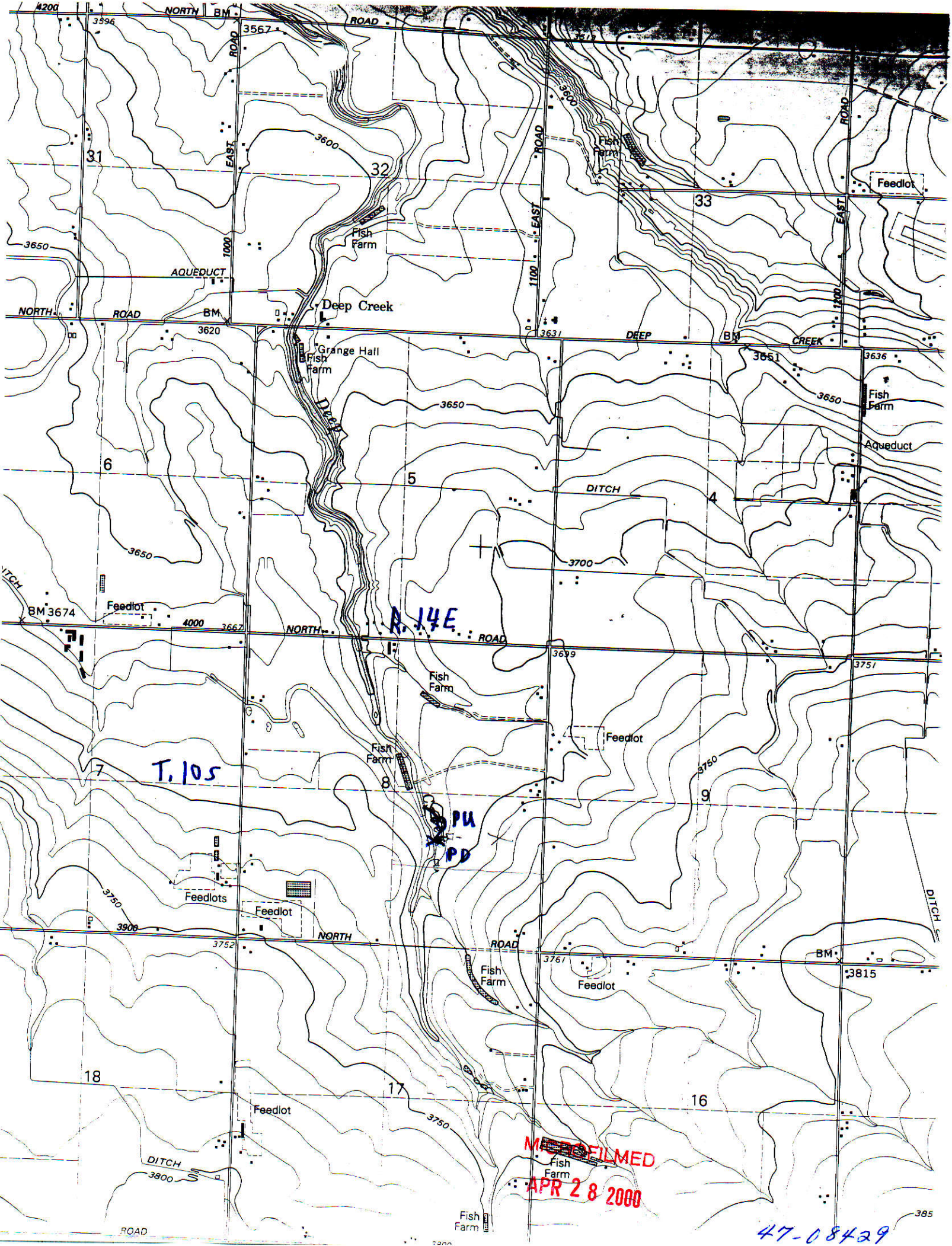

NORTH
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Fish Farm
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Deep Creek
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MICROFILMED
APR 28 2000
47-08429

Form No. 217
6/00

FOR OFFICE USE ONLY
Amt. of Fee $ 325 00
Receipt No. 0051598
Receipt By: [illegible]
Date Receipted: 12-21-00

RECEIVED
DEC 21 2000
Department of Water Resources

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

PROOF OF BENEFICIAL USE

The Idaho Department of Water Resources considers this form 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, when necessary, or be accompanied by a completed field examination report prepared by a certified water right examiner.

1. Permit No. 47-08429 Telephone No. 208 837 6114

2. Name of Permit Holder(s):
Leo E Ray Judith K. Ray

3. Mailing Address: 4647D River Rd

City Buhl State Id Zip 83316

4. Source of Water: Deep Creek If **GROUNDWATER** (well), Date Drilled: mo. ____ / yr. ____

Well Driller: ____ Drilling Permit Number: ____

5. Use(s) (as authorized by the water right permit):

Domestic (No. of households): ____ Stockwater (No. and type of stock): ____

Irrigation (No. of acres): ____ Other: Mitigation split Phosphorus removal From Deep Creek

6. Total rate of diversion and/or volume for which proof is submitted: 10 Sec Ft cfs **OR** ____ acre-feet

7. Measuring Device Requirement: **(refer to the approval conditions on your permit and respond accordingly)**
(This question is not optional. Please check either yes or no. Proofs returned not checked accordingly, will be considered incomplete)

Measuring Device: Is a measuring device required? Yes X or No ____
Has the measuring device been installed? Yes X or No ____

8. Fee Enclosed: $ $325. (See Fee Schedule on back of the instructions for filing proof of beneficial use)

9. Person to contact to accompany the Department representative during field examination of the water system.

Name: Leo E Ray Telephone Number: 208 837 6114

Address: 4647 D River Rd Buhl Id 83316

10. ***The information given on this form is my true statement of the extent to which the above numbered permit has been developed and water has been diverted. I agree to relinquish any undeveloped portion of the permit to the State of Idaho.***

Signature of permit holder: Leo E Ray Date: Dec 19, 2000
(include your title, if on behalf of company of organization)

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JAN 12 2001

State of Idaho
Department of Water Resources

Permit To Appropriate Water

NO. 47-08429

Priority: March 1, 1999 Maximum Diversion Rate: 10.00 CFS

This is to certify, that **LEO E RAY**
JUDITH RAY
4647 D RIVER RD
BUHL ID 83316
has applied for a permit to appropriate water from:
DEEP CREEK tributary of **SNAKE RIVER**

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

BENEFICIAL USE	PERIOD OF USE	RATE OF DIVERSION
WATER QUAL. IMPROVEMENT	01/01 to 12/31	10.00 CFS

LOCATION OF POINT(S) OF DIVERSION: NWSE , Sec. 8, Township 10S, Range 14E
TWIN FALLS County

PLACE OF USE: WATER QUAL. IMPROVEMENT

TWN	RGE	SEC	
10S	14E	8	NWSE

CONDITIONS OF APPROVAL AND REMARKS

1. See Preliminary Order for conditions and limitations for use of water under this 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

19th day of April, 2000.

for Karl J. Dreher, Director

MICROFILMED

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF APPLICATION)
FOR PERMIT NO. 47-08429 IN THE) **PRELIMINARY ORDER**
NAME OF LEO AND/OR JUDITH RAY)
_____)

This matter having come before the Idaho Department of Water Resources (the "Department") in the form of a protested application for permit and the Department having held a conference and a hearing in the matter, the hearing officer enters the following Findings of Fact, Conclusions of Law and Preliminary Order:

FINDINGS OF FACT

1. On March 1, 1999, Leo and/or Judith Ray ("applicant") submitted Application for Permit No. 47-08429 ("application") to the Department proposing the diversion of 10 cubic feet per second ("cfs") of water from Deep Creek tributary to the Snake River to be used year-round for water quality improvement. The application proposes to store a volume of up to 6 acre feet at one time. The proposed point of diversion and place of use are located in NW1/4SE1/4 Section 8, T10S, R14E, B.M.

(Note: The "1/4" designations will be omitted from subsequent legal descriptions in this order).

2. On May 15, 1992, the Director issued a moratorium order curtailing the use of surface and ground water within the Snake River Basin upstream from the USGS gauge on the Snake River near Weiser, Idaho ("Snake Plain Aquifer"). The moratorium was issued to prevent further development of water resources in the Snake Plain Aquifer to ensure compliance with provisions of chapter 2, title 42, Idaho Code. The Director subsequently amended the moratorium order on January 6, 1993 and on April 30, 1993. Paragraph 9 of the moratorium order provides that the Director may review applications for approval on a case-by-case basis, if protection and furtherance of the public interest requires consideration of an application irrespective of the general moratorium, or if the proposed use will have no effect on prior surface water and ground water rights because of its location, insignificant consumption of water or mitigation offered by the applicant.

3. The Department published notice of the Application which was subsequently protested by Fred F. and Betty J. Kippes, Idaho Department of Fish and Game, Floyd Kaufman and Twin Falls Canal Company. The Idaho Department of Fish and Game and the Twin Falls Canal Company entered into agreements with the

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applicant and subsequently withdrew their protests.

