

ALASKA LEGISLATURE COMMITTEE FILES 1985-1986 86/2

4243 SRES SB 150 1123

flows, and to furnish a continuous supply of timber..." 8/

Under the authority of the 1897 Organic Act, as limited by the above provision defining the purposes of the reservation, millions of acres of forested land were subsequently removed from the public domain.

In studying the legislative history of this important Act, it is clear that protection of timber and the timber industry was not foremost in many Congressional minds. Rather, a strong force behind the Organic Act was the knowledge that:

"As long as the forests stand, the branches, fallen leaves, and roots will hold much of the rain and snow until summer, and thus furnish water not only for navigation of our rivers, but also for the irrigation of the deserts." 9/

In succinctly paraphrasing his colleague from Colorado, Representative Ellis of Oregon concluded that "the purpose of his forest reservations is not to save the timber for future use so much as to preserve the water supply." 10/ This sentiment was echoed by the California delegate's statement that ". . .the only object of the forest reserves in this State of California is to retain the snows upon the mountains . . ." 11/

Lessons from many areas of the United States had made Congress painfully aware that forests "are necessary to prevent

destructive spring floods, and [to supplement] periods of low water in summer and autumn when the agriculture of a large part of western North America is dependent upon irrigation." 12/

Because of this realization, Western legislators were willing to submit to the establishment of the forest reservations in order to protect their water resources. They also chose, however, to enact protections to insure their continued ability to use the water arising on these reserved lands. The Organic Act, as passed in 1897, included the provision that:

"All waters within the boundaries of national forests may be used for domestic, mining, milling, or irrigation purposes, under the laws of the State wherein such national forests are situated..." 13/

Protections were also enacted to insure the necessary access to make diversions of water from the National Forest lands. In the bill encompassing the Creative Act of 1891, provisions were included to allow public entry on reserved lands in order to gain rights-of-way for irrigation works. 14/ Then in the Act of February 15, 1901, 15/ Congress provided for rights-of-way in National Forests for water developments of any sort, not just for irrigation purposes. This was done in order to correct "the anomaly that while forest reserves are being set aside to preserve watersheds and increase the water supply, the same legislation has denied its use in and for the industries calculated to be

8/ Codified at 16 U.S.C. 475.

9/ Rep. McRae, 30 Cong. Rec. 966 (1897).

10/ Rep. Ellis, 30 Cong. Rec. 1007 (1897).

11/ Rep. Loud, 30 Cong. Rec. 1399 (1897).

12/ S. Doc. No. 105, p. 36, 55th Cong., 1st Sess. (1897).

13/ Codified at 16 U.S.C. § 481.

14/ 26 Stat. 1095.

15/ 31 Stat. 790.

benefitted thereby." 16/ The bill corrected this anomaly of access limitations by "extending the opportunities to use the waters to mining, electrical, domestic, public and other beneficial uses." 17/

As a consequence of these Congressional actions, including the reservation of millions of acres of forest lands, Western water users at the turn of the century felt secure in both their legal and physical ability to develop and use unappropriated water within the National Forests.

In 1908, however, the Supreme Court gave birth to a doctrine that has since put a cloud on this expectation.

THE RESERVED RIGHTS DOCTRINE

As miners and settlers moved West in the mid-Nineteenth Century, the common law system of riparian water rights proved to be inappropriate. Although vestiges of this system remain in the West, each of the Western states currently utilizes the prior appropriation system as its primary guide in allocating the use of water. This system is based upon that oft-quoted phrase, "first in time, first in right." In other words, limited water resources are allocated in accordance with users' respective priority dates — dates that are generally established in accordance with when the water was first applied to a beneficial use. The user with the earlier priority date (i.e., the one who first put the stream to beneficial use) has the senior right to utilize the water, thereby precluding junior users from any such use

during times of shortfalls. This system differs from early common law in that under the riparian doctrine, upstream users are allowed to utilize the stream-flow only to the extent that their use does not inhibit further utilization downstream.

By the late 1800's, the prior appropriation system was well established, having been recognized by the Supreme Court as a valid exercise of states' power to override an inappropriate common law doctrine. 18/ In the dicta of the Rio Grande case, however, the Court stated a limitation that would soon prove important to water users under the prior appropriation system:

"[I]n the absence of specific statutory authority from Congress a State cannot by its legislation destroy the right of the United States, as the owner of lands bordering on a stream, to the continued flow of its waters; so far at least as may be necessary for the beneficial uses of the government property." 19/

In 1908, this concept blossomed into the Winters doctrine — and the reserved rights doctrine -- much to the dismay of many Western water users. 20/ In Winters, the court granted a water right associated with the Fort Belknap Indian Reservation with a priority date that was senior to water users who had already put water to beneficial use. The court looked to the date that the reservation had been established and concluded that, at the very least, Congress had at that time impliedly reserved sufficient water along with the land in order to fulfill the needs of the

16/ H. Rep. No. 1850, 56th Cong., 1st Sess. (1900).

17/ Ibid.

18/ *United States v. Rio Grande Ditch & Irrigation Co.*, 174 U.S. 690 (1899).

19/ 174 U.S. at 703.

20/ *Winters v. United States*, 207 U.S. 564 (1908). The Winters Doctrine is used to refer to water associated with Indian reservations while the Reserved Rights Doctrine is applicable to waters of non-Indian federal reservations. Although they are based on the same concept, subtle (but potentially important) distinctions exist between the two doctrines.

reservation. Such water was not available for later appropriation under state law; thus those non-Indians who had in fact been using it would now have to relinquish it to the tribes.

In 1939, the Court reaffirmed this concept regarding tribal lands, 21/ then later hinted that the doctrine may also apply to other types of federal reservations. 22/ It was not until 1963, however, that the reserved rights doctrine became firmly entrenched in all federal reservations. In *Arizona v. California*, 23/ the Court concluded that the principle espoused in the *Winters* case "was equally applicable to other federal establishments such as National Recreation Areas and National Forests."

The Court clearly affirmed this statement in *United States v. New Mexico*, 24/ when it prohibited well pumping in order to protect water that had been reserved to protect the ancient desert pupfish in Devils Hole National Monument. In its decision, the Court refined the reserved rights doctrine in several ways. It identified Congressional intent as the key factor in determining whether a reservation was made; it limited the quantity of water reserved to the minimum amount needed in order to fulfill the federal reservation's purpose; and it rejected balancing the equities in cases like this.

It was in this context that the Supreme Court in 1978 rejected the Forest Service's claim to reserved instream flow rights in *United States v. New Mexico*. Since preservation of the amenities of the

forest environment was not a primary purpose under the Organic Act of 1897, no water was reserved for such use under the reserved rights doctrine. A reserved water right could only be established in order to further the primary purpose of the National Forests, which the Court found to be limited to the pragmatic function of timber protection and to secure favorable water flows for private and public uses. 25/ Thus ended Round One of the Forest Service's attempt to gain instream flow rights.

ROUND TWO: INSTREAM FLOWS FOR CHANNEL MAINTENANCE

The Forest Service quickly ascertained the direction in which Round Two would need to progress in its attempt to obtain reserved instream flow rights. Somehow, the requested instream flow would have to be claimed as being necessary to fulfill the primary purpose of the National Forests — either to secure favorable condition of water flow or to furnish a continuous supply of timber.

The early attempts at developing this relationship between instream flows and the primary purpose of the forests were hastily conceived and proved unconvincing to the courts. For instance, it was argued that stream banks wetted by instream flows were less susceptible to erosion during high runoff and inhibited the spread of fire. 26/ In another case, Forest Service personnel defended the position that instream flows were necessary for timber protection because "trees growing next to

21/ *United States v. Powers*, 305 U.S. 527 (1939).

22/ *Federal Power Commission v. Oregon*, 349 U.S. 435 (1955).

23/ 373 U.S. 546, 601 (1963).

24/ 426 U.S. 128 (1976).

25/ 438 U.S. at 718.

26/ *State ex rel. Reynolds v. Lewis*, Case Nos. 20294 and 22600, Chaves County, New Mexico.

benefitted thereby." ^{16/} The bill corrected this anomaly of access limitations by "extending the opportunities to use the waters to mining, electrical, domestic, public and other beneficial uses." ^{17/}

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By the late 1800's, the prior appropriation system was well established, having been recognized by the Supreme Court as a valid exercise of states' power to override an inappropriate common law doctrine. ^{18/} In the dicta of the Rio Grande case, however, the Court stated a limitation that would soon prove important to water users under the prior appropriation system:

"[I]n the absence of specific statutory authority from Congress a State cannot by its legislation destroy the right of the United States, as the owner of lands bordering on a stream, to the continued flow of its waters; so far at least as may be necessary for the beneficial uses of the government property." ^{19/}

In 1908, this concept blossomed into the Winters doctrine — and the reserved rights doctrine — much to the dismay of many Western water users. ^{20/} In *Winters*, the court granted a water right associated with the Fort Belknap Indian Reservation with a priority date that was senior to water users who had already put water to beneficial use. The court looked to the date that the reservation had been established and concluded that, at the very least, Congress had at that time impliedly reserved sufficient water along with the land in order to fulfill the needs of the

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the creek . . . are going to get more water." 27/

During the time that these arguments were failing to convince judges to decree reserved instream flow rights, hydrologists of the Forest Service were busy developing a more credible, scientific basis for these claims. What has resulted is the claim that: (1) instream flows of a certain magnitude are needed to transport sediment downstream; (2) transport of a stream's sediment load is required in order to maintain a viable stream channel; and (3) viable stream channels are essential in securing favorable condition of flow from the National Forests.

In short, the United States asserts that reserved instream flow rights exist in the National Forests to the extent necessary to move sufficient sediment to insure favorable water conditions. If such instream flows are not available, sediment clogs the stream channel which in turn leads to erosion of the stream banks, increased meandering, encroachment of vegetation, and the potential for flooding. The value of the water arising from the forest lands is therefore diminished in terms of both quality and timing, and the reserved lands lose their capacity to secure favorable conditions of flow. 28/

The United States first tested the waters with this argument in northern Wyoming. 29/ It claimed reserved instream flow rights in streams throughout the National

Forest lands in the Big Horn Basin. The claim was based upon calculated flows of sufficient quantity to transport the suspended sediment downstream.

The Forest Service had determined that instream flows were needed year-round for this purpose. In quantifying its claims, the Service broke the annual runoff cycle into four components. 30/ The first component began during the early spring runoff when the stream flow first reaches the average annual flow rate. The U.S. claimed this flow and then increased the claim in small increments over the next month up to bankfull level, which is about ten times the average annual flow rate. This second component (called bankfull discharge) was then maintained for roughly three days. The recession component then followed, wherein the U.S. claimed incrementally less flow over the next month as the natural runoff diminished. During the remaining ten months of the yearlong cycle, a baseflow component was claimed amounting to 10 percent of the average annual flow rate.

The Forest Service estimated that the requested instream flows were responsible for transporting more than 80 percent of the total sediment load downstream, thereby insuring that the channel degradation would not occur. 31/ The cost in terms of the necessary water, however, was enormous; the requested instream flows amounted to 78 percent of the total average annual runoff from the

27/ United States v. Denver, 656 P.2d 1 (Colo. 1982), n. 35, at 22.

28/ United States Forest Service, "A Procedure and Rationale for SECURING FAVORABLE CONDITIONS OF WATER FLOWS on National Forest System Lands in Northern Wyoming," Draft Report (1982).

29/ In re the General Adjudication of All Rights to Use Water in the Big Horn River System and All Other Sources, Civil No. 4993, District Court of the Fifth Judicial District, State of Wyoming.

30/ United States Forest Service, n. 28.

31/ Id.

basin. ^{32/} Such a demand would severely limit diversions from within the National Forests and essentially foreclose the possibility of viable operation of major reservoirs within or above the forest boundaries.

The State of Wyoming did its homework in this case and effectively deterred the U.S. from taking these claims to trial. Depositions of Forest Service personnel were used effectively to highlight the fact that the channel maintenance theory was still in the formative stage, and that the instream flow claims based on the theory would be difficult to defend in court. Subsequently, Wyoming and the United States entered into a stipulation that many consider to be a complete victory for the state. Although the reserved instream flow claims are listed for numerous streams, the United States subordinated these rights to all existing water uses as well as to large scale future development that will cause additional depletions to the National Forest streams. ^{33/}

THE BATTLE IN COLORADO

After learning the lessons of Wyoming, the United States has taken its channel maintenance theory and instream flow claims to Colorado with a good deal more preparation and confidence. In various water courts in the state the U.S. has filed for reserved instream flows and reserved lake levels using the following language:

"United States of America claims reserved rights to those instream flows in streams, creeks, and rivers and natural levels in

lakes and other water bodies...which are necessary to fulfill the purposes for which this national forest was established, to wit: securing favorable conditions of water flows and to furnish a continuous supply of timber. The uses of water necessary to fulfill the aforesated purposes include, but are not limited to: growth, management, and production of timber; flood control; soil conservation; erosion control; and watershed and stream channel protection." ^{34/}

After making these filings, Forest Service personnel worked to quantify the amount of water needed in the streams of the National Forests within Colorado in order to move the sediment and maintain channel integrity. In November, 1984, they submitted the first set of numbers to the Water Court with jurisdiction over water matters in the northeastern portion of the state. ^{35/} These claims were of the same basic nature as those seen in Wyoming, reflecting large quantities for instream flows during the spring runoff season and a smaller baseflow component during the remainder of the year. As was feared by many Colorado water users, the claims also amounted to a vast percentage of the total runoff available for diversion from the forest lands.

The State of Colorado and other objectors to the instream flow filings are attempting to win this Round Two without getting bogged down in the scientific aspects of the channel maintenance theory. Instead of hiring hydrologists for expert witnesses and gearing up for protracted litigation on the merits of instream flows' role in

^{32/} Id. at 49.

^{33/} Stipulation in Civil No. 4993, supra.

^{34/} E.g., In the Matter of the Application of Water Rights of the United States of America in Water Division No. 2, Case No. 81CW220, District Court, Water Division No. 2, State of Colorado.

^{35/} E.g., Amended Application for Confirmation of Reserved Water Rights in Boulder, Gilpin, and Larimer Counties, Case No. W-8439-76, District Court, Water Division No. 1, State of Colorado.

sediment transport and channel maintenance, the state has filed a motion for summary judgment. In the motion, the state asserts that even if the scientific theory is valid, no instream flows rights for sediment transport can be established under the reserved rights doctrine. The argument focuses on the Colorado Supreme Court holding in *United States v. Denver*, 36/ that Congress intended that the National Forests be established in order to protect and promote use of the water from the forest lands -- a goal that would in many instances be hindered by an instream flow reservation that precludes use of the lawful reservoirs and ditches established within the forest boundaries.

Although there has been some discussion of possible subordination of the instream flows to existing water diversions within the National Forests of Colorado, the United States has made it clear that it is not willing to consider the broad-brush subordination that was stipulated to in Wyoming. The Forest Service stands ready to carry its scientific methodology and legal theories to court in an attempt to obtain reserved instream flow rights in Colorado -- and throughout the West. 37/

ALTERNATIVES TO LITIGATION

In light of the recent developments in the reserved rights doctrine in the Supreme Court, it is doubtful that the United States will be able to overcome the legal hurdles it faces in obtaining National Forest instream flow rights. First, the Court has made it clear that federal reserved water rights must reflect the intent of Congress, either expressed or implied. The U.S. will have a difficult

time convincing the Court that a reservation of more than half the water of the National Forests would have been acquiesced to by the 1897 Congress, even if the legislators had been aware of the need for such instream flows in order to maintain the stream channels. Such a conclusion is directly contrary to the expressed intent of Congress to allow Western water users to capture and divert water within the forest lands.

The United States will also face the standard of "minimal need" set forth in *Cappaert*. In *United States v. New Mexico*, the Court restated and refined this standard regarding when, and how much, water can be deemed reserved:

"While many of the contours of what has come to be called the 'implied-reservation-of-water doctrine' remain unspecified, the Court has repeatedly emphasized that Congress reserved 'only that amount of water necessary to fulfill the purpose of the reservation, no more.' [Cites omitted.] Each time this Court has applied the 'implied-reservation-of-water doctrine,' it has carefully examined both the asserted water right and the specific purposes for which the land was reserved, and concluded that without the water the purposes of the reservation would be entirely defeated." 38/

Can the U.S. actually show that without the requested instream flows, the National Forest purposes will be defeated? Probably not. Without the reserved instream flow rights, water users will simply be able to continue storing and diverting runoff from within the forest boundaries -- a result that is actually consistent with the reservation's purposes rather than

36/ *Supra*, at n. 27.

37/ The United States has recently filed similar claims in general stream adjudications in Utah, and has begun negotiating with officials in Montana regarding reserved instream flows in the areas's National Forest.

38/ 438 U.S. at 700.

contrary to them. It will indeed take a compelling argument by U.S. attorneys to convince the Court to rule otherwise.

The fact that the Forest Service is unlikely to prevail under the reserved rights doctrine does not negate the important issues raised by its claims. In many parts of the West, the problems with stream channel degradation are increasingly evident as spring runoff floods out of clogged beds. Such flooding results in property damage as well as in waste of precious water as it spreads out of its banks and is consumed or evaporated nonbeneficially. Such damage and waste is of growing concern to water planners in Western states, and will require serious attention in the coming years.

The legal framework already exists in which both the states and the Forest Service can work to mitigate this problem. In areas where the flooding, water quality, and waste problems are identified in the National Forest, the United States could work cooperatively with the states to obtain the necessary instream flows to prevent aggravation of the problem. Many Western states already have instream flow programs in place which can accommodate such needs to protect the natural stream environment. In addition, cooperative efforts could be initiated with the water users and property owners who are being adversely impacted by the channel clogging problem.

The Forest Service does not, however, need to rely on others' good faith alone in order to pursue its goals under existing law. If Forest Service personnel identify streams in which additional diversions will cause channel degradation problems, they have the authority to make the developer accommodate instream flows through administrative permitting processes. The courts have long recognized the validity of special use permits issued by the Forest

Service (through the Secretary of Agriculture) for construction projects within forest boundaries:

"Broad authority is conferred by 16 U.S.C.A. §§ 497 and 551 for the Secretary to issue use permits under such regulations as he may make and upon such terms and conditions as he may deem proper. This grant of authority seems clearly valid in view of Congress' power over public lands and the conditions that may be on their use." 39/

In 1976, Congress directly addressed the issuance of permits in the National Forests associated with rights-of-way for water developments. Under 16 U.S.C. § 1761(a)(1), the Secretary is authorized to "grant, issue or renew rights-of-way over, under, or through such lands for reservoirs, canals, ditches, flumes, laterals, pipes, pipelines, tunnels, and other facilities and systems for the impoundment, storage, transportation, or distribution of water." It is unlawful for a water developer to proceed without such a permit and the Secretary may deny it if the requested right-of-way would defeat the primary purpose of the forest reservation. Also, 16 U.S.C. § 1765(a)(ii) places an affirmative duty on the Secretary to incorporate into the right-of-way, "terms and conditions which will minimize damage to . . . fish and wildlife habitat and otherwise protect the environment." Subsection (b) follows by granting to the Secretary the ability to design additional terms and conditions for the protection of the federal lands and the public interest therein.

Application of these existing powers could facilitate site-specific solutions in National Forest areas where additional diversions will aggravate channel degradation problems. The Forest Service could write into the right-of-way permit specific requirements for minimum bypasses of

39/ Sabin v. Butz, 515 F.2d 1066 (10th Cir. 1975).

streamflow that are needed to protect the stream environment. Ideally, these could be developed in cooperation with states and local water users. But if litigation were to follow that attacks the channel maintenance theory upon which the instream flow levels are predicated, the Forest Service would carry administrative presumptions of validity into trial, instead of the heavy burden of overcoming the hurdles it faces in the current reserved rights litigation.

CONCLUSION

It may be naive to believe that the United States would forego its ongoing claims for reserved instream flow rights in order to cooperatively address a problem facing the Western states. The federal litigants are motivated by an honest belief that they have a valid claim worth pursuing in court. One can hope, however, that the states, water users, and the federal government will soon come together to assess this problem of channel degradation and the waste and damage it can cause. Government lawyers and expert witnesses

may shortly expend hundreds of thousands of tax dollars, both federal and state, in order to pursue adversary legal positions on what is actually a mutual problem.

Such money could be used instead to begin solving this problem that the Forest Service has brought to light through its claims. Onsite projects could be funded in order to alleviate past damage to natural stream channels. Likewise, administrative actions can be initiated through the existing legal framework (i.e., rights-of-way permits and state instream flow programs) to mitigate future channel degradation problems where necessary.

It is probable that the momentum of litigation in Colorado will prevent such a refocusing of resources there. But as Round Two of the battle for instream flows in the National Forests spills over into other states, those responsible for water resources — on both state and federal levels — should consider the alternatives available for its protection, management, and use.

ATTORNEY POSITIONS AVAILABLE

The Colorado State Attorney General's Office has openings for up to a dozen qualified attorneys with a minimum of two years litigation experience for federal district court hazardous waste litigation. Please send a resume and writing sample to: Janet L. Miller Office of the Attorney General, 1525 Sherman Street, Denver, CO 80203.

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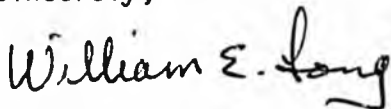
The Honorable Arliss Sturgulewski
Alaska State Senate
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Anchorage, AK 99508

Dear Senator Sturgulewski:

Enclosed is an updated 1985-1989 copy of the Alaska Water Resources Evaluation (AWARE) 5-Year Plan, compiled by the U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys. This cooperative effort is updated annually in order to accurately summarize the water resources related programs being conducted, and those that are needed, throughout the State of Alaska.

