet and at Prudhoe Bay and the related pipeline-construction activities. The continued rapid population growth of the early 1980's can be attributed to the general economic well-being that oil production brought to the State. The population reached 558,000 in 1985; 77 percent of the inhabitants live within 5 of the 28 census districts, or county equivalents (fig. 1D). Anchorage contained 44 percent of the State's population; the next largest concentrations of population were in Fairbanks (13 percent), Kenai (8 percent), Matanuska-Susitna (7 percent), and Juneau (5 percent).

Interest in Alaska's water supplies began during the gold rushes of the late 1800's; miners washed the placer deposits to extract the gold. The population growth and the corresponding urban development, especially after 1940, placed increasing emphasis on water supply. Increasing needs for water supplies for power in the Southeast Alaska and the South Central Alaska basins, for the pulp and paper industry in the Southeast Alaska basin, and for the canneries in the Southeast Alaska and Southwest Alaska basins created demands for water-resource information. Intensive development of other natural resources began during the 1960's and continued through the 1970's. Water was critical to support the oil fields in the Arctic Slope basin and the petrochemical, the seafood, and the timber production industries in the South Central Alaska and the Southeast Alaska basins. Continued population growth, especially in the South Central Alaska basin, increased the demand for public supplies; ground water became a major source of supply. Maintaining instream flows became an issue during the late 1970's, and that concern has increased during the 1980's. Instream flow for hydroelectric power generation and fish hatcheries is an additional water issue today.

WATER USE

The State's water budget is shown diagrammatically in figure 1A. Several natural conditions limit the quantity of freshwater that can be recovered efficiently from Alaska's hydrologic environment; for example, the availability of surface water may be affected by the timing of winter freezeup and spring breakup and by the quantity and the timing of runoff derived from melting snow and glacier ice. The availability of ground water is limited by thick lenses and layers of relatively impermeable siltments and by the limited extent of coarse-grained permeable sediments. In permafrost zones, even coarse-grained sediments may be frozen. Thus, although a substantial quantity of water may be present within the State, the water may not be available when and where it is needed.

Hydroelectric powerplants used 1,480 Mgal/d to generate 18 percent, or 746 GWh (gigawatthours), of the electricity used statewide. About 90 percent of this power was generated in the Southeast Alaska basin. The water was used instream, and no water was considered for consumptive use.

Surface-water withdrawals supplied 82.2 percent of the water needed for offstream uses; ground water provided the remaining 17.8 percent. These values were determined by using the results of a cooperative survey conducted by the Alaska Department of Natural Resources and the U.S. Geological Survey in 1985, in which communities and industries estimated their water use. Where quantities of water use were not available, such data were estimated on the basis of similarities between communities and uses. The statewide distribution of total, surface-water and ground-water withdrawals is aggregated by county in figures 2A, 2B, and 2C, respectively. Surface-water withdrawals by principal drainage basin and ground-water withdrawals by principal aquifer are shown in figures 3A and 3B, respectively. Aquifers have been grouped informally into unconsolidated alluvium and glacial outwash aquifers and bedrock aquifers (U.S. Geological Survey, 1985, p. 129-131). Major ground-water withdrawals were from the unconsolidated aquifers.

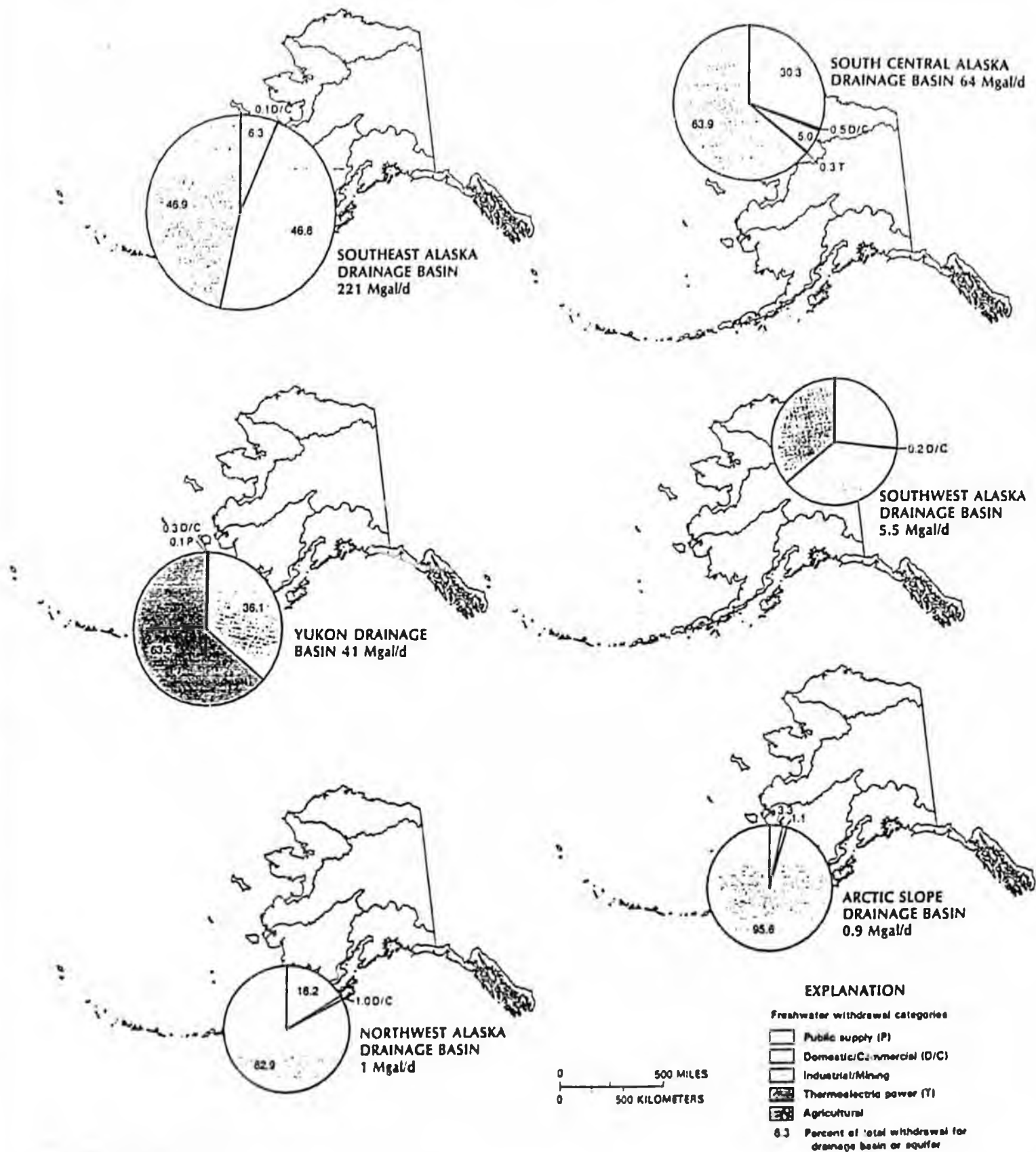
Most withdrawals occur in three of the principal river basins—Southeast Alaska, South Central Alaska, and Yukon (fig. 3A). Withdrawals in the Southeast Alaska basin were 55 percent (221 Mgal/d) of total water use in Alaska. About 99 percent of these withdrawals was surface water. Industry and fish hatcheries were the primary users of this water. In contrast, the South Central Alaska basin accounted for about 27 percent (110 Mgal/d) of the total withdrawals during 1985. This basin withdrew about 64 percent (64 Mgal/d) of the total ground water during 1985. The large withdrawals for public supply and self-supplied domestic uses provide water to the comparatively large population of the area. Public supply, self-supplied domestic, and industry were the major water users. The Yukon basin accounted for 15 percent (41 Mgal/d) of the total withdrawals. Water used for mining and fossil-fueled powerplants was 74 percent of the 61 Mgal/d withdrawn in the Yukon basin. Surface water was used for nearly two-thirds of this quantity.

The remaining basins, the Arctic Slope, the Southwest Alaska, and the Northwest Alaska, included 8 percent of the population and used 3 percent of the total water. Public supply and self-supplied domestic and commercial uses accounted for 61.9 percent of the ground-water withdrawals within the Yukon basin.

The source, use, and disposition of Alaska's water resources are shown diagrammatically in figure 4. The quantities of water given in this figure and elsewhere in this report may not add to the totals indicated because of independent rounding. The source data indicate that total freshwater withdrawals were 406 Mgal/d, of which 334 Mgal/d was surface water and 72 Mgal/d was ground water. The use data indicate that, of total freshwater use, industry and mining accounted for 34.7 percent and agriculture accounted for 38.6 percent. The disposition data indicate that most water (93.3 percent) was returned to natural sources and was available for reuse. Estimated consumptive use was 6.7 percent (27 Mgal/d).

Alaska's water is generally of sufficient quantity and acceptable quality for most uses. However, population increases during the last decade, especially in urban areas, have strained water-distribution systems and generated concern about water availability. In Anchorage, a measurable decline in ground-water levels has been attributed to increased withdrawals. Saltwater intrusion has halted further ground-water development in Auke Bay, near Juneau. In Kenai and in the Arctic Slope basin, water supply is a concern to communities near petrochemical industry activities.

Surface- and ground-water quality problems have been caused either by natural processes or by human activities. Natural processes include suspended sediment caused by glaciers, salinity, and undesirable concentrations of iron or arsenic produced by geo-



A. SURFACE WATER

Figure 3. Freshwater withdrawals by category of use and hydrologic unit in Alaska, 1985. A, Surface-water withdrawals by principal drainage basin. B, Ground-water withdrawals by principal aquifer. Abbreviation: Mgal/d is million gallons per day. (Sources: A, Drainage basins from Seaber and others, 1987; data from U.S. Geological Survey National Water Data Storage and Retrieval System. B, Data from U.S. Geological Survey files.)

chemical processes. Human activities include petrochemical contamination, the addition of nitrates through septic-tank systems, and the encroachment of saltwater in response to intensive ground-water withdrawal. Nevertheless, even in areas of water-supply difficulties, Alaska's water is generally satisfactory for most uses, although locally it may not be readily obtainable from the nearest or most economical source.

PUBLIC SUPPLY

Public-supply systems withdraw, treat, and distribute water to users. The total withdrawals for public-supply in Alaska were an estimated 76 Mgal/d (fig. 4), which was 18.7 percent of total withdrawals in 1985. Surface water provided 46.2 percent (35

Mgal/d) of public-supply withdrawals, and ground water provided 53.8 percent (41 Mgal/d). Of total withdrawals for public supply, 40.3 percent was delivered for commercial use, and 39.0 percent was delivered for domestic use. About 60 percent (45 Mgal/d) of public-supplied water was delivered in the South Central Alaska basin.

About 62 percent of Alaska's population was served by public water suppliers in 1985. The Municipality of Anchorage supplied water to one-half of the population served by public-supply systems. The per capita use by all public-supply customers ranged from 10 to 380 gal/d (gallons per day) in 1985. Public-supplied domestic use ranged from 6 to 170 gal/d per capita. These values reflect the different types of water-distribution systems; for example, a public-supply system in the Arctic Slope basin may consist of a water-

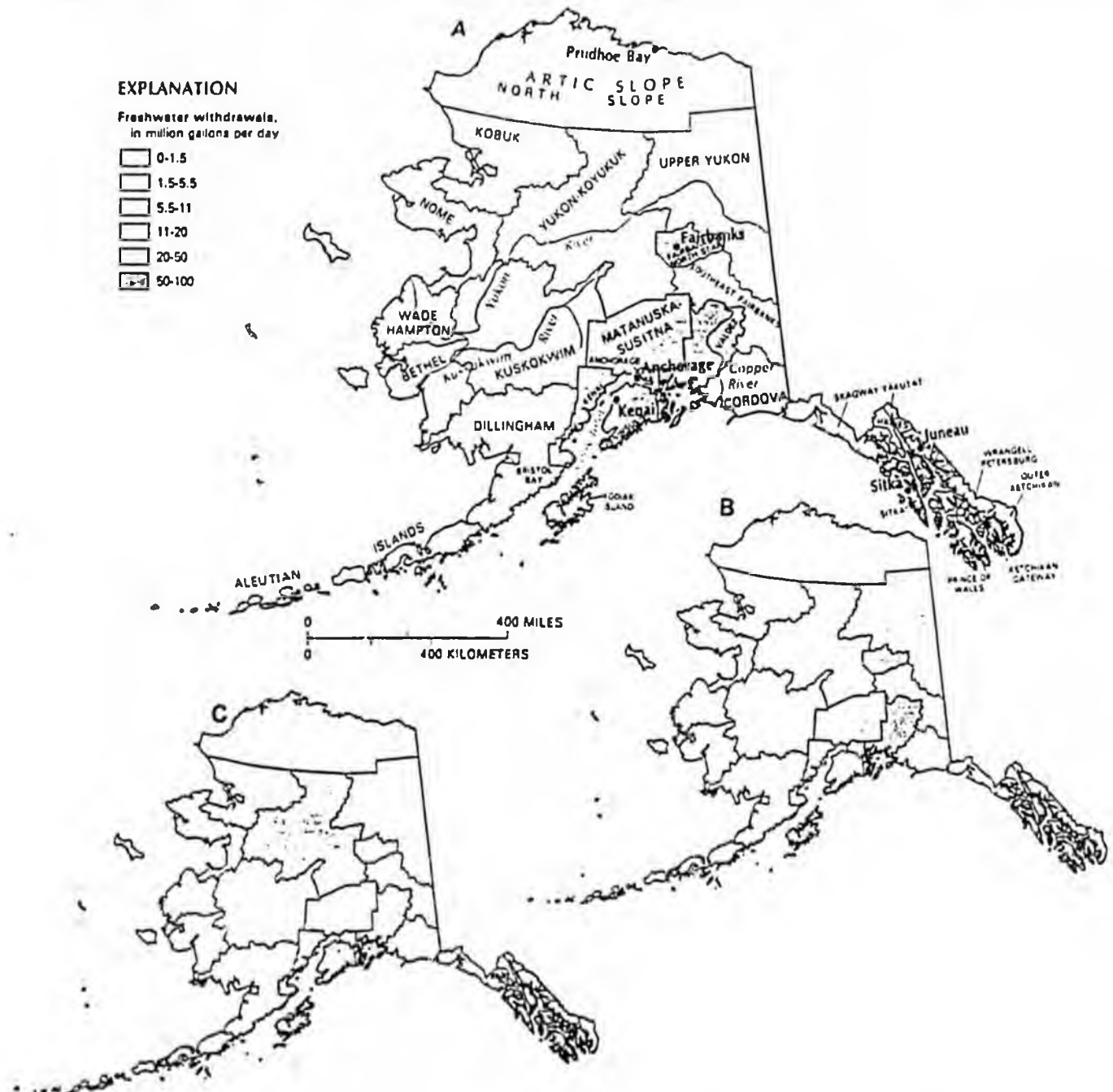


Figure 2. Freshwater withdrawals by county in Alaska, 1985. A, Total withdrawals. B, Surface-water withdrawals. C, Ground-water withdrawals. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)

delivery truck or a common well, and the primary use is domestic. In contrast, water in the Southeast Alaska basin is abundant, and distribution systems commonly are leaky; residents, commonly leave their faucets running to prevent the pipes from freezing. In addition, water-intensive industries in the Southeast Alaska basin are served by public supply.

DOMESTIC AND COMMERCIAL

Total domestic and commercial water use, including conveyance losses and consumptive use, from public-supplied and self-supplied sources was 78 Mgal/d (fig. 4). Domestic use was about 39 Mgal/d, of which 29 Mgal/d was delivered by public-supply systems and 10 Mgal/d was self-supplied. Commercial withdrawals were about 31 Mgal/d, virtually all from public-supply sources. Conveyance losses were 7.6 Mgal/d.

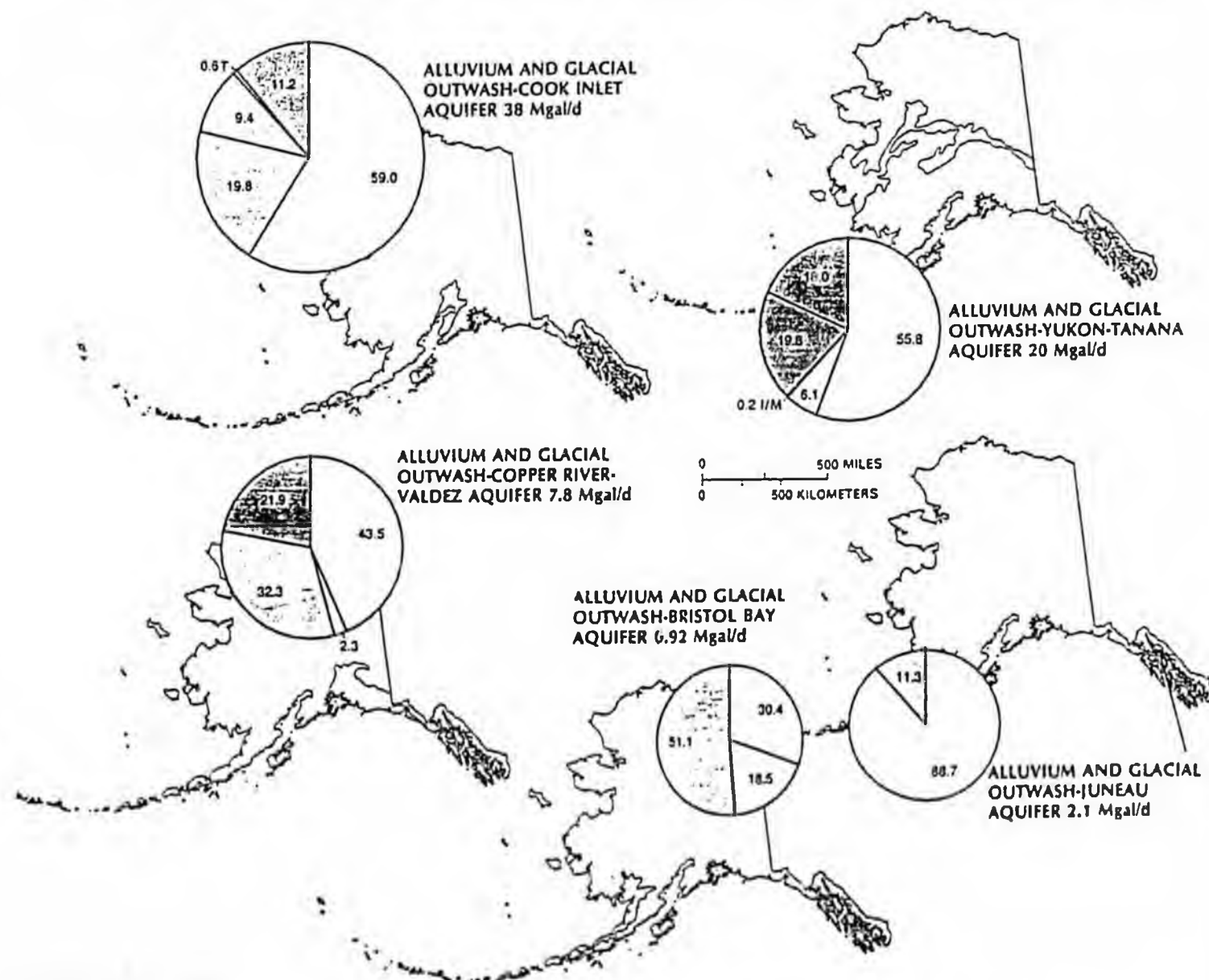
The average per capita domestic use for the population served by public supply was about twice that for the population that was self-supplied. This difference can be explained, in part, by conditions under which water is delivered to homes that use these two

types of supply. Public-supply systems typically serve a household that has standard plumbing. In contrast, many self-supplied households haul water from a lake, spring, river, or well and may have no plumbing.

INDUSTRIAL AND MINING

The estimated industrial and mining use was 141 Mgal/d in 1985. This represents 34.7 percent of total offshore water use (fig. 4). Industry used about 122 Mgal/d, of which 87 percent was self-supplied from surface-water sources. About 89 percent of the industrial water use was in the Southeast Alaska basin. Wood-pulp mills and seafood-processing industries in this basin used more than 100 Mgal/d in 1985. The petroleum industry was a major water user in the South Central basin.

Mining accounted for about 19 Mgal/d of water use. The Yukon basin had the largest area of mining activity and accounted for 76 percent of this water use. Adequate water supplies to support the exploration, development, and production in the Arctic Slope



B. GROUND WATER

Figure 3. Freshwater withdrawals by category of use and hydrologic unit in Alaska, 1985—Continued.

basin are commonly difficult to locate. Surface water is used primarily by placer-mining operations for washing sediments.

THERMOELECTRIC POWER

The fossil-fueled powerplants included in the survey used an estimated 31 Mgal/d (fig. 4) to produce 3,430 GWh of electricity during 1985. About 97 percent of the water was used by two plants in the Yukon basin, whereas 80 percent of the power produced by fossil fuel was produced by six plants in the South Central Alaska basin. These differences reflect the availability of water, the age of the powerplants, and perhaps different reporting methods. The water was used mainly for cooling purposes, and most was returned to surface-water sources.

AGRICULTURAL

Agricultural use during 1985 was an estimated 157 Mgal/d (fig. 4). Fish hatcheries dominated this category by using about 156 Mgal/d, of which 66 percent was used in the Southeast Alaska basin. Although the hatcheries in the Southeast Alaska basin exclusively use surface water, facilities elsewhere use ground water, which has a more consistent temperature and quality.

Agricultural water use for purposes other than fish hatcheries or irrigation totaled 0.21 Mgal/d, 48 percent of which was on Kodiak Island. Only 0.03 Mgal/d was used for irrigation; all of the reported irrigated farm acreage is in the Matanuska Valley, which is 40 miles north of Anchorage.

WATER MANAGEMENT

The Alaska Water Use Act (AS 46.15.010-270), which was enacted in 1966, established procedures to appropriate State water.

The Act defines the doctrine of prior appropriation ("first in time, first in right") authorized by the State Constitution and delegates administration of the Act to the Alaska Department of Natural Resources (ADNR). The Act established procedures for maintaining existing water rights and for obtaining new water rights to all surface and ground water in Alaska. Water appropriations are limited to the specific use for which an individual applies. Additionally, the ADNR issues permits authorizing development and beneficial use of water. Issuance of a certificate of appropriation by the ADNR to the applicant is the final step in the water-rights process.

The original regulations implementing the Water Use Act were amended extensively on December 29, 1979, and incorporated as 11 AAC 93, Water Management. Recent amendments to the Water Use Act relate to geothermal development, reservation of water for instream uses, and administrative and judicial basinwide water-rights adjudication.

To manage the State's water resources effectively, the ADNR's Division of Land and Water Management (DLWM) requires technical descriptions and analyses and interpretations of various hydrologic conditions. The Department's Division of Geological and Geophysical Surveys (DGGs), Water Resources Section, provides the necessary data, analyses, and interpretations. Many long-term data are collected and interpreted by the U.S. Geological Survey, in cooperation with other Federal, State, and municipal agencies. Water managers of the DLWM use this information for water appropriation and water management decisions. Additionally, the DGGs, in cooperation with the U.S. Geological Survey and other State and Federal agencies, has developed and implemented the Alaska Water Resources Evaluation Plan to coordinate water-data collection and water-resource investigations in the State (Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, and U.S. Geological Survey, 1985).

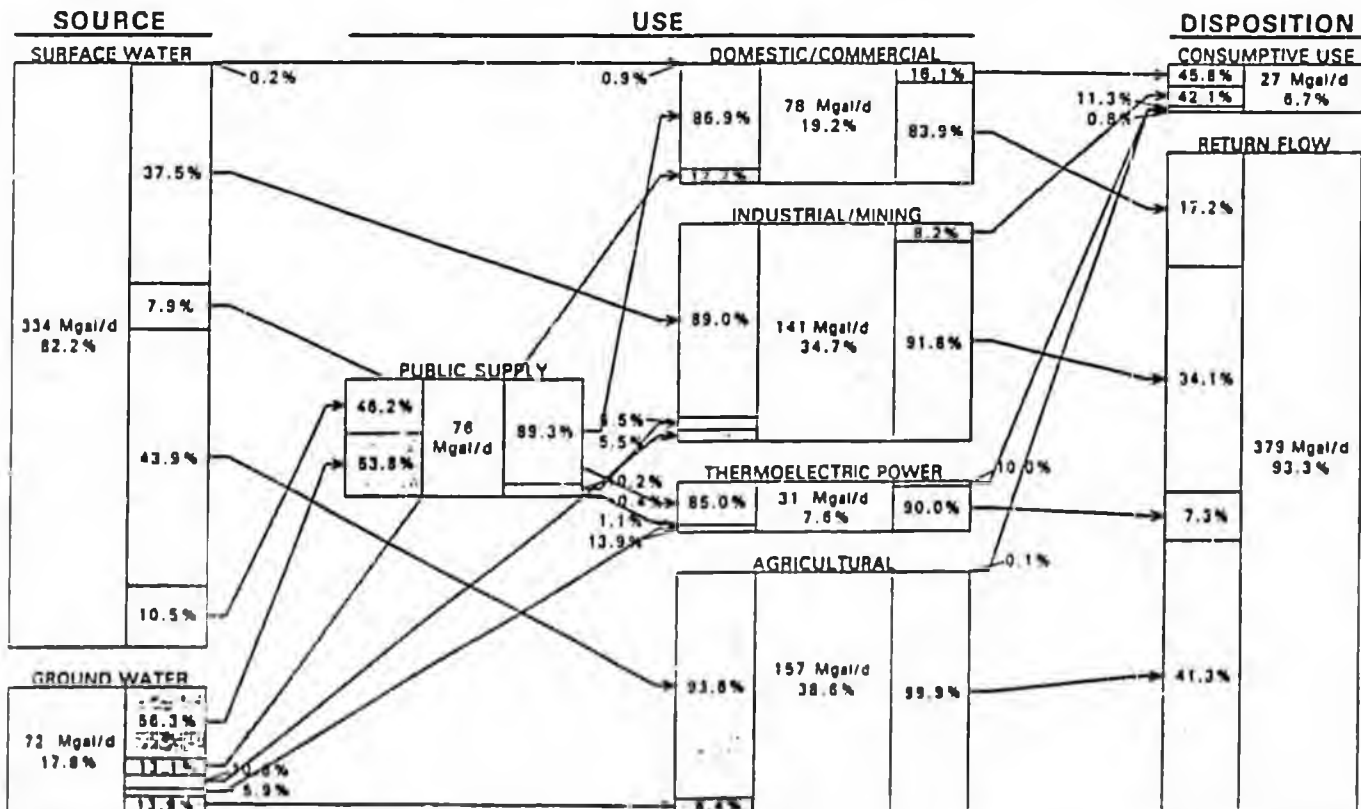


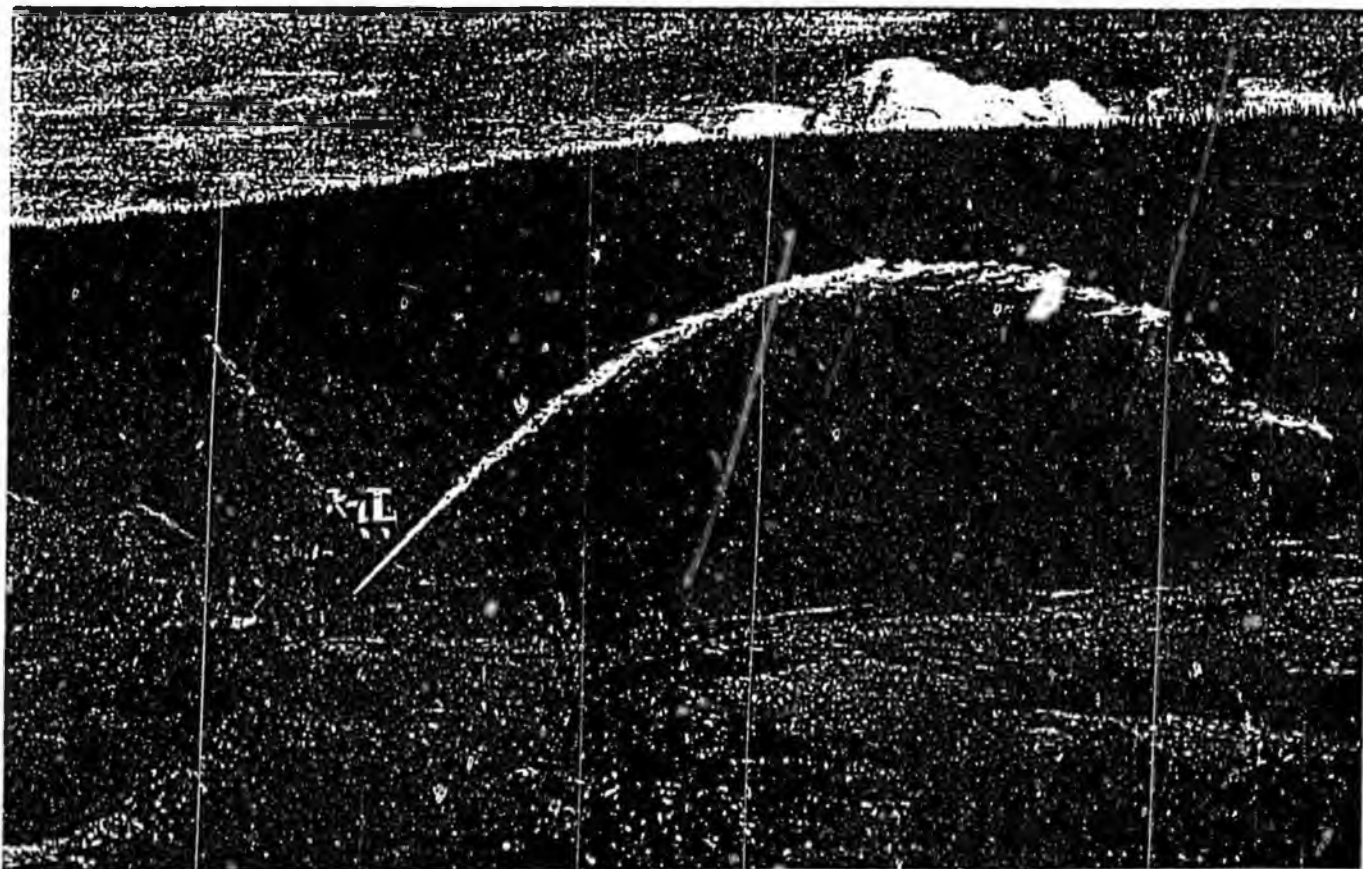
Figure 4. Source, use, and disposition of an estimated 406 Mgal/d (million gallons per day) of freshwater in Alaska, 1985. Conveyance losses in public-supply distribution systems and some public water uses, such as fire fighting, are included in the total shown for domestic and commercial use; losses in irrigation distribution systems are included in the total shown for agricultural return flow. All numbers have been rounded and values may not add to totals. Percentages are rounded to the nearest one-tenth of 1 percent (0.1%) between 0.1 and 99.9 percent. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System)

Although few streams in Alaska are overappropriated, potential water-use problems exist. In the event of water shortages or drought, Ship Creek at Anchorage and Indian River at Sitka could possibly be examples in which the amount of legally obtainable water may exceed the water available for use. Water issues in Alaska also include hydroelectric projects, placer mining, oil development, salmon aquaculture, and proposed mining developments in the Southeast Alaska basin.

