Fishery Data Series No. 95-39

Annual Summary of Alaska Department of Fish and Game Instream Flow Reservation Applications

by

Christopher C. Estes

December 1995

Alaska Department of Fish and Game Division of Sport Fish

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

This report summarizes the principal instream flow application and related activities of the Alaska Department of Fish and Game during the ninth year of its statewide instream flow program.

Between July 1, 1994 and June 30, 1995, instream flow analyses were completed for six river reaches: Nenana River (three reaches), Chuitna River, Kasilof River, and Salmon River. Applications to acquire instream flow reservations were prepared based on these analyses and will soon be submitted to the Alaska Department of Natural Resources for adjudication.

Ten instream flow reservation requests filed by the Alaska Department of Fish and Game in previous years have been granted by the Alaska Department of Natural Resources. Sixty-six applications from prior years are pending the completion of the adjudication process by the Alaska Department of Natural Resources.

Summaries of instream flow related Alaskan legislation, regulations, and the status of instream flow application actions of other agencies and the private sector are also presented.

Key words: instream flow, flow reservation, water rights, adjudication, Water Use Act, statutes, Water Use Act Regulations, Tennant Method, Montana Method, Alaska, flushing flow, Chuitna River, Kasilof River, Nenana River, Salmon River, water marketing, water exports.

INTRODUCTION

Alaska has abundant and diversified sport fisheries which are of considerable recreational importance to anglers and others. To date approximately 15,000 water bodies in Alaska have been formally identified as supporting anadromous and resident fish species (ADF&G 1994). Many others have yet to be investigated.

In 1994, an estimated 460,204 sport anglers took 1.9 million household trips and fished about 2.7 million days to catch approximately 6.1 million fish, of which 3.3 million were harvested (Howe et al. 1995). According to Howe et al. (1995), days fished in Alaska have increased 46 percent since 1984 on a statewide basis; and, the number of anglers fishing in Alaska has increased 37 percent since 1984. These increases signify the value placed on Alaska's sport fishery resources.

The continued production of Alaska's valuable fishery resources is, in part, dependent upon maintaining the quantity and quality of water within fish bearing water bodies (e.g. rivers and lakes). Private, government, and commercial developments resulting from population growth, urbanization, and resource development are contributing to increased competition for and changes in the volume of water in lakes and rates of flow (instream flows) in Alaskan rivers. Examples of developments and activities that can result in withrawals, diversions, and impoundments of water (out-of-stream uses) are hydroelectric facilities and operations, community and individual water supply facilities and operations, exportation of Alaskan water to other states and countries, recreational-based water uses such as artificial snow making, mining facilities and operations, agriculture, aquaculture, fish processing facilities and operations, municipal growth, forestry, manufacturing, oil and gas facilities and operations, etc.

The Alaska Legislature recognized the importance of instream flow protection to the economic and social well-being of its citizens by amending the Water Use Act (Alaska Statute, AS 46) in 1980. The amendments (AS 46.15.03 and AS 46.15.145) provided the opportunity for private individuals; in addition to state, federal, and local government agencies to legally acquire water rights (appropriations of water) to maintain a specific instream flow or level of water in rivers, streams, and lakes for one or a combination of four types of uses:

1) protection of fish and wildlife habitat, migration, and propagation;
2) recreation and parks purposes;
3) navigation and transportation purposes; and
4) sanitary and water quality purposes.

Under Alaskan law (AS 46.15.145) and regulations (11 AAC 93.970), an appropriation of water for these purposes is also defined as a "reservation of water". Reservations of water can be described as the rate of flow in a river, the volume of water in a lake, or a related physical attribute such as water depth. A reservation of water for instream flow purposes is usually referred to as an "instream flow reservation".

Regulations to implement the instream flow law were adopted by the Alaska Department of Natural Resources (DNR) in September 1983 and modified in 1990 and 1992. Additional regulation modifications relating to the reservation of water were approved in 1993.

To reserve water, an application containing supporting data and analyses that substantiate the need for the amount of water being requested must be submitted to the DNR for adjudication (the administrative determination of the validity and amount of a water right, including the settlement of conflicting claims among competing appropriators). Forms required to apply for reservations of water were first made available by the DNR in November 1983. Further information related to Alaska's instream flow water laws can be found in Curran and Dwight (1979), White (1981), Estes and Harle (1987), Harle (1988), Estes (1992), Estes (1993), Harle and Estes (1993), and Estes (1994).

The Fish and Game Act (AS 16) requires the Alaska Department of Fish and Game (ADF&G) to, among other responsibilities, "manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020). One of the AS 16 provisions enables the ADF&G to acquire water rights to further its objectives or purposes (AS 16.05.050). The Division of Sport Fish of the ADF&G initiated an ongoing program in 1986 to take advantage of the new opportunity to acquire instream flow water rights for sport fish resources.

This report summarizes the ninth year of this program (July 1, 1994 to June 30, 1995) in which the primary objective was to estimate seasonal quantities of instream flows necessary to sustain sport fishery resources in four stream reaches. Included in the Discussion is a summary of other instream flow related activities by the private sector and other agencies.

METHODS

STUDY DESIGN

Procedures for site selection, instream flow analysis, and completing applications for instream flow reservations were selected to comply with requirements established by state law (AS 46.15.145), state regulations (11 AAC 93.141-146), reservation of water application form instructions (Estes 1993), and the *"State of Alaska Instream Flow Handbook"* (DNR 1985).

SITE SELECTION

River/stream reaches nominated for instream flow protection in 1994-5 were selected following procedures in the 1984 Departmental Instream Flow Work Plan (ADF&G 1984, Estes 1985), and as modified in 1986 (Instream Flow Committee 1986). The final selection of a site was made by the Statewide Instream Flow Coordinator in consultation with Regional Supervisors for each region of the Division of Sport Fish or designees. The choice of a site was based on the importance of a water body to the sport fishery resources, the likelihood for competing out-of-stream uses, whether existing hydrologic and biologic data for a stream reach were adequate for performing an instream flow analysis (including the subsequent preparation and submission of an application), and whether other state and federal statutory mechanisms would provide better or more cost effective protection than an instream flow water right acquired under Alaskan law.

Six reaches (Figure 1; Appendices A1-6) were selected for instream flow analyses and preparation of instream flow reservations in Fiscal Year 1995 (FY 95, July 1, 1994 to June 30, 1995): Nenana River (three reaches), Chuitna River, Kasilof River, and Salmon River.

Stream reach boundaries for each FY 95 instream flow application were selected to insure that flow, habitat, and fish periodicity (seasonal use of habitat for passage, spawning, incubation, and rearing) characteristics within the reach were uniform throughout the study reach. Reaches were defined on U.S. Geological Survey (USGS) topographic maps with the assistance of ADF&G biologists and USGS hydrologists. Topography, watershed, and channel patterns, fish periodicity, USGS gage site descriptions and mean daily flow data were collectively analyzed.

Fish periodicity data for defining stream reaches and flow requirements were obtained and summarized from reviews of scientific literature, interviews with fishery and habitat biologists from the ADF&G and other agencies, the "*Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes*" (ADF&G 1994), and "*Harvest, Catch and Participation in Alaska Sport Fisheries During 1993*" (Mills 1994). ADF&G biologists, responsible for the areas encompassing targeted instream flow reaches, reviewed and refined the syntheses of periodicity data. If discrepancies were discovered among data sources for species distribution and life phase occurrence within a reservation reach area, individuals responsible for data sources were consulted to reach a consensus as to which data to use. The final periodicity chart was based on these consultations.

Flow data and gage site descriptions used for delineating reach boundaries were obtained from USGS "*Water Resources Data for Alaska*" Reports; and from interviews with ADF&G biologists, USGS hydrologists, DNR Division of Mining and Water hydrologists and water resource specialists, and other resource specialists that are known to have data pertinent to the reservation. Alaska water laws and regulations required that stream reach boundaries encompassed a stream reach with homogeneous flow and biologic characteristics. Boundaries were first determined by evaluating watershed and channel characteristics upstream and downstream of a stream gage or discharge site. Seasonal fish distribution and species periodicity were used to refine reach boundaries that were hydrologically defined. The resulting selection of boundaries were then refined based upon reviews by USGS hydrologic personnel and ADF&G regional biologists.

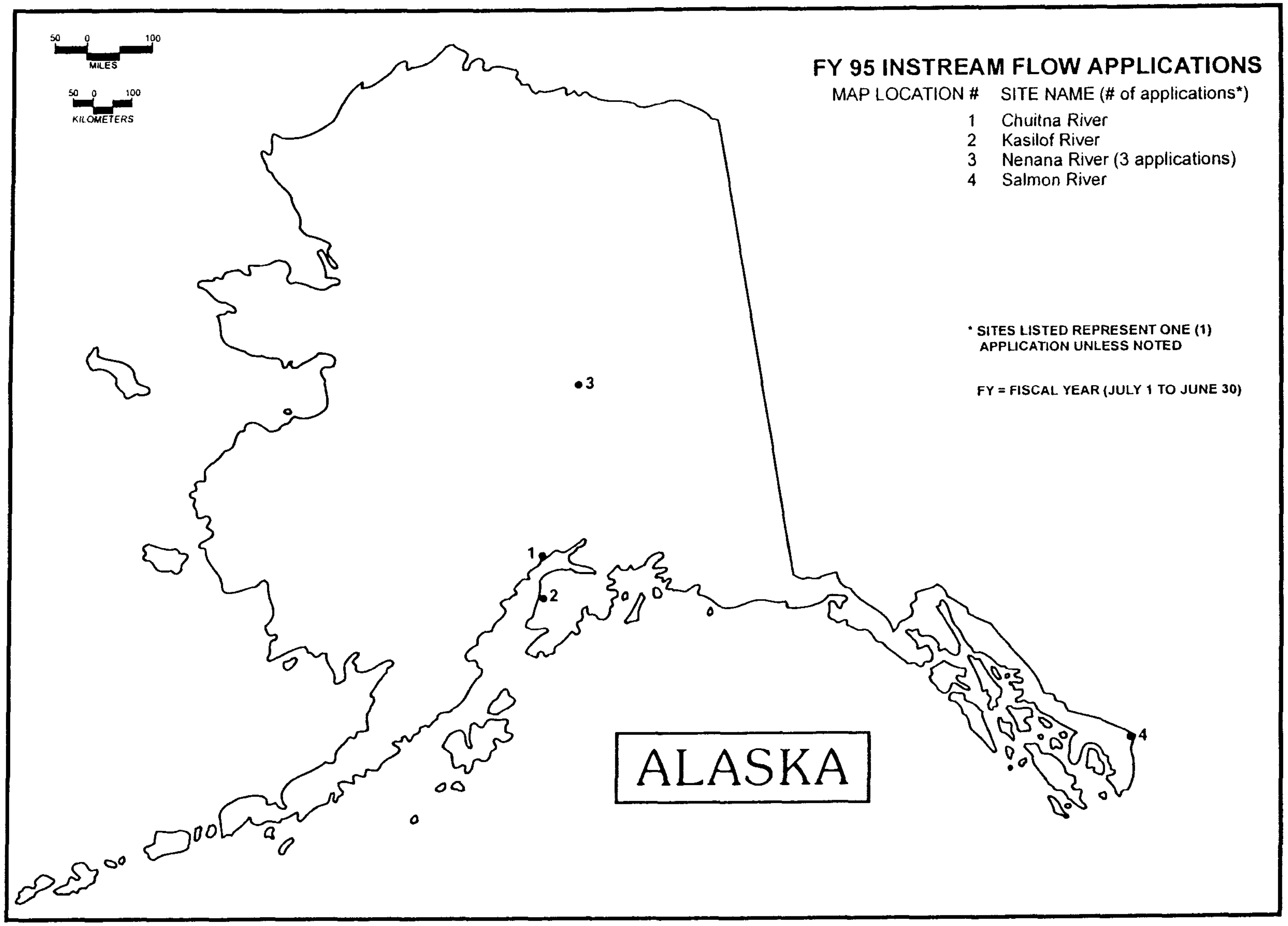

Figure 1. Locations of instream flow reservation application reaches, July 1, 1994 to June 30, 1995

INSTREAM FLOW ANALYSIS

An applicant's choice and use of a specific method for quantifying instream flow requirements is not restricted by existing Alaska water laws, regulations, or a set of established standards(DNR 1985, Estes and Harle 1987, AAC 1993a). However, the rationale for the selection of a method or methods must be documented and include a description of the procedures. This information must accompany the resulting instream flow application. The Tennant Method, also referred to as the Montana Method (Tennant 1972, 1976), was selected as the basis for quantifying instream flow requirements for the FY 95 study sites. The Tennant Method analysis was combined with an evaluation of mean daily flows, mean monthly flows, duration flows, and other hydrologic characteristics (Orsborn and Watts 1980, Estes 1984, Estes and Orsborn 1986, Shaw 1988) to determine whether sufficient water could be expected to be within each study reach during the various periods of the year in which the reservation was requested, and to enable a refinement of the instream flow choices derived with these analyses.

Surface water flow databases of the USGS, required for performing all of these analyses, were downloaded from local USGS computers.

Each data set was transferred into Statistical Analysis System (SAS) data files (SAS 1990). Summary analysis was used to check the data for simple errors. After initial error checking was complete, the data were analyzed by a series of SAS programs using the procedures outlined below to estimate the long-term average annual and average monthly mean daily flow values and the monthly (and/or semi-monthly) flow duration parameters.

Descriptive information pertaining to the fishery and hydrologic characteristics of the study sites were acquired through literature review and interviews with ADF&G biologists, USGS hydrologists, DNR Division of Water hydrologists, and other state, federal, and private resource specialists that were known to have data pertinent to the reservation analyses. ADF&G biologists and USGS hydrologists, most familiar with each study site, assisted with the refinement of this information whenever discrepancies occurred.

Tennant Method

The choice of the Tennant Method was based on its acceptance by both the DNR and courts as a valid instream flow analytical procedure (Supreme Court of Alaska 1995), and the limited availability of data, previous analyses, and financial resources required to prepare instream flow applications.

The first step of the Tennant Method was to calculate the average annual flow, QAA, (arithmetic mean of the annual mean of mean daily flows for all years of record) for each stream reach. Next, each QAA was multiplied by eight Tennant Method coefficients (percentages) to calculate instream flows for eight habitat categories. Seven of the Tennant Method habitat categories (ranging from 10% to 100% of the QAA) represent a range of poor to optimum habitat quality conditions for fish and wildlife. The eighth category (200% of the QAA) represents the short-term flushing flow that Tennant (1972) considers necessary to maintain channel substrate characteristics suitable for fish spawning and egg incubation, and benthic invertebrate production. Research by Estes (1984, Reiser et al. 1985) suggests supplemental analyses are required to modify or substitute for Tennant Method flushing flow calculations.

Next, hydrologic analyses were performed to estimate baseline flow conditions in each stream reach. This involved calculating mean monthly flows (QAM), the arithmetic mean of the monthly mean daily discharge for a given month for the entire period of record, and flow duration estimates (the expected frequency of occurrence of mean daily flows within a particular month).

Finally, seasonal instream flow requirements for individual life phases of fish for each stream reach were chosen by comparing the eight Tennant Method flows, fish periodicity data, QAM, and flow duration estimates. With the exception of flushing flows, instream flows were selected that corresponded to both fish periodicity and the highest of the other seven Tennant Method habitat categories that did not exceed flow duration estimates during that same period. During the months when spawning occurs, flows within the highest qualitative instream flow condition were selected from the Tennant analysis output that did not exceed those estimated by other hydrologic analyses (i.e. mean monthly flow or duration analysis values) during that same time period. During other life phase time periods, the highest of the flows were selected that were expected to occur within the system during that time period that fell within the Tennant ranges of "fair to excellent". When more than one life phase occurred for the same or different species during the same time period, the life phase for that time period requiring the highest instream flow value were requested for that time period.