Demand for water resources data are increasing yearly. There never are enough data. Persons using the hydrologic information generated by the AWARE program, or those needing data not addressed, are encouraged to suggest changes to us. Current budgetary cutbacks threaten completion of some projects and tasks outlined in this plan in spite of increased efficiency of the DNR water resources hydrologists.

Sincerely,



William E. Long
Chief, Water Resources Section

/jlw

Enclosure

5-YEAR PLAN



1985-1989

ALASKA DEPARTMENT OF NATURAL RESOURCES
Division of Geological and Geophysical Surveys

U.S. GEOLOGICAL SURVEY
Water Resources Division

ALASKA WATER RESOURCES EVALUATION

5-YEAR PLAN

1985-1989

Prepared jointly by

Division of Geological and Geophysical Surveys,
Department of Natural Resources, State of Alaska

and

Water Resources Division, U.S. Geological Survey,
Department of the Interior

June 1985

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INTRODUCTION

"One could write the story of man's growth in terms of his epic concerns with water. Through the ages people have elected or been compelled to live in regions where water was either deficient in amount, inferior in quality, or erratic in behavior.....(Yet) people have always preferred to meet their water troubles head on rather than quit their places of abode and industry, and.....applied their creative imagination and utilized their skills.....to find, develop, and maintain suitable water supplies.....We must pool our efforts if we expect to apply appropriate and durable prescriptions for our water ills."

(excerpts from "The Story of Water as the Story of Man," by Bernard Frank, in U.S. Dept. of Agriculture Yearbook, 1955)

The Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (DNR-DGGS), and the U.S. Geological Survey, Water Resources Division (USGS-WRD) have developed a statewide program for water-data collection and hydrologic studies called AWARE (Alaska Water Resources Evaluation). This document is a summary of the current and proposed future (through 1989) plan for hydrologic basic data collection and study activities in Alaska by these two agencies and will help define the Statewide Natural Resources Plan. Reference to related activities and programs of other agencies and institutions (Federal, State and Municipal) is also included.

It is emphasized that this is a plan, and that accomplishment of its goals and objectives (p. 6-7) will depend on the continued support and participation -- in terms of funding and available personnel -- of all agencies involved. These factors are, of course, subject to changing economic conditions, priorities, and policy decisions at all levels of government.

Water Resources Data

Although at first glance Alaska's rivers, lakes, snowfields, glaciers, and even muskeg and wet tundra areas seem to offer "water, water everywhere", a useable supply may not be available at a given time and place -- winter on the North Slope, for example. Too much water at the "wrong" time and place means flooding. Water may not be of suitable quality for its intended use or may be subject to contamination. Avoiding, or at least lessening the effect of such problems, even in the presence of abundant water, requires an understanding of the water resource -- its occurrence, movement, and availability -- as well as planning and management of its use. The basis for that understanding is an adequate bank or store of water resources data.

Water resources data are needed to effectively plan for and manage uses of water such as private, municipal, commercial, and industrial supply; recreational activities; hydroelectric power generation; irrigation; placer mining; and numerous other activities. Water data are analyzed to develop criteria for the protection of aquatic environments that support Alaska's all-important commercial and recrea-

tional fisheries and to predict the probable occurrence and severity of hydrologic hazards such as floods, erosion, and drought. Measurements and observations of hydrologic features and phenomena -- glaciers, icings, permafrost, ice-jam and glacier-outburst flooding -- unique to Arctic regions, and thus common in Alaska, are critical to the effective utilization of the State's water resources.

The U.S. Geological Survey first started systematic collection of hydrologic data in Alaska Territory in the late 1940's and the Water Resources Division of the USGS dominates Alaskan water data collection today. After statehood, the Division of Geological and Geophysical Surveys (DGGs) of the Alaska Department of Natural Resources became the Alaskan equivalent of the USGS and is the designated State agency responsible for water-resources data collection.

Agencies at all levels of government, universities and their associated institutes, many private enterprises, and individuals must have adequate information about water resources to conduct their activities. A primary user of water data is the Division of Land and Water Management of DNR, the agency responsible for adjudication of water rights and management of water use in Alaska. Coordination of water-data collection and management has become a major concern. This plan is a response to that concern.

AWARE 5-Year Plan

The AWARE 5-year plan complements and defines the DNR Statewide Natural Resources Plan which sets our Water Resources Inventory and Water Management goals and objectives. A Memorandum of Agreement between USGS-WRD and DNR-DGGs states the need for a comprehensive program to provide for the coordination of water-data collection and water resources study activities in Alaska. The Memorandum specifies that a 5-year plan for such a program be prepared, reviewed and updated annually.

This plan has been prepared by DNR and WRD hydrologists and water managers using input from other State and Federal agencies, particularly Alaska Division of Land and Water Management. The progress, status, and future needs for data collection and hydrologic studies in Alaska were primary considerations. State and Federal agencies directly involved in water-related activities or in need of or using water data have been contacted. Responses from those agencies, along with the results of the joint USGS-DGGs review of the AWARE program, have been incorporated in this revised 5-year plan. 1/

Unique aspects of Alaskan water resources have been included in the plan. Mid-winter river overflow icing, ice-jam flooding during spring breakup, snow surveys over 20 degrees of latitude, the effect of glaciers and outburst flooding on streamflow characteristics, analysis of permafrost terrain and its related hydrology, and the interactions between glaciers and volcanoes are examples of hydrological subjects which are rarely found elsewhere in the United States. In

1/ Due to the schedule set for issuing this document, contributions and/or updates were not received for all agencies. The Responsible Agency shown in the Related Programs sections should be contacted for further details on programs listed or for information on other ongoing or proposed projects.

the State of Washington considerable attention is paid to snow and glacier ice as important parts of the hydrological cycle. In Alaska we must focus even more on these aspects. (In April 1985, a "Workshop on Alaska Hydrology: Problems Related to Glacierized Basins," organized by the University of Alaska's Geophysical Institute, brought together scientists from Alaska and other states, Canada, and several European countries.) Future revisions of this plan will undoubtedly give increasing emphasis to unique Alaskan processes.

Plan Revision

A fundamental part of the AWARE program is the development and implementation of a plan to fulfill the data and information needs of all Alaska water users. In order to be successful, the program must include input from all groups or individuals who need or use water or water data. Participation in the continuing revision of and comments on this plan are welcomed by the DGGs and USGS. Suggestions for additions or other changes should be brought to the attention of:

Chief, Water Resources Section
DNR/DGGS
P.O. Box 77-2116
Eagle River, AK 99577

District Chief
USGS/WRD
4230 University Drive, Suite 201
Anchorage, AK 99508-4664

Acknowledgments

In addition to the ADNR-Division of Geological and Geophysical Surveys, Division of Land and Water Management, and the USGS-Water Resources Division, the following agencies are either involved in or provide funding for water resources study activities in Alaska. Their support of and participation in AWARE are critical to the success of the plan.

Federal

Bureau of Land Management (BLM)
U.S. Army, Corps of Engineers (USCE)
U.S. Environmental Protection Agency (USEPA)
U.S. Forest Service (USFS)
National Park Service (NPS)
National Weather Service (NWS)
Public Health Service (PHS)
Soil Conservation Service (SCS)
Cold Regions Research and Engineering
Laboratory (CRREL)
U.S. Fish and Wildlife Service
(USF&WS)
Alaska Cooperative Research
Fisheries Unit (ACRFU)

State of Alaska

Department of Natural Resources (DNR)
Division of Agriculture (DA)
Division of Mining (DM)
Division of Forestry (DF)
Division of Parks (DP)
Department of Environmental
Conservation (DEC)
Department of Fish and Game (DF&G)
Department of Transportation and Public
Facilities (DOT&PF)
Department of Commerce and Economic
Development (DC&ED)
Alaska Power Authority (APA)
Agricultural Action Council (AAC)

Industry

U.S. Borax (USB)

Department of Community & Regional
Affairs - Division of Municipal and
Regional Assistance
Geophysical Institute, University of
Alaska (GI)
Institute of Water Resources/
Engineering Experiment Station,
University of Alaska (IWR/EES)
Arctic Environmental Information and
Data Center, University of Alaska (AEIDC)

Local

Municipality of Anchorage (MOA)
Elfin Cove
Fairbanks North Star Borough (FNSB)
The City and Borough of Juneau (JCB)
Kena Peninsula Borough (KPB)
Matanuska-Susitna Borough (MSB)
North Slope Borough (NSB)
City of Petersburg
City of Sitka
City of Wasilla

ALASKA'S WATER RESOURCES

Glacier ice covers 17,000 square miles in Alaska, about 5 percent of the total area of the State. However, seasonal snow forms a veneer on most of Alaska for one-half to three-quarters of the year, and the freezing and thawing of water affect virtually all of the State to some extent.

Surface Water

Surface waters of Alaska include many large rivers. The Yukon River ranks fifth in size in the United States, and six Alaskan rivers (Yukon, Copper, Stikine, Susitna, Kuskokwim, and Tanana) are among the 30 largest U.S. rivers. Glacial sources for most Alaskan rivers cause important hydrologic consequences in addition to the heavy loads of glacier-derived silt carried by the glacial streams. For example, even a small amount of glacier-covered area in a drainage basin can have a major effect on the amount and timing of runoff.

Alaskan lakes are so numerous that they are essentially uncounted. Lake Iliamna, Alaska's largest, has a surface area of 1,000 square miles. Springs occur throughout the State -- as innumerable small seeps and as warm or mineral waters that support recreational centers. On the North Slope, flow from large springs produces widespread icings in winter.

Ground Water

Ground water is an untested resource in most of Alaska, but in many areas potential development of the resource far exceeds current use. Ground-water conditions are highly variable: major aquifers are present in the alluvium of large river valleys (Yukon, Tanana, Kuskokwim, Susitna), in glacial outwash deposits under coastal basins (Cook Inlet) and valleys (Seward and Juneau), and in carbonate bedrock of the Brooks Range. In many areas, however, the fine-grained material of glacial and glacial-lake deposits and poorly permeable consolidated rocks offer a much less promising ground-water potential. In addition, the recharge, discharge, movement, and thus the availability of ground water over much of the interior, western, and northern parts of the State and on the flanks of the Alaska Range are restricted by permafrost -- permanently frozen ground.

Water Quality

The quality of Alaskan waters is generally acceptable for most uses. However, available data do indicate naturally occurring problems such as suspended sediment in glacier-fed streams, and salt-water intrusions and undesirable concentrations of iron or arsenic in ground water at various locations. A few instances of local, man-caused water pollution have been identified.

ALASKA WATER RESOURCES EVALUATION

5-YEAR PLAN

1985 - 1989

LONG-RANGE GOAL

The AWARE goal is to provide water resource information and understanding needed by local, State, and Federal agencies, and by industry and the general public, for utilization and management of Alaska's water resources for the benefit of the people of Alaska through the conduct of water-resources investigations; and the collection and dissemination of these water resources data.

OBJECTIVES

This water resources evaluation program is comprised of three main elements. The first is to provide and improve the State-Federal Water Data and Information System, through collection, analysis, and dissemination of water data. The second element includes areal investigations, appraisals, and applied research related to defining and resolving specific water resource problems. The third element is to coordinate water data acquisition among State, Federal, and local agencies. The major objectives of each of these components follow:

A. State-Federal Water Data and Information System

Objectives:

1. To collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of Alaska's water resources.
2. To disseminate water data and results of investigations and research through reports, maps, computerized information services, and other forms of public release.

B. Water Resources Areal Investigations, Problem Appraisals, and Applied Research

Objectives:

1. To conduct analytical and interpretive water resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.
2. To provide scientific and technical assistance in hydrology to other State, Federal, and local agencies.
3. To conduct problem-oriented research in hydraulics, hydrology, and related fields of science, to improve the scientific basis for investigation and measurement techniques, and to understand hydrologic systems sufficiently well to predict their response to stress, either natural or man-made.

C. Coordinate Water Data Acquisition

Objective:

1. To coordinate the activities of State and Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water. (The Division of Geological and Geophysical Surveys has statutory authority [AS 41.08] for coordination of water-data collection by State agencies. The U.S. Geological Survey has such responsibility regarding Federal agencies under the provisions of OMB Circular A-67.)

APPROACH

Individual data-collection activities and projects within the AWARE program, and their more specific purposes and objectives, reflect the translation of the overall goals and objectives listed above into a proposed implementation plan for the period 1985-1989. The projects are listed and described in the following pages.

For management purposes, Division of Land and Water Management divides Alaska into three regions (fig. 1): Northern, Southcentral, and Southeast. Data collection and study activities are described for each region and projects with more wide-spread application are described under the Statewide category.

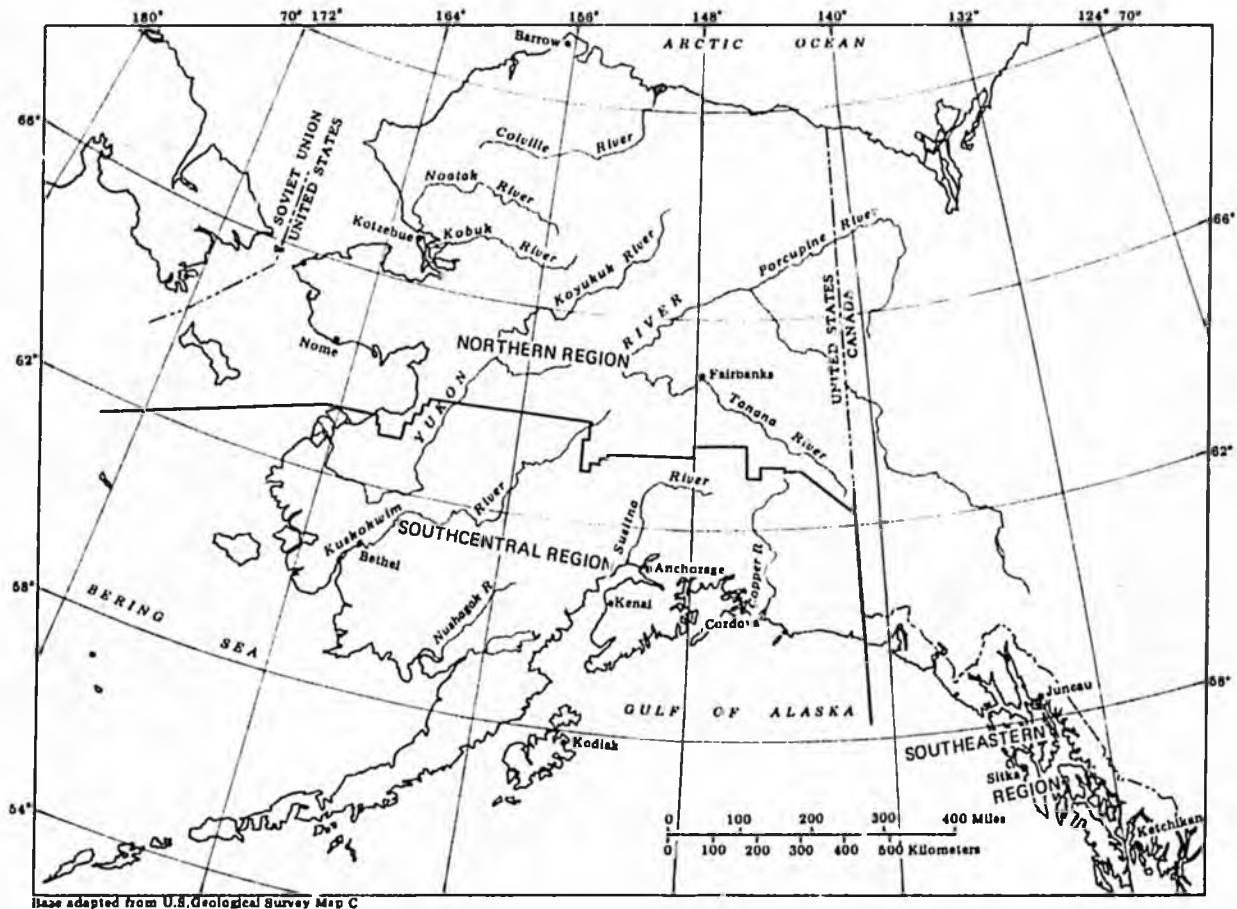


Figure 1. -- Index to land and water management regions.

STATEWIDE PROGRAMS

Statewide programs are primarily those activities aimed at achieving the objectives of the first major element of the AWARE program -- the collection, analysis, and dissemination of water data. The needs for such data may extend beyond the boundaries of a single region or may not be met within the scope, areal extent, and time constraints of one or more specific studies or resource appraisals. The selection of sites or areas to be included within a particular data-collection network is guided by the following criteria:

- a. Need - of an individual, group or agency for a specific type of data at a particular time or place, or for a specific application.
- b. Areal coverage - geologic and climatic differences in Alaska create a wide range and variety of hydrologic conditions and phenomena.
- c. Representativeness - data-collection sites should be the hydrologically most representative within the area or environment sampled. Data should have a maximum transfer value to other, hydrologically similar sites or areas.

A. Statewide DNR/USGS Projects

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
1. Surface-Water Stations	F	F	F	F	F	USGS	Many agencies
2. Ground-Water Stations	F	F	F	F	F	USGS	DGGS
3. Water-Quality Stations	F	F	F	F	F	USGS	USFS/DF&G/ DGGS/DEC
4. Sediment Stations	F	F	F	F	F	USGS	APA/USCE/ DGGS/DEC
5. Alaska Water-Use Data System	F	F	F	F	F	DLWM	USGS
6. River Navigability Surveys	F	F	F	F	F	DLWM	DGGS
7. Water Rights Advisory	F	F	F	F	F	DLWM	DGGS
8. Water Resources Data System	F	F	F	F	F	DGGS/DLWM/ USGS	
9. Land Disposal Review	F	F	F	F	F	DLWM	DGGS

A. Statewide DNR/USGS Projects--Continued

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
10. Basinwide Adjudication Technical Support	P	P	P	P	P	DLWM	DGGS
11. Dam Safety	F	F	F	F	F	DLWM	DGGS
12. Instream Flow Analysis	F	F	F	F	F	DLWM	DGGS
13. Community Assistance	P	P	P	P	P	DGGS	DLWM

F - funded at present; funding anticipated
P - proposed, funds needed
C - completed

1. SURFACE-WATER STATIONS

A network of 104 continuous gaging stations (see table 1, p. 10 to 14) and 65 crest stage stations (figs. 2 and 3) equipped with water stage recorders, peak stage indicators, as well as periodically observed water-level indicators (staff plates) provides information on lake levels and on streamflow, including flood heights and discharges. Recorded or observed values of stream stage (water level) are used in conjunction with periodic field measurements of discharge to compute flow on a daily basis. Data collected as part of the AWARE plan augment the USGS Collection of Basic Records (CBR) program. These data are used in planning, designing and operating water-supply systems and hydroelectric facilities, designing stream crossings (pipelines, bridges, culverts), and assessing environmental impacts of such structures or facilities. On a real-time basis, these data are used to provide flood warnings, current river conditions (navigation safety), and forecasts for commercial and recreational activities.

2. GROUND-WATER STATIONS

A network of observation wells (fig. 4) provides data on ground-water level fluctuations. Water-level data indicate the status of ground water in storage, changes in storage due to development (pumping), effects of land-use changes (clearing and artificial drainage), and probable base flow of hydraulically connected streams nearby. Continued operation of the network will provide long-term records for regional studies that, in turn, serve as a basis for correlation of short-term hydrologic data collected for specific purposes.

3. WATER-QUALITY STATIONS

Analyses of data collected at these stations (which generally are also surface-water data stations) allow for characterization of the chemical, physical, and biological properties of surface waters of the State to (1) serve as a base from which many changes can be measured, and (2) permit evaluation of the suitability of

Table 1.--Selected hydrologic data for stations in the Alaska surface-water program.

Index no.	Station no.	Station name	Drainage area (mi ²)	Period of record	Mean annual flow (ft ³ /s)
SOUTHEAST ALASKA					
1	15022000	Harding River near Wrangell	67.4	1951-	732
2	15024750	Goat Creek near Wrangell	17.3	1976-	192
3	15024800	Stikine River near Wrangell	19,920	1976-	56,674
4	15028300	Farragut River near Petersburg	151	1977-	1,574
5	15049900	Gold Creek near Juneau	8.41	1984-	
6	15051008	Salmon Creek above Diversion near Juneau	9.77	1982-	---
7	15052009	Lemon Creek near Mouth near Juneau	22.9	1982-	---
8	15052500	Mendenhall River near Auke Bay	85.1	1965-	1,129
9	15052800	Montana Creek near Auke Bay	15.5	1965-1975, 1983	105
10	15056100	Skagway River at Skagway	145	1963-	568
11	15056560	Klehini River near Klukwan	245	1981-	---
12	15067900	Upper Mahoney Lake outlet near Ketchikan	2.03	1977-	40.3
13	15072000	Fish Creek near Ketchikan	32.1	1915-36, 1938-	421
14	15081580	Black Bear Lake outlet near Klawock	1.82	1980-	---
15	15081995	Reynolds Creek below Lake Mellen near Hydaburg	5.20	1982-	---
16	15083500	Perkins Creek near Metlakatla	3.38	1976-	34
17	15085100	Old Tom Creek near Kasaan	5.90	1949-	38.8
18	15087545	Municipal Watershed Creek near Petersburg	2.20	1978-	22.9
19	15087570	Hamilton Creek near Kake	65.0	1972-73a, 1975-76a, 1976-	326
20	15087590	Rocky Pass Creek near Point Baker	2.72	1976-	11
21	15087690	Indian River near Sitka	10.1	1980-	---
22	15101500	Greens Creek near Juneau	22.8	1978-	60.2
23	15106920	Kadashan River above Hook Creek near Tenakee	10.2	1968-78, 1980-	63.1
24	15106980	Tonalite Creek near Tenakee	14.5	1968-	96.4

See footnotes at end of table.

