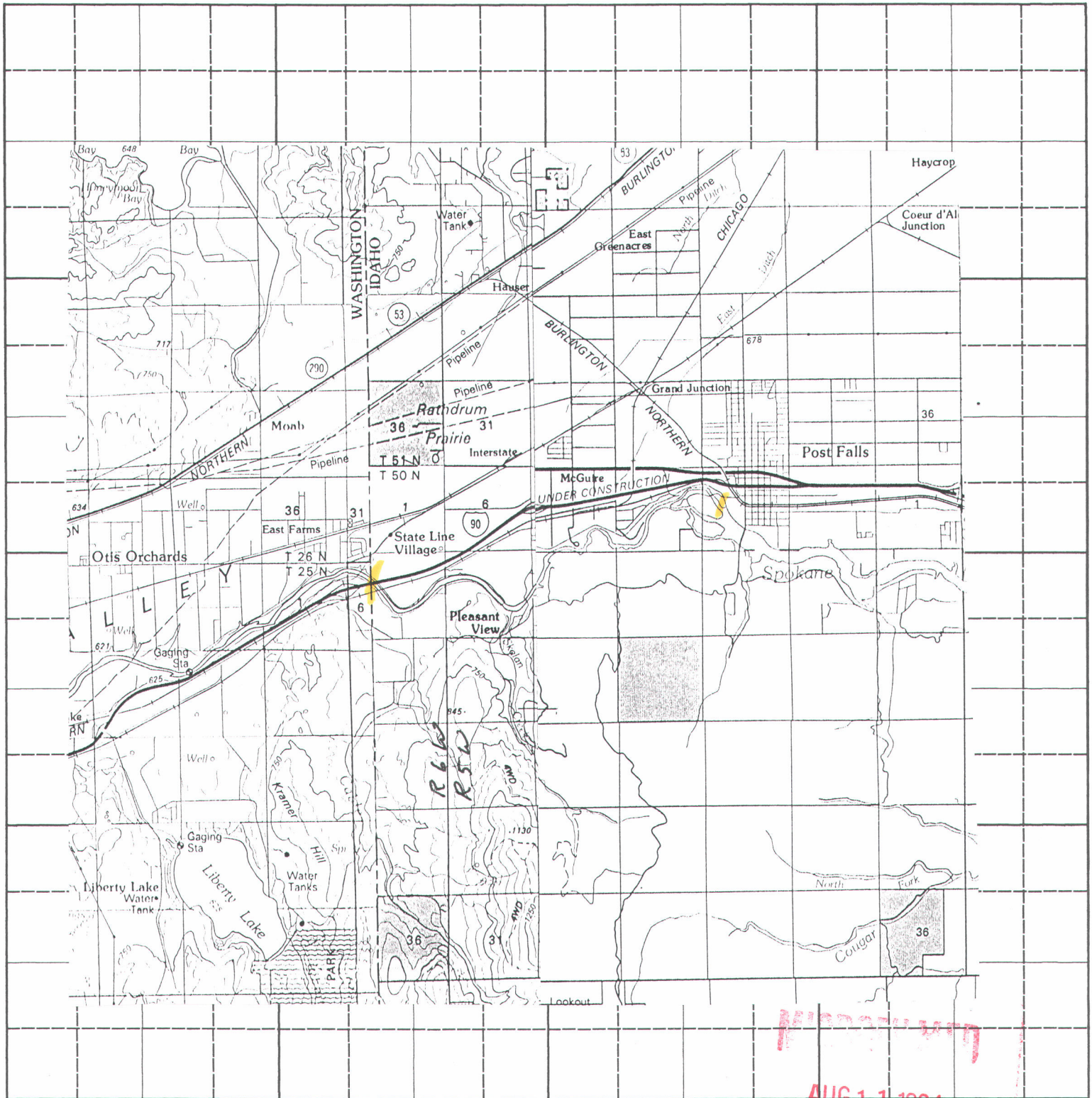


13. Map of proposed project: show clearly the proposed point of diversion, place of use, section number, township and range number.



Scale: 2 inches equal 1 mile.

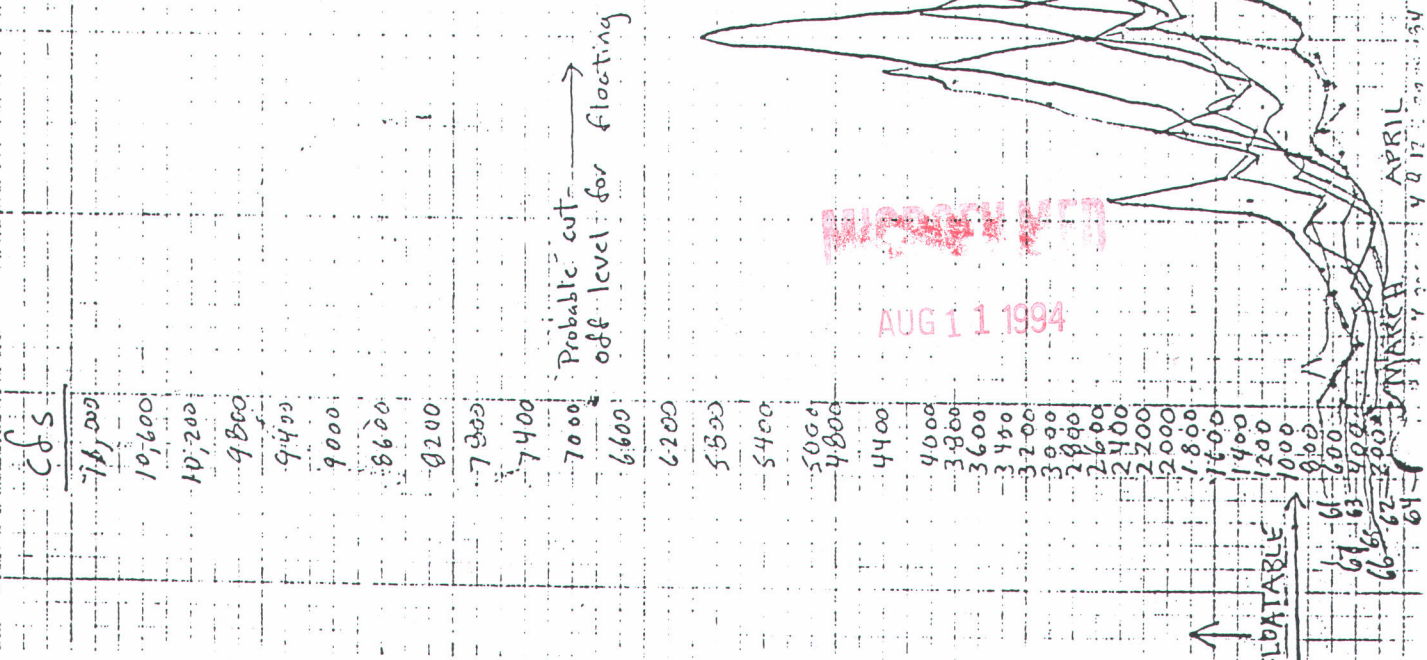
BE IT KNOWN that the undersigned hereby makes application for permit to appropriate the public waters of the State of Idaho as herein set forth.

William S. Flatt
(Applicant)

AUG 11 1994

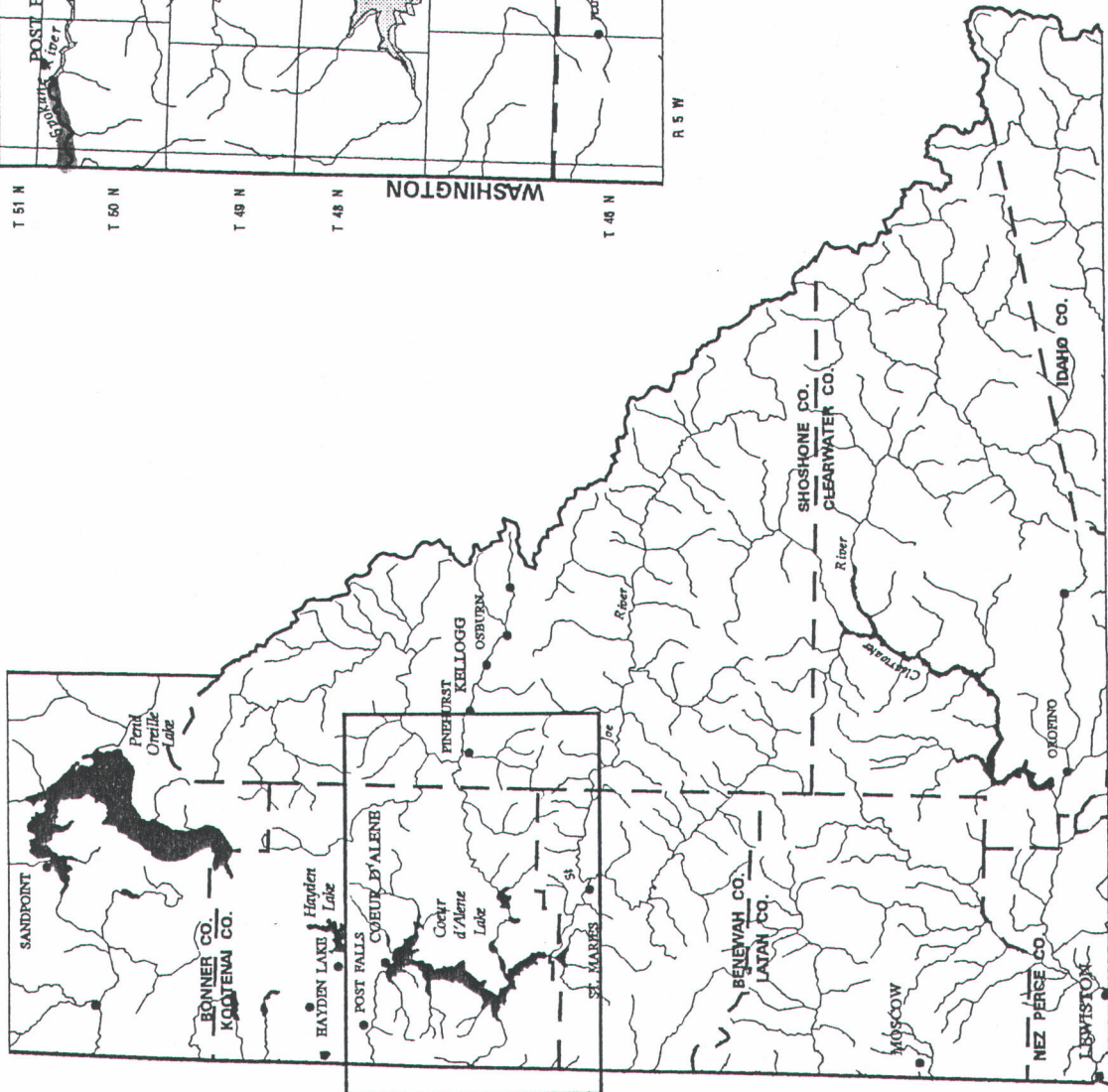
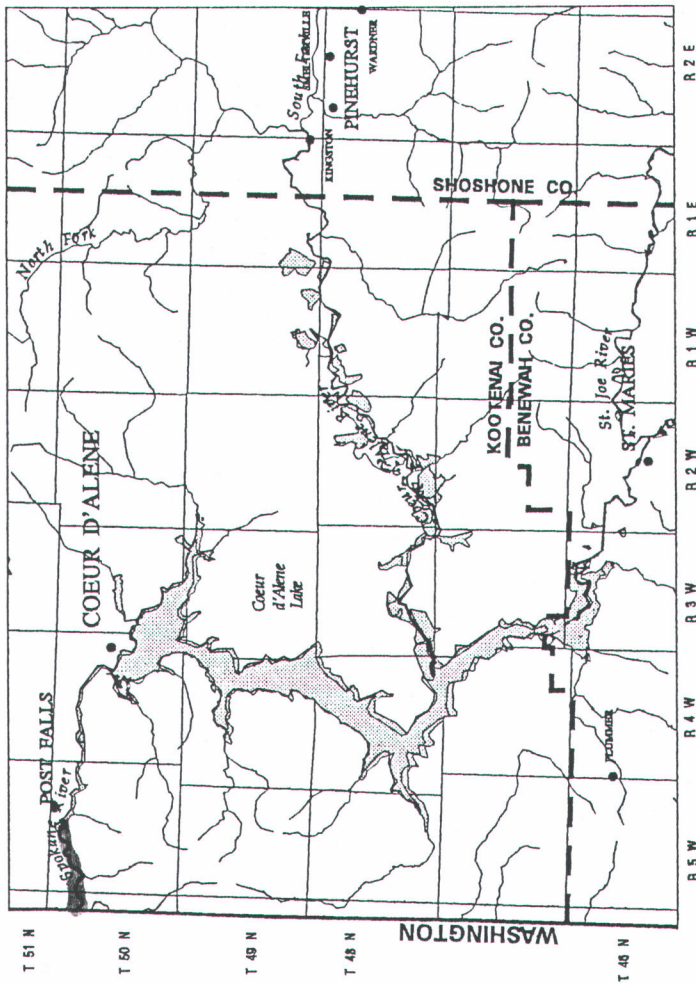
By Peter Grubb ©
River odysseys West

Moyie River Flows 1961-1967



Spokane River - Minimum Streamflow

Minimum Streamflow Reach



IWRB10

MICRO

TRIBUNE PUBLISHING COMPANY, INC.
The Lewiston Morning Tribune
505 C St., P.O. Box 957
Lewiston, Idaho 83501
(208) 743-9411

Date 091693 INVOICE No. L00381708
Account No. 964750 95-08780
Description 81708NOTIC
Times 1 Lines 41
Tab Lines _____

**LEGAL ADVERTISING
INVOICE**

SOLD TO:

ID DEPT. OF WATER RESOURC
1910 NORTHWEST BLVD. 210
COEUR D'ALE
ID 83501

\$ 61.50

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SEP 21 1993

NORTHERN REGION
IDWR

NOTICE: This is an invoice of Purchase made by you. Statement will be rendered the first of the month.
Please Retain This Invoice as Your Statement Will Refer To Invoice by No. Only.

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, ss.
County of Nez Perce

Karen J. Lewis, being duly sworn,

deposes and says, I am the Legal Clerk
of the Tribune Publishing Company, a corporation organized and existing
under and by virtue of the laws of the State of Idaho, publishers of the
LEWISTON MORNING TRIBUNE, a newspaper of general circulation
published at Lewiston, Nez Perce County, Idaho; That the said Lewiston
Morning Tribune is an established paper and has been published regular-
ly and issued regularly at least once a day for more than 21 consecutive
years next immediately preceding the first publication of this notice, and
has been so published uninterrupted for said period; that the

NOTICE OF HEARING ON THE

attached hereto and which is made a part of this affidavit was published in
the said Lewiston Morning Tribune, 1 time(s). Publication be-
ing on 091693, or once a

WEEK for 1 consecutive WEEKS, the first
publication thereof being on the 091693, and the last pub-
lication thereof being on the 091693, and said

NOTICE OF HEARING ON THE

was so published in the regular and entire issue of said newspaper and
not in a supplement thereof and was so published in every issue and
number of the said paper, during the period and times of publication as
set forth above.

Karen J. Lewis

SUBSCRIBED AND SWORN BEFORE ME THIS THE 17

day of September 1993

[Signature]

Notary Public in and for the State of Idaho,
residing at Lewiston, therein.

81708
**NOTICE OF HEARING FOR THE SPOKANE RIVER
MINIMUM STREAMFLOW**

Notice is hereby given that the Idaho Water Resource Board
application for permit to appropriate water to the Depart-
ment of Water Resources, proposing to appropriate water for a minimum streamflow
Spokane River. The application is further described as follows:

Source: Spokane River
Application No.: 95-08780
Proposed Priority: June 15, 1992
Amount and Period of Use: 2495.0 cfs from
through June 30, 1992
July through October 1992

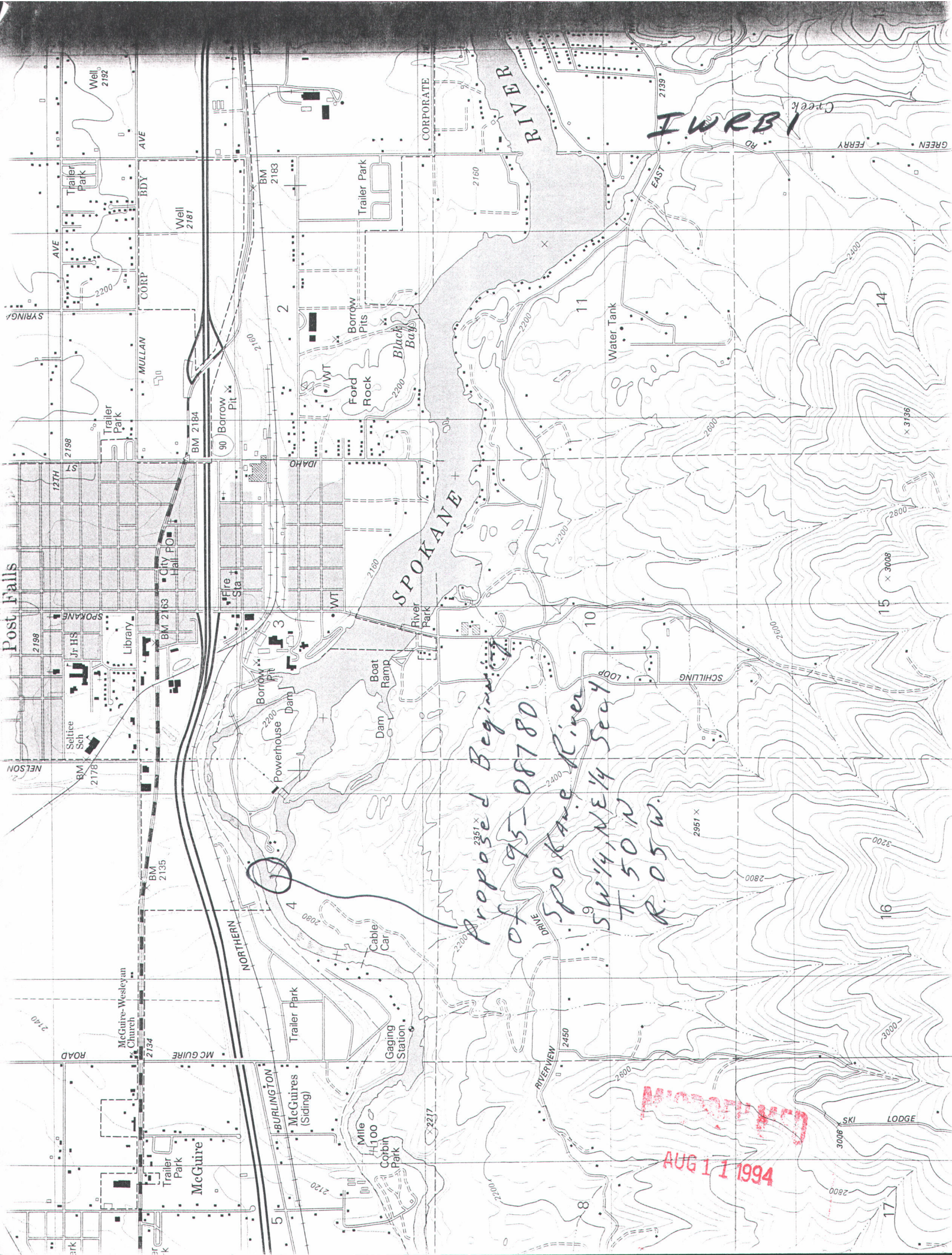
Purpose of Minimum Flow: Protection of fish and
aquatic life and values

Place of Use: Spokane River, co-located with
Post Falls Dam, located
SW 1/4 NW 1/4 and SE 1/4
2, T50N, R5W, and ex-
stream to the Idaho
State line to the SV
tion 12, T50N, R6W, 1
County

The Department of Water Resources will hold a public hearing
Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, ID 83814,
Idaho beginning at 2:00 p.m., on Wednesday, October 27, 1992.
The purpose of the hearing is to receive public testimony into the
hearing officer will also receive public testimony into the
p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for
presenting evidence or cross examining witnesses should file
appearance with the Director at the Department of Water Res-
house Mail, 1301 North Orchard Street, Boise, Idaho 83706, five
to the hearing. Other parties may informally present their vi-
ments without filing a notice of appearance. Written inform-
comments may also be submitted to the Department of Water
prior to the hearing.

If issued, this permit will be subject to all prior water rights.
R. Keith Higgins
IDAHO DEPT OF WATER RESOURCES



IWRB 1-A

Sec. 9.

Sec. 10.

Sec. 11.

WASHINGTON

Sec. 16.

Sec. 15.

Sec. 14.

Sec. 21.

Sec. 22.

Sec. 23.

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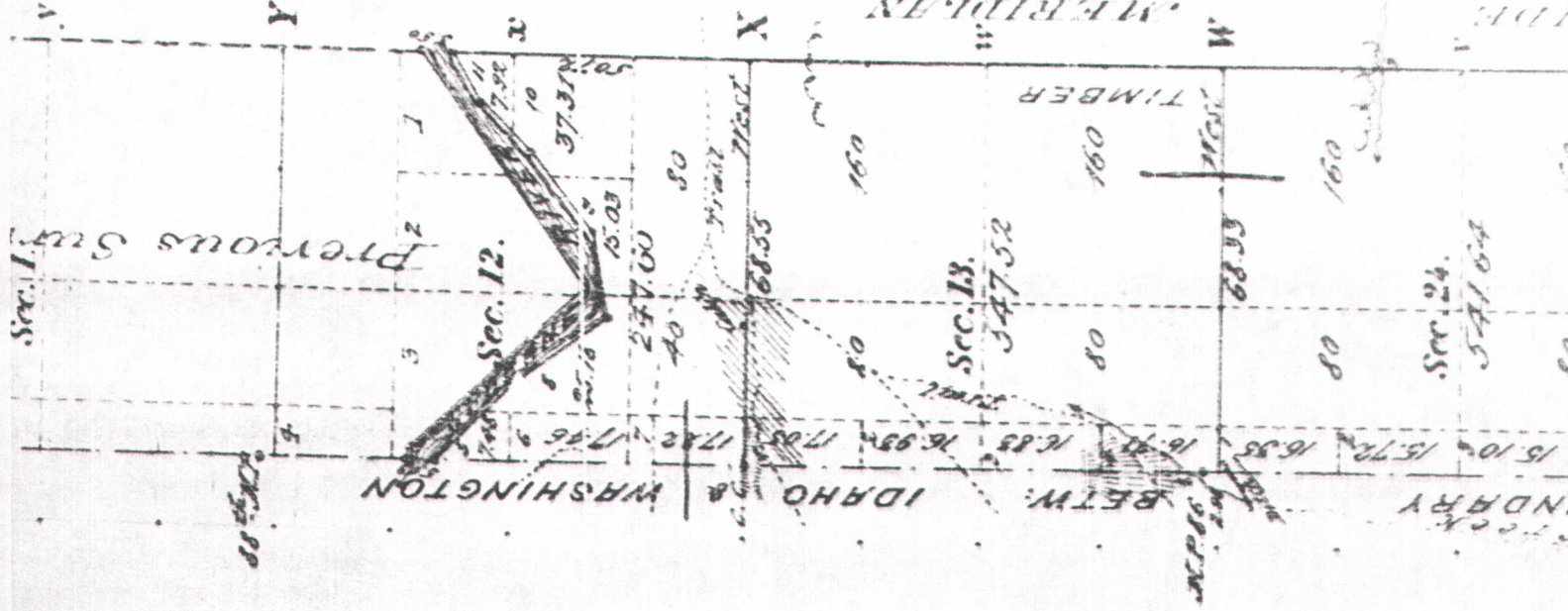
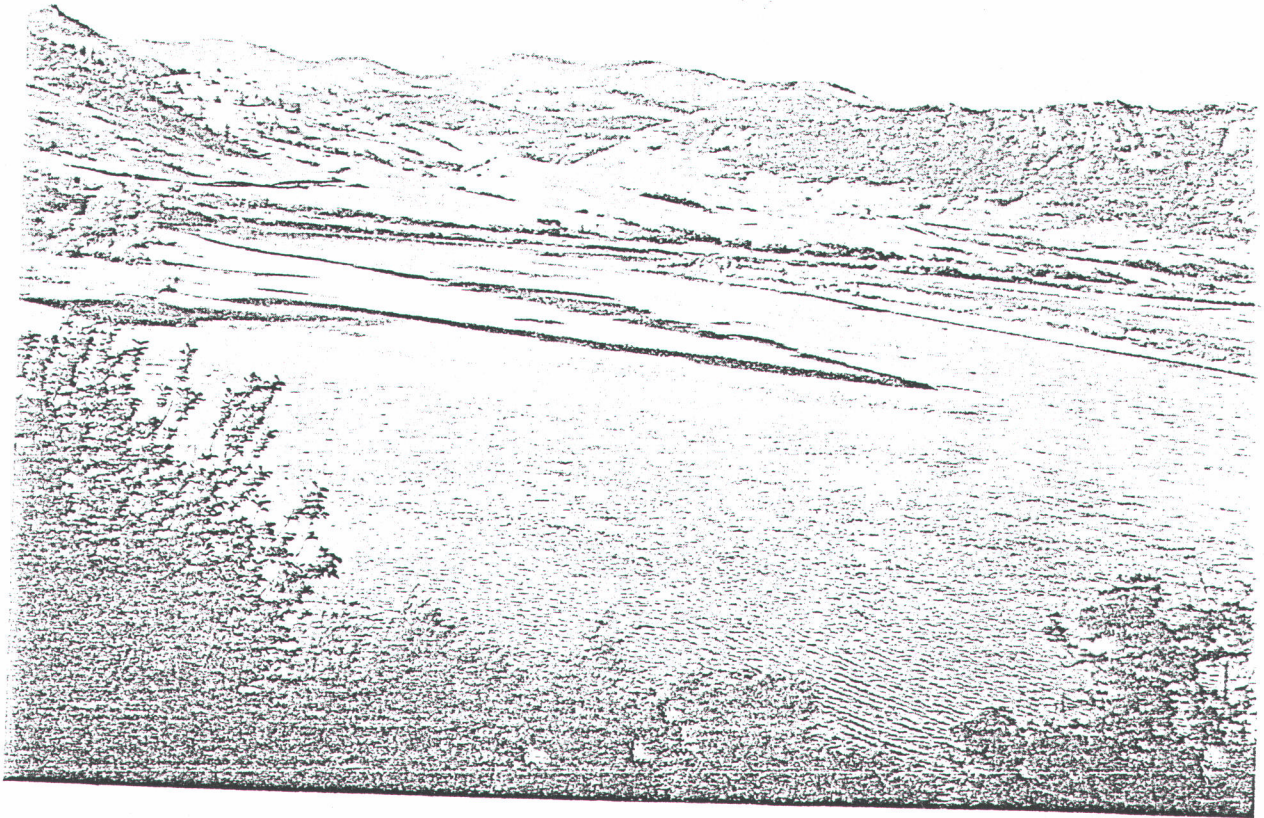


Fig. 2



Missouri River below Holter Dam, Montana, showing differences between flows of 3,000 cfs (55% of the average flow) and 2,000 cfs (37% of the average flow). The vertical drop was 7 inches. Flows reduced about midnight will clearly reveal differences in wetted substrate when photographed the next morning (photographic "regression analysis").

MRBS Photo #9000
by Don Tennant 6/10/70

Fig. 4



Republican River below Hardy Bridge, Nebraska, showing a flow of 42 c (10% of the average flow). Water depths were adequate to provide some fish cover, living space, movement and for fishing. Temperatures were within tolerable limits. This is a minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms.

MRBS Photo #7159
by Don Tennant 7/10/64

MRBS PHOTO

AUG 11 1994

Fig. 5



Bighorn River below Boysen Dam, Wyoming, showing a flow of 400 cfs (30% of the average flow). Water depth was adequate for trout movement, spawning incubation and winter survival in most run and pool areas for a distance of 45 car miles downstream. This is a base flow recommended to sustain good survival habitat for most aquatic life forms.

MRBS Photo #8542-B
by Don Tennant 10/2/68

Fig. 6



North Fork Shoshone River near Wapiti, Wyoming, showing a flow of 456 cfs (approximately 60% of the average flow). Water widths, depths and velocities very good for fish and fishing in all riffles, runs and pools. This is a base flow recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses.

FWS Photo #6-1-68
by Don Tennant 9/29/72

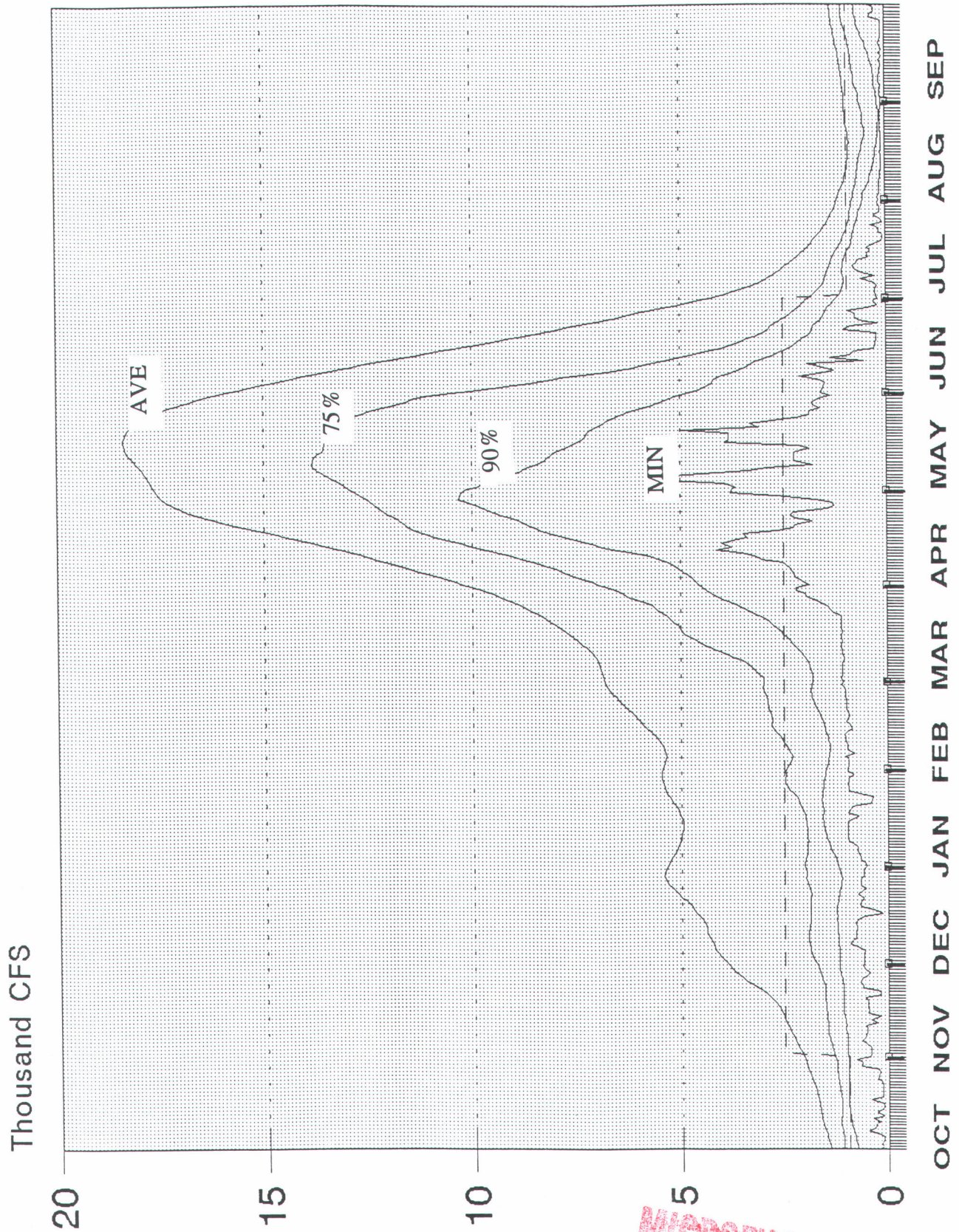
UNCLASSIFIED

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SPOKANE RIVER AT POST FALLS

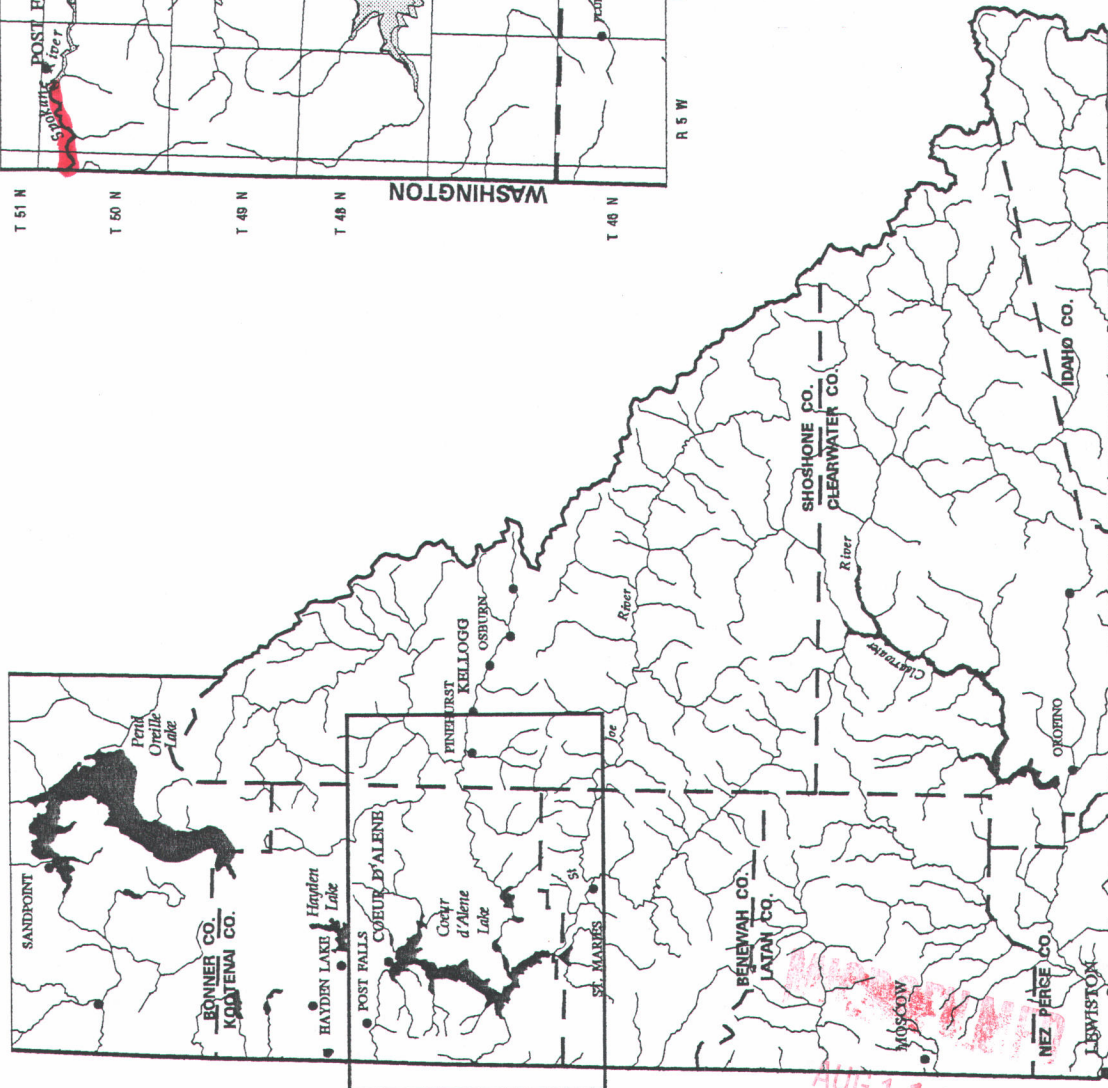
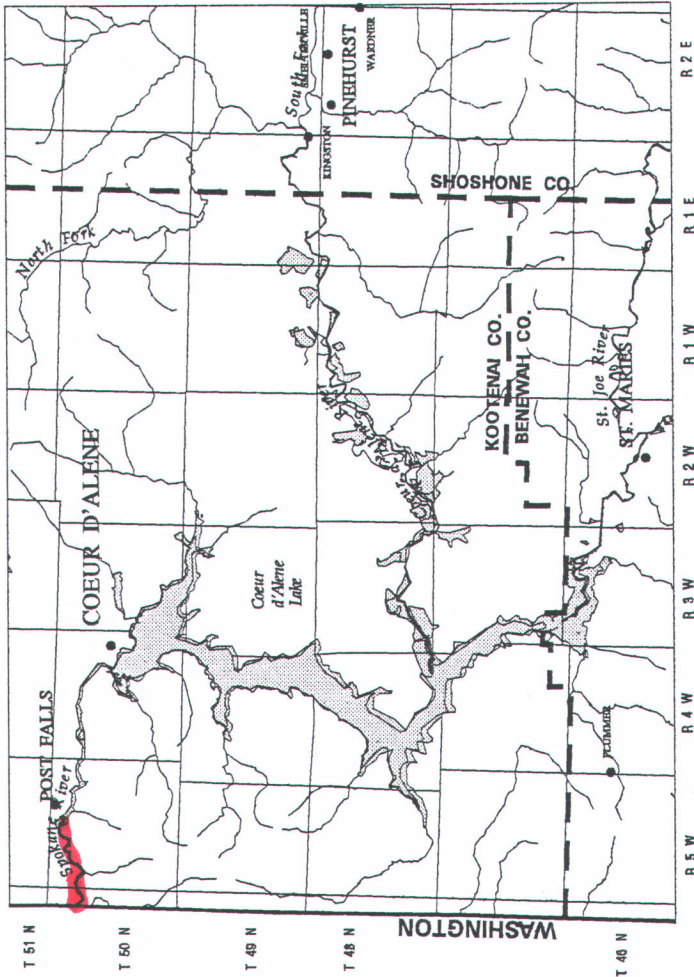
SUMMARY HYDROGRAPH PERIOD OF RECORD 1912-90

IWRB 9



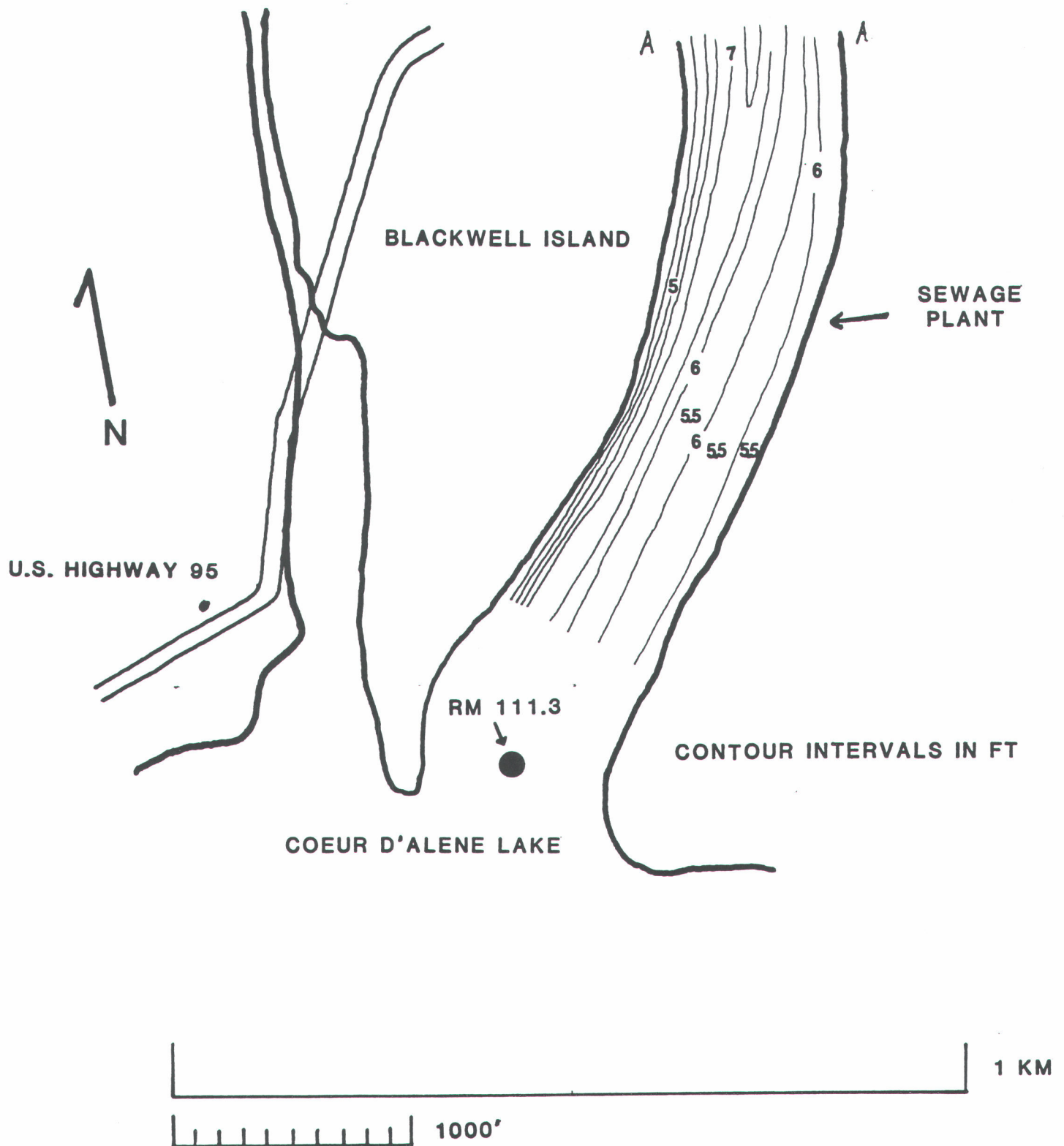
Spokane River - Minimum Streamflow

Minimum Streamflow Reach

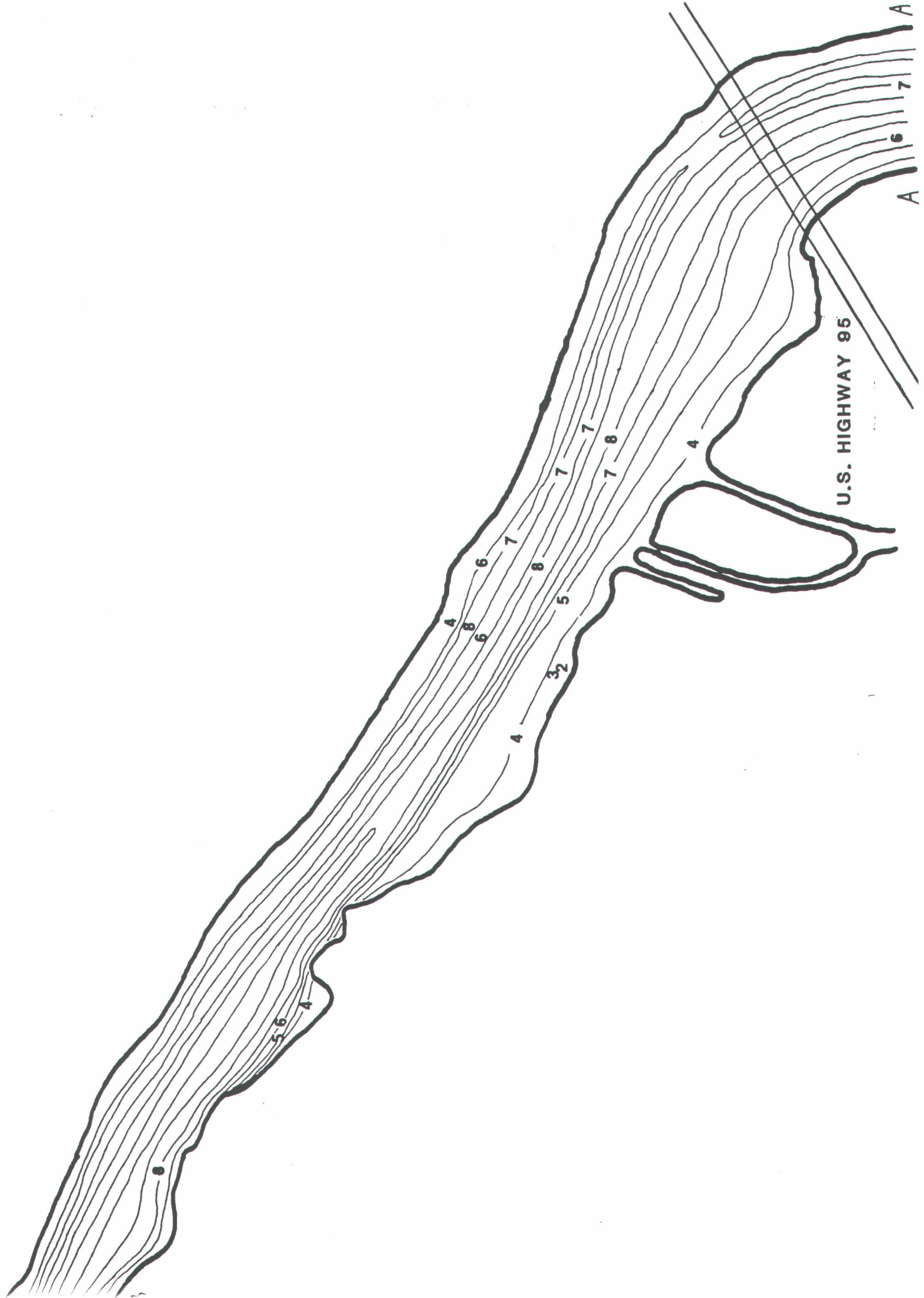


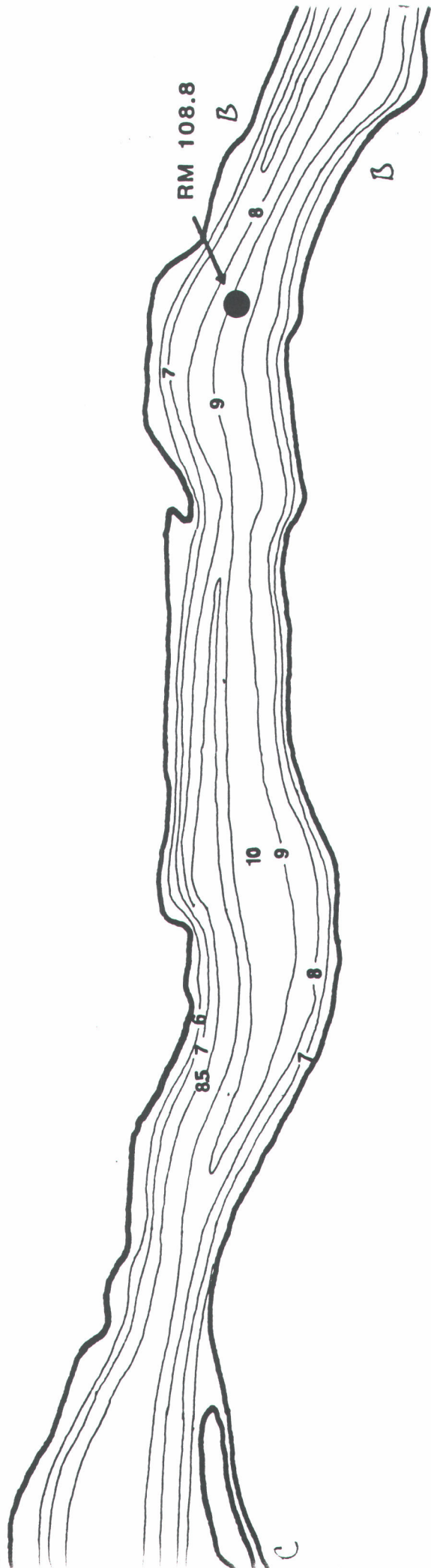
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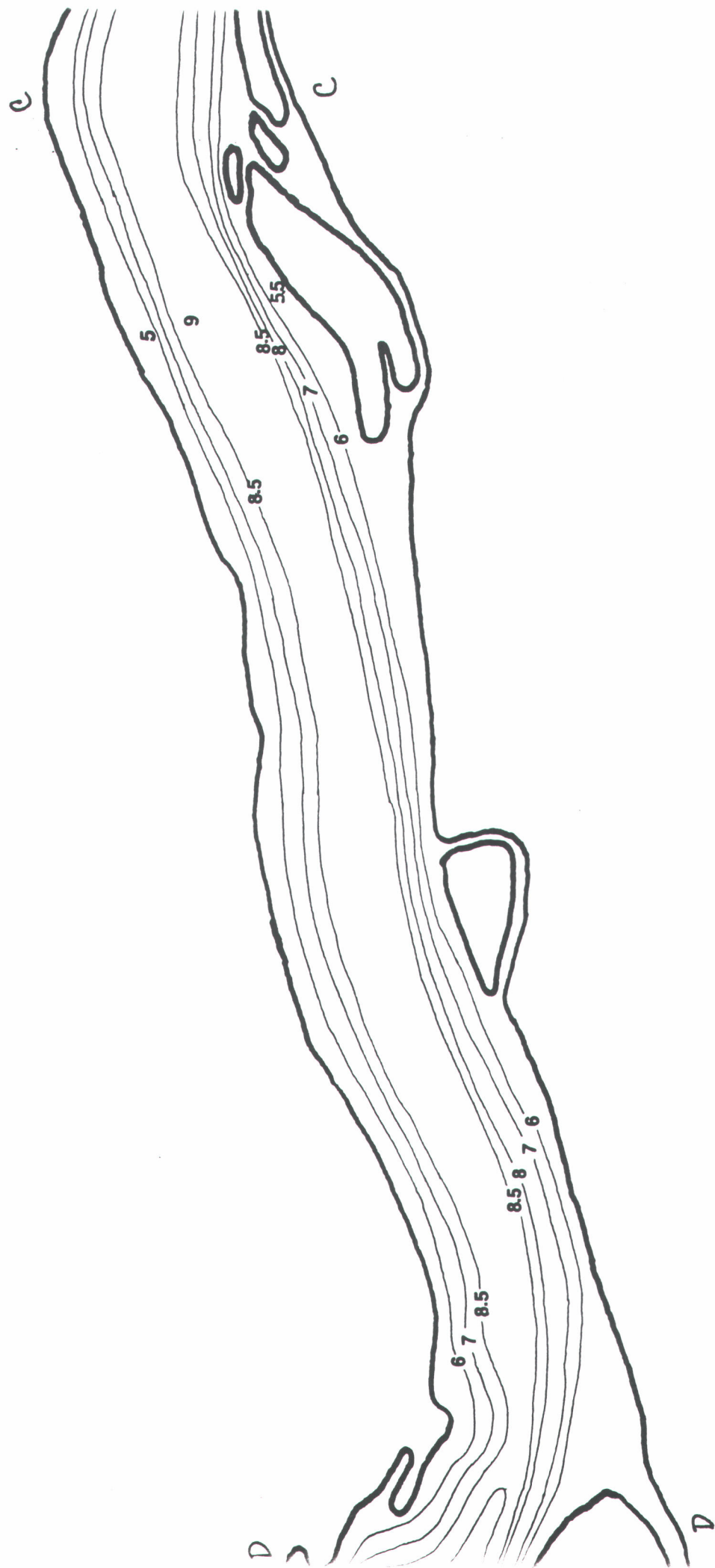


Morphometric map of the Spokane River (Idaho) at the Coeur d'Alene Lake outlet, May-October, 1980.





CONTOUR INTERVALS IN FT



RM 106.5

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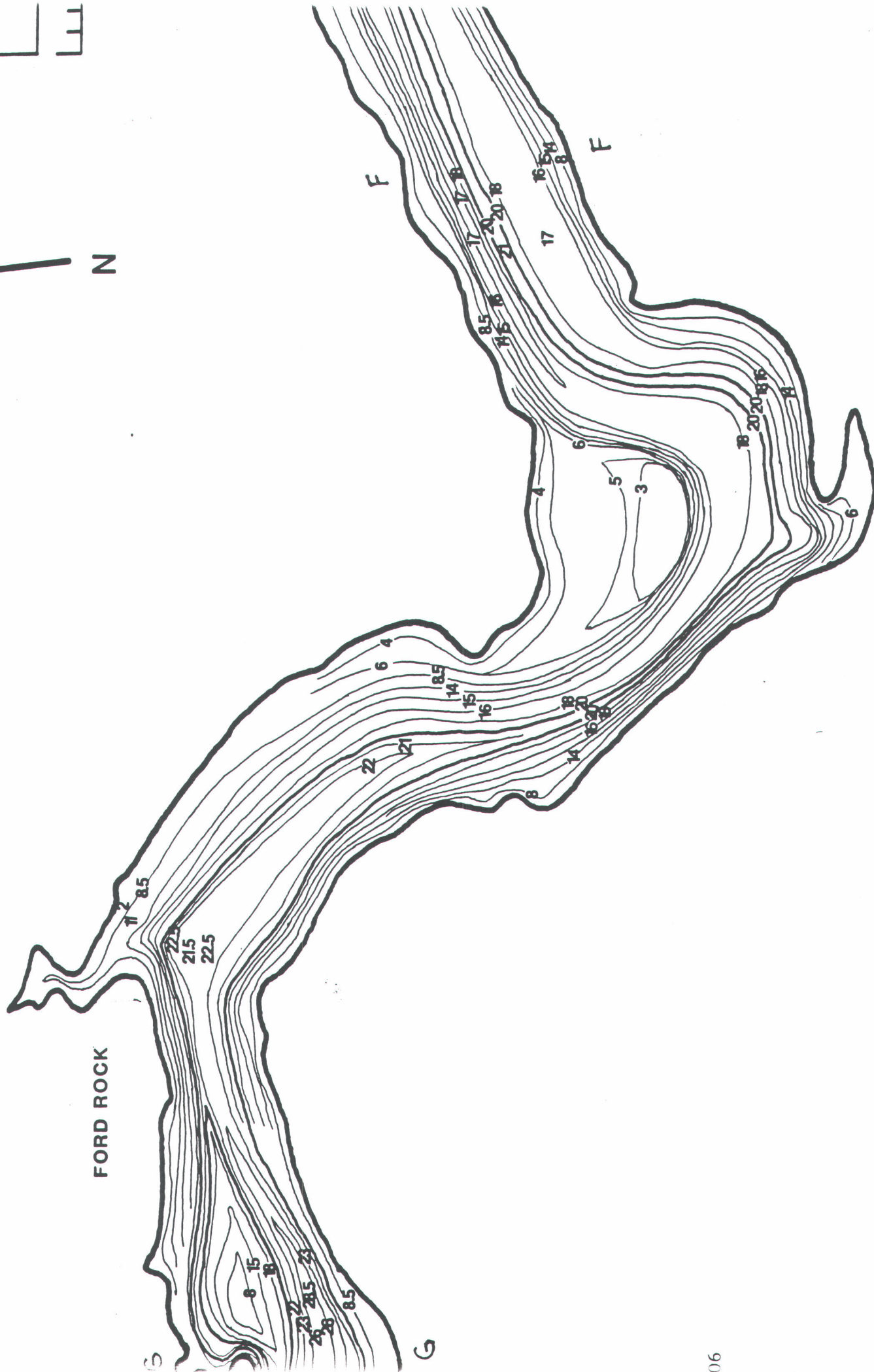
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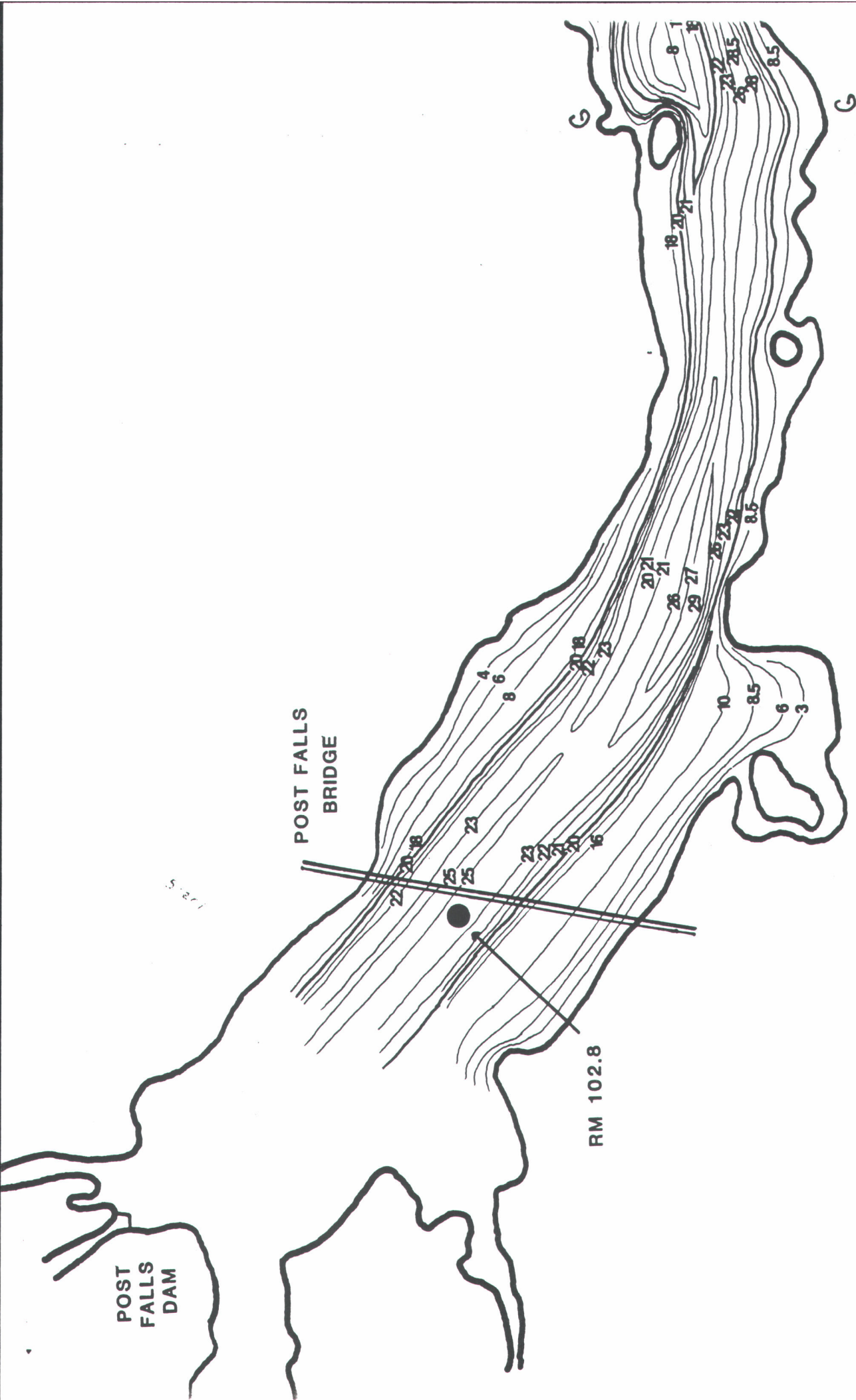
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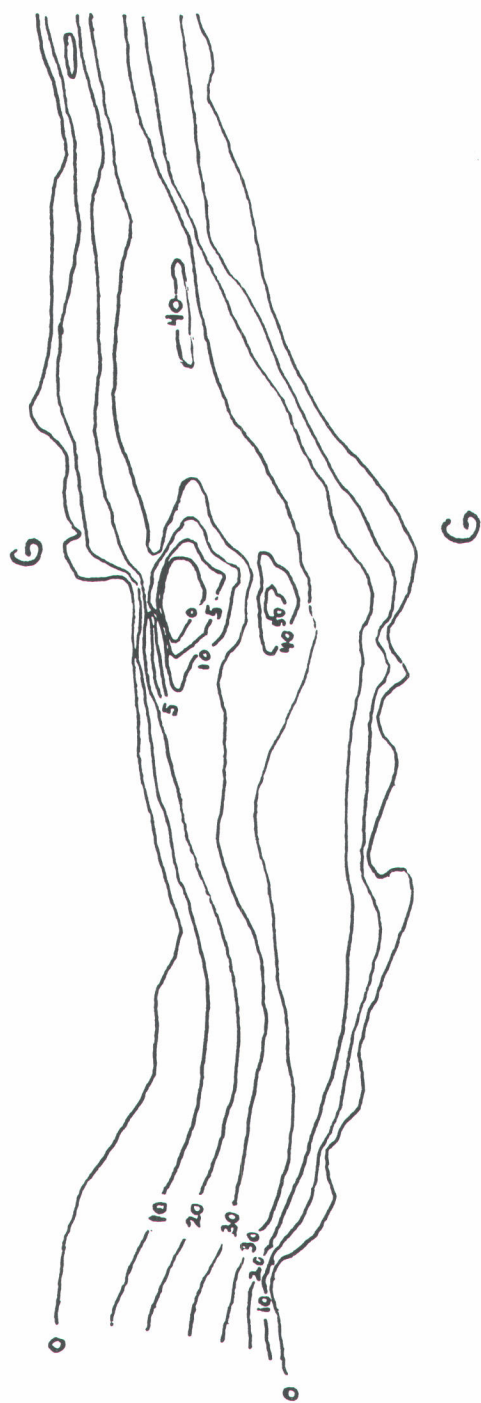
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Vicinity of Ford Rock on the Spokane River with revised depth measurements of 1991.

State of Idaho
Department of Water Resources

WATER RIGHT LICENSE

WATER RIGHT NO. 95-08780

Priority: June 15, 1992

Minimum Instream Flow:

2495.00 CFS

This is to certify, that STATE OF IDAHO

IDAHO WATER RESOURCE BOARD

STATEHOUSE

BOISE ID 83720

has complied with the terms and conditions of the permit, issued pursuant to Application for Permit dated June 15, 1992; and has submitted Proof of Beneficial Use on June 6, 1994. A minimum stream flow in

SPOKANE RIVER

tributary to COLUMBIA RIVER

has been established as follows:

<u>BENEFICIAL USE</u>	<u>PERIOD OF USE</u>	<u>RATE</u>
MINIMUM INSTREAM FLOW	11/01 to 06/30	2495.00 CFS
MINIMUM INSTREAM FLOW	07/01 to 10/31	951.00 CFS

LOCATION OF MINIMUM STREAM FLOW REACH:

Beginning of Stream Flow Reach

SWNE , Sec. 4, Township 50N, Range 05W

End of Stream Flow Reach

SWNW , Sec. 12, Township 50N, Range 06W
KOOTENAI County

CONDITIONS OF APPROVAL AND REMARKS

1. Use of water under this right shall be non-consumptive.
2. This minimum streamflow shall be subject to future municipal and domestic development from the Spokane River and its tributaries for the use in the basin within and upstream of the minimum streamflow reach. The minimum streamflow will not be subject to water rights established in the future for irrigation uses or other large consumptive purposes even though covered under a municipal or domestic use definition.
3. Specifically because of the generalization of the Tennant method, the Director retains jurisdiction, as described below, to review and amend any and all parameters of this right. The Board, upon receiving a request, or upon its own initiative, may petition the Director for an amendment to the right. The petition must set forth any significant change in circumstances and evidence of the public interest supporting the proposed amendment. The Director will notify the general public and specific persons or known interested parties of the proposed change, and conduct a hearing for the purpose of determining whether the right should be amended in the public interest. The burden of proof at the hearing shall be upon the persons or parties seeking the amendment to establish that the amendment of the right would be in the public interest.

NOV 16 1995

State of Idaho
Department of Water Resources**WATER RIGHT LICENSE**

WATER RIGHT NO. 95-08780

CONDITIONS OF APPROVAL AND REMARKS

4. Use of water under this right shall recognize and allow the continued beneficial diversion of water under any prior existing water right established by diversion and application to beneficial use or by an application, permit, or license on file or issued by the Director under the provisions of Chapter 2, Title 42, Idaho Code, with a priority of water right date earlier than 06/15/1992.
5. Upon further finding and order of the Director that gauging stations are required to maintain the approved minimum flows on Spokane River, such measuring devices shall be permanently installed and maintained as specified by the Director.
6. Establishment of minimum flows on the Spokane River in the requested reach shall serve to protect water released from Post Falls Dam as it flows through the requested reach at rates up to the established minimum flow, but shall not directly or indirectly cause any change in operation of Post Falls Dam.
7. The reach of the Spokane River for which the requested minimum flows are established is as follows: Spokane River, commencing at a point downstream from the Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SWNE, S4, T50N, R5W and extending downstream to the Idaho-Washington state line in the SWNW, S12, T50N, R6W, Kootenai County, a reach of approximately five miles.
8. This minimum stream flow is for the protection of fish and wildlife habitat, aquatic life and recreational values.

This license is issued pursuant to the provisions of Section 42-219, Idaho Code.
Witness the seal and signature of the Director, affixed at Boise, this 24TH
day of OCTOBER, 1995

Acting for

KARL J. DREHER, Director

NOV 1 6 1995

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JUN 06 1994

Department of Water Resources

STATE OF IDAHO

DEPARTMENT OF WATER RESOURCES

PROOF OF BENEFICIAL USE

The Idaho Department of Water Resources will consider this form as a statement that the permit holder(s) has/have completed all development that will occur under this permit and that water has been applied according to the provisions of the permit for the beneficial use(s) described below. This form must be accompanied by a license examination fee or a completed field examination report prepared by a certified water right examiner who has been appointed by the department.

1. Permit No. 95-08780 Telephone No. (208) 327-79102. Name(s) of Permit Holder(s): IDAHO WATER RESOURCE BOARD3. Post Office Address: 1301 N Orchard, PO Box 83720, Boise, Idaho 83720-00984. Source of Water: Spokane River

a. If ground water, well driller's name: _____ Date drilled: _____

b. Pump horsepower: _____ Pressure (psi): _____ Dynamic pumping level (ft.): _____

5. Extent of Use:

Domestic _____ (No. of households) Irrigation _____ (No. of acres)

Stockwater _____ (No. and type of stock) Other Minimum Stream Flow6. Total rate and/or volume for which proof is submitted 2495 cfs _____ acre/feet

7. Refer to the approval conditions on your permit and respond accordingly:

Measuring device: Required? Yes ☒ No Installed? Yes ☒ No

OR

Flow Measurement Port: Required? Yes ☒ No Installed? Yes ☒ No8. Fee Enclosed: \$ NA (See License Examination Fee Schedule)

9. Person to contact to accompany the Department representative during the field examination:

Name

Telephone No.

Address

10. The above information is my true statement of the extent to which the above numbered permit has been developed and I relinquish any undeveloped portion of the permit to the state of Idaho.

Date 5/31/94Signature F. Don G. Galt Chair I.W.R.B.
(and title if on behalf of a company or organization)

SEP 12 1994

BEFORE THE DEPARTMENT OF WATER RESOURCES
OF THE
STATE IDAHO

IN THE MATTER OF APPLICATION FOR)
PERMIT NO. 95-08780 (SPOKANE RIVER))
TO ESTABLISH A MINIMUM STREAMFLOW)
IN THE NAME OF THE IDAHO WATER)
RESOURCE BOARD)
_____)

ORDER ADOPTING
RECOMMENDED ORDER

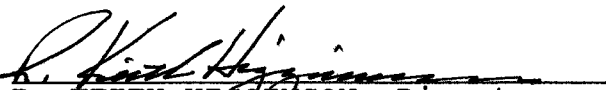
A Recommended Order in the above-captioned matter has been issued and a copy served on the parties;

WHEREAS, more than twenty-one days have passed since the service of the Recommended Order; and,

WHEREAS, no exception to that Recommended Order has been received,

IT IS, THEREFORE, HEREBY ORDERED that said Recommended Order be adopted and issued as the Final Order and proof of construction of works and application of water to beneficial use shall be submitted on or before March 1, 1999.

Dated this 20th day of December, 1993.


R. KEITH HIGGINSON, Director
Department of Water Resources

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AUG 11 1994

CERTIFICATE OF MAILING

I hereby certify that on the 20th day of December, 1993, I mailed a true and correct copy, postage prepaid, of the Order Adopting Recommended Order to the following individuals:

Clarence Parr
Route 2 Box 2128
Heyburn, ID 83336

Senator Mary Lou & Scott Reed
10 Giesa Road
Coeur d'Alene, ID 83814

Cindy Robertson
Dept. of Fish & Game
Statehouse Mail
Boise, ID 83720

Ross Walkin
Spokane River Association
W. 7911 E. Riverview
Coeur d'Alene, ID 83814

Blaunche Kohli
6415 Harbor Drive
Coeur d'Alene, ID 83814

Robert Nonini
W. 5900 Harbor Drive
Coeur d'Alene, ID 83814

James A. Emerson
2101 Lakewood Drive Suite 225
Coeur d'Alene, ID 83814

Rep. Marvin G. Vandenberg
6080 Sunrise Terrace
Coeur d'Alene, ID 83814

Kootenai County Commission
Courthouse
Coeur d'Alene, ID 83814

Shoshone County Commission
Box 1049
Wallace, ID 83873

Gwen Burr
Dept. of Health & Welfare, DEQ
2110 Ironwood Parkway
Coeur d'Alene, ID 83814

Mary Lucachick
Dept. of Parks & Recreation
Statehouse Mail
Boise, ID 83720

Larry LaBolle
E. 1411 Mission Avenue
Coeur d'Alene, ID 83814

Howard Funke
P.O. Box 969
Coeur d'Alene, ID 83814


JENNIFER SEIFERT, Records Clerk
Department of Water Resources


AUG 11 1994

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE

STATE OF IDAHO

**IN THE MATTER OF APPLICATION FOR)
PERMIT NO. 95-08780 (SPOKANE)
RIVER) TO ESTABLISH A MINIMUM)
STREAM FLOW IN THE NAME OF THE)
IDAHO WATER RESOURCE BOARD)**

**RECOMMENDED
ORDER**

On October 27, 1993, the Idaho Department of Water Resources (department) conducted a hearing to determine whether an application for permit to appropriate water, numbered in the Department records as 95-08780, should be approved or rejected. The application seeks to establish a minimum stream flow in the Spokane River, located in Kootenai County.

Notice of the hearing was published in the Coeur d'Alene Press in Kootenai County and statewide in the newspapers in Lewiston, Boise, Twin Falls and Idaho Falls. The Idaho Water Resource Board (Board) appeared as a formal party, and full party status was granted to intervenor Spokane River Association represented by Mr. Robert Nonini. Other individuals and representatives of organizations also appeared and presented their views and comments as public witnesses.

The hearing officer left the hearing record open until November 8, 1993 for submission of written public interest comments. Two comment letters were received after the hearing and six before the hearing. The evidence having been taken, and the record having closed, the hearing officer, as a representative of the Director of the Department of Water Resources, proposes the following Findings of Fact, Conclusions of Law, and Order:

RECOMMENDED ORDER - Page 1

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AUG 11 1994

FINDINGS OF FACT

1. Application for minimum stream flow No. 95-08780 proposes the following:

Rate of Flow: 2495 cfs from November 1 through June 30;
951 cfs from July 1 through October 31.

Location: Spokane River, commencing at Post Falls Dam, located in both the SW 1/4 NW 1/4 and the SE 1/4 SW 1/4, Section 3, T50N, R5W and extending downstream to the Idaho-Washington state line in the SW 1/4 NW 1/4, Section 12, T50N, R6W, B.M., Kootenai County.

Purpose: In stream flow use for the protection of fish and wildlife habitat, aquatic life and recreational values.

Priority Date: June 15, 1992.

2. At the hearing, the applicant requested that the location of the place of use be changed to read as follows:

Spokane River, commencing at a point downstream from Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SW 1/4 NE 1/4, Section 4, T50N, R5W and extending downstream to the Idaho-Washington state line in the SW 1/4 NW 1/4, Section 12, T50N, R6W B.M., Kootenai County, a reach of approximately five miles.

3. The Idaho Water Resource Board asked Fish & Game about specific data regarding Spokane River which could be used to establish a minimum stream flow.

4. While Fish & Game has not specifically studied the Spokane River to determine the minimum stream flow, a study conducted by Donald L. Tennant, a fisheries biologist for the U.S. Fish & Wildlife Service, concluded, after analyzing several western streams, that the percentage of the mean flow in the stream is related to the quality of the fish and aquatic habitat and the riparian health of the stream. Tennant's study was submitted as an exhibit, and marked IWRB 5. The study contains a table which lists the quality of various

AUG 11 1994

percentages of the mean annual flow as that flow relates to the stream habitat and environmental resources.

5. The Board's requested flow rate for the November through June period is based upon 40% of the mean annual flow. This flow rate is needed to prevent degrading instream habitat conditions during a critical part of this period. During the remainder of the requested period, the flow rate requested is lower than an optimum flow rate (60% of mean annual flow) as defined by Tennant. The Board determined that a stream flow which could result in stream habitat degradation would be less than the minimum desirable flow rate.

6. Flow data for Spokane River was measured at a site approximately one mile below the Post Falls Dam, in the upper end of the reach, from 1912 through 1990. The flow data is summarized graphically by the exhibit marked IWRB 6. Forty percent of the mean annual flow is sustainable during the months of November through June. Forty percent of the mean annual flow is not sustainable for the months of July, August, September and October. As a result, the minimum stream flow sought for the four months of July, August, September and October was reduced to 951 cfs, which is the average monthly flow for the month of August, and is the lowest average monthly flow of the four month period.

7. Statistical analysis of the available flow data indicates that for the November through June period of each year the requested flow of 2495 cfs has been met or exceeded 77 percent of the time during the 79 year period of record (IDWR Exhibit #7). A similar analysis indicates that the 951 cfs flow has been met or exceeded 70 percent of the time during the July through October period (IDWR Exhibit #8)

8. Spokane River is an important high yield urban fishery. It supports a naturally sustaining rainbow trout population, as well as brown trout and cutthroat trout populations. Public interest witnesses emphasized the value of having the accessible fishery that can be used for part day and evening recreation outings. A 1990 study sponsored by the Idaho Department of Fish & Game indicated that 6200 hours were spent fishing on the reach for which the minimum flow is requested with catch rates of about 0.3 fish per hour (Fish & Game Exhibit #2). An earlier Fish & Game study suggests that a flow of not less than 6000 cfs is needed in the reach during the April through June period to protect 65% of the available spawning habitat (Fish & Game Exhibit #1).

9. The general public also canoes, rafts, kayaks, drift boats and swims in the Spokane River in the requested reach.

10. The requested reach of Spokane River provides important wildlife habitat supporting duck and goose populations.

11. Public access to Spokane River in the requested reach is available at three public boat launching areas.

12. The records of the Department of Water Resources show 25 water rights and permits within the minimum stream flow reach authorizing a total withdrawal of 9.68 cfs. In addition, water rights held by Washington Water Power for hydroelectric generation at Post Falls Dam just upstream from the requested reach total 5410.00 cfs. All of the rights and permits identified have priority dates earlier than June 15, 1992.

13. The Department attempted to notify all water right holders with permits pending before the Department of the minimum stream flow hearing. To the extent that permits

AUG 11 1994

have been assigned dates of priority earlier than the minimum stream flow, the minimum stream flow must be subject to the rights which may be established if approved.

14. Intervenor Spokane River Association and several public interest witnesses expressed concern that establishment of the minimum stream flow with the rates requested would result in the level of Coeur D'Alene Lake being lowered on some years particularly during critical summer and fall recreation periods. Lowering of the lake level during the recreation period could render unusable the boat docks of homeowners located along the Spokane River upstream from the Post Falls Dam.

15. Intervenor Spokane River Association and several public interest witnesses expressed concern that establishment of the minimum stream flow with the rates requested would allow the Hayden Sewer District to release effluent during a longer period of the year perhaps endangering swimmers and other body-contact recreations.

16. Clarence Parr, Vice Chairman, stated the Board's position that establishment of a minimum flow could not legally force a change in the use of water under any water right having a priority date earlier than the minimum flow, whether the right was within the requested reach or upstream from it. He indicated that the operation of Post Falls Dam would not be legally affected by establishment of the minimum flow.

17. Several of the public interest witnesses expressed concern that even if regulation of Post Falls Dam was not legally altered by establishment of the minimum flows, Washington Water Power could be influenced to voluntarily change operation of the dam to meet the minimum flows thereby reducing lake levels.

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AUG 11 1994

18. Of the eight written comment letters received, six supported establishment of the minimum flow as requested, while the other two expressed concern that the level of Coeur d'Alene Lake would be lowered adversely affecting boating and that higher stream flows would encourage additional sewage effluent release into the river.

19. Of the fifteen public witnesses, eleven supported establishment of minimum flows. Several, including Idaho Department of Fish & Game, and representatives of the Coeur d'Alene and Spokane Tribes encouraged higher flow rates. Those testifying against the proposal expressed concern for lowered lake levels and increased sewage effluent releases, and the need to allow future domestic and municipal uses of water in the river basin.

20. Scott W. Reed, testifying as a public witness, indicated that Spokane River was the most vulnerable stream in northern Idaho to out-of-state appropriations and diversions because of its location and available flows.

CONCLUSIONS OF LAW

1. Idaho Code § 42-1501 provides that stream flow preservation for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, navigation, and water quality when made pursuant to the minimum stream flow statutes, is in the public interest and is declared to be a beneficial use of such water.

2. Idaho Code § 42-1503 sets forth the criteria to be considered by the Department in reviewing an application for minimum stream flow:

Upon the conclusion of the hearings and completion of any investigation conducted by the Director, he shall enter his findings in writing approving the application in full, or in part, or upon conditions or rejecting said application. Approval of any such

application must be based upon the findings that such appropriation of minimum stream flow:

- (a) will not interfere with any vested water right, permit, or water right application with priority of right date earlier than the date of receipt in the office of the Director of a complete application for appropriation of minimum stream flow filed under the provisions of this act;
- (b) is in the public, as opposed to the private interest;
- (c) is necessary for the preservation of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, navigation, transportation, or water quality of the stream;
- (d) is the minimum flow or lake level and not the ideal or most desirable flow or lake level; and
- (e) is capable of being maintained as evidenced by records of stream flows and water levels and the existing or future establishment of necessary gauging stations and bench marks.

3. Any right acquired under this application is for instream nonconsumptive use and is subject to all vested water rights, permits, or water right applications having dates of priority earlier than the filing date of the application set forth in the findings of fact. Establishment of the minimum flow cannot cause a change in established, legally authorized operations of Post Falls Dam.

4. Tennant's method is not an exact method for determining a minimum stream flow, but is an estimate of the minimum flow necessary to sustain stream habitat values. As a result, any approval of the minimum stream flow should be flexible enough to allow downward adjustment if further studies show the quantities approved are excessive. The minimum stream flow decision should be conditioned to allow for proper adjustment.

5. Since development is inevitable along the Spokane River and some of its tributaries and since portions of the Spokane River are already substantially developed, it is not in the public interest to use the Tennant method to establish a minimum stream flow which will preclude future municipal or domestic development in the basin within the requested reach and upstream. The minimum stream flow approval should be conditioned to allow future domestic and municipal development of the Spokane River and its tributaries within the requested reach and upstream.

6. The minimum stream flow is in the public interest.

7. The flow sought is necessary for the preservation of fish and wildlife habitat, aquatic life, and recreational values.

8. The minimum stream flow sought for both periods of time is the minimum flow and is not the ideal or most desirable flow.

9. The minimum flows sought are capable of being maintained as evidenced by flow records.

10. Any approval of a minimum stream flow for the Spokane River should recognize and protect the established interests of homeowners and others having an interest in the operation of Spokane River upstream from the Post Falls Dam.

ORDER

IT IS HEREBY ORDERED that application for permit No. 95-08780 is APPROVED under the following conditions:

1. This minimum stream flow shall be subject to future municipal and domestic development from the Spokane River and its tributaries for use in the basin within and

upstream of the minimum stream flow reach. The minimum stream flow will not be subject to water rights established in the future for irrigation uses or other large consumptive purposes even though covered under a municipal or domestic use definition.

2. Specifically because of the generalization of the Tennant method, the Director retains jurisdiction, as described below, to review and amend any and all parameters of this permit and subsequent license. The Board, upon receiving a request, or upon its own initiative, may petition the Director for an amendment to the permit or license. The petition must set forth any significant change in circumstances and evidence of the public interest supporting the proposed amendment. The Director will notify the general public and specific persons or known interested parties of the proposed change, and conduct a hearing for the purpose of determining whether the permit or subsequent license should be amended in the public interest. The burden of proof at the hearing shall be upon the persons or parties seeking the amendment to establish that the amendment of the permit or license would be in the public interest.

3. Use of water under this permit shall recognize and allow the continued beneficial diversion of water under any prior existing water right established by diversion and application to beneficial use or by an application, permit, or license on file or issued by the Director under the provisions of Chapter 2, Title 42, Idaho Code, with a priority of water right date earlier than June 15, 1992, for application No. 95-08780.

4. Use of water under this permit shall be nonconsumptive.

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AUG 11 1994

5. Upon further finding and order of the Director that gauging stations are required to maintain the approved minimum flows on Spokane River, such measuring devices shall be permanently installed and maintained as specified by the Director.

6. Proof of instream beneficial use of the minimum stream flow may be submitted immediately upon legislative approval of the permit, but shall be submitted no later than March 1, 1999.

7. Establishment of minimum flows on the Spokane River in the requested reach shall serve to protect water released from Post Falls Dam as it flows through the requested reach at rates up to the established minimum flow, but shall not directly or indirectly cause any change in operation of Post Falls Dam.

8. The reach of Spokane River for which the requested minimum flows are established is as follows:

Spokane River, commencing at a point downstream from Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SW 1/4 NE 1/4, Section 4, T50N, R5W and extending downstream to the Idaho-Washington state line in the SW 1/4 NW 1/4, Section 12, T50N, R6W B.M., Kootenai County, a reach of approximately five miles.

Dated this 24TH day of November, 1993.


NORMAN C. YOUNG
Hearing Officer

CERTIFICATE OF MAILING

I hereby certify that I served a true and correct copy of the following described document on the persons listed below by mailing in the United States mail, first class with the correct postage affixed thereto on the 21st day of November, 1993.

Document Served: **RECOMMENDED ORDER**

Persons Served:

Clarence Parr
Route 2 Box 2128
Heyburn, ID 83336

Senator Mary Lou & Scott Reed
10 Giesa Road
Coeur d'Alene, ID 83814

Cindy Robertson
Dept. of Fish & Game
Statehouse Mail
Boise, ID 83720

Ross Walkin
Spokane River Association
W 7911 E Riverview
Coeur d'Alene, ID 83814

Blaunche Kohli
6415 Harbor Drive
Coeur d'Alene, ID 83814

Robert Nonini
W 5900 Harbor Drive
Coeur d'Alene, ID 83814

James A. Emerson
2101 Lakewood Drive Suite 225
Coeur d'Alene, ID 83814

Rep. Marvin G. Vandenberg
6080 Sunrise Terrace
Coeur d'Alene, ID 83814

Kootenai County Commission
Courthouse
Coeur d'Alene, ID 83814

Shoshone County Commission
Box 1049
Wallace, ID 83873

Gwen Burr
Dept. of Health & Welfare, DEQ
2110 Ironwood Parkway
Coeur d'Alene, ID 83814

Mary Luckachick
Dept. of Parks & Recreation
Statehouse Mail
Boise, ID 83720

Larry LaBolle
E. 1411 Mission Avenue
Coeur d'Alene, ID 83814

Howard Funke
P. O. Box 969
Coeur d'Alene, ID 83814



RITA I. FLECK, Senior Secretary

AUG 11 1994

State of Idaho
Department of Water Resources
Permit To Appropriate Water

NO. 95-08780

Proposed Priority: June 15, 1992

Maximum Diversion Rate:

2495.00 CFS

This is to certify, that **STATE OF IDAHO**
IDAHO WATER RESOURCE BOARD
STATEHOUSE
BOISE ID 83720

has applied for a permit to appropriate water from:

SPOKANE RIVER

tributary of **COLUMBIA RIVER**

and a permit is **APPROVED** for development of water as follows:

<u>BENEFICIAL USE</u>	<u>PERIOD OF USE</u>	<u>RATE OF DIVERSION</u>
MINIMUM INSTREAM FLOW	11/01 to 06/30	2495.00 CFS
MINIMUM INSTREAM FLOW	07/01 to 10/31	951.00 CFS
	Totals	2495.00 CFS

LOCATION OF POINT(S) OF DIVERSION:

Beginning of Stream Flow Reach
End of Stream Flow Reach

SWNE , Sec. 4, Township 50N, Range 05W
SWNW , Sec. 12, Township 50N, Range 06W
KOOTENAI County

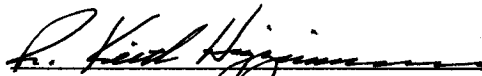
PLACE OF USE: See Remarks

CONDITIONS/REMARKS:

1. See Final Order for conditions of approval.

This permit is issued pursuant to the provisions of Section 42-204, Idaho Code.
Witness the signature of the Director, affixed at Boise, this

20TH day of DECEMBER, 1993.


R. Keith Higginson, Director

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**MINIMUM STREAMFLOW
Fact Sheet**

Water Right No. 95-08780

Source: Spokane River

Applicant: Idaho Water Resource Board

Date Filed: June 15, 1992

Rate of Flow: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW $\frac{1}{4}$ NW $\frac{1}{4}$, and the SW $\frac{1}{4}$ SW $\frac{1}{4}$, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line in the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R6W, B.M., Kootenai County.

Purpose: Protection of fish and wildlife habitat, aquatic life and recreational values.

Hearing Location

and Time: Wednesday, October, 27, 1993, Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2.00 p.m. General testimony may also be submitted at an evening meeting scheduled for 7:00 p.m. at the same location.

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AUG 11 1994

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JUN 15 1992
Department of Water Resources

Ident. No. 95-8780

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
APPLICATION FOR PERMIT

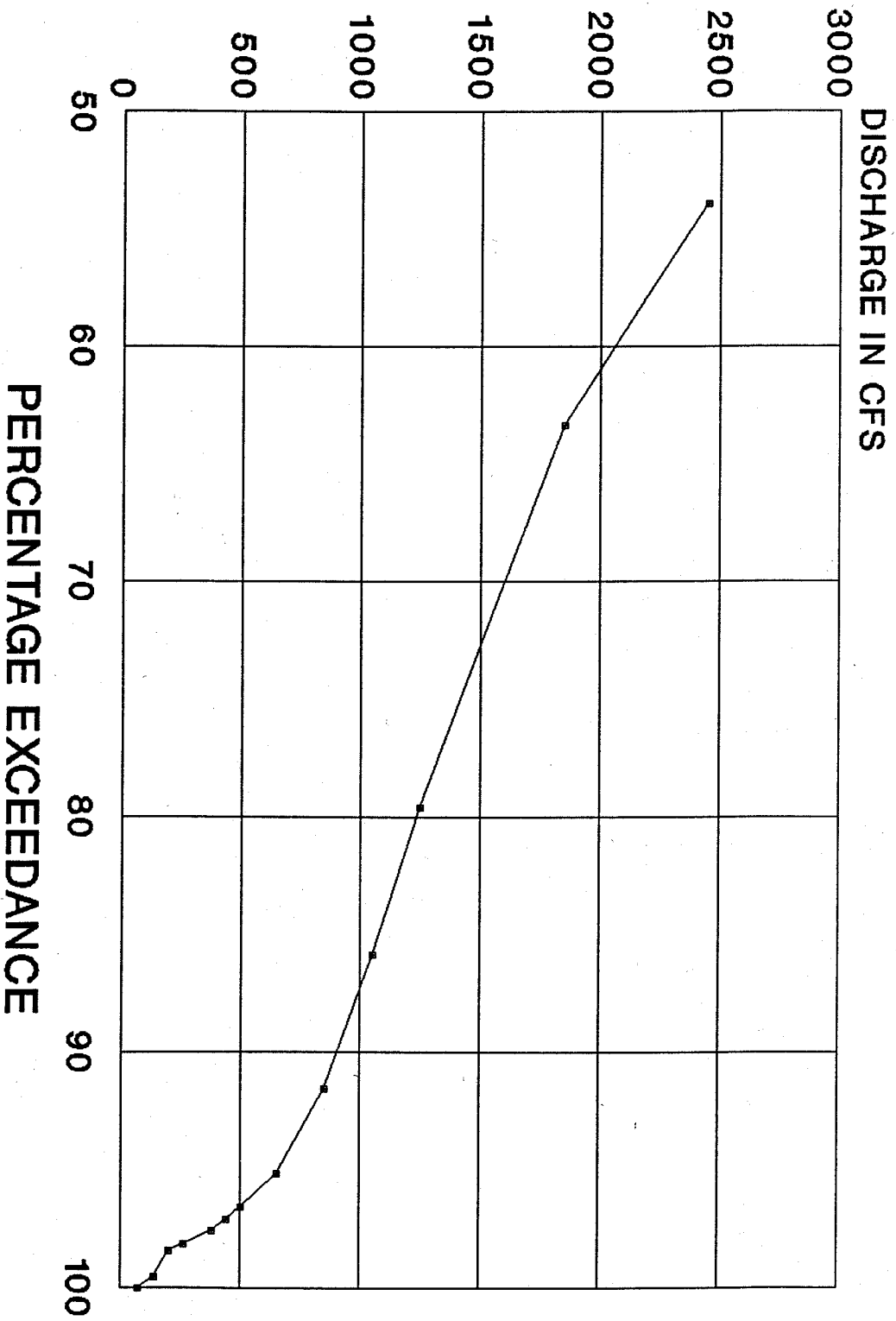
To appropriate the public waters of the State of Idaho

1. Name of applicant Idaho Water Resource Board Phone 327-7910
Post office address Statehouse, Boise, ID 83720
2. Source of water supply Spokane River which is a tributary of Columbia River
Instream flow ~~from~~ Post Falls Dam
in the SE SW NW
3. Location of point of diversion is NE SE SW 1/4 of 1/4 of Govt. Lot
Sec. 3 Township 50N Range 5W B.M. Kootenai County; additional
points of diversion if any: downstream to the state line in the NE 1/4 of SW 1/4 of NW 1/4, Sec. 12,
T50N, R6W, B.M.
4. Water will be used for the following purposes:
Amount 2495 cfs for instream purposes from Nov. 1 to June 30 (both dates inclusive)
(cfs or acre-feet per annum)
Amount 951 cfs for instream purposes from July 1 to Oct. 31 (both dates inclusive)
(cfs or acre-feet per annum)
Amount for purposes from to (both dates inclusive)
(cfs or acre-feet per annum)
Amount for purposes from to (both dates inclusive)
(cfs or acre-feet per annum)
5. Total quantity to be appropriated is (a) 2495 and/or (b)
cubic feet per second acre feet per annum
6. Proposed diverting works:
 - a. Description of ditches, flumes, pumps, headgates, etc.
None
 - b. Height of storage dam feet; active reservoir capacity acre-feet; total
reservoir capacity acre-feet; period of year when water will be diverted to storage:
 to inclusive.
 - c. Proposed well diameter is inches; proposed depth of well is feet.
 - d. Is ground water with a temperature of greater than 90°F being sought?
7. Time required for the completion of the works and application of the water to the proposed beneficial use is
5 years (minimum 1 year).

MICROFILMED

AUG 11 1994

FLOW DURATION CURVE SPOKANE RIVER AT POST FALLS



SUMMARY HYDROGRAPH DATA
12419000

FLOW DURATION TABLE FOR STATION 124190000

FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +
13550.	15.64	12550.	17.56	11550.	19.67	10550.	21.72	9550.	23.65
7550.	27.98	6550.	30.81	5550.	34.77	4550.	39.48	4450.	40.05
4250.	40.93	4150.	41.67	4050.	42.23	3950.	42.96	3850.	43.61
3650.	45.00	3550.	45.75	3450.	46.40	3350.	47.15	3250.	47.71
3050.	49.19	2950.	49.96	2850.	50.62	2750.	51.52	2650.	52.37
2450.	53.92	2350.	54.80	2250.	55.91	2150.	57.26	2050.	59.38
1850.	63.30	1750.	65.80	1650.	68.09	1550.	70.83	1450.	73.93
1250.	79.58	1150.	83.00	1050.	85.86	950.	88.99	850.	91.56
650.	95.17	550.	96.20	540.	96.27	530.	96.35	520.	96.44
500.	96.58	490.	96.64	480.	96.73	470.	96.86	460.	96.94
380.	97.10	440.	97.19	420.	97.30	410.	97.40	400.	97.49
320.	97.58	370.	97.62	360.	97.65	350.	97.68	340.	97.74
260.	98.14	310.	97.89	300.	97.94	290.	97.97	280.	98.02
200.	98.43	250.	98.21	240.	98.26	230.	98.29	220.	98.32
140.	98.82	190.	98.48	180.	98.58	170.	98.71	160.	98.91
80.	99.51	130.	99.71	120.	99.82	110.	99.89	100.	99.98
	99.99	70.	100.00	60.	100.00	50.	100.00		

Table 1

Instream Flow Regimens for Fish, Wildlife, Recreation and Related
Environmental Resources

Narrative Description of Flows ^{1/}	Fisheries Classification ^{2/}	Recommended Base Flow Regimens	
		Oct.-Mar.	: Apr.-Sept.
Flushing or Maximum	--	200% of the average flow ^{3/}	
Optimum Range	--	60%-100% of the average flow ^{4/}	
Outstanding	I	40%	60%
Excellent	II	30%	50%
Good	III	20%	40%
Fair or Degrading	IV	10%	30%
Poor or Minimum	--	10%	10%
Severe Degradation	--	10% of average flow to zero flow	

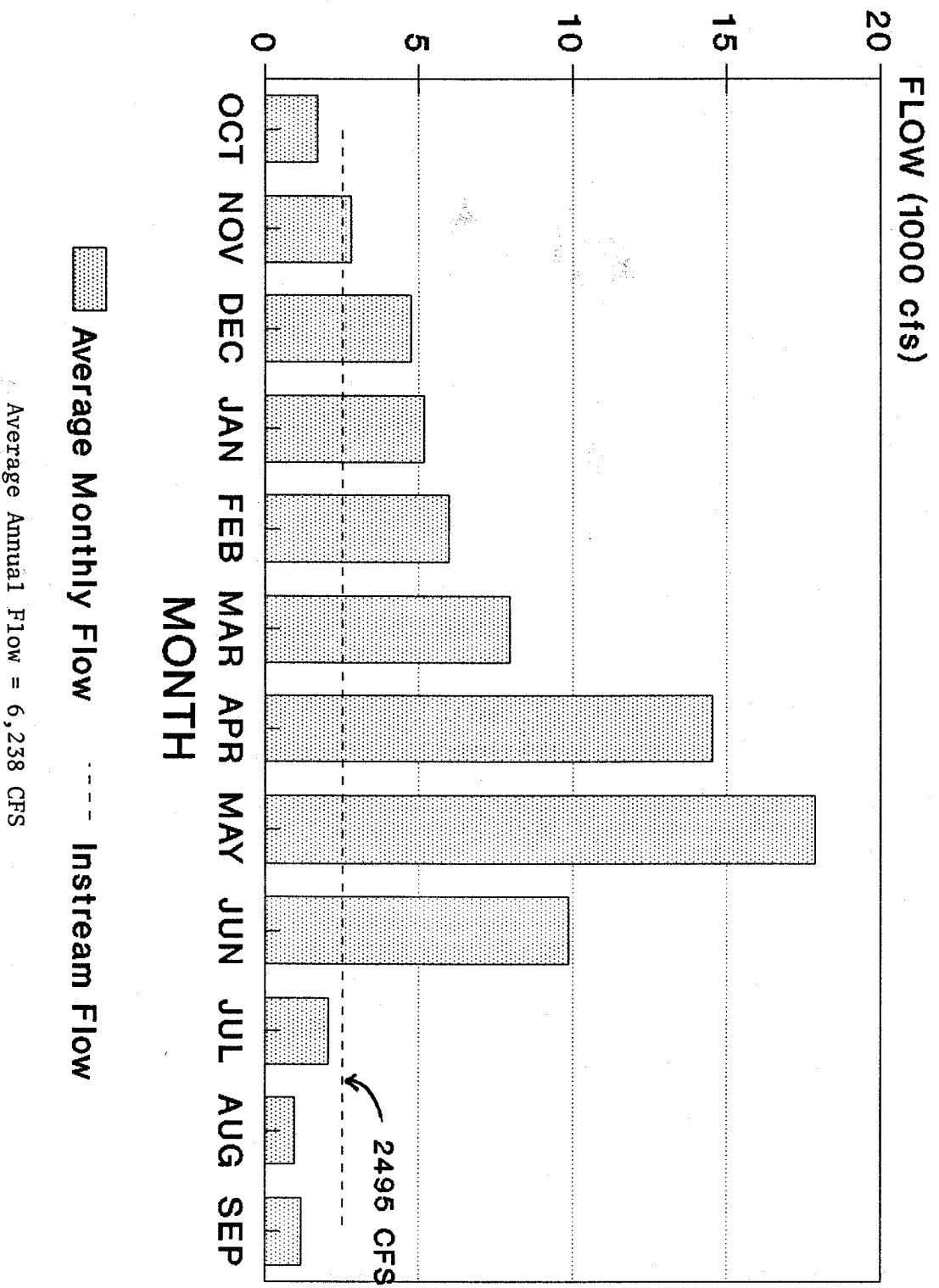
^{1/}Most appropriate description of the general condition of the streamflow for all the parameters listed in the title of this paper.

^{2/}Roman numeral ratings for Fisheries Classification Systems like those developed for the States of Idaho, Montana, West Virginia, Wyoming, and the Delaware River Basin Comprehensive Study by the U.S. Fish and Wildlife Service.^{5, 11, 14, 19, 26} The base flow regimens outlined above in columns 3 and 4 to maintain the respective designated classes, are judged to be as reliable and valid as the classification systems themselves. These recommended flows generally apply very well to both cold and warm water streams. Regimens should be reversed or altered to fit different hydrologic cycles, like the Salmonid streams on the West Coast, or to favor species like the fall spawning brown trout. Flows may be refined further by specifically matching them to vital periods of the life cycle of fishes, like migration, spawning, incubation, growth, etc. Use of the Montana Method on spring creeks or streams that have a very uniform flow year-around may provide unprecedented low-flow regimens at the minimum or base flow levels.

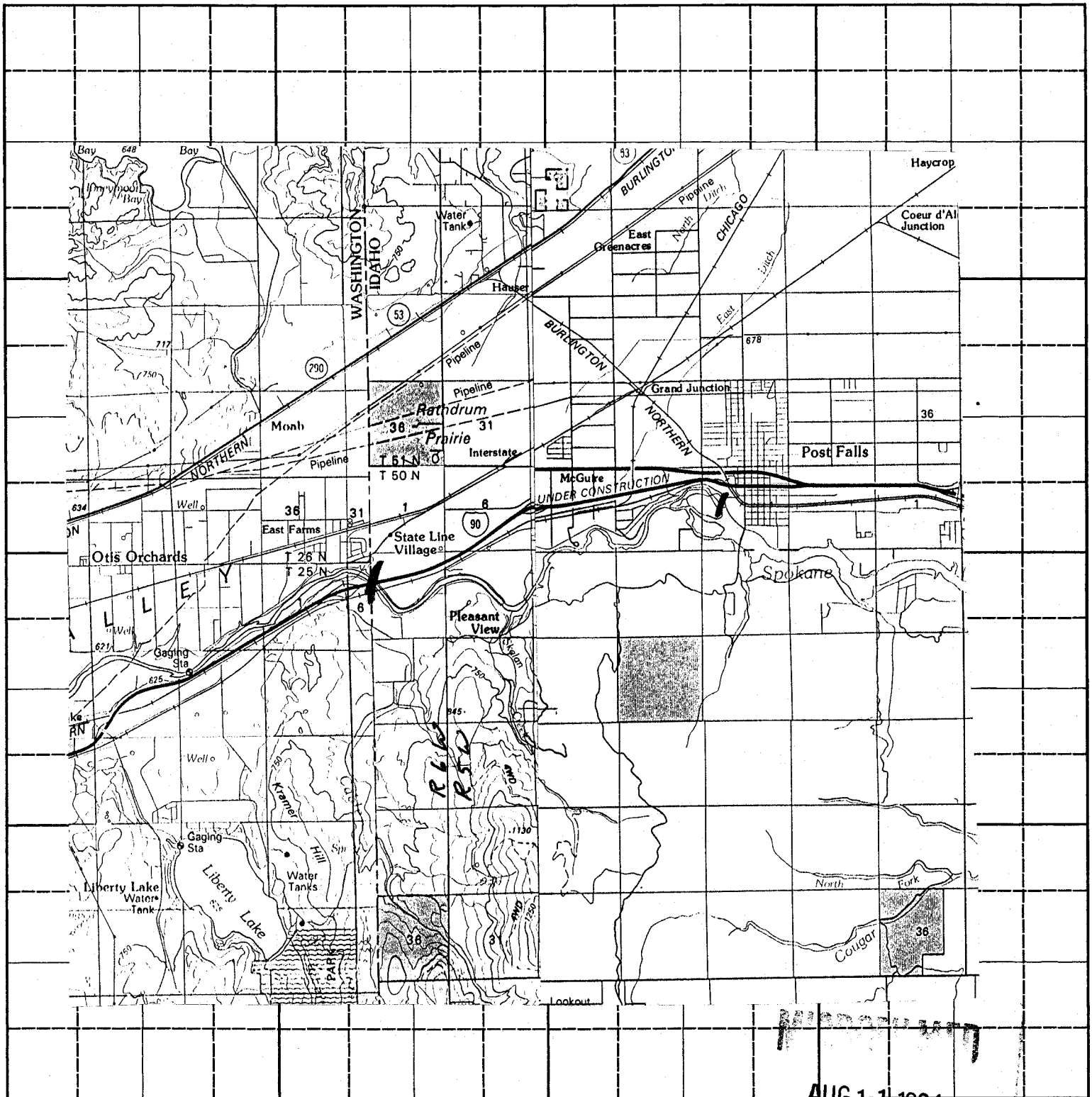
^{3/}The average flow will usually fill the active stream channel approximately 1/3 full or to the line of permanent terrestrial vegetation, while 3 times the average flow will often fill the active channel approximately to the point of spilling out on the first bench of the flood plain.¹⁵ Twice the average flow will produce effective depths and velocities within the stream channel for moving silt, sediment and other bed load material without doing extensive damage to the banks and riparian vegetation. Twice the average flow is a good maximum flow recommendation as well as a good flushing flow (Fig. 1).

^{4/}Optimum is a nebulous term; however, this flow range covers that definition best for all the parameters of this paper collectively.

SPokane River at Post Falls (1912-90)



13. Map of proposed project: show clearly the proposed point of diversion, place of use, section number, township and range number.



Scale: 2 inches equal 1 mile.

AUG 11 1994

BE IT KNOWN that the undersigned hereby makes application for permit to appropriate the public waters of the State of Idaho as herein set forth.

William S. Flatt
(Applicant)

AUG 1 1 1994

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e. Other:

- d. The water right acquired under this permit if for hydropower purposes shall be junior and subordinate to all rights to the use of water, other than hydropower, within the State of Idaho that are initiated later in time than the priority of this permit and shall not give rise to any right or claim against any future rights to the use of water, other than hydropower, within the State of Idaho initiated later in time than the priority of this permit.
- c. The rate of diversion, if water is to be used for irrigation under this permit, when combined with all other water rights for the same land shall not exceed 0.02 cubic feet per second for each acre of land.

_____, 19____

b. Proof of construction of works and application of water to beneficial use shall be submitted on or before

a. SUBJECT TO ALL PRIOR WATER RIGHTS.

1. Approval of said application is subject to the following limitations and conditions:

Idaho No. _____, and said application is hereby _____

This is to certify that I have examined Application for Permit to appropriate the public waters of the State of

ACTION OF THE DIRECTOR, DEPARTMENT OF WATER RESOURCES

Received by DB Date 10-15-92 Time 11:15 A.M.
Fee \$ _____ Received by _____ # _____ Date _____
Publication prepared by _____ Date _____ Published in _____
Publication approved _____ Date _____
Preliminary check by _____

ATTACHMENT TO APPLICATION FOR PERMIT
TO APPROPRIATE A MINIMUM STREAM FLOW

14. Provide evidence that the appropriation will not interfere with any vested water right, permit, or water right application of earlier date of priority.

The appropriation is junior to rights, permits, or applications with earlier dates of priority.

15. Provide evidence to show that the appropriation would be in the public interest as opposed to private interest.

The appropriation will be held by the Water Resource Board rather than a private entity.

The appropriated water will preserve river values for the benefit and enjoyment of all citizens of the state.

16. Provide evidence or justification that the appropriation is necessary for the purposes shown in Item 4.

The appropriation is for 40% of the mean annual flow for the period of November through June.

The request for the rest of the year is for the average monthly flow for August, the lowest month for the period of record. This flow is close to 15% of the mean annual flow. These flows will provide a "good" or better minimum flow for fish and wildlife habitat, aquatic life, and recreational values except for July to October.

17. Provide evidence that the minimum flow or lake level is minimum and not the ideal or most desirable flow or lake level.

The requested flows are based on the Montana Method which utilized field studies to identify riverine conditions at varying flow rates. The optimum flow for fish, wildlife, recreation and related environmental resources ranges from 60% to 100% of the mean flow value.

18. Provide evidence that the flow or lake level requested is capable of being maintained as evidenced by records of stream flows and water levels.

A flow of 2495 cfs is less than the average monthly flow for the requested period of use. The flow of 951 cfs is the lowest average monthly flow of the year for the period of record.

19. Describe the location of existing gaging stations that can be used in the administration of this appropriation.

The Post Falls gage which is one mile downstream from the Post Falls powerplant.

20. Do you intend to install additional gaging stations? Describe the location.

No

21. List any additional remarks related to this minimum stream flow application.

The flow request for July, August, and September provides only a "fair to poor" minimum flow for those months. Following consultation with the Division of Environmental Quality and the Departments of Fish & Game and Parks & Recreation, the Water Resource Board may amend this application to more accurately reflect the necessary minimum flow based on new data provided by the above or other agencies.



State of Idaho

DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720-9000

Phone: (208) 327-7900 FAX: (208) 327-7866

PHILIP E. BATT
GOVERNOR

KARL J. DREHER
DIRECTOR

October 24, 1995

STATE OF IDAHO
IDAHO WATER RESOURCE BOARD
STATEHOUSE
BOISE ID 83720

RE: WATER RIGHT NO. 95-08780

Dear Water Right Holder(s):

Enclosed is a copy of the Water Right License issued on the above referenced permit. If you have any questions, please contact me within 10 days of receipt of this license.

Sincerely,

Shelley W. Keen
Water Rights Supervisor

SK:rl

Enclosure

RECEIVED

NOV 16 1995

RIGHT NO. 95-08780

Printed license hand-edited

**ANALYSIS SHEET
FOR
PROOF OF BENEFICIAL USE**

Permit No. 95-08780

Reviewed by [Signature]

Date 11-15-94

GENERAL CONSIDERATIONS

yes Name same as permit?
yes Address same as permit?
yes Proof timely received?
If not, complete calculation below.

TYPES OF USE

minimum flow

Correct Uses? yes

SOURCE OF WATER

☒ Surface water source

☐ Ground water source

☒ Drilling permit required?
☒ Copy in the file? Drilling Permit No. _____
☒ Amount paid for permit _____ Correct?
☒ Well log in the file?

LICENSE EXAMINATION FEE

no Required?
/ Amount Submitted
/ Correct?

MEASURING DEVICE

/ Required?
/ Installed?
/ Waiver requested?

PRIORITY CALCULATION

Date proof received _____
Date proof due _____
No. of days late _____
Priority Date _____
New Priority Date _____

DEFICIENCIES OR ACTION ITEMS

Proof acceptable

DATA ENTRY

New Address _____

Proof Made 6-6-94

November 16, 1994

STATE OF IDAHO
IDAHO WATER RESOURCE BOARD
STATEHOUSE
BOISE ID 83720

PROOF ACKNOWLEDGMENT LETTER

RE: PERMIT NO. 95-08780

Dear Permit Holder:

The department acknowledges receipt of the proof of beneficial use form submitted for the above referenced permit. The next step in the process of developing a water right is for the department to conduct a field examination to determine and confirm the use being made of the water.

If you have questions concerning this matter, please feel free to contact the NORTHERN Regional Office in Coeur D' Alene at (208) 769-1450.

Sincerely,

JULIE L. YARBROUGH
Senior Secretary

c: IDWR - Region

DEC 14 1994

THE STATE OF IDAHO
SECOND REGULAR SESSION - 1994

A CONCURRENT RESOLUTION

**APPROVING AN APPLICATION TO APPROPRIATE WATER FOR MINIMUM
STREAMFLOW.**

Be It Resolved by the Legislature of the State of Idaho:

WHEREAS, the Idaho Water Resource Board may apply for a permit to appropriate unappropriated waters of a stream to establish a minimum streamflow; and

WHEREAS, under the provisions of Section 42-1503, Idaho Code, an approved application shall not become finally effective until acted upon by the Legislature, except that if the Legislature fails to act prior to the end of the regular session to which the application was submitted, the application shall be considered approved; and

WHEREAS, the Director of the Department of Water Resources approved Application for Permit No. 95-08780 on December 20, 1993, by adopting a Recommended Order authorizing the appropriation of a minimum streamflow in the Spokane River of 2495.0 cfs from November 1 through June 30 and 951.0 cfs from July 1 through October 31. The minimum streamflow commences at a point downstream from Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SW $\frac{1}{4}$ NE $\frac{1}{4}$, Section 4, T50N, R05W, and extends downstream to the Idaho-Washington State line in the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R06W, B.M., Kootenai County.

NOW THEREFORE, BE IT RESOLVED by the members of the Second Regular Session of the 52nd Idaho State Legislature, the House of Representatives and the Senate concurring therein, that the same is hereby approved subject to the conditions and limitations contained in the Recommended Order, dated November 24, 1993, and adopted by the Director of the Department of Water Resources on December 20, 1993.

SEP 12 1994

MINIMUM STREAMFLOW
Fact Sheet

Permit to Appropriate Water No. 95-08780

Source: Spokane River

Applicant: Idaho Water Resource Board

Requesting Agency: None. The Water Resource Board initiated the application.

Date Application Filed: June 15, 1992

Rate of Flow: 2495.0 cfs from November 1 through June 30
951.0 cfs from July 1 through October 31

Place of Use: Spokane River, commencing at a point downstream from Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SW $\frac{1}{4}$ NE $\frac{1}{4}$, Section 4, T50N, R05W, and extending downstream to the Idaho-Washington State line in the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R06W, B.M., Kootenai County.

Purpose: Protection of fish and wildlife habitat, aquatic life and recreational values.

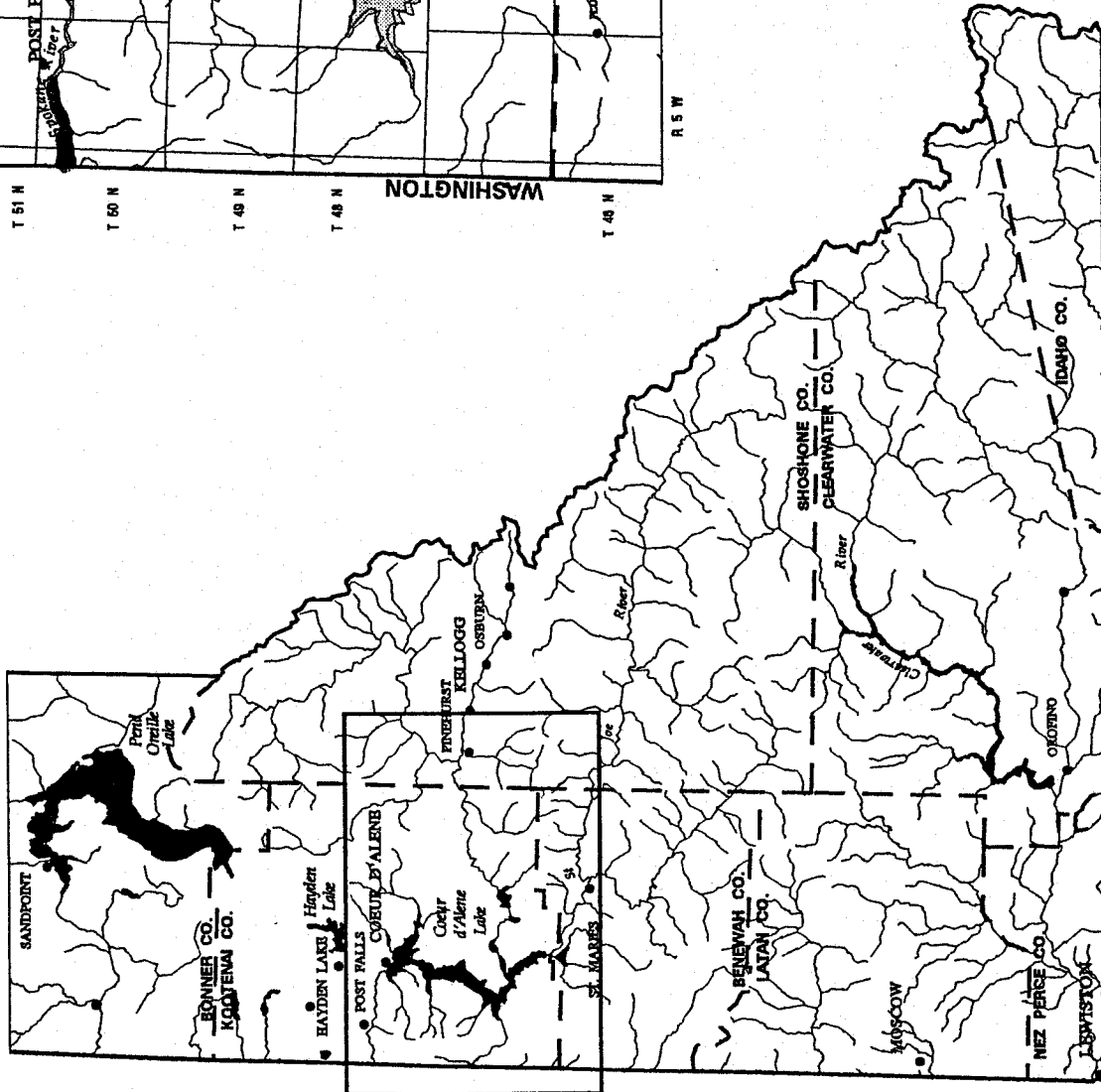
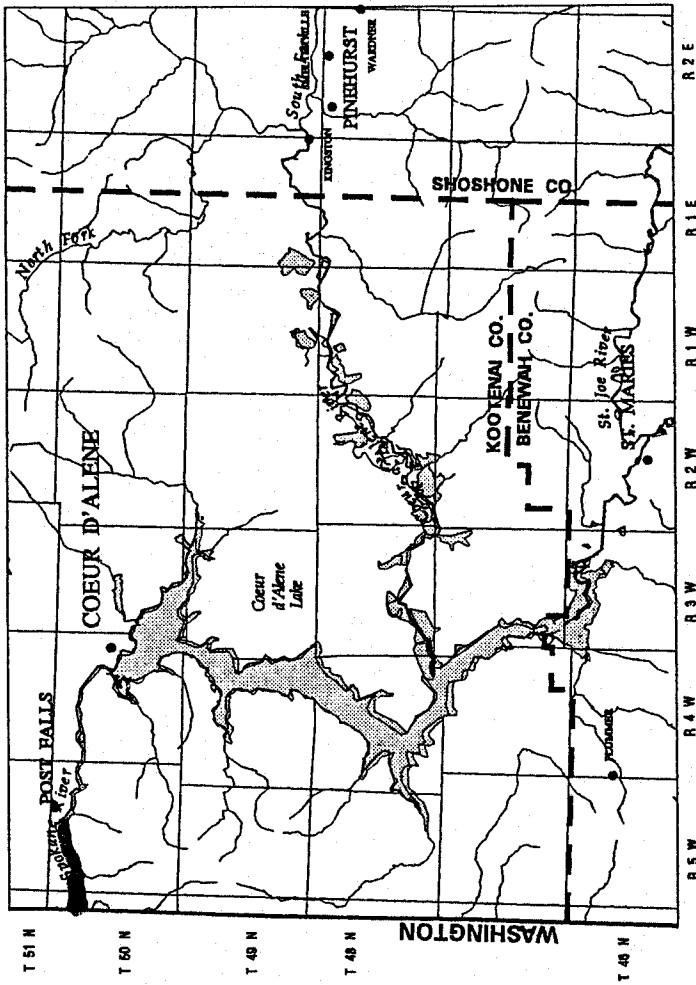
Unique Facts:

- The basis for the rate of instream flow is 40% of mean annual discharge, when available (Tennant method).
- Permit is conditioned to recognize that establishment of an instream flow cannot injure existing water rights. In particular the operation of Post Falls Dam and storage in Coeur d'Alene Lake under existing rights is not to be altered.
- Jurisdiction is retained to amend the permit if the public interest changes.
- The permit is subordinated to future municipal and domestic development.