Most ground-water shortages in Alaska currently involve water for public supply and domestic use. Some areas within the Municipality of Anchorage are experiencing great ground-water demand for public and single-family domestic water supplies. As water levels declined, domestic wells become dry. The ADNRC and Municipality of Anchorage are working cooperatively to solve several water-supply and distribution problems. Another area experiencing declining ground-water levels and saltwater intrusion is the Auke Bay area near Juneau (Dearborn, 1985), where the ADNRC established Alaska's first "Critical Groundwater Management Area" to restrict further water-well drilling and development of ground water.

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Hydraulic "giant" used to remove overburden and expose gold-bearing gravel north of Fairbanks, Alaska. (Photograph by Gary Prokosch, Alaska Department of Natural Resources.)

Prepared by Leslie D. Patrick and Elisabeth F. Snyder, U.S. Geological Survey, and Mary Lu Harle, Alaska Department of Natural Resources

FOR ADDITIONAL INFORMATION: District Chief, U.S. Geological Survey, 4230 University Drive, Anchorage, AK 99508-4664

In 1946, the Alaska District of the USGS was established and the stream-gaging program was initiated with 16 stations. By 1961, 68 gaging stations were operating. The graph below shows the status of the network since 1946. The greatest number of stream-gaging stations was 131 in 1970.

During 1990, water-discharge data were collected at 85 gaging stations and water-quality data at 24 of these. Data were also collected at 66 crest-stage partial-record stations and at 22 lakes. The map below shows the locations of these stations.

Although surface-water records have been compiled in Alaska since the early years of the century, the State is so large that data are sparse for many areas. Northern and western areas of the State, in particular, have few stream gages. More streamflow data are needed in response to the increasing water-resources development within the State.

DATA COMPILATION AND REPORTS

How can I acquire streamflow data?

The U.S. Geological Survey publishes the surface-water records obtained at gaging stations. From 1957 to 1971, water resources data for Alaska were published annually by the Survey in Water-Supply Papers. In 1972, a series of Water-Data Reports was started, which merged all water resources data. The most recent of these are referenced below:

U.S. Geological Survey, 1976-91, Water resources data for Alaska, water years 1975-90: U.S. Geological Survey Water Data Reports AK-75-1 to AK-90-1 (published annually).

The following report lists all sites in Alaska that had surface-water records up to 1988:

Stoll, P.J., and Cooby, J.M., 1989, Alaska index: Streamflow, lake levels, and water-quality records to September 30, 1988: U.S. Geological Survey Open-File Report 89-269, 189 p.

The following reports may also be of interest:

Feulner, A.J., and Reed, K.M., 1977, Bibliography of reports by members of the U.S. Geological Survey on the water resources of Alaska, 1870 through 1976: U.S. Geological Survey Open-File Report 77-687, 112 p.

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Parks, Bruce, and Madison, R.J., 1985, Estimation of selected flow and water-quality characteristics of Alaskan streams: U.S. Geological Survey Water-Resources Investigations Report 84-4247, 64 p.

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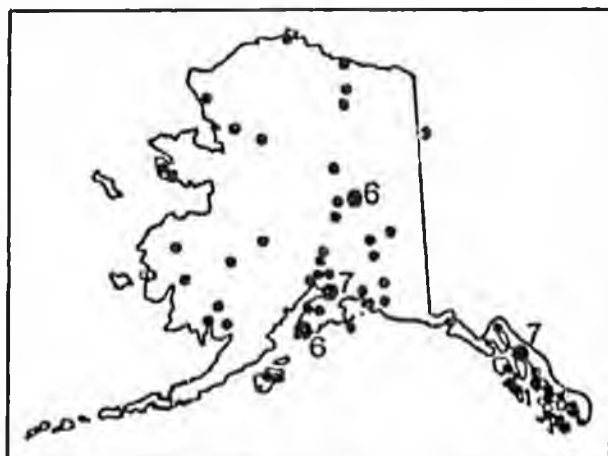
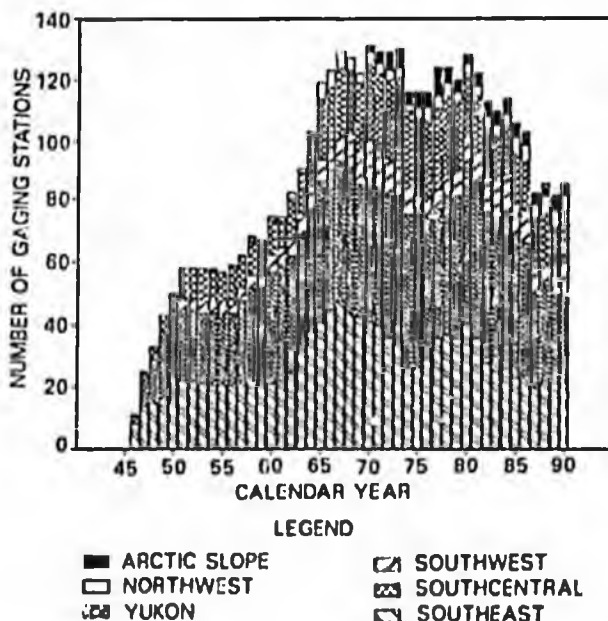
In addition to the reports, most of the surface-water data are available through computerized data-retrieval programs. For information contact:

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by Elisabeth F. Snyder

February 1992

HISTORY OF STREAM GAGING BY AREAS IN ALASKA



Locations of stream-gaging stations in 1990

THE U.S. GEOLOGICAL SURVEY STREAM-GAGING PROGRAM IN ALASKA

INTRODUCTION

The Water Resources Division of the U.S. Geological Survey (USGS) is the principal Federal agency that collects water data in the United States. These data are collected in cooperation with State and local governments and other Federal agencies. Water in rivers and lakes is called "surface water." One method of collecting data from surface water is the establishment of a stream-gaging program.

What is a stream-gaging program? It is a network of stream-gaging stations on rivers and lakes that provides data on surface-water resources. These data help planners make decisions on the use and management of these resources.

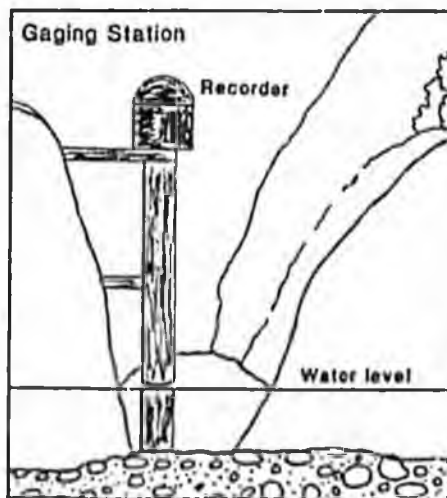
What is a stream-gaging station? It is a particular site on a stream or lake where systematic observations of hydrologic data are collected (see sketch below). The most commonly collected data, called "stages," are measured by recording gage heights (1) manually by an observer, (2) with mechanical instruments on special purpose paper, or (3) with electronic methods into a computer file. A continuous record of discharge at a station can be computed using recorded gage-height and 6 to 12 discharge measurements made at the station each year. The commonly reported data are discharges at a site for each day of the year.

What are surface-water records? Surface-water records consist of data on stage and discharge. Data are also collected at "partial-record stations," such as the network of "crest-stage gages" where only the peak discharge for the year is determined. Water-quality data are collected at many stream-gaging stations.

Stage (gage height) is the height of a water surface above an established datum plane. Stream-gaging stations provide a continuous record of stage.

Discharge is the volume of water that passes a given point at a given time.

Water-quality data report the following types of water characteristics: physical (such as water temperature), biological (such as fecal coliform bacteria), and chemical (such as dissolved iron).



USES OF DATA COLLECTED

What are the data collected at gaging stations used for?

Regional Hydrology: Discharge data at a station whose streamflow characteristics have not been altered by man can be used to develop relationships for a region. The relationship, which is based on streamflow characteristics (stage, discharge) and basin characteristics (geographic traits, climatic data), can estimate streamflow characteristics at ungaged sites on streams within the same region.

Hydrologic Systems: Data can be used to define current hydrologic conditions and to document changes in these conditions. For example, as an urban area becomes increasingly developed, stations can yield data that show changing streamflow characteristics.

Planning and Design: Data from these stations are used to plan and design a specific project, such as a dam or bridge.

Project Operation: Data are used to assist water managers in making operational decisions, such as reservoir releases at hydroelectric power plants and reservoir storage and release at flood-control projects.

Hydrologic Forecasts: Data provide information to various government agencies for flood forecasts.

Water-Quality Monitoring: Continued monitoring of streams can detect physical, chemical, and biological changes in water quality. Some gaging stations in Alaska are part of a nationwide network designed to assess the water-quality of major streams.

Research: Some gaging stations are operated for a particular research water-investigations study, such as those operated for the studying the effects of the Redoubt Volcano eruptions.

Other: Some stations are operated to collect data for legal obligations or for the adjudication of water rights.

THE STREAM-GAGING PROGRAM IN ALASKA

The USGS began its streamflow data collection in the summer of 1906 near Nome, in connection with gold placer mining. During the next few years, data collection expanded on the Seward Peninsula and into the Yukon and Tanana River basins. In 1913, emphasis shifted to reconnaissance of water-power sites in the lower Copper River basin and Prince William Sound area, and eventually in southeast Alaska. Although the USGS discontinued data collection in 1921, private companies and other Federal agencies continued to collect some data in southeast Alaska until 1946.

ALASKA

Floods and Droughts

Moisture-laden storms that move northeastward from the Pacific Ocean are the source of most of Alaska's precipitation (fig. 1) and subsequent streamflow. In the coastal area adjacent to the Gulf of Alaska and the Pacific Ocean, most of the annual precipitation is received from September through February, and October is the wettest month. Farther north toward the interior of Alaska, most of the precipitation occurs earlier, from June through November, and August is the wettest month. Seasonal distribution and type of precipitation (rain or snow) are affected by mountain ranges and fluctuations in air temperature. A prolonged cold, dry arctic airmass during the winter decreases annual precipitation in Alaska's interior. Annual precipitation increases tenfold from north to south.

Floods in coastal areas, which are affected by maritime conditions, generally result from late summer and fall rainstorms. The documented floods have been of local extent since the U.S. Geological Survey began widespread collection of streamflow data in the late 1940's and early 1950's. Adjacent to and somewhat inland from the coastal areas, rainfall combined with snowmelt causes local floods in the fall and winter. In the rest of the State, areawide floods have resulted from either snowmelt (and local rains) in late spring or from widespread summer rains. On large rivers, increased runoff during spring snowmelt breaks the winter ice cover, which can cause localized ice-jam floods. The severity of these floods depends on antecedent conditions of ice thickness, snowpack, air temperature, and quantity of water and ice released when ice jams upstream break free. Large and sometimes damaging floods also

occur on some streams because of a rapid release of water stored beneath glaciers or in glacier-dammed lakes. Storm waves or surges have flooded coastal towns, such as Nome and Barrow. Other coastal towns have been inundated by tsunamis, which are waves generated by earthquakes. Tsunamis during and after the Great Alaska Earthquake of March 27, 1964, in the Gulf of Alaska caused more loss of life and probably more total damage than all other floods within the State since 1950.

Alaska has had no statewide droughts; however, five prolonged regional droughts are identified in this report. The most severe drought was from the mid-1970's to 1980 in the Chena and Salcha River basins near Fairbanks. Regional droughts are little noticed because only a small percentage of Alaska's surface-water resources is used.

Flood- and drought-management programs are limited in extent because of Alaska's abundant water resources and small population. However, flood warnings are issued for inhabited areas, and flood-prone areas in most communities have been identified.

GENERAL CLIMATOLOGY

Most storms that affect Alaska throughout the year originate over the North Pacific Ocean and the southern fringes of the Bering Sea (Seikregg, 1974, p. 10-11). Seasonal fluctuations in the loca-

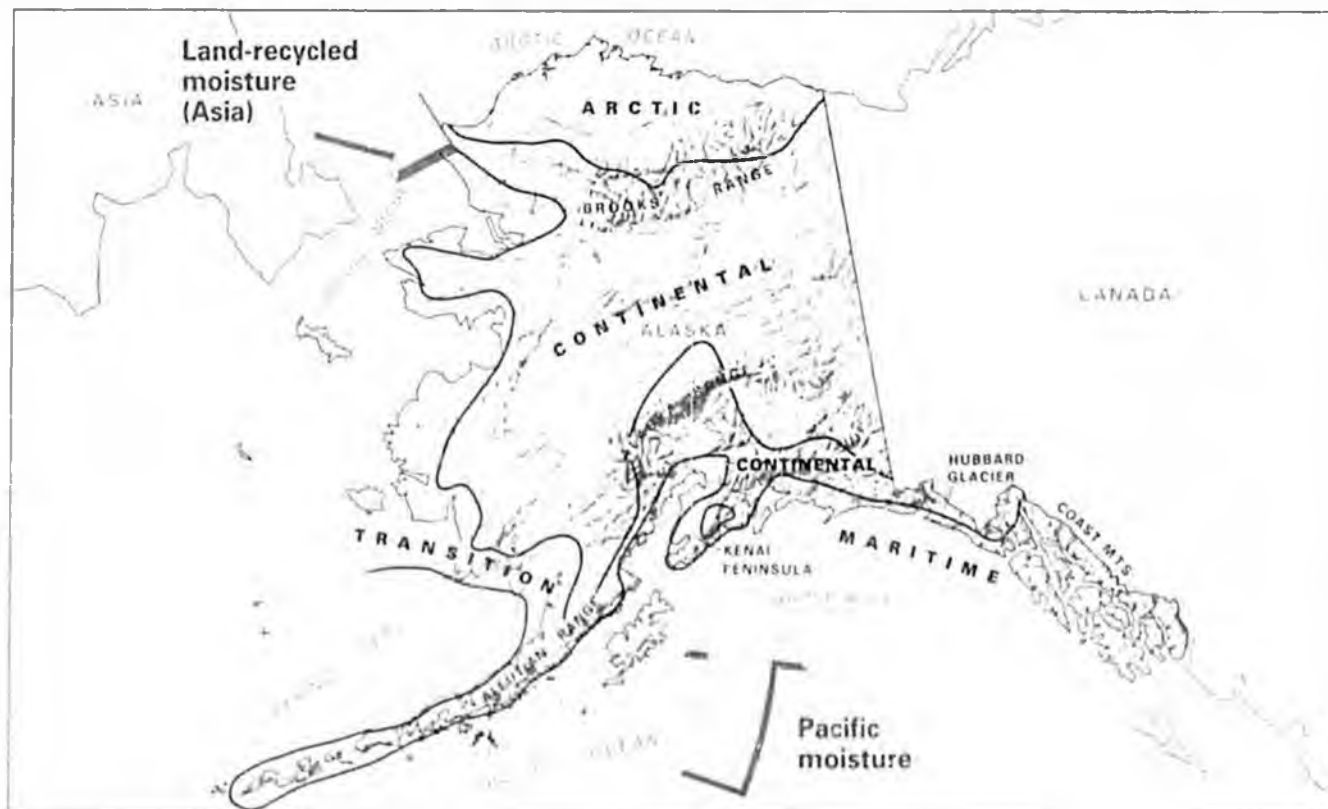


Figure 1. Principal sources and patterns of delivery of moisture into Alaska. Size of arrows implies relative contribution of moisture from source shown. (Adapted from Seikregg, 1974, and modified from U.S. Geological Survey, 1947, and U.S. Geological Survey, 1947, p. 10-11.)

tion and direction of the predominant paths of these storms partly control geographic distribution of seasonal and annual precipitation. During most of the year, major storms move northeastward toward the Gulf of Alaska and southeastern Alaska (fig. 1). During August, major storms also commonly move northward over the Bering Sea and the Bering Strait. As a result, storms penetrate Alaska's interior more frequently in the summer (mainly in August) than in the winter. A mass of cold air develops and increases in size over the interior as the seasons change; by October, the storm tracks have shifted and are located around the northwestern, northern, and southern edges of the State. These storm tracks are at the boundary of the cold and warmer airmasses; the southern storm tracks are predominant.

In addition to the oceans, Asia is a summertime moisture source for northern Alaska. Moisture that evaporated from lakes and local and upwind land surfaces combines with moisture from either the Arctic Ocean or the Bering Strait. This moisture source is also important to interior Alaska during the summer.

The differences in annual temperatures from north to south also affect the distribution of precipitation. During winter, the cold, dry airmass persists over interior and northern Alaska; most of the Bering Sea and the entire Arctic Ocean are frozen. The potential for winter precipitation is greater in the southern parts of the State because the Pacific Ocean is much warmer, is never ice covered, and thus serves as a source of abundant moisture.

Alaska has been divided into four climatic zones (fig. 1) because of its diverse climatic conditions (Selkregg, 1974, p. 9). The climatic differences result from the great size of Alaska, the topography (mainly, its major mountain ranges), and the mechanisms by

which temperature and precipitation are affected by the oceans on three sides. The climatic zones have the following characteristics. The Maritime Zone has small temperature variations, large annual precipitation, cool summers, and warm winters that have short periods of below-freezing temperature. The Transition Zone has greater diurnal and seasonal temperature variations and less precipitation than the Maritime Zone. The Continental Zone has large diurnal and annual temperature ranges and a small quantity of annual precipitation. The Arctic Zone has less temperature variation, less precipitation (especially near the Arctic Ocean), and lower mean annual temperature than the Continental Zone. Precipitation is greatest during August in the Arctic and Continental Zones and during October in the Maritime Zone (U.S. Geological Survey, 1986, p. 138). The seasonal precipitation pattern is not well defined for the Transition Zone.

The distribution of precipitation in Alaska is affected by several mountain ranges. From south to north, the principal mountain ranges are an arc of coastal mountains, an extensive second arc of higher mountains that includes the Coast Mountains (in southeastern Alaska), the Alaska and Aleutian Ranges, and still farther north, the Brooks Range (fig. 1). Moisture-laden airmasses rise and cool as they approach these ranges, which causes moisture to condense and precipitation to increase with altitude. The mountains in southeastern Alaska are barriers to the movement of precipitation. In the rest of the State, however, storm tracks tend to move parallel to major mountain ranges, and the effect of these ranges on precipitation varies. Several smaller mountain ranges affect local climate.

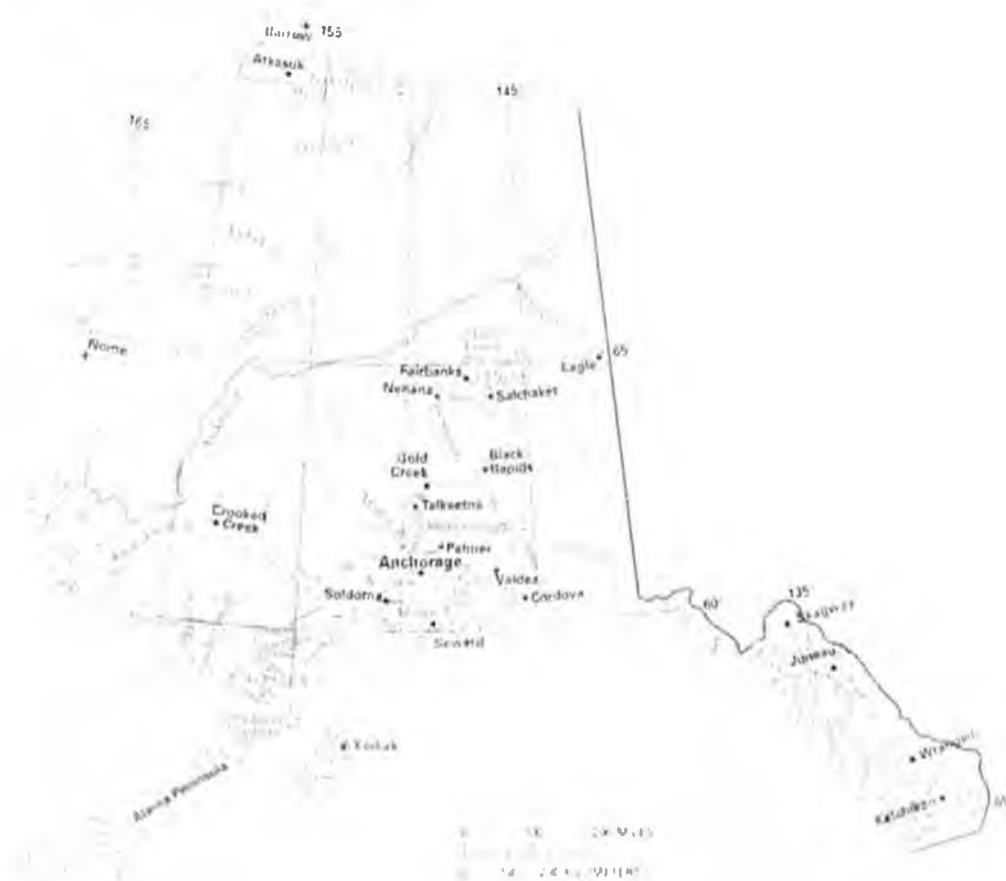


Figure 2. Selected geographic features, Alaska.

Average annual precipitation ranges from about 320 inches in parts of southeastern Alaska to less than 5 inches near the Arctic Ocean. Mean annual precipitation for the State is about 40 inches, but ranges from about 150 inches throughout southeastern Alaska to an average of about 15 inches north of the Brooks Range. Average annual temperature decreases from -45 to 10 °F (degrees Fahrenheit) from south to north. Temperature affects quantities and timing of runoff. For example, precipitation at temperatures below 32 °F generally falls as snow and becomes part of a snowpack; runoff may occur later in the year as the snow melts or some of the snow may be retained in glacier storage. As another example, local floods result from convective storms in the middle and eastern Yukon River basin where diurnal temperature variations are large during the summer. Although annual maximum peak discharges in the Maritime Zone occur mostly from August through October, temperatures commonly are mild enough for rainstorms and the resulting floods from November through January (Lamke, 1979, p. 8). In the rest of Alaska, most of the annual peak discharges occur between May and October.

The factors that produce flooding generally can be identified either during or after the flood. Causes of droughts are less obvious. Some reasons for droughts might be that storms normally causing precipitation are less severe or less frequent, or that the normal position of a major storm track has shifted for a prolonged time. This shift can be the result of changes in the surface temperatures of the oceans over which the storms originate or of global changes in air temperature.

MAJOR FLOODS AND DROUGHTS

Floods affect people directly, particularly if they inundate populated areas, are widespread, and cause loss of life and property. Droughts and their effects are not readily identifiable in Alaska, mainly because only a small part of the State's vast surface-water supply is used (U.S. Geological Survey, 1990a). The major floods and droughts discussed herein are those that were areally extensive and had significant recurrence intervals—greater than 25 years for floods and greater than 10 years for droughts. These major events, plus those of a more local nature, are listed chronologically in table 1; rivers and cities are shown in figure 2. Evaluation of floods and droughts, as determined from long-term streamflow records, is limited to a period starting about 1948. Long-term records of streamflow are sparse or nonexistent in much of Alaska, so that an analysis of floods and droughts is not possible for some areas. Six active, long-term gaging stations that monitor flows generally unaffected by human activity were selected to represent hydrologic conditions. Floods and droughts for these six sites are depicted in figures 3 and 4, respectively. Streamflow data are collected, stored, and reported by water year (a water year is the 12-month period from October 1 through September 30 and is identified by the calendar year in which it ends).

FLOODS

Little is known of the history of flooding in Alaska before the establishment of a network of gaging stations in the late 1940's and early 1950's. The few identified historical floods range in time from postulated late Pleistocene catastrophic floods in the upper Porcupine and Yukon Rivers that resulted from sudden draining of glacial lakes in Yukon Territory, Canada (Thorson and Dixon, 1983), to large releases of water from glacier-dammed lakes on the Alsek and Takli Rivers during the last 1 or 2 centuries (Post and Mayo, 1971). In this century, the flood history of the Chena River at Fairbanks began with a major flood in 1905. Fairbanks is one of the few large Alaskan cities located on a major river.

Floods are not always the result of extreme river discharges caused by precipitation or snowmelt. Storm-generated waves or surges can inundate coastal towns; such waves caused \$3 million in damage at Barrow in October 1963 (Wise and others, 1981, p. 1). In November 1974, Nome was inundated by storm waves, and water was as deep as 10 feet in places; damage was estimated at \$12 million (Wise and others, 1981, p. 1). Another type of flood, although rare, is the giant waves that have occurred in Lituya Bay, notably those of July 9, 1958. The maximum wave runup of 1,720 feet resulted from a massive rockslide caused by an earthquake (Miller, 1960, p. 79). Coastal communities along the Gulf of Alaska were affected by tsunamis after the Great Alaska Earthquake of March 27, 1964. These waves reached heights as great as 170 feet above tide level immediately after the earthquake, and a rhythmic series of seismic sea waves as high as 35 feet above tide level began about 20 minutes after the earthquake. Local waves were larger in Prince William Sound between Valdez and Seward, but at Kodiak and in the Cordova area, which are farther from the epicenter, seismic sea waves caused most of the damage (Plafker and others, 1969). Most deaths resulting from the earthquake (15 in Alaska and 15 in Oregon and California) were attributable to tsunamis, which also caused a large proportion of the property damage (National Academy of Sciences, 1968, p. X-XI).