Table 1.--Continued

Index no.	Station no.	Station name	Drainage area (mi ²)	Period of record	Mean annual flow (ft ³ /s)
SOUTH-CENTRAL ALASKA					
25	15212000	Copper River near Chitina	20,600	1950b, 1952b, 1955-	37,670
26	15216000	Power Creek near Cordova	20.5	1913c, 1947-	250
27	15238648	Upper Nuka River near Homer	d	1984-	---
28	15238653	Nuka River near tidewater near Homer	d	1984-	---
29	15238820	Barbara Creek near Seldovia	20.7	1972-	105
30	15238990	Upper Bradley River near Homer	10d	1979-	---
31	15239000	Bradley River near Homer	54d	1955b, 1957-	434
32	15239050	Bradley River tributary near Homer	9.25	1979-	---
33	15239070	Bradley River near tidewater near Homer	82	1983-	---
34	15239900	Anchor River near Anchor Point	137	1964-73, 1974a, 1978-	201
35	15241600	Ninilchik River at Ninilchik	131	1963-	107
II 36	15258000	Kenai River at Cooper Landing	634	1947-	2,824e
37	15266300	Kenai River at Soldotna	2,010	1965-	5,907
38	15267900	Resurrection Creek near Hope	149	1967-	281
39	15271000	Sixmile Creek near Hope	234	1979-	---
40	15273050	Rabbit Creek at Anchorage	15	1979-80, 1984-	---
41	15273095	Little Rabbit Creek above Goldenview Drive at Anchorage	5.06	1980-	---
42	15273105	Rabbit Creek at New Seward Highway at Anchorage	f	1984-	---
43	15274300	North Fork Campbell Creek near Anchorage	13.4	1967-74a, 1974-	18.2
44	15274600	Campbell Creek near Spenard	69.7	1966-	65.5
45	15274798	South Branch South Fork Chester Creek near 20th Avenue at Anchorage	9.39	1980-	---
46	15275100	Chester Creek at Arctic Boulevard at Anchorage	27.2	1966-	18.1
47	15276000	Ship Creek near Anchorage	90.5	1946-	163g

See footnotes at end of table.

Table 1.--Continued

Index no.	Station no.	Station name	Drainage area (mi ²)	Period of record	Mean annual flow (ft ³ /s)
SOUTH-CENTRAL ALASKA--Continued					
48	15281000	Knik River near Palmer	1,180	1959h	6,955
49	15290000	Little Susitna River near Palmer	61.9	1948-	208
50	15291000	Susitna River near Denali	950	1957-66, 1967j, 1968-	2,759
51	15291200	Maclaren River near Paxson	280	1958-	979
52	15291500	Susitna River near Cantwell	4,140	1961-72, 1980-	6,404
53	15292000	Susitna River at Gold Creek	6,160	1949-	9,724
54	15292400	Unulitna River near Talkeetna	2,570	1958-72, 1973-77a, 1979a, 1980-	8,798
55	15292700	Talkeetna River near Talkeetna	2,006	1964-	4,055
56	15292780	Susitna River at Sunshine	11,100	1981-	---
57	15294005	Willow Creek near Willow	166	1978-	417
12 58	15294010	Deception Creek near Willow	48.0	1978-	69.1
59	15294100	Deshka River near Willow	592	1978-	941
60	15294345	Yentna River near Susitna Station	6,180	1980-	---
61	15294350	Susitna River at Susitna Station	19,400	1974-	49,940
62	15294410	Capps Creek below North Capps Creek near Tyonek	10.5	1979-	---
63	15294450	Chuitna River near Tyonek	131	1975-	369
64	15294900	Paint River near Kamishak	205	1983-	---
65	15295600	Terror River near Kodiak	15.0k	1962-68, 1978-	142k
66	15295700	Terror River at mouth near Kodiak	45.7k	1964-68, 1981-	294k
67	15297200	Myrtle Creek near Kodiak	4.74	1963-	46.2
68	15297485	Kizhuyak River near Port Lions	27.5k	1980-	---

See footnotes at end of table.

Table 1.--Continued

Index no.	Station no.	Station name	Drainage area (mi ²)	Period of record	Mean annual flow (ft ³ /s)
SOUTHWEST ALASKA					
69	15297610	Russell Creek near Cold Bay	25	1981-	---
70	15303010	Silver Salmon Creek near Aleknagik	4.46	1965-67a, 1969-83a, 1984-1973-76, 1977-	---
71	15299900	Tazimina River near Nondalton	327	1981-	---
72	15300000	Newhalen River near Iliamna	3,478	1951-67, 1968-77a, 1982-	9,226
73	15300500	Kvichak River at Igiugig	6,500	1967-	18,060
74	15302000	Nuyakuk River near Dillingham	1,490	1953-	6,156
75	15302500	Nushagak River at Ekwok	9,850	1977-	23,840
76	15304000	Kuskokwim River at Crooked Creek	31,100	1951-	41,220
77	15304200	Kisaralik River near Akiak	270	1979-	---
YUKON ALASKA					
13 78	15344000	King Creek near Dome Creek	5.99	1975-82a, 1983-	---
79	15356000	Yukon River at Eagle	113,500	1911-13, 1950-	82,660
80	15388950	Porcupine River at Old Crow, Yukon Territory	21,400	1961-68, 1969-	m
81	15439800	Boulder Creek near Central	31.3	1964-65a, 1966-82, 1983a, 1984-	11.6
82	15453500	Yukon River near Stevens Village	196,300	1976-	119,200
83	15457800	Hess Creek near Livengood	662	1970-78, 1982-	227
84	15476000	Tanana River near Tanacross	8,550	1953-	7,943
85	15478040	Phelan Creek near Paxson	12.2	1966-78, 1983-	69.7
86	15484000	Salcha River near Salchaket	2,170	1909-10b, 1948-	1,640
87	15485500	Tanana River at Fairbanks	n	1973-	19,060
88	15493000	Chena River near Two Rivers	941	1967-	644
89	15493700	Chena River below Moose Creek Dam	1,430	1979-	---
90	15511000	Little Chena River near Fairbanks	372	1966-	203
91	15514000	Chena River at Fairbanks	1,980	1947-48b, 1948-	1,384
92	15515500	Tanana River at Nenana	25,600	1962-	23,550

See footnotes at end of table.

Table 1.--Continued

Index no.	Station no.	Station name	Drainage area (mi ²)	Period of record	Mean annual flow (ft ³ /s)
YUKON ALASKA-Continued					
93	15535000	Caribou Creek near Chatanika	9.19	1969-	5.09
94	15564875	Middle Fork Koyukuk River near Wiseman	1,200	1970-78, 1984-	709
95	15565447	Yukon River at Pilot Station	321,000	1975-	219,600
NORTHWEST ALASKA					
96	15621000	Snake River near Nome	85.7	1965-81, 1982-	183
97	15668200	Crater Creek near Nome	21.9	1964-65a, 1967-75a, 1975-	54.6
98	15744500	Kobuk River near Kiana	9,520	1976-	15,270
99	15747000	Wulik River below Tutak Creek near Kivalina	705	1984-	---
ARCTIC SLOPE ALASKA					
100	15798700	Nunavak Creek near Barrow	2.79	1971-	0.84
101	15896000	Kuparuk River near Deadhorse	3,130	1971-	1,367
102	15896700	Putuligayuk River near Deadhorse	176	1970-79, 1981-	42.2
103	15904900	Atigun River tributary near Pump Station 4	32.6	1976-	29.9
104	15908000	Sagavanirktok River near Pump Station 3	1,860	1982-	---

a Operated as a crest-stage gage.

b Seasonal summer record only.

c Fragmentary record.

d Drainage area not determinable to greater precision because it varies due to changes in route of meltwater stream from glacier at head of basin.

e Adjusted to exclude diversion from Cooper Lake.

f Not yet determined because drainage area depends on storm sewer network.

g Adjusted to include diversion for water supply.

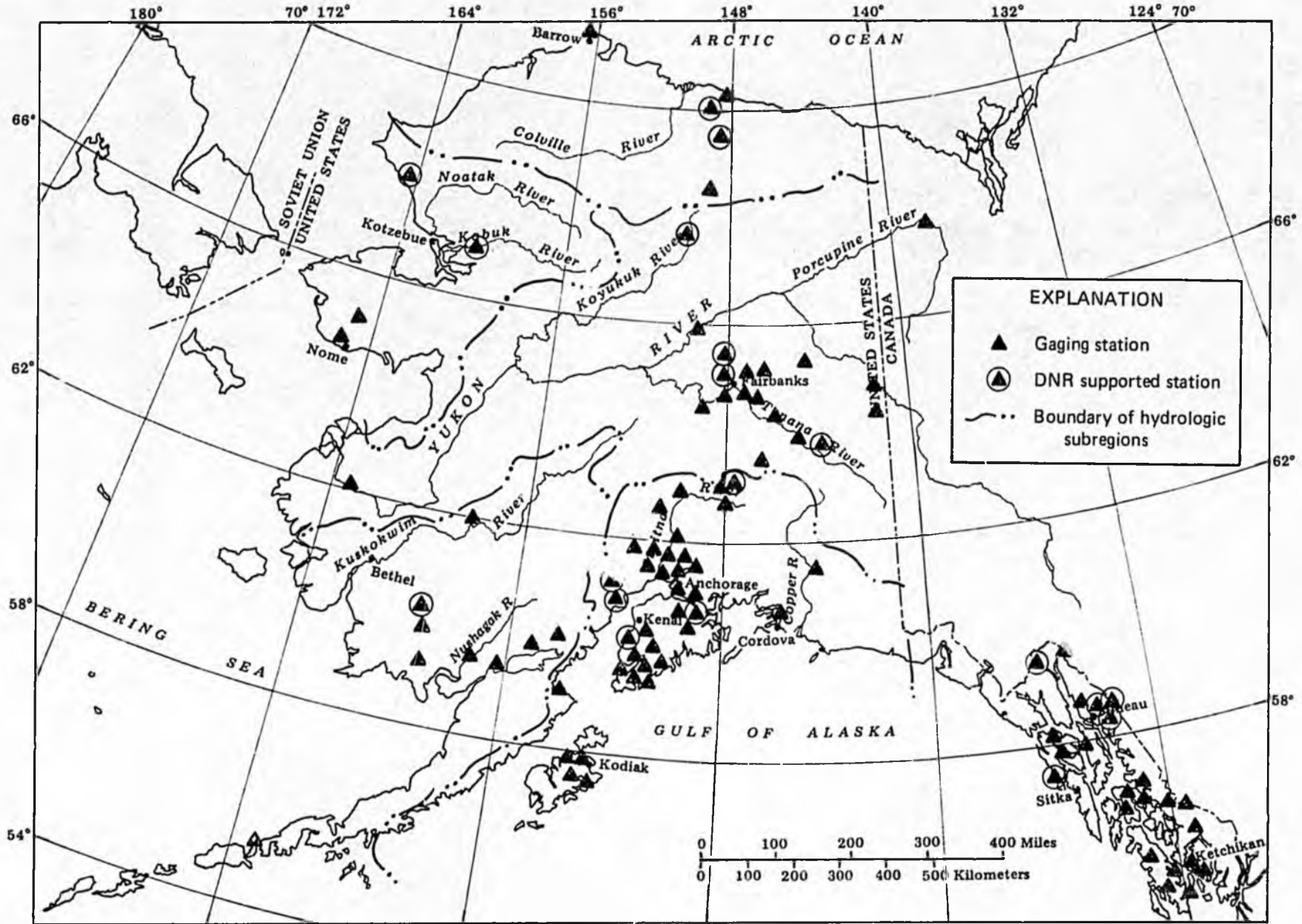
h Flood peaks due to outbreak of glacier-dammed Lake George for 1948-62 and 1964-65 available.

j Only flood peak available.

k Affected by construction of Terror Lake Hydroelectric Power Project

m Average not determined, Canadian record.

n Drainage area undefined as part of river flows through Salchaket Slough and is ungaged.



Base adapted from U.S. Geological Survey Map C

Figure 2.--Distribution of stream-gaging stations (diagrammatic - - 104 continuous-record stations operating in 1985).

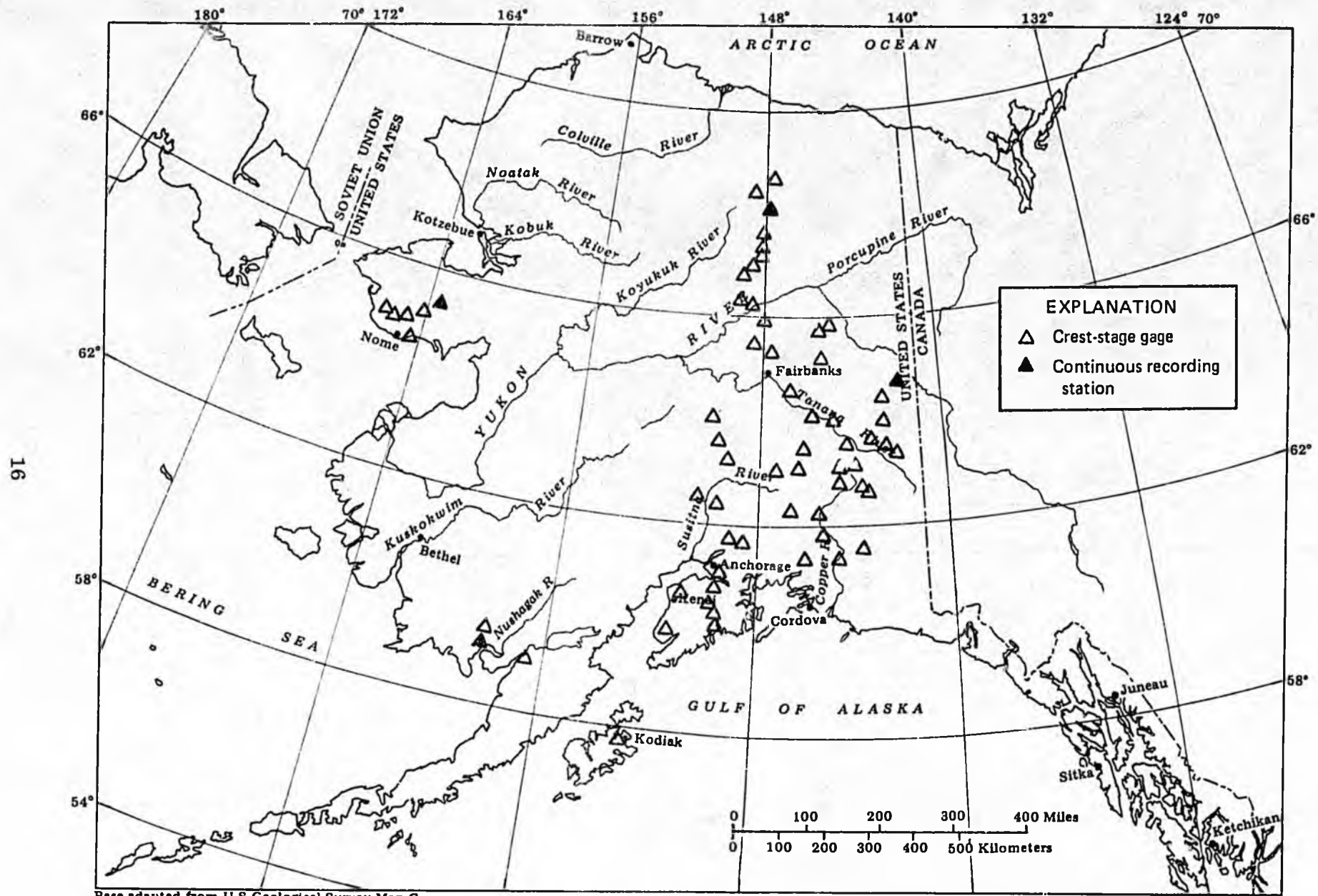
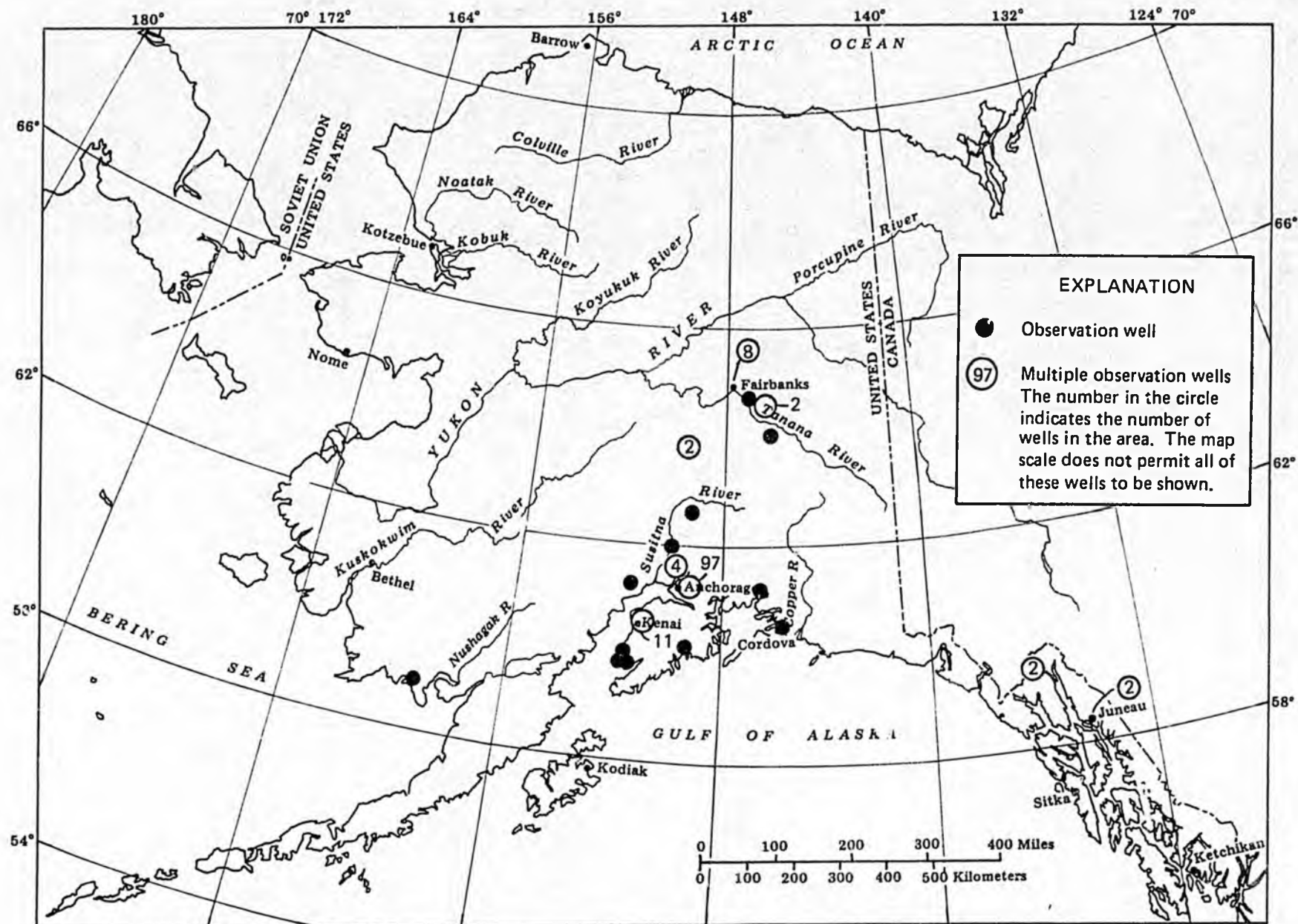


Figure 3.--Location of data-collection sites in small-streams (drainage area = 100 square miles or less) flood study network.



Base adapted from U.S. Geological Survey Map C

Figure 4.--Location of ground-water observation wells.

a water source for domestic, municipal, and industrial use. Water-quality stations operated as part of the AWARE plan augment the CBR program in development of the bank of data useful in broad State and Federal planning and action programs and in the management of international (Alaska-Canada) waters.

4. SEDIMENT STATIONS

Suspended-sediment concentration (actually a physical property of water) and sediment transport and discharge data collected at these stations are important for evaluating: effects of construction, bridges, culverts, pipeline crossings, and hydroelectric dams; effects of activities such as placer mining and sand-and-gravel removal; and effects of sediment on operation of hydroelectric facilities. Data from these stations also contribute to accomplishing the objectives of the USGS CBR program.

5. ALASKA WATER-USE DATA SYSTEM

The objectives of this program are to develop among agencies a coordinated and efficient system to collect, store, and disseminate data on water use in Alaska. The data are critical to planning the development and management of the State's water resources. Efforts within this program will contribute to the National Water-Use Data System (NWUDS) and support decisions in the appropriation of water rights in Alaska. DLWM collects the data and is a primary user of the data.

6. RIVER NAVIGABILITY SURVEYS

By Federal law, the State is entitled to the beds of all navigable water bodies, including the natural resources on and under the beds of those water bodies. DLWM needs criteria for determining "navigability" to argue Alaska's case in Federal courts in order to address anticipated disputes between various agencies, groups, and individuals. DGGs has the responsibility to describe the physical characteristics (such as width, depth, and velocity of flow) of selected water bodies throughout the State. Through 1983, surveys have been completed on the Matanuska, Alagnak, Gakona, Nenana, and Eagle Rivers; and Big Lake (Brooks Range), Hudson, Alexcy and Northway Lakes. Regional reports on water bodies in the Koyukuk, Bristol Bay, and Arctic areas are near completion. Surveys are planned for other areas of the State, though specific streams and lakes have not been selected.