A flushing flow calculation was calculated as part of the Tennant Method analyses, but not used to file for a flushing flow water right due to provisions in the Water Use Act (AS 46.15.145) that are interpreted by the DNR to limit reserving this type of flow to water bodies with controlled flows. Resources were also unavailable to perform supplemental flushing flow analyses recommended by Estes (1984) for refining or substituting for flushing flow results derived by using the Tennant Method.

Average Annual Flow Procedures

Calculation of QAA, from the existing USGS mean daily flow records for the stream reaches, involved first obtaining the mean of the mean daily flows within each water year (October 1-September 30):

$$qaa_h = \frac{\sum_{i=1}^{d_h} q_{hi}}{d_h}; \qquad (1)$$

where: qaa_h equaled the mean annual daily flow for each year (h) of record; d_h equaled the number of days in each year of record (note that only complete years of record were used in this analysis; d_h varied only between leap and non-leap years); q_{hi} equaled the daily mean flow in cubic feet per second for each day in the record.

Next, QAA was estimated as a mean of the annual mean daily flow values over all complete years of record:

$$Q\hat{A}A = \frac{\sum_{h=1}^{n} qaa_h}{n}; \qquad (2)$$

where: n equaled the years of record (with complete daily flow records for each water year).

Mean Monthly Flow Procedures

The QAM was estimated similarly by first estimating the mean daily discharge for each complete month in the record:

$$qam_{jh} = \frac{\sum_{k=1}^{d_{jh}} q_{jhk}}{d_{jh}}; \tag{3}$$

where: qam_{jh} equaled the monthly mean daily flow for each month (j) for each year of record (h); d_{jh} equaled the number of days in each month of record (note that only complete months of record were used in this analysis); q_{jhk} equaled the daily mean flow in cubic feet per second for each day in the record.

Next, QAM was estimated as a mean of the monthly mean daily flow values over all complete years of record:

$$Q\hat{A}M_j = \frac{\sum_{h=1}^{n} qam_{jh}}{n_j}; \tag{4}$$

where: n_j equaled the years of record with complete daily flow records for each j.

Duration Analysis Procedures

Flow duration estimates were calculated as percentiles of the distribution of observed values within the time periods involved over the years of record. For example, flow duration estimates for the month of April were calculated by combining all mean daily flow values for April (for all years having complete April records). Then the empirically defined distribution (observed-combined mean daily flow values) was calculated as follows. If the quantity to be calculated was defined as the "t^{th}" percentile, where $p = t / 100$, then setting:

$$np = j + g$$

where: n was equal to the number of observed mean daily flow values in the combined group (for example 300 days for a 10-year- record of complete months of April); j was the integer part of n times p; and g was the fractional part of n times p. For example, if n = 300 and we wanted to calculate the 97th percentile, then j = 291 and g = 0; or for the 2.5th percentile, then j = 7 and g = 5.

Then the t^{th} percentile (y) was defined as:

$$y = \left(x_{(j)} + x_{(j+1)}\right) / 2 \qquad \text{if } g = 0; \tag{5a}$$

or

$$= x_{(j+1)} \qquad \text{if } g > 0; \tag{5b}$$

where: $x_{(j)}$ and $x_{(j+1)}$ were the ordered (from smallest to largest) values in the combined group of mean daily flow values.

The above information was incorporated into instream flow applications (Estes 1993) with other required information following procedures defined by the DNR (1985). Additional descriptions of procedures are presented in each instream flow application (ADF&G 1995a, b, c, d, e, f).

RESULTS

Analyses were completed and applications prepared to request instream flow protection for fish in six stream reaches in four river systems (Figure 1; Appendices A1-A6; ADF&G 1995a, b, c, d, e, f): Nenana River near Rex (Reach A), Nenana River near Healy (Reach B), Nenana River-near Windy (Reach C), Chuitna River near Tyonek, and Kasilof River near Kasilof, and Salmon River near Hyder. Applications are undergoing review prior to submitting them to the DNR.

The lengths of the six stream reaches, ranged from approximately six miles (Chuitna River, Appendix A4) to 62 miles (Nenana River-Reach A, Appendix A1).

Fish periodicity for each stream is illustrated in Appendices A7-A12. Salmon River (Appendix A12) had the lowest variety of fish species reported (six) and the Chuitna River (Appendix A10) the most, with 12 species. Appendix A13 lists the common and scientific names of the fish species listed in the periodicity charts (Appendices A7-12).

Historical records of USGS mean daily flow data varied from 4 years for the Nenana River-Reach A to 29 years for Nenana River-Reach B (Appendix A14).

QAA, mean monthly flow, and Tennant Method results are summarized in Appendices A15-A20. QAA values ranged from 359 cubic feet per second (cfs) for Chuitna River (Appendix A18) to 4,536 cfs for the Nenana River-Reach A (Appendix A15). Mean monthly flows ranged from 79 cfs in the Chuitna River during March (Appendix A18) to 14,472 cfs in the Nenana River-Reach A during June (Appendix A15). Optimum habitat flows ranged from 215-359 cfs for Chuitna River (Appendix A18) to 2,722-4,536 cfs (Appendix A15) for the Nenana River-Reach A. Poor habitat flows ranged from 36 cfs for Chuitna River (Appendix A18) to 454 cfs for the Nenana River-Reach A (Appendix A15). Tennant flushing flow values ranged from 718 cfs for the Chuitna River (Appendix A18) to 9,072 cfs for the Nenana River-Reach A (Appendix A15).

Instream flow values requested usually ranged from 60% to 100% of the QAA for the spawning and passage seasons, and 10% to 40% of the QAA for incubation and rearing seasons (ADF&G 1995a, b, c, d, e, f).

There is presently no legal mechanism for reserving flushing flows in unregulated streams and rivers in Alaska. Research by Estes (1984) suggests flushing flow calculations, using the Tennant Method, require additional analyses that were not funded. Therefore, Tennant values were not modified and used for reserving flushing flows for the six river reaches. Nonetheless, a flushing flow statement was included in each instream flow application to establish a basis for protecting flushing flows in these unregulated systems (until an acceptable method is developed for use under state law). The statement explained that flushing flows were required to maintain fish habitat and (at a minimum) must be safeguarded whenever significant flow modifications or a structure capable of controlling flows were planned.

Instream flow regimes requested are not included in this report because they are subject to modification both while undergoing departmental review prior to submission to the DNR and during the various stages of the DNR adjudication process. These data will be presented in future reports following the completion of these processes.

DISCUSSION

Six applications for instream flow reservations were completed by the ADF&G during FY 95. The applications will be submitted to the DNR upon completion of internal review. The DNR has received 83 applications for reservations of water from the ADF&G, federal agencies, and the private sector since passage of the 1980 enabling legislation (Appendix A21, Estes 1987-1994, Harle 1988, Harle and Estes 1993, Bayha 1995, Harle 1995). Sixty-two of the applications were completed by the ADF&G (sixty-one for instream flow reservations and one for a reservation of water in a lake), one by the U.S. Bureau of Land Management (BLM), twelve by the U.S. Fish and Wildlife Service (USFWS), four by the Anchorage Audubon Society, two by private individuals, one by the Arctic Unit of the Alaska Chapter of the American Fisheries Society (AFS), and one by the Juneau Chapter of Trout Unlimited (TU). Only the ADF&G, BLM, USFWS, TU, and AFS applications met DNR requirements and were accepted for adjudication. The other six applications were rejected by the DNR for a variety of reasons (Estes 1993, Harle and Estes 1993). The BLM and 10 of the ADF&G applications for instream flow reservations have been adjudicated and granted by the DNR (Estes 1994). The remaining 66 applications are pending completion of the adjudication process by the DNR (Harle and Estes 1993, Estes 1994).

More than 15,000 fish bearing freshwater bodies (ADF&G 1994) are potentially subject to water extraction and flow modification in Alaska. Thus, it is not surprising the Alaska Legislature and Governor approved amendments to the Alaska Water Use Act in 1980 to allow for the formal reservation of water (AS 46.15.145) for, among other reasons, to help sustain the production of Alaska's invaluable fishery resources in rivers and lakes. To qualify for water rights protection under AS 46.15.145, many of the fish bearing rivers must be subdivided into two or more reaches. One may therefore question why only 82 rivers and 1 lake (out of an estimated 30,000 or more fish bearing river reaches and thousands of lakes) have been targeted for formal instream flow and related protection during the past 10-years. And of the applications for reservations of water filed and accepted, why have so few been granted; and, why are the remainder pending adjudication? There are several reasons; among them are: insufficient allocations of personnel and financial resources needed for performing application and adjudication functions related to the reservation of water, insufficient hydrologic data required for defining water availability and instream flow requirements, lengthy administrative processes for preparing and adjudicating applications for water reservations, insufficient public education relating to instream flow and other water reservation protection opportunities, and except for state agencies, reservation of water application fees (Estes 1993, Harle and Estes 1993).

The dearth of hydrologic data in Alaska is perhaps the most limiting factor governing our ability to define instream flow, and other water uses. Alaska has approximately 40 percent of the nation's surface freshwater supply. Yet, only 374 USGS continuous flow stream gaging sites have been established in Alaska since 1908 (Brabets 1995). This equates to flow measurements for less than 1 percent of Alaska's water bodies. Eleven of these Alaskan gage sites have less than 1 year of continuous flow data, 104 have 1 to less than 5 years of continuous flow data, 85 have 5 to less than 10 years of continuous flow data, 107 have 10 to less than 20 years of continuous flow data, 66 have 20 to less than 50 years of continuous flow data, and 1 site has 50 or more years of data (Appendix A22). Typically, no more than 25 percent of these Alaskan gages are active in any one year due to funding restrictions (Thompson 1992, 1994). Seventy-eight USGS gaging stations were operating in Alaska during Water Year 1995, October 1, 1994 to September 30, 1995 (Brabets 1995). This represents an average of one stream gage per 7,400 square miles in Alaska (Brabets 1995). Alaska's density of gages contrasts significantly with the lower "48" average of one gage site per 400 square miles. The stream gaging trend in Alaska is especially alarming, because as of September 30, 1995, only 47 percent (174) of the Alaskan gage sites (Appendix A22) could meet the USGS 10-year-minimum historical data standards for supporting a statistically reliable regional flow analysis. Daily stage and water surface elevation data is non existent for the majority of Alaskan lakes.

Ironically, to quantify instream flow and related requirements and apply for a reservation of water for ungaged stream reaches, one must use regional hydrologic models to estimate flow characteristics. It is obvious the USGS databases, from which these models were developed, will limit the ability to evaluate naturally occurring hydrologic patterns at these sites with confidence. It is also more time consuming to estimate flow characteristics for streams having a limited or non-existent database as opposed to summarizing data for a stream having an adequate historical record. Precipitation information also required for these ungaged flow models is also limited, further complicating the process for estimating flow availability. Similar data limitations hamper efforts to quantify water reservations for lakes.

Basic hydrologic data are required by all potential water users (out-of-stream and instream), and water management agencies to enable them to project the reliability and amount of water that might be available, even if there were no other competitors for their targeted water source. Continuous flow and stage data are also necessary to manage and enforce existing water rights. Limited road systems, extremes in weather conditions, and difficulties such as loss of equipment to bears and other wildlife make data collection difficult and expensive in Alaska. Therefore, unless a commitment is made to close these data gaps in Alaska, we will continue to be limited to making decisions regarding water allocation using these models with little or no hope for improving the precision or accuracy of our flow estimates. Therefore, it should be obvious that additional gaging stations should be added for a minimum of 10 to 20 years to improve the accuracy of the information used to make decisions pertaining to water availability and allocation in Alaska.

In an attempt to compensate for limited financial and personnel resources and the above hydrologic conditions, the ADF&G has developed and refined a cost-effective approach to acquire the majority of its instream flow protection for fish by using the Tennant Method as its primary technique for analyzing instream flow needs. When necessary, this method has been modified and new procedures (requiring minimal resource expenditures) were developed (Estes 1989, 1992) to request specialized instream flow and related reservations of water (e.g., flushing flows, and water depth and area in lakes). Consequently, as a rule, uses of more sophisticated and expensive methods for reserving water, such as the Instream Flow Incremental Methodology

(Bovee 1982), have been limited to situations where competition between out-of-stream uses and instream related requirements was likely to be highly controversial and required an incremental quantitative flow analysis. Occasionally, projects under federal jurisdiction (e.g., projects requiring a Federal Energy Regulatory License) have also mandated a specific data collection and analytical procedure. Unfortunately, supplemental funding, available in the past for projects requiring application of more sophisticated methods, has become increasingly difficult to obtain. Funding has also been unavailable to systematically evaluate whether reservations of water have been providing the desired protection and to monitor whether water uses have been in compliance with governing appropriations.

Administrative processes can be an added deterrent to potential and existing applicants, for reservations of water, including the ADF&G. Based upon past experiences, an estimated 1 to 3 weeks of an applicant's time may be required to participate in the various phases of the DNR adjudication process for each outstanding instream flow application (Estes 1994). Adding to an applicant's frustration, is the absence of a fixed timetable for the DNR to adjudicate water rights applications after they are filed. There have been no adjudications of ADF&G instream flow and other reservation of water applications by the DNR since 1991 (Estes 1992, 1993, 1994, Harle and Estes 1993), increasing the backlog to more than 50 applications. Accordingly, if too many adjudications of ADF&G's applications were scheduled by the DNR (at any one time), the added resource and time requirements would overtax ADF&G's instream flow program resources.

Adding to the uncertainty, associated with DNR's variable schedule for processing water rights applications for instream flow and other water reservations, is the overall backlog of water rights actions by the DNR. According to Prokosch (1995), DNR has a backlog of 800 water rights applications (including the 66 water reservation applications filed by the ADF&G and others) pending adjudication, and another 1,500 water use related permits and certificates requiring various administrative actions. The overall backlog is estimated to be growing at a ratio of approximately one application for a reservation of water per ten applications for out-of-stream water rights. Complicating the adjudication of the DNR backlog are water rights for out-of-stream uses that were grandfathered by the DNR in 1966. Many of these water rights were granted without identifying whether the quantity of water claimed by an applicant actually existed, was needed, or used. This may have resulted, or will result, in overappropriations from some of the affected water sources.

DNR's eventual adjudication of its backlog of applications for out-of-stream uses of water (derived from or affecting fish bearing water sources) will provide another type of opportunity for instream flow and related protection. This is because DNR, under AS 46.15.080 (b)(3), is required to provide the ADF&G the option to review any proposed water use that may affect fish and wildlife production. The ADF&G can, based upon its review, request DNR to condition (revise or deny) an applicant's proposed out-of-stream water use for the purpose of protecting fish and wildlife. On the other hand, the timing for adjudicating these out-of-stream water rights has the potential to strain ADF&G's instream flow and other program resources (similar to concerns expressed above associated with reservation of water adjudication processes). The potential benefit of this provision is also questionable because the unallocated water, resulting from a DNR condition placed on a water right (in consideration of a request from ADF&G), remains subject to future appropriations. This is because DNR is only required to consider the input of the ADF&G and can accept, modify, or ignore the ADF&G's recommendations under this provision.