Flooding on some Alaskan streams is caused by the release of water from glacier-dammed lakes (Post and Mayo, 1971); such outbursts may be sudden and unexpected. Ice jams also have caused local floods along major rivers. The maximum recorded flood stages at sites 2-5 (fig. 3) were the result of ice jams. A flood on January 18, 1969, on the Kenai River at Soldotna (fig. 3, site 2) was caused by an outburst from Skilak Glacier at the head of Skilak Lake and by subsequent ice jams downstream from the lake on the lower Kenai River. Maximum stage due to ice jamming is compared below with the stage of maximum discharge at sites 2-5.

Site (fig. 3)	Maximum stage from ice jams		Stage during the maximum discharge	
	Stage (feet)	Date	Stage (feet)	Date
2	22.62	Jan. 18, 1969	13.45	Sept. 9, 1977
3	24.48	May 10, 1954	16.58	June 7, 1964
4	26.36	May 16, 1968	25.74	June 5, 1964
5	35.94	May 1962	33.85	June 12, 1964

Because of its great size and the many different causes of flooding, Alaska does not have statewide floods. Southeastern Alaska has not experienced areawide floods, even though precipitation quantities are large and storms are frequent. Information on major flooding at communities in ungaged areas has been compiled by the U.S. Army Corps of Engineers (1987). The areal extent and severity of major floods in the rest of the State are shown in figure 3. The magnitude of annual peak discharges and discharges with 10- and 100-year recurrence intervals at the six gaging stations also are shown.

Since 1949, the State has had four major floods. The floods were major in areal extent (fig. 3) and in damage.

The flood of June and July 1964 resulted from record-breaking peak discharges on several streams in interior Alaska. The floods were caused by rapid snowmelt from large snowpacks and, in some places, rain on water-saturated snow. Flooding was sporadic but occurred mainly in sparsely populated areas of the middle Susitna, upper Yukon (in Alaska), Kuskokwim, and Koyukuk River basins. In many small streams, peak discharges were minor; in others, if the conditions of snow cover and rainfall were right, peak discharges were the largest of record. The dates of the peak discharges ranged from early June to early July, depending on the air temperature, the aspect and altitude of the contributing basins, and the dates of substantial rainfall. These floods caused relatively little damage, but a

few highways and small communities along the larger rivers were affected.

The flood of August 12-18, 1967, was caused by a series of widespread general rains beginning August 8 in the middle and lower Tanana River basin near Fairbanks. Locally, storm rainfall totaled 10 inches, which is nearly the average annual precipitation for the

area. Floods of the Salcha River near Salchaket (fig. 3, site 6) and the Chena River at Fairbanks were extremely large. The maximum discharge of the Chena River at Fairbanks was almost twice that of a flood peak that has a 100-year recurrence interval. About 95 percent of Fairbanks was under water (Childers and others, 1972, p. A25). Nenana, which is downstream from Fairbanks on the Tanana River,

Areal Extent of Floods

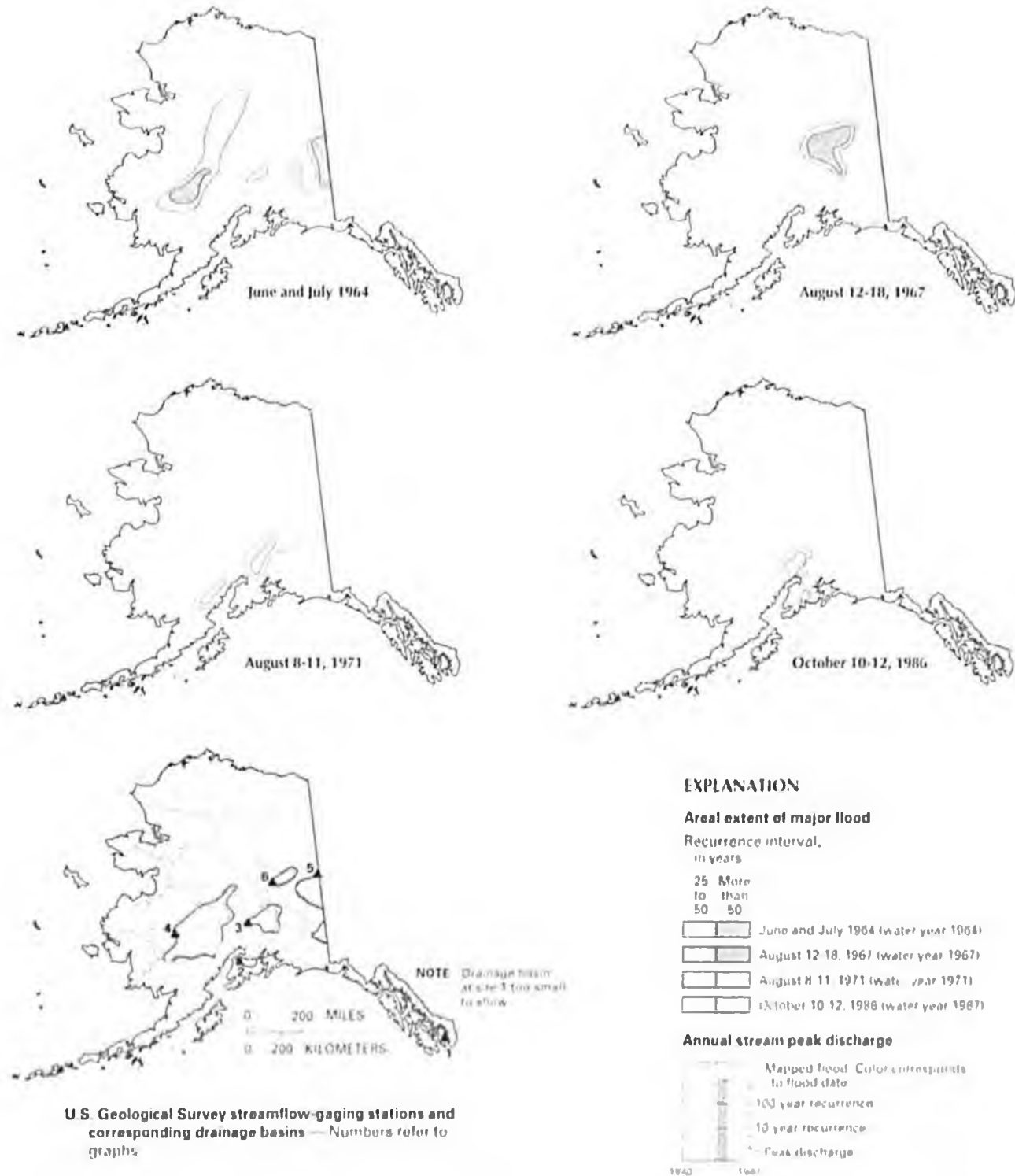


Figure 3. Areal extent of major floods with a recurrence interval of 25 years or more in Alaska, and annual peak discharge for selected sites, water years 1916-88. (Source: Data from U.S. Geological Survey files.)



Ice-jam formation in Meade River at Atkasuk south of Barrow, Alaska View downstream of newly formed ice jam on June 7, 1978, which increased the stage and caused local overbank flow. (Photograph by Charles T. Sloan, U.S. Geological Survey)

Peak Discharge

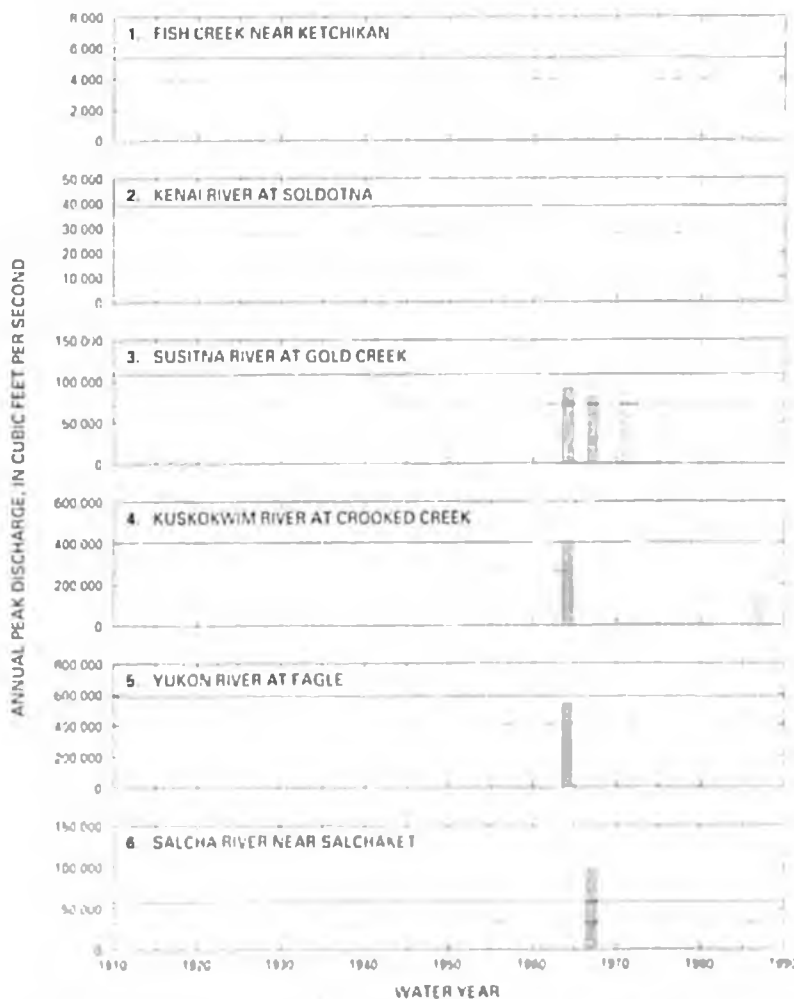


Figure 3. Areal extent of major floods with a recurrence interval of 25 years or more in Alaska, and annual peak discharge for selected sites, water years 1916-88—Continued

also was inundated. These floods caused 6 deaths, damage of about \$85 million, and the evacuation of 12,000 people (Childers and others, 1972, p. A1). These losses are much larger than the combined total loss during the other three major floods described here.

The flood of August 8-11, 1971, inundated areas northeast and west of Anchorage; the upper and middle Susitna River basin (fig. 3, site 3) and part of the Matanuska River basin were the most affected. Precipitation ranging from 3 to 9 inches was recorded during August 5-11 (Lamke, 1972, p. 12-15). July flooding in some streams in the area and in other nearby rivers created antecedent conditions that were a factor in the August flood. Total damage was about \$10 million, mostly to highways east of Palmer.

The flood of October 10-12, 1986 (water year 1987), affected south-central Alaska, generally south of the 1971 flood area. During October 9-11, almost 18 inches of rainfall was recorded at Seward on the Kenai Peninsula, and 8 or more inches fell farther north in the Susitna River basin near Talkeetna. These two storms were caused by different meteorological conditions. The rainstorm near Seward resulted from a stationary storm front, whereas that near Talkeetna resulted from a plume of relatively warm, moist air moving northward from Seward that met a cold front moving southeastward from Barrow (Lamke and Bigelow, 1988, p. 3-7). Most affected by these floods were the Seward area, the lower Susitna River valley, and a few small streams to the west along Cook Inlet. Peak discharges of several streams were greater than those having a 100-year recurrence interval. Kuskokwim River at Crooked Creek (site 4) was the only gaging station of the six in figure 3 at which the peak discharge was the maximum for the water year. Flood damage from inundation in the Seward area was increased by dammed streams resulting from landslides, as well as by eroding and migrating channels (Jones and Zenone, 1988). Flood damage was estimated to have been \$20 million (Lamke and Bigelow, 1988, p. 1).

Areal Extent of Droughts

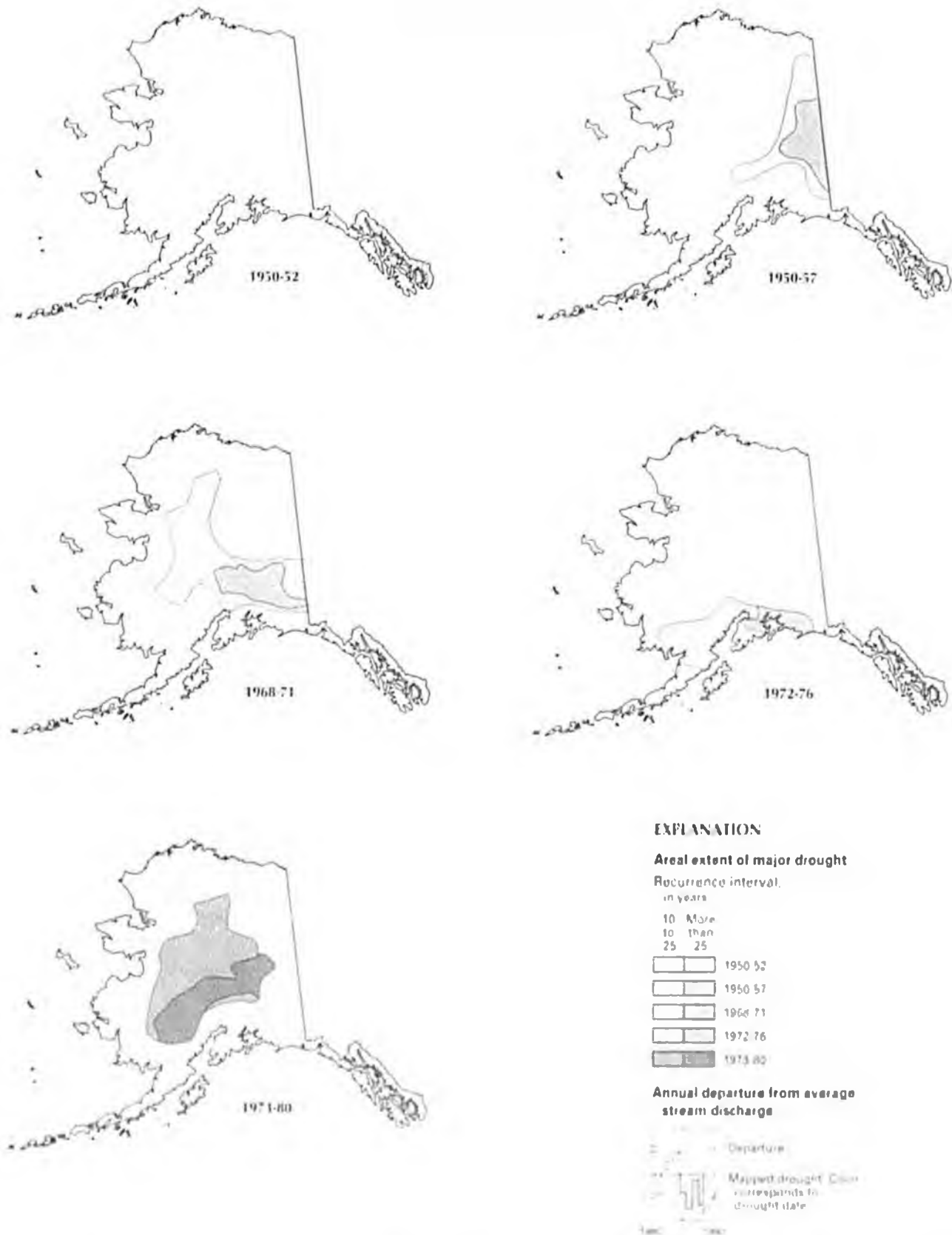
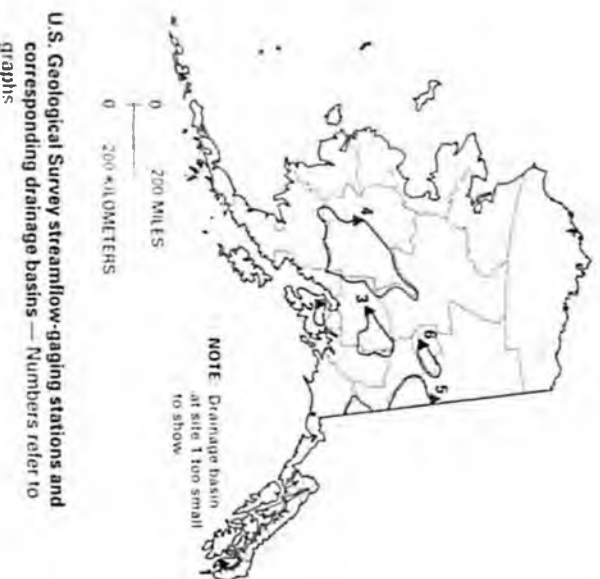


Figure 4. Areal extent of major droughts with a recurrence interval of 10 years or more in Alaska, and annual departure from average stream discharge for selected sites, water years 1916-88.



U.S. Geological Survey streamflow-gaging stations and corresponding drainage basins—Numbers refer to graphs

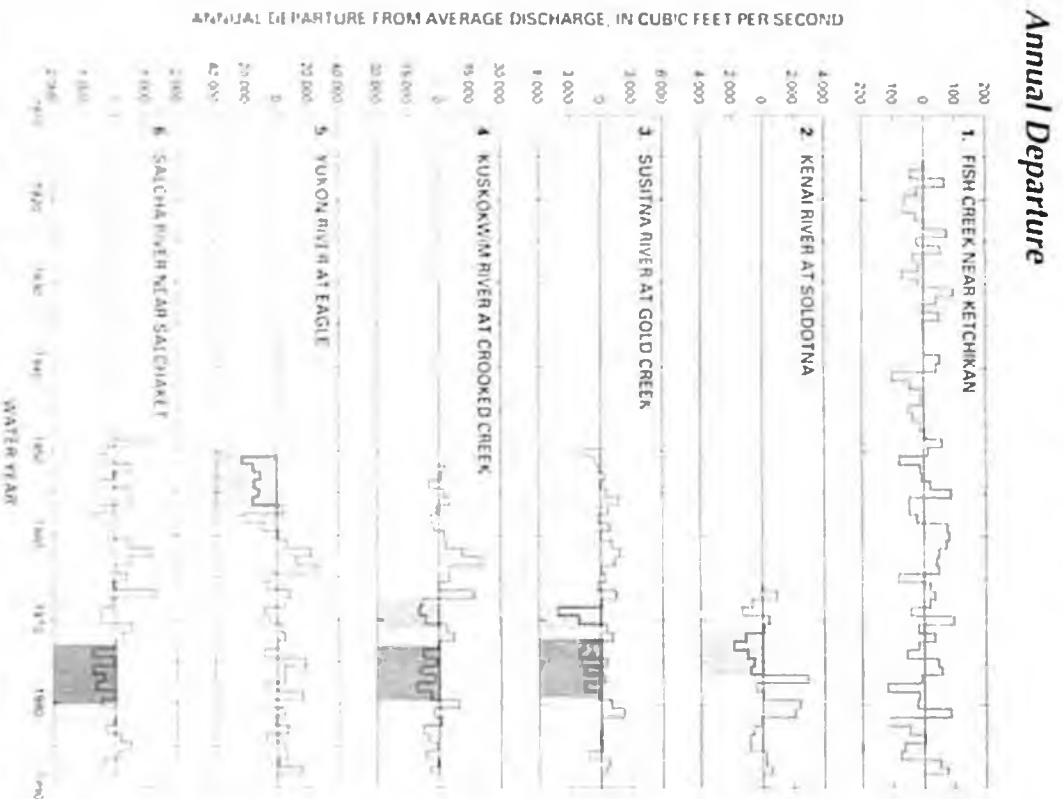


Figure 4. Areal extent of major droughts with a recurrence interval of 10 years or more in Alaska, and annual departure from average stream discharge for selected sites, water years 1916-88—Continued.

Intensive floods of local extent have occurred at other times and places in Alaska (table 1), but they generally caused minimal damage in unpopulated and undeveloped areas. For example, the discharge of many small streams in Anchorage was a record maximum on June 21, 1949, when most of the area was undeveloped. Floods on two small streams in urban areas of Anchorage resulted in record-breaking peak discharges on Aug. 25-29, 1989 (U.S. Geological Survey, 1990b, p. 6-9). Nearby areas were less severely affected; damage was estimated at about \$10 million, mostly from inundation of residences.

Two other recent floods of local extent are noteworthy (table 1). In 1986, Hubbard Glacier advanced and dammed Russell Fiord, thereby creating Russell Lake. The ice dam failed on October 8, 1986, and released an estimated 1.3 cubic miles of water from the lake; the peak discharge was estimated to be about 4,100,000 cubic feet per second (Mayo, 1988, p. 42-46). A flood near Black Rapids on July 14, 1987 (U.S. Geological Survey, 1988, p. 9), is an example of local flooding caused by convective rainstorms in the Yukon River basin.

DROUGHTS

To identify droughts in Alaska, monthly streamflow data were analyzed for 50 gaging stations that have 20 or more years of daily discharge record and for 26 other gaging stations that have shorter records. For each station, annual departures of actual monthly flows from average monthly flow for the period of record were determined. For the purposes of this report, drought periods were defined by a concurrent, extended negative trend in the annual departures for several streams in an area. Five major droughts in Alaska can be distinguished. A sixth drought of lesser intensity and areal extent also was evident in parts of southeastern Alaska. For this last drought, data for water years 1981-88 were used to determine whether conditions that caused severe deficit flows in Pacific Northwest streams in the 1980's, extended into Alaska. Even though Fish Creek near Ketchikan (fig. 4, site 1) experienced a drought from May 1981 to October 1986 that was the second most severe in 70 years of discharge record, flow deficits at other nearby long-term stations were not as large. Flows in these streams returned to normal within water year 1987.

Flow in most Alaskan streams outside the Maritime Climatic Zone is small during winter. However, severe droughts that last as long as a year can happen when flows far less than average persist throughout the normally high-flow period of summer and into winter. Such a drought occurred in 1969 in the Copper River basin and in the rest of south-central Alaska outside the Maritime Climatic Zone. Flow records indicate another severe short-term drought in the low-altitude mainland and island streams around Ketchikan during the latter part of water year 1965 and the early part of water year 1966.

The assignment of a time period for an areawide drought is somewhat subjective. For example, the drought of 1950-57 might be considered an extended, multiwater year 1960 on the Yukon River at

Eagle (fig. 4, site 5). However, at two nearby gaging stations in the upper Tanana River basin, the drought was ended by greater than normal snowmelt runoff after April 1957. For this report, a drought was considered to end just before a year of generally normal and greater than normal flows (indicated by zero or positive trends in

annual departures) or just preceding periods of noticeable high flow. If the cumulative deficit for a given drought is divided by the long-term average annual discharge, then an index to the severity of the drought can be calculated in terms of months of long-term average flow equivalent to the deficit. The five principal droughts in Alaska

Table 1. Chronology of major and other memorable floods and droughts in Alaska, 1949-89

Recurrence interval: The average interval of time within which streamflow will be greater than a particular value for floods, or less than a particular value for droughts. Symbol >, greater than. Sources: Recurrence intervals calculated from U.S. Geological Survey data, other information from U.S. Geological Survey, State and local reports, and newspapers.

Flood or drought	Date	Area affected (fig. 2)	Recurrence interval (years)	Remarks
Flood	June 21, 1949	Anchorage area	10 to >100	Largest known peak discharge in some small streams in Anchorage.
Drought	1950-52	Southeastern Alaska (mainland southeast of Juneau and islands near Ketchikan)	10 to >35	Deficit flows from Dec. 1949 to May 1952 in small streams. Less severe near Ketchikan.
Drought	1950-57	Upper Yukon River (in Alaska) and upper Tanana River basins.	10 to >30	Deficit flows on Yukon River from June 1950 to July 1960. Deficit flow ended May 1957 in upper Tanana River basin.
Flood	Aug. 12-13, 1961	Juneau area	10 to >100	High water in Juneau and mainland streams as much as 40 miles southeast.
Flood	Oct. 2-15, 1961	Ketchikan area	10 to >100	High water in island streams and mainland streams near Ketchikan.
Flood	June 1962	Yukon River and south-central Alaska (upper Susitna River basin).	10 to 75	Snowmelt and breakup peaks on Yukon River main stem and scattered streams in the Alaska Range.
Flood	Mar. 27, 1964	Gulf of Alaska coastal area	Unknown	Tsunami. Local and seismic sea waves from Great Alaska Earthquake extensively damaged coastal communities; lives lost, 115.
Flood	June-July 1964	South-central Alaska (middle Susitna River), southwestern Alaska (Kuskokwim River), and Yukon River in Alaska (upper Yukon and Koyukuk River basins).	10 to near 100	Snowmelt and rain on snow caused scattered flooding of villages along major rivers and some damage to highways.
Drought	Spring 1965-spring 1966	Southeastern Alaska (southern mainland and islands)	Unknown	Short, extreme low-flow period of about 1 year in many streams.
Flood	Aug. 12-18, 1967	Yukon River in Alaska (middle and lower Tanana River basin, particularly the Chena and Saicha River basins).	10 to >100	Result of widespread rainstorms. Fairbanks and Nenana almost inundated. Most damaging since records began. Lives lost, 6; damage, \$85 million.
Drought	1968-71	South-central (Copper, Matanuska, and Susitna River basins, Anchorage area), southwestern Alaska (Kuskokwim River), and Yukon River in Alaska (middle Yukon, Tanana, Nenana, and Koyukuk River basins).	10 to >35	Severe streamflow deficits on southern side of Alaska Range; less severe in other areas. Drought began in Aug. 1968 and ended in July and Aug. 1971.
Flood	Aug. 8-11, 1971	South-central (lower Matanuska and upper and middle Susitna River basins, Palmer area) and southwestern Alaska (Kvichak River basin).	10 to >100	Mostly result of widespread rainstorms; antecedent rain and high water were also significant. Damage, \$10 million.
Drought	1972-76	South-central and southwestern Alaska (southern one-half of these regions, excluding lower Kenai and Alaska Peninsulas).	10 to >35	Deficit flows from Cordova to the Kenai River, and Anchorage areas, less severe on Kodiak Island and Bristol Bay drainages. Started in fall 1971 and ended in fall 1976.
Drought	1973-80	South-central (middle Susitna River), southwestern Alaska (upper Kuskokwim River), and Yukon River in Alaska (lower Tanana, central Yukon, and Koyukuk River basins).	10 to >30	Streamflow deficiencies most severe on northwestern side of Alaska Range and in Saicha-Chena River basins. Began in spring 1973 and generally ended in fall 1980.
Flood	Nov. 11-13, 1974	Nome area	Est. 30	Storm surge. Storm waves as much as 10 feet in depth flooded parts of Nome. Damage, \$12 million.
Drought	1981-86	Southeastern Alaska (islands near Ketchikan and on mainland north to Juneau)	10 to >30	Deficient runoff in some island streams near Ketchikan. Lesser deficits elsewhere. Extended from May 1981 to Oct. 1986.
Flood	Oct. 8, 1986	Russell Ford Lake	Unknown	Breakout of lake formed when advancing Hubbard Glacier dammed a fiord.
Flood	Oct. 10-12, 1986	South-central Alaska (Seward area, lower Susitna River basin, and streams west of Susitna River mouth).	10 to >100	More than 15 inches of rain near Seward and 8 inches near Talkeetna. Damage, \$20 million, mostly to roads and the railroad.
Flood	July 14, 1987	Black Rapids area in Tanana River basin	Unknown	Local, caused by a convective rainstorm. Damage, \$1 million, mostly to highway and exposed Trans-Alaska pipeline.
Flood	Aug. 25-29, 1989	Anchorage area	25 to >100	Local floods on two urban streams in Anchorage and, to a lesser extent, on other streams in Anchorage area. Damage, \$10 million, mostly from inundation of residences.

are described in chronological order. The extent of these droughts and the annual departures from the long-term mean flow are shown in figure 4.