7. WATER RIGHTS ADVISORY

Increasing conflicting uses of water statewide has led the DLWM to frequently require detailed technical analyses and interpretations of various hydrologic conditions. Services provided by the Water Resources Section of DGGs include data acquisition and the needed analyses and interpretations. Water managers of DLWM use this information in decisions on appropriations.

8. WATER RESOURCES DATA SYSTEMS (WATSTORE)

Data collected on the quantity and quality of ground, surface, and coastal waters through various State and Federal programs are entered into several computer systems. The USGS and DGGs have long enjoyed a unique and successful cooperative

agreement where Alaskan data entered into national systems such as NAWDEX and WATSTORE are readily available for project research and distribution to all users. Compatibility between the above-mentioned Federal data systems and DGGs' geoprocessor and Well Log Tracking System (WELTS) enables users to utilize the most recent and reliable data on water resources in Alaska.

9. LAND DISPOSAL REVIEW

Land disposals of many forms are a major activity for DLWM. Each land disposal action is reviewed by DGGs for hydrological implications and factors such as flooding, water supply, erosion, and water-quality effects.

10. BASINWIDE ADJUDICATION TECHNICAL SUPPORT

Due to unquantified Federal Reserve Water Rights and unknown streamflow values, several high-density, competitively used water bodies have been subject to over-appropriation. In the event of water shortages or drought, Ship Creek in Anchorage, and possibly Indian River at Sitka would be primary examples of situations where the right to use water may exceed the water available for use. Basin-wide Adjudications designed to quantify all uses, either private, State, or Federal, will assure orderly, effective management scenarios for high-use areas. In such cases, DLWM would request that DGGs designate drainage basin boundaries, collect and evaluate hydrologic data, and provide other technical assistance needed for basin-wide adjudication.

11. DAM SAFETY

The Water Management Section of DLWM is charged with permitting the construction or modification of dams 10 feet or more in height or storing 50 acre-feet or more of water. Detailed hydrologic data on affected drainage basins, spillway capacities, and flooding potentials downstream are occasionally directed to DGGs for review of adequacy.

12. INSTREAM FLOW ANALYSIS (RESERVATION)

All surface and subsurface waters of Alaska are reserved to the people for common use, and are subject to appropriations. One form of nonconsumptive use of water is the instream flow reservation. A person may apply to reserve sufficient water to maintain a critical level of water at a specified point on a stream or water body or in a specified stream reach for certain periods of time. The four types of instream flow uses are fish and wildlife, navigation and transportation, parks and recreation, and sanitary and water quality. DLWM, with technical assistance from DGGs, reviews, issues, and manages these appropriations.

13. COMMUNITY ASSISTANCE

Within the limits of funds available, DGGs will provide assistance, on an as-requested basis, to communities that have water-related problems.

DGGs hydrologists provide technological advice and even site-specific investigation for hydrologic problems arising in Alaskan communities. Water supply location,

erosion evaluation, gravel supplies, and pollution evaluation are typical kinds of problems hydrologists address for Alaskan communities.

B. Related Programs

Responsible Agency

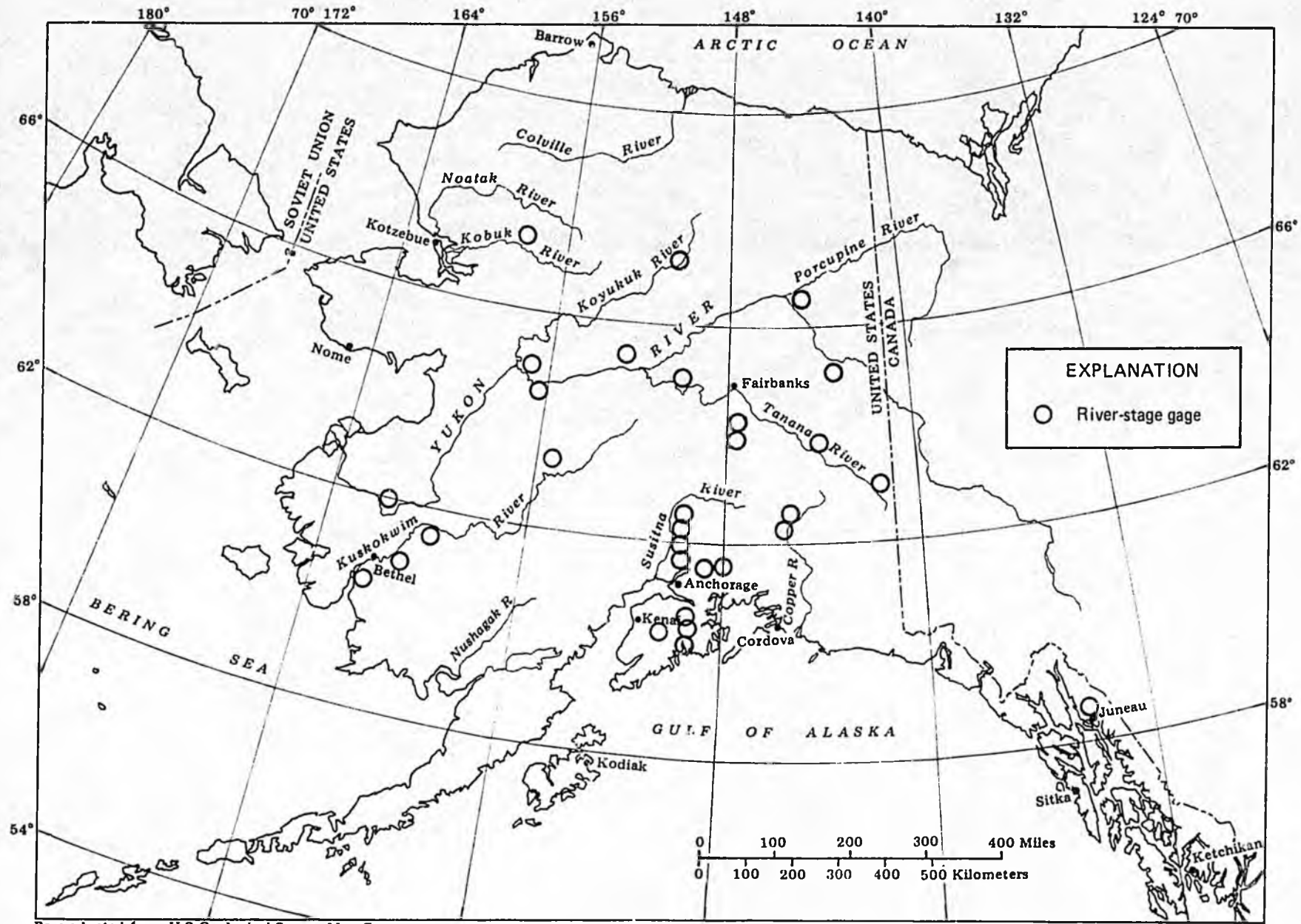
1. River information, forecast, and flood warning program.

National Weather Service (NWS)

 - a. River Gage Network -- A network of 28 river gage sites, located along the major rivers and in flood-prone locations, is operated by the NWS (fig. 5). Either staff or wire-weight gages are used at most sites. All of the observations are transmitted to the NWS River Forecast Center in Anchorage on a daily basis. The data from the network are used in the NWS river information, forecast and flood warning programs and are supplemental to the USGS network.
 - b. Ice Measurement -- The NWS operates 10 river and lake ice observation sites (fig. 6). Observations are made twice per month and consist of drilling a hole in the ice and measuring its thickness. The data are used for estimating spring breakup ice-jam flood potential.
 - c. Precipitation Data Monitoring and Archives -- A precipitation data monitoring and archiving program is in the process of being developed. The monitoring portion of the project is well developed and is a primary tool used in the NWS flood warning program. The archival portion is under development and will archive all of the precipitation data received by the River Forecast Center from telemetry systems operated by Federal and State agencies.
 - d. River Information -- River stage/discharge information for the recent past (last 60 days), present and future, is on file for many of the USGS and the Corps of Engineers sites as well as the NWS network. The data are available seven days per week through the NWS offices in Anchorage, Fairbanks, and Juneau.
 - e. Streamflow Modeling -- Developed for various types of watersheds to illustrate some measures to mitigate or counteract flood damages.

2. Evaluation of capability of fish passage through roadway drainage structures (culverts). Complementary studies will address fish passage as it is affected by streamflow characteristics (seasonal variation, flow frequency and duration) and provide methods to determine those characteristics.

Institute of Water Resources, Engr. Experiment Station (IWR/EES)
[Co-op with ADOT&PF]



Base adapted from U.S. Geological Survey Map C

Figure 5.--Location of the National Weather Service river gages.

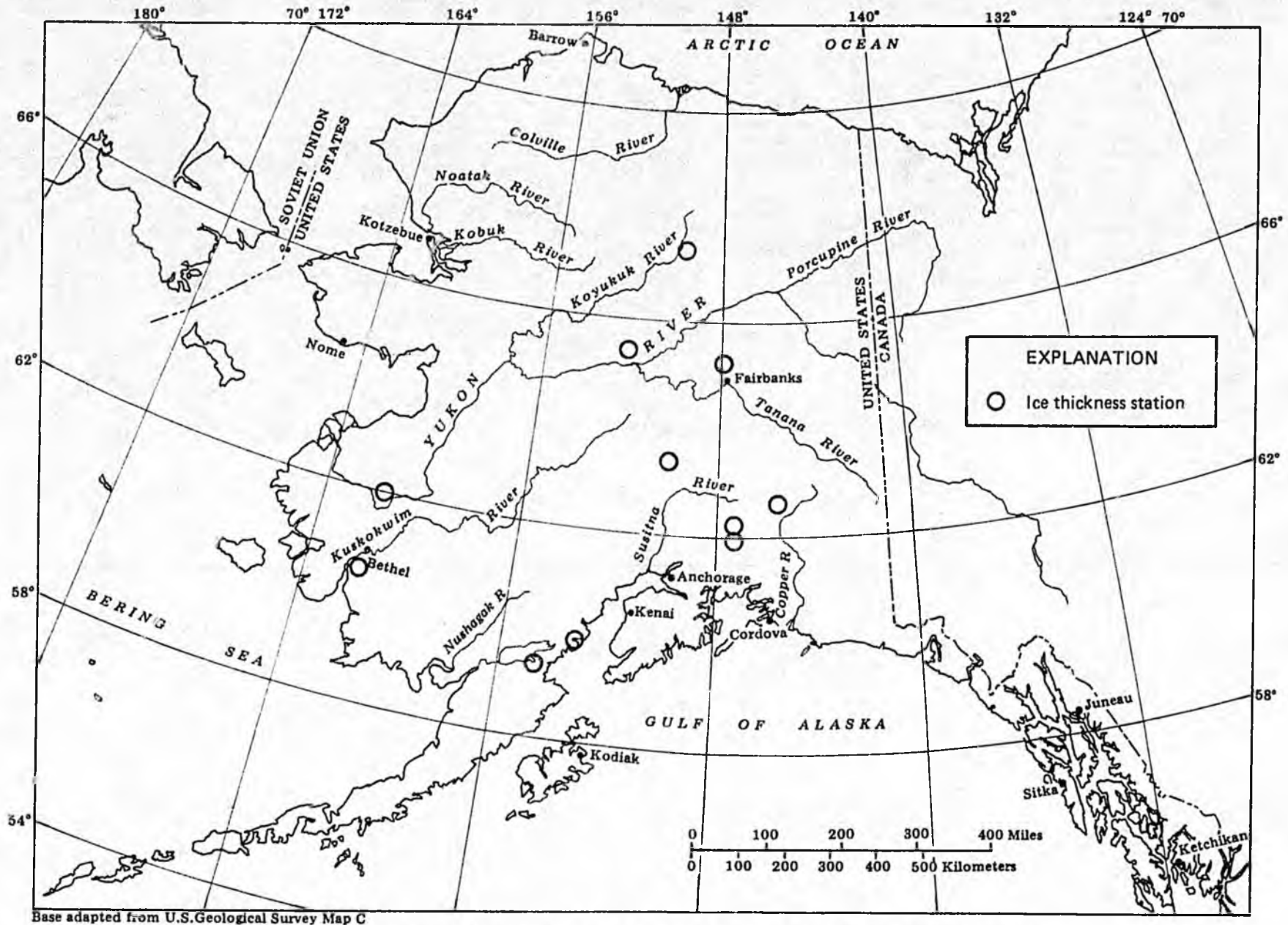


Figure 6.--Location of the National Weather Service ice observation sites.

B. <u>Related Programs--Continued</u>	<u>Responsible Agency</u>
3. Evaluate potential for production of acid and/or dissolution of metals from coal and other mine spoils.	IWR/EES
4. Assist in development of stipulations for operation and abandonment of coal and other mines by studying impacts of mining on riparian ecosystems.	IWR/EES
5. Developmental research program for on-site wastewater and sewage disposal methods in Alaska.	IWR/EES
6. Potential impacts on water quality from activities such as seafood processing, agricultural practices, and development of timber, petroleum and mineral resources. Potential effects of placer mining are of particular concern in various areas of Alaska.	Alaska Department of Environmental Conservation (DEC)
7. Quality of public-drinking supplies.	DEC
8. Snow Surveys Program -- Snow survey data are useful or critical to water-resources and water-related research, assessment, planning, forecasting and management activities. At end of the 1984 winter, the network consisted of 196 snow measurement sites, 17 of which are precipitation gages equipped with Wyoming windshields. Manually measured data are published monthly from February through June. Recording and/or radio telemetry equipment is installed at about 40 of the measurement sites (table 2). Most of the climatological data collected at these sites have not been published, but can be obtained from the Snow Survey Unit of SCS.	U.S. Soil Conservation Service (SCS) [Co-op with many Federal & State agencies]
9. Hydropower studies -- various surveys, assessments, and investigations related to the feasibility, design and operation of hydroelectric power generating facilities.	Alaska Power Authority
10. Glacial hydrology, water supply -- to assess the role of glaciers in the regulation and quality of Alaska's water supply.	Geophysical Institute, Univ. of Alaska (GI)
11. Glacial hydrology, hazards -- to assess the hazards from glacier-dammed lakes, glacier-covered volcanoes and surging glaciers.	GI
12. Glacier-melt modeling -- development of subroutine for the NWS/RFC's operational river forecast model to make the model more applicable to basins that contain large areas of glaciers.	Arctic Environ. Info. and Data Center [Coop. with NWS]

Table 2.--Snow survey network sites with daily records
(Soil Conservation Service, February 1985)

Data site	Region/Drainage	Elevation	Latitude	Longitude	Begin daily record	Snow water-content	Precip.	Air temp.
Anchor River Divide	Cook Inlet	1,600	59°52'N	151°19'W	10/80	X	X	
Atigun Cirque	Yukon River	4,750	68°08'N	149°29'W	07/79	X		
Atigun Pass	Yukon River	4,800	68°08'N	149°28'W	09/93		X	
Barter Island	North Slope	30	70°07'N	143°39'W	08/84		X	
Bettles Field	Koyukuk River	640	66°55'N	151°32'W	10/80	X	X	
Botts Creek	Cook Inlet	1,500	61°10'N	151°38'W	11/81		X	
Caribou Snow Pillow	Tanana River	900	65°09'N	147°33'W	10/69	X		
Chuitna Plateau	Cook Inlet	1,540	61°13'N	151°38'W	12/82	X		X
Colorado Creek	Tanana River	700	64°54'N	146°37'W	10/65	X	(Discontinued 5/77)	
Congahbuna Lake	Cook Inlet	500	61°04'N	151°26'W	10/82	X	X	
Cooper Lake	Kenai River	1,200	60°23'N	149°41'W	10/81	X	X	
Cottonwood Camp	Seward Peninsula	100	65°07'N	164°43'W	08/82		X	
Fairbanks Test Site	Tanana River	450	64°51'N	147°48'W	10/82	X	X	X
Falls Creek	Kodiak Island	1,980	57°38'N	152°58'W	12/82		X	X
Grandview	Kenai Peninsula	1,100	60°36'N	149°04'W	10/84		X	
Indian Pass	Cook Inlet	2,350	61°04'N	149°29'W	10/79	X	X	X
Kenai Moose Pens	Kenai River	300	60°44'N	150°28'W	09/80	X	X	
Kizhuyak Valley	Kodiak Island	20	57°42'N	152°53'W	12/82		X	X
Little Chena Ridge	Tanana River	2,000	65°07'N	146°44'W	06/79	X	X	X
Monahan Flat	Susitna River	2,710	63°18'N	147°39'W	10/83		X	
Monument Creek	Tanana River	1,850	65°04'N	145°52'W	06/79	X	X	X
Mt. Alyeska	Cook Inlet	1,540	61°58'N	149°05'W	10/72	X	X	
Mt. Ryan	Tanana River	2,800	65°15'N	146°09'W	01/82	X	X	X
Munson Ridge	Tanana River	3,050	64°51'N	146°12'W	06/79	X	X	X
Nome 20-Mile	Seward Peninsula	250	64°44'N	165°14'W	08/84		X	
Point MacKenzie	Cook Inlet	200	61°23'N	150°04'W	01/81	X	X	
Ptarmigan Hills	Kenai Peninsula	1,200	59°43'N	150°42'W	10/79		X	
Ramsdyke Creek	Susitna River	2,220	62°37'N	150°48'W	10/79	X		
Rhoads Creek	Tanana River	1,225	63°56'N	145°22'W	12/80		X	
Sagwon	North Slope	1,000	69°26'N	148°41'W	07/83		X	
Ship Creek	Cook Inlet	1,750	61°08'N	149°27'W	10/72	X		
Terror Lake	Kodiak Island	1,450	57°36'N	153°02'W	12/82		X	X
Teuchet Creek	Tanana River	1,640	64°57'N	145°31'W	06/81	X	X	X
Toolik River	North Slope	3,050	69°38'N	149°18'W	07/83		X	
Totchaket	Tanana River	350	64°46'N	149°25'W	10/80	X	X	X
Turnagain Pass	Kenai Peninsula	1,880	60°46'N	149°13'W	12/82	X	X	X
Upper Chena Pillow	Tanana River	3,440	65°06'N	144°56'W	05/81	X	X	X
Upper Long Lake	Southeast	1,000	58°11'N	133°53'W	10/67		(Discontinued 6/75)	

Related Programs--Continued

Responsible Agency

- | | |
|--|--|
| 13. Statewide assistance to local governments, lenders, and citizens regarding the National Flood Insurance Program (NFIP); technical assistance to improve community flood-plain management programs. | Dept. of Community & Regional Affairs/
Municipal & Regional Assistance Div. |
| 14. Statewide coastal wind and wave data-collection sites located at Akutan, Atka, Chignik, Homer, Kake, King Cove, Kodiak, Nome, Saxman, Seward, and Whittier. | U.S. Army Corps of Engineers (USCE) |
| 15. Statewide small hydropower projects - sites collecting data on temperature, precipitation, and streamflow at Bear Creek near Hope, Falls Creek near Gustavus, Indian Creek near Chignik, Kings River near Chickaloon, Pyramid Creek near Unalaska, Shaishnikof River near Unalaska, unnamed creek at Scammon Bay, and Windy River near Seldovia. | USCE |

REGIONAL PROGRAMS

NORTHERN REGION

Arctic Area

The occurrence, movement, and availability of water in this region are strongly controlled by conditions created by its climate -- permafrost (permanently frozen ground), and rivers and lakes that are ice covered (or frozen solid) except during a short summer season. Prior to investigations conducted within the past 10 to 15 years along the Alaska Pipeline and other proposed transportation corridors, hydrologic data were collected at only a few, widely scattered sites. More recently, data collection activities have been expanded to fulfill requirements of the Alaska National Interests Land Conservation Act (ANILCA) of 1980. The potential future water needs of industry are great, but the paucity of water-resources data in the Arctic Region hinders a full understanding of hydrologic processes and the efficient development and use of the resource.

Seward Peninsula Area

The western part of the region includes extensive uplands and isolated groups of rugged, glaciated mountains of the Seward Peninsula, and alluvium-filled flats and lowlands of the Koyukuk, upper Kuskokwim, and lower Yukon basins. The Brooks Range (Baird Mountains) and Kuskokwim Mountains are dominant highland areas.

Surface-water data for the Seward Peninsula-Kotzebue Sound area have been collected for both long and short periods, or on an intermittent or one-time basis at several sites, and ground-water conditions are known locally at several communities. Yet the character of and the potential for development of water resources in this remote part of Alaska are probably the least studied of any area in the State.

Future requirements for hydrologic data and information probably will be related to development of known mineral reserves on the Seward Peninsula, extension and/or connection of now isolated, local road systems, and development and protection of the quality of community water supplies at the larger communities in the region (Nome, Unalakleet, Golovin, etc.). Hydrologic reconnaissance surveys, similar to those conducted in the Kobuk and Noatak basins, provide valuable, preliminary information for regional-scale resource assessment and planning. Establishment of one or more index stations on representative streams in large basins and a few crest gages in small basins provide a basis for interpreting additional reconnaissance-level observations and measurements at widely scattered sites in ungaged basins.

Interior Area

Interior Alaska is dominated by the valleys of the Yukon and Tanana Rivers, where alluvial deposits may be as thick as 2,000 feet. Permafrost is absent or thawed to a considerable depth beneath major streams, and rarely extends all the way to bedrock. Ground water is generally available in these thawed areas and in unfrozen zones within or beneath the permafrost. The melting of glacier ice (Alaska Range) and of perennial and seasonal snow affects the timing and amount of runoff to

streams draining the upland areas. Surface-water bodies are ice covered for at least half of each year, and most large streams carry heavy loads of glacier-derived sediment during summer months.