SEP 12 1994

Spokane River - Minimum Streamflow

Minimum Streamflow Reach



IWRB10

MICRO

IN THE SENATE

SENATE CONCURRENT RESOLUTION NO. 123

BY RESOURCES AND ENVIRONMENT COMMITTEE

1 A CONCURRENT RESOLUTION
2 APPROVING AN APPLICATION TO APPROPRIATE WATER FOR MINIMUM STREAMFLOW.

3 Be It Resolved by the Legislature of the State of Idaho:

4 WHEREAS, the Idaho Water Resource Board may apply for a permit to appro-
5 priate unappropriated waters of a stream to establish a minimum streamflow;
6 and

7 WHEREAS, under the provisions of Section 42-1503, Idaho Code, an approved
8 application shall not become finally effective until acted upon by the Legis-
9 lature, except that if the Legislature fails to act prior to the end of the
10 regular session to which the application was submitted, the application shall
11 be considered approved; and

12 WHEREAS, the Director of the Department of Water Resources approved Appli-
13 cation for Permit No. 95-08780 on December 20, 1993, by adopting a Recommended
14 Order authorizing the appropriation of a minimum streamflow in the Spokane
15 River of 2495.0 cfs from November 1 through June 30 and 951.0 cfs from July 1
16 through October 31. The minimum streamflow commences at a point downstream
17 from Post Falls Dam at which the overflow channels converge with the main
18 channel below the dam in the SW1/4NE1/4, Section 4, T50N, R05W, and extends
19 downstream to the Idaho-Washington State line in the SW1/4NW1/4, Section 12,
20 T50N, R06W, B.M., Kootenai County.

21 NOW, THEREFORE, BE IT RESOLVED by the members of the Second Regular Ses-
22 sion of the Fifty-second Idaho Legislature, the Senate and the House of Repre-
23 sentatives concurring therein, that the same is hereby approved subject to the
24 conditions and limitations contained in the Recommended Order, dated November
25 24, 1993, and adopted by the Director of the Department of Water Resources on
26 December 20, 1993.



State of Idaho

DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720-9000

Phone: (208) 327-7900 FAX: (208) 327-7866

December 20, 1993

CECIL D. ANDRUS
GOVERNOR

R. KEITH HIGGINSON
DIRECTOR

Re: In the matter of application for permit no. 95-08780 filed in the name of the Idaho Water Resource Board to establish a minimum streamflow water right on Spokane River, a tributary of Columbia River

Dear Interested Party:

The accompanying order is an "order adopting recommended order" issued by the department pursuant to section 67-5246 or 67-5247, Idaho Code.

Section 67-5246 provides as follows:

- (1) If the presiding officer is the agency head, the presiding officer shall issue a final order.
- (2) If the presiding officer issued a recommended order, the agency head shall issue a final order following review of that recommended order.
- (3) If the presiding officer issued a preliminary order, that order becomes a final order unless it is reviewed as required in section 67-5245, Idaho Code. If the preliminary order is reviewed, the agency head shall issue a final order.
- (4) Unless otherwise provided by statute or rule, any party may file a petition for reconsideration of any order issued by the agency head within fourteen (14) days of the issuance of that order. The agency head shall issue a written order disposing of the petition. The petition is deemed denied if the agency head does not dispose of it within twenty-one (21) days after the filing of the petition.
- (5) Unless a different date is stated in the final order, the order is effective fourteen (14) days after its issuance if a party has not filed a petition for reconsideration. If a party has filed a petition for reconsideration with the agency head, the final order becomes effective when:
 - (a) the petition for reconsideration is disposed of; or
 - (b) the petition is deemed denied because the agency head did not dispose of the petition within twenty-one (21) days.

SEP 12 1994

(6) A party may not be required to comply with a final order unless the party has been served with or has actual knowledge of the order. If the order is mailed to the last known address of a party, the service is deemed to be sufficient.

(7) A non party shall not be required to comply with a final order unless the agency has made the order available for public inspection or the nonparty has actual knowledge of the order.

(8) The provisions of this section do not preclude an agency from taking immediate action to protect the public interest in accordance with the provisions of section 67-5247, Idaho Code.

PETITION FOR RECONSIDERATION

Any party may file a petition for reconsideration of a final order within fourteen (14) days of service date of this order. The department will act on a petition for reconsideration within twenty-one (21) days of its receipt, or the petition will be considered denied by operation of law. See section 67-5243(4), Idaho Code.

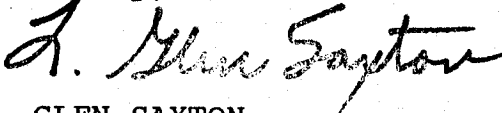
APPEAL OF FINAL ORDER TO DISTRICT COURT

Pursuant to sections 67-5270 and 67-5272, Idaho Code, any party aggrieved by a final order or orders previously issued in a matter before the department may appeal the final order and all previously issued orders in the matter to district court by filing a petition in the district court of the county in which:

- i. A hearing was held,
- ii. The final agency action was taken,
- iii. The party seeking review of the order resides, or
- iv. The real property or personal property that was the subject of the agency action is located.

The appeal must be filed within twenty-eight (28) days a) of the service date of the final order, b) of an order denying petition for reconsideration, or c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration, whichever is later. See section 67-5273, Idaho Code. The filing of an appeal to district court does not in itself stay the effectiveness or enforcement of the order under appeal.

Sincerely,



L. GLEN SAXTON
Chief, Water Allocation Bureau

SEP 12 1994

WR0749NP
No. P95-08780

IDAHO DEPARTMENT OF WATER RESOURCES
WATER RIGHT PROFILE REPORT
(REGIONAL)

DATE: 12/17/93
PAGE: 1

OWNER CODE	NAME & ADDRESS	PRIORITY DATE	WATER USE	USE PERIOD FROM TO	DIVERSION RATE	DIVERSION VOLUME
C	STATE OF IDAHO IDAHO WATER RESOURCE BOARD STATEHOUSE BOISE ID 83720 (208) 327-7910	06/15/1992	MINIMUM INSTREAM FLOW MINIMUM INSTREAM FLOW	11-01 06-30 07-01 10-31	2495.00 CFS 951.00 CFS	
TOTAL DIVERSION:					2495.00 CFS	

Water Source: SPOKANE RIVER

Tributary to: COLUMBIA RIVER

Stage: PERMIT

Point(s) of Beginning Stream Reach: T50N R05W S04 SW NE
Point(s) of Ending Stream Reach: T50N R06W S12 SW NW

Pou County:

Remarks: This minimum streamflow shall be subject to future municipal and domestic development from the Spokane River and its tributaries for the use in the basin within and upstream of the minimum streamflow reach. The minimum streamflow will not be subject to water rights established in the future for irrigation uses or other large consumptive purposes even though covered under a municipal or domestic use definition.

Specifically because of the generalization of the Tennant method, the Director retains jurisdiction, as described below, to review and amend any and all parameters of this permit and subsequent license. The Board, upon receiving a request, or upon its own initiative, may petition the Director for an amendment to the permit or license. The petition must set forth any significant change in circumstances and evidence of the public interest supporting the proposed amendment. The Director will notify the general public and specific persons or known interested parties of the proposed change, and conduct a hearing for the purpose of determining whether the permit or subsequent license should be amended in the public interest. The burden of proof at the hearing shall be upon the persons or parties seeking the amendment to establish that the amendment of the permit or license would be in the public interest.

Use of water under this permit shall recognize and allow the continued beneficial diversion of water under any prior existing water right established by diversion and application to beneficial use or by an application, permit, or license on file or issued by the Director under the provisions of Chapter 2, Title 42, Idaho Code, with a priority of water right date earlier than June 15, 1992, for application No. 95-08780.

Use of water under this water right shall be nonconsumptive. Upon further finding and order of the Director that gauging stations are required to maintain the approved minimum flows on Spokane River, such measuring devices shall be permanently installed and maintained as specified by the Director.

Proof of instream beneficial use of the minimum streamflow may be submitted immediately upon legislative approval of the permit, but shall be submitted no later than March 1, 1999.

IDAHO DEPARTMENT OF WATER RESOURCES
WATER RIGHT PROFILE REPORT
(REGIONAL)

Remarks: Establishment of minimum flows on the Spokane River in the requested reach shall serve to protect water released from Post Falls Dam as it flows through the requested reach at rates up to the established minimum flow, but shall not directly or indirectly cause any change in operation of Post Falls Dam. The reach of the Spokane River for which the requested minimum flows are established is as follows: Spokane River, commencing at a point downstream from the Post Falls Dam at which the overflow channels converge with the main channel below the dam in the SW¹/₄NE¹/₄, Section 4, T50N, R5W and extending downstream to the Idaho-Washington state line in the SW¹/₄NW¹/₄, Section 12, T50N, R6W, B.M., Kootenai County, a reach of approximately five miles. See Final Order for additional conditions of approval.

Dates: App. Received: 06/15/1992 Priority Date: 06/15/1992
Proof Due Date: 03/01/1999 Proof Made Date:
Exam Made Date: Exam Sent to S.O.:
Licensed Date:

Misc: Water District Number: Field Exam Fee:

Audit: 12/17/93 ZIMMERMA



State of Idaho

DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720-9000

Phone: (208) 327-7900 FAX: (208) 327-7866

CECIL D. ANDRUS
GOVERNOR

R. KEITH HIGGINSON
DIRECTOR

November 24, 1993

Re: In the matter of Applications for Permit No. 95-8780 the name
of Idaho Water Resource Board

Dear Interested Party:

The accompanying order is a "recommended order" issued by the department pursuant to Section 67-5243, Idaho Code. The provisions of this order will not become effective until the Director issues a final order in this matter.

Each party to these proceedings who appeared at the hearing may file a petition for reconsideration, briefs and exceptions to the recommended order and may request oral argument before the Director of the department as further described below:

PETITION FOR RECONSIDERATION

Any party may file a petition for reconsideration of a recommended order with the hearing officer issuing the order within fourteen (14) days of the service date of the order. The hearing officer will act on a petition for reconsideration within twenty-one (21) days of its receipt, or the petition will be considered denied by operation of law. See Section 67-5243(3), Idaho Code.

EXCEPTIONS AND BRIEFS

Within twenty-one (21) days after (a) the service date of this recommended order, (b) the service date of a denial of a petition for reconsideration from this recommended order, or (c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration from this recommended order, any party may in writing support or take exceptions to any part of a recommended order and may file briefs in support of the party's position on any issue in the proceeding. Written briefs in support of or taking exceptions to the recommended order shall be filed with the Director. Opposing parties shall have twenty-one (21) days to respond.

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ORAL ARGUMENT

The Director may schedule oral argument in the matter before issuing a final order. Oral argument on exceptions to a recommended order shall be heard at the discretion of the Director. If oral arguments are to be heard, the Director will, within a reasonable time, notify each party of the place, date and hour for the argument of the case. Unless the Director orders otherwise, all oral arguments will be heard in Boise, Idaho.

CERTIFICATE OF SERVICE

All exceptions, briefs, requests for oral argument and any other matters filed with the Director in connection with the recommended order shall be served on all other parties to these proceedings in accordance with Rules of Procedure 302 and 303.

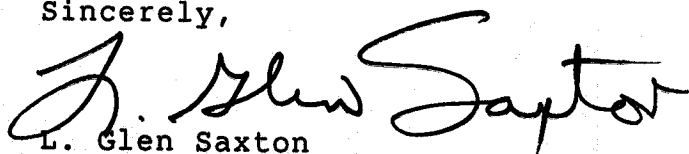
FINAL ORDER

The Director will issue a final order within fifty-six (56) days of receipt of the written briefs, oral argument or response to briefs, whichever is later, unless waived by the parties or for good cause shown. The agency may remand the matter for further evidentiary hearings if further factual development of the record is necessary before issuing a final order. The department will serve a copy of the final order on all parties of record.

APPEAL OF FINAL ORDER TO DISTRICT COURT

A party aggrieved by a final order of the Director is entitled to judicial review in compliance with sections 67-5271 through 67-5279, Idaho Code.

Sincerely,


L. Glen Saxton
Chief, Water Allocation Bureau

Enclosures

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FAX TRANSMITTAL COVER

TO: DEPT. WATER RESOURCES DATE: 11-5-93

LOCATION: BOISE, ID FAX NO. 1-327-7866

ATTENTION: NORMAN YOUNG PHONE NO. _____

FROM: BRANCHE KOLLI FAX NO. _____

LOCATION: CORVALIS, ORE PHONE NO. 503-3852

TIME SENT: 11:55 2 pgs. incl. cover

COMMENTS:

Wanted comments on WATER FLOW LEGISLATION.

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5 Nov 93

To: Dept. of Water Resources

Re: Spokane/ Coeur d'Alene River Minimum Flows

Attn: Norman Young

Dear Sir:

This letter is a follow-up to my comments made at the hearing in Coeur d'Alene. I fully support protecting Idaho waters from out-of-state diversion, but I feel that our primary objective should be to maintain those waters at a level that provides a maximum opportunity for recreational use above the Post Falls Dam on the Spokane River. The stretch of river from the mouth of Lake Coeur d'Alene to the Post Falls Dam is probably the most heavily used water area in North Idaho. There are 527 waterfront parcels on this area of shoreline as of 5-23-93. If only two people from each of these homes swim, boat, or otherwise partake of water activities, 1 hour per day during the summer months, this would equal 1,054 recreational hours per day and 31,620 for each of the months. This is a very conservative number as at our home at least 5 people spend a minimum of 3 hours per day and often there are more people for longer periods of time. This area of the river has been surveyed for boat usage during the past few years and on optimum days the boat traffic count exceeds 700 per day. The heaviest months are July and August with June and September slightly less. May and October show somewhat less traffic. Your minimum flows for May through October could take precedence over recreational and homeowners needs: I feel that this would be totally unjustified. The recreational value of the river above the Post Falls Dam exceeds that of the value below the Dam, many, many times over and should be maintained and preserved as much as is practical, still maintaining flood control and power generation capability.

I urge you to visit the area personally or form a group made up of local people familiar with the unique properties and problems surrounding this particular stretch of the Spokane River.

An added consideration is the fact that at the present time the Hayden Sewer District is allowed to discharge effluent whenever the streamflow exceeds 2,000 C.F.S. It is very important that this effluent discharge is curtailed long before swimming season begins as many areas along the river do not have a good "wash" for minimizing the contamination of sewage effects. We trust that you can write your proposal to protect this water for a clean and healthy environment, especially for the time encompassing the months of May through September.

Sincerely,



Blanche Kohli
6415 Harbor Drive.
Coeur d'Alene, Id. 83814



SEP 12 1994

FAX TRANSMITTAL COVER

TO: NORMAN YOUNG DATE: 11-5-93
DEPT. WATER RESOURCES
LOCATION: Base FAX NO. 1-327-7866
ATTENTION: _____ PHONE NO. _____
FROM: DAVE KOTLI FAX NO. _____
LOCATION: CORNER 2 DUNE PHONE NO. 664-3852
TIME SENT: 10⁴⁵ A. 3 PGS incl. cover.

COMMENTS:

Re: RIVER FLOW

DUE: 11-8-93 TO YOUR OFFICE



SEP 12 1994

**HARBOR ISLAND PROPERTY OWNERS
CO-OPERATIVE ASSOCIATION**

Nov 4, 1993

To: Dept. of Water Resources, State of Idaho
1301 Orchard
Boise, Idaho 83706
Attn: Norman Young

Re: Minimum Flow for Idaho Waterways.

Dear Sir:

I am writing this letter as a follow-up to the recent public hearings held in Coeur d'Alene concerning minimum flows for the Coeur d'Alene and Spokane Rivers. As an officer and board member for the Harbor Island Homeowners Co-operative Association, I have been designated to represent this Association on the above subject.

Harbor Island development consists of approximately 85 riverfront lots and approximately 40 secondary lots, some facing a canal that is dry about 8 months of the year. This Island is located above the Post Falls dam on the Spokane River approximately 5 miles upstream from the dam.

This Island was developed in the early 1960's some 50 years after the Post Falls dam was constructed, well after water levels of the Spokane River had been established. Sea walls, non-floating docks, launch ramps, beaches, etc. have been constructed with the known water levels being the major criteria for locations of the above.

The minimum water flows that your study group have recommended will, if implemented, reduce the level of the Spokane River above the Post Falls Dam by an estimated 2 - 3 feet during summer, recreational time. This will greatly impact the property values and could cause hardship for many of our homeowners, who like myself are retired and counting on our property to sell at waterfront prices to tide us through old age.

I understand that, because the W.W.P Co. is under contractual agreements, the river level above the Post Fall Dam will have to be maintained at present levels. After some discussion with the operating personnel of the Post Falls Dam, I discovered that the levels that are presently being maintained are somewhat flexible and could easily be adjusted downward still allowing W.W.P. to fulfill their contracts and legal obligations. This downward adjustment, conceivably could be made in favor of approaching your minimum flows, especially during the summer months when recreation is at its peak. Because of this possibility, as remote as it may seem at this time, it could happen in future years if these minimum flows as you have outlined are legislated.

I am asking you and your study group change your thinking by rewording the Spokane River waterway minimum flow so that the law could not supercede the Dam operation, even if the W.W.P. ceased to exist.

Another factor, as we discussed at the Coeur d'Alene Hearing, is the fact that the Hayden Sewer district can only dump effluent if the Spokane River is flowing at 2000 C.F.S. or greater. Your stated minimum flows, if maintained for whatever reason, could possibly create a further degradation of the water with additional effluent from their sewage treatment plant.

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In summary, I hope that you realize that this particular stretch of the Spokane river (approx. 10 miles) has some peculiar circumstances that could conceivably cause many more problems than the increased flow might solve. Your consideration of the "Harbor Island Plight" would be much appreciated. We as residents will be watching closely what your decision will be and also how the legislation is written to protect the property owners values and maintain the recreational use along this stretch of waterway.

Sincerely,



David M. Kohli, V. Pres.

Harbor Island Homeowners Co-operative Ass'n

SEP 12 1994

The Final Falter Report
(attachment to letter dated Oct 29, 93) Microfilmed
Here.

GIVENS, FUNKE & WORK

ATTORNEYS AT LAW
TOP FLOOR - OLD CITY HALL
424 SHERMAN AVE. P.O. BOX 969
COEUR D'ALENE, IDAHO 83816-0969
(208) 667-5486
FAX (208) 667-4695

October 27, 1993

Idaho Water Resource Board
F. David Rydalch, Chairman

Re: Minimum Streamflows - Coeur d'Alene and Spokane Rivers

Dear Dave:

Greetings to you, Gene, Clarence, Kenneth, other members of the Board and IDWR staff.

On behalf of the Coeur d'Alene Tribe, please accept the following comments for the record, presented to the Idaho Water Resource Board, Wednesday, October 27, 1993, at the Minimum Streamflow Hearings, held at the Cooperative Extension Service, 106 E. Dalton Ave., Coeur d'Alene, Idaho.

Initially, the Coeur d'Alene Tribe strongly supports the concept and effort to establish minimum streamflows for the protection of fish, wildlife, habitat and ecosystem values. These critical instream, public interest values are too often sacrificed in pursuit of short-term profits for a relative few.

Preserving riverflows in the South Fork of the Coeur d'Alene River is crucial to the concerted effort by the Coeur d'Alene Tribe and others to establish a long-term restoration plan to clean up and restore the Coeur d'Alene Basin. The South Fork of the Coeur d'Alene River contains extremely elevated levels of toxic heavy metal waste due to over one hundred years of mining, dumping, smelting, milling and other related activities in the basin.

Maintenance of riverflows in the South Fork of the Coeur d'Alene River is essential to strategies being developed by the Tribe and other interested parties to restore this basin and hopefully return it to a healthy state.

In the Spokane River from Lake Coeur d'Alene to the Idaho-Washington stateline, a large volume of sewage is being dumped in the river by a group of municipalities. Large scale residential development is occurring along this reach of river contributing additional



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nutrient loading and other water quality problems in the river. Maintenance of adequate flows in this reach of the river is necessary for dilution of pollution.

While the Coeur d'Alene Tribe supports the establishment and protection of flows in both rivers, the Tribe has significant claims to both river reaches which predate all present or future state law rights.

The Tribe claims ownership of the beds, banks, and waters of the South Fork of the Coeur d'Alene and the south half of the Spokane River excluding Post Falls within the 1873 Coeur d'Alene Reservation boundary. Federal District Court Judge Harold Ryan held the Tribe did not own this and other watercourses the Tribe claimed in a decision issued in an Order Granting Motion to dismiss on July 20, 1992, Case No. CV-91-437-HCR (Dist. of Idaho). This decision is now the subject of an appeal before the Federal Court of Appeals for the Ninth Circuit. U. S. Court of Appeals Docket No. 92-36703.

Also within the 1873 Reservation boundary, the Tribe claims an aboriginal water right for hunting, fishing and other purposes pursuant to its aboriginal title to these reserved lands and waters.

In addition, the Tribe claims water in the subject reaches of the South Fork of the Coeur d'Alene River and Spokane River, both on and off the Reservation, sufficient to satisfy the purposes of the establishment of the Coeur d'Alene Indian Reservation pursuant to the Winters doctrine. Winters v. United States, 207 U.S. 564 (1908). The reason or purpose for the Tribe and the United States reserving this portion of the Tribe's aboriginal territory was the establishment of a permanent homeland, including hunting and fishing and the attendant right to flows for these purposes.

In any designation of minimum streamflows in these rivers the State of Idaho should give appropriate notice of these prior claims by the Coeur d'Alene Tribe.



HOWARD FUNKE
Tribal Attorney
Coeur d'Alene Tribe

HF.jf



AUG 11 1994

IDAHO DEPARTMENT OF WATER RESOURCES
Minimum Streamflow Hearing

October 27, 1993

Coeur D'Alene, ID
 Spokane & Coeur d'Alene Rivers
 Evening Meeting

Page 1 of 1

Please Print

Check If
 You Wish To

Name

Address

Representing

Comment

Michael Gagner	5,355 Singer Rd Rathbun 83858	CoA Tribe	
MIKE MIHELICH	626 N 18TH ST	CDA	
Gordon Anderson	6595 Harbor Dr	CDA	
Joyce Monroe	6585 " " "		
Tom Dunnigan	6575 " " "		
David Hunt	934 Elm, CDA, ID.	CNRG/SELF	✓
Tom Elmer	514 20th	CDA	
Craig Cornelius	8170 West View Dr	CDA	✓
Ross McAllister	W7911 Elkview Dr	CDA	SPokane River Assoc + SELF
GARY Stockinger	E1411 Mission Ave	WWP	
X Larry LaBole	E " " "	"	
Fred Ayer	" " "	NDET	
X Howard Finkle	P.O. 969 424 Sherman Ave Coeur d'Alene, ID 83814	Coeur d'Alene Tribe	✓
Ron W. Green	W. 6085 Harbor Dr CDA Id 83814	Harbor Id. Home Owners Assoc.	✓

NOTED

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Exhibits Microfilmed Here.

10/27/93

Spokane River Minimum Flow Hrg CDA

allowed Spokane River Assn as intervenor

② Clarence Parr - used statement
Robert Doomi -

② John Beal -

Cannot affect prior water rights or WWP
operation of the power plant

SW NE Sec 4 T50 R5W - location
of where overflow channels meet - move point
of beginning -

Approx. 5 mile min flow req -
water rights

WWP - 5410.00 cfs (2 rights
(now upstream from reach)

other - 25 rights 9.68 cfs -

IOURB water right before Report Recommendation
IOURB responded by filing

Detailed studies not available - Tennant method.

Low flow period came from average flow for
low flow month (Sept)

2495 - 77% of time Nov - June

<10% of time July - Oct

951 cfs - 70% of time - July Oct -

Some discrepancy between IOURB math request vs

Tenant's time going

Beal explained.

- Admitted IOURB exhibits

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X-Exam - Parr - will this request affect
water uses upstream - ans. only new would be

affected -

Mr. Norcini - X-Exam

- recreational uses -
- studies done above the dam to change ?
- Contact with WWP -
- HAYDEN LAKE'S disposal of effluent ?

PARR -

- Change in operation of WWP dam - No -

(3) Cindy Robertson

F&G supports

Substantial fish & wildlife values

1985-86 WWP study

wild rainbow trout -

- 3 public access
- drift boats

approx 2000 rainbow trout

800 brook trout

1990 - 6200 lbs of fishing in Idaho

65% of fish harvested are rainbow

- Chinook + cutthroat do occur -

April 1 to June 30 - 2495 is a minimum

- 6000 lb is recommended for year

X-Exam -

Recreational use? fishing!

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*Mitch Silver - Parks + Rec.

- IDPR supports -
- Recreation + aesthetics
- Boating -

Most of boating is rafts or drift boats -
No specific studies -

Bob Nonini - Spokane River Assn.

184 homeowners -

want to be sure that when WWP
draw gets in early June that the level is
kept up until fall -

Wants to be sure that Hayden Water + sewer
district - 750,000 gpd allowed into river when flowing ²⁰⁰⁰ ^{ft}
^{at least 5 ft} ^{+ above}

Would like DEQ total flow study completed
first -

Recreation occurs above reservoir more than
below -

Keeps water in Idaho by keeping in reservoir.

Property taxes have gone up 18% per year.

Can't use docks when dropped - after labor day

Blanche Kohli -

Concern for effect on homeowners on river above
dam - 900 ft cannot be maintained during summer
months without dropping reservoir ~~recreation~~
recreation -

Concern this could cause WWP to use

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their latitude to provide min flow
instead of keeping the level up - affect their
discretion -

Do not want Hayden to dump more sewage
in & longer - would not want it during
the summer month -

Boaters care never even below 2128

Concern for property values if water
level dropped - as much as \$100K -

John Patrouche =

Kayaker - downstream users -

- Class II -

Scott Reed - P.O. Box 80 -

Mary Lou Reed - total support -

Water Board member - 12 years

Water Right Defense League -

Recreation rights in north Idaho to
protect water from out of state uses -
supports Board action to protect
Spokane River is most vulnerable to out of state
diversion - convenient & large amount

Personally recreates -

fished, canoed, walked along

Must maintain water level for homeowners -
Not speaking for city of Hayden - but important
to maintain water quality - keep water level
high

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Post Falls + CDA are dumping even more effluent - must keep levels up.

Offered exhibit on Spokane River WQ 90-91
Felt's Report - draft - wants to submit draft of report - copies will be sent to all parties.

X-Exam - Parr

Would this require WWP to adjust release?

In broad generality > not unless they voluntarily do so. -

Sandy Emerson -

Concern about water level -

Comptroller that cannot change system level
Wants water flow protected & enhanced if possible.

Prime area for fly fishing.

Access is not well signed - can get

canoe in. Good evening area close
to town -

Serene but not wilderness.

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Kootenai Environmental Alliance

P.O. Box 1515 Coeur d'Alene, ID 83814-1515

Idaho Department of Water Resources
Cooperative Extension Office
106 E. Dalton Ave.
Coeur d'Alene, ID. 83814

Coeur d'Alene, ID.
October 27, 1993

RE: Minimum Streamflow
for Spokane River No.
95-08780

Att: Gary Spackman:

Dear Sir:

Please be advised that Kootenai Environmental Alliance, PO Box 1515, Coeur d'Alene, Id. 83816, wishes to go on record as supporting the application of the Idaho Water Resource Board for minimum streamflow on a portion of the Spokane River as identified above. It is time the need be recognized to provide some protection of fish and wildlife habitat, aquatic life and recreational values in our rivers.

Sincerely yours,

KOOTENAI ENVIRONMENTAL ALLIANCE


Art Manley, President

MAILED
AUG 11 1994



State of Idaho

DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720-9000

Phone: (208) 327-7900 FAX: (208) 327-7866

CECIL D. ANDRUS
GOVERNOR

R. KEITH HIGGINSON
DIRECTOR

MEMORANDUM

To: Norman C. Young

From: R. Keith Higginson *R. Keith Higginson*

RE: APPOINTMENT AS HEARING OFFICER - PROCEDURE RULE 410

Date: October 20, 1993

I, R. Keith Higginson, Director of the Idaho Department of Water Resources (department) hereby appoint **NORMAN C. YOUNG** in compliance with department Procedure Rule 410 to act as Hearing Officer on behalf of the department in the following contested matter:

In the Matter of Application for Permit Nos. 94-07341 and 95-08780 for minimum streamflows on the Coeur d'Alene and Spokane Rivers, respectively, both applications having been filed in the name of the Idaho Water Resource Board

The department has scheduled a hearing in the matter as follows:

Date: October 27, 1993

Time: 9:30 a.m. and 2:00 p.m.

Place: Cooperative Extension Service Bldg, Coeur d'Alene, Idaho

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CITY OF COEUR D'ALENE

WASTEWATER DIVISION

CITY HALL - 710 MULLAN AVENUE
COEUR D'ALENE, IDAHO 83814
208/769-2281
FAX 208/769-2338

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OCT 20 1993

October 18, 1993

Department of Water Resources

Mr. Gary Spackman
Idaho Dept. of Water Resources
1301 North Orchard
Boise, ID 83706

Dear Mr. Spackman:

The City of Coeur d'Alene would like to go on record as endorsing minimum streamflows in the Spokane River.

The Idaho Division of Environmental Quality has identified times that a dissolved oxygen sag occurs behind the Post Falls dam. At periods of extreme low flow (less than 500 cfs) and high water temperature (greater than 20° C), the dissolved oxygen level can fall below the state's water quality standard of 6.0 milligrams per liter.

The City is mandated to remove 85% of the phosphorus from the effluent at its wastewater treatment facility. This is to comply with the bi-state *Total Maximum Daily Limit* (TMDL) of 259 kilograms per day for Lake Spokane. This TMDL is based on an in-lake concentration maximum of 25 micrograms per liter.

Obviously, higher streamflows means a lower concentration of nutrients, a better flush cycle of Lake Spokane, and a higher dissolved oxygen content behind the dam. As a permitted discharger to the Spokane River, extremely low streamflows could require the city to expend capital costs for additional advanced treatment processes.

We hope that you will consider these points in your decision. Feel free to contact me if I can be of further assistance.

Sincerely,

H. Sid Fredrickson
Wastewater Superintendent

cc: Rodger Wm. Lewerenz, P.E., Public Works Director
Don Keil, Assistant Wastewater Superintendent

a:hsf.181

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AUG 11 1994

RECEIVED

OCT 14 1993

Department of Water Resources

Gary Spackman
Idaho Department of Water Resources
1301 N. Orchard
Boise, ID 83701

October 11, 1993

Dear Mr. Spackman:

As an avid flyfisher and sometimes rafter I am eager to see the issue of minimum streamflows addressed. I appreciate the opportunity to comment; I will confine my comments to rivers which I am knowledgeable. I have lived in Idaho for twenty years. I have been a fly tying and fly fishing instructor at North Idaho College for twelve years and I have been a fly fishing guide in Idaho for two years.

In relation to the **Coeur d' Alene River** I support your minimum streamflow requests of 1018 cfs from November 1 to June 30 and 413 cfs from July 1 to October 31. I believe that this will maintain the integrity of the river for both fish habitat needs and recreational uses.

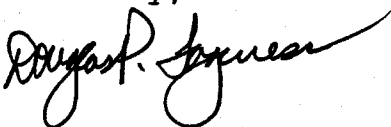
In relation to the **Spokane River** I support the minimum streamflow request of 2495 cfs from November 1 to June 30 and 951 cfs from July 1 to October 31. This will be particularly beneficial to main stem spawning rainbows which are the predominate fish species in this section. Some years early drops in water level have left eggs high and dry. Additionally, the minimum flows in the summer should help reduce the stress the fish experience due to increased water temperature and reduced water oxygen content due to high temperature and slower flows.

In reference to the **Moyie River** I request that you amend your request of 354 cfs from April 1 to July 31 to a flow of 900 cfs from April 15 to June 30. Your flow request of 149 cfs from August 1 through March 31 is acceptable. The amended request will protect the fabulous whitewater recreational use, and will provide for spawning rainbows, particularly the stream born fish in the canyon section which seem to be making a comeback.

In reference to the **Kootenai River** I support your request for 5340 cfs year round to provide the minimum needed for fish and wildlife values. I am particularly concerned that we be as proactive as is still possible to prevent the need for the sturgeon to become a listed species.

Again, thank you for this opportunity to comment.

Sincerely,



Douglas P. Fagerness
2608 N. 10th Place
Coeur d'Alene, Idaho 83814



AUG 11 1994

RECEIVED

OCT 18 1993

Department of Water Resources

Ron Grant
PO Box 75
Cottonwood ID 83522

October 14, 1993

Mr. Gary Spackman
Idaho Dept. of Water Resources
1301 N. Orchard
Boise ID 83706

Mr. Spackman:

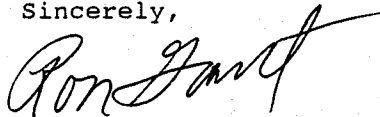
I understand that your agency is conducting public hearings for minimum instream flows on the Pack, Kootenai, Moyie, Coeur d'Alene and Spokane Rivers. Since I will not be able to attend any of these hearings, I would like to say the following:

Please do not compromise the integrity of these streams for any reason.

Please choose minimum streamflows that are consistently adequate for the safety, life, and health of the fish and wildlife connected with these rivers.

Please choose minimum streamflows that will consistently support recreational use, water quality, and aesthetics.

Sincerely,



Ron Grant

AUG 11 1994

RECEIVED

OCT 18 1993

Department of Water Resources

Kristin Frish
RR3 Box 181
Cottonwood ID 83522

October 14, 1993

Mr. Gary Spackman
Idaho Dept. of Water Resources
1301 N. Orchard
Boise ID 83706

Mr. Spackman:

It is my understanding that your agency is conducting public hearings for minimum instream flows on the Pack, Kootenai, Moyie, Coeur d'Alene and Spokane Rivers. I will not be able to attend any of these hearings in person. Therefore, I would make the following requests:

I ask that you do not compromise the integrity of these streams for any reason.

I ask that you choose minimum streamflows that are consistently adequate for the safety, life, and health of the fish and wildlife connected with these rivers.

I ask that you choose minimum streamflows that will consistently support recreational use, water quality, and aesthetics.

In my opinion, it would demonstrate clear evidence of a lack of ethics if you allow nature's balance in these ecosystems to be destroyed.

For our rivers,



Kristin Frish

NOV 11 1993



PO BOX 633, BOISE, ID 83701
(208) 343-7481

EXECUTIVE DIRECTOR

Wendy L. Wilson
Boise

BOARD OF DIRECTORS

Gail Ater
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Idaho Falls

Whale Szczepanowski
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Curtis Webb
Twin Falls

September 27, 1993

RECEIVED

SEP 28 1993

Department of Water Resources

Mr. Gary Spackman
Idaho Dept. of Water Resources
1301 N. Orchard
Boise, ID 83706

Dear Mr. Spackman:

Idaho Rivers United wishes to submit the following comments relative to five applications for minimum streamflows in northern Idaho and one minimum lake level application for Bear Lake.

Pack River No. 96-08717 - We support the requested minimum of 129 cfs from November 1 but only until April 15. We recommend the IWRB and IDWR adopt a higher minimum flow of 350 cfs from April 15 to June 30 for recreational whitewater boating. The purpose of the higher minimum is to protect the river for recreational purposes.* We support the request of 129 cfs from July 1 to July 31, and a flow request of 54 cfs from August 1 through October 31. Those flows will provide the minimum needed for fish and wildlife values.

Kootenai River No. 98-07705 - Idaho Rivers United supports the request for 5340 cfs year round to provide the minimum needed for fish and wildlife values, with the following change: From May 15 to July 15 the IWRB and IDWR should adopt a minimum flow of 10,000 cfs to provide the minimum flow for recreational whitewater boating.*

Moyie River No. 98-07704 - We recommend that the IWRB and IDWR amend their request of 354 cfs from April 1 to July 31 to a flow of 900 cfs from April 15 to June 30 to provide the minimum streamflow needed to protect recreational whitewater boating. This flow request is based on information provided by Peter Grubb, River Odysseys West, on the segment from Cooper Creek to Meadow Creek immediately upstream from the segment under consideration. I also have personal experience floating both of these sections as a commercial river guide and private boater and believe the charts Peter Grubb developed accurately reflect the minimum flow needed.* I have enclosed copies of data Peter Grubb provided me on the Moyie. The flow request of 149 cfs from August 1 through March 31 is acceptable.

Coeur d'Alene River No. 98-07705 - I note that the water right number recorded for the Coeur d'Alene and the Kootenai River are the same. I am certain this must be a typographical error by the Department. According to my records, the correct number is 94-07341. We support the minimum streamflow requests of 1018 cfs from November 1 to June 30 and 413 cfs from July 1 to October 31 to protect fish and wildlife values, recreation and aesthetics. I am unable to substantiate the needed minimum for a recreational flow. However, should data or relevant information become available, we will petition the Department and the Board for a higher flow to protect recreational whitewater boating.

Spokane River No. 95-08780 - We support the minimum flow requests of 2495 cfs from November 1 to June 30 and 951 cfs from July 1 to October 31 to protect fish and wildlife values, recreation and aesthetics. We are unable to substantiate the necessary minimum for recreational whitewater boating at this time. If additional information becomes available we will petition the Department and the Board for a higher minimum to protect that use.

AUG 11 1994

*Amended requests are based on information obtained from "Idaho Whitewater, the complete river guide," by Don McClaran and Greg Moore, 1989, and personal knowledge of the affected stream segments.

Idaho Rivers United also supports the minimum lake level request for Bear Lake. We believe this will aid in protecting the integrity of the lake, its water quality, fishery and recreation.

Many of our members use and enjoy the waters of these stream segments for fishing, whitewater recreation, viewing or to merely see a river in its free flowing state. Historically, southern Idaho rivers have been dammed, diverted, and dewatered for irrigation, mining, hydropower and industrial uses. Our fish are dying, our streams are dry, and our water quality is abysmal in the Snake River basin in many places. Hydropower projects have marred the landscape and visually impaired many of our scenic wonders like Shoshone Falls and Twin Falls.

Some opponents of minimum streamflows will attempt to convince the department that these flows will impede their economic development. I'd like to remind the Department that the fish were here first, as were the Native Americans. It is imperative that minimum streamflows are adopted on all streams in the state. This is an opportunity to prevent the decimation of north Idaho streams, unlike what has occurred in much of southern Idaho. Maintaining the integrity of the riverine ecosystem is of utmost importance! We support the efforts of the Board to protect Idaho's river resources.

Sincerely,

Marti L. Bridges

Marti L. Bridges
Water Policy Director

AUG 11 1994

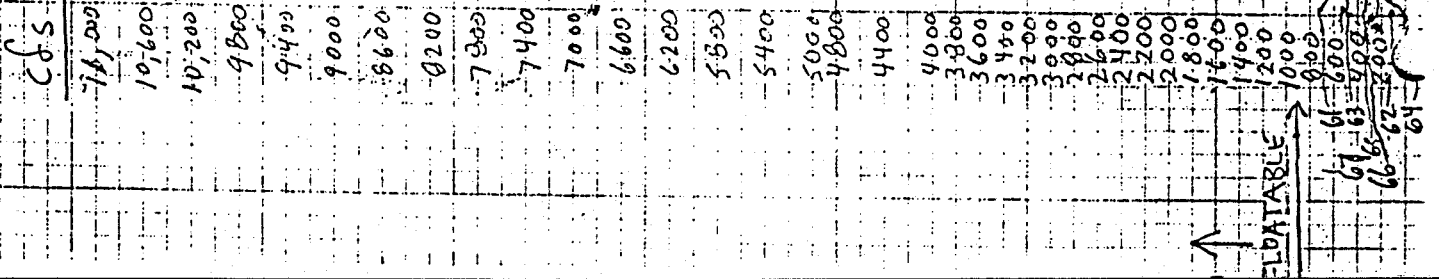
By Peter Grubb ©
River Odysseys West

Moyie River Flows

1961-1967

Probable cut-off level for floating

NOV 11 1994



MOYIE WATER FLOW INFORMATION

Power plant reading seems to be generally 3/10ths of a foot lower than yellow gauge stick on Bonners Ferry Municipal Dam. So, if yellow gauge reads 2.3, power plant should tell you 2'. Based on this, if you call power plant and they say river is at 1.7, then it should be runnable. We do know that it is runnable when power plant reading is 2' and gauge reading is 2.25. *(However, on 5/25/92, 9:00 am N. Mertz saw gauge water level was just covering black line marked 2 ft, and the Powerplant told me 2.1)*

<u>Power Plant Gauge Reading</u>	<u>CFS</u>
1'	309
1½'	576
2'	899
2½'	1265
3'	1680
3½'	2150
4'	2653
4½'	3198
5'	3781
5½'	4393
6'	5023
6½'	5701
7'	6413
7½'	7119
8'	7852
8½'	

In 1992, we ran it at 2.2 - pretty bony - rocks on river left immed. after Hole in the Wall are easy to get stuck on when boat full of water

From past experience we know that an unrunnable water level is around 7'. No trips should be attempted above 6' without prior scouting. If logs are frequent in river, cancel trip. Danger lies in lack of eddies and possible log jam at the old Eileen Dam.

Prepared by Peter Grubb

11 1994

NOTICE OF HEARING FOR THE COEUR D'ALENE RIVER MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Coeur d'Alene River, a tributary of Coeur d'Alene Lake. The application is further described as follows:

Source: Coeur d'Alene River

Application No.: 94-07341

Proposed Priority: September 13, 1993

Amount and Period of Use: 1018.0 cfs from November 1 through June 30. 413.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Coeur d'Alene River, commencing at the confluence with the South Fork of the Coeur d'Alene River, located in the NE 1/4 NW 1/4, Section 31, T49N, R2E, Shoshone County and extending downstream to the mouth of the Coeur d'Alene River in lots 3 and 4 (SW 1/4 NW 1/4), Section 36, T48N, R4W, B.M., Kootenai County. The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 9:30 a.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director

Idaho Department of Water Resources.

NOTICE IS HEREBY GIVEN that the undersigned has been appointed personal representative of the estate of Carol M. Ainsworth, deceased, in and for the County of Blaine, State of Idaho. The undersigned is the daughter of the deceased and is the sole surviving issue of the deceased. The undersigned is the daughter of the deceased and is the sole surviving issue of the deceased. The undersigned is the daughter of the deceased and is the sole surviving issue of the deceased.

Publication

TO
TWIN FALLS } SS.

RECEIVED

OCT 22 1993

No 25242

Capps McBurn being first duly sworn upon oath, depose David Clark of the TIMES-NEWS, published daily, at Twin Falls, and do solemnly swear that a copy of the notice of advertisement, as per hereof, for Two consecutive Publications, the issue dated September 16, 1993, the issue dated September 23, 1993.

I certify that said newspaper is a consolidation, effective February 16, 1942, of the Idaho Times-News, published theretofore daily except Sunday, and the Twin Falls News, published theretofore daily except Sunday, which newspapers prior to consolidation had been published under said names in said city and county and uninterruptedly during a period of more than twelve consecutive months, and said TIMES-NEWS, consolidation, has been published as a daily newspaper except Saturday, until July 31, 1978, at which time said newspaper began daily publication under said name in said city and county continuously and

I certify that pursuant to Section 60-108 Idaho Code, Thursday of each week has been designated as the day on which legal notice by law or by order of any court of competent jurisdiction within the state of Idaho, shall be published; and that at the head of the editorial column of said combined newspapers, the day on which said legal notices will be published.

TWIN FALLS

14 day of October in the year of 1993, before me, Linda Capps McBurn personally appeared Linda Capps McBurn to me to be the person whose name subscribed to the within instrument, and being by me first examined, he acknowledged to me that he executed the same.

Shirley R. Feltman
Notary Public for Idaho
Residing at Twin Falls
My commission expires: 5/19/94

RECEIVED

AUG 11 1994

TRIBUNE PUBLISHING COMPANY, INC.
The Lewiston Morning Tribune
505 C St., P.O. Box 957
Lewiston, Idaho 83501
(208) 743-9411

Date 091693 INVOICE No. L00531708
Account No. 954750 95-08780
Description 81708NOTIC
Times 1 Lines 41
Tab Lines _____

**LEGAL ADVERTISING
INVOICE**

SOLD TO:

ID DEPT. OF WATER RESOURC
1910 NORTHWEST BLVD. 210
COEUR D'ALENE
ID

\$ 61.50

RECEIVED

SEP 21 1993

NORTHERN REGION
IDWR

NOTICE: This is an invoice of Purchase made by you. Statement will be rendered the first of the month.
Please Retain This Invoice as Your Statement Will Refer To Invoice by No. Only.

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, ss.
County of Nez Perce

81708
**NOTICE OF HEARING FOR THE SPOKANE RIVER
MINIMUM STREAMFLOW**

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River. The application is further described as follows:

Source: Spokane River
Application No.: 95-08780
Proposed Priority: June 15, 1992
Amount and Period of Use: 2495.0 cfs from November 1 through June 30, 951.0 cfs from July through October 31.
Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values
Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW $\frac{1}{4}$ NW $\frac{1}{4}$ and SE $\frac{1}{4}$ SW $\frac{1}{4}$, Section 2, T50N, R5W, and extending downstream to the Idaho-Washington State line to the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R6W, B.M. Kootenai County

The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho beginning at 2:00 p.m., on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive public testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director at the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
IDAHO DEPT OF WATER RESOURCES

Karen J. Lewis, being duly sworn,

deposes and says, I am the Legal Clerk of the Tribune Publishing Company, a corporation organized and existing under and by virtue of the laws of the State of Idaho, publishers of the LEWISTON MORNING TRIBUNE, a newspaper of general circulation published at Lewiston, Nez Perce County, Idaho; That the said Lewiston Morning Tribune is an established paper and has been published regularly and issued regularly at least once a day for more than 21 consecutive years next immediately preceding the first publication of this notice, and as been so published uninterrupted for said period; that the

NOTICE OF HEARING ON THE

attached hereto and which is made a part of this affidavit was published in the said Lewiston Morning Tribune, 1 time(s). Publication began on 091693, or once a

WEEK for 1 consecutive WEEKS, the first publication thereof being on the 091693, and the last publication thereof being on the 091693, and said

NOTICE OF HEARING ON THE

as so published in the regular and entire issue of said newspaper and not in a supplement thereof and was so published in every issue and number of the said paper, during the period and times of publication as set forth above.

Karen J. Lewis

SUBSCRIBED AND SWORN BEFORE ME THIS THE 17

Day of September

1993

AUG 11 1994

Notary Public in and for the State of Idaho,
residing at Lewiston, therein.

TRIBUNE PUBLISHING COMPANY, INC.
The Lewiston Morning Tribune
505 C St., P.O. Box 957
Lewiston, Idaho 83501
(208) 743-9411

Date 091693 INVOICE No. L00351708
Account No. 964750 95-08780
Description 81708NOTIC
Times 1 Lines 41
Tab Lines _____

**LEGAL ADVERTISING
INVOICE**

SOLD TO:

ID DEPT. OF WATER RESOURC
1910 NORTHWEST BLVD. 210
COEUR D'ALE
ID 83501

\$ 61.50

RECEIVED

SEP 21 1993

NORTHERN REGION
IDWR

NOTICE: This is an invoice of Purchase made by you. Statement will be rendered the first of the month.
Please Retain This Invoice as Your Statement Will Refer To Invoice by No. Only.

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, ss.
County of Nez Perce

Karen J. Lewis, being duly sworn,

deposes and says, I am the Legal Clerk
of the Tribune Publishing Company, a corporation organized and existing
under and by virtue of the laws of the State of Idaho, publishers of the
LEWISTON MORNING TRIBUNE, a newspaper of general circulation
published at Lewiston, Nez Perce County, Idaho; That the said Lewiston
Morning Tribune is an established paper and has been published regular-
ly and issued regularly at least once a day for more than 21 consecutive
years next immediately preceding the first publication of this notice, and
has been so published uninterrupted for said period; that the

NOTICE OF HEARING ON THE

attached hereto and which is made a part of this affidavit was published in
the said Lewiston Morning Tribune, 1 time(s). Publication be-
ing on 091693

or once a
WEEK for 1 consecutive WEEKS, the first
publication thereof being on the 091693, and the last pub-
lication thereof being on the 091693, and said

NOTICE OF HEARING ON THE

was so published in the regular and entire issue of said newspaper and
not in a supplement thereof and was so published in every issue and
number of the said paper, during the period and times of publication as
set forth above.

Karen J. Lewis

SUBSCRIBED AND SWORN BEFORE ME THIS THE 17

day of September 1993

[Signature]
Notary Public in and for the State of Idaho,
residing at Lewiston, therein.

AUG 11 1994

**NOTICE OF HEARING FOR THE SPOKANE RI,
MINIMUM STREAMFLOW**

Notice is hereby given that the Idaho Water Resource Board
application for permit to appropriate water to the Depart-
Resources, proposing to appropriate water for a minimum stream
Spokane River. The application is further described as follows

Source: Spokane River
Application No.: 95-08780
Proposed Priority: June 15, 1992
Amount and Period of Use: 2495.0 cfs from
through June 30, 1992
July through October 1992

Purpose of Minimum Flow: Protection of fish and
aquatic life and
values

Place of Use: Spokane River, co)
Post Falls Dam, loca
SW1/4NW1/4 and SE1/4
T50N, R5W, and ex
stream to the Idaho
State line to the SV
tion 12, T50N, R5W, 3
County

The Department of Water Resources will hold a public hearing
Cooperative Extension Service, 106 East Dalton Avenue, 83501, 603
Idaho beginning at 2:00 p.m., on Wednesday, October 27, 1992.
pose of hearing evidence pertaining to the application. The he-
held pursuant to the provisions of Section 42-1503, Idaho Code.
the hearing officer will also receive public testimony into the
p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for
of presenting evidence or cross examining witnesses should file
appearance with the Director at the Department of Water Res-
house Mail, 1301 North Orchard Street, Boise, Idaho 83706, five
to the hearing. Other parties may informally present their vi-
ments without filing a notice of appearance. Written inform-
comments may also be submitted to the Department of Water
prior to the hearing.

If issued, this permit will be subject to all prior water rights.
R. Keith Higgins
IDAHO DEPT OF WATER R



State of Idaho

DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720-9000

Phone: (208) 327-7900 FAX: (208) 327-7866

CECIL D. ANDRUS
GOVERNOR

R. KEITH HIGGINSON
DIRECTOR

September 20, 1993

RE: Minimum Streamflow Application for Spokane River No. 95-08780

Dear Interested Party:

The Idaho Department of Water Resources will conduct a hearing on Wednesday, October 27, 1993, to determine whether a minimum streamflow for the Spokane River should be approved. The hearing will commence at the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2:00 p.m. The hearing will recess at the close of formal testimony, but will reconvene at 7:00 p.m. for the taking of public testimony.

The hearing will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in, or understand the hearing, please advise the Department.

The enclosed fact sheet describes the application. Also enclosed is a brochure which describes the minimum flow procedures.

A notice of appearance must be filed with the Department at least five (5) days prior to the hearing if you want to become full party to the action. A full party may call and cross examine witnesses.

If you do not wish to become a full party, you may testify informally without filing a notice of appearance. Written comments may also be filed with the Department prior to the hearing.

Sincerely,

Gary Spackman
Gary Spackman

Enclosures

AUG 11 1994

**MINIMUM STREAMFLOW
Fact Sheet**

Water Right No. 98-07705

Source: Coeur d'Alene River

Applicant: Idaho Water Resource Board

Date Filed: September 13, 1993

Rate of Flow: 1018.0 cfs from November 1 through June 30.
413.0 cfs from July 1 through October 31.

Place of Use: Coeur d'Alene River, commencing at the confluence with the South Fork of the Coeur d'Alene River, located in the NE $\frac{1}{4}$ NW $\frac{1}{4}$, Section 31, T49N, R2E, Shoshone County and extending downstream to the mouth of the Coeur d'Alene River in lots 3 and 4 (SW $\frac{1}{4}$ NW $\frac{1}{4}$), Section 36, T48N, R4W, B.M., Kootenai County.

Purpose: Protection of fish and wildlife habitat, aquatic life and recreational values.

Hearing Location
and Time:

Wednesday, October 27, 1993, Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 9:30 a.m. General testimony may also be submitted at an evening meeting scheduled for 7:00 p.m. at the same location.

RECEIVED
AUG 11 1994

NOTICE



The Idaho Department of Water
Resources will hold a
Minimum Stream Flow Public
Hearing for the Spokane River
at 2:00 p.m. October 27, 1993 at the
Cooperative Extension Service, 106 East
Dalton Ave., Coeur d'Alene.

All interested parties are
invited to attend.

AUG 11 1994

For more information, please contact the Department of Water Resources, 1920 Northwest Blvd., 769-1450.

Advertised in statewide papers and in the county papers where the streams are located.

9/15 & 22/1993

and/or

9/16 & 23/1993

Pat 9/8/1993

Handwritten notes:
Hemlock Press ✓
Gov. Gib ✓
Ad. Freeman ✓
Times News ✓
Port Register ✓

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AUG 11 1994

Kenneth E Hungerford

2005 Orchard Ave
Moscow, ID 83843

Boundary County Comm

Court House
Bonners Ferry, ID 83805

Sen Tim Tucker

HCR 60 Box 227
Porthill, ID 83853

Sen Barbara Chamberlain

E 4555 Ohio Match Ave
Post Falls, ID 83854

Sen Dennis M Davis

816 Sherman Ave
Coeur d'Alene, ID 83814

Sen Mary Lou Reed

10 Giesa Road
Coeur d'Alene, ID 83814

Dan Picard

Nez Perce Tribe of Idaho
PO Box 365
Lapwai, ID 83540

Susan Martin

US Fish & Wildlife Svc
4696 Overland Rd Rm 576
Boise, ID 83705

Marti Bridges

Idaho Rivers United
PO Box 633
Boise, ID 83701

Mike Satterwhite

327 Skyline Drive
Lewiston, ID 83501

Kootenai County Comm

Court House
Coeur d'Alene, ID 83814

Rep Monica Beaudoin

602 Lakeview Blvd
Sandpoint, ID 83864

Rep Hilde Kellogg

PO Box 1479
Post Falls, ID 83854

Rep Marvin G Vandenberg

6080 Sunrise Terrace
Coeur d'Alene, ID 83814

Rep Louis J. Horvath

Box 888
Pinehurst, ID 83850

Chris Hardy

Coeur d'Alene Tribe
Rt 1
Plummer, ID 83851

Cindy Robertson

Dept of Fish & Game
Statehouse Mail
Boise, ID 83720

Gwen Burr

Health & Welfare, DEQ
2110 Ironwood Parkway
Coeur d'Alene, ID 83814

Bonner County Comm

215 S First
Sandpoint, ID 83631

Shoshone County Comm

Box 1049
Wallace, ID 83873

Rep Jim Stoicheff

615 Lakeview
Sandpoint, ID 83864

Rep Wally Wright

PO Box 388
Bayview, ID 83803

Rep Janet Jenkins

1627 Boyd
Coeur d'Alene ID 83814

Rep Gino L. White

PO Box 237
Plummer, ID 83851

Kootenai Tribe Idaho

PO Box 1269
Bonners Ferry ID 83805

Mary Luckachick

Parks & Recreation
Statehouse Mail
Boise, ID 83720

MAILED
AUG 11 1994

95-02105A
RICHARD L. HOLLISTER
FLORENCE M. HOLLISTER
RT. 2 BOX 562
POST FALLS ID 83854

95-02105B
JACK EVENSIZER
RT. 2 BOX 561
POST FALLS ID 83854

95-04052
ELMER L. PIERSON
ELFIE L. PIERSON
RT. 2 BOX 303
POST FALLS ID 83854

95-04168
WILLIAM M. FANDRY
RT. 2 BOX 361
POST FALLS ID 83854-0000

95-04168
WILLA M. FANDRY
RT. 2 BOX 361
POST FALLS ID 83854-0000

95-04518
WASHINGTON WATER POWER CO.
P.O. BOX 3727
SPOKANE WA 99220

95-04705
BURLINGTON NORTHERN RAILROAD CO.
350 CENTRAL BLDG.
SEATTLE WA 98104

95-07017
RALPH EWING DAVIDSON
RT. 2 BOX 325
POST FALLS ID 83854-0000

95-07100
LEO R. MORGAN
RT. 2 BOX 223-6
POST FALLS ID 83854-0000

95-07134
DONALD L. LUBBERS
RT. 2 BOX 326
POST FALLS ID 83854-0000

95-07376
MICHAEL A. PENNESTRI
2637 TENNYSON ST.
THOUSAND OAKS CA 91360

95-07376
DONALD L. LUBBERS
RT. 2 BOX 326
POST FALLS ID 83854-0000

95-07376
DARLENE S. PENNESTRI
2637 TENNYSON
THOUSAND OAKS CA 91360

95-07461
JAMES R. STILLER
RT. 2 BOX 223C
POST FALLS ID 83854-0000

95-07568
PATRICK H. STANSBURY
E. 13221 23RD
SPOKANE WA 99216-0000

95-07761
BERNARD BALLARD
P.O. BOX 275
POST FALLS ID 83854

95-07762
KENNETH W. MC CHESNEY
P.O. BOX 215
POST FALLS ID 83854

95-08003
WASHINGTON WATER POWER CO.
P.O. BOX 3727
SPOKANE WA 99220

95-08541
W. F. GALVIN
S. 1315 PLEASANT VIEW RD.
POST FALLS ID 83854-0000

95-08541
CAROLYN W. GALVIN
S. 1315 PLEASANT VIEW RD.
POST FALLS ID 83854-0000

95-08550
MICHAEL ROBERT WARD
4125 W. RIVERVIEW DR.
POST FALLS ID 83854-0000

95-08550
CAROL MARIE WARD
4125 W. RIVERVIEW DR.
POST FALLS ID 83854-0000

95-08648
HOWARD K. JUSTUS
MAVIS L. JUSTUS
W. 2020 BREEZY WAY
POST FALLS ID 83854

95-08676
LIMA GREENHOUSES
S. 2100 INLAND EMPIRE WAY
SPOKANE WA 99201

95-08780
IDAHO WATER RESOURCE BOARD
STATEHOUSE
BOISE ID 83720

SPOKANE RIVER

RECEIVED

AUG 11 1994

Includes Applications

WR NUMBER	SOURCE	TRIBUTARY TO	PRIORITY DATE	DIVERSION RATE - CFS	DIVERSION VOLUME - AFA	STAGE	USE
9504168	SPOKANE RIVER	COLUMBIA RIVER	06/01/50	0.030	0.00	S	IRRIGATION
9508648	SPOKANE RIVER	COLUMBIA RIVER	04/10/90	0.040	0.00	P	IRRIGATION
9502061	SPOKANE RIVER	COLUMBIA RIVER	12/27/21	0.300	0.00	L	IRRIGATION
9502089	SPOKANE RIVER	COLUMBIA RIVER	10/23/50	0.320	0.00	L	IRRIGATION
9502105A	SPOKANE RIVER	COLUMBIA RIVER	05/06/53	0.030	0.00	L	IRRIGATION
9504052	SPOKANE RIVER	COLUMBIA RIVER	06/01/02	0.020	0.00	S	IRRIGATION
9508550	SPOKANE RIVER	COLUMBIA RIVER	07/07/87	0.020	1.80	L	IRRIGATION
9502092	SPOKANE RIVER	COLUMBIA RIVER	09/10/51	1.060	0.00	L	IRRIGATION
9502105B	SPOKANE RIVER	COLUMBIA RIVER	05/06/53	0.130	0.00	L	IRRIGATION
9502106	SPOKANE RIVER	COLUMBIA RIVER	05/02/55	0.380	0.00	L	IRRIGATION
9507568	SPOKANE RIVER	COLUMBIA RIVER	10/27/75	0.500	87.50	L	IRRIGATION
9502108	SPOKANE RIVER	COLUMBIA RIVER	08/28/54	0.240	0.00	L	IRRIGATION
9508676	SPOKANE RIVER	COLUMBIA RIVER	10/01/90	0.660	0.00	P	IRRIGATION
9507134	SPOKANE RIVER	COLUMBIA RIVER	01/28/71	0.150	25.55	L	IRRIGATION
9502030	SPOKANE RIVER	COLUMBIA RIVER	12/14/08	0.300	0.00	L	IRRIGATION
9507017	SPOKANE RIVER	COLUMBIA RIVER	05/24/68	1.230	430.50	L	IRRIGATION
9507376	SPOKANE RIVER	COLUMBIA RIVER	09/28/73	0.140	24.50	L	IRRIGATION
9502087	SPOKANE RIVER	COLUMBIA RIVER	01/08/52	2.680	0.00	L	IRRIGATION
9502078	SPOKANE RIVER	COLUMBIA RIVER	04/14/45	0.730	0.00	L	IRRIGATION
9504705	SPOKANE RIVER	COLUMBIA RIVER	09/01/89	0.560	0.00	S	INDUSTRIAL
9504518	SPOKANE RIVER	COLUMBIA RIVER	01/01/07	4250.000	0.00	S	POWER
9508003	SPOKANE RIVER	COLUMBIA RIVER	03/17/80	1160.000	0.00	P	POWER
9508780	SPOKANE RIVER	COLUMBIA RIVER	06/15/92	2495.000	0.00	A	MINIMUM INSTREAM FLOW
9507100	SPOKANE RIVER	COLUMBIA RIVER	03/24/70	0.020	1.20	L	DOMESTIC
9507762	SPOKANE RIVER	COLUMBIA RIVER	08/05/77	0.040	1.20	L	DOMESTIC
9507761	SPOKANE RIVER	COLUMBIA RIVER	08/05/77	0.040	1.20	L	DOMESTIC
9507461	SPOKANE RIVER	COLUMBIA RIVER	06/21/74	0.040	1.20	L	DOMESTIC
9508541	SPOKANE RIVER	COLUMBIA RIVER	03/24/87	0.020	0.60	L	DOMESTIC
NUMBER OF RIGHTS = 28				7914.680	575.25		

1994

OD-XXX
WR5806NP
SELECTION FILE: BEAL-1450437
WATER RIGHT NUMBER

LAST NAME

WATER RIGHTS
BAD ADDRESS LIST
OWNER
CODE

CITY

STATE ZIP CODE

DATE: 09/10/93
TIME: 14:51:08
PAGE: 1

95-02030	NEYLAND	C	SPOKANE	WA
95-02061	GRAHAM	C	POST FALLS	ID
95-02078	WILSON	C	POST FALLS	ID
95-02087	HOLLAND	C	POST FALLS	ID
95-02089	DENMAN	C	POST FALLS	ID
95-02092	CARNEGIE	C	POST FALLS	ID
95-02106	REYNOLDS	C	POST FALLS	ID
95-02108	MADISON	C	POST FALLS	ID
TOTAL BAD ADDRESS RECORDS: 8				

SPOKANE RIVER

1894

NOTICE OF HEARING FOR THE SPOKANE RIVER
MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River, a tributary of the Columbia River. The application is further described as follows:

Source: Spokane River

Application No.: 95-08780

Proposed Priority: June 15, 1992

Amount and Period of Use: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW 1/4 NW 1/4, and the SE 1/4 SW 1/4, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line in the SW 1/4 NW 1/4, Section 12, T50N, R6W, B.M., Kootenai County. The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2:00 p.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
Idaho Department of Water Resources

NOTICE OF HEARING FOR THE COEUR D'ALENE
RIVER MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Coeur d'Alene River, a tributary of Coeur d'Alene Lake. The application is further described as follows:

Source: Coeur d'Alene River

Application No.: 94-07341

Proposed Priority: September 13, 1993

Amount and Period of Use: 1018.0 cfs from November 1 through June 30. 413.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Coeur d'Alene River, commencing at the confluence with the South Fork of the Coeur d'Alene River, located in the NE 1/4 NW 1/4, Section 31, T49N, R2E, Shoshone County and extending downstream to the mouth of the Coeur d'Alene River in lots 3 and 4 (SW 1/4 NW 1/4), Section 36, T48N, R4W, B.M., Kootenai County. The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 9:30 a.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
Idaho Department of Water Resources.

Publication

TO
TWIN FALLS } ss.

RECEIVED

OCT 22 1993

No 25242

Capps McSwain being first duly sworn upon oath, depose
Blaine Clark of the ^{LDWR} TIMES-NEWS, published daily, at
Twin Falls, and do solemnly swear that a copy of the notice of advertisement, as per
hereof, for Two consecutive Publications,
the issue dated September 16, 1993,
the issue dated September 23, 1993.

I certify that said newspaper is a consolidation, effective February 16, 1942, of the Idaho
which newspapers prior to consolidation had been published under said names in said city and
and uninterruptedly during a period of more than twelve consecutive months, and said TIMES-
consolidation, has been published as a daily newspaper except Saturday, until July 31, 1978, at
newspaper began daily publication under said name in said city and county continuously and

I certify that pursuant to Section 60-108 Idaho Code, Thursday of each week has been designated
legal notice by law or by order of any court of competent jurisdiction within the state of Idaho,
ly, will be published; and that at the head of the editorial column of said combined newspapers,
proof, Thursday is announced as the day on which said legal notices will be published.

TWIN FALLS

14 day of October in the year of 1993, before me,
personally appeared Linda Capps McSwain,
to me to be the person whose name subscribed to the within instrument, and being by me first
that the statements therein are true, and acknowledged to me that he executed the same.

Shirley R. Gettman
Notary Public for Idaho

Residing at Twin Falls

My commission expires: 5/19/94

AUG 11 1994

NOTICE OF HEARING FOR THE SPOKANE RIVER MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River, a tributary of the Columbia River. The application is further described as follows:

Source: Spokane River

Application No.: 95-08780

Proposed Priority: June 15, 1992

Amount and Period of Use: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW $\frac{1}{4}$ NW $\frac{1}{4}$, and the SE $\frac{1}{4}$ SW $\frac{1}{4}$, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line in the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R6W, B.M., Kootenai County.

The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2.00 p.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Gary Spackman, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
Idaho Department of Water Resources

AUG 11 1994

Proof of Publication The Post-Register

State of Idaho,
County of Bonneville } ss

I, S. BOB BRIGHT or TED DELEZENE, first being duly sworn, depose and say: That I am the Production Supervisor or Asst. Prod. Supervisor of The Post Company, a corporation of Idaho Falls, Bonneville County, Idaho, publishers of The Post-Register, a newspaper of general circulation, published daily, except Saturday, at Idaho Falls, Idaho; said Post-Register being a consolidation of the Idaho Falls Times, established in the year 1890, The Idaho Register, established in the year 1880 and the Idaho Falls Post, established in 1903, such consolidation being made on the 1st day of November, 1931, and each of said newspapers have been published continuously and uninterruptedly, prior to consolidation, for more than seventy-eight (78) weeks and said Post-Register having been published continuously and uninterruptedly from the date of such consolidation, up to and including the last publication of notice hereinafter referred to.

That the notice, of which a copy is hereto attached and made a part of this affidavit, was published in said Post-Register for two consecutive weeks, first publication having been made on the 16th day of September, 1993, last publication having been made on the 23rd day of September, 1993, and that the said notice was published in the regular and entire issue of said paper on the respective dates of publication, and that such notice was published in the newspaper and not in a supplement.

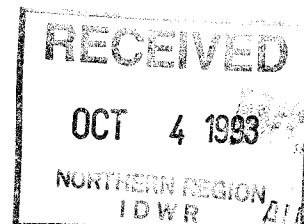
Subscribed and sworn to before me, this 29th day of September, 1993.

[Signature]
Notary Public

My commission expires July 1, 1997.

B10

ad on back



**NOTICE OF HEARING
FOR THE SPOKANE RIVER
MINIMUM STREAMFLOW**

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River, a tributary of the Columbia River. The application is further described as follows:

Source: Spokane River

Application No.: 95-08780

Proposed Priority: June 15, 1992

Amount and Period of Use: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW $\frac{1}{4}$ NW $\frac{1}{4}$, and the SE $\frac{1}{4}$ SW $\frac{1}{4}$, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington state line in the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R6W, B.M., Kootenai County.

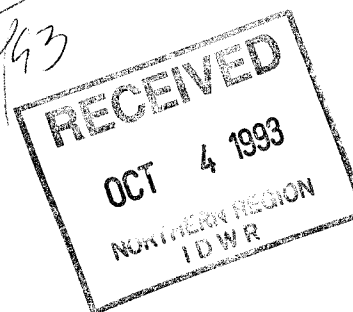
The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2:00 p.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
Idaho Department of Water Resources
Published: Sept. 16, 23, 1993



UNRECORDED
AUG 11 1994

The Idaho Statesman

P.O. BOX 40, BOISE, IDAHO 83707

LEGAL ADVERTISING INVOICE

Amount Due

\$1,849.96

Account Number 100631		Identification NOTICE OF HEARING FOR THE SPOKANE RIVER MINIMUM STREAMFLOW	
Ordered By Patricia M. Stypa	P.O. Number	Rate NT	Run Dates September 16, 23, 1993
State of Idaho Department of Water Resources Northern Region 1910 Northwest Blvd., Suite 210 Coeur d'Alene, Idaho 83814		Estimated Inches.	Real Inches
		# Affidavits 1	Legal Number 5879

RECEIVED

OCT 1 1993

NORTHERN REGION
IDWR

CAROL PAYNE-CULPAN

LEGAL NOTICE NOTICE OF HEARING FOR THE SPOKANE RIVER MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River, a tributary of the Columbia River. The application is further described as follows:

Source Spokane River
Application No.: 95-08780
Proposed Priority: June 15, 1992
Amount and Period of Use:

2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Purpose of Minimum Flow:
Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use:
Spokane River, commencing at Post Falls Dam, located in both the SW1/4NW1/4 and the SE1/4SW1/4, Section 3, T50N, R1E, and extending downstream to the Idaho-Washington State line in the SW1/4NW1/4, Section 12, T50N, R6W, B.M., Kootenai County.

The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, beginning at 2:00 p.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, (310) North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Id. 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. KEITH HIGGINSON

Director

Idaho Department of Water Resources

Pub. September 16, 23, 1993 5879

being duly

sworn, deposes and says: That she is the Principal Clerk of The Idaho Statesman, a daily newspaper printed and published at Boise, Ada County, State of Idaho, and having a general circulation therein and which said newspaper has been continuously and uninterruptedly published in said County during a period of twelve consecutive months prior to the first publication of the notice, a copy of which is attached hereto; that said notice was published in The Idaho Statesman in conformity with Section 60-108, Idaho Code as amended, for TWO

xxxx consecutive weekly ☐ consecutive daily ☐ single ☐ odd skip

insertion(s) beginning with the issue of SEPTEMBER 16, 1993

and ending with the issue of SEPTEMBER 23, 1993

C. Payne-Culpan

STATE OF IDAHO)

ss.

COUNTY OF ADA)

On this 23RD day of SEPTEMBER in the year of 1993, before me, a Notary Public, personally appeared CAROL PAYNE-CULPAN, known or identified to me to be the person whose name subscribed to the within instrument, and being by me first duly sworn, declared that the statements therein are true, and acknowledged to me that she executed the same.

Notary Public for Idaho

Residing at BOISE, ID

AUG 11 1994 My commission expires: 11-27-93

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, }
County of Kootenai, } ss.

Ken Alexander

being first duly sworn
upon oath deposes and says:

1. I am now and at all times hereinafter mentioned was a citizen of the United States, resident of the State of Idaho, over the age of twenty-one years and not a party of the above entitled action.

2. I am now and at all times hereinafter mentioned was the printer (principal clerk) of the "Coeur d'Alene Press," a newspaper printed and published daily except Sunday in Coeur d'Alene, Kootenai County, Idaho, and having a general circulation in said county.

3. The

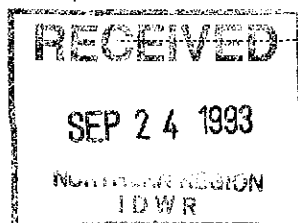
legal notice

of which the annexed is a printed copy, was published in the regular issue of said newspaper for *2* consecutive *weeks* commencing on the *16th* day of *September*, 19*93*, and ending on the *23rd* day of *September*, 19*93*, and such publication was made as often during said period as said *daily* newspaper was regularly issued.

4. That said newspaper has been continuously and uninterruptedly published in said Kootenai County, during a period of more than seventy-eight consecutive weeks immediately prior to the first publication of said notice.

Ken Alexander

Subscribed and sworn to before me this *23rd* day of *September*, 19*93*



Roberta Manley

Notary Public for the State of Idaho,
residing at Coeur d'Alene, Idaho.

ROBERTA MANLEY
My commission expires *2-5-99*

AUG 11 1994

NOTICE OF HEARING FOR THE SPOKANE RIVER MINIMUM STREAMFLOW

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River, a tributary of Columbia River. The application is further described as follows:

Source: Spokane River
Application No. *9408780* *95-8780*
Proposed Priority: June 15, 1992
Amount and Period of Use: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July 1 through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values.

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW1/4NW1/4, and the SE1/4SW1/4, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line in the SW1/4NW1/4, Section 12, T50N, R6W, B.M., Kootenai County.

The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho, beginning at 2:00 p.m. on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive informal testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purposes of presenting evidence or cross examining witnesses should file a notice of appearance with the Director of the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho, 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

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If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
Idaho Department of Water Resources
Legal 949
Sept. 16, 23, 1993

TRIBUNE PUBLISHING COMPANY, INC.

The Lewiston Morning Tribune
505 C St., P.O. Box 957
Lewiston, Idaho 83501
(208) 743-9411

Date 092393 INVOICE No. L00381708

Account No. 964750 95-08780

Description 81708NOTIC

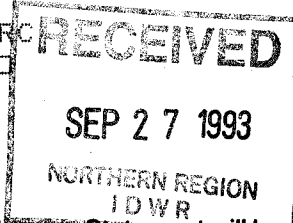
Times 1 Lines 48

Tab Lines

**LEGAL ADVERTISING
INVOICE**

SOLD TO:

ID DEPT. OF WATER RESOURCES
1910 NORTHWEST BLVD. 210
COEUR D'ALE
ID 83814



\$ 72.00

NOTICE: This is an invoice of Purchase made by you. Statement will be rendered the first of the month.
Please Retain This Invoice as Your Statement Will Refer To Invoice by No. Only.

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, ss.
County of Nez Perce

**NOTICE OF HEARING FOR THE SPOKANE RIVER
MINIMUM STREAMFLOW**

Notice is hereby given that the Idaho Water Resource Board submitted an application for permit to appropriate water to the Department of Water Resources, proposing to appropriate water for a minimum streamflow in the Spokane River. The application is further described as follows:

Source: Spokane River
Application No.: 95-08780
Proposed Priority: June 15, 1992
Amount and Period of Use: 2495.0 cfs from November 1 through June 30. 951.0 cfs from July through October 31.

Purpose of Minimum Flow: Protection of fish and wildlife habitat, aquatic life and recreational values

Place of Use: Spokane River, commencing at Post Falls Dam, located in both the SW1/4NW1/4 and SE1/4SW1/4, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line at the SW1/4NW1/4, Section 12, T50N, R6W, B.M. Kootenai County

The Department of Water Resources will hold a public hearing in the Cooperative Extension Service, 106 East Dalton Avenue, Coeur d'Alene, Idaho beginning at 2:00 p.m., on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. In addition, the hearing officer will also receive public testimony into the record at 7:00 p.m. in the evening and at the same location.

Any party who wishes to formally appear in the proceeding for the purpose of presenting evidence or cross examining witnesses should file a notice of appearance with the Director at the Department of Water Resources, Statehouse Mail, 1301 North Orchard Street, Boise, Idaho 83706, five (5) days prior to the hearing. Other parties may informally present their views and comments without filing a notice of appearance. Written informal views and comments may also be submitted to the Department of Water Resources prior to the hearing.

Any hearing scheduled will be conducted in a facility which meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise the department within ten (10) days prior to the hearing. The hearing will be conducted by Mr. Norman Young, Idaho Dept. of Water Resources, Statehouse Mail, Boise, Idaho 83720, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

R. Keith Higginson, Director
IDAHO DEPT OF WATER RESOURCES

Karen J. Lewis, being duly sworn,
poses and says, I am the Legal Clerk
the Tribune Publishing Company, a corporation organized and existing under and by virtue of the laws of the State of Idaho, publishers of the LEWISTON MORNING TRIBUNE, a newspaper of general circulation published at Lewiston, Nez Perce County, Idaho; That the said Lewiston Morning Tribune is an established paper and has been published regularly and issued regularly at least once a day for more than 21 consecutive years next immediately preceding the first publication of this notice, and it has been so published uninterrupted for said period; that the

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attached hereto and which is made a part of this affidavit was published in the said Lewiston Morning Tribune, 1 time(s). Publication began on 092393 or once a WEEK for 1 consecutive WEEKS, the first publication thereof being on the 092393, and the last publication thereof being on the 092393, and said
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is so published in the regular and entire issue of said newspaper and in a supplement thereof and was so published in every issue and number of the said paper, during the period and times of publication as set forth above.

Karen J. Lewis
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day of September 1993

Ray Rosal
Notary Public in and for the State of Idaho,
residing at Lewiston, therein.

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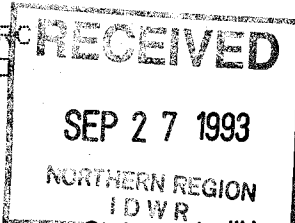
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The Lewiston Morning Tribune
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Lewiston, Idaho 83501
(208) 743-9411

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Karen J. Lewis

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Ray Rasmussen

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residing at Lewiston, therein.

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Application No.: 95-08780
Proposed Priority: June 15, 1992
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Purpose of Minimum Flow: Protection of fish and aquatic life at values

Place of Use: Spokane River, c Post Falls Dam, located SW 1/4 NW 1/4 and SE 1/4, T50N, R5W, and stream to the Idaho State line to the Section 12, T50N, R6W, County

The Department of Water Resources will hold a public Cooperative Extension Service, 106 East Dalton Avenue, Idaho beginning at 2:00 p.m., on Wednesday, October 27, 1993, for the purpose of hearing evidence pertaining to the application. The hearing will be held pursuant to the provisions of Section 42-1503, Idaho Code. The hearing officer will also receive public testimony into the record at the hearing. The hearing will be held at 2:00 p.m. in the evening and at the same location.

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R. Keith Higgins
IDAHO DEPT OF WATER

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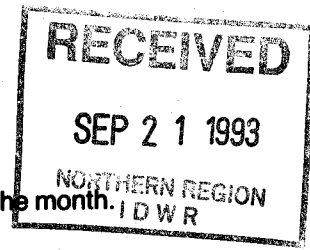
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95-08780
June 15, 1992
2495.0 cfs from November 1 through June 30. 951.0 cfs from July through October 31.
Protection of fish and wildlife habitat, aquatic life and recreational values
Spokane River, commencing at Post Falls Dam, located in both the SW $\frac{1}{4}$ NW $\frac{1}{4}$ and SE $\frac{1}{4}$ SW $\frac{1}{4}$, Section 3, T50N, R5W, and extending downstream to the Idaho-Washington State line to the SW $\frac{1}{4}$ NW $\frac{1}{4}$, Section 12, T50N, R6W, B.M. Kootenai County

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R. Keith Higginson, Director
IDAHO DEPT OF WATER RESOURCES

Karen J. Lewis, being duly sworn,
Legal Clerk

I depose and says, I am the _____ of the Tribune Publishing Company, a corporation organized and existing under and by virtue of the laws of the State of Idaho, publishers of the EWISTON MORNING TRIBUNE, a newspaper of general circulation published at Lewiston, Nez Perce County, Idaho; That the said Lewiston Morning Tribune is an established paper and has been published regularly and issued regularly at least once a day for more than 21 consecutive years next immediately preceding the first publication of this notice, and as been so published uninterrupted for said period; that the

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Karen J. Lewis

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Sheryl M. Lentz
Notary Public in and for the State of Idaho,
residing at Lewiston, therein.

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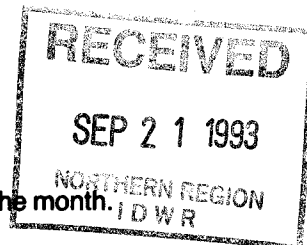
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Place of Use: Spokane River, Post Falls Dam, 1/2 SW 1/4 NW 1/4 and S 1/2, T50N, R5W, and stream to the State line to the section 12, T50N, R6W, Nez Perce County

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If issued, this permit will be subject to all prior water rights. R. Keith
IDAHO DEPT OF WA

AUG 11 1994

Water Right Number - 95-08780 Prefix Translation: WATER RIGHT Old (D) Number -
+ - - - - Last Name - - - - + + - First Name - - + + - - - - Address - - - - - +
*** C - CURRENT OWNER ***
IDAHO WATER RESOURCE BOARD
1 - STATEHOUSE
2 -
3 -
City- BOISE
Phone - 208-327-7910
State- ID Zip- 83720

+ - - Priority Date - - + + - - Region - - - + + - - Stage - - - + + - - Status - - - +
06/15/1992 18 NORTHERN A - APPLICATION

+ - - Source - - - - - + + - - Tributary - - - - - +
SPOKANE RIVER COLUMBIA RIVER

Twn	Rng	Sec	Tract	Lot	Rflg	County	Point of Diversion	Stream Index (Blank if no Index Code)
50N	05W	3	SE SW NW	B	(55)	KOOTENAI		
			NE SE SW	B	(55)	KOOTENAI		
06W	12		NE SW NW	E	(55)	KOOTENAI		

Code	Description	Period From	Period To	Water Use	Diversion Rate	Diversion Volume
34 -	MINIMUM INSTREAM FLOW	11/01	06/30		2495.000	
34 -	MINIMUM INSTREAM FLOW	07/01	10/31		951.000	
+ - Total Div. Rate - +		+ - Total Div. Volume - +		+ - Total Div. Capacity - +		
				2495.000		

Twn	Rng	Sec	Tract	Lot	Acres	Place of Use	Description	County
+ - - Diversion Means -								
+ - - Non-Irrigation Use -								
+ - - Other Rights for Same Use -								

+ - - Remarks - - - - - +
The beginning of the reach is from the Post Falls Dam in the
SESWM and NESESW, Sec. 3, T50N, R5W downstream to the state line
in the NESWM, Sec. 12, T50N, R6W.
The affected reach is approximately 5.7 miles long.
Minimum stream flow use is for protection of fish and wildlife
habitat, aquatic life, and recreational values.
+ - - Old Water Right Numbers - - - - - +
No Old Water Right Numbers found.

Prefix Translation: WATER RIGHT

No Conditions of Approval found.

+ - Decree Date
00/00/0000

No Comments Found

+ - - Audit Fields - 09/29/92 STYPA 12/03/92 STYPA

Water Rights Dates and Flags Area

Proof Due Date	- 00/00/0000	Field Exam Made	- 00/00/0000	Field Exam Fee	-
Approved/Denied	- 00/00/0000	Tested Date	- 00/00/0000	Swan Falls	-
Proof Made Date	- 00/00/0000	Hearing Date	- 00/00/0000	Temporary Right	- P
Exam to S.O. Date-	00/00/0000	Verified Date	- 00/00/0000	DLE/Carrey Act	-
Order Show Cause	- 00/00/0000	Receipt Number	-	Water District	-
Licensed Date	- 00/00/0000	Appl Received	- 06/15/1992	Transfer/Amended	-
Decree Date	- 00/00/0000	Presumption Flag	-		

IDAHO

DEPARTMENT OF FISH AND GAME

Jerry M. Conley, Director

FEDERAL AID IN FISH RESTORATION

Job Performance Report

Project F-71-R-12



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REGIONAL FISHERIES MANAGEMENT INVESTIGATIONS

- Job No. 1-a. Region 1 Mountain Lakes Investigations
- Job No. 1-b. Region 1 Lowland Lakes Investigations
- Job No. 1-c. Region 1 River and Stream Investigations
- Job No. 1-d. Region 1 Technical Guidance

By

Ned J. Horner, Regional Fishery Manager
Larry D. LaBolle, Regional Fishery Biologist
Cynthia A. Robertson, Regional Fishery Biologist

October 1988

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Catch rates supported by hatchery rainbow trout in the Moyie River was moderate (0.31 fish/hour) and return to the creel was good (42%). This may be a reflection of the strain of fish stocked. We stocked Mt. Lassen rainbow in the Moyie River in 1987 and they returned at a significantly greater rate than the R1 (unspecified) rainbow stocked in other Region 1 streams. The rate of return to the creel was comparable to return rates for Hayspur strain rainbow stocked in Marble Creek and the North Fork St. Joe River in 1986. We did not stock any R1 rainbow in Region 1 streams in 1987 and recommend we stock only Hayspur or Mt. Lassen rainbow in the future.

It appears we are providing catch rates of approximately 0.3 to 0.5 fish per hour with stocking rates of 150 to 300 fish per kilometer on most northern Idaho streams. Additional evaluation of the performance of various strains of rainbow trout in northern Idaho streams is needed to most effectively utilize the limited resource.

Additional data on return to the creel, angler effort, and catch rates on streams stocked with catchable rainbow trout will be collected on a random basis in 1988.

Spokane River

The fishery of the lower Spokane River from Post Falls Dam downstream to the Idaho state line (about 10 km) is supported by a natural rainbow trout population. This fishery has been managed as a year-round, high-yield urban fishery without supplemental stocking. The lower Spokane River rainbow appear to be unique in their ability to support this type of fishery, despite major flow fluctuations from power generation and seasonally poor water conditions.

A graduate student project undertaken in 1985 and 1986 determined that the Spokane River rainbow are main channel spawners restricted to relatively few areas (Bennett and Underwood 1988). Low flows and high summertime water temperatures are suspected of causing high postspawning mortality. Water fluctuations during incubation and hatching result in large variations in year-class strength. In May 1986, a power outage at Upriver Dam in Spokane, Washington, resulted in the failure of the spill gates to open and a washout of the dam. To compensate, spill gates at Post Falls Dam were closed and flows in the river dropped from 8,120 cfs [230 to 424 cfs (12 m³/s)] over a three-day period. Such dewatering of redds can cause substantial mortality to pre-emergent fry (Becker et al. 1983).

On June 4, 1987, we sampled the river to determine the subsequent impact of the Upriver Dam power failure on trout numbers, specifically age 1 rainbow. We electrofished the river between Post Falls Dam and the Idaho state line from a drift boat. Fish were anesthetized, identified to species, and total lengths (to the nearest mm) were recorded.

100-1000-1000
AUG 11 1994

The average back-calculated lengths-at-age for age 1 rainbow trout in 1985 and 1986 were 176 and 159 mm, respectively (Table 3) and most age 1 fish appeared to be less than 220 mm in length. Using 220 mm as an arbitrary cutoff, approximately 41% and 35% of the rainbow collected in 1985 and 1986, respectively, were age 1 fish (Figure 1). In 1987, <25% of the fish sampled were less than 220 mm long (age 1), indicating poor survival of the 1986 year class.

Bennett and Underwood (1988) indicated the Spokane River provided a moderately productive rainbow trout fishery and produced some fish greater than 500 mm. However, annual mortality was high (approximately 76%) so few fish survived to attain this size. Their data indicated that natural mortality was a major limitation to the fishery. The abundance of rainbow trout and the quality of the fishery appear to rely heavily upon year-class strength. Greater recruitment is necessary to maintain abundance and allow enough fish to survive to trophy size. Successful spawning and emergence appears to be closely linked to flows. If minimum flows were maintained above 6,000 cfs (170 m³) April 1 to June 30, approximately 65% of available spawning habitat would be protected. We are currently exploring the feasibility of maintaining such a minimum flow with the Washington Water Power Company, owner and operator of Post Falls Dam. In addition, we also implemented a closure on fishing from March 1 to the general stream opener during 1988-1989 to protect vulnerable spawning adults.

Fishing mortality was estimated to make up less than 10% of total annual mortality. This appears to conflict with observations of local conservation officers and long-time (15-20 years) anglers who indicate fishing pressure has increased substantially in recent years. Large fish were apparently much more abundant in historic catch than they are now. Warm summer temperatures (24+°C), low flows, and fluctuating spring flows have been very similar for the past 80 years.

The estimate of fishing mortality was based on exploitation estimates from tag returns and is subject to bias by fishermen who fail to report tagged fish (Shetter 1968). Additional data are needed to better quantify fishing pressure and angler harvest. A tentative creel survey is planned for the 1988 field season to collect necessary data to determine if a regulation change is appropriate to maintain this unique urban trout fishery.

Stocking of brown trout in the lower Spokane River was curtailed in 1987 because research indicated the available habitat may be saturated (Dr. David H. Bennett, Professor of Fisheries Resources, University of Idaho, Moscow, personal communication). Brown trout were introduced to provide a trophy fishery with increasing fishing pressure and to take advantage of the abundant sucker and dace forage base. The percentage of brown trout in the electrofishing samples from 1985 and 1986 averaged about 6%; in the 1987 sampling effort, brown trout represented approximately 13% (18 of 142 fish). Additional information should be collected to determine growth and distribution of brown trout, whether natural reproduction is occurring, and relative contribution of brown trout to the fishery in the lower Spokane River.

AUG 11 1994

Table 3. Back-calculated total length (mm) at annulus for rainbow trout captured in the Spokane River, Idaho, in September 1985 and October 1986.^a

	N	Age				
		1	2	3	4	5
1985	72	161				
	70	161	255			
	28	156	253	318		
	15	173	269	324	370	
	4	175	238	320	369	412
Average		162	256	320	369	412
1986	19	142				
	45	148	228			
	18	148	243	318		
	2	165	238	332	386	
Average		147	232	319	386	

^aAdapted from Bennett and Underwood, 1988.

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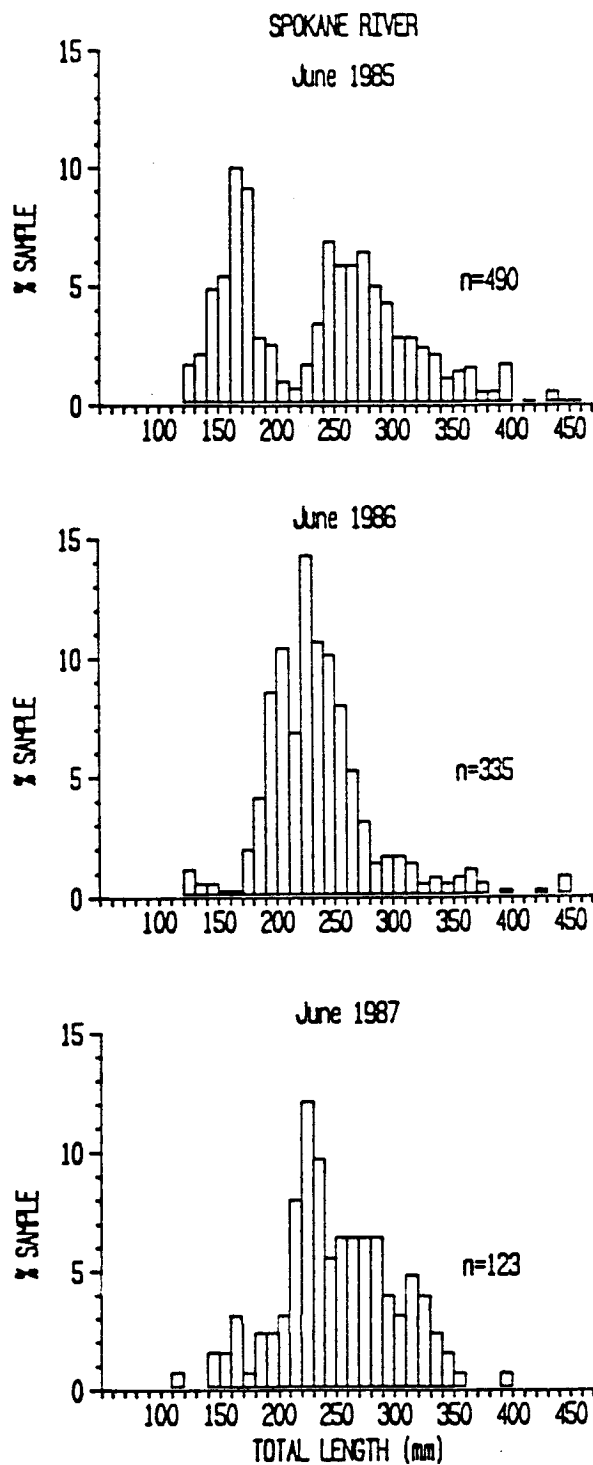


Figure 1. Length frequency distributions of rainbow trout collected from the Spokane River, Idaho, June 1985-1987.

AUG 11 1994

OBJECTIVES

1. Determine fishing pressure, harvest and catch rates in Idaho and Washington.
2. Determine exploitation of trout over 350 mm (13 in).
3. Estimate the population of trout in Washington and Idaho.

STUDY AREA

The Spokane River begins at the mouth of Coeur d'Alene Lake and empties into the Columbia River. In 1906, a dam was built near Post Falls, Idaho and inundated the upper 16.8 km of the river. At the dam, the Spokane River drains 958,300 ha and includes the Coeur d'Alene and St. Joe river drainages. River flows below the dam ranged 14 m³/s (lowest on record, 1967) to >1416 m³/s (highest on record, 1974) (Bailey and Saltes 1982).

The study area covered the section of river from Post Falls Dam, Idaho to Sullivan road, Spokane, Washington, a total of 23 km (Figure 2.). It was divided into 2 sections, Washington 13.7 km and Idaho 9.4 km (Bailey and Saltes 1982). The study area was restricted to this section for the Spokane River because of the similarity of habitat and water temperatures. Below Sullivan Road, the river receives water from the Rathdrum aquifer which reduces water temperature and increases discharge.

AUG 11 1994

Introduction

The Spokane River has the potential to provide a good fishery experience for anglers. It is located between two major population centers, Spokane, Washington and Coeur d'Alene, Idaho (Figure 1.). Two major studies have been conducted to assess the fish population and the fishery; Bailey and Saltes (1982) and Bennett and Underwood (1988). Bailey and Saltes (1982) covered the river from Post Falls Dam (river km 164.2) to Green Street, Spokane, WA (river km 125.5). Bennett and Underwood (1988) concentrated from Post Falls Dam downstream to the Idaho state line (river km 154.8).

The study conducted in 1990 covered the river from Post Falls Dam down to Sullivan Road, Spokane, WA. (river km 141.1) This study had two major goals:

1. Compare the fish populations in Washington and Idaho to determine if fishing regulations affect the abundance and structure of the fish population. Washington fishing regulations on the Spokane River are: 1 fish over 203 mm (8 inches) and terminal fishing tackle is restricted to flies and lures only with an opening day of April 28, 1990. In Idaho there is a 6 fish bag limit, no length restriction and no tackle restriction and opening day was May 27, 1990.
2. Verify the findings of Bennett and Underwood (1988) relating to exploitation and mortality of fish over 350 mm (14 inches).

AUG 11 1994

Insert Figure 1. Spokane River

AUG 11 1994

Insert Figure 2. Idaho and Washington Spokane Rivery study area, 1990.

AUG 11 1994

METHODS

The fish were collected by electrofishing in the spring for the tagging/exploitation component of the study and in the fall for the population estimate. An aluminum drift boat modified with electrofishing equipment was used to collect the fish. Two boom-type electrodes, mounted on the bow with a 60 cm diameter hoop and six 60 cm metal cables on each boom were the positive electrodes. The drift boat was the negative electrode. A Coffelt model VVP 2C converted the AC current into pulsed DC current. The voltage was set at 350 volts, which provided the strongest field with minimum injury to the fish. Four flood lights were mounted on the bow to illuminate the netting area. The crew consisted of two netters in the bow of the boat, one of which controlled the on/off foot pedal, and an oarman who controlled the boat and generator/VVP complex.

We launched at dark and drifted downstream along the shoreline. The shoreline was alternated on different nights. Eddys were fished with the current (usually upstream). The duration of the energized field time (EFT, the time electrical current is applied to the water) varied from 30 seconds to several minutes. Stunned fish were netted and placed in a live well. Periodically, we would stop midstream and collect data from the captured fish. Data included, species length (total, mm), weight (g) and scale samples from the first 10 fish per 10 mm length group. Tagging or fin clipping took place at this time.

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Exploitation

Fish over 350 mm were tagged with a numbered \$5.00 reward floy tag on March 26-29, 1990. Exploitation was calculated from the number of tags returned.

Population estimate

All fish collected during the initial marking period, October 1-12, 1990, were marked with an adipose fin clip. All fish collected during the first of two recapture nights, October 19-20, 1990, were marked with a caudal fin hole punch so they would not be counted again the second night.

A Petersen mark and recapture method modified by Chapman (1951) was used to estimate the trout population in Idaho and Washington.

$$\hat{N} = \frac{(M+1)(C+1)}{R+1}$$

Where: $\hat{N}$ = population estimate.
M = number of fish marked.
C = number of fish caught during the recapture run.
R = number of recaptures.

Variance of $\hat{N}$

$$V\hat{N} = \hat{N}^2 \left\{ \frac{(\hat{N}-M)(\hat{N}-C)}{MC(\hat{N}-1)} \right\}$$

Where: $V\hat{N}$ = variance of the population estimate M, C, & $\hat{N}$ same as above.

Confidence interval:

$$95\%CI = \pm 1.96 \sqrt{V\hat{N}}$$

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Aging

Impressions were made from the collected fish scales . Scales were placed on a 25 mm x 75 mm plastic strips. The strips were placed between 2 metal plates and inserted into a Carver model C laboratory press. Pressure was increased to 364 kg/cm² (20000 psi) and held for 10 seconds. The number of annuli was counted using an Eberbach Scale Reader and recorded.

Creel Survey

A creel survey was used to collect data to estimate fishing pressure and harvest on the Spokane River from Post Falls Dam, Idaho, downstream to Sullivan Road, Spokane, Washington (Figure 2.). The river was divided into two sections, Post Falls Dam to the state line (9.4 km) and the state line to Sullivan Road, Spokane, Washington (13.7 km).

The creel survey period April 28, 1990, - September 7, 1990, in Washington and May 27, 1990, - September 7, 1990 in Idaho, was divided into 10 - 2 week intervals. During each interval, each section was sampled on 50% of the weekend days and 20% of the weekdays. Instantaneous angler counts were made 4 times per survey day. Angler interviews were conducted between counts. Information collected during the interviews included: number of anglers per group, total number of hours, number of fish harvested, number of fish released, total number of fish caught and number of each species harvested.

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A computer program designed and developed by Tom McArthur (Idaho Department of Fish and Game, Boise) was used to summarize creel data, estimate fishing pressure and harvest and calculate catch rates for each section during each interval and for the entire census period.

RESULTS

Population Estimate

The estimated number of rainbow trout in Idaho and Washington was similar 2,012 and 1,992, respectively. Confidence intervals were $\pm 17\%$ and 19% for Idaho and Washington, respectively (Table 1). Density estimates for rainbow trout were 0.7 fish/100 m² or 214 fish/km and 0.4 fish/100 m² or 145 fish/km in Idaho and Washington, respectively (Table 2).

The number of brown trout in each section was 292 and 219 for Idaho and Washington, respectively. The confidence intervals were ± 102 and ± 40 for Idaho and Washington, respectively (Table 1).

Exploitation

A total of 144 tags were put into rainbow and brown trout over 340 mm in Washington (75) and Idaho (69)(Table 3). The exploitation for the tagged fish was 13% and 7% in Idaho and Washington.

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Table 1. Population estimates for rainbow trout and brown trout in the Spokane River from Corbin Park, Post Falls, Idaho to the state line and from the state line to Harvard Road, Spokane, WA, October 20, 1990.

Species	Location	M+1	C+1	R+1	$\hat{N}$	$V\hat{N}$	CI	Range
Rainbow trout	Idaho	456	375	85	2,012	30,169	340(17%)	$1672 < \hat{N} < 2352$
	Washington	448	298	67	1,992	39,046	387(19%)	$1605 < \hat{N} < 2379$
Brown trout	Idaho	53	33	6	292	10,370	102(35%)	$190 < \hat{N} < 395$
	Washington	70	50	16	219	1,583	40(18%)	$179 < \hat{N} < 259$
Combined	Idaho	508	407	90	2,297	37,581	380(16.5%)	$1917 < \hat{N} < 2677$
	Washington	517	347	80	2,242	40,870	396(17.7%)	$1846 < \hat{N} < 2638$

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Table 2. Density estimates for rainbow and brown trout in the Spokane River from Corbin Park, Post Falls, Idaho, to the Idaho/Washington state line and from the stateline to Harvard Road, Spokane, Washington, October 20, 1990.

Location	Length (km)	Mean width (m)	Area (m ²)	N		Fish/100n ²		(Fish/km)	
				Rb	Bn	Rb	Bn	Rb	Bn
Idaho	6.1	46	280,600	2012	292	0.7	0.1	320	48
Washington	5.3	69	365,700	1992	219	0.4	0.05	376	41

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Table 3. The number of tags returned and exploitation of fish caught in the Spokane River from Post Falls Dam, Idaho, to Sullivan Road, Spokane, Washington, 1990.

Location	Number of tags		Number of tags returned		Exploitation percentage		
	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown	Combined
Idaho	47	22	8	1	17.0	4.5	13.0
Washington	65	10	4	1	6.2	10.0	0.67

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Creel Survey

Idaho anglers expended an estimated 6193 hours to catch an estimated 2009 fish for a catch rate of 0.3 fish/hour (Table 4.). Only 30% of the fish caught were harvested and rainbow trout were 85% of the fish harvested. Chinook salmon, brown trout and cutthroat trout comprised 12%, 1% and 3% respectively of the fish harvested.

Washington anglers expended an estimated 2844 hours to catch an estimated 781 fish for a catch rate of 0.3 fish/hour. Only 12% of the fish caught were harvested and 55% of the harvested fish were rainbow trout. Brown trout and cutthroat trout comprised 34% and 11% respectively of the harvested fish (Table 4.).

Population Structure

The combination of age 1, 2 and 3 rainbow trout comprised 94% and 86% of the aged rainbow trout in Idaho and Washington, respectively. The combination age 1, age 2 and age 3 brown trout comprised 86% and 93% of the aged brown trout in Idaho and Washington, respectively (Table 5.). Mean lengths of rainbow trout age 1, age 2 and age 3 in Idaho were 194 mm, 258 mm and 358 mm, respectively, (Table 6.). Mean lengths of rainbow trout age 1, age 2 and age 3 in Washington were 201 mm, 276 mm and 362 mm, respectively, (Table 6.)

In Idaho, 36% of the rainbow trout over 200 mm were greater than 300 mm (Table 7.). In Washington, 50% of the rainbow trout over 200 mm were greater than 300 mm (Table 7.). The percentage of brown trout greater than 300 mm in Idaho and Washington was 61% and 25%, respectively (Table 8.).

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Table 4. Estimated angler hours, total fish caught and catch rates per section for the survey period (April 28, 1990 to September 7, 1990) on the Spokane river from Post Falls Dam, Idaho to Sullivan Road, Spokane, WA.

Section	Hours fished	Number of fish			C/R	Rb	Bn	Ct	Bk	Ck
		harvested	released	caught						
1 (Idaho)	6193	623	1332	1955	0.3	528	5	18	0	72
<u>+</u> at 95% CI	854	260	91	306		236	9	28	0	86
2 (Washington)	2844	92	690	782	0.3	50	31	10	0	0
<u>+</u> at 95% CI	613	97	485	516		44	83	22	0	0
Total	9037	714	2022	2736	0.3	578	36	28	0	72
<u>+</u> at 95% CI	1051	277	493	600		240	84	36	0	86

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Table 5. Number and percentage of aged rainbow and brown trout collected by electrofishing in the Spokane River in 1990, from Corbin Park, Post Falls, Idaho, to Harvard Road, Spokane, Washington.

Species	Location	Ages									
		I		II		III		IV		V	
		n	%	n	%	n	%	n	%	n	%
Rainbow trout	Idaho	15	10	76	50	52	34	6	4	2	1
	Washington	21	21	41	41	24	24	9	9	5	5
Brown trout	Idaho	1	2	23	52	14	32	2	5	4	9
	Washington	2	3	48	80	6	10	4	7	0	0

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Table 6. Mean length of aged rainbow and brown trout in the Spokane River, 1990, from Corbin Park, Post Falls, Idaho to Harvard Road, Spokane, WA..

Species	Location	Mean lengths (mm)				
		age 1	age 2	age 3	age 4	age 5
Rainbow Trout	Idaho	194	258	358	397	410
	Washington	201	276	362	410	413
Brown Trout	Idaho	195	267	381	528	502
	Washington	243	265	401	430	

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Table 7. Percent composition of various length groups of rainbow trout collected by electrofishing in the Spokane River from Corbin Park, Post Falls, Idaho to Harvard Road, Spokane, Washington, 1990.

Length (mm)	Idaho		Washington		Both	
	n	%	n	%	n	%
>200	433	100	405	100	838	100
200-299	277	64	202	50	479	57
300-399	144	33	179	44	323	39
400-499	12	3	24	6	36	4
500 and up	0	0	0	0	0	0

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Table 8. Percent composition of various length groups of brown trout collected by electrofishing in the Spokane River from Corbin Park, Post Falls, Idaho to Harvard Road, Spokane, Washington, 1990.

Length (mm)	Idaho		Washington		Both	
	n	%	n	%	n	%
>200	51	100	68	100	119	100
200-299	20	39	51	75	71	60
300-399	9	18	8	12	17	14
400-499	18	35	9	13	27	23
500 and up	4	8	0	0	4	3

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The proportional stock density (PSD) was calculated for rainbow trout and brown trout (Table 9.). PSD is the proportion of fish of quality length (300 mm) or trophy length (400 mm) in the population.

example:

$$\text{PSD} = \frac{\text{Number} \geq \text{quality length (300 mm)}}{\text{Number} \geq \text{stock length (200 mm)}}$$

The PSD values for rainbow trout over 400 mm (trophy length) in Idaho and Washington was 3 and 6, respectively (Table 9.). The PSD values for brown trout over 400 mm in Idaho and Washington was 43 and 13, respectively, (Table 9.).

DISCUSSION

The rainbow trout populations in Washington and Idaho appear to be very similar. The population estimates were virtually the same; 2012 in Idaho (Corbin Park to the state line) and 1992 in Washington (state line to Harvard Road). The percentage of rainbow trout in each age group was similar (Table 5). Mean lengths of each age group were also similar (Table 6). Total mortality was similar 0.66 and 0.58 for Idaho and Washington, respectively. The biggest difference was in the percentage of quality fish, fish over 300 mm. PSD values were 36 and 50 for Idaho and Washington, respectively. The PSD values calculated from Bennett and Underwood (1988) was 32%. The difference between Idaho and Washington was attributed to the higher exploitation rate in Idaho; 17% in Idaho and 6.2% in Washington. The lower

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Table 9. Proportional stock densities for rainbow trout and brown trout collected by electrofishing in the Spokane river from Corbin Park, Post Falls, Idaho, to Harvard Road, Spokane, Washington, 1990.

Length (mm)	Idaho		Washington	
	n	PSD	n	PSD
<u>Rainbow trout</u>				
200 and up	433		405	
300 and up	156	36	203	50
400 and up	12	3	24	6
<u>Brown trout</u>				
200 and up	51		68	
300 and up	31	61	17	25
400 and up	22	43	9	13
500 and up	4	8	0	0

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exploitation rate in Washington may be due to noncompliance of tag returns. The exploitation rates corresponded to the total fishery effort which was over two times greater in Idaho (Post Falls Dam to the state line) than in Washington (state line to Sullivan Road) (Table 4.). The lower fishing effort in Washington may be attributed to the unusually hot air temperatures. During interval 6, the weather moderated and fishing pressure increased (Appendix A.). Bailey and Saltes (1982) reported total fishing hours in Idaho in 1980 and 1981 as 11,026 hours and 8,816 hours, respectively and in Washington (Sections 6,.5, and 4) as 8,503 hours and 9,324 hours in 1980 and 1981, respectively. These totals were much higher than the 1990 totals for the corresponding sections of 6,193 hours and 2,844 hours, in Idaho and Washington respectively. Again weather was probably the controlling factor. Even though pressure was down, catch rates increased from 0.1 fish/hour in 1980 and 1981 for both Idaho and Washington to 0.3 fish/hour in 1990 for both Idaho and Washington. Our survey did not cover the period after September 7, 1990. It appeared, from our personal observations that fishing continued at a lower effort in Idaho but catch rates may be higher especially as the water cooled down and the fish became more available to the angler. It is my opinion that a substantial number of trout may have been caught during the fall 1990. Each of the anglers I contacted had a minimum of 3 trout all greater than 340 mm.

A regulation emphasizing conservation of wild trout by limiting the bag limit to two trout would be beneficial to the overall fishery, especially during the fall when the trout become more vulnerable. The public may perceive this regulation as restricting their ability to catch more fish, but rarely did the anglers contacted during the creel survey period exceed 2 trout in possession in Idaho.


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Mortality

Fishing mortality was relatively low in both Idaho and Washington, 0.28 and 0.09, respectively (Table 10.). The difference was attributed to the more restrictive regulations for Washington, 1 fish over 200 mm and the lower fishing effort. These fishing mortality values were similar to those reported by Bennett and Underwood (1988) which ranged 0.153 to 0.366. Natural mortality is the larger component of total mortality and may negate any attempt to improve the fishery through fishing regulations. The combination of post spawning stress and high water temperature which can exceed 20°C, may cause most of the natural mortality.

Population Estimate

Bennett and Underwood (1988) estimated 19,029 trout in the Spokane River from Post Falls Dam to the Idaho state line. To be directly comparable to the 1990 study, only the middle and lower sections in Bennett and Underwood's study were included in an estimate of $7,858 \pm 1,557$ trout (from Corbin Park down to the Idaho state line (Table 11.) Bailey and Saltes (1982) reported 889 trout in Idaho in the same section and 167 trout in Washington from the state line to Harvard Road (they suggest this was an underestimate of the true population; Table 12.). Our study reported population estimates of 2,012 and 1,992 in Idaho and Washington, respectively in October 1990. This represented a 75% decline in Idaho of the estimated population number from the Bennett and Underwood (1988) adjusted population estimate.

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Table 10. Summary of annual and instantaneous mortality rate in the Spokane River from Corbin Park, Post Falls, Idaho, to Harvard Road, Spokane, Washington, 1990.

State Species	S	A	F	M	Z	E
Idaho						
Rainbow	0.34	0.66	0.28	0.82	1.10	0.17
Brown	0.42	0.58	0.07	0.80	0.87	0.045
Washington						
Rainbow	0.42	0.58	0.09	0.77	0.86	0.06
Brown	0.19	0.81	0.20	1.40	1.60	0.10

S = Annual survival
 A = Annual mortality
 F = Instantaneous fishing mortality
 M = Instantaneous natural mortality
 Z = Total instantaneous mortality
 E = Annual exploitation

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Table 11. Comparisons of population estimates for rainbow trout in the Spokane River in 1981, 1986 and 1990 (Bailey and Saltes 1982; Bennett and Underwood 1988). (The 1986 modified population estimate was calculated for the section as in the 1990 study.)

Year	M	C	R	$\hat{N}$	VN	CI	Fish/km
1981	61	115	7	899	84,290	567(63%)	150/118
1986	1,014	1950	111	17,681	2,344,620	3,001(16.7%)	1,881/979
1986 (Modified)	637	972	78	7,858	631,140	1,557(20%)	1,288/650
1990	455	374	84	2,012	30,169	340(17%)	377/154

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Table 12. Comparisons of population estimates in the Spokane River, from the Idaho/Washington state line to Harvard Road, Spokane, Washington, 1982, 1990.

Year	M	C	R	$\hat{N}$	$V\hat{N}$	CI	Fish/km
1982	43	18	4	167	4,010	124(74%)	30
1990	447	297	66	1,992	39,046	387(19%)	376

M = number of fish marked
 C = number of fish caught during recapture run
 R = number of fish recaptured
 $\hat{N}$ = population estimate
 $V\hat{N}$ = variance of the population estimate
 CI = confidence interval

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Bennett and Underwood (1988) suggested that successful spawning and emergence appeared to be closely related to flows and that a higher recruitment is necessary to provide enough fish to survive to trophy size. Their data indicated minimum flows of over $170 \text{ m}^3/\text{s}$ (6000 cfs) from April 1 through June 30 would protect 65% of the available spawning habitat. Flows less than $170 \text{ m}^3/\text{s}$ would increase intergravel mortality of eggs and fry. During the past ten years, only once in 1984 did flows remain above $170 \text{ m}^3/\text{s}$ until June 30 (Table 13.).