4. On November 9, 1999, the Department conducted a hearing in the matter. The applicant was present and was represented by Lloyd Webb. Protestants Fred Kippes and Floyd Kaufman were present and represented themselves.

5. Issues identified by the protestants are as follows:

a) The application will reduce the quantity of water under existing water rights.

b) The water supply available itself is not sufficient for the purposes intended.

c) The applicant does not have sufficient financial resources with which to complete the project.

d) The application conflicts with the local public interest.

e) The application is contrary to the conservation of water resources within Idaho.

6. Exhibits premarked, offered or accepted as a part of the record are as follows:

a. Applicant's Exhibit 1 - "Deep Creek Fish Farm Effluent Study - Final Report" by Keya Collins and Ernest L. Brannon, Aquaculture Research Institute, University of Idaho, dated December 1993

b. Protestant's Exhibit A - "The Upper Snake Rock Watershed Management Plan", October 25, 1999, Public Review Draft, The Middle Snake River Technical Advisory Committee

c. Protestant's Exhibit B - "The Upper Snake Rock Subbasin Assessment", December 31, 1998, Proposed Final Draft, The Middle Snake River Technical Advisory Committee

7. Subsequent to the hearing, the hearing officer requested additional information from the applicant relative to the application. The applicant provided the information to the hearing officer and to the protestants for review and comment. The information provided is incorporated as supplemental exhibits in the matter and are described as follows:

a. Applicant's Exhibit 2 - Report titled Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts by R. Brett Barry - June 1996

b. Applicant's Exhibit 3 - Report titled The Upper Snake Rock Watershed Management Plan by Dr. Balthasar B. Buhidar and others - December 20, 1999

c. Applicant's Exhibit 4 - Letter dated August 23, 1999 to Leo Ray from Michael J. McMasters and a Consent Order between the applicant and DEQ signed in August 1999

d. Applicant's Exhibit 5 - Agreement entered into on April 15, 1999 between the Twin Falls Canal Company and Leo E. Ray

8. On October 24, 1997, the Department issued Permit No. 47-08076 ("permit") in the name of Leo and/or Judith Ray as follows:

Source:	Unnamed streams tributary to Deep Creek
Priority:	January 14, 1988
Rate of diversion:	12 cfs
Point of diversion:	NWSE Section 8, T10S, R14E, B.M.
Use:	Fish propagation
Season of use:	Year-round
Place of use:	NWSE Section 8, T10S, R14E, B.M.

9. The Idaho Department of Health and Welfare, Division of Environmental Quality ("DEQ") will not approve the fish propagation facility associated with Permit No. 47-08076 ("permit") because it will increase the amount of phosphorous in the receiving water, which in this case is Deep Creek. DEQ, however, has entered into a consent order with the applicant allowing the fish propagation facility to be built, if the applicant provides mitigation to remove as much phosphorous from Deep Creek as the fish propagation facility adds to Deep Creek. Hence, the applicant plans to mitigate his fish propagation operation under Permit No. 47-08076 by removing as much or more phosphorous from Deep Creek using the ponds described in the application than the applicant will contribute to Deep Creek under the permit.

10. The applicant explained that the sole purpose of the application is to mitigate the water quality of Deep Creek to compensate for the development and use of water for fish propagation purposes under Permit No. 47-08076. More specifically, the applicant said he planned to construct two settling ponds on the eight acres he owns adjacent to Deep Creek, each pond being 24' wide x 150' long by 2' or 3' deep (total capacity of about 0.5 acre feet). The applicant plans to divert Deep Creek water to the settling ponds to allow sediment and phosphorous to settle out of the water. Effluent

from the ponds would then be returned directly to Deep Creek through a ditch or returned to Deep Creek after flowing through wetland areas adjacent to Deep Creek. The applicant does not plan to raise any fish in the ponds.

11. Deep Creek and the Snake River downstream from Deep Creek are water quality limited reaches. Total suspended solids, fecal coliform and nutrients are water quality parameters that at times do not meet applicable water quality standards. The applicant has provided evidence that the mitigation project proposed in the application will reduce each of these parameters to improve water quality in these reaches.

12. The applicant explained that phosphorous attaches to clay particles and that after the ponds have been drained, the applicant would periodically remove the sediment and associated phosphorous from the ponds using a backhoe. This method of phosphorous removal is recommended by the DEQ.

13. The applicant intends to use his own equipment to construct the ponds and estimates the cost to be about $1,000.

14. The applicant estimates that 2 cfs diverted from Deep Creek will be enough water to remove the required amount of phosphorous and sediment from Deep Creek water to allow his fish propagation facility to operate. The applicant is not entitled to divert more water than required to meet the mitigation plan approved by DEQ.

15. Operation of the fish propagation facility will create three full time jobs.

16. Evaporation from the ponds will consume water. This loss will be offset by shares of Twin Falls Canal Company water used on the land which the applicant does not intend to remove from the land.

17. Protestant Floyd Kaufman lives upstream from the applicant's proposed fish propagation facility and settling ponds. Mr. Kaufman is concerned that operation of the applicant's fish propagation facility will further impair the water quality of Deep Creek even if the applicant removes more sediment and phosphorous than the applicant contributes to Deep Creek.

18. Protestants Fred and Betty Kippes own land adjoining the applicant's land downstream from the applicant. The Kippes are concerned that fish propagation facilities, in general, have degraded waters in the Middle Snake River region including Deep Creek.

19. The protestants did not introduce evidence to show that the proposal of the applicant will worsen water quality in the region or in Deep Creek.

CONCLUSIONS OF LAW

1. Section 42-203A, Idaho Code, provides in pertinent part as follows:

> In all applications whether protested or not protested where the proposed use is such (a) that it will reduce the quantity of water under existing water rights, or (b) that the water supply itself is insufficient for the purpose for which it is sought to be appropriated, or (c) where it appears to the satisfaction of the director that such application is not made in good faith, is made for delay or speculative purposes, or (d) that the applicant has not sufficient financial resources with which to complete the work involved therein, or (e) that it will conflict with the local public interest, where the local public interest is defined as the affairs of the people in the area directly affected by the proposed use, or (f) that it is contrary to conservation of water resources within the state of Idaho; the director of the of water resources may reject such application and refuse issuance of a permit therefor... .

2. The protestants do not have water rights which will be impacted by the mitigation proposal of the applicant. Use of water as proposed in the application will not reduce the quantity of water under existing water rights.

3. The water supply itself is sufficient for the purposes intended.

4. The application is made in good faith and not for delay or speculative purposes.

5. The applicant has sufficient financial resources with which to complete the project.

6. The project can be constructed and operated to not conflict with the local public interest.

7. The application is not contrary to the conservation of water resources within Idaho.

8. The Department should approve the application with certain conditions.

ORDER

IT IS THEREFORE, hereby ORDERED that Application for Permit No. 47-08429 in the name of Leo and/or Judith Ray is **APPROVED** subject to the following conditions and limitations:

1. Use of water under the right is subject to all prior water rights.

2. Proof of construction of works and application of water to beneficial use shall be submitted to the Department on or before **April 1, 2001**.

3. The right holder or successors in interest shall not divert more than one-half (½) the rate of flow of water in Deep Creek as measured at the point of diversion under this right. The maximum rate of diversion also may not exceed a rate larger than required to meet the mitigation plan approved by DEQ.

4. A fish screen of ½ inch or smaller mesh shall be installed and maintained at the point of diversion.

5. After specific notification by the Department, the right holder shall install suitable measuring devices at the point of diversion from Deep Creek and at the point of effluent return to Deep Creek. Upon request of the Department, the right holder shall annually report the amount of water diverted from and returned to Deep Creek.

6. Water discharged from the settling ponds to Deep Creek shall comply with applicable water quality standards of the DEQ of the Idaho Department of Health and Welfare.

7. Use of water under the right may be affected by private agreements between the right holder and the Idaho Department of Fish and Game and the Twin Falls Canal Company.

8. The right holder shall return effluent from the settling ponds directly to Deep Creek and shall not divert the water for wetland use after use in the settling ponds of the right holder.

9. Diversion and use of water under this right is only valid in connection with operation of the fish propagation facility authorized by Permit No. 47-08076. The right holder is not authorized to raise fish or other aquatic life in the settling ponds or to make other beneficial uses of the water.

10. Use of water under the right shall be non-consumptive. The right holder shall retain ownership and control of the shares of Twin Falls Canal Company water used on the 8 acre project site.

11. The right holder shall submit plans for the check/diversion structure and for the return structure to the Department for review and approval prior to construction. In addition, the right holder shall provide evidence to the Department that DEQ has approved the mitigation proposal before working in the channel of Deep Creek.

12. Failure of the right holder to comply with any condition of approval of this permit is cause for the Department to cancel the permit.

Signed this 23rd day of March, 2000.