An absence of standards governing how DNR documents its rationale for adjudication decisions under AS 46.15.080 further weakens instream flow related considerations under these provisions. Inadequately documented decisions for denying or reducing the amount of water granted to an applicant for an out-of-stream use (in response to a request from the ADF&G) may result in future DNR adjudicators inadvertently interpreting that the remaining unallocated water in a water body remains subject to allocation, when in fact, a public interest decision had been previously made for purposes of instream protection. This record keeping problem would be solved if DNR were to adopt findings of fact and conclusions of law procedures for all water rights applications. Presently, this process is only mandatory for reservation of water adjudication decisions (11 AAC 93.0145). These were among the reasons AS 46.15.145 provisions were enacted to establish a formal mechanism for allocating water rights for instream flows and other reservations of water (Harle and Estes 1993). Accordingly, it is in the best interests of the ADF&G to closely monitor DNR's future plans for adjudicating their large backlog of out-of-stream water rights and completing other pending water allocation related administrative actions.

The growing backlog of ADF&G applications for water reservations pending adjudication has, until recently, not been interpreted to pose an immediate threat to desired instream flow and related protection. This is because a priority date was assigned to each application for a reservation of water at the time it was accepted by the DNR. The priority date establishes the order of priority for the allocation of water within and from the source of water. However, until the adjudication process is completed, the amounts of water requested in applications for water reservations and out-of-stream water uses remain subject to modification or rejection by the DNR. Until recently, this principle has been applied consistently. Thus, until an instream flow or reservation of water right application has been fully adjudicated, it is assumed 100% of the original amount of water requested in the application will be managed by the DNR on behalf of the applicant. However, the ADF&G has become increasingly concerned as more time passes before an application for a reservation of water is adjudicated. This is because it is more likely that those responsible for the original instream flow and water reservation analyses and application preparation, and the DNR staff who completed the initial phases of an adjudication will have changed employment or responsibilities. It is also conceivable that out-of-stream competition for water from sites pending adjudication of previously filed applications for instream flow and other reservations of water will increase over time. Experiences gained by other states indicate that protection of instream flow and other reservation of water uses is often judged to be less important than allocating water to competing out-of-stream water uses when competition for water allocation is keen. Accordingly, lengthy delays in adjudicating applications for reservation of water uses may result in less than desired protection than would otherwise be granted today, while competition from other out-of-stream water uses remains minimal.

Compounding concerns related to the adjudication of pending water rights, is recent correspondence to the USFWS from the DNR (Appendix A23) which contradicts earlier DNR practices by implying that the date for filing an instream flow application does not establish a priority. Instead, the DNR correspondence infers that the date of priority for an instream flow water use is instead based on the date the application for instream flow water rights has been granted. This and internal DNR correspondence (Appendix A24) also imply the DNR can and will selectively treat applicants unequally based on who they are and by the type of water use requested. This highlights a contradiction between language pertaining to priority of water uses in the Alaska Constitution (Article VIII, Section 13) and provisions within the Water Use Act, AS 46.15.145 (e). This Water Use Act language is also in conflict with Water Management Regulations, 11 AAC 93.146 (e), governing priority of water uses. Article VIII, Section 13 of the Alaska Constitution (Harrison 1986) and 11 AAC 93.146 (e) of the Water Management Regulations state that a water right priority of use for a reservation of water is based on the date an application is filed and accepted by the DNR. Yet, according to the DNR (Appendix A24), AS 46.15.145 (e), can be interpreted to imply that a priority of use for instream flow purposes will not be granted until the application is fully adjudicated and the certificate of reservation is granted. Public trust provisions in AS 46.15.080 require that fish and wildlife, among other uses, be considered when adjudicating water for out-of-stream, diversionary and impoundment uses. This priority of use language in AS 46.15.080 contradicts the AS 46.15.145 (e) language by suggesting an application for water rights for a reservation of water filed prior to an application for an out-of-stream or related use merits full consideration, if not priority, regardless of whether the application for a reservation of water is fully adjudicated. It is therefore assumed the state statutory language requires modification to be consistent with the Alaska Constitution, other Water Use Act provisions, and earlier practices established by the DNR, the Public Trust Doctrine, and principles of the Doctrine of Prior Appropriation.

AS 46.15.145(f) requires the DNR to review reservations of water, that have been granted, once every 10 years to evaluate whether to revoke or modify an instream flow or other type of reservation of water, or retain the status quo. Consequently, proprietors of reservations of water, must maintain a permanent storage system for the original data and analyses. Documentation must be sufficient to enable original applicants (or representatives) to periodically defend the status quo of their water reservation. This data storage requirement is costly in terms of space and serves as an impediment to private applicants with limited resources. It is also unclear whether owners of reservations of water must fund their own participation in 10-year-reviews. There are no equivalent provisions for automatic reviews of out-of-stream water rights.

Another limitation of existing water management practices, is the DNR policy of not managing water diversions when water is not used. For example, this applies to a water body that has been diverted but no use has been made of the water, and the water is returned to the original water source at the same or different location from the point of diversion. The DNR claims they have no water management authority for this type of diversion unless someone possesses a prior water right for instream flows or water extraction within the river reach that was diverted. DNR bases its position on the belief that they cannot manage the water unless it is put to a beneficial use (even if fish were identified as using the reach from where the water was diverted). This DNR policy could result in the dewatering of portions of fish bearing waters, unless ADF&G were aware of the water diversion and exercised its AS 16.05.840 and 870 authorities.

Fees charged by the DNR for filing instream flow and other reservation of water applications are another deterrent for applicants. With the exception of state agencies, all applicants seeking to acquire a reservation of water are charged $500 per application (AAC 1993b). There is no charge to state agencies. The $500 fee is expensive relative to application fees charged by the DNR for most other water rights and (unlike other water rights) is not based on the amount of water requested. An additional regulatory fee was adopted by the DNR in 1993 (AAC 1993c). It enables the DNR to charge for the cost of staff time expended on the adjudication of water rights that exceeds the application fee. This supplemental fee is discretionary and serves as another obstacle for filing instream flow and other reservation of water applications by the private sector, and perhaps federal agencies.

Formal programs to educate and assist the public to file for instream flow and other reservations of water are nonexistent. Procedural and background publications to aid applicants for reservations of water are inadequate. The DNR and other state agencies are hoping to develop formal water education programs to correct this deficiency. In the interim, the ADF&G provides educational information, assistance, and lectures to the public upon request. Based on this approach, technical instruction and assistance was provided to two private citizen organizations to perform instream flow analyses and prepare applications for instream flow reservations (Estes 1993).

The above factors, and the complexity of water law and regulations, all contribute to the low number of applications filed for reservations of water. Some of these and related concerns have been addressed by the Alaska Legislature (Estes 1992, 1993, 1994, Harle and Estes 1993), the Interagency Hydrology Committee for Alaska (IHCA), and the Alaska Water Management Council (AWMC). It is likely some of these issues will be addressed again in the future.

The AWMC was established in 1992 to improve water management through better interagency state and federal coordination and cooperation. The Governor of Alaska signed an Administrative Order formalizing the activities of the AWMC in 1993 (Hickel 1993). The IHCA was formed in 1977 to coordinate technical concerns relating to the collection, analysis, and reporting of Alaskan hydrologic and climatologic data by state, federal and local agencies. In 1993, the IHCA accepted a request from the AWMC to serve as their technical advisor. Although the IHCA meets twice a year, the AWMC has not met since the Fall of 1993. Representatives from the DNR, Alaska Department of Environmental Conservation, and ADF&G are slated to meet in late 1995 to discuss the fate of the AWMC.

Alaska legislation enacted in 1992 (AS 46.15.020-.037), relating to the export and marketing of water (House Bill 596), has the potential to affect the protection of instream flows and other water reservations on a large scale (Estes 1992, Harle and Estes 1993). Regulations to execute the provisions of the law have not been completed. Furthermore, attempts to revise the water export and marketing law are anticipated for 1996. Accordingly, the impact of this law cannot be fully assessed at this time.

Interest for exporting water from Alaska to other states and countries appears to be increasing. Two water use applications to export water from Alaska were filed by Sun Belt, a California based company, prior to the passage of HB 596. The applications were closed due to incomplete information. If these water rights had been granted by the DNR, Sun Belt would have withdrawn water from Orchard Lake in Ketchikan and the tailrace of the Snettisham Hydroelectric Project in Juneau. Water has been purchased from the Municipality of Anchorage water supply for export to Seattle, and eventually Saudi Arabia, by Alaska Glacier Fresh. The company hopes to eventually export 14 million gallons of water per tanker load using a Saudi Arabian ocean vessel (Prokosch 1993). The Municipality of Anchorage sold 1.7 million gallons of water to an unspecified industrial plant in Japan during 1994 (Blumberg 1994). The water was sold for $3.14 per 1,000 gallons, for a total sale of $5,338. The water was transported to Japan by an industrial ocean tanker. Other development plans for water export operations in Alaska include Crystal Creek water in Petersburg, Blue Lake water in Sitka, subsurface water from aquifers in the vicinity of Starrigavan Creek in Sitka, Alaska, and a planned Saudi Arabian operation to bottle and export water supplied by the Ketchikan Public Utility hydroelectric facility at Beaver Falls near Ketchikan. The effects of water exports and sales will undoubtedly increase as time passes, placing a greater emphasis on the laws passed to regulate these activities.

The development of small and medium sized hydropower operations in Alaska is on the rise and adding to increased competition for water needed instream and within lakes for fish production. Transfers of hatcheries to the Division of Sport Fish by other divisions of the ADF&G have resulted in the identification of inadequate water rights needed for hatchery operations and instream flow water rights required for fish production in waters impacted by these hatchery operations.

Perhaps, the most significant threat to future instream flow protection in Alaska are plans being considered by the DNR to eliminate their Water Management Section within the Division of Mining and Water (Kowalski 1995). At this time, it is unknown whether this proposal is supported by Governor Knowles and whether an alternate plan has been established for adjudicating and monitoring the enforcement of water rights allocations in lieu of the existing water management organization.

In addition to filing for reservations of water with limited resources, the ADF&G's instream flow protection program has become increasingly burdened with an annual increase in the number of requests for instream flow and related technical support by other ADF&G staff, agencies, and the private sector. Without additional staffing and financial resources, the limitations above, combined with the growth in demands for assistance to others, will increasingly hamper the ability of the ADF&G to maintain its average production rate of seven applications per year (Estes 1987-94).

On the brighter side, the DNR portion of the 1993 Capital Improvement Project (CIP) budget approved by the Alaska legislature included $200,000 funding to perform a stream gage network evaluation to evaluate the existing gage network and develop priorities for future gaging. Funding for this evaluation had been requested for several years (Estes 1991, 1992, 1993). The final results of the evaluation are expected by early 1996. Preliminary results were used to successfully acquire CIP funding from the legislature in 1995 for new stream gage sites. USGS is matching the state funding. Eight gage sites will be installed during the period July 1, 1995 to June 30, 1996. The new gage sites were selected from a list of candidate sites nominated by the IHCA. The IHCA based their recommendations on a review of the draft USGS network evaluation.

RECOMMENDATIONS

Based upon the experiences of the ADF&G, the following recommendations are provided to improve instream flow protection.

1) Additional ADF&G staff (fishery biologists and hydrologists) and financial resources should be allocated to the instream flow program to allow for a greater number of applications to be processed for reservations of water on an annual basis. Staff should also be provided to perform adjudication activities without impeding the completion of new applications.

2) Additional ADF&G instream flow staff (fishery biologists and hydrologists) and financial resources should be allocated to allow the ADF&G to provide better and more technical reviews of AS 46 water rights applications filed for water withdrawals, diversions, and impoundments. DNR submits these applications to the ADF&G to provide the Department an opportunity to express its instream flow and other fish and wildlife concerns pertaining to the proposed out-of-stream water uses.

3) Legislation should be enacted annually to continue funding additional stream gage data collection stations based upon the recommendations of the USGS network evaluation. The stations are required to improve flow projection models and estimates and to determine the availability of water for out-of-stream, instream and related uses.

4) Out-of-stream appropriations of water should be automatically reviewed by the DNR once every 10 years, as are reservations of water.

5) The DNR water rights data base should be fully automated and easily accessible to other agencies and the public.

6) All water rights acquired under grandfather provisions in 1966 should be evaluated to determine their accuracy based on hydrologic analyses of water availability. If analyses of flow data indicate water is overappropriated and public interest criteria were not addressed adequately, corrective adjustments should be made to the affected certificate of appropriation.

7) The ADF&G should review the status and adequacy of all water rights held by the department. The department should also evaluate whether all water uses comply with state statutory and regulatory requirements.

8) The Instream Flow Incremental Methodology should be used to reanalyze the adequacy of instream flow reservations obtained using the Tennant Method for the most important sport fisheries. If results indicate additional water should be reserved, a supplemental instream flow reservation application should be completed and filed.

9) All DNR water rights decisions and the rationale for granting, conditionally granting, or denying diversionary, withdrawal, and impoundment water rights (i.e. findings of fact and conclusion of law) should be in writing. This requirement is presently mandatory for instream flow water rights, but only optional for out-of-stream water rights.

10) Legislation should be enacted or regulations established that will guarantee a base level of instream flow protection for stream reaches that are classified as supporting fish.

11) A formal instream flow educational program should be funded to encourage public participation in the instream flow reservation process.

12) An instream flow methods and application handbook should be prepared to provide sufficient guidance for the public and other interested parties to file for instream flow reservations.

13) Private sector instream flow applicants should be exempt from optional administrative fees that can presently be assessed by DNR to pay for DNR staff adjudication time and resources.

14) The validity of statutory provisions, that can be interpreted to automatically grant instream flow water rights for water bodies within Alaska State Parks, should be established.

15) The DNR should acquire resources to implement a proposal agreed upon by the ADF&G and DNR for reducing the backlog of instream flow water rights applications.

16) The Alaska Water Use Act should be amended for consistency with the Alaska Constitution and Alaska Water Management regulations to clarify that priority of use for instream flow water rights is on equal footing with priority of use for other water allocation purposes.

17) Regulations for implementing all of the provisions of House Bill 596 should be completed.

18) DNR should reevaluate the validity of earlier policies preventing management of water that is diverted from a water body and not used.

19) DNR should discuss proposed policies with the ADF&G relating to treatment of instream flow water rights applications filed by federal agencies and other applicants prior to implementing these policies.

In summary, the ability to complete instream flow applications by the ADF&G continually improves with experiences gained through analysis and preparation of each application. Unfortunately, data requirements and delayed adjudication processes will continue to limit the number of reservations completed, submitted, and granted. Additional resources will be required for data collection and analyses, and the preparation and defense of applications to counter these limitations until laws and regulations governing the process to reserve water are improved.