The low population estimate in 1990 can be attributed to four years of flows below $170 \text{ m}^3/\text{s}$ before June 17, 1986-1989, (Table 13.). The high population estimate in 1985 was preceded by four out of five years of flows remaining above $170 \text{ m}^3/\text{s}$ until the last week of June, 1980-1984, (Table 13.).

CONCLUSION

The trout populations in the Spokane River in Idaho and Washington are virtually the same and should be managed as such. The fishery is strongly related to year class strength which is determined by river flows during April through June. Flows should remain above $170 \text{ m}^3/\text{s}$ (6000 cfs) until June 30. Fishing mortality appeared to be a small portion of total mortality and in the traditional way fishing mortality and natural mortality are dependent. This may not be the situation in the Spokane river. The main causes of natural mortality in the Spokane River appeared to be post spawning stress and warm water temperature stress with these factors density independent.

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Table 13. Mean monthly flows in Spokane River below Post Falls Dam, Idaho, 1980-1990.

Year	Mean monthly flow (cfs)					Date when flows receded to 6000 cfs
	March	April	May	June	July	
1980	6194	9307	12950	9308	2431	6-24
1981	6740	9952	12170	10048	3230	6-29
1982	18780	14730	19500	12760	3011	6-26
1983	14890	10460	12400	7483	3778	6-12
1984	10550	13280	14140	13570	2847	6-30
1985	3380	16790	18020	10360	1535	6-16
1986	18230	12940	9594	3806	1167	6-04
1987	10160	11220	8525	2113	1066	5-18
1988	4824	14460	7779	3621	1219	6-01
1989	7569	20360	16800	6674	1445	6-17
1990	8963	18090	14300	15130	2442	6-28
1991	11820	14710	17200	10920	3652	6-30
1992	8020	14430 6014	17050 5141	9769 2077	2442 1065	4-13
1993						May

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Spokane River
Hearing Officer

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AUG 1 1984



SPOKANE RIVER

WATER RIGHT NUMBER 95-08780

SOURCE: SPOKANE RIVER

APPLICANT: IDAHO WATER RESOURCE BOARD

DATE FILED: JUNE 15, 1992

MINIMUM STREAMFLOW REACH:

**BEGINNING DOWNSTREAM OF THE POST FALLS
DAM IN SECTION 4, T50N, R05W AND EXTENDING
DOWNSTREAM APPROXIMATELY 5 MILES TO
THE IDAHO - WASHINGTON STATE LINE ON THE
WEST EDGE OF SECTION 12, T50N, R06W, B.M.
KOOTENAI CO.**

PERIOD OF USE: RATE OF FLOW

**NOVEMBER 1 TO JUNE 30: 2,495 CFS
JULY 1 TO OCTOBER 31: 951 CFS**

PURPOSE:

**INSTREAM FLOW FOR THE PROTECTION OF
FISH AND WILDLIFE HABITAT, AQUATIC LIFE,
AND RECREATIONAL VALUES.**

IWRB3

WATER RIGHT SUMMARY

**SOURCE LISTED AS SPOKANE RIVER
IN MINIMUM STREAMFLOW REACH AND AT
POST FALLS DAM**

POWER RIGHTS AT DAM

5,410.00 CFS 2 RIGHTS

OTHER RIGHTS IN MINIMUM STREAMFLOW SECTION

9.68 CFS 25 RIGHTS

[Faint, illegible stamp or text in bottom right corner]

Includes Applications

WR NUMBER	SOURCE	TRIBUTARY TO	PRIORITY DATE	DIVERSION RATE - CFS	DIVERSION VOLUME- AFA	STAGE	USE
9508780	SPOKANE RIVER	COLUMBIA RIVER	06/15/92	2495.000	0.00	A	MINIMUM INSTREAM FLOW
9504705	SPOKANE RIVER	COLUMBIA RIVER	09/01/89	0.560	0.00	S	INDUSTRIAL
9504168	SPOKANE RIVER	COLUMBIA RIVER	06/01/50	0.030	0.00	S	IRRIGATION
9504518	SPOKANE RIVER	COLUMBIA RIVER	01/01/07	4250.000	0.00	S	POWER
9507100	SPOKANE RIVER	COLUMBIA RIVER	03/24/70	0.020	1.20	L	DOMESTIC
9507762	SPOKANE RIVER	COLUMBIA RIVER	08/05/77	0.040	1.20	L	DOMESTIC
9507761	SPOKANE RIVER	COLUMBIA RIVER	08/05/77	0.040	1.20	L	DOMESTIC
9508003	SPOKANE RIVER	COLUMBIA RIVER	03/17/80	1160.000	0.00	P	POWER
9507461	SPOKANE RIVER	COLUMBIA RIVER	06/21/74	0.040	1.20	L	DOMESTIC
9508648	SPOKANE RIVER	COLUMBIA RIVER	04/10/90	0.040	0.00	P	IRRIGATION
9502061	SPOKANE RIVER	COLUMBIA RIVER	12/27/21	0.300	0.00	L	IRRIGATION
9502089	SPOKANE RIVER	COLUMBIA RIVER	10/23/50	0.320	0.00	L	IRRIGATION
9502105A	SPOKANE RIVER	COLUMBIA RIVER	05/06/53	0.030	0.00	L	IRRIGATION
9504052	SPOKANE RIVER	COLUMBIA RIVER	06/01/02	0.020	0.00	S	IRRIGATION
9508550	SPOKANE RIVER	COLUMBIA RIVER	07/07/87	0.020	1.80	L	IRRIGATION
9508541	SPOKANE RIVER	COLUMBIA RIVER	03/24/87	0.020	0.60	L	DOMESTIC
9502092	SPOKANE RIVER	COLUMBIA RIVER	09/10/51	1.060	0.00	L	IRRIGATION
9502105B	SPOKANE RIVER	COLUMBIA RIVER	05/06/53	0.130	0.00	L	IRRIGATION
9502106	SPOKANE RIVER	COLUMBIA RIVER	05/02/55	0.380	0.00	L	IRRIGATION
9507568	SPOKANE RIVER	COLUMBIA RIVER	10/27/75	0.500	87.50	L	IRRIGATION
9502108	SPOKANE RIVER	COLUMBIA RIVER	08/28/54	0.240	0.00	L	IRRIGATION
9508676	SPOKANE RIVER	COLUMBIA RIVER	10/01/90	0.660	0.00	P	IRRIGATION
9507134	SPOKANE RIVER	COLUMBIA RIVER	01/28/71	0.150	25.55	L	IRRIGATION
9502030	SPOKANE RIVER	COLUMBIA RIVER	12/14/08	0.300	0.00	L	IRRIGATION
9507017	SPOKANE RIVER	COLUMBIA RIVER	05/24/68	1.230	430.50	L	IRRIGATION
9507376	SPOKANE RIVER	COLUMBIA RIVER	09/28/73	0.140	24.50	L	IRRIGATION
9502087	SPOKANE RIVER	COLUMBIA RIVER	01/08/52	2.680	0.00	L	IRRIGATION
9502078	SPOKANE RIVER	COLUMBIA RIVER	04/14/45	0.730	0.00	L	IRRIGATION
NUMBER OF RIGHTS = 28				7914.680	575.25		

IWRB3-A

Water Right Number - 95-04518 Prefix Translation: WATER RIGHT Old (D) Number -

+ - - - - Last Name - - - - + + - First Name - - - - + + - - - - Address - - - - - +

*** C - CURRENT OWNER ***
WASHINGTON WATER POWER CO.

1 - P.O. BOX 3727
2 -
3 -
City- SPOKANE State- WA Zip- 99220
Phone -

+ - - Priority Date - - + + - - Region - - - + + - - Stage - - - + + - - Status - - - +
01/01/1907 18 NORTHERN S - STATUTORY CLAIM

+ - - - - Source - - - - + + - - - - Tributary - - - - - +
SPOKANE RIVER COLUMBIA RIVER

+ - - - - Point of Diversion - - - - - +

TwN	Rng	Sec	Tract	Lot	Rflg	County	Diversion Name	Diversion Rate	Diversion No.
50N	05W	4	SE NE		(55)	KOOTENAI			

+ - - - - Description Period From Period To Diversion Rate Diversion Volume

28 - POWER 01/01 12/31 4250.000

+ - Total Div. Rate - + + - Total Div. Volume - + + - Total Div. Capacity - +
4250.000

TwN	Rng	Sec	Tract	Lot	Acres	Code	Description	County
50N	05W	4	SE NE			28	POWER	(55) KOOTENAI

+ - - Diversion Means -

+ - - Non-Irrigation Use - P/3260 HP UNDER 62 FT. HEAD.

+ - - Other Rights for Same Use -

+ - - - - Remarks - - - - - +
No Remarks found.

+ - - - - Old Water Right Numbers - - - - - +
No Old Water Right Numbers found.

+ - - - - Conditions of Approval - - - - - +
No Conditions of Approval found.

+ - - - - Decree Plaintiff - - - + + - - - - Decree Defendant - - - + + - Decree Date - +
00/00/0000

I WRB3B

WATER RIGHT

Water Rights Dates and Flags Area

Proof Due Date	- 00/00/0000	Field Exam Made	- 00/00/0000	Field Exam Fee	-
Approved/Denied	- 00/00/0000	Protested Date	- 00/00/0000	Swan Falls	-
Proof Made Date	- 00/00/0000	Hearing Date	- 00/00/0000	Temporary Right	-
Exam to S.O. Date	- 00/00/0000	Verified Date	- 00/00/0000	DLE/Carey Act	-
Order Show Cause	- 00/00/0000	Receipt Number	-	Water District	-
Licensed Date	- 00/00/0000	Appl Received	- 00/00/0000	Transfer/Amended	-
Decree Date	- 00/00/0000	Presumption Flag	-		-

IV RB 3C

Water Right Number - 95-08003 Prefix Translation: WATER RIGHT Old (D) Number -
+ - - - - Last Name - - - + + - First Name - - - + - - - - - Address - - - - - +

*** C - CURRENT OWNER ***
WASHINGTON WATER POWER CO.

1 - P.O. BOX 3727
2 -
3 -
City- SPOKANE State- WA Zip- 99220
Phone -

+ - - Priority Date - - + + - - - Region - - - + + - - - Stage - - - + + - - - Status - - - +
03/17/1980 18 NORTHERN P - PERMIT
+ - - - - Source - - - - - + + - - - - - Tributary - - - - - +
SPOKANE RIVER COLUMBIA RIVER

+ - - - - - - - - - - - - - - - Point of Diversion - - - - - Diversion Name Diversion Rate Diversion No.
TwN Rng Sec Tract Lot RFlg County (55) KOOTENAI

50N 05W 4 SE NE 1160.000
+ - - - - - - - - - - - - - - - Water Use - - - - - Diversion Rate Diversion Volume
Code Description Period From Period To 01/01 12/31 1160.000

28 - POWER
+ - Total Div. Rate - + + - Total Div. Volume - + + - Total Div. Capacity - +
1160.000

+ - - - - - - - - - - - - - - - Place of Use - - - - - Description County
TwN Rng Sec Tract Lot Acres Code 28 POWER (55) KOOTENAI

+ - - Diversion Means - TURBINE GENERATOR.
+ - - Non-Irrigation Use -
+ - - Other Rights for Same Use -

+ - - - - - - - - - - - - - - - Remarks - - - - - +
No Remarks found.

+ - - - - - - - - - - - - - - - Old Water Right Numbers - - - - - +
No Old Water Right Numbers found.

+ - - - - - - - - - - - - - - - Conditions of Approval - - - - - +
01A - For licensing purposes, a scientific measurement of the diver-
- sion rate of the system as it is normally operated shall be pro-
- vided by either properly installing and approved type of mea-
- suring device or by having a professional engineer certify the
- rate of diversion to the Department prior to submitting proof of
- beneficial use of water.
08A - This right is subject to the provisions of Sections 42-205

IWRB3D

WATER RIGHT

| | | | | | |
|-------------------|--------------|------------------|--------------|------------------|-----|
| Proof Due Date | - 03/01/1985 | Field Exam Made | - 04/12/1985 | Field Exam Fee | - |
| Approved/Denied | - 02/24/1983 | Protested Date | - 00/00/0000 | Swan Falls | - |
| Proof Made Date | - 01/01/1900 | Hearing Date | - 00/00/0000 | Temporary Right | - P |
| Exam to S.O. Date | - 00/00/0000 | Verified Date | - 00/00/0000 | DLE/Carey Act | - |
| Order Show Cause | - 00/00/0000 | Receipt Number | - | Water District | - |
| Licensed Date | - 00/00/0000 | Appl Received | - 00/00/0000 | Transfer/Amended | - |
| Decree Date | - 00/00/0000 | Presumption Flag | - | | |

INR 63E

IVRB4

IN DEFENSE OF IDAHO'S WATER

A Report to Governor Cecil D. Andrus

September 1991

IN DEFENSE OF IDAHO'S WATER

A Report to Governor Cecil D. Andrus

Prepared by

**Ray Rigby
John Rosholt
Scott Reed
A. Kenneth Dunn
Brian Donesley
Reed Hansen
Gene Gray
J. D. Williams
R. Keith Higginson**

September 1991

Recommendations

1) The Group recommends that the state continue to participate in discussions of the issue of potential endangered species listing for salmon with other entities in the Northwest. Our effort should be geared toward reaching the goal of fishable salmon in Idaho while protecting the ability of the state to utilize its water resources for multiple purposes. It is noted that the legislature approved some funding through the Governor's office to allow the various state agencies to participate in these regional water and fishery discussions. Idaho needs to aggressively assert its position that the problem of survival of the salmon in the Snake River basin will not be resolved by placing the burden upon the state of Idaho and its citizens.

2) The state needs a coordinated effort through the Governor's office to respond to the other activities in the region which will impact on Idaho's water resources. These include those items listed in the early part of this section. It will particularly be important that the state influence the decisions made in relicensing the power projects of the Idaho Power Company in Hells Canyon and elsewhere along the Snake River to assure that the benefits gained from prior license conditions and the Swan Falls Agreement are not lost.

Summary

The Water Defense Group has been pleased to respond to Governor Andrus' request that it consider and make recommendations of actions which need to be taken to protect Idaho's valuable water resources. We hope that this paper which has discussed the issues originally presently to the Group by the Governor will be helpful to officials of the state whose responsibility it is to represent Idaho and her interests.

We have recommended the following:

1) Idaho should place a great deal more emphasis and effort (financial and staff) into comprehensive water resources planning which considers the present and potential future uses of Idaho's water. This would demonstrate the need of conserving the resource for future use within the state. It should be Idaho's goal to have in place a completed and approved comprehensive water plan for at least two-thirds of the state's river basins by the year 2000. Particular attention and priority should be given to those streams which potentially could be threatened for water export. Under Section 10 of the FPA, FERC is required to consider state comprehensive water plans in its licensing decisions. Since FERC does little or no comprehensive planning, a well-crafted state water plan should provide the record necessary for the state to successfully argue for water uses consistent with the state long term needs. Additionally, under section 210 of the Public Utility Regulatory Policies Act of 1978, PURPA benefits cannot be extended by FERC to a hydroelectric project on

any segment of a natural watercourse designated by the state as a natural or recreational river.

2) The Governor should consider recommending to the Legislature the appropriation in trust of a portion of the unappropriated waters of streams in north Idaho to preserve the flows required to protect instream values. The Departments of Water Resources, Fish and Game and Parks and Recreation should be asked to study these northern streams and recommend the quantities to be preserved in this manner to protect these uses.

3) The Water Defense Group recommends that the State of Idaho support the legislation drafted by the Idaho Department of Water Resources and the Idaho Attorney General's Office and introduced in the House of Representatives by Rep. Richard Stallings and Rep. Larry LaRocco as H.R. 649 and in the Senate by Senator Craig and Senator Symms as S. 106 to correct the Supreme Court's misinterpretation of the FPA. The bill clarifies that the FPA is not intended to preempt state authority to regulate the use of water by hydropower facilities.

4) There should be a central clearing house for state agency comments to the FERC. Although state agencies have attempted to some extent to coordinate their comments in FERC proceedings, a formal process for participation in the process would enhance the state's ability to influence the FERC decision-making process and to avoid conflicting state positions.

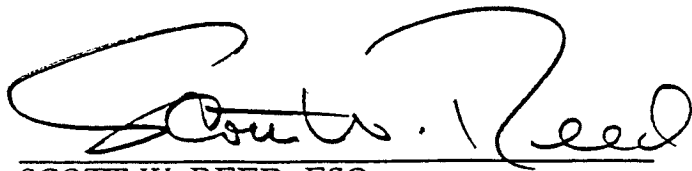
5) Minimum flow water rights should be established for all river reaches in Idaho as expeditiously as practical. These minimum flows will serve as a means of ensuring that FERC-established conditions recognize and protect other state interests.

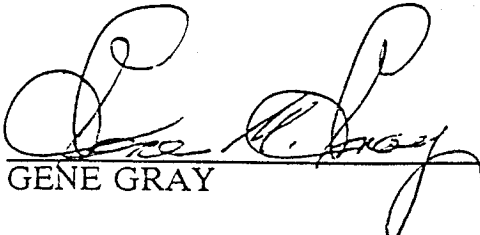
6) The state should continue to discuss with other entities in the Northwest the issues of listing salmon stocks as endangered species. It will also be important for the state to continue participating in efforts to recover declining salmon stocks to insure that the state's interests in both its anadromous fisheries and water resources are protected.

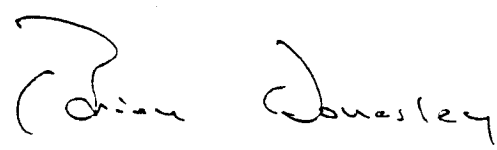
7) The state needs a coordinated effort through the Governor's office to respond to all activities in the region and state which will impact on Idaho's water resources. For example, it will particularly be important for the state to participate in the FERC relicensing process for hydropower projects along the Snake River to assure that the state's right to regulate its water resources is protected.

The foregoing report and recommendations are respectfully submitted to Governor Cecil D. Andrus by the members of his appointed Water Defense Group.


RAY RIGBY, ESQ.

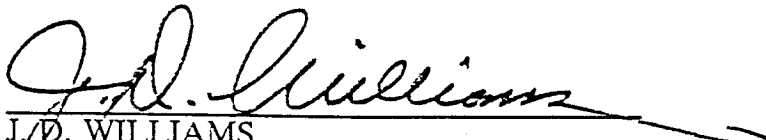

SCOTT W. REED, ESQ.

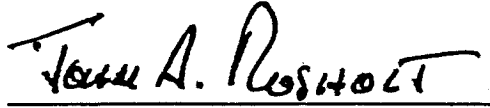

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J.D. WILLIAMS


JOHN ROSHOLT


R. KEITH HIGGINSON

AUG 1 1974

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JUL 1 1975

Department of Water Resources

INSTREAM FLOW REGIMENS
FOR
FISH, WILDLIFE, RECREATION
AND
RELATED ENVIRONMENTAL RESOURCES

| | |
|--------------------------------|--|
| Director | |
| Asst. Dir. | |
| Adm. Serv. | |
| Ext. Aff. | |
| Finance | |
| Gen. Inv. | |
| Ident. & Rec. | |
| Inspection | |
| Int. Aff. | |
| Lab. | |
| Legal Coun. | |
| Plan. & Eval. | |
| Spec. Inv. | |
| Training | |
| Off. of Cong. & Public Affairs | |

By

DONALD L. TENNANT
U.S. FISH AND WILDLIFE SERVICE
711 CENTRAL AVENUE
BILLINGS, MONTANA 59102

1975

| | | |
|--------------------------|-------------|----|
| WZ ST. WATER PLG. BUREAU | | |
| / | Snake River | DM |
| / | Bear | DM |
| / | Panhandle | 11 |
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| | File: | |

ACKNOWLEDGEMENT

*Dedicated to all the scientists who helped develop the
"Montana Method" for prescribing instream flows to protect
our natural, free-flowing aquatic environment.*

*May this work serve them and their colleagues well in
future efforts to preserve and enhance this vital resource.*

D. L. Tennant

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ABSTRACT

Describes the "Montana Method," a quick, easy methodology for determining flows to protect the aquatic resources in both warm-water and coldwater streams based on their average flow. With this method, biologists do their analysis with the aid of hydrological data provided by the U.S. Geological Survey. Detailed field studies were conducted on 11 streams in 3 states between 1964 and 1974, testing the "Montana Method." This work involved physical, chemical, and biological analyses of 38 different flows at 58 cross-sections on 196 stream-miles, affecting both coldwater and warmwater fisheries. Reports or publications on 6 study streams are available. Numerous black and white photos and 35 mm. slides were taken of all the flow stages studied at each cross-section. The studies were all planned, conducted, and analyzed with the help of state fisheries biologists. Results reveal that the condition of the aquatic habitat is remarkably similar on most of the streams carrying the same portion of the average flow. Similar analyses of hundreds of additional flow regimens near U.S.G.S. gages in 21 different states during the past 17 years substantiated this correlation on a wide variety of streams. Running waters studied ranged from small precipitous brooks high in the Rocky Mountains to large, low-gradient rivers and streams out on the prairies of mid-America or along the coastal plains. Results are consistent from stream to stream or state to state, and it is impossible to get a zero flow recommendation using this method. Ten percent (10%) of the average flow is a minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms. Thirty percent (30%) of the average flow is recommended as a base flow to sustain good survival habitat for most aquatic life forms. Sixty percent (60%) of the average flow is recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses. Thirty pages illustrated with tables, graphs, and photos.

INTRODUCTION

Natural, free-flowing streams are one of the world's most beautiful and valuable resources. Before the coming of Christ, the Roman Emperor Justinian said: "By the law of nature certain things are common property; for example, the air, running water, and the sea." America's late Senator Norris said: "The streams that are flowing downhill were given us by a creator. They do not belong to any special interest or to any individual. They belong to the people and ought to be utilized for the benefit of all of them."

Few streams in the United States have escaped degradation from altered flows by some kind of man-made, "water development" project. Some recognition is finally being given to instream flow regimens to protect the natural environment. Scientists from many disciplines are seeking reliable, practical methods for determining streamflow requirements to protect fishes, waterfowl, furbearers, reptiles, amphibians, mollusks, aquatic invertebrates, and related life forms from all the various people competing for our Nation's water.

With the help of several hydrologists and many state and federal biologists, I have developed a quick, easy method for determining ? flows to protect the aquatic resources, in both warmwater and cold-water streams. This methodology evolved over the past 17 years from my work on hundreds of streams in the states north of the Mason-Dixon Line between the Atlantic Ocean and the Rocky Mountains. My work has been cited in a score of publications and is best known as the "Montana Method."

METHOD

The Montana Method is so brief it can be typed on a 3" x 5" card. It can be applied rapidly to many segments of thousands of streams by referring to Table 1 of this paper and surface water records of the U.S. Geological Survey (U.S.G.S.). 1/

The following intensive use of this method will produce a factual, conclusive, streamflow study on any stream. First, determine the average annual flow of the stream at the location(s) of interest (listed as AVERAGE DISCHARGE by U.S.G.S. and hereinafter called average flow). If the average flow isn't published by the U.S.G.S., they can quickly calculate it for you. Visit the stream and observe, photograph, sample, and study flow regimens approximating 10%, 30%, and 60% of the average flow. Other flows can be studied, but these three regimens will cover a flow range from about the minimum to near the maximum that can normally be justified and recommended to protect the natural environment on most streams (fig. 1).

If the flow is not controlled, study U.S.G.S. records for flow patterns, then go to the field and check their gage(s) until you can view and study natural flows approximating 10%, 30%, and 60% of the average flow.

If flows are controlled, begin by having the highest flow you wish to study released first, then regulate so that each succeeding lower flow will begin the following midnight. Photos taken early the next morning

1/ Water Resources Data for (name of state), Part 1. Surface Water Records, United States Department of the Interior, Geological Survey.

Table 1

Instream Flow Regimens for Fish, Wildlife, Recreation and Related
Environmental Resources

| Narrative Description
of Flows ^{1/} | Fisheries
Classification ^{2/} | Recommended Base Flow Regimens | |
|---|---|--|--------------|
| | | Oct.-Mar. | : Apr.-Sept. |
| Flushing or Maximum | -- | 200% of the average flow ^{3/} | |
| Optimum Range | -- | 60%-100% of the average flow ^{4/} | |
| Outstanding | I | 40% | 60% |
| Excellent | II | 30% | 50% |
| Good | III | 20% | 40% |
| Fair or Degrading | IV | 10% | 30% |
| Poor or Minimum | -- | 10% | 10% |
| Severe Degradation | -- | 10% of average flow to zero flow | |

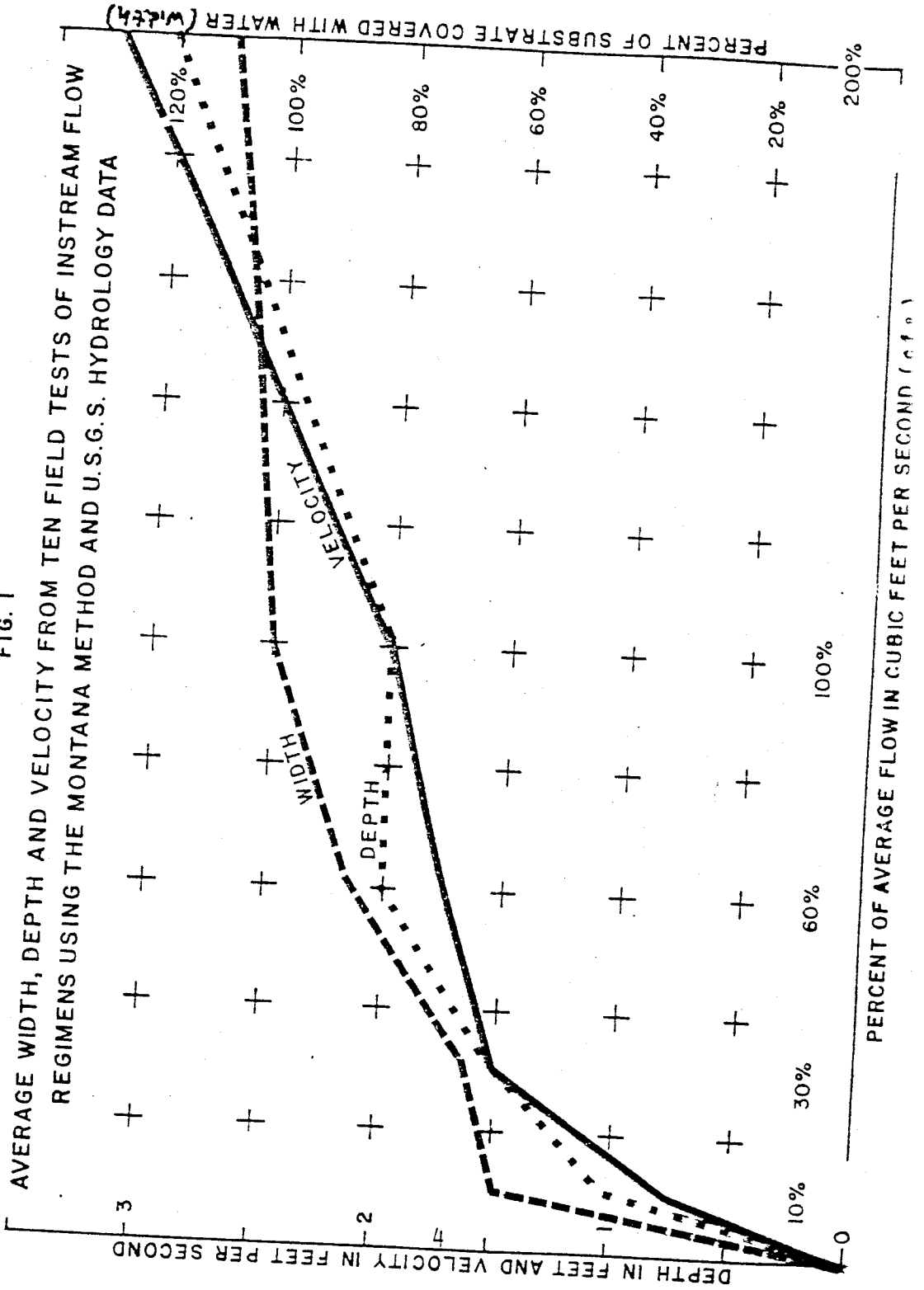
^{1/}Most appropriate description of the general condition of the streamflow for all the parameters listed in the title of this paper.

^{2/}Roman numeral ratings for Fisheries Classification Systems like those developed for the States of Idaho, Montana, West Virginia, Wyoming, and the Delaware River Basin Comprehensive Study by the U.S. Fish and Wildlife Service.^{5, 11, 14, 19, 26} The base flow regimens outlined above in columns 3 and 4 to maintain the respective designated classes, are judged to be as reliable and valid as the classification systems themselves. These recommended flows generally apply very well to both cold and warm water streams. Regimens should be reversed or altered to fit different hydrologic cycles, like the Salmonid streams on the West Coast, or to favor species like the fall spawning brown trout. Flows may be refined further by specifically matching them to vital periods of the life cycle of fishes, like migration, spawning, incubation, growth, etc. Use of the Montana Method on spring creeks or streams that have a very uniform flow year-around may provide unprecedented low-flow regimens at the minimum or base flow levels.

^{3/}The average flow will usually fill the active stream channel approximately 1/3 full or to the line of permanent terrestrial vegetation, while 3 times the average flow will often fill the active channel approximately to the point of spilling out on the first bench of the flood plain.¹⁵ Twice the average flow will produce effective depths and velocities within the stream channel for moving silt, sediment and other bed load material without doing extensive damage to the banks and riparian vegetation. Twice the average flow is a good maximum flow recommendation as well as a good flushing flow (Fig. 1).

^{4/}Optimum is a nebulous term; however, this flow range covers that definition best for all the parameters of this paper collectively.

FIG. 1



will reveal the difference in exposed substrate or wetted perimeter (fig. 2). This is photographic "regression analysis." An 8 - 10 hour interval will normally be sufficient to negate any appreciable differences in flow levels due to bank storage.

Pictures may be the best data you will collect for selling your recommendations to the general public, administrators of construction agencies managing water development projects, and judges or juries adjudicating water laws. Black and white photographs and 35 mm. slides of key habitat types (e.g., riffles, runs, pools, islands and bars) from elevated vantage points like bridges and high stream banks will give results superior to ground level shots or photos from aircraft high above the stream. Record appropriate, vital information on all photographs and slides as soon as they are received.

U.S.G.S. monthly measurements cover a variety of flows at most of their stream gage or cable crossings. Obtain cross-sectional data on width, depth, and velocity measurements from the local U.S.G.S. field office for flow regimens under study. Use this information to plot and compare water widths, depths, and velocities to known requirements for aquatic resources. U.S.G.S. will make specific cross-sectional measurements of width, depth, and velocity at any point on a stream for a reasonable fee. With the proper experience, equipment, and plenty of time, others can make the necessary cross-sectional measurements. Study both the average daily streamflow regimen tables and previous historic low-flow data published by U.S.G.S. to learn the base flow patterns of the climatic year and help determine and justify your final recommendations.

Fig. 2



Missouri River below Holter Dam, Montana, showing differences between flows of 3,000 cfs (55% of the average flow) and 2,000 cfs (37% of the average flow). The vertical drop was 7 inches. Flows reduced about midnight will clearly reveal differences in wetted substrate when photographed the next morning (photographic "regression analysis").

MRBS Photo #9000
by Don Tennant 6/10/70

Recommend the most appropriate and reasonable flow(s) that can be justified to provide protection and habitat for all aquatic resources.

RESULTS

Detailed field studies were conducted on 11 streams in 3 states between 1964 and 1974 testing the Montana Method (Table 2). This work involved physical, chemical, and biological analyses of 38 different flows at 58 cross-sections on 196 stream miles, affecting both coldwater and warmwater fisheries. Reports or publications on 6 study streams are available as indicated in Table 2. Numerous black and white photos and 35 mm. slides were taken of all the flow stages studied at each cross-section. The studies were all planned, conducted, and analyzed with the help of state fisheries biologists. These studies reveal that the condition of the aquatic habitat is remarkably similar on most streams carrying the same portion of the average flow.

Width, depth, and velocity are physical instream flow parameters vital to the well-being of aquatic organisms and their habitat. Sixteen-hundred measurements of these parameters for 48 different flows on 10 of the streams cited in Table 2 show that they all increase with flow and that changes are much greater at the lower levels of flow (fig.1). Width, depth, and velocity all changed more rapidly from no flow to a flow of 10% of the average, than at any point thereafter. Ten percent (10%) of the average flow covered 60% of the substrates, depths averaged 1 foot, and velocities averaged $3/4$ foot per second. Studies show that these are critical points or the lower limits for

Table 2

DETAILED STUDIES OF INSTREAM FLOW REGIMENS USING THE MONTANA METHOD

| Name of Stream | State | Date | Miles Studied | Number of Stations | Different Flows | Parameters Studied (1) | Type of Fishery (2) | Reference |
|-------------------|----------|------|---------------|--------------------|-----------------|------------------------|---------------------|-----------|
| Republican R. | Nebraska | 1964 | 40 | 3 | 4 | W,D,V,S,B,C,T,F | WW | 25 |
| Wind-Bighorn R. | Wyoming | 1968 | 50 | 10 | 3 | W,D,S,B,C,T,F | CW & WW | 24 |
| Marias R. | Montana | 1968 | 67 | 9 | 3 | W,D,V,S,B,C,T,F | CW & WW | |
| Missouri R. | Montana | 1970 | 15 | 8 | 4 | W,D,V,S,B,C,I,F | CW & WW | |
| Blacks Fork R. | Wyoming | 1971 | 16 | 4 | 3 | W,D,V,S,C,I | CW | 31 |
| Shoshone Creek | Wyoming | 1971 | 1 | 2 | 9 | W,D,V,S,B,C,F | CW | |
| Ruby R. | Montana | 1971 | 1 | 4 | 3 | W,D,V,S,B,C,F | CW | |
| W. Fk. Bitterroot | Montana | 1971 | 1 | 5 | 3 | W,D,V,S,B,C,F | CW | 10 |
| W. Rosebud R. | Montana | 1971 | 3 | 3 | 4 | W,D,V,S,B,C,F | CW | 10 |
| N. Platte R. | Wyoming | 1974 | 2 | 10 | 2 | W,D,V,S,B,C,F | CW & WW | 10 |
| Totals | | | 196 | 58 | 38 | | | |

- (1) Parameters Studied -- W=Width, D=Depth, V=Velocity, S=Substrate & Sidechannels, B=Bars & Islands, C=Cover
M=Migration, T=Temperature, I=Invertebrates, F=Fishing & Floating, E=Esthetics & Natural Beauty
- (2) Type Fishery -- WW=Warmwater, CW=Coldwater

the well-being of many aquatic organisms, particularly fishes. This substantiates the conclusion that this is the area of most severe degradation or that 10% is a minimum short-term survival flow at best. Flows from 30% to 100% of average result in a gain of 40% for wetted substrate, average depth increases from $1\frac{1}{2}$ to 2 feet, and average velocities rise from $1\frac{1}{2}$ to 2 feet per second. These are within good to optimum ranges for aquatic organisms, however, it requires 3 to 10 times the amount of water needed for a short-term minimum or good base flow, and gains or benefit-cost ratios may become questionable. Increasing flow from 100% of average to 200% of average (doubled) only increases average wetted substrate by 10%, average depth increases from 2 to 3 feet, and average velocity rises from 2 to $3\frac{1}{2}$ feet per second. Velocities averaging $3\frac{1}{2}$ feet per second are probably too high for the general well-being of most aquatic organisms but good for moving sediment, bedload, and white water boating. In all 11 field tests of the Montana Method, water depth appeared adequate for aquatic organisms whenever velocities were satisfactory.

Analyses of hundreds of additional flow regimens near U.S.G.S. gages in 21 different states during the past 17 years substantiate these correlations between similar flows on a wide variety of streams. Running waters studied ranged from small precipitous brooks high in the Rocky Mountains, to large, low-gradient rivers out on the prairies of mid-America and streams along the coastal plains. This phenomenon of nature is documented with hundreds of black and white photographs and 35 mm. slides that are registered and filed with the U.S. Fish and Wildlife Service (FWS) in Billings, Montana; Grand Island, Nebraska; and Denver, Colorado.

The average flow of a stream (or any given portion or percent of the average flow) is a composite manifestation of the size of the drain area, geomorphology, climate, vegetation, and land use. These relationships have also been evaluated and reported by other biologists and hydrologists. 8, 13, 15, 16, 18, 29, 31

Use of the Montana Method has produced over 100 separate streamflow recommendations to protect fish, wildlife, and environmental resources in more than 70 reports issued by the FWS.²⁰ The recommendations were made with the aid of district fishery biologists from 11 different states, endorsed by both the Directors of their state Fish and Game Departments and the Director of the FWS and generally accepted by various construction agencies. This work occurred on at least 30 warmwater streams and 70 coldwater streams.

Many of our recommendations were not adopted, since providing stream flow for fish, wildlife, and environmental preservation or enhancement is not a legal beneficial use of water in most of the country, especially the 17 western states.⁹ Administrators managing water development projects have generally been willing to regulate flow regimens for instream flow studies and provide minimum flows necessary to protect these resources when there is plenty of water. However, these resources are the first to suffer when water is short. 6, 9, 24, 25, 27

In 1970, the project managers of the U.S. Bureau of Reclamation, U.S. Corps of Engineers, and the Montana Power Company were requested to identify the minimum flows that they recognized solely for the

n- protection of fish, wildlife, and the aquatic environment, downstream from dams under their jurisdiction.²¹ These agencies control the operation of 23 major dams in Montana and Wyoming. Table 3 compares their replies to previous FWS recommendations and mean and minimum flows of record.

The agencies reported minimum flows for fish, wildlife, and environmental protection which ranged from zero (four instances) to 38% of the average flow. The 38% flow was the result of fish and wildlife interests getting 500 cubic feet per second (cfs) released below Kortes Dam on the North Platte River in Wyoming. Congress reauthorized the operation of that project, which took about 10 years and is the only known accomplishment of its kind in the U.S.A.

Twelve of the 21 flows accepted by the agencies were less than 10% of the average flow of record, which is inadequate to sustain the normal life cycles of either warmwater or salmonid fishes.

Federal and state biologists analyzed flows and made flow recommendations on 12 of the streams involved. However, flows accepted by the agencies agreed with these recommendations in only 3 instances.

In 10 of 20 cases, the minimum natural inflow of record to the regulating reservoir exceeded their recognized release for the conservation of fish, wildlife, and the aquatic environment downstream below the dams. All flow recommendations should stipulate that outflow from dams should at least equal inflow when managing agencies cannot release the flow regimens requested to protect the environment. Project

Table 3
Minimum Instantaneous Flows for Fish, Wildlife, and Aquatic Environment Below Dams
in the Missouri River Basin in Montana and Wyoming - 1970

| Dam & Agency | Minimum Flow for Fish Recognized by Construction Agency | % of Mean Flow | Mean Flow of Record | FWS Recommended Min. Flow | % of Mean Flow | Minimum Reservoir Inflow or Natural Flow of Record |
|----------------------|---|----------------|---------------------|---------------------------|----------------|--|
| Seminole (BR) | --- | | | | | |
| Kortes (BR) | 500 cfs | 38% | 1279 cfs | | | 70 cfs |
| Pathfinder (BR) | 0 cfs | 0% | 1300 cfs | 500 cfs | 38% | 70 cfs |
| Alcova (BR) | --- | | 1423 cfs | | | 70 cfs |
| Gray Reef (BR) | 330 cfs | 22% | 1500 cfs | | | 70 cfs |
| Glendo (BR) | 0 cfs | 0% | 1500 cfs | 330 cfs | 22% | 70 cfs |
| Guernsey (BR) | 0 cfs | 0% | 1680 cfs | | | 70 cfs |
| Boysen (BR) | 100 cfs | 7% | 1710 cfs | | | 170 cfs |
| Buffalo Bill (BR) | 15 cfs | 1% | 1350 cfs | 250-400 cfs | 19-30% | 170 cfs |
| Heart Mountain (BR) | 200 cfs | 16% | 1256 cfs | 350 cfs | 28% | 42 cfs |
| Yellowtail (BR) | 1000 cfs | 29% | 1256 cfs | 350 cfs | 28% | 41 cfs |
| Clark Canyon (BR) | 25 cfs | 8% | 3500 cfs | 1000 cfs | 29% | 41 cfs |
| Barretts Div. (BR) | 25 cfs | 6% | 324 cfs | 250 cfs | 77% | 179 cfs |
| Hebgen (MP) | 50 cfs | 5% | 405 cfs | 200 cfs | 29% | 69 cfs |
| Ennis (MP) | 200 cfs | 12% | 969 cfs | 400 cfs | 41% | 69 cfs |
| Holter (MP) | 1000 cfs | 19% | 1675 cfs | | | |
| Moroney (MP) | 1500 cfs | 20% | 5289 cfs | 2000 cfs | 38% | 200 cfs |
| Ft. Peck (CE) | 3000 cfs | 32% | 7362 cfs | | | 275 cfs |
| Gibson (BR) | 50 cfs | 6% | 9292 cfs | | | 747 cfs |
| Sun River Div. (BR) | 100 cfs | 12% | 850 cfs | 270 cfs | | 1760 cfs |
| Sherburne (BR) | 0 cfs | 0% | 852 cfs | 270 cfs | 32% | 1120 cfs |
| St. Mary's Div. (BR) | 25 cfs | 3% | 200 cfs | | | 60 cfs |
| Fresno (BR) | 25 cfs | 6% | 790 cfs | | 32% | 47 cfs |
| Tiber (BR) | 100 cfs | 11% | 430 cfs | | | 0 cfs |
| | | | 880 cfs | 250 cfs | 28% | 16 cfs |
| | | | | | | 0 cfs |
| | | | | | | 10 cfs |

1/ Outflow directly into Kortes
 2/ Outflow directly into Gray Reef
 3/ A Canal to Milk River - Canada

managers often reminded us that there were no legal requirements for providing any water specifically for the conservation or enhancement of fish, wildlife, and environmental resources. Water agencies "sell" their projects by declaring that their operation will moderate the extreme high and low flows that occur naturally. Just the opposite was true on $\frac{1}{2}$ of these projects. Our analysis did not include scores of existing, smaller projects under the programs of the U.S. Forest Service and the U.S. Soil Conservation Service, most of which did not recognize or provide any minimum flows for fish, wildlife, or the environment.

The Montana Method has been used by the FWS while conducting major comprehensive type studies that required quick, consistent streamflow recommendations for fish, wildlife, and the aquatic environment on numerous streams, covering extensive geographic areas.^{1, 2, 3, 4, 28} It has also been very useful for prescribing streamflows on large rivers where data are difficult to obtain using other procedures.

The Montana Method has virtues other than being quick and easy to use. It assures consistency from stream to stream or state to state. You always know the portion of the total streamflow requested and will never get a zero flow recommendation like some other methods produce (e.g., use of 7-day or 3-day minimum or historic minimum flow criteria). In 1970, I evaluated 7-day minimum flow criteria input for the Upper Missouri, Yellowstone, Kansas, and Platte-Niobrara Sub-Basins of the Missouri River Basin Comprehensive Study. I found that these criteria resulted in zero flow in 86 of 305 instances, or about 28% of the time.²²

In 236 of 305 cases (77%), the 7-day minimum flow was less than 10 of the average flow, which I consider in the range of severe degradation for most elements of the aquatic environment. Criteria for 3-day minimum flows would be worse yet, and recommending the meager, alltime, historic minimum flow would be unthinkable. That would be like prescribing a person's alltime worst health condition as a recommended level for a portion of his future well-being.

Avoid recommending vacillating flow regimens specifically for fishes coincidental with monthly (m.a.f.) or daily (d.a.f.) average flows because there are too many unknown, degrading effects on the life cycles of many other organisms in the aquatic environment and other uses of water to justify frequent ebb and flow changes in most streams. Quarterly variations in flow regimens might approximate climatic hydrology and be appropriate. The Montana Method can easily be modified to suit the individual convictions of any biologist or the monthly or daily hydrological variations of any given stream. I usually recommend variation in flow regimens for 6-month periods (e.g., columns 3 and 4 of Table 1) that mimic nature and coincide most naturally with the so-called climatic year used by the U.S.G.S. and the U.S. National Weather Service. This offers the following distinct advantages:¹² a) Stages of ground water are more nearly uniform on October 1 in most inland sections of the United States than on any other date, leading in general to fairly reliable comparisons of annual rainfall-runoff relations because of the relatively small errors due to annual differences in the ground-water table on that date; b) In the arid and semi-arid parts of the country, September 30 usually marks the end of the irrigation season and in humid regions

it approximates the end of the growing season; c) There is a minimum probable error due to the effect of ice in the records of winter flow if the discharge for the winter period (November to April) is computed together at one time; d) The winter or base flow period coincides with reduced metabolic functions and decreased demands for vital life elements by most aquatic organisms (e.g., oxygen, food, removal of waste products, and increased tolerance to pollution); e) A low flow winter period matches the downstream migration habits of many fishes (warmwater and coldwater), when they travel to deeper more permanent water to spend the winter. This is also the spawning and incubation season for most salmonids, when they naturally seek less water by moving into headwater or tributary streams and onto redds in shoal or shallow riffle areas; and f) Higher summer flow regimens provided by this method coincide with the frost-free, recreation season and the major growth period for most aquatic plants and animals, when their requirements for dissolved gases, space, food, and removal of septic waste products are naturally higher (the attendant increased width, depth, and velocities in the stream all serve to enhance the availability of elements vital to these recreation uses and critical life functions). These phenomena may be seasonally reversed for anadromous fishes using the coastal streams of Alaska, the Canadian Provinces, and our west coast states and flow regimens should be adjusted accordingly.

Using the Montana Method, it is easy to adjust to above or below normal water years and maintain stream flows that are appropriate portions of monthly, quarterly, or annual instream supplies of water. This helps fish, wildlife, and aquatic resources share surpluses and

shortages of water equitably with other users.

With the Montana Method, U.S.G.S measures the hydraulic characteristics of the stream and biologists interpret the biological responses. This saves considerable precious time that biologists can use on a more complete ecological analysis of streamflow needs. U.S.G.S. is recognized nationwide for its expertise in making reliable streamflow measurements, and their results are less apt to be questioned by water resource development agencies and more likely to withstand the scrutiny of adversaries in a court of law.¹² This method is applied to hundreds of thousands of streamflow records that have been published by U.S.G.S. since 1888 on most of the perennial streams in America. In 1972 alone, there were nearly 24,000 active, surfacewater gaging stations in the United States.¹⁷ U.S.G.S. employs more than 2,000 professional hydrologists, working out of 220 different locations to measure streamflow parameters on our Nation's lotic waters.¹² These scientists maintain and use several million dollars worth of specialized supplies and equipment specifically for this purpose.⁷

There is significant hydrological and biological evidence that the Montana Method can also be used successfully on streams throughout the world. 6, 8, 10, 13, 15, 16, 18, 23, 24, 25, 27, 29, 30, 31

U.S.G.S. is considering the revision of streamflow data programs for most of the states.²³ The majority of existing gages may be discontinued under its future program. Techniques like measuring channel geometry, interpolation from a known flow to an unknown flow, and correlations with adjacent streams will be used to provide streamflow

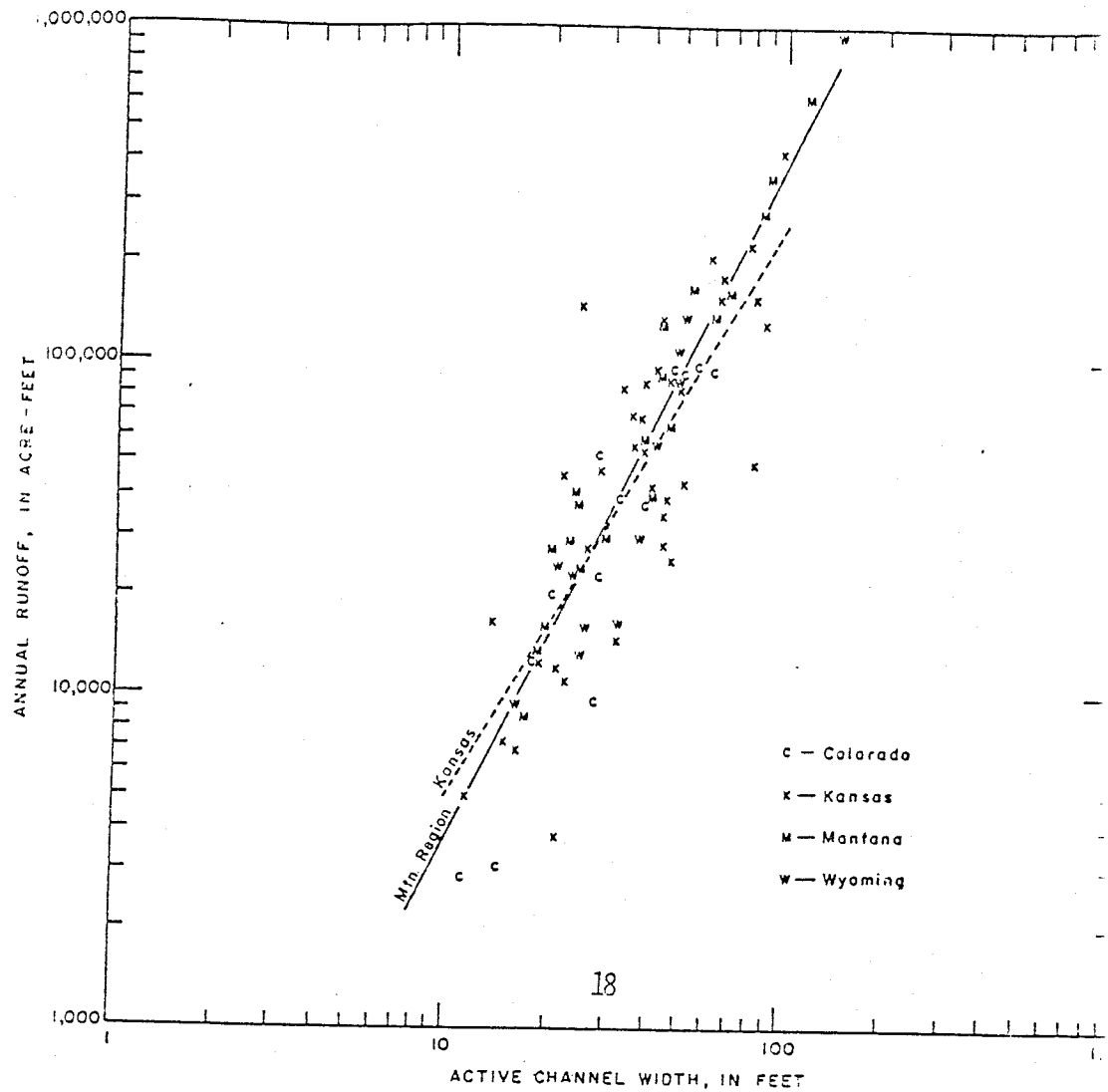
information at any point on any stream. Simple channel geometry measurements have produced average flow data as accurate as 10 years of continuous gage records.¹³ The standard errors were lowest for mountain regions and in competition with 5 to 10 years of gaged records for the plains region. There is very little variation when results are compared between channel width and average flow (fig.5). Mean annual discharge is one of the few criteria that will be routinely provided by this future program. Therefore, the Montana Method can still be used with this new program, since it is based primarily on knowledge of the mean annual discharge or average flow. The ability to provide the average flow at any point on any stream would actually facilitate the use of the Montana Method in the future.

Adopting the metric system would not require conversion tables or other problems since this method is based on percentages of the average flow however it is expressed.

CONCLUSIONS

The following conclusions on flows are the result of frequent observations and detailed analyses of flows from a wide variety of streams over a large geographical area of the United States

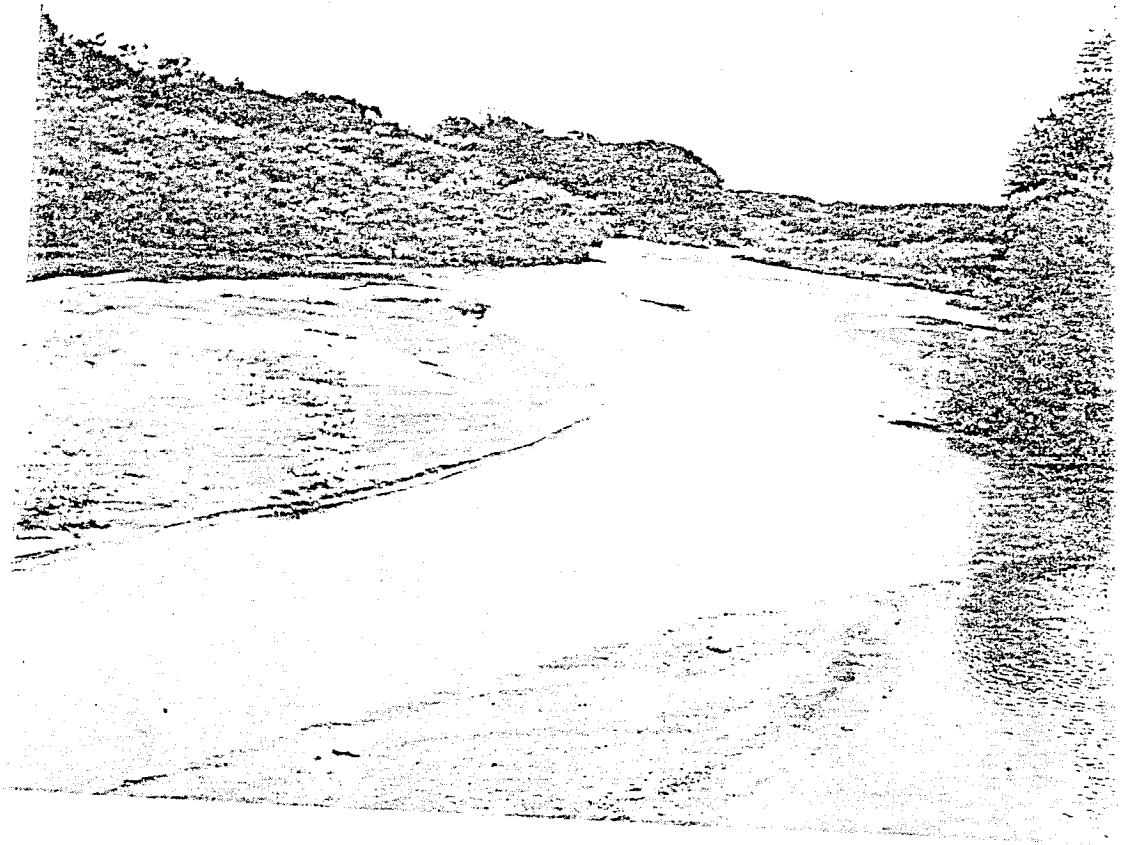
Fig. 3



Correlation between average flow and channel width for streams in the mountain and plains regions of Colorado, Kansas, Montana and Wyoming

Ten percent (10%) of the average flow (fig. 4): This is a minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms. Channel widths, depths, and velocities will all be significantly reduced and the aquatic habitat degraded (fig. 1). The stream substrate or wetted perimeter may be about $\frac{1}{2}$ exposed, except in wide, shallow riffle or shoal areas where exposure could be higher. Most side channels will be severely or totally dewatered. Most gravel bars will be substantially dewatered, and islands will usually no longer function as wildlife nesting, denning, nursery, and refuge habitat. Streambank cover for fish and fur animal denning habitat will be severely diminished. Many wetted areas will be so shallow they no longer will serve as cover, and fish will generally be crowded into the deepest pools. Riparian vegetation may suffer from lack of water. Large fish may have difficulty migrating upstream over many riffle areas. Water temperature may become a limiting factor, especially in the lower reaches of the stream in July and August. Invertebrate life will be severely reduced. Fishing will often be very good in the deeper pools and runs since fish will be concentrated. Many fishermen prefer this level of flow! However, fish may be vulnerable to overharvest. Floating is usually difficult even in a canoe or rubber raft (stream with an average flow of more than 100 cfs). Natural beauty and stream esthetics are badly degraded. Most streams carry less than 10% of the average flow at times, so even this low level of flow will occasionally provide some enhancement over a natural flow regimen.

Fig. 4



Republican River below Hardy Bridge, Nebraska, showing a flow of 42 c (10% of the average flow). Water depths were adequate to provide some fish cover, living space, movement and for fishing. Temperatures were within tolerable limits. This is a minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms.

MRBS Photo #7159
by Don Tennant 7/10/64

Thirty percent (30%) of the average flow (fig. 5): This is a base flow recommended to sustain good survival habitat for most aquatic life forms. Widths, depths, and velocities will generally be satisfactory (fig. 1). The majority of the substrate will be covered with water, except for very wide, shallow riffle or shoal areas. Most side channels will carry some water. Most gravel bars will be partially covered with water and many islands will provide wildlife nesting, denning, nursery, and refuge habitat. Streambanks will provide cover for fish and wildlife denning habitat in many reaches. Many runs and most pools will be deep enough to serve as cover for fishes. Riparian vegetation should not suffer from lack of water. Large fish should have no trouble moving over most riffle areas. Water temperatures are not expected to become limiting in most stream segments. Invertebrate life is reduced but not expected to become a limiting factor in fish production. Water quality and quantity should be good for fishing, floating, and general recreation, especially with canoes, rubber rafts, and smaller shallow draft boats (streams with an average flow of more than 100 cfs). Stream esthetics and natural beauty will generally be satisfactory.

Fig. 5



Bighorn River below Boysen Dam, Wyoming, showing a flow of 400 cfs (30% of the average flow). Water depth was adequate for trout movement, spawning incubation and winter survival in most run and pool areas for a distance of 45 car miles downstream. This is a base flow recommended to sustain good survival habitat for most aquatic life forms.

MRBS Photo #8542-B
by Don Tennant 10/2/68

Sixty percent (60%) of the average flow (fig. 6): This is a base flow recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses. Channel widths, depths, and velocities will provide excellent aquatic habitat (fig. 1). Most of the normal channel substrate will be covered with water, including many shallow riffle and shoal areas. Side channels that normally carry water will have adequate flows. Few gravel bars will be exposed, and the majority of islands will serve as wildlife nesting, denning, nursery, and refuge habitat. The majority of streambanks will provide cover for fish and safe denning areas for wildlife. Most pools, runs, and riffles will be adequately covered with water and provide excellent feeding and nursery habitat for fishes. Riparian vegetation will have plenty of water. Fish migration is no problem in any riffle areas. Water temperatures are not expected to become limiting in any reach of the stream. Invertebrate life forms should be varied and abundant. Water quality and quantity should be excellent for fishing and floating canoes, rafts, and larger boats, and general recreation (stream with an average flow in excess of 100 cfs). Stream esthetics and natural beauty will be excellent to outstanding.

Fig. 6



North Fork Shoshone River near Wapiti, Wyoming, showing a flow of 456 cfs (approximately 60% of the average flow). Water widths, depths and velocities very good for fish and fishing in all riffles, runs and pools. This is a base flow recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses.

FWS Photo #6-1-68
by Don Tennant 9/29/72

A flow of 2 to 3 times the average flow is often best for kayaks and whitewater canoeing. A flow of this magnitude is also preferable for larger boats with inboard or outboard motors, like those many people use on the annual Missouri and Yellowstone River floats held in June and July in Montana.

RECOMMENDATIONS

1. Request "instantaneous flows" to prevent flow releases from dams and diversion structures that are averaged over a day, month, or year, which permits erratic releases or even no flow at times.
2. Recommend that dual or multiple outlets to all dams be designed and constructed so that minimum flows of an appropriate temperature and quality to protect the aquatic environment can be by-passed at all times, including drawdowns for safety inspections and emergency repairs.
3. Insist that costs for providing of instream flows to protect the aquatic environment downstream below dams be project costs, including costs for unforeseen emergency repairs and routine maintenance over the life of the project.
4. Justify only that portion of a stream flow required to fulfill specific instream needs. If fish need a flow of 100 cfs in a segment of stream where there are already legal requirements of 25 cfs for municipal water, 15 cfs for irrigation water transport, and 10 cfs for a U.S. Environmental Protection Agency water quality requirement, you logically and legally should only have to justify a flow of 50 cfs

(the additional increment necessary to provide 100 cfs). Planners of water development projects may ask you to justify and apply cost/benefit ratios for fish to the 100 cfs flow because this makes their "project purpose" look more favorable on a comparable cost/benefit basis.

5. Stipulate that the downstream flow will not be less than the inflow to impoundments, whenever operators of water development projects cannot provide specific flow requirements. Make this an integral part of every flow regimen recommendation, preferably part of the same sentence.
6. Reduced releases to a stream should not exceed a vertical drop of 6 inches in 6 hours (equal to 2 feet in 24 hours). Fluctuations greater than this may significantly degrade aquatic resources.
7. Request that maximum flows released from dams not exceed twice the average flow. Prolonged releases of clear water greater than this will cause severe bank erosion and degrade the downstream aquatic environment.
8. Use "undepleted" U.S.G.S. hydrology data for flow recommendations that relate to the stream in its pristine conditions (e.g., before dams, diversions, pumps, etc.). Otherwise, recommendations from the Montana Method may relate to depleted stream conditions and result in less than ideal flows.
9. Avoid recommending minimum instantaneous stream flow regimens less than 10% of the average flow since they will result in catastrophic degradation to fish and wildlife resources and harm both the aquatic

and riparian environments (fig. 1). Encourage lawmakers to pass legislation that would prevent diversions or regulation at dams, whenever it would reduce streamflow below this level. If water development projects cannot make it on 90% of the water carried by a stream, use of the remaining 10% probably won't justify their projects. Philosophically, it is a crime against nature to rob a stream of that last portion of water so vital to the life forms of the aquatic environment that developed there over eons of time.

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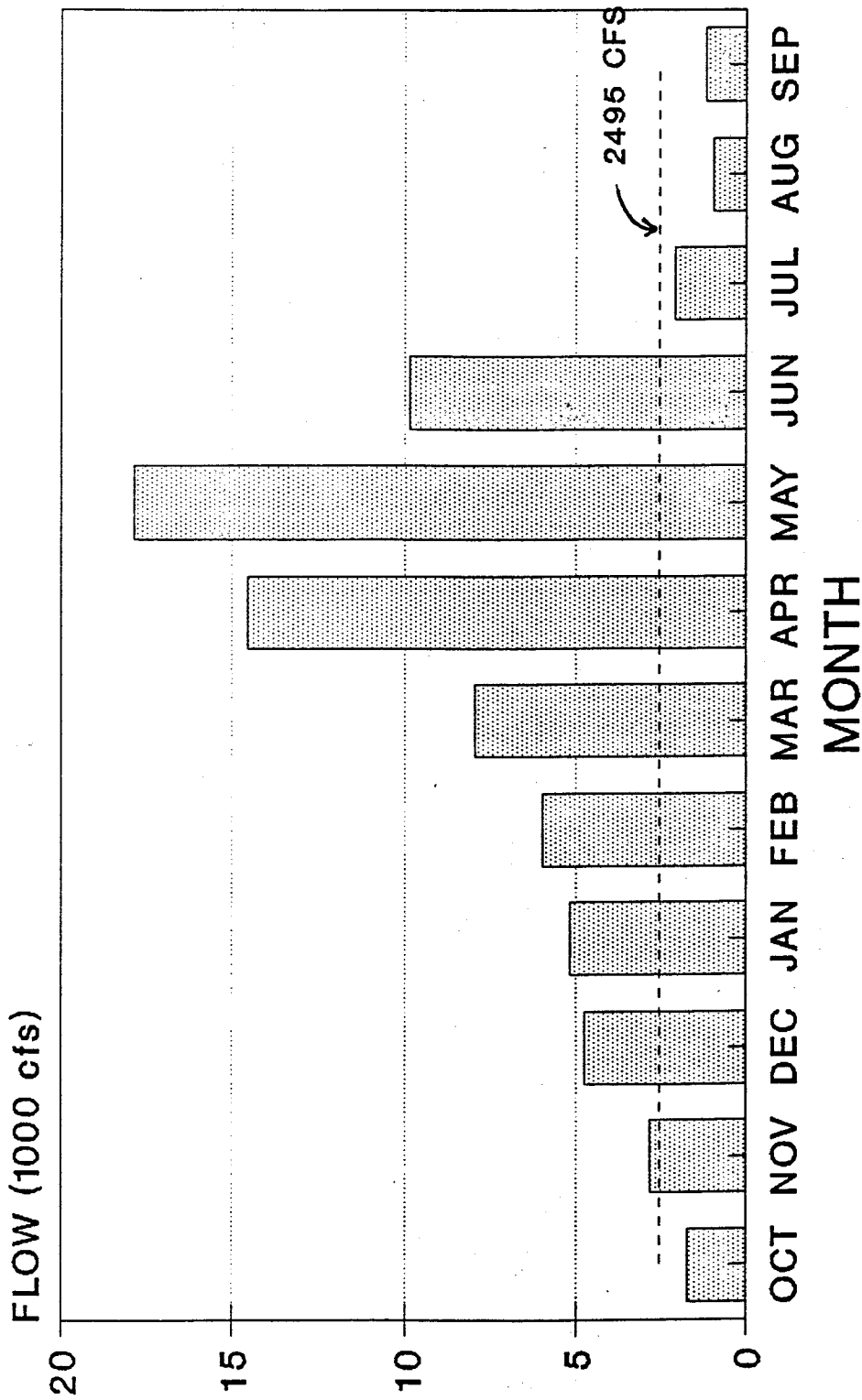
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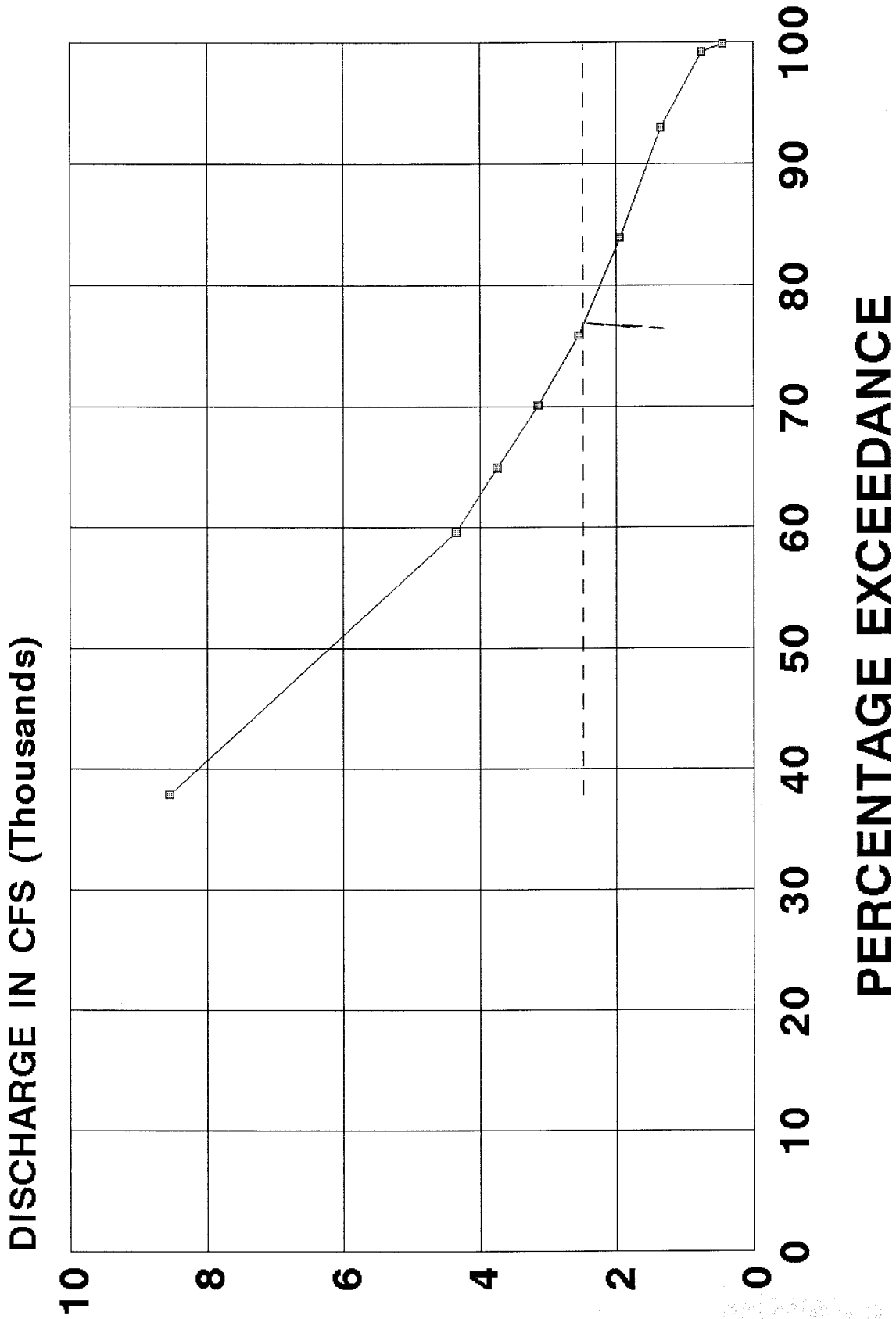
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SPOKANE RIVER AT POST FALLS (1912-90)



IWRB-6

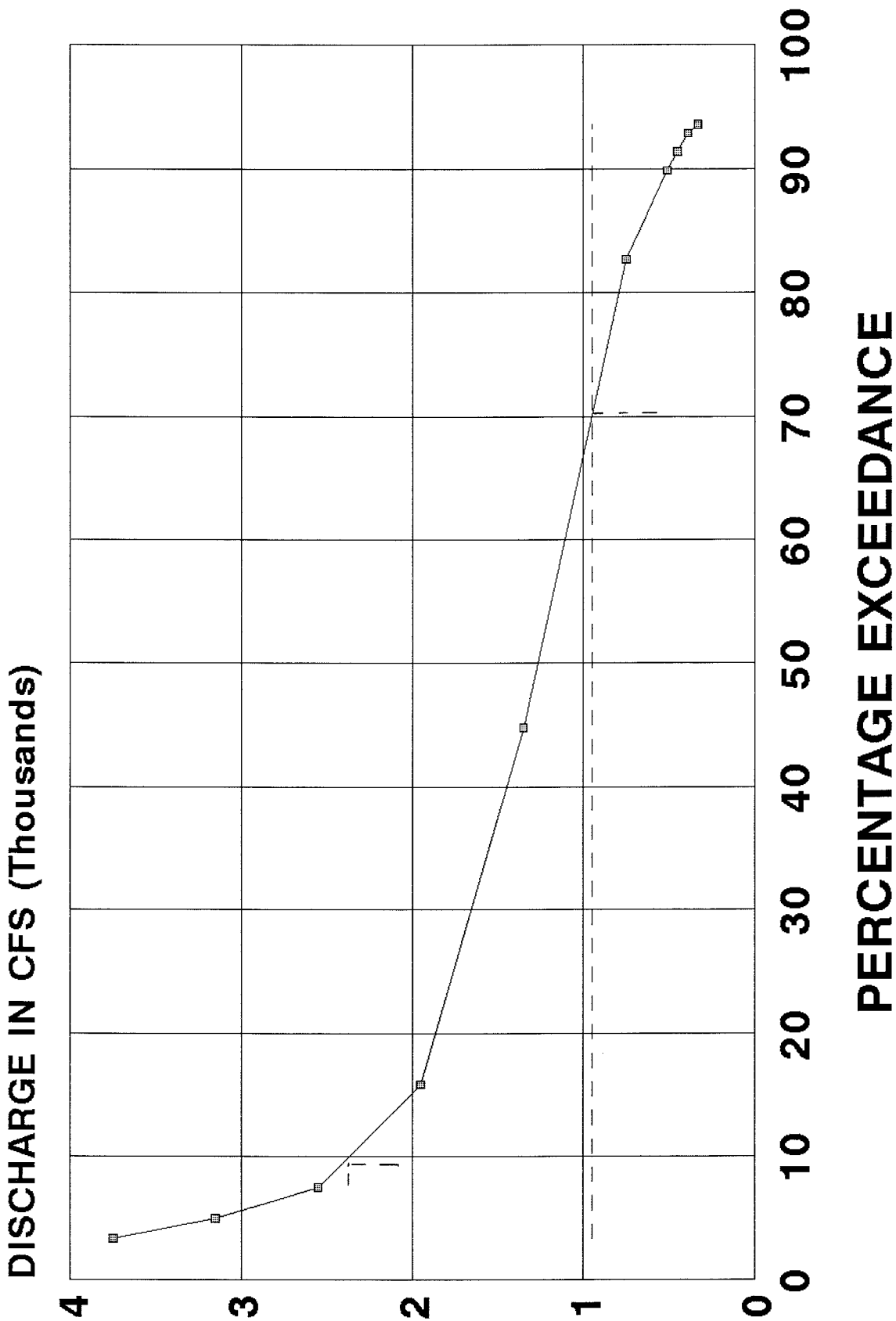
FLOW DURATION CURVE, NOV-JUN SPOKANE RIVER AT POST FALLS



IWRB-7

FLOW DURATION CURVE, JUL-OCT SPOKANE RIVER AT POST FALLS

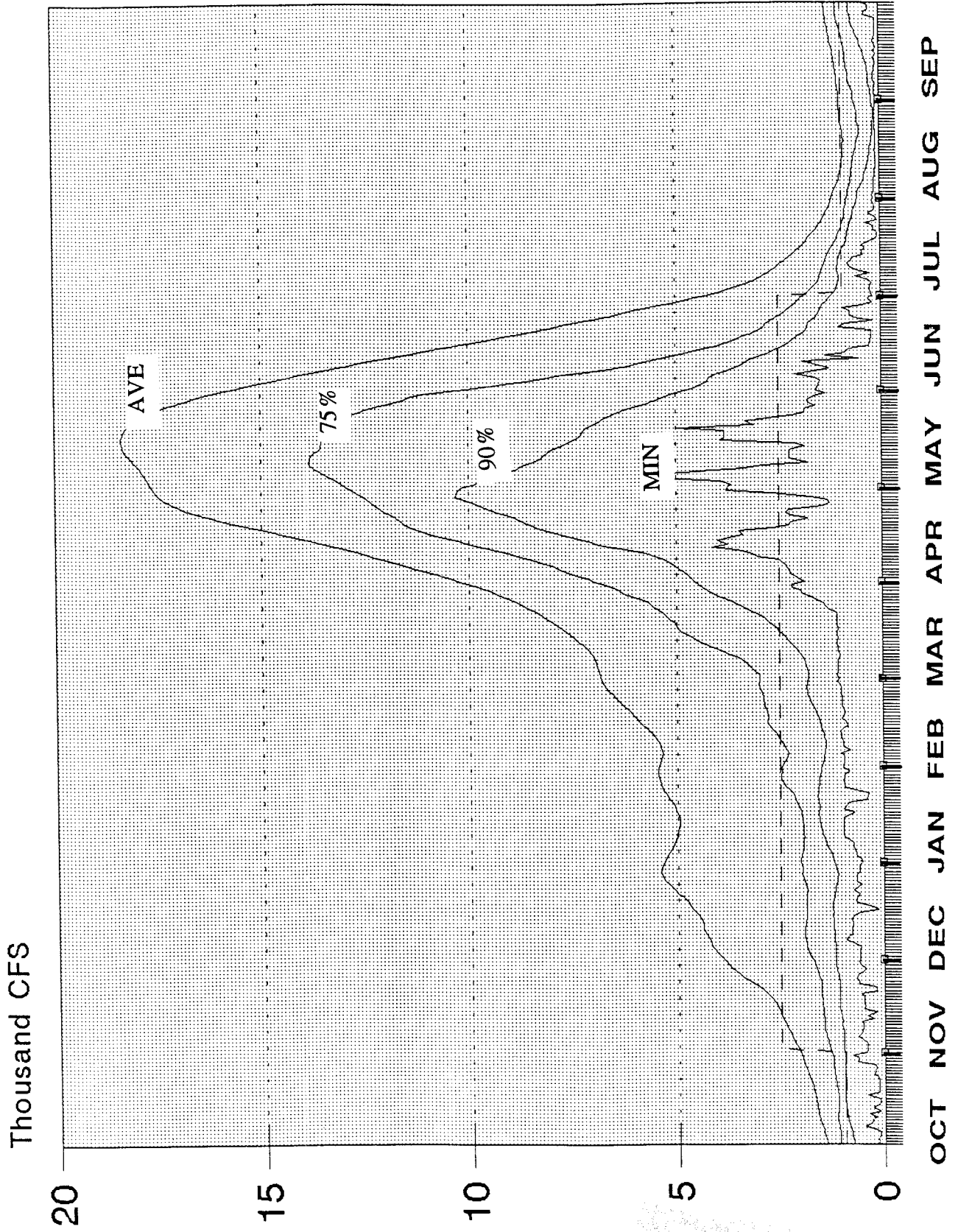
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SPOKANE RIVER AT POST FALLS

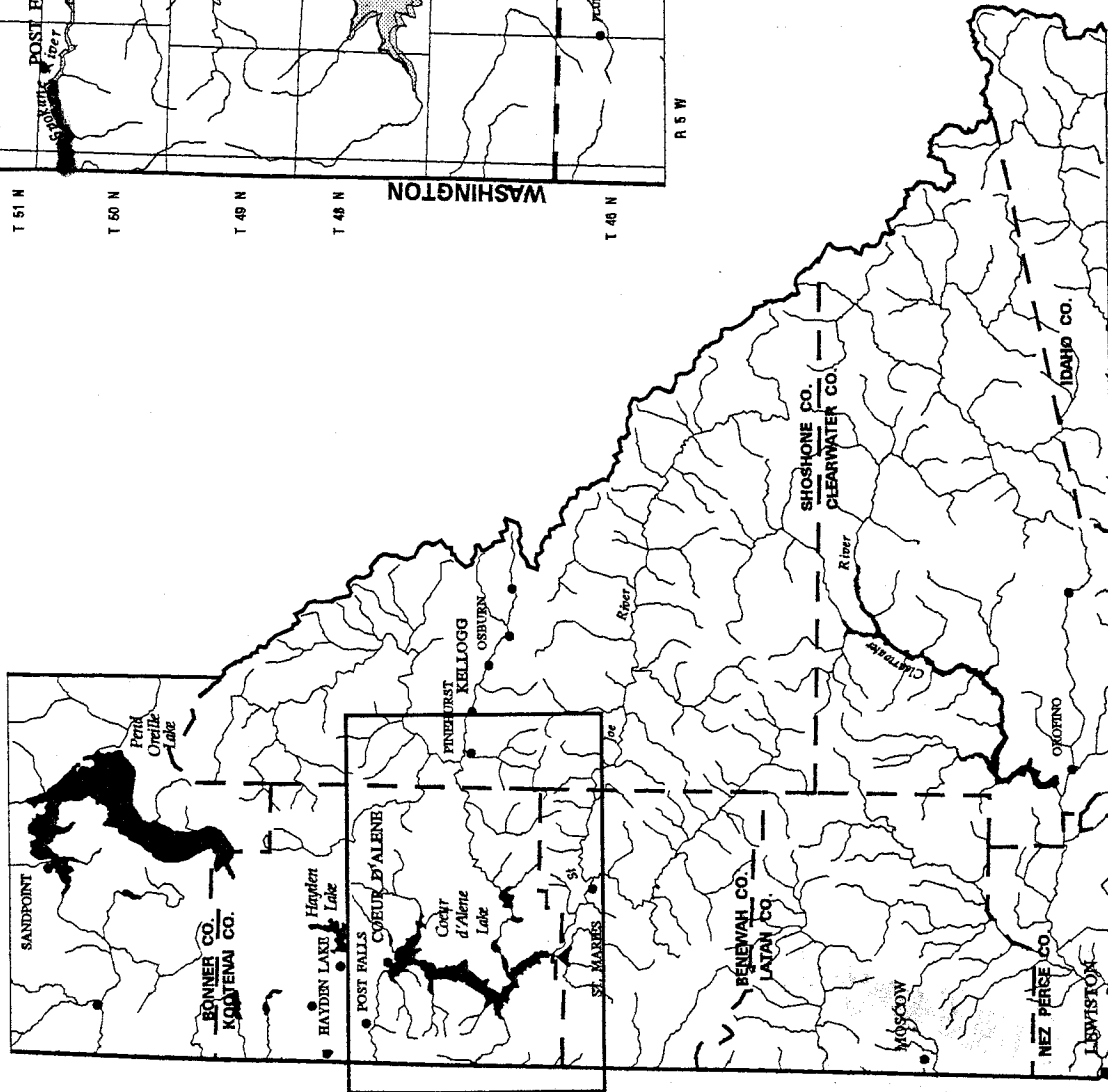
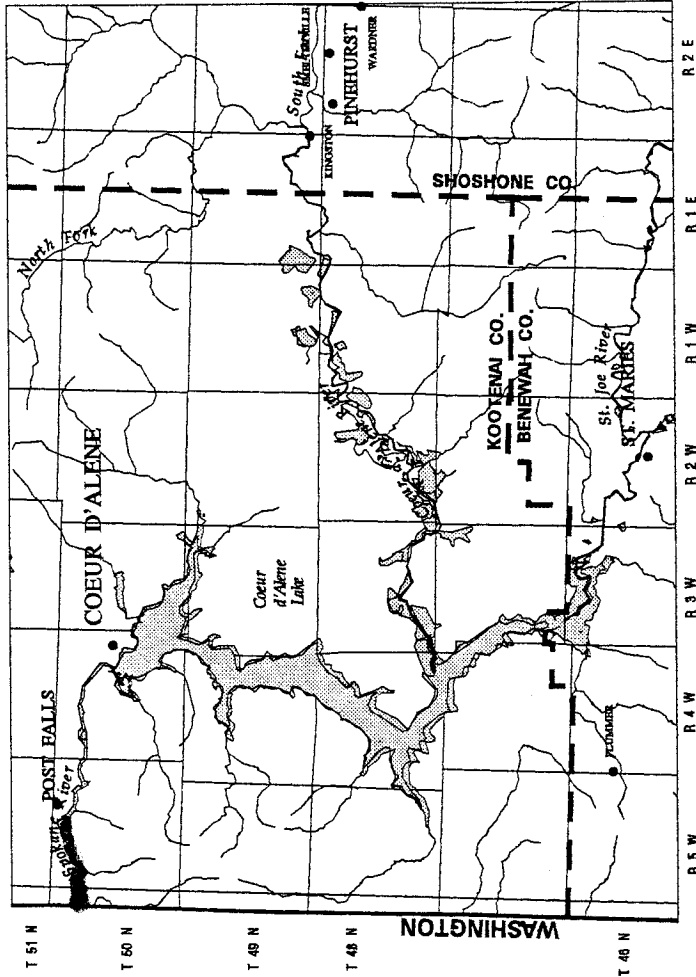
SUMMARY HYDROGRAPH PERIOD OF RECORD 1912-90

IWRB9



Spokane River - Minimum Streamflow

Minimum Streamflow Reach



IWRB10

SCOTT W. REED, Attorney at Law/P. O. Box A/Coeur d'Alene, Idaho 83816/(208) 664-2161

October 29, 1993

FAX (208) 765-5117

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Department of Water Resources

Idaho Department of Water Resources
Statehouse Mail
Boise, Idaho 83720

Attention: Norman Young

Re: Stream Flow Hearing - Spokane River

Dear Norman:

Enclosed are three copies of the final Falter report which I mentioned in my testimony. I assume you can make the proper distribution.

Thank you very much for your attention.

Yours truly,

Scott W. Reed

SWR:gs

SEP 12 1994

**Physical and Chemical Water Quality of the
Spokane River Outlet Reach
of
Lake Coeur d'Alene, Kootenai County, Idaho
1990 and 1991**

*C.M. Falter
B. Riggers
J.W. Carlson*

Department of Fish & Wildlife Resources
College of Forestry, Wildlife & Range Sciences

and the

Idaho Water Resources Research Institute

University of Idaho
Moscow, Idaho 83843
(208) 885-7123

Final Report (with Revisions) Submitted to the

Idaho Division of Environmental Quality
Coeur d'Alene, Idaho

March, 1992

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ABSTRACT

The University of Idaho conducted a water quality study on the Spokane River outlet arm of Lake Coeur d'Alene from June, 1990 through September, 1991. The project was sponsored by the Idaho Division of Environmental Quality (Coeur d'Alene office). Objectives of the study were to: 1) Characterize baseline river water quality; 2) determine seasonal river water quality variation; 3) assess diel temperature and dissolved oxygen changes for indications of aquatic ecosystem stress; and 4) provide a cursory view of the effects of existing and proposed wastewater discharges on river water quality, to the extent that river water quality data and WWTP data will allow. The study updated earlier work by the University of Idaho and USEPA in 1980 and 1988. The study area covered the 8.1-mile reach of the Spokane River from the outlet of Lake Coeur d'Alene at River Mile 108.8 downstream to just below Post Falls Dam at River Mile 100.7. This reach is typified by swift water currents and cobble bottom channel in the upper section merging to deeper, slower lacustrine conditions in the lower section where channel cobbles yield to fine sediments in lateral embayments. Water depths ranged from 2 to 18 m through the reach.

Water flows in the 16-month study ranged from high flows of 31,750 cfs in May, 1990 to low flows of 340 cfs in September, 1990. Retention times of the study reach varied from 4.3 hours at annual high flows in 1990 and 1991, respectively, to 12.7 days at annual low flows in 1990 and 1991. Surface water temperatures peaked at 25.7 and 26.1 C in 1990 and 1991. Vertical thermal stratification was minimal, always less than 3.0 C from surface to bottom. Slight summer temperature increases were noted downstream through the reach. Sample site mean summer dissolved oxygen was always greater than 7.0 mg/l; one sample occurrence was recorded of 5.4 mg/l. Electrical conductivity generally ranged from 30 to 55 μ mhos. Median pH was slightly on the acid side (5.7 to 7.8) throughout the reach.

Secchi depth ranged from 2.4 to 6.5 m with a study average of 4.0 m. High flows coincided with low secchi depths, as a result of suspended sediments and an extended spring algae pulse. Mean *year-round* chlorophyll *a* averaged 2.5 and 4.2 mg/m³ at the upper and lower sections of this river reach for an average 73% increase over the 7.6 mile reach.

Mean *summer* chlorophyll *a* of the lower sections averaged 6.0 mg/m³ in 1990 but only 3.3 mg/m³ in 1991 (= 45% reduction) following 1) a very large spring algae bloom, and 2) 80% phosphorus removal from the Coeur d'Alene WWTP. The 1990 and 1991 chlorophyll *a* levels place the Spokane River in mesotrophic and meso-oligotrophic productivity ranges, re-

spectively. Mean Kjeldahl nitrogen was 0.18 mg/l and generally increased >20% below the Coeur d'Alene WWTP at low flows. There was a general trend of TKN increasing downstream through the study reach. The WWTPs contributed 25 to 50% of the TKN load to the Spokane River at low flows. Nitrate nitrogen was typically less than 0.05 mg/l through summer months with fall-winter maxima of 0.50 mg/l. At low flows, WWTPs supplied 40% of the total nitrate load to the river. Mean total ammonia in the Spokane River arm of Lake Coeur d'Alene was 0.14 mg/l. From RM 111.1 to 108.8, there typically was an average 75% increase of total ammonia in the River, but less than one third of that increase was from the Coeur d'Alene WWTP. However, 30% of the average summer ammonia load to the river was from the Coeur d'Alene WWTP (up to 60% of the total ammonia load in September, 1991 at 340 cfs river flow).

Total phosphorus ranged from 0.007 to 0.025 mg/l with a study mean of 0.014 mg/l (in the mesotrophic range). Total phosphorus increased 70% between RM 111.1 and 108.8 over the entire study. *Summer* total phosphorus increased 87% between RM 111.1 and 108.8 over the entire study, 187% in 1991, but showed a 30% decline in 1991 *after* phosphorus removal in the Coeur d'Alene WWTP. WWTPs contributed ~50% of the total phosphorus load to the reach at low flows. Upgrading the Coeur d'Alene WWTP in June, 1991 resulted in an effluent TP decline of 79%. Total N:total P ratios indicate phosphorus limitation most of the time with the exception of summer-fall 1990.

BOD₅ levels in the Spokane River were moderately high, averaging 3.4 mg/l over all sites and dates. WWTP BOD₅ levels from the Coeur d'Alene and Post Falls plants averaged 81.2 and 13.2 mg/l, respectively. Mean BOD₅ increased 14% in the lower four river sites compared to the two upstream sites. Ultimate BOD in the Spokane River averaged 10.7 mg/l. WWTP ultimate BOD levels from the Coeur d'Alene and Post Falls plants averaged 644.7 and 371 mg/l, respectively. Mean ultimate BOD increased 11% in the lowest river site compared to the uppermost site.

Median fecal coliform bacteria in the Spokane River were ~1 colony/100 ml except for immediately below the WWTPs. Median fecal coliform bacteria were 30 and 24 colonies/100 ml in the Coeur d'Alene and Post Falls WWTPs, respectively. Median fecal coliform bacteria increased ~30-fold from above to immediately below the Coeur d'Alene WWTP. River fecal coliform levels dropped to background concentrations within two river miles. Median fecal coliform bacteria increased ~2-fold from above to immediately below the Post Falls WWTP. The diel study in August, 1991 showed insignificant stratification of either temperature or oxygen and little day-to-night fluctuation of either temperature or oxygen.

INTRODUCTION

The Spokane River Project was initiated in June, 1990, under contract from the Idaho Division of Environmental Quality (IDEQ) to the University of Idaho, College of Forestry, Wildlife, and Range Sciences. Field work extended from June, 1990 through September, 1991. The study was intended to address concerns over the ability of the Spokane River arm of Lake Coeur d'Alene to continue absorbing increased amounts of point and nonpoint source pollution without violating water quality standards or creating undesirable water quality changes. Additionally, it provides an updated database for the IDEQ in Coeur d'Alene to identify problem areas and management possibilities for the Spokane River.

Specific objectives of the study were to:

- 1) Characterize baseline river water quality;
- 2) Determine seasonal river water quality variation, with an emphasis on thermally stratified conditions;
- 3) Assess diel temperature and dissolved oxygen changes for indications of aquatic ecosystem stress; and
- 4) Provide a cursory view of the effects of existing and proposed wastewater discharges on river water quality, to the extent that river water quality data and WWTP data will allow.

The Spokane River begins as the outlet to Lake Coeur d'Alene in northern Idaho. The 11-mile outlet reach (Spokane River Mile (RM) 111.1 to 102.5) from Lake Coeur d'Alene to Post Falls, Idaho, was the focus of this study (Figure 1). The Spokane River drainage area above Post Falls comprises 3,840 square miles and is drained by two major rivers flowing into Lake Coeur d'Alene, the Coeur d'Alene and St. Joe Rivers. Both drainages are principally forested, deeply dissected mountainous terrain with peaks and ridges approaching 8,000 feet msl. Population is concentrated on the valley floors, especially throughout the length of the South Fork and main Coeur d'Alene Rivers and around Coeur d'Alene on the Rathdrum Prairie at the north end of Lake Coeur d'Alene. More than a century of deep shaft mining activities for sulfide-based heavy metals has caused excessively high levels of cadmium, lead, arsenic, and zinc in the South Fork of the Coeur d'Alene River. In 1981, the USEPA designation of a portion of the South Fork as a CERCLA Superfund Site. The consequential closing of smelter

plants along the river, combined with the tailings impoundments constructed in the 1960's, caused a reduction in metals content of the water in this major tributary of the Spokane River. Watershed development, principally in Coeur d'Alene and around the outlet reach of Lake Coeur d'Alene in the last decade has proceeded rapidly, raising concerns of reach water quality. Several possible point and non-point sources exist in this area.

Numerous lumber mills and associated log floating operations are along the 11-mile outlet reach. Extensive movement and storage of raw logs has resulted in accumulations of benthic bark deposits throughout the river. These deposits are potential sources of biological growth and activity. Another concern is the presence of numerous private septic systems along this developed reach. Nutrient loading from private systems from these developments on the Spokane River is an unquantified factor as is the phosphorus input from lawn fertilization along the river.

Some baseline water quality information has been collected on the upper Spokane River over the last decade. Yearsley (1980) studied water quality in the Idaho reach of the Spokane River and computed mean summer loadings of phosphorus from Lake Coeur d'Alene and from the Coeur d'Alene Waste Water Treatment Plant (WWTP). Falter and Mitchell (1982) conducted a comprehensive limnological assessment of the upper Spokane River during water year 1980. Later work by Yearsley and Duncan (1989) partitioned nutrient loading and identified areas of oxygen depletion. Oxygen depletion zones were also noted by Seitz and Jones (1981).

METHODS

Sample Dates, Sites, and Procedures

Water quality sampling on the Spokane River began on June 29, 1990, and continued every two weeks through October, 1990, for a total of 10 summer sampling periods. Throughout the winter months of low biological activity, sampling was reduced to once a month. In June, 1991, samples were again collected every two weeks until the end of WY-91 through September, 1991. This resulted in a total of 27 sampling runs on the Spokane River from June, 1990 through September, 1991.

Water samples were collected from six river locations and two wastewater treatment plant locations (Cities of Coeur d'Alene and Post Falls) (Figure 1). These stations were selected for their comparability with previous research and unique physical characteristics of each reach of the river.

Samples were distributed horizontally (with samples collected in the right, middle, and left thirds of the river for each river location) and vertically (with samples collected at mid-depth and off the bottom) within each location (Figures 2 and 3). Mid-depth water quality samples were composited horizontally to produce a single integrated sample. Deep water samples below the thermocline (collected in areas where the river was thermally stratified) were kept separate.

Samples from the municipal treatment facilities in Coeur d'Alene and Post Falls were obtained during each river sampling period from a 24-hour composite of each treatment plant effluent.

Parameter Sampling Procedures

In situ temperature, dissolved oxygen, and specific conductance profiles were taken in 1-meter increments at all ambient stations using a YSI Model 57 Oxygen Meter and a YSI Model 33 S-C-T Meter. Secchi disk transparency depth was measured at the five stations above Post Falls dam using a 20 cm standard black and white Secchi disk.

River flow records for the entire sampling period were obtained from the USGS in Sandpoint, ID, and daily flows from the municipal treatment facilities were provided by the respective plant. Cross-sectional transects of the river were measured in the spring at peak flow using a Raytheon recording fathometer.

Retention times were calculated by dividing the water volume between stations by the mean hourly outflow. The water volume between stations was determined by mechanical planimetry of morphometric data.

At each station, a cross-sectional composite water sample was collected from mid-depth when the river was thermally mixed. A separate sample was taken 1-meter off the bottom below the thermocline under stratified conditions. These water samples were collected using a 2-liter brass Kemmerer bottle and transferred to a covered, acid-washed 5-gallon plastic container. Subsamples were then taken from this large container for the following laboratory analyses:

pH and Turbidity

A subsample was obtained in a 1-liter plastic bottle, cooled to 4 C, and taken back to the University of Idaho lab for analysis of pH (Corning Model 7 pH Meter) and turbidity (Hach Model 2100A Turbidimeter).

Chlorophyll *a*

Another 1-liter subsample was collected in a dark bottle and cooled. This water was later analyzed for chlorophyll *a* according to the monochromatic spectrophotometric procedure outlined in Standard Methods (1989).

Bacteria

One sample was taken at each station in a sterile 200-ml polyethylene bottle and cooled. At the lab, 10 ml and 100 ml portions were filtered through sterile, 0.45 μ m GN-6 Grid Metrical Membrane Filters and cultured on growth media specific for fecal coliform and fecal streptococcus bacteria. Incubation was done in accordance with Standard Methods (1989). Counting of fecal coliform and fecal streptococcus colonies was done under Wild-Leitz microscopes at 100-power magnification.

Biochemical Oxygen Demand

Five 300-ml BOD bottles from each station were filled from the composite container and cooled for transport to the lab. After warming to room temperature, a series of dilutions were made on each bottle whereby bacterial "seed" (from Moscow, ID, WWTP) and nutrients were added to the sample water in different concentrations. Dissolved oxygen was then measured using an Extech Dissolved Oxygen Meter. The bottles were then water-sealed and allowed to incubate in the dark at 20 C for 5 days. Dissolved oxygen was then measured again to determine 5-day BOD as outlined in Standard Methods (1989). Ultimate BOD was determined at stations 1 and 6. This consisted of measuring the dissolved oxygen in the bottles at 5, 10, 15, 20, 27, 35, and 45 days.

Chemical Analyses

A sub-sample was collected from the large container at each station in an acid washed 1-liter plastic bottle and immediately fixed with 2 ml concentrated H₂SO₄ for preservation. These samples were frozen at the lab and later analyzed for the following chemicals:

| <u>CHEMICAL PARAMETER</u> | <u>METHOD OF ANALYSIS</u> |
|--------------------------------|---------------------------|
| Total ammonia as N | Direct ammonia |
| Total nitrite and nitrate as N | Ultraviolet Screening |
| Total Kjeldahl nitrogen as N | Micro Kjeldahl |
| Total phosphorus as P | Persulfate digestion |
| Orthophosphate | Stannous chloride |

All analyses were in accordance with procedures outlined in APHA Standard Methods (1989) with spectrophotometric measurements on a Beckman DU-8 Spectrophotometer.

WWTP Effluent Analyses

Turbidity, pH, all chemical analyses, 5-day BOD, ultimate BOD, and bacterial analyses of WWTP effluent were processed and analyzed in the same manner as river water samples.

Note: Ammonia oxidation was not inhibited in WWTP ultimate BOD tests. Therefore, ultimate BOD results should be viewed with caution.

Depth Transects

On August 13, 1991, we conducted a number of bottom transects on the Spokane River outlet arm to map the bottom contours and determine precise depths at each of the five established sampling stations and to verify reports of a deep hole in the vicinity of Ford Rock. Transects were recorded from a small powerboat traveling at a constant, slow speed from one side of the channel to the other at each Station. Fifteen transects were taken 20 to 50 meters apart below Station 4 at Ford Rock.

Diel Study (August 12-13, 1991)

A diel study was undertaken on August 12-13, 1991 to assess 24-hour temperature and dissolved oxygen changes in the Spokane River arm above Post Falls Dam. This diel study enabled more accurate description of diel water quality in this reach, since large fluctuations in oxygen could indicate water quality stress in the system. Pronounced afternoon thermal stratification would be conducive to algae blooms.

Temperature and dissolved oxygen profiles were taken following our standard methodology at one-meter increments, surface to bottom, in the left, middle, and right thirds of the river at Stations 4 and 5 (RM 103.5 and 102.5, respectively) and at the left third of the river off the Cedars Floating Restaurant dock near Station 1 (RM 111.1) on August 12-13, 1991. The river water quality parameters (profiles, nutrients, bacteria, and chlorophyll *a*) were sampled at Station 4 and 5 and at the Cedars dock at 6:00 p.m. on August 12 and 6:00 a.m. on August 13.

Readings were taken every three hours, beginning at 3:00 p.m. on August 12 and continuing through 3:00 p.m. August 13. Temperature and dissolved oxygen measurements were obtained at Stations 4 and 5 using a YSI Model 57 Dissolved Oxygen meter and at the Cedars dock using an Extech Dissolved Oxygen meter. Both meters were calibrated with air temperature and partial pressure and against each other for quality assurance. We determined pH in the

field immediately following each run using a Nester Model 47 mini pH meter. Lab analysis of the 6:00 p.m. and 6:00 a.m. samples followed the same procedures as those used on the standard river sampling.

Quality Control / Quality Assurance

QA/QC measures were taken in all sampling procedures, as well as field and lab analyses. Sampling was conducted on Tuesdays, beginning at approximately 10:00 a.m. at Station 6 (RM 100.7) and continuing upstream to Station 1 (RM 111.1). Sampling was usually completed by 6:00 p.m. The only exceptions to this schedule were in the first four sample periods, when logistics required two days to complete sampling. Permanent shore landmarks were used at each station to ensure consistency of sampling points.

We measured pH routinely with two meters calibrated daily with pH 7.0 buffer. The low pH values measured on May 7, 1991, were confirmed for each sample with three pH meters, independently calibrated. The turbidimeter was standardized against Hach formazin turbidity standards initially and against a new set of Hach Gelex turbidity standards at every sampling after July 1, 1990. Only single samples of chlorophyll *a* were run, however. Multiple samples of chlorophyll *a* were run on July 30, 1991 samples because of low values.

Eight fecal coliform and eight fecal streptococcus bacteria samples (from the February 12, 1991 sample series) were analyzed at the Coeur d'Alene DEQ lab for comparison with our bacterial results. At least one duplicate BOD sample for 5-day BOD and ultimate BOD was analyzed at each station on every date sampled (except on April 9, 1991). Duplicates were run on at least ten percent of all chemical analyses throughout the study. Additionally, 39 samples were analyzed for TP, OP, NH₃-N, and NO₃-N by both the UI Forestry Lab and at the UI Analytical Lab for comparison. Data on the Spokane River collected by the Citizen Volunteer Monitoring Program (CVMP) and on-site effluent analyses performed by each wastewater treatment plant (WWTP) over the current study period is also presented for a check between sample groups. Detailed QA/QC data are presented in Appendix B.

RESULTS / DISCUSSION

Water Discharge

Integral to any stream water quality study is an understanding of flow conditions throughout the period in which samples are collected. We can estimate individual water quality parameters measured simultaneously, biweekly, etc. and make inferences based on these, but in order to more closely understand the entire situation in a river system, sample measurements and trends must be related to flows.

USGS stream flow reports for the Spokane River were used to compare water flows of the Spokane River over recent years. The annual hydrograph reflects the discharge character of the Spokane River watershed below the ameliorating effect of Lake Coeur d'Alene (Figure 4). Peak runoff typically occurs in May (~ 20,000 cfs), with mean monthly low flow in August-September (1,500 cfs) (Figures 5 and 6). Mean daily low flow often drops below 800 cfs in late summer. We could discern no meaningful trend in the data of minimum or maximum flow in the Spokane River since 1969 (Figure 6).

Water Year 1990 was a typical, although flashy, flow year in the Spokane River System. A mid-winter thaw caused a minor flow peak in January, 1990. Peak flow occurred in mid-April (18,000 cfs). This was approximately one month earlier than the mean historical peak runoff in the Spokane River (Figure 7). Low flows were in September, 1990 with mean daily and mean monthly low flows of 340 cfs and 1,299 cfs respectively.

Water Year 1991 was similar to WY 90, with winter flows somewhat higher than the 78-year mean for the same period. Extremely cold temperatures in late-December and early-January (-14 F on December 28) caused flows to drop during January to mean daily low flows of 4,390 cfs (Figure 4). The mean monthly flows from April through September in WY 91, were nearly identical to the 78-year mean monthly flows for the same period with peak runoff occurring in May at a mean daily peak of 31,750 cfs and a mean monthly high flow of 17,830 cfs. The WY 91 may be viewed as the more typical of the two study years for describing mean baseline water quality characteristics of the Spokane River.

Previous studies on the Spokane River by Falter and Mitchell (1982), Seitz and Jones (1981), and Yearsley and Duncan (1989) were conducted under low flow conditions, and thus might be viewed as extreme conditions when presenting an overall water quality assessment of the river (Figure 7). They are, however, valuable in describing the river during periods of drought and during summer low flows.

Wastewater Treatment Plant (WWTP) Discharge

Nutrients and suspended solids, bacterial numbers, and biochemical oxygen demand were generally much higher in treated wastewater effluent than in the Spokane River itself. As mentioned earlier, Spokane River flows fluctuate widely throughout the year, but are generally high in the winter and spring (November-June) and low in the summer and fall (July-October). In contrast, discharge from the Coeur d'Alene and Post Falls WWTPs remains relatively constant throughout the year (Figure 8). The mean yearly treated wastewater discharge into the Spokane River from Coeur d'Alene, Post Falls, and the proposed Hayden WWTPs are 4.83, 1.27, and 0.38 cfs, respectively (Figure 9). The Hayden plant would not discharge under periods of low flow (when river flow is less than 2,000 cfs during the months of June through September). WWTP discharge accounts for an insignificant portion of the total Spokane River flow during high flows ($<0.03\%$). Dilution is very high and resulting water quality is not a problem. Discharge from the Coeur d'Alene and Post Falls WWTPs accounts for approximately 0.5% and 0.1%, respectively, of the total Spokane River flow under summer low flow conditions (Figure 10). The percentages of the Spokane River's discharge contributed by the Coeur d'Alene and Post Falls WWTPs increased to 1.4% and 0.4%, respectively, at minimum flow recorded during the study period (340 cfs on Sept 5, 1990) (Figure 11).

Mixing of wastewater effluent is a concern in the Spokane River. The Coeur d'Alene WWTP discharge pipe extends approximately 200 ft toward mid-river at RM 110.7, and effluent is discharged through ten diffusers (CDA WWTP Superintendent, personal communication, April 9, 1991). Post Falls discharges into the river at RM 101.5. The proposed Hayden Lake discharge would be through five diffusers, 150 ft into the river (Jim Kimball, Kimball Engineering, personal communication, October 25, 1991). Due to the diffuser construction of these discharge pipes, mixing of wastewater effluent is not considered a critical issue in the Spokane River.

Morphometry

On August 13, 1991, we undertook a relatively small-scale depth transect study on the Spokane River outlet arm of Lake Coeur d'Alene to map bottom contours and determine exact depths at each of the five established sampling stations of the Spokane River Water Quality Project. Earlier depth transect work by Falter and Mitchell (1982) on this portion of the Spokane River produced detailed morphometric maps of the river (Appendix C).

The Spokane River channel is shallow (1.5-3.5 m) and relatively flat from the outlet of Coeur d'Alene Lake (RM 111.2) to the upstream end of Harbor Island (RM 107.0), with mid-channel depth gradually increasing downstream (Falter and Mitchell 1982). Stations 1 (RM 111.1) and 2 (RM 108.8) have gradually sloping banks with relatively flat bottoms. Maximum

depth at high water is typically 3.6 m and 5.2 m, respectively in this reach (Figure 12 and 13). Stations 3 (RM 106.2), 4 (RM 103.5), and 5 (RM 102.5), are much deeper and have steep sloping banks. Maximum depths at high water are 7.1 m, 10.8 m, and 9.8 m, respectively for the three stations (Figures 14-16). The Spokane River becomes less riverine and more lacustrine downstream as water depth at each station increases.

Seitz and Jones (1981) also carried out extensive cross sectional area mapping of the reach. Sampling efforts by the EPA after 1982 located a deep hole near Ford Rock. This deep area could be a site of stratification and oxygen depletion, thus warranting a more accurate understanding of its size and depth.

The deep hole near Ford Rock is approximately 110 m long and 94 m wide. Maximum depth is 17.7 m (Appendix C). Because of the small size and comparatively small water volume contained in this deep hole, we feel that extensive research on the characteristics of this area are unwarranted. Water exchange is probably great enough to prevent significant water quality problems in the area.

Flushing Rates and Retention Times

Flushing rate is the number of times all of the water in a section of river leaves that section in a given time. It determines how much of the nutrient load will be converted into plant biomass. When flushing rates are low, there is more time for nutrient uptake by phytoplankton, aquatic macrophytes, attached algae, etc. Conversely, high flushing rates allow less time for this uptake. The flushing rate is dependent on the volume of water within the section and the water flow through it. Large static volumes yield low flushing rates, and high water flows yield high flushing rates. In this study, in order to develop workable results, we assumed that all of the water in a section was exchanged over one flushing time.

The inverse of flushing rate is retention time. Retention time for the section between sites 1 and 3 is less than half that of the remainder of the study reach. When flows equal the 78-year mean, the retention time for the area from RM 111.1 to 106.2 is 4.9 hr compared to 11.5 hr for the area from RM 106.2 to 102.5. The downstream section of the study area is deeper which increases the volume which in turn increases the retention time.

Retention time plays a key role in the development of thermal stratification. Generally a retention time of 15 days is required for stratification to occur. The lowest mean daily flow occurring during the study was 340 cfs which resulted in a average retention time for the entire river reach of 12.7 days. The lowest flow recorded in the 78 years of record was 65 cfs (July 27, 1973) and would have resulted in a retention time of 66.4 days (Table 1).

Physical Profiles

Temperature

In 1990, water temperature in the Spokane River peaked in late July at 25.7 C and began to fall by early August. This peak is about one to two weeks earlier than we would expect in a typical slow-moving northern Idaho stream of this size (Appendix E). The earlier warming was likely a result of warm surface discharges from Lake Coeur d'Alene, combined with the lower flows for the year. Temperatures peaked on August 27, 1991, at RM 102.5 at 26.7 C (Appendix Table 1). The date of the 1991 thermal peak was more typical of this area, but the temperatures observed were relatively high. Most North Idaho streams of comparable size and flow reach a summer maximum temperature of 22-24 C. Again, these high temperatures were probably due to warm surface discharges from Lake Coeur d'Alene. Overall reach mean temperature peaked at 24.0 C on July 23, 1990, and at 25.6 C on August 27, 1991. Reach mean low temperatures of the study were recorded at 2.1 C on February 12, 1991 (Table 2).

Mean water temperatures increased slightly downstream from July through August with low discharge and increased retention times (Table 2). There was only one instance where thermal stratification (1.8 C/m) was observed. This was on July 9, 1990, at RM 102.5 when surface temperature peaked at 23.9 C. No oxygen or conductivity stratification coincided with this thermal stratification. Similarly, Falter and Mitchell (1982) found no significant vertical stratification during the 1980 study under low flow conditions. Some vertical stratification of temperature, dissolved oxygen, and pH was detected by Yearsley in a portion of the Spokane River near Ford Rock in August, 1979 (Yearsley 1980) and again in 1988 at several locations on the upper Spokane River under low flow conditions in August (Yearsley and Duncan 1989). Yearsley and Duncan (1989) conducted their study under extremely low water conditions (less than 340 cfs) which may have been the cause for the stratification during that time.

While almost no thermal stratification was noticed during the present study, some definite temperature trends were observed. Temperatures nearly always decreased gradually with depth during the summer months. This indicated some surface warming downstream through the Spokane River in summer. Also of interest was the increase in mean temperature across the channel. Mean temperatures were consistently 0.3 to 0.8 C warmer in mid-channel than along the right bank and 0.1 to 0.3 C warmer along the left bank than in mid-channel (Table 3). This slight difference was most likely due to the greater depths in mid-channel and along the right bank, and suggests that while water in the Spokane River was not thermally stratified, neither was it completely mixed.

Dissolved Oxygen

Dissolved oxygen concentrations were generally uniform throughout the water column, but decreased slightly with depth in the deeper sites of RM 103.5 and 102.5 during the warm summer months. Minor dissolved oxygen "sags" of up to 2.2 mg/l below surface concentrations were occasionally observed. Dissolved oxygen occasionally dropped below the Idaho Water Quality Standard for Cold Water Biota and Salmonid Spawning of 6.0 mg/l. This occurred during August, 1990 when mean flow in the Spokane River was lowest. Dissolved oxygen levels never dropped below 5.4 mg/l or 56% saturation. This is in contrast to the strong dissolved oxygen stratification observed by Yearsley and Duncan (1989) in 1988 when oxygen declined to near 0 mg/l in the Ford Rock area. Again, that 1988 instance is believed to be due to extremely low water conditions at the time of the 1988 data collection in a very small volume of water.

Mean dissolved oxygen levels in the Spokane River showed little variation throughout the outlet arm reach to Post Falls dam. Mean dissolved oxygen increased approximately 10% below the dam (Tables 4 & 5) probably from turbulence created as water passed over the dam.

Dissolved oxygen percent saturation varied little throughout the outlet arm reach, but increased at Station 6. Percent saturation levels were somewhat low (Table 5). Levels were well below 100% saturation during most of the year. Dissolved oxygen levels exceeded 100% during spring for a short time when flows were highest. Stations were similar in their mean dissolved oxygen concentrations (Table 3).

Electrical Conductivity

Conductivity was low, averaging 30 to 55 μ mhos (Table 6). Highest conductivity occurred in July, 1990 (80 μ mhos at RM 106.2). An isolated pocket of high conductivity was observed along the right bank at RM 100.7 on August 20 (120 μ mhos). A general increase in conductivity with depth was seen throughout all river sections. Conductivity patterns were typical with low conductivity occurring at high flow and high conductivity at low flow. Conductivities measured in this study were comparable to values observed during WY 1977, 1980, and 1988.

Composite Measurements

pH

Median pH values among all stations of the Spokane River per sample date ranged from 5.7 to 7.8. An overall low pH of 3.3 was observed on October 1, 1990, (RM 102.5) and a

high of 7.9 was measured on March 12, and April 9, 1991 (RM 103.5 to 100.7) (Table 7). The extremely low pH at RM 102.5 could have been a result of an unknown point discharge somewhere upstream, but below RM 103.5. We could not locate this discharge, but quality control assured us that this was a correct measurement and not the result of malfunctioning equipment.

River pH was quite low during the spring of 1991. Median pH values were near 6.0 during all but one sample period from May 7 to July 2, 1991 (Figure 17). This overall low pH in the river may benefit the biota, however, by reducing ammonia toxicity, which might otherwise be a problem given the high ammonia-nitrogen loading from WWTP's. No pronounced differences in pH values were observed between stations on the Spokane River during the study (Figure 18 and Table 7).

The pH values of the Post Falls and Coeur d'Alene WWTP's effluents were slightly higher than the median river water pH. Effluent pH was usually near neutral, thus causing no adverse effects on overall pH in the Spokane River (Figure 17).

Turbidity

Turbidity in the Spokane River was low with mean values ranging from 0.5 to 2.4 NTU over the sample period (Table 8). In comparison, the Post Falls and Coeur d'Alene WWTP's effluents were higher in turbidity, with overall means of 2.7 and 9.4 NTU, respectively (Figure 19).

Turbidity increased slightly downstream from the outlet of Lake Coeur d'Alene (Table 8). This was probably due to the riverine character of the Spokane River at high flow. As flow increased in the spring, bottom sediments were stirred up and re-suspended in the water column increasing turbidity (Figures 20 and 21). Turbidity appears to be directly related to flow in the Spokane River, especially in the deeper sections of RM 106.2 to 102.5, where Falter and Mitchell (1982) reported a majority of the bottom sediments to be fines.

Secchi Disk Transparency

Numerous studies have shown that Secchi disk depth is inversely proportional to chlorophyll *a* concentrations in systems with low inorganic turbidity and can be used as an estimate of the primary productivity of a body of water. Mean Secchi disk depth between RM 106.2 and RM 102.5 in the Spokane River ranged from 2.4 to 6.5 m with an overall average of 4.0 m during the 1990-1991 study period (Figure 21 and Table 9). Wetzel (1983) gives a trophic classification system based on Secchi disk transparency, which puts the Spokane River in the mesotrophic range of two to six meters. Greatest Secchi disk depths were observed in

the fall (October 15 to November 12, 1990, and September 10-24, 1991) due to low phytoplankton concentrations and low turbidity (Table 9).