The drought of 1950-52 began with deficit flows in south-eastern Alaska in December 1949 or January 1950 in most mainland streams from Juneau southward past Wrangell and in most island streams near Ketchikan. The drought ended in either April or May 1952. The annual departures for Fish Creek near Ketchikan (fig. 4, site 1) show that this drought is the sixth most severe in nearly 70 years of record; thus, the recurrence interval is slightly greater than 10 years. However, the recurrence interval of the drought, as reflected in streamflow records at most mainland gaging stations, is 30-35 years. Where the drought was most severe, the cumulative deficit at the end of the period was equivalent to 5-6 months of average flow.

The drought of 1950-57 affected the upper Yukon River basin (in Alaska), which includes the upper Tanana River basin. The drought was less severe farther west along the Alaska Range. On the main stem of the Yukon River, deficit flows began in June 1950 at Dawson City in Yukon Territory, Canada, upstream from the Alaska border. The cumulative deficit in the almost 7 years of drought was equivalent to about 1 year of average flow.

The drought of 1968-71 resulted from severe deficits in streamflow in south-central Alaska outside the Maritime Climatic Zone; the 3-year drought includes a more severe short-term drought in 1969. Deficits were less extreme in adjacent areas, notably the Anchorage area, the Kuskokwim River basin, and in streams that drain northward from the Alaska Range to the Tanana River. Deficits also were less extreme in the central Yukon River main stem and Koyukuk River basin. Effects of the drought were marginal in the Skagway area in southeastern Alaska and in low-altitude streams on the Kenai Peninsula. The drought ended with high flows that began in June and July 1971 and the floods of August 8-11, 1971 (see fig. 3, site 3). Cumulative deficits in the most severely affected areas were equivalent to about 10 months of average streamflow.

The drought of 1972-76 resulted from severe flow deficits in south-central Alaska streams in the high-altitude areas of the Kenai Peninsula, in the Anchorage vicinity, and in coastal areas from Cordova to Seward. Drought conditions had begun to develop in water year 1968 in these areas but were interrupted by the floods of October 1969 (fig. 3, site 2; U.S. Geological Survey, 1975). The drought was less severe on Kodiak Island and in the Bristol Bay drainages of southwestern Alaska. Deficits in cumulative departures in the most affected streams were equal to about 1 year of normal flow.

In terms of total flow deficit and length, the regional drought of 1973-80 was the most severe everywhere in Alaska since streamflow recordkeeping began. In the most severely affected drainage basins, those of the Salcha River (fig. 4, site 6) and the adjacent Chena River, the cumulative deficits at the end of the drought period were equivalent to 2-2.5 times the normal annual flow. The ending date of this drought differed among stations. The period of less than average flows ended in Fall 1980 on the Salcha River and in December 1978 on the Tanana River at Nenana, but persisted until September 1983 on the Chena River at Fairbanks. Severe deficits extended westward to the Kuskokwim River basin (fig. 4, site 4); deficits were less severe in adjacent areas that extended northward into the main stem of the Yukon River and the Koyukuk River basin and southward to parts of the Susitna River basin.

Deficit streamflow in Alaska primarily affects anadromous fish, which may not have sufficient streamflow to migrate upstream to spawn, or affects the eggs after spawning, which may not survive if they are exposed by decreasing stream levels. Long periods of deficit rainfall commonly lead to declines in ground-water levels, which, in turn, decrease base flows of streams, decrease available supply from small yield wells, and lower water levels in recreational lakes. A decrease in soil moisture can create poor growing conditions for plants and an increased potential for tundra fires.

WATER MANAGEMENT

Because of the relative abundance of water for the small population and large size of Alaska, intensive water management of most of the State's streams is not needed. However, some aspects of water management are necessary. These areas of responsibility include flood plain management, flood warning systems, and water-use management during droughts.

Flood Plain Management.—Management of flood plains at the State level is the responsibility of the Alaska Department of Community and Regional Affairs. The principal Federal responsibility lies with the Federal Emergency Management Agency, which coordinates the National Flood Insurance Program and studies of flood prone areas. Locally, communities may or may not have been granted flood plain management control, which depends on their classification by the State (for example, city, borough, or unincorporated area). Incorporated cities and boroughs are permitted by State statutes to have flood-control responsibility, but many have not assumed it. Most of the larger Alaska communities are included in the National Flood Insurance Program. All three governmental levels—local, State, and Federal—have some management responsibility for development on flood plains or coastal areas and encroachment on wetlands.

The only large-scale, flood-control project in Alaska is the Moose Creek Reservoir on the Chena River near Fairbanks, which is operated by the U.S. Army Corps of Engineers. Floodwaters are stored temporarily in the reservoir, and during extreme floods can be diverted from the Chena River into the Tanana River. The flood-control project also incorporates levees built along the Tanana River on the southern side of Fairbanks. In other areas of the State, dikes, levees, and drainage ditches have been built to control more localized floods.

Flood-Warning Systems.—The National Weather Service maintains a River Forecast Center in Anchorage that is responsible for issuing flood warnings for inhabited areas of the State. One of their principal flood-prediction tools is river-stage information from about 60 sites; about one-third of these sites are active U.S. Geological Survey gaging stations, and another one-third are at discontinued Geological Survey gaging stations. The River Forecast Center also monitors spring ice breakups on the major rivers (principally the Kuskokwim and Yukon) that are particularly subject to ice-jam flooding. The Alaska Division of Emergency Services also has flood-warning responsibilities and arranges for evacuation of threatened communities. The U.S. Department of Commerce's Alaska Tsunami Warning Center in Palmer issues warnings for potential tsunamis following earthquakes.

Water-Use Management During Droughts.—No explicit provision exists at any governmental level for management of droughts in Alaska. However, the Alaska Department of Natural Resources, which administers water rights, has some implied authority in the allocation of water in streams during low-flow periods. The Alaska Water Use Act (Alaska Statutes 46.15.010, 270) provides for instream water rights, but the administrative process necessary to reserve instream water rights has been completed for only a few streams. The water rights of the larger hydroelectric projects usually contain provisions for minimum flows if the stream downstream from the project contains fish.

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ALASKA

Surface-Water Resources

Alaska contains more than 40 percent of the Nation's surface-water resources, but most of the rivers and lakes are undeveloped and unaffected by humans. However, water is not always available where and when it is needed. For example, the most readily available and economical local water sources will be insufficient to meet projected demands at Anchorage and Juneau. Surface-water sources are not always dependable during the winter; some streams freeze completely or have periods of very low flows or no flow. Conversely, too much water occasionally is a problem. Ice-jam floods are common on many rivers during periods of snowmelt, and summer floods have caused extensive damage on other streams.

Generally, surface water is of suitable quality for most uses, but, in some areas, local degradation occurs from human activities or from natural causes. Suspended sediment in glacier-fed rivers makes the water unsuitable for most uses without some treatment. Alaska's principal surface-water issues are to maintain its good water quality, to minimize adverse effects on water resources when development occurs, and to improve conditions adversely affected by development.

Surface water supplies 32 percent of the State's population and 78 percent of the total water withdrawn for offstream use. Only 18 percent of this use is for public supply; the remainder is for fish processing, pulp mills, mining, and other industrial uses. In 1980, water used instream for hydropower generation was 3.5 times more than that used offstream. Surface-water withdrawals in Alaska in 1980 for various purposes and related statistics are given in table 1.

GENERAL SETTING

Wahrhaftig (1965) defined four major physiographic divisions—Pacific Mountain System, Intermontane Plateaus, Rocky Mountain System, and Arctic Coastal Plain (fig. 1). The Pacific Mountain System contains the Coast Mountains, Alaska Range, Aleutian Range, Aleutian Islands, and a parallel southern arc of lower elevation mountains in the islands of southeastern Alaska and along the Gulf of Alaska. The Intermontane Plateaus, which consist of dissected uplands, broad alluvial valleys, and lowland basins, lie between the Alaska Range and the Brooks Range of the Rocky Mountain System.

Alaska has four climatic zones (Hartman and Johnson, 1978, p. 59-61)—Maritime, Transition, Continental, and Arctic (fig. 1). The State's high mountain ranges, extensive ocean bounds, and vast size—one-sixth of the total area of the United States—are the principal causes of the great differences in climatic conditions and in the diverse patterns and amounts of runoff throughout the State. From the southern part of the Maritime Zone to the northern part of the Arctic Zone, average annual precipitation and temperature range from 320 to 5 inches and from 45 to 10 °F (degrees Fahrenheit), respectively. In the Maritime Zone, two-thirds of the annual precipitation occurs from September through March; October usually is the wettest month (fig. 1, bar graph for Annette). The driest period is from mid-May through July. In the Continental and Arctic Climatic Zones, about two-thirds of the precipitation falls from June through November and the driest months are March through May (fig. 1, bar graphs for Talkeetna and Barrow). In the Transition Zone, seasonal precipitation patterns are not sharply defined, fluctuate from year to year, and may resemble those of either the Maritime or Continental Zones. In low-elevation areas of the Maritime Zone, snow falls but usually melts fairly rapidly.

Table 1. Surface-water facts for Alaska

(Data may not add to totals because of independent rounding. Mg/d = million gallons per day, gal/d = gallons per day, < = less than. Source: Sulley, Chase and Mann, 1983.)

POPULATION SERVED BY SURFACE WATER, 1980	
Number (thousands)	127
Percentage of total population	32
From public water-supply systems	
Number (thousands)	113
Percentage of total population	28
From rural self-supplied systems	
Number (thousands)	14
Percentage of total population	4
OFFSTREAM USE, 1980	
FRESHWATER WITHDRAWALS	
Surface water and ground water, total (Mgal/d)	229
Surface water only (Mgal/d)	170
Percentage of total	77
Percentage of total excluding withdrawals for thermoelectric power	78
Category of use	
Public supply withdrawals	
Surface water (Mgal/d)	30
Percentage of total surface water	18
Percentage of total public supply	57
Per capita (gal/d)	265
Rural-supply withdrawals	
Domestic	
Surface water (Mgal/d)	0.1
Percentage of total surface water	< 1
Percentage of total rural domestic	1
Per capita (gal/d)	10
Livestock	
Surface water (Mgal/d)	0.1
Percentage of total surface water	< 1
Percentage of total livestock	50
Industrial self-supplied withdrawals:	
Surface water (Mgal/d)	140
Percentage of total surface water	82
Percentage of total industrial self-supplied:	
including withdrawals for thermoelectric power	91
excluding withdrawals for thermoelectric power	95
Irrigation withdrawals:	
Surface water (Mgal/d)	0
Percentage of total surface water	0
Percentage of total irrigation	100
INSTREAM USE, 1980	
Hydroelectric power (Mgal/d)	770

Along the Arctic coast, snow generally falls from mid-September to mid-June but may occur in July and August. At higher elevations, snow falls throughout the year. Glaciers cover 5 percent of the State and are present mainly in the Coast Mountains, the Alaska Range, and the mountains bordering the Gulf of Alaska.

Average annual runoff for the State is about 25 inches, but the amount varies significantly depending on location (fig. 1). In southeastern Alaska, average runoff is about 150 inches, but locally it may be as much as 300 inches (not shown on map). At the other extreme, runoff averages about 8 inches north of the Brooks Range, but the average is only 4 inches in some Arctic coastal areas. No consistent statewide, long-term trend in streamflow is evident in the bar graphs of average annual discharges in figure 2.

Seasonal variations in streamflow result from precipitation and temperature fluctuations; ranges in basin elevation; and the effects of natural storage and release from the snowpack, glaciers, and lakes. Most streamflow patterns in the Maritime Climatic Zone are similar to those for Fish Creek (fig. 1); peak-flow periods occur

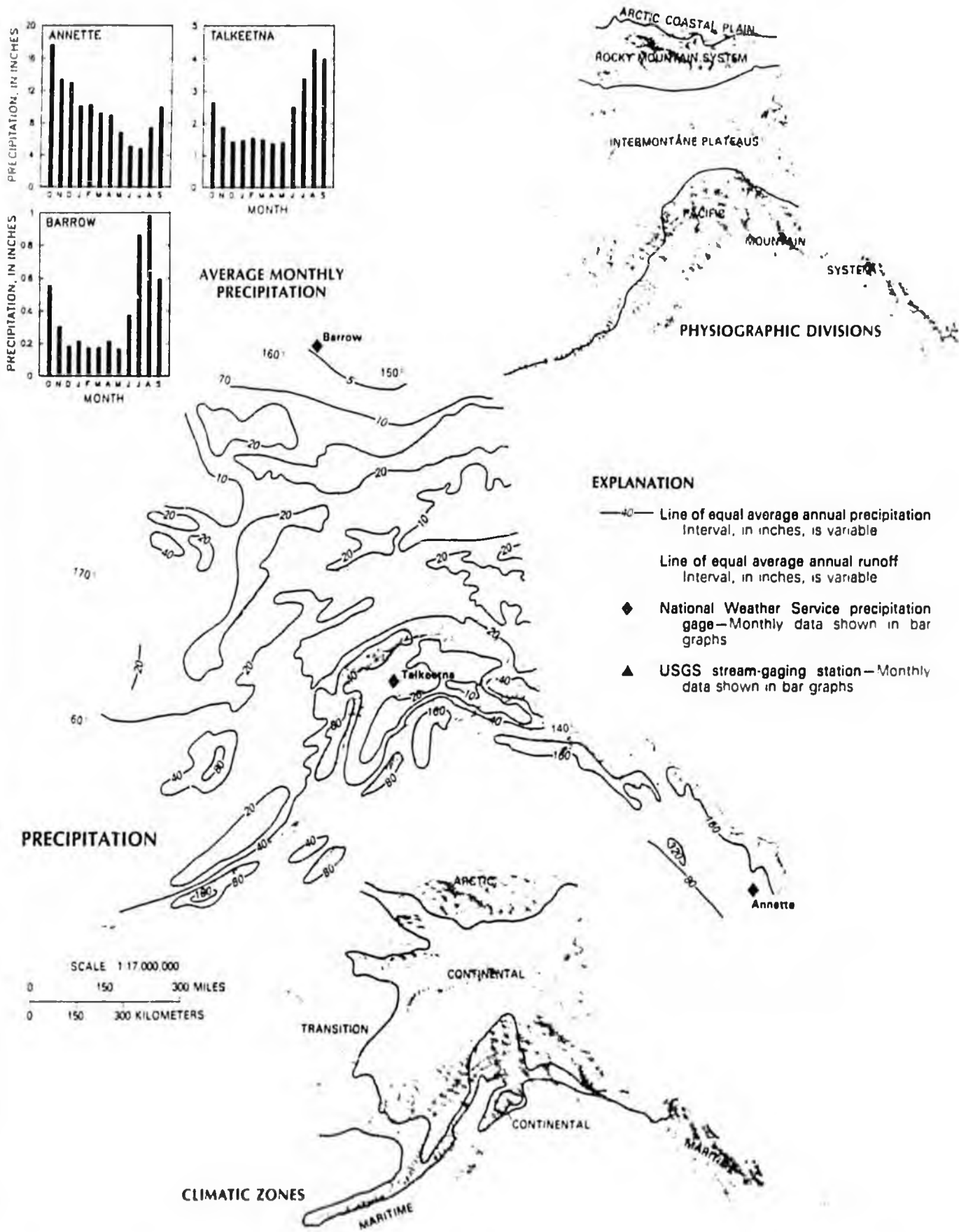
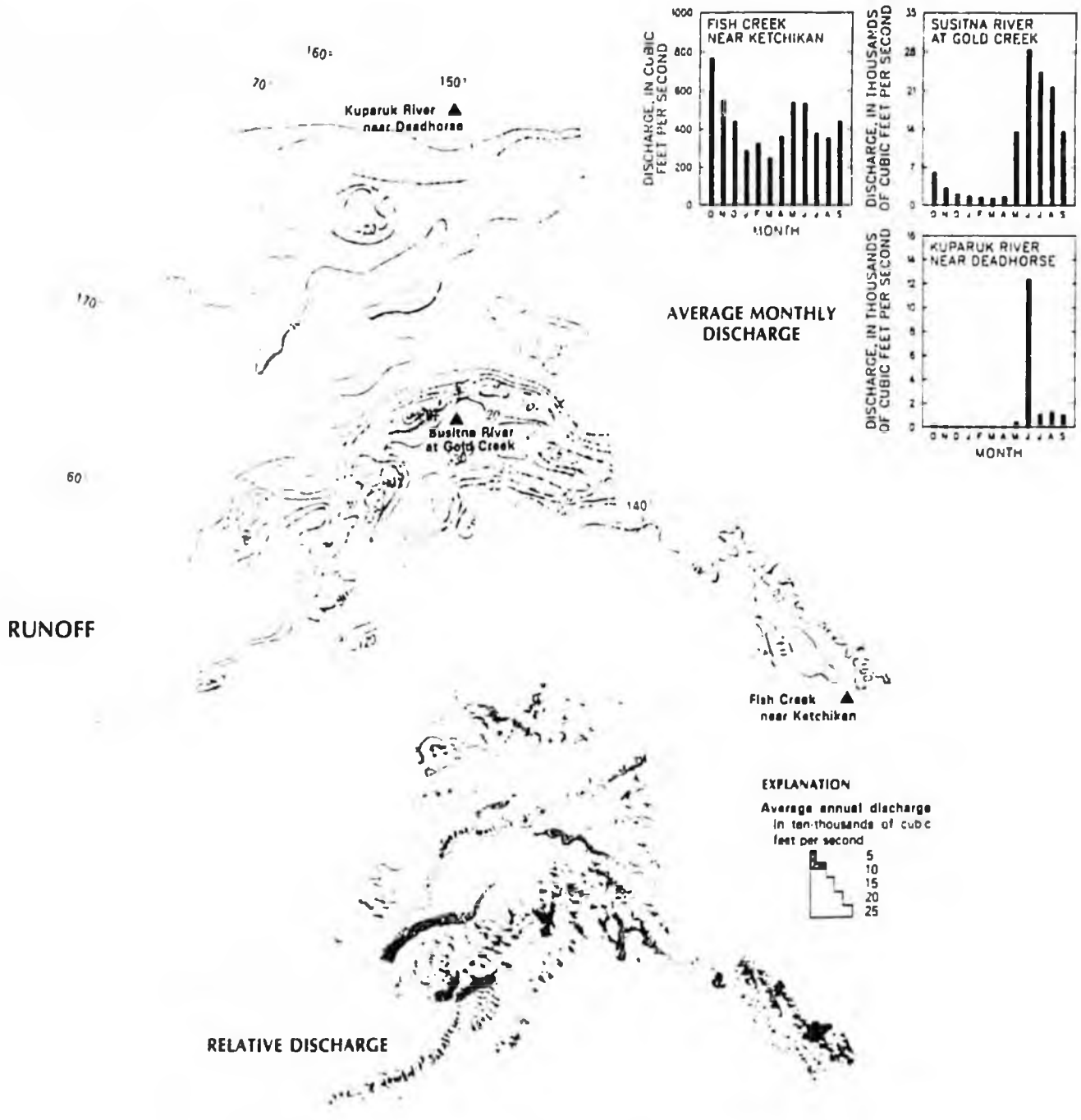


Figure 1. Average annual precipitation and runoff in Alaska and average monthly data for selected sites, 1951-80.

Sources: Precipitation—annual data modified from National Weather Service, 1972; monthly data from National Oceanic and Atmospheric Administration files. Runoff—annual data from Gebert, Graczyk, and Krug, 1985. Discharge—monthly—and relative discharge data, and discharge data at mouth of principal rivers, from U.S. Geological Survey files. Physiographic diagram from Harrison, 1969; divisions from Wahrhaftig, 1965. Climatic zones from Hartman and Johnson, 1978.



AVERAGE DISCHARGE AT MOUTH OF PRINCIPAL RIVERS
[Units in thousands]

RIVER	AREA (mi ²)	DIS-CHARGE (ft ³ /s)	RIVER	AREA (mi ²)	DIS-CHARGE (ft ³ /s)
Stikine	20.0	56	Nushagak	b 12	b 32
Taku	6.6	a 20	Kuskokwim	48	67
Aleak	11	a 30	Yukon	328	225
Copper	24.4	59	Porcupine	45.1	23
Chitina	7.9	a 20	Tanana	34.5	41
Susitna	20.0	51	Adakuska	32.4	22
Ventna	6.2	21	Kobuk	12.0	18
Kuchik	9.6	21	Colville	23.3	a 20

a - Approximate b - Does not include Wood River

Figure 1. Average annual precipitation and runoff in Alaska and average monthly data for selected sites, 1951-80—Continued.

Sources: Precipitation—annual data modified from National Weather Service, 1972; monthly data from National Oceanic and Atmospheric Administration files. Runoff—annual data from Gebert, Graczyk, and Krug, 1965. Discharge—monthly and relative discharge data, and discharge data at mouth of principal rivers, from U.S. Geological Survey files. Physiographic diagram from Harrison, 1969; divisions from Wainwright, 1965. Climatic zones from Hartman and Johnson, 1973.

in the fall and spring due to rainfall and snowmelt, respectively. However, the seasonal flow distribution in some southeastern-mainland streams, whose basins contain glaciers in their higher elevations, are similar to those for other high-elevation mountain streams throughout the State.

The seasonal flow pattern of the Susitna River (fig. 1) is characteristic of most large major rivers and of streams in the State's interior, but the temporal distribution in flow varies with basin elevation, latitude, and relative amounts of natural storage in lakes and glaciers. Discharge increases when snowmelt at lower elevations begins in late May or June, and it peaks in the following month; flow is sustained through the summer by rain, snowmelt at higher elevations, and runoff from glaciers. Most low-elevation basins have two high-flow periods—during the spring snowmelt period and a late-summer rainy period. The Kuparuk River (fig. 1) is characteristic of streams on the Arctic Coastal Plain that have short, intense, snowmelt-runoff periods but little response to summer rains.

According to Iseri and Langbein (1974), 16 rivers in Alaska qualify as "large" rivers because average annual discharge exceeds 17,000 ft³/s (cubic feet per second) or 11,000 Mgal/d (million gallons per day). Estimated average discharges at the mouth of the 16 rivers are shown in figure 1.

Lakes cover about 1 percent of Alaska. Ninety-five lakes have a surface area larger than 10 mi² (square miles), eight are larger than 100 mi², and one (Iliamna Lake) has an area of 1,000 mi² (Bue, 1963). The State has an estimated 3 million lakes larger than "pond-size," mainly in lowland areas of the Yukon-Kuskokwim Delta, Yukon Flats, and Arctic Coastal Plain. Twenty-two reservoirs (fig. 2) have usable storage capacities of more than 5,000 acre-ft (acre-feet) or 1,600 Mgal (million gallons).

PRINCIPAL RIVER BASINS

The Alaska Water-Resources Region, which coincides with the State of Alaska, contains six subregions (fig. 2). The tabulation below (modified from Balding, 1976) summarizes runoff originating in each subregion. If part of the drainage area is in Canada, the drainage size and inflows to Alaska are given in parentheses.

(mi² = square miles; ft³/s = cubic feet per second)

Subregion	Drainage area (thousand mi ²)	Runoff (thousand ft ³ /s)	Subregion	Drainage area (thousand mi ²)	Runoff (thousand ft ³ /s)
Southeast	45 (35)	500 (120)	Yukon	210 (130)	154 (78)
South-Central	80 (1)	207 (5)	Northwest	67	78
Southwest	108	224	Arctic	81	44

The location of the subregions, and long-term variations in streamflow at representative streamflow-gaging stations, are shown in figure 2. Streamflow characteristics and other pertinent information are given in table 2. The Hydrologic Unit Map for Alaska is being revised. Table 2 and figure 2 use provisional information from the proposed map. A few subregion boundaries and names were changed from the previous map.

ALASKA REGION

Southeast Alaska Subregion

The Southeast Alaska Subregion encompasses the mountainous, glaciated southeastern panhandle of Alaska and includes hundreds of islands, which comprise 37 percent of the subregion's area. Most drainage basins in the subregion are smaller than 200 mi²; however, basins with headwaters in Canada are larger. Runoff from the subregion (including inflow from Canada) is almost as much as that of the Mississippi River.

Twelve hydroelectric reservoirs (mountain lakes that have been dammed at their outlets) have a total usable storage capacity of 624,000 acre-ft or 203,400 Mgal. Blue Lake (150,000 acre-ft or 48,900 Mgal) and Long Lake (140,000 acre-ft or 45,600 Mgal) have the largest usable storage capacities. The Snettisham Project (Long Lake) has 70,000 kW (kilowatts) of power generation capacity; the capacity of each of the other powerplants is less than 25,000 kW. The largest natural lake is Bering Lake (surface area about 17 mi²) near Cordova. Offstream users are pulp mills at Ketchikan and Sitka, seafood processors, and public water-supply systems. The development of small, local streams to meet growing demands in outlying areas is being considered at Juneau.

South-Central Alaska Subregion

The South-Central Alaska Subregion lies between the crest of the Alaska and the Aleutian Ranges and the Gulf of Alaska and includes Kodiak Island (Alaska's largest island at 3,670 mi²) and several smaller islands. The principal river basins—the Copper and the Susitna—comprise 56 percent of the subregion. Tustumena Lake (117 mi²) is the largest lake, and 15 other lakes are 10 mi² or larger in area.

Four hydroelectric reservoirs have a total usable storage capacity of 380,500 acre-ft or 124,000 Mgal. Eklutna Lake, with 163,300 acre-ft or 53,220 Mgal of usable capacity, is the largest and supplies the Eklutna project (30,000 kW).

Offstream uses are for public water supply and industrial use, primarily seafood processing. The Municipality of Anchorage, home to half of Alaska's population, has begun construction of a pipeline to Eklutna Lake to augment the water supply in developed areas. Water from the glacier-fed lake will have to be treated to remove suspended sediment; also, an alternate means of power generation will be provided to compensate for power lost in the Eklutna project. The municipality recently has embarked on a program to reduce pollution of urban streams.

Southwest Alaska Subregion

The Southwest Alaska Subregion includes basins that drain to the southwest into Kuskokwim and Bristol Bays, the Aleutian Islands (6,820 mi²), and many other islands. The principal river basins—the Kuskokwim, the Nushagak, and the Kvichak—comprise 64 percent of the subregion. Iliamna, Becharof, Naknek, Clark, and Dall Lakes have surface areas of 1,000, 458, 242, 110, and 100 mi², respectively; 50 more lakes are 10 mi² or larger. The interconnected stream and lake systems draining to Bristol Bay constitute the most productive area for salmon in Alaska. Floods, particularly those caused by recurrent ice jams, occur along the

Kuskokwim River and other large streams. Relatively small amounts of water are withdrawn for domestic supply, mining, and fish processing.

Yukon Subregion

The Yukon Subregion is virtually equivalent to the Yukon River basin, which extends across interior Alaska between the Alaska and the Brooks Ranges. Outflow at the mouth of the Yukon River is about 225,000 ft³/s or 145,000 Mgal/d; inflow from Canada (table 2, site 10) is about 83,000 ft³/s or 53,600 Mgal/d. Major tributaries are the Tanana, the Porcupine, and the Koyukuk Rivers. According to Bue (1963), the largest lakes in the subregion are Kgun Lake (31 mi²) and Tetlin Lake (27 mi²). Eight other lakes in the Yukon Delta and another farther upstream are 10 mi² or larger. Floods on the Yukon River and its major tributaries are caused by ice jams in May or early June and by rainstorms later in the year. The maximum recorded discharge (1,030,000 ft³/s or 666,000 Mgal/d) on the Yukon River was at Kaltag (drainage area, 296,000 mi²) on June 22, 1964. Extreme floods in the Tanana River basin occur in July or August from a combination of runoff caused by melting of snow and glacier ice at high elevations and areawide rainstorms. The State's most damaging flood occurred August 15, 1967, on the Chena River, when about 95 percent of Fairbanks was inundated. Floodwaters of the Chena River are temporarily stored (since 1981) in Moose Creek Reservoir, which has a capacity of 160,000 acre-ft or 52,000 Mgal, and may be diverted to the Tanana River when reservoir capacity is exceeded. Principal water uses are for cooling fossil-fuel powerplants, placer mining, and public water-supply systems. The principal surface-water issue in the subregion concerns placer mining and its effects on water quality; particularly, how to efficiently control the amount of sediment downstream from the mining area.