L. GLEN SAXTON
Hearing Officer

CERTIFICATE OF SERVICE

I DO HEREBY CERTIFY that on this 23rd day of March, 2000, the above and foregoing document was served upon the following by placing a copy of the same in the United States Mail, postage prepaid and properly addressed to the following:

Leo E. Ray
Judith Ray
4647-D River Rd.
Buhl, ID 83316

Floyd Kaufman
1119 E 38000 N
Buhl ID 83316

Fred F. Kippes
3951 N 1100 E
Buhl, ID 83316

Deborah Drew-Ellis

Deborah Drew-Ellis, Administrative Assistant
Water Allocation Bureau

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APR 2 8 2006

FORM 202
2/96

RECEIVED
MAR 01 1999
Department of Water Resources
Southern Region

Ident. No. 47-08429

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT

To appropriate the public waters of the State of Idaho

1. Name of Applicant Leo E. Ray &/or Judith Ray Phone 543-6407 home 837-6114 office
   Mailing address 4697-D River Rd, Buhl, ID 83316
2. Source of water supply Deep Creek which is a tributary of Snake River
3. Location of point of diversion is Township 10S Range 14E Sec. 8, in the ____ 1/4. NW 1/4, SE 1/4, Govt. Lot ____, B.M., Twin Falls County
   additional points of diversion if any: ____
4. Water will be used for the following purposes: ~~Div. To Storage~~
   Amount 10.0 cfs (cfs or acre-feet per annum) for Water Quality Improvement purposes from 1-1 to 12-31 (both dates inclusive)
   Amount 6.0 AFA (cfs or acre-feet per annum) for Storage for Wat. Qual. Imp. purposes from " to " (both dates inclusive)
   Amount 10.0 cfs (cfs or acre-feet per annum) for Div. to Storage purposes from " to " (both dates inclusive)
   Amount ____ (cfs or acre-feet per annum) for ____ purposes from ____ to ____ (both dates inclusive)
   Amount ____ (cfs or acre-feet per annum) for ____ purposes from ____ to ____ (both dates inclusive)
   Amount ____ (cfs or acre-feet per annum) for ____ purposes from ____ to ____ (both dates inclusive)
5. Total quantity to be appropriated is (a) 10.0 cubic feet per second and/or (b) ____ acre feet per annum
6. Proposed diverting works:
   a. Describe type and size of devices used to divert water from the source ~~Check dam~~ Check dam + headgate, ditch to pond, ditch back into Deep Creek.
   b. Height of storage dam 1.0 feet; active reservoir capacity 3.0 acre-feet; total reservoir capacity 6.0 acre-feet
   c. Proposed well diameter is ____ inches; proposed depth of well is ____ feet
   d. Is ground water with a temperature of greater than 85°F being sought? ____
   e. If well is already drilled, when? ____; Drilling firm ____;
   Well was drilled for (well owner) ____; Drilling Permit No. ____
7. Time required for completion of works and application of water to proposed beneficial use is 1 years (*minimum 1 year*)
8. Description of proposed uses (*if irrigation only, go to item 9*):
   a. Hydropower; show total feet of head and proposed capacity in KW. ____
   b. Stockwatering; list number and kind of livestock. ____
   c. Municipal; show name of municipality. ____
   d. Domestic; show number of households. ____
   e. Other; describe fully. ____

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APR 28 2000

9. Description of place of use:

a. If water is for irrigation, indicate acreage in each subdivision in the tabulation below.

b. If water is used for other purposes, place a symbol of the use (*example: D for Domestic*) in the corresponding place of use below. See instructions for standard symbols.

TWP	RGE	SEC	NE				NW				SW				SE				TOTALS
			NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	
10S	14E	8														X			

X = P/4 For WAQ Storage

Total number of acres to be irrigated _____

10. Describe any other water rights used for the same purposes as described above. _____

11. a. Who owns the property at the point of diversion? Applicants

b. Who owns the land to be irrigated or place of use? "

c. If the property is owned by a person other than the applicant, describe the arrangement enabling the applicant to make this filing: _____

12. Remarks: We have a permit to raise fish on this property (47-08076) using seep water, but cannot get an NPDES permit from EPA without a way to mitigate for phosphorus. The proposed pond will remove more phosphorus from Deep Creek Than what will be discharged from the proposed fish ponds.
The site for the 3-acre WAQ pond is irrigated with TFCC shares. The shares will be allowed to run into Deep Creek as mitigation for any water loss in the pond.

13. **MAP OF PROPOSED PROJECT REQUIRED** - Attach an 8½"x11" map clearly identifying the proposed point of diversion, place of use, section #, township & range. (A photocopy of a USGS 7.5 minute topographic quadrangle map is preferred.)

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

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APR 2 8 2000

Lee E Ray

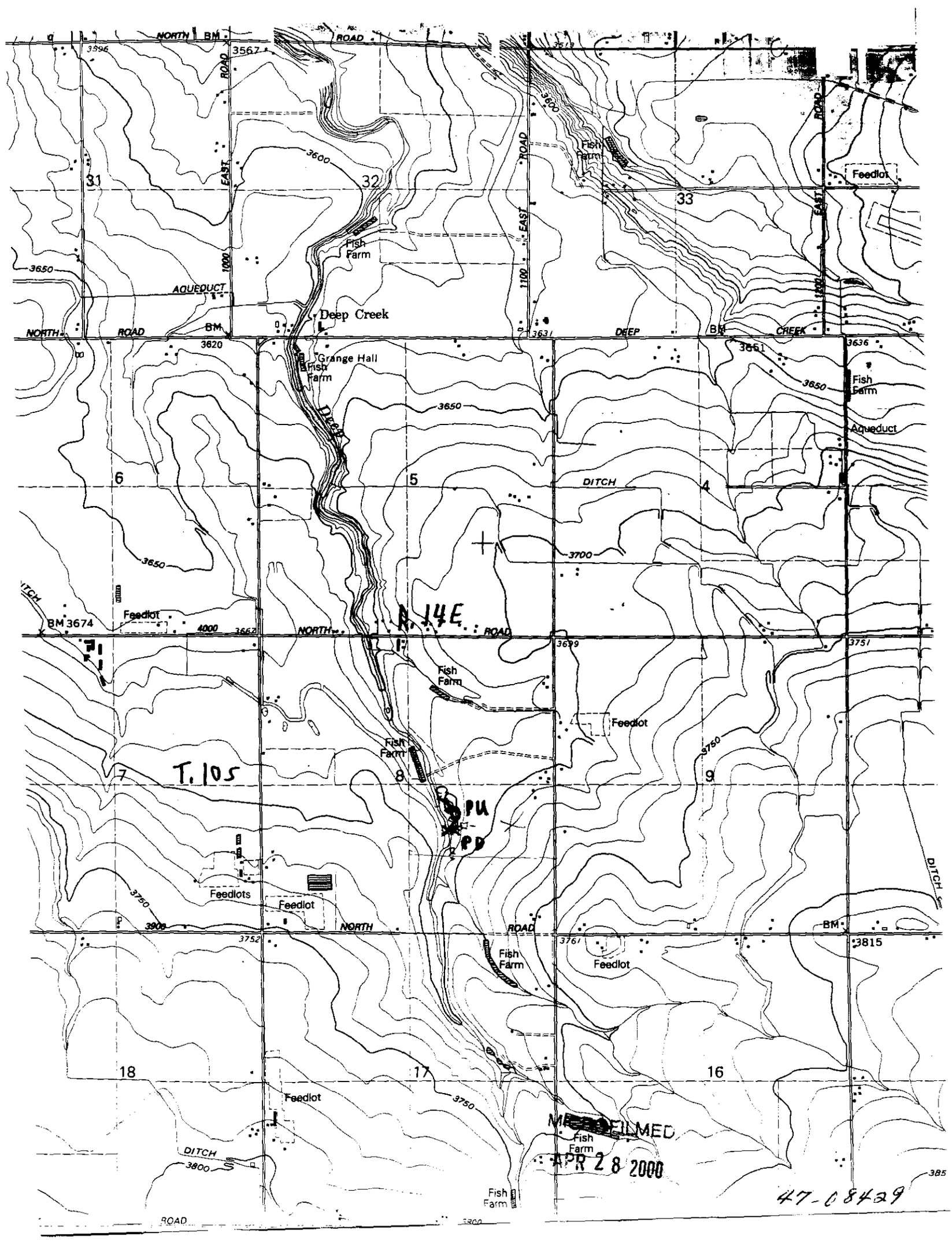
Signature of Applicant (and title if applicable)

Received by J F Kenton Date 3-1-99 Time 11:37 am Preliminary check by JK

Fee $ 280.00 Receipted by JK # 5021831 Date 3-1-99

Publication prepared by MB Date 03/16/99 Published in Times News

Publication approved MB Date 4/12/99


NORTH
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ROAD
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Fish Farm
Feedlot
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AQUEDUCT
Deep Creek
DEEP
CREEK
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Grange Hall
Fish Farm
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MICROFILMED
APR 28 2000
47-08429

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Boise, ID 83706 - P.O. Box 83720, Boise, ID 83720-0098
Phone: (208) 327-7900 Fax: (208) 327-7866 Web Site: www.idwr.state.id.us

DIRK KEMPTHORNE
Governor

KARL J. DREHER
Director

January 12, 2001

LEO E RAY
JUDITH RAY
4647 D RIVER RD
BUHL, ID 83316

PROOF ACKNOWLEDGEMENT LETTER

RE: Permit No. 47-8429

Dear Permit Holder(s):

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.