Secchi disk transparency remained relatively constant between stations with only a slight decrease at River Mile 102.5. This was most likely a factor of higher turbidity at this location, rather than plankton levels.

Chlorophyll *a*

Mean chlorophyll *a* concentration in 1990 increased as the water temperature increased and flows declined into late August, peaking at downstream sites at 11.0 and 9.7 mg/m³ chlorophyll *a* (Figure 21 and Table 10). Chlorophyll *a* concentrations in the river were very low during one summer sampling period (September 17, 1990), most likely due to a "population crash" in the phytoplankton community which was reflected in the low absorption peak ratio for the same day (Figure 22).

Chlorophyll *a* concentrations peaked much earlier in WY 91 than in 1990. Mean levels began to increase in mid-April and reached an annual maximum on May 7 (6.82 mg/m³). Mean chlorophyll *a* concentrations then gradually decreased to a low (July 30, 1991) of 0.37 mg/m³ (Figure 21 and Table 10). Aside from the July 30 sample, chlorophyll *a* concentrations were relatively stable throughout the summer of 1991. Values were similar to, but slightly lower than those measured in the summer of 1990. The 1991 chlorophyll *a* peak in early May coincided with high flows with declining chlorophyll *a* peaking declining flows into the summer (Figure 23). This spring plankton pulse contrasted with 1990 where chlorophyll peaked in late summer, essentially a mirror image of flow (Figure 23).

Chlorophyll *a* levels were in the mesotrophic range (2.0 to 6.0 mg/m³). Mean summer (mid-July through September) chlorophyll *a* averaged 3.9 and 2.5 mg/m³ in 1990 and 1991 respectively (Figures 21 and Table 10).

Mean chlorophyll *a* concentrations between stations increased from RM 111.1 to RM 103.5, and from 2.45 to 4.24 mg/m³ over the entire study period (Figure 21 and Table 10). Downstream increases in chlorophyll *a* are a cumulative result of phosphorus and nitrogen loading from various sources along the river and the more lake-like conditions in the river as the current slows and depth increases.

It is interesting to note that Falter and Mitchell (1982) measured chlorophyll *a* values in the 0 to 5.5 mg/m³ range with a mean of 1.9 mg/m³ from February to mid-September in 1980. These values were determined by the Trichromatic method which does not correct for pheophytin *a* and tends to overestimate chlorophyll *a*. The actual monochromatic chlorophyll *a* level in their samples was probably somewhat lower than reported. Keeping this in mind, when comparing the current study mean of 3.39 mg/m³ (range of 1.4 to 6.8 mg/m³) to the 1.9

mg/m³ mean for 1980, it appears that primary productivity in the Spokane River has increased over the last 11 years, possibly even more than these numbers indicate. A doubling of monochromatic chlorophyll *a* between 1980 and 1990-91 is probably a reasonable conclusion.

Nutrients

Primary production of any system is directly related to the concentration and availability of nutrients in the water. Those nutrients present in the lowest quantity in terms of the need of an organism control the production or growth of that organism.

Phosphorus and nitrogen are the most important nutrients since these two nutrients most often control plant growth in waters of the Columbia basin. Phosphorus, although needed in small amounts, is generally the most common phytoplankton growth-limiting nutrient because of the geochemical shortage of phosphorus in many watersheds coupled with the lack of a phosphorus equivalent to nitrogen fixation. Where phosphorus is present in relatively large quantities due to erosion or pollution, nitrogen usually becomes the nutrient limiting phytoplankton growth. Phosphorus has been shown to be the limiting nutrient most often in the Spokane River, except during August, when nitrogen has been shown to limit phytoplankton growth (Falter and Mitchell 1982).

Relatively small quantities of nitrogen exist in the combined forms of ammonia-nitrogen (NH₃), nitrate-nitrogen (NO₃), nitrite-nitrogen (NO₂), urea, and dissolved organic compounds. Nitrate is usually the most important form of nitrogen. Nitrate ions move easily through soils so the concentration and rate of supply of nitrate is intimately connected to land-use practices in the watershed. Nitrite, the partially reduced form of nitrate, is shortlived in water and usually present in insignificant quantities (Goldman and Horne 1983).

Phosphorus occurs in both organic and inorganic forms. The majority of inorganic phosphates present are in the form of orthophosphates, but there are numerous forms of phosphorus in the organic state. Phosphorus, in contrast to nitrate, is readily adsorbed to soil particles and does not move easily with groundwater. Because of this, high levels of phosphorus in water are usually associated with surface erosion in the watershed, agricultural practices, domestic wastes, and industrial wastes (Goldman and Horne 1983).

Total Kjeldahl Nitrogen (TKN)

Total Kjeldahl Nitrogen is the sum of the organic nitrogen and ammonia-nitrogen in water. Organic nitrogen includes such natural materials as proteins, peptides, nucleic acids, and urea (APHA 1989).

Mean TKN levels in the Spokane River during 1990 and 1991 remained relatively stable, ranging from 0.12 mg/l (July 16, 1991) to 0.24 mg/l (June and August, 1990). TKN

concentrations fluctuated little with changes in river flow (Figure 24). Overall mean for the period was 0.18 mg/l, with slightly lower mean levels in 1991 than in 1990 (Table 11).

Mean TKN concentrations increased 21% between RM 111.1 and RM 108.8 (0.14 to 0.17 mg/l) during WY 91 (Figure 25). This increase correlated with effluent discharge from the Coeur d'Alene WWTP (91,000 kg TKN) and other undefined sources throughout the reach (116,000 kg TKN) (Figures 25 and 26). Mean TKN values gradually decreased from RM 108.8 to RM 103.5, but then increased by about 25% between RM 103.5 and RM 102.5 (from 0.16 mg/l to 0.20 mg/l). The source of this increased TKN loading in the lower reaches is unclear, but private drainfields along this heavily developed stretch of shoreline may be partially responsible. A similar increase in TKN in this reach was noted during August 1980 by Falter and Mitchell (1982). Mean TKN values decreased below RM 102.5. There was no significant TKN increase below the Post Falls WWTP (Figure 25).

WWTPs accounted for a study-wide average of 9.3% of TKN load to the river (Figure 27). With lower flows in the Spokane River, the percentage of the TKN load contributed from the Coeur d'Alene WWTP increased (Figure 28). In 1991, during mean summer low flows, (August to mid-October = 1,300 cfs), the Coeur d'Alene WWTP contributed over 25% of the TKN, while at the lowest flow during the study (340 cfs on Sept 5, 1990) Coeur d'Alene WWTP contributed over 50% of the TKN load in the Spokane River. These results are comparable to those determined by Yearsley (1980) under low flow conditions. A general increase in TKN between RM 111.1 and RM 102.5 was observed in all three studies (Figure 29).

Nitrate-Nitrogen (NO_3)

Nitrate-nitrogen concentrations in the Spokane River were consistently low throughout the summers of 1990 and 1991 (<.05 mg/l) (Table 12). A mid-December maximum (0.49 mg/l), was observed when flows in the Spokane River increased indirectly as a result of abnormally high air temperatures (46 F on December 8, 1990). Similar but smaller peaks were observed throughout the spring of 1991 as melting snow and rains brought nitrate-rich runoff from the watershed into the Spokane River. This pattern of high nitrate concentrations at high flow and low concentrations at low flow is typical of most North Idaho streams.

Concentrations of nitrate-nitrogen between sampling stations showed a general increase downstream, from RM 111.1 to RM 100.7 (Figure 30). Mean nitrate-nitrogen concentrations increased over 100% from RM 108.8 to RM 106.2 and over 75% from RM 102.5 to RM 100.7. The high levels at RM 106.2 are a result of undefined loading between RM 108.8 and RM 106.2 (Figure 30). This increase may be from conversion of ammonia-nitrogen to nitrate-nitrogen within the reach, but this is purely speculative. The Coeur d'Alene WWTP contributes very little nitrate-nitrogen to the Spokane River (13,400 kg NO_3 during the entire

study) (Figure 31). The high levels of nitrate-nitrogen at RM 100.7 are partially due to the Post Falls WWTP, but most loading between RM 102.5 and RM 100.7 is undefined. Even though Post Falls effluent is high in nitrate (Figure 30), the small volume of Post Falls effluent discharged to the Spokane River makes it an insignificant source of NO_3 compared to the total nitrate load (21,800 kg during the entire study).

Nitrate-nitrogen loading from wastewater treatment plants, as a percentage of the total load in the river, increased as Spokane River flows decreased (Figure 32). The contribution from WWTPs made up over 40% of the total nitrate load, nearly 25% of which came from Post Falls during summer low flows.

Ammonia-Nitrogen (NH_3)

Note: The Direct Ammonia procedure used to analyze ammonia samples is no longer approved by the EPA because of the possibility of background interference, however it is still an approved APHA method (APHA 1989). The extremely low turbidity of the Spokane River, and consequential improbability of background interference, convinced us of the validity of these ammonia-nitrogen measurements with no distillation. Values determined for the WWTPs however, should be received with caution due to the possibility of background interference in those samples of high organic content.

Ammonia-nitrogen concentrations in the Spokane River were similar to, although slightly lower than, TKN concentrations throughout the study period (Figure 33 and Table 13). Ammonia-nitrogen levels ranged from a low mean of 0.08 mg/l on September 24, 1991, to a maximum mean over the entire river of 0.20 mg/l on August 20, 1990, and July 30, 1991 (Table 13). Mean ammonia-nitrogen concentration of the Spokane River over the entire period was 0.14 mg/l. Comparing this to a mean TKN concentration over the period of 0.18 mg/l shows that nearly 80% of the TKN in the Spokane River is in the form of ammonia-nitrogen. This is a very high percentage, and is potentially significant from both a toxicity and eutrophication concern. The high summer temperatures in the Spokane River make ammonia toxicity a potential problem. Observed low pH values, however, may counter the high temperatures and cause ammonia toxicity to be of little concern.

The high ammonia concentrations are of concern in another way during the short periods in which the Spokane River is nitrogen-limited. Ammonia is the form of nitrogen most readily available for plant uptake, so a high ammonia concentration could at times support phytoplankton blooms in the river.

Mean concentrations of ammonia-nitrogen at the different sampling stations followed the same general pattern as mean TKN values, increasing to RM 108.8, decreasing to RM

103.5, and increasing to RM 102.5 (Figure 33). The 42% increase in Water Year 1991 and 58% increase over the study period in ammonia-nitrogen concentrations between RM 111.1 and RM 108.8 is of particular concern. Coeur d'Alene WWTP effluent contributed slightly over 10% (113,200 kg) of the total ammonia-nitrogen load to the Spokane River during the study period (Figure 34). While this was a substantial amount, it did not account for the entire increase in ammonia-nitrogen between RM 111.1 and RM 108.8. There was a substantial ammonia-nitrogen load coming into the Spokane River (over 300,000 kg in WY 91) between RM 111.1 and RM 108.8 aside from that entering from the Coeur d'Alene WWTP. We were unable to determine the source of outside ammonia-nitrogen loading within the scope of this study.

It appears that much of this ammonia-nitrogen is being converted to nitrate-nitrogen between RM 108.8 and RM 103.5. Thus, the high ammonia-nitrogen loading in the upper reaches may be an indirect source of nitrate-nitrogen loading in the lower reaches.

Ammonia-nitrogen loading from the Coeur d'Alene WWTP accounted for nearly 30% of the total ammonia-nitrogen load during the summer of 1991 and over 60% of the total ammonia-nitrogen load at low flow (340 cfs) on September 5, 1991 (Figures 34 and 36). Low flow discharge by the Coeur d'Alene WWTP accounted for a significant portion of the overall summer load. Post Falls WWTP did not appreciably increase the ammonia-nitrogen load to the Spokane River.

Total Phosphorus (TP)

Total phosphorus is the sum of all of the orthophosphates, condensed phosphates, and organically bound phosphates in water (APHA 1989). It is a very common measurement used in assessing the productivity of a body of water and can be used to determine N:P ratios.

Mean total phosphorus levels in the Spokane River during the June 29, 1990 to September 24, 1991, sample period varied considerably, ranging from 0.007 mg/l (September 10, 1991) to 0.025 mg/l (September 3, 1990) (Table 14). Mean TP concentration throughout the entire study area over the period was .014 mg/l. These phosphorus values are in the mesotrophic range described by Wetzel (1983), and compare well with chlorophyll *a* and Secchi disk transparency values which also put the Spokane River in the mesotrophic range. Lower TP levels were observed in 1991 compared to 1990. This was probably due to greater flushing by the high flows during the spring of 1991 (Figure 37) and also a result of phosphorus removal by the CDA WWTP in 1991.

A general increase in total phosphorus, between RM 111.1 and RM 102.5, similar to that in TKN, was observed in Water Year 1991 (Figure 29). Total phosphorus more than doubled between WY 1980 and 1988, but dropped significantly in WY 1991 to levels only

slightly higher than WY 1980. This increase was significant because it showed an overall deterioration in water quality of the Spokane River from 1980 to 1988, but major improvement in TP in WY 1991.

Within WY 91, mean concentrations of total phosphorus between stations increased 45% between RM 111.1 and RM 108.8, decreased slightly downstream to RM 102.5, and increased 12% between RM 102.5 and RM 100.7 (Figure 38). Concentrations between RM 108.8 and RM 102.5 decreased gradually as reactive phosphorus was taken up by phytoplankton and converted into plant biomass. The Coeur d'Alene and Post Falls WWTPs contributed most of the phosphorus loading (within this reach) of the Spokane River. The river itself acted as a phosphorus sink (Figure 26). Coeur d'Alene WWTP contributed over 3 times as much total phosphorus to the Spokane River as Post Falls WWTP (18,000 kg TP vs. 5,900 kg TP, respectively) during the study period (Figures 26 and 39). The two plants combined accounted for almost 25% of the total phosphorus load entering the Spokane River over the period. Coeur d'Alene WWTP was responsible for 18% of the total load. This is substantially less than the 66.7% calculated by Yearsley (1980).

Total phosphorus entering the Spokane River through both WWTP effluents nearly always accounted for a substantial amount of the total phosphorus load in the river (Figure 40). The load from the Coeur d'Alene and Post Falls WWTPs made up over 50% of the total phosphorus load in the river during mean summer low flows.

Since June, 1991, when the Coeur d'Alene WWTP initiated phosphorus removal of treated effluent, mean phosphorus levels in effluent from the Coeur d'Alene WWTP decreased 80%, from 4.24 mg/l to 0.87 mg/l (Table 14). This substantially lowered the amount of total phosphorus in the Spokane River throughout the the summer when WWTP TP loading is such a significant part of the TP load. Summer TP concentrations in 1991 were approximately half of summer 1990 values (Figure 37).

Orthophosphorus (OP)

Orthophosphorus, or soluble-reactive phosphorus, is the form of phosphorus that is readily available for plant growth (APHA 1989). Mean orthophosphorus concentrations in the Spokane River were nearly always below the detection limit of 0.006 mg/l, except from July 23, 1990 to September 17, 1990, when values ranged from 0.006 mg/l to 0.019 mg/l (Table 15). Orthophosphorus concentrations mimicked total phosphorus concentrations when O-P was detectable. Orthophosphorus levels increased during low flows in the summer of 1990 (Figure 43).

Mean concentrations of orthophosphorus at different sample stations were consistently below detection limits, except at RM 108.8 during Water Year 1991. Mean concentrations in-

creased 46% between RM 111.1 and RM 108.8 during Water Year 1991. This increase occurred below the Coeur d'Alene WWTP and other sources below RM 111.1 (Figure 41).

Both Coeur d'Alene and Post Falls WWTPs contributed a substantial portion of the total orthophosphorus load to the Spokane River (16,500 Kg OP and 5,800 Kg O-P, respectively) (Figure 42). This load becomes important in the summer, when much of this available orthophosphorus is converted into phytoplankton biomass. The Coeur d'Alene WWTP contributed nearly 25% of the total orthophosphorus load to the Spokane River even under moderately high flow conditions, while the Post Falls WWTP contributed approximately half this amount. The combined orthophosphorus load from both WWTP's was nearly 10% of the total during mean summer low flows. The concentration of orthophosphorus in the Spokane River is deceptively low, because unlike total phosphorus, most of the available orthophosphorus is converted rapidly into phytoplankton biomass.

The implementation of phosphorus removal by the Coeur d'Alene WWTP has greatly reduced the amount of orthophosphorus in its effluent. Loading levels have decreased approximately 80% since June, 1991, from an effluent mean of 3.9 mg/l to a mean of 0.78 mg/l (Table 15).

N:P Ratio

Falter and Mitchell (1982) determined that productivity in the Spokane River was phosphorus-limited through most of the year except in August when nitrogen was the limiting nutrient. Chlorophyll *a* levels correlate very well with TP concentrations, but appear to be independent of TKN concentrations (Figure 44).

Total N:Total P ratios determined during the study ranged from 10.9:1 to 75.9:1 with a mean ratio of 19.8:1, indicating phosphorus limitation most of the time. The mean N:P ratio decreased to 17.6:1 when the high value of 75.9:1 (December 18, 1990) was deleted from the data. This was still above the 14-16:1 ratio range considered to be the minimum N:P ratio range indicating phosphorus limitation. Figure 45 illustrates the trend in mean N:P ratios determined during the study (all sites averaged). The only period of apparent extended nitrogen limitation, when the N:P ratio dropped below 16:1, occurred from August 8 to October 1, 1990. Nitrogen levels in the river at this time did not decrease, but instead phosphorus levels increased causing the N:P ratio to drop to 12-14 making it appear that nitrogen limitation occurred (Figure 44). Total nitrogen levels remained above 0.2 mg/l during the time in question. Sporadic nitrogen limitation occurred in Spring and Summer, 1991.

Site-specific N:P ratios present a different picture as shown in the following data:

| | Station 1 | Station 2 | Station 3 |
|--|-----------|-----------|-----------|
| 1990 Summer Mean N:P Ratio (pre TP removal) | 21:1 | 11:1 | 12:1 |
| 1991 Summer Mean N:P Ratio (post TP removal) | 17:1 | 28:1 | 21:1 |
| Winter 1990-1991 Mean N:P Ratio | 24:1 | 17:1 | 22:1 |

The lake station showed phosphorus limitation all year. Prior to TP removal, stations below the Coeur d'Alene WWTP showed nitrogen limitation; after TP removal, these sites showed phosphorus limitation on average. Winter conditions prior to TP removal also showed phosphorus limitation.

Current data and that collected over the past ten years on chlorophyll *a* and nutrients indicate nitrogen-limitation has limited productivity in the Spokane River at times, particularly late in the growing season. This also is the time when the lowest flows occur. The data collected in the current project shows that phosphorus-limitation is the major factor affecting productivity with respect to nutrients.

Zinc

One factor not addressed in the current study, but of potential importance in determining phytoplankton levels in the Spokane River, is the amount of zinc in the river. Zinc is a trace element required by plants in very minute quantities. If the concentration of dissolved zinc is high growth inhibition and direct toxicity will result in many phytoplankton species (Goldman and Horne 1983) and has been documented in the Spokane River (Falter and Mitchell 1982). Zinc concentrations in the Spokane River during 1980 ranged from 85 to 160 mg/l. These are high levels and probably were a significant factor in controlling phytoplankton biomass at that time (chlorophyll *a* values were at 0 to 5.5 mg/m³). Since shut-down of the smelter in the Silver Valley area in 1980, zinc concentrations in the Spokane River have dropped significantly. Yearsley and Duncan (1989) found zinc concentrations during August 1988, to range from >5 to 75 µg/l. Water Year 1990 total zinc averaged 82 µg/l (USGS 1991). These lower levels may not be inhibiting phytoplankton growth to the extent that they were 10 years ago. This may be another factor which contributes to the increased phytoplankton biomass.

Biochemical Oxygen Demand (BOD)

5-day BOD

Biochemical oxygen demand is a measure of the oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron (APHA 1989). BOD is not a pollutant itself, it is simply a gauge by which we can make inferences about oxygen demand in a water body.

BOD samples analyzed and presented in the Spokane River Interim Data Summary (Falter & Riggers 1990 and 1991) were incorrect. Calculations were based on a 300-ml sample, and not adjusted up to 1-liter. Therefore, those earlier values were in mg/300ml, and were approximately 70% below the true BOD value for the sample. This error has been corrected, and the correct values are presented in Table 16.

Mean 5-day BOD in the Spokane River was moderately high, ranging from 0.3 mg/l to 7.5 mg/l over the sample period (Table 16). Overall mean for the river during the study was 3.4 mg/l. These values are approximately three times greater than March, 1980, through January, 1981, mean 5-day BOD values reported by Seitz and Jones (1981). Again, this suggests a general, overall deterioration of water quality in the Spokane River over the last decade. Highest 5-day BOD values during the current study were observed in the spring of 1991 (Figure 46). This was most likely a result of high phytoplankton standing crop during this period, reflected in the corresponding high chlorophyll *a* values at the same time (Figure 44) as well as organics and detritus in the high flow runoff.

Mean 5-day BOD of the wastewater treatment plants throughout the study was extremely variable and consistently higher than that of the Spokane River (Figure 47 and Table 16). In Water Year 1991, Post Falls WWTP effluent 5-day BOD averaged nearly 4 times that of the Spokane River. Coeur d'Alene WWTP effluent 5-day BOD over the same period averaged nearly 25 times that in the river (Note: We point out that our measured values were considerably higher than those of the Coeur d'Alene WWTP. We have checked our data and can find no reason for the discrepancy).

Mean 5-day BOD levels increased nearly 11% between RM 111.1 and RM 108.8 and nearly 25% between RM 111.1 and 106.2 over the study period (Figure 47). Yearsley and Duncan (1988) reported a similar significant contribution of 5-day BOD from the Coeur d'Alene WWTP. A portion of this downstream increase in BOD is secondary 5-day BOD from phytoplankton production in the lower reaches, but a significant portion is undoubtedly directly attributable to Coeur d'Alene WWTP discharges. Five-day BOD gradually decreased in the Spokane River between RM 106.2 and RM 102.5, and then increased again between RM 102.5 and RM 100.7. The Post Falls WWTP effluent was probably partially responsible for this slight increase below Post Falls Dam; the flushing of deep water below RM 102.5 through the dam and through RM 100.7 was also a factor.

Ultimate BOD

Note: Ammonia oxidation was not inhibited in ultimate BOD test. The results should be used for guidance only.

Ultimate biochemical oxygen demand (BOD analyses carried out over time to the point where increased incubation time does not give a higher BOD value) determines the total biochemical oxygen demand in a sample of water. It also gives an estimate of the relative life span of the organic material in different water samples.

Ultimate BOD in the Spokane River ranged from 5.7 mg/l to 29.3 mg/l with a mean of 9.4 mg/l at RM 111.1. Values were similar at RM 100.7 with a range of 5.7 mg/l to 31.3 mg/l and a mean of 9.4 mg/l (Table 17). Although mean ultimate BOD was identical between RM 111.1 and RM 100.7, the number of days required to reach this level was different (Figure 48). Ultimate BOD was reached after 27 days at RM 100.7 compared to 35 days for water samples from RM 111.1.

Ultimate BOD in Post Falls WWTP effluent ranged from 28.0 mg/l to 44.0 mg/l, with a mean of 35.9 mg/l. Ultimate BOD was much higher in Coeur d'Alene WWTP effluent ranging from 283.3 mg/l to 1,000 mg/l, with a mean of 626.6 mg/l (Table 17). These high levels of ultimate BOD could create a substantial oxygen demand in the Spokane River, especially during summer low flow conditions. Ultimate BOD was reached at 35 days and 27 days in the Post Falls and Coeur d'Alene WWTP effluents, respectively (Figure 48).

Since retention times in the Spokane River are generally much less than the time required for incubating samples to realize ultimate BOD values, we submit that ultimate BOD is not a major cause for concern in the Spokane River outlet arm.

Fecal Coliform Bacteria

Samples analyzed for fecal coliform and fecal streptococcus bacteria showed extremely variable counts throughout the 1990 sample period (Tables 18 and 19). Fecal coliform counts were highest on July 23, 1990, (220 colonies/100 ml at RM 111.1) and on August 20, 1990 (180 colonies/100 ml at RM 106.2). Fecal streptococci counts were also extremely high on these same dates (>1,000 colonies/100 ml at RM 111.1 and 2,000 colonies/100 ml at RM 100.7 on each date, respectively). Plate counts of both bacteria were much lower and less variable in the Spokane River during 1991.

Plate counts of fecal coliform and fecal streptococci were consistently higher in WWTP effluent than in Spokane River water (Figure 49 and Table 18-19). Fecal coliform levels ranged from <1 to 1,620 colonies/100 ml (April 9, 1991) with a median of 35 colonies/100 ml in Coeur d'Alene WWTP effluent and <1 to >600 colonies/100 ml (March 12, 1991) with a

median of 40 colonies/100 ml in Post Falls WWTP effluent during Water Year 1991. As a result, fecal coliform bacteria showed increases below the Coeur d'Alene and Post Falls plants (Figure 49). Fecal streptococci counts ranged from <1 to 570 colonies/100 ml (April 9, 1991) with a median of 20 colonies/100 ml in Coeur d'Alene WWTP effluent and <1 to 203 colonies/100 ml (April 9, 1991) with a median of 15 colonies/100 ml in Post Falls WWTP effluent during Water Year 1991. Fecal streptococci levels show an increase at RM 108.8 and RM 100.7. The higher levels of fecal streptococci below WWTP discharges are, to some extent, a result of the WWTP effluent discharges into the river. It is worth noting that Falter and Mitchell (1982) found lower concentrations of fecal coliform in the river during their sampling in 1980.

Diel Study

Mean temperature in the Spokane River varied only slightly over the August 24 hour diel, never declining more than 1 degree C from mid-afternoon peaks to early morning lows at a sample station (Figure 50). Diel temperature profiles at each station showed little variation with depth, except for the early morning bottom reading at RM 111.1, which was approximately 1° C lower than surface, 1 m depth, and 2 m depth readings (Figures 50, 52, 53, and 54).

Mean dissolved oxygen patterns followed the same general trend of mid-afternoon highs over 90% saturation with early morning lows of approximately 80 to 85% saturation (Figure 51). Diel oxygen profiles showed little variation with depth (Figure 55 and 57). A minor dissolved oxygen sag near the bottom was measured at RM 111.1 during the mid-afternoon sample.

These diel patterns are quite typical for mesotrophic waters during the summer months, and show no indication of ecosystem stress. Similar diel temperature and dissolved oxygen patterns in the Spokane River were observed by Falter and Mitchell (1982) and Seitz and Jones (1981).

Idaho Water Quality Standards

The Spokane River outlet arm of Lake Coeur d'Alene designated uses include domestic and agricultural water supply, cold water biota, salmonid spawning, and primary and secondary contact recreation. General minimum water quality standards for each of these designated uses are provided in Appendix D.

The data indicate (not definitively because of the lack of closely spaced sampling series within a specified time period) that this reach of the Spokane River violated at least three of the guidelines for cold water biota and salmonid spawning during the study period.

Dissolved oxygen occasionally dropped below the 6.0 mg/l guideline, especially during August of 1990 and 1991 (Table A-2). pH values were commonly below 6.5, and dropped to a median (over the entire reach) of 5.7 in early May, 1991 (Table 7). Water temperatures were consistently greater than 22°C (the standard for cold water biota) during August of both study years. Additionally, water temperatures were higher than the 13°C standard for salmonid spawning during some of the cutthroat trout spawning and incubation period in the Spring (Table A-1).

Subjective Observations on Conditions in the River

Two additional observations on general biotic conditions in this reach were made, but not quantified during this study.

- 1) Attached algae growths in the river were very heavy through the summer months and continuing through the winter if substrates remained fully submerged. Conversations with many property owners assured us that this was a recurring problem which has visibly worsened through the 1980's.
- 2) Aquatic macrophyte beds were quite heavy in 1990-91 in the summer in shallower embayments and even on the open river channel. *Elodea nuttalli* is the dominant species. Again, numerous property owners told us that the abundance of these macrophytes has increased dramatically over recent years.

CONCLUSIONS

1. • The Spokane River arm of Coeur d'Alene Lake is shallow near the lake outlet (2 m maximum depth) with gradually increasing depth towards Post Falls (17.7 m maximum depth).
2. • *Mean daily* Retention Times in the study ranged from 4.3 hr to 12.7 days. Over the 12-year period 1980-1991, *mean monthly* retention times ranged from 4.3 hr to 8.6 days.
3. • Surface water temperatures peaked at 25.7 and 26.1 C in 1990 and 1991, respectively.
 - Vertical thermal stratification was only observed once, at RM 102.5 but surface to bottom temperature differences were still <3 C.
 - Water temperatures increased slightly downstream in summer months.
4. • Dissolved oxygen levels were generally less than 100% saturation throughout the year, and showed up to 2.0 mg/l depletion with depth.
 - Minimum dissolved oxygen observed was 5.4 mg/l or 55% saturation.
 - River mean oxygen levels at each each sample time were always >7.0 mg/l in summer months
 - Oxygen levels were similar between stations; downstream oxygen sags were not seen..
5. • Electrical conductivity generally was 30 to 55 μ mhos with a study high of 120 μ mhos.
6. • Median pH was 5.7 - 7.8 with highs and lows of 7.9 and 3.3, respectively.
 - WWTP effluent pH was typically near neutral.
7. • River turbidity averaged 0.5 to 2.4 NTU and increased slightly downstream.
 - Effluent turbidity from the Coeur d'Alene and Post Falls WWTPs averaged 9.4 and 2.7 NTUs, respectively.

Conclusions (cont.)

8.
 - Secchi depth ranged from 2.4 to 6.5 meters with a study average of 4.0 meters.
 - High flows stirred up bottom sediments through the reach and combined with a spring algae pulse to reduce secchi depth to 2.2 m at those times.
9.
 - Mean *year-round* chlorophyll *a* averaged 2.5 and 4.2 mg/m³ at the upper and lower sections of this river reach for an average 73% increase over the 7.6 mile reach.
 - Mean *summer* chlorophyll *a* of the lower sections averaged 6.0 mg/m³ in 1990 but only 3.3 mg/m³ in 1991 (= 45% reduction) following: 1) a very large spring algae bloom; and 2) 80% phosphorus removal from the Coeur d'Alene WWTP.
 - The 1990 and 1991 chlorophyll *a* levels place the Spokane River in mesotrophic and meso-oligotrophic productivity ranges, respectively.
 - 1990-91 mean chlorophyll *a* levels were approximately double 1980 levels but summer chlorophyll *a* dropped to near 1980 levels following phosphorus removal from Coeur d'Alene WWTP effluent.
10.
 - Mean Kjeldahl nitrogen was 0.18 mg/l and generally increased >20% below the Coeur d'Alene WWTP at low flows.
 - There was a general trend of TKN increasing downstream through the study reach.
 - TKN varied little with time of year or with water flows.
 - The WWTPs contributed 25 to 50% of the TKN load to the Spokane River at low flows.
11.
 - Nitrate-nitrogen was typically less than 0.05 mg/l through summer months with fall-winter maxima of 0.50 mg/l.
12.
 - Mean total ammonia-nitrogen in the Spokane River arm of Lake Coeur d'Alene was 0.14 mg/l.
 - Mean *summer* total ammonia-nitrogen in the Spokane River arm of Lake Coeur d'Alene was 0.16 mg/l.
 - From RM 111.1 to 108.8, there typically was an average 75% increase of total ammonia-nitrogen in the River, but less than one third of that increase was from the Coeur d'Alene WWTP. However, 30% of the average summer ammonia-nitrogen load to the river was from the Coeur d'Alene WWTP (up to 60% of the total ammonia-nitrogen load in September, 1991 at 340 cfs river flow).

Conclusions (cont.)

13.
 - Total phosphorus ranged from 0.007 to 0.025 mg/l with a study mean of 0.014 mg/l (in the mesotrophic range).
 - Total phosphorus increased 70% between RM 111.1 and 108.8 over the entire study.
 - Total Phosphorus increase between RM 111.1 and RM 100.7 averaged only 40%, so the reach was most likely a net phosphorus sink during this study.
 - *Summer* total phosphorus increased 87% between RM 111.1 and 108.8 over the entire study, 187% in 1991, but showed a 30% decline in 1991 after phosphorus removal in the Coeur d'Alene WWTP.
 - WWTPs contributed ~50% of the total phosphorus load to the reach at low flows.
 - Upgrading the Coeur d'Alene WWTP in June, 1991 resulted in an effluent TP decline of 79%.
14.
 - Orthophosphorus averaged <0.006 mg/l in the river during this study.
 - Very rapid uptake and transformation of O-P kept river concentrations low.
 - Upgrading the Coeur d'Alene WWTP in June, 1991 resulted in an effluent O-P decline of 80%.
15.
 - Total N:total P ratios exceeded 16:1 throughout most of the study, suggesting phosphorus-limitation. Some nitrogen limitation was apparent in summer-fall 1990.
16.
 - Five-day BOD levels in the Spokane River were moderately high averaging 3.4 mg/l over all sites and dates.
 - WWTP five-day BOD levels from the Coeur d'Alene and Post Falls plants averaged 81.2 and 13.2 mg/l, respectively.
 - Mean five-day BOD increased 14% in the lower four river sites compared to the two upstream sites.
17.
 - Ultimate BOD in the Spokane River averaged 10.7 mg/l.
 - WWTP ultimate BOD levels from the Coeur d'Alene and Post Falls plants averaged 644.7 and 371 mg/l, respectively.
 - Mean ultimate BOD increased 11% in the lowest river site compared to the uppermost site.

Conclusions (cont.)

18.
 - Median fecal coliform bacteria in the Spokane River were ~1 colony/100 ml except for immediately below the WWTPs.
 - Median fecal coliform bacteria were 30 and 24 colonies/100 ml in the Coeur d'Alene and Post Falls WWTPs, respectively.
 - Median fecal coliform bacteria increased ~30-fold from above to immediately below the Coeur d'Alene WWTP. River fecal coliform levels dropped to background concentrations within two river miles.
 - Median fecal coliform bacteria increased ~2-fold from above to immediately below the Post Falls WWTP.
19.
 - The diel study in August, 1991 showed insignificant stratification of either temperature or oxygen and little day-to-night fluctuation of either temperature or oxygen.

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GLOSSARY OF LIMNOLOGICAL TERMS RELEVANT TO THE SPOKANE RIVER STUDY

acre-foot • The quantity of water needed to cover one acre to a depth of one foot. Equals 43,560 cubic feet = 1,233.4 cubic meters = 325,851 gallons = 1,233,480 liters.

adsorption • The adhesion of one substance to the surface of another; clays, for example, can adsorb phosphorus and organic molecules to the surface of the clay particle.

aerobic • Characterizing organisms able to live only in the presence of air or free oxygen, and conditions that exist only in the presence of air or free oxygen.

algae • Small aquatic plants which occur as single cells, colonies, or filaments.

algal bloom • Rapid, even explosive growth of algae on the surface of lakes, streams, or ponds; stimulated by nutrient enrichment.

alkaline • The presence of alkalies (hydroxides, bicarbonates, or carbonates) in water or soil in amounts sufficient to raise the pH value above 7.0.

allochthonous • Energy and nutrients which enter a stream *via* the watershed. Terrestrial leaves, grasses, and other debris contribute large amounts of allochthonous material to small streams. Contrast with **autochthonous**.

anaerobic • Characterizing organisms able to live and grow only where there is no air or free oxygen (O₂), and conditions that exist only in the absence of air or free oxygen.

annual flood • The highest peak discharge of a stream in a water year.

aquatic macrophyte • The larger, non-microscopic aquatic plants found in shallow areas of lakes and streams. Some common examples are cattails, milfoil, rushes, duckweed, watercress, etc.

attached benthic algae (periphyton) • The community of algae (but which, in practice, also includes bacteria, protozoans, and rotifers) living on submerged surfaces.

autochthonous - Energy and nutrients which originate within the stream itself. Attached algae, macrophytes, and mosses, contribute to the autochthonous input of streams. Contrast with **allochthonous**.

average flow • The average of annual water volume carried by a channel converted to an average yearly rate of flow; measured in cubic feet per second (cfs) or cubic meters per second (cms).

bedload • The larger or heavier particles of the stream load moved along the bottom of a stream by the moving water and not continuously in suspension or solution.

benthic region • The bottom or substrate of a body of water, supporting the benthos.

benthos • All the plant and animals living on or closely associated with the bottom or substrate of a body of water.

best management practices (BMP's) • Accepted methods for controlling nonpoint source pollution; may include one or more conservation practices.

biochemical oxygen demand (BOD) • A measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements. Measurement of BOD is used to determine the level of organic pollution of a stream or lake.

biological community • All of the living things in a given environment.

biomass • The weight of biological matter. Standing crop is the amount of biomass (*eg.*, fish) in a body of water at a given time or algae on a submerged surface at a point in time.

biota • The plant and animal life in a region or ecosystem.

chemical oxygen demand (COD) • A measure of the amount of oxygen needed to oxidize all organic and inorganic material present in water or sediment; a measure of the organic and inorganic pollutant level of sewage and industrial waste water; COD includes BOD of a water sample.

chlorophyll a • The dominant green, photosynthetic pigment in plants; a measure of aquatic plant production.

coliform bacteria • A group of bacteria found in the colons of animals and humans but also in natural soil and water where organic content is high. The presence of coliform bacteria in water is an indicator of possible pollution by fecal material.

cubic feet per second (cfs) • A unit expressing rate of discharge, typically used in measuring streamflow. One cubic foot per second is equal to the discharge in a stream of a cross section one foot wide and one foot deep, flowing with an average velocity of one foot per second; = 448.8 gallons per minute.

decomposition • The transformation of organic molecules (*eg.*, sugar) to inorganic molecules (*eg.*, carbon dioxide and water) through biological and non-biological processes.

discharge • In the simplest form, discharge means outflow of water. The use of this term is not restricted as to course or location and it can be used to describe the flow of water from a pipe or from a drainage basin. Other words related to discharge are **runoff**, **streamflow**, and **yield**.

dissolved oxygen (DO) • Molecular oxygen freely available in water and necessary for the respiration of aquatic life and the oxidation of organic materials.

drainage area • The land area contributing runoff to a stream or other body of water, and generally defined in terms of acres, square miles, or square kilometers.

effluent • The sewage or industrial liquid waste which is released into natural waters by sewage treatment plants, industry, or septic tanks.

epilimnion • The near surface, uppermost, warmer layer of water in a lake or pond which lies above the horizontal zone of maximum temperature and density gradient.

eutrophication • The natural process by which lakes and ponds become enriched with dissolved nutrients, resulting in increased growth of algae and other microscopic plants.

export coefficient • The amount of a substance (usually nutrients such as nitrogen or phosphorus) which leaves a watershed *via* surface runoff per unit area of watershed per unit time, *eg.* kg P/sq. mile/year.

fauna • The entire animal population of a specific region and/or time.

fecal streptococci • Enteric (in the gut), chain-forming bacteria found in the intestines of warm-blooded animals, including humans. Occurrence in fresh water is indicative of fecal contamination by either humans or animals.

flora • The entire plant population of a specified region and/or time.

flow • The rate of water discharged past a point; expressed in water volume per unit time

flushing rate • The rate at which water exits a lake through outflows; (= R_{ho}) and measured as number of flushings per year.

flushing time • The amount of time it takes for all of a lake's water to exit through the outflow.

free-flowing • Without artificial restrictions (dams) to water movement down-channel.

hydraulic residence time • The amount of time it would take to completely fill a lake if it were empty; = lake volume/water inflow.

hypolimnion • The lowermost, non-circulating layer of cold water in a thermally stratified lake; usually deficient in oxygen.

internal loading • The release of lake sediment-bound nutrients into the water column. This process most commonly occurs when phosphorus is released from the sediments when low dissolved oxygen occurs at the sediment-water interface.

lentic • Characterizing aquatic communities found in standing water (=lacustrine).

limnology • The branch of science pertaining to the study of the physical, chemical, biological, and ecological aspects of fresh water; the structure and dynamics of ponds, lakes, streams, and wetlands.

liter • The basic unit of measurement for volume in the metric system; equal to 61.025 cubic inches or 1.057 liquid quarts.

littoral • The region along the lakeshore.

lotic environment • Characterizing aquatic communities found in running water.

mean depth • A lake's volume divided by its surface area.

mesotrophic • Literally, "moderate nutrients". Generally refers to a moderately fertile body of water.

metalimnion • The zone of a lake over which temperature drops relatively rapidly with depth.

milligram (mg) • One-thousandth of a gram.

model • A simulation, by descriptive, statistical, or other means, of a process otherwise difficult or impossible to observe directly.

morphometry • The shape or form of a lake basin or stream channel.

nonpoint source pollution • Pollution discharged over a wide land area, not from one specific location.

nutrient loading • The addition of nutrients, usually nitrogen or phosphorus, to a water body (often expressed as g/m^2 of lake surface area per year). The majority of nutrient loading in a lake usually comes from its tributaries.

nutrients • Elements or compounds essential to life, including but not limited to oxygen, carbon, nitrogen, phosphorus.

oligotrophic • Literally, "nutrient poor". Generally refers to an infertile, unproductive body of water. Contrast with **eutrophication**.

organic matter • Plant and animal residues; substances made by living organisms.

overturn • The complete circulation or mixing of upper and lower layers of water when temperatures, and therefore densities, are similar. Overturn usually occurs in the spring and fall.

parts per million (PPM) • The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Large concentrations are expressed in percentages...equivalent to mg/l.

pH • An expression of both acidity and alkalinity on a scale of 0-14, with 7 representing neutrality; numbers less than 7 indicate increasing acidity, and numbers greater than 7 indicate increasing alkalinity.

pheophytin • A degradation product of chlorophyll. The relative amount of pheophytin can be used to determine the "health" of the phytoplankton community.

photic zone • The zone in a lake through which light penetrates and plant growth occurs.

phytoplankton • Usually microscopic aquatic plants (sometimes consisting of only a cell).

point source pollution • Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

pollution • Any alteration in the character or quality of the environment which renders it unfit or less suited for certain uses. See **water contamination** and **water pollution**.

profundal • The deeper portion of a body of water below the area of plant growth.

reach • Any arbitrarily defined length of a stream.

reservoir • A pond, lake, or basin (natural or artificial) that stores, regulates, or controls water flow downstream.

riparian area • Land areas directly influenced by a body of water. Usually have visible vegetation or physical characteristics showing this water influence. Stream sides, lake borders, and marshes are typical riparian areas.

secchi depth • The mean depth at which a black and white disk 20-cm in diameter is no longer visible from the water surface; a measure of water transparency.

sediment • Fragmented organic or inorganic material derived from the weathering of soil, alluvial, and rock materials; removed by erosion and transported by water, wind, ice, and gravity.

senescent • Aging, growing old; with a lake, senescent = **eutrophic**.

stratification • The forming or arrangement of layers. This is usually caused by differences in temperature and density between layers.

substrate • The permanent bottom material of a lake or stream which forms the lake basin or stream bed.

terrestrial • Living or growing in a land-based ecosystem rather than in water or air.

topographic maps • Maps with lines showing equal elevation or a region's relief; also showing natural surface features, including hills, valleys, rivers, and lakes; as well as man-made surface features such as canals, bridges, roads, cities, etc.

total dissolved solids (TDS) • The quantity of dissolved materials in the water.

total suspended solids • Solids, found in waste water or in a stream, which can be removed by filtration. The origin of suspended matter may be man-made wastes or natural sources such as silt.

toxin • Any of a variety of unstable, poisonous compounds produced by organisms; may be capable of causing certain diseases.

trophic • Referring to the nourishment status of a lake. **Oligotrophic** = poorly nourished; **Eutrophic** = well-nourished.

turbidity • Cloudiness caused by the presence of suspended solids in water; an indicator of water quality.

ultimate BOD • The biochemical oxygen demand exerted in an oxygen consumption test run long enough so that no further oxygen reduction occurs.

water quality standard • Legally mandated and enforceable maximum contaminant levels of chemical parameters (e.g., BOD, TDS, iron, arsenic, and others) of water. These parameters are established for water used by municipalities, industries, agriculture, and recreation.

water quality • A term used to describe the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

water year • The 12-month period October 1 through September 30, and designated by the calendar year in which the water year ends.

watershed • Area of land that contributes surface runoff to a given point in a drainage system.

wetlands • Lands where water saturation of the soil for at least part of the year is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. Other common names for wetlands are sloughs, ponds, swamps, marshes, and riparian zones

FIGURES

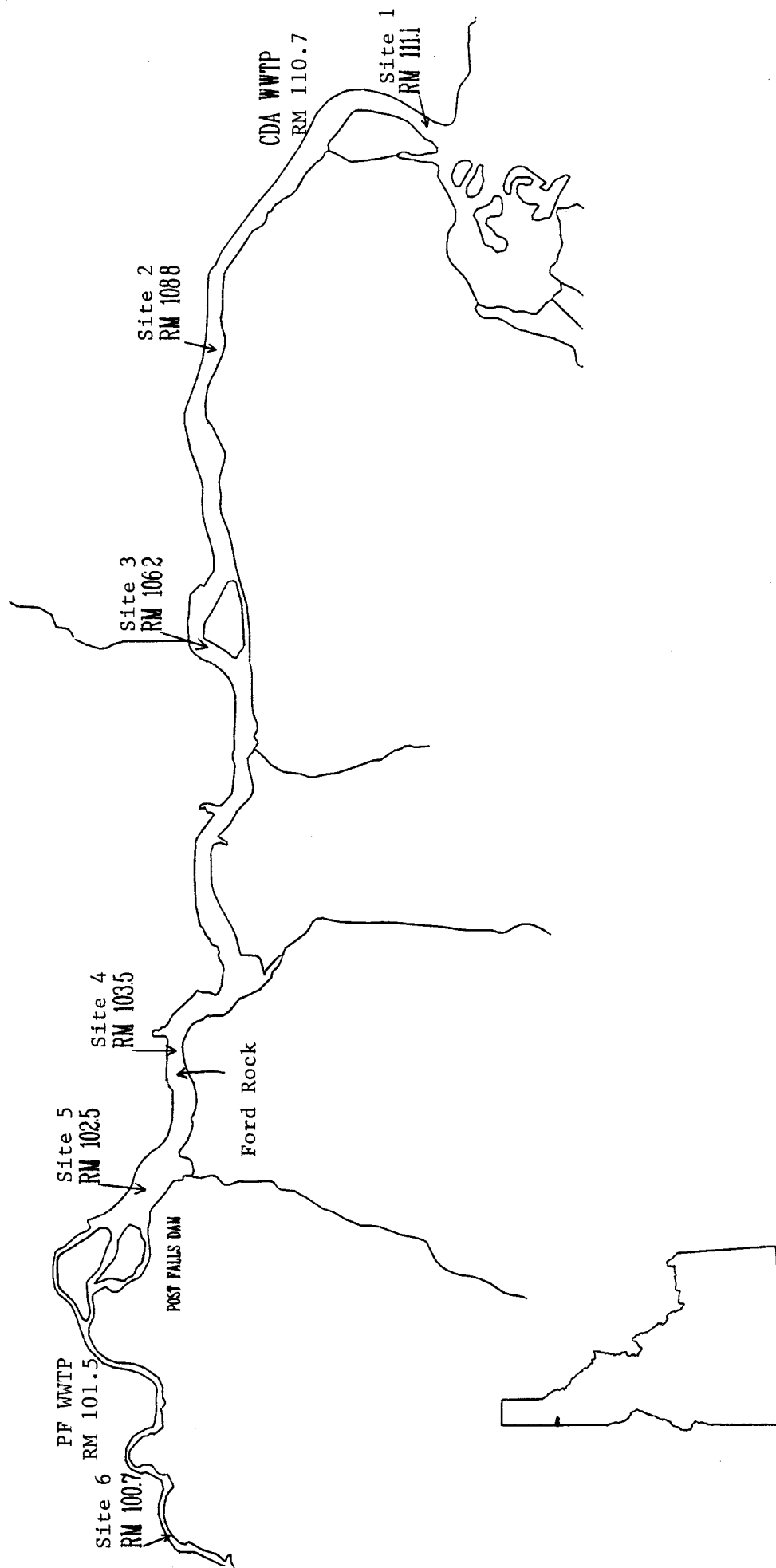


Figure 1. Location map and sampling sites for the Spokane River outlet arm of Lake Coeur d'Alene water quality survey, June 29, 1990 to September 24, 1991.

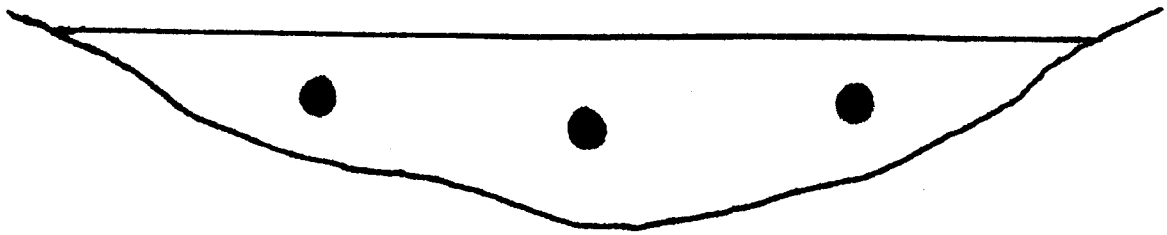


Figure 2. Water quality grab sampling locations at mid-depth for Spokane River stations exhibiting *mixed* conditions.

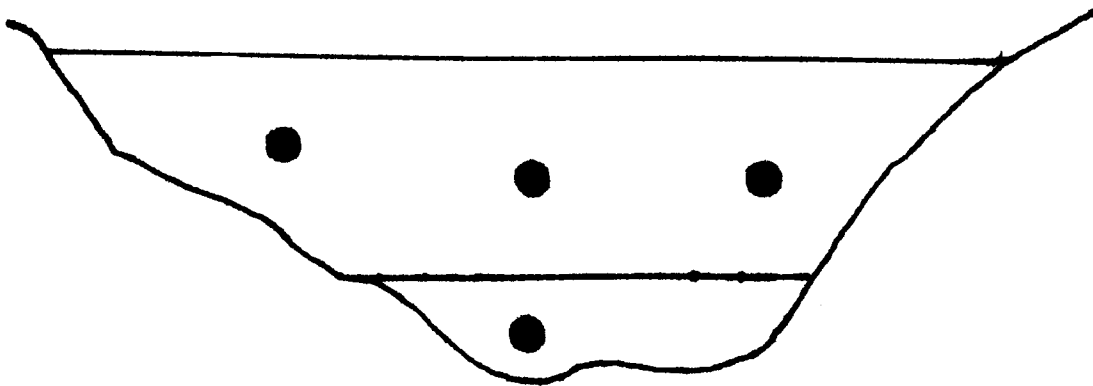


Figure 3. The spatial distribution of water quality grab samples for Spokane River sampling stations exhibiting stratified conditions.

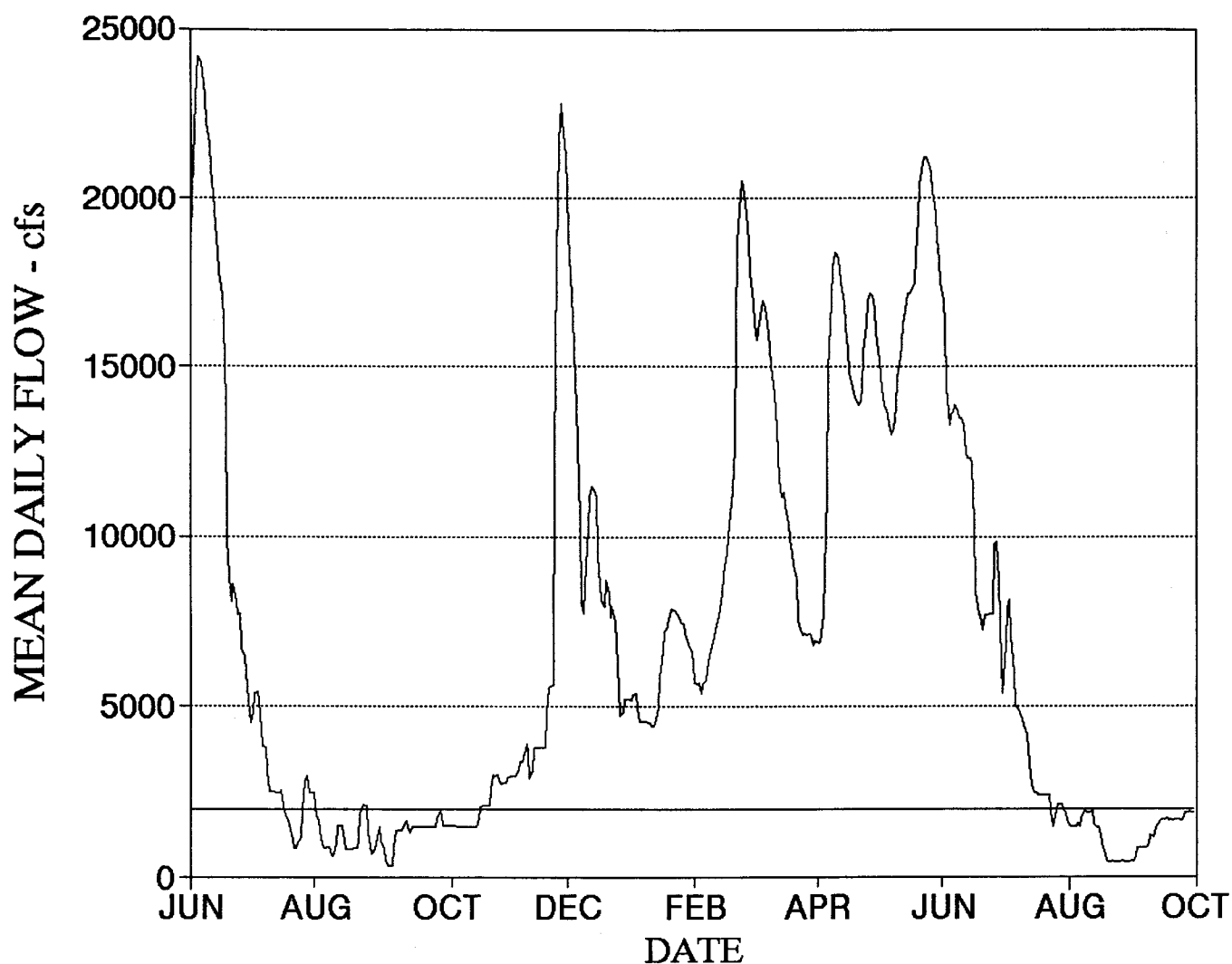


Figure 4.

Mean daily flow of the Spokane River near Post Falls (station number 12419000) for June 29, 1990 to September 24, 1991, (USGS 1990 and USGS 1991).

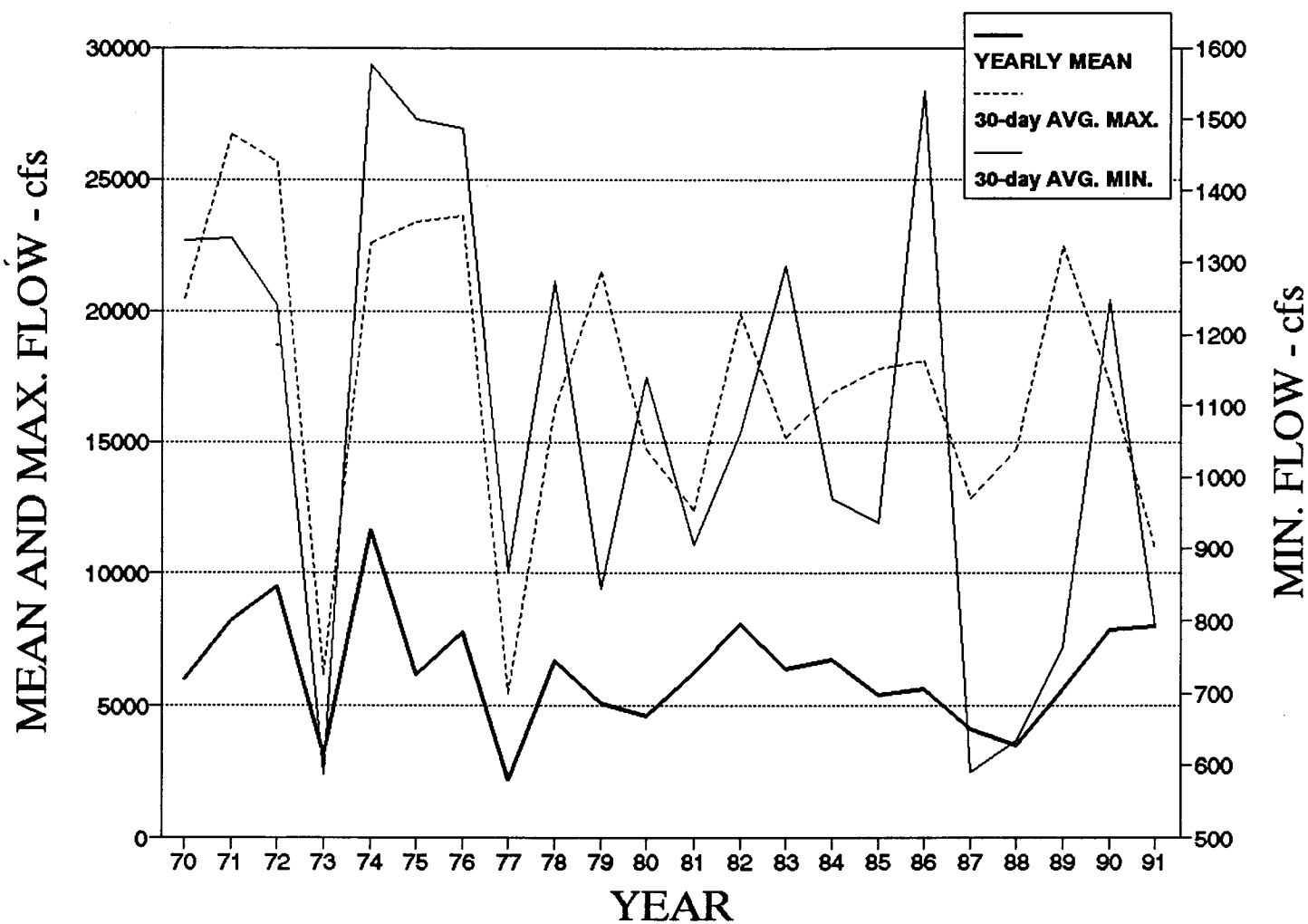


Figure 5.

Flow characteristics of the Spokane River near Post Falls over the past 22 water years (USGS 1970-1991).

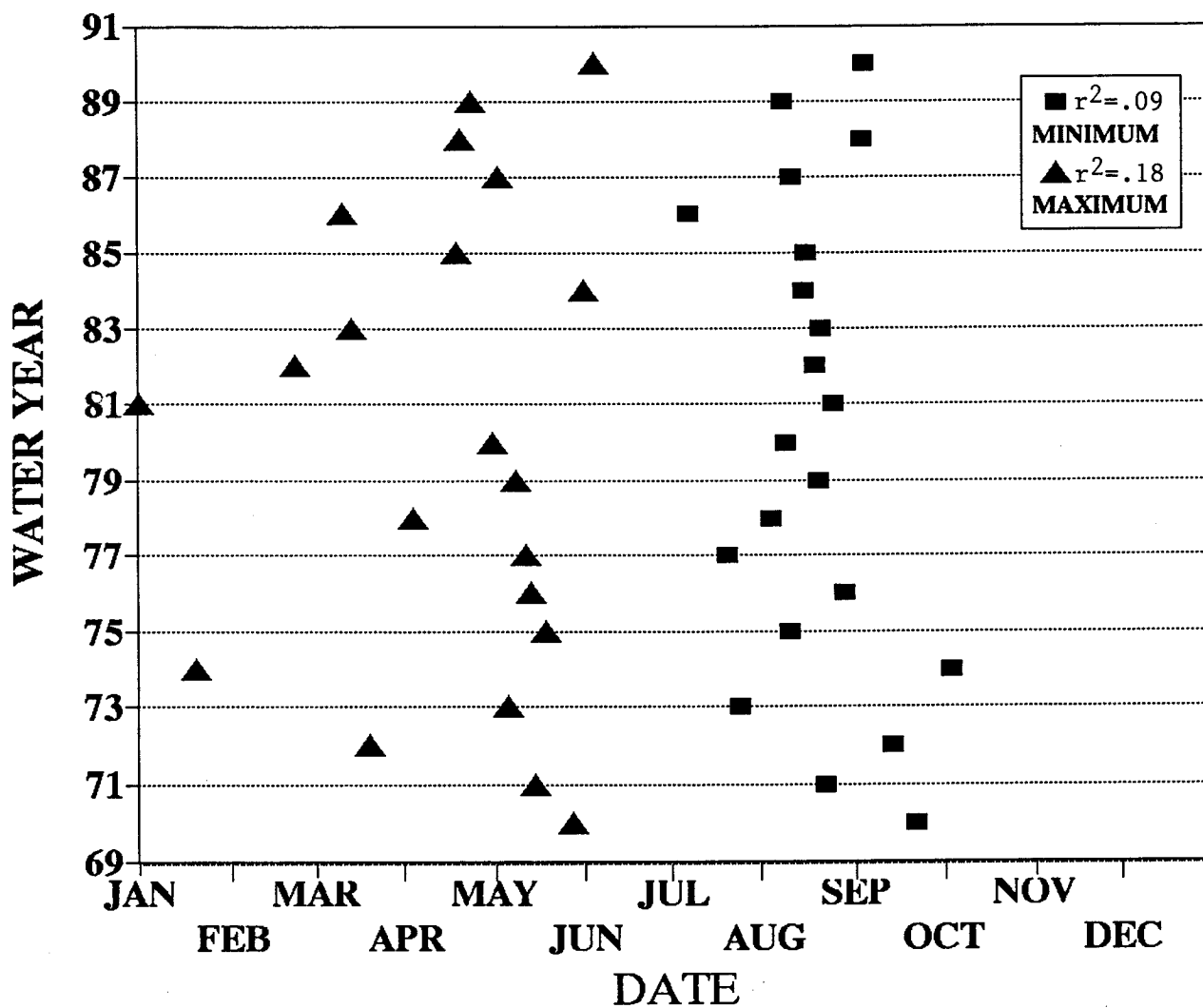


Figure 6.

Date of minimum and maximum flow on the Spokane River near Post Falls over the past 22 water years (USGS 1970-1991).

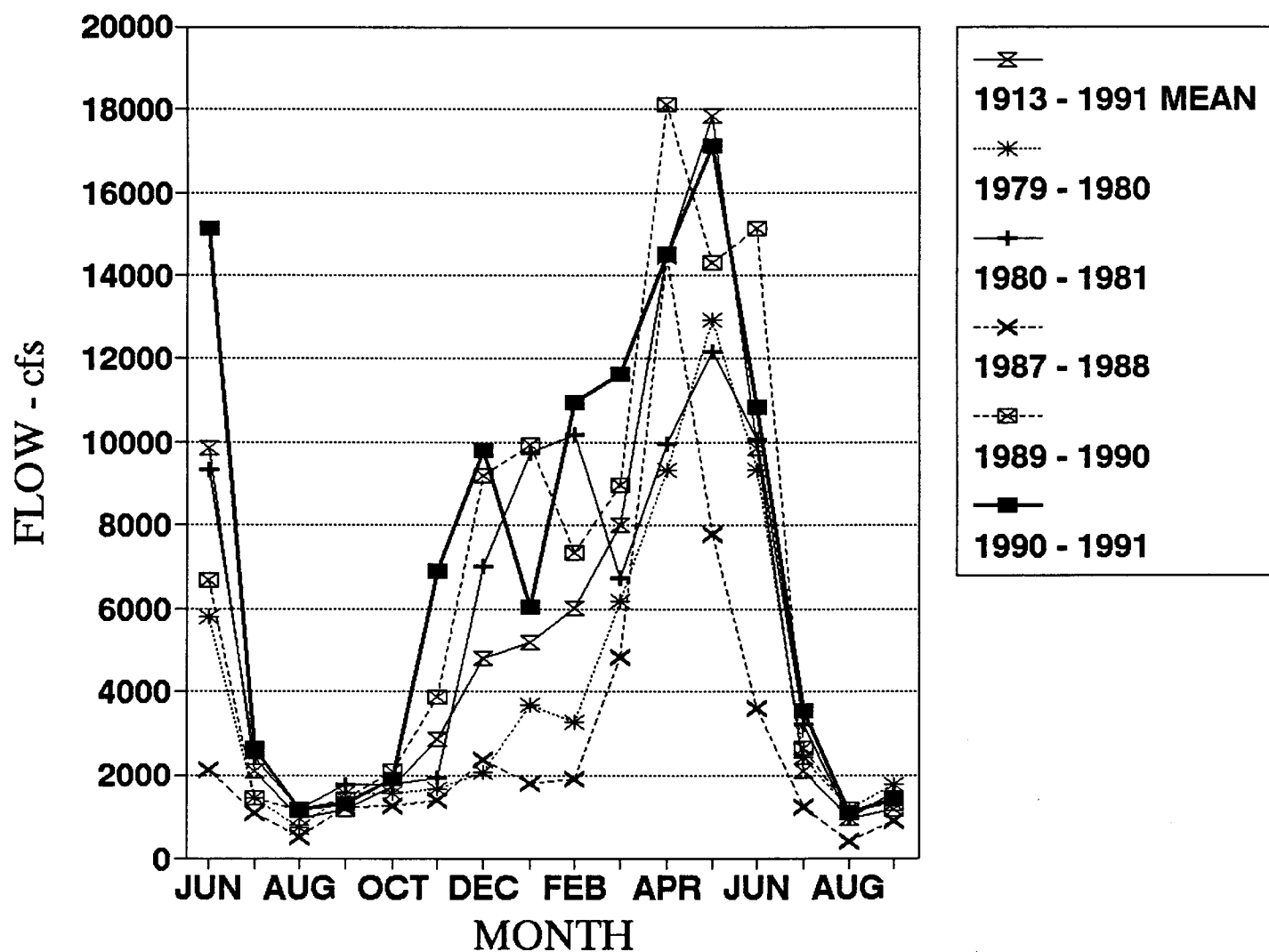


Figure 7.

Mean monthly flow (cfs) of the Spokane River near Post Falls during water quality study periods--(Falter and Mitchell 11/79-10/80), (Seitz and Jones 3/80-1/81), (Yearsley and Duncan 8/15-18/88), (Falter and Riggers 6/90-9/91), and over the seventy-eight year period of record (1913-1991) (USGS 1979, 1980, 1987-1991).

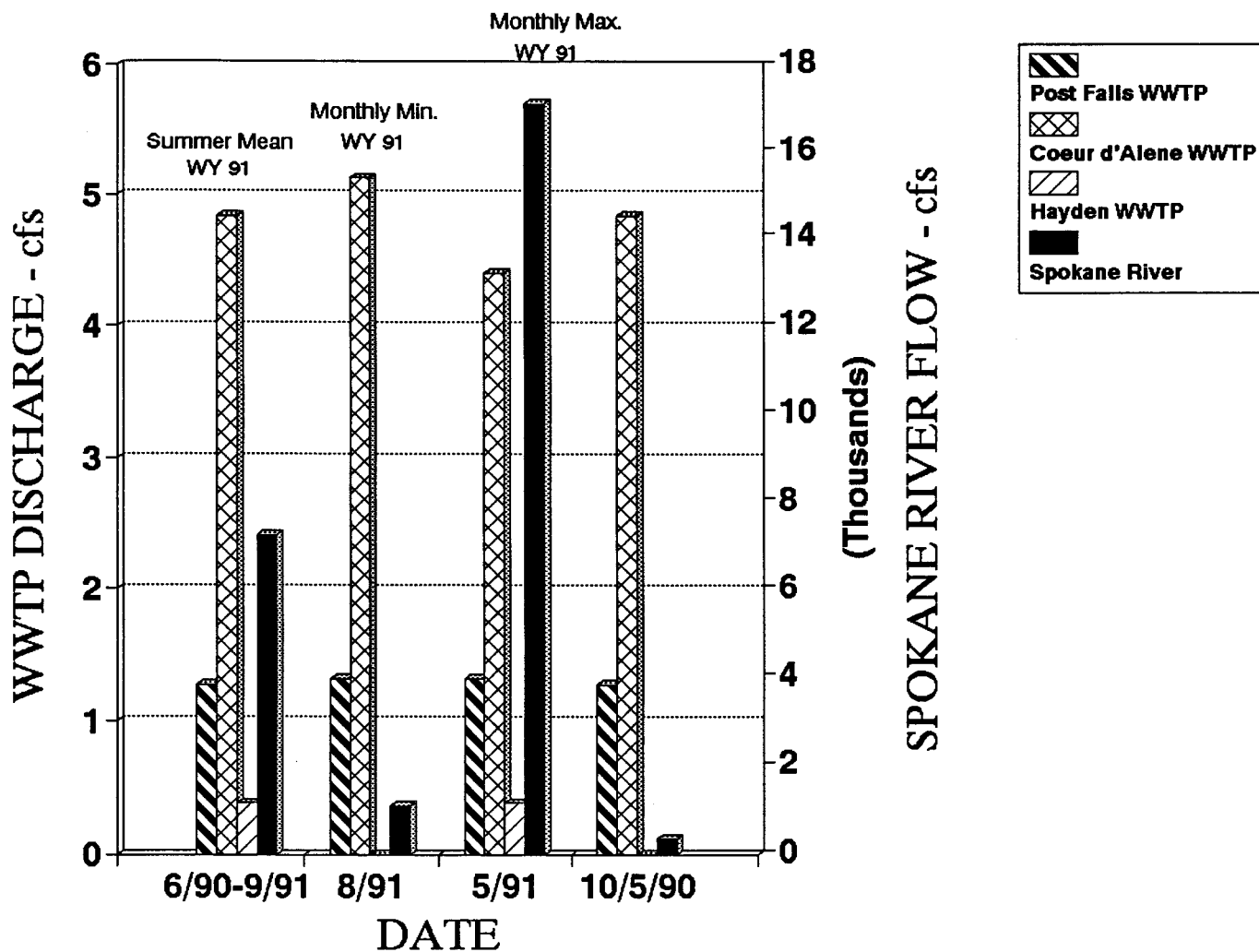


Figure 8.

Mean flow (cfs) of the Spokane River and discharge (cfs) to the river from Coeur d'Alene, Post Falls, and Hayden (proposed) wastewater treatment plants under various flow conditions for June 29, 1990 to September 24, 1991.

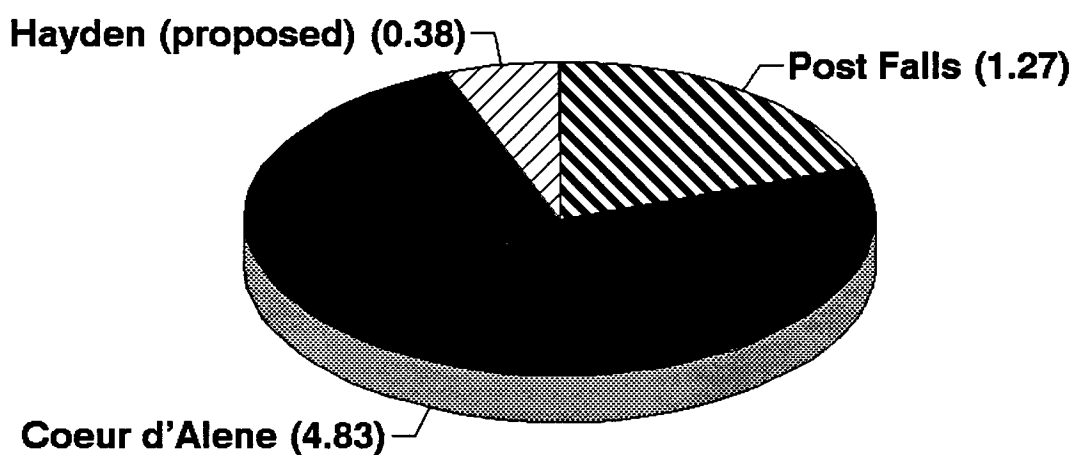


Figure 9. Mean yearly discharge (cfs) to the Spokane River from Coeur d'Alene and Post Falls wastewater treatment plant and from the proposed City of Hayden Outfall.

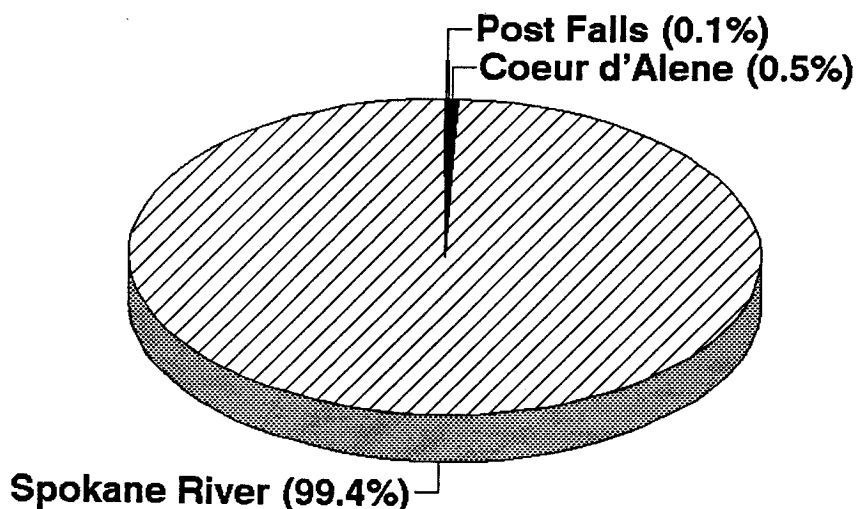


Figure 10.

Wastewater treatment plant discharge to the Spokane River as a percentage of river flow under the lowest mean monthly flow conditions (1,075 cfs) during the June 29, 1990 to September 24, 1991 study period.

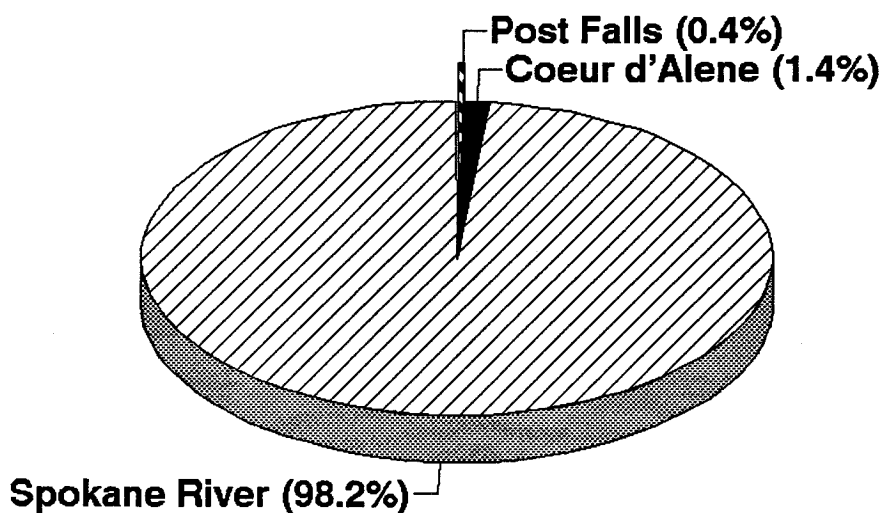


Figure 11.

Wastewater treatment plant discharge to the Spokane River as a percentage of river flow under the lowest flow conditions (340 cfs) during the June 29, 1990 to September 24, 1991 study period.

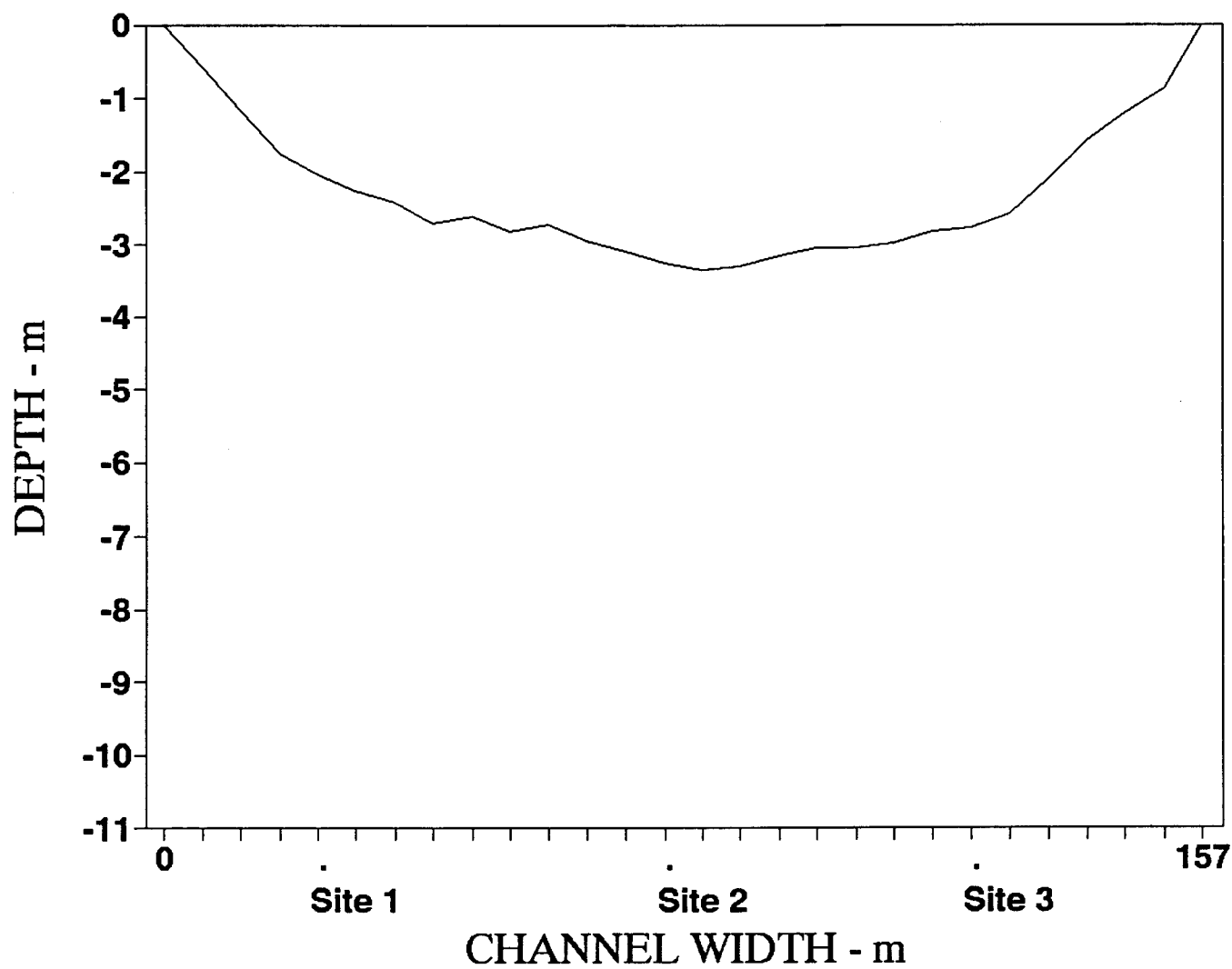


Figure 12. Bottom profile and sample site location for Station 1 (RM 111.1), Spokane River, 1991.

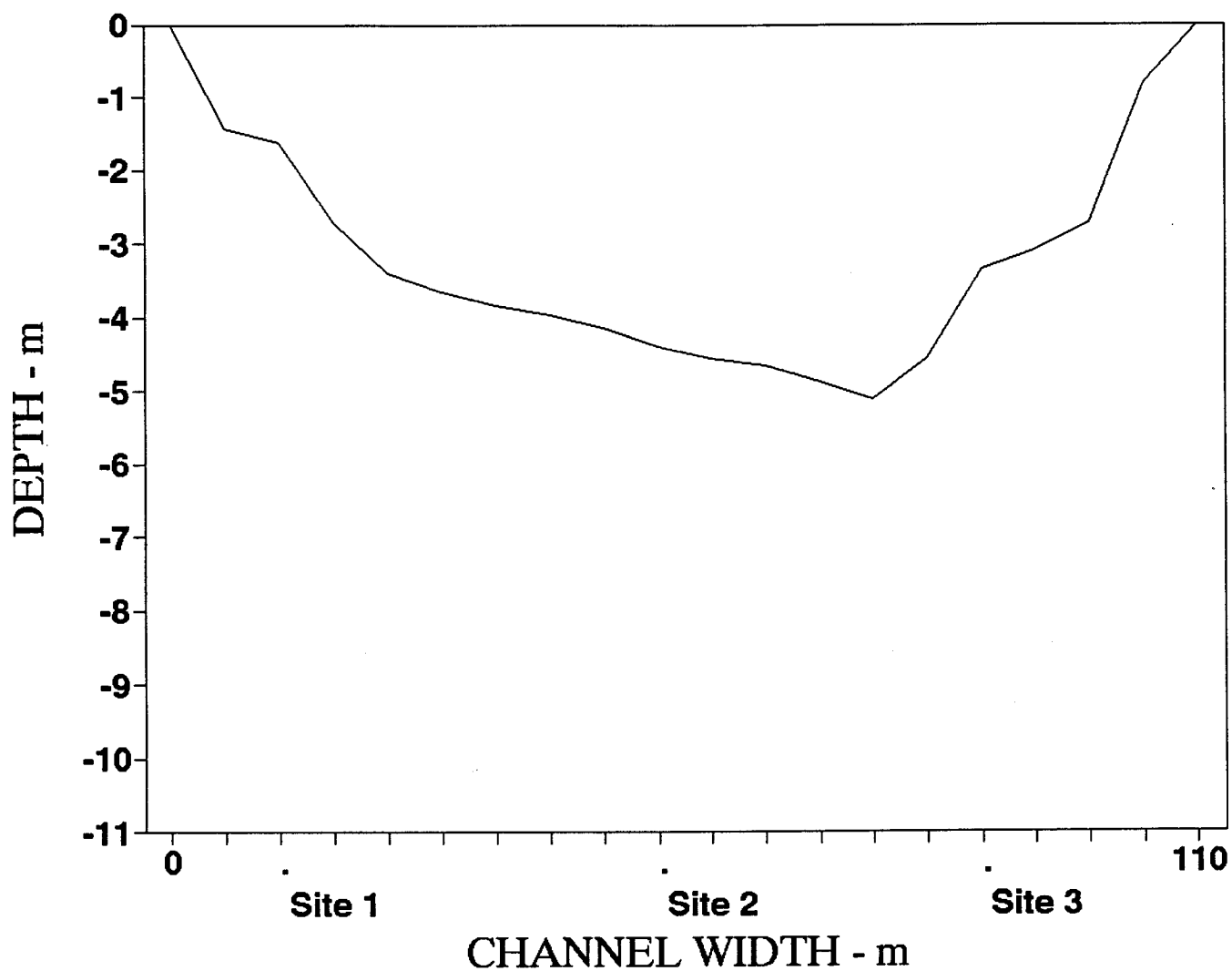


Figure 13. Bottom profile and sample site location for Station 2 (RM 108.8), Spokane River, 1991.

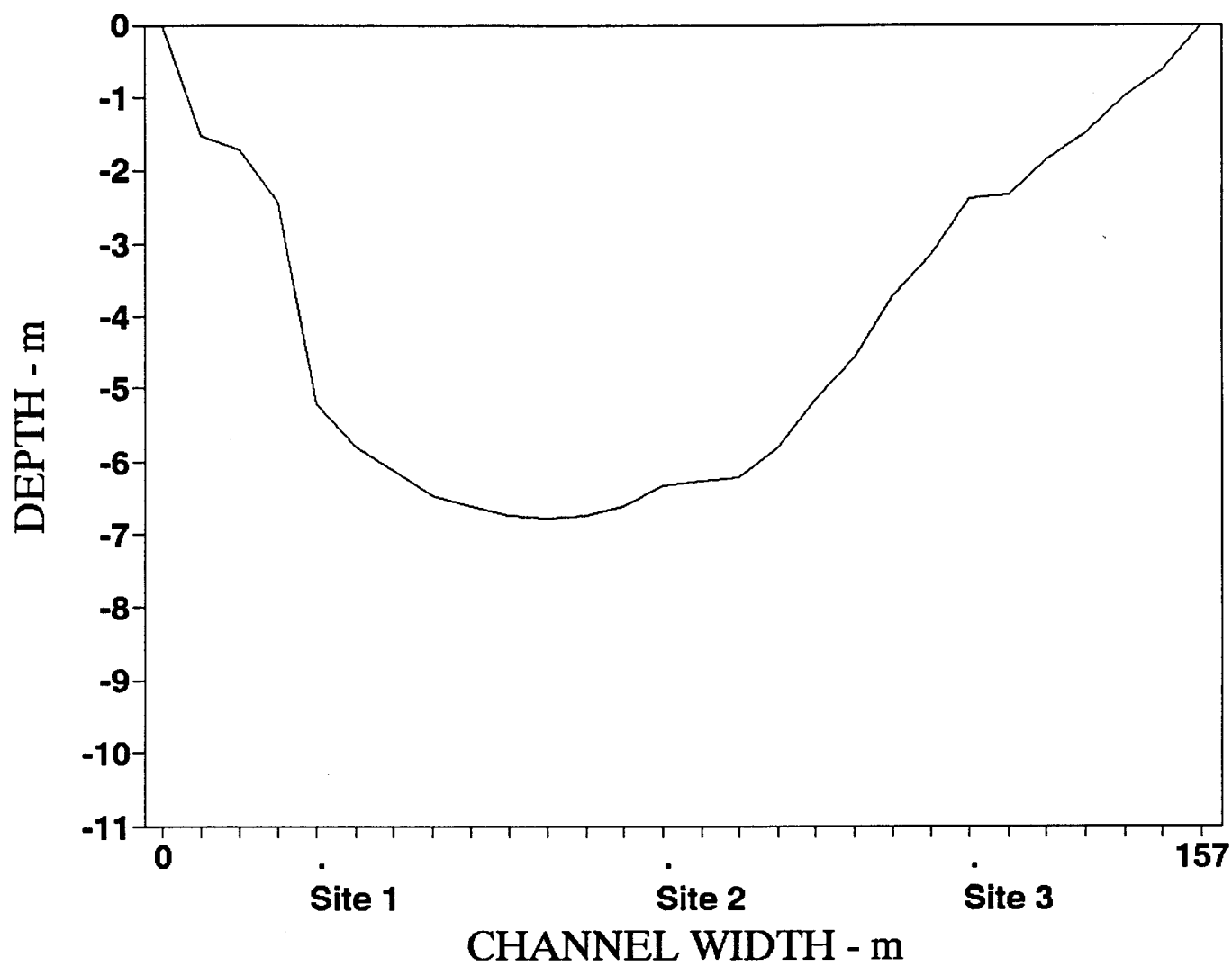


Figure 14.

Bottom profile and sample site location for Station 3
(RM 106.2), Spokane River, 1991.

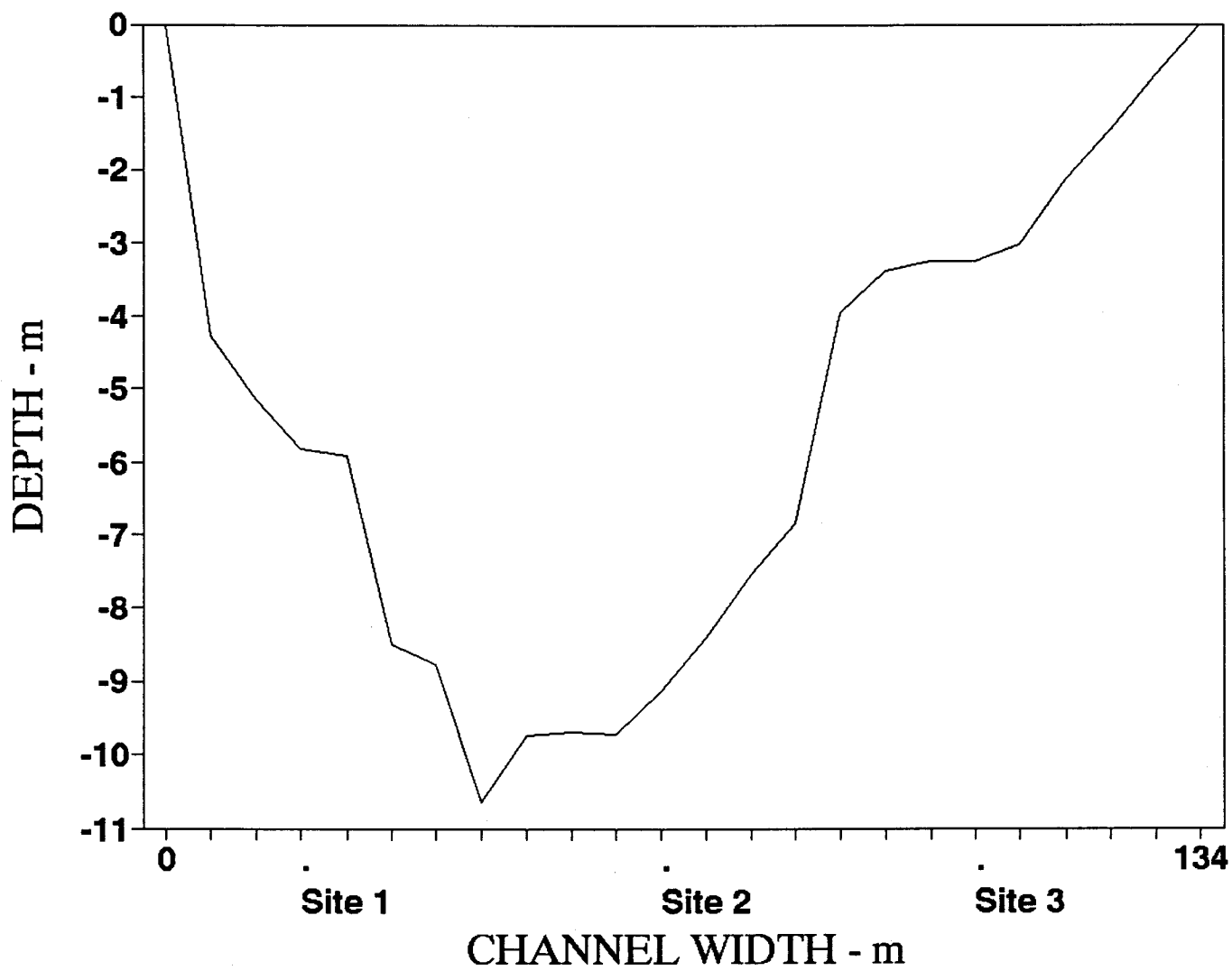


Figure 15.

Bottom profile and sample site location for Station 4
(RM 103.5), Spokane River, 1991.

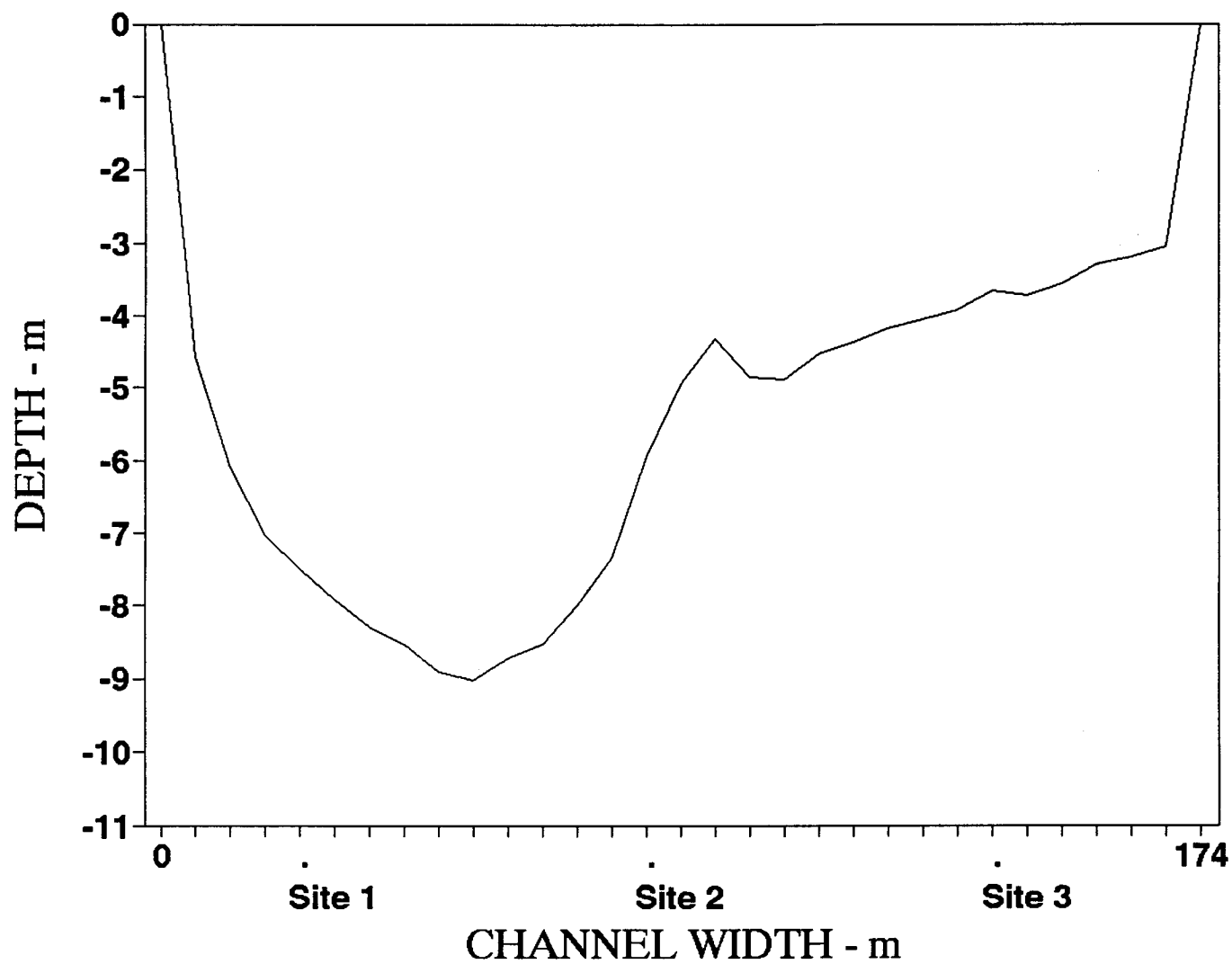


Figure 16.

Bottom profile and sample site location for Station 5
(RM 102.5), Spokane River, 1991.

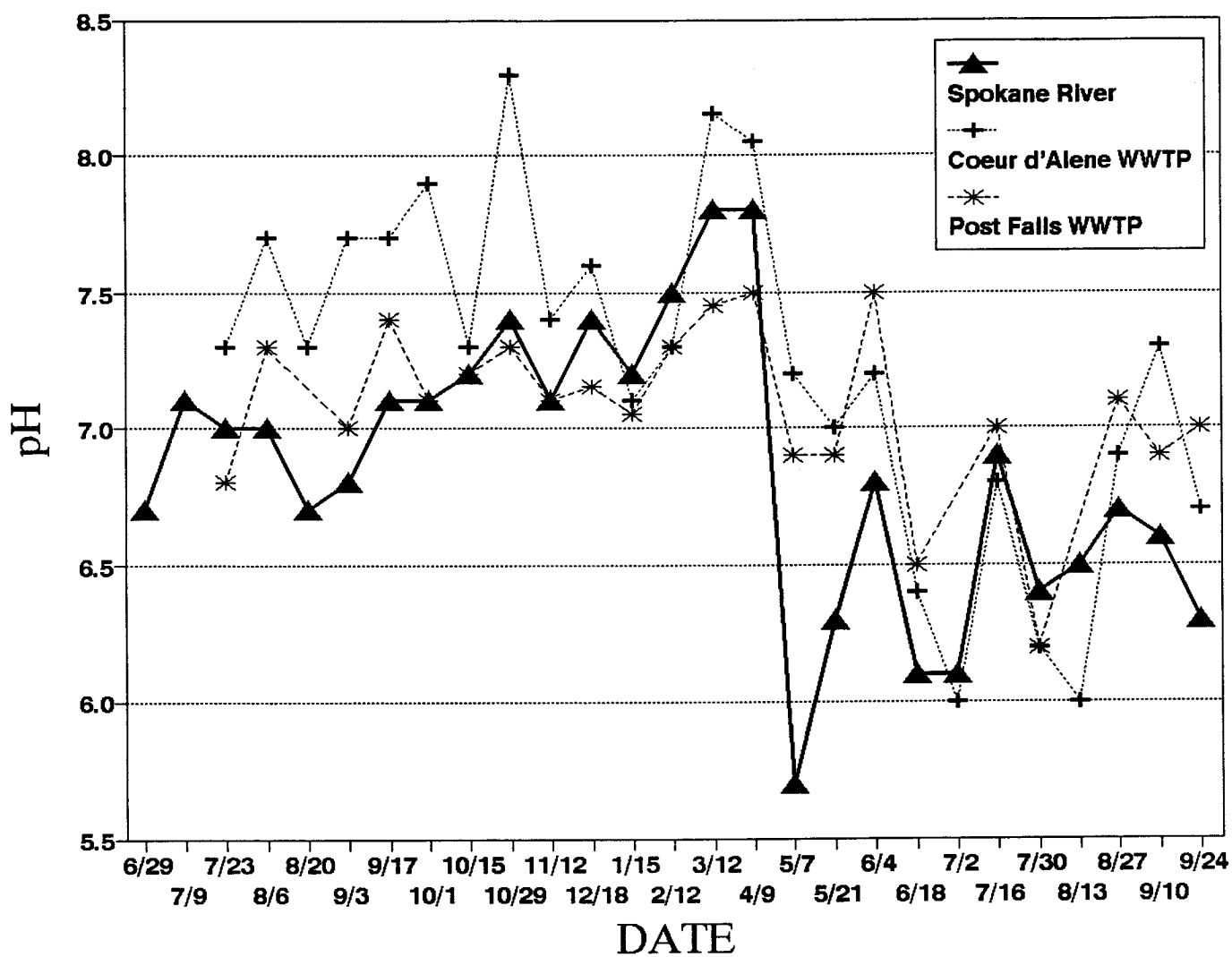


Figure 17.

Median pH of the Spokane River, Post Falls WWTP, and Coeur d'Alene WWTP for June 29, 1990 to September 24, 1991.

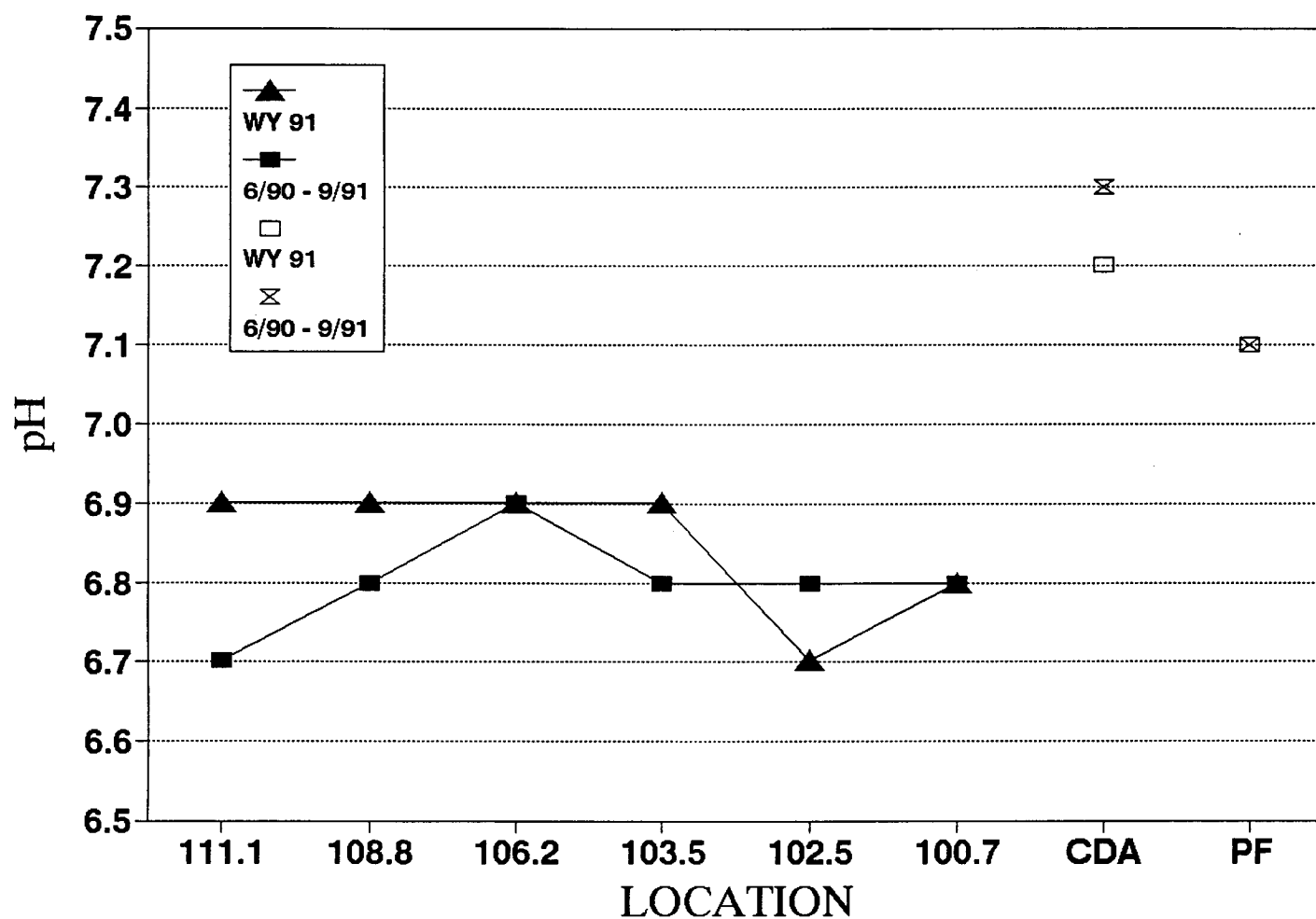


Figure 18.

Median pH between stations; Spokane River RM 111.1 to RM 100.7, Post Falls WWTP, and Coeur d'Alene WWTP during Water Year 1991 and June 29, 1990 to September 24, 1991.

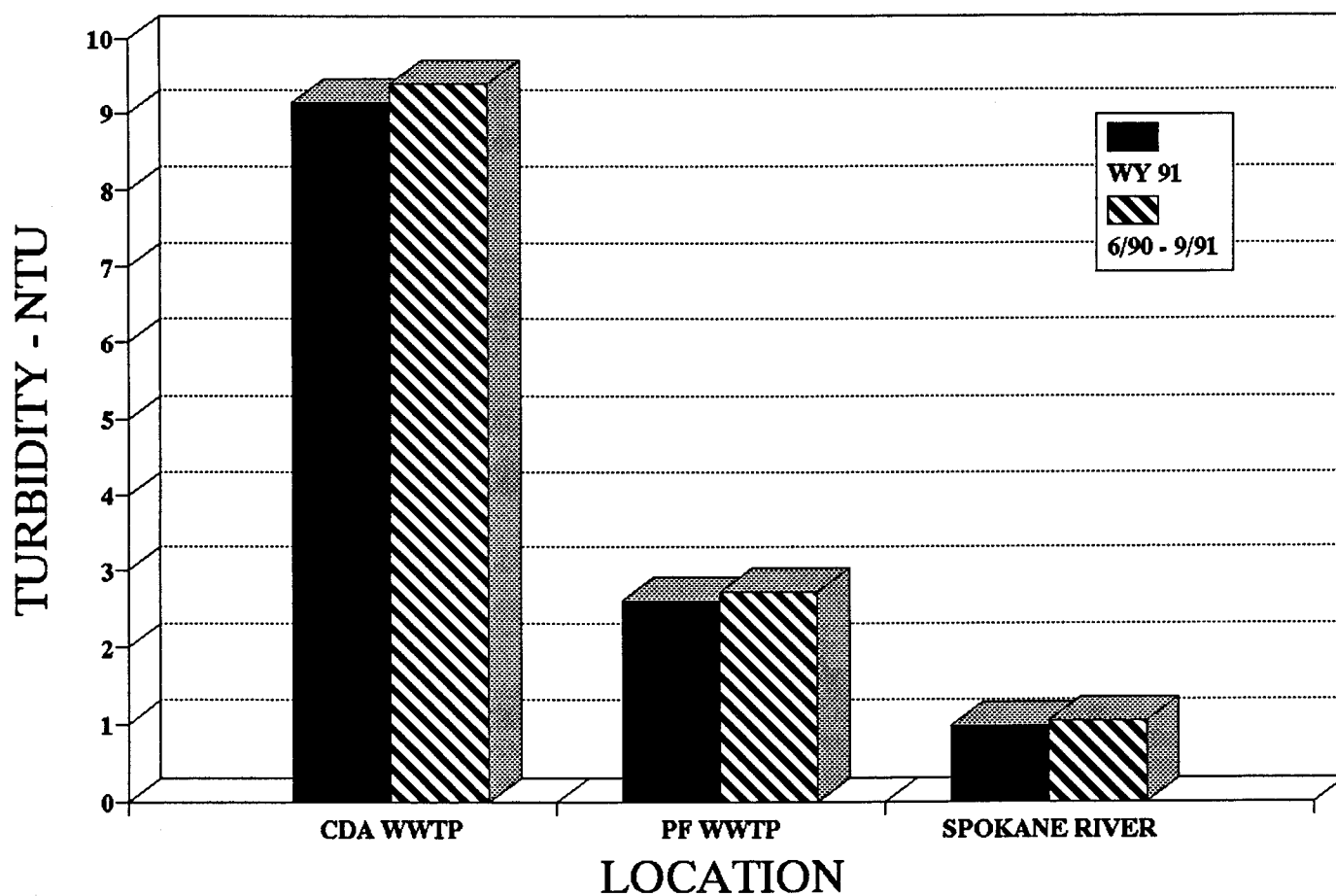


Figure 19.

Mean turbidity of the Spokane River and Post Falls and Coeur d'Alene Wastewater Treatment Plants during Water Year 1991 and June 29, 1990 to September 24, 1991.

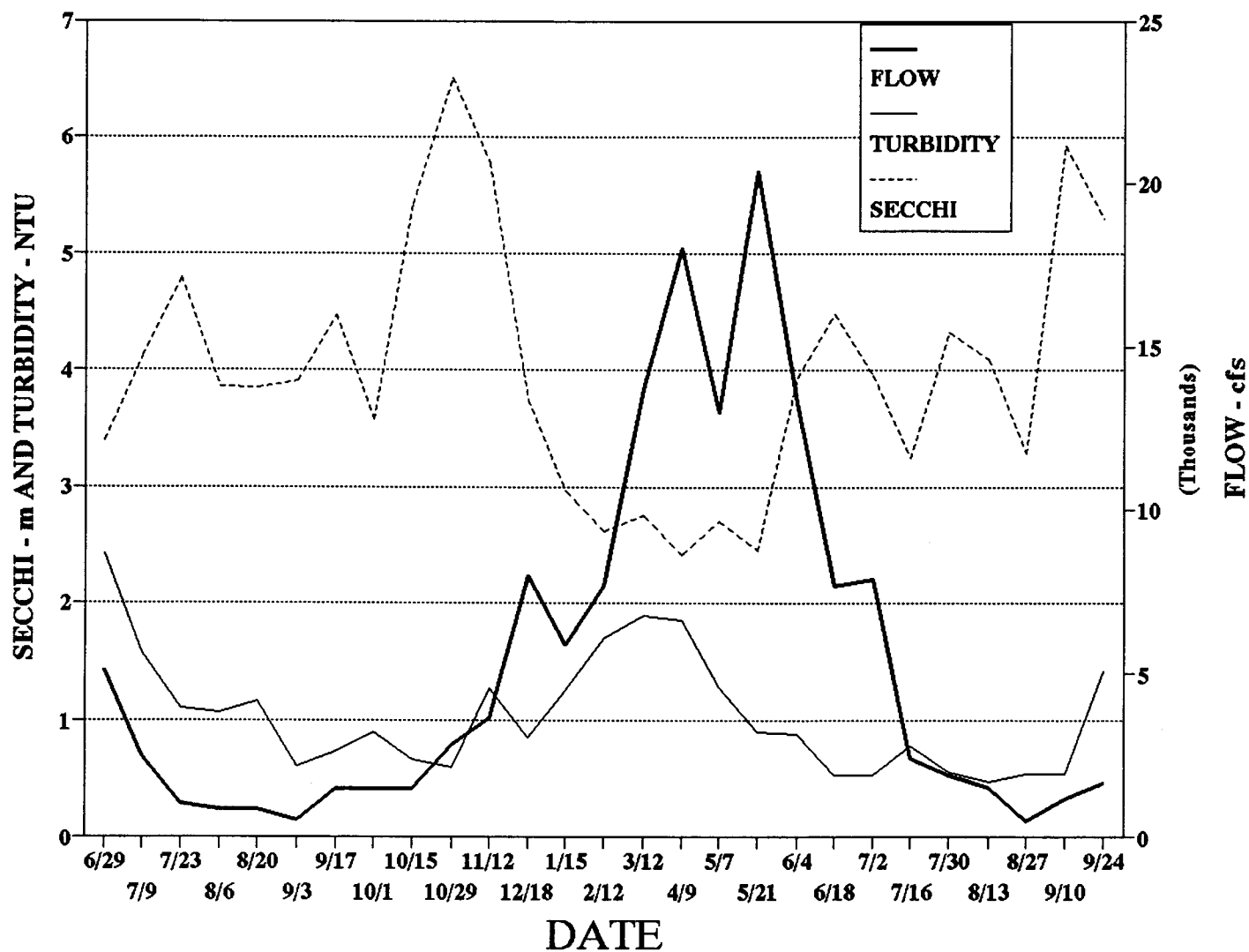


Figure 20.

Mean Secchi depth and turbidity versus flow in the Spokane River on each sample date for June 29, 1990 to September 24, 1991.

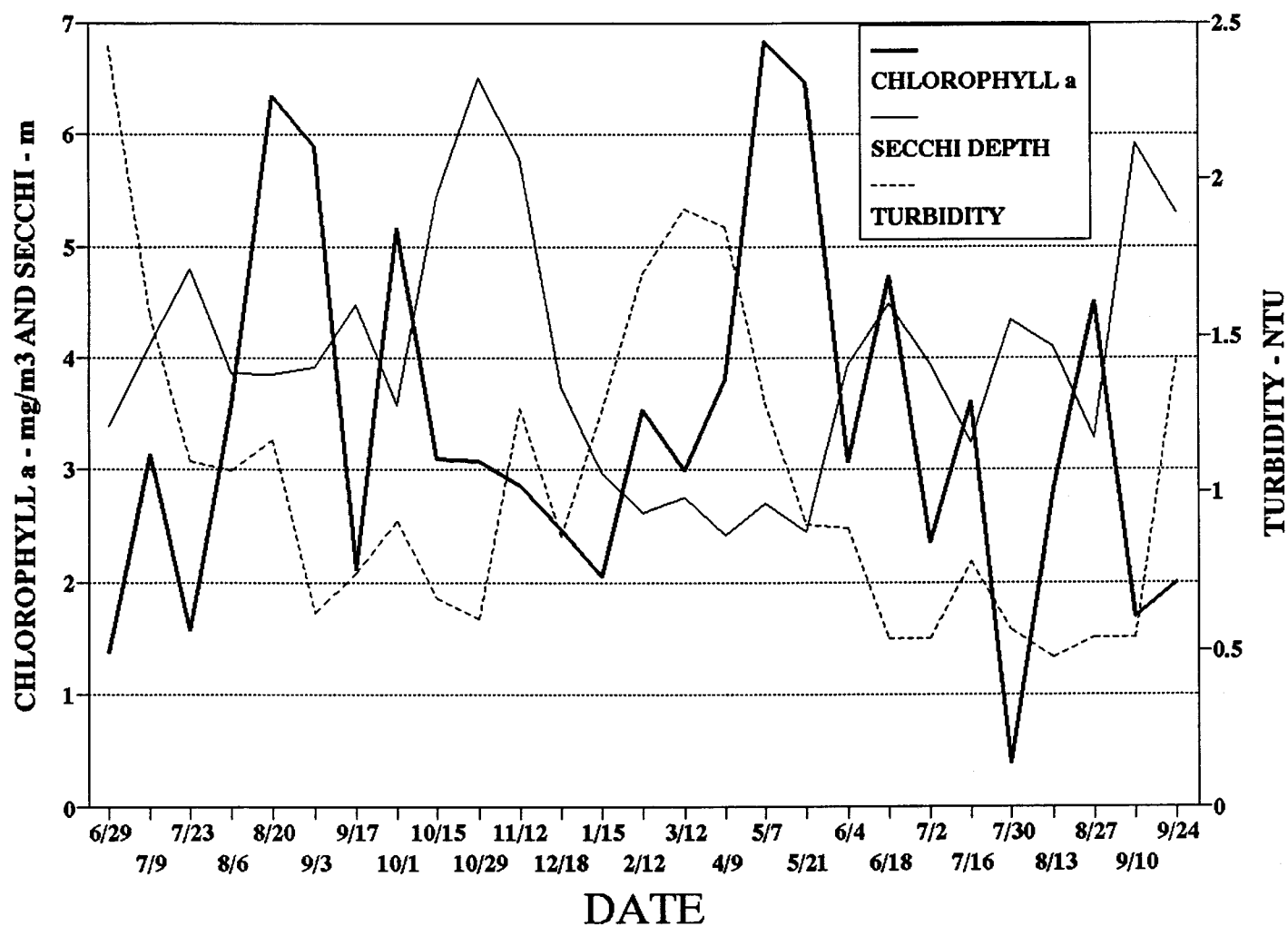


Figure 21.

Mean chlorophyll a, secchi depth, and turbidity in the Spokane River on each sample date for June 29, 1990 to September 24, 1991.