Northwest Alaska Subregion

The Northwest Alaska Subregion consists of the drainage basins of rivers that flow westward into Kotzebue and Norton Sounds. The principal rivers are the Kobuk and the Noatak; their basins comprise 36 percent of the subregion. Although their drainage areas are similar, flow in the Noatak is only about three-fourths that of the Kobuk River. Selawik Lake—a tidal, saline lake (400-mi²)—is the largest in the subregion. The largest freshwater lakes are Imuruk Lake (26 mi²) and Walker Lake (14 mi²) (fig. 2). Surface water is used mainly for rural domestic purposes and for a few public water-supply systems.

Arctic Subregion

The streams in the Arctic Subregion flow northward from the Brooks Range into the Arctic Ocean. The Colville River—the subregion's largest—flows eastward for 200 miles before turning north; its basin comprises 29 percent of the subregion. Teshekpuk Lake has a surface area of 315 mi²; two other lakes are larger than 10 mi². Because of the underlying permafrost, more than half of the flat, western parts of the coastal plain are covered by shallow lakes. Water is used mainly for domestic purposes and for petroleum

development and production. The rivers, except for a few that are fed by springs, have no-flow periods during the winter. The larger deep lakes are a more dependable water-supply source. If water is withdrawn during the winter from shallow lakes or from rivers, the "overwintering" habitat of fish can be impaired or destroyed.

SURFACE-WATER MANAGEMENT

The "Alaska Water Use Act" (Alaska Statutes 46.15.010-270, enacted in 1966 and amended in 1980) defines the doctrine of prior appropriation authorized by the State Constitution, and it delegates administration of the act to the Alaska Department of Natural Resources (ADNR). The act states "Wherever occurring in a natural state, the waters are reserved to the people for common use and are subject to appropriation and beneficial use and to reservation of instream flows and levels of water. . . ." (Alaska Department of Natural Resources, 1985, p. 39). The regulations provide for certifying water rights for users prior to 1966 and for obtaining rights to appropriate surface and subsurface waters thereafter. ("Appropriate" means to divert, impound, or withdraw water or to reserve water for instream uses, including fisheries, navigation, recreation, and water-quality purposes (Alaska Department of Natural Resources, 1985, p. 48).) Dam safety is also covered in the act.

The Alaska Department of Environmental Conservation enforces Alaska's Water Quality Standards established in Title 18, Chapter 70 of Alaska Administrative Code. The standards identify limits to allowable pollution (Alaska Department of Environmental Conservation, 1979). The Alaska Department of Fish and Game, Alaska Statutes 16.05.840 and 16.05.870, has permit jurisdiction over activities that could affect fish (Alaska Department of Fish and Game, 1984).

Alaska has 25 rivers in the National Wild and Scenic Rivers System; 12 other rivers are being studied for possible inclusion. The designated rivers are administered by the following U.S. Department of the Interior agencies: National Park Service, Fish and Wildlife Service, and Bureau of Land Management. These agencies and the other Federal land-management agencies in Alaska—the Forest Service (Department of Agriculture) and the Department of Defense—also have water-related responsibilities. The U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Environmental Protection Agency have review and permitting responsibilities for specific activities on navigable rivers, wetlands, anadromous fish streams, and other water bodies.

The Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (DGGS), is the designated State agency responsible for water-data collection. Most long-term surface-water data are collected and interpreted by the U.S. Geological Survey in cooperation with other Federal, State, and municipal agencies. Short-term, special-purpose data are collected by the U.S. Geological Survey, DGGS, and other agencies. The DGGS, in cooperation with the U.S. Geological Survey and other State and Federal agencies, has developed and implemented an Alaskan Water Resources Evaluation (AWARE) Plan to coordinate water-data collection and water-resource studies in the State (U.S. Geological Survey and Alaska Department of Natural Resources, 1985).

Table 2. Selected streamflow characteristics of principal river basins in Alaska

(Gaging station: Period of analysis is for the water years used to compute average discharge and may differ from that used to compute other streamflow characteristics. Streamflow characteristics: The 7 day, 10 year low flow is a discharge statistic; the lowest mean discharge during 7 consecutive days of a year will be equal to or less than this value, on the average, once every 10 years. The average discharge is the arithmetic average of annual average discharges during the period of analysis. The 100 year flood is that flow that has a 1-percent chance of being equalled or exceeded in a given year. Abbreviations: Do = ditto, mi² = square miles, ft³/s = cubic feet per second. Sources: Reports of the U.S. Geological Survey.)

Site no. (see fig. 2)	Gaging station			Streamflow characteristics				Remarks
	Name and USGS no.	Drainage area (mi ²)	Period of analysis	7 day, 10 year low flow (ft ³ /s)	Average discharge (ft ³ /s)	100 year flood (ft ³ /s)	Degree of regulation	
ALASKA REGION								
SOUTHEAST ALASKA SUBREGION								
1.	Stikine River near Wrangell (15024800)	19,920	1976-83	14,500	56,674	299,600	Moderate	Flow crosses international boundary. Major tributary is regulated.
2.	Fish Creek near Ketchikan (15072000)	32.1	1915-36 1938-83	31	421	5,420	None	Longest record in Alaska. Representative island stream.
SOUTH-CENTRAL ALASKA SUBREGION								
3.	Copper River near Chitna (15212000)	20,600	1955-83	3,040	37,670	321,000	None	Large stream draining part of Alaska Range.
4.	Susitna River at Gold Creek (15292000)	6,160	1949-83	723	9,724	115,000	do	Drainage basin in Alaska Range. Proposed hydropower development. Long-term record.
5.	Susitna River at Susitna Station (15294350)	19,400	1974-83	5,000	49,940	230,000	do	Large stream draining part of Alaska Range.
SOUTHWEST ALASKA SUBREGION								
6.	Kychak River at Igroog (15300500)	6,500	1967-83	7,380	18,060	65,500	None	Ikamna Lake and other smaller lakes total 1,100 mi ² .
7.	Nuyakuk River near Dillingham (15302000)	1,490	1953-83	1,100	6,156	36,200	do	Representative long-term record.
8.	Nushagak River at Ekwick (15302500)	9,850	1977-83	6,000	23,840	89,200	do	Large stream. Headwaters of main tributary drain Aleutian Range.
9.	Kuskokwim River at Crooked Creek (15304000)	31,100	1951-83	7,650	41,220	445,000	do	Large stream draining part of Alaska Range.
YUKON SUBREGION								
10.	Yukon River at Eagle (15356000)	113,500	1911-13, 1950-83	10,500	82,660	605,000	Negligible	Flow crosses international boundary.
11.	Porcupine River near Fort Yukon (15389000)	29,500	1964-79	16	14,230	476,000	None	Headwaters in Canada.
12.	Chena River at Fairbanks (15514000)	1,980	1948-83	150	1,384	38,800	Moderate	Some flood control by Moose Creek Dam since 1981.
13.	Tanana River at Nenana (15515500)	25,600	1962-83	4,740	23,550	153,000	Negligible	Large river draining part of Alaska Range.
14.	Koyukuk River at Hughes (15564900)	18,700	1960-82	267	14,540	332,000	None	Large river draining part of Brooks Range.
15.	Yukon River at Pilot Station (15565447)	321,000	1975-83	37,000	218,600	751,000	Negligible	Gaged at head of distributary delta. Largest river in Alaska.
NORTHWEST ALASKA SUBREGION								
16.	Kobuk River near Kiama (15744500)	9,520	1976-83	1,300	15,270	152,000	None	Large river.
ARCTIC SUBREGION								
17.	Kuparuk River near Deadhorse (15896000)	3,130	1971-83	No flow	1,367	218,000	do	Longest record in subregion. Representative stream.

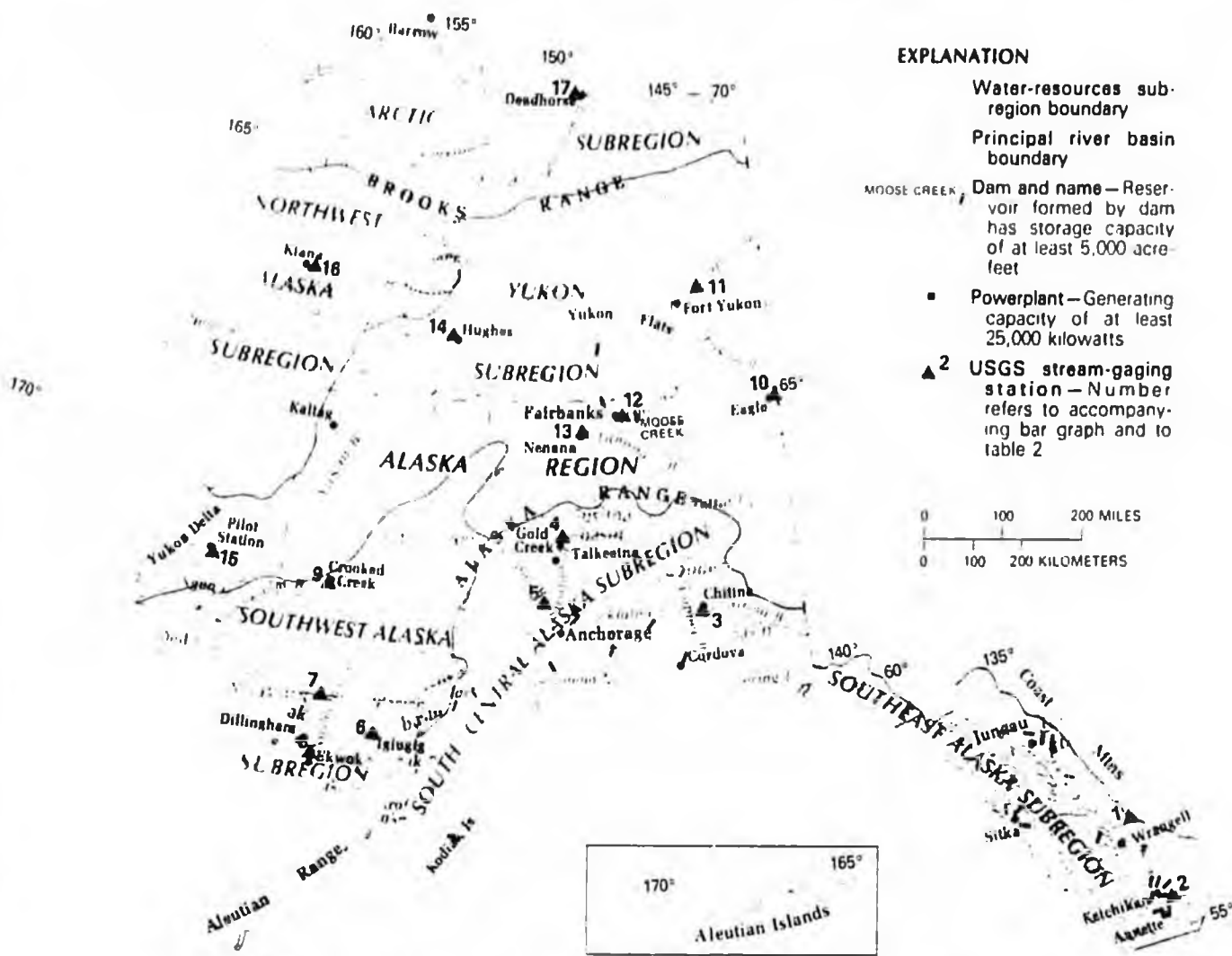
¹Less than 10 years of record. Minimum discharge and maximum instantaneous discharge for period of record are shown.

²Record interrupted.

³Adjusted for no flow periods.

⁴Adjusted for high outlier in period of record. Did not use 1981 peak because it was regulated.

⁵Adjusted for high outlier in period of record.



EXPLANATION

Water-resources sub-region boundary

Principal river basin boundary

Dam and name — Reservoir formed by dam has storage capacity of at least 5,000 acre-feet

Powerplant — Generating capacity of at least 25,000 kilowatts

USGS stream-gaging station — Number refers to accompanying bar graph and to table 2

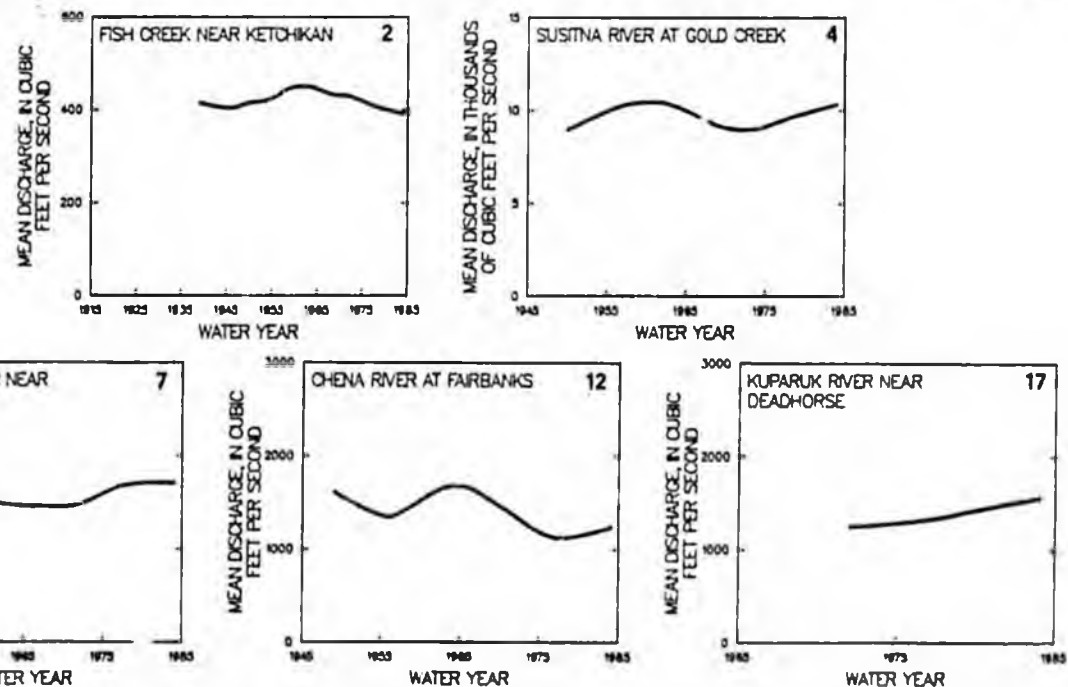


Figure 2. Principal river basins and related surface-water resources development in Alaska and average discharges for selected sites.

Bar graphs show average discharge by water year at selected stream-gaging sites, the curve is a 15 year weighted moving average of the annual values. Sources: Water-resources regions and subregions modified from Seaber and others, 1964; surface-water-resources development from Alaska Department of Natural Resources 1983, and from Hitt, 1985; discharge data from U.S. Geological Survey files.

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U.S. GEOLOGICAL SURVEY - ALASKA

Perspective

The U.S. Geological Survey (USGS) is a natural resources assessment Bureau of the Department of the Interior and is the Nation's largest earth-science resource agency. It is a non-regulatory, non management agency whose mission is:

"to provide hydrologic, geologic, and topographic information that contributes to the wise management of the Nation's natural resources and that promotes the safety and well-being of the public".

The USGS was created in 1879, and water-resources investigations have been a part of it's program since inception. The general objective of the Water Resources Division, USGS, is to provide the hydrologic information and understanding needed for optimum utilization and management of the Nation's water resources. This is accomplished through data collection, interpretive appraisals, basic and applied research in hydraulics and hydrology, and providing scientific and technical assistance to other agencies.

The Water Resources Division of the USGS accomplishes these missions through cooperatively funded programs (50-50) with State and local agencies, full funding by other Federal Agencies, and some direct appropriations. Our goal at the District (state) level is to maintain communication and cooperation with the principal state water agencies so that the state is properly represented in the national context. The desired result is a broad, progressive, and flexible cooperative water-resources program in Alaska that meets both state and national needs.

The Water Resources Division program in Alaska consists of hydrologic monitoring activities and in-depth scientific investigations of hydrology.

Hydrologic Monitoring for Alaska

Collection of stream flow data by the Geological Survey in the Territory of Alaska began during the summer of 1906 in connection with placer mining for gold near Nome on the Seward Peninsula. Data collection expanded in 1907 on the Seward Peninsula and into the Yukon and Tanana River basins. In 1913, efforts shifted to a general reconnaissance of the water-power potential of many sites in the lower Copper River basin and in southeast Alaska. In 1921, data collection in Alaska by the U.S. Geological Survey halted but was restarted in 1946. By 1950, there were 47 active stream-gaging stations operated by the U.S. Geological Survey. A bar graph showing a history of the number of continuous-recording stream gages operated in Alaska since 1946 is attached.

Streamflow data have been collected continuously by the U.S. Geological Survey at about 230 sites for 5 or more years and about 160 sites for 10 or more years. Most of these records have been collected in Southeast Alaska, developed areas of South Central Alaska, and within the Tanana River basin. In the "lower 48" the density of stream-gaging stations is about 1 gage per 400 square miles. By comparison, Alaska contains more than 40 percent of the nation's surface-water resources, however the density of stream-gaging stations is only about 1 gage per 6,000 square miles.

The maximum number of stream-gaging stations operated during one water year was 130 stations in 1972. During the 1989 water year, we collected data from 85 stream-gaging stations, which is about 35 percent fewer stations.

* — One of the principal reasons for this reduction in stream-gaging activity, especially during the 1980's has been the reduction of cooperative funding from State, local and other agencies who experienced budget cuts in their programs. (See attached figure and table showing funding sources for the current stream gaging program).

Data for about 2,560 surface-water sites, including data for 96 Canadian stations, are stored in the USGS National Water Information System (NWIS) data base for Alaska. Among these surface-water sites are about 1,880 streams, 630 lakes, 33 meteorological sites and 11 estuaries.

Information for about 17,000 ground-water sites is stored in the data base. The aerial distribution of the data is about 6,400 sites in the Municipality of Anchorage, 2,610 sites in the Kenai Peninsula Borough and 1,630 sites in the Fairbanks North Star Borough. The remaining sites are in towns, villages and remote areas scattered across the State. Some of the earliest ground-water data were collected in 1903 from wells near Cordova. The deepest well in Alaska contained in our data base was drilled by SOCAL in 1962 to a depth of 16,428 feet in the Beluga gas field, on the west side of Cook Inlet. Logs of most wells drilled in Alaska, however, have not been entered into the data base.

In our water-quality data base, we have water-quality information at about 4,130 sites in Alaska. Surface-water sites comprise about 1,550 of these sites and ground-water about 2,100 of these sites. The majority of the remaining sites are lakes and estuaries.

Hydrologic Investigations for Alaska

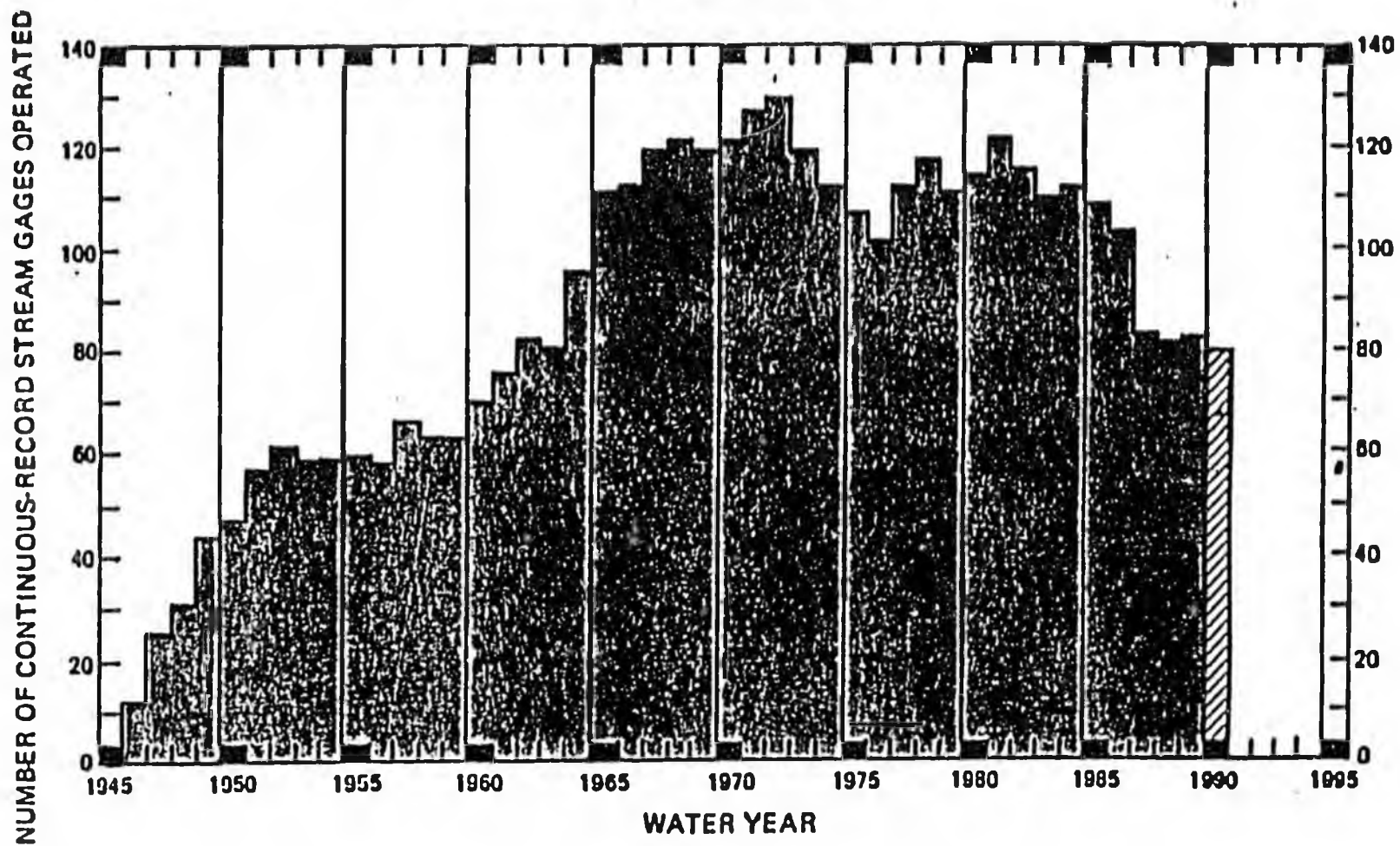
The Geological Survey conducted the first water-resources assessments in Alaska shortly after the gold miners arrived near the turn of the century. Prior to Alaska Statehood, these studies were federally funded and were conducted in response to Federal information needs. By the 1960's, however, the Geological Survey's "Cooperative Program", in which State or local government agencies paid half of the costs, became a principal component of the water-resources studies in the State. Initially, the State lacked revenues to support a significant long-term program and much of the Survey's efforts were in cooperation with the Boroughs, notably the Greater Anchorage Area Borough. Almost from the beginning of the Cooperative Program, however, a study with the Alaska Department of Transportation has maintained a network of gages on small streams. It is this network that provides the flood data required to evaluate flood risks and calibrate equations for estimating regional flood hazards.

When State revenues increased dramatically following completion of the Alyeska Pipeline, the Alaska Division of Geological and Geophysical Surveys (DGGs) assumed responsibility for investigations previously conducted by other State agencies and became a major cooperator of the Geological Survey. The USGS and DGGs formalized this large program of hydrologic studies during the early 1980's as the AWARE Program (an acronym for Alaska Water Resources Evaluation). The AWARE Program has been the only long-range planning document for hydrologic studies in Alaska. Unfortunately, its utility has been severely limited by lack of funding to implement long-term plans. Most hydrologic studies in Alaska are therefore in response to short-term information needs.

The Geological Survey, in cooperation with many Federal, State, and local agencies, has published more than 200 reports on the hydrology of Alaska and maintains the largest data base of water-resources information in the State. Much of that data base would not exist without the support of State and local agencies. In particular, the long-term support of DGGs is largely responsible for the quality of Alaska's ground water data base, which is among the best in the Nation.

Although there are now many agencies and firms conducting hydrologic studies in Alaska, the background information cited in virtually every water-resources report in the State includes the pioneering work by the U.S. Geological Survey. In addition, the Geological Survey is the only agency that maintains a long-term commitment to maintenance of a water-resources data base that is accessible to all users.

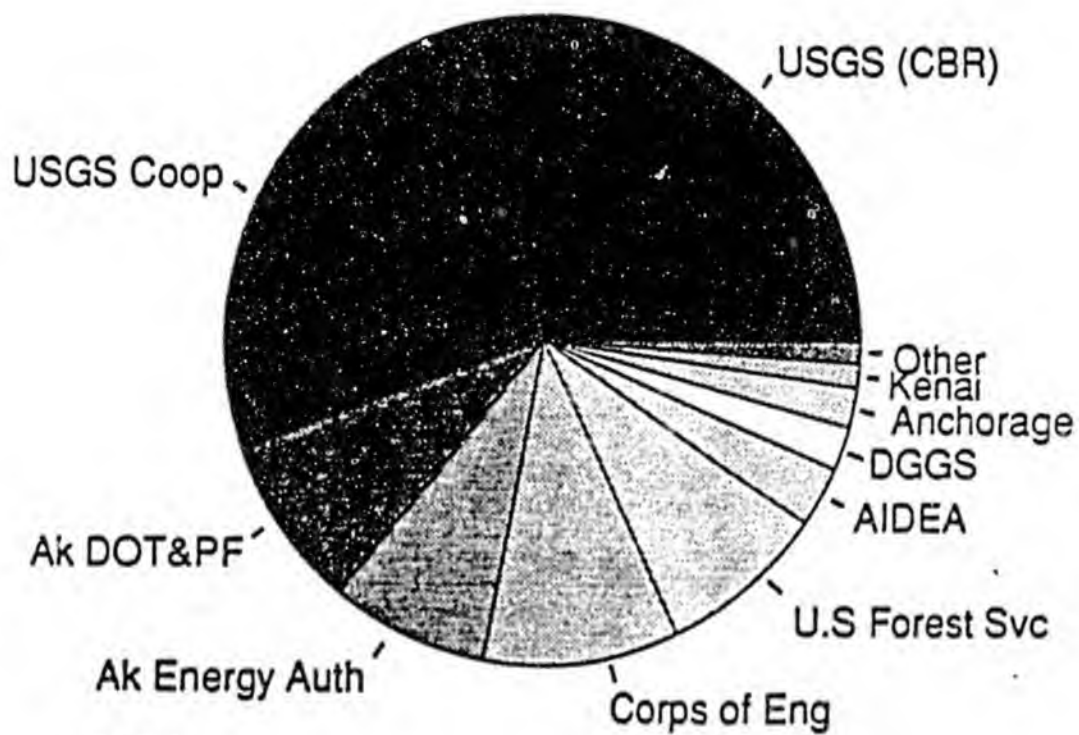
U.S. GEOLOGICAL SURVEY
ALASKA DISTRICT



U.S. GEOLOGICAL SURVEY

Stream gaging program

\$ 2,187,800



**FY90 or Projected FY91 Program Costs
Surface Water Stream Gaging Sites**

<u>Cooperator</u>	No. of Gaging Stations	<u>CGS</u>	<u>Funding</u>			<u>Total</u>
			<u>Coop</u>	<u>USGS</u>	<u>OFA</u>	
CAR (1)	28	--	--	\$657,500	--	\$657,500
DOT	--	70	\$200,000	\$200,000	--	\$400,000
AEA (1)(2)	9	--	\$183,000	\$ 91,980	--	\$274,980
Corps	15	6	--	\$ 61,000	\$171,000	\$232,000
Forest Service (1)	12	--	--	--	\$194,700	\$194,700
DGGS	7	--	\$ 48,700	\$ 48,700	--	\$ 97,400
AIDEA (1)(2)	2	--	\$ 69,300	\$ 20,800	--	\$ 90,100
Anchorage (1)	6	--	\$ 45,000	\$ 45,000	--	\$ 90,000
Kenai	3	2	\$ 27,800	\$ 27,800	--	\$ 55,600
Other	2	--	\$ 25,100	\$ 25,100	--	\$ 50,200
Juneau (1)	2	--	\$ 18,700	\$ 18,700	--	\$ 37,400
Sitka	1	--	\$ 4,000	\$ 4,000	--	\$ 8,000
	81					
	Subtotals		\$621,600	\$1,200,580	\$ 365,700	
					TOTAL	\$2,187,880

(1) Includes water-quality work
(2) Includes construction costs

Stream Gaging for Alaska

Advantages of the U.S. Geological Survey Program

- o The U.S. Geological Survey (USGS) has developed, published and uses standard methods for collection, analysis and dissemination of data and information. These standards have been accepted and recognized by the National and International hydrologic communities and ensure the compatibility of widely used analytical techniques.
- o The USGS has developed and used a nationwide quality control and quality assurance program to quantify the accuracy of data collected, stored, and published.
- o The USGS, a non-regulatory and non-management agency, has a strong reputation for the collection of unbiased data. This data has historically stood up in court after close technical scrutiny.
- o Data collected by the USGS in Alaska are published for use by all parties including other Federal agencies, State agencies, local Boroughs, cities, private Alaskan business, and the general public.
- o Data collected by the USGS are stored in a local and a national computer data base. These data bases allow easy access to all current and historic USGS data.
- o The data base allows timely retrieval of data. Existing software allows for efficient tabling, graphics, data reduction and statistical evaluation of Alaskan data.
- o No other comprehensive data base exists in Alaska that allows easy access by not only all Alaskans but all interested parties nation-wide. The USGS data are also available commercially on CD-ROM (laser disks) for ease of use in desk-top applications.
- o The USGS data base will be maintained indefinitely.
- o The USGS cooperative program provides up to 50% of the costs in joint water-resource programs with State and local government agencies in Alaska.
- o The USGS has a local staff of trained hydrologists and hydrologic technicians familiar with all aspects of hydrology in Alaska.
- o The USGS has local field offices in Anchorage, Juneau and Fairbanks. Locating field offices in three different areas of the state allows our staff to be aware of local hydrology and associated local problems and needs.
- o The USGS has a nationally recognized training program that insures our personnel use the best techniques available to collect water-resource data. This training program is available to cooperators.
- o The USGS has the necessary equipment to collect all types of water-resource data.