Please be advised that Section 42-248, Idaho Code, requires you or the owner of this water right to maintain current ownership and address records on file with the department. Forms to file a change of ownership of a water right and/or a change in the address of the water right owner are available from any department office.

If you have any questions concerning the field examination, please contact the Southern Regional Office of the department in Twin Falls at (208) 736-3033.

Sincerely,

Deborah J. Gibson

Deborah J. Gibson
Administrative Assistant
Water Allocation Bureau

c: IDWR - Region

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JAN 12 2001

ANALYSIS SHEET FOR PROOF OF BENEFICIAL USE

Permit No.: 47-8429 Reviewed By: dgibson Date: January 12, 2001

	Yes	No
Proof received timely?	X	
License examination fee required?	X	
Appropriate fee submitted?	X	
Receipt No.:	C051598	
Additional Amount Due:		
Name and address same as permit?	X	
Are the water uses correct?	X	

	Yes	No
Drilling permit required?		X
Drilling permit No.:		
Drilling permit upgrade needed?		
Well driller's report filed?		X
Measuring device required?		X
Measuring device installed?	X	
Measure device waiver requested?		

Priority Calculation

Date proof received		12/21/2000
Date proof due		01/01/2001 04/01/2001
No. of days late	=	0
Holiday allowance	+	
Priority date	+	03/01/1999
New priority date	=	03/01/1999

Deficiencies of Actions Items

Acknowledge proof.

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JAN 12 2001

Idaho Department of Water Resources Receipt

Receipt ID C051598

Payment Amount	$325.00	**Date Received**	12/21/00 3:59:59 PM	**Region**	State	**Status**	
Payment Type	Check	**Check Number**	1356				

Payer FISH BREEDERS OF IDAHO INC

Comment WATER PERMIT # 47-08429

Fee Detail

Amount	Description	Fund	FD	PCA	SO
$325.00	BENEFICIAL USE	0229	21	56104	1155

Signature Line (Dept. Representative)

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JAN 12 2001

October 31, 2000

LEO E RAY
JUDITH RAY
4647 D RIVER RD
BUHL ID 83316

PROOF DUE NOTICE

RE: PERMIT NO. 47-08429

Dear Permit Holder:

One of the conditions of approval of the above referenced water permit was that proof of the extent of your beneficial use must be submitted to this office on or before January 1, 2001. (See last page of your approved permit or your last approved extension request.) Enclosed is a form which when accompanied by the license examination fee or a complete field examination report prepared by a certified water right examiner may be used to submit the required proof.

If you have not fully completed your project, and you or a previous owner of this permit have not received a prior extension of time, you may request an extension of time if the delay is for reasonable cause as provided in Section 42-204, Idaho Code. If you have been prevented from proceeding by a governmental agency or by litigation which might bring title to the water in question, more than one extension of time can be granted. An extension of time request form is enclosed for your convenience.

Either an acceptable proof of beneficial use submittal or an acceptable request for an extension of time must be received by this department on or before the above described proof due date. If neither is received, the department will send you a lapse notice. Within sixty (60) days of the mailing of the lapse notice, the permit will no longer be of any force nor effect.

SINCERELY,

DEBORAH GIBSON
Administrative Assistant

Enclosures

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JAN 12 2001

CERTIFIED MAIL
7099 3220 0005
NO. 5178 7982

MEMORANDUM

May 8, 2000

TO: File No. 47-08429

FROM: Cindy Hodges
Water Distribution Section

RE: Measurement and Reporting Requirement

The Order granting approval of this permit contains a condition that the water right owner install measuring devices .."After specific notification by the Department."

Per Glen Saxton's direction, IDWR will not require measurement and reporting at this time because 1) the source of the permit is surface water, 2) the permit is not in a water measurement district, and 3) the use of the water is nonconsumptive. However, IDWR may require measurement and reporting in the future if it becomes necessary.

cc: IDWR Southern Region

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JAN 12 2001

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

April 19, 2000

LEO E RAY
JUDITH RAY
4647 D RIVER RD
BUHL ID 83316

RE: Permit 47-08429

Dear Permit Holder(s):

Enclosed please find an approved Permit issued by the department in reference to the above listed information.

If you have any questions regarding this matter, please call me at 327-7940.

Sincerely,

Jeff Peppersack, Manager
Water Right Permits Section

JP:klt

Enclosure

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APR 2 8 2000

Is your RETURN ADDRESS completed on the reverse side?

SENDER:

- ☐ Complete items 1 and/or 2 for additional services. Complete items 3, 4a, and 4b.
- ☐ Print your name and address on the reverse of this form so that we can return this card to you.
- ☐ Attach this form to the front of the mailpiece, or on the back if space does not permit.
- ☐ Write *"Return Receipt Requested"* on the mailpiece below the article number.
- ☐ The Return Receipt will show to whom the article was delivered and the date delivered.

I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

3. Article Addressed to: 47-08429
Fred F. Kippes
3951 N 1100 E
Buhl Id 83316

4a. Article Number
Z 269 224 766

4b. Service Type
☐ Registered ☑ Certified
☐ Express Mail ☐ Insured
☐ Return Receipt for Merchandise ☐ COD

7. Date of Delivery
4-1-00

5. Received By: (Print Name)

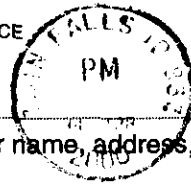
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DEPARTMENT OF WATER RESOURCES
1301 N. ORCHARD ST.
BOISE, ID 83706-2237

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3. Article Addressed to:

Floyd Kaufman
1119 E 38000 N
Bulk, Id. 83316

47-08429

4a. Article Number

Z 269 224 767

4b. Service Type

☐ Registered ☑ Certified
☐ Express Mail ☐ Insured
☐ Return Receipt for Merchandise ☐ COD

7. Date of Delivery

3-24-00

5. Received By: *(Print Name)*

IDA KAUFMAN

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Ida Kaufman

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Department of Water Resources

DEBORAH DREW-ELLIS
DEPARTMENT OF WATER RESOURCES
1301 N. ORCHARD ST.
BOISE, ID 83706-2237

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APR 2 8 2000

March 23, 2000

Copies forwarded to:

IDWR NORTHERN - Bob Haynes

SOUTHERN - Allen Merritt

EASTERN - Ron Carlson / Skip Jones

WESTERN - Gary Spackman

SALMON OFFICE - Bob Foster

Legal Division - Phil Rassier

Adjudication Bureau - Dave Tuthill

Information Officer - Dick Larsen

Water Allocation Bureau - Glen Saxton

Water Distribution Section - Tim Luke

Water Permits Section - Jeff Peppersack / Shelley Keen

Administration - Norm Young

Planning - Bill Graham

AG's Office - David Barber

PLEASE ROUTE:

Darla Block
Richard Hansen
Sharla Curtis
Burke Scholer
Dayna Ball

Pam Skaggs
Kay Walker
Kari Lynn Townsend
Cindy Hodges

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APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

March 23, 2000

RE: In the matter of Application for Permit No. 47-08429 in the name of Leo and/or Judith Ray

Dear Interested Parties:

The accompanying order is a **Preliminary Order** issued by the department pursuant to section 67-5243, Idaho Code. **It can and will become a final order without further action of the department unless a party petitions for reconsideration within fourteen (14) days after issuance as further described below:**

PETITION FOR RECONSIDERATION

Any party may file a petition for reconsideration of a preliminary order with the hearing officer within fourteen (14) days of the service date of this 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 a preliminary order, (b) the service date of a denial of a petition for reconsideration from this preliminary order, or (c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration from this preliminary order, any party may in writing support or take exceptions to any part of a preliminary order and may file briefs in support of the party's position on any issue in the proceeding to the Director. Otherwise, this preliminary order will become a final order of the agency.

If any party appeals or takes exceptions to this preliminary order, opposing parties shall have twenty-one (21) days to respond to any party's appeal. Written briefs in support of or taking exceptions to the preliminary order shall be filed with the Director. The Director retains the right to review the preliminary order on his own motion.

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ORAL ARGUMENT

If the Director grants a petition to review the preliminary order, the Director shall allow all parties an opportunity to file briefs in support of or taking exceptions to the preliminary order and may schedule oral argument in the matter before issuing a final order. If oral arguments are to be heard, the Director will within a reasonable time period 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 preliminary order shall be served on all other parties to the 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 Director 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.

Section 67-5246(5), Idaho Code, provides as follows:

> Unless a different date is stated in a 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.

APPEAL OF FINAL ORDER TO DISTRICT COURT

Pursuant to sections 67-5270 and 67-5272, Idaho Code, if this preliminary order becomes final, any party aggrieved by the final order or orders previously issued in this case may appeal the final order and all previously issued orders in this case 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,

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Return Receipt Showing to Whom & Date Delivered	
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I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

3. Article Addressed to: 47-08429
Leo E. Kay
4647-D River Rd.
Buhl, Id.
83316

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4a. Article Number
Z 269 224 765

4b. Service Type
☐ Registered ☑ Certified
☐ Express Mail ☐ Insured
☐ Return Receipt for Merchandise ☐ COD

7. Date of Delivery 3/27/00

5. Received By: *(Print Name)*

8. Addressee's Address *(Only if requested and fee is paid)*

6. Signature *(Addressee or Agent)*
Jedah K. Kay

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DEPARTMENT OF WATER RESOURCES
1301 N. ORCHARD ST.
BOISE, ID 83706-2237

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Department of Water Resources

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 of this preliminary order becoming final. See section 67-5273, Idaho Code. The filing of an appeal to district court does not itself stay the effectiveness or enforcement of the order under appeal.