Ground water is the source of nearly all public and most private supplies in the region. Well yields as great as 1,000 gal/min have been developed from alluvial deposits of the Tanana Valley at Fairbanks, Eielson AFB and at Big Delta, but yields of wells drilled in bedrock north of Fairbanks are generally adequate only for individual household use. Two hydrologic "problems" have been identified in studies in the Fairbanks uplands: (1) anomalous concentrations of arsenic in the ground water and (2) a 10-year decline in water levels (although precipitation totals have been stable and baseflow of streams seems to be increasing during the same period).

Demands for water are most intense in the Fairbanks area, where the population increased during and after construction of the Alaska oil pipeline. Future needs for water in this region will probably continue to be concentrated at Fairbanks, but anticipated development of the Nenana and Big Delta agricultural areas, and potential impacts of placer and hardrock mining on water quality are also important concerns.

A. Northern Region USGS/DNR Projects

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
1. Streamflow Data	F	F	F	F	F	USGS/DGGS	DGGS/DLWM
2. Stream Basin Reconnaissance Surveys	F	F	F	F	F	DGGS	
3. Placer Mining Stream Basin Research	F	F	F	F	F	DGGS/USGS	DEC/DF&G/USFWS
4. Fairbanks Ground-Water Monitoring	F	F	F	F	F	DGGS/DLWM	USGS
5. Nenana Agricultural Area Hydrologic Resources	F	F	F	F	F	DGGS/SCS	DLWM
6. Delta Agricultural Area	F	F	F	F	F	DGGS/DF	DLWM/DA/AAC
7. Hydrology of the North Star Borough	F	F	F	F	F	USGS	FNSB
8. Ground-Water Levels in Chena-Tanana Flood Plain	F	P	P	P		USGS	FNSB

F - funded at present; funding anticipated
P - proposed, funds needed
C - completed

1. STREAMFLOW DATA

A total of 22 continuous gaging stations provide streamflow data for the Northern Region. Operation of long-term, continuous recording gaging stations ("index stations") and selective discharge measurements provide data necessary for predicting streamflow and runoff characteristics in other basins. A stream-gaging site on the Sagavanirktok River (near Alaska Pipeline Pump Station 3) and a site on the Putuliga, ik River (near Deadhorse) for which 10 years of streamflow data are available serve as index stations for large, northward flowing streams.

Additional index stations on the Colville and Canning Rivers are being considered, but costs are very high. Special emphasis should be directed to the Arctic National Wildlife Refuge. Continuation of stream discharge measurements at selected sites and times, and operation of partial-record and seasonal (summer) stations are planned. Partial record stations are planned for selected streams in the Seward Peninsula, and on placer mining streams, including the Chatanika River.

2. STREAM BASIN RECONNAISSANCE SURVEYS

Reconnaissance surveys of representative ungaged river basins are planned to provide data on channel and valley characteristics from which reasonable estimates of streamflow and flood levels can be made. Such surveys provide a sound basis for streamflow estimates in lieu of continuous gaging. Surveys have been completed for the Togiak, Kobuk, and Noatak basins (results published) and the Wulik and Unalakleet basins, and a survey of the Sheenjek River basin is being considered for 1985 and 1986.

3. PLACER MINING STREAM BASIN RESEARCH PROJECT

Placer mining activities significantly disrupt streams and stream valleys. Streamflow and stream water-quality data are needed by miners and agency managers. This multiagency cooperative project monitors flows, turbidities, water quality, and valley morphological changes in a variety of ways at 20 to 30 sites in the Birch Creek basin. Special emphasis is given to specific data needed for habitat studies as well as general hydrologic studies to determine volumes and times of flows for efficient mining and water-quality monitoring above and below placer operations.

4. FAIRBANKS GROUND-WATER MONITORING

Ground-water levels near school sites and other locations in the Fairbanks area are being monitored in order to evaluate impacts of the large producing well on local aquifers and general aquifer variation. Also, well data reports are being processed for entry into the USGS WATSTORE computer system (see Statewide Projects) by DNR/USGS. A report on Fairbanks ground water based on existing data is being prepared by USGS.

5. NENANA AGRICULTURAL AREA HYDROLOGIC RESOURCES

The objectives of this study are: to determine the availability of water from lakes, small streams, and ground water; to identify flood plains of large streams; to collect meteorological data for hydrologic cycle interpretation and wind analysis for erosion protection; and to assess potential for contamination of the

water resources by anticipated agricultural development. One monitoring well and two meteorological stations operated during 1984. Expanded surface-water studies are proposed for 1985.

6. DELTA AGRICULTURAL AREA

Hydrologic, meteorological, and ground cover baseline data for interagency plans for the Delta agricultural development areas have been reported. A data collection system monitors water level and wind of the Delta area. Five wind stations, several precipitation stations (rain and snow), as well as water-quality sampling sites provide data necessary for evaluating waters and winds of the area. Flood evaluation, erosion control design, wind break design, and ground-water recharge evaluation require data provided by the project.

7. HYDROLOGY OF NORTH STAR BOROUGH

This continuing study will provide basic hydrologic data useful for: (1) determining the availability of water from surface- and ground-water systems; (2) describing the "operation" of the hydrologic system in upland bedrock area and evaluating possible causes of the continuing water-level declines; (3) defining water quality with special attention to high nitrate and arsenic concentrations in ground water; and (4) assisting residents, officials, and consultants concerning hydrologic problems.

A research effort just being completed at the Fairbanks landfill was directed at explaining geochemical processes (production and movement of leachate) in sub-arctic areas. Potential effect of any leachate movement on Fairbanks municipal and domestic water-supply systems downgradient will be evaluated.

8. GROUND-WATER LEVELS IN CHENA-TANANA FLOOD PLAIN

Changes in stage of the Chena and Tanana Rivers are the principal controls on water-table fluctuations in the adjacent alluvial aquifers. Various ground-water modeling techniques will be used to simulate and attempt prediction of trends and ranges of water-table changes in response to changing river levels. Of particular concern are increases in ground-water levels that would result from any extended releases of water from flood-control dams above Fairbanks.

B. Related Programs

Responsible Agency

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| 1. Determination of energy sources supporting arctic freshwater fauna (in anticipation of rapid increases in demand for generally scarce freshwater sources in arctic Alaska). | Institute of Water Resources/Engr. Exp. Sta. (IWR/EES) |
| 2. Evaluation of impact of drilling-mud disposal on wetlands (Prudhoe Bay area). | Alaska Department of Environmental Conservation (DEC) |

B. Related Programs--Continued

Responsible Agency

- | | |
|--|--------------------------------------|
| 3. Study of hydrologic system in Ester Dome area west of Fairbanks; results will be applicable to management of quantity and quality of ground water where potential conflicts exist over its use. | IWR/EES |
| 4. Flood-hydrograph modeling, Chena Lakes Flood Control Project -- models developed from data collected at streamflow and meteorological stations. Near real-time data transmittal facilities provide flood prediction capabilities. | U.S. Army, Corps of Engineers (USCE) |
| 5. Hydrologic and other natural resources of Tanana River Basin -- broad-based planning and management applications. | U.S. Soil Conservation Service (SCS) |
| 6. Evaluation of Tanana River Basin flood hazards, particularly as they apply to flood-plain management in the Fairbanks area. | SCS |
| 7. Water-quality impacts from chemical spills, abandoned landfills and "dump" sites, and military operations (Fairbanks area). | DEC |
| 8. Effects of urban development on surface waters (Fairbanks). | DEC |
| 9. Effects of use of fertilizers, other agricultural chemicals on water quality. | DEC |
| 10. Impacts of placer mining on main-stem streams. | DEC |
| 11. Water quality impacts of the Atkasuk Dredging Program -- will provide data on environmental impacts of dredging on the chemical and physical aspects of village water supplies, and ancillary information related to impact on anadromous and resident fish populations. | IWR/EES |
| 12. Snowmelt infiltration into frozen ground -- will examine the role that moisture content within the seasonally frozen layers plays in controlling the infiltration and movement of snowmelt water. | IWR/EES |
| 13. Geochemistry of saline lakes in northeastern Yukon Flats -- will determine the conditions leading to the formation of evaporite lakes in the Yukon Flats. | IWR/EES |
| 14. Mineralogy of soils following forest fires (interior Alaska) and subsequent effect on ground-water quality. | IWR/EES |
| 15. Consequences of removal of riparian vegetations on physical, chemical and biological characteristics of a headwaters, first-order taiga stream. | IWR/EES |

B. Related Programs--Continued

Responsible Agency

16. Effects of placer mining on stream channel morphology, water quality, and aquatic organisms at sites in Denali National Park and Preserve. Continue water-quality studies and collection of baseline hydrologic data of DNP&P.
17. Initiate baseline hydrologic-data collection and studies at Kobuk Valley National Park, Gates of the Arctic NP&P, Cape Krusenstern National Monument, and Noatak and Yukon-Charley Rivers National Preserves. Begin study of mining effects on water resources at Yukon-Charley Rivers National Preserve.

National Park
Service (NPS)

NPS

SOUTHCENTRAL REGION

Terrain, climate, and development are diverse within this large area. Physiographically, the Cook Inlet/Copper River basin is characterized by broad lowlands surrounded by rugged, glacier-clad mountains. The occurrence and potential for development of ground water are controlled by the wide range and complex distribution of underlying materials. Mixed glacier deposits, stream-sorted sand and gravel, wind-blown sand and silt, and lake-deposited silt and clay underlie the Matanuska and Susitna valleys, Anchorage Bowl area, Kenai Peninsula Lowlands, and the Copper River basin. Sedimentary and metasedimentary rocks form the Kenai and Chugach ranges, and the Talkeetna and Wrangell Mountains are made up primarily of igneous rocks. Ground water has been developed from glacial outwash for public supplies at Kenai, Anchorage, and the Palmer-Wasilla area. Wells in either unconsolidated materials or bedrock also supply most individual, private water systems in the region. Frozen, fine-grained glacial-lake deposits in much of the Copper River basin restrict the occurrence and availability of ground water in that area.

The large, glacier-fed rivers of the region -- Copper-Chitina system, Susitna, Matanuska, Knik, and Kenai -- carry a high concentration of suspended sediment (glacier flour) during the summer melt periods, but many nonglacier-fed tributaries and other streams contain clear water. Ship Creek is an important source of supply at Anchorage, and the municipality proposes to pipe water, treated to remove the suspended sediment, from glacier-fed Eklutna Lake to the Anchorage Bowl area.

The water resources of the region as a whole are perhaps the most studied, documented, and developed in the State. Yet the rapid industrial and commercial development and accompanying population increases in Southcentral Alaska, where half the people of the State now live, are already stressing currently developed supplies in some areas (particularly Anchorage) and pose the potential for degradation of water quality (urban and residential runoff, untreated industrial and household wastewater). Anticipated future growth and development (coal resources in the Beluga area, agricultural activities at Pt. MacKenzie) will inevitably lead to additional demands for water supplies and concerns about protection of water quality. The timely and economical solution of these problems will require the continued expansion of the hydrologic information and data base.

The compound delta of the Yukon-Kuskokwim Rivers, the Bristol Bay-Nushagak Lowland, the intervening Ahklun/Kuskokwim Mountains, the Alaska Peninsula (Aleutian Range), and the volcanic Aleutian Island are separated and isolated by mountains, distance, and weather from developments in Cook Inlet and interior Alaska.

Ground-water conditions in the Bristol Bay-Nushagak Lowland are probably similar to those in other thick alluvial sequences, except that here the availability of water is influenced (reduced) by a layer of permafrost as thick as 175 feet. Potential for development of ground water in the Yukon-Kuskokwim Delta is limited by predominantly fine-grained sediment, permafrost, and shallow depth to the freshwater-saltwater interface near the coast. Ground-water conditions are probably highly variable in the volcanic rocks of the Alaska Peninsula and Aleutian Islands.

Man's use of and impact on the water resources of southwestern part of Alaska have so far been minor, and our knowledge of those resources is correspondingly limited.

Immediate needs for water data and information will most likely remain those at settled communities, military installations, and seasonal recreational and commercial fishery facilities. However, an understanding of the hydrologic environment is necessary to plan the orderly development of agricultural, hydropower, geothermal, and likely offshore mineral potentials in part of the region. Thus, significant increases in hydrologic data collection and in the current scope of study efforts are required.

A. Southcentral Region USGS/DNR Projects

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
1. Streamflow Data	F	F	F	F	F	DGGS/USGS	
2. Beluga Coalfields Projects							
a. Beluga Water Quality Monitoring	F	F	C			DGGS	DEC
b. Beluga Snow/Precipitation Survey	F	F	F	F	F	DGGS	SCS
3. Matanuska-Susitna Valley Projects							
a. Peak Flow, Low Flow & Lake Level Monitoring	F	F	F	F	F	USGS	DGGS/DF&G
b. Matanuska River Basin Survey	F	F	C			DGGS	DLWM
c. Knik Glacier Monitoring	F	F	F	F	F	USGS	DGGS
d. Pt. MacKenzie Ag Area Meteorologica ¹ Data	C					DGGS	DA
e. Matanuska Aquifer Study	F	F	F	F	F	DGGS	DLWM
f. Mat-Su Large Lake Study	C					USGS/DGGS	
g. Mat-Su Small Lake Study	C					USGS/DGGS/ DF&G	
h. Lake Eutrophication	F	F	F	F	C	USGS	DGGS
i. Hatcher Pass Snow Surveys	F	F	F	F	F	DGGS	SCS/DLWM
j. Susitna River Sediment Transport	F	F	C			USGS	APA
k. Knik River Gravel Survey	P	P	P			DGGS	DLWM
l. Matanuska Valley Moose Range Hydrology	F	F	F	F	F	DGGS	DLWM
4. Anchorage Area Projects							
a. Geohydrology of the Anchorage Area	F	F	F	F	F	USGS	MOA
b. Eagle River Ground Water Availability	F	C				DGGS	DLWM
c. Potter Marsh/Rabbit Creek Hydrological Evaluation	F	F	C			USGS	MOA/DLWM
d. South Anchorage Water Supply & Lake Levels	P	P	P	P	P	DGGS	DLWM
e. Hillside Area Ground Water Study	F	F	C			DGGS	

A. Southcentral Region USGS/DNR Projects--Continued

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
f. Eklutna Lake	F	F	F	C		USGS	MOA
5. Kenai Peninsula Projects							
a. North Kenai Ground Water Model		P	P	P		USGS	DGGS/DLWM
b. Lake Level & Ground Water Monitoring	F	F	F	F	F	USGS	DGGS
c. Water Resources of the Kenai Peninsula Borough	F	F	F	F	F	USGS	KPB
d. Kenai River Management Data		P	P	P	P	DGGS/DP	KPB
6. Kuskokwim Basin Reconnaissance Survey	F	F	C			DGGS	
7. Copper River Basin Projects							
a. Kenney Lake/Copper Center Water Supplies	P	P	P	P	P	DGGS	DLWM
b. Copper River Gaging Station		P				USGS	ADOT&PF
8. Alaska Peninsula/Aleutian Islands Projects							
a. Aleutian Island Stream-flow Data	F	F	F	F	F	DGGS	DLWM
b. Bristol Bay Water Supply Study	P	P	P	P	P	DGGS	DLWM

F - funded at present; funding anticipated

P - proposed, funds needed

C - completed

1. SOUTHCENTRAL STREAMFLOW CHARACTERISTICS

Streamflow data are basic to management of the water of Southcentral Alaska. Continuous recording gages are established, maintained, and data collected and published by USGS/DGGS cooperative, jointly funded contracts.

Continuous streamflow recording gages are located on Anchor River, Kenai River, Capps Creek, Chuitna River, Willow Creek, Deception Creek, and Deshka River.

Peak flow and lake levels are maintained on 23 other streams and several lakes. Some stations are part of the GOES satellite real time system for which the receiving station is located in Anchorage.

2. BELUGA COALFIELD PROJECTS

a. Beluga Water Quality Monitoring - Water quality of the streams of the Beluga Coalfields will be threatened by coal mining. Baseline data are needed as well as water quality monitoring of the streams in order to adequately manage the water quality. This program provides data to DEC as well as DNR. This project involves a systematic sampling and analysis of water from designated sites in the Beluga Coal Mine area. The data are provided to management agencies.

b. Beluga Snow/Precipitation Survey - Precipitation and snow accumulation are an important part of monitoring and managing surface waters of the Beluga Coalfields area. This project is part of the statewide snow survey system coordinated by the U.S. Soil Conservation Service, which maintains five snow survey and precipitation sites in the Beluga Coalfields. Data are collected throughout the winter snow accumulation season.

3. MATANUSKA-SUSITNA VALLEY PROJECTS

a. Peak Flow, Low Flow, and Lake Level Monitoring - Peak-stage indicators (crest-stage gages) at several sites document flood events. Stream discharge measurements are made at other selected sites during low-flow conditions. Water levels are measured semiannually at 12 lakes. These streamflow and lake data (3 years of record now available) provide background information for other ongoing and planned areal and research studies.

b. Matanuska River Basin Survey - The Matanuska River system has good access and is one of the major river systems of the Matanuska-Susitna area. Very few data exist for the tributaries of the Matanuska River and no gaging stations presently monitor any part of the system. Data are needed to interpret water and sediment transport by the river. Gravel extraction, water quality, flooding, and erosion near Palmer are being monitored. This project will support preliminary streamflow measurement of the Matanuska River tributaries and sediment transport characteristics of the river system.

c. Knik Glacier Monitoring - The outburst of glacier-dammed Lake George once produced large floods on the Knik River. Although the lake has not formed since 1966, the potential exists for its re-formation and resumption of annual flooding. Such floods could affect existing and proposed future development along the Knik River. The activity of Knik Glacier is monitored in an attempt to predict the likelihood of the formation of a "new" Lake George.

d. Pt. MacKenzie Ag Area Meteorological Data - A meteorological station installed in 1981 records wind velocity and direction data needed for development of agricultural plans. The University of Alaska Agricultural Extension Service is planning to assume maintenance and monitoring of the station.

e. Matanuska Valley Aquifer Study - Demands for ground water in the Matanuska Valley are increasing rapidly as the population and associated development grow. Ground-water systems of the area need to be defined and evaluated in order to manage the area's water demands wisely. This project will analyze existing data and collect new information necessary to understand and describe ground-water systems of the Matanuska-Susitna area.

f. Matanuska-Susitna Large Lake Study - Big Lake in the Matanuska-Susitna Valley is an important area of development for recreation and fishing. The waters of the lake can produce necessary nutrients for the aquatic life there, but should not be polluted. Careful investigation of the nutrient condition of the lake will allow decisions for management of lake development and use to be based on fundamental biological principles and characteristics of the lake.

This project will define the physical and biological character of the waters of Big Lake and will document the distribution and variety of organic matter, the ability of the lake to support fish, and the potential for pollution of the waters. Principles learned through this study will be applicable to other lakes in subarctic areas of Alaska.

g. Matanuska-Susitna Small Lake Study - Smaller, heavily used lakes of the Matanuska-Susitna Valley support important fish population. Limnological investigations provide a scientific basis for management of the water of these recreational lakes.

h. Lake Eutrophication - An extension of earlier limnological studies in the Matanuska-Susitna Valley, this project will provide criteria for lake management by identifying those factors/conditions in shallow, subarctic lakes that make them most susceptible to cultural eutrophication.

i. Hatcher Pass Snow Surveys

Snow survey courses to monitor snow depth and water content will be established at selected locations to provide needed snow-cover data for managing these recreational areas for skiing and other winter sports. Data will also be useful for stream runoff and flood prediction.

j. Susitna River Sediment Transport Study - Alaska Power Authority has contracted USGS to conduct an in-depth investigation of the characteristics of sediment production, concentration, and yield of a glacier-fed stream. The data will be used for planning, design, and operation of proposed hydroelectric dams and power generation facilities. This study on the Susitna River (below the Devils Canyon dam site) will address the following aspects:

- (a) Suspended-sediment transport rate as a function of discharge.
- (b) Size distribution of suspended sediment as a function of transport rate.
- (c) Bedload sediment-transport rate as a function of discharge.
- (d) Size distribution of bedload sediment as a function of transport rate.
- (e) Spatial distribution of total sediment transport.
- (f) Stream vertical-velocity distributions as a function of discharge.
- (g) Stream water-surface gradient as a function of discharge.
- (h) Bed material particle-size distribution.

k. Knik River Gravel Survey - The project will evaluate the amount of gravel available for extraction from the bed of the Knik River, the effects of gravel mining and the potential gravel "recharge" of the river. In response to demand for aggregate resources, DNR land managers have requested this study.

1. Matanuska Valley Moose Range Hydrology - Streamflow, lake level, ground-water levels, water quality, wind and precipitation data needed to prepare a management plan for the newly created Matanuska Valley Moose Range will be provided to DLWM planners. Monitoring sites will provide data for ongoing management of the range.

4. ANCHORAGE AREA PROJECTS

a. Geohydrology of Anchorage Area - The objectives of this project are to: (1) operate a data-collection network for streamflow, lake levels, and ground-water levels; (2) maintain a "state-of-the-art" digital computer model of the confined aquifer system to simulate the hydrologic effects of ground-water development; (3) describe hydrologic characteristics of selected areas in Anchorage where information is required to guide land-use planning decisions; (4) determine current conditions and changes in streamflow characteristics and stream water quality due to urbanization of Campbell and Chester Creek basins; and (5) evaluate availability and quality of potential new public water supplies at Girdwood.

b. Eagle River Ground Water Availability - Eagle River community has had a history of ground-water supply problems. A study of the area's ground-water system, begun in 1982 at the request of DLWM, will result in the definition and understanding of Eagle River aquifers necessary for prudent management of the community's water resources.

c. Potter Marsh/Rabbit Creek Hydrological Evaluation - Potter Marsh is the focal point of a prime coastal waterfowl natural area which is potentially threatened by Anchorage subdivision development. Many agencies, organizations, and citizens have requested that steps be taken to preserve the natural qualities of the estuarine environment.