- o The USGS has an ongoing program of research and development of new methods and new instrumentation in the field of hydrology.
- o The USGS in Alaska has access to a highly skilled research staff and leading experts in the field of hydrology nationwide capable of addressing the most difficult hydrologic problems. This pool of expertise is unparalleled worldwide.
- o The USGS actively seeks out local governmental agencies to share resources and knowledge and cooperate with on water-resource data collection and water-resource studies.
- o The USGS collects data from all areas of Alaska.
- o The USGS works jointly with Canada to share data and information concerning water-resources common to both countries.
- o The USGS works cooperatively with local universities to provide expertise when needed and learn from new ideas generated by the universities.
- o The USGS hires local university students in our "Student Coop Program" to help train future Alaskan scientists and inject new ideas in our day-to-day programs.
- o The USGS hires local high school students to aid career development and job skills.
- o The USGS collects data in the most cost effective manner consistent with the quality assurance guidelines.
- o USGS programs and presence in Alaska feed monies directly into the Alaskan business community.
- o USGS data are often the first stepping stone in detailed studies of hydrology.

- A review of the State institutional and administrative plans to address priority State water-resources issues.
- A review of the technical, financial, and logistical capabilities of the USGS to enter into cooperative programs with the State and/or local agencies in order to assist them in their water-resources regulatory and management efforts. This would include a review of USGS goals and objectives for water-resources investigations in the State, of USGS technical qualifications, personnel, and of anticipated timely response.
- A discussion of problems or barriers to future cooperative program development.
- A discussion of multi-agency funded cooperative programs; for example one quarter funding by a local agency, one quarter by the State, and one half by the USGS.
- A discussion on how to maximize the use of technical personnel, data bases and software, and physical facilities of both agencies in support of the cooperative program.

Products of the meeting should include:

- A prioritized listing of short- and long-term cooperative program objectives.
- A joint statement by both agencies describing their intentions relative to the extent and program content of the cooperative program, both for the upcoming fiscal year and beyond.
- A joint statement by both agencies describing their intent and giving direction to maximize the use of personnel, software, and facilities of each agency in support of the cooperative program.

Development of projects within the cooperative program should be the responsibility of the State program managers, operation managers, and the USGS Assistant Chiefs. They should meet periodically to discuss mutual water resources concerns, to develop cooperative project proposals, and to implement the general directive of their respective supervisors and higher headquarters. Project chiefs and other technical personnel of both agencies should be encouraged to meet periodically to exchange water resources information and data, and to propose new projects in support of the objectives of the cooperative program.

APPENDIX

Observations on Streamflow Information for Alaska

Water resources planners, managers, and regulators rely on several types of water data all of which has associated errors (or accuracy). The most basis data is stream stage and discharge; a higher level of information would be that taken from a regression analysis.

- Discharge Measurements. A discharge measurement consists of a water surface elevation and a flow measurement at a single point on a stream and at a single time. The accuracy of the water surface elevation depends on the stability of the sensor and the ability of the hydrographer to read. The USGS anchors the sensor such that it is stable at all stages and pipes the water to a stilling well for ease of reading. If a stilling well is not used the stage is transmitted to a recorder in a shelter on the bank. The accuracy of a discharge measurement depends on the equipment and procedures used by the hydrographer; we use equipment and methods prescribed by the Bureau of Standards. Discharge measurements made by the USGS are accurate to the 95% level unless otherwise noted. One cannot compute stream flow statistics at a site from a discharge measurements(s) alone; such statistics may be computed from correlations with sites having continuous record with the error of estimate dependent on the correlation coefficient.
- Continuous record of discharge. A continuous record of discharge at a point on a stream is developed from a rating of discharge measurements plotted against the water surface elevation at the time of the measurement. Daily discharges are computed from a continuous record of stage and the rating adjusted for shifts in the channel conditions. Accuracy of the computed daily discharges depends on the accuracy and number of discharge measurements, the field observation of channel conditions by the hydrographer, and the ability and experience of the person performing the analysis. The USGS makes 6-8 measurements per year (including ice periods) and all data analyses are performed or checked by senior engineers. An accuracy statement is estimated for each record (such as 95% accurate 95% of the time) and all daily discharges are entered and stored in a National Data Base. Streamflow statistics can be computed from a continuous record of discharge with the accuracy increasing with the number of years of record. For instance the mean annual discharge at a gaging station in Alaska can be computed from 10 years of record with an error of estimate of 20%; 10 years or more of record are required for computation of other statistics with larger errors of estimate - figure 1. (Note this is site data only.) Figures 2 and 3 show the year to year variability at two Alaska gaging stations and the error possible using 5 years of data.
- Discharge information from correlation techniques. As noted above discharge measurements made at a site can be correlated with concurrent daily discharges at a continuous gaging station. The accuracy of the correlation depends on the number of observations and the similarity of basin, climatic, and channel parameters, as well as, the accuracy of the discharge measurements and computed daily discharges. Correlations on the same stream often work well, whereas, correlations between streams do not. If the correlation coefficient is .8 or greater it is possible to estimate streamflow statistics from the relationship. In Alaska, such correlations should be limited to within at least 6 similar physiographic provinces. (Note this is site data only)

- Discharge information from multiple regression techniques. Records of continuous discharge at several or many gaging stations can be combined using multiple regression techniques. Streamflow statistics at continuous gaging stations are regressed against basin, climatic, and channel parameters. An error of estimate is computed by comparing the station data to that obtained from the regression; the station error is included. In, Alaska, the error associated with computation of the mean annual discharge in 6 physiographic provinces ranges from 20 to 35%; the error for other statistics is greater, with those for flood and low flows being much greater. The value of this technique is that discharge information for any point on any stream can be estimated. This technique can be misused, however, when it is extended to areas or drainage area sizes outside of those used in the investigation.

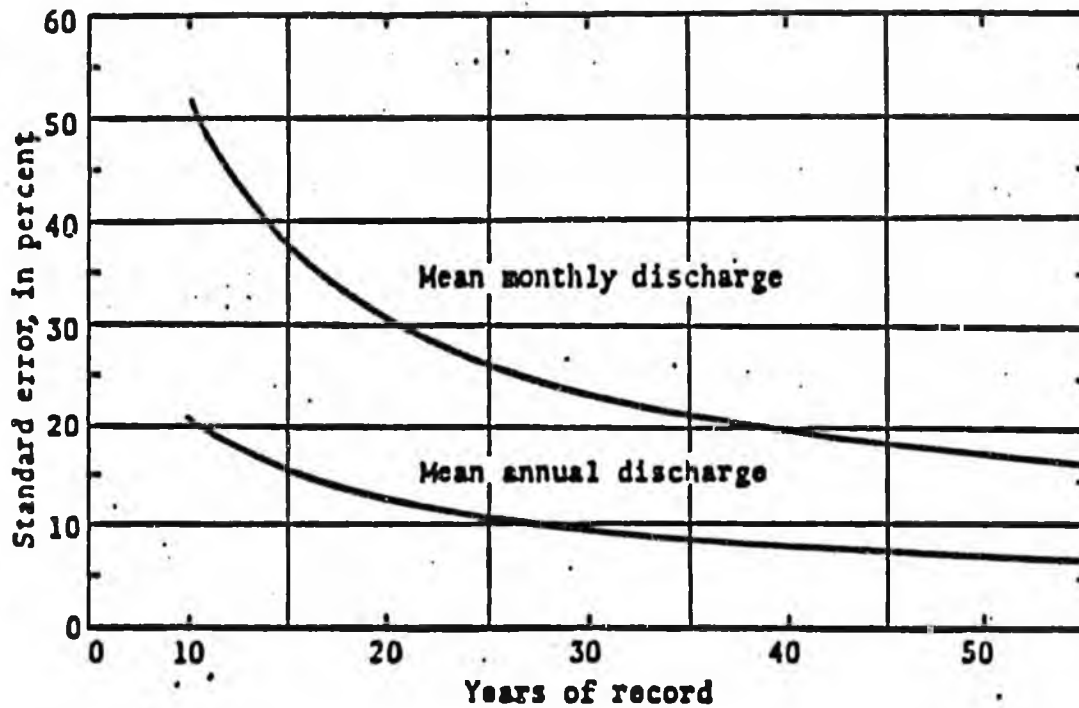
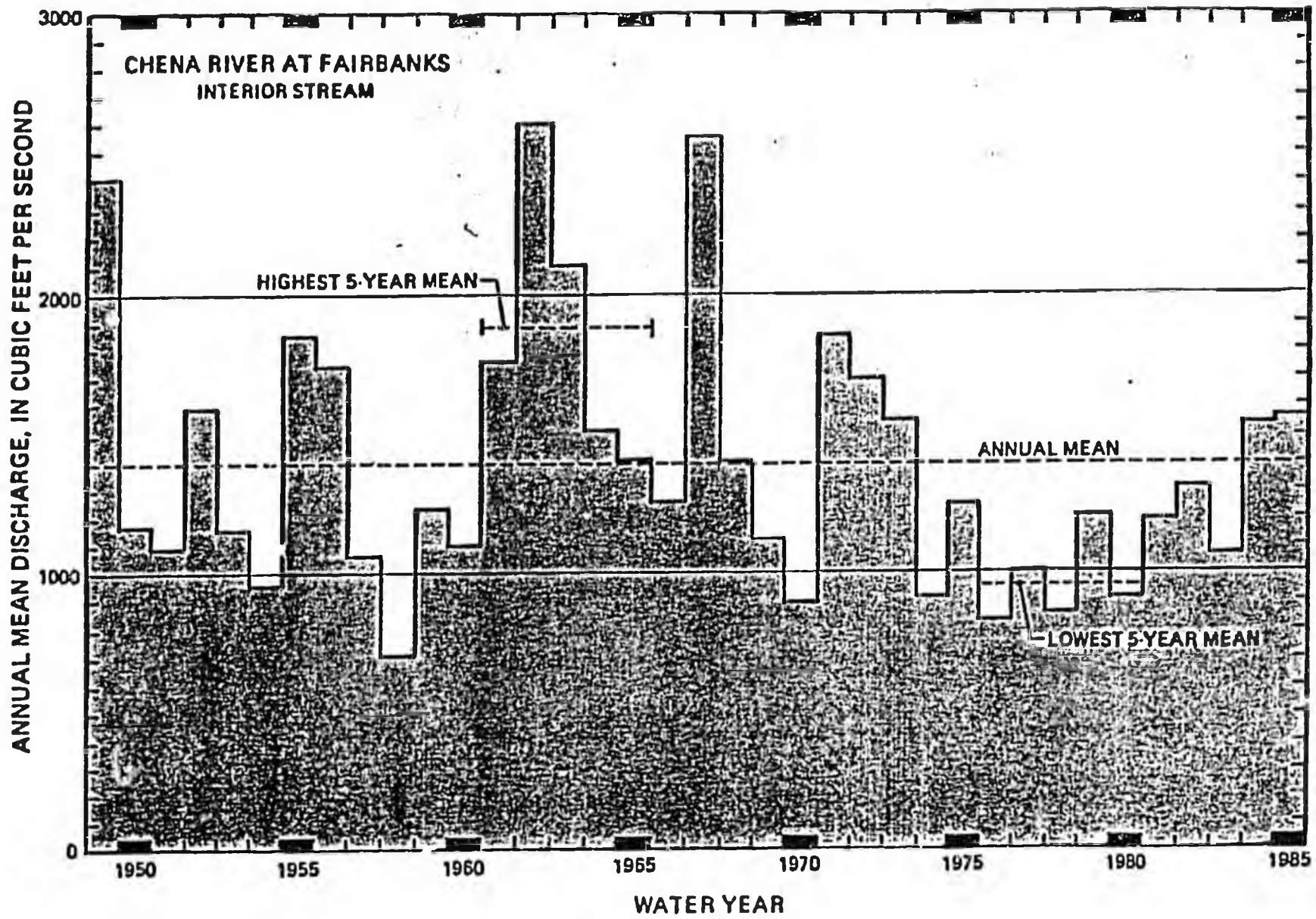
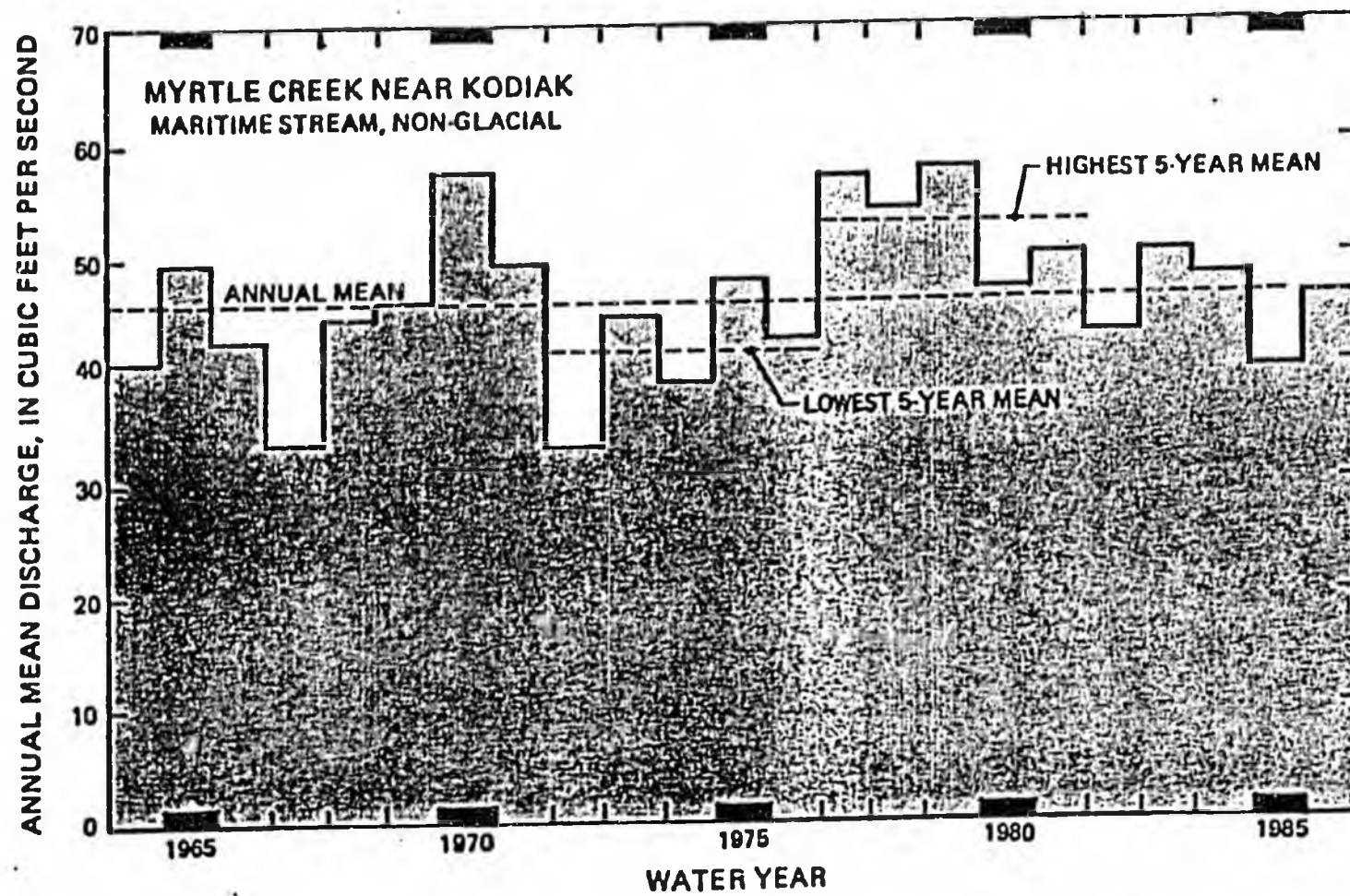


Figure 1.--Curve showing relation of standard error to length of record.

SE Ak (Maritime)





Suggested USGS-State of Alaska Cooperative Program Process

The Alaska District, USGS, desires to coordinate its activities with a State agency principally responsible for identifying the States water resources priorities. We look to that agency for guidance in program development and coordination of studies with other State and local agencies. Additionally, that agency could provide a stable funding base to the cooperative program in Alaska. From the State's perspective, a strong cooperative program insures that study results will be used by all management and regulatory agencies. Acceptance of our cooperative program at the Survey's Regional and National headquarters level depends on the State's success in this area.

Following are some of the advantages of the cooperative program to the State of Alaska as viewed by the Geological Survey;

- Water resources investigations are conducted by an unbiased agency which has no management or regulatory function. The results of these investigations can be used by the State with confidence that they will stand up to close technical scrutiny by all users and the Courts without the apparent conflict of interest suggested if the State were to do the same investigations.
- The cost of water resources investigations for the State can be shared equally by the Geological Survey. This enables the State to obtain the benefits of a large staff without incurring a comparable large cost.
- The water resources investigations will be conducted by the Geological Survey with minimum personnel commitments by the State. This will free the State for technical and administrative oversight of the investigations and for other Agency work.
- State personnel have the opportunity to work first hand with Geological Survey in project proposal formulation and conduct.
- State personnel are offered the opportunity for technical training at the Survey's training center in Denver, at its Regional office in Menio Park, California, and in the District offices in Anchorage. Several have participated in this training.

We believe that for the cooperative program to meet its objectives in the State of Alaska, strong leadership by the State and USGS is required. General program direction should be provided at least yearly through a formal meeting between the Commissioner, Department of Natural Resources and/or State Geologist (or equivalent) and the District Chief, USGS. The meeting should be focused on general program direction, not specific projects. Topics to be covered would include:

- A discussion of the short- and long-term water-resources issues of the State as viewed by both agencies.
- A review of the National priority programs of the USGS to determine their short-term relevance to the State water-resources issues and to provide the the USGS with information for the setting of long-term future programs.

- o The USGS has an ongoing program of research and development of new methods and new instrumentation in the field of hydrology.
- o The USGS in Alaska has access to a highly skilled research staff and leading experts in the field of hydrology nationwide capable of addressing the most difficult hydrologic problems. This pool of expertise is unparalleled worldwide.
- o The USGS actively seeks out local governmental agencies to share resources and knowledge and cooperate with on water-resource data collection and water-resource studies.
- o The USGS collects data from all areas of Alaska.
- o The USGS works jointly with Canada to share data and information concerning water-resources common to both countries.
- o The USGS works cooperatively with local universities to provide expertise when needed and learn from new ideas generated by the universities.
- o The USGS hires local university students in our "Student Coop Program" to help train future Alaskan scientists and inject new ideas in our day-to-day programs.
- o The USGS hires local high school students to aid career development and job skills.
- o The USGS collects data in the most cost effective manner consistent with the quality assurance guidelines.
- o USGS programs and presence in Alaska feed monies directly into the Alaskan business community.
- o USGS data are often the first stepping stone in detailed studies of hydrology.

Alaska's Constitution A Citizen's Guide

GORDON S. HARRISON

Agreed upon by the delegates in Constitutional Convention assembled at the University of Alaska, this fifth day of February, in the year of our Lord one thousand nine hundred and fifty six, and of the Independence of the United States the one hundred and eighth.

Wm A. Spurr
Governor of the State

Richard B. Bunting, Douglas H. Gray, Alan W. Anderson
Herbert J. Ames, Glenn C. Hume, George W. Anderson, Victor C. Russell
Frank B. Bess, John W. Anderson, [unclear], John H. [unclear]
John C. Brannell, [unclear], John G. [unclear], [unclear]
Richard B. Bunting, [unclear], [unclear], [unclear]
John C. Brannell, [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]
[unclear], [unclear], [unclear], [unclear]

Shirley K. Stewart
Secretary of the Convention

ARTICLE I
NATURAL RIGHTS OF ALASKANS
SECTION 1 The Constitution for the State of Alaska agreed upon by the delegates in the Alaska Constitutional Convention on February 5, 1956, shall be submitted to the voters of Alaska for ratification or rejection at the general election called to be held on April 24, 1959. The election shall be conducted according to voting laws regarding primary elections in force at that time.

SECTION 2 Each citizen who votes in this year's election shall be given a ballot by the state and judges which shall be prepared from the ballot or ballots available in the primary election on that date and the propositions offered by the state. The appropriate propositions shall be set forth on the ballot in the order in which they shall be voted on.
 That the Constitution for the State of Alaska proposed and agreed upon by the Alaska Constitutional Convention be adopted.

Article VIII **AK Water Use Act + AK Constitution**

Section 13. Water Rights

All surface and subsurface waters reserved to the people for common use, except mineral and medicinal waters, are subject to appropriation. Priority of appropriation shall give prior right. Except for public water supply, an appropriation of water shall be limited to stated purposes and subject to preferences among beneficial uses, concurrent or otherwise, as prescribed by law, and to the general reservation of fish and wildlife.

This section continues the traditional right to use water on a "first-come-first-served" basis. This method differs from an early method of acquiring water rights used historically on the East Coast known as the "riparian method," it allocated water rights to owners of the stream bank. In Alaska and the other western states, however, water rights were traditionally acquired by actual use of the water. Under this constitutional provision, which is further developed in state statute and regulation, a prior user of water has preference to it, but his rights may be withdrawn or limited as necessary to protect public interests.

Section 14. Access to Navigable Waters

Free access to the navigable or public waters of the State, as defined by the legislature, shall not be denied any citizen of the United States or resident of the State, except that the legislature may by general law regulate and limit such access for other beneficial uses or public purposes.

Citizens have the right to use publicly owned lakes and streams. The state may not deny this use except by a general law that protects a public interest. For example, the state may keep people away from a lake that supplies drinking water to a town, or build a dam on a river, but it may not prevent the public from fishing in a public lake because it wants to protect the interest of nearby private fishing lodges. Disposals of state owned land along navigable waters must reserve a public access easement.

Section 15. No Exclusive Right of Fishery

No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State.

The second sentence of this section was added in 1972 by amendment. In the mid 1960s, Alaska's major salmon fisheries were in bad shape: too few fish, too many fishermen, and low prices.

Alaska Statutes

Title 46. Water, Air, Energy, and Environmental Conservation.

Chapter 15. Water Use Act.

Article

1. Administration (§§ 46.15.010 - 46.15.020)
2. Appropriation and Use of Water (§§ 46.15.030 - 46.15.105)
3. Water Resources Board (§§ 46.15.190 - 46.15.240)
4. General Provisions (§§ 46.15.250 - 46.15.270)

Article 1. Administration.

Section

10. Determination of water rights
20. Authority and duties of the commissioner

Sec. 46.15.010. Determination of water rights. The Department of Natural Resources shall determine and adjudicate rights in the waters of the state, and in its appropriation and distribution. (§ 1 ch 50 SLA 1966)

Sec. 46.15.020. Authority and duties of the commissioner. (a) The commissioner shall exercise all those powers and do all those acts necessary to carry out the provisions and objectives of this chapter. The commissioner may

(1) enter into contractual agreements necessary to carry out the provisions of this chapter including agreements with federal, state and local agencies;

(2) apply for, accept, administer and expand grants, gifts, and loans from the federal government and any other public or private sources for the purpose of this chapter, and adopt procedures and do acts not otherwise restricted by law which are necessary to qualify the state to receive grants, gifts and loans;

(3) establish a division of water in the Department of Natural Resources and assign to that division the responsibility for carrying out the provisions of this chapter.

(b) The Commissioner shall

(1) adopt procedural and substantive regulations to carry out the provisions of this chapter, taking into consideration the responsibilities of the Department of Environmental Conservation under AS 46.03 and the Department of Fish and Game under AS 16;

(2) Keep a public record of all applications for permits and certificates and other documents filed in his office, and shall record all permits and certificates and amendments and orders affecting them and shall index them in accordance with the source of the water and the name of the applicant or appropriator.

(3) cooperate with, assist, advise and coordinate plans with the federal, state and local agencies in matters relating to the appropriation, use, conservation, quality, disposal or control of waters and activities related thereto;

(4) prescribe fees or service charges for any public service rendered. (§ 1 ch 50 SLA 1966, am § 6 ch 104 SLA 1971, am § 50 ch 71 SLA 1972)

Legislative committee report. For report on ch. 71, SLA 1972 (H. 550, 380, am 11), see 1972 House Journal, p. 898.

Article 2. Appropriation and Use of Water.

Section

30. Waters reserved to the people
30. Right to appropriate
50. Priority
60. Existing rights
65. Determination of existing rights
70. [Renumbered]
80. Criteria for issuance of permit
90. Preference in granting permits

100. Terms of permit
110. Time for construction and completion
120. Certificates

Section

130. Priority
133. Notices, objections
135. [Renumbered]
140. Abandonment, forfeiture, and reversion of appropriations
145. Reservation of water
147. Termination of permits
150. Preferred use
160. Transfer and change of appropriations
170. Effect of recording
180. Crimes
185. Appeals

Sec. 46.15.030. Waters reserved to the people. Wherever occurring in a natural state, the waters are reserved to the people for common use and are subject to appropriation and beneficial use and to reservation of in-stream flows and levels of water, as provided in this chapter. (§ 1 ch 50 SLA 1966; am § 4 ch 84 SLA 1980)

Effect of amendment. — The 1980 amendment, effective June 19, 1980, inserted "and to reservation of in-stream flows and levels of water" near the end of the section.

Pursuant to the Alaska Statehood Act, the Submerged Lands Act of 1953 applies to Alaska. Alaska Pub. Easement Defense Fund v. Andrus, 435 F. Supp. 664 (D. Alas. 1977).

Ownership and control of land under navigable waters. — The court takes judicial notice of the fact that Alaska lies westward of the 98th meridian. Thus, under federal law ownership and control of the land under navigable waters is confined in the state. Alaska Pub. Easement Defense Fund v. Andrus, 435 F. Supp. 664 (D. Alas. 1977).

Ownership of ground and surface waters is to be determined according to state law. Under the Alaska Constitution and state law, the right to use such waterways is placed in the people of the state. Alaska Pub. Easement Defense Fund v. Andrus, 435 F. Supp. 664 (D. Alas. 1977).

Purpose of easement along courses of major waterways is to provide a place for docks, campsites, and such facilities to service those who are properly using the public waters. This purpose is apparently accommodated by the reservation of site easements under the order of the Secretary of the Interior. Alaska Pub. Easement Defense Fund v. Andrus, 435 F. Supp. 664 (D. Alas. 1977).