Sincerely,

Deborah Drew-Ellis

Deborah Drew-Ellis
Administrative Assistant
Water Allocation Bureau

Enclosure
c: IDWR - Region

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SEP 28 2005

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

March 22, 2000

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

FRED F KIPPES
3951 N 1100 E
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08426 - LEO AND JUDITH RAY

Dear Mr. and Ms. Kippes:

This letter follows up our telephone conversation today in which I inquired whether you had served copies of nine (9) photographs of Deep Creek in connection with the above referenced matter on the other parties. Ms. Kippes advised me she had not provided the photographs to the other parties and did not plan to do so. Hence, I can not consider the photographs as part of the hearing record and am returning those photographs to you as enclosures with this letter.

The contested matter is now considered submitted with the next step being the issuance of a Preliminary Order.

Sincerely,

L. GLEN SAXTON
Hearing Officer

Encl: 9 photographs

c: Leo Ray w/o encl
Floyd Kaufman w/o encl
IDWR - Region w/o encl

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SEP 28 2000

APPLICATION FOR PERMIT
STATE OFFICE ANALYSIS
Reviewed by Sharla Curtis on 1/16/99

No. 47-12429 Name: Ray Corp. Officers N/A Ad ok ✓ Govt Lots ——

AREA OF CONCERN: No/~~Yes~~ ESPA **Moratorium** F **GWMA** ~~TRUST/NON-TRUST~~

GROUNDWATER: (√Flow Chart)

DRILLING PERMIT	
All wells	- 046(**P23**)
Basin 34	- 085
Irr. w/in WD	- **P05**
WMD	- North/East/West
≤ 0.24 cfs/5 acres	- No MD
> 0.24 cfs/5 acres	- 067
~~WMD~~	
Supp irr (irr = only use)	- 065-079
Supp irr (+ other uses)	- 100-101
≤ 0.24 cfs/5 acres	- No MD
> 0.24 cfs/5 acres	- 01M

~~SURFACE~~ WATER: (√Flow Chart)

F&G contacted	- Yes/No Response _____
~~In/Above MSF~~	- WB9
PLANNING SECTION REVIEW/RESPONSE	_____
~~In-stream development~~	- **P52**
WD	- R04 (WD# _____)
≤ 0.20 cfs/others	- 01H(P01), 01P or No MD
> 0.20 cfs	- 01J(**P08**)
SPRINGS/SINK, INACTIVE WD & REST OF STATE	
≤ 0.24 cfs/5 acres	- No MD
>0.24 cfs/5 acres	- **01M** or No MD

LOCATION:

~~Boise Front LoGeo~~	- 058 (<85 GW)
~~Mitigation~~	- 121
~~42-248 Area~~	- **~~P84~~** (20s-70s, 81-86)
Swan Falls Flag	- _____ NA
Trust	- 051(**P74**) (~~consumptive uses~~)
~~Non-Trust~~	- **~~048-049~~** (consumptive uses or ~~non-cons. > 1.0 cfs~~)

RIVER BASINS: (SW special considerations)

Snake R (01)	- W22(**P04**), N/A
(02.03)	- 007 (w/ remark WB9 if above Weiser)
Payette R (65)	- 047(**P04**) (Payette Lake)
Salmon R (70's)	- **029** (fish screens)
Weiser R (67)	- 086-087

USES:

~~STORAGE~~	- 18A-01H(**P01**),01P-18B(**P09**)-~~NA~~
IRR ≤ 5 ac	- R66/R67/R68/R69 (0.03 cfs/ac)
> 5 ac	- R62/R63/R64/R65 (0.02 cfs/ac)
STOCKWATER	- R37 (BLM/USFS)
MINING	- 054-081(**P10**)
FISH PROP	- 029(70'S only)-007-042-081(**P10**)
HEAT/COOL	- R07(injection well)
FIRE PROT.	- 077

USES:

POWER	- 17H-17K (+uses)-08A-025(**P18**)-01N-081(**P10**)
MUNICIPAL	
Restricted area	- 022,075
Irr., GW supp to SW	- 102
DOMESTIC	
Surface water	- WB5 (Big Wood or Boise above Star Bridge) 27A (Payette R)
>1 in restricted area	- 070-071-075(no parks/common areas, etc)
Irr use listed separate	- WB5
Moratorium approvable	- W03 (2400 gpd – meetd domestic definition i..e. D/convenience store)

allow 1/1/2001

~~BENEFICIAL USE DUE:~~ ~~12/01/2000~~

~~MISC CONDITIONS/REMARKS:~~

~~Protested~~	- 020-~~W19~~
~~Development Period~~	
≤ 1 yr	- **P16**
~~> 1 yr~~	- 26A(**P17**)
~~Ownership~~	- 004
Non-consumptive	- 027
~~Water Quality~~	- 081-R07
Multiple pd's per ¼¼	- W32
Subd lot desc (pd)	- W59
Subd lot desc (pu)	- W60
Use definitions	- W02 example – S/50 range
Pre-1987 development	- 068-074 (allow 120 days for proof due)

OTHER CONDITIONS/REMARKS _____

COMMENTS _____

March 17, 2000

State of Idaho Department of Water Resources
1301 N. Orchard St.
P.O.Box 83720
Boise, ID 83720-0098

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Water Resources

L.Glen Saxton
Hearing Officer

Mr. Saxton:

Application 47-08426--Leo and Judith Ray
Re: Permits #47-08076 and #47-08429

For your information only; the photographs that we sent to you in a previous letter were taken in the area of one mile upstream and one mile downstream from the site of the proposed facility. These pictures were taken to indicate the condition of Deep Creek during the winter of 1999-2000.

Respectfully,

Fred F. Kippes
3951N 1100E
Buhl, ID 83316
543-8373

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SEP 28 2000

March 13, 2000

L. Glen Saxton
Hearing Officer
Idaho Department of Water Resources
1301 North Orchard Street
P.O.Box 83720
Boise, ID 83720-0098

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MAR 20 2000
Department of Water Resources

Mr. Saxton:

Application 47-08426--Leo and Judith Ray
Re: Permits #47-08076 and #47-08429

Until water entering Deep Creek from this proposed fish facility is free of contaminants year round, this permit to operate is or will not be in compliance with the DEQ regulations.

You might also consider the quantity of water that is now flowing at this proposed facility in Deep Creek before granting further use for fish growing operations. The way the water table is dropping, the present water flows on Deep Creek will not support the fish ponds that are currently in operation there.

It is within your jurisdiction to prevent Deep Creek from becoming a sewer.

Respectfully,

Fred F. Kippes
3951N 1100E
Buhl, ID 83316

cc: Leo Ray
Floyd Kaufman
IDWR Region

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APR 28 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

March 16, 2000

FRED F KIPPES
3951 N 1100 E
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08426 - LEO AND JUDITH RAY

Dear Mr. Kippes:

I have received your letter dated March 13, 2000 together with nine (9) photographs of Deep Creek in connection with the above referenced matter. I can not determine from your letter whether you have served a copy of the letter and the photographs upon the other parties as you are required to do by IDAPA Rule 37.01.01302 (Rule of Procedure 302). Also note that IDAPA Rule 37.01.01270.02 (Procedure Rule 270.02) entitles the other parties to a period of 14 days in which to respond to your letter and photographs if they so wish.

You need to provide evidence to me within ten (10) days of the date of this letter to show that you have served the other parties. If you have not served the other parties or do not timely respond to this request, your letter and the photographs can not become a part of the hearing record.

Sincerely,

L. GLEN SAXTON
Hearing Officer

c: Leo Ray
Floyd Kaufman
IDWR - Region

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March 13, 2000

L. Glen Saxton
Hearing Officer
Idaho Department of Water Resources
1301 North Orchard Street
P.O.Box 83720
Boise, ID 83720-0098

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Department of Water Resources

Mr. Saxton:

Application 47-08426--Leo and Judith Ray
Re: Permits #47-08076 and #47-08429

Until water entering Deep Creek from this proposed fish facility is free of contaminants year round, this permit to operate is or will not be in compliance with the DEQ regulations.

You might also consider the quantity of water that is now flowing at this proposed facility in Deep Creek before granting further use for fish growing operations. The way the water table is dropping, the present water flows on Deep Creek will not support the fish ponds that are currently in operation there.

We have enclosed, for your consideration, some photographs of the present condition of Deep Creek.

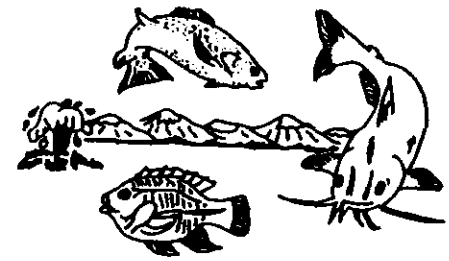
It is within your jurisdiction to prevent Deep Creek from becoming a sewer.