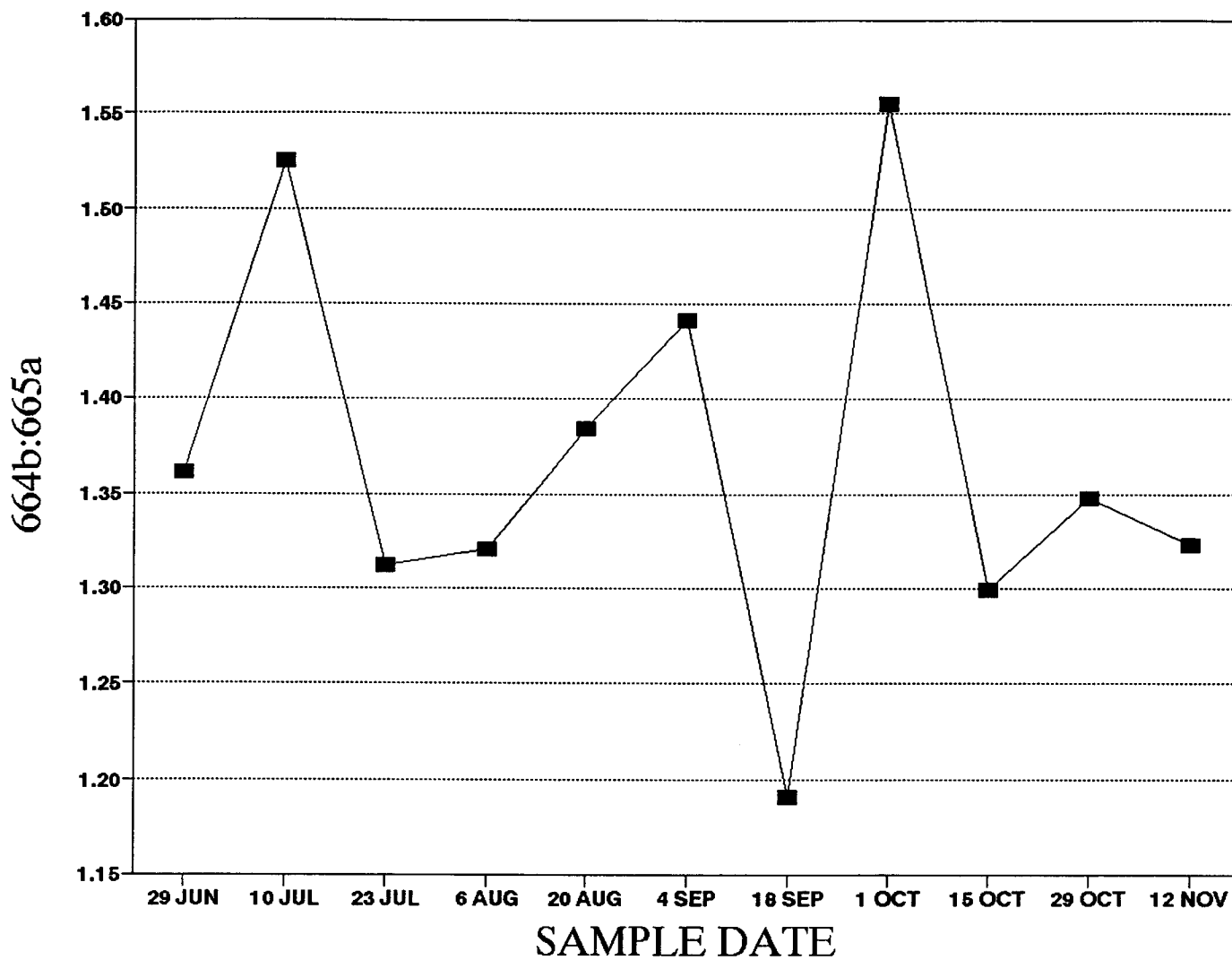


Figure 22.

Absorption peak ratios for chlorophyll a samples collected June 29, to November 17, 1990. Ratio values near 1.70 indicate healthy chlorophyll a. Values near 1.00 indicate high pheophytin content.

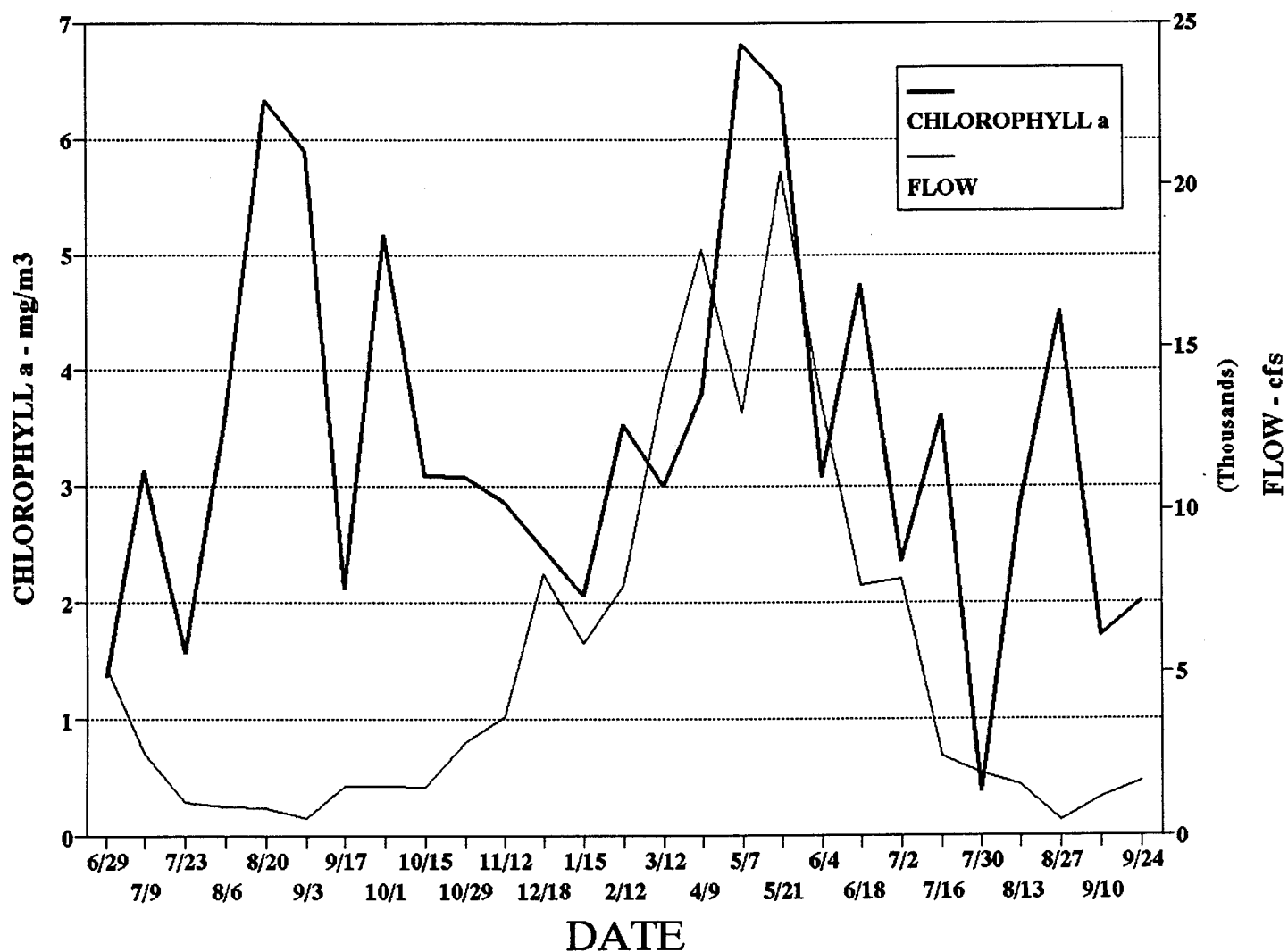


Figure 23.

Mean chlorophyll a versus flow in the Spokane River on each sample date for June 29, 1990 to September 24, 1991.

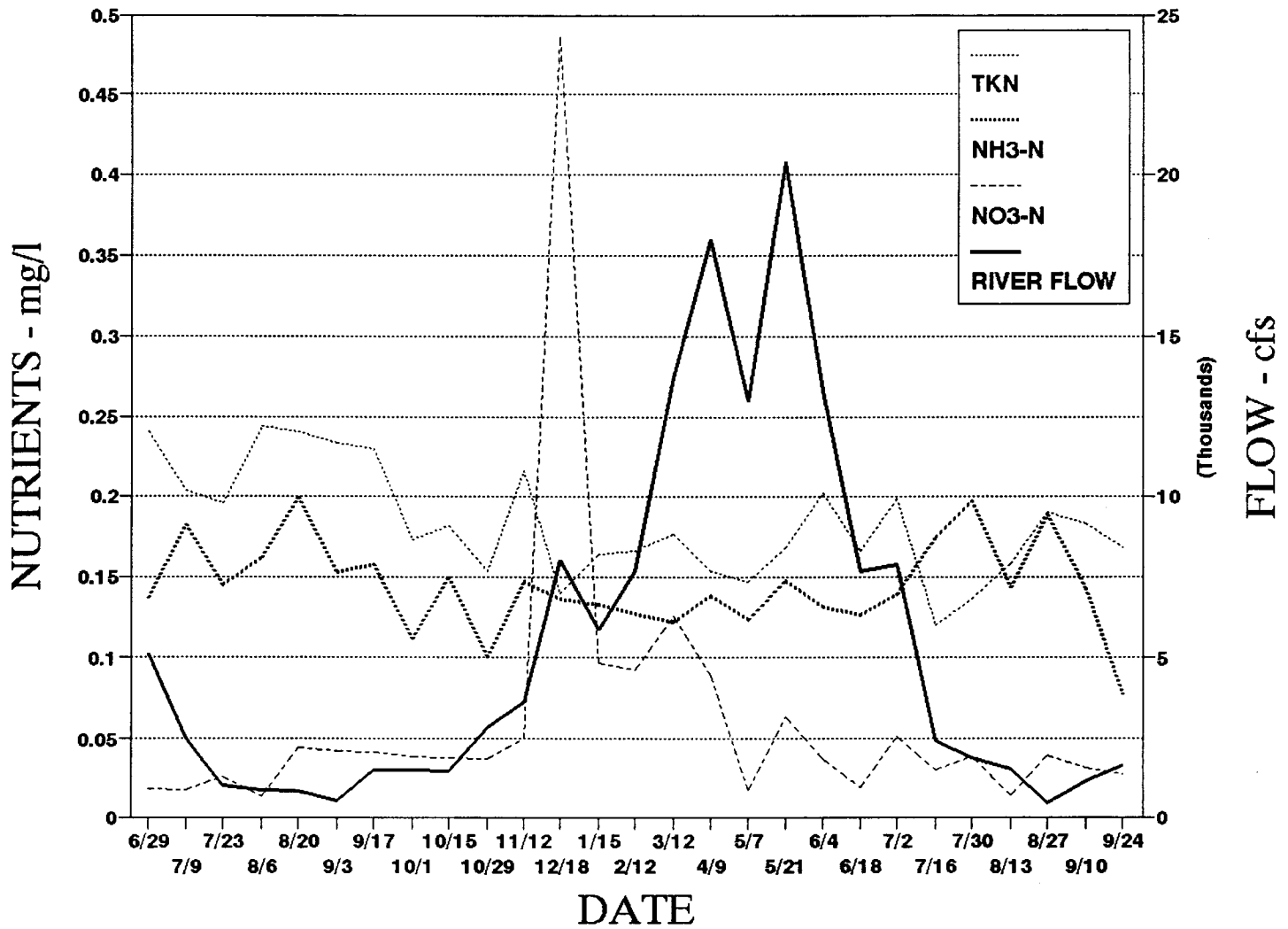


Figure 24.

Total Kjeldahl nitrogen, ammonia-nitrogen, and nitrate-nitrogen concentrations versus flow in the Spokane River on each sample date for June 29, 1990 to September 24, 1991.

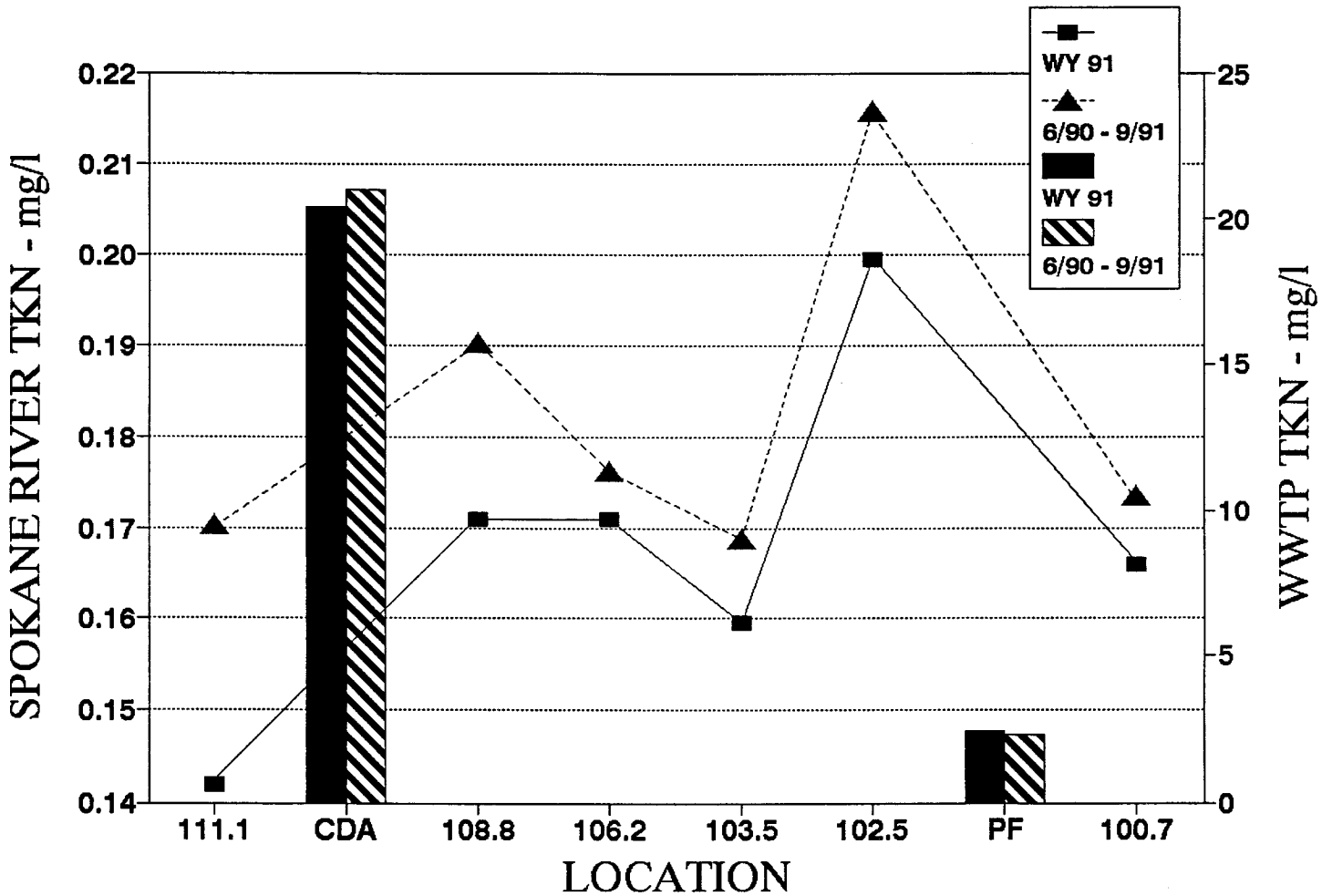


Figure 25.

Mean total Kjeldahl nitrogen concentrations in the Spokane River and Coeur d'Alene and Post Falls wastewater treatment plants during Water Year 1991 and June 29, 1990 to September 24, 1991.

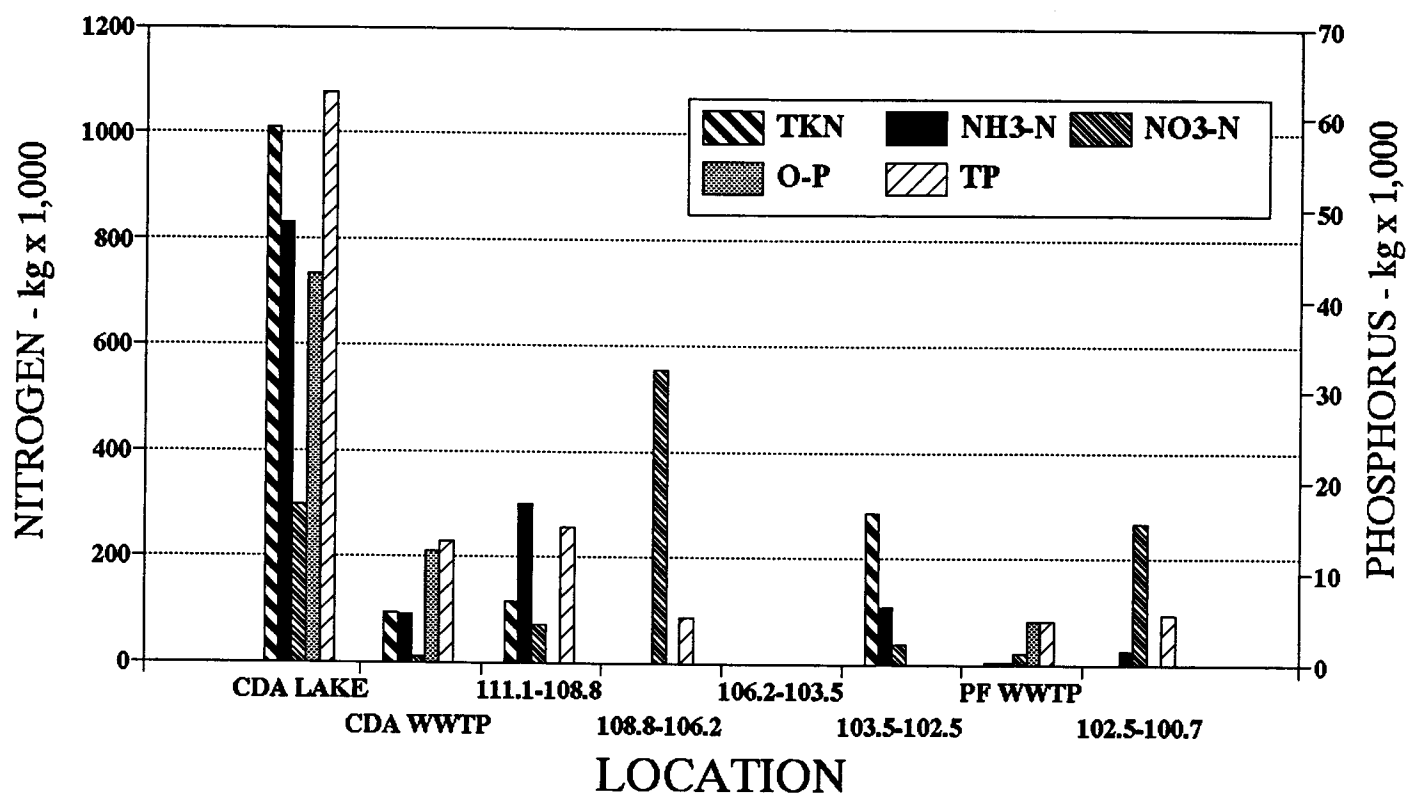


Figure 26.

Sources and amounts of nutrient loading to the Spokane River during Water Year 1991.

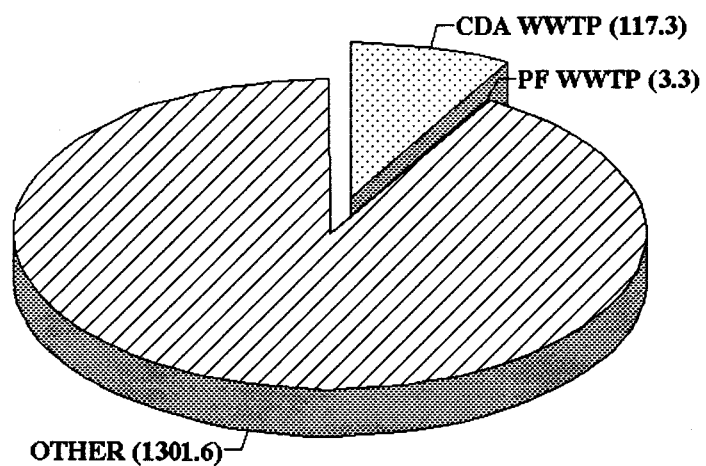


Figure 27.

Total Kjeldahl nitrogen loading from Coeur d'Alene and Post Falls wastewater treatment plants for June 29, 1990 to September 24, 1991 (kg X 10³/study period).

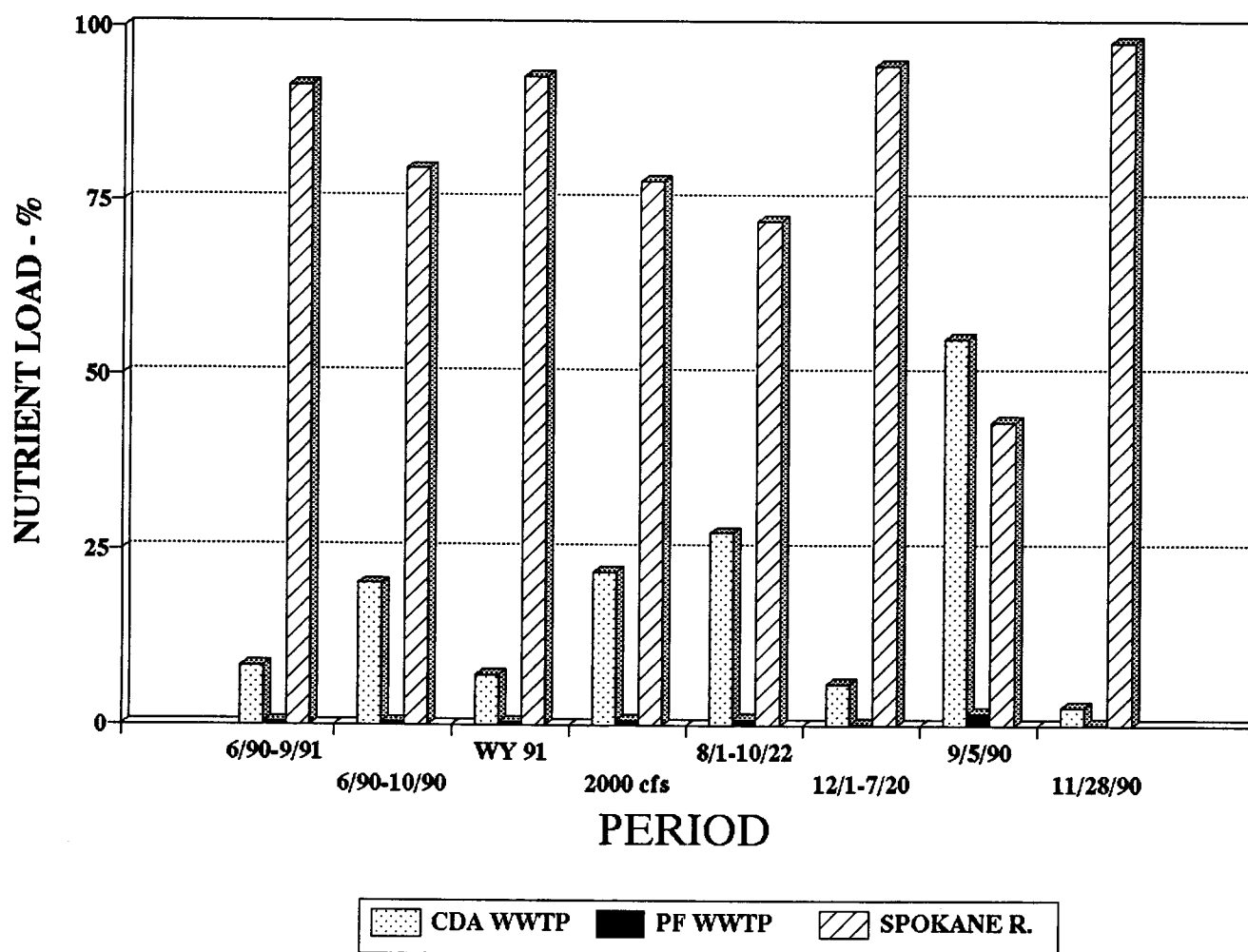


Figure 28.

Percentage of total Kjeldahl nitrogen load from Coeur d'Alene and Post Falls wastewater treatment plants and the Spokane River at various time periods from June 29, 1990 to September 24, 1991.

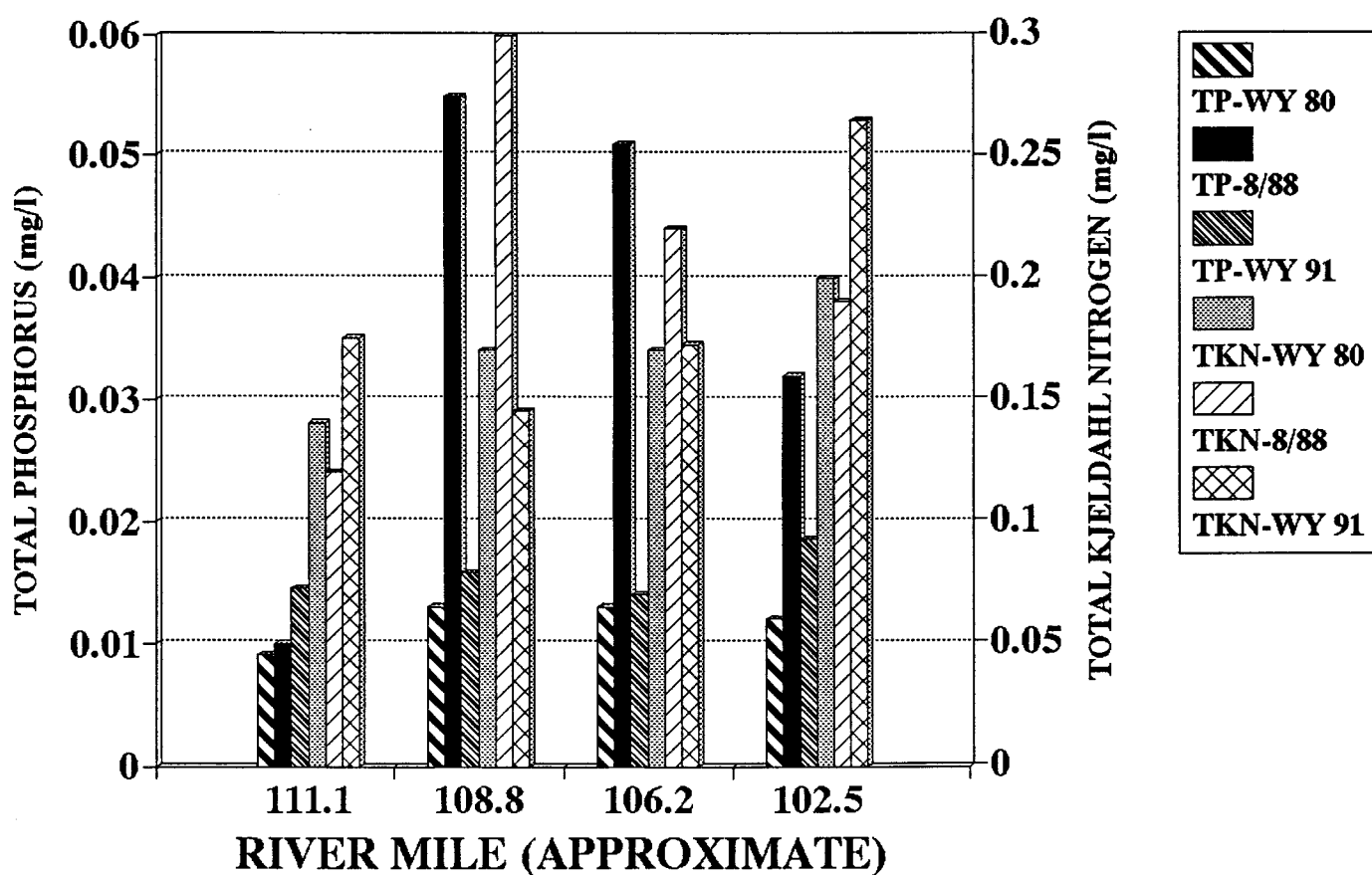


Figure 29.

Total phosphorus and total Kjeldahl nitrogen throughout the Spokane River during Water Year 1991 (current study), August, 1988 (Yearsley and Duncan), and Water Year 1980 (Falter and Mitchell).

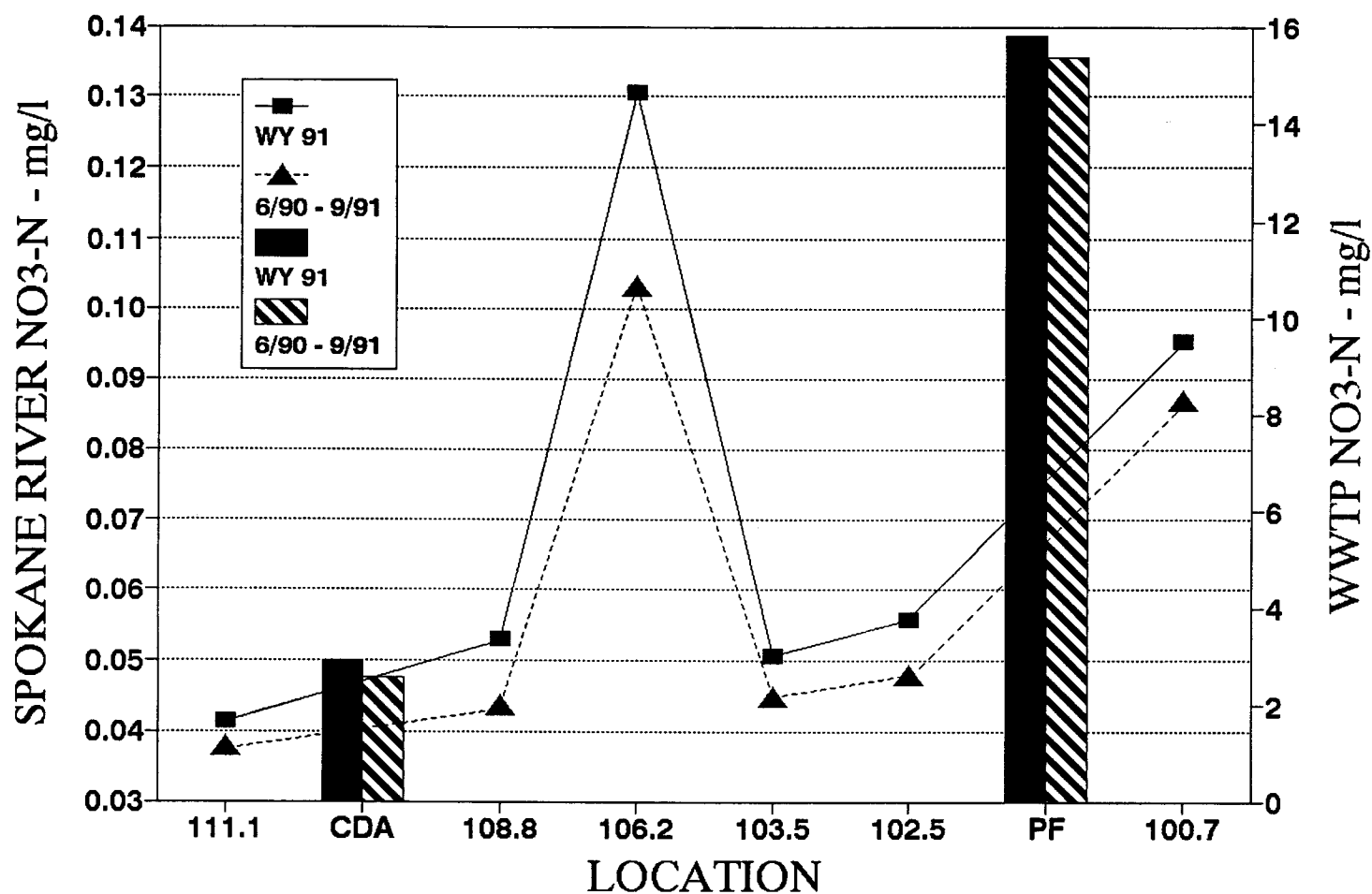


Figure 30.

Mean nitrate-nitrogen concentrations in the Spokane River and Coeur d'Alene and Post Falls wastewater treatment plants during Water Year 1991 and for the period June 29, 1990 to September 24, 1991.

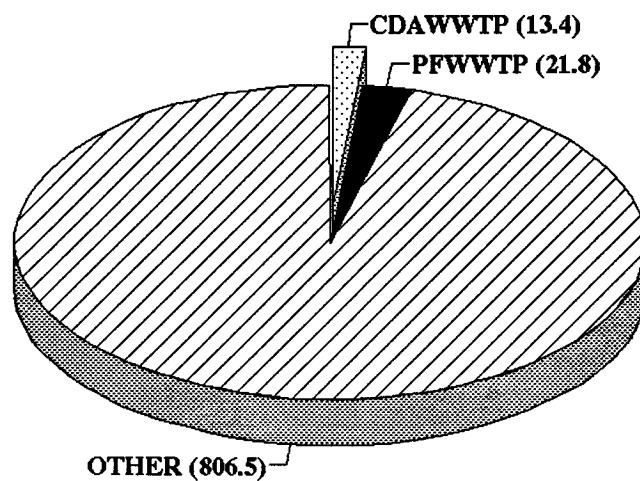


Figure 31.

Total nitrate-nitrogen loading from Coeur d'Alene and Post Falls wastewater treatment plants for June 29, 1990 to September 24, 1991 (kg X 10³/study period).

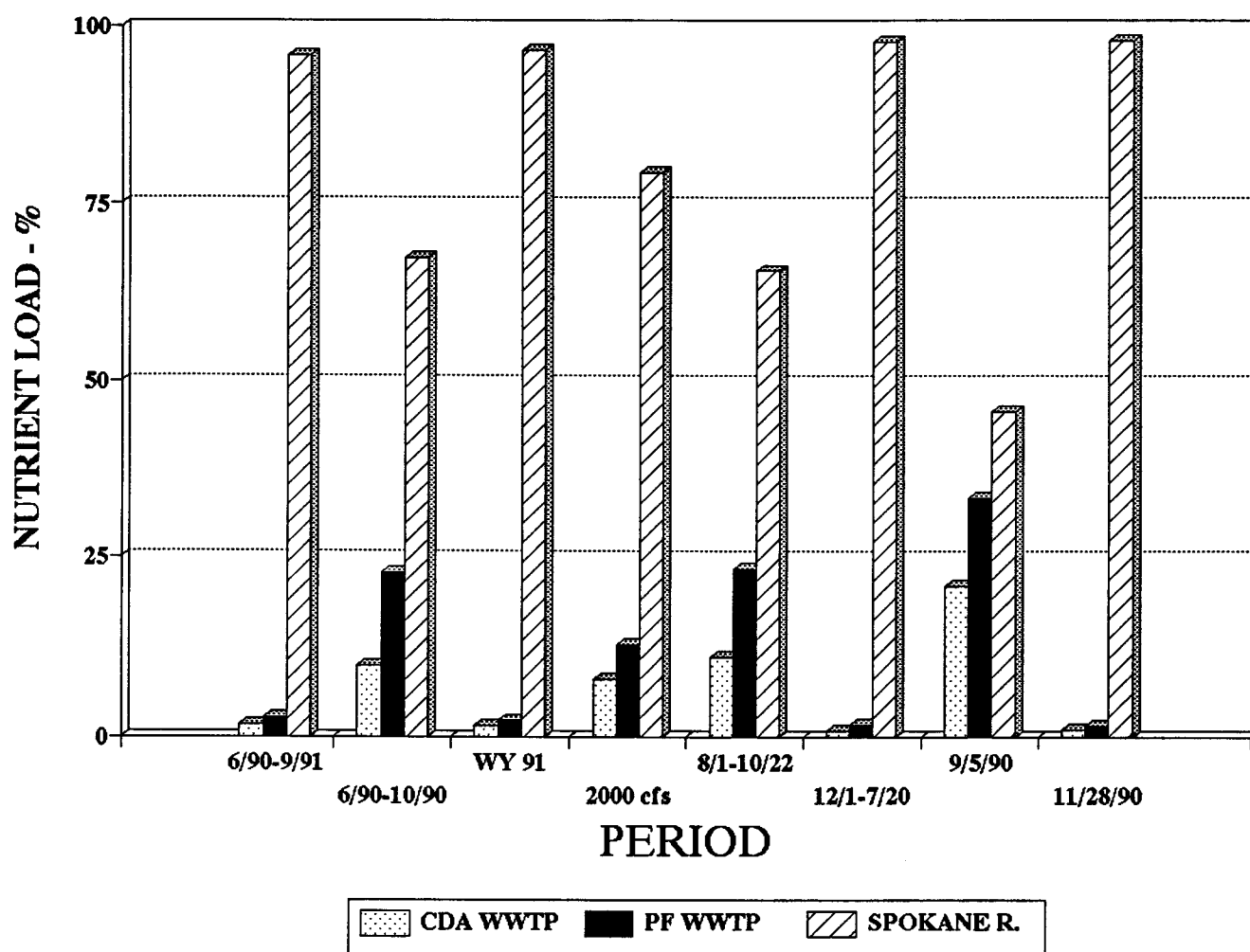


Figure 32.

Percentage of total nitrate-nitrogen load from Coeur d'Alene and Post Falls wastewater treatment plants and the Spokane River at various time periods from June 29, 1990 to September 24, 1991.

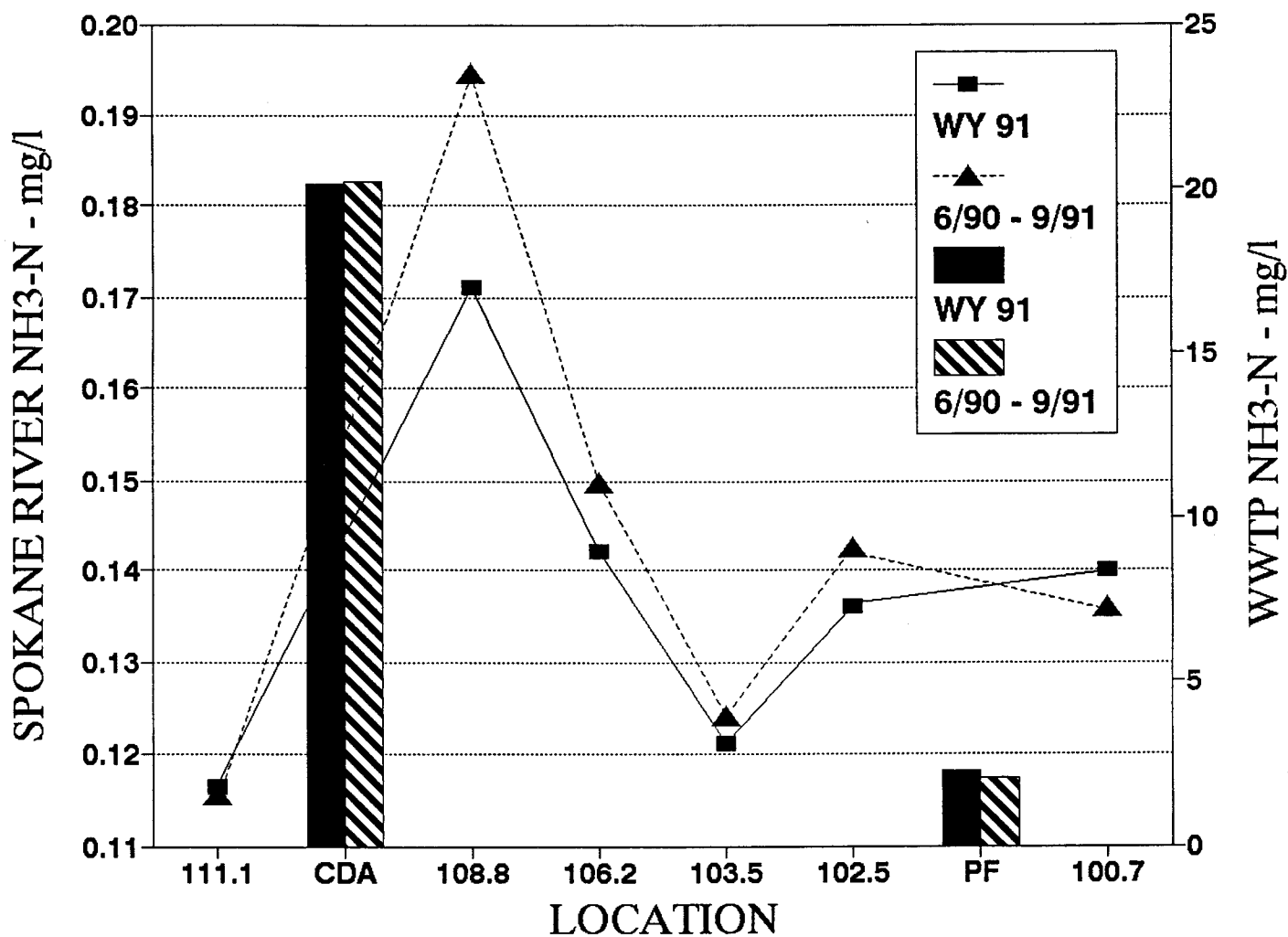


Figure 33.

Mean total ammonia-nitrogen concentrations in the Spokane River and Coeur d'Alene and Post Falls wastewater treatment plants during Water Year 1991 and from the period June 29, 1990 to September 24, 1991.

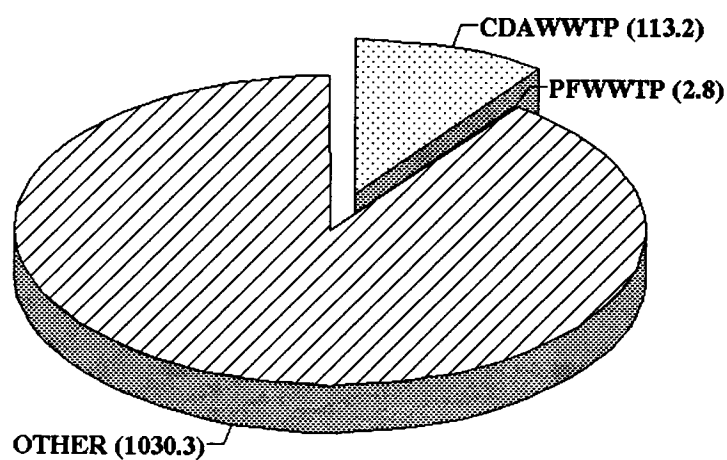


Figure 34. Total ammonia-nitrogen loading from Coeur d'Alene and Post Falls wastewater treatment plants for June 29, 1990 to September 24, 1991 (kg x 10³/study period).

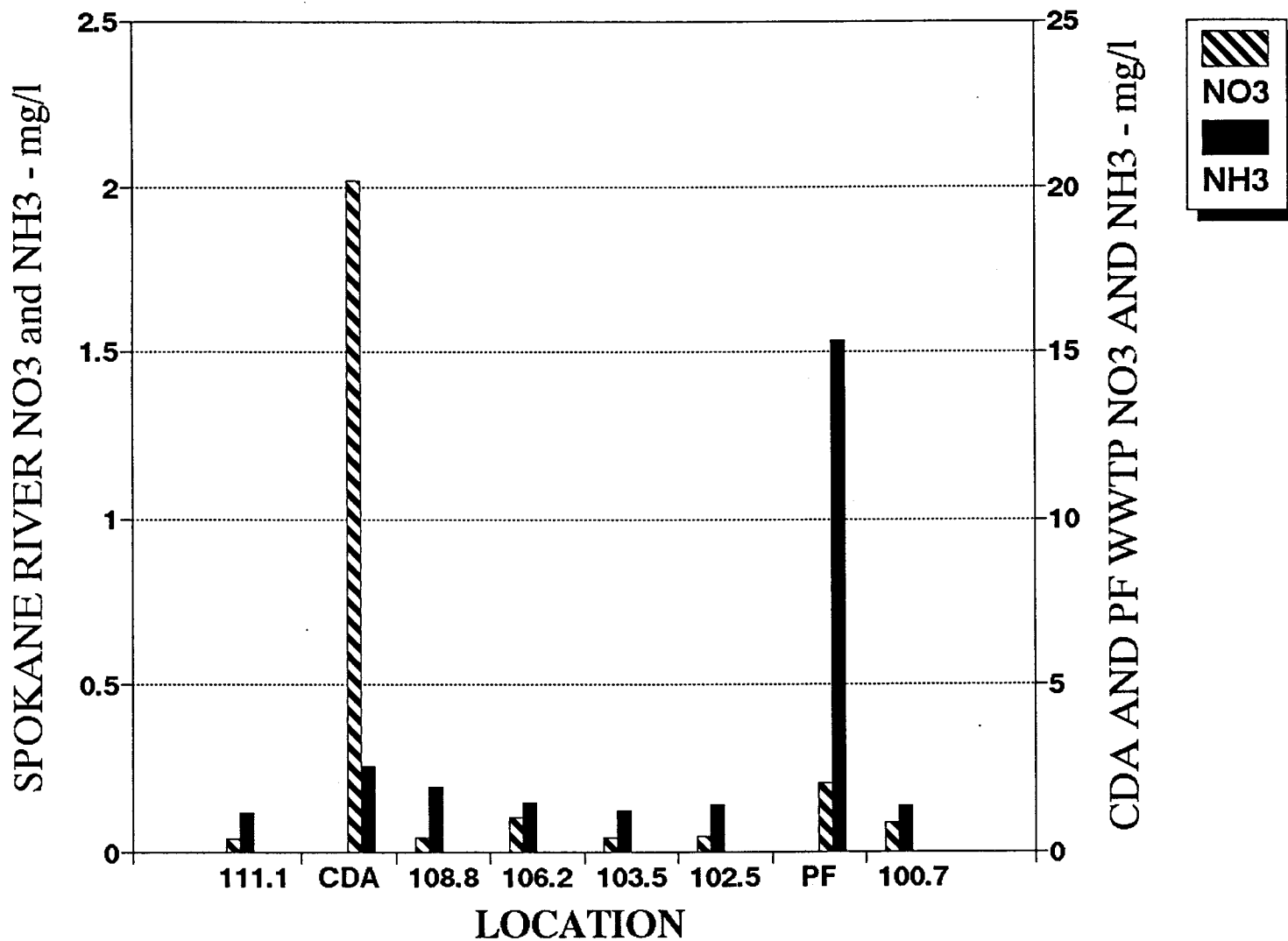


Figure 35.

Nitrate-nitrogen and ammonia nitrogen concentrations in the Spokane River for June 29, 1990 to September 24, 1991.

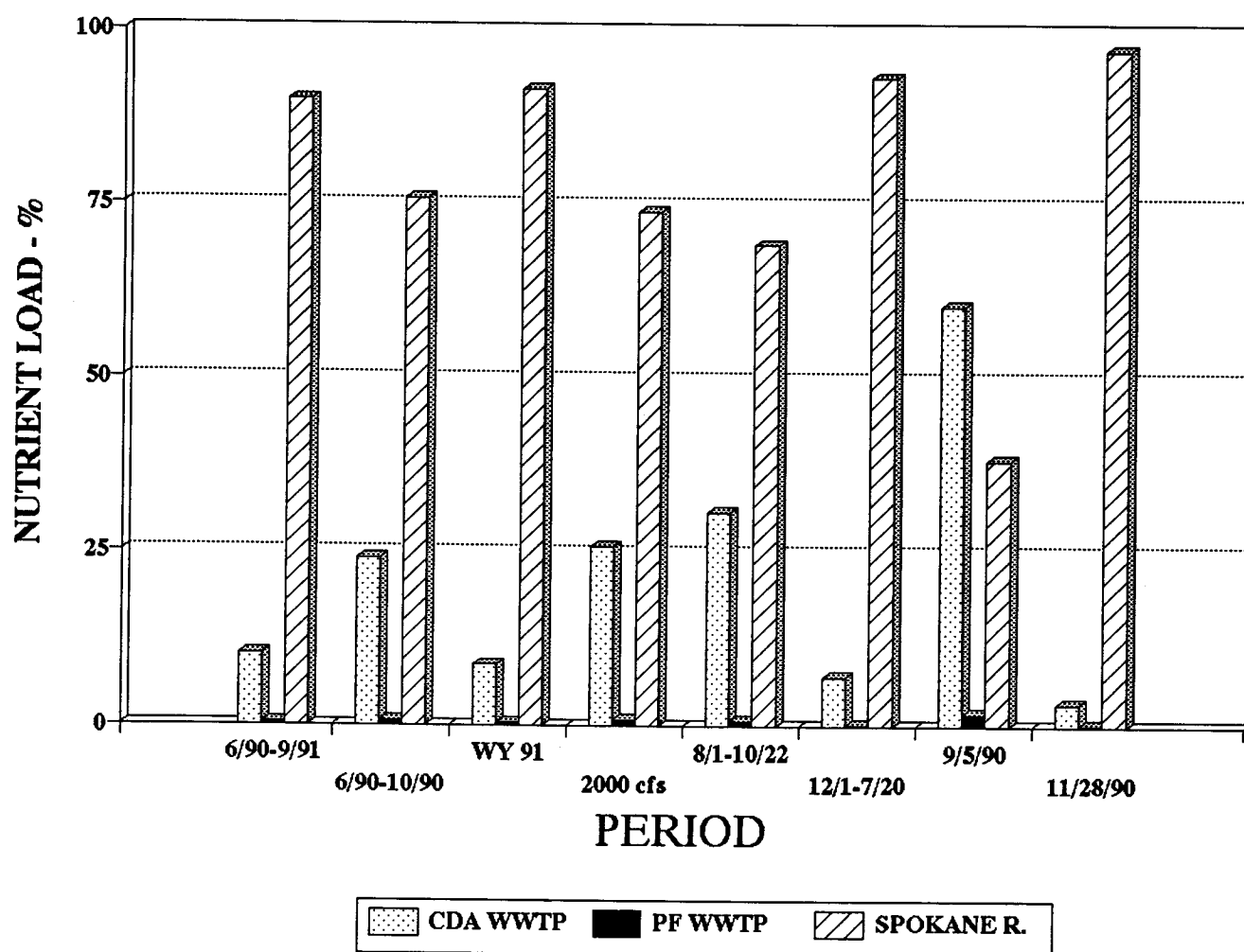


Figure 36.

Percentage of total ammonia-nitrogen load from Coeur d'Alene and Post Falls wastewater treatment plants and the Spokane River at various time periods from June 29, 1990 to September 24, 1991.

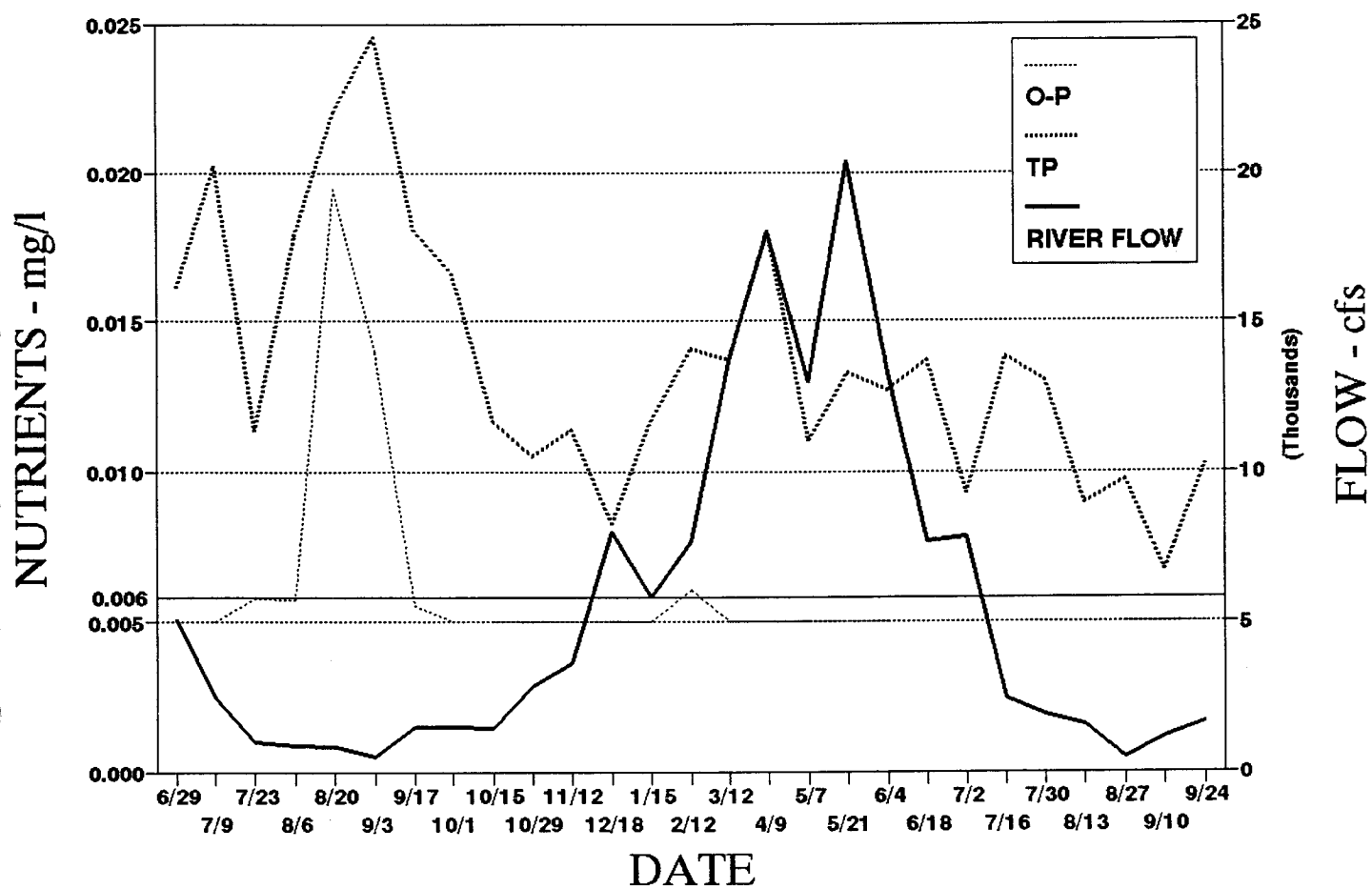


Figure 37.

Total orthophosphorus and total phosphorus concentrations versus flow in the Spokane River on each sample date for June 29, 1990 to September 24, 1991.

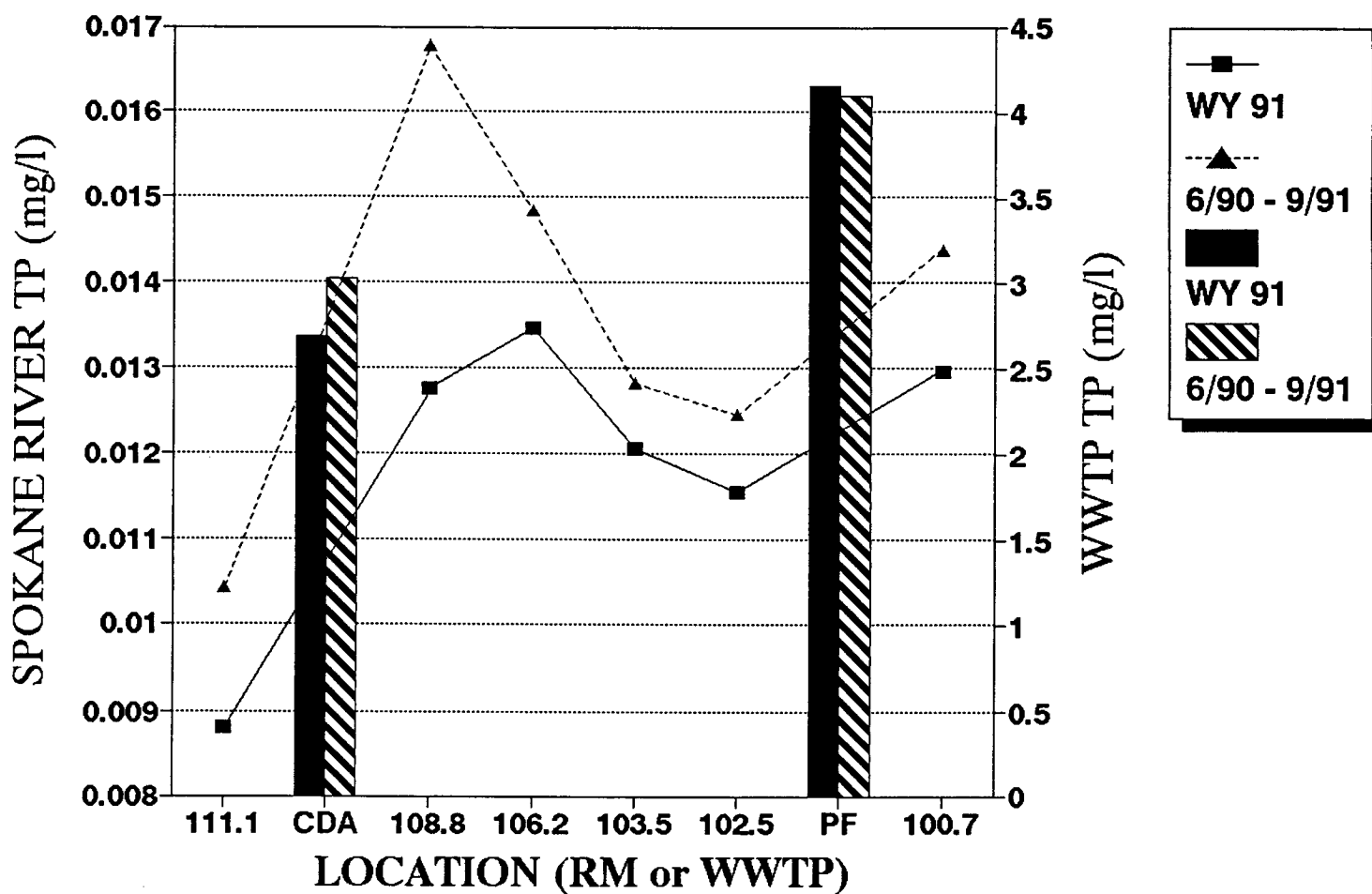


Figure 38.

Mean total phosphorus concentrations in the Spokane River and Coeur d'Alene and Post Falls wastewater treatment plants during Water Year 1991 and over the period June 29, 1990 to September 24, 1991.

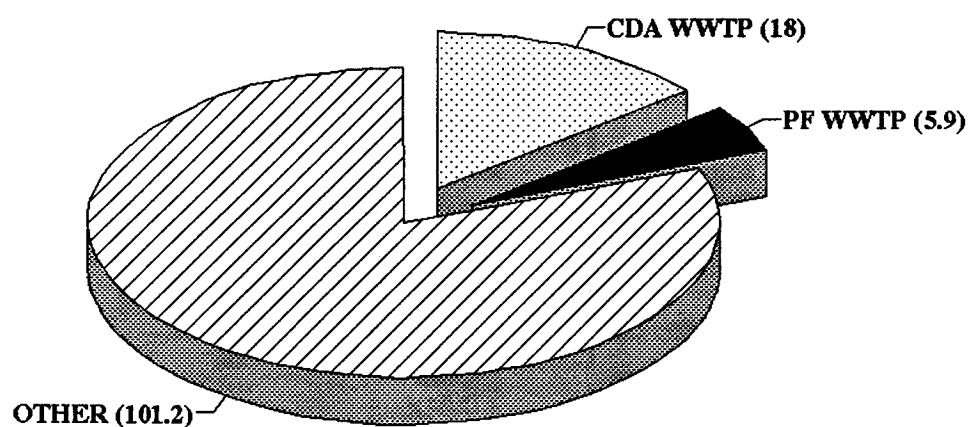


Figure 39. Total phosphorus loading from Coeur d'Alene and Post Falls wastewater treatment plants for June 29, 1990 to September 24, 1991 (kg X 10³/study period).

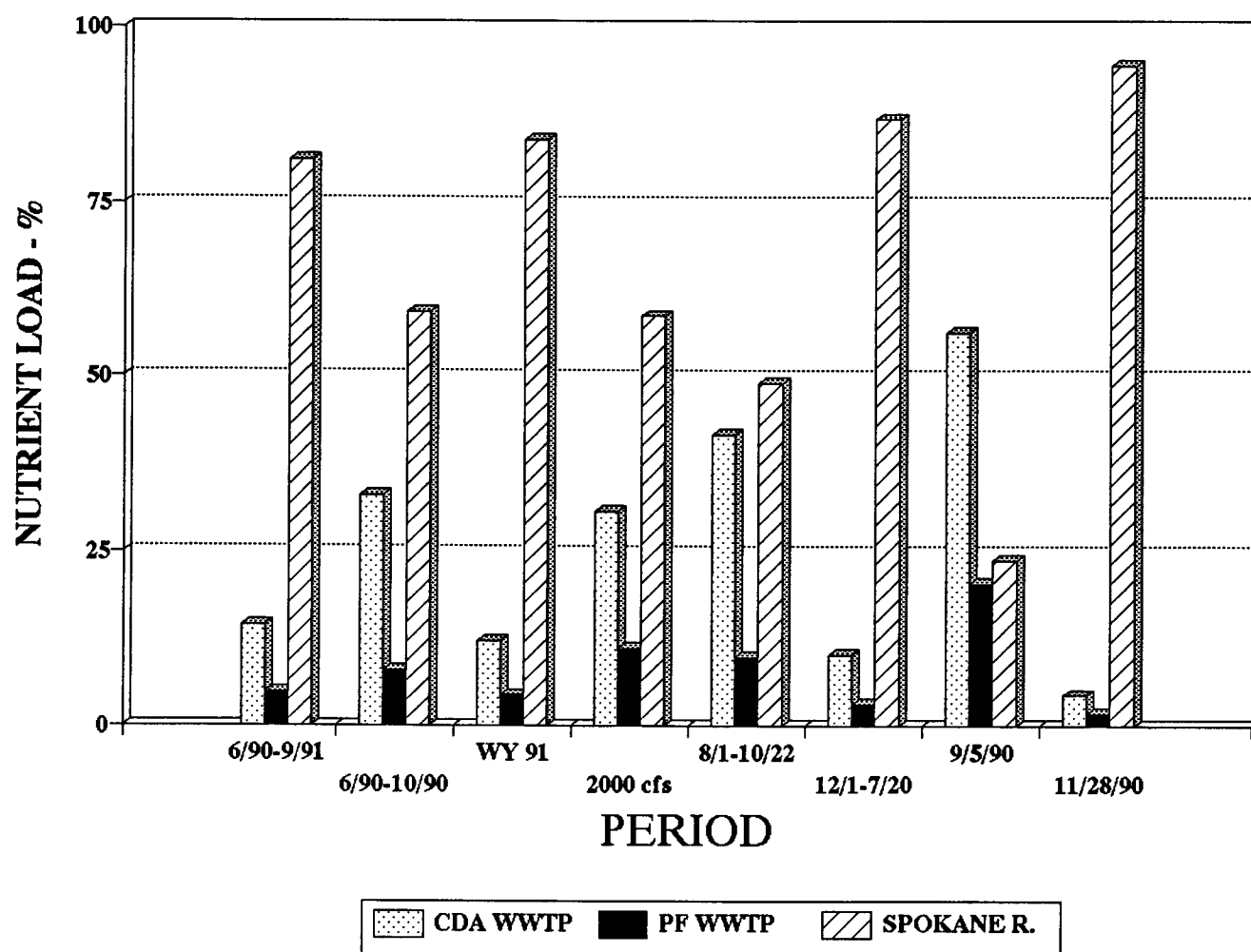


Figure 40.

Percentage of total phosphorus load from Coeur d'Alene and Post Falls wastewater treatment plants and the Spokane River at various time periods during June 29, 1990 to September 24, 1991.

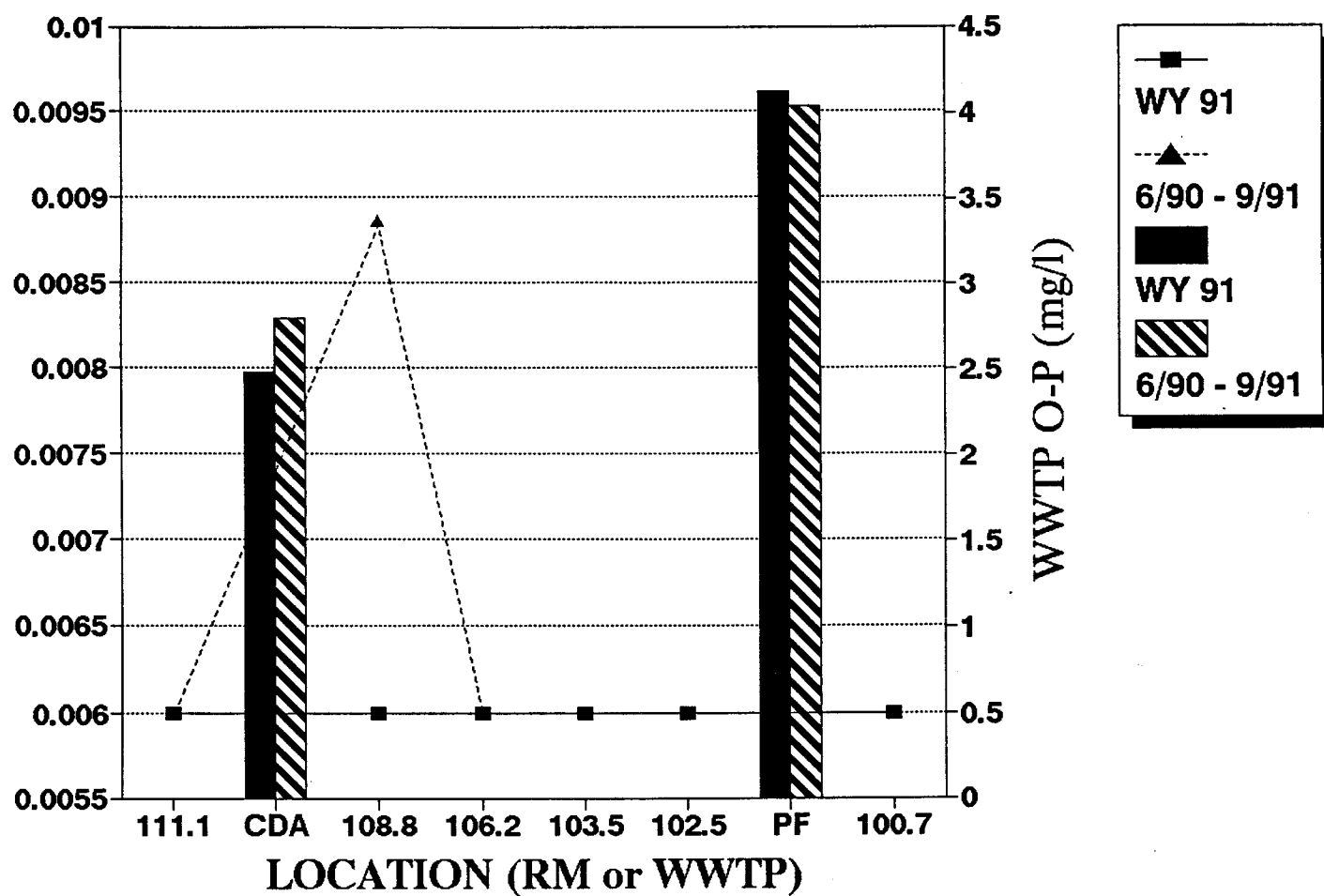


Figure 41.

Mean total orthophosphorus concentrations in the Spokane River and Coeur d' Alene and Post Falls wastewater treatment plants during Water Year 1991 and the period June 29, 1990 to September 24, 1991.

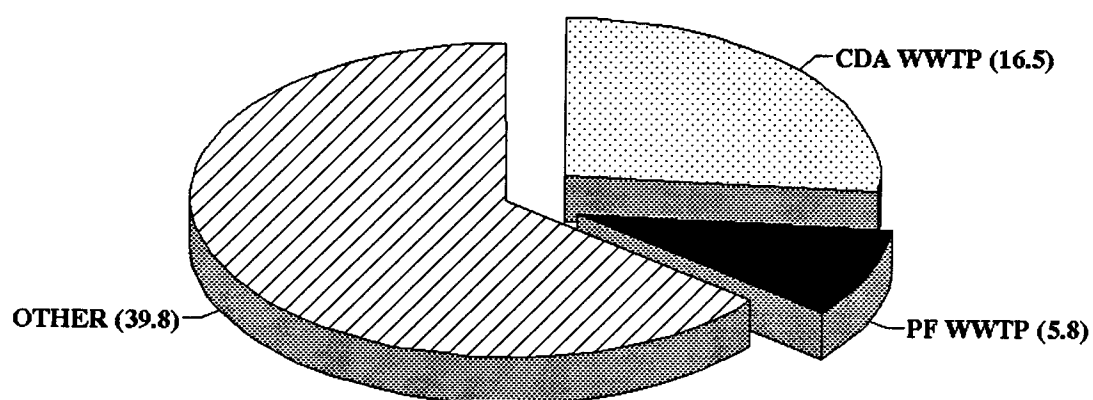


Figure 42.

Total orthophosphorus loading from Coeur d'Alene and Post Falls wastewater treatment plants for June 29, 1990 to September 24, 1991 (kg X 10³/study period).

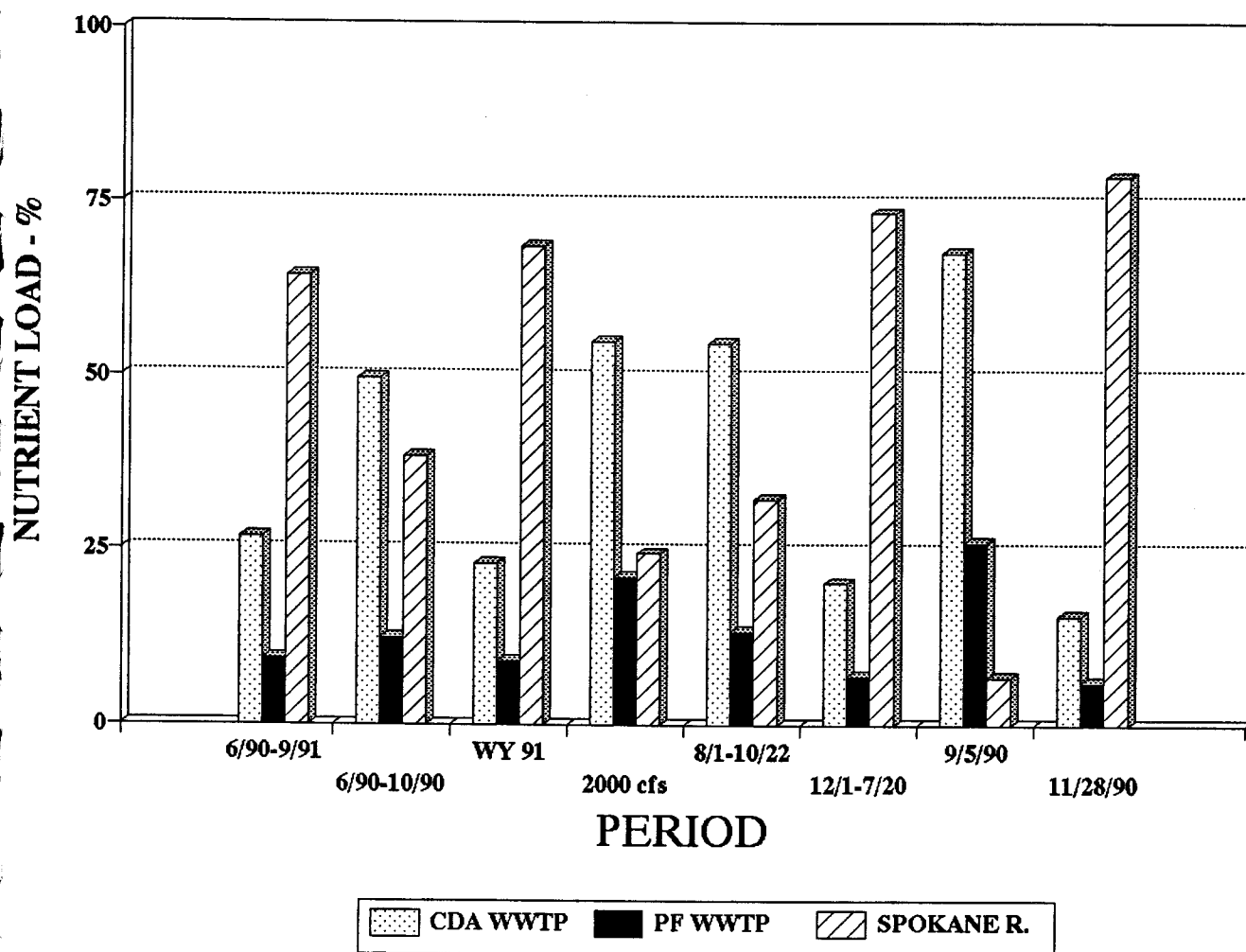


Figure 43.

Percentage of total orthophosphorus load from Coeur d'Alene and Post Falls wastewater treatment plants and the Spokane River at various time periods from June 29, 1990 to September 24, 1991.

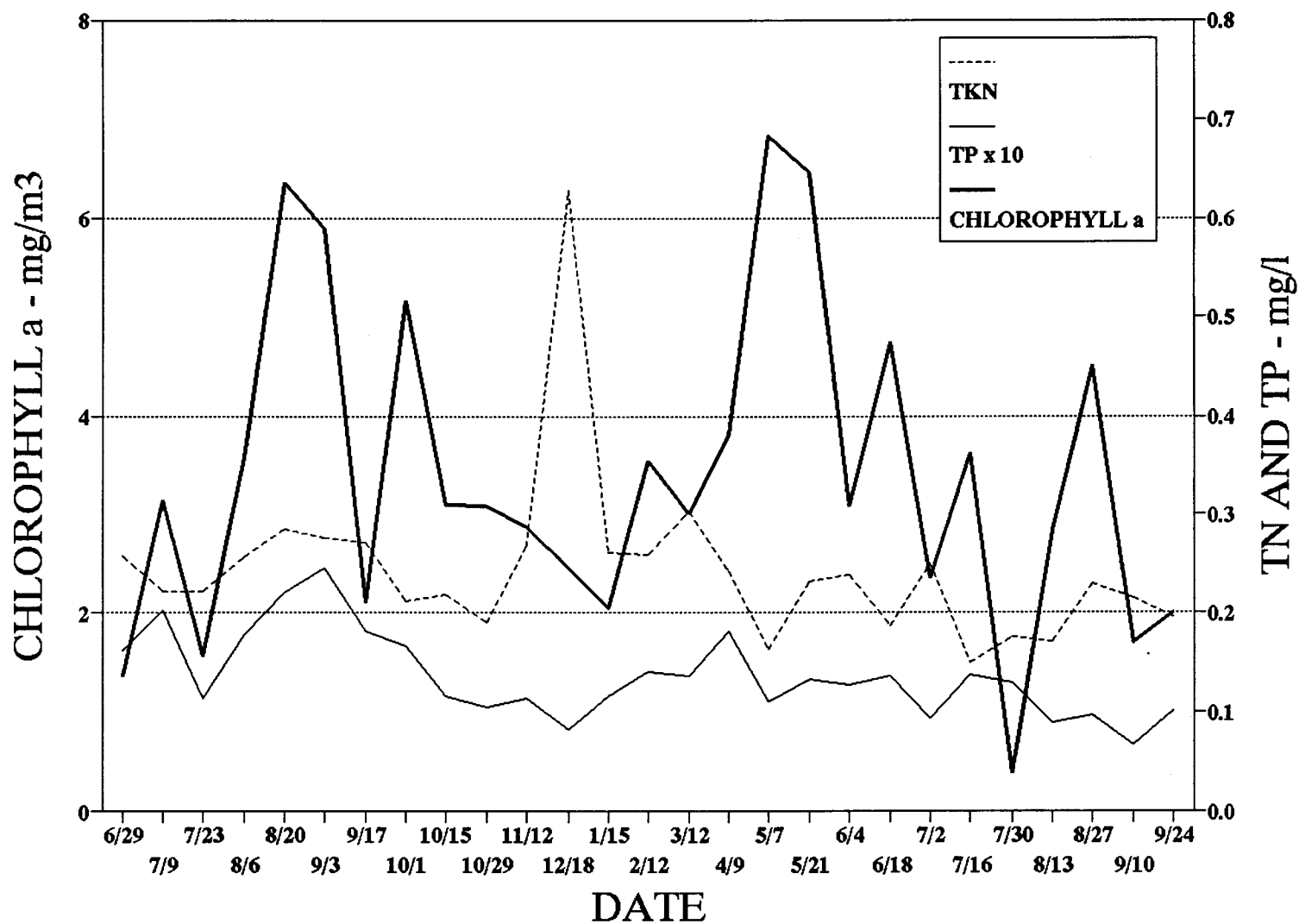


Figure 44.

Mean chlorophyll a, total Kjeldahl nitrogen, and total phosphorus in the Spokane River on each sample date during June 29, 1990 to September 24, 1991.

NITROGEN:PHOSPHORUS

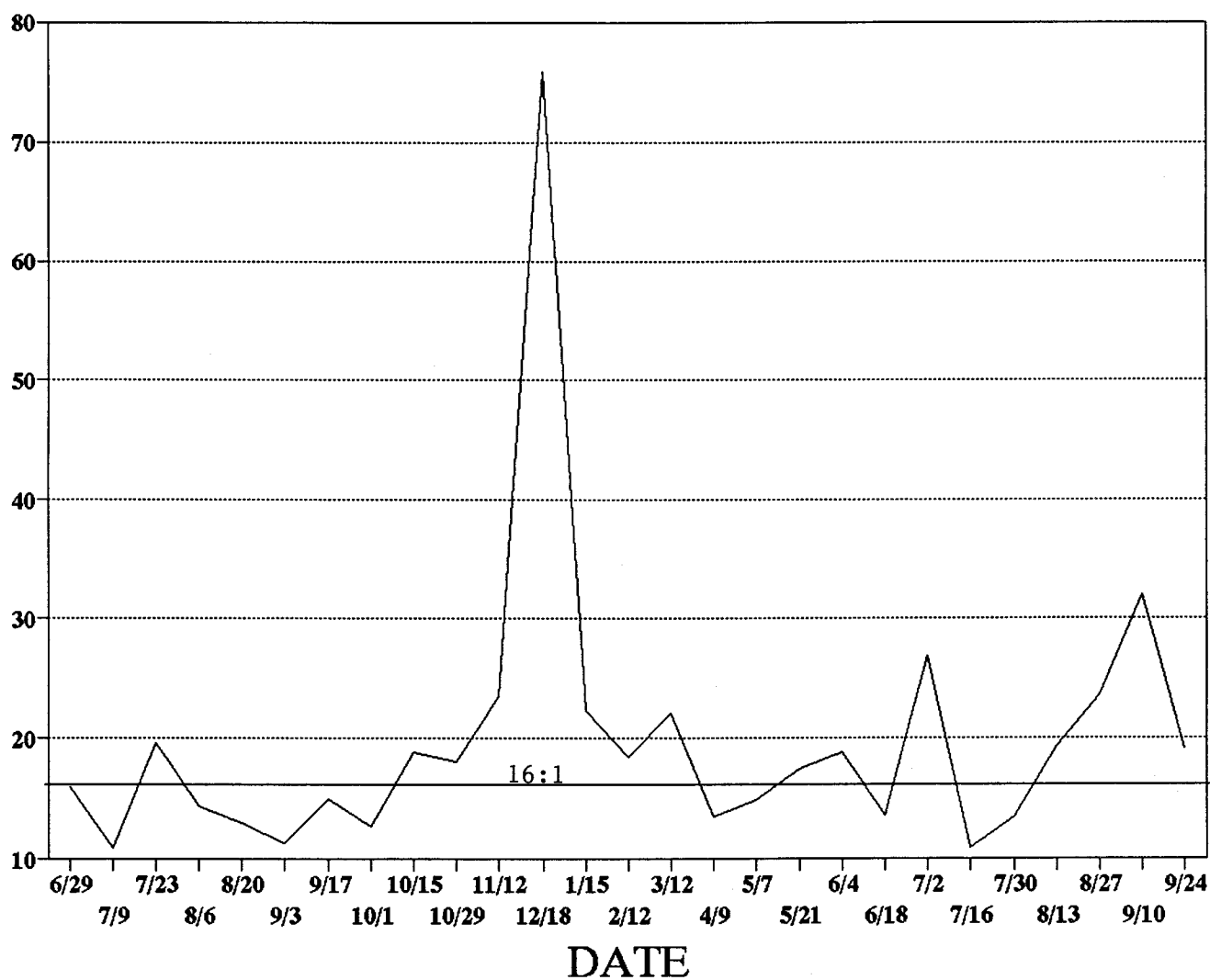


Figure 45.

TN:TP ratios in the Spokane River for each sample date during June 29, 1990 to September 24, 1991.

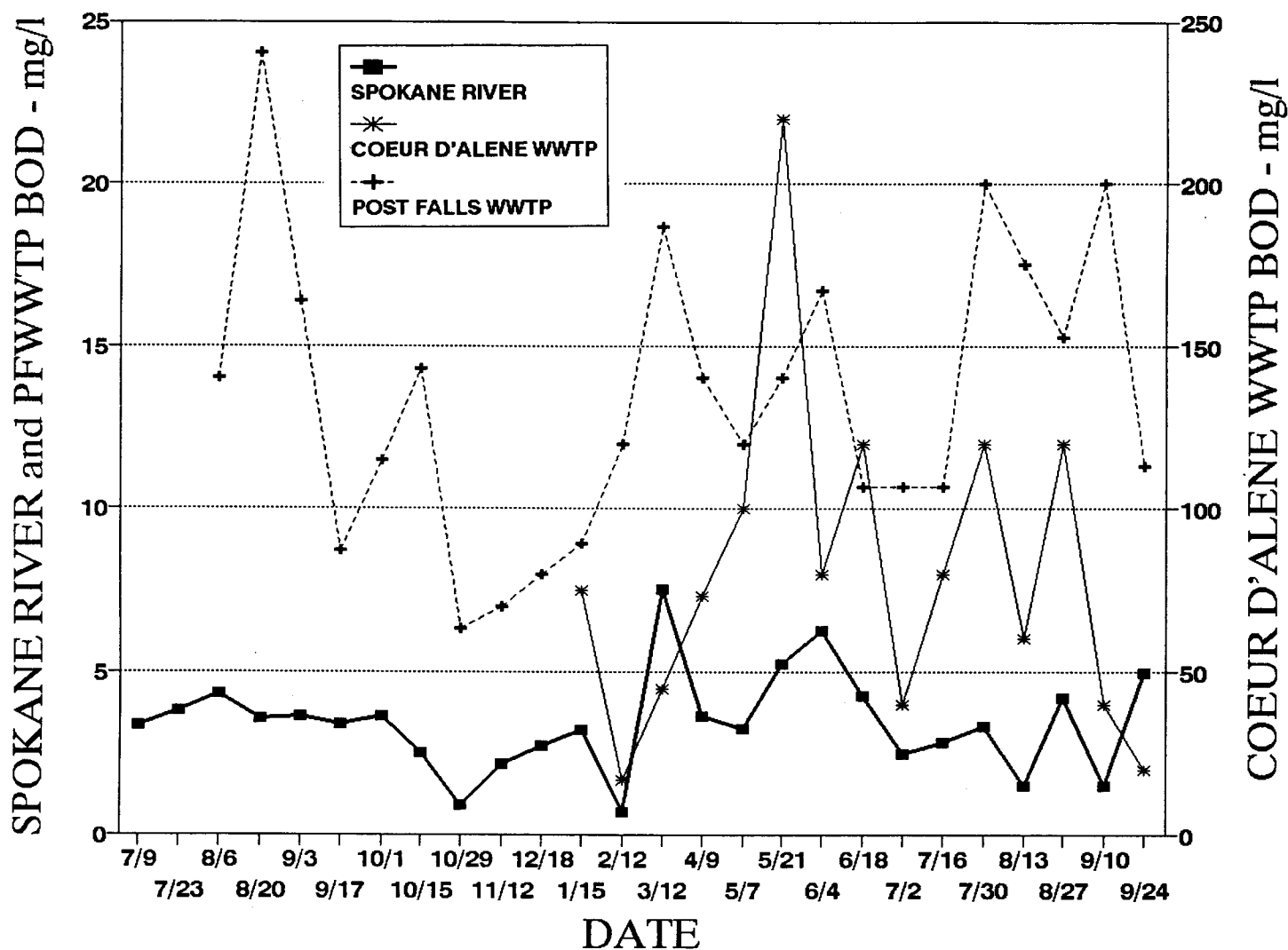


Figure 46.

Mean 5-day Biochemical Oxygen Demand in the Spokane River, Coeur d'Alene WWTP, and Post Falls WWTP on each sample date during June 29, 1990 to September 24, 1991. Note: Problems with dilutions of WWTP effluent resulted in no BOD data in the early WWTP tests.

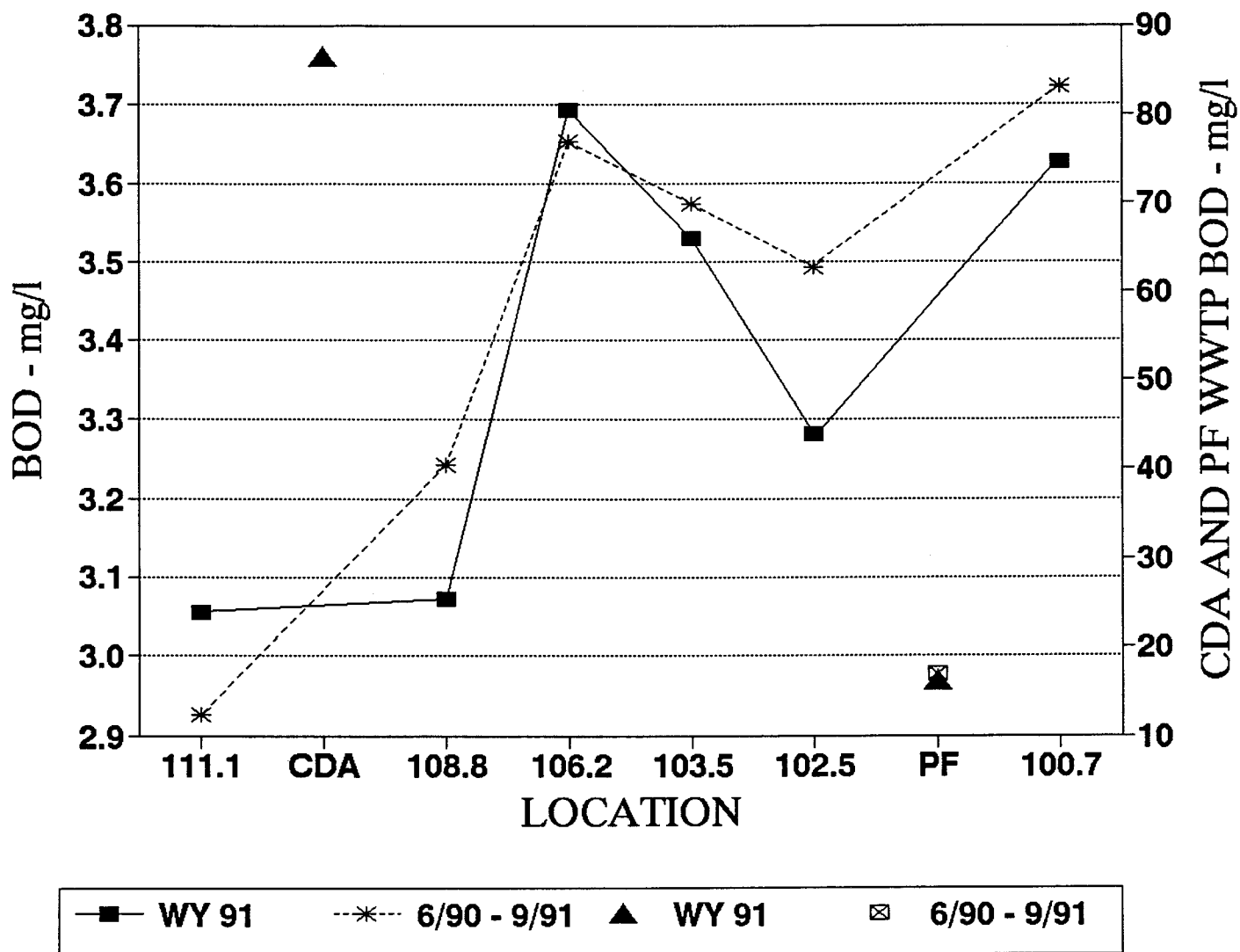


Figure 47.

Mean 5-day Biochemical Oxygen Demand in the Spokane River and Coeur d'Alene and Post Falls wastewater treatment plants during Water Year 1991 and the period June 29, 1990 to September 24, 1991.

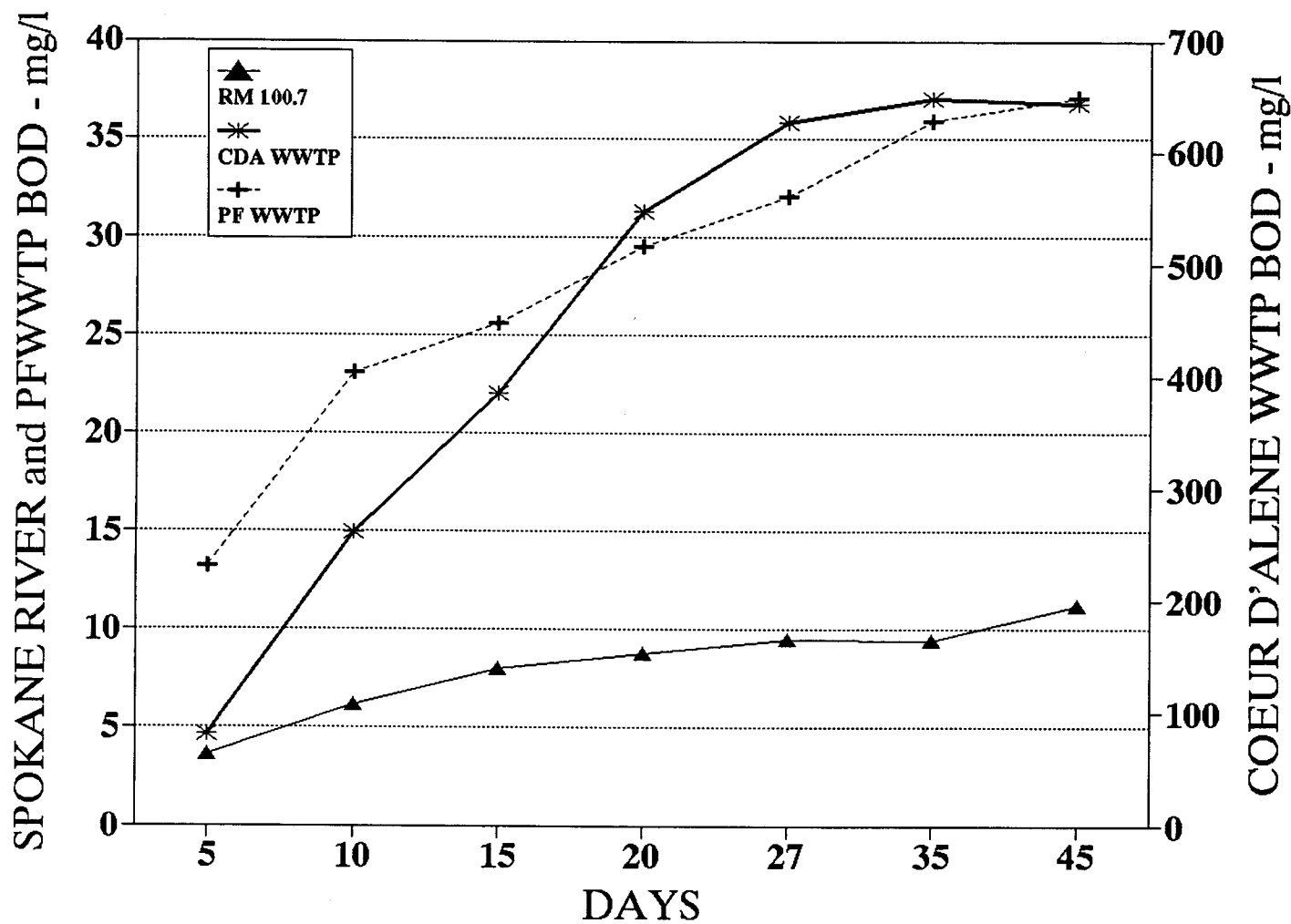


Figure 48.

Mean ultimate Biochemical Oxygen Demand at RM 111.1 and RM 100.7, and in Coeur d'Alene and Post Falls WWTP effluents during Water Year 1991.

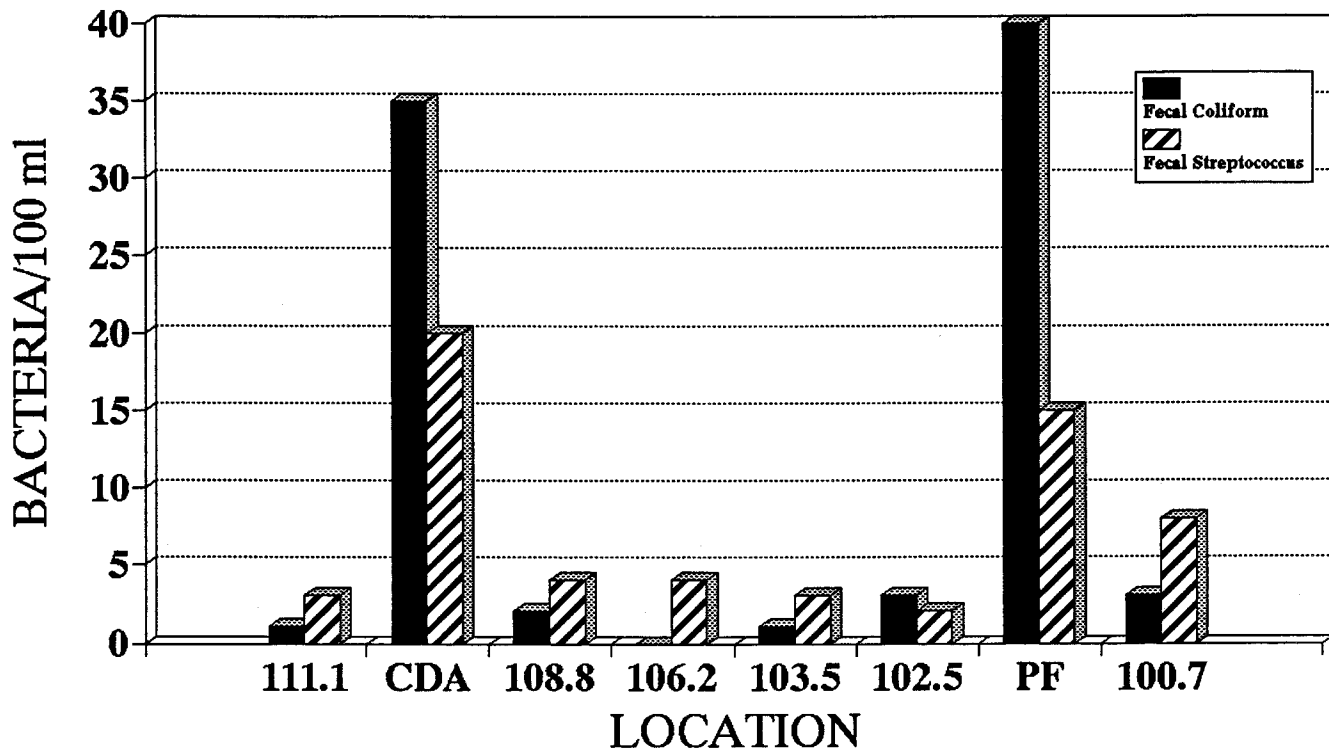


Figure 49. Median fecal coliform and fecal streptococcus bacteria counts in the Spokane River during Water Year 1991.

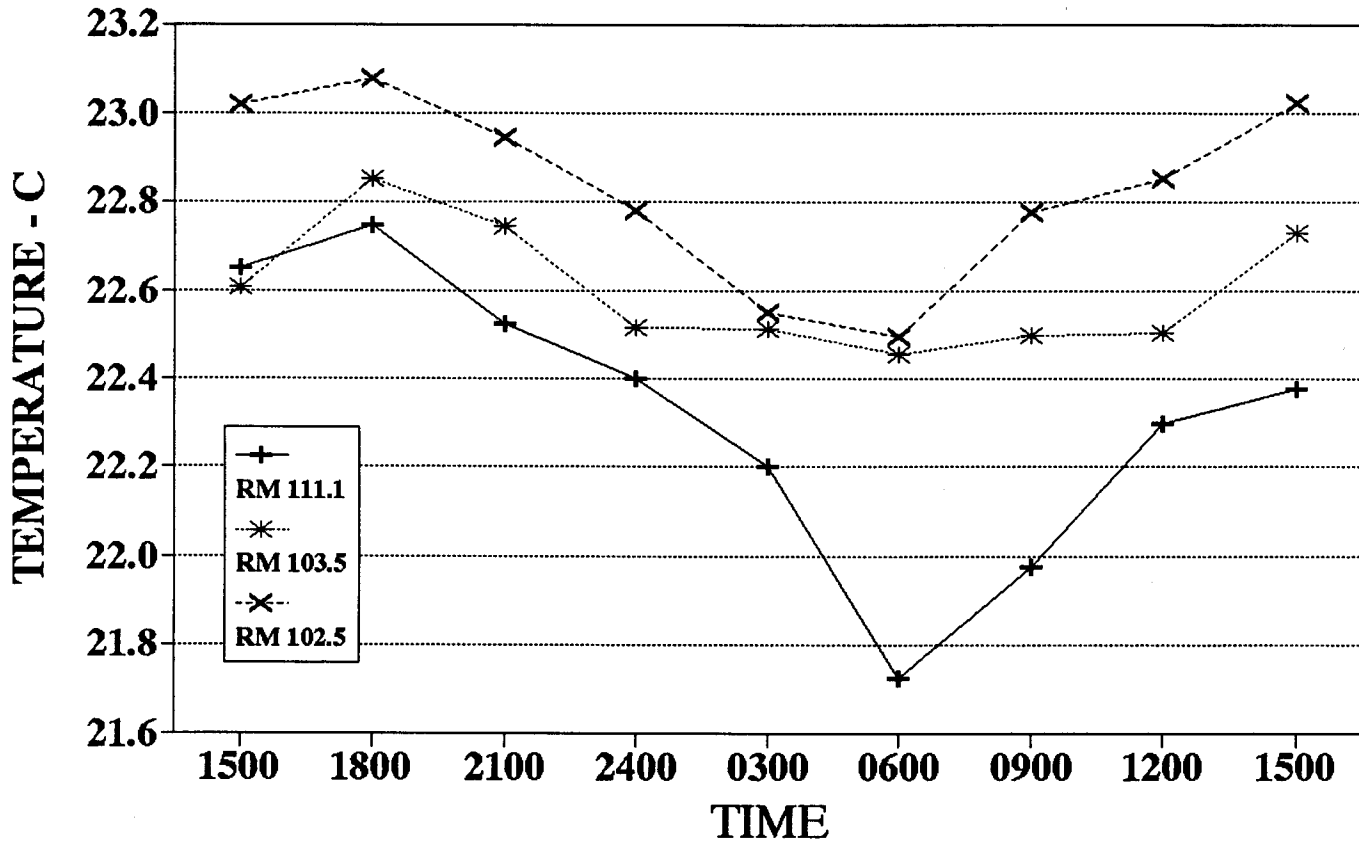


Figure 50.

Mean temperature at RM 111.1, RM 103.5, and RM 102.5 in the Spokane River during the diel study of August 12-13, 1991.

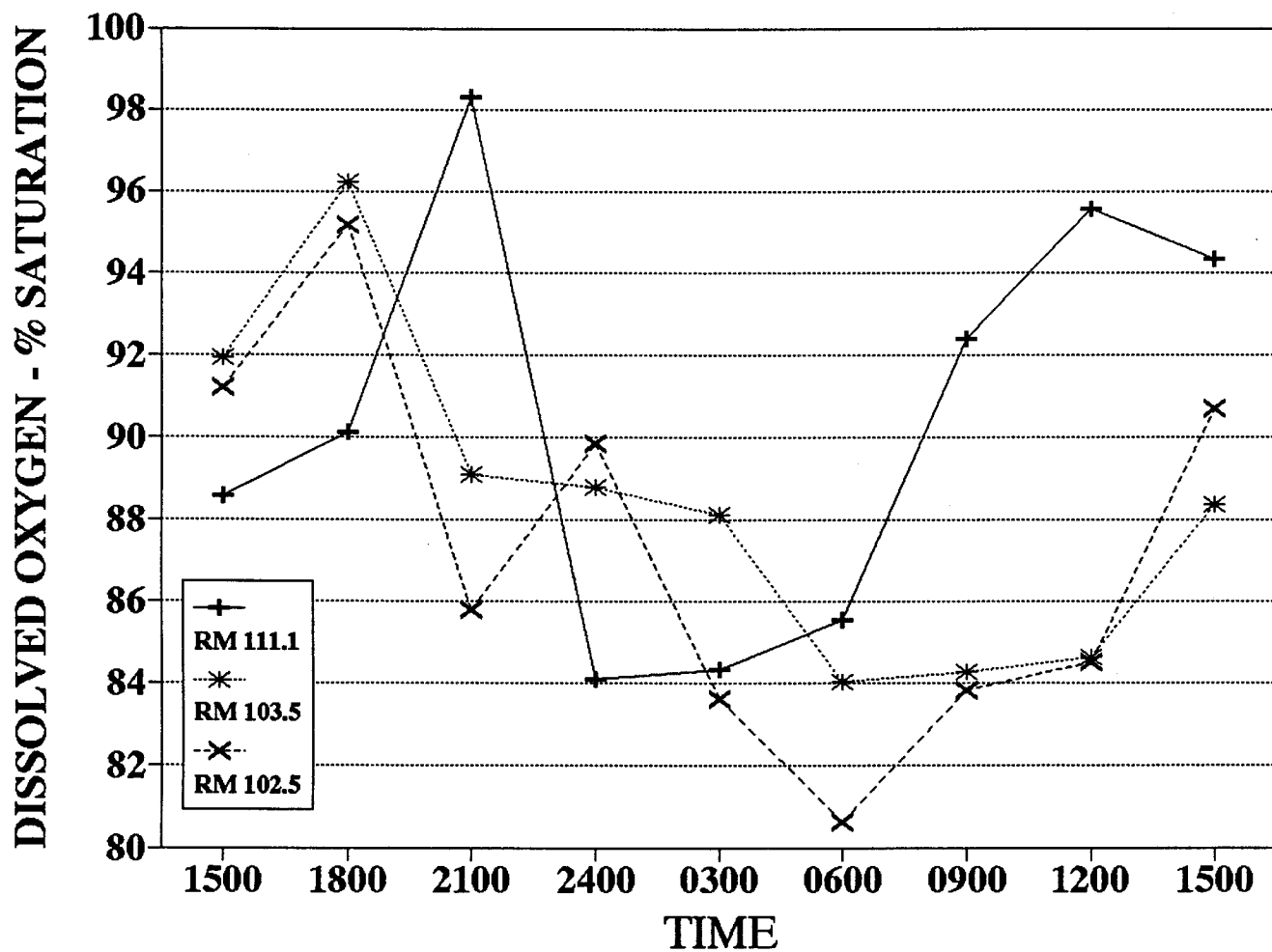


Figure 51.

Mean dissolved oxygen percent saturation at RM 111.1, RM 103.5, and RM 102.5 in the Spokane River during the diel study of August 12-13, 1991.

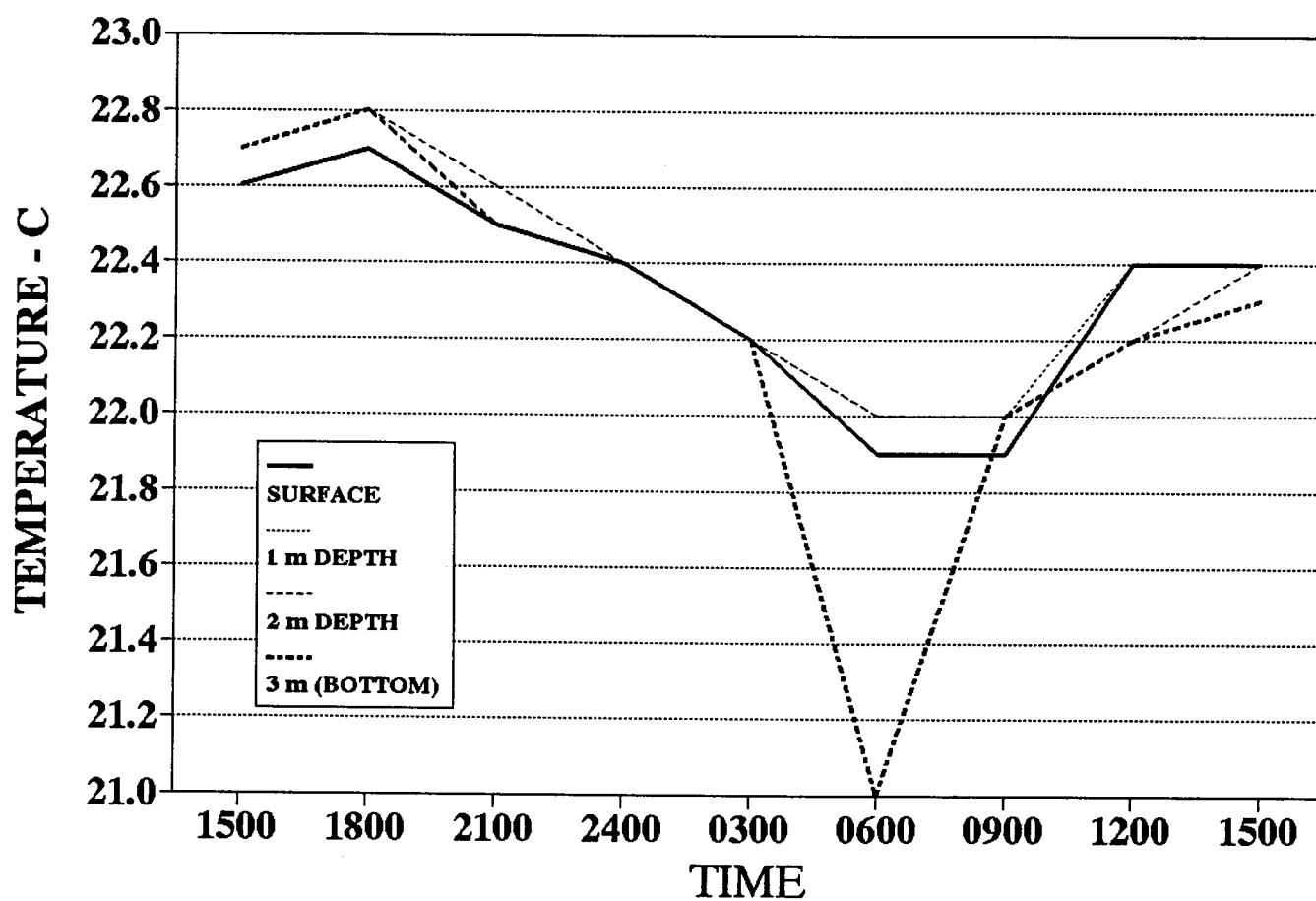


Figure 52.

Temperature profiles at RM 111.1 in the Spokane River during the diel study of August 12-13, 1991.

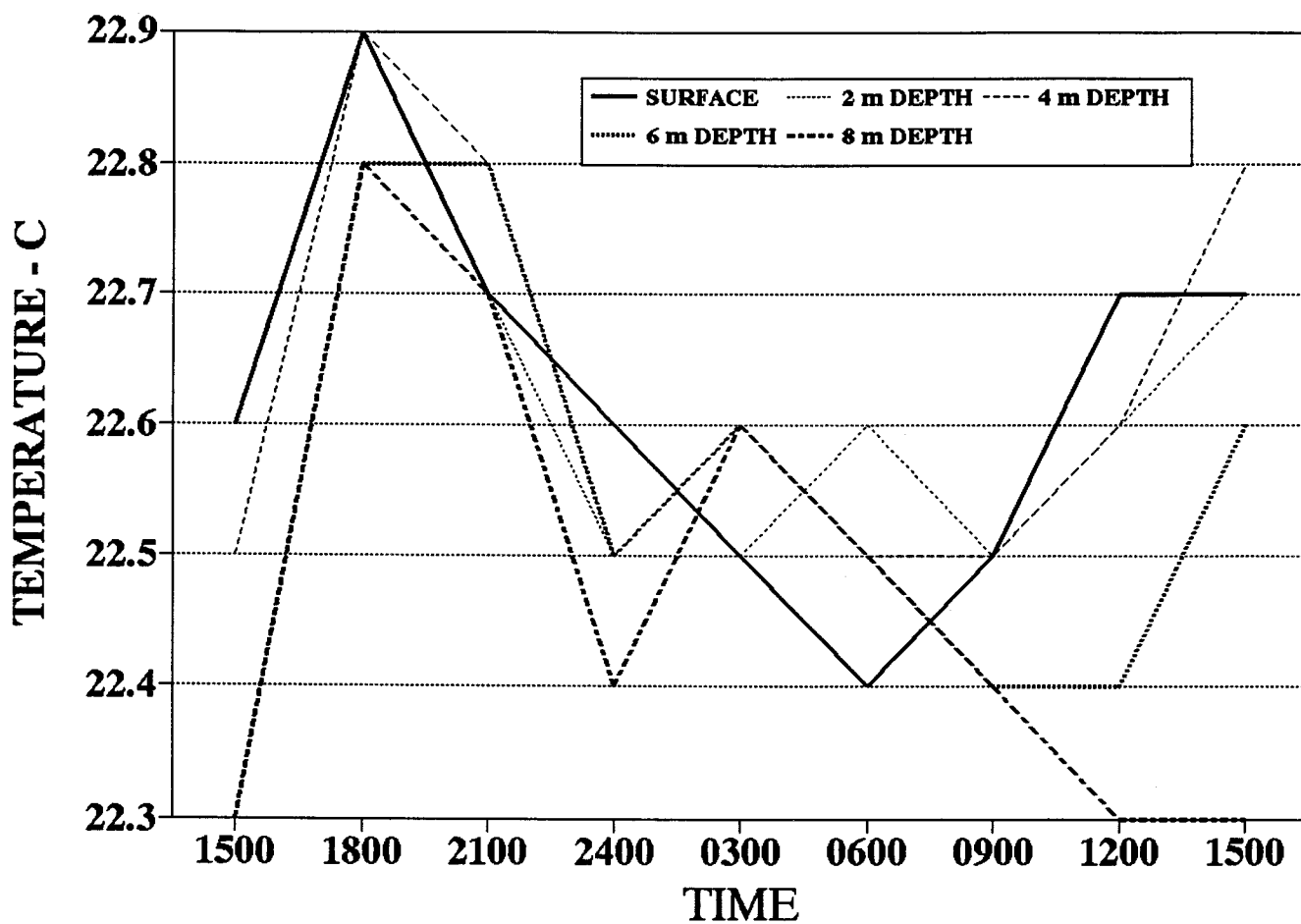


Figure 53.

Temperature profiles at RM 103.5 in the Spokane River during the diel study of August 12-13, 1991.

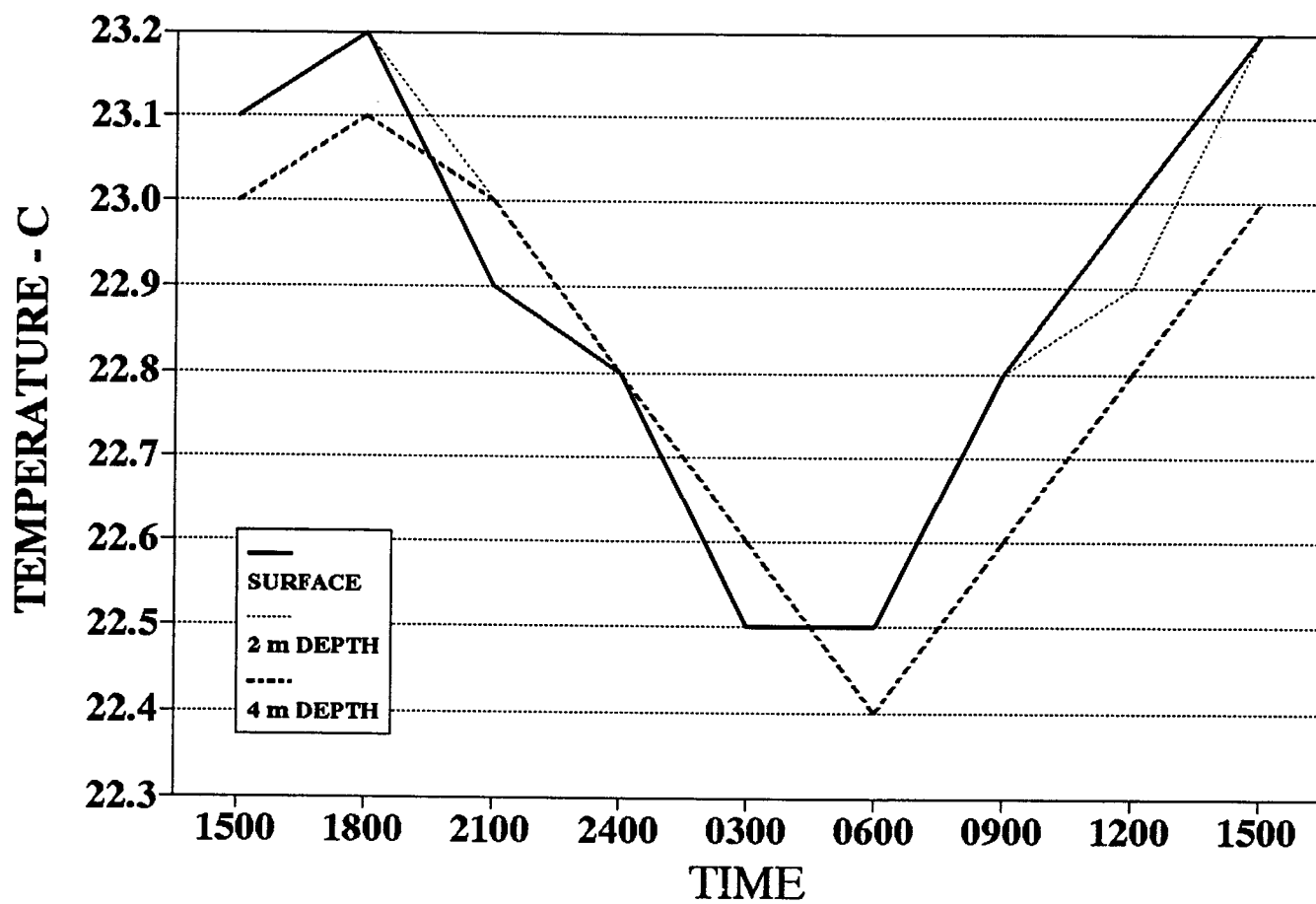


Figure 54.