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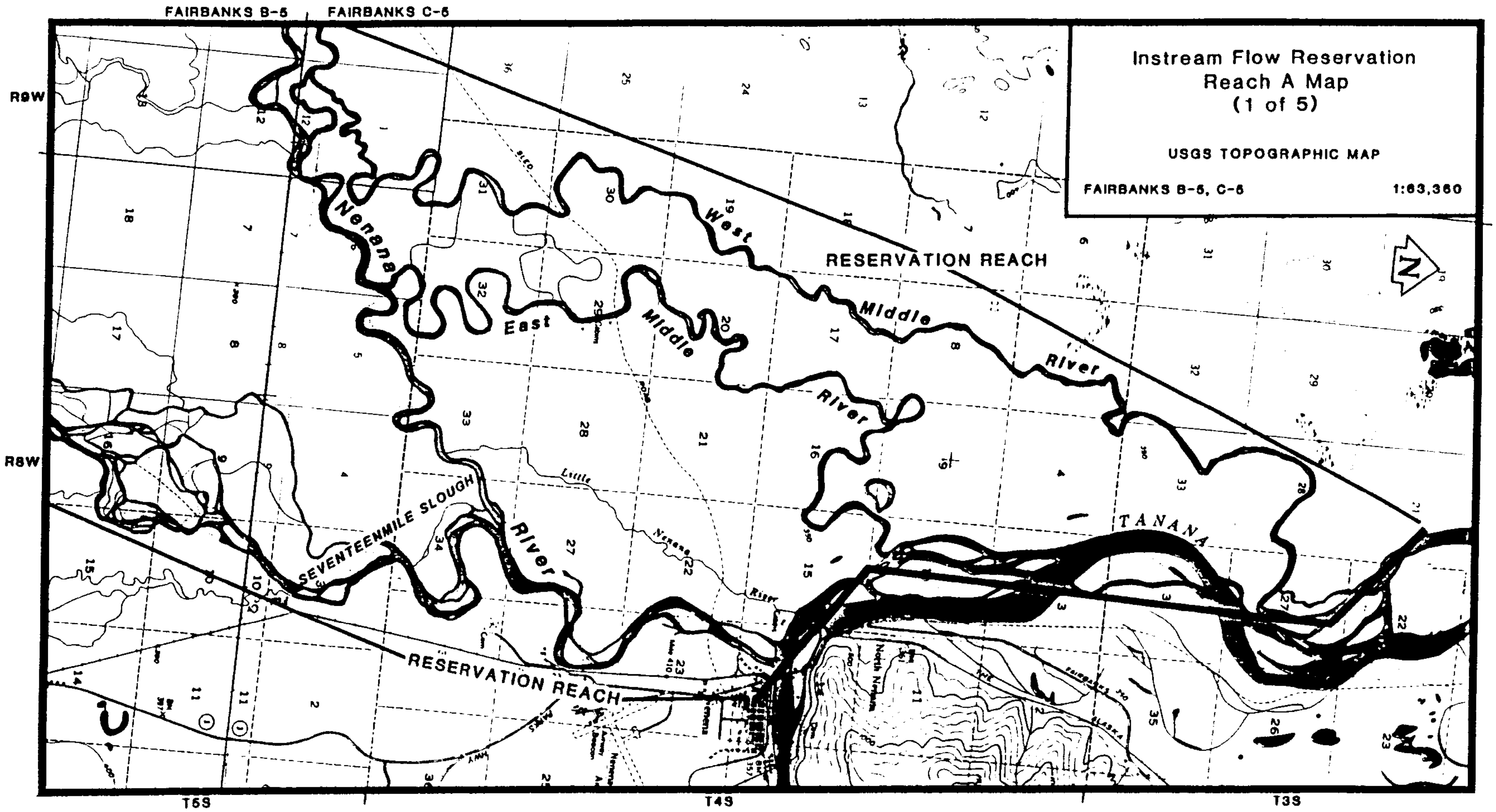
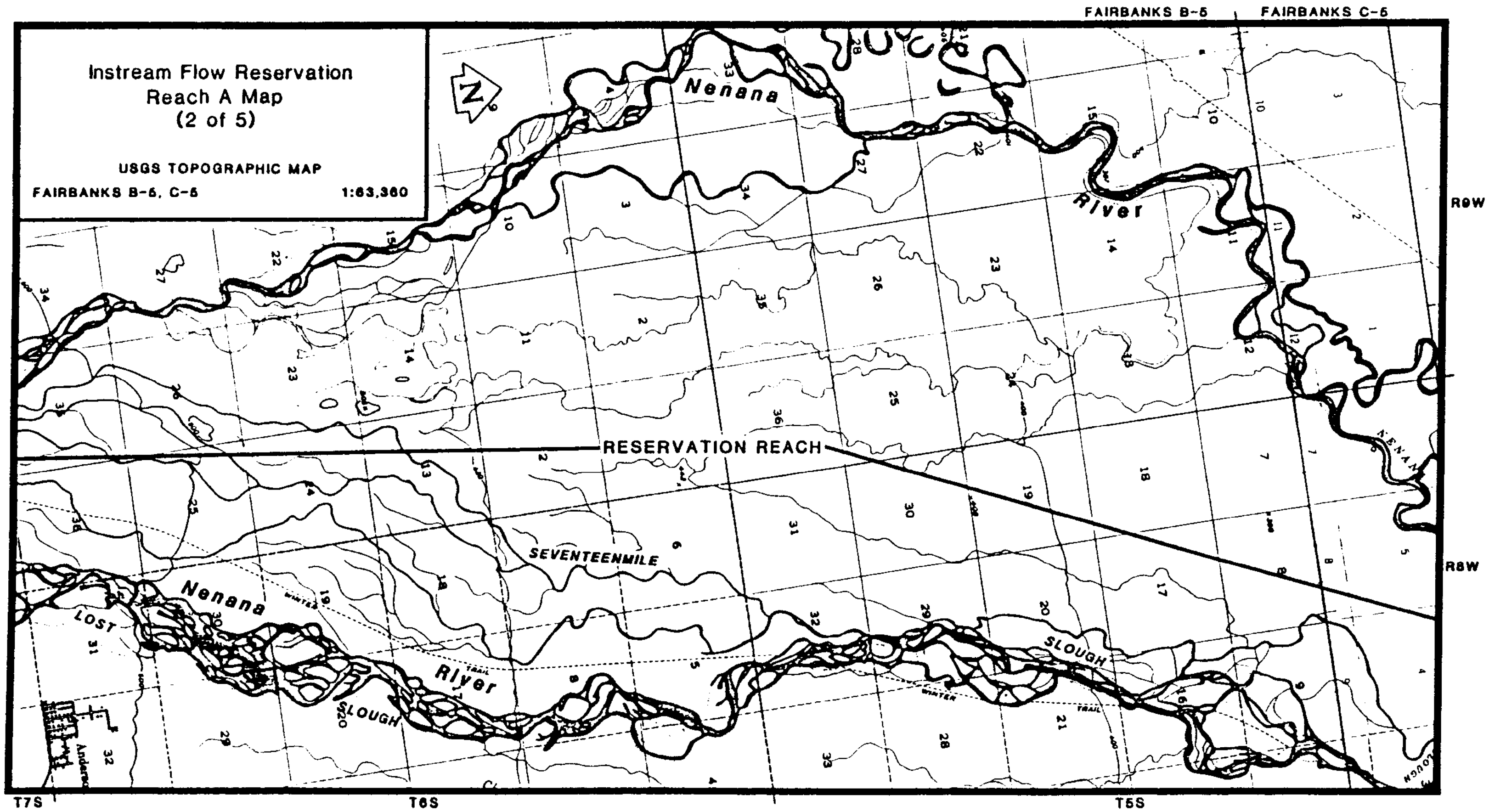
APPENDIX A



Appendix A1.-Reservation reach boundaries, Nenana River-Reach A.



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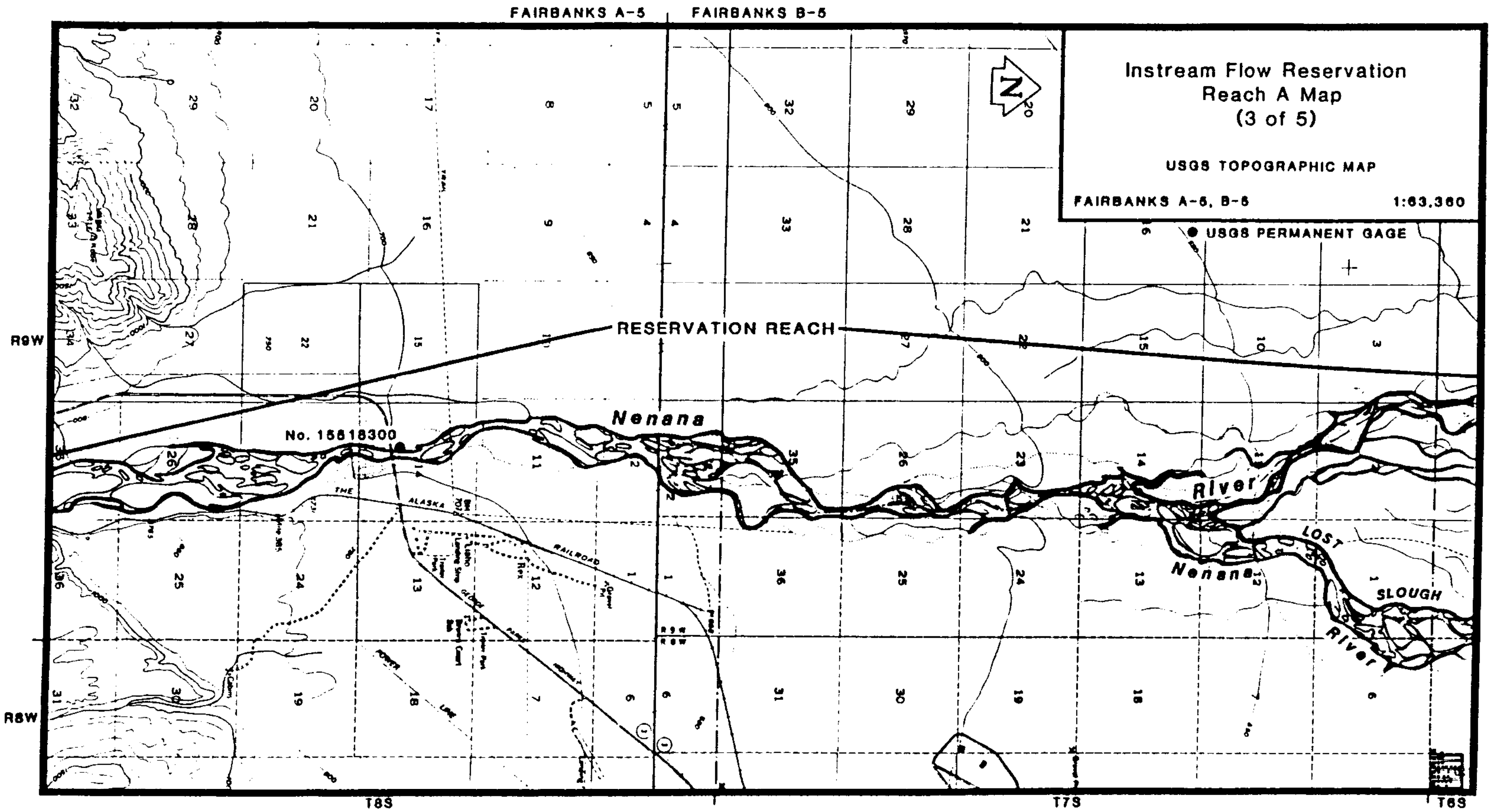

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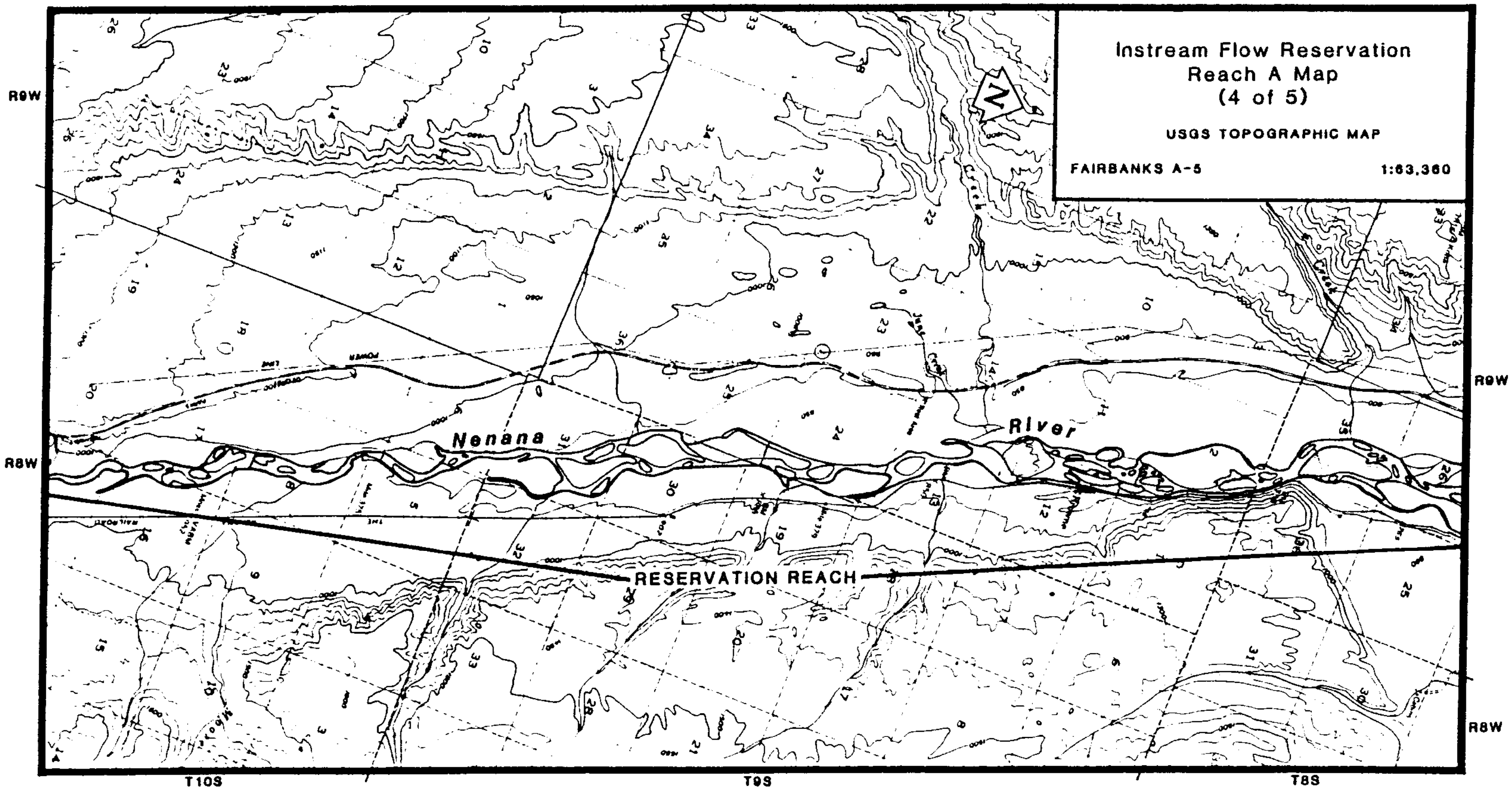
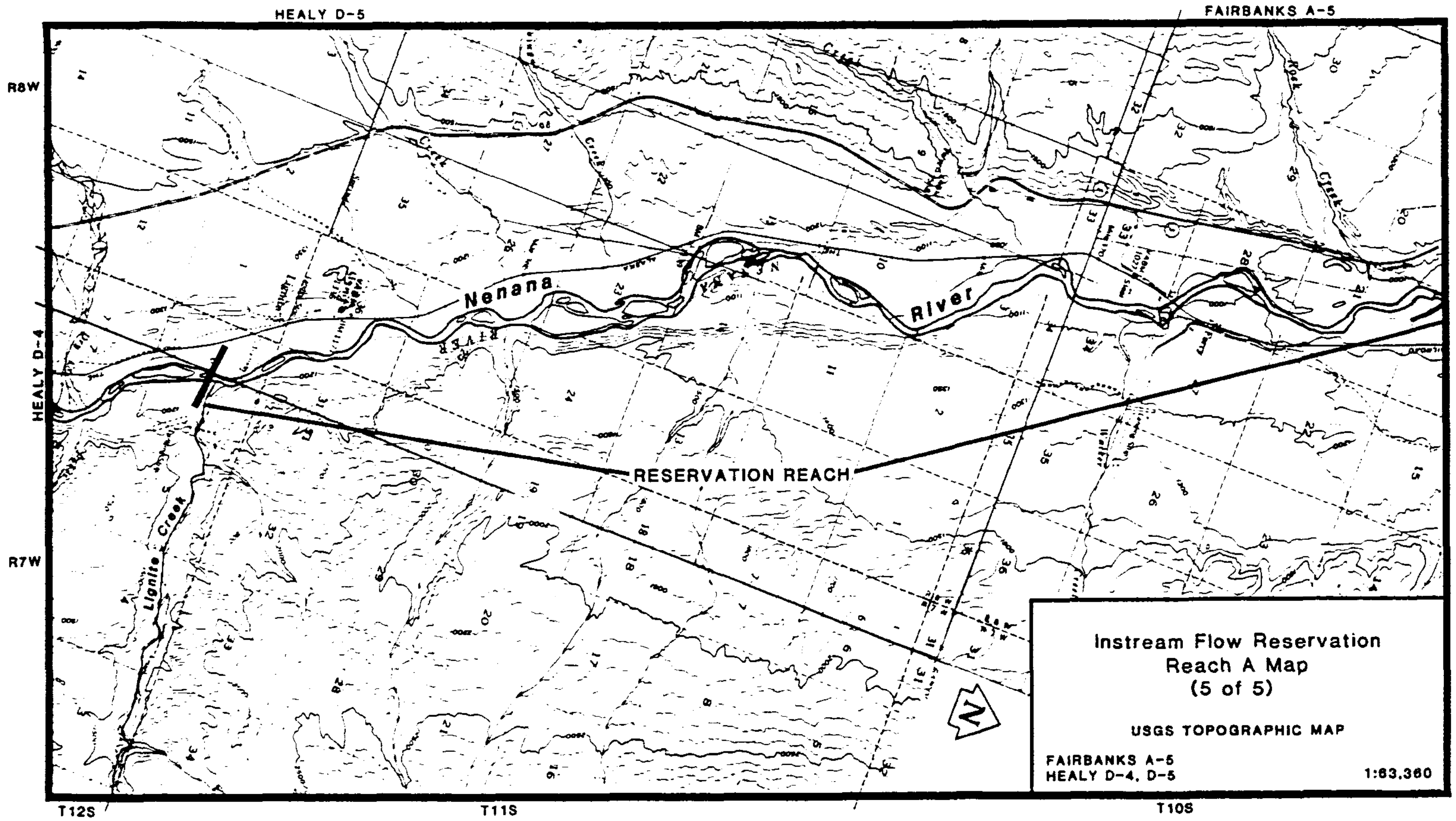


Appendix A1.-Page 4 of 5.