Respectfully,

Fred F. Kippes
3951N 1100E
Buhl, ID 83316

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APR 28 2000

Fish Breeders of Idaho, Inc.
Fish Processors, Inc.



RECEIVED
FEB 17 2000
Department of Water Resources

January 14,2000

TO L. Glen Saxton
Hearing officer
Dept. of Water Resources
1301 North Orchard Street,
P.O. Box 83720,
Boise Idaho 83720-0098
Fax 208 327 7866

RE: Application for permit No. 47-08429 in the name of Leo E. Ray and/or Judith Ray

Dear Mr. Saxton:

Following are the answers to your letter of December 21, 1999

Question

1. Can the effluent from the hatchery under Permit No. 47-08076 be cleaned up using the ponds you propose under application 47-08429? If not, why not?

Answer

No. The effluent from the hatchery under Permit No. 47-08076 cannot be cleaned up using the ponds proposed under application 47-08429. It is impossible, with current technology, to remove all of the phosphorus discharged from fish production when spring water is used. Permit No. 47-08076 uses spring water. Much of the phosphorus and other nutrients added by fish culture can be removed, however, all of the phosphorus cannot be removed. There will be a slight increase of phosphorus in the discharge. Settling ponds are designed into the plans for permit No 47-08076 that will remove all that is removable.

EPA's No Net Increase policy does not allow any increase in phosphorus in the receiving water, in this case Deep Creek. EPA does allow, and in certain situations encourages, the development of facilities if mitigation can cause a net reduction in phosphorus in public water. Permit No 47-08429 will allow us to not only remove the phosphorus being added by Permit No 47-08076 but will allow us to remove more phosphorus from Deep Creek than the fish hatchery will add in Permit No 47-08076. The result of the two permits will be a net reduction in phosphorus in Deep Creek. The water quality of Deep Creek will be improved.

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SEP 28 2000

FISH BREEDERS of IDAHO, INC. • P.O. BOX 479 • HAGERMAN, IDAHO 83332 • (208) 837-6114
FISH PROCESSORS, INC. FAX (208) 837-6254

Phosphorus attaches to clay particles. In spring water there is no clay. Deep Creek water has a lot of suspended clay particles. If these clay particles are settled out of the water, phosphorus is removed from the water. The best thing that can be done to clean up Deep Creek water is to run the water through settling ponds.

Question

2. The hearing record shows that 2 cfs is sufficient for the water cleanup proposal described in the application. Why did you apply for 10 cfs: Please provide documentation and justification for 10 cfs.

Answer

I have estimated that I could remove the amount of phosphorus from Deep Creek that would be put in Deep Creek by permit No 47-08076 by settling as little as 2 cfs of Deep Creek water. It is not my desire to do the minimum I am required to do in the DEQ/EPA Consent Order. I would like to do all that I can to clean up Deep Creek. The site involved is ideal for cleaning up Deep Creek water. I am willing, at my expense, to build a facility that will remove more phosphorus and sediment than I will put in Deep Creek. The site can efficiently clean up 10 cfs. I filed on 10 cfs because I can clean up 10 cfs.

The Twin Falls Canal Company has built facilities similar to this proposed facility to remove sediment and phosphorus from its discharge water. In order for this community to clean up the Snake River and its tributaries all of us in the community must do our part to clean the water in the valley whenever we can. I have the opportunity to do more than I am required to improve the water quality of Deep Creek and the Snake River. I would like to do that extra cleanup.

I have attached a research paper by R. Brett Barry, June 1996, Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts. This Thesis states that 16 canal systems return flows (of which Deep Creek is one) delivers 18,153 tons of suspended sediment, 5.0 tons of ammonia nitrogen, 74 tons of organic nitrogen of which 5.0 tons was ammonia nitrogen, 108 tons of nitrite+nitrate nitrogen, and 36 of total phorphorus of which 22.6 tons was dissolved ortho phosphate to the snake river. The thesis estimated that treatment facilities similar to the one proposed here could remove 47% of the 1990-1991 load or 39% of the 1995 load.

In the irrigation season this section of Deep Creek is part of the Twin Falls Canal Company delivery system. The water is very dirty. It is loaded with silt. It needs to be cleaned. If space was available more water should be diverted and cleaned.

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APR 2 8 2003

Question

3. Has DEQ agreed to the concept of the mitigation project? If so, had DEQ put any requirements on the project, such as, is it a one-for-one ratio of pollution added by the fish facility to pollution subtracted by the mitigation project: Describe and provide documentation.

Answer

DEQ has agreed to the concept of the mitigation project. The Consent Order is attached. DEQ has put requirements on the project. They require a one-for-one reduction. A reduction must be made before the fish can be raised. The volume removed must be greater at all times than the volume added. The facility must be monitored. Records must be kept and reported to DEQ and EPA. If at any time the amount of phosphorus returned to the river exceeds the amount of phosphorus removed (a net increase in phosphorus) the fish farm must be shut down. Other requirements are listed in the Consent Order.

Question

4. Is Deep Creek or the Snake River downstream from Deep Creek a water quality limited reach? If so, what are the parameters that do not meet standards? Will the mitigation project reduce or add to the existing problems in these reaches? Of particular concern are temperature increases and bacterial contamination. Please provide appropriate documentation.

Answer

In answering this question I ask the assistance of Dr. Bulthasar B. Buhidar, PHD. of Idaho Dept. of Environmental Quality. He supplied a copy of the Upper Snake Rock Watershed Management Plan. The final plan was submitted to USEPA December 20, 1999. A copy highlighted by Dr. Buhidar is attached.

Deep Creek and the Snake River downstream from Deep Creek are water quality limited reaches. The parameters that do not meet water quality standards are Total Suspended Solids, Bacteria, and Nutrients. This mitigation project will reduce each of the parameters that cause these reaches to be water quality limited reaches.

Suspended Solids

The thesis Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts by Brett Barry is attached. This thesis addresses this question. I will quote several statements from the thesis.

Page 3. "One goal of this evaluation procedure was to estimate the total percentage of sediment reduction that can be achieved through water quality facilities.

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Page 9. "Sediment removal efficiencies on return flows generally range from 60-75%. A 60 X 500 X 5 ft. pond monitored from 1972-74 in southern Idaho removed about 70% of incoming sediment from a 10 cfs stream (Brown et al, 1981). This same pond removed 25–33% of the incoming total phosphorus."

Page 15,16. "DEQ estimated that 5,150 tons of sediment were discharged from Deep Creek during the irrigation season in 1986 (Litke, 1988)." "Brockway and Robison (1992) estimated Deep Creek contributed 8,317 tons of to the Snake River between June 1990 and July 1991."

Page 32. " With the exceptions of J8 Drain and S19/S Drain, the loading results indicate that controlling the amount of sediment returning to the Snake River also controls the amount of total phosphorus returning as well."

Page 39. ---"while the streams forming Deep Creek represent the water quality in the High Line Canal."----- "There is potential to implement water quality facilities on these streams."

Page 41. "However, mean suspended sediment concentration decreased from 223 mg/L to 34 mg/L, a change of 85%. This indicates the sediment ponds are very effective in decreasing sediment."

Page 41,42. "Water quality monitoring of this facility during the 1994 irrigation season indicated removal efficiencies of up to 65% for suspended sediment and 20 % for total phosphorus (unpublished data, IWRRI)."

This project will reduce suspended sediments.

BACTERIA

The bacteria of concern is Fecal Coliform. It should be noted that Fecal Coliform is from warm blooded animals and fish farms do not contribute Fecal Coliform. This project will not contribute Fecal Coliform. It will reduce Fecal Coliform and total bacteria. By settling organic material from Deep Creek the project will not only remove bacteria but will remove the food supply for bacteria, therefore reducing the bacterial load of Deep Creek. Page 170 3.1.3 PATHOGENS of The Upper Shanke Rock Watershed Management Plan by Dr. Balthasur B. Buhidar, PHD>

Page 198 section 3.5.1 PATHOGENS of The Upper Snake Rock Watershed Management Plan prepared by Dr. Balthasur B. Buhidar, PH.D. and others and submitted to USEPA on December 20, 1999 reports on Pathogens of concern or Fecal Coliform.

MICRO
SEP 2 8 2000

NUTRIENT

For the purpose of a TMDL (total maximum daily load) phosphorus is used to represent all nutrients of concern. If phosphorus levels are known DEQ believes they can adequately predict other nutrients.

As previous stated phosphorus is attached to the clay particles in Deep Creek. The quotes, listed under Suspended Solids of the answer to this question, applies to nutrients also. This project will reduce the nutrients of Deep Creek.

Temperature has not been listed as a water quality limiting factor. It is not anticipated that this project will increase the temperature of Deep Creek or the Snake River. The water in the canal system has reached equilibrium with the environment in this reach. The status of temperature is discussed on page 177, 3.1.8 TEMPERATURE in The Upper Snake Rock Watershed Management Plan.