This project will provide data and analyses that will provide a basis for determining the potential of future development to alter the present hydrological balance of the marsh.

d. South Anchorage Water Supply and Lake Levels - Ground-water data (both quantity and quality) from bedrock aquifers and other aquifers are necessary for improved water management of water resources of South Anchorage. Saltwater intrusion poses a threat to wells near the inlet. Lake levels and quality have been jeopardized by continuing land development so that evaluation of the hydrological changes is needed by water managers and residents.

e. Hillside Area Ground-Water Study - Detailed data compilation and computer analysis will yield data for models which will provide a method for monitoring and interpreting hillside area ground-water systems. The model will be used to attempt to predict effects of potential withdrawals from the system. These data and interpretations are needed to manage water applications in this growing Anchorage suburb.

f. Eklutna Lake - Construction has begun on a pipeline that will eventually carry water from Eklutna Lake to communities along the Glenn Highway and to the Anchorage Bowl area. This study will investigate aspects of the water source, including (1) runoff characteristics of snow- and glacier-fed Eklutna Lake, and (2) sedimentation rates in and processes of transport of suspended sediment through the lake.

5. KENAI PENINSULA PROJECTS

- a. North Kenai Ground Water Model - Continued monitoring of local ground water will allow development of a digital model of the lower confined aquifer, in order to simulate the extent of, and predict probable changes in, the intrusion of salt water from Cook Inlet into the aquifer due to anticipated increases in pumping of large-yield industrial wells, as well as effects on lakes and other hydrologic expressions of the area.
- b. Lake Level and Ground Water Monitoring - This continuing program, begun as part of earlier USGS interpretive studies in the North Kenai area, further defines the relationships between ground-water use and fluctuations in lake levels.
- c. Water Resources of the Kenai Peninsula Borough - The objectives are to monitor hydrologic conditions in parts of the Borough outside the specific study areas addressed in a and b above, and to evaluate needs for detailed studies.
- d. Kenai River Management Data - Division of Parks needs all Kenai River hydrologic data available in order to prepare a management plan for the river. This project will summarize and evaluate existing data as well as define and initiate a data collection system adequate for managing the Kenai River in order to maintain the fisheries and recreational values of that system.

6. KUSKOKWIM BASIN RECONNAISSANCE SURVEY

Flow and flood data are developed from reconnaissance surveys of the Kuskokwim River tributaries. Surveys of valley and channel profiles as well as water surface slope and discharge allow reasonably accurate calculations for streamflow and flood characteristics for these major, hydrologically unknown interior Alaskan rivers which are tributary to the largest totally Alaskan river. The hydrologic data and interpretations are needed for knowledge, planning, and management of the Kuskokwim River system as well as the state lands through which the rivers flow.

7. COPPER RIVER BASIN PROJECTS

- a. Kenney Lake/Copper Center Water Supply Evaluation - Residents and DNR water managers request data and evaluation of water supply sources for this Copper Basin population center particularly for domestic and agricultural water supplies.
- b. Copper River Gaging Station - The streamgaging station on the Copper River near Chitina, operated by USGS, should be augmented or replaced by a station at the Million Dollar Bridge near Cordova. The new station would monitor runoff of the entire basin (which is not provided by the present gage) as well as obtain streamflow data needed for planning and design of proposed highway structures on the lower Copper River.

8. ALASKA PENINSULA/ALEUTIAN ISLAND PROJECTS

- a. Aleutian Islands Streamflow Data - Small cooperator operated stations are located at Nikolski and Unalaska to provide streamflow data for small streams in the Aleutian Islands. Data are used to appraise the local water resource potential

for domestic and industrial water supply, hydroelectric potential, and fish habitat. Also the data can be used for improving ungaged streamflows in a hydrologically unsampled corner of Alaska.

b. Bristol Bay Water Supply Study - The study would evaluate available data and install new data collection stations in order to develop information needed to improve water supplies for Bristol Bay communities and seafood industrial plants at Naknek, King Salmon, Dillingham, or other villages as demand requires. Some work has already been done in Dillingham.

B. Related Programs

Responsible Agency

- | | |
|---|---|
| 1. Chugach National Forest -- Establish and maintain a current water-resources data index for CNF; inventory and update current water rights permits on forest lands; transfer USGS gaging station from Resurrection Creek to Portage Creek and identify potential sites on Montague Island for streamflow data collection. | U.S Forest Service (USFS) |
| 2. Fisheries ground-water studies -- assess potential for developing spawning and rearing areas in stream channel gravels fed by ground water (Turnagain Pass, Portage Valley and other areas). | USFS
[Co-op with DF&G] |
| 3. Potential for degradation of water quality:
(a) Anchorage - urban runoff.
(b) Kenai - disposal and storage of drilling muds in wetland areas. | Alaska Department of Environmental Conservation (DEC) |
| 4. Collection of baseline hydrologic data in anticipation of coal mining (Beluga area). | DEC/DNR Co-op Study |
| 5. Sterling Special Waste Site Evaluation. | DEC |
| 6. Impacts of disposal of seafood processing wastes on receiving marine waters -- studies at Kodiak, Akutan, and at Cordova. | DEC |
| 7. Geochemistry of Copper River Basin ground water - will provide a multivariate statistical analysis of the area's geochemistry. | Institute of Water Resources (IWR)
[Co-op with DGGS] |
| 8. Initiate water resources baseline studies at Lake Clark and Wrangell-St. Elias National Park and Preserve (NP&P); study of mining effects on water resources at Wrangell-St. Elias NP&P; study of salmon nutrient re-cycling at Katmai NP&P. | National Park Service (NPS) |

B. Related Programs--Continued

Responsible Agency

9. Monitoring of aquatic habitat and fish populations of the Tuluksak River with respect to placer-gold dredging operations at Nyac. Alaska Department of Fish & Game

10. Stream-temperature modeling -- Evaluate potential effects of proposed two-dam Susitna hydroelectric project on downstream water temperature. Model will simulate natural and "with-project" instream temperatures under a range of meteorologic and hydrologic conditions and various reservoir operating procedures. Associated with this project are investigations of thermal effects on fish and effects of an altered ice regime on physical and biologic system of the river. Arctic Environ. Info. and Data Center [Coop. w/APA, USF&WS]

11. Identification of flood hazard areas along selected streams or reaches of those streams for use in flood-plain management studies. Tentative list of streams includes Kuskokwim, Copper, Matanuska, Kenai, Anchor, Kasilof, and Ninilchik Rivers, and Deep Creek. Soil Conservation Service

12. Strandline Lake/Beluga River outburst flood analysis -- Strandline Lake is a glacially dammed lake which outbursts nearly every year causing flooding of the Beluga River. Power transmission lines, bridges, and fishermen are endangered by this flood. Detailed analysis of the processes responsible for the flooding will allow interpretation and possible prediction of the outburst flood. This project will support the final surveys and analyses and the preparation of the study report. Geophysical Institute (GI) [Co-op with DGGS]

13. Mt. Redoubt/Drift River: flood evaluation -- Drift River outburst floods occur when the North Glacier on Mt. Redoubt surges and dams the Drift River. Developments in the Drift River valley are threatened by such a flood. Recent investigation indicates the North Glacier is in the process of surging. Monitoring the surging glacier will allow forecast of flooding of the Drift River. This project will support continued surveillance and surveying of the North Glacier on Mt. Redoubt and collection of data necessary to make glacial terminus advance predictions GI [Co-op with DGGS]

SOUTHEAST REGION

Water is abundant in the relatively mild (for Alaska) and very wet climate of Alaska's coastal "panhandle". The high precipitation (more than 200 inches per year measured at Little Port Walter; probably much greater at higher altitudes) on glaciers and on steeply sloping glacially scoured bedrock produces the highest mean annual and peak runoff rates in the State. Several large rivers originating in Canada flow through Southeast Alaska: the Taku (Drainage Area = 6,000 mi²), the Alsek (D.A. = 11,000 mi²) and the Stikine (D.A. = 20,000 mi²). These glacier-fed rivers carry large amounts of suspended sediment. Most of the smaller streams in the region are free of glacial debris. Ground water can be obtained readily from alluvium of the larger stream valleys, although these deposits are not as extensive as in other parts of Alaska. Most of the water used in Southeast Alaska -- for hydroelectric power generation, seafood processing, and pulp mill operations -- is from surface sources, but ground water provides the principal public supply at Juneau, Sitka, Yakutat, Ketchikan, and at other large communities.

The following potential problems and needs exist in the Southeast Region: (1) Effects of past and ongoing logging practices as well as proposed mining operations (at Quartz Hill near Ketchikan and Greens Creek on Admiralty Island) pose potentially significant impacts on quality of surface water. Avalanches and landslides may occur naturally on steep, saturated slopes in areas being disturbed by man's activities; separation of "causes" may be difficult. (2) Potential hazards from glaciers (outburst floods) and heavy, wet snowfall on steep mountain slopes (avalanches) have been identified locally. A compilation of data and a coordinated action plan in case of emergency are needed. (3) Water-supply needs in the Juneau area (Mendenhall Valley and Douglas Island) and other communities require extension of information on ground-water systems -- complex hydrology (and local water-quality problems) of glacio-fluvial deposits and alluvial fans. Salt-water intrusion may occur naturally or be caused by pumping from coastal valleys. (4) Conduct of hydrologic-data collection and research activities on Native- or corporate-owned lands by government agencies (at least Federal) may be restricted by legal "considerations." (Federal government cannot accept funds for studies from such entities. This situation not unique to SE Alaska.)

A. Southeast Region USGS/DNR Projects

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
1. Streamflow Characteristics							
a. Gaging Stations (see Statewide Programs)	F	F	F	F	F	USGS	USFS/USB/DGGS/DLWM*
b. River Basin Surveys		P	P	P	P	DGGS	DLWM
2. Mendenhall Valley Hydrological Study	F	C				USGS	JCB/DLWM

*Also cities of Sitka and Petersburg

A. Southeast Region USGS/DNR Projects--Continued

Program Element	'85	'86	'87	'88	'89	Responsible agency(s)	Co-op agency(s)
3. Auke Bay Water Supply Study	F	F	C			DGGS	DLWM
4. Indian River Basinwide Adjudication	P	P	P	P	P	DLWM/DGGS	
5. Quartz Hill Water Monitoring	P	P	P	P	P	USGS	USB/DGGS
6. Greens Creek Water Monitoring	F	F	F	F	F	USFS/USGS	
7. Land Disposal Water Availability Studies	P	P	P	P	P	DGGS/DL M	

F - funded at present; funding anticipated
P - proposed, funds needed
C - completed

1. STREAMFLOW CHARACTERISTICS

a. Gaging Stations (listed with Statewide Programs) - In southeast Alaska, long-term records from several active and discontinued gaging stations probably provide a more complete and representative picture of the regional variation and range of streamflow than for any other large area of the State. Although a relatively intensive region-wide basic data collection effort continues, new developments, activities or problem areas require additional and/or more detailed data at specific sites. Stations recently established to provide such information include: Indian River near Sitka (water rights adjudication), Mendenhall River near Auke Bay, and Klehini River near Klukwan (surface-water/ground-water relations).

A reconnaissance of runoff characteristics in the Alsek River basin is planned for 1985-86. This large river (drainage area 11,000 mi²) is fed primarily by glacial meltwater.

b. River Basin Surveys - Reconnaissance surveys of ungaged stream systems to produce streamflow and flood predictions have been planned for the Alsek and Taku Rivers as well as other streams which DNR water managers identify for which data are needed. (Nonfunded projects.)

2. MENDENHALL VALLEY HYDROLOGICAL STUDY

The Borough and City of Juneau as well as residents and DNR water managers have requested an intensive investigation and evaluation of the water supplies of the Mendenhall Valley area. A USGS-WRD study nearing completion will provide necessary data and interpretation for determining quantities of available water and effects on the quantity and quality of the water from salt water intrusion and sewage resulting from increasing demands from the system.

3. AUKE BAY WATER SUPPLY STUDY

The study will provide more complete data and interpretation of ground water and other water supplies of the Auke Bay area in order to more accurately define salt water intrusion and provide a technical basis for more effective management policies for this developing area. The study was requested by Region water managers.

4. INDIAN RIVER BASINWIDE ADJUDICATION

Appropriations of water from Indian River in Sitka may be greater than the amount of water in the river during low flows. Users and water rights holders include Alaska Department of Fish and Game, City of Sitka, National Park Service, Sheldon Jackson College, and private parties. DLWM water managers are planning to adjudicate Indian River's waters on a basinwide basis and will require good, basic data as well as analyses and interpretation of those data for meaningful adjudication of this over-appropriated stream system.

5. QUARTZ HILL WATER MONITORING

This project will provide baseline data to characterize present hydrologic conditions in an area of known potential for molybdenum development near Ketchikan. Two gage sites provide quantity and seasonal distribution of stream discharge and seasonal and areal variations in surface-water quality

6. GREENS CREEK WATER MONITORING

Information similar to that collected at Quartz Hill will document surface-water conditions in this proposed mining development in the Hawk Inlet-Young Bay area in the northern part of Admiralty Island. The ongoing work is conducted by U.S. Forest Service hydrologists.

7. LAND DISPOSAL WATER AVAILABILITY STUDIES

Technical hydrological evaluations of water supply, flooding, erosion, recreation, and habitat will be provided as requested and needed by DNR planners and managers in order to conduct land disposals.

B. Related Programs

Responsible Agency

- | | |
|---|---|
| 1. Impacts of forestry practices on water quality. | Alaska Department of Environmental Conservation (DEC) |
| 2. Water quality and sediment analysis of Swan Lake, Sitka | DEC |
| 3. Evaluate usefulness of the mussel <u>Mytilus</u> as a bio-accumulator and thus an index of metals added to streams by mining operations (Greens Creek and Hawk Inlet at Admiralty Island). | DEC |

B. <u>Related Programs</u> --Continued	<u>Responsible Agency</u>
4. Impact of ore spillage on water quality (Skagway harbor)	DEC
5. Receiving water quality in the vicinity of Petersburg seafood processors.	DEC
6. Juneau area water-quality studies: a. Water quality investigations of North Twin Lake. b. Aurora Basin and Gastineau Channel -- circulation and water exchange. c. Effects of small boat moorage -- Auke Bay, Aurora Basin, Tee Harbor.	DEC
7. Forest Practices Advisory -- determine effects of forest practices on hydrologic system and monitor effectiveness of "Best Management Practices."	U.S. Forest Service (USFS)
8. Fishway Investigations -- to provide hydraulic and hydrologic data to fisheries management agencies.	USFS
9. Kadashan Barometer Watershed -- intensive effort to monitor effects of roads and timber harvesting practices on water quality and streamflow regime.	USFS [Co-op with USGS]
10. Water resource inventory of the Chatham Area (Tongass National Forest) -- relation of stream channel morphology to suitability and sensitivity of aquatic habitats for anadromous and resident fish.	USFS
11. Snow surveys and precipitation stations -- data significant in evaluation of runoff and water availability in areas of small or virtually nonexistent ground-water supplies.	U.S. Soil Conservation Service [Co-op with DGGS]
12. Instream flow study of Indian River, Sitka National Historical Park.	National Park Service (NPS)
13. Water-resources baseline study, Glacier Bay National Park and Preserve.	NPS
14. Streamflow data in support of potential hydroelectric power studies -- Favorite Creek near Angoon and small stream near Klukwan (north of Haines).	Alaska Power Authority (APA)
15. Monitoring effects of operation of Tyee hydroelectric project on fish-spawning channel developed in tailrace of the plant.	Arctic Environmental Info. & Data Center [Co-op. w/APA]

HYDROLOGICAL ACTIVITIES IN YUKON TERRITORY, 1985-1989

The great Yukon River system heads in the Yukon Territory and British Columbia, where our neighbors to the east must deal with water resources issues and problems similar to those we face in Alaska. We are thus pleased to include in this AWARE Plan the following statements provided by J.R. (Ric) Janowicz, Regional Hydrologist for Yukon Territory, with the Water Resources Division, Indian and Northern Affairs, Canada:

During the 1985/86 fiscal year a five-year plan will be implemented to expand the hydrometric network operated by Water Survey of Canada in Yukon Territory as part of the Water Survey of Canada/Department of Indian and Northern Development (WSC/DIAND) cooperative cost sharing agreement. The proposed plan, consisting primarily of baseline stations, will expand the existing network of 72 stations by 15 stations.

Water Survey of Canada intends to begin the installation of Data Collection Platforms at all remote hydrometric stations with five Yukon stations being instrumented during 1985. These five stations have ports available for the installation of additional sensors. Cooperation between WSC and Atmospheric Environmental Service, as well as other government agencies is anticipated with the inclusion of various meteorological instruments at WSC hydrometric sites.

The hydrometric network operated by DIAND during 1985/86 will consist of 24 stations of which 11 are baseline stations and 13 site specific stations. The future plan for the network is to transfer the 11 baseline stations to WSC (as outlined in the WSC/DIAND 5 year plan). The site specific stations, which represent primarily mining and transportation concerns, will be maintained only as long as a need exists. It is expected that other site specific stations will be added to the network. A historical summary of the data was published in 1984. It is expected that an update will be published every two years.

The snow course network operated by DIAND with the cooperation of the Atmospheric Environmental Service presently consists of 41 stations throughout the Territory. These will be sampled for snow depth and snow water equivalent on February 1, March 1, April 1, May 1 and May 15; a snow survey bulletin with runoff forecasts will be published after each sample. A historical snow survey summary is planned for 1985.

DIAND hopes to establish a snow pillow station in the Mackenzie Mountains to provide information on a real time basis for spring flood forecasting.

The Vancouver office of the National Water Research Institute is conducting a multiyear research project to develop a better understanding of freeze-up and break-up processes on the Yukon River in the Whitehorse area. Five river stage and ice front progression observation stations have been established in the reach. This particular river reach is traditionally a problem area with respect to freeze-up ice jam flooding on an almost annual frequency and the study will hopefully provide the basis for mitigative measures.

A joint study between DIAND and the Department of Civil Engineering, University of Alberta in Edmonton, is planned to study freeze-up and break-up processes on the

Yukon River in the reach between Fort Selkirk at the confluence of the Pelly River, and Eagle, Alaska. Emphasis will be placed on the Dawson area which is susceptible to ice jam flooding on a relatively frequent basis. The overall objective of the study is to obtain a solution to the flooding problem.

Negotiations between the Inland Water Directorate, Department of Environment, DIAND and Yukon Territory leading to the implementation of the Flood Damage Reduction Program (FDRP) in Yukon are planned to commence during 1985 with an agreement hopefully in place in the foreseeable future. The FDRP is a cooperative program to discourage future flood vulnerable developments in areas designated as flood prone. The Program is made up of a two stage process consisting of the floodplain mapping followed by designation. Nationally approximately 200 communities in the Northwest Territories, New Brunswick, Quebec, Ontario, Manitoba and Saskatchewan have been mapped and designated.

A general hydrology study of northern Canada (Northwest and Yukon Territories) is planned for 1986. The study to be funded by DIAND will consist of an inventory of hydrologic parameters, an estimation of these parameters for gauged areas followed by the transfer to ungauged areas. Recommendation for future hydrometeorologic data needs will be assessed on this basis. A similar study was carried out for NWT in 1982 with the 1986 publication representing a four-year update encompassing both Territories.

Primary work will continue to study the surface hydrology of Haeckel Creek near Whitehorse. The experimental watershed established in 1984 is a 17.4 square kilometer basin which is characteristic of Coast Mountain drainages. The basin will be used primarily for development and calibration of hydrologic models, the results of which will be transferred to ungauged areas.

A Canada-wide flood guide being prepared by the National Research Council, Associated Subcommittee on Hydrology will contain examples extracted from Yukon Territory. The guide is expected to be released during 1985.

The Mackenzie River Basin Study is at the implementation stage of several recommendations which include the establishment of an integrated monitoring network in the Liard and Peel River sub-basins of Yukon Territory and spring flood studies on the Liard. The proposed integrated monitoring network, which will consist of Hydrometric, Meteorologic, Snow Course, Water Quality and Sediment stations is anticipated to go ahead during 1986/87 through existing agreements where available.

The Canadian Climate Program is expected to be active in northern Canada through various subcommittees. The overall objective of the program is to better define the requirements for climate information for northern planning and development, and to provide insight into the ways which climate information can be acquired and used in responding to northern issues.

YUKON RIVER BASIN STUDY

The Yukon River Basin Study was a joint (2.2 million dollar Canadian) study by Canada, British Columbia and Yukon of the water and related resources of the Yukon River Basin in Canada. The study was carried out between 1980 and 1984. The final

report of the Yukon River Basin Committee is expected to be released in the spring of 1985.

During the course of the study, projects were completed in eight program areas: hydrology, water quality, wildlife, tourism, parks and recreation, fisheries, energy, placer mining and socio-economics. In addition, a program to exchange information between the governments and with the public was developed.

A computer model of the basin and a model of the basin's economy have been developed which will be of particular use to planners in the basin.

For further information on the study contact:

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STATE OF ALASKA INSTREAM FLOW HANDBOOK

A GUIDE TO RESERVING WATER FOR INSTREAM USE



Division of
LAND AND WATER
MANAGEMENT



Alaska Department of
**NATURAL
RESOURCES**

STATE OF ALASKA INSTREAM FLOW HANDBOOK

A Guide to Reserving Water
for Instream Use

Department of Natural Resources
Division of Land and Water Management
Water Management Section



March 1985

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The cover photos were supplied by the following: Gary J. Prokosch (waterfall); Lisa R. Holzapfel (Tanana barge and kayaker); Alaska Department of Fish & Game (red salmon).