Temperature profiles at RM 102.5 in the Spokane River during the diel study of August 12-13, 1991.

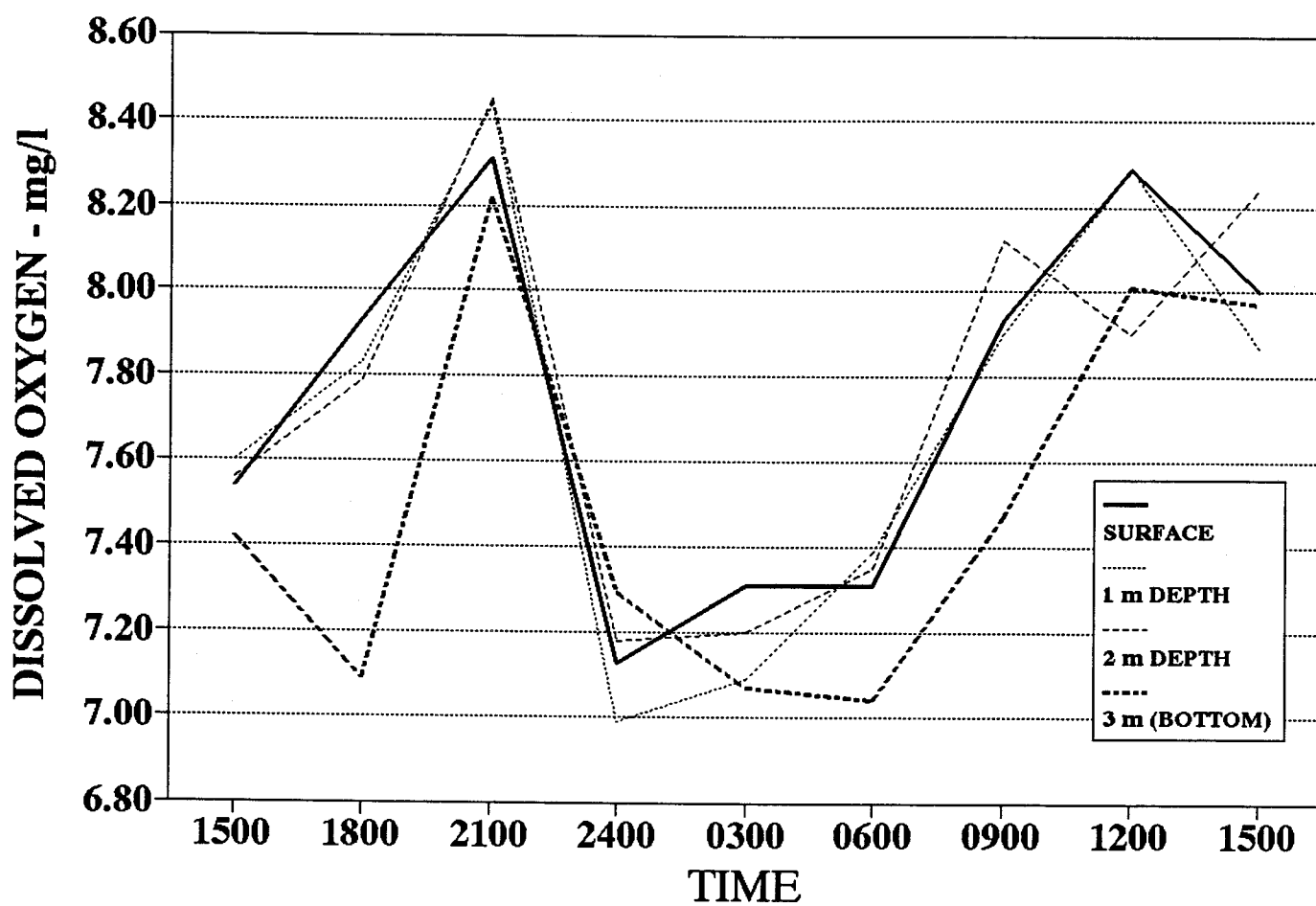


Figure 55.

Diel oxygen profiles at RM 111.1 in the Spokane River during the diel study of August 12-13, 1991.

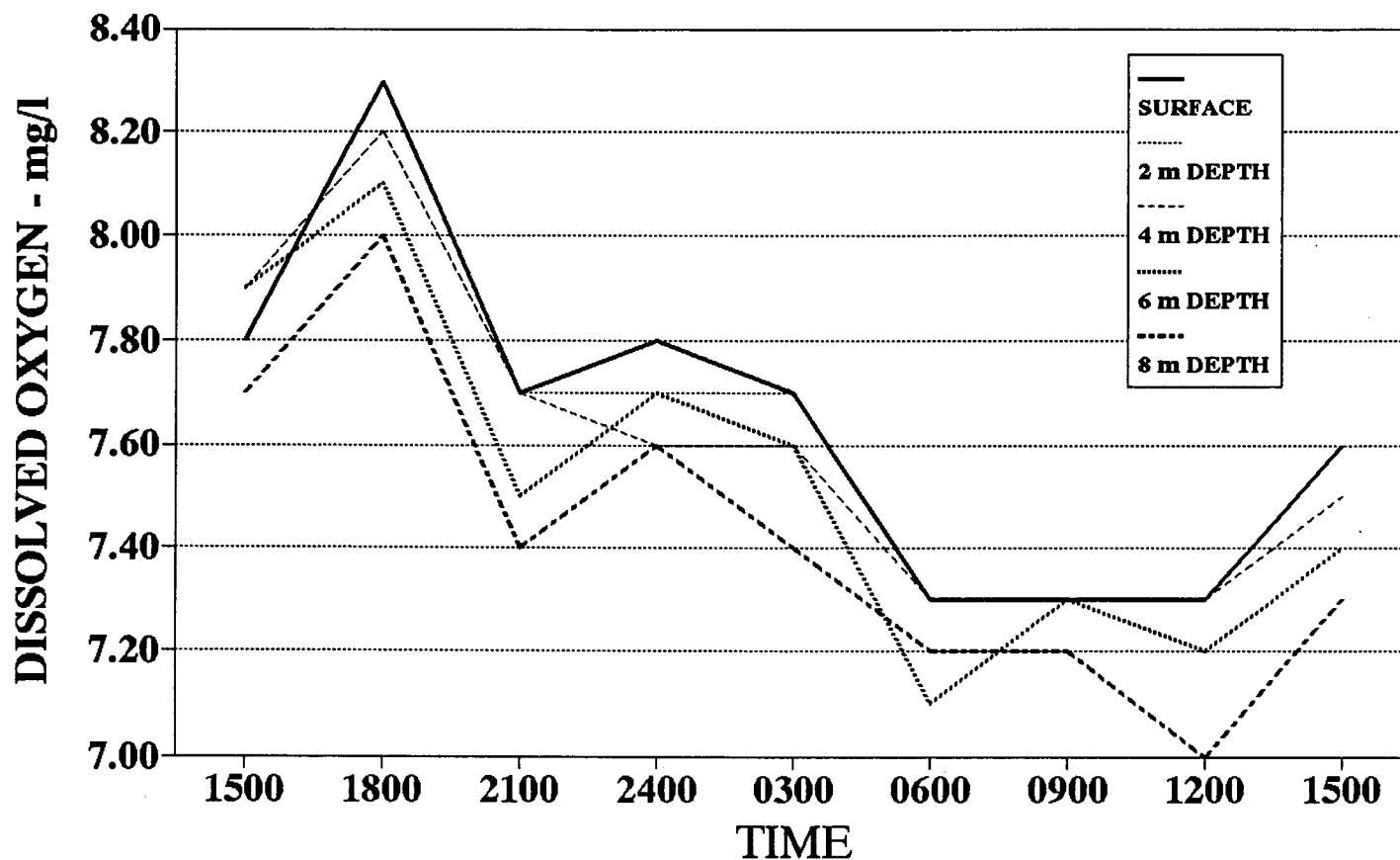


Figure 56.

Mean dissolved oxygen percent saturation at RM 103.5 in the Spokane River during the diel study of August 12-13, 1991.

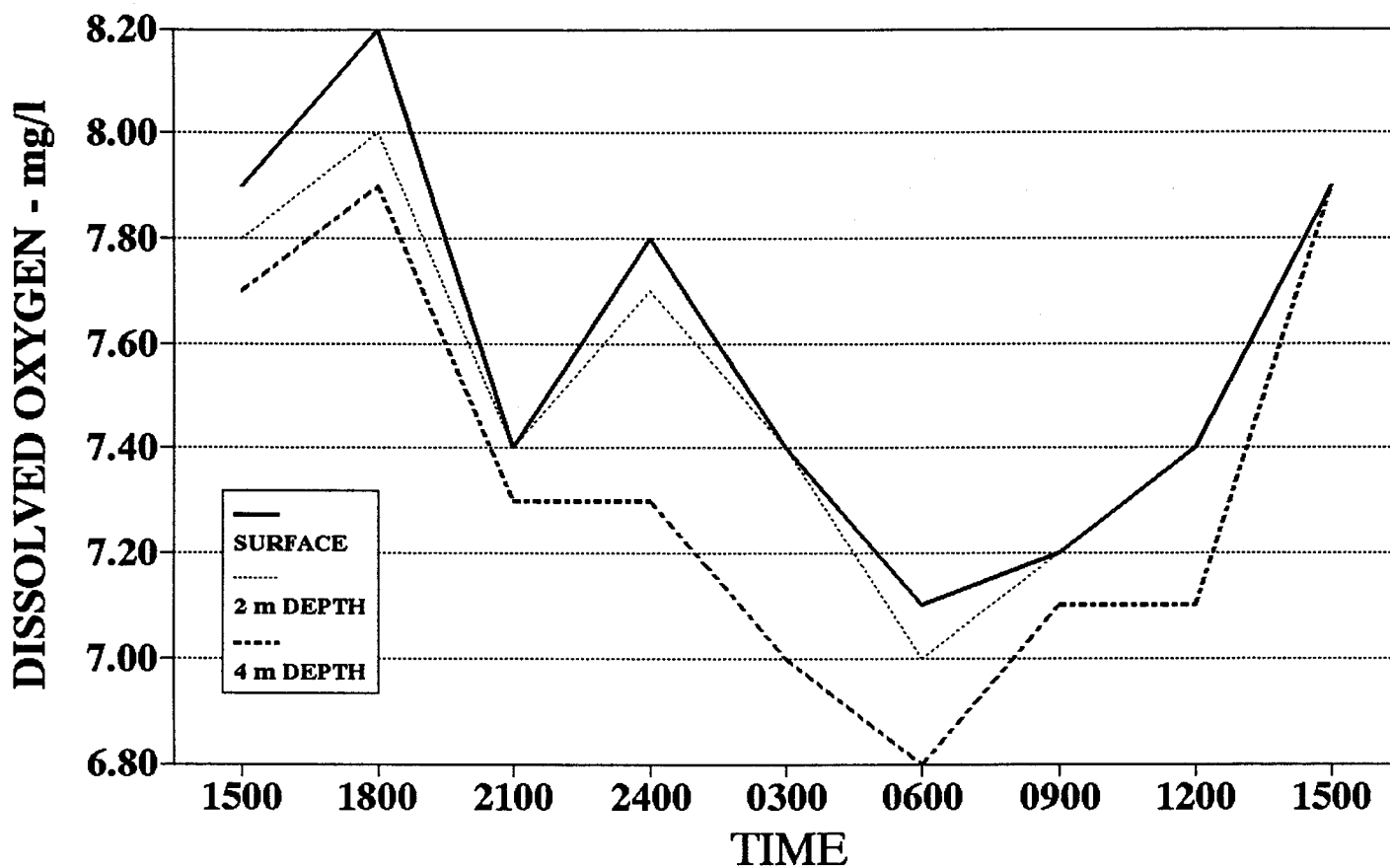


Figure 57.

Mean dissolved oxygen percent saturation at RM 102.5 in the Spokane River during the diel study of August 12-13, 1991.

TABLES

Table 1.

Retention times of sections on the Spokane River, RM 111.1 to Post Falls Dam, June 24, 1990 to September 29, 1991.

| RIVER
MILE | CONTOUR
DEPTH
(ft) | CONTOUR
DEPTH
(m) | CONTOUR
AREA
(m2) | CONTOUR
VOLUME
(m3) | TOTAL SECTION
VOLUME
(m3) |
|--|--------------------------|-------------------------|-------------------------|---------------------------|---------------------------------|
| 111.1-108.8 | 0 | 0 | 6.44E+05 | 7.38E+05 | 1,190,000 |
| | 4 | 1.2 | 5.68E+05 | 2.97E+05 | |
| | 6 | 1.8 | 4.11E+05 | 1.42E+05 | |
| | 8 | 2.4 | 9.32E+04 | 1.61E+04 | |
| | 9 | 2.7 | 2.12E+04 | | |
| 108.8-106.2 | 0 | 0 | 8.39E+05 | 1.48E+06 | 1,920,000 |
| | 6 | 1.8 | 7.80E+05 | 3.76E+05 | |
| | 8 | 2.4 | 4.66E+05 | 6.71E+04 | |
| | 9 | 2.7 | 4.66E+04 | | |
| 106.2-103.5 | 0 | 0 | 1.12E+06 | 2.52E+06 | 4,900,000 |
| | 8 | 2.4 | 9.45E+05 | 1.58E+06 | |
| | 14 | 4.3 | 7.84E+05 | 7.65E+05 | |
| | 20 | 6.1 | 1.40E+05 | 4.18E+04 | |
| | 22 | 6.7 | 1.69E+04 | | |
| 103.5-102.5 | 0 | 0 | 4.66E+05 | 1.07E+06 | 2,520,000 |
| | 8 | 2.4 | 4.11E+05 | 1.21E+06 | |
| | 20 | 6.1 | 2.58E+05 | 2.41E+05 | |
| | 26 | 7.9 | 3.81E+04 | | |
| TOTAL RIVER SECTION VOLUME (RM 111.1-102.5) = | | | | 10,500,000 m3 | |
| SPOKANE RIVER TOTAL DISCHARGE FOR WATER-YEAR 1990 = 7,010,000,000 m3 | | | | | |

RETENTION TIMES FOR SPECIFIC SECTIONS AND THE RIVER

| FLOW | DATE | 111.1-108.8 | 108.8-106.2 | 106.2-103.5 | 103.5-102.5 | RIVER |
|------------|---------------------------|-------------|-------------|-------------|-------------|----------|
| 50,100 cfs | 78 YR. MAX (DEC 25, 1933) | 0.2 hr | 0.4 hr | 1.0 hr | 0.5 hr | 2.1 hr |
| 24,200 cfs | DAILY HIGH (JUNE 5, 1990) | 0.5 hr | 0.8 hr | 2.0 hr | 1.0 hr | 4.3 hr |
| 23,891 cfs | 80-91 MEAN MAX MONTHLY | 0.5 hr | 0.8 hr | 2.0 hr | 1.0 hr | 4.3 hr |
| 6,300 cfs | 78 YR MEAN | 1.9 hr | 3.0 hr | 7.6 hr | 3.9 hr | 16.4 hr |
| 65 cfs | 78 YR MIN (JULY 25, 1973) | 7.5 day | 12.1 day | 30.9 day | 15.9 day | 66.4 day |
| 340 cfs | DAILY LOW (SEPT 5, 1990) | 1.4 day | 2.3 day | 5.9 day | 3.0 day | 12.7 day |
| 500 cfs | 80-91 MEAN MIN MONTHLY | 1.0 day | 1.6 day | 4.0 day | 2.1 day | 8.6 day |

Table 2. Mean temperature (C) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 18.2 | 19.6 | 20.0 | 19.4 | 19.2 | N/A | 19.3 |
| 09 JUL 90 | 22.1 | 21.8 | 21.7 | N/A | 22.0 | 22.0 | 18.3 |
| 23 JUL 90 | 23.7 | 23.4 | 24.0 | 24.4 | 24.7 | 24.0 | 24.0 |
| 06 AUG 90 | 24.1 | 23.6 | 23.7 | 23.7 | 23.8 | 23.6 | 23.8 |
| 20 AUG 90 | 21.7 | 21.7 | 22.7 | 23.1 | 23.1 | 22.2 | 22.4 |
| 03 SEP 90 | 20.1 | 20.5 | 20.6 | 20.6 | 20.7 | 20.9 | 20.6 |
| 17 SEP 90 | 19.8 | 19.6 | 19.3 | 19.3 | 19.7 | 19.0 | 19.5 |
| 01 OCT 90 | 18.4 | 18.2 | 17.9 | 18.2 | 18.2 | 16.9 | 18.0 |
| 15 OCT 90 | 12.7 | 12.4 | 12.2 | 12.1 | 12.0 | 11.2 | 12.1 |
| 29 OCT 90 | 11.1 | 11.0 | 10.9 | 10.7 | 10.1 | 10.3 | 10.7 |
| 12 NOV 90 | 10.3 | 10.2 | 10.0 | 9.8 | 9.7 | 8.5 | 9.8 |
| 18 DEC 90 | 6.1 | 6.1 | 6.0 | 5.7 | 5.7 | 5.3 | 5.8 |
| 15 JAN 91 | 3.4 | 3.4 | 3.0 | 2.9 | 2.8 | 2.0 | 2.9 |
| 12 FEB 91 | 2.1 | 2.3 | 2.1 | 2.1 | 2.0 | 1.9 | 2.1 |
| 12 MAR 91 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 | 2.2 |
| 09 APR 91 | 3.8 | 3.9 | 4.0 | 3.9 | 3.8 | N/A | 3.9 |
| 07 MAY 91 | 8.3 | 8.3 | 8.7 | 9.0 | 8.8 | N/A | 8.6 |
| 21 MAY 91 | 10.2 | 10.6 | 10.5 | 10.5 | 10.4 | 9.3 | 10.3 |
| 04 JUN 91 | 12.2 | 12.6 | 12.8 | 13.3 | 12.4 | 12.2 | 12.6 |
| 18 JUN 91 | 13.2 | 13.4 | 13.9 | 13.8 | 13.5 | 15.2 | 13.8 |
| 02 JUL 91 | 17.7 | 17.5 | 17.2 | 17.0 | 17.3 | 16.8 | 17.3 |
| 16 JUL 91 | 20.7 | 20.6 | 20.3 | 20.4 | 20.7 | N/A | 20.5 |
| 30 JUL 91 | 22.0 | 21.8 | 21.7 | 22.0 | 22.5 | 22.5 | 22.1 |
| 13 AUG 91 | 22.5 | 22.2 | 22.6 | 22.5 | 22.9 | 23.1 | 22.6 |
| 27 AUG 91 | 25.2 | 25.1 | 25.1 | 26.0 | 26.1 | 26.3 | 25.6 |
| 10 SEP 91 | 19.8 | 19.7 | 19.9 | 20.2 | 20.5 | 20.6 | 20.1 |
| 24 SEP 91 | 18.0 | 17.4 | 17.1 | 16.9 | 16.8 | 17.9 | 17.4 |
| WY 91 MEAN | 13.0 | 12.9 | 12.9 | 13.0 | 12.9 | 13.1 | 13.0 |
| STUDY MEAN | 15.2 | 15.2 | 15.2 | 14.4 | 15.2 | 15.4 | 15.1 |

Table 3.

Mean temperature, dissolved oxygen, and electrical conductivity in the right (R), middle (M), and left (L) thirds of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| TEMPERATURE (C) | | | | | | |
|---------------------------------|-------|------|------|-------|------|------|
| RIVER
MILE | WY 91 | | | 90-91 | | |
| | R | M | L | R | M | L |
| 111.1 | 13.2 | 13.5 | 13.6 | 15.4 | 15.8 | 15.6 |
| 108.8 | 13.4 | 13.7 | 13.8 | 15.5 | 15.8 | 16.0 |
| 106.2 | 13.0 | 13.8 | 14.1 | 15.5 | 16.1 | 16.4 |
| 103.5 | 13.2 | 13.9 | 14.2 | 15.2 | 15.9 | 16.2 |
| 102.5 | 13.3 | 13.9 | 14.2 | 15.5 | 16.3 | 16.5 |
| 100.7 | 12.6 | 13.2 | 13.1 | 14.9 | 14.3 | 14.5 |
| OXYGEN (mg/l) | | | | | | |
| RIVER
MILE | WY 91 | | | 90-91 | | |
| | R | M | L | R | M | L |
| 111.1 | 9.8 | 9.7 | 9.8 | 9.2 | 9.2 | 9.2 |
| 108.8 | 9.6 | 9.6 | 9.6 | 9.1 | 9.1 | 9.1 |
| 106.2 | 9.6 | 9.5 | 9.6 | 9.1 | 9.0 | 9.1 |
| 103.5 | 9.6 | 9.5 | 9.4 | 9.3 | 9.1 | 9.1 |
| 102.5 | 9.5 | 9.4 | 9.4 | 9.1 | 9.0 | 9.0 |
| 100.7 | 10.3 | 10.3 | 10.2 | 9.7 | 10.0 | 9.8 |
| ELECTRICAL CONDUCTIVITY (umhos) | | | | | | |
| RIVER
MILE | WY 91 | | | 90-91 | | |
| | R | M | L | R | M | L |
| 111.1 | 39.0 | 39.3 | 39.3 | 39.9 | 40.7 | 40.6 |
| 108.8 | 41.1 | 40.6 | 40.4 | 42.4 | 42.1 | 42.2 |
| 106.2 | 40.6 | 41.2 | 40.5 | 42.7 | 43.2 | 42.2 |
| 103.5 | 41.0 | 41.3 | 41.0 | 42.8 | 43.2 | 42.4 |
| 102.5 | 40.7 | 40.7 | 41.0 | 42.1 | 42.2 | 42.2 |
| 100.7 | 38.5 | 39.1 | 39.6 | 43.6 | 41.6 | 42.1 |

Table 4. Mean dissolved oxygen (mg/l) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 period.

| Sample
Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | RIVER
MEAN |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 10.2 | 10.2 | 10.3 | 9.3 | 8.4 | N/A | 9.7 |
| 09 JUL 90 | 8.5 | 8.6 | 8.3 | N/A | 8.7 | 8.8 | 8.6 |
| 23 JUL 90 | 7.3 | 7.3 | 6.9 | 7.9 | 8.1 | 7.5 | 7.5 |
| 06 AUG 90 | 8.0 | 7.8 | 8.1 | 8.4 | 8.2 | 8.0 | 8.1 |
| 20 AUG 90 | 5.9 | 5.8 | 6.5 | 6.8 | 6.6 | 6.8 | 6.4 |
| 03 SEP 90 | 6.5 | 6.9 | 8.1 | 8.4 | 8.3 | 8.0 | 7.7 |
| 17 SEP 90 | 8.0 | 7.7 | 7.5 | 7.6 | 7.7 | 7.9 | 7.7 |
| 01 OCT 90 | 8.4 | 8.3 | 8.2 | 8.3 | 8.0 | 8.1 | 8.2 |
| 15 OCT 90 | 8.6 | 8.5 | 8.5 | 8.7 | 8.7 | 9.3 | 8.7 |
| 29 OCT 90 | 8.7 | 9.0 | 8.9 | 8.8 | 8.5 | 9.3 | 8.9 |
| 12 NOV 90 | 10.2 | 9.2 | 9.1 | 9.1 | 9.1 | 9.9 | 9.4 |
| 18 DEC 90 | 10.6 | 10.6 | 10.6 | 10.5 | 10.4 | 12.4 | 10.9 |
| 15 JAN 91 | 12.0 | 11.8 | 11.7 | 11.5 | 11.5 | 12.7 | 11.9 |
| 12 FEB 91 | 12.6 | 12.0 | 12.8 | 12.7 | 12.4 | 12.9 | 12.6 |
| 12 MAR 91 | 12.8 | 12.8 | 12.8 | 12.7 | 12.7 | 13.1 | 12.8 |
| 09 APR 91 | 12.5 | 12.4 | 12.4 | 12.5 | 12.6 | N/A | 12.5 |
| 07 MAY 91 | 11.2 | 11.2 | 11.3 | 11.3 | 11.1 | N/A | 11.2 |
| 21 MAY 91 | 11.6 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 |
| 04 JUN 91 | 10.7 | 10.8 | 10.8 | 11.0 | 10.6 | 11.5 | 10.9 |
| 18 JUN 91 | 10.5 | 10.5 | 10.4 | 10.5 | 10.4 | 10.5 | 10.5 |
| 02 JUL 91 | 9.7 | 9.7 | 9.8 | 9.8 | 9.8 | 9.5 | 9.7 |
| 16 JUL 91 | 7.9 | 7.9 | 7.6 | 7.8 | 7.8 | N/A | 7.8 |
| 30 JUL 91 | 7.5 | 7.5 | 7.2 | 7.4 | 7.2 | 8.0 | 7.5 |
| 13 AUG 91 | 7.5 | 7.0 | 6.8 | 7.2 | 7.2 | 8.5 | 7.4 |
| 27 AUG 91 | 7.7 | 7.6 | 7.4 | 7.1 | 7.0 | 7.9 | 7.5 |
| 10 SEP 91 | 8.0 | 8.0 | 7.8 | 7.9 | 7.8 | 8.1 | 7.9 |
| 24 SEP 91 | 8.1 | 8.4 | 8.2 | 7.9 | 8.1 | 8.7 | 8.2 |
| WY 91 MEAN | 9.8 | 9.7 | 9.7 | 9.7 | 9.6 | 10.2 | 9.8 |
| STUDY MEAN | 9.3 | 9.2 | 9.2 | 9.3 | 9.2 | 9.7 | 9.3 |

Table 5.

Mean dissolved oxygen (percent saturation) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample
Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | RIVER
MEAN |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 108.2 | 111.0 | 113.3 | 101.3 | 90.8 | N/A | 104.9 |
| 09 JUL 90 | 97.0 | 97.7 | 94.4 | N/A | 99.4 | 100.6 | 97.8 |
| 23 JUL 90 | 86.7 | 85.3 | 82.0 | 94.6 | 97.3 | 88.9 | 89.1 |
| 06 AUG 90 | 95.5 | 92.4 | 95.3 | 99.7 | 97.2 | 94.8 | 95.8 |
| 20 AUG 90 | 66.8 | 66.4 | 75.2 | 79.5 | 77.6 | 78.2 | 74.0 |
| 03 SEP 90 | 71.6 | 76.3 | 90.3 | 93.5 | 92.2 | 89.1 | 85.5 |
| 17 SEP 90 | 87.8 | 83.5 | 81.3 | 82.8 | 83.8 | 85.2 | 84.1 |
| 01 OCT 90 | 89.9 | 88.1 | 86.0 | 88.2 | 85.1 | 83.9 | 86.9 |
| 15 OCT 90 | 81.3 | 79.7 | 79.2 | 81.2 | 80.5 | 84.9 | 81.1 |
| 29 OCT 90 | 79.4 | 81.5 | 80.8 | 79.4 | 75.8 | 83.0 | 80.0 |
| 12 NOV 90 | 90.9 | 82.2 | 80.4 | 80.0 | 80.2 | 84.7 | 83.1 |
| 18 DEC 90 | 85.2 | 85.3 | 84.8 | 84.0 | 83.0 | 97.8 | 86.7 |
| 15 JAN 91 | 90.2 | 88.8 | 86.8 | 85.1 | 84.9 | 92.2 | 88.0 |
| 12 FEB 91 | 91.4 | 87.7 | 92.8 | 92.4 | 90.0 | 92.7 | 91.2 |
| 12 MAR 91 | 93.0 | 93.0 | 92.8 | 92.5 | 92.6 | 95.0 | 93.2 |
| 09 APR 91 | 94.4 | 94.5 | 94.4 | 94.8 | 95.3 | N/A | 94.7 |
| 07 MAY 91 | 94.9 | 95.7 | 97.0 | 98.0 | 96.0 | N/A | 96.3 |
| 21 MAY 91 | 103.0 | 104.9 | 104.7 | 105.2 | 105.1 | 101.9 | 104.1 |
| 04 JUN 91 | 100.2 | 101.3 | 101.9 | 104.8 | 94.0 | 107.5 | 101.6 |
| 18 JUN 91 | 99.6 | 100.8 | 100.9 | 101.1 | 99.7 | 104.8 | 101.2 |
| 02 JUL 91 | 102.0 | 101.5 | 101.5 | 100.9 | 102.4 | 98.2 | 101.1 |
| 16 JUL 91 | 88.0 | 87.4 | 84.5 | 86.6 | 86.9 | N/A | 86.7 |
| 30 JUL 91 | 85.4 | 85.7 | 81.6 | 84.5 | 83.2 | 92.2 | 85.4 |
| 13 AUG 91 | 86.3 | 80.2 | 78.9 | 83.1 | 83.5 | 99.2 | 85.2 |
| 27 AUG 91 | 93.8 | 91.8 | 90.2 | 87.0 | 86.3 | 97.6 | 91.1 |
| 10 SEP 91 | 87.1 | 87.4 | 85.9 | 87.3 | 86.8 | 90.4 | 87.5 |
| 24 SEP 91 | 85.6 | 87.4 | 85.1 | 81.8 | 83.4 | 91.9 | 85.9 |
| WY 91 MEAN | 91.1 | 90.2 | 89.5 | 89.9 | 88.7 | 94.0 | 90.6 |
| STUDY MEAN | 90.2 | 89.5 | 89.7 | 90.4 | 89.4 | 92.8 | 90.3 |

Table 6. Mean electrical conductivity (umhos) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample | Sta. 1 | Sta. 2 | Sta. 3 | Sta. 4 | Sta. 5 | Sta. 6 | RIVER |
|------------|------------|------------|------------|------------|------------|------------|-------|
| Date | (RM 111.1) | (RM 108.8) | (RM 106.2) | (RM 103.5) | (RM 102.5) | (RM 100.7) | MEAN |
| 29 JUN 90 | 39.4 | 39.9 | 40.2 | 40.4 | 40.3 | N/A | 40.0 |
| 09 JUL 90 | 41.1 | 44.8 | 46.3 | N/A | 45.2 | 39.0 | 43.3 |
| 23 JUL 90 | 62.7 | 65.8 | 69.4 | 69.1 | 58.5 | 61.6 | 64.5 |
| 06 AUG 90 | 48.1 | 48.4 | 49.7 | 49.2 | 47.7 | 41.9 | 47.5 |
| 20 AUG 90 | 33.5 | 34.3 | 39.6 | 41.4 | 41.5 | 103.6 | 49.0 |
| 03 SEP 90 | 39.0 | 45.0 | 44.4 | 43.8 | 42.6 | 40.5 | 42.6 |
| 17 SEP 90 | 39.7 | 41.6 | 41.1 | 42.8 | 42.3 | 42.9 | 41.7 |
| 01 OCT 90 | 37.5 | 39.7 | 40.1 | 40.7 | 40.4 | 34.3 | 38.8 |
| 15 OCT 90 | 33.4 | 36.2 | 35.4 | 36.4 | 36.1 | 42.5 | 36.7 |
| 29 OCT 90 | 40.4 | 41.6 | 41.2 | 41.7 | 40.3 | 36.6 | 40.3 |
| 12 NOV 90 | 39.7 | 40.7 | 40.5 | 40.7 | 40.1 | 35.5 | 39.5 |
| 18 DEC 90 | 32.5 | 33.6 | 33.7 | 34.0 | 33.8 | 33.2 | 33.5 |
| 15 JAN 91 | 30.4 | 30.9 | 31.1 | 29.9 | 31.5 | 28.6 | 30.4 |
| 12 FEB 91 | 30.3 | 30.6 | 30.5 | 30.6 | 30.4 | 27.8 | 30.0 |
| 12 MAR 91 | 30.0 | 29.5 | 32.0 | 29.9 | 29.6 | 32.7 | 30.6 |
| 09 APR 91 | 29.9 | 30.2 | 30.2 | 28.9 | 29.5 | N/A | 29.7 |
| 07 MAY 91 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 21 MAY 91 | 32.7 | 32.9 | 33.1 | 32.8 | 32.5 | 29.3 | 32.2 |
| 04 JUN 91 | 35.0 | 36.5 | 36.6 | 37.4 | 37.7 | 29.7 | 35.5 |
| 18 JUN 91 | 37.8 | 38.6 | 38.9 | 40.0 | 39.5 | 38.4 | 38.9 |
| 02 JUL 91 | 41.4 | 41.9 | 42.0 | 42.7 | 41.9 | 40.4 | 41.7 |
| 16 JUL 91 | 44.5 | 46.9 | 46.7 | 47.5 | 47.1 | N/A | 46.5 |
| 30 JUL 91 | 48.9 | 49.9 | 50.1 | 50.3 | 50.2 | 49.0 | 49.7 |
| 13 AUG 91 | 49.3 | 49.9 | 50.6 | 51.0 | 50.6 | 49.7 | 50.2 |
| 27 AUG 91 | 48.6 | 53.8 | 52.8 | 53.4 | 53.0 | 57.6 | 53.2 |
| 10 SEP 91 | 47.8 | 49.4 | 49.6 | 51.1 | 50.6 | 51.6 | 50.0 |
| 24 SEP 91 | 47.3 | 48.2 | 48.1 | 48.6 | 47.6 | 48.5 | 48.1 |
| WY 91 MEAN | 38.8 | 40.1 | 40.2 | 40.4 | 40.1 | 39.1 | 39.8 |
| STUDY MEAN | 40.0 | 41.6 | 42.1 | 42.2 | 41.6 | 43.3 | 41.8 |

Table 7. pH among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEDIAN |
|--------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|-----------------|
| 29 JUN 90 | 6.7 | 6.8 | 6.7 | 6.7 | 6.6 | N/A | N/A | N/A | 6.7 |
| 09 JUL 90 | 7.1 | 7.1 | 7.1 | N/A | 6.8 | 6.6 | N/A | N/A | 7.1 |
| 23 JUL 90 | 6.7 | 6.9 | 6.9 | 7.0 | 7.0 | 7.0 | 7.3 | 6.8 | 7.0 |
| 06 AUG 90 | 6.7 | 6.8 | 6.9 | 7.0 | 7.0 | 7.0 | 7.7 | 7.3 | 7.0 |
| 20 AUG 90 | 6.5 | 6.6 | 6.7 | 6.7 | 6.8 | 6.8 | 7.3 | N/A | 6.7 |
| 03 SEP 90 | 6.5 | 6.6 | 6.7 | 6.7 | 6.8 | 6.8 | 7.7 | 7.0 | 6.8 |
| 17 SEP 90 | 6.9 | 7.0 | 7.0 | 7.1 | 7.1 | 7.1 | 7.7 | 7.4 | 7.1 |
| 01 OCT 90 | 7.0 | 7.1 | 7.1 | 7.1 | 3.3 | 6.3 | 7.9 | 7.1 | 7.1 |
| 15 OCT 90 | 7.1 | 7.1 | 7.2 | 7.2 | 7.2 | 7.3 | 7.3 | 7.2 | 7.2 |
| 29 OCT 90 | 7.4 | 7.3 | 7.3 | 7.4 | 7.3 | 7.5 | 8.3 | 7.3 | 7.4 |
| 12 NOV 90 | 7.1 | 7.1 | 7.1 | 7.2 | 6.7 | 7.1 | 7.4 | 7.1 | 7.1 |
| 18 DEC 90 | 7.3 | 7.3 | 7.4 | 7.4 | 7.4 | 7.4 | 7.6 | 7.2 | 7.4 |
| 15 JAN 91 | 7.1 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.1 | 7.1 | 7.2 |
| 12 FEB 91 | 7.5 | 7.5 | 7.5 | 7.6 | 7.6 | 7.6 | 7.3 | 7.3 | 7.5 |
| 12 MAR 91 | 7.7 | 7.7 | 7.7 | 7.9 | 7.9 | 7.9 | 8.2 | 7.5 | 7.8 |
| 09 APR 91 | 7.6 | 7.7 | 7.8 | 7.8 | 7.8 | 7.9 | 8.1 | 7.5 | 7.8 |
| 07 MAY 91 | 5.1 | 5.2 | 5.4 | 5.5 | 5.7 | 5.8 | 7.2 | 6.9 | 5.7 |
| 21 MAY 91 | 5.7 | 5.9 | 6.1 | 6.3 | 6.2 | 6.3 | 7.0 | 6.9 | 6.3 |
| 04 JUN 91 | 6.8 | 6.8 | 6.8 | 6.8 | 6.9 | 6.8 | 7.2 | 7.5 | 6.8 |
| 18 JUN 91 | 6.3 | 5.7 | 5.5 | 6.1 | 6.1 | 5.7 | 6.4 | 6.5 | 6.1 |
| 02 JUL 91 | 5.7 | 6.0 | 6.1 | 6.2 | 6.3 | 6.3 | 6.0 | N/A | 6.1 |
| 16 JUL 91 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.8 | 7.0 | 6.9 |
| 30 JUL 91 | 6.5 | 6.5 | 6.5 | 6.4 | 6.4 | 6.0 | 6.2 | 6.2 | 6.4 |
| 13 AUG 91 | 6.5 | 6.8 | 6.9 | 6.7 | 6.4 | 6.5 | 6.0 | N/A | 6.5 |
| 27 AUG 91 | 6.7 | 6.6 | 6.7 | 6.6 | 6.6 | 6.7 | 6.9 | 7.1 | 6.7 |
| 10 SEP 91 | 6.4 | 6.4 | 6.3 | 6.7 | 6.6 | 6.5 | 7.3 | 6.9 | 6.6 |
| 24 SEP 91 | 6.3 | 6.3 | 6.4 | 6.3 | 6.3 | 6.2 | 6.7 | 7.0 | 6.3 |
| WY 91 MEDIAN | 6.9 | 6.9 | 6.9 | 6.9 | 6.7 | 6.8 | 7.2 | 7.1 | 6.9 |
| STUDY MEDIAN | 6.7 | 6.8 | 6.9 | 6.8 | 6.8 | 6.8 | 7.3 | 7.1 | 6.8 |

Table 8. Turbidity (NTU) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 2.9 | 2.7 | 1.9 | 1.6 | 3.0 | N/A | N/A | N/A | 2.4 |
| 09 JUL 90 | 2.0 | 1.9 | 1.5 | 1.6 | 1.4 | 1.0 | N/A | N/A | 1.6 |
| 23 JUL 90 | 0.7 | 0.7 | 1.1 | 1.4 | 1.5 | 1.2 | 9.1 | 1.2 | 1.1 |
| 06 AUG 90 | 0.8 | 1.1 | 1.1 | 1.0 | 1.6 | 0.8 | 11.2 | 2.5 | 1.1 |
| 20 AUG 90 | 0.9 | 2.2 | 0.6 | 0.8 | 1.2 | 1.3 | 15.0 | N/A | 1.2 |
| 03 SEP 90 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 7.2 | 7.7 | 0.6 |
| 17 SEP 90 | 0.6 | 0.6 | 0.6 | 0.7 | 0.6 | 1.3 | 9.6 | 1.9 | 0.7 |
| 01 OCT 90 | 0.5 | 0.7 | 1.0 | 0.9 | 0.8 | 1.6 | 6.6 | 1.4 | 0.9 |
| 15 OCT 90 | 0.5 | 0.8 | 0.6 | 0.7 | 0.9 | 0.7 | 13.0 | 3.7 | 0.7 |
| 29 OCT 90 | 0.3 | 0.5 | 0.5 | 1.0 | 1.0 | 0.5 | 9.2 | 1.4 | 0.6 |
| 12 NOV 90 | 0.4 | 0.4 | 0.5 | 0.4 | 5.4 | 0.6 | 9.4 | 2.4 | 1.3 |
| 18 DEC 90 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 1.1 | 14.1 | 2.4 | 0.9 |
| 15 JAN 91 | 1.1 | 1.1 | 1.3 | 1.3 | 1.3 | 1.5 | 10.5 | 2.8 | 1.3 |
| 12 FEB 91 | 1.6 | 1.7 | 1.7 | 1.7 | 1.7 | 1.8 | 13.5 | 2.3 | 1.7 |
| 12 MAR 91 | 1.7 | 2.3 | 1.9 | 2.0 | 1.7 | 2.0 | 10.5 | 2.2 | 1.9 |
| 09 APR 91 | 1.8 | 1.7 | 1.9 | 1.9 | 1.8 | 2.0 | 11.0 | 3.7 | 1.9 |
| 07 MAY 91 | 1.5 | 1.5 | 1.4 | 1.2 | 1.1 | 1.1 | 12.0 | 2.0 | 1.3 |
| 21 MAY 91 | 0.8 | 0.8 | 1.0 | 0.8 | 1.1 | 0.9 | 9.4 | 1.3 | 0.9 |
| 04 JUN 91 | 0.9 | 0.9 | 0.8 | 1.0 | 1.1 | 0.6 | 5.1 | 2.3 | 0.9 |
| 18 JUN 91 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 | 0.5 | 8.1 | 2.2 | 0.5 |
| 02 JUL 91 | 0.5 | 0.6 | 0.5 | 0.6 | 0.5 | 0.5 | 9.6 | N/A | 0.5 |
| 16 JUL 91 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 9.8 | 3.6 | 0.8 |
| 30 JUL 91 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 9.0 | 4.8 | 0.6 |
| 13 AUG 91 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 8.7 | N/A | 0.5 |
| 27 AUG 91 | 0.4 | 0.5 | 0.6 | 0.8 | 0.6 | 0.6 | 4.7 | 1.9 | 0.5 |
| 10 SEP 91 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 2.4 | 3.4 | 0.5 |
| 24 SEP 91 | 1.3 | 1.5 | 1.4 | 1.3 | 1.6 | 1.4 | 6.2 | 3.2 | 1.4 |
| WY 91 MEAN | 0.8 | 0.9 | 0.9 | 1.0 | 1.2 | 1.0 | 9.1 | 2.6 | 1.0 |
| STUDY MEAN | 0.9 | 1.0 | 1.0 | 1.0 | 1.3 | 1.0 | 9.4 | 2.7 | 1.0 |

Table 9. Mean secchi disk depths (m) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | RM 106.2 - RM 102.5
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------------|
| 29 JUN 90 | >3.3 | 3.6 | 3.8 | 3.3 | 3.1 | 3.4 |
| 09 JUL 90 | >3.2 | 3.7 | 4.7 | N/A | 3.6 | 4.1 |
| 23 JUL 90 | >3.4 | >4.5 | 5.0 | 4.4 | 5.1 | 4.8 |
| 06 AUG 90 | >3.2 | >4.7 | 4.0 | 4.0 | 3.6 | 3.9 |
| 20 AUG 90 | >3.2 | 2.0 | 3.6 | 3.9 | 4.1 | 3.9 |
| 03 SEP 90 | >3.1 | >4.5 | 4.0 | 3.6 | 4.2 | 3.9 |
| 17 SEP 90 | >3.2 | >4.3 | 4.8 | 4.5 | 4.2 | 4.5 |
| 01 OCT 90 | >2.8 | 3.8 | 3.6 | 3.5 | 3.7 | 3.6 |
| 15 OCT 90 | >2.7 | >4.0 | 5.8 | 5.5 | 5.0 | 5.4 |
| 29 OCT 90 | >2.7 | >3.8 | >6.1 | 6.2 | 7.2 | 6.5 |
| 12 NOV 90 | >2.8 | >4.0 | 5.4 | 5.9 | 6.1 | 5.8 |
| 18 DEC 90 | >2.8 | >3.8 | 3.9 | 4.0 | 3.4 | 3.8 |
| 15 JAN 91 | >1.9 | >2.8 | 3.1 | 3.1 | 2.7 | 3.0 |
| 12 FEB 91 | >2.0 | 1.8 | 2.6 | 2.5 | 2.9 | 2.6 |
| 12 MAR 91 | >2.2 | >2.8 | 2.7 | 2.8 | 2.8 | 2.8 |
| 09 APR 91 | >2.1 | 2.8 | 2.3 | 2.9 | 2.2 | 2.4 |
| 07 MAY 91 | 2.8 | 2.7 | 2.8 | 2.7 | 2.6 | 2.7 |
| 21 MAY 91 | 2.9 | 2.8 | 2.7 | 2.4 | 2.3 | 2.5 |
| 04 JUN 91 | >3.0 | >3.8 | 3.4 | 4.2 | 4.2 | 3.9 |
| 18 JUN 91 | >3.1 | 4.3 | 4.2 | 5.0 | 4.3 | 4.5 |
| 02 JUL 91 | >3.1 | 3.5 | 4.2 | 3.8 | 3.9 | 4.0 |
| 16 JUL 91 | >3.0 | 3.3 | 3.8 | 2.9 | 3.1 | 3.2 |
| 30 JUL 91 | >3.2 | >4.6 | 4.4 | 4.9 | 3.8 | 4.3 |
| 13 AUG 91 | >3.0 | >4.2 | 4.2 | 4.1 | 4.1 | 4.1 |
| 27 AUG 91 | >3.0 | 4.1 | 3.8 | 3.1 | 2.9 | 3.3 |
| 10 SEP 91 | >3.2 | >4.4 | 6.2 | 5.8 | 5.8 | 5.9 |
| 24 SEP 91 | >2.9 | 4.1 | 5.5 | 5.2 | 5.2 | 5.3 |
| WY 91 MEAN | N/A | N/A | 4.0 | 4.0 | 3.9 | 4.0 |
| STUDY MEAN | N/A | N/A | 4.1 | 4.0 | 3.9 | 4.0 |

Table 10. Chlorophyll a concentrations (mg/m3) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample
Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | RIVER
MEAN |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 1.93 | 1.06 | 1.62 | 0.93 | 1.30 | N/A | 1.37 |
| 09 JUL 90 | 1.77 | 2.40 | 2.82 | N/A | 3.80 | 4.90 | 3.14 |
| 23 JUL 90 | 0.00 | 0.04 | 2.17 | 5.32 | 1.49 | 0.40 | 1.57 |
| 06 AUG 90 | 1.79 | 2.08 | 5.19 | 7.37 | 5.06 | 0.00 | 3.58 |
| 20 AUG 90 | 2.55 | 3.18 | 3.92 | 10.96 | 9.66 | 7.80 | 6.35 |
| 03 SEP 90 | 2.19 | 3.38 | 6.73 | 8.58 | 7.37 | 7.07 | 5.89 |
| 17 SEP 90 | 1.50 | 1.71 | 1.59 | 2.23 | 2.42 | 3.20 | 2.11 |
| 01 OCT 90 | 2.82 | 4.35 | 4.43 | 6.58 | 5.85 | 6.98 | 5.17 |
| 15 OCT 90 | 2.72 | 3.81 | 2.66 | 2.91 | 3.32 | 3.11 | 3.09 |
| 29 OCT 90 | 1.90 | 4.61 | 3.31 | 2.97 | 2.69 | 3.01 | 3.08 |
| 12 NOV 90 | 2.46 | 2.72 | 3.02 | 2.64 | 2.66 | 3.65 | 2.86 |
| 18 DEC 90 | 4.41 | 3.10 | 2.77 | 3.52 | 0.94 | 0.00 | 2.46 |
| 15 JAN 91 | 1.83 | 1.83 | 1.37 | 2.76 | 2.17 | 2.38 | 2.06 |
| 12 FEB 91 | 3.34 | 3.53 | 3.82 | 3.53 | 3.72 | 3.25 | 3.53 |
| 12 MAR 91 | 3.02 | 3.00 | 2.91 | 3.06 | 2.83 | 3.12 | 2.99 |
| 09 APR 91 | 3.52 | 3.87 | 1.16 | 4.66 | 4.31 | 5.30 | 3.80 |
| 08 MAY 91 | 7.38 | 6.95 | 6.66 | 7.00 | 6.36 | 6.54 | 6.82 |
| 21 MAY 91 | 6.19 | 6.19 | 6.70 | 6.15 | 7.00 | 6.52 | 6.46 |
| 04 JUN 91 | 3.10 | 3.31 | 2.97 | 2.94 | 2.65 | 3.46 | 3.07 |
| 18 JUN 91 | 3.25 | 12.14 | 3.69 | 3.71 | 2.90 | 2.72 | 4.74 |
| 02 JUL 91 | 2.18 | 1.43 | 2.55 | 2.52 | 3.10 | 2.35 | 2.36 |
| 16 JUL 91 | 1.16 | 1.63 | 1.93 | 2.83 | 3.57 | 10.55 | 3.61 |
| 30 JUL 91 | 0.12 | 0.00 | 0.00 | 2.12 | 0.00 | 0.00 | 0.37 |
| 13 AUG 91 | 1.27 | 3.03 | 2.18 | 3.49 | 3.80 | 3.21 | 2.83 |
| 27 AUG 91 | 1.51 | 2.09 | 4.11 | 6.55 | 5.91 | 6.87 | 4.51 |
| 10 SEP 91 | 0.90 | 1.08 | 1.40 | 2.70 | 4.14 | 0.00 | 1.70 |
| 24 SEP 91 | 1.24 | 1.90 | 1.76 | 2.18 | 2.55 | 2.39 | 2.00 |
| WY 91 MEAN | 2.72 | 3.53 | 2.97 | 3.75 | 3.52 | 3.77 | 3.38 |
| STUDY MEAN | 2.45 | 3.13 | 3.09 | 4.24 | 3.76 | 3.80 | 3.39 |

Table 11.

Total Kjeldahl nitrogen concentrations among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWTP | PFWWTP | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|--------|--------|---------------|
| 29 JUN 90 | 0.46 | 0.20 | 0.18 | 0.20 | 0.16 | N/A | N/A | N/A | 0.24 |
| 09 JUL 90 | 0.24 | 0.20 | 0.18 | N/A | 0.26 | 0.14 | N/A | N/A | 0.20 |
| 23 JUL 90 | 0.18 | 0.16 | 0.20 | 0.20 | 0.24 | N/A | 25.32 | 1.74 | 0.20 |
| 06 AUG 90 | 0.24 | 0.20 | 0.20 | 0.24 | 0.36 | 0.22 | 23.96 | 1.37 | 0.24 |
| 20 AUG 90 | 0.20 | 0.40 | 0.20 | 0.22 | 0.22 | 0.20 | 22.60 | N/A | 0.24 |
| 03 SEP 90 | 0.22 | 0.36 | 0.20 | 0.14 | 0.26 | 0.22 | 20.69 | 2.31 | 0.23 |
| 17 SEP 90 | 0.22 | 0.20 | 0.18 | 0.20 | 0.34 | 0.24 | 24.78 | 1.40 | 0.23 |
| 01 OCT 90 | 0.12 | 0.18 | 0.16 | 0.16 | 0.20 | 0.22 | 20.69 | <.04 | 0.17 |
| 15 OCT 90 | 0.20 | 0.20 | 0.16 | 0.14 | 0.26 | 0.13 | 19.45 | 2.40 | 0.18 |
| 29 OCT 90 | 0.10 | 0.16 | 0.16 | 0.14 | 0.22 | 0.14 | 22.06 | 0.15 | 0.15 |
| 12 NOV 90 | 0.22 | 0.16 | 0.24 | 0.20 | 0.30 | 0.18 | 20.51 | 1.60 | 0.22 |
| 18 DEC 90 | 0.14 | 0.14 | 0.18 | 0.12 | 0.14 | 0.12 | 22.60 | 1.36 | 0.14 |
| 15 JAN 91 | 0.12 | 0.16 | 0.16 | 0.16 | 0.16 | 0.22 | 20.69 | 2.18 | 0.16 |
| 12 FEB 91 | 0.14 | 0.18 | 0.16 | 0.14 | 0.18 | 0.20 | 23.15 | 1.47 | 0.17 |
| 12 MAR 91 | 0.16 | 0.22 | 0.16 | 0.22 | 0.16 | 0.14 | 21.51 | 1.36 | 0.18 |
| 09 APR 91 | 0.16 | 0.16 | 0.18 | 0.12 | 0.16 | 0.14 | 24.10 | 1.58 | 0.15 |
| 07 MAY 91 | 0.14 | 0.14 | 0.14 | 0.12 | 0.20 | 0.14 | 26.14 | 1.14 | 0.15 |
| 21 MAY 91 | 0.14 | 0.14 | 0.22 | 0.10 | 0.22 | 0.19 | 26.41 | 0.06 | 0.17 |
| 04 JUN 91 | 0.16 | 0.12 | 0.22 | 0.23 | 0.34 | 0.14 | 22.60 | 0.06 | 0.20 |
| 18 JUN 91 | 0.10 | 0.20 | 0.16 | 0.18 | 0.20 | 0.16 | 18.79 | 0.44 | 0.17 |
| 02 JUL 91 | 0.22 | 0.30 | 0.20 | 0.14 | 0.15 | 0.18 | 19.33 | N/A | 0.20 |
| 16 JUL 91 | 0.14 | 0.12 | 0.12 | 0.10 | 0.12 | 0.12 | 17.15 | 1.20 | 0.12 |
| 30 JUL 91 | 0.12 | 0.12 | 0.12 | 0.12 | 0.16 | 0.18 | 20.42 | 9.42 | 0.14 |
| 13 AUG 91 | 0.10 | 0.18 | 0.17 | 0.16 | 0.18 | 0.16 | 20.42 | N/A | 0.16 |
| 27 AUG 91 | 0.14 | 0.22 | 0.20 | 0.18 | 0.22 | 0.18 | 15.79 | 1.25 | 0.19 |
| 10 SEP 91 | 0.10 | 0.14 | 0.16 | 0.24 | 0.24 | 0.22 | 11.44 | 17.05 | 0.18 |
| 24 SEP 91 | 0.12 | 0.18 | 0.15 | 0.22 | 0.18 | 0.16 | 14.16 | 0.68 | 0.17 |
| WY 91 MEAN | 0.14 | 0.17 | 0.17 | 0.16 | 0.20 | 0.17 | 20.37 | 2.41 | 0.17 |
| STUDY MEAN | 0.17 | 0.19 | 0.18 | 0.17 | 0.22 | 0.17 | 20.99 | 2.28 | 0.18 |

Table 12. Nitrate-nitrogen concentrations among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|---------------|
| 29 JUN 90 | 0.079 | <.006 | <.006 | <.006 | <.006 | N/A | N/A | N/A | 0.018 |
| 09 JUL 90 | 0.022 | 0.029 | 0.028 | N/A | <.006 | <.006 | N/A | N/A | 0.017 |
| 23 JUL 90 | 0.024 | 0.035 | 0.028 | <.006 | 0.022 | 0.045 | 0.896 | 11.34 | 0.026 |
| 06 AUG 90 | 0.015 | <.006 | <.006 | 0.007 | <.006 | 0.046 | 0.609 | 13.70 | 0.013 |
| 20 AUG 90 | 0.012 | 0.014 | 0.031 | 0.042 | 0.074 | 0.093 | 0.560 | N/A | 0.044 |
| 03 SEP 90 | 0.012 | 0.032 | 0.045 | 0.044 | 0.036 | 0.085 | 2.064 | 13.69 | 0.042 |
| 17 SEP 90 | 0.031 | <.006 | 0.040 | 0.054 | 0.040 | 0.081 | 1.596 | 14.51 | 0.041 |
| 01 OCT 90 | 0.017 | 0.061 | <.006 | 0.053 | 0.040 | 0.058 | 2.853 | 13.07 | 0.039 |
| 15 OCT 90 | 0.055 | 0.052 | 0.014 | <.006 | 0.088 | 0.014 | 2.480 | 12.99 | 0.038 |
| 29 OCT 90 | 0.036 | <.006 | 0.037 | 0.058 | 0.040 | 0.048 | 2.845 | 17.50 | 0.037 |
| 12 NOV 90 | <.006 | 0.077 | 0.075 | 0.038 | 0.030 | 0.077 | 2.359 | 15.85 | 0.050 |
| 18 DEC 90 | 0.227 | 0.183 | 1.596 | 0.267 | 0.238 | 0.407 | 3.835 | 13.40 | 0.486 |
| 15 JAN 91 | 0.036 | 0.056 | 0.215 | 0.040 | 0.077 | 0.156 | 1.164 | 9.47 | 0.097 |
| 12 FEB 91 | 0.071 | 0.089 | 0.106 | 0.094 | 0.087 | 0.107 | 1.457 | 19.12 | 0.092 |
| 12 MAR 91 | 0.114 | 0.113 | 0.107 | 0.116 | 0.155 | 0.150 | 2.041 | 15.81 | 0.126 |
| 09 APR 91 | 0.070 | 0.097 | 0.072 | 0.069 | 0.090 | 0.136 | 1.899 | 11.90 | 0.089 |
| 07 MAY 91 | 0.013 | <.006 | 0.020 | 0.033 | <.006 | 0.031 | 1.808 | 23.34 | 0.017 |
| 21 MAY 91 | 0.017 | <.006 | <.006 | <.006 | 0.050 | 0.306 | 1.646 | 23.14 | 0.064 |
| 04 JUN 91 | <.006 | 0.020 | 0.044 | 0.047 | <.006 | 0.107 | 1.450 | 20.79 | 0.037 |
| 18 JUN 91 | 0.011 | 0.020 | 0.023 | 0.021 | 0.022 | 0.018 | 3.550 | 19.75 | 0.019 |
| 02 JUL 91 | 0.058 | 0.064 | 0.107 | 0.029 | <.006 | 0.050 | 1.428 | N/A | 0.052 |
| 16 JUL 91 | 0.036 | 0.008 | 0.014 | 0.046 | 0.031 | 0.046 | 3.421 | 29.31 | 0.030 |
| 30 JUL 91 | 0.027 | 0.034 | 0.039 | 0.011 | 0.044 | 0.076 | 4.006 | 9.55 | 0.039 |
| 13 AUG 91 | 0.007 | 0.036 | 0.031 | <.006 | <.006 | <.006 | 3.769 | N/A | 0.014 |
| 27 AUG 91 | 0.008 | 0.080 | 0.044 | 0.019 | 0.038 | 0.049 | 5.132 | 8.04 | 0.040 |
| 10 SEP 91 | 0.008 | 0.040 | 0.040 | 0.026 | 0.049 | 0.027 | 6.081 | 2.07 | 0.032 |
| 24 SEP 91 | 0.014 | 0.022 | 0.024 | 0.038 | 0.021 | 0.044 | 5.022 | 19.25 | 0.027 |
| WY 91 MEAN | 0.041 | 0.053 | 0.131 | 0.051 | 0.056 | 0.095 | 2.912 | 15.80 | 0.071 |
| STUDY MEAN | 0.038 | 0.044 | 0.103 | 0.045 | 0.048 | 0.087 | 2.559 | 15.35 | 0.061 |

Table 13. Ammonia concentration (mg/l) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|---------------|
| 29 JUN 90 | 0.20 | 0.15 | 0.11 | 0.10 | 0.12 | N/A | N/A | N/A | 0.14 |
| 09 JUL 90 | 0.05 | 0.28 | 0.20 | N/A | 0.25 | 0.14 | N/A | N/A | 0.18 |
| 23 JUL 90 | 0.12 | 0.24 | 0.20 | 0.13 | 0.10 | 0.07 | 24.7 | 1.79 | 0.15 |
| 06 AUG 90 | 0.09 | 0.17 | 0.17 | 0.18 | 0.23 | 0.13 | 21.1 | 0.91 | 0.16 |
| 20 AUG 90 | 0.11 | 0.43 | 0.23 | 0.14 | 0.14 | 0.16 | 18.3 | N/A | 0.20 |
| 03 SEP 90 | 0.16 | 0.34 | 0.15 | 0.09 | 0.10 | 0.07 | 17.4 | 1.32 | 0.15 |
| 17 SEP 90 | 0.07 | 0.22 | 0.14 | 0.16 | 0.18 | 0.17 | 21.5 | 0.74 | 0.16 |
| 01 OCT 90 | 0.09 | 0.18 | 0.10 | 0.10 | 0.11 | 0.08 | 17.9 | 1.49 | 0.11 |
| 15 OCT 90 | 0.15 | 0.20 | 0.11 | 0.16 | 0.16 | 0.13 | 14.9 | 0.65 | 0.15 |
| 29 OCT 90 | 0.08 | 0.13 | 0.10 | 0.08 | 0.13 | 0.09 | 19.2 | 1.28 | 0.10 |
| 12 NOV 90 | 0.15 | 0.13 | 0.22 | 0.07 | 0.20 | 0.11 | 18.2 | 0.90 | 0.15 |
| 18 DEC 90 | 0.12 | 0.18 | 0.16 | 0.12 | 0.11 | 0.13 | 21.6 | 1.39 | 0.14 |
| 15 JAN 91 | 0.10 | 0.14 | 0.14 | 0.13 | 0.14 | 0.16 | 20.5 | 1.03 | 0.13 |
| 12 FEB 91 | 0.09 | 0.12 | 0.16 | 0.12 | 0.17 | 0.10 | 22.2 | 0.93 | 0.13 |
| 12 MAR 91 | 0.11 | 0.16 | 0.11 | 0.13 | 0.12 | 0.11 | 20.5 | 0.81 | 0.12 |
| 09 APR 91 | 0.13 | 0.15 | 0.16 | 0.13 | 0.14 | 0.12 | 26.0 | 0.38 | 0.14 |
| 07 MAY 91 | 0.13 | 0.14 | 0.13 | 0.11 | 0.13 | 0.11 | 25.2 | 0.29 | 0.12 |
| 21 MAY 91 | 0.14 | 0.17 | 0.14 | 0.14 | 0.14 | 0.16 | 24.6 | 0.68 | 0.15 |
| 04 JUN 91 | 0.14 | 0.14 | 0.12 | 0.11 | 0.13 | 0.15 | 24.5 | 0.69 | 0.13 |
| 18 JUN 91 | 0.13 | 0.11 | 0.14 | 0.13 | 0.11 | 0.14 | 20.1 | 0.67 | 0.13 |
| 02 JUL 91 | 0.13 | 0.14 | 0.14 | 0.14 | 0.13 | 0.15 | 18.5 | N/A | 0.14 |
| 16 JUL 91 | 0.14 | 0.24 | 0.17 | 0.15 | 0.16 | 0.18 | 18.4 | 0.99 | 0.17 |
| 30 JUL 91 | 0.16 | 0.24 | 0.19 | 0.14 | 0.24 | 0.21 | 21.0 | 9.02 | 0.20 |
| 13 AUG 91 | 0.10 | 0.20 | 0.17 | 0.14 | 0.11 | 0.14 | 22.2 | N/A | 0.14 |
| 27 AUG 91 | 0.12 | 0.41 | 0.19 | 0.15 | 0.10 | 0.15 | 17.8 | 0.89 | 0.19 |
| 10 SEP 91 | 0.07 | 0.12 | 0.10 | 0.11 | 0.12 | 0.33 | 13.0 | 17.92 | 0.14 |
| 24 SEP 91 | 0.05 | 0.13 | 0.08 | 0.07 | 0.08 | 0.06 | 16.2 | 0.65 | 0.08 |
| WY 91 MEAN | 0.12 | 0.17 | 0.14 | 0.12 | 0.14 | 0.14 | 20.1 | 2.26 | 0.14 |
| STUDY MEAN | 0.12 | 0.19 | 0.15 | 0.12 | 0.14 | 0.14 | 20.2 | 2.06 | 0.14 |

Table 14. Total phosphorus concentrations among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | 0.019 | 0.019 | 0.016 | 0.011 | 0.016 | N/A | N/A | N/A | 0.016 |
| 09 JUL 90 | 0.031 | 0.020 | 0.017 | N/A | 0.022 | 0.011 | N/A | N/A | 0.020 |
| 23 JUL 90 | <.006 | 0.015 | 0.022 | 0.017 | <.006 | 0.009 | 4.62 | 3.44 | 0.011 |
| 06 AUG 90 | 0.007 | 0.016 | 0.014 | 0.023 | 0.022 | 0.025 | 4.77 | 4.01 | 0.018 |
| 20 AUG 90 | 0.016 | 0.055 | 0.021 | 0.015 | 0.007 | 0.019 | 3.75 | N/A | 0.022 |
| 03 SEP 90 | 0.020 | 0.055 | 0.023 | 0.012 | 0.006 | 0.032 | 4.29 | 3.96 | 0.025 |
| 17 SEP 90 | 0.011 | 0.017 | 0.019 | 0.015 | 0.029 | 0.019 | 4.51 | 3.99 | 0.018 |
| 01 OCT 90 | 0.010 | 0.021 | 0.018 | 0.017 | 0.012 | 0.021 | 3.97 | 3.96 | 0.017 |
| 15 OCT 90 | <.006 | 0.017 | 0.011 | 0.013 | 0.016 | 0.011 | 3.41 | 2.74 | 0.012 |
| 29 OCT 90 | <.006 | 0.014 | 0.012 | 0.011 | 0.009 | 0.014 | 3.63 | 3.23 | 0.011 |
| 12 NOV 90 | 0.015 | 0.015 | 0.011 | 0.013 | <.006 | 0.011 | 4.50 | 4.52 | 0.011 |
| 18 DEC 90 | <.006 | <.006 | 0.027 | <.006 | 0.006 | 0.008 | 4.09 | 3.90 | 0.008 |
| 15 JAN 91 | 0.007 | 0.011 | 0.011 | 0.008 | 0.017 | 0.016 | 4.01 | 3.50 | 0.012 |
| 12 FEB 91 | 0.012 | 0.014 | 0.015 | 0.017 | 0.018 | 0.010 | 3.74 | 4.02 | 0.014 |
| 12 MAR 91 | <.006 | 0.020 | 0.021 | 0.015 | 0.013 | 0.011 | 4.13 | 3.95 | 0.014 |
| 09 APR 91 | 0.016 | 0.026 | 0.018 | 0.015 | 0.014 | 0.019 | 4.68 | 3.53 | 0.018 |
| 07 MAY 91 | 0.010 | 0.013 | 0.011 | 0.012 | 0.010 | 0.012 | 5.01 | 5.08 | 0.011 |
| 21 MAY 91 | 0.011 | 0.017 | 0.011 | 0.014 | 0.014 | 0.013 | 4.72 | 4.36 | 0.013 |
| 04 JUN 91 | 0.012 | 0.011 | 0.013 | 0.013 | 0.017 | 0.011 | 1.30 | 4.40 | 0.013 |
| 18 JUN 91 | 0.012 | 0.017 | 0.011 | 0.015 | 0.012 | 0.015 | 0.95 | 4.44 | 0.014 |
| 02 JUL 91 | 0.007 | 0.009 | 0.013 | 0.009 | 0.009 | 0.009 | 1.01 | N/A | 0.009 |
| 16 JUL 91 | 0.015 | 0.017 | 0.014 | 0.013 | 0.013 | 0.011 | 1.11 | 5.28 | 0.014 |
| 30 JUL 91 | 0.010 | 0.008 | 0.013 | 0.016 | 0.017 | 0.015 | 1.04 | 5.54 | 0.013 |
| 13 AUG 91 | <.006 | <.006 | 0.018 | 0.012 | <.006 | 0.015 | 0.91 | N/A | 0.009 |
| 27 AUG 91 | 0.013 | <.006 | 0.006 | 0.009 | 0.011 | 0.018 | 0.08 | 4.24 | 0.010 |
| 10 SEP 91 | <.006 | 0.007 | 0.006 | 0.007 | 0.008 | 0.009 | 0.59 | 4.19 | 0.007 |
| 24 SEP 91 | 0.009 | 0.010 | 0.011 | 0.011 | 0.010 | 0.011 | 0.88 | 3.96 | 0.010 |
| WY 91 MEAN | 0.009 | 0.013 | 0.013 | 0.012 | 0.012 | 0.013 | 2.69 | 4.16 | 0.012 |
| STUDY MEAN | 0.010 | 0.017 | 0.015 | 0.013 | 0.012 | 0.014 | 3.03 | 4.10 | 0.014 |

Table 15. Orthophosphorus concentrations among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWTP
(RM 110.7) | PFWWTP
(RM 101.5) | RIVER
MEAN |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| 29 JUN 90 | <.006 | <.006 | <.006 | <.006 | 0.006 | N/A | N/A | N/A | <.006 |
| 09 JUL 90 | <.006 | 0.008 | 0.006 | N/A | <.006 | <.006 | N/A | N/A | <.006 |
| 23 JUL 90 | <.006 | 0.010 | 0.009 | 0.007 | <.006 | <.006 | 4.38 | 3.32 | 0.006 |
| 06 AUG 90 | <.006 | <.006 | <.006 | 0.008 | 0.009 | 0.008 | 4.07 | 3.92 | 0.006 |
| 20 AUG 90 | <.006 | 0.087 | 0.008 | 0.006 | <.006 | 0.011 | 3.39 | N/A | 0.019 |
| 03 SEP 90 | 0.009 | 0.038 | 0.009 | <.006 | <.006 | 0.022 | 4.00 | 3.66 | 0.014 |
| 17 SEP 90 | <.006 | 0.009 | 0.006 | <.006 | 0.006 | 0.007 | 4.44 | 3.75 | 0.006 |
| 01 OCT 90 | <.006 | 0.007 | <.006 | <.006 | <.006 | <.006 | 3.91 | 4.04 | <.006 |
| 15 OCT 90 | <.006 | 0.010 | <.006 | <.006 | 0.006 | <.006 | 3.56 | 2.73 | <.006 |
| 29 OCT 90 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 3.38 | 3.46 | <.006 |
| 12 NOV 90 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.006 | 4.28 | 4.48 | <.006 |
| 18 DEC 90 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.006 | 3.63 | 3.88 | <.006 |
| 15 JAN 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 3.36 | 3.31 | <.006 |
| 12 FEB 91 | <.006 | 0.006 | 0.009 | <.006 | 0.007 | 0.008 | 3.38 | 3.77 | 0.006 |
| 12 MAR 91 | <.006 | 0.007 | <.006 | <.006 | <.006 | <.006 | 3.68 | 4.18 | <.006 |
| 09 APR 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 4.38 | 3.51 | <.006 |
| 07 MAY 91 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.007 | 4.59 | 5.10 | <.006 |
| 21 MAY 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 4.41 | 4.33 | <.006 |
| 04 JUN 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 1.09 | 4.33 | <.006 |
| 18 JUN 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.94 | 4.30 | <.006 |
| 02 JUL 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.90 | N/A | <.006 |
| 16 JUL 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.90 | 5.33 | <.006 |
| 30 JUL 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.79 | 5.29 | <.006 |
| 13 AUG 91 | <.006 | 0.006 | <.006 | <.006 | <.006 | <.006 | 0.65 | N/A | <.006 |
| 27 AUG 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | <.06 | 4.27 | <.006 |
| 10 SEP 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 1.02 | 4.07 | <.006 |
| 24 SEP 91 | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 0.72 | 3.86 | <.006 |
| WY 91 MEAN | <.006 | <.006 | <.006 | <.006 | <.006 | <.006 | 2.48 | 4.12 | <.006 |
| STUDY MEAN | <.006 | 0.009 | <.006 | <.006 | <.006 | <.006 | 2.80 | 4.04 | <.006 |

Table 16.

Five Day Biochemical Oxygen Demand (BOD₅) (mg/l) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample
Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWT | PFWWTP | RIVER
MEAN |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|--------|--------|---------------|
| 29 JUN 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 09 JUL 90 | 1.7 | 4.0 | 3.7 | N/A | 3.7 | 3.7 | N/A | N/A | 3.3 |
| 23 JUL 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 06 AUG 90 | 2.3 | 4.3 | 4.3 | 5.7 | 5.0 | 4.3 | >50.0 | 14.0 | 4.3 |
| 20 AUG 90 | 3.3 | 5.3 | 2.3 | 2.7 | 3.7 | 4.0 | >51.3 | 24.0 | 3.6 |
| 03 SEP 90 | 1.8 | 2.8 | 4.2 | 4.8 | 4.2 | 4.2 | N/A | N/A | 3.7 |
| 17 SEP 90 | 3.0 | 3.0 | 3.0 | 2.0 | 5.0 | 4.3 | >28.8 | 8.7 | 3.4 |
| 01 OCT 90 | 3.7 | 4.7 | 3.7 | 4.7 | 0.8 | 4.3 | N/A | N/A | 3.6 |
| 15 OCT 90 | 1.5 | 2.5 | 3.2 | 2.2 | 2.8 | 2.8 | >28.3 | 14.3 | 2.5 |
| 29 OCT 90 | 0.5 | 1.5 | 0.5 | 0.5 | 1.2 | 1.2 | N/A | 6.3 | 0.9 |
| 12 NOV 90 | 2.0 | 2.0 | 2.3 | 2.0 | 2.0 | 2.7 | >46.7 | 7.0 | 2.2 |
| 18 DEC 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 15 JAN 91 | 3.8 | 3.0 | 3.4 | 3.0 | 2.7 | 3.5 | 74.7 | 8.9 | 3.2 |
| 12 FEB 91 | 1.7 | <.3 | <.3 | <.3 | <.3 | 2.6 | 16.7 | 12.0 | 0.7 |
| 12 MAR 91 | 6.7 | 8.7 | 6.7 | 8.0 | 6.7 | 8.4 | 45.0 | 18.7 | 7.5 |
| 09 APR 91 | 3.3 | 3.3 | 4.7 | 3.3 | 3.3 | 4.0 | N/A | 14.0 | 3.7 |
| 08 MAY 91 | 3.0 | 3.3 | 5.7 | 2.7 | 2.0 | 3.0 | 100.0 | 12.0 | 3.3 |
| 21 MAY 91 | 4.7 | 5.0 | 5.3 | 4.7 | 5.7 | 6.0 | 220.0 | 14.0 | 5.2 |
| 04 JUN 91 | 3.7 | 4.7 | 8.7 | 7.3 | 8.7 | 4.4 | 80.0 | 16.7 | 6.3 |
| 18 JUN 91 | 2.3 | 2.7 | 6.0 | 5.3 | 6.0 | 3.3 | 120.0 | 10.7 | 4.3 |
| 02 JUL 91 | 2.7 | 0.7 | 2.7 | 2.7 | 2.7 | 3.3 | 40.0 | N/A | 2.5 |
| 16 JUL 91 | 2.7 | 0.7 | 2.0 | 6.7 | 2.0 | 3.0 | 80.0 | 10.7 | 2.9 |
| 30 JUL 91 | 3.3 | 2.0 | 4.0 | 3.3 | 4.0 | 3.3 | 120.0 | 20.0 | 3.3 |
| 13 AUG 91 | 1.3 | 2.3 | 1.3 | 0.7 | 1.7 | 1.7 | 60.0 | N/A | 1.5 |
| 27 AUG 91 | 3.2 | 4.0 | 3.3 | 4.7 | 6.0 | 4.0 | 120.0 | 15.3 | 4.2 |
| 10 SEP 91 | 3.0 | 1.3 | 2.0 | 1.3 | <.3 | 1.4 | 40.0 | 20.0 | 1.5 |
| 24 SEP 91 | 5.0 | 6.0 | 4.7 | 4.0 | 4.0 | 6.0 | 20.0 | 11.3 | 5.0 |
| WY 91 MEAN | 3.1 | 3.1 | 3.7 | 3.5 | 3.3 | 3.6 | 81.2 | 13.2 | 3.4 |
| STUDY MEAN | 2.9 | 3.2 | 3.7 | 3.6 | 3.5 | 3.7 | N/A | 13.6 | 3.4 |

Table 17.

Ultimate Biochemical Oxygen Demand (mg/l) among
sampled stations of the Spokane River during the June
29, 1990 to September 24, 1991 sample period.

| Sample | | 5 | 10 | 15 | 20 | 27 | 35 | 45 |
|-----------|---------|------|------|------|-------|-------|-------|-------|
| Date | STATION | Day | Day | Day | Day | Day | Day | Day |
| 20 AUG 90 | 1 | 3.3 | N/A | N/A | 7.2 | N/A | N/A | 12.0 |
| 20 AUG 90 | 6 | 4.0 | N/A | N/A | 9.2 | N/A | N/A | 11.7 |
| 03 SEP 90 | 1 | 1.8 | N/A | N/A | 4.8 | N/A | N/A | 24.0 |
| 03 SEP 90 | 6 | 4.2 | N/A | N/A | 9.5 | N/A | N/A | 27.3 |
| 17 SEP 90 | 1 | 3.0 | N/A | N/A | 5.7 | 7.7 | 9.3 | N/A |
| 17 SEP 90 | 6 | 4.3 | N/A | N/A | 9.2 | 10.0 | 11.5 | N/A |
| 01 OCT 90 | 1 | 3.7 | 4.0 | N/A | N/A | N/A | 7.8 | 8.3 |
| 01 OCT 90 | 6 | 4.3 | 5.0 | N/A | N/A | N/A | 9.8 | 10.8 |
| 15 OCT 90 | 1 | 1.5 | N/A | 3.0 | 3.2 | 3.8 | N/A | N/A |
| 15 OCT 90 | 6 | 2.8 | N/A | 5.3 | 5.2 | 7.2 | N/A | N/A |
| 29 OCT 90 | 1 | 0.5 | 0.0 | 0.3 | 0.0 | 2.0 | N/A | N/A |
| 29 OCT 90 | 2 | 1.5 | 2.0 | 3.0 | 2.7 | 4.0 | N/A | N/A |
| 29 OCT 90 | 3 | 0.5 | 2.0 | 1.7 | 2.7 | 4.0 | N/A | N/A |
| 29 OCT 90 | 4 | 0.5 | 2.0 | 2.3 | 2.7 | 4.0 | N/A | N/A |
| 29 OCT 90 | 5 | 1.2 | 2.0 | 2.3 | 4.0 | 5.3 | N/A | N/A |
| 29 OCT 90 | 6 | 1.2 | 2.7 | 3.7 | 4.0 | 4.7 | N/A | N/A |
| 29 OCT 90 | PFWWTP | 6.3 | 9.7 | 11.0 | 14.3 | 16.3 | N/A | N/A |
| 12 NOV 90 | | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 18 DEC 90 | 1 | N/A | N/A | N/A | N/A | 8.4 | 8.0 | 8.6 |
| 18 DEC 90 | 2 | N/A | N/A | N/A | N/A | 7.7 | 8.0 | 8.0 |
| 18 DEC 90 | 3 | N/A | N/A | N/A | N/A | 8.7 | 8.7 | 9.0 |
| 18 DEC 90 | 4 | N/A | N/A | N/A | N/A | 2.7 | 4.0 | 4.0 |
| 18 DEC 90 | 5 | N/A | N/A | N/A | N/A | 9.3 | 9.3 | 9.7 |
| 18 DEC 90 | 6 | N/A | N/A | N/A | N/A | 9.7 | 10.2 | 10.4 |
| 18 DEC 90 | CDAWWTP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 18 DEC 90 | PFWWTP | N/A | N/A | N/A | N/A | 28.4 | 30.7 | 30.4 |
| 15 JAN 91 | | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 12 FEB 91 | 1 | 1.7 | 2.7 | 5.0 | 6.3 | 6.3 | 6.3 | 6.7 |
| 12 FEB 91 | 6 | 3.0 | 5.3 | 6.3 | 7.0 | 7.0 | 7.0 | 7.0 |
| 12 FEB 91 | CDAWWTP | 16.7 | 46.7 | 70.0 | 110.0 | 283.3 | 286.7 | 286.7 |
| 12 FEB 91 | PFWWTP | 12.0 | 22.0 | 26.7 | 30.0 | 32.7 | 36.7 | 37.3 |
| 12 MAR 91 | 1 | 6.7 | 14.4 | 15.3 | 12.4 | 12.4 | 12.0 | 13.0 |
| 12 MAR 91 | 6 | 8.4 | 15.0 | 18.0 | 16.3 | 16.7 | 15.7 | 15.7 |
| 12 MAR 91 | CDAWWTP | 45.0 | >270 | N/A | N/A | N/A | N/A | N/A |
| 12 MAR 91 | PFWWTP | 18.7 | 24.7 | 28.0 | 35.3 | 39.3 | 41.3 | 42.7 |
| 09 APR 91 | 1 | 3.3 | 14.0 | 25.3 | 26.7 | 28.7 | 28.7 | 29.3 |
| 09 APR 91 | 2 | 3.3 | 14.0 | 26.0 | 26.7 | 29.3 | 30.0 | 30.7 |
| 09 APR 91 | 3 | 4.7 | 14.0 | 26.0 | 27.3 | 30.0 | 30.0 | 30.7 |
| 09 APR 91 | 4 | 3.3 | 13.3 | 26.0 | 27.3 | 25.3 | 24.7 | 25.3 |

Table 17. (cont.)

| Sample | | 5 | 10 | 15 | 20 | 27 | 35 | 45 |
|-----------|---------|-------|-------|-------|-------|--------|--------|--------|
| Date | STATION | Day | Day | Day | Day | Day | Day | Day |
| 09 APR 91 | 5 | 3.3 | 12.0 | 22.7 | 27.3 | 26.0 | 26.0 | 26.0 |
| 09 APR 91 | 6 | 4.0 | 17.3 | 25.3 | 30.7 | 30.0 | 31.3 | 31.3 |
| 09 APR 91 | CDAWWTP | N/A | 380.0 | 520.0 | 520.0 | 500.0 | 490.0 | 500.0 |
| 09 APR 91 | PFWWTP | 14.0 | 19.3 | 22.0 | 24.0 | 28.7 | 28.0 | 30.0 |
| 07 MAY 91 | 1 | 3.0 | 4.3 | 6.3 | 8.3 | 10.0 | 11.0 | 11.7 |
| 07 MAY 91 | 2 | 3.3 | 4.7 | 8.7 | 10.3 | 12.0 | 12.7 | 13.0 |
| 07 MAY 91 | 3 | 5.7 | 6.3 | 7.0 | 9.7 | 11.0 | 12.3 | 13.0 |
| 07 MAY 91 | 4 | 2.7 | 3.3 | 7.0 | 8.7 | 10.3 | 11.0 | 11.7 |
| 07 MAY 91 | 5 | 2.0 | 3.3 | 7.3 | 8.0 | 10.7 | 11.3 | 12.7 |
| 07 MAY 91 | 6 | 3.0 | 6.0 | 7.7 | 9.0 | 10.7 | 12.0 | 13.0 |
| 07 MAY 91 | CDAWWTP | 100.0 | 120.0 | 200.0 | 420.0 | 660.0 | 740.0 | 740.0 |
| 07 MAY 91 | PFWWTP | 12.0 | 16.0 | 18.7 | 22.7 | 26.7 | 28.0 | 30.0 |
| 21 MAY 91 | 1 | 4.7 | 6.0 | 8.3 | 10.0 | 10.7 | 11.0 | 11.7 |
| 21 MAY 91 | 6 | 6.0 | 6.7 | 8.3 | 10.0 | 11.0 | 12.3 | 12.3 |
| 21 MAY 91 | CDAWWTP | 220.0 | 600.0 | 900.0 | 960.0 | 1000.0 | 1020.0 | 1020.0 |
| 21 MAY 91 | PFWWTP | 14.0 | 26.0 | 30.7 | 33.3 | 34.7 | 36.7 | 38.0 |
| 04 JUN 91 | 1 | 3.7 | 5.3 | 6.0 | 6.7 | 8.0 | 9.0 | 9.0 |
| 04 JUN 91 | 6 | 4.4 | 6.0 | 7.7 | 7.7 | 8.2 | 8.3 | 8.3 |
| 04 JUN 91 | CDAWWTP | 80.0 | 160.0 | 200.0 | 560.0 | 660.0 | 780.0 | 800.0 |
| 04 JUN 91 | PFWWTP | 16.7 | 28.0 | 34.0 | 36.7 | 38.7 | 42.0 | 42.7 |
| 18 JUN 91 | 1 | 2.3 | 3.7 | 4.7 | 5.0 | 6.3 | 6.7 | 7.3 |
| 18 JUN 91 | 6 | 3.3 | 4.0 | 5.3 | 6.7 | 6.7 | 8.3 | 8.7 |
| 18 JUN 91 | CDAWWTP | 120.0 | 340.0 | 430.0 | 440.0 | 450.0 | 430.0 | 380.0 |
| 18 JUN 91 | PFWWTP | 10.7 | 27.3 | 33.3 | 38.7 | 41.3 | 44.0 | 45.3 |
| 02 JUL 91 | 1 | 2.7 | 2.7 | 3.0 | 4.7 | 5.3 | 5.7 | 5.7 |
| 02 JUL 91 | 6 | 3.3 | 3.7 | 4.0 | 5.3 | 7.0 | 7.0 | 7.3 |
| 02 JUL 91 | CDAWWTP | 40.0 | 60.0 | 160.0 | 540.0 | 680.0 | 700.0 | 700.0 |
| 02 JUL 91 | PFWWTP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 16 JUL 91 | 1 | 2.7 | 3.0 | 3.3 | 4.3 | 4.7 | 5.7 | 5.7 |
| 16 JUL 91 | 6 | 3.0 | 5.0 | 6.0 | 7.0 | 7.7 | 8.3 | 8.3 |
| 16 JUL 91 | CDAWWTP | 80.0 | 280.0 | 380.0 | 540.0 | 660.0 | 660.0 | 660.0 |
| 16 JUL 91 | PFWWTP | 10.7 | 17.3 | 23.3 | 28.7 | 32.7 | 36.0 | 37.3 |
| 30 JUL 91 | 1 | 3.3 | 3.0 | 5.7 | 6.0 | 4.0 | 5.7 | 6.0 |
| 30 JUL 91 | 6 | 3.3 | 5.7 | 5.7 | 6.3 | 6.7 | 7.0 | 7.0 |
| 30 JUL 91 | CDAWWTP | 120.0 | 300.0 | 360.0 | 660.0 | 660.0 | 660.0 | 660.0 |
| 30 JUL 91 | PFWWTP | 20.0 | 39.3 | >41.3 | N/A | N/A | N/A | N/A |
| 13 AUG 91 | 1 | 1.3 | 2.0 | 2.7 | 3.7 | 5.0 | 5.7 | 6.0 |
| 13 AUG 91 | 6 | 1.7 | 2.7 | 3.3 | 3.7 | 4.7 | 5.0 | 5.7 |
| 13 AUG 91 | CDAWWTP | 60.0 | 140.0 | 360.0 | 560.0 | 660.0 | 660.0 | 700.0 |

Table 17. (cont.)

| Sample | | 5 | 10 | 15 | 20 | 27 | 35 | 45 |
|------------|---------|-------|-------|-------|-------|-------|-------|-------|
| Date | STATION | Day | Day | Day | Day | Day | Day | Day |
| 13 AUG 91 | PFWWTP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 27 AUG 91 | 1 | 3.2 | 2.7 | 3.3 | 3.7 | 5.7 | 7.3 | N/A |
| 27 AUG 91 | 6 | 4.0 | 3.3 | 4.7 | 6.0 | 6.7 | 8.3 | N/A |
| 27 AUG 91 | CDAWWTP | 120.0 | 300.0 | 560.0 | 620.0 | 680.0 | 700.0 | N/A |
| 27 AUG 91 | PFWWTP | 15.3 | 24.0 | 28.7 | 31.3 | 33.3 | 35.3 | N/A |
| 10 SEP 91 | 1 | 3.0 | 2.8 | 3.3 | 4.3 | N/A | N/A | N/A |
| 10 SEP 91 | 6 | 1.4 | 4.3 | 6.0 | 7.7 | N/A | N/A | N/A |
| 10 SEP 91 | CDAWWTP | 40.0 | 400.0 | 480.0 | 640.0 | N/A | N/A | N/A |
| 10 SEP 91 | PFWWTP | 20.0 | N/A | N/A | N/A | N/A | N/A | N/A |
| 24 SEP 91 | 1 | 5.0 | N/A | N/A | N/A | N/A | N/A | N/A |
| 24 SEP 91 | 6 | 6.0 | N/A | N/A | N/A | N/A | N/A | N/A |
| 24 SEP 91 | CDAWWTP | 20.0 | N/A | N/A | N/A | N/A | N/A | N/A |
| 24 SEP 91 | PFWWTP | 11.3 | N/A | N/A | N/A | N/A | N/A | N/A |
| WY 91 MEAN | 1 | 3.1 | 4.7 | 6.4 | 7.0 | 8.1 | 9.4 | 10.1 |
| | 6 | 3.6 | 6.1 | 8.0 | 8.8 | 9.5 | 9.4 | 11.2 |
| | CDAWWTP | 81.2 | 260.6 | 385.0 | 547.5 | 626.6 | 647.9 | 644.7 |
| | PFWWTP | 13.2 | 23.1 | 25.6 | 29.5 | 32.1 | 35.9 | 37.1 |

Table 18. Fecal coliform bacterial counts (#/100ml) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWTP | PFWWTP | RIVER
MEDIAN |
|--------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------|--------|-----------------|
| 29 JUN 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 09 JUL 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 23 JUL 90 | 220 | >60 | >60 | 23 | >60 | 200 | N/A | N/A | 200 |
| 06 AUG 90 | 1 | <1 | <1 | 1 | <1 | 30 | >600 | CG | 1 |
| 20 AUG 90 | 80 | >60 | 180 | 36 | 49 | 160 | N/A | N/A | 80 |
| 03 SEP 90 | 3 | 3 | 10 | 2 | 2 | <10 | 730 | <1 | 3 |
| 17 SEP 90 | 1 | 11 | 7 | 10 | 12 | 32 | 42 | 54 | 11 |
| 01 OCT 90 | <1 | 5 | <1 | 5 | 3 | 1 | <1 | 40 | 3 |
| 15 OCT 90 | 4 | 11 | 3 | 5 | 10 | 6 | >600 | 21 | 6 |
| 29 OCT 90 | <1 | <1 | <1 | <1 | <1 | <1 | 240 | 1 | <1 |
| 12 NOV 90 | <1 | <1 | <1 | <1 | 9 | <1 | <1 | 75 | <1 |
| 18 DEC 90 | <1 | <1 | 2 | <1 | 20 | <1 | >600 | 21 | <1 |
| 15 JAN 91 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 12 FEB 91 | 1 | 7 | 3 | 2 | 5 | 1 | 10 | 340 | 3 |
| 12 MAR 91 | 20 | >60 | N/A | 11 | 8 | 2 | >600 | >600 | 11 |
| 09 APR 91 | 4 | 6 | 2 | 7 | 8 | 17 | 1620 | 253 | 7 |
| 07 MAY 91 | <1 | <1 | <1 | <1 | <1 | 1 | N/A | <1 | <1 |
| 21 MAY 91 | <1 | <1 | <1 | 1 | <1 | <1 | <1 | 10 | <1 |
| 04 JUN 91 | 2 | 3 | <1 | <1 | 2 | 4 | 320 | 140 | 2 |
| 18 JUN 91 | <1 | <1 | <1 | 1 | <1 | 2 | 30 | 12 | <1 |
| 02 JUL 91 | <1 | 1 | <1 | <1 | 1 | <1 | 30 | N/A | <1 |
| 16 JUL 91 | 1 | 10 | 18 | <1 | 4 | 3 | 35 | 180 | 4 |
| 30 JUL 91 | 1 | <1 | <1 | <1 | <1 | <1 | 5 | 175 | <1 |
| 13 AUG 91 | <1 | 2 | <1 | <1 | <1 | 3 | 227 | N/A | <1 |
| 27 AUG 91 | <1 | 2 | 6 | <1 | 4 | 5 | <1 | 24 | 4 |
| 10 SEP 91 | <1 | <1 | <1 | <1 | <1 | 4 | 16 | <1 | <1 |
| 24 SEP 91 | <1 | 1 | <1 | <1 | 3 | 5 | 8 | 4 | 1 |
| WY 91 MEDIAN | 1 | 35 | 2 | <1 | 1 | 3 | 35 | 40 | 2 |
| STUDY MEDIAN | <1 | 30 | 1 | <1 | <1 | 3 | 30 | 24 | 1 |

Table 19. Fecal streptococcus bacterial counts (#/100ml) among sampled stations of the Spokane River during the June 29, 1990 to September 24, 1991 sample period.

| Sample Date | Sta. 1
(RM 111.1) | Sta. 2
(RM 108.8) | Sta. 3
(RM 106.2) | Sta. 4
(RM 103.5) | Sta. 5
(RM 102.5) | Sta. 6
(RM 100.7) | CDAWWTP PFWWTP RIVER | | |
|--------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----|--------|
| | | | | | | | N/A | N/A | MEDIAN |
| 29 JUN 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 09 JUL 90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 23 JUL 90 | >1000 | >100 | >100 | >100 | >100 | 180 | N/A | N/A | >100 |
| 06 AUG 90 | 3 | <1 | <1 | <10 | <1 | 1000 | 700 | 26 | 3 |
| 20 AUG 90 | 71 | 56 | 29 | 28 | 3 | 2000 | N/A | N/A | 56 |
| 03 SEP 90 | <1 | <1 | <1 | <1 | <1 | <1 | 110 | <1 | <1 |
| 17 SEP 90 | 14 | 13 | 11 | 1 | 6 | 11 | 2 | 20 | 11 |
| 01 OCT 90 | 72 | 31 | 42 | 16 | <1 | 8 | 7 | 15 | 31 |
| 15 OCT 90 | 8 | 81 | 19 | 10 | 10 | 2 | 33 | 3 | 10 |
| 29 OCT 90 | N/A | 129 | 6 | 71 | 3 | 238 | 50 | 3 | 71 |
| 12 NOV 90 | 13 | 26 | 16 | 20 | <1 | 8 | 40 | 21 | 16 |
| 18 DEC 90 | 5 | 3 | 6 | 7 | 6 | 2 | 190 | 13 | 6 |
| 15 JAN 91 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 12 FEB 91 | 1 | 7 | 3 | 4 | 2 | 2 | 20 | 20 | 3 |
| 12 MAR 91 | 3 | 70 | N/A | 1 | 1 | <1 | 240 | 130 | 1 |
| 09 APR 91 | 6 | 3 | 6 | 6 | 10 | 28 | 570 | 203 | 6 |
| 07 MAY 91 | <1 | <1 | 4 | 5 | 2 | 3 | N/A | 1 | 3 |
| 21 MAY 91 | <1 | 1 | <1 | 1 | 2 | 2 | 70 | <1 | 1 |
| 04 JUN 91 | 1 | 1 | <1 | 2 | 2 | 4 | <1 | 110 | 2 |
| 18 JUN 91 | <1 | 1 | 4 | 1 | 1 | 1 | 20 | 110 | 1 |
| 02 JUL 91 | 3 | 1 | 2 | 1 | 2 | 5 | 10 | N/A | 2 |
| 16 JUL 91 | 7 | 15 | 2 | 3 | 9 | 10 | 50 | 165 | 9 |
| 30 JUL 91 | 3 | 4 | <1 | <1 | <1 | 8 | <1 | <1 | 3 |
| 13 AUG 91 | 3 | 6 | 5 | 1 | <1 | 12 | 3 | N/A | 5 |
| 27 AUG 91 | <1 | <1 | 3 | <1 | <1 | 3 | <1 | 4 | <1 |
| 10 SEP 91 | 5 | 3 | 2 | 1 | <1 | 9 | 4 | 4 | 3 |
| 24 SEP 91 | 2 | <1 | <1 | 1 | <1 | 3 | 4 | 4 | 1 |
| WY 91 MEDIAN | 3 | 4 | 4 | 3 | 2 | 8 | 20 | 15 | 4 |
| STUDY MEDIAN | 3 | 3 | 4 | 2 | 2 | 4 | 20 | 13 | 3 |

Table 20.

Post Falls and Coeur D'Alene Wastewater Treatment Plant monthly mean values for selected parameters of treated effluent during the June 29, 1990 to September 24, 1991 Spokane River study period. (Data submitted by the respective WWTP.)

| POST FALLS WWTP | | | | | | | | | | |
|--------------------|---------------|--------------|-----|----------------|----------------|------------------|-------------------|----------------|-----------------|-----------------------|
| DATE | FLOW
(MGD) | TEMP
(C) | pH | TURB.
(NTU) | D.O.
(mg/l) | 5d BOD
(mg/l) | F.C.
(#/100ml) | T.P.
(mg/l) | NH3-N
(mg/l) | RES. CHLOR.
(mg/l) |
| 6/90 | 0.76 | 20.0 | 6.8 | N/A | 6.3 | 2.7 | 1.0 | 5.8 | 0.98 | 0.33 |
| 7/90 | 0.78 | 23.0 | 6.8 | N/A | 6.4 | 1.5 | 1.0 | 4.6 | 0.28 | 0.34 |
| 8/90 | 0.82 | 24.0 | 6.8 | N/A | 6.4 | 1.4 | 1.0 | 5.1 | <0.05 | 0.26 |
| 9/90 | 0.83 | 23.0 | 6.8 | N/A | 6.6 | 1.6 | 2.0 | 4.4 | 0.56 | 0.26 |
| 10/90 | 0.80 | 18.0 | 6.8 | N/A | 6.8 | 2.0 | 21.0 | 4.5 | 0.56 | 0.33 |
| 11/90 | 0.78 | 15.0 | 6.7 | N/A | 7.7 | 3.7 | 98.0 | 4.7 | 0.53 | 0.28 |
| 12/90 | 0.78 | 12.0 | 6.6 | N/A | 8.3 | 4.2 | 1.0 | 4.6 | 0.15 | 0.32 |
| 1/91 | 0.80 | 12.0 | 6.5 | N/A | 8.1 | 5.0 | 54.0 | 4.5 | 0.08 | 0.30 |
| 2/91 | 0.79 | 13.0 | 6.9 | N/A | 8.0 | 5.0 | 33.0 | 4.7 | 0.08 | 0.29 |
| 3/91 | 0.78 | 13.0 | 6.9 | N/A | 8.4 | 5.6 | 85.0 | 4.7 | 0.15 | 0.24 |
| 4/91 | 0.83 | 15.0 | 7.1 | N/A | 7.6 | 4.1 | 9.0 | 4.4 | 0.25 | 0.22 |
| 5/91 | 0.86 | 17.0 | 7.1 | N/A | 7.5 | 3.6 | 36.0 | 3.5 | N/A | 0.23 |
| 6/91 | 0.86 | 19.0 | 7.1 | N/A | 7.4 | 4.3 | 116.0 | 4.8 | 0.30 | 0.23 |
| 7/91 | 0.86 | 22.0 | 6.9 | N/A | 6.4 | 6.5 | >16.5 | 3.9 | 0.10 | 0.19 |
| 8/91 | 0.86 | 23.0 | 7.2 | N/A | 6.8 | 3.9 | 11.0 | 4.4 | 0.60 | 0.22 |
| 9/91 | 1.00 | 21.0 | 7.1 | N/A | 6.4 | 5.5 | 21.0 | 4.4 | 14.50 | 0.38 |
| COEUR D'ALENE WWTP | | | | | | | | | | |
| DATE | FLOW
(MGD) | TEMP.
(C) | pH | TURB.
(NTU) | D.O.
(mg/l) | 5d BOD
(mg/l) | F.C.
(#/100ml) | T.P.
(mg/l) | NH3-N
(mg/l) | RES. CHLOR.
(mg/l) |
| 6/90 | 3.13 | N/A | 6.9 | 6.9 | 4.4 | 9.0 | 1.7 | 5.8 | 20.44 | 0.44 |
| 7/90 | 3.49 | N/A | 7.0 | 7.9 | 2.6 | 18.0 | 7.5 | 5.0 | 21.50 | 0.17 |
| 8/90 | 3.35 | N/A | 6.9 | 7.8 | 2.1 | 23.0 | 32.0 | 4.8 | 23.05 | 0.22 |
| 9/90 | 3.15 | N/A | 6.9 | 6.5 | 3.2 | 15.0 | 1.8 | 5.1 | 21.53 | 0.20 |
| 10/90 | 3.12 | N/A | 7.0 | 12.2 | 4.8 | 13.0 | <1 | 4.7 | 18.57 | 0.23 |
| 11/90 | 3.04 | N/A | 6.9 | 14.0 | 3.5 | 14.0 | 2.6 | 4.6 | 19.64 | 0.04 |
| 12/90 | 3.16 | N/A | 7.0 | 14.7 | 4.3 | 16.0 | 3.9 | 4.9 | 23.00 | 0.25 |
| 1/91 | 3.53 | N/A | 6.9 | 14.0 | 3.2 | 19.0 | 1.0 | 4.7 | 20.58 | 0.10 |
| 2/91 | 3.64 | N/A | 6.8 | 15.2 | 2.6 | 14.0 | 1.1 | 5.1 | 21.87 | 0.06 |
| 3/91 | 2.88 | N/A | N/A | N/A | N/A | 15.8 | N/A | 5.1 | 21.45 | 0.03 |
| 4/91 | 2.88 | N/A | 6.7 | 19.6 | 2.9 | 19.7 | 4072.0 | 4.9 | 24.55 | 0.09 |
| 5/91 | 2.87 | N/A | 6.7 | 16.4 | 2.6 | 15.8 | 1.9 | 4.3 | 22.27 | 0.05 |
| 6/91 | 2.98 | N/A | 6.6 | N/A | 4.9 | 15.7 | 1.1 | 1.2 | 21.39 | 0.03 |
| 7/91 | 3.21 | N/A | 6.4 | N/A | 4.9 | 6.1 | 1.3 | 1.0 | 19.71 | 0.07 |
| 8/91 | 3.34 | N/A | 6.3 | N/A | 4.4 | 7.0 | 7.8 | 0.8 | 19.34 | 0.07 |
| 9/91 | 2.60 | N/A | 6.4 | N/A | 4.3 | 8.2 | 2.1 | 0.9 | 14.21 | 0.05 |

Table 21.

Spokane River Citizen Volunteer Monitoring Program
(CVMP) water quality data, at Cedars, Harbor Island,
and Post Falls Bridge, May 1988 to August, 1991.

| CEDARS | | | | | | | | | | | |
|-------------------|---------------|----------------------|------------------------|------------------------------|---|---------------|--------------|--------------|---------------|--------------------|--------|
| DATE | SECCHI
(m) | MEAN
TEMP.
(C) | MEAN
D.O.
(mg/l) | NH ₃ -N
(mg/l) | NO ₂ + NO ₃
(mg/l) | TKN
(mg/l) | TP
(mg/l) | OP
(mg/l) | EC
(umhos) | CHLOR. a
(ug/l) | N:P |
| 25 MAY 88 | 2.8 | 12.8 | 12.0 | 0.013 | 0.014 | 0.11 | 0.011 | N/A | 52 | N/A | 11.3:1 |
| 27 JUN 88 | 2.8 | 20.5 | 4.0 | 0.014 | 0.008 | 0.13 | 0.009 | 0.001 | 45 | 1.1 | 15.3:1 |
| 19 JUL 88 | 2.8 | 20.5 | 8.0 | 0.050 | 0.018 | 0.05 | 0.008 | 0.001 | 48 | 1.1 | 8.5:1 |
| 23 AUG 88 | 2.6 | 20.0 | 7.5 | 0.007 | 0.020 | 0.09 | 0.009 | 0.002 | 51 | 1.7 | 12.2:1 |
| 27 SEP 88 | 2.5 | 16.0 | 8.0 | 0.018 | 0.020 | 0.12 | 0.007 | 0.002 | 51 | 1.0 | 20.0:1 |
| 18 OCT 88 | N/A | N/A | N/A | 0.007 | 0.012 | 0.13 | 0.008 | 0.001 | 54 | 0.7 | 17.8:1 |
| 02 MAY 89 | 2.0 | 8.0 | 8.0 | 0.020 | 0.005 | 0.18 | 0.013 | 0.001 | N/A | 4.4 | 14.2:1 |
| 13 JUN 89 | 2.8 | 19.0 | 9.0 | 0.071 | 0.022 | 0.03 | 0.013 | 0.003 | N/A | 1.3 | 3.6:1 |
| 18 JUL 89 | 2.8 | 20.0 | 8.0 | 0.020 | 0.002 | 0.14 | 0.008 | 0.002 | N/A | 0.6 | 17.8:1 |
| 28 AUG 89 | 2.6 | 19.0 | 9.0 | 0.018 | 0.001 | 0.12 | 0.007 | 0.001 | N/A | 2.0 | 17.3:1 |
| 11 SEP 89 | 2.6 | 15.0 | 9.0 | 0.042 | 0.001 | 0.11 | 0.008 | 0.003 | N/A | 2.0 | 13.9:1 |
| 10 OCT 89 | 2.2 | 15.0 | 10.0 | 0.093 | 0.042 | 0.18 | 0.008 | 0.003 | N/A | 1.8 | 27.8:1 |
| 12 JUN 90 | 2.5 | 11.0 | 8.0 | 0.003 | 0.003 | 0.08 | 0.009 | 0.001 | N/A | 3.5 | 9.2:1 |
| 24 JUL 90 | 2.8 | 21.0 | 9.0 | 0.005 | 0.003 | 0.12 | 0.010 | 0.001 | N/A | 1.1 | 12.3:1 |
| 28 AUG 90 | 2.8 | 19.0 | 8.0 | 0.114 | 0.003 | 0.07 | 0.007 | 0.001 | N/A | 1.3 | 10.4:1 |
| 16 OCT 90 | 2.3 | 11.5 | 8.5 | 0.094 | 0.007 | 0.25 | 0.014 | 0.001 | N/A | 2.1 | 18.3:1 |
| 02 JUL 91 | N/A | N/A | N/A | 0.033 | 0.005 | 0.37 | 0.006 | 0.002 | N/A | 0.8 | N/A |
| 13 AUG 91 | N/A | N/A | N/A | 0.027 | 0.005 | 0.13 | 0.006 | 0.002 | N/A | 0.5 | N/A |
| HARBOR ISLAND | | | | | | | | | | | |
| DATE | SECCHI
(m) | MEAN
TEMP.
(C) | MEAN
D.O.
(mg/l) | NH ₃ -N
(mg/l) | NO ₂ + NO ₃
(mg/l) | TKN
(mg/l) | TP
(mg/l) | OP
(mg/l) | EC
(umhos) | CHLOR. a
(ug/l) | N:P |
| 25 MAY 88 | 3.3 | 13.3 | 12.0 | 0.011 | 0.019 | 0.14 | 0.014 | 0.001 | 50 | N/A | 11.3:1 |
| 27 JUN 88 | 3.8 | 20.5 | 9.0 | 0.027 | 0.017 | 0.13 | 0.017 | 0.007 | 46 | 1.6 | 8.6:1 |
| 19 JUL 88 | 3.3 | 21.0 | 7.5 | 0.045 | 0.009 | 0.12 | 0.018 | 0.003 | 50 | 1.7 | 7.2:1 |
| 23 AUG 88 | 2.8 | 21.0 | 6.0 | 0.026 | 0.027 | 0.19 | 0.037 | 0.022 | 55 | 6.5 | 5.9:1 |
| 27 SEP 88 | 4.5 | 15.0 | 8.5 | 0.053 | 0.036 | 0.17 | 0.029 | 0.017 | 53 | 0.8 | 7.1:1 |
| 18 OCT 88 | N/A | N/A | N/A | 0.024 | 0.025 | 0.13 | 0.020 | 0.013 | 56 | 0.6 | 7.8:1 |
| 13 JUN 89 | 4.5 | 19.0 | 9.0 | 0.035 | 0.011 | 0.03 | 0.016 | 0.002 | N/A | 1.2 | 2.3:1 |
| 18 JUL 89 | 3.3 | 21.0 | 7.3 | 0.043 | 0.004 | 0.15 | 0.019 | 0.011 | N/A | 1.2 | 8.1:1 |
| 28 AUG 89 | 5.8 | 19.0 | 8.0 | 0.054 | 0.050 | 0.22 | 0.030 | 0.006 | N/A | 3.0 | 9.0:1 |
| 11 SEP 89 | 4.0 | 16.0 | 9.0 | 0.070 | 0.007 | 0.09 | 0.021 | 0.007 | N/A | 3.0 | 4.6:1 |
| 10 OCT 89 | 4.5 | 15.0 | 8.5 | 0.187 | 0.033 | 0.13 | 0.020 | 0.010 | N/A | 1.8 | 8.2:1 |
| 24 JUL 90 | 6.3 | 23.5 | 6.5 | 0.040 | 0.003 | 0.24 | 0.019 | 0.008 | N/A | 1.4 | 12.7:1 |
| 28 AUG 90 | 5.3 | 19.9 | 7.5 | 0.107 | 0.003 | 0.07 | 0.025 | 0.006 | N/A | 3.9 | 2.9:1 |
| 16 OCT 90 | 5.3 | 11.5 | 7.8 | 0.129 | 0.013 | 0.21 | 0.028 | 0.009 | N/A | 1.2 | 8.0:1 |
| 02 JUL 91 | N/A | N/A | N/A | 0.029 | 0.029 | 0.19 | 0.002 | 0.002 | N/A | 1.0 | N/A |
| 13 AUG 91 | N/A | N/A | N/A | 0.045 | 0.010 | 0.30 | 0.006 | 0.003 | N/A | 1.0 | N/A |
| POST FALLS BRIDGE | | | | | | | | | | | |
| DATE | SECCHI
(m) | MEAN
TEMP.
(C) | MEAN
D.O.
(mg/l) | NH ₃ -N
(mg/l) | NO ₂ + NO ₃
(mg/l) | TKN
(mg/l) | TP
(mg/l) | OP
(mg/l) | EC
(umhos) | CHLOR. a
(ug/l) | N:P |
| 25 MAY 88 | 3.3 | 13.7 | 13.0 | 0.013 | 0.017 | 0.14 | 0.014 | N/A | N/A | N/A | 11.2:1 |
| 27 JUN 88 | 3.5 | 20.4 | 5.0 | 0.019 | 0.021 | 0.12 | 0.016 | 0.005 | 48 | 2.6 | 8.8:1 |
| 19 JUL 88 | 2.8 | 21.8 | 9.0 | 0.028 | 0.003 | 0.13 | 0.017 | 0.002 | 50 | 3.4 | 7.8:1 |
| 23 AUG 88 | 4.8 | 22.0 | 9.0 | 0.010 | 0.016 | 0.12 | 0.028 | 0.010 | 55 | 3.1 | 4.9:1 |
| 27 SEP 88 | 4.8 | 15.0 | 8.0 | 0.035 | 0.033 | 0.16 | 0.027 | 0.017 | 54 | 2.4 | 7.1:1 |
| 18 OCT 88 | N/A | N/A | N/A | 0.024 | 0.018 | 0.16 | 0.023 | 0.014 | 56 | 0.9 | 7.7:1 |
| 13 JUN 89 | 3.3 | 19.0 | 7.0 | 0.037 | 0.004 | 0.03 | 0.015 | 0.003 | N/A | 2.4 | 1.9:1 |
| 18 JUL 89 | 3.5 | 21.0 | 6.5 | 0.021 | 0.005 | 0.15 | 0.018 | 0.009 | N/A | 1.7 | 8.6:1 |
| 28 AUG 89 | 5.8 | 19.0 | 8.0 | 0.020 | 0.011 | 0.18 | 0.015 | 0.001 | N/A | 4.0 | 12.7:1 |
| 11 SEP 89 | 3.3 | 17.0 | 9.0 | 0.034 | 0.001 | 0.09 | 0.024 | 0.007 | N/A | 6.0 | 3.8:1 |
| 10 OCT 89 | 4.5 | 15.0 | 8.0 | 0.021 | 0.005 | 0.12 | 0.014 | 0.007 | N/A | 2.6 | 8.9:1 |
| 24 JUL 90 | 5.5 | 23.5 | 6.0 | 0.007 | 0.003 | 0.30 | 0.016 | 0.003 | N/A | | 20.6:1 |
| 28 AUG 90 | 5.5 | 20.0 | 8.0 | 0.038 | 0.003 | 0.07 | 0.017 | 0.003 | N/A | 4.8 | 4.3:1 |
| 16 OCT 90 | 5.3 | 11.1 | 7.8 | 0.098 | 0.013 | 0.25 | 0.019 | 0.007 | N/A | 2.1 | 13.8:1 |
| 02 JUL 91 | N/A | N/A | N/A | 0.050 | 0.008 | 0.55 | 0.007 | 0.002 | N/A | 1.0 | N/A |
| 13 AUG 91 | N/A | N/A | N/A | 0.033 | 0.011 | 0.23 | 0.008 | 0.002 | N/A | 2.1 | N/A |

Table 22.