This project would not increase any of the factors causing the stream segments to be listed as water quality limited. It would reduce all of the factors causing the stream segments to be listed as water quality limited. It is anticipated the project would reduce those factors by 39 % in the water going through the settling ponds. See the abstract Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts.

Question

5. Is there a way to prevent waterfowl from adding to the bacterial load in the ponds?

Answer

Yes. The two settling ponds necessary to remove sediment and phosphorus are small and would be cleaned regularly. The cleaning would remove the vegetation that is the food supply that attracts ducks. Ducks would not cause a problem on these ponds. These settling ponds will continuously reduce sediment, phosphorus and bacterial load from Deep Creek.

The wetland area would attract ducks and other wildlife. During winter when ducks disturb sediment, water flow to the wetland area would be reduced or shut off when the sediment is disturbed by ducks. Ducks do most of their feeding that disturbs the sediment at night. This area could be kept wet and full of water without discharging water to Deep Creek or the discharge from the wetland could be shut off at night and allowed to flow during the day. The settling ponds would continue to improve water quality. This procedure would prevent ducks from adding bacteria, solids or nutrient to Deep Creek.

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In certain situations ducks add to the degradations of a water system. However, ducks in general have a net improvement on most water systems. They feed on the vegetation in the water. They usually remove more organic material than they deposit. With proper management we can captalize on benefit ducks do and bypass the wetland when ducks active is detrimental.

It should be remembered that sediment ducks disturb in the wetlands and cause to flow out of the system is material the system has settled out. Ducks would normally not cause a net increase of discharge in the system over an extended period. They would only decrease the efficiency of the system or cause spikes in discharge.

Question
6. Will the project be non-consumptive? If not, how will losses be mitigated? If Twin Falls Canal Company (TFCC) shares are proposed as the source of mitigation, how will the water be applied or provided to Deep Creek? You also need to provide written concurrence of TRCC in connection with mitigation involving shares of FRCC water.

Answer
The project will be not consumptive, with the exception of evaporation. The land being flooded has TFCC shares. These shares will be maintained to cover any consumptive water.

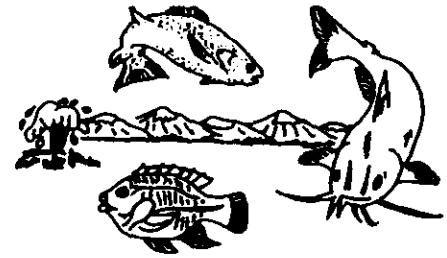
At this point Deep Creek is part of the TFCC delivery system. The point of diversion for the TFCC shares will be changed from one diversion point to another. The water going through the settling ponds will be returned to Deep Creek within 200 feet of the diversion point. The water going through the wetlands will be returned to Deep Creek about 400 feet from the diversion point.

A copy of the agreement with the TFCC is attached.

Sincerely,
Leo E. Ray

MICROFILMED
SEP 28 2006

Fish Breeders of Idaho, Inc.
Fish Processors, Inc.



RECEIVED
FEB 28 2000
Department of Water Resources

February 24, 2000

L. Glen Saxton
Hearing Officer
Department of Water Resources
1301 North Orchard Street
P.O. Box 83720
Boise, Idaho 93720-0098

RE: APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO E. RAY AND/OR JUDITH RAY

Dear Mr. Saxton:

Complete copies of the letter answering your questions and the documents I supplied with that letter were sent to Fred Kippes and Floyd Kaufman on Feb.17, 2000. A copy of the U.S. Postal Service receipt is enclosed. I did not send the documents certified mail so I do not have a signed receipt. I apologize for not notifying you of this in my letter.

My attorney, Lloyd Webb is retiring. I have not supplied Lloyd with a copy as he is trying to terminate his legal practice. Other cases I am working on with Lloyd are either being finished or we are obtaining other attorneys to continue the cases. I will supply him with a copy. If additional legal assistance is needed I may need to use another attorney.

Sincerely;

Leo E. Ray

Leo E. Ray

MICROFILMED
MAR 2 8 2000

FISH BREEDERS of IDAHO, INC. • P.O. BOX 479 • HAGERMAN, IDAHO 83332 • (208) 837-6114
FISH PROCESSORS, INC. FAX (208) 837-6254

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

February 22, 2000

LEO E RAY
4647-D RIVER RD
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO E. RAY AND/OR JUDITH RAY

Dear Mr. Ray:

I have received the information you provided in connection with my December 21, 1999 letter to you. I can not determine from your submittal, however, that you have provided a copy of the information to the protestants in the matter. If you have not, please do so, and in any event, provide evidence to me that you have served them. The date of service is important since that date starts the 30 day response period for the protestants.

Enclosed is a copy of my December 21, 1999 letter for your reference.

Sincerely,

L. GLEN SAXTON
Hearing Officer

Encl: 1

c: IDWR - Region
Lloyd Webb
Fred J. Kippes
Floyd Kaufman

MICROFILMED
APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

January 19, 2000

Leo E. Ray
Fish Breeders of Idaho, Inc.
P.O. Box 479
Hagerman, ID 83332

RE: APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO E. RAY AND/OR JUDITH RAY

Dear Mr. Ray:

I have reviewed your letter dated January 12, 2000 in which you ask for an additional 30 days in which to respond to questions raised in my December 21, 1999 letter to you.

Your request for an additional 30 days to provide the requested information is reasonable and is granted.

Sincerely,

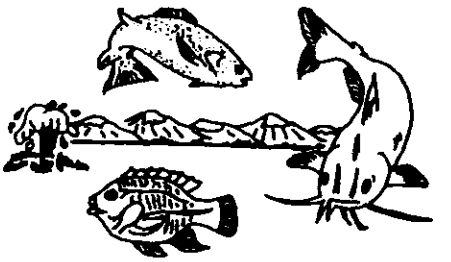
L. Glen Saxton

L. GLEN SAXTON
Hearing Officer

c: IDWR - Allen Merritt
Lloyd Webb
Fred J. Kippes
Floyd Kaufman

MICROFILMED
JAN 2 8 2000

Fish Breeders of Idaho, Inc.
Fish Processors, Inc.



RECEIVED
JAN 18 2000
Department of Water Resources

Jan. 12, 2000

L Glen Saxton Hearing officer
State of Idaho
Dept. of Water Resources
1301 North Orchard Street
P.O. Box 83720
Boise, Idaho 83720-0098

RE: Application for permit No. 47-08429 in the name of Leo E. Ray and/or Judith Ray.

Dear Mr. Saxton:

In your letter of December 21, 1999 you requested documentation and additional information to a series of questions regarding permit No. 47-08429. You ask that this information be supplied in 30 days. I would like to request an additional 30 days to accumulate this information.

My daughter Kacy Kay Ray was murdered at Burley on Dec. 26 1999. The body was not found until Jan. 1, 2000. The internment was Jan. 10, 2000. Please grant my request for a 30 day extension of time to supply the information you requested.

Sincerely;

Leo E Ray

Leo E. Ray

MICRO
SEP 28 2000

FISH BREEDERS of IDAHO, INC. • P.O. BOX 479 • HAGERMAN, IDAHO 83332 • (208) 837-6114
FISH PROCESSORS, INC. FAX (208) 837-6254

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

December 21, 1999

Leo E. Ray
4647-D River Rd
Buhl, ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO E. RAY AND/OR JUDITH RAY

Dear Mr. Ray:

Subsequent to the hearing held by the department on November 9, 1999, I have reviewed both the oral hearing record and the exhibits which were accepted as a part of the record. My review shows that I need additional information from you to supplement the record.

Questions and information needed are as follows:

1. Can the effluent from the hatchery under Permit No. 47-08076 be cleaned up using the ponds you propose under application 47-08429? If not, why not?

2. The hearing record shows that 2 cfs is sufficient for the water cleanup proposal described in the application. Why did you apply for 10 cfs? Please provide documentation and justification for 10 cfs.

3. Has DEQ agreed to the concept of the mitigation project? If so, has DEQ put any requirements on the project, such as, is it a one-for-one ratio of pollution added by the fish facility to pollution subtracted by the mitigation project? Describe and provide documentation.

4. Is Deep Creek or the Snake River downstream from Deep Creek a water quality limited reach? If so, what are the parameters that do not meet standards? Will the mitigation project reduce or add to the existing problems in these reaches? Of particular concern are temperature increases and bacterial contamination. Please provide appropriate documentation.

5. Is there a way to prevent water fowl from adding to the bacterial load in the ponds?

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SEP 2 8 2000

6. Will the project be non-consumptive? If not, how will losses be mitigated? If Twin Falls Canal Company (TFCC) shares are proposed as the source of mitigation, how will the water be applied or provided to Deep Creek? You also need to provide written concurrence of TFCC in connection with mitigation involving shares of TFCC water.

Please provide the requested information within 30 days and provide a copy of all information to the protestants, who will have 30 days to review and respond to the information. I will appreciate your prompt submittal of this information in order that I can further consider the pending application.