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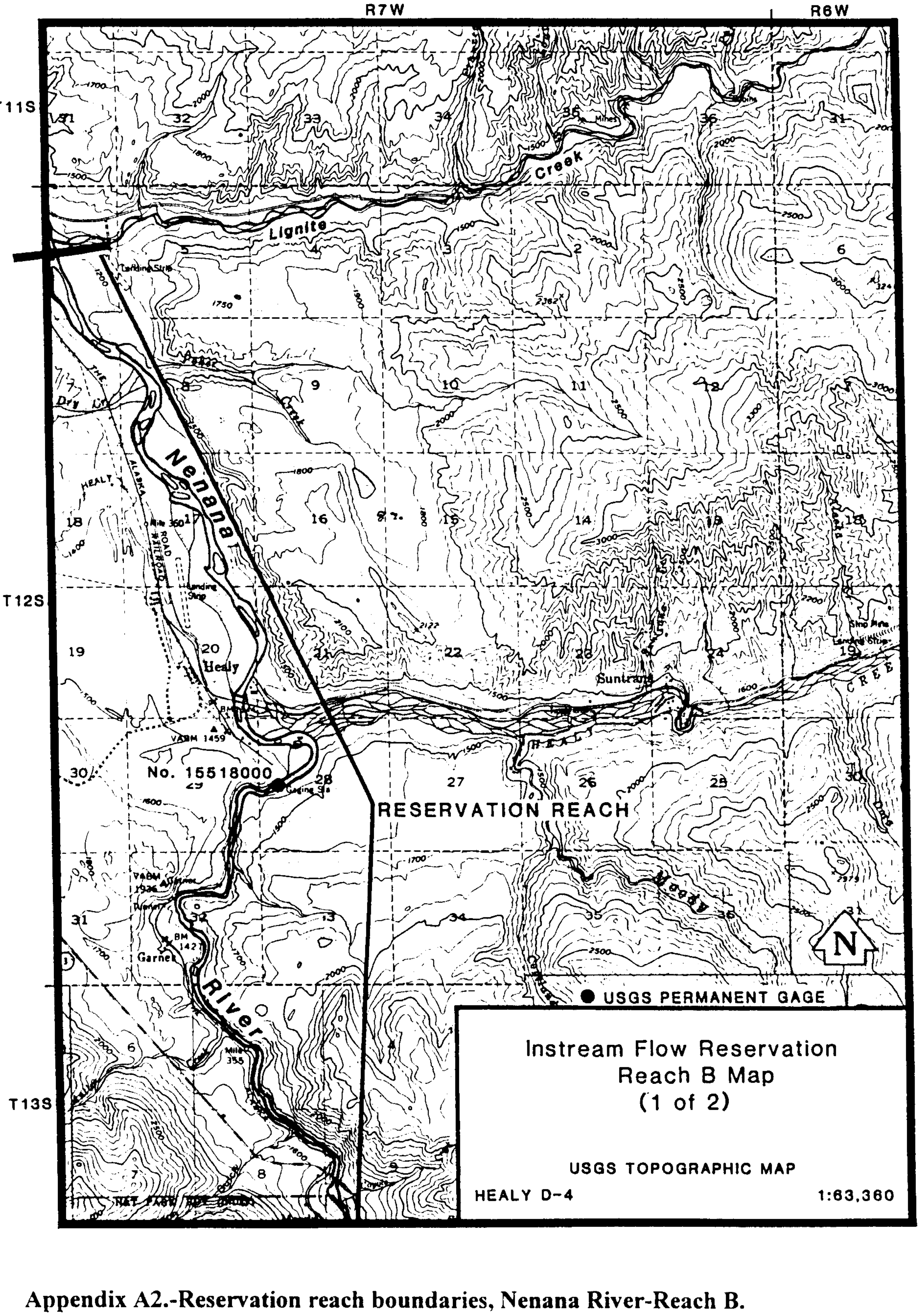
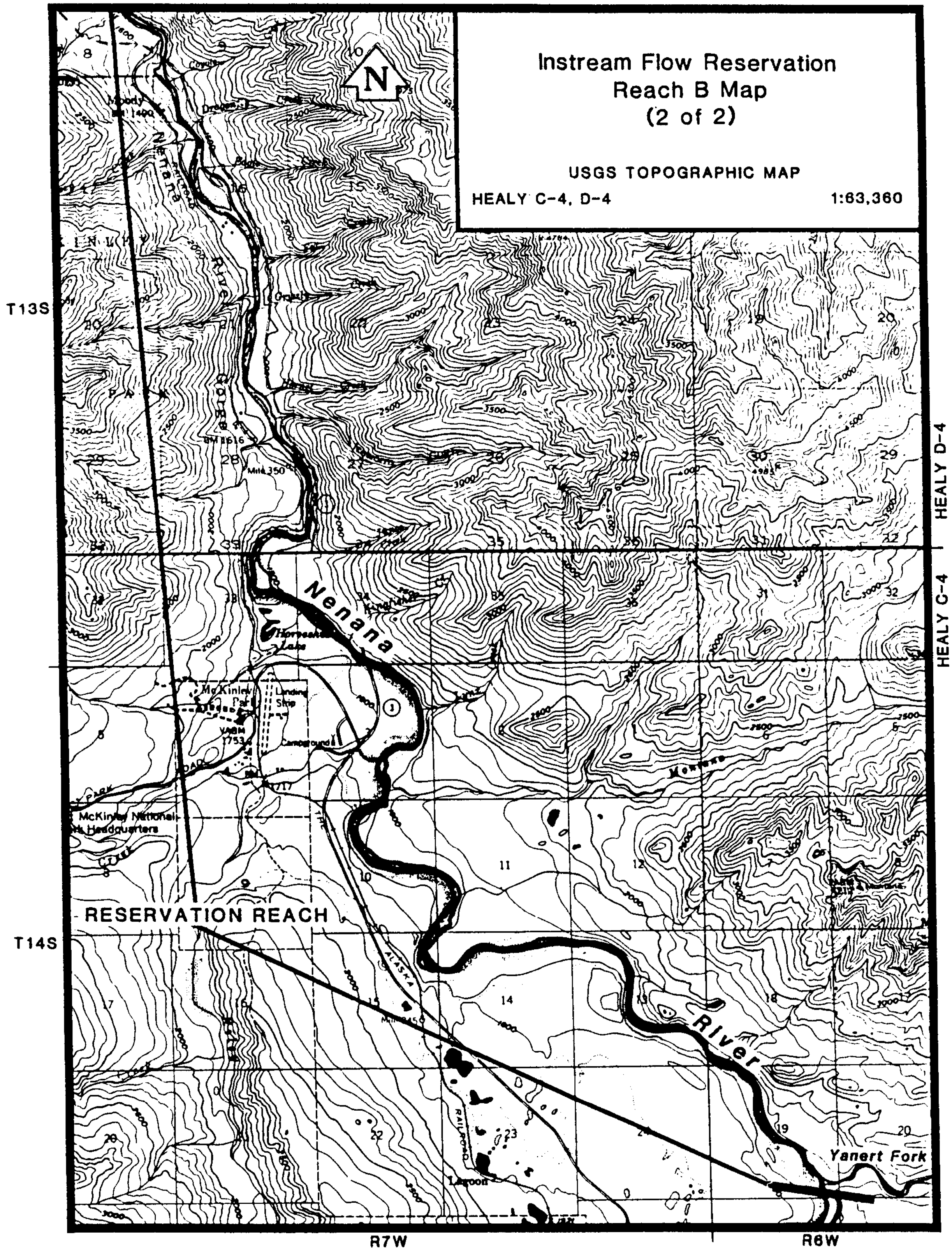


Appendix A2.-Reservation reach boundaries, Nenana River-Reach B.



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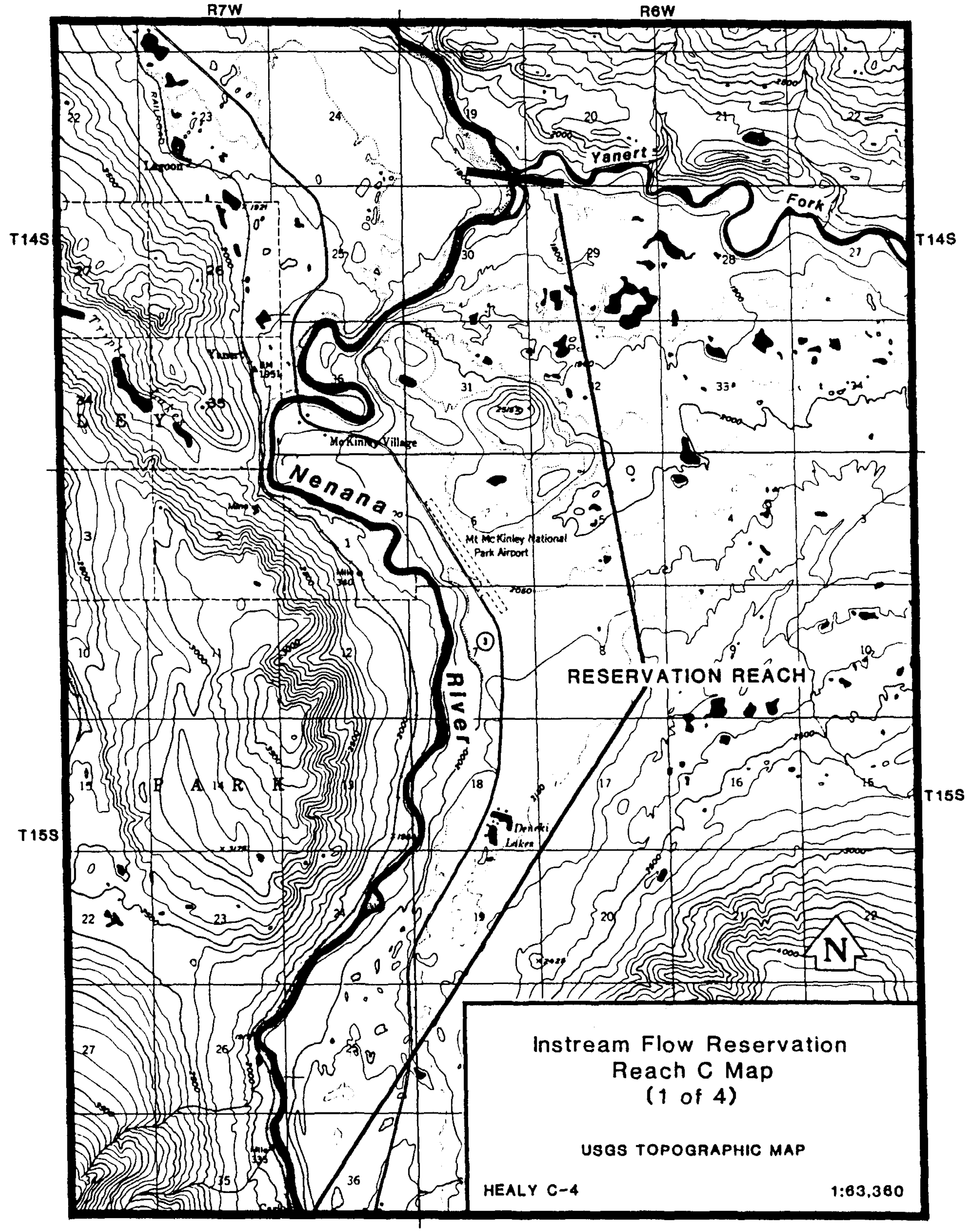
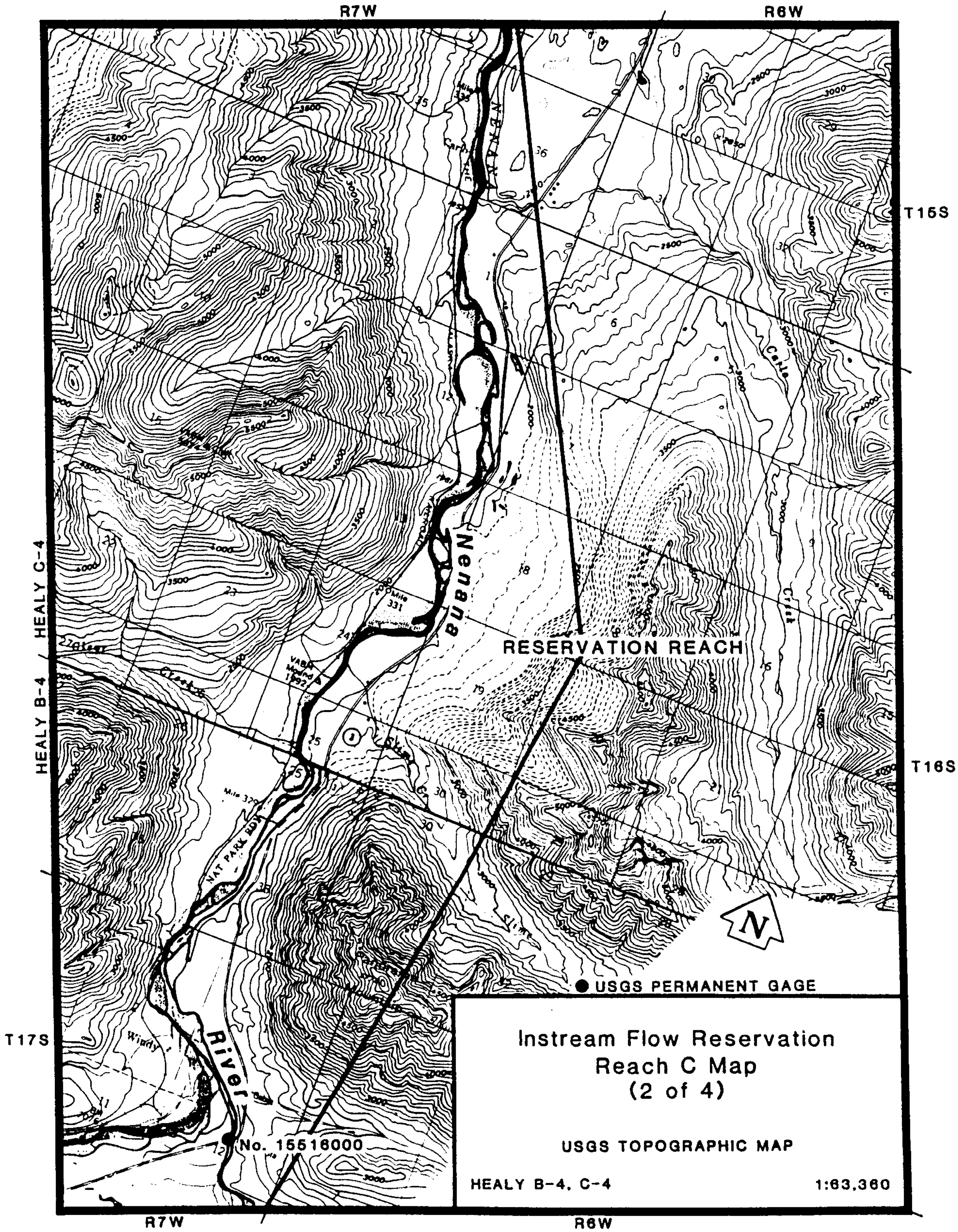


Appendix A3.-Reservation reach boundaries, Nenana River-Reach C.