Sec. 46.15.040 Right to appropriate. (a) A right to appropriate water can be acquired only as provided in this chapter. No right to the use of water either appropriated or unappropriated shall be acquired by adverse use or possession.

(b) A right to appropriate water shall be obtained by first making application to the commissioner for a permit to appropriate. The commissioner shall by regulation prescribe the form and contents of the application and the procedure for filing the application. If a permit is granted and the means of appropriation is constructed a certificate of appropriation may be obtained.

(c) All applications to the commissioner for a permit to appropriate water, filed subsequent to July 1, 1966, shall be considered as having been simultaneously filed with the Department of Fish and Game under AS 16 and the Department of Environmental Conservation under AS 46.03. (§ 1 ch 50 SLA 1966; am § 6 ch 104 SLA 1971; am § 51 ch 71 SLA 1972)

Legislative committee report. — 1st report on ch 71, SLA 1972 (HC 55B 38) am 11, see 1972 House Journal, p 898.

Sec. 46.15.050. Priority. Priority of appropriation gives prior right. Priority of appropriation does not include the right to prevent changes in the condition of water occurrence, such as the increase or decrease of stream flow, or the lowering of a water table, artesian pressure, or water level, by later appropriators, if the prior appropriator can reasonably acquire his water under the changed conditions. (§ 1 ch 50 SLA 1966)

Sec. 46.15.060. Existing rights. A water right acquired by law before July 1, 1966 or a beneficial use of water on July 1, 1966, or made within five years before July 1, 1966, or made in conjunction with works under construction on July 1, 1966, under a lawful common law or customary appropriation or use, is a lawful appropriation under this chapter. The appropriation is subject to applicable provisions of this chapter and rules and regulations adopted under this chapter. (§ 1 ch 50 SLA 1966)

Sec. 46.15.065. Determination of existing rights. (a) A claimant of an existing right under AS 46.15.060 shall file a declaration of appropriation with the commissioner as set out in this section. The declaration shall be considered correct until a certificate of appropriation is issued or denied. Priority of such right dates from the day work was begun on the appropriation if due diligence was used in completing the work; otherwise, from the day water was applied for the beneficial use.

(b) The commissioner shall, as soon as practicable, determine the rights of persons owning existing appropriations. To accomplish this, the commissioner shall

(1) by order set a definite period for filing a declaration of appropriation within a specified area or from a specified source;

(2) publish notice of the order once a week for three weeks before the beginning of the period in a newspaper of general circulation in the affected area;

(3) give notice of the order by certified mail to any appropriator within the specified area or from the specified source who has requested mailed notice or of whom the commissioner can readily obtain knowledge including each owner of a recorded mining claim.

(c) The commissioner shall make such investigations as he considers necessary of rights asserted by declarations filed under this section and shall determine each existing appropriation and mail a summary of such determination to each person who has filed a declaration with respect to the specified area or source. Any person adversely affected by a determination may file with the commissioner a request for a hearing within 20 days of the date the notice is mailed. If a hearing is requested the commissioner shall send a notice of the time and place of the hearing to each person who has filed a declaration.

(d) If a hearing is not requested with respect to a determination, or if, after the hearing, the commissioner finds the determination to have been correctly made, he shall immediately issue a certificate of appropriation. If the commissioner finds the determination to be incorrect, he shall correct it and either issue a certificate of appropriation or refuse the certificate according to his findings.

(e) A person aggrieved by the action of the commissioner may appeal to the superior court within 30 days of the date on which that action is final. (§ 1 ch 50 SLA 1966)

Revised's note. — This section formerly appeared as AS 46.15.135. It was renumbered by the revision of statutes for their logical arrangement.

Sec. 46.15.070. Notices; objections [Renumbered].

Revised's note. — This section formerly appeared as AS 46.15.133. It was renumbered by the revision of statutes for their logical arrangement.

Sec. 46.15.080. Criteria for issuance of permit. (a) The commissioner shall issue a permit if he finds that

- (1) rights of a prior appropriator will not be unduly affected;
- (2) the proposed means of diversion or construction are adequate;
- (3) the proposed use of water is beneficial, and
- (4) the proposed appropriation is in the public interest

(b) In determining the public interest, the commissioner shall consider

(1) the benefit to the applicant resulting from the proposed appropriation;

- (2) the effect of the economic activity resulting from the proposed appropriation;
- (3) the effect on fish and game resources and on public recreational opportunities;
- (4) the effect on public health;
- (5) the effect of loss of alternate uses of water that might be made within a reasonable time if not precluded or hindered by the proposed appropriation;
- (6) harm to other persons resulting from the proposed appropriation;
- (7) the intent and ability of the applicant to complete the appropriation; and
- (8) the effect upon access to navigable or public waters. (§ 1 ch 50 SLA 1966)

Sec. 46.15.090. Preference in granting permits. When there are competing applications for water from the same source, and the source is insufficient to supply all applicants, the commissioner shall give preference first to public water supply and then to the use which alone or in combination with other foreseeable uses will constitute the most beneficial use. (§ 1 ch 50 SLA 1966)

Sec. 46.15.100. Terms of permit. The commissioner may issue a permit for less than the amount of water requested, but in no case may he issue a permit for more water than can be beneficially used for the purposes stated in the application. He may require modification of plans and specifications for the appropriation. He may issue a permit subject to terms, conditions, restrictions, and limitations he considers necessary to protect the rights of others, and the public interest. However, the permit shall be subject to termination only as provided in this chapter. (§ 1 ch 50 SLA 1966)

Sec. 46.15.110. Time for construction and completion. A permit may place a time limit for beginning construction and perfecting appropriation. Reasonable extensions of time shall be permitted for good cause shown. (§ 1 ch 50 SLA 1966)

Sec. 46.15.120. Certificates. Upon completion of construction of the works and commencement of use of water, the permit holder shall notify the commissioner that he has perfected his appropriation. If the commissioner determines that the appropriation has been perfected in substantial accordance with the permit, he shall issue the permit holder a certificate of appropriation. The certificate shall set out any condition which the commissioner may prescribe by regulation, including conditions that are necessary to protect the prior rights of other persons and the public interest. (§ 1 ch 50 SLA 1966; am § 9 ch 175 SLA 1980)

Sec. 46.15.130. Priority. (a) Priority of appropriation made under this chapter dates from the filing of an application with the commissioner.

(b) Priority of appropriation perfected before July 1, 1966, shall be determined as provided in § 135 of this chapter. (§ 1 ch 50 SLA 1966)

Sec. 46.15.133. Notices; objections. (a) Upon receipt of an application, the commissioner shall prepare a notice containing the location and extent of the proposed appropriation, the name and address of the applicant and other information he considers pertinent. The notice shall state that within 15 days of publication or service of notice, persons may file with the director written objections, stating the name and address of the objector, and any facts tending to show that rights of the objector or the public interest would be adversely affected by the proposed appropriation.

(b) The commissioner shall publish the notice at the applicant's expense in one issue of a newspaper of general distribution in the area of the state in which the water is to be appropriated. The commissioner shall also have notice served personally or by certified mail upon an appropriator of water or applicant for or holder of a permit who, according to the records of the division of lands, may be affected by the proposed appropriation and may serve notice upon any governmental agency, political subdivision or person, notice shall also be served upon the Department of Fish and Game and the Department of Environmental Conservation.

(c) Within 15 days of publication or service of notice, an interested person may file an objection. The commissioner may hold hearings upon giving due notice and shall grant, deny, or condition the application in whole or in part within 30 days of receipt of the last objection or, if the commissioner elects to hold hearings, within 180 days of receipt of the last objection. Notice of the order or decision shall be served personally or mailed to any person who has filed an objection.

(d) If no objection is filed, the commissioner may proceed to make his determination upon the application.

(e) A person aggrieved by the action of the commissioner or by the failure of the commissioner to grant, deny, or condition an application in accordance with (c) of this section may appeal to the superior court.

(f) The commissioner may, by regulation, designate types of appropriations which are exempt from this section and provide simplified procedures for ruling on the applications. (§ 1 ch 50 SLA 1966; am § 6 ch 104 SLA 1971; am § 52 ch 71 SLA 1972; am §§ 5, 6 ch 84 SLA 1980)

Revisor's note. — This section formerly appeared as AS 46.15.070. It was renumbered by the revisor of statutes for more logical arrangement.

Effect of amendment. — The 1980 amendment, effective June 19, 1980, substituted "if the commissioner elects to hold hearings,

within 180 days of receipt of the last objection" "at the conclusion of the hearing" at the end of the second sentence of subsection (c), and inserted "or by the failure of the commissioner to grant, deny, or condition an application in accordance with (c) of this section" near the middle of subsection (c).

Sec. 46.15.135. Determination of existing rights [Renumbered].

Revisor's note. — This section now appears as AS 46.15.065. It was renumbered by the revisor of statutes for more logical arrangement.

Sec. 46.15.140. Abandonment, forfeiture, and reversion of appropriations. (a) The commissioner may declare an appropriation to be wholly or partially abandoned and revoke the certificate of appropriation if an appropriator, with intention to abandon, does not make beneficial use of all or a part of his appropriated water. An appropriation so forfeited and abandoned reverts to the state and the water becomes unappropriated water.

(b) The commissioner may declare an appropriation to be wholly or partially forfeited and shall revoke the certificate of appropriation if an appropriator voluntarily fails or neglects, without sufficient cause, to make use of all or a part of his appropriated water for a period of five successive years. (§ 1 ch 50 SLA 1966)

Sec. 46.15.145. Reservation of water. (a) The state, an agency or a political subdivision of the state, an agency of the United States or a person may apply to the commissioner to reserve sufficient water to maintain a specified instream flow or level of water at a specified point on a stream or body of water, or in a specified part of a stream, throughout a year or for specified times, for

(1) protection of fish and wildlife habitat, migration, and propagation;

(2) recreation and park purposes;

(3) navigation and transportation purposes; and

(4) sanitary and water quality purposes.

(b) Upon receiving an application for a reservation under this section, the commissioner shall proceed in accordance with AS 46.15.070.

(c) The commissioner shall issue a certificate reserving the water applied for under this section if he finds that

(1) the rights of prior appropriators will not be affected by the reservation;

(2) the applicant has demonstrated that a need exists for the reservation;

(3) there is unappropriated water in the stream or body of water sufficient for the reservation; and

(4) the proposed reservation is in the public interest.

(d) After the issuance of a certificate reserving water, the water specified in the certificate shall be withdrawn from appropriation and the commissioner shall reject an application for a permit to appropriate the reserved water.

(e) A reservation under this section does not affect rights in existence on the date the certificate reserving water is issued.

(f) At least once each 10 years the commissioner shall review each reservation under this section to determine whether the purpose described in (a) of this section for which the certificate reserving water was issued and the findings described in (c) of this section still apply to the reservation. If the commissioner determines that the purpose or part or all of the findings no longer apply to the reservation, he may revoke or modify the certificate reserving the water in accordance with AS 46.15.140(b). (§ 7 ch 84 SLA 1980)

Effective date. — Section 12, ch 84, SLA 1980, makes this section effective June 19, 1980, in accordance with AS 01.10.070(c).

Editor's note. — As to declaration of legislative policy, see § 1, ch 175, SLA 1980, in Temporary and Special Acts and Resolves.

Sec. 46.15.147. Termination of permits. (a) If the commissioner has reason to believe that a person who holds an appropriation permit under this chapter is wilfully violating or has wilfully violated a term, condition, restriction or limitation of his permit, he may commence proceedings to terminate the appropriation permit under the Administrative Procedure Act (AS 44.62.330 — 44.62.630).

(b) When an appropriation permit is terminated under this section, the appropriation of water made by the permit reverts to the state and becomes unappropriated water. (§ 8 ch 175 SLA 1980)

Editor's note. — As originally enacted, this section was designated AS 46.15.145. However, since a section with that designation had already been enacted by SLA 1980, ch 84, this section was redesignated AS 46.15.147.

Sec. 46.15.150. Preferred use. (a) An applicant who asserts and proves a preferred use shall be granted a permit and shall be granted preference over other appropriators. A preferred use of water is for a public water supply.

(b) To be entitled to a preference an applicant must show that his use will be prevented or substantially interfered with by a prior appropriation; the use is a preferred use; the applicant agrees to compensate a permit or certificate holder for the prior appropriation for any damages sustained by the preferred use; and other information which the commissioner requires by regulation. (§ 1 ch 50 SLA 1966)

Sec. 46.15.160. Transfer and change of appropriations. (a) The right to use water under an appropriation or permit shall be appurtenant to the land or place where it has been or is to be beneficially used, provided, that water supplied by one person to another person's property shall not be appurtenant to the property unless the parties so intend. An appurtenant water right shall pass with a conveyance of the land, or transfer, or by operation of law unless specifically exempted from the conveyance.

(b) With the permission of the commissioner, all or any part of an appropriation may be severed from the land to which it is appurtenant, may be sold, leased or transferred for other purposes or to other lands and be made appurtenant to other lands. A permit or certificate or a deed, lease, contract, assignment of permit or other instrument transferring an appropriation must be filed for record in the office of the commissioner and a certified copy of the instrument must be recorded in the recorder's office of the recording district in which the appropriation is located. (§ 1 ch 50 SLA 1966)

Sec. 46.15.170. Effect of recording. (a) A deed, lease, contract, assignment of permit or other instrument transferring an appropriation is void as against a subsequent innocent purchaser who in good faith paid a valuable consideration for the appropriation or any portion of it and whose instrument is first filed and recorded under § 160(b) of this chapter.

(b) A deed, lease, contract, assignment of permit or other instrument transferring an appropriation which is recorded under § 160(b) of this chapter is constructive notice of its contents to subsequent purchasers of the appropriation or any portion of it. An unrecorded instrument is valid between the parties to it and as against one who has actual notice of it. (§ 1 ch 50 SLA 1966)

Sec. 46.15.180. Crimes. A person who constructs works for an appropriation, or diverts, impounds, withdraws or uses a significant amount of water from any source without a permit or certificate of appropriation; or a person who violates an order of the commissioner to cease and desist from preventing any water from moving to a person having a prior right to use the same; or who disobeys an order of the commissioner requiring him to take steps to cause the water to so move; or who fails or refuses to install meters, gauges or other measuring devices or control works; or who violates an order establishing corrective control works; or who violates an order establishing corrective controls for an area or for a source of water, or who knowingly makes a false or misleading statement in a declaration of existing rights, is guilty of a misdemeanor. Crimes under this section are in addition to any other crimes provided by law. (§ 1 ch 50 SLA 1966)

Quoted in *C. & A. Contractors, Inc. v. Alaska Greenhouses, Inc.*, Sup Ct (Op No 98) (file No. 1761), 517 P 2d 1379 (1974)

Sec. 46.15.185. Appeals. Appeals to the superior court under this chapter are subject to the provisions of the Administrative Procedure Act, AS 44.62.560 — 44.62.570. (§ 1 ch 50 SLA 1966)

Article 3. Water Resources Board.

Section	Section
190 The Water Resources Board	220 Board meetings
200 Term of office	230 Public meetings
210 Duties of the board	240 Compensation of board members

Sec. 46.15.190. The Water Resources Board. There is created the Water Resources Board composed of seven members having a general knowledge of the use and requirements for use of the waters of the state and the conservation and protection thereof, and the commissioner of environmental conservation or his designee shall serve as an additional, ex officio member serving without a vote. The commissioner of natural resources shall act as the executive secretary of the board, and shall provide clerical staff for the board. Members of the board are appointed by the governor, subject to confirmation by a majority of the members of the legislature in joint session. (§ 1 ch 50 SLA 1966; am § 1 ch 58 SLA 1972)

Sec. 46.15.200. Term of office. The term of office for members of the board is four years. The first members appointed serve as follows: two members serve for one year, three for two years and two for three years. If a vacancy occurs, the governor shall fill it by appointment for the unexpired term. The appointment shall be submitted to the legislature for confirmation at the next regular or special session. (§ 1 ch 50 SLA 1966)

Sec. 46.15.210. Duties of the board. The board shall inform and advise the governor on all matters relating to the use and appropriation of water in the state, including, but not limited to: the effect and adequacy of all state laws and regulations governing the establishment of water rights, the multi-purpose uses of water, the prevention of pollution and the protection of fish and game, studies of the state's water supplies and plans for future requirements, development of water resources, participation of local governmental units in the management of water resources, lands which are or may be needed for dams, reservoirs, flood dams, flood ways, canals or ditches for the impoundment, storage, flow and control of waters. (§ 1 ch 50 SLA 1966)

Sec. 46.15.220. Board meetings. The board shall hold one regular meeting annually at the state capital and one or more additional meetings at the time and place in the state the board selects for the transaction of business. (§ 1 ch 50 SLA 1966)

Sec. 46.15.230. Public meetings. The board may hold and conduct public meetings at any time or any place in the state in order to obtain public opinion on a water use problem or proposal and it may, by majority vote of all members, formally or informally delivered, authorize one or more of its members to hold and conduct a public meeting. (§ 1 ch 50 S.L.A. 1966)

Sec. 46.15.240. Compensation of board members. Each member of the board is entitled to travel expenses and per diem as authorized for state boards by AS 39.20.180 while traveling to or from, or in attendance at, regular or special meetings or conferences authorized by the board. (§ 1 ch 50 S.L.A. 1966)

Article 4. General Provisions.

Enforcement authority
Definitions
Short title

Sec. 46.15.250. Enforcement authority. The following persons are peace officers of the state and they shall enforce this chapter:

- (1) a state employee authorized by the commissioner;
- (2) a police officer of the state. (§ 1 ch 50 S.L.A. 1966)

Sec. 46.15.260 Definitions. In this chapter, unless the context otherwise requires,

(1) "appropriate" means to divert, impound, or withdraw a quantity of water from a source of water, for a beneficial use or reserve water in accordance with AS 46.15.145;

(2) "appropriation" means the diversion, impounding or withdrawal of a quantity of water from a source of water for a beneficial use or the reservation of water in accordance with AS 46.15.145;

(3) "beneficial use" means a use of water for the benefit of the appropriator, other persons or the public, that is reasonable and consistent with the public interest, including, but not limited to, domestic, agricultural, irrigation, industrial, manufacturing, fish and shellfish processing, navigation and transportation, mining, power, public, sanitary, fish and wildlife, recreational uses, and maintenance of water quality;

(4) "source of water" means a substantial quantity of water capable of being put to beneficial use;

(5) "water" means all water of the state, surface and subsurface, occurring in a natural state, except mineral and medicinal water;

(6) "commissioner" means the commissioner of the Department of Natural Resources;

(7) "director" means the director of the Division of Lands, Department of Natural Resources,

(8) "person" includes an individual, partnership, association, public or private corporation, state agency, political subdivision of the state, and the United States. (§ 1 ch 50 S.L.A. 1966)

(9) "mineral and medicinal water" means

(A) water of a hot spring or spring with curative properties which has been reserved by the federal government under Public Land Order No. 399; and

(B) geothermal fluid, as the term is defined in AS 41.06.060. (am § 58 — 10 ch 84 S.L.A. 1980; am § 9, 11 ch 175 S.L.A. 1980)

Effect of amendment. The first 1980 amendment, effective June 19, 1980, added "or to reserve water in accordance with AS 46.15.145" at the end of paragraph (1); added "or the reservation of water in accordance with AS 46.15.145" at the end of paragraph (2); inserted "fish and shellfish processing, navigation and transportation" near the middle of paragraph (1) and added "and maintenance of water quality" at the end of paragraph (1).

The second 1980 amendment substituted "subsurface" for "subsurface" near the middle of paragraph (1); and added paragraph (9).

As the rest of the section was not affected by the amendment, it is not set out.

Editor's note. As to declaration of legislative policy, see § 1, ch 175, S.L.A. 1980, in Temporary and Special Acts and Resolves.

Sec. 46.15.270. Short title. This chapter may be cited as the Alaska Water Use Act. (§ 1 ch 50 S.L.A. 1966)

State: Charge for use of water

By DIRK MILLER

THE JUNEAU EMPIRE

The Hickel administration wants to put a price on the water that flows through Alaska's streams, rivers, lakes, hot springs and underground aquifers, and start charging users for a resource that until now has been as free as rain.

The proposal could translate into nominal charges for homeowners, bigger fees for larger users such as hydroelectric plants, seafood processors and possibly some miners, and an export fee on those who want to sell the state's precipitation to dry states like California.

Authorizing the state to begin charging water fees is one of the administration's legislative priorities this session, state officials say. Currently, Alaska law does not allow the state to charge fees for its water.

The idea of water fees for large consumers came from Gov. Walter J. Hickel's new division of water at the Department of Natural Resources. Even before that, Hickel has boosted the idea of a 2,000-mile pipeline to pump millions of gallons of fresh water from Southeast Alaska to arid California.

"Bringing up the idea of a pipeline to California opened up the concept of exporting water," said Keith Tryck, a member of the state's Water Resources Board in Anchorage. "When you remove that water from Alaska and somebody uses it, whether shipping it out in 12-ounce cans or bottles like Perrier, somebody should pay for it."

Ric Davidge, director of the state's water division, said when he started looking into water exports - even glacier ice - he discovered the state was not making money on the deals.

Under current law, the state charges at most a \$200 filing fee for people or firms seeking water appropriations - simply the right to take a certain volume from a water supply.

And firms have been lining up for the chance to export Alaska's water to the Lower 48.

"Should we give them a water right and basically give it away?" Davidge said. "Unless we have statutory authority, the state cannot realize any benefit from that water."

Please turn to Water, Page 12

California firm to use water tankers

By DIRK MILLER

THE JUNEAU EMPIRE

A Santa Barbara, Calif., company has downsized Gov. Walter J. Hickel's idea of a water pipeline to thirsty California, instead proposing to ship tankers of fresh water from Southeast to water districts in the Golden State.

Sun Belt Water Inc. has applied for rights for as much as 200,000 acre feet of water a year from Orchard Lake near Ketchikan and as much as 150,000 acre feet a year from the Snettisham River, south of Juneau.

An acre foot is the amount of water it takes to cover an acre, one foot deep, or 325,851 gallons of water.

Company officials said today they plan to file for water rights at approximately 10 more sites in Southeast.

"You have so many streams and lakes available, it's our current feeling we will never be in a position of being in conflict with other activities of the state," said Jack Lindsey, Sun Belt's chief executive officer.

"Alaska is the most fabulous water resource story in the world," he said. "And as people begin to understand the magnitude of what the state is trying to harness, it's our feeling that you will see this, not as a renewable resource, but as a continuous resource."

Hickel has been pushing for a 2,000-mile pipeline from Southeast Alaska to California to ship fresh water to the dry state. The Hickel administration also plans on filing legislation that would allow the state to levy fees on in-state water.

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Water...

Continued from Page 1

Davidge said the proposed legislation - which has not yet been submitted to lawmakers - would give the state the authority to levy fees. Regulations to enforce the law would determine if some users, such as non-profit organizations, would be exempted.

Non-consumptive uses, depending on what they are, would be exempted, he said. That would be any user that returns the water back to its system essentially unchanged, such as those who use water to cool buildings.

Davidge said the money would be used to fund the state's water division and water programs statewide.

Officials have been talking about charging users \$1 per acre foot for larger users.

An acre foot is equivalent to the amount of water that would cover one acre to a depth of one foot, or 325,851 gallons.

The funds could be used for village safe-water projects for example, Davidge said. The idea is to have the water resource and its use pay for itself.

Though no one is shipping tankers full of Alaska water to California just yet, the state already has issued 76 permits for harvesting glacier ice, which is sold both in- and out-of state as glacial water, he said.

Some bottlers already are selling Alaska water, and the state last year granted the first large-scale permit for water exports to a Wrangell hatchery, which is looking to make

money off excess water from its Etolin island site.

Bruce Geraghty, one of Hickel's legislative lobbyists, said the water-fee idea is in accord with the governor's owner-state philosophy, in which the state's resources are owned by all Alaskans and managed for their mutual benefit. Instead of giving away water, the state could make money, he said.

The prospect of water fees means many municipal water systems might be charged a user fee for the water they sell to their residents, Davidge said. But those types of domestic uses likely would not be charged as much as a private company making a profit from the sale of water.

The municipality of Anchorage uses more than 26,350 acre feet a year, he said, but every household would probably pay less than a dollar a year for that.

Robert LeVar, water treatment superintendent for Anchorage, said the fees might run the municipality about \$25,000 to \$30,000 a year, and cost each homeowner a couple of cents a month.

In Juneau, the city's water system uses about 4,600 acre feet a year. Using LaVar's figures, the could cost Juneau about \$5,200 a year, or less than 50 cents a year per household.

"I'm surprised. This is the first that I've heard about it," said Jim Beeson, Juneau's water utility superintendent. "I would imagine if the state charges us, we would pass that on to the consumer."

The idea has conditional support from some environmental organizations.

"Our initial thought is it makes sense to levy some charge on this natural resource, just as we do on other natural resource," said Cliff Eames of the Alaska Center for the Environment in Anchorage.

"I think it's a good idea to charge for a resource you're going to sell," said Cliff Davidson, D-Kodiak and House Resource Committee chairman. But he cautioned that the state needs more information on water resources and the effect of large-scale water sales on fish, wildlife and people before it begins to sell its supply.

"We do not know enough about our water resources to set a price on that and try to sell off a lot of water," Davidson said. "Until we have in place the policy to get that information, we have the cart before the horse."

"We don't want the people in Alaska to take a second seat behind a tanker of water going to California," he said.

Steve Borell, executive director of the Alaska Miners Association, said his group has not been approached by the administration. Mining operations, in general, use a lot of water in processing ore.

"We are very concerned to see exactly what the governor's proposing," Borell said.

The association is a booster of Hickel, but Borell said the water fees might not be something that miners support, especially if the fees are excessive.

Davidge said miners might not be affected.

"Most miners, particularly placer miners, they recycle their water," Davidge said.

Tanker...

Continued from Page 1
users and exporters

Ric Davidge, director of Hickel's new water division in the Department of Natural Resources, said he has met with Sun Belt and other companies and California municipalities to discuss water-export projects.

Davidge said Sun Belt's applications would be analyzed by the division for its effect on fish and wildlife resources, water sources and other users. "We cannot appropriate water... if it would take water away that had a previous appropriation," he said.

The business could start carrying water to California by the end of the year, he said.

Davidge and Lindsey said Southeast Alaska's great draw was its closeness to California and its abundance of water.

Lindsey would not disclose the other Southeast locations the company is considering, though Sun Belt recently withdrew an application for water rights from the Maksoutof River on Baranof Island.

"They did withdraw one appli-

cation because it was in a federal wilderness area," Davidge said. "We requested they withdraw that and they did."

Lindsey said the company has no contracts as yet to deliver water to California water districts, though it has financial backing from the Bank of America in San Francisco, he said.

Well, maybe support but no money yet. "What we've done is we have given him a strong expression of interest in providing project financing to a project," said Lester Stephens, vice president of the bank. "We have not committed any equity money to the company, nor have we committed to any specific financing yet."

Stephens said the bank would have to be satisfied that the company could deliver water before it would sign any financing arrangements.

Shipping water is an expensive proposition. The company does not own any tankers and would have to buy or lease them, Lindsey said. The plan is to fill tankers offshore, using pipelines to deep-water moorage facilities. Pipelines, he said, could cost about \$1

million a mile.

Environmental organizations say the idea of shipping Alaska's fresh water south must be carefully reviewed.

"If they're going to deplete water to go sell down south, there may be existing uses that will be affected," said Buck Lindekugel of the Southeast Alaska Conservation Council in Juneau. Fish and wildlife resources must be protected, he said.

Cliff Eames of the Alaska Center for the Environment in Anchorage, said the idea of exporting water south may open up a deeper philosophical question than strictly environmental concerns.

"Throughout the world we need to start assessing whether we are exceeding carrying capacity of some portions of the world," he said. California's water scarcity is in part due to a tremendous population growth and a lengthy drought.

Eames and Lindsey said some of the sites the company is considering might require a federal environmental impact study because of their location in the Tongass National Forest.

Water director has past ties to Calif. firm

By DIRK MILLER

THE JUNEAU EMPIRE

A state official overseeing Alaska's largest water-rights case has past ties to the California company that wants billions of gallons of water from Southeast.