Photo Lisa R. Holzapfel © 1985

FOREWORD

Alaska water law provides for the appropriation of water for both out-of-stream and instream uses. The "Instream Flow Handbook" provides an understanding and basic knowledge of reservations of water for instream uses and serves as a guide to reserving water for instream uses.

The handbook is divided into two sections. The first section reviews the administrative process by which individuals, organizations, or government agencies may reserve water for instream use. The second section is designed to acquaint the reader with some of the various methods of determining instream flows or lake levels and to guide the reader to sources of more detailed information. Descriptions of methods in this handbook constitute neither endorsements of these methods nor guarantees of the applicability of a quantification method to a given situation.

This handbook is a companion to the "State of Alaska Water User's Handbook," published by the Alaska Department of Natural Resources (DNR), Division of Land and Water Management in 1981 and revised in 1984. The "Water User's Handbook" provides extensive background and detail on the Alaska water appropriation system and should be read before reading the "Instream Flow Handbook." Both handbooks can be obtained at the DNR offices listed in the appendix.

GENERAL INFORMATION ABOUT RESERVING WATER FOR INSTREAM USES

Under Alaska water law, Alaskans may obtain two kinds of water rights: out-of-stream (diversionary) water rights and instream water rights. Those people wishing to divert, withdraw, or impound water from a surface or underground water source must file for a diversionary water right under Alaska Statute 46.15. This process is presented in detail in the "Water User's Handbook." Those wishing to ensure that a sufficient flow of water in a stream, or level of water in a lake, will remain in the stream or lake and will not be appropriated or diverted for another use may seek an instream flow reservation.

An instream flow reservation is not a required permit, but rather an optional water right. Private individuals or organizations as well as public agencies may apply for one. Those holding an established instream flow reservation have a legal standing to assert their right against conflicting uses of water by people who do not have water rights or who are junior in priority.

Under Alaska Statute 46.15.145, instream flow reservations may be made for the following uses:

- Protection of fish and wildlife habitat, migration, and propagation
- Recreation and parks
- Navigation and transportation
- Sanitation and water quality

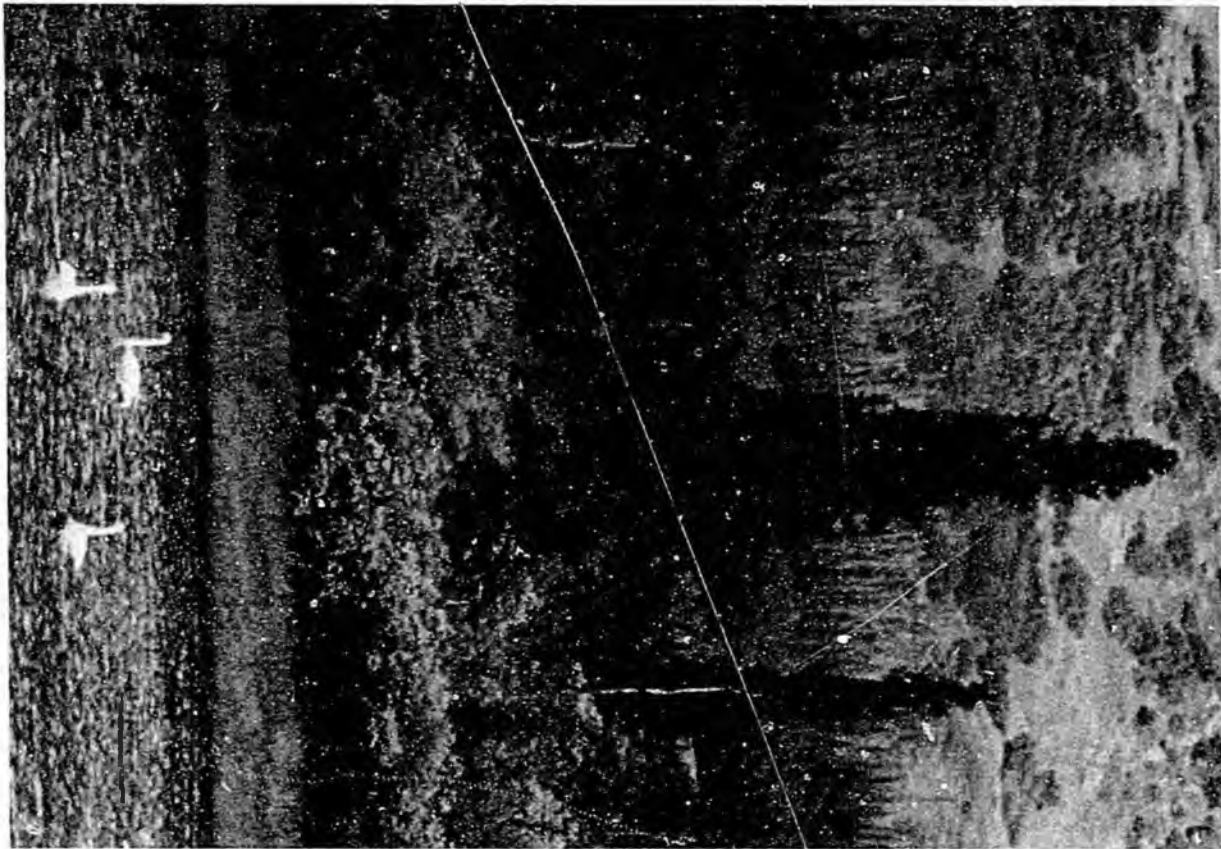
Water can be reserved for one or more of these permissible uses at a particular point or part of a stream or other water body for a period of time specified in the certificate of reservation.

An instream flow reservation does not, however, authorize the certificate holder to:

- Prevent access to, on, or through the water of the reservation
- Prohibit the use of the reserved water for other compatible purposes
- Abandon, convey, transfer, assign, or convert the certificate to another use without the approval of the Department of Natural Resources (DNR)

An Application for Reservation of Water (Form 10-1151) can be obtained at any DNR regional office. Completed applications must be submitted to the regional office located in the area of the proposed reservation of water.

Photo Gary J. Prokosch.



HISTORY OF INSTREAM FLOW LEGISLATION IN ALASKA

In 1959, when Alaska was admitted to the Union, water use was addressed in Article VIII, Sections 3, 13, and 16 of the state constitution. These sections outline the doctrine of "prior appropriation," allowing earlier appropriators of water a priority of right over subsequent appropriators on a "first-in-time, first-in-right" basis.

The Alaska Water Use Act, Alaska Statute 46.15.010-270, governing appropriation and use of water, was enacted in 1966 by the Alaska Legislature. This act gave a statutory definition to the doctrine of prior appropriation as authorized by the state constitution. The Alaska Water Use Act established procedures for maintaining existing rights and for obtaining new rights to all ground and surface waters of the state. It delegated to DNR the authority to administer the act and to adjudicate water rights.

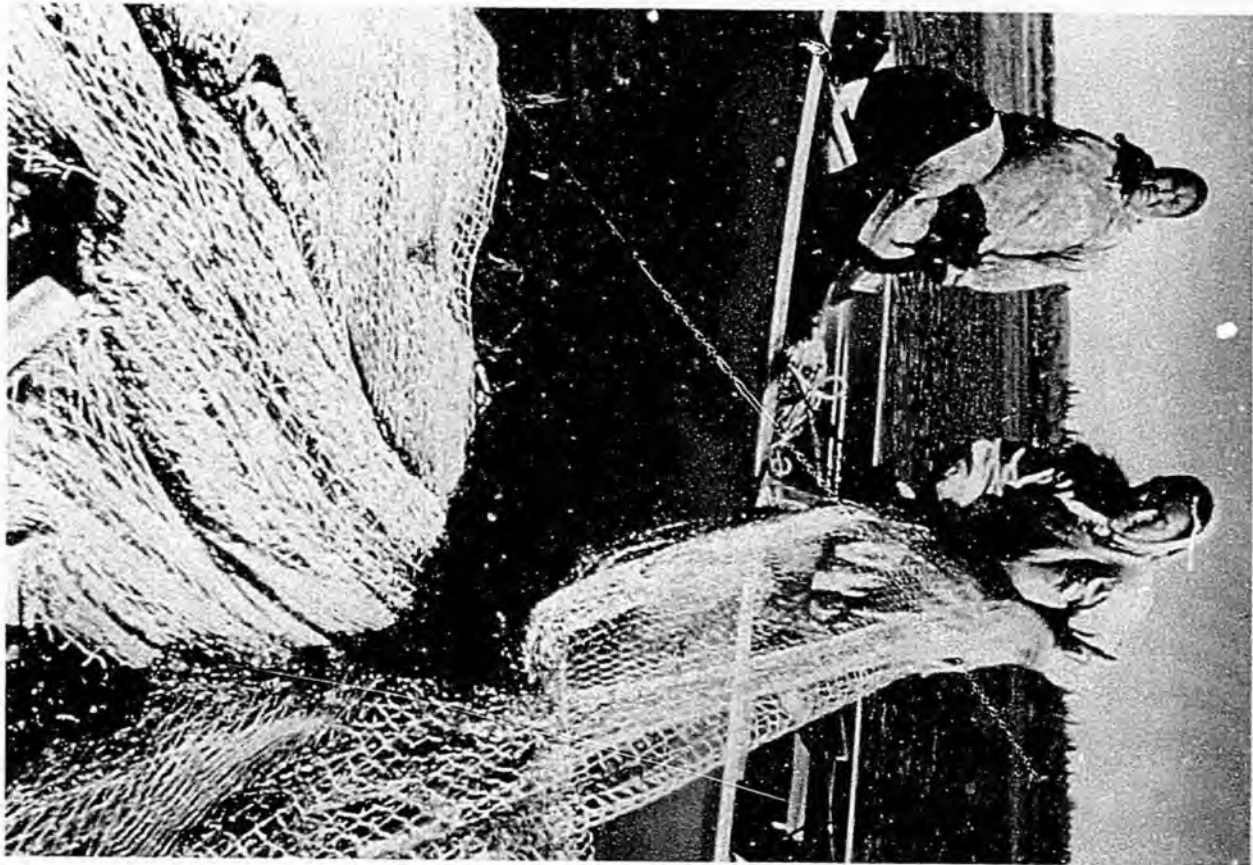
In 1980 the instream flow amendments to the Water Use Act were enacted to address the following issues:

- The State's need for a clear administrative process to adjudicate instream water rights that might be asserted by the federal government
- The fishing industry and fishery management agencies' concern that there was no legal mechanism to establish water rights to maintain streamflows for fish habitat and production, other than by putting conditions on DNR water rights permits
- Concern that reduced streamflow might affect water quality conditions downstream from municipal treatment plants and mining operations

The instream flow amendments established a mechanism by which private parties and public agencies can apply to DNR for reservations of water for instream uses, including fisheries, navigation, recreation, and water quality purposes. They provide for quantification of instream water uses, the establishment of a priority date, and issuance of a Certificate of Reservation within the existing state water rights system.

The Alaska instream flow legislation is unique within the United States in its specific inclusion of private citizens among those who may formally apply for an instream or lake level reservation. With the Alaska citizen's opportunity to reserve water goes the responsibility to be aware of the rather complex field of water resources allocation, particularly within the framework of instream flow activities.

Photo Robert Belous, NPS.



HOW TO RESERVE WATER FOR INSTREAM USES IN ALASKA

The Application To Certificate Process



1 Applicant contacts DNR for forms and assistance.

2 Applicant determines the quantity needed.



3 Applicant submits completed forms to DNR regional office.



4 DNR reviews the application and public is notified.

5 DNR issues Certificate of Reservation.



6 DNR reviews issued Certificate of Reservation.

Contact Department of Natural Resources

Those interested in filing an application to reserve water for instream use should first contact the DNR regional office in the area of the proposed reservation to find out:

- How to apply
- How to *quantify* the water to be reserved for a particular use; that is, how to determine how much water is needed, and how to choose the most appropriate quantification method for the stream or lake in question
- If there are any existing or pending water rights on the stream or lake in question
- If DNR has existing data on the stream which may be helpful in an instream flow study
- Which other local, state, or federal agencies may provide information or assistance or may have instream flow studies planned or underway on the stream or lake in question

The locations, addresses, and phone numbers of DNR regional and area offices are listed in the appendix.

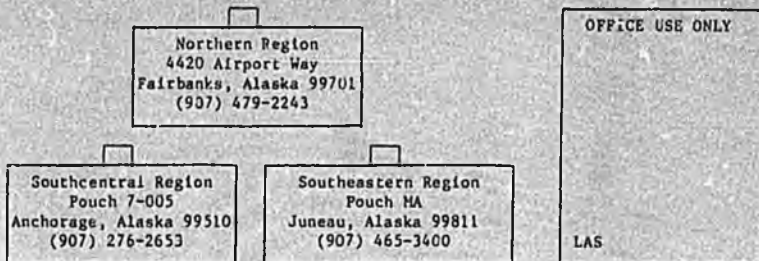
Determine the Amount of Water to Apply for

When you have decided to reserve water in a stream or lake and know what use you want to reserve the water for, you are ready to plan how to quantify, or measure, how much water is needed. Once you have chosen a quantification method you will need to investigate how to apply it. The second part of this handbook introduces quantification techniques and some basic *hydrologic* (water-related) concepts. The references in the Annotated Bibliography have been selected to provide background information for further reading. You may also need to contact experts, such as hydrologists, biologists, instream flow specialists, and recreation planners, to assist you. Next, you need to collect all available information on the stream or water body and on the use for which you are proposing to reserve water. You or a selected contractor should conduct the study to determine how much water to request for reservation, then summarize the results in writing.

File an Application for Reservation of Water

Submit the completed Application for Reservation of Water (Form 10-1151) to the DNR regional or area office located in the area of the proposed reservation. The appendix contains a list of these offices. Include the filing fee as outlined in the DNR fee schedule. Fill out the application completely; answer all questions and include all attachments. An incomplete application will not be accepted but will be returned to you. The date and time that your complete application is accepted establishes the priority date for the application.

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF LAND AND WATER MANAGEMENT



APPLICATION FOR RESERVATION OF WATER

INSTRUCTIONS: This is an application to reserve a specific instream flow or level of water under AS 46.15.145 and 11 AAC 93.141-147. This application must be filled out completely and all requested attachments submitted with it. Failure to complete all parts of the application may result in return of the application. Attach extra pages to fully answer questions. If a report is attached as part of this application, indicate appropriate page numbers following each question. Submit this application to the region in which the proposed reservation is located (identified above). Please type or print in ink.

1. Full legal name of applicant(s): _____
2. Mailing Address: _____
City: _____ State: _____ Zip: _____
Business Phone: _____ Home Phone: _____
3. Name of the stream or water body in which water is proposed to be reserved:

4. Location of the proposed reservation of water:
(a) List ALL sections, townships, ranges and meridians from the beginning to the end of the stream segment and for all parts of the lake or waterbody in which water is requested to be reserved. (Attach extra pages if needed.)

- (b) Describe the location of the point or points defining the boundary of the proposed reservation of water by river mile index, river mile, geographical or cultural landmark, etc., or the stream or water body. (Attach extra pages if needed.) _____
- _____
- _____

- (c) ATTACH a U.S. Geological Survey map at 1:63,360 scale, or 1:250,000 scale if 1:63,360 scale is unavailable for the area, clearly identifying the following for the proposed reservation of water:

- (1) Sections, townships, ranges and meridians
- (2) The stream or water body in which the reservation of water is proposed
- (3) Specific point or points defining the boundary of the proposed reservation of water
- (4) Permanent, temporary or planned locations of water measurement devices (such as gaging stations, weirs, staff gages)
- (5) Permanent, temporary or planned bench marks

5. (a) Identify the purpose(s) of the proposed reservation of water by checking the appropriate box(es).

- protection of fish and wildlife habitat, migration, and propagation
- recreation and park purposes
- navigation and transportation purposes
- sanitary and water quality purposes

- (b) Describe in detail the purpose(s) of the proposed reservation, including, when appropriate; species and life stage, type of recreation, vehicle, or water quality parameter, or other relevant information. (Attach extra page if needed.) _____
- _____
- _____
- _____
- _____

(b) Identify and describe the methodology, data, and data analysis used to substantiate the need for and the quantity of water requested for the proposed reservation of water, including:

- (1) Name and description of method used,
- (2) Who conducted the study and analysis,
- (3) Schedule of when data collection and analysis occurred,
- (4) Type(s) of instrument(s) used to collect and analyze data,
- (5) Description of data and how the data was collected, including when applicable, (A) selection of stream reach, study site and transect selection, (B) flow, survey, elevation, and depth measurements, (C) pertinent physical, biological, water chemistry and socio-economic data,
- (6) Description of how data was analyzed, and
- (7) Maps, photos, aerial photos, calculations, and any other documents supporting this application.

9. If there are provisions for monitoring this proposed reservation of water, include the following:

- (a) Description of monitoring equipment (such as gaging stations, staff gages, weirs)
- (b) Location of monitoring equipment
- (c) Provisions for payment of monitoring
- (d) Reporting system

Statements contained in this application are true and correct to the best of my knowledge.

Signed _____
Applicant(s) Full Legal Name(s)

Date _____

10-1151 (11/83)

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Provide Public Notice of the Application

After your application is complete and has been accepted, DNR will review it to ascertain the need for the reservation of water and the impacts on other water rights holders and the public interest. DNR will make an assessment to determine if water is available for the reservation and if the hydrologic data and supporting information in the application is accurate and adequate. A site inspection of the proposed reservation of water may also be made at this time.

DNR will then provide you with a prepared public notice which you must place, at your expense, in a newspaper of general distribution in the vicinity of the proposed reservation of water. This legal advertisement will summarize the proposed reservation of water and allow the public to submit comments or objections to the DNR regional office.

During this public notice period DNR will serve individual notice to:

- Prior appropriators who may be affected by the new reservation of water
- The Alaska Department of Fish & Game
- The Alaska Department of Environmental Conservation
- The U.S. Department of Interior
- The U.S. Forest Service
- Any local government in whose jurisdiction the proposed reservation of water would occur

Objections resulting from the legal advertisement or individual notice must be submitted in writing to the DNR regional office within 15 days of publication of the advertisement or receipt of the notice. Objections should state all facts and all reasons for modifying or withholding the reservation of water. DNR will answer all objections in writing.

Photo Gary J. Prokosch.



Certificate of Reservation of Water

If the proposed reservation meets the requirements of Alaska Statute 46.15.145 a certificate of reservation will be granted. DNR will summarize the decision in writing and issue the certificate to the applicant. The certificate of reservation grants a water right, for the specified use of water within the stream or lake, to maintain an adequate instream flow or level of water for that use for a stated period of time during the year.

Conditions may be placed on the certificate of reservation, and the certificate holder is responsible for complying with them. Conditions might include a provision to install equipment, such as stream gages, weirs, or staff gages, to monitor the reserved flow or level of water and to periodically provide reports to DNR.

Review of Certificates of Reservation

Certificates of reservation must be reviewed by DNR every 10 years but can be reviewed any time within the 10-year period if necessary. The review will determine if:

- The purpose and need for the reservation still apply
- The reservation affects prior appropriators and the public interest
- A new beneficial use of water has been proposed
- New information is available about the reservation
- The quantity or level of water reserved is adequate for the purposes of the reservation
- The time periods for the reservation still apply
- Additional research, data collection, or analysis are needed to review the reservation

Public and individual notice of the review will be given in a manner similar to the notice of the application for reservation of water in order to gather information that may assist in the review. At the conclusion of the review, DNR will summarize the findings in writing and will continue, amend, or revoke the certificate of reservation.



Appeal Procedures

By statute, interested parties have 15 days to respond to a notice of a proposed reservation of water and to file any written objection regarding the application.

DNR is obligated by statute to grant or deny any application, in whole or in part, within 30 days of receipt of the last objection. If a hearing is held, the application must be granted or denied within 180 days of receipt of the last objection. If DNR fails to grant, deny, or condition the application in accordance with these time periods, the unsatisfied party may appeal directly to Superior Court.

If any party is dissatisfied by a delegated decision of the Commissioner, that party may, within 30 days after the date that the decision was mailed or personally served, appeal directly to the Commissioner for modification or reversal of the decision. Before making a decision, the Commissioner may require additional information or hold a hearing. The appellant may also request permission to present further information to the Commissioner. If a party is still not satisfied by the decision of the Commissioner, that party has 30 days to appeal to Superior Court in accordance with the Administrative Procedures Act.

INSTREAM FLOW QUANTIFICATION METHODS

Basic Information Requirements

The objective of an instream flow quantification study is to determine the amount of water necessary to maintain a given instream use or resource. There are numerous instream flow methods ranging from simple to complex, but regardless of the method selected, certain information will always be required: streamflow, stream channel (shape and dimensions), and hydraulic (depth, velocity, and substrate) information, and knowledge of the stream use.

STREAMFLOW INFORMATION

Knowledge of the natural or present streamflow in the stream under study is the starting point for determining how much water to request to be reserved. Streamflow is referred to as *discharge* and is measured in cubic feet per second (cfs). A discharge of 1 cfs defines a volume of 1 cubic foot of water passing a given point of a stream in one second. Discharges in Alaskan streams and rivers range from less than 1 cfs to over a half million cfs in the Yukon River.

Stream discharge is highly variable during the year; therefore it is not sufficient to characterize a stream simply by its average discharge, or *mean annual flow*. Knowledge of the maximum discharges (usually seen during breakup or following heavy rains) and minimum discharges (seen during winter or dry periods) will aid you in describing the natural pattern of streamflows.

Stream discharge is measured by the U.S. Geological Survey (USGS) at locations known as stream gaging stations. The continuous discharge record for each USGS gaging station within the state is compiled each year by the USGS in water resources publications which are available through USGS and major libraries. These publications are the most comprehensive source of information on the amount of discharge in a stream during the period when the gage was operating (see annotated bibliography).