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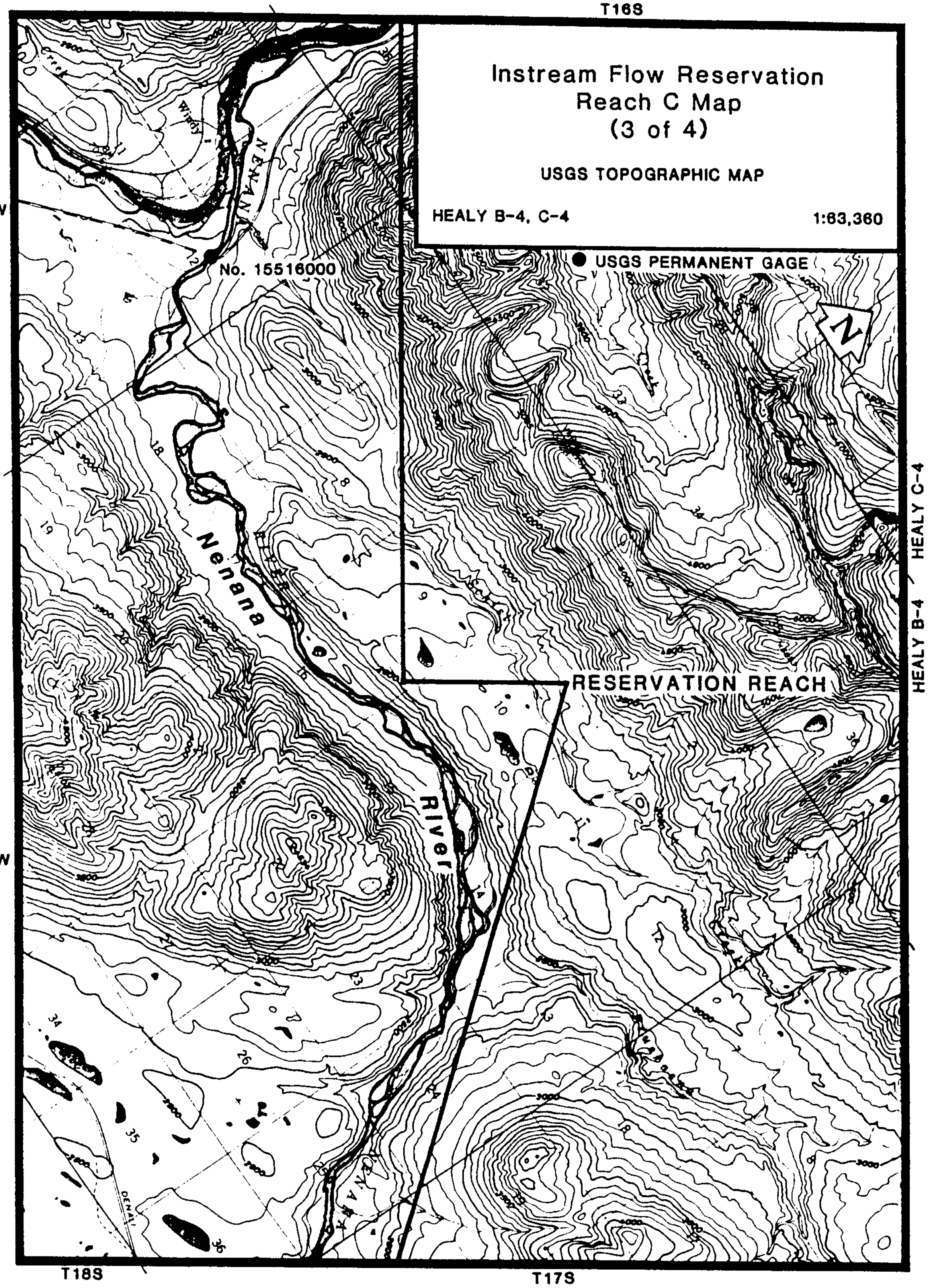

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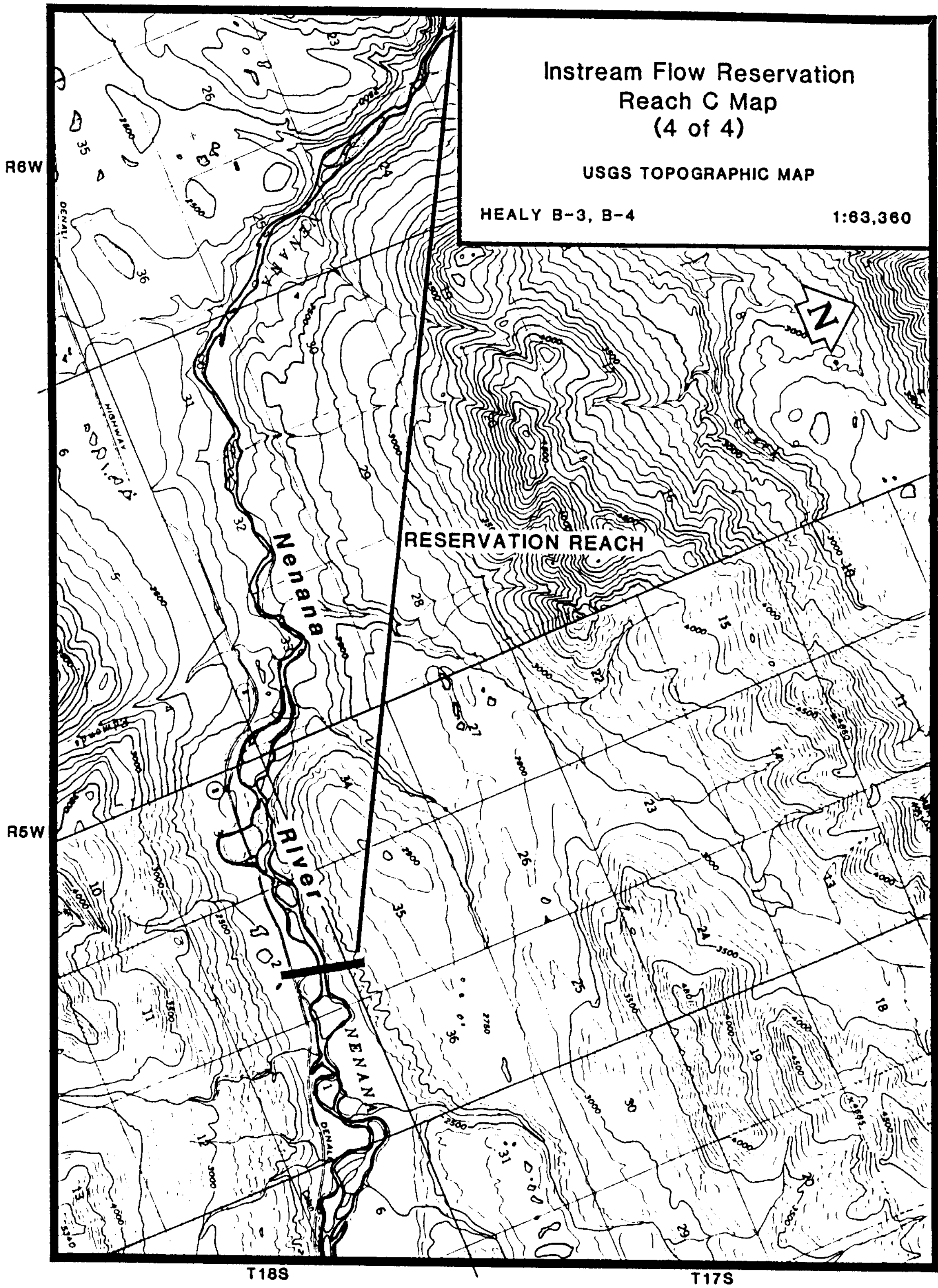

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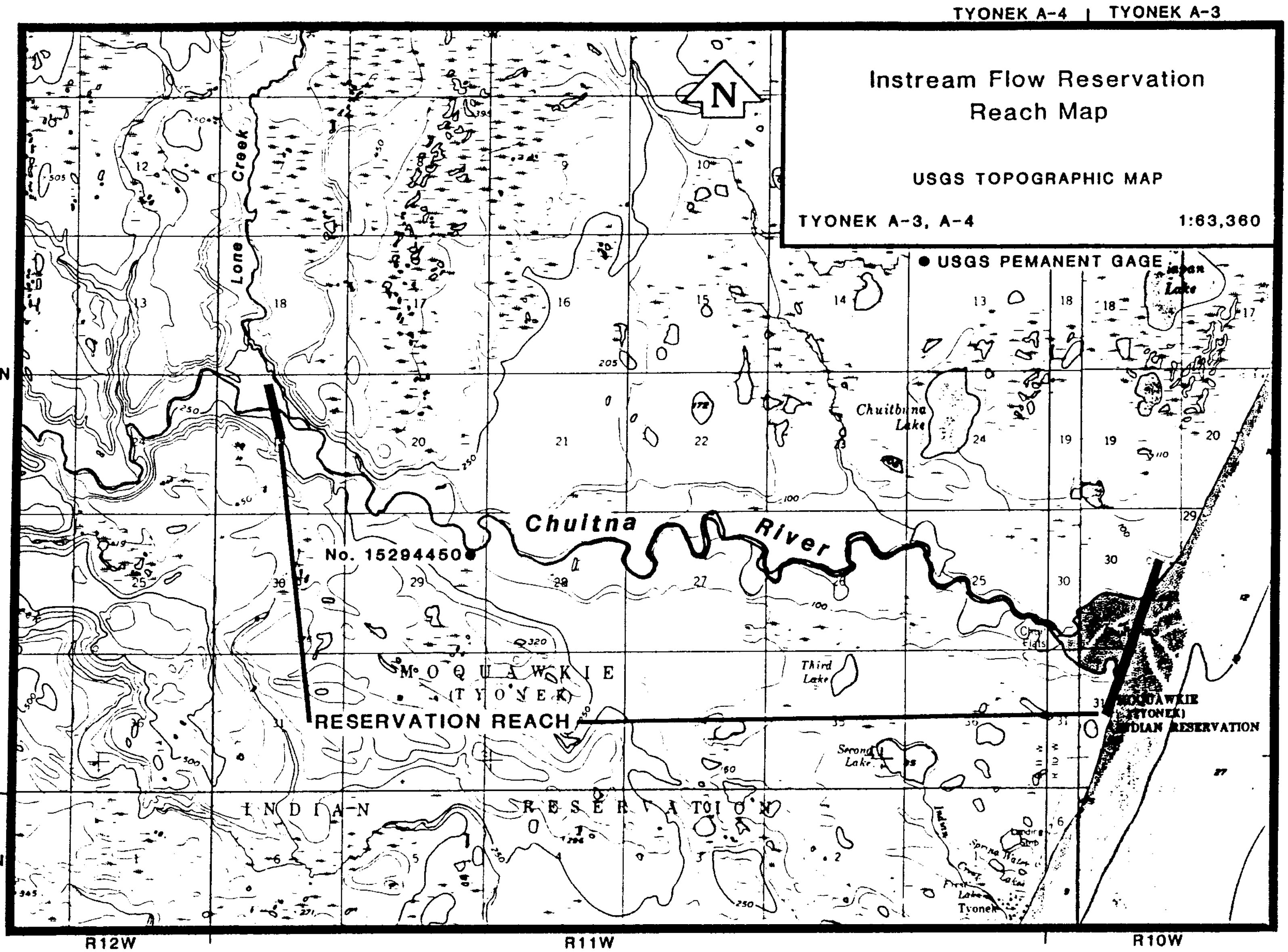
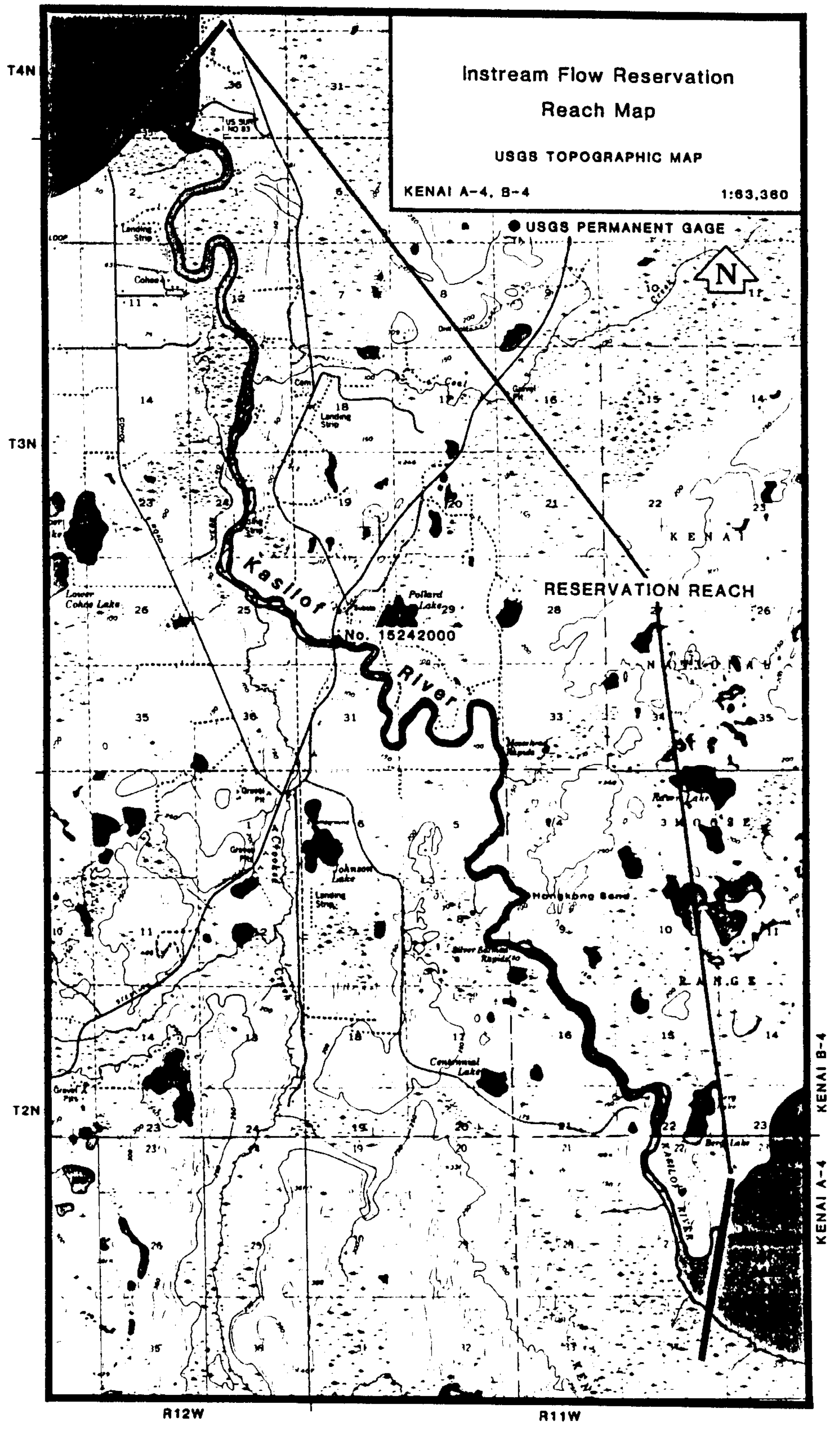
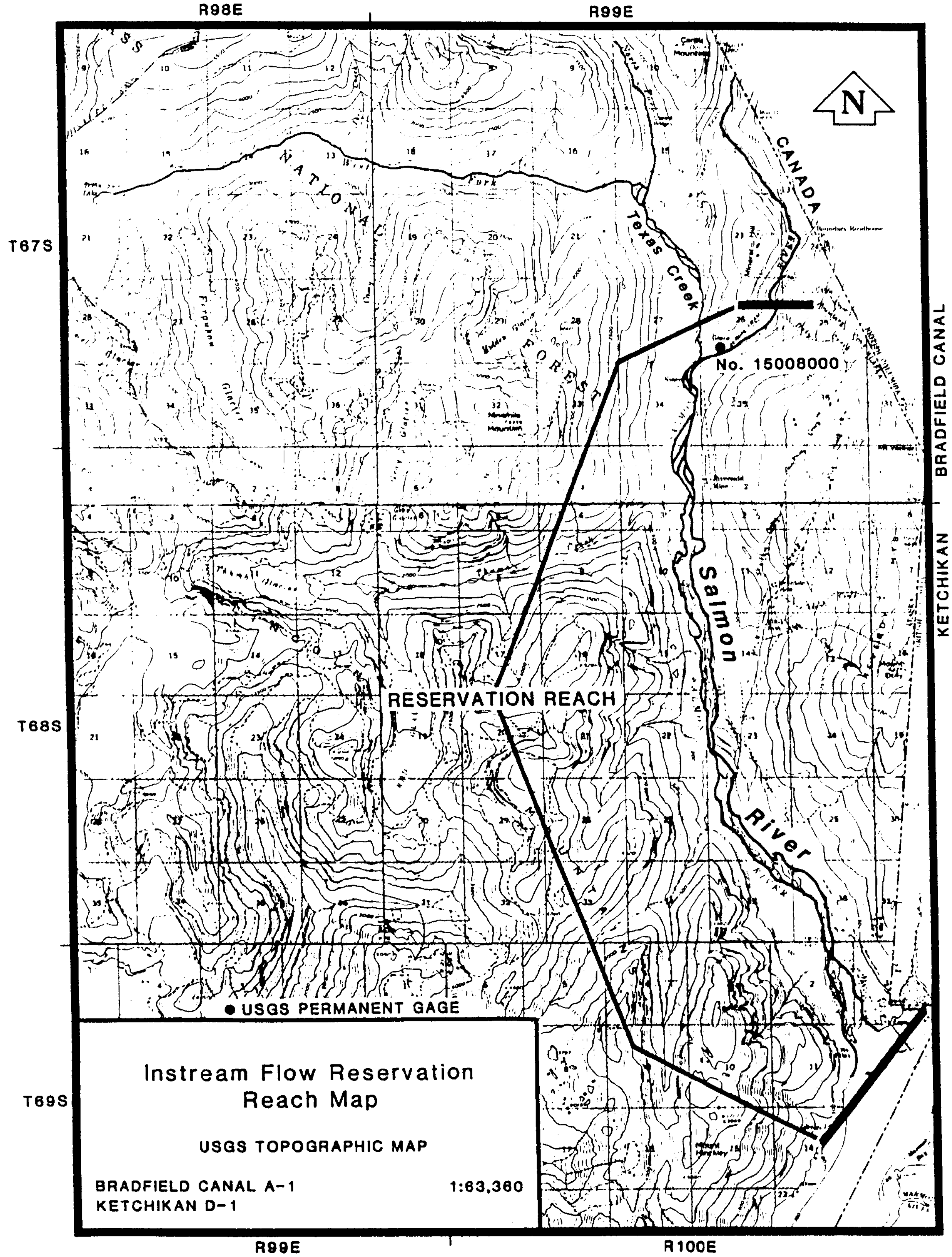