Ric Davidge, director of the state's new water division, is a former employee of Environmental Services Ltd., the Alaska representative for Sun Belt Water Inc., Sun Belt is a Santa Barbara, Calif., company that wants to ship water in tankers from lakes and rivers near Ketchikan and Juneau to thirsty California cities. The water division is handling Sun

Belt's water rights application.

State ethics law prohibits a former public employee from working on any matter for two years in which the former employee had participated while in public service. But there is nothing barring the state from hiring people from a private firm to work on related matters in public service, said Tina Kobayashi, an assistant attorney general, if the employee has no financial interest in his former firm.

"That's the sort of the key, whether it's going to benefit him personally," she said today.

Davidge said Thursday that Envi-

ronmental Services had not started working on Sun Belt's water application until after he left the firm to work for the Hickel administration. He gets no retirement or pension benefits from the firm and has no financial link whatsoever, he said. Environmental Services president Jim Kross did not return a phone call this morning.

Davidge, 45, said he has delegated the authority to decide whether Sun Belt should be given the water rights to Gary Prokosch, a water resources officer in Anchorage.

"That's one of the reasons why Gary is delegated to make decisions

on water appropriations," Davidge said. "If there's a statutory problem here, Gary and I talked it through and felt comfortable with fact that he signs the appropriation."

Davidge said he told his boss, Natural Resources Commissioner Harold Heinze of his former involvement on Thursday.

Heinze said today Davidge had done the right thing by telling him and the division's staff of prior employment with the consultant.

"It is not an extraordinary issue in my mind," Heinze said.

"The fact that you know somebody or have worked with somebody

is not a disqualification," he said. "More importantly, he does not have a financial interest in it."

Water rights, or appropriations, are simply the right to a certain amount of water from a certain source. The state issues water rights after investigating applications from interested parties. In most cases, parties are given a temporary permit for the water and once their facilities are in place, a permanent appropriation can be granted after the state considers the application.

Gov. Walter J. Hickel's administration is planning to push law-

makers to approve legislation that would allow the state to levy fees on water exported and used in the state.

Prokosch said he is supervised by Davidge.

"If things go wrong on my end and someone doesn't like what I've done, it's going to be elevated," Prokosch said.

If a party wants to appeal Prokosch's decision, Davidge said, the director normally would handle the appeal. But, Davidge said, he plans to send any appeals of Sun Belt's cases on to Heinze.

"The only time I would be involved is if it's appealed," Davidge said. "I would suggest it go directly to the commissioner."

Davidge, though, is still working with Sun Belt on its application for water rights, and he said he has met several times with the company.

Davidge is the former planning, permitting and government affairs director for Environmental Services, an Anchorage consulting firm. He

joined the firm during the Exxon Valdez oil spill in 1989 and worked there until being hired by the Hickel administration last year.

Sun Belt is seeking rights to up to 200,000 acre feet of water a year from Orchard Lake near Ketchikan and 150,000 acre feet of water from Snettisham River near Juneau. An acre foot is the amount of water it would take to cover an acre to a depth of a foot. That amount is 325,851 gallons.

Prokosch said the Sun Belt proposal is so large that the eventual decision might end up in Heinze's lap, anyway.

Sun Belt plans to ship the water to California for sale to water districts, said Jack Lindsey, the company's chief executive officer. Sun Belt is also considering filing for water rights on up to 10 other sites in Southeast, he said.

Lindsey said Environmental Services is the company's Alaska representative.

"They are sort of the voice for

Sun Belt in Alaska," Davidge said. "They interact with the adjudication staff."

"It's one of those things, if you're employed in Alaska, you eventually end up running into a conflict with one of your employers."

It is not the first apparent conflict of interest that has arisen in the Hickel administration. Hickel fired former Revenue Commissioner Lee Fisher last year over allegations that he had mishandled a contract with his old accounting firm, Coopers & Lybrand. State lawyers are also investigating a contract issued by the Alaska Energy Authority to an Alaska contractor with past ties to the agency's executive director, Charlie Bussell.

Hickel himself was alleged by a state Personnel Board report to have violated conflict-of-interest rules in promoting a gas pipeline project in which he held stock. To resolve the problem, Hickel donated the stock in Yukon Pacific to a charitable foundation he set up bearing his name.

Hickel wants to dip into water profits

The Associated Press

JUNEAU — Alaska's endless supply of fresh water may not be free for long. Gov. Wally Hickel plans to introduce legislation soon to charge water user and export fees.

The legislation may mean nominal charges for homeowners and higher fees for large users such as hydroelectric plants, seafood processors and possibly mines. An export fee also may be

charged on water sales outside the state.

Hickel has proposed building a 2,000-mile freshwater pipeline to California. When he resurrected the idea last year, it raised some interest in Southern California but was quickly dismissed because of the pipeline's huge cost.

The idea got administration officials thinking of other ways to make money

from Alaska's many streams, rivers, lakes, hot springs and underground aquifers.

"Bringing up the idea of a pipeline to California opened up the concept of exporting water," said Keith Tryck, a member of the state Water Resources Board in Anchorage.

"When you remove that water from Alaska and somebody uses it, whether shipping it out in 12-ounce cans or bottles like Perrier, somebody should pay for it," he said.

Hickel's new Water Division at the Department of Natural Resources proposed charging water fees to large users after discovering that the state didn't make any money on water or glacier-ice exports.

Authorizing the state to begin charging water fees is one of the administration's legislative priorities this session, said Ric Davidge, director of the Water Division.

"Should we basically give it away? Unless we have statutory authority, the state cannot realize any benefit from that water."

The proposed legislation likely will be introduced in the coming week, Hickel spokesman John Manly said Friday. It would fund the Water Division and water programs statewide.

Officials have talked about charging users \$1 an

acre-foot, or 325,851 gallons, for larger users.

Non-profit groups and users that return water to its system essentially unchanged, such as those who use water to cool buildings, may be exempted from the proposed fees, Davidge said.

The state has issued 26 permits for harvesting glacial ice, which is sold as glacial water in Alaska and out of state, he said.

Some bottlers already sell Alaska water, and the state last year granted the first large-scale permit for water exports to a Wrangell hatchery, which wants to profit off of excess water from its Etolin Island site.

Under the proposal, water fees may be charged to many municipal water systems for the water they sell to residential customers, Davidge said. But domestic users likely would not be charged as much as a private company that profits from water sales.

Robert LeVar, water treatment superintendent for Anchorage, said the fees may cost the city about \$25,000 to \$30,000 a year, and cost each homeowner a couple of cents a month.

Cliff Davidson, D-Kodiak and chairman of the House Resource Committee, called

the fees a good idea for groups that profit from selling Alaska water. But he said the state needs more information on the effect of large-scale water sales on fish, wildlife and people.

"We do not know enough about our water resources to set a price on that and try to sell off a lot of water," Davidson said. "We don't want the people in Alaska to take a second seat behind a tanker of water going to California."

Steve Borell, executive director of the Alaska Miners Association, said miners, who generally use a lot of water, are concerned the fees may be excessive.

"I guess it's one thing to be able to charge for blocks of ice that leave the state," he said. "It's a political decision, whether or not you charge tourists for the air they breathe. That's the next step."

But Davidge said most miners, especially placer miners, recycle their water, and would not be charged.

Water rights attract Outside firm

The Associated Press

JUNEAU — A Southern California company has applied to ship billions of gallons of fresh water from southeast Alaska to help quench the Golden State's thirst.

Sun Belt Water Inc. of Santa Barbara, Calif., has applied to the state for rights to as much as 65 billion gallons of water a year from Orchard Lake near Ketchikan, and as much as 48 billion gallons annually from the Snettisham River, south of Juneau.

By comparison, Anchorage residents use about 8.5 billion gallons a year.

Sun Belt officials said this week they plan to file for water rights at about 10 other southeast Alaska sites not yet disclosed.

Jack Lindsey, Sun Belt's chief executive officer, said people will realize that Alaska water is not a renewable resource, but a continuous one.

"Alaska is the most fabulous water-resource story in the world," he said. "You have so many streams and lakes available. It's our current feeling we will never be in a position of being in conflict with other activities of the state."

Ric Davidge, director of Gov. Wally Hickel's new Water Division in the Department of Natural Resources, said he has met with Sun Belt and other companies

and California cities to discuss water-export projects.

Sun Belt's applications will be analyzed by the division for potential effects on fish and wildlife, water sources and other users. Davidge said.

If the applications are approved, the company may be able to ship water to California by the end of the year, he said.

Sun Belt recently withdrew an application for water rights from the Maksoutof River on Baranof Island because it was in a federal wilderness area, Davidge said. The state asked the company to withdraw the application.

The company has no contracts to deliver water to California water districts.

Bank of America in San Francisco has expressed interest in providing financing

for the project but has not committed any money to Sun Belt, said Lester Stephens, a bank vice president.

Sun Belt must convince the bank it can deliver water before it would sign any financing arrangements, Lester said.

The company does not own any tankers and would have to buy or lease them, Lindsey said. The plan is to fill tankers offshore, using pipelines to deep-water moorage facilities. Pipelines, he said, could cost about \$1 million a mile.

Environmental groups say the idea of shipping Alaska's fresh water south must be carefully reviewed.

"If they're going to deplete water to go sell down south, there may be existing uses that will be affected," said Buck Lindekugel of the Southeast Alaska Conservation Council in Juneau.



THE DIVISION OF WATER

The Alaska Division of Water manages an estimated 40% of our Nation's water resources including over 3 million lakes and an estimated 20,000 streams. These responsibilities include the State Water Policy and Management Strategy; issuing water rights; administering the dam safety program; rendering and reviewing administrative navigability determinations, asserting ownership and management of submerged lands; surveying, collecting and distributing water resource data related to the quantity and quality of surface, ground and coastal waters of Alaska; coordinating water related data collection and management activities with other agencies; providing support to the State Water Board; advocating responsible water development including water exports. The Director of the Division represents the Governor at the Western States Water Council consisting of 17 western states.

In addition to the Office of the Director, the Division of Water is comprised of five sections; Hydrologic Survey which includes the State Water Lab, Water Management, Policy and Special Projects, Navigability, and Dam Safety and Construction. The Division has offices in Anchorage, Fairbanks, Juneau and Wasilla.

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

DIRECTOR'S OFFICE
Davidgo, R.
Director
EBA 0004 26

ADMINISTRATION
Avery, B.
Admin. Asst. II
EBA 8243 14

SECRETARIAL SUPPORT
Vacant
Secretary I
EBA 8201 10

DAM SAFETY
Cherry, K.
Technical Engr II
EK 1879 22

HYDROLOGIC SURVEY
Long, W.
Hydrologist V
EDK 2051 22

WATER MANAGEMENT
Prokosch, G.
MWD I
EBA 1315 18

POLICY & SPECIAL PROJECTS
Dyr, D.
MWD I
EBA 1724 18

ADMINISTRATION
Weir, J.
Field Office Asst
EDK 2108 10

NORTHERN REGION
Karin, J.
MWD II
JBC 1584 13

SOUTHCENTRAL REGION
Litten, K.
MWD II
EBA 1274 18

Lang, Simone
CT III
EBA 1718 8

SURFACE WATER
Ingras, M.
Hydrologist IV
EDK 2078 20

GROUND WATER
Hunter, J.
Hydrologist IV
EDK 2144 20

Monsen, A.
MWD I
EBA 1377 14

Navigability
Allison, D.
MWD I
EBA 3063 18

Carrick, S.
Hydro III
EDK 2145 18

Alley, R.
Hydro II
EDK 2097 18

Wynn, S.
MWD I
EBA 1633 14

Watts, R.
MWD II
EBA 1692 18

Patrik, B.
Hydro II
EDK 2095 16

Mal-Su Area
Compton, C.
MWD II
ECP 1272 12

Vacant
Hydro II
EDK 2141 18

SOUTHEAST REGION
Rader, T.
MWD II
AMA 1809 18

COMPUTER SUPPORT
Ireland, R.
Hydrologist III
EDK 2143 18

WATER QUALITY
Maurer, M.
Hydrologist III
EDK 2142 18

Dunker, J.
MWD I
AMA 1283 14

NORTHERN REGION
Ray, S.
Hydrologist III
JBC 2174 18

SOUTHEAST REGION
Mull, R.
Hydrologist I
AMA 2052 14

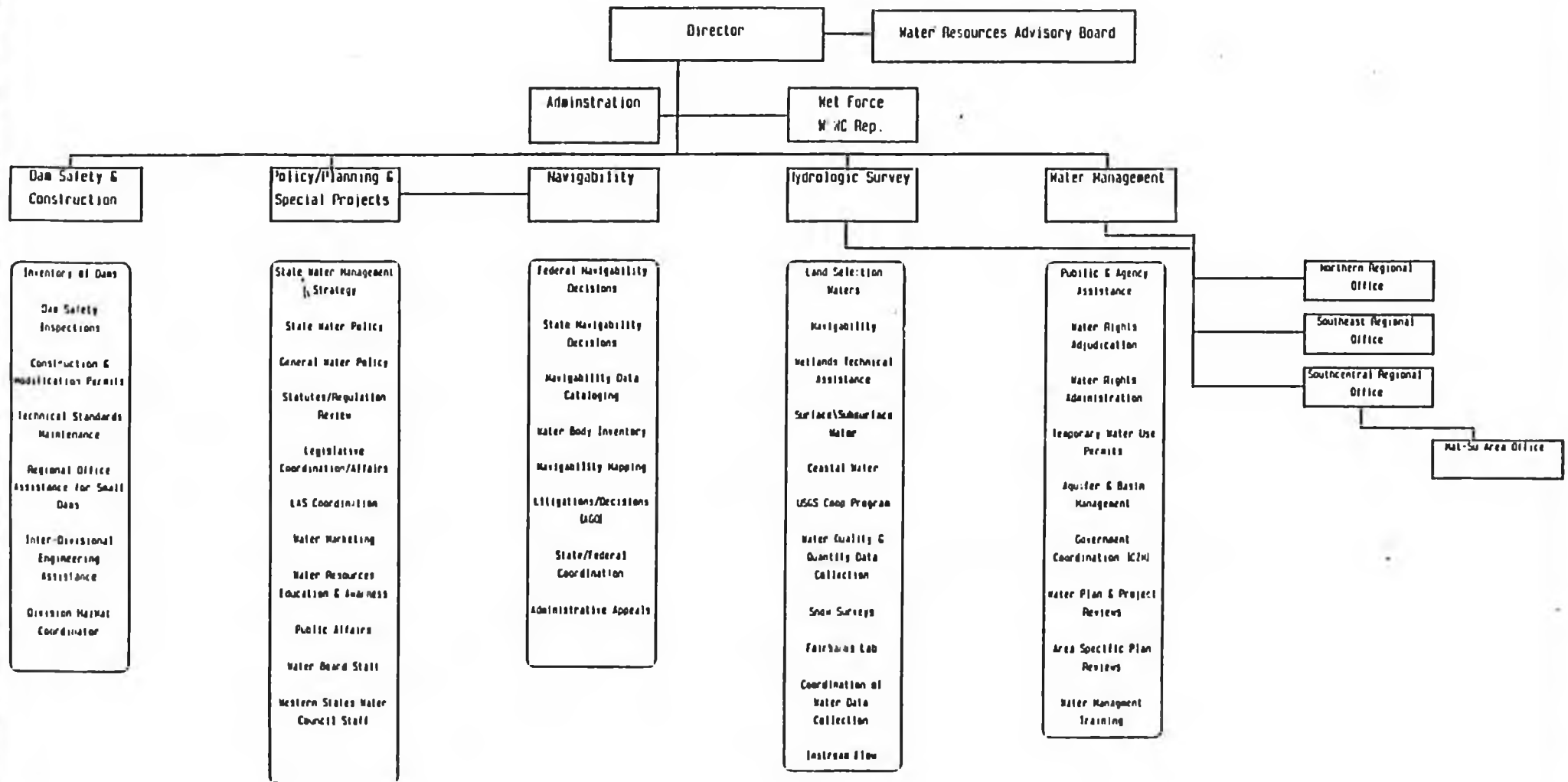
Water Lab
Vanden, J.
Chemist II
JBC 2037 18

Vacant
Hydro III
JBC 18 2058

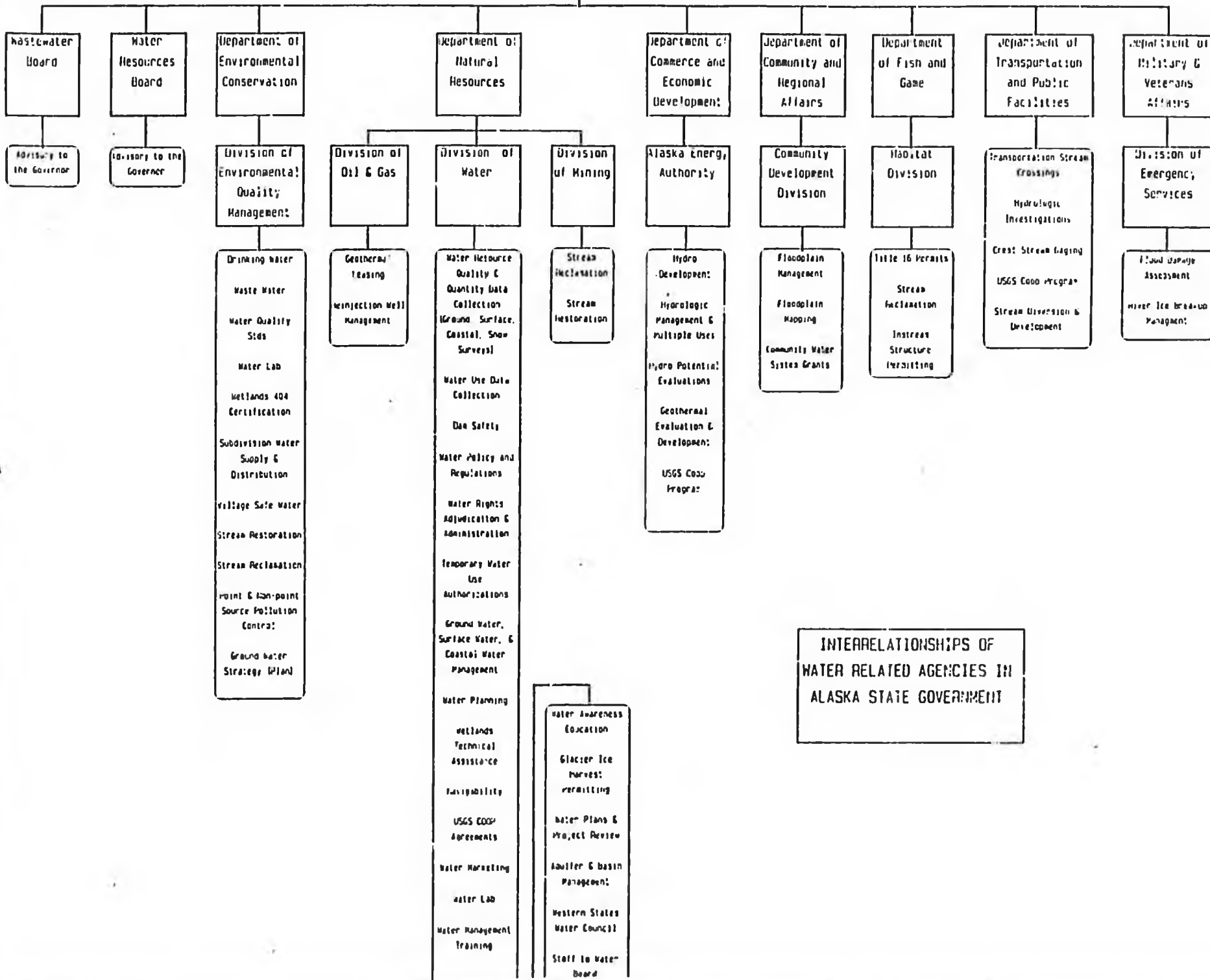
Department of Natural Resources

Division of Water

Program Functions



Governor



INTERRELATIONSHIPS OF
WATER RELATED AGENCIES IN
ALASKA STATE GOVERNMENT

MEMORANDUM
DEPARTMENT OF NATURAL RESOURCES

STATE OF ALASKA
DIVISION OF MANAGEMENT

TO: Max Hodel
Chief of Staff
Office of the Governor

DATE: June 25, 1991

FILE NO.: Diwater

PHONE NO.: 465-2409

THRU: Shelby Stastny
Director
Office of Management and
Budget

SUBJECT: Establishment of Division
of Water Resources

FROM: Harold C. Heinze
Commissioner

* § One of the first organizational suggestions I received as Commissioner was to establish a separate Division of Water Resources. Now that I have had time to study this suggestion and consult with affected interests (i.e., Water Resources Board, House Resources Committee, etc.). I am convinced that creation of this division would be in the best interest of the State.

In recent years, water management has become increasingly important to Alaskans. Water availability is critical to our cities and villages, our fisheries, oil and gas production, seafood processing, hydroelectric development, mining, recreation, navigation and a host of other purposes. Maintenance of our water resources and water allocation decisions among user groups is expected to become even more important in the 1990's. A Division of Water will provide the necessary focus and demonstrate our recognition of the importance of this resource and our commitment to responsible management.

Water resources programs within the Department of Natural Resources currently reside in two divisions -- the Division of Land and Water (DLW) and the Division of Geological and Geophysical Surveys (DGGS). The DLW water programs include the water rights and dam safety projects. Other DLW water responsibilities include serving as staff to the Water Resources Board, representing the State on the Western States Water Council, and water resources planning. The DGGS is responsible for water resources data collection, storage, analysis, and dissemination, and for providing hydrologic assistance to DLW and other government agencies.

The Division of Water Resources would initially consist of 20-25 permanent positions. A new Director position at the Range 26 level will be established. The proposed organizational chart is attached for your approval.

AS 46.15.020(3) specifically authorizes the Commissioner to establish a Division of Water and no new statutes or changes to existing law will be necessary.

Max Kodal
Page 2
June 25, 1991

IN ACCORDANCE WITH AS 46.15.020(3), A DIVISION OF WATER IS ESTABLISHED IN THE DEPARTMENT OF NATURAL RESOURCES AS DESCRIBED ABOVE, EFFECTIVE ON THE DATE APPROVED.

Shelby Stastny

SHELBY STASTNY
DIRECTOR
OFFICE OF MANAGEMENT AND BUDGET

Walter J. Hickel

WALTER J. HICKEL
GOVERNOR

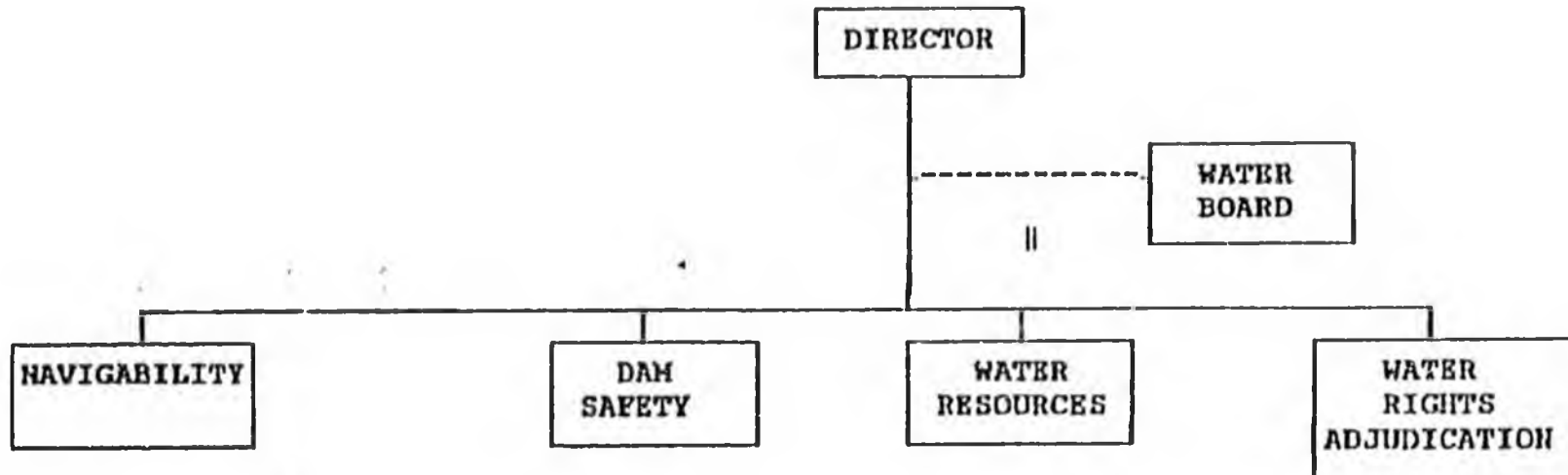
6-27-91

DATE

Attachment

- cc: Gary Gustafson, Director, DLW
- Tom Smith, Acting Director, DGGS
- Sharon Barton, Director, Management

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER



Harold C. Henning
COMMISSIONER, DEPARTMENT OF NATURAL RESOURCES

Ally Study
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

Walter J. Kiechel
GOVERNOR, STATE OF ALASKA

6-27-91
EFFECTIVE DATE

06-27-1991 15:10 007 588 2754 DAD OFFICE OF THE COMMISSIONER B.04

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
PCN LIST

Division of Geological & Geophysical Surveys

<u>PCN</u>	<u>Title</u>	<u>Name</u>	<u>Location</u>
10-2051	Hydrologist V	Long	Eagle River
10-2144	"	IV Muntar	" "
10-2097	"	II Allely	" "
10-2141	"	II LaSage	" "
10-2095	"	II Petrik	" "
10-2078	"	IV Inghram	" "
10-2145	"	III Carrick	" "
10-2142	"	III Maurer	" "
10-2143	"	III Ireland	" "
10-2174	"	II Ray	Fairbanks
10-2037	Chemist II	Vohden	" "
10-2056	Hydrologist III	Moorman	" "
10-2055	Geologist IV	Motyka	Juneau
10-2052	Hydrologist I	Noll	" "
10-2108	Field Office Assistant	Weir	Eagle River

Division of Land & Water

10-1679	Tech Engineer	K. Cherry	Anchorage
10-1724	Nat Res Mgr I	M. Harle	" "
10-1692	Nat Res Off II	R. Watts	" "
10-1718	Clerk Typ III	P. Reamer	" "

Water Rights Adjudicators

10-1263	Nat Res Off I	Dunker	Juneau
10-1609	Nat Res Off II	Rader	" "
10-1274	Nat Res Tech	Litzen	Anchorage
10-1377	Nat Res Off I	Monson	" "
10-1272	Nat Res Tech	Compton	Wasilla (1/2 time)
10-1315	Nat Res Mgr I	Prokosch	Anchorage
10-1633	Nat Res Off I	Weeks	" "
10-1504	Nat Res Off II	Karin	Fairbanks

Division of Water

Director: Ric Davidge (762-2575)



3.76% of DNR budget

Mission

The Division of Water was created in 1991 to manage, plan, promote and authorize the responsible use and economic potential of Alaska's water resources; to resolve state title to the submerged lands under all navigable water bodies; to collect and provide information needed on the quantity and quality of Alaska's vast surface, ground and coastal waters; to protect lives and property at risk by dams; and to educate Alaskans about the responsible use of their water resources.

	General Fund	Other Funds	FTE
FY92 Authorized	0	0	0
FY93 Governor's Budget	2,115.9	540.9	28

NOTE: A full explanation of the transfers required to fund and staff the new Division of Water can be found in Appendix D.

Governor's Approved Increments

Funding Request

Water Management

337.0 (GF/PR)

Increasing program receipts encourages cost effectiveness and establishes a dollar relationship to services provided. These funds, generated through water rights applications fees, temporary water use fees, dam safety application fees and the USGS-Hydro Survey Co-op cost recovery program, are essential to the continued operation of the Division of Water at the current level. Failure to authorize this increase in program receipts will require personnel layoffs in water rights adjudication and hydrologic surveys. Backlogs in permit applications would likely increase and site inspection of high hazard dams will be limited.

FY93 Project Descriptions

<u>Project</u>	<u>Benefit</u>	<u>Funding</u>
Director's Office Provides overall management and administrative support.	Focuses division objectives and methods of obtaining them.	154.6 (GF)