August 13, 1991, water quality profiles at Cedars, Harbor Island, and Post Falls Bridge, collected by the Spokane River CVMP.

| STATION | DEPTH
(m) | D.O.
(mg/l) | TEMP.
(C) | EC
(umhos) | pH |
|-------------|--------------|----------------|--------------|---------------|-----|
| CEDARS | 0 | 7.3 | 23.3 | 44 | 6.3 |
| CEDARS | 1 | 7.2 | 22.2 | 44 | 6.3 |
| CEDARS | 2 | 7.3 | 22.2 | 44 | 6.4 |
| CEDARS | 2.75 | 7.3 | 22.2 | 44 | 6.4 |
| HARBOR IS. | 0 | 7.4 | 22.7 | 46 | 6.1 |
| HARBOR IS. | 1 | 7.3 | 22.6 | 46 | 6.3 |
| HARBOR IS. | 2 | 7.3 | 22.5 | 46 | 6.3 |
| HARBOR IS. | 3 | 7.0 | 22.5 | 46 | 6.3 |
| HARBOR IS. | 4 | 6.9 | 22.5 | 46 | 6.3 |
| HARBOR IS. | 5 | 6.9 | 22.5 | 46 | 6.3 |
| P.F. BRIDGE | 0 | 7.2 | 22.9 | 46 | 6.2 |
| P.F. BRIDGE | 1 | 7.9 | 22.9 | 46 | 6.4 |
| P.F. BRIDGE | 2 | 7.8 | 22.9 | 46 | 6.4 |
| P.F. BRIDGE | 3 | 7.6 | 22.9 | 46 | 6.4 |
| P.F. BRIDGE | 4 | 7.5 | 22.8 | 46 | 6.3 |
| P.F. BRIDGE | 5 | 7.3 | 22.8 | 45 | 6.4 |
| P.F. BRIDGE | 6 | 7.3 | 22.8 | 45 | 6.4 |
| P.F. BRIDGE | 7 | 7.3 | 22.8 | 45 | 6.4 |
| P.F. BRIDGE | 8 | 7.3 | 22.7 | 45 | 6.4 |
| P.F. BRIDGE | 8.75 | 7.3 | 22.7 | 45 | 6.4 |

APPENDIX A

APPENDIX TABLES A-1...4

Tables of Physical /Chemical Profiles and Diel Study

Table A-1

Temperature (C) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DEPTH | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 18DEC90 | 0 | 6.2 | 6.0 | 5.8 | 6.1 | 6.0 | 6.0 | 6.0 | 5.8 | 5.8 | 5.8 | 5.7 | 5.8 | 5.7 | 5.8 | 5.4 | 5.4 | 5.3 |
| | 1 | 6.2 | 6.0 | 6.1 | 6.2 | 6.0 | 6.1 | 6.0 | 5.8 | 5.8 | 5.8 | 5.7 | 5.7 | 5.7 | 5.8 | 5.4 | 5.3 | 5.3 |
| | 2 | 6.2 | 6.0 | (1.2)6.1 | 6.3 | 6.2 | 6.0 | 6.1 | (1.6)5.7 | 3.8 | 5.8 | 5.7 | 5.7 | 5.7 | 5.8 | (1.3)5.3 | (1.6)5.3 | (1.1)5.3 |
| | 3 | (2.4)6.2 | (2.6)6 | | 6.2 | (2.3)6 | 6.1 | 6.1 | | 5.9 | 5.8 | (2.2)5.7 | 5.7 | 5.7 | 5.8 | | | |
| | 4 | | | | (3.8)6.2 | | 6.1 | 6.1 | | 5.9 | 5.8 | | 5.7 | 5.7 | | | | |
| | 5 | | | | | | 6.1 | 6.1 | | 5.8 | 5.9 | | 5.7 | 5.7 | | | | |
| | 6 | | | | | | (5.3)6.1 | (5.5)6.1 | | 5.8 | 5.9 | | 5.8 | 5.8 | | | | |
| | 7 | | | | | | | | | 5.9 | 5.9 | | 5.7 | 5.7 | | | | |
| | 8 | | | | | | | | | 5.9 | (7.7)5.9 | | 5.8 | | | | | |
| | 9 | | | | | | | | | (6.7)5.9 | | | (6.5)5.7 | | | | | |
| 15JAN91 | 0 | 3.3 | 3.3 | 3.5 | 3.1 | 3.4 | 3.0 | 3.1 | 3.1 | 3.0 | 3.0 | 3.1 | 2.8 | 3.0 | 2.9 | 2.1 | 2.0 | 2.0 |
| | 1 | 3.3 | 3.3 | (0.9)3.4 | 3.4 | 3.4 | 3.4 | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 2.7 | 2.9 | 2.9 | 2.1 | 2.0 | 1.9 |
| | 2 | (1.8)3.4 | (1.9)3.3 | | 3.3 | 3.4 | 3.4 | 3.0 | (1.7)3.1 | (1.6)3 | 3.0 | (1.6)3 | 2.7 | 2.9 | (1.8)2.9 | (1.9)2.1 | 2.0 | (1.3)1.9 |
| | 3 | | | | (2.4)3.3 | 3.4 | (2.8)3.4 | 3.0 | | 2.9 | 3.0 | | 2.7 | (2.4)2.9 | | (2.3)2.1 | | |
| | 4 | | | | | | | 3.1 | | 2.9 | 3.0 | | 2.7 | | | | | |
| | 5 | | | | | | (4.7)3 | (4.1)3.1 | | 2.8 | (4.2)3 | | 2.7 | | | | | |
| | 6 | | | | | | | | | 2.9 | | | 2.7 | | | | | |
| | 7 | | | | | | | | | 2.8 | | | 2.7 | | | | | |
| | 8 | | | | | | | | | 2.9 | | | (7.2)2.7 | | | | | |
| | | | | | | | | | | (8.8)2.9 | | | | | | | | |
| 12FEB91 | 0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.4 | 2.2 | 2.1 | 2.1 | 2.2 | 2.2 | 2.1 | 2.1 | 2.2 | 1.9 | 1.9 | 1.9 |
| | 1 | 2.1 | 2.1 | 2.2 | 2.2 | 2.1 | 2.5 | 2.1 | 2.2 | 2.1 | 2.1 | 2.2 | 2.0 | 2.1 | 2.2 | 1.9 | 1.9 | 1.8 |
| | 2 | 2.1 | 2.1 | (1.2)2.2 | 2.2 | 2.4 | | 2.1 | 2.2 | (1.2)2.1 | 2.1 | (1.5)2.2 | 2.0 | 2.1 | 2.2 | (1.1)1.9 | 1.9 | (1.5)1.9 |
| | 3 | | | | (2.6)2.2 | (2.6)2.2 | (2.6)2.5 | 2.1 | 2.1 | | 2.1 | | 2.0 | 2.1 | | (2.1)1.9 | | |
| | 4 | | | | | | | 2.1 | 2.1 | | 2.1 | | 2.0 | 2.1 | | | | |
| | 5 | | | | | | (4.8)2.1 | (4.2)2.1 | | 2.0 | 2.1 | | 1.9 | | | | | |
| | 6 | | | | | | | | | 2.0 | 2.1 | | 1.9 | | | | | |
| | 7 | | | | | | | | | 2.0 | 2.2 | | 1.9 | | | | | |
| | 8 | | | | | | | | | 2.0 | (7.1)2.2 | | (7.3)1.9 | | | | | |
| 12MAR91 | 0 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 | 2.2 | 2.2 |
| | 1 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 | 2.2 | 2.2 | 2.1 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 |
| | 2 | 2.3 | 2.2 | (1.2)2.2 | 2.2 | 2.2 | (1.5)2.2 | 2.1 | 2.1 | (1.4)2.2 | 2.2 | (1.2)2.2 | 2.2 | 2.2 | (1.7)2.2 | 2.1 | 2.2 | (1.9)2.2 |
| | 3 | (2.1)2.3 | (2.2)2.2 | | (2.2)2.2 | (2.6)2.2 | | 2.2 | (3.1)2.1 | | 2.2 | | 2.2 | (2.6)2.2 | | (2.1)2.1 | 2.2 | (2.6)2.2 |
| | 4 | | | | | | | 2.2 | | | 2.2 | (4.2)2.2 | 2.2 | | | | | |
| | 5 | | | | | | (4.2)2.2 | | | | 2.2 | | 2.2 | | | | | |
| | 6 | | | | | | | | | | 2.2 | | 2.2 | | | | | |
| | 7 | | | | | | | | | | 2.2 | | 2.2 | | | | | |
| | 8 | | | | | | | | | | 2.2 | | 2.2 | | | | | |
| | | | | | | | | | | (6.1)2.2 | | | | | | | | |
| 9APR91 | 0 | 3.8 | 3.7 | 3.8 | 3.9 | 3.8 | 3.9 | 4.0 | 4.0 | 4.0 | 3.9 | 3.9 | 3.8 | 3.8 | 3.8 | 3.9 | 3.9 | 3.8 |
| | 1 | 3.8 | 3.7 | 3.8 | 3.9 | 3.9 | 3.9 | 4.0 | 4.0 | 4.0 | 3.9 | 3.9 | 3.8 | 3.8 | 3.8 | 3.9 | 3.9 | 3.8 |
| | 2 | 3.7 | 3.7 | (1.7)3.8 | 3.8 | 3.9 | (1.4)3.8 | 4.0 | 4.0 | (1.5)4 | 3.9 | (1.8)3.9 | 3.8 | 3.8 | (1.6)3.8 | 3.9 | 3.9 | (1.9)3.8 |
| | 3 | (2.1)3.7 | | | 3.9 | 3.9 | | 4.0 | 4.0 | | 3.9 | 3.9 | 3.8 | (2.2)3.8 | | (2.1)3.9 | (2.5)3.9 | |
| | 4 | | | | (3.2)3.8 | (3.4)3.8 | | 3.9 | 4.0 | | 3.9 | 3.9 | 3.8 | | | | | |
| | 5 | | | | | | | 3.9 | | | 3.9 | 3.9 | 3.8 | | | | | |
| | 6 | | | | | | (5.4)3.9 | | | | 3.9 | 3.9 | 3.8 | | | | | |
| | 7 | | | | | | | | | | 3.9 | 3.9 | 3.8 | | | | | |
| | 8 | | | | | | | | | | (6.6)3.9 | | | | | | | |

Table A-1 (continued) Temperature (C) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DEPTH | | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| DATE | (m) | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 8MAY91 | 0 | 8.2 | 8.2 | 8.3 | 8.3 | 8.3 | 8.3 | 8.8 | 8.8 | 8.8 | 9.0 | 8.9 | 8.9 | 8.8 | 8.8 | 8.8 | 9.0 | 8.9 | 8.8 |
| | 1 | 8.2 | 8.2 | 8.3 | 8.4 | 8.3 | 8.4 | 8.8 | 8.7 | 8.6 | 9.0 | 9.0 | 9.0 | 8.8 | 8.8 | 8.8 | 8.9 | 8.9 | 8.8 |
| | 2 | 8.2 | 8.3 | (1.2)8.3 | 8.4 | 8.3 | 8.4 | 8.9 | 8.7 | (1.8)8.6 | 9.0 | 9.0 | 9.0 | 8.9 | 8.9 | (1.4)8.9 | 8.9 | 8.9 | (1.9)8.9 |
| | 3 | (2.8)8.2 | 8.3 | | (2.4)8.4 | 8.3 | (2.9)8.4 | 8.9 | 8.6 | | 9.0 | 9.0 | 9.0 | 8.9 | (2.9)8.8 | | (2.1)8.9 | (2.8)8.9 | |
| | 4 | | (3.2)8.3 | | | 8.3 | | (3.8)8.9 | 8.7 | | 9.0 | (3.9)9 | | 8.8 | | | | | |
| | 5 | | | | | 8.3 | | | 8.7 | | 9.0 | | | 8.9 | | | | | |
| | 6 | | | | | | | (5.1)8.7 | | | 9.0 | | | (5.1)8.9 | | | | | |
| | 7 | | | | | | | | | | 9.0 | | | | | | | | |
| | 8 | | | | | | | | | | 9.0 | | | | | | | | |
| | 9 | | | | | | | | | | 9.0 | | | | | | | | |
| | 10 | | | | | | | | | | 9.0 | | | | | | | | |
| 21MAY91 | 0 | 10.3 | 10.3 | 10.1 | 10.7 | 10.5 | 10.6 | 10.5 | 10.5 | 10.4 | 10.5 | 10.5 | 10.3 | 10.8 | 10.5 | 9.8 | 9.3 | 9.3 | 9.3 |
| | 1 | 10.3 | 10.3 | 10.1 | 10.7 | 10.5 | 10.6 | 10.5 | 10.5 | 10.4 | 10.5 | 10.5 | 10.3 | 10.8 | 10.5 | 9.9 | 9.3 | 9.3 | 9.4 |
| | 2 | 10.3 | 10.3 | 10.2 | 10.8 | 10.5 | 10.6 | 10.4 | 10.5 | 10.4 | 10.5 | 10.4 | 10.3 | 10.8 | 10.5 | 10.0 | 9.3 | 9.3 | 9.4 |
| | 3 | 10.2 | 10.3 | | 10.6 | 10.5 | (2.9)10.6 | 10.4 | 10.5 | 10.4 | 10.5 | 10.4 | (2.8)10.3 | 10.8 | 10.4 | (2.3)10 | (2.9)9.3 | 9.3 | (2.2)9.3 |
| | 4 | (3.8)10.2 | 10.2 | (3.4)10.1 | 10.6 | 10.5 | | 10.5 | 10.5 | (3.8)10.4 | 10.5 | 10.4 | | 10.8 | (3.2)10.4 | | (3.1)9.3 | | |
| | 5 | | | | (4.2)10.8 | (4.8)10.5 | | 10.5 | (4.8)10.4 | | 10.5 | 10.4 | | 10.8 | | | | | |
| | 6 | | | | | | | 10.5 | | | 10.5 | 10.4 | | 10.8 | | | | | |
| | 7 | | | | | | | 10.5 | | | 10.8 | (6.4)10.3 | | 10.8 | | | | | |
| | 8 | | | | | | | 10.5 | | | 10.5 | | | 10.8 | | | | | |
| | 9 | | | | | | | 10.6 | | | 10.6 | | | 10.8 | | | | | |
| | 10 | | | | | | | 10.6 | | | 10.6 | | | (8.1)10.6 | | | | | |
| 4JUN91 | 0 | 12.3 | 12.3 | 12.5 | 12.8 | 12.4 | 12.5 | 12.8 | 12.7 | 13.1 | (10.8)10.7 | 14.4 | 12.7 | 12.2 | 12.7 | 12.8 | 12.3 | 12.2 | 12.1 |
| | 1 | 12.3 | 11.9 | 12.5 | 12.8 | 12.5 | 12.3 | 12.7 | 12.6 | 13.0 | 12.8 | 14.3 | 12.8 | 12.2 | 12.6 | 12.8 | 12.3 | 12.2 | 12.1 |
| | 2 | 12.3 | 11.9 | (1.8)12.5 | 12.8 | 12.5 | 12.6 | 12.8 | 12.7 | 13.0 | 12.8 | 14.3 | 12.8 | 12.2 | 12.6 | (1.5)12.3 | (1.5)12.3 | 12.3 | (1.7)12.1 |
| | 3 | 12.3 | 11.9 | | 12.7 | 12.5 | 12.6 | 12.8 | 12.7 | 13.1 | 12.7 | 14.3 | (2.3)12.8 | 12.2 | 12.8 | (2.8)12.8 | | (2.2)12.2 | |
| | 4 | | | | (3.2)12.7 | (3.8)12.5 | | 12.8 | 12.8 | (3.8)13 | 12.7 | 14.3 | | 12.2 | 12.6 | | | | |
| | 5 | | | | | | | 12.8 | 12.6 | | 12.8 | 14.3 | | 12.2 | | | | | |
| | 6 | | | | | | | (5.5)12.8 | (5.5)12.7 | | 12.8 | 14.3 | | 12.2 | | | | | |
| | 7 | | | | | | | | | | 12.8 | 14.4 | | 12.2 | | | | | |
| | 8 | | | | | | | | | | 12.8 | 14.4 | | 12.2 | | | | | |
| | 9 | | | | | | | | | | 12.8 | 14.4 | | 12.2 | | | | | |
| | 10 | | | | | | | | | | 12.8 | | | 12.2 | | | | | |
| 16JUN91 | 0 | 13.3 | 13.2 | 13.2 | 13.6 | 13.3 | 13.7 | 13.9 | 13.9 | 14.1 | (10.8)12.8 | 13.9 | 13.8 | 13.7 | 13.8 | 13.9 | 15.0 | 15.1 | 15.4 |
| | 1 | 13.2 | 13.2 | 13.2 | 13.5 | 13.2 | 13.6 | 13.9 | 13.8 | 14.0 | 13.7 | 13.9 | 13.8 | 13.4 | 13.6 | 13.9 | (9.9)15 | 15.1 | 15.4 |
| | 2 | 13.2 | 13.1 | 13.2 | 13.5 | 13.2 | 13.4 | 13.9 | 13.8 | 14.0 | 13.6 | 13.8 | 13.8 | 13.3 | 13.5 | 13.7 | 15.1 | 15.1 | (1.2)15.4 |
| | 3 | (2.8)13.1 | 13.1 | (2.8)13.1 | 13.5 | 13.2 | 13.3 | 13.9 | 13.7 | 14.1 | 13.6 | 13.8 | 13.8 | 13.3 | 13.5 | 13.5 | | (2.1)15.1 | |
| | 4 | | (3.1)13.1 | | (3.2)13.5 | 13.1 | (3.2)13.3 | 13.8 | 13.7 | (3.1)14.1 | 13.5 | 13.8 | (3.1)13.9 | 13.3 | 13.5 | (3.5)13.5 | | | |
| | 5 | | | | | (4.5)13.1 | | 13.8 | 13.7 | | 13.5 | 13.9 | | 13.3 | (4.1)13.5 | | | | |
| | 6 | | | | | | | 13.8 | 13.7 | | 13.5 | 15.8 | | 13.3 | | | | | |
| | 7 | | | | | | | (8.2)13.7 | | | 13.4 | 13.8 | | 13.3 | | | | | |
| | 8 | | | | | | | | | | 13.5 | 13.8 | | 13.3 | | | | | |
| | 9 | | | | | | | | | | 13.4 | 13.8 | | 13.3 | | | | | |
| | 10 | | | | | | | | | | (9.3)13.4 | (9.2)13.8 | | | | | | | |

Table A-1 (continued) Temperature (C) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH (m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|-----------|-----------|-----------|-----------|-----------|-----------|------|-----------|-----------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 2 JUL 91 | 0 | 18.0 | 17.8 | 17.6 | 17.8 | 17.4 | 17.7 | 17.3 | 17.1 | 17.3 | 17.3 | 17.0 | 16.9 | 17.8 | 17.6 | 17.6 | 16.8 | 16.8 | 16.7 |
| | 1 | 18.0 | 17.7 | 17.5 | 17.8 | 17.3 | 17.7 | 17.2 | 17.1 | 17.3 | 17.2 | 17.0 | 16.9 | 17.5 | 17.5 | 17.4 | 16.8 | 16.8 | 16.7 |
| | 2 | 18.0 | 17.5 | 17.5 | 17.8 | 17.3 | 17.6 | 17.2 | 17.3 | 17.3 | 17.2 | 16.9 | 16.9 | 17.3 | 17.3 | 17.2 | 16.8 | (1.4)16.8 | (1.1)16.7 |
| | 3 | 17.9 | 17.3 | (1.9)17.5 | 17.7 | 17.2 | 17.6 | 17.2 | 17.2 | 17.4 | 17.1 | 16.9 | 16.8 | 17.4 | 17.3 | 17.2 | 16.8 | | |
| | 4 | | (3.1)17.3 | | (3.5)17.7 | 17.2 | 17.5 | 17.2 | 17.2 | (3.1)17.4 | 17.1 | 16.9 | 16.8 | 17.3 | 17.3 | (3.5)17 | | | |
| | 5 | | | | (4.2)17.2 | | | 17.2 | 17.2 | | 17.0 | 16.9 | | 17.3 | (4.2)17.3 | | | | |
| | 6 | | | | | | | 17.3 | 17.2 | | 17.0 | 16.9 | | 17.3 | | | | | |
| | 7 | | | | | | | (6.1)17.3 | (6.2)17.2 | | 17.0 | 16.9 | | 17.2 | | | | | |
| | 8 | | | | | | | | | | 16.9 | 16.9 | | 17.2 | | | | | |
| | 9 | | | | | | | | | | 16.8 | (6.4)16.9 | | 17.2 | | | | | |
| 16 JUL 91 | 0 | 20.6 | 20.8 | 20.6 | 20.3 | 20.5 | 20.9 | 20.4 | 20.3 | 20.4 | 20.2 | 20.6 | 20.7 | 20.7 | 20.8 | 20.7 | 21.1 | 21.0 | 20.9 |
| | 1 | 20.7 | 20.7 | 20.6 | 20.3 | 20.5 | 20.9 | 20.3 | 20.3 | 20.4 | 20.2 | 20.6 | 20.8 | 20.7 | 20.8 | 20.7 | 21.1 | 21.0 | 20.9 |
| | 2 | 20.6 | 20.7 | 20.6 | 20.3 | 20.6 | 20.9 | 20.3 | 20.3 | 20.4 | 20.1 | 20.5 | 20.8 | 20.7 | 20.7 | 20.7 | (1.9)21.1 | (1.4)21 | (1.1)20.9 |
| | 3 | 20.7 | 20.7 | | 20.3 | 20.6 | 20.8 | 20.3 | 20.3 | (2.6)20.4 | 20.1 | 20.5 | 20.8 | 20.6 | 20.7 | 20.8 | | | |
| | 4 | | | | (3.5)20.3 | 20.6 | (3.6)20.9 | 20.3 | 20.3 | | 20.1 | 20.5 | (3.2)20.6 | 20.7 | 20.6 | (3.8)20.5 | | | |
| | 5 | | | | (4.3)20.6 | | | 20.3 | 20.3 | | 20.1 | 20.5 | | 20.6 | (4.3)20.6 | | | | |
| | 6 | | | | | | | 20.3 | 20.3 | | 20.1 | 20.5 | | 20.6 | | | | | |
| | 7 | | | | | | | (6.2)20.3 | | | 20.1 | 20.5 | | 20.6 | | | | | |
| | 8 | | | | | | | | | | 20.1 | 20.5 | | 20.6 | | | | | |
| 30 JUL 91 | 0 | 22.1 | 22.3 | 22.1 | 21.7 | 21.8 | 22.1 | 22.3 | 21.6 | 22.7 | 22.4 | 22.6 | 22.4 | 22.9 | 22.9 | 23.3 | 22.7 | 22.4 | 22.2 |
| | 1 | 22.0 | 22.1 | 22.0 | 21.5 | 21.8 | 22.0 | 22.1 | 21.5 | 22.3 | 22.3 | 22.5 | 22.3 | 22.7 | 22.9 | 23.1 | 22.7 | 22.3 | (0.5)22.2 |
| | 2 | 21.9 | 22.0 | (1.9)21.9 | 21.5 | 21.8 | 22.0 | 22.0 | 21.4 | 21.9 | 22.3 | 22.4 | 22.2 | 22.5 | 22.7 | 22.7 | (1.3)22.8 | (1.1)22.4 | |
| | 3 | 21.8 | 21.9 | | 21.5 | 21.7 | 22.0 | 21.8 | 21.3 | 21.8 | 22.1 | 22.3 | 22.1 | 22.3 | 22.3 | 22.4 | | | |
| | 4 | | (3.2)21.9 | | (3.4)21.4 | 21.7 | (3.3)21.9 | 21.7 | 21.3 | (3.6)21.7 | 21.9 | 22.0 | (3.4)21.9 | 22.2 | 22.2 | (3.8)22.3 | | | |
| | 5 | | | | (4.8)21.7 | | | 21.7 | 21.3 | | 21.7 | 21.9 | | 22.2 | (4.5)22.2 | | | | |
| | 6 | | | | | | | (5.9)21.6 | 21.2 | | 21.7 | 21.9 | | 22.2 | | | | | |
| | 7 | | | | | | | | (6.6)21.2 | | 21.6 | 21.8 | | 22.1 | | | | | |
| | 8 | | | | | | | | | | 21.6 | 21.8 | | 22.1 | | | | | |
| | 9 | | | | | | | | | | 21.5 | (6.2)21.8 | | 22.0 | | | | | |
| 13 AUG 91 | 0 | 22.5 | 22.5 | 22.6 | 22.3 | 22.3 | 22.2 | 22.6 | 22.6 | 22.7 | (10.5)21.4 | 22.7 | 22.6 | 23.0 | 23.0 | 23.1 | 23.0 | 23.1 | 23.1 |
| | 1 | 22.6 | 22.4 | 22.7 | 22.2 | 22.2 | 22.2 | 22.7 | 22.8 | 22.6 | 22.6 | 22.6 | 22.6 | 23.0 | 23.0 | 23.0 | 23.0 | 23.1 | 23.1 |
| | 2 | 22.4 | 22.4 | | 22.2 | 22.2 | 22.1 | 22.7 | 22.7 | 22.6 | 22.5 | 22.6 | 22.6 | 23.0 | 22.9 | 22.9 | (1.9)23 | 23.1 | (1.4)23.1 |
| | 3 | (2.6)22.5 | 22.4 | (2.1)22.5 | 22.2 | 22.2 | 22.1 | 22.6 | 22.6 | (2.2)22.6 | 22.5 | 22.6 | 22.6 | 22.9 | 22.8 | 22.8 | | (2.1)23.1 | |
| | 4 | | | | (3.2)22.2 | 22.2 | | 22.6 | 22.6 | | 22.5 | 22.6 | (3.3)22.5 | 22.8 | 22.8 | (3.2)22.8 | | | |
| | 5 | | | | (4.2)22.2 | | | 22.6 | 22.7 | | 22.5 | 22.5 | | 22.8 | (4.1)22.8 | | | | |
| | 6 | | | | | | | (5.3)22.6 | 22.8 | | 22.5 | 22.4 | | 22.8 | | | | | |
| | 7 | | | | | | | | (6.4)22.6 | | 22.5 | 22.3 | | 22.7 | | | | | |
| | 8 | | | | | | | | | | 22.4 | 22.3 | | 22.7 | | | | | |
| | 9 | | | | | | | | | | 22.4 | 22.3 | | 22.6 | | | | | |
| | 10 | | | | | | | | | | 22.4 | (6.5)22.3 | | (6.3)22.6 | | | | | |

Table A-1 (continued)

Temperature (C) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DEPTH | | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----|-----------|-----------|-----------|-----------|---------|-----------|----------|-----------|-----------|------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| DATE | (m) | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 27AUG91 | 0 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 26.3 | 26.3 | 26.2 | 26.2 | 26.4 | 26.7 | 26.2 | 26.3 | 26.3 |
| | 1 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.1 | 25.1 | 25.2 | 25.6 | 26.2 | 26.3 | 26.2 | 26.2 | 26.3 | 26.7 | 26.3 | 26.3 | 26.4 |
| | 2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.1 | 25.1 | 25.2 | 25.5 | 26.2 | 26.3 | 26.2 | 26.2 | 26.3 | 26.4 | (1.8)26.3 | 26.2 | (1.8)26.4 |
| | 3 | (2.9)25.3 | 25.3 | (2.7)25.2 | 25.1 | 25.1 | 25.1 | 25.0 | 25.1 | 25.4 | 26.0 | 26.2 | 26.0 | 26.0 | 26.2 | 26.3 | 26.3 | (2.1)26.2 | |
| | 4 | | | | (3.6)25.1 | 25.1 | (3.2)25.1 | 24.9 | 25.1 | 25.2 | 25.9 | 26.2 | 25.9 | 25.9 | 26.1 | (3.4)26.2 | | | |
| | 5 | | | | (4.3)25.1 | 25.1 | | 24.6 | 25.0 | | 25.9 | 26.1 | 25.9 | (4.1)26.1 | | | | | |
| | 6 | | | | | | | 24.6 | 24.9 | | 25.6 | 26.0 | 25.7 | | | | | | |
| | 7 | | | | | | | 24.6 | (6.3)24.6 | | 25.8 | 25.9 | 25.7 | | | | | | |
| | 8 | | | | | | | | | | 25.8 | (7.3)25.9 | 25.6 | | | | | | |
| | 9 | | | | | | | | | | 25.8 | | 25.6 | | | | | | |
| | 10 | | | | | | | | | | 25.3 | | 25.6 | | | | | | |
| 10SEP91 | 0 | 19.6 | 20.0 | 20.1 | 20.4 | 20.5 | 19.3 | 20.5 | 20.2 | 20.4 | (10.9)24.8 | 20.8 | 21.0 | 21.4 | 21.0 | 21.6 | 20.6 | 20.7 | 20.6 |
| | 1 | 19.5 | 20.0 | 20.1 | 20.1 | 20.3 | 18.7 | 20.3 | 20.0 | 20.2 | | 20.7 | 20.8 | 21.0 | 20.7 | 21.0 | 20.6 | 20.6 | 20.6 |
| | 2 | 19.4 | 19.8 | 19.9 | 19.8 | 20.0 | 19.9 | 20.0 | 19.8 | 19.8 | | 20.4 | 20.3 | 20.6 | 20.6 | 20.4 | (1.4)20.6 | 20.6 | (1.3)20.7 |
| | 3 | (2.9)19.4 | 19.7 | | 19.7 | 19.8 | 19.9 | 19.8 | 19.7 | 19.8 | | 20.2 | 20.2 | 20.2 | 20.4 | 20.4 | | 20.6 | |
| | 4 | | (3.2)19.7 | | (3.5)19.2 | 20.0 | (3.7)19.9 | 19.7 | 19.6 | (3.2)19.8 | | 20.0 | 20.2 | 20.4 | 20.4 | (3.6)20.4 | | (2.1)20.5 | |
| | 5 | | | | | (4.4)20 | | 19.6 | 19.6 | | | 19.9 | (3.2)20.2 | 20.3 | 20.4 | | | | |
| | 6 | | | | | | | 19.6 | 19.6 | | | 19.8 | | 20.3 | (4.9)20.4 | | | | |
| | 7 | | | | | | | 19.5 | (6.7)19.6 | | | 19.8 | | 20.2 | | | | | |
| | 8 | | | | | | | 19.5 | | | | 19.8 | | 20.1 | | | | | |
| | 9 | | | | | | | 19.8 | | | | (6.8)19.7 | | 20.0 | | | | | |
| | 10 | | | | | | | 19.9 | | | | 19.9 | (10.5)19.9 | (9.3)20 | | | | | |
| 24SEP91 | 0 | 18.2 | 18.0 | 18.0 | 17.5 | 17.3 | 17.8 | 17.3 | 17.3 | 17.1 | | 17.7 | 17.6 | 17.2 | 17.2 | 17.8 | 17.8 | 17.9 | 17.8 |
| | 1 | 18.2 | 17.9 | 18.0 | 17.4 | 17.3 | 17.6 | 17.3 | 17.3 | 17.0 | | 17.5 | 17.4 | 16.9 | 17.0 | 17.7 | 17.8 | 17.9 | 17.8 |
| | 2 | | 17.8 | 17.8 | 17.4 | 17.2 | 17.5 | 17.2 | 17.3 | 17.0 | | 17.3 | 17.2 | 16.7 | 16.8 | 16.8 | (1.8)17.9 | (1.8)17.8 | |
| | 3 | (2.3)18 | (2.9)17.7 | (2.2)17.8 | 17.4 | 17.1 | 17.4 | 17.2 | 17.2 | 17.0 | | 17.1 | 17.0 | 16.6 | 16.7 | 16.7 | | | |
| | 4 | | | | (3.3)17.4 | 17.1 | (3.1)17.4 | 17.1 | 17.1 | (3.1)17 | | 16.8 | (3.2)16.8 | 16.4 | 16.6 | (3.2)16.7 | | | |
| | 5 | | | | (4.1)17.1 | 17.1 | | 17.1 | 17.1 | | | 16.8 | | 16.4 | (4.1)16.5 | | | | |
| | 6 | | | | | | | (5.8)17 | 17.0 | | | 16.8 | | 16.3 | | | | | |
| | 7 | | | | | | | | | | | 16.7 | | 16.3 | | | | | |
| | 8 | | | | | | | | | | | 16.4 | | 16.3 | | | | | |
| | 9 | | | | | | | | | | | (6.1)16.6 | | 16.3 | | | | | |
| | 10 | | | | | | | | | | | 16.3 | (10.1)16.3 | (6.9)16.3 | | | | | |

Table A-2 Dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH (m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 18DEC80 | 0 | 10.5 | 10.6 | 10.5 | 10.6 | 10.5 | 10.8 | 10.4 | 10.4 | 10.6 | 10.7 | 10.6 | 10.7 | 10.4 | 10.5 | 10.5 | 10.5 | 12.4 | 12.4 |
| | 1 | 10.5 | 10.6 | 10.5 | 10.5 | 10.5 | 10.7 | 10.4 | 10.7 | 10.7 | 10.6 | 10.6 | 10.7 | 10.3 | 10.5 | 10.5 | 10.5 | 12.4 | 12.4 |
| | 2 | 10.8 | 10.6 | (1.2)10.7 | 10.5 | 10.5 | 10.6 | 10.4 | 10.7 | (1.6)10.8 | 10.6 | 10.6 | 10.6 | 10.4 | 10.5 | 10.3 | 10.5 | (1.1)12.4 | (1.8)12.4 |
| | 3 | (2.4)10.6 | (2.8)10.7 | | 10.6 | 10.5 | (2.3)10.7 | 10.3 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | (2.2)10.5 | 10.5 | 10.0 | 10.8 | | |
| | 4 | | | | (3.8)10.6 | | | 10.3 | 10.6 | | 10.6 | 10.6 | 10.6 | 10.4 | 10.4 | 10.1 | | | |
| | 5 | | | | | | | 10.3 | 10.6 | | 10.5 | 10.5 | 10.5 | 10.4 | 10.4 | | | | |
| | 6 | | | | | | | (5.3)10.4 | (5.5)10.7 | | 10.5 | 10.5 | 10.5 | 10.3 | 10.3 | | | | |
| | 7 | | | | | | | | | | 10.5 | 10.5 | 10.5 | 10.3 | 10.3 | | | | |
| | 8 | | | | | | | | | | 10.4 | (7.7)10.5 | 10.3 | 10.3 | 10.3 | | | | |
| | 9 | | | | | | | | | | 10.4 | | (8.5)10.4 | | | | | | |
| 15JAN81 | 0 | 12.1 | 12.0 | 11.8 | 11.9 | 11.9 | 11.7 | 11.6 | 11.8 | 11.8 | 11.5 | 11.4 | 11.6 | 11.4 | 11.8 | 11.4 | 11.4 | 12.7 | 12.8 |
| | 1 | 12.1 | 12.0 | (9)11.9 | 11.9 | 11.9 | 11.8 | 11.6 | 11.8 | 11.8 | 11.5 | 11.4 | 11.7 | 11.4 | 11.7 | 11.4 | 11.4 | 12.7 | 12.7 |
| | 2 | (1.8)12.2 | (1.9)12.1 | | 11.9 | 11.9 | 11.6 | 11.5 | 11.7 | (1.7)11.9 | 11.5 | 11.4 | (1.6)11.8 | 11.4 | 12.3 | 12.3 | (1.9)12.8 | 12.8 | (1.3)12.8 |
| | 3 | | | | (2.4)12 | 12.1 | (2.8)11.7 | 11.4 | 11.7 | | 11.5 | 11.3 | 11.4 | 11.4 | (2.4)12.3 | | | (2.3)12.8 | |
| | 4 | | | | | | | 11.4 | 11.7 | | 11.5 | 11.3 | 11.3 | 11.3 | | | | | |
| | 5 | | | | | | | (4.7)11.6 | (4.1)11.8 | | 11.5 | (4.2)11.5 | 11.3 | 11.3 | | | | | |
| | 6 | | | | | | | | | | 11.4 | 11.4 | 11.4 | 11.3 | | | | | |
| | 7 | | | | | | | | | | 11.4 | 11.4 | 11.0 | | | | | | |
| | 8 | | | | | | | | | | 11.3 | | (7.2)11 | | | | | | |
| 12FEB81 | 0 | 12.6 | 12.5 | 12.6 | 13.0 | 12.8 | 13.0 | 12.8 | 13.0 | 12.9 | 12.8 | 12.8 | 12.9 | 12.5 | 12.5 | 12.8 | 12.9 | 12.9 | 12.8 |
| | 1 | 12.6 | 12.5 | 12.6 | 13.0 | 12.6 | 12.9 | 12.7 | 12.9 | 12.9 | 12.7 | 12.8 | 13.0 | 12.4 | 12.4 | 12.4 | 12.8 | 12.9 | 12.8 |
| | 2 | 12.7 | 12.5 | (1.2)12.7 | 3.0 | 12.6 | 12.9 | 12.7 | 12.8 | (1.2)12.9 | 12.7 | 12.8 | (1.5)12.8 | 12.4 | 12.3 | 12.3 | (1.1)12.9 | 12.9 | (1.5)12.8 |
| | 3 | | | | (2.8)13 | (2.8)12.7 | (2.8)13.1 | 12.6 | 12.8 | | 12.7 | 12.7 | 12.7 | 12.4 | 12.3 | | | (2.1)12.9 | |
| | 4 | | | | | | | 12.6 | 12.7 | | 12.7 | 12.7 | 12.7 | 12.4 | 12.3 | | | | |
| | 5 | | | | | | | (4.8)12.7 | (4.2)12.8 | | 12.7 | 12.7 | 12.4 | 12.4 | | | | | |
| | 6 | | | | | | | | | | 12.6 | 12.7 | 12.4 | 12.4 | | | | | |
| | 7 | | | | | | | | | | 12.7 | 12.7 | 12.4 | 12.4 | | | | | |
| | 8 | | | | | | | | | | 12.7 | (7.1)12.7 | (7.3)12.4 | | | | | | |
| 12MAR81 | 0 | 12.7 | 12.8 | 12.8 | 12.9 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.7 | 12.7 | 12.8 | 12.7 | 12.8 | 12.7 | 13.1 | 13.0 | 13.2 |
| | 1 | 12.7 | 12.8 | 12.8 | 12.8 | 12.7 | 12.8 | 12.8 | 12.8 | 12.7 | 12.7 | 12.8 | 12.8 | 12.7 | 12.8 | 12.7 | 13.1 | 13.0 | 13.2 |
| | 2 | 12.8 | 12.8 | (1.2)12.8 | 12.8 | 12.8 | (1.5)12.8 | 12.8 | 12.8 | (1.4)12.8 | 12.7 | 12.8 | (1.2)12.8 | 12.7 | 12.8 | 12.7 | 13.0 | 13.0 | (1.9)13.1 |
| | 3 | (2.1)12.7 | (2.2)12.9 | | (2.2)12.8 | (2.8)12.7 | | 12.8 | (3.1)12.8 | | 12.7 | 12.7 | 12.7 | 12.7 | (2.8)12.8 | 12.7 | (2.1)13.1 | (2.6)13.1 | |
| | 4 | | | | | | | 12.8 | | | 12.7 | (4.2)12.7 | 12.7 | 12.7 | 12.7 | 12.7 | | | |
| | 5 | | | | | | | (4.2)12.7 | | | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | | | |
| | 6 | | | | | | | | | | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | | | |
| | 7 | | | | | | | | | | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | | | |
| | 8 | | | | | | | | | | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | | | |
| 6APR81 | 0 | 12.5 | 12.5 | 12.4 | 12.5 | 12.4 | 12.4 | 12.4 | 12.4 | 12.3 | 12.4 | 12.5 | 12.4 | 12.7 | 12.5 | 12.4 | 12.9 | 12.8 | 12.9 |
| | 1 | 12.5 | 12.5 | 12.4 | 12.5 | 12.5 | 12.4 | 12.4 | 12.4 | 12.3 | 12.4 | 12.5 | 12.4 | 12.7 | 12.4 | 12.4 | 12.8 | 12.8 | 13.0 |
| | 2 | 12.4 | 12.4 | (1.7)12.4 | 12.4 | 12.4 | (1.4)12.3 | 12.4 | 12.4 | (1.5)12.3 | 12.4 | 12.6 | (1.8)12.4 | 12.7 | 12.4 | (1.6)12.4 | 12.9 | 12.9 | (1.9)12.9 |
| | 3 | (2.1)12.5 | | | 12.5 | 12.4 | | 12.4 | 12.3 | | 12.4 | 12.5 | 12.5 | 12.7 | (2.2)12.3 | | (2.1)12.9 | (2.5)12.9 | |
| | 4 | | | | (3.2)12.4 | (3.4)12.4 | | 12.4 | 12.4 | | 12.5 | 12.5 | 12.5 | 12.7 | 12.7 | 12.7 | | | |
| | 5 | | | | | | | 12.4 | | | 12.5 | 12.5 | 12.5 | 12.7 | 12.7 | 12.7 | | | |
| | 6 | | | | | | | (5.4)12.4 | | | 12.4 | 12.4 | 12.4 | 12.7 | 12.7 | 12.7 | | | |
| | 7 | | | | | | | | | | 12.4 | 12.4 | 12.5 | 12.7 | 12.7 | 12.7 | | | |
| | 8 | | | | | | | | | | 12.4 | (6.7)12.5 | 12.5 | 12.7 | 12.7 | 12.7 | | | |

Table A-2 (continued) Dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DEPTH | | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|
| DATE | (m) | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 8MAY91 | 0 | 11.2 | 11.1 | 11.1 | 11.3 | 11.1 | 11.2 | 11.2 | 11.3 | 11.2 | 11.3 | 11.2 | 11.3 | 11.1 | 11.2 | 11.1 | 11.6 | 11.6 | 11.5 |
| | 1 | 11.2 | 11.2 | 11.1 | 11.3 | 11.1 | 11.3 | 11.3 | 11.3 | 11.2 | 11.3 | 11.2 | 11.2 | 11.2 | 11.1 | 11.1 | 11.6 | 11.5 | 11.5 |
| | 2 | 11.2 | 11.2 | (1.2)11.1 | 11.3 | 11.2 | 11.3 | 11.3 | 11.3 | (1.8)11.2 | 11.4 | 11.3 | (1.2)11.2 | 11.1 | 11.1 | (1.4)11.1 | 11.6 | 11.5 | (1.9)11.4 |
| | 3 | (2.8)11.2 | 11.2 | 11.2 | (2.4)11.3 | 11.2 | (2.9)11.2 | 11.3 | 11.4 | 11.4 | 11.4 | 11.3 | 11.1 | 11.1 | (2.9)11.1 | 11.2 | (2.1)11.5 | (2.9)11.5 | |
| | 4 | (3.2)11.2 | (3.2)11.2 | | 11.3 | 11.3 | | 11.3 | 11.4 | (3.9)11.3 | 11.4 | (3.9)11.3 | | 11.2 | | | | | |
| | 5 | | | | 11.2 | | | 11.3 | (5.1)11.4 | | 11.4 | | (5.1)11.2 | | | | | | |
| | 6 | | | | | | | | 11.4 | | 11.4 | | | | | | | | |
| | 7 | | | | | | | | 11.4 | | 11.4 | | | | | | | | |
| | 8 | | | | | | | | 11.4 | | 11.4 | | | | | | | | |
| | 9 | | | | | | | | 11.4 | | 11.4 | | | | | | | | |
| 21MAY91 | 0 | 11.5 | 11.6 | 11.7 | 11.7 | 11.7 | 11.7 | 11.8 | 11.7 | 11.7 | 11.8 | 11.7 | 11.7 | 11.8 | 11.6 | 11.6 | 11.7 | 11.7 | 11.7 |
| | 1 | 11.5 | 11.5 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.8 | 11.7 | 11.7 | 11.8 | 11.6 | 11.6 | 11.7 | 11.8 | 11.7 |
| | 2 | 11.5 | 11.5 | 11.7 | 11.6 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.8 | 11.7 | 11.7 | 11.8 | 11.5 | 11.6 | 11.7 | 11.7 | 11.7 |
| | 3 | 11.5 | 11.5 | 11.7 | 11.6 | 11.7 | (2.9)11.7 | 11.7 | 11.7 | 11.7 | 11.8 | 11.7 | (2.9)11.5 | 11.8 | 11.6 | (2.9)11.6 | 11.7 | 11.7 | (2.2)11.7 |
| | 4 | (3.8)11.5 | 11.4 | (3.4)11.7 | 11.6 | 11.8 | | 11.7 | 11.7 | (3.6)11.7 | 11.9 | 11.7 | 11.9 | 11.9 | (3.2)11.6 | | (3.1)11.7 | | |
| | 5 | | | | (4.2)11.6 | (4.9)11.8 | | 11.6 | (4.9)11.7 | | 11.9 | 11.7 | | 11.9 | | | | | |
| | 6 | | | | | | | 11.6 | | | 11.9 | 11.7 | | 11.9 | | | | | |
| | 7 | | | | | | | | | | 11.9 | (6.4)11.7 | | 11.9 | | | | | |
| | 8 | | | | | | | | | | 11.9 | | | 11.9 | | | | | |
| | 9 | | | | | | | | | | 11.9 | | | 11.9 | | | | | |
| 4JUN91 | 0 | 10.7 | 10.8 | 10.7 | 10.7 | 10.9 | 10.8 | 10.7 | 10.9 | 10.9 | 10.9 | 11.3 | 10.6 | 10.7 | 10.7 | 10.7 | 11.8 | 11.9 | 10.6 |
| | 1 | 10.7 | 10.9 | 10.7 | 10.7 | 10.9 | 10.8 | 10.7 | 10.9 | 10.9 | 10.9 | 11.3 | 10.5 | 10.8 | 10.6 | 10.7 | 11.8 | 11.8 | 10.8 |
| | 2 | 10.7 | 10.8 | (1.9)10.6 | 10.7 | 10.9 | 10.7 | 10.7 | 10.9 | 10.9 | 10.9 | 11.3 | 10.5 | 10.6 | 10.5 | 10.7 | (1.5)11.9 | 11.8 | (1.7)10.9 |
| | 3 | 10.7 | 10.8 | | 10.7 | 10.9 | 10.7 | 10.6 | 10.9 | 10.9 | 10.9 | 11.3 | (2.3)10.6 | 10.6 | 10.5 | (2.9)10.7 | (2.2)11.6 | | |
| | 4 | | | | (3.2)10.6 | (3.8)10.6 | | 10.5 | 10.9 | (3.6)10.9 | 10.9 | 11.3 | 10.6 | 10.6 | 10.7 | | | | |
| | 5 | | | | | | | 10.5 | 10.8 | | 10.9 | 11.3 | 10.6 | 10.6 | | | | | |
| | 6 | | | | | | | (5.5)10.5 | (5.5)10.8 | | 10.9 | 11.3 | 10.5 | 10.5 | | | | | |
| | 7 | | | | | | | | | | 10.8 | 11.2 | 10.4 | 10.4 | | | | | |
| | 8 | | | | | | | | | | 10.8 | 11.2 | 10.3 | 10.3 | | | | | |
| | 9 | | | | | | | | | | 10.8 | | 10.3 | 10.3 | | | | | |
| 18JUN91 | 0 | 10.5 | 10.5 | 10.5 | 10.6 | 10.6 | 10.5 | 10.4 | 10.6 | 10.6 | 10.5 | 10.7 | 10.4 | 10.5 | 10.5 | 10.5 | 10.4 | 10.6 | 10.7 |
| | 1 | 10.5 | 10.5 | 10.4 | 10.6 | 10.6 | 10.5 | 10.4 | 10.6 | 10.6 | 10.5 | 10.7 | 10.3 | 10.5 | 10.5 | 10.4 | (9)10.4 | 10.5 | 10.7 |
| | 2 | 10.4 | 10.5 | 10.3 | 10.5 | 10.5 | 10.5 | 10.4 | 10.5 | 10.5 | 10.5 | 10.7 | 10.3 | 10.5 | 10.5 | 10.3 | 10.5 | 10.5 | (1.2)10.6 |
| | 3 | (2.8)10.4 | 10.4 | (2.8)10.5 | 10.5 | 10.5 | 10.4 | 10.3 | 10.5 | 10.5 | 10.5 | 10.8 | 10.3 | 10.5 | 10.5 | 10.1 | 10.5 | 10.5 | |
| | 4 | (3.1)10.5 | | | (3.2)10.6 | 10.5 | (3.2)10.5 | 10.2 | 10.4 | (3.1)10.5 | 10.5 | 10.6 | (3.1)10.5 | 10.5 | 10.4 | (3.5)10.3 | | | |
| | 5 | | | | (4.5)10.6 | | | 10.2 | 10.3 | | 10.4 | 10.6 | 10.4 | 10.4 | (4.1)10.4 | | | | |
| | 6 | | | | | | | 10.3 | 10.3 | | 10.4 | 10.6 | 10.3 | 10.3 | | | | | |
| | 7 | | | | | | | (6.2)10.4 | | | 10.3 | 10.3 | 10.2 | 10.2 | | | | | |
| | 8 | | | | | | | | | | 10.3 | 10.4 | 10.1 | 10.1 | | | | | |
| | 9 | | | | | | | | | | 10.3 | 10.4 | 10.1 | 10.1 | | | | | |
| 20JUN91 | 0 | 8.7 | 10.6 | 8.7 | 8.8 | 9.8 | 8.8 | 8.7 | 8.9 | 8.9 | 8.9 | 8.9 | 8.6 | 8.9 | 8.9 | 8.8 | 8.5 | 8.5 | 8.7 |
| | 1 | 8.7 | 10.0 | 8.7 | 8.8 | 9.8 | 8.7 | 8.7 | 8.9 | 8.9 | 8.9 | 8.9 | 8.4 | 10.1 | 8.8 | 8.7 | 8.5 | 8.5 | 8.6 |
| | 2 | 9.5 | 9.9 | (1.9)9.6 | 9.7 | 9.8 | 9.8 | 9.7 | 9.8 | 9.8 | 9.8 | 9.9 | 9.3 | 10.0 | 9.8 | 9.8 | 8.4 | (1.4)9.5 | (1.1)9.6 |
| | 3 | 9.6 | 9.8 | | 9.6 | 9.7 | 9.8 | 9.7 | 9.8 | 9.7 | 9.9 | 9.9 | 9.5 | 10.0 | 9.8 | 9.8 | 9.6 | 9.6 | |
| | 4 | (3.1)9.7 | | | (3.5)9.6 | 9.7 | 9.5 | 9.6 | 9.8 | (3.1)9.8 | 9.9 | 9.9 | 9.5 | 10.0 | 9.8 | (3.5)9.7 | | | |
| | 5 | | | | | (4.2)9.7 | | 9.6 | 9.8 | | 9.8 | 9.9 | | 9.9 | (4.2)9.4 | | | | |
| | 6 | | | | | | | 9.6 | 9.7 | | 9.8 | 9.8 | | 9.9 | | | | | |
| | 7 | | | | | | | (6.1)9.6 | (6.2)9.6 | | 9.8 | 9.8 | | 9.9 | | | | | |
| | 8 | | | | | | | | | | 9.7 | 9.7 | | 9.8 | | | | | |
| | 9 | | | | | | | | | | 8.6 | (8.4)8.7 | | 10.0 | | | | | |

Table A-2 (continued) Dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH (m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----------|----------|----------|----------|----------|-----|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 16JUL91 | 0 | 8.1 | 8.1 | 7.9 | 8.0 | 8.0 | 8.0 | 7.8 | 7.8 | 7.9 | 8.0 | 8.1 | 8.0 | 8.2 | 8.1 | 7.8 | 8.5 | 8.7 | 8.8 |
| | 1 | 8.0 | 7.8 | 7.8 | 7.9 | 8.0 | 8.0 | 7.8 | 7.8 | 7.9 | 8.0 | 8.1 | 8.0 | 8.2 | 8.0 | 7.7 | 8.4 | 8.6 | 8.7 |
| | 2 | 7.9 | 7.8 | 7.8 | 7.9 | 7.9 | 7.9 | 7.8 | 7.8 | 7.7 | 8.0 | 8.0 | 7.9 | 8.2 | 8.0 | 7.7 | (1.9)8.3 | (1.4)8.6 | (1.1)8.7 |
| | 3 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | (2.6)7.3 | 7.9 | 8.0 | 7.9 | 8.1 | 7.9 | 7.6 | (3.8)7 | | |
| | 4 | | | | (3.5)7.8 | 7.7 | (3.6)7.8 | 7.5 | 7.8 | | 7.8 | 8.0 | (3.2)7.5 | 8.1 | 7.7 | | | | |
| | 5 | | | | (4.3)7.6 | | | 6.3 | 7.8 | | 7.8 | 7.9 | | 8.0 | (4.3)7 | | | | |
| | 6 | | | | | | | | 7.7 | | 7.7 | 7.9 | | 8.0 | | | | | |
| | 7 | | | | | | | | (6.2)6.9 | | 7.7 | 7.9 | | 8.0 | | | | | |
| | 8 | | | | | | | | | | 7.8 | 7.7 | | 7.8 | | | | | |
| | 9 | | | | | | | | | | (6.7)6.9 | (6.7)7 | | 8.6 | | | | | |
| 30JUL91 | 0 | 7.8 | 7.6 | 7.6 | 7.3 | 7.9 | 7.9 | 7.1 | 7.3 | 7.5 | 7.8 | 7.5 | 7.8 | 7.5 | 7.5 | 7.5 | 7.9 | 7.9 | 8.3 |
| | 1 | 7.7 | 7.5 | 7.5 | 7.3 | 7.8 | 7.9 | 7.1 | 7.3 | 7.4 | 7.8 | 7.5 | 7.5 | 7.4 | 7.5 | 7.4 | 7.8 | 8.0 | (0.5)8.3 |
| | 2 | 7.8 | 7.4 | (1.9)7.3 | 7.1 | 7.8 | 7.9 | 7.1 | 7.3 | 7.3 | 7.8 | 7.5 | 7.5 | 7.4 | 7.4 | 7.3 | (1.3)7.8 | (1.1)7.9 | |
| | 3 | 7.4 | 7.2 | | 7.0 | 7.7 | 7.8 | 7.1 | 7.2 | 7.3 | 7.6 | 7.5 | 7.4 | 7.4 | 7.3 | 7.2 | | | |
| | 4 | | (3.2)7 | | (3.4)6.9 | 7.6 | (3.3)7.8 | 7.1 | 7.2 | (3.6)7.1 | 7.6 | 7.4 | (3.4)6.8 | 7.4 | (4.5)6.3 | (3.8)6.7 | | | |
| | 5 | | | | | | | 6.9 | 7.2 | | 7.5 | 7.4 | | 7.4 | | | | | |
| | 6 | | | | | | | (5.9)6.9 | 7.2 | | 7.5 | 7.3 | | 7.3 | | | | | |
| | 7 | | | | | | | | (6.6)6.8 | | 7.4 | 7.3 | | 7.2 | | | | | |
| | 8 | | | | | | | | | | 7.4 | 7.0 | | 7.0 | | | | | |
| | 9 | | | | | | | | | | 7.4 | (6.2)7 | | 8.1 | | | | | |
| 13AUG91 | 0 | 7.8 | 7.7 | 7.4 | 7.2 | 7.1 | 7.1 | 7.0 | 7.2 | 7.2 | 7.4 | 7.3 | 7.5 | 7.4 | 7.4 | 7.4 | 8.6 | 8.6 | 8.4 |
| | 1 | 7.8 | 7.7 | 7.4 | 7.1 | 7.1 | 7.1 | 7.0 | 7.1 | 7.1 | 7.4 | 7.4 | 7.5 | 7.4 | 7.4 | 7.4 | 8.6 | 8.5 | 8.4 |
| | 2 | 7.5 | 7.6 | 7.3 | 7.1 | 7.1 | 7.1 | 7.0 | 7.0 | 7.0 | 7.3 | 7.3 | 7.5 | 7.3 | 7.4 | 7.4 | (1.9)8.6 | 8.5 | (1.4)8.4 |
| | 3 | (2.6)7.1 | 7.6 | (2.1)7.2 | 6.9 | 6.9 | 6.9 | 7.0 | 6.9 | (2.2)6.9 | 7.3 | 7.3 | 7.5 | 7.4 | 7.3 | 7.3 | | | |
| | 4 | | | | (3.2)6.8 | 6.8 | | 7.0 | 6.9 | | 7.3 | 7.3 | (3.3)7.3 | 7.3 | 7.1 | (3.2)6.6 | | | |
| | 5 | | | | | | | 6.9 | 6.9 | | 7.3 | 7.3 | | 7.3 | (4.1)6.3 | | | | |
| | 6 | | | | | | | (5.3)4.8 | 6.6 | | 7.2 | 7.2 | | 7.2 | | | | | |
| | 7 | | | | | | | | (6.4)6 | | 7.2 | 7.2 | | 7.2 | | | | | |
| | 8 | | | | | | | | | | 7.1 | 7.0 | | 7.1 | | | | | |
| | 9 | | | | | | | | | | 6.9 | 7.0 | | 7.1 | | | | | |
| 27AUG91 | 0 | 7.8 | 7.7 | 7.7 | 7.5 | 7.5 | 7.7 | 7.5 | 7.5 | 7.5 | 7.9 | 7.4 | 7.7 | 7.3 | 7.0 | 7.7 | 7.8 | 8.0 | 7.8 |
| | 1 | 7.7 | 7.7 | 7.7 | 7.5 | 7.5 | 7.7 | 7.4 | 7.6 | 7.6 | 7.8 | 7.3 | 7.5 | 7.1 | 7.3 | 7.6 | 7.8 | 7.9 | 7.9 |
| | 2 | 7.7 | 7.7 | 7.8 | 7.6 | 7.5 | 7.7 | 7.4 | 7.5 | 7.2 | 7.8 | 7.4 | 7.8 | 7.2 | 7.2 | 7.6 | (1.8)7.9 | 7.9 | (1.6)7.9 |
| | 3 | (2.9)7.6 | 7.7 | (2.7)7.8 | 7.7 | 7.3 | 7.7 | 7.1 | 7.4 | 7.8 | 7.3 | 7.4 | 7.4 | 7.0 | 7.1 | 7.5 | | | |
| | 4 | | | | (3.6)7.8 | 7.4 | (3.2)7.8 | 7.3 | 7.4 | 7.8 | 7.3 | 7.3 | (3.5)7.4 | 7.0 | 6.9 | (3.4)7.6 | | | |
| | 5 | | | | | | | 7.1 | 7.2 | | 7.3 | 7.1 | | 7.0 | (4.1)4.1 | | | | |
| | 6 | | | | | | | 6.9 | 7.2 | | 7.3 | 7.1 | | 7.0 | | | | | |
| | 7 | | | | | | | | (6.3)7.1 | | 7.2 | 7.0 | | 6.9 | | | | | |
| | 8 | | | | | | | | | | 7.0 | (7.3)6.5 | | 6.7 | | | | | |
| | 9 | | | | | | | | | | 6.6 | | | 5.9 | | | | | |
| 10SEP91 | 0 | 7.8 | 8.1 | 8.2 | 8.1 | 8.3 | 8.0 | 7.8 | 7.8 | 7.8 | 8.2 | 8.0 | 7.9 | 7.8 | 8.1 | 8.0 | 8.1 | 8.2 | 8.2 |
| | 1 | 7.7 | 8.1 | 8.1 | 8.0 | 8.2 | 7.9 | 7.7 | 7.8 | 7.8 | 8.2 | 8.0 | 7.9 | 8.2 | 8.0 | 8.0 | 8.2 | 8.1 | 8.1 |
| | 2 | 7.6 | 8.1 | 8.1 | 8.0 | 8.2 | 7.8 | 7.7 | 7.7 | 8.2 | 7.9 | 7.9 | 8.4 | 7.8 | 8.0 | 8.0 | (1.4)8 | 8.1 | (1.3)8.1 |
| | 3 | (2.9)7.5 | 8.1 | | 8.0 | 8.2 | 7.6 | 7.7 | 7.7 | 8.2 | 7.8 | 7.8 | 8.5 | 7.8 | 8.0 | 7.9 | | | |
| | 4 | | (3.2)8.1 | | (3.5)8 | 8.1 | (3.7)7.6 | 7.7 | 7.7 | (3.2)8.2 | 7.9 | 7.8 | (3.2)8.5 | 7.8 | 8.0 | (3.6)7.7 | | | |
| | 5 | | | | | | | 7.7 | 7.8 | | 7.9 | 7.8 | | 7.9 | (4.9)8 | | | | |
| | 6 | | | | | | | 7.7 | 7.8 | | 8.0 | 7.7 | | 7.8 | | | | | |
| | 7 | | | | | | | 7.7 | 7.7 | | 7.9 | 7.7 | | 7.6 | | | | | |
| | 8 | | | | | | | 7.7 | (6.7)7.7 | | 7.8 | 7.5 | | 7.4 | | | | | |
| | 9 | | | | | | | | | | 7.9 | (6.9)7 | | 7.3 | | | | | |

Table A-2 (continued) Dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH (m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----------|----------|----------|--------|----------|----------|----------|----------|-----|----------|----------|-----|----------|----------|----------|----------|----------|----------|----------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 24SEP91 | 0 | 8.2 | 8.2 | 8.2 | 8.5 | 8.4 | 8.4 | 8.2 | 8.2 | 8.3 | 8.4 | 8.1 | 8.1 | 7.8 | 8.2 | 8.2 | 8.3 | 8.7 | 8.8 |
| | 1 | 8.2 | 8.1 | 8.1 | 8.4 | 8.4 | 8.5 | 8.2 | 8.2 | 8.3 | 8.4 | 8.1 | 8.1 | 7.8 | 8.2 | 8.2 | 8.2 | 8.7 | 8.8 |
| | 2 | 8.1 | 7.9 | 7.9 | 8.3 | 8.3 | 8.3 | 8.2 | 8.2 | 8.2 | 8.5 | 8.0 | 8.1 | 7.7 | 8.1 | 8.2 | 8.2 | (1.8)8.9 | (1.9)8.5 |
| | 3 | (2.3)8.2 | (2.9)8.2 | (2.2)8 | 8.3 | 8.3 | 8.2 | 8.1 | 8.1 | 8.1 | 8.5 | 8.0 | 8.0 | 7.5 | 8.1 | 8.3 | 8.1 | | |
| | 4 | | | | (3.3)8.5 | 8.3 | (3.1)8.4 | 8.0 | 8.0 | (3.1)8.5 | | 8.0 | 8.0 | (3.2)7.7 | 8.1 | 8.3 | (3.2)7.7 | | |
| | 5 | | | | | (4.1)8.5 | | 7.9 | 8.0 | | | 8.0 | 7.9 | | 8.0 | (4.1)8.2 | | | |
| | 6 | | | | | | | (5.8)7.9 | 8.1 | | | 8.0 | 7.9 | | 8.0 | | | | |
| | 7 | | | | | | | | | | | 8.0 | 7.9 | | 7.9 | | | | |
| | 8 | | | | | | | | | | | 7.8 | 7.8 | | 7.9 | | | | |
| | 9 | | | | | | | | | | | 7.9 | (8.1)7.8 | | (8.9)7.8 | | | | |
| | 10 | | | | | | | | | | | 7.9 | | | | | | | |
| | | | | | | | | | | | | | (10.1)8 | | | | | | |

Table A-3 Electrical conductivity (umho) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH (m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|-----------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 18DEC90 | 0 | 33 | 31 | 32 | 33 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 |
| | 1 | 33 | 31 | 33 | 33 | 33 | 32 | 33 | 32 | 32 | 32 | 32 | 32 | 32 | 33 | 33 | 32 | 34 | 35 |
| | 2 | 34 | 31 | (1.2)33 | 35 | 33 | 33 | 33 | 33 | (1.6)33 | 32 | 33 | 32 | 33 | 33 | 34 | (1.3)32 | (1.6)35 | (1.1)35 |
| | 3 | (2.4)34 | (2.8)33 | | 36 | 34 | (2.3)34 | 34 | 33 | | 33 | 33 | (2.2)32 | 33 | 34 | 34 | | | |
| | 4 | | | | | (3.8)35 | | 35 | 34 | | 34 | 34 | | 34 | 34 | | | | |
| | 5 | | | | | | | 35 | 35 | | 34 | 35 | | 34 | 34 | | | | |
| | 6 | | | | | | | (5.3)36 | (5.5)36 | | 35 | 36 | | 35 | 35 | | | | |
| | 7 | | | | | | | | | | 36 | 36 | | 36 | 36 | | | | |
| | 8 | | | | | | | | | | 36 | (7.7)37 | | 36 | | | | | |
| | 9 | | | | | | | | | | 38 | | | (8.5)37 | | | | | |
| 15JAN91 | 0 | 30 | 30 | 31 | 31 | 30 | 30 | 31 | 30 | 30 | 31 | 31 | 31 | 31 | 31 | 31 | 30 | 28 | 29 |
| | 1 | 30 | 30 | (0.9)31 | 31 | 30 | 31 | 31 | 31 | 30 | 31 | 31 | 31 | 31 | 31 | 31 | 30 | 26 | 30 |
| | 2 | (1.8)31 | (1.9)30 | | 31 | 31 | (1.7)31 | 31 | 31 | (1.7)31 | 31 | 31 | (1.6)31 | 31 | (1.8)31 | (1.9)30 | 26 | (1.3)30 | |
| | 3 | | | | (2.4)3 | 32 | (2.8)31 | 32 | 31 | | 31 | 31 | | 32 | (2.4)31 | | (2.3)27 | | |
| | 4 | | | | | | | 32 | 32 | | 31 | 31 | | 32 | | | | | |
| | 5 | | | | | | | (4.7)32 | (4.1)32 | | 32 | (4.2)32 | | 32 | | | | | |
| | 6 | | | | | | | | | | 32 | | | 33 | | | | | |
| | 7 | | | | | | | | | | 32 | | | 33 | | | | | |
| | 8 | | | | | | | | | | 33 | | | (7.2)32 | | | | | |
| 12FEB91 | 0 | 30 | 31 | 29 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 29 | 29 | 30 | 29 | 26 | 27 |
| | 1 | 30 | 31 | 30 | 31 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | (1.5)30 | 30 | 30 | 30 | 29 | 26 | 28 |
| | 2 | 31 | 31 | (1.2)30 | 31 | 31 | 30 | 30 | 31 | (1.2)30 | 30 | 30 | | 30 | 30 | 31 | (1.1)29 | 27 | (1.5)29 |
| | 3 | | | | (2.2)3 | (2.8)31 | (2.9)31 | 31 | 31 | | 30 | 31 | | 30 | 30 | 30 | | (2.1)28 | |
| | 4 | | | | | | | 31 | 31 | | 30 | 31 | | 30 | 30 | 31 | | | |
| | 5 | | | | | | | (4.8)31 | (4.2)31 | | 31 | 31 | | 31 | 31 | 31 | | | |
| | 6 | | | | | | | | | | 31 | 31 | | 31 | 31 | 31 | | | |
| | 7 | | | | | | | | | | 32 | 32 | | 32 | 32 | 32 | | | |
| | 8 | | | | | | | | | | 32 | (7.1)32 | | (7.3)32 | | | | | |
| 12MAR91 | 0 | 29 | 30 | 30 | 29 | 29 | 29 | 60 | 30 | 29 | 29 | 30 | 29 | 29 | 29 | 29 | 33 | 33 | 32 |
| | 1 | 30 | 30 | 30 | 29 | 29 | 30 | 30 | 29 | 29 | 29 | 30 | 30 | 29 | 29 | 29 | 33 | 32 | 33 |
| | 2 | 30 | 30 | (1.2)30 | 30 | 29 | (1.5)30 | 30 | 30 | (1.4)30 | 29 | 30 | (1.2)30 | 29 | 30 | (1.7)29 | 33 | 33 | (1.9)33 |
| | 3 | (2.1)30 | (2.2)31 | | (2.2)3 | (2.8)30 | | 30 | (3.1)29 | | 30 | 30 | | 29 | (2.9)30 | (2.1)32 | (2.6)33 | | |
| | 4 | | | | | | | 30 | | | 30 | 30 | | 29 | | | | | |
| | 5 | | | | | | | (4.2)30 | | | 30 | 30 | | 30 | 30 | | | | |
| | 6 | | | | | | | | | | 30 | 30 | | 31 | 31 | | | | |
| | 7 | | | | | | | | | | 31 | 31 | | 31 | 31 | | | | |
| | 8 | | | | | | | | | | 31 | 31 | | 31 | 31 | | | | |

Table A-3 (continued) Electrical conductivity (umho) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH
(m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|--------------|----------|----|---------|----------|---------|---------|----------|---------|----------|----------|---------|---------|----------|---------|---------|----------|---------|---------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 09APR91 | 0 | 29 | 30 | 30 | 30 | 30 | 30 | 29 | 30 | 30 | 27 | 29 | 28 | 28 | 29 | 29 | 29 | 30 | 30 |
| | 1 | 29 | 30 | 30 | 30 | 30 | 31 | 30 | 30 | 31 | 27 | 29 | 28 | 28 | 29 | 30 | 29 | 30 | 30 |
| | 2 | 30 | 30 | (1.7)31 | 30 | 29 | (1.4)31 | 30 | 29 | (1.5)32 | 27 | 29 | (1.8)28 | 29 | 29 | (1.6)29 | 30 | (1.9)30 | (1.9)30 |
| | 3 | (2.1)30 | | | 31 | 30 | | 30 | 30 | | 28 | 30 | | 29 | (2.2)30 | (2.1)30 | | (2.5)31 | |
| | 4 | | | | (3.2)3 | (3.4)30 | | 30 | 30 | | 28 | 30 | | 30 | | | | | |
| | 5 | | | | | | | 31 | | | 29 | 30 | | 31 | | | | | |
| | 6 | | | | | | | (5.4)31 | | | 30 | 30 | | 31 | | | | | |
| | 7 | | | | | | | | | | 30 | (6.7)30 | | 31 | | | | | |
| | 8 | | | | | | | | | | 30 | | (8.6)30 | | | | | | |
| 08MAY91 | 0 | 32 | 32 | 33 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 31 | 32 | 32 | 30 | 25 | 28 |
| | 1 | 32 | 32 | 33 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 31 | 32 | 32 | 30 | 28 | 30 |
| | 2 | 33 | 32 | 33 | 33 | 33 | 32 | 33 | 33 | 32 | 32 | 33 | 32 | 32 | 32 | 32 | 30 | 30 | 30 |
| | 3 | 34 | 32 | 33 | 34 | 33 | (2.9)33 | 34 | 33 | 33 | 33 | 33 | (2.8)33 | 32 | 32 | (2.3)33 | (2.9)30 | 30 | (2.2)30 |
| | 4 | (3.8)34 | 33 | (3.4)33 | 34 | 33 | | 34 | 34 | (3.6)33 | 33 | 34 | | 32 | (3.2)34 | | | (3.1)30 | |
| | 5 | | | | (4.2)3 | (4.6)34 | | 35 | (4.8)34 | | 33 | 34 | | 32 | | | | | |
| | 6 | | | | | | | 35 | | | 33 | 34 | | 33 | | | | | |
| | 7 | | | | | | | | | | 33 | (6.4)34 | | 33 | | | | | |
| | 8 | | | | | | | | | | 33 | | | 33 | | | | | |
| | 9 | | | | | | | | | | 33 | | | 34 | | | | | |
| | 10 | | | | | | | | | | 33 | | (9.1)35 | | | | | | |
| 04JUN91 | 0 | 34 | 34 | 35 | 36 | 35 | 36 | 35 | 35 | 35 | 36 | 35 | 36 | 35 | 36 | 36 | 29 | 30 | 29 |
| | 1 | 35 | 35 | 35 | 36 | 35 | 36 | 36 | 36 | 35 | 36 | 35 | 37 | 36 | 36 | 36 | 30 | 30 | 29 |
| | 2 | 35 | 35 | (1.6)35 | 37 | 35 | 37 | 37 | 36 | 35 | 36 | 36 | 37 | 37 | 37 | 37 | (1.5)30 | 30 | (1.7)30 |
| | 3 | 36 | 36 | | 38 | 36 | 38 | 37 | 36 | 37 | 37 | 36 | (2.3)38 | 38 | 37 | (2.9)37 | (2.2)30 | | |
| | 4 | | | | (3.2)3 | (3.8)38 | | 38 | 37 | (3.8)38 | 37 | 37 | | 39 | 38 | | | | |
| | 5 | | | | | | | 38 | 37 | | 38 | 37 | | 39 | 39 | | | | |
| | 6 | | | | | | | (5.5)38 | (5.5)39 | | 38 | 37 | | 40 | 40 | | | | |
| | 7 | | | | | | | | | | 39 | 38 | | 41 | 41 | | | | |
| | 8 | | | | | | | | | | 40 | 38 | | 41 | 41 | | | | |
| | 9 | | | | | | | | | | 40 | | | 41 | 41 | | | | |
| | 10 | | | | | | | | | (10.6)41 | 41 | | | | | | | | |

Table A-3 (continued) Electrical conductivity (µmho) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH
(m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|--------------|----------|----|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 16JUN91 | 0 | 37 | 37 | 37 | 38 | 37 | 38 | 38 | 38 | 38 | 38 | 38 | 39 | 38 | 39 | 39 | 39 | 37 | 39 |
| | 1 | 37 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 39 | 38 | 39 | 39 | (0.9)39 | 38 | 39 |
| | 2 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 39 | 38 | 39 | 40 | 40 | 38 | (1.2)39 |
| | 3 | (2.8)38 | 38 | (2.8)38 | 38 | 38 | 39 | 38 | 39 | 39 | 39 | 39 | 40 | 39 | 40 | 40 | 40 | (2.1)38 | |
| | 4 | (3.1)39 | 38 | (3.1)39 | 39 | 40 | (3.1)39 | 39 | 40 | (3.1)39 | 40 | 40 | (3.1)40 | 39 | 40 | (3.5)40 | | | |
| | 5 | | | | 40 | 40 | | 40 | 40 | | 40 | 40 | | 40 | (4.1)40 | | | | |
| | 6 | | | | 40 | 41 | | 40 | 41 | | 40 | 41 | | 40 | | | | | |
| | 7 | | | | (6.2)41 | | | 41 | 41 | | 41 | 41 | | 40 | | | | | |
| | 8 | | | | | | | 41 | 40 | | 41 | 40 | | 41 | | | | | |
| | 9 | | | | | | | 42 | 41 | | 42 | 41 | | 42 | | | | | |
| 02JUL91 | 0 | 41 | 41 | 41 | 42 | 41 | 41 | 41 | 41 | 41 | (9.3)43 | (9.2)42 | 42 | 40 | 41 | 41 | 41 | 40 | 40 |
| | 1 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 42 | 40 | 41 | 42 | 41 | 40 | 40 |
| | 2 | 42 | 41 | 41 | 42 | 41 | 42 | 42 | 42 | 41 | 41 | 42 | 42 | 41 | 41 | 42 | 41 | (1.4)41 | (1.1)40 |
| | 3 | 42 | 41 | 42 | 43 | 41 | 42 | 42 | 42 | 41 | 42 | 42 | 43 | 41 | 42 | 42 | 42 | | |
| | 4 | (3.1)42 | 42 | 42 | (3.5)4 | 42 | 42 | 43 | 43 | (3.1)42 | 42 | 43 | | 42 | 42 | (3.5)42 | | | |
| | 5 | | | | | (4.2)42 | | 43 | 43 | | 42 | 43 | | 42 | (4.2)43 | | | | |
| | 6 | | | | | | | 43 | 43 | | 43 | 43 | | 43 | | | | | |
| | 7 | | | | (6.1)43 | (6.2)43 | | 43 | 43 | | 43 | 43 | | 44 | | | | | |
| | 8 | | | | | | | 44 | 44 | | 44 | 44 | | 44 | | | | | |
| | 9 | | | | | | | 45 | (8.4)46 | | 45 | | | 45 | | | | | |
| 16JUL91 | 0 | 44 | 44 | 44 | 49 | 45 | 45 | 45 | 46 | 45 | 45 | 46 | 46 | 44 | 45 | 46 | 45 | 45 | 45 |
| | 1 | 45 | 44 | 45 | 50 | 45 | 45 | 46 | 46 | 45 | 45 | 46 | 47 | 45 | 46 | 46 | 46 | 46 | 46 |
| | 2 | 45 | 44 | 45 | 50 | 46 | 45 | 47 | 46 | 46 | 46 | 47 | 47 | 46 | 46 | 47 | (1.9)47 | (1.4)47 | (1.1)46 |
| | 3 | 45 | 45 | 45 | 50 | 46 | 45 | 47 | 47 | (2.6)46 | 47 | 47 | 47 | 47 | 47 | 48 | | | |
| | 4 | | | | (3.5)5 | 46 | (3.6)47 | 48 | 47 | | 48 | 48 | (3.2)48 | 47 | 48 | (3.8)49 | | | |
| | 5 | | | | | (4.3)47 | | 48 | 48 | | 48 | 48 | | 48 | (4.3)49 | | | | |
| | 6 | | | | | | | 48 | 48 | | 48 | 49 | | 48 | | | | | |
| | 7 | | | | | (6.2)49 | | | | | 49 | 49 | | 49 | | | | | |
| | 8 | | | | | | | | | | 49 | 49 | | 49 | | | | | |
| | 9 | | | | | | | | | (8.7)50 | (8.7)49 | | | 50 | | | | | |

Table A-3 (continued) Electrical conductivity (μmho) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH
(m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|-----------|--------------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|----------|----------|---------|---------|----------|---------|---------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 30 JUL 91 | 0 | 48 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 50 | 49 | 49 | 50 | 49 | 49 | 49 | 49 | 49 | 49 |
| | 1 | 49 | 49 | 49 | 49 | 49 | 50 | 49 | 50 | 50 | 49 | 49 | 50 | 49 | 49 | 50 | 49 | 49 | (0.5)49 |
| | 2 | 49 | 49 | (1.9)49 | 50 | 50 | 50 | 50 | 50 | 50 | 49 | 50 | 50 | 50 | 50 | 50 | (1.3)49 | (1.1)49 | |
| | 3 | 49 | 49 | | 50 | 50 | 50 | 50 | 50 | 50 | 49 | 50 | 50 | 50 | 50 | 50 | | | |
| | 4 | | (3.2)49 | | (3.4)5 | 51 | (3.3)50 | 50 | 50 | (3.6)50 | 50 | 50 | 50 | 50 | 50 | (3.8)50 | | | |
| | 5 | | | | | (4.6)51 | | 51 | 51 | | 50 | 50 | 50 | 50 | (4.5)52 | | | | |
| | 6 | | | | | | | (5.9)51 | 51 | | 50 | 50 | 50 | 51 | | | | | |
| | 7 | | | | | | | (6.6)51 | | | 51 | 51 | 51 | 51 | | | | | |
| | 8 | | | | | | | | | | 52 | 51 | 51 | 51 | | | | | |
| | 9 | | | | | | | | | | 52 | (8.2)52 | 52 | 52 | | | | | |
| | 10 | | | | | | | | | | 52 | | 52 | | | | | | |
| 13 AUG 91 | 0 | 49 | 49 | 49 | 50 | 50 | 49 | 50 | 50 | 50 | 49 | 50 | 50 | 49 | 50 | 50 | 49 | 50 | 50 |
| | 1 | 49 | 49 | 49 | 50 | 50 | 49 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 49 | 50 | 50 |
| | 2 | 50 | 49 | 50 | 50 | 50 | 49 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | (1.9)49 | 50 | (1.4)50 |
| | 3 | (2.8)50 | 49 | (2.1)50 | 50 | 50 | 49 | 51 | 51 | (2.2)50 | 50 | 51 | 51 | 50 | 51 | 50 | | (2.1)50 | |
| | 4 | | | | (3.2)5 | 51 | | 51 | 51 | | 50 | 51 | (3.3)50 | 50 | 51 | (3.2)50 | | | |
| | 5 | | | | | (4.2)51 | | 51 | 52 | | 51 | 51 | | 51 | (4.1)51 | | | | |
| | 6 | | | | | | | (5.3)51 | 52 | | 51 | 52 | | 51 | | | | | |
| | 7 | | | | | | | | (6.4)52 | | 52 | 52 | | 52 | | | | | |
| | 8 | | | | | | | | | | 52 | 52 | | 52 | | | | | |
| | 9 | | | | | | | | | | 53 | 53 | | 53 | | | | | |
| | 10 | | | | | | | | | | 53 | (9.5)53 | (9.3)53 | | | | | | |
| 27 AUG 91 | 0 | 48 | 48 | 48 | 55 | 56 | 52 | 51 | 52 | 52 | 51 | 51 | 51 | 52 | 51 | 51 | 56 | 56 | 59 |
| | 1 | 48 | 48 | 49 | 56 | 56 | 53 | 52 | 52 | 52 | 51 | 51 | 52 | 52 | 52 | 51 | 56 | 57 | 58 |
| | 2 | 49 | 49 | 49 | 56 | 56 | 52 | 52 | 52 | 52 | 52 | 53 | 52 | 53 | 52 | 52 | (1.8)60 | 58 | (1.6)58 |
| | 3 | (2.9)49 | 49 | (2.7)49 | 53 | 53 | 52 | 52 | 53 | 53 | 52 | 54 | 52 | 53 | 53 | 53 | | (2.1)58 | |
| | 4 | | | | (3.6)5 | 52 | (3.2)52 | 53 | 53 | 53 | 52 | 55 | (3.5)52 | 53 | 53 | (3.4)54 | | | |
| | 5 | | | | | (4.3)53 | | 53 | 54 | | 53 | 55 | | 53 | (4.1)53 | | | | |
| | 6 | | | | | | | 53 | 55 | | 53 | 56 | | 54 | | | | | |
| | 7 | | | | | | | | (6.3)57 | | 53 | 56 | | 55 | | | | | |
| | 8 | | | | | | | | | | 55 | (7.3)56 | | 56 | | | | | |
| | 9 | | | | | | | | | | 56 | | | 56 | | | | | |
| | 10 | | | | | | | | | | 56 | | (10.8)58 | | | | | | |

Table A-3 (continued) Electrical conductivity (μmho) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 100.7 to 111.1, 1991.

| DATE | DEPTH
(m) | RM 111.1 | | | RM 108.8 | | | RM 106.2 | | | RM 103.5 | | | RM 102.5 | | | RM 100.7 | | |
|---------|--------------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|----|---------|
| | | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L | R | M | L |
| 10SEP91 | 0 | 47 | 48 | 47 | 49 | 49 | 49 | 50 | 49 | 48 | 50 | 50 | 50 | 50 | 50 | 50 | 54 | 50 | 52 |
| | 1 | 48 | 48 | 48 | 50 | 49 | 49 | 50 | 49 | 48 | 50 | 50 | 51 | 50 | 50 | 51 | 53 | 50 | 52 |
| | 2 | 48 | 48 | 48 | 50 | 49 | 49 | 50 | 49 | 49 | 50 | 50 | 51 | 50 | 50 | 50 | (1.4)53 | 50 | (1.3)51 |
| | 3 | (2.9)48 | 48 | 48 | 50 | 50 | 49 | 50 | 49 | 49 | 51 | 51 | 51 | 50 | 50 | 50 | (2.1)51 | 50 | |
| | 4 | | (3.2)48 | | (3.5)5 | 50 | (3.7)49 | 50 | 50 | (3.2)49 | 51 | 51 | (3.2)51 | 50 | 51 | (3.6)50 | | | |
| | 5 | | | | | (4.4)50 | | 50 | 50 | | 51 | 51 | | 50 | (4.9)52 | | | | |
| | 6 | | | | | | | 51 | 50 | | 51 | 52 | | 51 | | | | | |
| | 7 | | | | | | | 51 | (6.7)50 | | 51 | 52 | | 51 | | | | | |
| | 8 | | | | | | | | | | 52 | 52 | | 52 | | | | | |
| | 9 | | | | | | | | | | 52 | (8.8)52 | | 52 | | | | | |
| | 10 | | | | | | | | | | 53 | (9.3)54 | | | | | | | |
| 24SEP91 | 0 | 47 | 47 | 47 | 48 | 48 | 48 | 47 | 47 | 47 | 47 | 47 | 48 | 46 | 47 | 48 | 49 | 48 | 48 |
| | 1 | 47 | 47 | 47 | 48 | 48 | 47 | 48 | 47 | 48 | 48 | 48 | 48 | 46 | 47 | 47 | 48 | 48 | 49 |
| | 2 | 47 | 47 | 48 | 49 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 47 | 46 | 47 | 47 | (1.8)48 | 48 | (1.9)50 |
| | 3 | (2.3)47 | (2.9)48 | (2.2)48 | 49 | 48 | 47 | 48 | 48 | 48 | 48 | 48 | 49 | 47 | 48 | 48 | | | |
| | 4 | | | | (3.3)5 | 49 | (3.1)47 | 49 | 48 | (3.1)48 | 48 | 48 | (3.2)49 | 47 | 48 | (3.2)48 | | | |
| | 5 | | | | | (4.1)49 | | 49 | 49 | | 48 | 49 | | 48 | (4.1)48 | | | | |
| | 6 | | | | | | | (5.8)50 | 49 | | 49 | 49 | | 49 | | | | | |
| | 7 | | | | | | | | | | 49 | 49 | | 49 | | | | | |
| | 8 | | | | | | | | | | 49 | 49 | | 49 | | | | | |
| | 9 | | | | | | | | | | 49 | 49 | | 49 | | | | | |
| | 10 | | | | | | | | | | 50 | (8.1)50 | | (8.9)50 | | | | | |

Table A-4 Temperature (C) and dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 111.1, 103.5, and 102.5 during the diel study of August 12-13, 1991. Only the right 1/3 section was measured at RM 111.1.

| RM 111.1 | | | | | | | | | | RM 103.5 | | | | | | | | | | RM 102.5 | | | | | | | | | |
|----------|-------|-------|-----|------|-----|-------|-----|------|-----|----------|-----|------|-----|-------|-----|------|-----|-------|-----|----------|-----|-------|-----|------|-----|-------|-----|------|-----|
| TIME | DEPTH | TEMP. | O2 | R | R | TEMP. | O2 | R | M | TEMP. | O2 | M | M | TEMP. | O2 | L | L | TEMP. | O2 | R | R | TEMP. | O2 | M | M | TEMP. | O2 | L | L |
| 1500 | 0 | 22.6 | 7.5 | 22.9 | 8.0 | 22.6 | 7.8 | 22.8 | 8.2 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 |
| 1500 | 1 | 22.6 | 7.6 | 22.9 | 8.0 | 22.6 | 7.9 | 22.8 | 8.2 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 |
| 1500 | 2 | 22.7 | 7.6 | 22.9 | 7.9 | 22.6 | 7.9 | 22.8 | 8.0 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 | 23.1 | 7.9 |
| 1500 | 3 | 22.7 | 7.4 | 22.9 | 7.9 | 22.5 | 7.7 | 22.7 | 8.0 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 |
| 1500 | 4 | | | 22.9 | 7.9 | 22.5 | 7.9 | 22.8 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 |
| 1500 | 5 | | | 22.9 | 7.8 | 22.4 | 7.9 | 22.8 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 |
| 1500 | 6 | | | 22.8 | 7.8 | 22.3 | 7.9 | 22.8 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 | 23.0 | 7.9 |
| 1500 | 7 | | | 22.8 | 7.7 | 22.3 | 7.8 | 22.8 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 |
| 1500 | 8 | | | 22.6 | 7.7 | 22.3 | 7.7 | 22.8 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 |
| 1500 | 9 | | | 22.5 | 7.7 | 22.3 | 7.7 | 22.8 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 | 23.0 | 7.7 |
| 1500 | 10 | | | 22.4 | 7.5 | 22.2 | 7.6 | 22.8 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 | 23.0 | 7.6 |
| 1800 | 0 | 22.7 | 7.9 | 22.9 | 8.4 | 22.9 | 8.3 | 22.9 | 8.5 | 23.1 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 |
| 1800 | 1 | 22.7 | 7.8 | 22.9 | 8.4 | 22.9 | 8.3 | 22.9 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 | 23.2 | 8.4 |
| 1800 | 2 | 22.8 | 7.8 | 22.9 | 8.4 | 22.9 | 8.2 | 22.9 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 | 23.2 | 8.3 |
| 1800 | 3 | 22.8 | 7.1 | 22.9 | 8.4 | 22.9 | 8.3 | 22.9 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 |
| 1800 | 4 | | | 22.9 | 8.3 | 22.9 | 8.2 | 22.8 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 | 23.0 | 8.2 |
| 1800 | 5 | | | 22.9 | 8.2 | 22.8 | 8.2 | 22.8 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 |
| 1800 | 6 | | | 22.9 | 8.2 | 22.8 | 8.1 | 22.8 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 |
| 1800 | 7 | | | 22.8 | 8.2 | 22.8 | 8.1 | 22.8 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 | 23.0 | 8.1 |
| 1800 | 8 | | | 22.8 | 7.9 | 22.8 | 8.0 | 22.8 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 |
| 1800 | 9 | | | 22.8 | 8.0 | 22.8 | 8.0 | 22.8 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 | 23.0 | 8.0 |
| 1800 | 10 | | | 22.8 | 7.9 | 22.7 | 7.8 | 22.7 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 | 23.0 | 7.8 |
| 2100 | 0 | 22.5 | 8.3 | 22.8 | 7.9 | 22.7 | 7.7 | 22.8 | 7.8 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 | 22.9 | 7.5 |
| 2100 | 1 | 22.5 | 8.4 | 22.8 | 7.8 | 22.7 | 7.6 | 22.8 | 7.7 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 | 22.9 | 7.4 |
| 2100 | 2 | 22.6 | 8.5 | 22.8 | 7.7 | 22.7 | 7.7 | 22.8 | 7.7 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 | 22.9 | 7.6 |
| 2100 | 3 | 22.5 | 8.2 | 22.8 | 7.6 | 22.8 | 7.7 | 22.8 | 7.7 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 |
| 2100 | 4 | | | 22.7 | 7.6 | 22.8 | 7.7 | 22.8 | 7.7 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 | 23.0 | 7.4 |
| 2100 | 5 | | | 22.7 | 7.6 | 22.8 | 7.6 | 22.8 | 7.6 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 | 23.0 | 7.3 |
| 2100 | 6 | | | 22.7 | 7.6 | 22.8 | 7.5 | 22.8 | 7.5 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 |
| 2100 | 7 | | | 22.7 | 7.5 | 22.8 | 7.5 | 22.8 | 7.5 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 | 23.0 | 7.2 |
| 2100 | 8 | | | 22.6 | 7.4 | 22.7 | 7.4 | 22.7 | 7.4 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 | 23.0 | 7.1 |
| 2100 | 9 | | | 22.6 | 6.7 | 22.7 | 7.1 | 22.7 | 7.1 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 | 23.0 | 6.9 |

Table A-4 (continued) Temperature (C) and dissolved oxygen (ppm) profiles at the right (R), middle (M), and left (L) 1/3 sections of the Spokane River, River Mile (RM) 111.1, 103.5, and 102.5 during the diel study of August 12-13, 1991. Only the right 1/3 section was measured at RM 111.1.

| RM 111.1 | | | | | | | | | | RM 103.5 | | | | | RM 102.5 | | | | |
|----------|-------|-------|-----|------|-------|------|-----|-------|-----|----------|-------|------|-----|-------|----------|------|-------|------|-----|
| TIME | DEPTH | TEMP. | O2 | R | TEMP. | O2 | R | TEMP. | O2 | R | TEMP. | O2 | M | TEMP. | O2 | M | TEMP. | O2 | L |
| 2400 | 0 | 22.4 | 7.1 | 22.6 | 8.0 | 22.5 | 7.7 | 22.4 | 7.6 | 22.6 | 8.1 | 22.8 | 7.8 | 22.8 | 7.8 | 22.8 | 7.8 | 22.8 | 7.8 |
| 2400 | 1 | 22.4 | 7.0 | 22.6 | 7.9 | 22.5 | 7.7 | 22.4 | 7.5 | 22.7 | 8.1 | 22.9 | 7.8 | 22.8 | 7.8 | 22.8 | 7.8 | 22.8 | 7.8 |
| 2400 | 2 | 22.4 | 7.2 | 22.7 | 7.9 | 22.5 | 7.7 | 22.4 | 7.4 | 22.7 | 8.0 | 22.8 | 7.7 | 22.8 | 7.7 | 22.8 | 7.8 | 22.8 | 7.8 |
| 2400 | 3 | 22.4 | 7.3 | 22.7 | 7.8 | 22.5 | 7.6 | 22.4 | 7.4 | 22.7 | 8.0 | 22.8 | 7.6 | 22.8 | 7.6 | 22.8 | 7.8 | 22.8 | 7.8 |
| 2400 | 4 | | | 22.7 | 7.8 | 22.4 | 7.8 | | | 22.8 | 8.0 | 22.8 | 7.3 | 22.8 | 7.3 | 22.8 | 7.7 | 22.8 | 7.7 |
| 2400 | 5 | | | 22.4 | 8.0 | 22.5 | 7.6 | | | 22.8 | 7.9 | | | | | | | | |
| 2400 | 6 | | | 22.7 | 7.6 | 22.5 | 7.7 | | | 22.8 | 7.8 | | | | | | | | |
| 2400 | 7 | | | 22.7 | 7.5 | 22.4 | 7.6 | | | 22.8 | 7.6 | | | | | | | | |
| 2400 | 8 | | | 22.6 | 7.3 | 22.4 | 7.6 | | | 22.8 | 7.2 | | | | | | | | |
| 2400 | 9 | | | 22.6 | 7.3 | 22.4 | 7.6 | | | 22.8 | 6.2 | | | | | | | | |
| 2400 | 10 | | | 22.6 | 6.4 | 22.5 | 6.6 | | | | | | | | | | | | |
| 300 | 0 | 22.2 | 7.3 | 22.4 | 7.7 | 22.5 | 7.7 | 22.5 | 7.5 | 22.4 | 7.4 | 22.5 | 7.4 | 22.5 | 7.4 | 22.6 | 7.2 | 22.6 | 7.2 |
| 300 | 1 | 22.2 | 7.1 | 22.5 | 7.7 | 22.5 | 7.7 | 22.5 | 7.5 | 22.5 | 7.4 | 22.5 | 7.4 | 22.5 | 7.4 | 22.5 | 7.2 | 22.5 | 7.2 |
| 300 | 2 | 22.2 | 7.2 | 22.5 | 7.7 | 22.5 | 7.7 | 22.4 | 7.5 | 22.6 | 7.4 | 22.5 | 7.4 | 22.5 | 7.4 | 22.6 | 7.0 | 22.6 | 7.0 |
| 300 | 3 | 22.2 | 7.1 | 22.5 | 7.7 | 22.6 | 7.7 | 22.4 | 7.3 | 22.6 | 7.4 | 22.6 | 7.3 | 22.6 | 7.3 | 22.6 | 7.0 | 22.5 | 7.0 |
| 300 | 4 | | | 22.5 | 7.7 | 22.6 | 7.6 | | | 22.6 | 7.4 | 22.6 | 6.0 | 22.6 | 6.0 | 22.6 | 6.0 | 22.3 | 6.0 |
| 300 | 5 | | | 22.5 | 7.7 | 22.6 | 7.7 | | | 22.6 | 7.4 | | | | | | | | |
| 300 | 6 | | | 22.5 | 7.7 | 22.6 | 7.6 | | | 22.6 | 7.4 | | | | | | | | |
| 300 | 7 | | | 22.5 | 7.6 | 22.6 | 7.5 | | | 22.6 | 7.3 | | | | | | | | |
| 300 | 8 | | | 22.5 | 7.5 | 22.6 | 7.4 | | | 22.6 | 7.2 | | | | | | | | |
| 300 | 9 | | | 22.5 | 7.1 | 22.6 | 7.2 | | | 22.6 | 7.0 | | | | | | | | |
| 300 | 10 | | | 22.5 | 6.6 | 22.5 | 6.6 | | | | | | | | | | | | |
| 600 | 0 | 21.9 | 7.3 | 22.3 | 7.3 | 22.4 | 7.3 | 22.3 | 7.1 | 22.5 | 7.2 | 22.5 | 7.1 | 22.5 | 7.1 | 22.3 | 7.1 | 22.3 | 7.1 |
| 600 | 1 | 22.0 | 7.4 | 22.4 | 7.3 | 22.5 | 7.3 | 22.3 | 7.1 | 22.6 | 7.2 | 22.5 | 7.1 | 22.5 | 7.1 | 22.3 | 7.0 | 22.3 | 7.0 |
| 600 | 2 | 22.0 | 7.4 | 22.5 | 7.3 | 22.6 | 7.3 | 22.3 | 7.0 | 22.6 | 7.2 | 22.5 | 7.0 | 22.5 | 7.0 | 22.3 | 6.9 | 22.3 | 6.9 |
| 600 | 3 | 21.0 | 7.0 | 22.5 | 7.3 | 22.6 | 7.3 | 22.3 | 6.9 | 22.6 | 7.2 | 22.5 | 6.9 | 22.5 | 6.9 | 22.3 | 6.6 | 22.3 | 6.6 |
| 600 | 4 | | | 22.5 | 7.3 | 22.5 | 7.3 | | | 22.7 | 7.2 | 22.4 | 6.8 | 22.4 | 6.8 | 22.2 | 6.0 | 22.2 | 6.0 |
| 600 | 5 | | | 22.5 | 7.2 | 22.5 | 7.2 | | | 22.7 | 7.2 | 22.4 | 4.5 | | 4.5 | | | | |
| 600 | 6 | | | 22.5 | 7.2 | 22.5 | 7.1 | | | 22.6 | 7.2 | | | | | | | | |
| 600 | 7 | | | 22.5 | 7.2 | 22.5 | 7.2 | | | 22.6 | 7.1 | | | | | | | | |
| 600 | 8 | | | 22.5 | 7.2 | 22.5 | 7.2 | | | 22.6 | 7.1 | | | | | | | | |
| 600 | 9 | | | 22.5 | 7.2 | 22.5 | 6.9 | | | 22.6 | 6.9 | | | | | | | | |
| 600 | 10 | | | 22.5 | 6.9 | 22.5 | 6.9 | | | 22.6 | 6.3 | | | | | | | | |

Table A-4 (continued)

| RM 102.5 | | | | | | | | | | | | | |
|----------|-------|-------|-----|----------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| RM 111.1 | | | | RM 103.5 | | | | | | | | | |
| TIME | DEPTH | TEMP. | O2 | TEMP. | O2 | TEMP. | O2 | TEMP. | L | TEMP. | O2 | TEMP. | O2 |
| | | R | R | R | R | M | M | L | L | R | R | M | L |
| 900 | 0 | 21.9 | 7.9 | 22.6 | 7.3 | 22.5 | 7.3 | 22.6 | 7.3 | 22.8 | 7.3 | 22.8 | 7.2 |
| 900 | 1 | 22.0 | 7.9 | 22.6 | 7.3 | 22.5 | 7.4 | 22.6 | 7.2 | 22.8 | 7.3 | 22.8 | 7.2 |
| 900 | 2 | 22.0 | 8.1 | 22.5 | 7.3 | 22.5 | 7.3 | 22.6 | 7.2 | 22.8 | 7.3 | 22.8 | 7.2 |
| 900 | 3 | 22.0 | 7.5 | 22.5 | 7.3 | 22.5 | 7.3 | 22.5 | 7.1 | 22.8 | 7.3 | 22.7 | 7.2 |
| 900 | 4 | | | 22.5 | 7.3 | 22.5 | 7.3 | | | 22.8 | 7.2 | 22.6 | 7.1 |
| 900 | 5 | | | 22.5 | 7.3 | 22.5 | 7.3 | | | 22.8 | 7.1 | 22.5 | 6.6 |
| 900 | 6 | | | 22.5 | 7.2 | 22.4 | 7.3 | | | 22.8 | 7.2 | | |
| 900 | 7 | | | 22.4 | 7.1 | 22.4 | 7.2 | | | 22.8 | 7.2 | | |
| 900 | 8 | | | 22.4 | 7.0 | 22.4 | 7.2 | | | 22.7 | 7.1 | | |
| 900 | 9 | | | 22.5 | 6.0 | 22.4 | 7.1 | | | 22.7 | 6.9 | | |
| 900 | 10 | | | | | | | | | | | | |
| 1200 | 0 | 22.4 | 8.3 | 22.7 | 7.4 | 22.7 | 7.3 | 22.6 | 7.5 | 23.0 | 7.4 | 23.0 | 7.4 |
| 1200 | 1 | 22.4 | 8.3 | 22.6 | 7.4 | 22.6 | 7.4 | 22.6 | 7.5 | 23.0 | 7.4 | 23.0 | 7.4 |
| 1200 | 2 | 22.2 | 7.9 | 22.5 | 7.3 | 22.6 | 7.3 | 22.6 | 7.5 | 23.0 | 7.4 | 22.9 | 7.4 |
| 1200 | 3 | 22.2 | 8.0 | 22.5 | 7.3 | 22.6 | 7.3 | 22.6 | 7.5 | 22.9 | 7.4 | 22.8 | 7.3 |
| 1200 | 4 | | | 22.5 | 7.3 | 22.6 | 7.3 | | | 22.8 | 7.3 | 22.8 | 6.6 |
| 1200 | 5 | | | 22.5 | 7.3 | 22.5 | 7.3 | | | 22.8 | 7.3 | | |
| 1200 | 6 | | | 22.5 | 7.2 | 22.4 | 7.2 | | | 22.8 | 7.2 | | |
| 1200 | 7 | | | 22.5 | 7.2 | 22.3 | 7.2 | | | 22.7 | 7.2 | | |
| 1200 | 8 | | | 22.4 | 7.1 | 22.3 | 7.0 | | | 22.7 | 7.1 | | |
| 1200 | 9 | | | 22.4 | 6.9 | 22.3 | 7.0 | | | 22.6 | 7.1 | | |
| 1200 | 10 | | | 22.4 | 6.1 | 22.3 | 6.2 | | | | | | |
| 1500 | 0 | 22.4 | 8.0 | 22.9 | 7.6 | 22.7 | 7.6 | 22.7 | 7.6 | 23.0 | 7.6 | 23.2 | 7.9 |
| 1500 | 1 | 22.4 | 7.9 | 22.9 | 7.6 | 22.7 | 7.6 | 22.8 | 7.6 | 23.1 | 7.8 | 23.2 | 7.9 |
| 1500 | 2 | 22.4 | 8.2 | 22.8 | 7.6 | 22.7 | 7.6 | 22.9 | 7.6 | 23.0 | 7.7 | 23.2 | 7.9 |
| 1500 | 3 | 22.3 | 8.0 | 22.8 | 7.5 | 22.8 | 7.6 | 22.7 | 8.0 | 22.8 | 7.7 | 23.0 | 7.9 |
| 1500 | 4 | | | 22.7 | 7.5 | 22.8 | 7.5 | | | 22.8 | 7.7 | 23.0 | 7.9 |
| 1500 | 5 | | | 22.7 | 7.6 | 22.7 | 7.5 | | | 22.8 | 7.6 | 23.0 | 7.6 |
| 1500 | 6 | | | 22.6 | 7.5 | 22.6 | 7.4 | | | 22.7 | 7.6 | | |
| 1500 | 7 | | | 22.6 | 7.5 | 22.5 | 7.4 | | | 22.7 | 7.5 | | |
| 1500 | 8 | | | 22.5 | 7.5 | 22.3 | 7.3 | | | 22.7 | 7.4 | | |
| 1500 | 9 | | | 22.5 | 7.4 | 22.3 | 7.3 | | | 22.7 | 6.6 | | |
| 1500 | 10 | | | 22.5 | | 22.3 | | | | 22.7 | | | |

APPENDIX B

QA / QC Raw Data

Spokane River pH Quality Control.

| Date | Station | Field model 47 | Lab model 7 | Lab Model 3500 |
|---------|---------|----------------|-------------|----------------|
| ===== | ===== | ===== | ===== | ===== |
| 9/10/91 | 1 | 6.2 | 6.4 | N/A |
| | 2 | 6.2 | 6.4 | N/A |
| | 3 | 6.4 | 6.3 | N/A |
| | 4 | 6.3 | 6.7 | N/A |
| | 5 | 6.2 | 6.6 | N/A |
| | 6 | 6.3 | 6.5 | N/A |
| | PF | 6.7 | 7.3 | N/A |
| | CDA | 6.4 | 6.9 | N/A |
| 5/12/91 | 1 | 6.1 | 5.7 | N/A |
| | 2 | 6.5 | 5.9 | N/A |
| | 3 | 6.6 | 6.1 | N/A |
| | 4 | 6.7 | 6.3 | N/A |
| | 5 | 6.7 | 6.2 | N/A |
| | 6 | 6.7 | 6.3 | N/A |
| | PF | 7.0 | 6.9 | N/A |
| | CDA | 7.2 | 7.0 | N/A |
| 7/2/91 | 1 | 5.9 | 5.7 | N/A |
| | 2 | 5.3 | 6.0 | N/A |
| | 3 | 5.5 | 6.1 | N/A |
| | 4 | 5.6 | 6.2 | N/A |
| | 5 | 5.8 | 6.3 | N/A |
| | 6 | 5.9 | 6.3 | N/A |
| | PF | NA | NA | N/A |
| | CDA | 6.3 | 6.0 | N/A |
| 3/12/91 | 1 | 7.3 | 7.7 | N/A |
| | 2 | 7.3 | 7.7 | N/A |
| | 3 | 7.4 | 7.7 | N/A |
| | 4 | 7.5 | 7.9 | N/A |
| | 5 | 7.4 | 7.9 | N/A |
| | 6 | 7.5 | 7.9 | N/A |
| | PF | 7.1 | 7.5 | N/A |
| | CDA | 8.0 | 8.2 | N/A |

| | | | | |
|--------|-----|-----|-----|-----|
| 5/7/91 | 1 | 5.0 | 5.1 | 5.3 |
| | 2 | 5.2 | 5.2 | 5.3 |
| | 3 | 5.5 | 5.4 | 5.4 |
| | 4 | 5.6 | 5.5 | 5.5 |
| | 5 | 5.6 | 5.7 | 5.6 |
| | 6 | 5.7 | 5.8 | 5.7 |
| | PF | 6.8 | 6.9 | 6.9 |
| | CDA | 7.4 | 7.2 | 7.1 |

| | | | | |
|---------|-----|-----|-----|-----|
| 10/1/90 | 1 | 6.9 | 7.0 | 7.1 |
| | 2 | 6.9 | 7.1 | 7.1 |
| | 3 | 7.0 | 7.1 | 7.0 |
| | 4 | 7.1 | 7.1 | 7.0 |
| | 5 | 3.5 | 3.3 | 3.3 |
| | 6 | 6.4 | 6.3 | 6.5 |
| | PF | 7.1 | 7.1 | 7.0 |
| | CDA | 7.9 | 7.9 | 7.8 |

Grand Mean

Mean of Ranges

| | | |
|---------------|-----|-----|
| River (1 - 6) | 6.3 | 0.3 |
| PF | 7 | 0.3 |
| CDA | 7.2 | 0.3 |

Spokane River Nutrient Quality Control.

NH3 DUP'S

| location | # of dup's | mean | std dev. |
|----------|------------|----------|----------|
| river | 21 | 0.141962 | 0.02283 |
| pfwwtp | 5 | 1.586 | 0.392602 |
| cdawwtp | 2 | 23.4725 | 0.015 |

NO3 DUP'S

| Location | # of Dup's | mean | Std dev. |
|----------|------------|----------|----------|
| river | 18 | 0.070139 | 0.009594 |
| pfwwtp | 2 | 12.735 | 0.48 |
| cdawwtp | 3 | 2.064683 | 0.11183 |

O-P DUP'S

| Location | # of dup's | mean | std dev. |
|----------|------------|----------|----------|
| river | 18 | <.006 | 0.001329 |
| pfwwtp | 3 | 3.791667 | 0.153261 |
| cdawwtp | 2 | 3.985 | 0.05 |

TP DUP'S

| Location | # of dup's | mean | std dev. |
|----------|------------|----------|----------|
| river | 28 | 0.01281 | 0.002452 |
| pfwwtp | 3 | 3.014683 | 0.074962 |
| cdawwtp | 1 | 3.73 | 0.02 |

TKN DUP'S

| Location | # of dup's | mean | std dev. |
|----------|------------|------|----------|
| river | 49 | N/A | 0.0137 |
| pfwwtp | 3 | N/A | 0.1367 |
| cdawwtp | 3 | N/A | 0.1367 |

Spokane River Chlorophyll a Quality Control.

| | | chlor a (mg'm3) | | | |
|-------------|-----|-----------------|-------|-------|-------|
| Date | sta | Run 1 | Run 2 | mean | range |
| Aug 6, 1990 | 1 | 1.79 | 1.93 | 1.86 | 0.14 |
| | 2 | 2.08 | 1.85 | 1.965 | 0.23 |
| | 3 | 5.19 | 5.16 | 5.175 | 0.03 |
| | 4 | 7.37 | 7.25 | 7.31 | 0.12 |
| | 5 | 5.06 | 6.31 | 5.685 | 1.25 |
| | 6 | 0 | 0.24 | 0.12 | 0.24 |

| Date | sta | Run 1 | Run 2 | | |
|-------------|-----|-------|-------|-------|------|
| Apr 9, 1991 | 1 | 3.52 | 3.56 | 3.54 | 0.04 |
| | 2 | 3.87 | 3.94 | 3.905 | 0.07 |
| | 3 | 1.16 | 1.08 | 1.12 | 0.08 |
| | 4 | 4.66 | 4.93 | 4.795 | 0.27 |
| | 5 | 4.31 | 3.91 | 4.11 | 0.4 |
| | 6 | 5.3 | 5.24 | 5.27 | 0.06 |

| Date | sta | Run 1 | Run 2 | | |
|---------------|-----|-------|-------|-------|------|
| July 30, 1991 | 1 | 0.12 | 0 | 0.06 | 0.12 |
| | 2 | 0 | 0 | 0 | 0 |
| | 3 | 0 | 0.14 | 0.07 | 0.14 |
| | 4 | 2.12 | 2.01 | 2.065 | 0.11 |
| | 5 | 0 | 0 | 0 | 0 |
| | 6 | 0 | 0.04 | 0.02 | 0.04 |

Grand Mean

Mean of Ranges

River (1 - 6)

2.6

0.19

NUTRIENT DUPLICATES - STD. DEVIATIONS

NH3 DUP'S

| location | # of dup's | mean | std dev. |
|----------|------------|-------|----------|
| RIVER | 21 | 0.14 | 0.02 |
| PFWWTP | 5 | 1.59 | 0.39 |
| CDAWWTP | 2 | 23.47 | 0.02 |

NO3 DUP'S

| location | # of dup's | mean | std dev. |
|----------|------------|-------|----------|
| RIVER | 18 | 0.07 | 0.01 |
| PFWWTP | 2 | 12.74 | 0.48 |
| CDAWWTP | 3 | 2.06 | 0.11 |

O-P DUP'S

| location | # of dup's | mean | std dev. |
|----------|------------|-------|----------|
| RIVER | 18 | <.006 | 0.00 |
| PFWWTP | 3 | 3.79 | 0.15 |
| CDAWWTP | 2 | 3.99 | 0.05 |

TP DUP'S

| location | # of dup's | mean | std dev. |
|----------|------------|------|----------|
| RIVER | 28 | 0.01 | 0.00 |
| PFWWTP | 3 | 3.01 | 0.07 |
| CDAWWTP | 1 | 3.73 | 0.02 |

TKN DUP'S

| | | | |
|---------|----|--|------|
| RIVER | 49 | | 0.01 |
| PFWWTP | 3 | | 0.14 |
| CDAWWTP | 3 | | 0.14 |

Spokane River 5-day BOD Quality Control.

| Date | Station | 5-day BOD | | | | |
|-------------|---------|-----------|-------|-------|-----------|-------|
| | | Run 1 | Run 2 | Run 3 | mean | range |
| Aug 6, 1990 | 1 | 2.1 | 3.6 | 1.3 | 2.3333333 | 2.3 |
| | 2 | 3.3 | 5.3 | | 4.3 | 2 |
| | 3 | 4.6 | 4 | | 4.3 | 0.6 |
| | 4 | 4.8 | 6.6 | | 5.7 | 1.8 |
| | 5 | 4.5 | 5.5 | | 5 | 1 |
| | 6 | 3.3 | 5.7 | 4 | 4.3333333 | 2.4 |
| | PF | 12.6 | 15.4 | | 14 | 2.8 |
| | CDA * | >50 | >50 | | N/A | N/A |

* -- sample = < 2 mg/l after 5 days.

| Date | Station | Run 1 | Run 2 | Run 3 | | |
|--------------|---------|-------|-------|-------|------|-----|
| Jan 15, 1991 | 1 | 3 | 4 | 4.4 | 3.8 | 1.4 |
| | 2 | 2.7 | 3.3 | | 3 | 0.6 |
| | 3 | 4 | 2.7 | | 3.35 | 1.3 |
| | 4 | 3.3 | 2.7 | | 3 | 0.6 |
| | 5 | 2.7 | 2.7 | | 2.7 | 0 |
| | 6 | 3.3 | 3.5 | 3.7 | 3.5 | 0.2 |
| | PF | 7.7 | 10 | | 8.85 | 2.3 |
| | CDA | 70.1 | 79.3 | | 74.7 | 9.2 |

| Date | Station | Run 1 | Run 2 | Run 3 | | |
|-------------|---------|-------|-------|-------|-----|-----|
| May 8, 1991 | 1 | 2 | 4 | 3 | 3 | 2 |
| | 2 | 3.3 | 3.3 | | 3.3 | 0 |
| | 3 | N/A | N/A | | N/A | N/A |
| | 4 | 2.4 | 3 | | 2.7 | 0.6 |
| | 5 | 1.6 | 2.4 | | 2 | 0.8 |
| | 6 | 2.2 | 4 | 2.8 | 3 | 1.8 |
| | PF | 13.6 | 10.4 | | 12 | 3.2 |
| | CDA | 75 | 125 | | 100 | 50 |

| Date | Station | Run 1 | Run 2 | Run 3 | | |
|---------------|---------|-------|-------|-------|-----------|-----|
| July 16, 1991 | 1 | 2.6 | 2.5 | 2.9 | 2.6666667 | 0.4 |
| | 2 | 0.6 | 0.8 | | 0.7 | 0.2 |
| | 3 | 1.9 | 2 | | 1.95 | 0.3 |
| | 4 | 3 | 10.4 | | 6.7 | 7.4 |
| | 5 | 1.7 | 2.3 | | 2 | 0.6 |
| | 6 | 3 | 2.8 | 3.2 | 3 | 0.4 |
| | PF | 10.5 | 10.9 | | 10.7 | 0.4 |
| | CDA | 62.5 | 97.5 | | 80 | 35 |

| Date | Station | Run 1 | Run 2 | Run 3 | | |
|---------------|---------|-------|-------|-------|------|-----|
| Sept 24, 1991 | 1 | 6.7 | 3.3 | 5 | 5 | 3.4 |
| | 2 | 6 | 6 | | 6 | 0 |
| | 3 | 4.2 | 5.2 | | 4.7 | 1 |
| | 4 | 4.1 | 3.9 | | 4 | 0.2 |
| | 5 | 4.3 | 3.7 | | 4 | 0.5 |
| | 6 | 2.5 | 6 | 9.5 | 6 | 7 |
| | PF | 10.8 | 11.8 | | 11.3 | 1 |
| | CDA | 15 | 25 | | 20 | 10 |

Grand Mean

Mean of Ranges

| | | |
|---------------|------|------|
| River (1 - 6) | 3.7 | 1.4 |
| PF | 11.4 | 1.9 |
| CDA | 68.7 | 26.1 |

No ultimate BOD samples were run in duplicate due to limitations on glassware.

Spokane River Bacteria Quality Control.