Appendix A4.-Reservation reach boundaries, Chuitna River.



Appendix A5.-Reservation reach boundaries, Kasilof River.



Appendix A6.-Reservation reach boundaries, Salmon River.

Appendix A7.-Species periodicity chart for Nenana River-Reach A.

Coho Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				XX	XXXX	X						
Adult Passage									XX	XXXX	XXXX	X
Spawning									XX	XXXX	XXXX	X
Incubation	XXXX	XXXX	XXXX	XX					X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chinook Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				XX	XXXX	X						
Adult Passage						XX	XXXX	X				
Spawning							XX	X				
Incubation	XXXX	XXXX	XXXX	XX			XX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chum Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				X	XXXX							
Adult Passage							XXXX	XXXX	XXXX	XXXX	XXXX	
Spawning							XX	XXXX	XXXX	XXXX	XXXX	
Incubation	XXXX	XXXX	XX				XX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			XX	XXXX	X							

Northern Pike	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning					XXXX							
Incubation					XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Longnose Sucker	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Lake Chub	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX	XX						
Incubation				X	XXXX	XXX?						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Arctic Grayling	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									XX	XXXX	X	
Incubation	XXXX	XXXX	XXXX	XXXX	XXX				XX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Burbot	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning	XXX	XXX										
Incubation	XXX	XXXX	XXXX	?								
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Slimy Sculpin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				XXXX	XXXX							
Incubation				XXXX	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Round Whitefish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									X	XXXX		
Incubation	XXXX	XXXX	XX						X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A8.-Species periodicity chart for Nenana River-Reach B.

Coho Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				XX	XXXX	X						
Adult Passage									XX	XXXX	XXXX	X
Spawning									XX	XXXX	XXXX	X
Incubation	XXXX	XXXX	XXXX	XX					X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chum Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				X	XXXX							
Adult Passage							XXXX	XXXX	XXXX	XXXX	XXXX	
Spawning							XX	XXXX	XXXX	XXXX	XXXX	
Incubation	XXXX	XXXX	XX				XX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			XX	XXXX	X							

Northern Pike	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning					XXXX							
Incubation					XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Longnose Sucker	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Lake Chub	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX	XX						
Incubation				X	XXXX	XXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Arctic Grayling	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									XX	XXXX	X	
Incubation	XXXX	XXXX	XXXX	XXXX	XXX				XX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Burbot	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning	XXX	XXX										
Incubation	XXX	XXXX	XX?									
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Slimy Sculpin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				XXXX	XXXX							
Incubation				XXXX	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Round Whitefish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									X	XXXX		
Incubation	XXXX	XXXX	XX						X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A9.-Species periodicity chart for Nenana River-Reach C.

Longnose Sucker	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Lake Chub	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX	XX						
Incubation				X	XXXX	XXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Arctic Grayling	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				X	XXXX							
Incubation				X	XXXX	XXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									XX	XXXX	X	
Incubation	XXXX	XXXX	XXXX	XXXX	XXX				XX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Burbot	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning	XXX	XXX										
Incubation	XXX	XXXX	XXX?									
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Slimy Sculpin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning				XXXX	XXXX							
Incubation				XXXX	XXXX	XXXX						
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Lake Trout	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning										XXXX	X	
Incubation	XXXX	XXXX	XXXX	XXXX						XX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Round Whitefish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning									X	XXXX		
Incubation	XXXX	XXXX	XX						X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for other species, immigration and emigration unless noted
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A10.-Species periodicity chart for Chuitna River.

Coho Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				? X	XXXX	XXXX	XXX?					
Adult Passage							XX	XXXX	XXXX	XXXX	XXXX	?
Spawning									?X	XXXX	XXXX	?
Incubation	XXXX	XXXX	XXXX	XXXX	XX?				?X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chinook Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				?	XXXX	XX?						
Adult Passage					?X	XXXX	XXXX	XXXX	X			
Spawning							?X	XXXX	X?			
Incubation	XXXX	XXXX	XXXX	X?			?X	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chum Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			?X	XXXX	X?							
Adult Passage							?XX	XXX?				
Spawning							?	XXXX	?			
Incubation	XXXX	XXXX	XXXX	XX?			?	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			?X	XXXX	XX?							

Pink Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			?X	XXXX	X?							
Adult Passage							?X	XXXX	X?			
Spawning							?	XXXX	XX?			
Incubation	XXXX	XXXX	XXXX	XX?			?	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			?X	XXXX	XX?							

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Sockeye Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage	?											
Adult Passage							?XX	?				
Spawning	?						?XX	?				
Incubation	?											
Rearing	?											

Rainbow Trout	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage												
Spawning				?	XXXX	?						
Incubation					XXXX	XXXX	?					
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				?	XXXX	X?						
Adult Passage			?	XXXX	XXXX	?	?X	XXXX	XXXX	XXXX	?	
Spawning										?XXX	X?	
Incubation	XXXX	XXXX	XXXX	XXXX	XX?					?XXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Threespine Stickleback	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage	?											
Adult Passage	?											
Spawning	?											
Incubation	?											
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Brook Lamprey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage	?											
Adult Passage	?											
Spawning	?											
Incubation	?											
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Pacific Lamprey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage	?											
Adult Passage							?X	XXXX	?			
Spawning	?											
Incubation	?											
Rearing	?											

Round Whitefish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage	?											
Adult Passage	?											
Spawning	?											
Incubation	?											
Rearing	?XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A11.-Species periodicity chart for Kasilof River.

Coho Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				?X	XXXX	X?						
Adult Passage								XXXX	XXXX	XXXX		
Spawning									?X	XXXX	XXXX	?
Incubation	XXXX	XXXX	XXXX	XX?					X	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chinook Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				?	XXXX	X						
Adult Passage					X	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	
Spawning							XX	XXXX	X			
Incubation	XXXX	XXXX	XXXX	XX			XX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Pink Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			X	XXXX	X							
Adult Passage							XX	XXX				
Spawning								XXXX	XX			
Incubation	XXXX	XXXX	XXXX	XX				XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			?X	XX?								

Chum Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			?X	XXXX	?							
Adult Passage							?XX	XXX?				
Spawning							?	XXXX	XX?			
Incubation	XXXX	XXXX	XXXX	?			?	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			?X	XX?								

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

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Sockeye Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage					XXXX	XXXX						
Adult Passage							XXXX	XX				
Spawning	?											
Incubation	?											
Rearing	?											

Steelhead Trout	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage					XX	X?						
Adult Passage				?XXX	XXXX	X?		X	XXXX	XXXX	XX	
Spawning				XX	XXXX	?						
Incubation				XX	XXXX	XXXX	?					
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage					XX	X?						
Adult Passage			?	XXXX	XXXX	?	XXXX	XXXX				
Spawning										?XXX	X?	
Incubation	XXXX	XXXX	XXXX	XXXX	XX?					?XXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A12.-Species periodicity chart for Salmon River.

Coho Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				XXXX	XXXX	XXXX						
Adult Passage								XXXX	XXXX	XXXX	XXXX	XX
Spawning									XX	XXXX	XXXX	XXXX
Incubation	XXXX	XXXX	XXXX	XXXX	XXXX				XX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Chum Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			XXXX	XXXX	XXXX							
Adult Passage						X	XXXX	XXXX	XXXX	XXXX	X	
Spawning							XXXX	XXXX	XXXX	XXXX	XXXX	
Incubation	XXXX	XXXX	XXXX	XXXX			XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing		XX	XXXX	XXXX	XX							

Pink Salmon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			XXXX	XXXX	XXXX							
Adult Passage							XXX	XXXX	XXXX			
Spawning							XX	XXXX	XXXX			
Incubation	XXXX	XXXX	XXXX	XXXX			XX	XXXX	XXXX	XXXX	XXXX	XXXX
Rearing			XXXX	XXXX	XXXX	X						

Cutthroat Trout	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage				XXXX	XXXX	XX						
Adult Passage				XXXXX	XXXX	XXXX	X	XXXX	XXXX	XX		
Spawning				XX	XXXX	XXXX						
Incubation				XX	XXXX	XXXX	XXXXX					
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

-continued-

Appendix A12.-Page 2 of 2.

Dolly Varden	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage			XX	XXXX	XXXX	XX						
Adult Passage		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XX	
Spawning									XXXX	XXXX	XX	
Incubation	XXXX	XXXX	XXXX	XXXX	XX				XXXX	XXXX	XXXX	XXXX
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Threespine Stickleback	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning	?											
Incubation	?											
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Ninespine Sticklebac	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Smolt Passage												
Adult Passage	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Spawning	?											
Incubation	?											
Rearing	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Based upon professional judgment of ADF&G biologists
Smolt passage is for juvenile emigration to estuarine/marine environment
Adult passage: for salmon is immigration: for trout, char, and other species, immigration and emigration.
Incubation life phase includes time of egg deposition to fry emergence
? = Data not available or timing is incomplete

Appendix A13.-Common and scientific names of fishes identified in periodicity charts (Appendices A7-A12).

COMMON NAME	SCIENTIFIC NAME
Arctic cisco	*Coregonus autmnalis*
Arctic grayling	*Thymallus arcticus*
Burbot	*Lota lota*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Cutthroat trout	*Oncorhynchus clarki*
Dolly Varden	*Salvelinus malma*
Lake chub	*Couesius plumbeus*
Lake trout	*Salvelinus namaycush*
Longnose sucker	*Catostomus catostomus*
Ninespine stickleback	*Pungitius pungitius*
Northern pike	*Esox lucius*
Pink salmon	*Oncorhynchus gorbuscha*
Rainbow trout	*Oncorhynchus mykiss*
Round whitefish	*Prosopium cylindraceum*
Slimy sculpin	*Cottus cognatus*
Sockeye salmon	*Oncorhynchus nerka*
Starry flounder	*Platichthys stellatus*
Steelhead trout	*Oncorhynchus mykiss*
Threespine stickleback	*Gasterosteus aculeatus*

Appendix A14.-Summary of U.S. Geological Survey (USGS) hydrologic data for instream flow reservation application reaches (Appendices A1-A6).

Stream/Reach	USGS Site Number	Years of Daily Flow Record
Nenana River near Rex-Reach A	15518300	1964-1968
Nenana River near Healy-Reach B	15518000	1950-1979
Nenana River near Windy-Reach C	15516000	1950-1956 1958-1973
Kasilof River near	15242000	1949-1970
Chuitna River near Cordova	15294450	1975-1986
Salmon River near Hyder	15008000	1963-1973

Appendix A15.-Tennant Method analysis for Nenana River-Reach A.

* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Nenana River-Reach A

SEASONAL FLOW DESCRIPTIONS	% OF QAA NOV-APR	FLOW (cfs)
QAA	100	4536
Flushing or Maximum	200	9072
Optimum Range	60-100	2722-4536
Outstanding	40	1814
Excellent	30	1361
Good	20	907
Fair or Degrading	10	454
Poor or Minimum	10	454
Severe Degredation	<10	<454
	MAY-OCT	
QAA	100	4536
Flushing or Maximum	200	9072
Optimum Range	60-100	2722-4536
Outstanding	60	2722
Excellent	50	2268
Good	40	1814
Fair or Degrading	30	1361
Poor or Minimum	10	454
Severe Degredation	<10	<454

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	727
Feb	695
Mar	645
Apr	686
May	4877
Jun	14472
Jul	11993
Aug	9663
Sep	5758
Oct	2792
Nov	1080
Dec	827

Appendix A16.-Tennant Method analysis for Nenana River-Reach B.

* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Nenana River-Reach B

SEASONAL FLOW DESCRIPTIONS	% OF QAA NOV-APR	FLOW (cfs)
QAA	100	3506
Flushing or Maximum	200	7012
Optimum Range	60-100	2104-3506
Outstanding	40	1402
Excellent	30	1052
Good	20	701
Fair or Degrading	10	351
Poor or Minimum	10	351
Severe Degredation	<10	<351
	MAY-OCT	
QAA	100	3506
Flushing or Maximum	200	7012
Optimum Range	60-100	2104-3506
Outstanding	60	2104
Excellent	50	1753
Good	40	1402
Fair or Degrading	30	1052
Poor or Minimum	10	351
Severe Degredation	<10	<351

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	558
Feb	473
Mar	434
Apr	514
May	3885
Jun	9884
Jul	9516
Aug	7872
Sep	4879
Oct	2149
Nov	1021
Dec	688

Appendix A17.-Tennant Method analysis for Nenana River-Reach C.

* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Nenana River-Reach C

SEASONAL FLOW DESCRIPTIONS	% OF QAA NOV-APR	FLOW (cfs)
QAA	100	1209
Flushing or Maximum	200	2418
Optimum Range	60-100	725-1209
Outstanding	40	484
Excellent	30	363
Good	20	242
Fair or Degrading	10	121
Poor or Minimum	10	121
Severe Degredation	<10	<121
	MAY-OCT	
QAA	100	1209
Flushing or Maximum	200	2418
Optimum Range	60-100	725-1209
Outstanding	60	725
Excellent	50	605
Good	40	484
Fair or Degrading	30	363
Poor or Minimum	10	121
Severe Degredation	<10	<121

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	208
Feb	180
Mar	167
Apr	195
May	1799
Jun	3731
Jul	2644
Aug	2281
Sep	1700
Oct	809
Nov	387
Dec	256

Appendix A18.-Tennant Method analysis for Chuitna River.

* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Chuitna River

SEASONAL FLOW DESCRIPTIONS	% OF QAA DEC-APR	FLOW (cfs)
QAA	100	359
Flushing or Maximum	200	718
Optimum Range	60-100	215-359
Outstanding	40	144
Excellent	30	108
Good	20	72
Fair or Degrading	10	36
Poor or Minimum	10	36
Severe Degredation	<10	<36
	MAY-NOV	
QAA	100	359
Flushing or Maximum	200	718
Optimum Range	60-100	215-359
Outstanding	60	215
Excellent	50	180
Good	40	144
Fair or Degrading	30	108
Poor or Minimum	10	36
Severe Degredation	<10	<36

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	106
Feb	84
Mar	79
Apr	156
May	947
Jun	981
Jul	308
Aug	300
Sep	519
Oct	462
Nov	245
Dec	117

Appendix A19.-Tennant Method analysis for Kasilof River.

* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Kasilof River

SEASONAL FLOW DESCRIPTIONS	% OF QAA DEC-APR	FLOW (cfs)
QAA	100	2385
Flushing or Maximum	200	4770
Optimum Range	60-100	1431-2385
Outstanding	40	954
Excellent	30	716
Good	20	477
Fair or Degrading	10	239
Poor or Minimum	10	239
Severe Degredation	<10	<239
	MAY-NOV	
QAA	100	2385
Flushing or Maximum	200	4770
Optimum Range	60-100	1431-2385
Outstanding	60	1431
Excellent	50	1193
Good	40	954
Fair or Degrading	30	716
Poor or Minimum	10	239
Severe Degredation	<10	<239

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	716
Feb	569
Mar	515
Apr	517
May	664
Jun	1369
Jul	3848
Aug	6628
Sep	6404
Oct	4001
Nov	2042
Dec	1142

Appendix A20.-Tennant Method analysis for Salmon River.

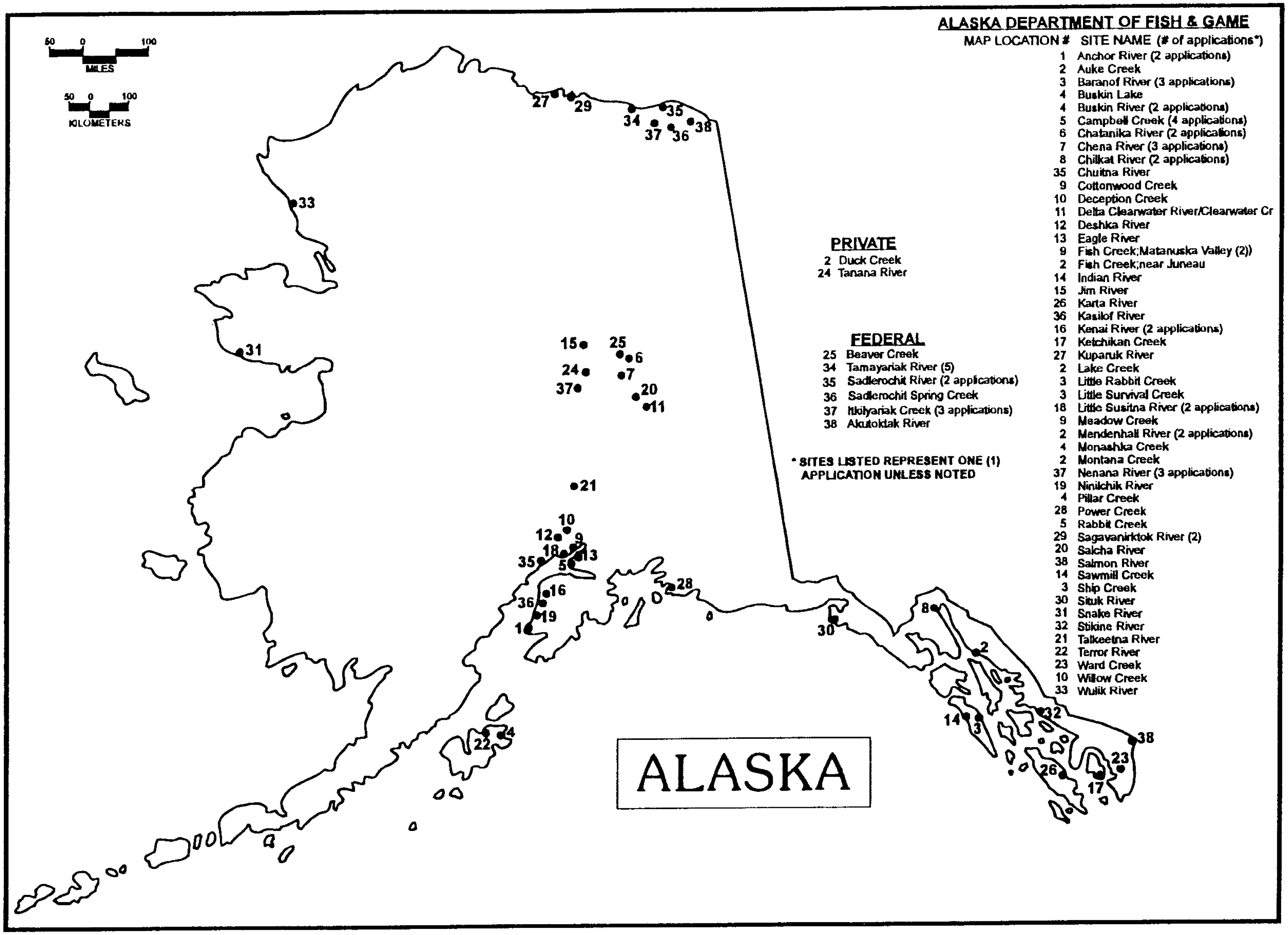
* Tennant Method Flow Classifications (adapted from Tennant 1975)

Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) for Salmon River

SEASONAL FLOW DESCRIPTIONS	% OF QAA DEC-APR	FLOW (cfs)
QAA	100	1070
Flushing or Maximum	200	2140
Optimum Range	60-100	642-1070
Outstanding	40	428
Excellent	30	321
Good	20	214
Fair or Degrading	10	107
Poor or Minimum	10	107
Severe Degredation	<10	<107
	MAY-NOV	
QAA	100	1070
Flushing or Maximum	200	2140
Optimum Range	60-100	642-1070
Outstanding	60	642
Excellent	50	535
Good	40	428
Fair or Degrading	30	321
Poor or Minimum	10	107
Severe Degredation	<10	<107

Long-term Mean Monthly Flows (cfs)

MONTH	FLOW
Jan	85
Feb	97
Mar	151
Apr	134
May	522
Jun	1902
Jul	2289
Aug	3068
Sep	2267
Oct	1161
Nov	855
Dec	225



Appendix A21. Locations of instream flow reservation application reaches, July 1, 1986 to September 30, 1995

Appendix A22.-Historical data summary for U.S. Geological Survey continuous streamflow gage sites in Alaska, 1908 to September 1995 (Brabets 1995).

NUMBER OF GAGE SITES	PERIOD OF RECORD (YEARS)
11	0 to < 1
22	1
104	1 to < 5
85	5 to < 10
107	10 to < 20
66	20 to < 50
1	≥50
78	Number of active gages during the period October 1, 1994 to September 30, 1995

Appendix A23.-Alaska Department of Natural Resources policy relating to adjudication of U.S. Fish and Wildlife Service water rights applications in the Arctic National Wildlife Refuge.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

OFFICE OF THE COMMISSIONER

TONY KNOWLES, GOVERNOR

400 WILLOUGHBY AVENUE
JUNEAU, ALASKA 99801-1796
PHONE: (907) 465-2400
FAX: (907) 465-3886

3601 C STREET, SUITE 1210
ANCHORAGE, ALASKA 99503-5921
PHONE: (907) 762-2483
FAX: (907) 562-4871

September 14, 1995

David B. Allen
Regional Director
U.S. Fish and Wildlife Service
1011 E. Tudor Rd.
Anchorage, Alaska 99503-6199

Dear Mr. Allen:

On August 4, 1995 we received seven water right applications for the reservation of water (instream flow) and the appropriate filing fee (Order of Supplies or Services # 70181-5-3284). In your transmittal letter you requested a status of the 22 water right applications you have filed over the past two years, and a schedule of when DNR will process and grant the water rights.

Enclosed is a status list of all the water right applications we currently have on file for the USF&WS. On May 18, 1995, at the request of the State Attorney General's Office, Alaska Department of Law, DNR imposed a moratorium on the adjudication of any pending or future water right applications filed by any federal government agency. This moratorium will stay in effect until the U.S. Supreme Court, if they decide to take the appeal, has rendered a decision on the State's appeal of the Ninth Circuit Court's decision on the State of Alaska v. Bruce Babbitt and Katie John, et al.,v. USA. A copy of Jules Tileston's memo to the Division of Mining and Water Management, Water Resources Section is enclosed. In the most recent Alaska Supreme Court decision, the Totemoff case, the Court found that the federal government has no authority to regulate hunting and fishing on navigable waters. This decision is in conflict with the "Katie John" decision of the Ninth Circuit Court; and the fact that the Ninth Circuit Court turned down the State's request for reconsideration, means that the "Katie John" case will be appealed the U.S. Supreme Court. DNR will continue to accept applications from the federal government and date stamp the applications to establish a priority date which becomes effective only when the adjudication process is complete.

Mary Lu Harle was informed of the adjudication moratorium when the most recent batch of seven applications were submitted. She was unsure if the USF&WS was still willing to submit the reservation applications under the current moratorium. We would like to know if the USF&WS applications submitted on August 4, 1995, along with the fees, should be accepted or returned.

Twelve of the pending water right applications for instream flows are specific to several rivers in the 1002 (ANWR) Area. We do not intend to process any USF&WS applications involving the 1002 Area until such time as there is a final decision on oil and gas development options by the Congress. As you are aware, the Knowles administration strongly supports oil and gas development in the 1002 Area and adjacent coastal areas. Accordingly, since water is a critical resource in the 1002 Area the State will not proceed with any action that might compromise development opportunities. During a meeting in October 1994, between Jules Tileston, Gary Prokosch and Mark Inghram (DMWM); and Keith Bayha and Mary Lu Harle(USF&WS); Jules stated that the adjudication of applications in the 1002 Area would start only when all instream flow applications (or other water right applications) are available. It is our understanding that USF&WS intends to file hundreds of lake level instream flow applications in the 1002 Area in the future. By waiting for all applications to be filed, we can insure a single public involvement process instead of a process that would require public notice on each application or river system. We still feel that this approach is in the best public interest, and avoids the appearance that the USF&WS is requesting the State to piecemeal its decisions. This is the general policy that the State will follow for all USF&WS refuge water right applications.

Regarding your question concerning a review of the instream flow applications for adequacy of data and methodology used for determining instream flow request, the Water Resource Section will begin the formal review of the hydrology associated with the pending applications and provide your staff with comments or, if necessary, a request for additional information or data. The review of the applications will take place in the order they were received and should not take more than 90 days.
If you have any further questions regarding these applications or the adjudication process, please contact Jules Tileston, Director, Division of Mining and Water Management or Gary Prokosch, Chief, Water Resource Section at 762-2575.

Sincerely,

John Shively
Commissioner

cc: Jules Tileston, DMWM
Gary Prokosch, DMWM
Joanne Grace, AGO

Appendix A24.-Alaska Department of Natural Resources temporary water rights policy relating to water rights applications from federal agencies.

MEMORANDUM

Dept. of Natural Resources

State of Alaska

Division of Mining & Water Mgmt

TO: Water Resources Section

DATE: May 18, 1995

Thru: Gary Prokosch
Chief, Water Resources

TELEPHONE NO: 762-2571
FAX NO: 562-1384

FROM: Jules V. Tileston
Director

SUBJECT: Temporary Policy

As many of you are aware, the Ninth Circuit Court of Appeals recently made a decision on the State of Alaska v. Bruce Babbitt and Katie John, et al., v. USA. The decision is too long to go into detail in this memo, and anyone who would like a copy can contact Dan Allison. Because of this court decision, the AGO has recommended that the Division hold up on the adjudication of any water rights or instream flow applications filed by the federal government. The AG's offices feels that any rights granted by the state to use water may be used by the federal government to assert a right to the management of the water source for its purpose over and above the actual right to a specific quantity of water.

For this reason, effective immediately and until the matters associated with this circuit court decision and any appeals of the decision are settled, the Division of Mining and Water Management, Water Resources Section, will not adjudicate any water right applications filed by the federal government for out-of-stream or instream purposes currently pending or those filed in the future.

cc: John Shively, Commissioner
Marty Rutherford, DNR
Patty Bielawski, DNR
Joanne Grace, AGO
DMWM Management Team