In Alaska, where there is generally little diversion of water, the gage records often very nearly reflect the natural discharge patterns of the streams. Unfortunately, only a small number of Alaska's streams are currently gaged, and of those, the length of time the gage has operated—the *period of record*—is often quite short. Despite this problem, the USGS gage record should be checked as the first step in an instream flow study in Alaska. If the required discharge information is missing or insufficient, it will have to be supplemented through simulation techniques, usually under the direction of a hydrologist or engineer.

Photo Dick Nadeau, USFWS.



HYDRAULIC AND STREAM CHANNEL-RELATED INFORMATION

Hydraulics is a branch of science that deals with the practical applications of liquid in motion. Certain hydraulic parameters such as *stream depth*, *water velocity*, *wetted perimeter*, and *substrate* (the gravel, rocks, sticks, leaves, and other material covering the bottom of the stream) are important to fish habitat, recreation, and other instream uses. For example, the water depth in a stream must be sufficient to cover incubating eggs and to allow for fish passage. Water depth also provides protective cover for the fish. Flowing water transports food and continually flushes the stream of waste products and sediments. Water moving with excessive velocity, however, may dislodge fish and cause fatigue or may scatter substrates in which eggs are incubating. The wetted portion of a stream channel has been found to relate to the stream's food-producing abilities. *Wetted perimeter* (figure 1) is a measure of this production.

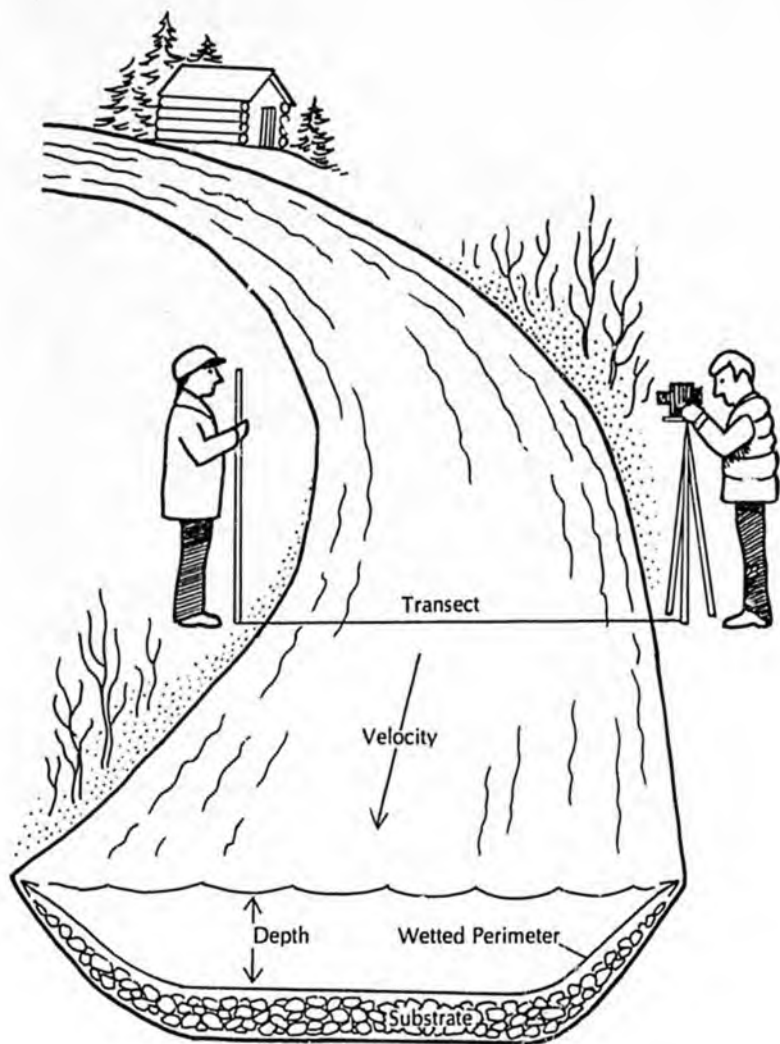


Figure 1. Stream characteristics typically measured in instream flow studies.

These hydraulic characteristics are usually measured along a stream *transect*, which is a line extending across the stream from bank to bank, perpendicular to the direction of water flow, located so that it will cross certain habitat types or stream features. Many instream flow methods are based on hydraulic characteristics measured along one or more transects. Measurement and use of hydraulic data from transects is a specialized technique requiring skills in the use of streamflow measurement equipment, surveying techniques, and stream habitat analysis.

KNOWLEDGE OF THE STREAM USE

To determine how much water is required for a particular instream use, you will need to understand the stream use in some detail. This may require knowledge of the recreational use (boating, fishing, swimming) or more specific information about the biology of fish species and the timing of their *life stages* (spawning, passage, rearing, and egg incubation). The simplest fishery methods may require little knowledge about fish in a particular stream. More complex fishery methods, however, will require detailed knowledge about a variety of fish species, their life histories, and their relative numbers within the study location. Some of this information may be available in reports and scientific publications.

Instream Flow Methods for Fisheries

Most quantification methods for fisheries are concerned with *fishery habitat*—the environment in which fish travel, feed, and reproduce. The fishery methods described in this handbook are divided into four major categories:

- Discharge-related methods
- Hydraulic rating methods
- Habitat rating methods
- Miscellaneous methods

Each category is described in the following sections, with specific examples that represent their general characteristics. However, presentation of example methods does not constitute endorsement of those methods.

DISCHARGE-RELATED METHODS

Discharge-related methods are based on existing discharge, or streamflow, records of the stream under study. In their simplest application, discharge-related methods require little knowledge of the biologic resources of the stream. Of the four categories of fisheries instream flow methods, this one is the most appropriate for use by private citizens.

The simplest methods are those based on percentages of the mean annual flow. Discharge-related methods rely on past research which has developed relationships between the quality of instream fish habitat and various percentages of the mean annual flow. The most widely used discharge-related method is the Tennant, or "Montana," method developed for use in streams in the northern United States. The Tennant method associates discharges of less than 10 percent of the mean annual flow with "severe degradation" of fishery habitat, discharges equal to 40 to 60 percent of mean annual flow with "excellent" fishery conditions, and those between 60 and 100 percent of mean annual flow with "optimum" conditions. The Tennant method percentages, while requiring a minimum of time and field study expense, provide a conservative way of determining instream flow needs.

Discharge-related methods are attractive because of their simplicity; however, they should be used with caution. Most discharge-related methods were developed after close observation of streamflows and fish habitat conditions in regions in the Lower 48, but Alaska conditions differ from those in other states or regions. In Alaska, streamflows are highest in summer and lowest in winter. Glaciers contribute sediment to Alaskan rivers, causing them to be milky in appearance, and river surfaces are frozen for extensive periods of time in most regions of the state. Therefore, discharge-related methods developed in the Lower 48 may have to be adapted for Alaskan conditions.

Finally, discharge-related methods may not be as simple and inexpensive as they first appear. Where stream gage records are not available, or where the period of record is quite short, these methods may not be appropriate. Most discharge-related methods need a minimum of one to five years of stream gage data, and 10 or more years of data are required for complex methods. If the period of record is short or data are missing because stream gages did not operate or were faulty, the services of a professional hydrologist may be required to fill in or expand the record by simulating stream discharges. This process may be expensive and time-consuming.

HYDRAULIC RATING METHODS

A number of instream flow methods relate changes in discharge to changes in *hydraulic characteristics* (stream depth, velocity, wetted perimeter, and substrate). These stream characteristics affect the quality of fishery habitat (figure 1).

To begin a hydraulic rating study, a hydrologist measures the natural or existing hydraulic characteristics of the stream and evaluates the substrate at locations along stream transects. More than one transect may be measured within a stream reach to more fully describe varied habitats or to aid in certain kinds of hydraulic simulation.

Once the stream characteristics have been measured and the data processed, the stream's depth, velocity, and wetted perimeter can be related to the stream's discharge on a graph known as a *rating curve* (figure 2). A recommended instream flow level is often selected by examining these rating curves. For example, the *inflection*, or "break point," in the curve of a *wetted perimeter vs. discharge* graph often indicates the discharge below which food production decreases or crowding and stress occurs. Therefore, this inflection point indicates a discharge below which habitat conditions may not be acceptable. In other cases, minimum flow requests may be based on the lowest discharge which provides water depth to cover the fish species present or water velocities sufficient to avoid stagnation.

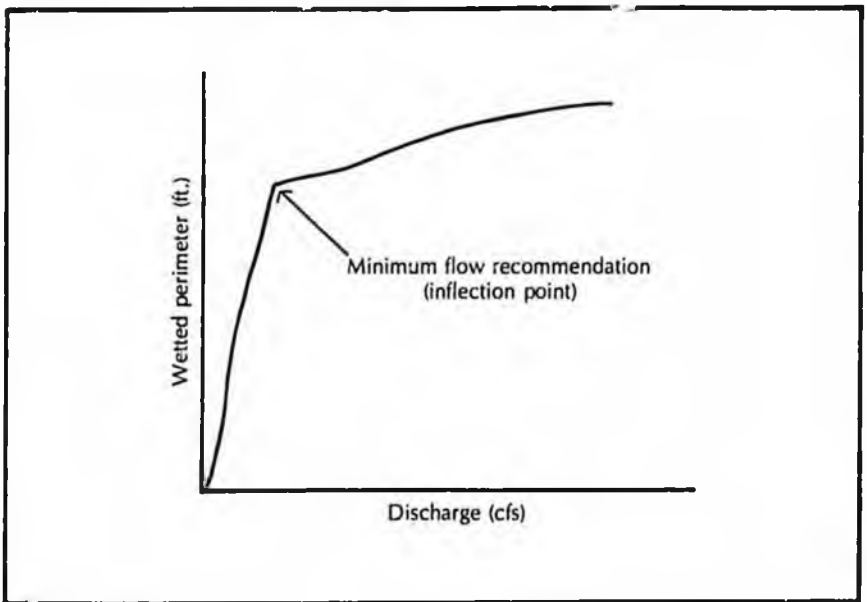


Figure 2. Hydraulic rating curve showing wetted perimeter vs. discharge.

Hydraulic rating methods provide a relatively simple means of quantifying an instream flow reservation for a specific site and perhaps for a specific species at that site. These methods provide more detailed information than discharge-related methods, especially in those locations where there are limited or no stream gage data. They do not incorporate extensive amounts of biologic information; however, the cross-sectional data may be usable in more sophisticated, computer-based approaches, such as habitat rating methods which do utilize biological data.

Hydraulic rating methods do, however, require field work which may be difficult and costly under Alaskan conditions. While the simplest approaches may require only a hand calculator, most hydraulic ratings will require the use of computer facilities and the services of trained professionals which, combined with the need for field measurements, may greatly increase the cost of these methods.



Photo Alaska Dept. of Fish and Game.

HABITAT RATING METHODS

Fish do not utilize all portions of a stream equally, but instead seek areas with preferred ranges of water depth, velocity, and substrate. Since these parameters vary with discharge, the amount of usable habitat within a stream is also a function of discharge. Habitat rating methods were developed to evaluate the relationship between discharge and habitat. One example of a habitat rating method is the Instream Flow Incremental Methodology (IFIM). The IFIM uses a package of computer programs to predict depth, velocity, and substrate for a range of unmeasured discharges. The system then incorporates habitat preferences of the fish species and life stages of interest to develop *habitat rating curves*, which are graphs showing *discharge vs. the amount of usable habitat*.

To develop a habitat rating curve using SIM, the following steps are required:

1. Following a specified study site selection process, locate multiple transects where they will best describe the habitat and hydraulic features of the stream.
2. Measure stream depth, velocity, and substrate along each transect to serve as input to computer models which then predict these habitat characteristics at unmeasured flows.
3. For each fish species and life stage of interest, *preference curves* for depth, velocity, and substrate are stored in the computer. The biologic information used to generate the preference curves is based on prior research or field observations. The computer programs compare predicted depths, velocities, and substrates with the preference curves and calculate a value known as *Weighted Usable Area (WUA)*, which is an estimate of the amount of preferred habitat at the study site at a given discharge. The results for a range of discharges are presented as a *WUA vs. discharge* curve (figure 3). An instream flow recommendation based on *WUA vs. discharge* curves generated for the life stages of the species of interest will assure adequate habitat during the most critical yearly time periods.

Though some field work is necessary for habitat rating methods, computer simulation greatly reduces the amount of field work required. Habitat rating methods provide the highest resolution for specific fishery resources of the methods described in this handbook. When conflicts for water are severe, these methods offer a precise approach. However, the added resolution of habitat rating methods is not always necessary for planning-level studies or for many instream flow reservation situations. The time, cost, and training requirements also limit the accessibility of these methods to those individuals or organizations that can afford them.

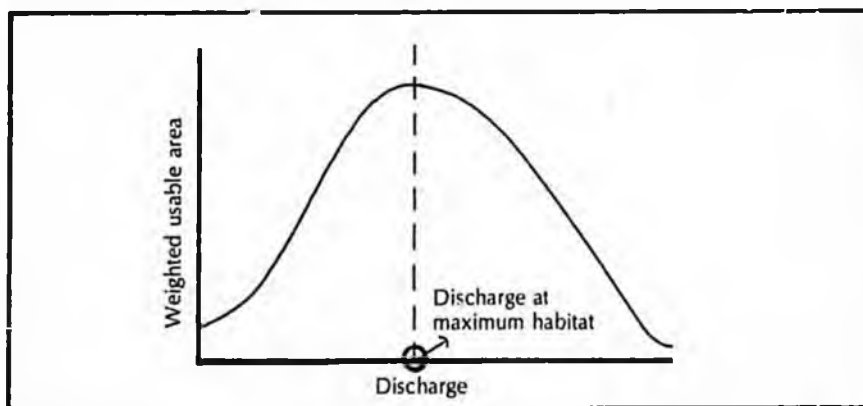


Figure 3. Weighted usable area vs. discharge curve.

OTHER FISHERY METHODS

In some situations, simpler approaches than those previously described can be used. It may be sufficient to determine the minimum instream flow required for fish migration through all or part of a critical reach of a stream. Most species of fish require a certain water depth to swim up- or downstream; this information has been published and you can obtain it from a library or with help from a fishery biologist. The applicant could then determine the streamflow required to maintain the minimum depths over the shallowest part of the stream. That discharge would be the flow required for fish passage.

Some fishery instream flow methods do not fit conveniently into the categories already discussed. Also, new methods not included in this handbook are constantly being developed. Those wishing more detailed information should inquire at the DNR regional offices or consult the publications listed in the Annotated Bibliography.

INSTREAM FLOW METHODS FOR WILDLIFE

Instream flow needs for wildlife and streamside habitats are often quite different from those for fisheries. For example, minimum streamflows may be required to maintain streamside vegetation or wetlands, or sufficient water depth may be needed to prevent animals from preying on birds nesting on sand bars. Instream flow needs for wildlife are specific to the locality and to the interactions between the plants and animals and the stream.

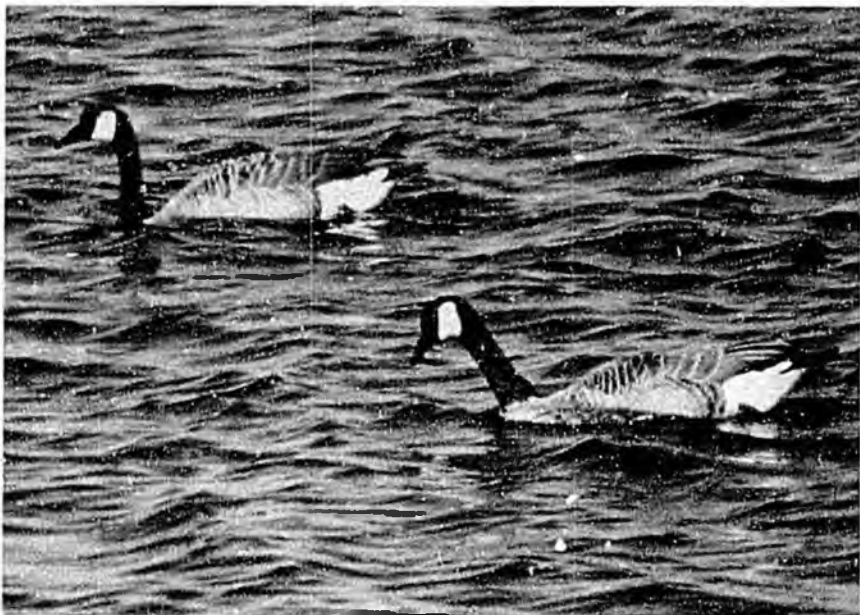


Photo Gary J. Prokosch.

Photo Gary J. Prokosch.



There are currently no formal wildlife methods of the types described for fisheries. References on some proposed methods for wildlife are presented in the annotated bibliography.

INSTREAM FLOW METHODS FOR RECREATION

Water-related recreational activities which involve streamflow include boating, fishing, and swimming. The actual quality of recreational experience for any of these activities at a given streamflow is the product of human and natural factors.

Although few formal methods for assessment of instream flows for recreation exist, some aspects of fisheries assessment methods are applicable to recreation. There are also a variety of social science techniques which can be applied to assess recreational streamflows.

Everyone who has recreated on or near a stream has an opinion of the quality of that experience. It is possible, using social survey techniques, to sample those opinions to determine the value of a particular recreation activity at several different streamflows. With enough information of this type, a rating curve relating the quality of a recreational experience to discharge can be developed.

For example, to construct a *whitewater rafting experience vs. discharge rating curve*, the following steps might be taken:

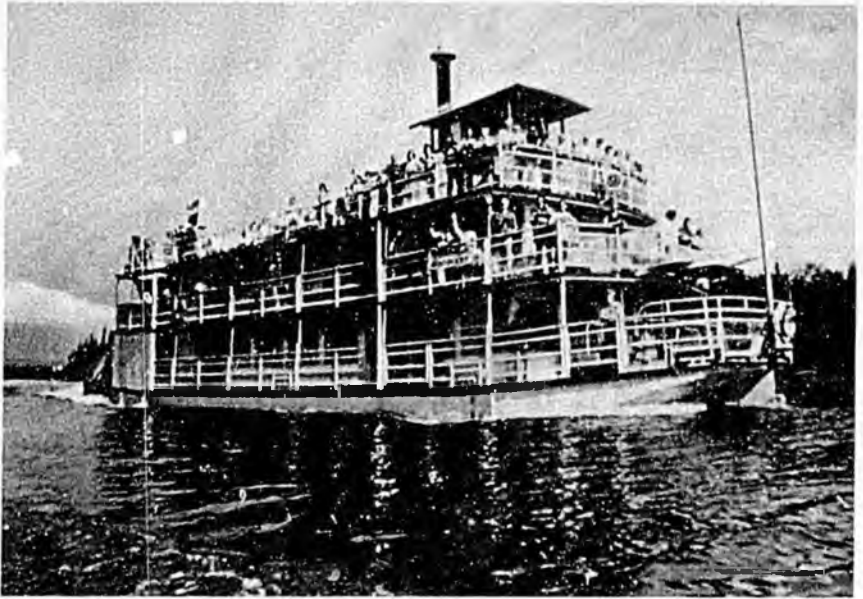
1. Develop a questionnaire to sample opinions of a rafting experience based on criteria such as enjoyment and passage difficulties encountered.
2. Analyze responses to questionnaires from a given day and assign a value to the discharge known to be in the river on that day.
3. Repeat the process for different discharges until a graph of *recreation value vs. discharge* can be constructed.

Another method would involve determining the minimum water depths required to float a raft or to operate various kinds of boats. The applicant can identify shallow reaches of a recreational stream and measure the streamflow at which the minimum depth to float a boat will occur. It may be necessary to measure water depth across several transects in a segment of a river in order to adequately describe alternate routes of boat or raft travel.

In general, recreation methods should be directed by an experienced recreation planner in association with an instream flow specialist. The publications listed in the Annotated Bibliography will provide valuable background.



Photo Lisa R. Holzappel © 1985



INSTREAM FLOW METHODS FOR NAVIGATION AND TRANSPORTATION

In Alaska, people may reserve instream flows to navigate streams and lakes. Some uses in this category may be closely tied to recreational uses because water-based recreation depends heavily on the ability to navigate Alaska's waterways. Quantification of flows for navigation or transportation may be accomplished through survey or opinion techniques similar to those described for recreation. Individuals or groups may compile evaluations of navigation conditions on certain days and then determine the stream discharge on those days. The resulting relationship between flow and navigation may be useful in determining minimum navigation flows.

An applicant may determine the minimum depth required for passage of a particular type of boat through a shallow reach of a river. The discharge needed to maintain minimum water depths over those reaches can then be measured and considered the instream flow required for transportation on that river. Contact DNR for specific guidance.

INSTREAM FLOW METHODS FOR WATER QUALITY

Instream flows may be reserved to meet stream or lake water quality standards. For example, as discharge of a stream is reduced, the concentration of pollutants from a source such as a sewage outfall increases. Maintaining an instream flow level which assures sufficient flow to dilute the pollutants would be an acceptable instream use of water in Alaska.



Photo Lisa R. Holzappel © 1985

Two important concerns govern the activities of private citizens in reserving water for maintenance or enhancement of water quality conditions:

- Quantification of flow for water quality is usually a very complex problem requiring the services of professional engineers, chemists, and biologists.
- Established water quality standards will be utilized during the DNR application review; these standards are set by the Alaska Department of Environmental Conservation to meet federally defined clean water criteria.

There are no formal methods for the quantification of instream flow needs for water quality. At a minimum, however, applicants should collect water quality data which is sufficient to describe the existing state of the stream or lake in question. DNR can provide guidance.