Feb 12, 1991.

| Sta | Fecal Coliform | | Fecal Streptococcus | | FC Mean | FC Range | FS Mean | FS Range |
|-----|----------------|-----|---------------------|-----|---------|----------|---------|----------|
| | U of I | DEQ | U of I | DEQ | | | | |
| 1 | 0 | 1 | 0 | 1 | 0.5 | 1 | 0.5 | 1 |
| 2 | 10 | 7 | 4 | 7 | 8.5 | 3 | 5.5 | 3 |
| 3 | 5 | 3 | 0 | 3 | 4 | 2 | 1.5 | 3 |
| 4 | 2 | 2 | 1 | 4 | 2 | 0 | 2.5 | 3 |
| 5 | 5 | 5 | 0 | 2 | 5 | 0 | 1 | 2 |
| 6 | 0 | 1 | 1 | 2 | 0.5 | 1 | 1.5 | 1 |
| PF | 310 | 340 | 16 | 20 | 325 | 30 | 18 | 4 |
| CDA | 8 | 10 | 29 | 20 | 9 | 2 | 24.5 | 9 |

Sept 17, 1990.

| | Fecal Coliform | | Fecal Streptococcus | | | | | |
|-----|----------------|------------|---------------------|------------|------|----|------|---|
| | U of I (1) | U of I (2) | U of I (1) | U of I (2) | | | | |
| 1 | 1 | 3 | 14 | 8 | 2 | 2 | 11 | 6 |
| 2 | 11 | 14 | 13 | 8 | 12.5 | 3 | 10.5 | 5 |
| 3 | 7 | 9 | 11 | 6 | 8 | 2 | 8.5 | 5 |
| 4 | 10 | 9 | 1 | 4 | 9.5 | 1 | 2.5 | 3 |
| 5 | 12 | 16 | 6 | 5 | 14 | 4 | 5.5 | 1 |
| 6 | 32 | 30 | 11 | 14 | 31 | 2 | 12.5 | 3 |
| PF | 54 | 38 | 20 | 22 | 46 | 16 | 21 | 2 |
| CDA | 42 | 44 | 2 | 6 | 43 | 2 | 4 | 4 |

May 7, 1991.

| | Fecal Coliform | | Fecal Streptococcus | | | | | |
|-----|----------------|------------|---------------------|------------|------|-----|------|-----|
| | U of I (1) | U of I (2) | U of I (1) | U of I (2) | | | | |
| 1 | <1 | 2 | <1 | <1 | 1.25 | 1.5 | 0.5 | 0 |
| 2 | <1 | <1 | <1 | 2 | 0.5 | 0 | 1.25 | 1.5 |
| 3 | <1 | 1 | 4 | 3 | 0.75 | 0.5 | 3.5 | 1 |
| 4 | <1 | <1 | 5 | 7 | 0.5 | 0 | 6 | 2 |
| 5 | <1 | <1 | 2 | 1 | 0.5 | 0 | 1.5 | 1 |
| 6 | 1 | 2 | 3 | 5 | 1.5 | 1 | 4 | 2 |
| PF | <1 | 2 | 1 | 3 | 1.25 | 1.5 | 2 | 2 |
| CDA | NA | NA | NA | NA | NA | NA | NA | NA |

Fecal Coliform

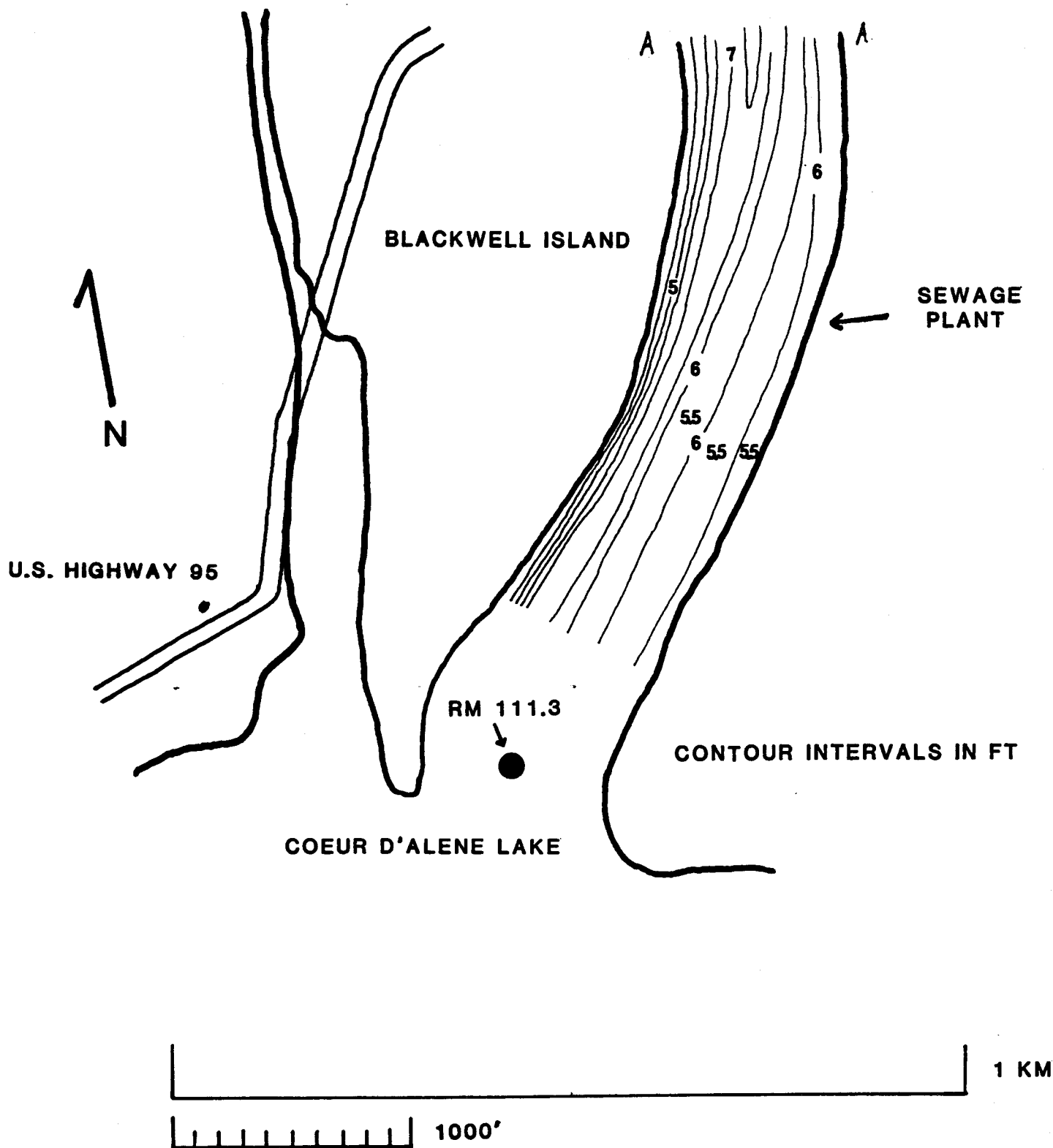
| | Grand Mean | Mean of Ranges |
|---------------|------------|----------------|
| River (1 - 6) | 5.7 | 1.33 |
| PF | 124.1 | 15.8 |
| CDA | 26 | 2 |

Fecal Streptococcus

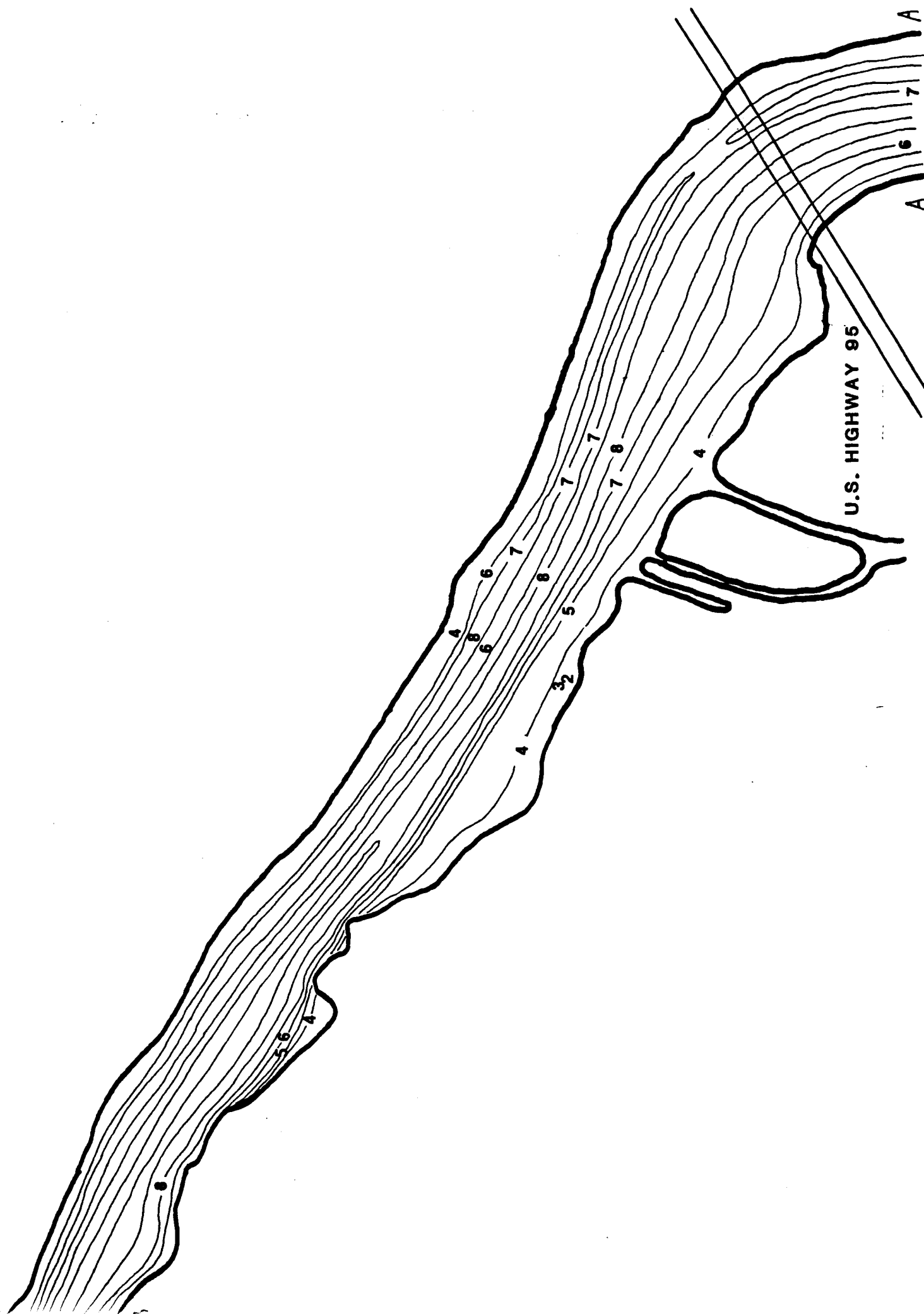
| | Grand Mean | Mean of Ranges |
|---------------|------------|----------------|
| River (1 - 6) | 4.4 | 2.4 |
| PF | 13.7 | 2.7 |
| CDA | 14.25 | 6.5 |

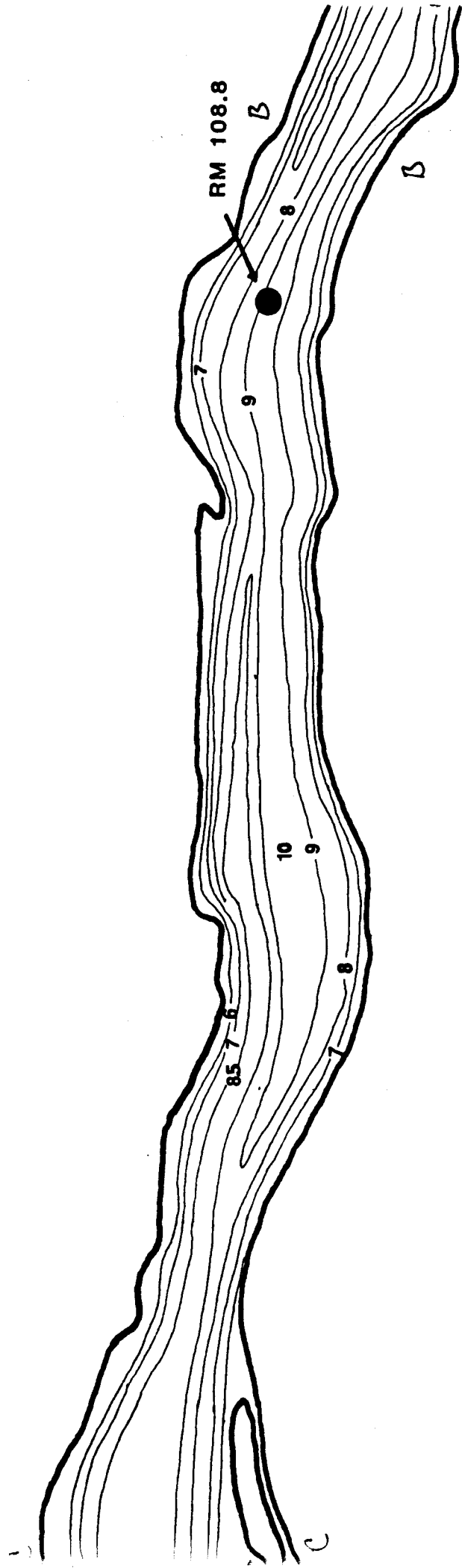
APPENDIX C

Morphometric Maps of the Spokane River

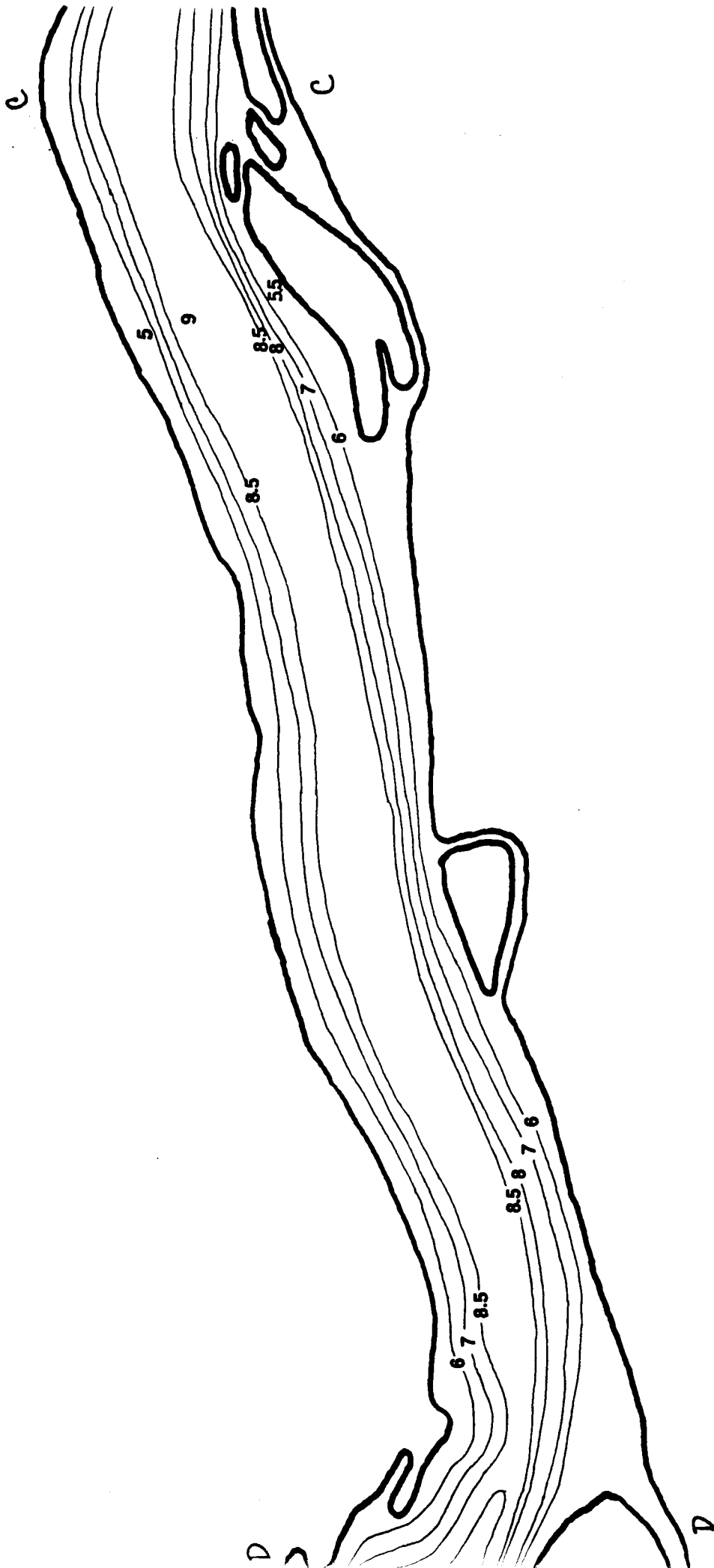


Morphometric map of the Spokane River (Idaho) at the Coeur d'Alene Lake outlet, May-October, 1980.





CONTOUR INTERVALS IN FT



RM 106.5

D

D

HARBOR ISLAND

14
15
16
16
15
14
9

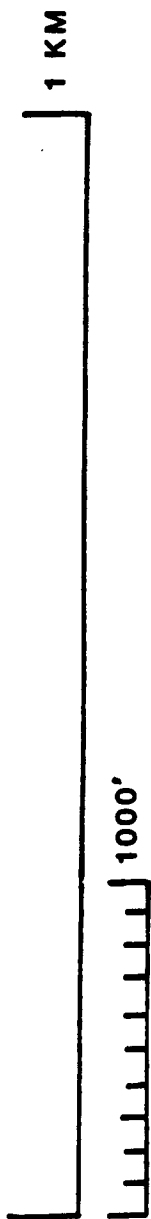
45
87.6

8
8.5
14
15
16
18
18
15
14
8.5
8.76

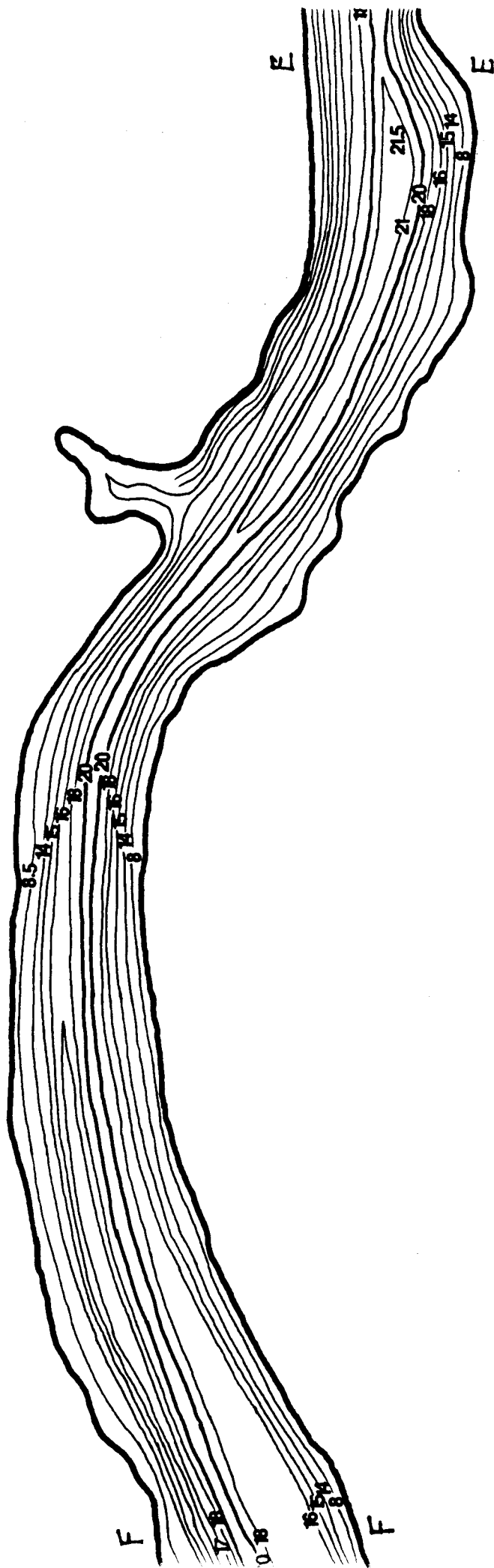
6
18
15
16
20
18
16
15
14
8

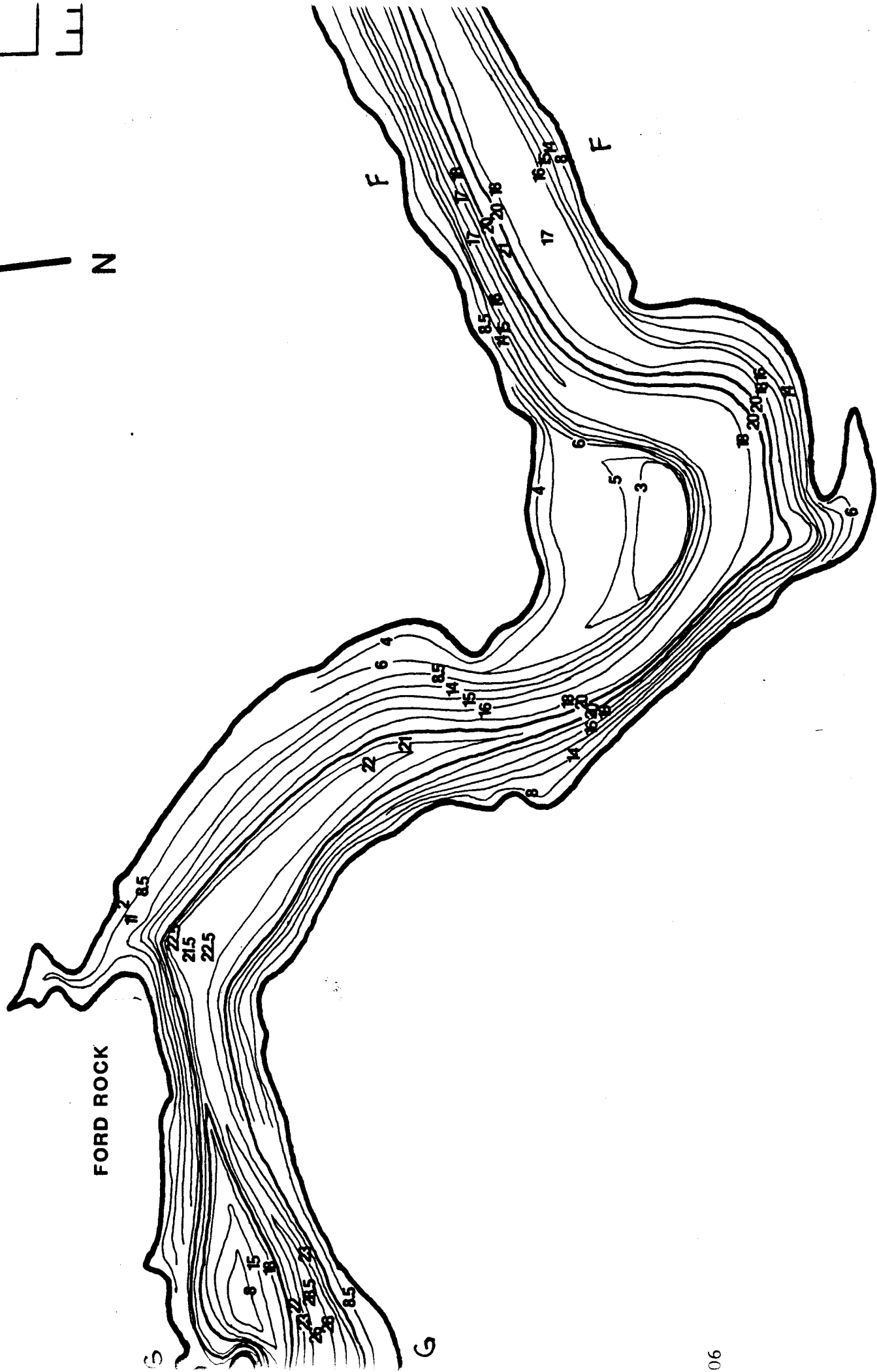
E

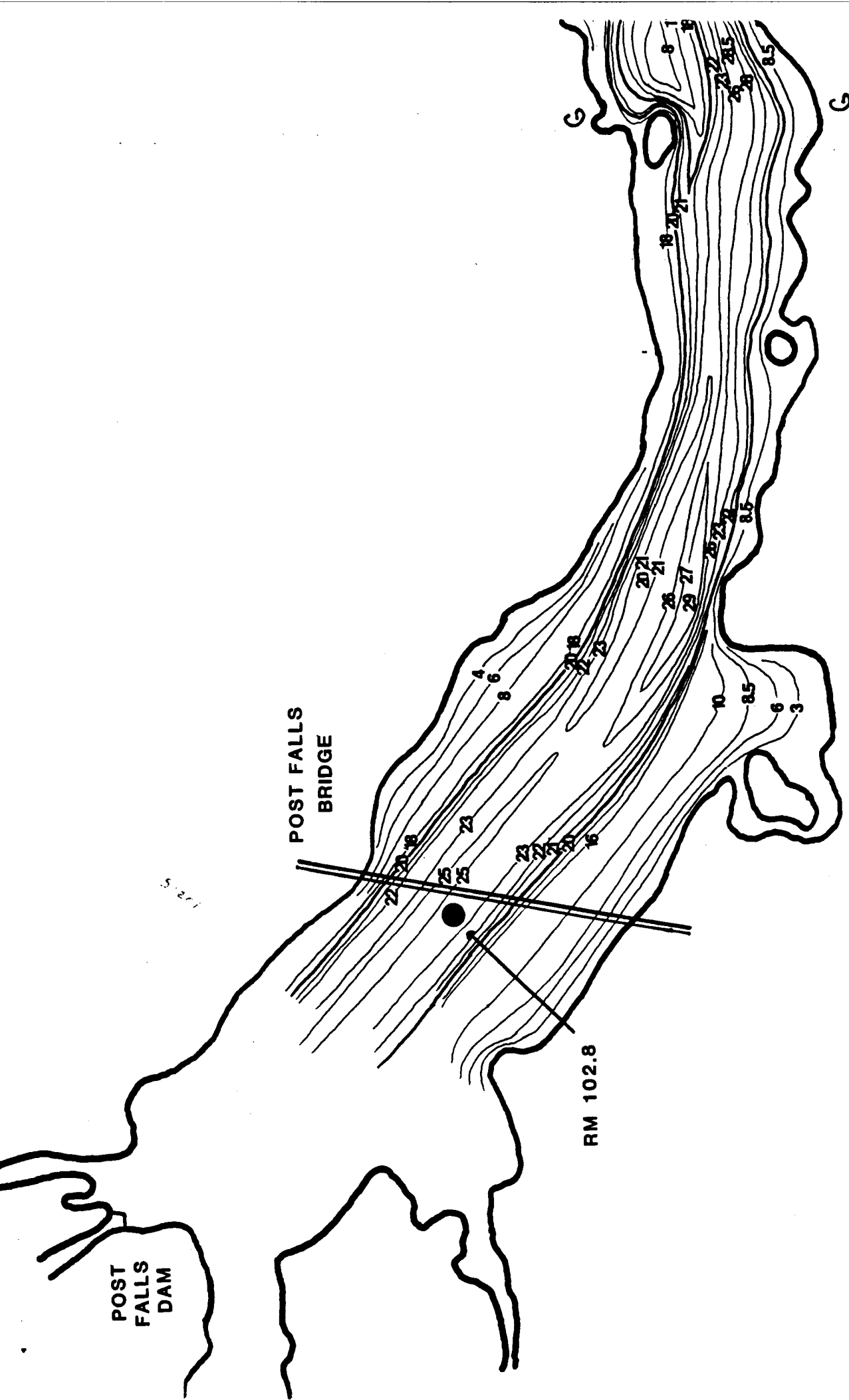
E

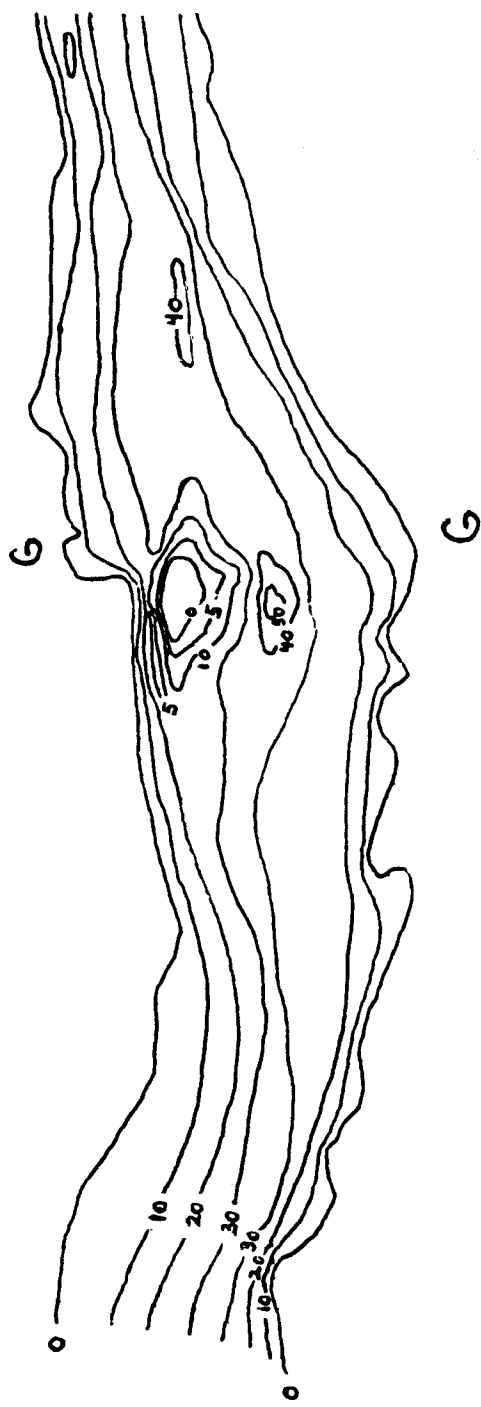


CONTOUR INTERVALS IN FT









Vicinity of Ford Rock on the Spokane River with revised depth measurements of 1991.

APPENDIX D

Appropriate Idaho Water Quality Standards

DESIGNATED USES

Protected for General Use

* Protected for Future Use

Legend X Use Protected Above
Mining Impact Area

| Map
Code | Waters | Domestic
Water
Supply | Agricultur-
al Water
Supply | Cold
Water
Biota | Warm
Water
Biota | Salmonid
Spawning | Primary
Contact
Recreation | Secondary
Contact
Recreation | Special
Resource
Water | |
|--------------|---|-----------------------------|-----------------------------------|------------------------|------------------------|----------------------|----------------------------------|------------------------------------|------------------------------|------------|
| | source to mouth | | | | | | | | | (1-1-85) |
| ii. PB-320S | ST. JOE RIVER-Calder
to St. Maries River | # | # | # | # | # | # | # | # | (1-30-80) |
| jj. PB-321S | ST. MARIES RIVER -
source to Fernwood | # | # | # | * | * | # | # | # | (1-30-80) |
| kk. PB-322S | ST. MARIES RIVER -
Fernwood to mouth | # | # | * | * | * | # | # | # | (1-30-80) |
| ll. PB-3221S | SANTA CREEK - source
to mouth | # | # | * | * | * | # | # | # | (1-30-80) |
| mm. PB-330S | ST. JOE RIVER -
St. Maries to mouth | # | # | # | # | # | # | # | # | (1-30-80) |
| nn. PB-340S | PLUMMER CREEK | # | # | # | # | # | # | # | # | (1-30-80) |
| oo. PB-350S | FERNAN LAKE AND
OUTLET to Coeur
d'Alene Lake | # | # | # | # | # | # | # | # | (1-30-80) |
| pp. PB-40S | SPOKANE RIVER -
Coeur d'Alene Lake
outlet to Ida-Wash
border | # | # | # | # | # | # | # | # | (10-15-85) |
| qq. PB-410S | SPIRIT LAKE | # | # | # | # | # | # | # | # | (1-30-80) |
| rr. PB-420S | TWIN LAKES | # | # | # | # | * | # | # | # | (1-30-80) |
| ss. PB-430S | HAYDEN LAKE | # | # | # | # | # | # | # | # | (1-30-90) |
| tt. PB-440S | HAUSER LAKE | # | # | # | # | * | # | # | # | (1-30-80) |

1.2161 -- 01.2199 (RESERVED)

01.2200, GENERAL WATER QUALITY STANDARDS. The following general water quality standards will apply to waters of the State, both surface and underground, in addition to the water quality standards set forth for specifically classified waters. Idaho Department of Health and Welfare Rules and Regulations Sections 01.2200,04. -- 01.2200,06. will, however, apply only to surface waters. As a result of man-caused point or nonpoint source discharge, waters of the State must not contain: (1-30-80)

01. Hazardous Materials. Hazardous materials (see Idaho Department of Health and Welfare Rules and Regulations Section 01.2003,19.) in concentrations found to be of public health significance or to adversely affect designated or protected beneficial uses. These materials do not include suspended sediment produced as a result of nonpoint source activities. (1-1-85)
02. Deleterious Materials. Deleterious materials (see Idaho Department of Health and Welfare Rules and Regulations Section 01.2003,07.) in concentrations that impair designated or protected beneficial uses without being hazardous. These materials do not include suspended sediment produced as a result of nonpoint source activities. (1-1-85)
03. Radioactive Materials. Radioactive materials or radioactivity which:
 - a. Exceed one-third (1/3) of the values listed in Idaho Department of Health and Welfare Rules and Regulations, Title 1, Chapter 9, Section 01.9110,03.a.ii., "Rules Governing Radiation Control." (1-1-85)
 - b. Exceed concentrations required to meet the "Radiation Protection Guides" for maximum exposure of critical human organs recommended by the former Federal Radiation Council in the case of foodstuffs harvested from these waters for human consumption. (1-30-80)
04. Floating, Suspended or Submerged Matter. Floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may adversely affect designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities. (2-2-83)

- 05. Excess Nutrients. Excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated or protected beneficial uses. (1-30-80)
- 06. Oxygen-Demanding Materials. Oxygen-demanding materials in concentrations that would result in an anaerobic water condition. (1-30-80)
- 07. Suspended Sediment. Suspended sediment in concentrations that seriously injure a designated or protected beneficial use. (2-2-83)

01.2201 -- 01.2249 (RESERVED)

01.2250, WATER QUALITY CRITERIA FOR USE CLASSIFICATIONS

- 01. Primary Contact Recreation. Between May 1 and September 30 of each calendar year, waters designated for primary contact recreation are not to contain fecal coliform bacteria significant to the public health in concentrations exceeding: (1-30-80)
 - a. 500/100 ml. at any time; and (1-30-80)
 - b. 200/100 ml. in more than ten percent (10%) of the total samples taken over a thirty (30) day period; and (1-30-80)
 - c. A geometric mean of 50/100 ml. based on a minimum of five (5) samples taken over a thirty (30) day period. (1-30-80)
- 02. Secondary Contact Recreation. Waters designated for secondary contact recreation are not to contain fecal coliform bacteria significant to the public health in concentrations exceeding: (1-30-80)
 - a. 800/100 ml. at any time; and (1-30-80)
 - b. 400/100 ml. in more than ten percent (10%) of the total samples taken over a thirty (30) day period; and (1-30-80)
 - c. A geometric mean of 200/100 ml. based on a minimum of five (5) samples taken over a thirty (30) day period. (1-30-80)
- 03. Warm Water Biota. Waters designated for warm water biota are to exhibit the following characteristics: (1-30-80)
 - a. Dissolved oxygen concentrations exceeding 5

mg/l at all times. In lakes and reservoirs this standard does not apply to: (1-30-80)

- i. The bottom twenty percent (20%) of the water depth in natural lakes and reservoirs where depths are thirty-five (35) meters or less. (1-30-80)
 - ii. The bottom seven (7) meters of water depth in natural lakes and reservoirs where depths are greater than thirty-five (35) meters. (1-30-80)
 - iii. Those waters of the hypolimnion in stratified lakes and reservoirs. (1-30-80)
- b. Hydrogen Ion Concentration (pH) values within the range of 6.5 to 9.0. (1-30-80)
- c. Water temperatures of 33° C or less with a maximum daily average not greater than 29° C. (1-30-80)
- d. The total concentration of dissolved gas not exceeding one hundred ten percent (110%) of saturation at atmospheric pressure at the point of sample collection. (1-30-80)
- e. Mean concentration of un-ionized ammonia at a level of 0.05 mg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period. (1-30-80)

04. Cold Water Biota. Waters designated for cold water biota are to exhibit the following characteristics: (1-30-80)

- a. Dissolved Oxygen Concentrations exceeding 6 mg/l at all times. In lakes and reservoirs this standard does not apply to: (1-30-80)
 - i. The bottom twenty percent (20%) of water depth in natural lakes and reservoirs where depths are thirty-five (35) meters or less. (1-30-80)
 - ii. The bottom seven (7) meters of water depth in natural lakes and reservoirs where depths are greater than thirty-five (35) meters. (1-30-80)
 - iii. Those waters of the hypolimnion in stratified lakes and reservoirs.

(1-30-80)

- b. Hydrogen Ion Concentration (pH) values within the range of 6.5 and 9.0. (1-30-80)
- c. Water temperatures of 22° C or less with a maximum daily average of no greater than 19° C. (1-30-80)
- d. The total concentration of dissolved gas not exceeding one hundred ten percent (110%) of saturation at atmospheric pressure at the point of sample collection. (1-30-80)
- e. Mean concentration of un-ionized ammonia at a level of 004. mg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period if water quality characteristics are near optimal for the protected use. In all other cases, the mean concentration of un-ionized ammonia is to be 002. mg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period. (1-30-80)

05. Salmonid Spawning. Waters designated for salmonid spawning are to exhibit the following characteristics during the spawning period and incubation for the particular species inhabiting those waters: (1-30-80)

- a. Dissolved Oxygen concentrations exceeding 6 mg/l or ninety percent (90%) of saturation, whichever is greater. (1-30-80)
- b. Hydrogen Ion Concentration (pH) values within the range of 6.5 to 9.0. (1-30-80)
- c. Water temperatures of 13° C or less with a maximum daily average no greater than 9° C. (1-30-80)
- d. Total concentration of dissolved gas not exceeding one hundred ten percent (110%) of saturation at atmospheric pressure at the point of sample collection. (1-30-80)
- e. Mean concentration of un-ionized ammonia at a level of 004. mg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period if water quality characteristics are near optimal for the protected use. In all other cases, the mean concentration of un-ionized ammonia is to be

002. mg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period. (1-30-80)

06. Domestic Water Supplies. Waters designated for domestic water supplies are to exhibit the following characteristics: (1-30-80)

TABLE

| | Substance | Maximum Allowable Concentrations mg/l | Degrees Celsius | |
|------|-----------------|---|-----------------|-----------|
| a. | Arsenic | 005.0 | | (1-30-80) |
| b. | Barium | 1.000 | | (1-30-80) |
| c. | Cadmium | 001.0 | | (1-30-80) |
| d. | Chromium | 005.0 | | (1-30-80) |
| e. | Cyanide | 0.200 | | (1-30-80) |
| f. | Fluoride* | | | |
| i. | | 2.400 | Up to 12.0 | (1-30-80) |
| ii. | | 2.200 | 12.1 - 14.6 | (1-30-80) |
| iii. | | 2.000 | 14.7 - 17.6 | (1-30-80) |
| iv. | | 1.800 | 17.7 - 21.4 | (1-30-80) |
| v. | | 1.600 | 21.5 - 26.1 | (1-30-80) |
| vi. | | 1.400 | 26.3 - 32.5 | (1-30-80) |
| g. | Lead | 005.0 | | (1-30-80) |
| h. | Mercury | 0.002 | | (1-30-80) |
| i. | Nitrate (as N) | 10.000 | | (1-30-80) |
| j. | Selenium | 001.0 | | (1-30-80) |
| k. | Silver | 005.0 | | (1-30-80) |
| l. | Endrin | 0.0002 | | (1-30-80) |
| m. | Lindane | 0.004 | | (1-30-80) |
| n. | Methoxychlor | 0.100 | | (1-30-80) |
| o. | Sodium | No maximum established; 20 suggested as optimum | | (1-1-85) |
| p. | Toxaphene | 0.005 | | (1-30-80) |
| q. | Trihalomethanes | 0.100 | | (1-1-85) |
| r. | 2,4-D | 0.100 | | (1-1-85) |
| s. | 2,4,5-TP Silvex | 001.0 | | (1-1-85) |

* As determined by the average annual maximum daily air temperature for the area where the water is to be used.

t. Radioactive materials. Radioactive materials or radioactivity not to exceed concentrations specified in Idaho Department of Health and Welfare Rules and Regulations Title 1, Chapter 8, Section 01.8102,01., "Rules Governing Public Drinking Water Systems." (1-1-85)

APPENDIX E

Water Quality Characteristics of Other Northern Idaho Streams

Water quality characteristics of the Upper Spokane River, the Pend Oreille
River below Box Canyon Dam, and the Palouse River near Potlatch, Idaho.*

Spring Water Quality Characteristics (April)

| | Spokane R.
(4/9/91) | Pend Oreille R.
(4/90) | Palouse R.
(4/20/76) |
|--------------------------------|------------------------|---------------------------|-------------------------|
| Temperature (C) | 3.9 | 8.7 | 3.5 |
| Dissolved Oxygen (mg/l) | 12.5 | 11.05 | 11.9 |
| Secchi (m) | 2.4 | 1.7 | N/A |
| pH | 7.8 | 7.9 | 7.2 |
| Total Phosphorus (mg/l) | 0.018 | 0.022 | 0.26 |
| Total Kjeldhal Nitrogen (mg/l) | 0.15 | 0.29 | 1.2 |
| Nitrate-nitrogen (mg/l) | 0.089 | 0.04 | 1.07 |
| Ammonia-nitrogen (mg/l) | 0.14 | 0.21 | 0.07 |
| Chlorophyll a (mg/m3) | 3.8 | 4.1 | N/A |

Late-Summer Water Quality Characteristics (Aug.-Sept.)

| | Spokane R.
(8/27/91) | Pend Oreille R.
(8/89 & 8/90) | Palouse R.
(9/10/75) |
|--------------------------------|-------------------------|----------------------------------|-------------------------|
| Temperature (C) | 25.6 | 21.7 | 18.5 |
| Dissolved Oxygen (mg/l) | 7.5 | 8.4 | 8.5 |
| Secchi (m) | 3.3 | 4.5 | N/A |
| pH | 6.7 | 8.3 | 7.2 |
| Total Phosphorus (mg/l) | 0.01 | 0.01 | 0.08 |
| Total Kjeldhal Nitrogen (mg/l) | 0.19 | 0.16 | 1.7 |
| Nitrate-nitrogen (mg/l) | 0.04 | 0.02 | <.01 |
| Ammonia-nitrogen (mg/l) | 0.19 | 0.15 | 0.21 |
| Chlorophyll a (mg/m3) | 4.51 | 1.02 | N/A |

* -- Pend Oreille River data from WATER QUALITY, FISH AND WILDLIFE CHARACTERISTICS
OF BOX CANYON RESERVOIR, WASHINGTON. C. M. Falter, C. Baines, and J. W. Carlson.
1991. Completion Report 1989-1990. University of Idaho.
Palouse River data from WATER QUALITY STATUS REPORT, PALOUSE RIVER.
1975-1976. Report No. 33. Idaho Department of Health and Welfare.
Division of Environment.

**REVIEW COMMENTS AND AUTHORS' RESPONSES
SPOKANE RIVER WATER QUALITY STUDY
JUNE, 1990 - OCTOBER, 1991**

March 24, 1992

Note of the Authors: Many of following reviewers' questions and comments refer to points that were simply beyond the scope of this study. We point out that this study was not, nor was it ever intended to be, an exhaustive study of the Spokane River and Wastewater Treatment Plants. Nor did the project scope of work given us did not include the amount of intensive sampling that would have been required to answer many of reviewers' questions. Both the length of the study and amount of funding were insufficient to have answered so many of the river dynamics questions of what is happening at any given time in the Spokane River ecosystem. Most of these questions are great questions, but should have been posed as this study was being designed and funding appropriated. The funding of \$25,000 a year was far below the funding level required to answer most of these concerns.

The Spokane River is a complex system with a diverse array of point and non-point pollution sources affecting it. The basic goal of this study was to collect a limited amount of data, as outlined in the study plan, and based on this data, try to define general trends which, when viewed and acted upon would lead to an overall improvement in water quality of the Spokane River in the future. We feel we accomplished the goal.

**CITY OF COEUR D'ALENE
COMMENTS TO THE
WATER QUALITY STUDY
OF
THE UPPER SPOKANE RIVER CONDUCTED BY:
C.M. FALTER
B. RIGGERS
J.W. CARLSON
1990/91**

Draft published December 1991.

Comments will be in numerical order by Section, Page Number and Paragraph Number.

Comments will be in numerical order by Section, Page Number and Paragraph Number.

No. 1, Abstract, Page xi, Paragraph I

The authors in describing the upper reaches of the Spokane River state that: "this reach is typified by swift water currents and cobble bottomed channel in the upper section.." In fact, numerous field trips by our staff and others of the community have noted a tremendous amount of "wood product" debris all along the upper reaches of the river, both in mid-channel and along the shores. This is easily evidenced at the Cedars Floating Restaurant, where the entire area is littered with logging debris.

The statement was made based on extensive SCUBA studies by Falter & Mitchell (1982). We have no reason to believe that the bottom composition has changed significantly since that time. Wood debris is common along the entire river due to the log rafting throughout the year. The debris accumulates in the slower sections (the lower reaches) where it has a chance to settle to the bottom.

No. 2, Abstract, Page xi, Paragraph II

The authors note that the flow of 340 cfs occurred in September, 1990. However, elsewhere within the report the low flow was noted as being in September of 1991. This information needs to be corrected.

No. 3, Abstract, Page xi, Paragraph II

The authors report a range of median pH's of 5.7 to 7.8; not just a median pH. We are curious as to why a median pH range was reported rather than a mean or mode?

It is statistically inaccurate to calculate a mean based on a set of logarithmic data (pH values). The median value to be more significant than the modal value when left with these two options and is commonly used in water quality studies.

No. 4, Abstract, Page xi, Paragraph III

The authors report a 73% increase of the mean year round chlorophyll a over the 7.6 mile reach. We are uncertain as to the significance of this statement and why the authors chose to report this. We would naturally expect a significant increase in the chlorophyll a content of any waters after it has exited a lake. Higher sunlight penetration combined with shallower waters and higher temperatures would naturally produce an increase; all other factors being equal.

We presented this chlorophyll *a* increase because it is a potential problem in the river. As chlorophyll *a* increases, water transparency decreases, thus detracting from the aesthetic quality of the water. Overall water quality is also reduced.

As to the assumptions that sunlight and warm temperatures alone cannot support phytoplankton as in any biological community, the population must have nutrients in order to grow and multiply. In the case of phytoplankton, these nutrients are mainly phosphorus and nitrogen. In this area, phosphorus is nearly always the number one limiting nutrient in determining the phytoplankton production in a body of water (*i.e.* the phosphorus level determines the phytoplankton level).

In the Spokane River, all other factors are not equal, as suggested in the comments. Concentrations of all nutrients measured in the study increased over the 7.6 mile reach. This correlates with the increase in chlorophyll *a* concentrations over the reach.

No. 5, Abstract, Page xi, Paragraph IV

The concentrations of chlorophyll *a* placed in the Spokane River in the Mesotrophic and the Meso-oligotrophic productivity ranges. These two terms indicate that river is in a quite healthy condition. We wonder why these terms were chosen to define the river quality without any further discussion.

These terms were obtained from tables by Wetzel (1983) based on various water quality parameters. The trophic status of a water body is a relative term. Studies done 10 years ago by Falter & Mitchell classify the Spokane River as extremely oligotrophic based on algal productivity. This suggests that either overall nutrient loading to the Spokane River is increasing or that inhibiting metals are on the decline.

No. 6, Abstract, Page xii, Paragraph I

The authors note a general trend of TKN increasing downstream through the study reach. This is contrary to results obtained by Soltero in his study. The Soltero study noted a decrease in the TKN between the lake outlet and the Spokane Industrial Park. We question whether the authors took into account either in-flow or out-flow to the Spokane/Rathdrum aquifer? What is this trend indicative of?

We claim no responsibility for Soltero's study nor his conclusions. The Spokane Industrial Park is ?? miles downstream of the study area. This makes comparisons questionable. Our study was not designed to determine sources and sinks of TKN below RM 100.7.

As far as trends are concerned, the increased downstream TKN concentrations are indicative of high TKN in WWTP effluent discharges, private drainfields, and other unknown sources, as pointed out in the report (pg. 15). It would be speculative to surmise further on the sources as they have not been assessed.

No. 7, Abstract, Page xii, Paragraph II

The authors note summer total phosphorus increased 87% between RM-111.1 and RM-108.8 over the entire study, 187% in 1991, but showed a 30% decline in 1991 after phosphorus removal in the Coeur d' Alene WWTP. This statement is quite confusing. How was the 87% figure arrived at: is this a mean between 187% increase in 1990 and 30% decrease in 1991? What is meant by summer total phosphorus increased over the entire study? The entire study period was for approximately 1 1/2 years and included winter. The authors note that beginning in June of 1991, total phosphorus in our effluent declined by 79%. This is incorrect inasmuch that for the period of June through October 1991, our average removal rate was 85.4% to an average discharge concentration of 0.93 mg/l. There is no mention of statistical meaning to these and other variations in nutrients and chlorophyll a in this report. If the author is using simple percentages to draw conclusions, he should include the normal ranges of deviations (in percent) that one would normally find in a river system of this category. (See Table #1).

No. 8, Abstract, Page xii, Paragraph III

The authors note that the wastewater treatment plant BOD₅ levels from the CD'A plant averaged 81.2 mg/l. This is incorrect. Our discharge permit prohibits us from discharging in excess of 30 mg/l BOD₅. We have not been in violation of this discharge permit. Using BOD₅ data from our records either on the same dates the study sampled, or the closest date to that, our average for the study period was 15.0 mg/l.

We reproduced the results of our independent tests on CDA WWTP effluent as they appeared. We are aware of the discrepancy between our results and those of your lab. Our river BOD values were in expected ranges; we can find no explanation in our data for the discrepancy on WWTP values.

No. 9, Abstract, Page xii, Paragraph IV

The authors are reporting median fecal coliform bacteria. Coliform data when used properly, can only show log differences, *i.e.*, geometric means are reported.

In many cases, the extreme variability in coliform counts can cause geometric means to be misleading and of little use (see Table 18). It is also inaccurate to compute a mean with values such as > 60. Therefore, we deemed the median value to have more significance.

No. 10, Introduction, Page 1, Specific Objectives No. 4

The authors claim that a specific objective of the study was to determine the effects of existing and proposed wastewater discharges on river water

quality. We do not feel that this objective was adequately completed within the text of this study.

Objective 4 was written unclearly. See revision.

No. 11, Methods, Page 3, Paragraph II

The authors note that samples of municipal treatment effluent were taken from a 24 hour composite sampler located at each wastewater treatment plant. Such a composite sample should not be used to determine the presence of coliform bacteria. This is contrary to the Standard Methods, 1989 Edition.

We ran the samples given us by the WWTP personnel. Using a composited sample can increase variability of bacterial samples.

No. 12, Methods, Page 3, Paragraph IV

Water volumes between stations were determined by mechanical planimetry of morphometric data. This information was used to determine retention times. We question the completeness of the existing data bases to determine accurate river volumes by planimetry.

Falter & Mitchell (1982) conducted extensive depth transect studies on this reach and developed complete morphometric maps of the area. In addition, we ran depth transects at all sample stations and extensively in the Ford Rock area, as outlined in the Methods section of the report (pg. 5). Both of these resources were used in calculating river volumes, and we believe the calculations to be quite accurate. Planimetry is, of course, the accepted method of determining river and lake volumes. Other suggestions? Morphometric maps have been included in Appendix A1 and A2.

No. 13, Methods, Page 4, Paragraph II, Bacteria

In Paragraph I of this page, the authors say that the procedures used for analyses were outlined in Standard Methods, 1989 Edition. However, the authors indicate that coliform bacteria were analyzed using a membrane filter technique and colonies were counted with microscope at 100 power. This is contrary to Standard Methods procedures, which says that a microscope of 10-15 power should be used. (See also Comment No. 9, above.)

Standard Methods does suggest the use of 10-15 power microscopes in counting coliform bacteria. However, since the entire filter is counted for coliform colonies, the magnification makes no difference, and we found the counting to be even more accurate under the higher magnification. We know the difference between real colonies and the blue media specks and did not count anomaly.

No. 14, Methods, Page 4, Biochemical Oxygen Demand

Several problems/conflicts with the authors' methods of determining BOD arise. Of particular concern is the determination of ultimate BOD's. Standard Methods do not include any procedures for determining ultimate BOD's. As a matter of fact, Standard Methods state that in doing a BOD test, at least 2 mg/l of oxygen should be consumed and that at least 2 mg/l of oxygen should remain. However, if the authors chose to do some sort of an ultimate BOD testing, time periods chosen should closely resemble those detention periods for the basins; assuming that these detention periods can be accurately calculated. At that, it is suggested that the protocol should include sufficient dilutions to ensure that at least 1 mg/l is consumed, and that at least 1 mg/l remains in the samples.

Effluents do not just remain in a receiving water for 5 days; They are in the receiving water until total degradation it reaches the sea, whichever comes first. The BOD₅ test originated in England where no WW source was more than 5 days' flow time from the sea, hence the use of BOD₅....The practice stuck. Ultimate BOD is a common diagnostic tool in larger countries (compared to England) to give a more realistic estimate of total BOD loading.

Our ultimate BOD testing did follow those residual oxygen guidelines. Measurement of ultimate BOD of an effluent stands by itself, independent of treatment time so similarity of assay times with detention times is meaningless.

No. 15, Methods, Page 6, Quality Control/Quality Assurance

Our single greatest concern is that of the authors' QA/QC program. The authors do detail how multiple instruments were used, and how duplicates were run on at least 10% of the samples throughout the study. They also mention that 39 samples were split and analyses performed by the UI Forestry Lab and the UI Analytical Lab for comparison. Did the results of

the splits indicate good quality control? We are at significant variance with some of the analytical results being reported. We will deal with those individual parameters within the body of the comment concerning that individual analysis.

As is described in Section 1020 of Standard Methods, 17th Edition, QA and QC are two distinctly different approaches to laboratory control. It is assumed that the authors' laboratory procedures do, in fact, have a written QA plan. In some cases, however, we do question whether data validation is adequate.

Of single greatest concern is that of quality control. Quality control may be either internal or external; both are recommended. There are basically seven outlined steps for a effective quality control program. Nowhere in the authors' discussion of their QC program has it been stated that known additions are used as part of their regular analytical protocol. (Sometimes known as running "spiked" samples.) As is noted in this section of Standard Methods, at least 10% of the number of samples should be represented by known addition or spiked samples. We ask if this was done?

Another key factor of a good QC program is that of externally supplied standards. We are required to run a set of unknowns furnished by the EPA on an annual basis. The results of these are attached to these comments. (Tables #2 and #3).

Nor do the authors mention whether or not an analysis of reagent blanks has been performed as part of their QC program in addition to calibration with standards.

We feel that more discussion of the study's QA/QC program should be provided. Attached to these comments are Table 2, which is a comparison of our test results with that of the DEQ Lab in Coeur d' Alene for five (5) different parameters on influent and effluent samples. It can be noted that we are in very good statistical agreement. Attached also is Table 3, our analyses of EPA provided known quantities over the past three (3) years. It can be noted that our results are definitely within the acceptable limits and ranges of the EPA program.

Additional explanations provided in report.

No. 16, Results/Discussion, Page 11, Dissolved Oxygen, Para I

The authors refer to the Idaho Water Quality Standards for Cold Water Biota and Salmonid Spawning of DO levels being 6.0 mg/l. In addition, Idaho Water Quality Standards also indicate a saturation of 90% or 6 mg/l,

whichever is highest. The authors do not mention which standard was used to determine saturation percentages; *i.e.*, was the actual Spokane River Water used to determine saturation concentrations?

The percent of dissolved oxygen saturation is usually calculated from standard tables assuming clean water with no salinity and no surface active agents. Field survey work should include testing to determine a "true saturation" concentration in the river water to permit accurate calculation of percent saturation from ambient dissolved oxygen measurements.

Yes. See text.

No. 17, Results/Discussion, Page 11, Dissolved Oxygen, Para II

The authors note that, "Percent saturation levels were somewhat low compared to other North Idaho streams, (Table 5)". However, no actual comparative data for other North Idaho streams are presented in any of the tables, including Table 5. What is the significance of this statement? How do other North Idaho streams compare with the Spokane River as to temperatures and atmospheric pressures?

See text.

No. 18, Results/Discussions, Page 11, Electrical Conductivity

The authors note ranges of conductivity tests taken throughout the study area. However, no significance or explanation of these results are offered. If they have no significance, why were they conducted?

The study plan provided us called for them.

No. 19, Results/Discussions, page 12, pH

The authors again report median values for pH. What is a median value and why are the results reported as median values? (See also comment No. 3)

A median is the middle value in a set of data that has been organized in ascending or descending order (see answer to Comment No. 3).

No. 20, Results/Discussions, Page 12, Turbidity, Paragraph II

The authors note that turbidity increased as flow did in the spring and note that turbidity appears to be directly related to flow and bottom sediments being stirred up and re-suspended. Not accounted for was the additional flushing of nutrients, BOD and suspended solids through the lake's system during spring runoff.

That was accounted for by comparison with the upstream station.

No. 21, Results/Discussion, Page 13 & 14, Chlorophyll a, Para V

The authors note that in the Falter and Mitchell study of 1982, the chlorophyll a results reported did not correct for pheophytin a, and that this tended to over-estimate the chlorophyll a. They further state that a doubling of chlorophyll a between 1980 and 1990/91 is probably a reasonable conclusion. However, the authors offer no substantial information to verify such a speculative conclusion.

That statement only applies to the two-year 1990-91 - one-year 1980 comparison. As such, it stands.

No. 22, Results/Discussions, Page 15, Nitrate-Nitrogen, Para II

The authors state that the Coeur d' Alene WWTP contributes very little nitrate/nitrogen to the Spokane River. This is in conflict with the graphs and text presented later in the study. Downstream tests indicate that the Cd'A NH_3 discharge is rapidly converted to NO_3 .

The ammonia is converted to NO_3 , but not until at least after RM 108.8 (see correlating incline and decline of NO_3 & NH_3 , respectively, in Figures 30 & 33).

No. 23, Results/Discussion, Page 16, Ammonia-Nitrogen, Para I

The authors note that the direct ammonia procedure used to analyze ammonia samples is no longer approved by the EPA because of the possibility of background interference. The authors indicate that they are using this direct method of measuring ammonia. They note that it is still a Standard Methods approved technique. They further state that, "values determined for WWTP'S, however, should be received with caution due to the possibility of background interference in those samples of high organic content". The statement concerning the direct ammonia procedure no longer being approved by EPA is correct. The use of the direct "probe" method has not been allowed by EPA for a good number of years. However, the Cd'A WWTP does not use this method. We use *Standard Method 350.2*, which is approved by the EPA as noted in the text, *EPA's Sampling and Analysis Methods*, edited by Lawrence H. Keith, copyright 1992. The authors obviously have not determined which methods each of the WWTP's use to determine ammonia.

The statement concerning WWTP values pertains to our methods and values, not the analysis methods of the WWTP's. Furthermore, our method for determining ammonia-nitrogen was not the direct probe method, it was the Direct Nesslerization procedure outlined by Standard Methods. We never indicated we used the probe method but will make this clarification the update of the report.

No. 24, Results/Discussion, Page 17, Total Phosphorus, Para III

The authors note increases in mean concentrations of total phosphorus between several RM Stations. Said presentations of percentage of increases in the river reach have little or no meaning. Actual loadings furnished by the respective treatment plants are not presented here. We offer the following information as attached Tables #4, #5 and Figures #1 and #2.

This study was designed by the Idaho DEQ as a characterization of this reach of the Spokane River, describing seasonal and spatial variation, not as a waste loading allocation study (See Objectives). Much of the criticism of the study originates from that mistaken expectation, of efforts to make it something it was not designed to do from the outset. Percentage increases do have a valuable role in the description of surface waters, responding to external factors.

No. 25, Results/Discussion, Page 18, Total Phosphorus, Para II & III

The authors note that a much reduced summer total phosphorus load occurred in 1991. They also state that this increase is significant, because it shows an overall deterioration in water quality of the Spokane River over the past 10 years. We are uncertain if the conjecture actually occurs, because the two statements appear to be in conflict. Is there still a deteriorating relationship even after phosphorus removal has begun at the Coeur d'Alene WWTP during the growing period?

Two different points are presented, and perhaps they should be clarified. First, the past 10 years have seen a general decline in overall river water quality, as evident in the total phosphorus trends over this period. Secondly, 1991 did see a reduction in TP compared to 1990, largely due to the efforts of CDA WWTP to remove phosphorus from treated effluent. This improved TP removal was significant to the river and the river's response was noted. The text has been clarified on that point.

No. 26, Results/Discussion, Page 19, N:P Ratio

Previous data obtained from the *Spokane River Basin: Allowable Phosphorus Loading*, C.R. Patmont of Harper-Owes, September, 1987, indicates that the Spokane River is clearly nitrogen limiting from the lake outlet to somewhere in Washington. (See attached Figure #3)

We have taken the information provided by the study from Stations No. 1, 2, and 3 and calculated an N:P Ratio. It appears that the N:P Ratio generally

decreases between Sta. 1 and Sta. 2 until phosphorus removal began in 1991. During the phosphorus removal periods, the N:P Ratio increased greatly as a direct result of the WWTP's high ammonia-nitrogen discharge and low phosphorus discharge. This information is presented as Table #6.

Only partially true, but clarifications made in text.

No. 27, Results/Discussion, Page 19 & 20, Zinc

The authors note that there is a significant reduction in the concentration of zinc in the Spokane River over the past 10 years. They further state, "these lower levels may not be inhibiting phytoplankton growth to the extent that they were 10 years ago". However, we wonder if zinc concentrations in the bottom sediments are sufficient enough to inhibit bottom growth and does this have any significant impact to river water quality?

We conducted no studies to determine zinc concentrations in bottom sediments of the Spokane River and therefore cannot comment on growth inhibition of either algae or macrophytes. Our statements concerning zinc inhibition of phytoplankton growth are conjectural, based on past measurements and bioassays conducted on Spokane River water.

No. 28, Results/Discussion, Page 20, Biochemical Oxygen Demand, Paragraph II

The authors note that the interim results published in early 1991 were incorrect. They note in this discussion that they failed to adjust for 300 ml sample up to 1 l. Not knowing exactly how the miscalculated these results, we can make no other comment other than that that was noted in Comment No. 8, that shows that more than likely the study results reported for the Coeur d'Alene WWTP effluent is off by a factor in excess of 3. It is strongly suggested that the authors re-examine their calculations. We have taken our results on the date nearest to the test dates and provided the BOD₅ information. Attached is Table #7 showing the variations. As can be noted, the study results report and average BOD₅ for the effluent at Cd'A's WWTP as 81.2. We only had three test results that corresponded exactly with the study's test dates; the average of those three results was 14.2 mg/l. However, as can be noted, for the dates closest to the sampling dates of the study our overall BOD₅ effluent average was 15.0 mg/l. Some of the study results are as high as the plant's influent; indicating that no BOD₅ treatment occurred at the plant - highly unlikely.

We would request that the BOD's be re-taken and that split samples be performed by the study authors' lab, the City of Cd'A WWTP's lab and the DEQ lab at Coeur d'Alene.

We have reviewed our lab notes, data, and calculations and can find no explanation for error other than the discrepancy between the two labs. We cannot, therefore, change the numbers. The discrepancy can only be noted in interpretation of our data. If the UI does another study year in 1992, we would be happy to include BOD split sampling.

No. 29, Results/Discussion, Page 20, BOC, Paragraph V

The authors note that a portion of this downstream increase in BOD is secondary five day BOD from phytoplankton production in the lower reaches. They also note here, "but a significant portion is undoubtedly directly attributable to the Coeur d'Alene WWTP discharges". This statement indicates that the report is incomplete. We do not know how the authors came to the conclusion that a significant portion is due to Coeur d'Alene effluent, when no research data is provided. Sediment, algae, etc., deposits under low-flow will also increase BOD₅. This would appear to be an editorial statement not based on sound scientific evidence.

We are revising this section of the report to further elaborate, but our statements were reasonable conclusions based upon interpretation of our BOD data and therefore were not an editorial statement.

No. 30, Results/Discussion, Page 21, Ultimate BOD

As was noted in Comments No. 14 and No. 15, QA/QC procedures have to be rigidly defined in order to show any validity in reporting ultimate BOD determinations. In as much as the BOD₅ results have been misreported and still are incorrect, we question the validity of the ultimate BOD results.

There is question as noted above, with the BOD₅ data but they have not been misreported; our available data were accurately reported.

No. 31, Results/Discussion, Page 21, Fecal coliform Bacteria

Our Comment No. 13 is again referred to. Standard Methods indicate that with these high numbers, confirmation should be made with EC media. We wonder if this was done? (The study results do not indicate so.) Under the Section of "Methods", the authors state that they used the membrane filter technique for determining fecal coliforms and fecal streptococcus bacteria. Yet all the results are reported as Most Probable Number (MPN). These are two separate and distinct analytical methods. We wonder which procedure was actually used to determine coliform colony counts?

As was noted in previous comments, only the geometric means are used to report colony counts. Attached, please find our Table #87, which compares the study results for fecal coliform with Coeur d'Alene Wastewater Treatment Plant Lab results. As can be noted, we have considerable

variation from that of the study results. We strongly recommend that the authors re-evaluate their testing procedure and particularly their method of calculating results. Again, we wonder whether or not confirmation of results were performed as prescribed by *Standard Methods, 17th Edition*? Finally as was previously noted, colony counts are made with a 10 to 15 power microscope, not a 100 power microscope.

Already addressed.

No. 32, Results/Discussion, Page 22, Paragraph 1

The authors discuss fecal streptococcus MPN numbers (most probable number) for the Cd'A WWTP effluent. As we do not routinely run fecal streptococcus within our own laboratory, we have no way to verify or challenge the results reported here. (See also comments concerning fecal coliform bacteria, above.)

No. 33, Conclusions, page 23, No. 6

The authors report a low pH of 3.3. Even though the authors discuss the thoroughness and repeat testing done to verify a pH 3.3, we question these results. Noting the sampling locations for mid-depth of the Spokane River as displayed in "Figure 2", a pH of 3.3 would indicate that a large volume of the river water was represented by that number. It is hard to imagine that some aquatic life would endure a pH that acid. We wonder if replicate samples or re-sampling was done to verify this low of a number. Two possible explanations come to mind; could the sample bottle have a remnant trace of acid solution in it before collection? Why wasn't re-sampling done and why didn't subsequent sampling show similar results?

Acid contamination was possible but unlikely since we used the same bottles for pH determination repeatedly. The low pH was measured several hours after sampling, precluding going back to redo the sampling. The pH was taken on several meters, however.

No. 34, Conclusions, Page 24, No. 10

The authors conclude that high flows stirred up bottom sediments through the reach and combined with spring algae pulps to reduce secchi disk depth to 2.2 meters at those times. No mention of the effect of log traffic and/or log debris in the bottom of the river has been made here.

The study was not intended to address the effects of log traffic and/or log debris. We do, however, believe these to be insignificant in contributing to the decreased secchi depth, especially in the lower, deeper reaches of the river.

No. 35, Conclusions, Page 24, No. 10

The authors report that the TKN varied little with time of year or with water flows. We question these results as some of the draft data indicates it did, in fact, change. We would certainly expect the TKN to change in as much as that our total ammonia-nitrogen output in our effluent changes considerably with time of year. Therefore, in-river flows of TKN should likewise change.

The graphs show the data that we collected and analyzed. Results are results, whether or not they arrive at an expected conclusion.

No. 36, Conclusions, Page 24, No. 11

The authors state that at low flows WWTP's supplied 40% of the total nitrate load to the river. This is in contrast with the statement found in Comment No. 22, that the Coeur d' Alene treatment contributes very little nitrate-nitrogen to the Spokane River. Most of all the Coeur d' Alene WWTP's nitrogen discharges is in the form of ammonia. Therefore, this statement seems to be at odds with the scientific data.

Corrected in report.

No. 37, Conclusions, Page 24, No. 12

The authors note that between RM-111.1 and RM-108.8 there was an average 75% increase in the total ammonia in the river, but less than 1/3 of that increase was from the Coeur d' Alene WWTP. The authors offer no suggestions as to where the other 2/3 of the ammonia load is coming from. Failure to provide this solution appears to be in conflict with the objectives of the study.

It would appear that a new river sampling station is highly desirable. We would strongly suggest that any further sampling and testing have a new station directly upstream of the Coeur d' Alene WWTP's outfall, and a sampling station be located immediately downstream.

Determining all point and non-point pollution sources was not an objective of the study as formulated by Idaho DEQ. To further elaborate on ammonia sources as called for in the comments would be unsupported speculation.

No. 38, Conclusions, Page 25, No. 13

The authors note a total phosphorus increase between RM-111.1 and RM-108.8 over the entire study. While their data does, in fact, indicate that this be the case, no mention of the fact that by RM-102.5 approximately the Post Falls Dam, the phosphorus level has decreased very significantly.

This is based on results from previous studies. It should be noted in the conclusions section that this total phosphorus increase only occurs during low-flow conditions.

We have clarified the statements so that they are more clear. Contrary to the comments, however, we do mention the net phosphorus sink by RM 102.5 (pg 25, No. 13). What one should be aware of is that the phosphorus doesn't just disappear. Much of it is converted into phytoplankton, attached algae, or macrophyte growth, resulting in the higher chlorophyll a values downstream (pg. 25, No. 9). Eventual fate may be in the sediments or removal from the aquatic system by insect emergence.

No. 39, Conclusions, Page 25, No. 14

The authors note that orthophosphorus averaged less than 0.006 mg/l in the river, but WWTP's effluent averaged 3.42 mg/l during this study. Two items of omission should be noted here. First of all, we have noted that the Coeur d' Alene WWTP's effluent phosphorus is approximately 80% orthophosphorus. We also note that during the growing season, we are obligated to remove phosphorus to 85% removal or down to 1 mg/l. This was done during the summer of 1991 and continued through the fall growing season. No mention of this significant fact is noted.

We suggest a re-read of Conclusion 14, pg. 25, under the third sub-heading. We feel we have adequately addressed effluent phosphorus removal treatment.

No. 40, Conclusions, Page 25, No. 16

Again, we draw the readers' attention to the incorrect reporting of the Coeur d' Alene effluent average BOD₅ of 81.2 mg/l. (See previous comments).

Already addressed.

No. 41, Conclusions, Page 25, No. 17

Again, ultimate BOD levels were reported in the conclusions while they have very little, if any significance as a study result. Mean ultimate BOD increases of 11% in the lower reaches cannot necessarily be attributable to wastewater treatment plant effluent. No mention of possible log waste, log debris, or algae contributions is made here.

Nowhere in the conclusions do we state that the 11% increase is directly attributable to wastewater treatment plant effluent. However, an 11% increase in ultimate BOD throughout the reach is significant as a study result, no matter where it originates.

No. 42, Conclusions, Page 26, No. 18

Again, median fecal coliform counts were listed here. This is in direct conflict with reporting methods as detailed in Standard Methods.

See answers to Comment 9.

No. 43, Page F-1, Figure 1

In the map of the sampling sites for the upper Spokane River, the authors do not locate any of the large mill sites that may be considered almost as a significant point-source in themselves.

The scope of the study was not intended to directly address mill effluent.

No. 44, page F-7, Figure 8

This graphic depicting both Spokane River flow and wastewater treatment plant discharges is confusing at best and shows a bias on the part of the authors at the worst. WWTP discharges shown on the left of this graph are in units of cfs. An initial scanning of this graph gives the appearance that the treatment plants' flows are a very large percentage of the overall river flow; which, of course, is not the case. This graphic should be revised into two graphs, or at the least use one scale for both discharges.

We agree that this graph is misleading, and have deleted it.

No. 45, Page F-23, Figure 25

Please see our Comment No. 35. The authors, in their conclusions, state that TKN varied little with time-of-year, or with water flows.

See Figure 24.

No. 46, Page F-28, Figure 30

This graphic shows an extreme increase in the mean nitrate-nitrogen concentrations between RM-108.8 and RM-106.2. No conclusions or discussions of why this peaking occurred have been given. Are we to conclude that this increase in nitrate-nitrogen is a result of the Cd'A's WWTP effluent ammonia being oxidized to nitrate by RM-106.2, or is this indicative of a different source of nitrate-nitrogen?

Our thought is that this increase is, in fact, a result of ammonia being oxidized to nitrate in this section, as a similar decline in ammonia-nitrogen is seen (see Figure 33, pg. F-31). However, we do not have sufficient data to support this claim.

No. 47, Page F-33, Figure 35

This graphic is in error as the nitrate and ammonia bars should be reversed, i.e., the striped bar should be marked ammonia and the solid black should be marked nitrate.

We have corrected this. Thank you.

No. 48, Page F-35, Figure 37

Not emphasized by this graphic is the fact that total phosphorus loading to the river varies between 0.01 and 0.025 mg/l. The flows of the river vary a great deal. During Spring run-off, tremendous amounts of phosphorus come down with these increased flows, so while the concentration of P does not vary a great deal, total phosphorus loading heading down-river to Long Lake does vary a great deal. No discussion of this phenomenon was presented.

The area of concern in this study was the 11-mile outlet reach of the Spokane River, and while we do not pretend to ignore the effects of high flows and moderately high phosphorus concentrations entering Long Lake, neither do we address them. The comment question is simply not within the scope of this study.

No. 49, Page F-36, Figure 38

This graphic notes the phosphorus concentrations in the upper reaches of the Spokane River during the two test periods. All river concentrations are well below 0.02 mg/l; the threshold indicated as harmful to Long Lake. The significance of this has not been discussed.

See answer to Comment 48.

No. 50, Page F-39, Figure 41

This graphic shows mean total orthophosphorus concentrations. Again, at best this is an extremely confusing graphic that has very little significance and certainly no discussion about its significance of the data being represented here.

This graph shows that O-P concentrations were generally below detectable limits (.006 mg/l) in the Spokane River, and were extremely high in both WWTP's. A discussion of the significance of this is in the text (pg. 18, paragraphs 5 & 6).

No. 51, Page F-41, Figure 43

This graphic shows the percentage of total orthophosphorus loads from the Cd'A and Post Falls WWTP's versus the Spokane River background load at

various times throughout the study period. The question arises as to what may occur to the orthophosphorus load during periods of little or no mixing. Does the river bottom have a high P up-take?

See pg. 18, paragraph 6. Chemical reactions occurring in the bottom sediments of the Spokane River were not addressed in this study.

No. 52, Page F-44, Figure 46

This graphic showing mean five (5) day BOD's in the Spokane River and both treatment plant effluents during the study period. We see no correlation in the fluctuations of river BOD₅. The graphic notes problems with dilutions of WWTP effluent resulted and no BOD₅ data in the early tests. We can furnish those results. The significance of this apparent lack of correlation between the concentrations has not been discussed.

Figure 46 was not intended to show a correlation between mean Spokane River BOD₅ and effluent BOD₅, and no inference of such correlation was made. The graph was referenced in an attempt to point out the period of highest BOD in the river, and to show fluctuations in river and effluent BOD throughout the study (see pg. 20, paragraph 4).

No. 53, Page F-46, Figure 48

Again, we refer to our comments concerning ultimate BOD's.

No. 54, Page F-47, Figure 49

We refer to our comments concerning reporting of median fecal coliform counts as being outside of the Standard Methods for examination of wastewater.

Addressed

No. 55, Page T-15, Table 16

The threshold of detectability for orthophosphorus concentrations appears to be 0.006 mg/l. Many concentrations are listed as being less than this threshold of detectability. How then, can one use the lower limits of detectability in averaging numbers? What is the statistical significance of averaging data below the Method's Detectability Limits (MDL)?

It is common limnological and water quality practice to use the mid-way point between 0 and the MDL as the value to average.

No. 56, Page T-16, Table 16

Refer to our attached Table #7.

No. 57, Page T-20, Table 18

This table tabulates results from fecal coliform tests. Please see our previous comments concerning result reporting. There is a difference between MPN and membrane filter methods. What, if any, differences in results can be expected?

Cannot say on the basis of our data.

No. 58, Page T-22, Table 20

Two items of significance are found here. First, the flows reported by the Cd'A treatment plant prior to September of 1991, were in significant error. After that date, a flow meter at the effluent end of the plant was put on-line. We estimate that flows can be off as much as 400,000 gpd. However, we have not adjusted previous reported results due to the uncertainty of the variation. Secondly, the fecal coliform count reported for April, 1991, in our self-monitoring data is reported incorrectly. The number should be 17.9 col./100 ml.

The flows we have reported were obtained directly from Coeur d'Alene WWTP Lab Personnel. If they were incorrect, we would like to know the correct values, as all nutrient loading calculations may be similarly biased.

We have copies of the report from the CDA WWTP lab which show this number to be 4,072.0, as we reported. However, we are making this change in the table, in view of the new data you have presented us with.

A review of the planning documents prior to the study being conducted indicates that several needs/requests for data inclusion were not done. The following comments are from planning documents reviewed by this office. In a memorandum dated November 6, 1989, from Irene Nautch of the Division of Environmental Quality to Ed Tulloch and Tim Eiler, through Susan Martin and Gwen Burr, the following suggestions were to be included within the study documents.

Note of Report Authors: These following items were not in our Scope of Work and, therefore, cannot be addressed by us (except for Comment # 68).

No. 59

Item No. 2 of this memorandum requested a discussion of why these sample sites and stations were good sites for the study. In addition,

latitude, longitude, and elevation information was to be provided. This information is not contained within the body of the study.

In a letter to Mr. Ed Tulloch of the DEQ from the Honorable Richard C. Panabaker, Mayor, City of Hayden, dated February 20, 1990, the City requested several items to be included in the Spokane River Study.

No. 60

Referencing the above memorandum; the City of Hayden requested plume dispersion analyses of Coeur d' Alene and the proposed Hayden outfall to determine if the discharge adds to the DO problems in the hypolimnion. This was covered very cursory within the body of the study. Does additional analyses of such a plume dispersion need to be performed?

No. 61

It was suggested that bacteriological sampling stations should be expanded and include the slack water areas in Harbor Island and Greensferry areas to determine the impact of treated wastewater discharges on these areas in relation to non-point sources. A survey should be conducted after a stormwater event in August. Was this suggestion considered? Should it be separately addressed?

No. 62

It was determined that velocity profiles should be conducted to determine the flow distribution during August and October to verify the absence or presence of "dead" areas, and further define the area above the dam as a reservoir or river. No instream velocity measurements were reported within the body of the study. Should these be considered? What are their significances?

In a document transmitted to the Division of the Environmental Quality on April 5, 1990, entitled, Review of Spokane River Water Quality Survey Study Plan, prepared by Brown & Caldwell Consultants, and authored by M. Steve Merrill, PhD, several issues were brought out.

No. 63

It was noted on Page 2 of the report in Paragraph No. 4 that possible violations of the Idaho State 90% Saturation Criteria may occur out the outlet of Lake Coeur d'Alene, above the City of Coeur d' Alene discharge due to background oxygen demand. The data presented in the study seems to indicate that this, indeed, has occurred. What is the significance of this? How do the results compare to readings in the Cd'A and St. Joe Rivers?

No. 64

On Page 3 of the above-mentioned document, a question was raised; "What is the impact of oxygen concentrations below the 90% saturation criteria?" We also raise the same question.

No. 65

Item 2 on Page 3 reiterates our standpoint that oxygen saturation is usually calculated from standard tables, assuming clean water with no salinity and no surface active agents. It was suggested that survey work should include testing to determine the true saturation concentration in the river water to permit accurate calculation of percent saturation from ambient dissolved oxygen measurements. Our question is; Was this not done?

No. 66

Under item 4 on Page 3, the author again suggests current velocity measurements with depth during the stratification period be made. Although no stratification period was identified during the study, it would seem that current velocity measurements should have been taken. (See above).

No. 67

Under Item 4g, it was suggested that BOD testing be conducted with nitrification suppressed. The study indicates that no nitrification suppression was performed. What is the significance of not suppressing nitrification in the BOD testing; particularly ultimate BOD determination?

No. 68, Statistical Analysis of Results

Nowhere throughout this report are any examples of a statistical analysis of the data reported. No standard deviations are reported for any of the results that were used to form the conclusions. Likewise, no confidence limits for the data have been presented. Quantification and propagation of the uncertainty common to each term in the model is necessary in order to determine the degree of confidence which can be placed on any prediction. We question whether the authors did any uncertainty calculations or statistical analyses of their data?

As stated earlier, this study was designed by Idaho DEQ to be a time-series assessment of water quality at 6 sites in the upper Spokane River. Effort was put into sampling to obtain representative conditions across the river at each of the 5 above-dam sites rather than into replicating field samples. This study was not designed as a comprehensive Spokane R. TMDL study.

No. 69

Also attached for your information are Table #9 - #11; Shoreline P Results, P Results 1988-91, and comparisons of various parameters.

1. From the Spokane River Basin: Allowable Phosphorus Loading, C.R. Patmont of Harper-Owes, September, 1987.

**USEPA
COMMENTS TO THE
WATER QUALITY STUDY
OF
THE UPPER SPOKANE RIVER:**

The data presentation is questionable. Several checks of tables showed errors and inconsistencies in calculations and reporting.

1. Without reference to the water quality standard, any reported increase (percent or magnitude) can't be evaluated for environmental significance. Percent increases were confusing and did not always specify what value was the basis for the percent calculation.

A State of Idaho Water Quality Standards Appendix has been added.

2. Was an error analysis done to determine confidence levels of measurements and calculated results?

Few error analyses were done due to the lack of duplication of samples. Where data sets are sufficient for this type of statistical analysis, they have been computed and are in the attached appendix.

3. Was data analyzed to determine if changes, from one river location to another, or from year to year, were statistically significant?
Example 1: *"From RM 111.1 to 108.8, there typically was an average 75% increase of total ammonia in the River."* Table 13 shows a mean ammonia (NH_3 or $\text{NH}_3\text{-N}$) concentration at RM 111.1 of 0.12 mg/L and at RM 108.8 a 0.17 mg/L concentration for water year (WY)91 and 0.19 mg/L for the entire study period. What calculation was used to give a 75% increase between the points?

0.12 to 0.17 is a 41.6% increase

0.12 to 0.19 is a 58.3% increase

The worst case of ammonia increase (8/27/91) coincides with the most stringent $\text{NH}_3\text{-N}$ water quality criterion, 0.8 mg/L (EPA "Quality Criteria for Water 1986" as referenced by Idaho State Water Quality Standards for this site specific temperature and pH data.) Theoretically, an 800% increase (0.10 mg/L to 0.8 mg/L) from RM 111.1 to RM 108.8 could be tolerated by the river without exceeding water quality standards, for the worst case situation. This example shows one of the drawbacks of presenting data as percent increases, and not referencing the water quality standards.

Example 2: The bacteria data needs to be revisited in detail. Calculations

presented as "median" are really arithmetic means; neither of which are appropriate measures, because water quality standards are given in terms of geometric means.

Example 3: (Confusion about what value the percent increase is based upon) *"Concentrations of nitrate-nitrogen between sampling stations increased downstream, from RM 111.1 to RM 100.7. Mean nitrate values were much higher at RM 106.2 and RM 100.2 (a 150% and 75% increase, respectively)."* Do the percent increases occur from RM 111.1 or 100.7. Similar examples can be found throughout the document.

The data set is too limited for this. There is only one full year of data, so a year to year comparison is not valid, and there are too many variables between stations to determine statistical significance with respect to one another. We did not compare to Idaho Water Quality Standards because the Ammonia Standard for Warm Water Biota, Cold Water Biota, and Salmonid Spawning requires comparison to "...a level ofmg/l or less as based on a minimum of five (5) samples taken over a thirty (30) day period." (Idaho Water Quality Standards, The sampling rigor of the Project Work Plan given us did not come close to this required sampling base number.

Ammonia was measured as NH₃-N. All corrections in the report have been made.

The 75% ammonia increase between RM 111.1 and RM 108.8 was an error in our calculation, based on water volumes and total load. The text has been corrected.

The median calculations of bacteria data are exactly what they are labeled as - - Medians, not arithmetic means, as suggested by reviewers. We chose to compare median values, fully aware of what Standard Methods states concerning bacteria statistical analyses, because of the high occurrence of imprecise data. Numerous "greater than" and "less than" counts occur in the data sets for both fecal coliform and fecal streptococci, making both arithmetic and geometric mean calculations invalid (Tables 18 and 19).

The nitrate-nitrogen percent increase at RM 106.2 and RM 100.7 statements have been clarified in the text.

4. The stated objective of the diel temperature and dissolved oxygen study was to assess the data in terms of possible aquatic ecosystem stress. This was not done.

Copy comments to question 10 of DEQ comments address this one.

5. The authors' definitions of several important terms should be included in the report: *water year*, (and the associated time periods described by winter, summer, etc.), *other North Idaho streams*, *high and low relative flows*.

Water Year - October 1 thru September 30.

The terms winter and summer were used to indicate general periods throughout the study, not specific time frames. Similarly, high and low flows were general terms used to describe the discharge in the river over certain periods of time, relative to the rest of the

hydrograph. Some other North Idaho Streams, with selected parameters, are included in an appendix for comparison with Spokane River parameters.

6. Value judgments, such as "poor mixing of wastewater effluent is not considered a critical issue" and "Nitrate is usually the most important form of nitrogen" are not appropriate in a technical report of this kind. Those decisions should be made by the State or appropriate regulatory agency. Describing these issues in terms of their probability of causing significant environmental impact would be more appropriate.

Correct, and we have since tried to remove remaining ones from the report.

7. When expressing pollutant increases caused by wastewater treatment plants (WWTP), are the values calculated from effluent data only or from the increase observed between sampling stations upstream and downstream of the treatment plant (which would include any non-point or unauthorized point discharges)?

Any references made to pollutant increases caused by wastewater treatment plants were calculated from effluent data only. Observed in-stream responses would, of course, have included other unidentified point- and nonpoint inputs.

8. There is no discussion of observed plant biomass growth in the river during the study. A narrative description of observations would be useful in assessing the water quality.

The request for observations of plant biomass growth during the study seem to contradict earlier questions concerning the statistical validity of many of the data calculations. We refrained from including observations of parameters not measured.

Nevertheless, we have incorporated some comments on this area into the report (See Results/Discussion).

ABSTRACT

9. Some discussion of pollutant sources besides WWTP's is also appropriate, even though the magnitude of the impact of those sources may not be known.

See Introduction for a discussion of pollutants. Beyond that, we have no measurements. Again, this was not a TMDL study to provide a listing of inputs, but a study focused on in-stream conditions.

10. What data set does "mean summer D.O." describe? Water quality standards address instantaneous measurements for dissolved oxygen. Similarly, is "mean summer chlorophyll *a*" a reasonable reporting method for addressing water quality?

"Mean summer D.O." refers to the mean D.O. over the warm summer months (July through September) throughout the entire reach. The significance is that this is the time period in which D.O. levels are a potential problem (due to high temperatures, biological decomposition, etc.) and plant production maximal.

The same data sets and significance pertain to "mean summer chlorophyll *a*". Again, we were addressing trends and general reach water quality.

11. EPA is extremely interested in the average 5-day biochemical oxygen demand (BOD) value of 81.3 mg/L presented for Coeur d' Alene WWTP effluent. Was this data collected and analyzed using 40 CHR 136 methods and QA/QC? Please provide more specific information about dilutions, final titration values, and calculations. Data presented in Coeur d' Alene WWTP's discharge monitoring reports for the study period show a maximum instantaneous discharge of 15.4 mg/L. EPA has split samples with the WWTP for the past three years, and has not discovered any discrepancies of such a large magnitude. Any insight as to the nature of the discrepancies in this report, and measurement variability noted by the author in the Results section, would be appreciated.

5-day BOD's were calculated precisely as outlined in Standard Methods (15th Edition, pg. 483-489). Because of the high BOD of the CDA WWTP effluent, it was necessary to make large dilutions on the effluent samples. During each run, one effluent sample of 5 ml and one of 3 ml were diluted up to 300 ml to determine the 5 day BOD. These dilutions were arrived at after running a series of 20 effluent samples at different dilutions from 100% (300 ml) to .33% (1 ml) to determine the range. We realize that the large dilution of CDA WWTP causes measurement error to be high (as pointed out in the Results section), however consistently high readings seem to indicate to us that the BOD₅ of CDA WWTP is, in fact somewhat higher than values reported by the CDA lab. We direct your attention to the turbidity of the treated CDA WWTP effluent (Table 8.), which would support the the higher oxygen demand values. We also call attention to ammonia levels in CDA effluent, which are quite high. Generally, high ammonia levels go hand in hand with high BOD levels, which would support our findings. Calculations were done as outlined in Standard Methods, and were re-checked for accuracy.

METHODS

12. The sampling sites and compositing protocols are confusing. Text, figures and tables do not present a consistent picture of what was done. Were two vertical samples taken at each of the three cross channel sampling locations for each site, yielding six samples per site? Or were two samples taken at only the mid-channel? The text describes three mid-depth samples (and in another text location "standard...one meter increments") but Figures 2 and 3 show only a single vertical sample. The same question arises for stratified conditions.

One vertical sample was taken at mid-depth at each of the three cross channel sampling locations for each site. These samples were composited and subsamples were taken from this for composite measurements. Physical profiles of temperature, dissolved

oxygen, and electrical conductivity were measured at one-meter increments, top to bottom, at each of the three cross-channel sampling locations per site. Figures 2 and 3 show the locations of water samples which were then composited. Under stratified conditions, we took an additional sample from the hypolimnion, kept it separate, and collected one additional grab sample at mid-depth from the epilimnion.

13. We understood that sampling at the left and right banks has been discontinued during the first summer because data was consistent across the river at each site. Is this really the case?

No, cross-channel sampling and compositing continued throughout the study.

14. No discussion of detection limits is given. Can BOD₅ be measured to the 0.3 mg/L level, as presented in Results section, and 0 mg/L level, as presented in Table 16?

Detection limits for Spokane River water BOD₅ were .33. Table 16 has been corrected. The following detection limits were determined on our samples:

| | BOD ₅ | TP | OP | NH ₃ | NO ₃ |
|----------|------------------|-------|-------|-----------------|-----------------|
| River | 0.33 | 0.006 | 0.006 | 0.04 | 0.006 |
| CDA WWTP | - | 0.03 | 0.06 | 0.20 | 0.006 |
| PF WWTP | - | 0.03 | | | |

15. Chemical Analyses.

Were orthophosphate samples frozen on collection day for later analysis? Don't orthophosphate samples need to be analyzed on day of collection? (We will check with EPA Region 10 Laboratory on this issue).

Orthophosphate samples were frozen on collection day for later analysis. This is not a Standard Method or approved by EPA, but staffing constraints prevented us from running the lab analyses the next day.

16. Diel Study. The data in Table 4-A does not indicate a composite mid-depth sample being taken at the Cedar's dock site, as discussed in the text.

The Cedars Dock Site is labeled as RM 111.1 in this table (see Diel Study, pg. 5).

17. QA/QC. Because of problems with calculations and results presentation, would like to see raw data presented in an appendix or made available through other means.

Volumes of raw data are available by contacting us at:

Mike Falter or Brian Riggers
Dept. of Fish & Wildlife Resources
University of Idaho
Moscow, ID 83843

However, we have condensed all of the data into usable form and presented it in Tables and Appendices in the report.

18. Some discussion of the low number of duplicate samples analyzed should be presented. Isn't it standard to run duplicate samples for each parameter, except triplicate samples for BOD?

Duplicate sampling of each parameter was not addressed in the study plan. However, random samples were run in duplicate as a check, and most BOD samples were run in duplicate. (See QA/QC appendix).

19. How are the data for the duplicate samples presented? Are the two data points averaged and presented, or is the duplicate data not presented in this report in any form? Some analysis of what the duplicate samples showed would be appropriate. Example: The multiple chlorophyll *a* samples run on July 30, 1991. What data is presented, was there a statistically significant difference between the multiple samples?

The standard, first-run answers were presented in the report. Duplicate samples were purposely left out because of the randomness of the duplicate sampling schedule. Generally, (except with BOD₅'s), duplicates were only ran as a check on measurements that seemed erroneous (as in the chlorophyll *a* samples of July 30, 1991). The random schedule and procedures whereby duplicates were analyzed makes them statistically invalid. However, they did serve as a good rough check on equipment and personnel performance, which is all they were intended to do. (See QA/QC Appendix).

20. There is no discussion to indicate that blanks were run when required. Were seed corrections done for BOD's? For ultimate BOD's was ammonia oxidation inhibited with thiosulfate? If so, how was the NBOD measured?

All blanks were run as required, and as outlined in Standard Methods (referenced in the report). Seed corrections were done for BOD's, as outlined in Standard Methods.

Ammonia oxidation was not inhibited in ultimate BOD's, and we have noted this in the report.

21. Data from Citizens Volunteer Monitoring Program and discharge monitoring data from wastewater treatment plants is presented, but how does it correlate with data collected in this study? There appear to be some significant differences in the data submitted by the WWTP's shown in the study and data submitted to EPA. EPA would be willing to work with the authors to determine the validity of the WWTP data sets.

The CVMP and WWTP data is presented simply as a comparison for the reader. Analysis of the outside data was not a part of the study plan...we did not want to tread on DEQ's territory since they ran the CVMP program.

RESULTS/DISCUSSION

22. Was any attempt made to integrate data of previous studies with the data from this study to present a comprehensive view of the water quality, as opposed to looking at each study individually?

Data from previous studies was referenced a number of times to show general trends in river water quality over the past 10-12 years. (See Figs. 5-7 & 29, Also noted in text).

23. There is no discussion of the interactive effects of the various nutrients, as related to plant biomass growth and dissolved oxygen (D.O.) depletion.

See Observations section.

24. Water discharge What is the "ameliorating effect of Lake Coeur d' Alene" that is referred to? Which parameters does it affect?

Lake Coeur d' Alene is a storage basin for Spokane River water before it exits the lake and enters the river. This causes peaks and troughs in the hydrograph to be less volatile in the Spokane River than in the tributary rivers which feed the lake. Flashiness of most water chemistry parameters would also be expected to be tempered in the River below the Lake.

25. If Water Year 1991 was more "typical" than the entire study period, how is it being treated differently in results discussion? Figure 7 indicates that all data is similar during the low flow months, (the period of particular interest) except Yearsley's 1988 study.

Important differences between measurements in Water Year 1991 and the entire study are pointed out in the report. We did not make any effort to treat WY 1991 differently.

As shown in Figure 7, the mean monthly flows of all study years are similar from July to October (the period of interest). However, mean monthly flows in June are drastically different between studies (over 13,000 cfs difference between Yearsley's study and Water Year 1991). The flow during this "pre-summer" period is very important in that it sets the stage for the upcoming months by either flushing out the system or acting as an algae and weed incubator lengthening the summer high growth period. This issue was probably not sufficiently addressed in issuing the HARSB discharge permit period.

26. WWTP discharge. When discussing discharge flows from WWTPs as percent of total river flow, allowable mixing zones should at least be mentioned. Water quality parameters at the edge of the allowed mixing zones are an important feature of assessing the impact of the WWTP's on the water body.

The study plan did not include sampling at the edge the allowed mixing zone. It was an overall river water quality study plan with no effort to discern actual mixing zones, so we could not address their probable locations.

27. The conditions for Hayden Area Regional Sewer Board discharge stated in the report are possible limitations suggested by the author. Please clarify

that the current permit conditions prohibit discharge when river flow is less than 2000 cfs during the months of June through September.

Done.

28. Please include the Ford Rock Hole on the map or give its river mile location. Another potential area of oxygen reduction, which was not mentioned, is the area behind the dam. Was Site 5 chosen using previous research (which showed low D.O. behind the dam) to address this concern? Can the D.O. in this area be related to water quality standards?

Morphometric maps of the entire study area (except below Post Falls Dam), as well as detailed maps of the Ford Rock Hole, have been included in an Appendix. All sample sites were chosen and approved in the study plan, based on previous research done on the river. Site 5 was chosen in earlier years for its presumed great depth. Later studies simply adhered to the same site.

29. Flushing rates. What is "instantaneous mean flow", described in this section, and "instantaneous retention time", described in the Conclusions section? Isn't river flow data based on USGS daily mean flows?

River flow data is based on USGS daily mean flows. Corrections in the text on this point have been made.

30. Temperature. Is it reasonable to compare this water body to other North Idaho streams during summer, when the water body exhibits characteristics of a lake?

This reach of the Spokane River (or outlet arm of Coeur d'Alene Lake) has riverine characteristics at high flow and lacustrine characteristics at low flow. Belonging to each water body type then, it is certainly reasonable to compare this reach to either type, depending on the time of year. It is not a black or white issue.

31. Would the data from this study correlate with previous studies' assessments of characteristics which cause thermal stratification?

As pointed out in the report, we observed only one instance of slight thermal stratification. Stratification observed during other studies occurred at extremely low flows which did not occur during our study.

32. D.O. Can any discussion be made about the dam's effect on D.O., especially during periods of low D.O. above the dam?

The study was poorly designed to address the impacts of Post Falls Dam on dissolved oxygen. Site 6 should have picked up dam-enhanced deoxygenation, especially during early morning hours, but such stresses were not observed.

33. The D.O. standard of 6 mg/L does not apply to some lake/reservoir situations. What is the significance of 100% saturation, when the water quality criterion is 90%?

The equilibrium saturation level of oxygen in water is 100%. 90% is simply the minimum level the State has set in its water quality criterion.

34. Text indicates that data for North Idaho streams is presented in Table 5 for comparison with this water body.

Done.

35. Conductivity. Was the pocket of high conductivity verified with duplicate sampling or more than one sample at that site?

The pocket of high conductivity was verified by taking three sets of conductivity profiles at the station. All readings supported the initial observations.

COMPOSITE MEASUREMENTS

36. pH. Please clarify the meaning of *median pH range*.

See text.

37. Turbidity. Figure 20 does not illustrate the slight turbidity increase downstream of Lake Coeur d' Alene. How statistically significant is this increase to overall water quality and water quality standards?

See Table 8. The increase is averaged slightly greater than 10% (between RM 111.1 and RM 100.7) over the study period. The increase was not directly attributable to any defined source along the river

38. Chlorophyll a. Please expand on or explain the reference to "increased nutrient loading" in the fourth paragraph.

Done.

39. Could the high 1991 Chlorophyll a measurements with high flow be due to algae bloom(s) in Lake Coeur d' Alene being washed into this water body?

Certainly a possibility, but with no data from Lake Coeur d'Alene at those times, we can't say.

40. Figure 21 indicates several rapid concentration decreases of similar magnitude to the "population crash" described on 9/17/90. Can this phenomenon be discussed?

Chlorophyll *a* levels are commonly sporadic, especially a data record with a two week interims between sampling dates. The population crash of 9/17/90 was notable in that the pheophytin content of the phytoplankton samples was extremely high, indicating an unhealthy or senescing population (See Figure 22). We probably caught the tail end of a bloom.

41. Figure 45 does not correspond with the statement that nitrogen is the limiting factor during August; does that statement only apply to Falter's 1982 study? The TMDL affecting this water body uses a different approach for determining which nutrient is limiting? For consistency, could that approach also be presented?

Figure 45 is an all-station composite of N:P ratios. In the composited data, the lake station tends to dominate with its very high N:P ratios. Station 2, below the CDA WWTP, had N:P ratios $\leq 16:1$ every sampling date from June 29, 1990 through November 12, 1990. Following P removal in June, 1991, the N:P ratios soared to over 50:1. Figure 45 does indicate nitrogen limitation from August 8 to October 1, 1990 for the all-station data composite, as the text implies (See N:P ratio section in text). Calculating TMDL's for the Spokane River was not an objective of this study. We were not given that charge by DEQ and don't want to intrude on their turf.

42. Throughout this section there are references to mean river concentrations followed by WWTP contributions that appear to be a total yearly load. A direct comparison, using the same form for the data, would be more appropriate.

We reference both concentrations and total loading throughout the report for the river and WWTP's. Tables are provided for clarification.

43. There seems to be a general inconsistency when discussing nitrogen compounds by name. Text, figures, and tables go back and forth between the chemical compound name only and the compound name followed by "-nitrogen". This is especially confusing when numerical data is presented because it's not clear which convention is being followed in calculating the concentrations.

The labeling has been corrected but all of our data should be expressed as "...."-nitrogen" or "...."-phosphorus," etc.

44. The report discusses possible biological nitrate conversion to ammonia. Wouldn't this require anaerobic conditions in the river? Does the data, for D.O. and all nitrogen compound concentrations, support this theory? Is any ammonia being converted to nitrate downstream? If ammonia is being converted to nitrate and nitrites, does the Coeur d' Alene effluent have a more significant impact on nutrient concentration in the water body than discussed in this report?

Denitrification occurs both aerobically and anaerobically. Aerobic conditions in the mud or water permit higher rates of denitrification though. In the Spokane River, we suspect that most denitrification occurs with photosynthetically-driven nitrate reduction and later release of reduced organic nitrogen or ammonia. In a well-aerated, ammonia-rich system such as the upper Spokane River, nitrification certainly must be occurring at a rapid rate. We didn't measure such nitrification and could not, therefore, conjecture on the rate of ammonia oxidation.

45. The Post Falls nitrate load is referred to as insignificant because of small effluent volume, then described as 25% of the summer load.

The Post Falls nitrate load is seen as an "insignificant" source of NO_3 compared to the total nitrate load." This refers to the entire study period. The 25% contribution refers to summer low flows only.

46. If the quality of the ammonia data for WWTP effluents is questionable, as described in the bold-faced note, why not use, or at least compare, data collected by the WWTP's using EPA approved methods?

Data collected by the WWTP's is presented in Table 20 for comparison.

47. Has the general increase in total phosphorus, which the author states has resulted in an "overall deterioration in water quality....over the last 10 years," changed the trophic state of the water body? Could a more thorough discussion of Figure 29 be given to explain its apparent conflict with the generally agreed upon statement that nutrient levels have been increasing over time in this water body? Why does this figure show only WY91? How does the entire study period, 6/90 through 9/91 compare with the other data?

The increase in TP is one factor which has led to a change in the Spokane River trophic status to mesotrophic. It is not the only one.

The legends on this graphic are in error. We apologize for this mistake. Corrections have been made.

Data for the entire study period includes two spring seasons, and would not be a realistic comparison to the 1980 study.

48. Is all measured total phosphorus reduction caused by plant biomass uptake? Were other possible phosphorus sinks considered, such as orthophosphate being adsorbed to particles containing iron and its hydroxy complexes, or sorbed to other metals? Could metals play an important role because of mining activities in the watershed?

We speculate that most of the reactive phosphorus was converted into plant biomass because of the relatively turbidity low carried by the river below the lake. Decreasing total phosphorus levels, however, were not solely a result of decreasing reactive phosphorus sink in this section. No metals were studied so conjecture can't be made, nor can we offer any more speculation as to the possibility of the orthophosphate absorption in the report. However, this seems to be a logical assumption.

49. Does the level of phosphorus measured in the water body show a statistically consistent decrease after Coeur d'Alene began phosphorus removal? (Figure 38 and Table 14 do not seem to support the conclusion of

the text). Can an estimate be made as to the effects of yearly variations and flow differences on total phosphorus?

The mean phosphorus level in the CDAWWTP effluent was 4.26 mg/l (n=16) before phosphorus removal, compared to a mean of 0.87 mg/l (n=9) after phosphorus removal. River mean phosphorus levels were .017 mg/l (n=16) before phosphorus removal and .011 mg/l (n=9) after phosphorus removal. These calculations were from data taken directly out of Table 14. This trend is apparent in Figure 38. WY 91 encompasses the phosphorus removal period, with fewer non-phosphorus removal measurements to bias the means.

CONCLUSIONS

50. No discussion of water quality standards.

State Water Quality Standards have been added.

FIGURES AND TABLES

51. For non-local readers, please add the river mile locator for Post Falls Dam to Figure 1.

52. The legend in Figure 6 is confusing.

53. Does the data set used for Figure 10 agree with a standard definition of low flow? Does Figure 11 compare the data (flow and WWTP effluent) for only Sept. 5, 1990, or is WWTP shown as the average of some larger data set?

The Figure 10 data set is over the lowest mean monthly flow during the period. In Figure 11, the river flow is a daily mean, whereas WWTP discharges are daily means based on an average daily flow throughout a one month period.

54. Although the trend of increasing nitrate concentration with increasing flow relationship still holds, can the author discuss the relatively low nitrate concentrations observed from 3/91 to 7/91 shown in Figure 24?

We don't know that we can say much more about the low nitrate values of 3-7/91. The minima seem to compare to the similar period in 1990, both times of annual chlorophyll *a* highs. Phytoplankton uptake is a reasonable explanation.

55. The figures using dual ordinate scales can be confusing. Was a standard methodology used to determine how much of a full scale should be used on each ordinate? Because the figures that use River Mile location on the abscissa are often trying to show effects of WWTP effluents, standardization seems necessary.

Dual ordinate scales were used because of the great difference in values between river water measurements and wastewater measurements. Scaling the WWTP ordinate down would cause the river measurements to be so low as to be unreadable.

56. There is a general confusion of EPA staff about nutrient data presented in figures 28, 32, 36, 40, and 43. What trends are being displayed in these figures and what is the data set "2000 cfs"? Does the nutrient load attributed to Spokane River include Lake Coeur d' Alene output, groundwater, and non-point source inputs?

These figures are not intended to illustrate trends. They illustrate the relative percentage loading from both wastewater treatment plants compared to loading from all other sources (Spokane River) during various time periods. The time period classifications were used to illustrate differing percentage inputs from each source under various flow conditions. Similarly, the 2,000 cfs data set is the relative loading from each source when flow in the river is equal to 2,000 cfs, the point below which Hayden is not allowed to discharge.

57. Figures 38 and 47 are very confusing. Are these supposed to be showing the same type of data as figures 25, 30 and 33? If not, what is being shown? Same question regarding Figure 18.

Figures 38 and 47 have been corrected. Figure 18 shows CDA and PFWWTP's median pH values in point values. This was the intent, and this figure remains unchanged.

58. The ordinates of Figure 46 do not indicate units for Coeur d' Alene WWTP scale or clearly specify that the river and Post Falls WWTP are measured on the left scale. Figure 48 is more clear but leaves out which scale should be used for Post Falls.

Fixed.

59. Table 3: Are these dissolved oxygen measurements? Averaging the data for right, middle, and left in Table 3, doesn't seem to match the means given in Table 4 for each site.

We assume the averages do not correlate because of the loss of accuracy involved with rounding such a large data set.

60. In Table 9, please explain the data presented as >x. Is this water depth?

In Table 9, >x indicates that the secchi disk was visible on the bottom, the maximum measured depth (x).

Specific Comments:

7) Page 1, Objectives.

Objective 4 was kind of a tag on item that the study design does not address. Qualification of this objective to assess POTW impacts to the extent data will allow may be in order.

See text, pg 1.

8). Page 1, Introduction, last line.

Reductions in Coeur d 'Alene River metals actually started prior to smelter shutdown. Construction of tailings impoundments in the late sixties stopped direct discharge of metals laden mill tailings and slimes to the river.

See text, pgs 1-2.

9). Page 2, Sampling.

Sample methods are appropriate for meeting Objective 1. Explain why reduction in winter sampling was statistically feasible, given Objective 2 to determine seasonal variability.

Winter is typically a time of low biological productivity, due to low water temperature, short photoperiod, etc. This was addressed in the study plan, and the sampling method used was approved.

10). Page 5, Diel Study.

Does the sampling method of only taking one diel series hold up statistically? How does one-day snapshot meet Objective 3?

If there were any diel fluctuations in D.O. and temperature, they would most likely occur during the summer, when water temperature and biological productivity is highest. We conducted the diel study at this time (mid-August) which we feel is adequate to develop a general river picture. A more thorough study would require more money and time.

- 11) Page 6, QA/QC.

There are no duplicate sampling results presented in an appendix for QA/QC. If there were some chemical constituents with overall poor duplication, then the Results section needs a qualifier for discussion of those parameters.

See Appendix B.

- 12) Page 9, Flushing Rates, 1st paragraph.

One exchange of a pool volume does not mean that all the water has physically exchanged. More like 65% has actually exchanged. It takes three or so volume exchanges before complete actual exchange has reached greater than 95%. Implying that one flushing rate indicates a complete exchange of water is misleading. Discuss.

See text, pg 9.

- 13) Page 9, Flushing rates, last paragraph.

Reference the line wherein a 15 day retention time is required.

This is a personal observation.

- 14) Page 10, Temperature, first paragraph.

Discussion of the role temperature may play on ammonia toxicity should be either here or in the ammonia section. Exceedence of the cold water biota criteria should also be discussed.

See text, pg 16.

- 15) Page 10, Temperature, last paragraph.

See general comment #4 regarding mixing.

The study was intended to address differences in water chemistry within the water column at each station only during thermally stratified conditions. All other water samples were to be composite samples from three sites at each station (See Methods, pg 3). Thermal stratification was defined in the project study plan as a change of >1 C within one meter of the water column. Thermal stratification was only observed once during the entire study period.

- 16) Page 11, Dissolved Oxygen, last paragraph.

Percent saturation levels are compared to other north Idaho streams. It is a dubious comparison, given that the outlet reach is fairly unique compared to most north Idaho streams. The table referred to (Table 5) does not give values for other streams. A more appropriate stream for comparison may be the river arm of Pend Oreille Lake.

See text, pg 11 and Appendix E.

- 17) Page 12, pH.

What do these pH levels mean with respect to beneficial uses? Specifically, ammonia toxicity may increase at higher pH levels. Given the seemingly high loads of ammonia being discharged from the POTWs, what are the consequences to cold water biota?

See text, pg 12.

- 18) Page 12, Turbidity.

If riverine character of the high flow period was important, separate the data and compare the data sets. Statistically, it should confirm or deny the statement. Also, how does background influence reach turbidity. If turbidity is related to flow, wouldn't the presence of fines in the lower reaches indicate a depositional zone?

We believe that the lower reaches are areas of deposition throughout most of the year, due to very little flow through this area. However, under high flows, the lower reaches experience significant water movement and consequential bottom sediment disturbance and re-suspension.

- 19) Page 12,13, Secchi.

The study reach is more lacustrine during the summer. The summer secchi disk transparency data shows the Spokane River to fall in the mesotrophic range of two to six meters.

- 20) Page 16, Ammonia-Nitrogen, 1st paragraph.

This first paragraph is a bold type qualifier, but again the QA/QC duplicate results are not shown or discussed for the reader. Throughout the report there is considerable discussion of ammonia and TKN values (and ammonia was 80% of the TKN), but what is the reliability? We have found from the IDEQ laboratory in Boise, that

both ammonia and TKN duplicates can have very high average relative ranges (ARR's).

See Appendix B.

21) Page 16, Ammonia-Nitrogen, 2nd paragraph.

The last sentence contains two questionable statements, namely that the high percentage of ammonia is a toxicity and a eutrophication concern. First, toxicity of ammonia is due to the free form produced at higher temperatures and pH. Toxicity is also a function of concentration and time of exposure. How do these considerations affect this statement? Secondly, the comment about eutrophication contradicts other statements in the report that the system is mostly a P-limited system. Explain.

See text, pg 16.

22) Page 17, Total Phosphorus, 2nd paragraph.

The last sentence refers to lower TP levels in 1991. Could this also be related to the addition of phosphorus removal by the CdA WWTP? See general comment #1, regarding use of means of time series data.

See text, pg 17.

23) Same, 3rd paragraph.

A sentence notes that CdA contributed 3X the phosphorus load that Post Falls did. A deception lies here in that CdA has a much higher flow than Post Falls. See general comment #5, regarding use of load in the reach.

We are simply stating how much total phosphorus was added to the Spokane River from each WWTP. Because CDA WWTP is much more diluted is not a valid reason for dismissing the facts concerning how much total phosphorus is being added.

24) Same, 4th paragraph.

What is a "significant percentage"? Was significance tested statistically? See general comment #2, regarding use of percentages.

See text, pg 18.

25) Page 18, Total Phosphorus.

Figure 26 does not support the statement made about TP increase. Is the correct reference Figure 29?

Yes.

26) Page 19, N:P Ratio.

To better discuss the relationship of the WWTPs on water quality, a discussion of phosphorus removal implications may be appropriate here. P-removal may change N:P ratios. What impacts may result?

See text, pg 20.

27) Page 20, BOD, paragraph 3.

See comment #1 regarding use of means of time series data for comparisons.

The 5-day BOD means of this time series are compared to 5-day BOD means of another time series study which covered nearly a year. We feel the comparison, while probably not statistically valid, is a good reference to the general

28) Same, paragraph 4.

Is the increase in variability by the WWTPs reflected in increased sampling? Are comparisons to the river still statistically valid?

This paragraph, like many others, is an attempt to boil down some of the data into a usable, understandable form. We make no claim as to its statistical validity, however, we do feel that the statement is accurate. See text, pg 21.

29) Page 21, Ultimate BOD.

In discussion of Ultimate BOD effects in the Spokane River reach, it seems it becomes most important in the context of retention time. The earlier section indicated 15 days were needed for stratification to occur. It seems ultimate BOD would only be relevant during extreme retention times. Based on flow records, how many exceedences of the 15 day retention time have occurred? How does ultimate BOD reached in 27 or 35 days fit this scenario?

See text, pg 22.

30) Page 21, Fecal Coliform.

The methods indicate that FC was sampled using a pour plate technique. Most Probable Numbers of coliform bacteria are only reported when the MPN tube fermentation technique is used. Plate counts result in # colonies/ 100 ml. It is incorrect to report a combination of MPN colonies/ 100ml.

The plate count technique is typically used when turbidity of the sample is low. Excess turbidity as a result of sediment or algae may result in confluent growth patterns, and can contribute to extremely variable counts.

Again, a median of time series data was used for comparison of different river mile stations. See general comment #1 for this discussion.

A discussion of beneficial use impact is in order in this section. Permissible fecal coliform levels should be compared to the data. Statements that FC were high should be placed in context (ie: highest, high observed during study, etc.).

See text, pgs 22-23. We deemed the pour plate technique most useful in this study in light of the low turbidity of water in the Spokane River. We used the median calculation with the bacteria counts because of the relatively few outliers which would have skewed a mean calculation, and also because of the uncertainty as to the exact # of colonies/100 ml in some samples (i.e. >60, "Confluent Growth", etc) (Table 18-19). See Appendix D, Section 01.2250.01 for State of Idaho Water Quality Criteria concerning fecal bacteria.

31) Page 22, Diel study.

Accomplishment of Objective 3 was the goal of performing this experiment. Either here or in the conclusions, relate the results to the study goal; are there any indications of ecosystem stress?

Did one series of diel measurements accomplish the goal? One sample event provides little insight into variability. Was the sampling strategy sufficient to answer the question? How?

The last sentence of the second paragraph states that a minor sag was "deemed insignificant". rather than deem it, analyze it statistically.

See text, pg 23, and comments to question #10 above.

32) Page 23, Conclusions.

The conclusions section reads in many ways like a results section. If statements are made about increases between stations, they should be backed up statistically. Conclusions should relate back to study objectives.

If early in the sampling, or even before initiation of sampling, it was known that there would be significant increases in concentrations between stations 111.1 and 108.8, it would have been insightful to include a block sampling design in the study. Same day site replications at the station grids could have led to standard ANOVA testing which would have more appropriately addressed objective 4.

The study objectives, although concise in appearance and number, are quite detailed and require a lengthy conclusion section in order to address them adequately. For instance, we cannot "characterize baseline river water quality" into one statement by saying it is "good" or "bad".