Sincerely,

L. GLEN SAXTON
Hearing Officer

c: IDWR - Allen Merritt
Lloyd Webb
Fred J. Kippes
Floyd Kaufman

MICROFILMED
SEP 28 2006

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL
ALAN G. LANCE

RECEIVED
NOV 01 1999
Department of Water Resources
Southern Region

October 20, 1999

Allen D. Merritt
Regional Manager
Idaho Department of Water Resources
1341 Fillmore St., Suite 200
Twin Falls, ID 83301-3380

Re: Application for Permit No. **47-08429** in the name of Leo Ray.

Dear Allen:

Enclosed is a Stipulation and Withdrawal of Protest that resolves all matters between Leo Ray and the Idaho Department of Fish and Game. Please note that paragraphs 4 and 5 require certain limiting language on the permit itself. If you have any questions regarding this, please feel free to call me at (208) 334-4125.

Thank you.

Sincerely,

PETER J. AMPE
Deputy Attorney General
Natural Resources Division

PJA/krj
Enclosure
cc: Cindy Robertson
L9301NAA.doc

MICROFILMED
APR 2 8 2000

Natural Resources Division
P.O. Box 83720, Boise, Idaho 83720-0010
Telephone: (208) 334-2400, FAX: (208) 334-2690
Located at 700 W. Jefferson Street, Suite 210

ALAN G. LANCE
ATTORNEY GENERAL

CLIVE J. STRONG
Deputy Attorney General
Chief, Natural Resources Division

PETER J. AMPE
Deputy Attorney General
Natural Resources Division
700 W. Jefferson Street, Room 210
P.O. Box 83720
Boise, ID 83720-0010
Telephone: (208) 334-2400
FAX: (208) 334-2690
Idaho State Bar No. 5209

Attorneys for Protestant Idaho Department of Fish and Game

RECEIVED
NOV 01 1999
Department of Water Resources
Southern Region

BEFORE THE IDAHO DEPARTMENT OF WATER RESOURCES

IN THE MATTER OF APPLICATION FOR PERMIT NO. 47-08429	)	**WITHDRAWAL OF PROTEST**
In the name of LEO AND/OR JUDITH RAY	)	

Comes now Protestant Idaho Department of Fish and Game and moves to withdraw its *Protest* filed in the above captioned matter.

Idaho Department of Fish and Game moves to withdraw its *Protest* based upon the *Stipulation* entered into between Applicant and Idaho Department of Fish and Game, filed contemporaneously hereto and incorporated as if fully set forth herein. Based upon said *Stipulation*, Idaho Department of Fish and Game moves the Hearing Officer to dismiss Idaho Department of Fish and Game's *Protest* with prejudice.

ORIGINAL

MICROFILMED
APR 28 2000

DATED This 28th day of October, 1999

PETER J. AMPE
Deputy Attorney General
Natural Resources Division
For Idaho Department of Fish and Game

CERTIFICATE OF SERVICE

I hereby certify that on this 28th day of October, 1999, I caused to be served a true and correct copy of the **WITHDRAWAL OF PROTEST** upon all parties of record in this proceeding by placing same in the United States mail, postage prepaid, addressed as follows:

Leo E. Ray
4647-D River Rd
Buhl, ID 83316

Fred F. Kippes
Betty J. Kippes
3951 N. 1100 E.
Buhl, ID 83316

Floyd Kaufman
1119 E. 38000 N.
Buhl, ID 83316

PETER J. AMPE
Deputy Attorney General
P9301NAA.doc

MICROFILMED
NOV 28 2000

ALAN G. LANCE
ATTORNEY GENERAL

CLIVE J. STRONG
Deputy Attorney General
Chief, Natural Resources Division

PETER J. AMPE
Deputy Attorney General
Natural Resources Division
700 W. Jefferson Street, Room 210
P.O. Box 83720
Boise, ID 83720-0010
Telephone: (208) 334-2400
FAX: (208) 334-2690
Idaho State Bar No. 5209

Attorneys for Protestant Idaho Department of Fish and Game

BEFORE THE IDAHO DEPARTMENT OF WATER RESOURCES

IN THE MATTER OF APPLICATION FOR PERMIT NO. 47-08429	)	**STIPULATION**
In the name of LEO AND/OR JUDITH RAY	)	

Come now Applicants, Leo Ray and Judith Ray, and Protestant Idaho Department of Fish and Game and enter into this Stipulation in order to resolve the Idaho Department of Fish and Game's Protest in the above captioned matter.

ORIGINAL

RECITALS

1. This document is a stipulation entered into by Leo Ray and Judith Ray and the Idaho Department of Fish and Game, collective referred to herein as "Signatories."

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2 8 2008

2. On or about March 1, 1999, Leo and Judith Ray applied to the Idaho Department of Water Resources for a new water right, permit no. 47-08429 The Idaho Department of Fish and Game filed a *Protest* to Application No. 47-08429.

3. The Signatories to the Stipulation wish to resolve the matter of the Idaho Department of Fish and Game's *Protest* in Application No. 47-08429 in a mutually beneficial manner.

STIPULATION

4. Neither Leo Ray, Judith Ray, nor any successors in interest shall divert or cause to be diverted more than 50% (one-half) of the flow in Deep Creek at the point of diversion for Permit No. 47-08429 pursuant to Permit No. 47-08429. This condition shall be incorporated into any license issued by the Idaho Department of Water Resources for this Application. This agreement may be enforced in either a court or administrative proceeding.

5. The intake at the point of diversion for Permit No. 47-08429 shall be screened with ½ inch screen. This condition shall be incorporated into any license issued by the Idaho Department of Water Resources for this Application.

6. The project shall be constructed in accordance with the specifications and schematic contained within the letter from Leo E. Ray to Dave Parrish (October 12, 1999) attached hereto.

7. The Idaho Department of Fish and Game shall withdraw its *Protest* in Application No. 47-08429 and take no further action against Application No. 47-08429.

8. The Signatories agree this Stipulation touches and concerns the lands to which Permit No. 47-08429 is appurtenant to and constitutes a covenant that shall run with the land.

9. The Signatories agree this Stipulation shall be considered fully in effect and enforceable at such time as the Idaho Department of Water Resources approves this condition and shall be incorporated into any license issued by the Idaho Department of Water Resources for this Application. Such approval may include such additional terms and conditions as the Idaho Department of Water Resources deems necessary and such conditions shall not affect the validity of this Stipulation.

10. This Stipulation was reached through negotiations for the purpose of resolving legal disputes. Signatories agree that no offers, statements, and/or compromises made in the course of this matter shall be construed as admissions against interest or otherwise used in any other legal or administrative proceeding.

11. Signatories agree this Stipulation is entered into and executed voluntarily by all parties in good faith and without any fraud, misunderstanding, overreaching, misrepresentation or duress.

12. Signatories agree this document contains the Stipulation in full and incorporates and takes precedence over any prior agreement among the Signatories in this matter, whether oral or written.

13. Signatories agree that each shall bear their own costs and fees incurred in connection with this matter.

DATED this 26 day of October, 1999

Leo E Ray
LEO E. RAY

DATED this 26 day of October, 1999

Judith Ray
JUDITH RAY

DATED This 28 day of October, 1999

PETER J. AMPE
Deputy Attorney General
Natural Resources Division
For Idaho Department of Fish and Game

MICRO

CERTIFICATE OF SERVICE

I hereby certify that on this 28 day of October, 1999, I caused to be served a true and correct copy of the Stipulation upon all parties of record in this proceeding by placing same in the United States mail, postage prepaid, addressed as follows:

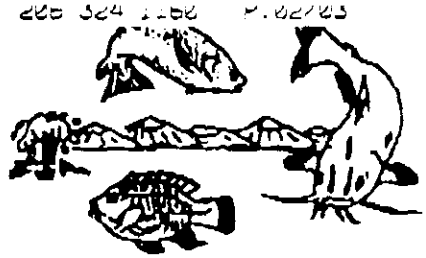
~~Ken Ellis~~
Leo E. Ray
4647-D River Rd
Buhl, ID 83316

Fred F. Kippes
Betty J. Kippes
3951 N. 1100 E.
Buhl, ID 83316

Floyd Kaufman
1119 E. 38000 N.
Buhl, ID 83316

PETER J. AMPE
Deputy Attorney General

MICROFILMED
APR 28 2000



Fish Breeders of Idaho, Inc.
Fish Processors, Inc.

Oct. 12, 1999

TO: Dave Parrish
Idaho Fish and Game
868 East Main Street
Jerome. Idaho 83338-0428
Fax 208 324 1160

FROM: Leo E. Ray

SUBJECT Plans for development of Deep Creek water clean up facility on water right application #47-08429.

I propose the following to address the concerns of Fish and Game.

1. At no time will over 50 % of the flow of Deep Creek be diverted under this permit.

2. The intake and discharge will be screened. The screen size will be 1/2 inch.

3. Two settling ponds will be built. Each settling pond be 24 ft. wide and 150 ft. long. The discharge from the settling ponds will be built so the water can be discharged back to Deep Creek below the rapids as shown on the accompanying drawing or ran into a series of wildlife ponds or wetlands. The ponds or wetlands will be built in the area North of the settling ponds according to the elevation and rock of the area. These ponds or wetlands will be managed for wildlife.

I believe this addresses your concerns. If you have questions or concerns please call me.

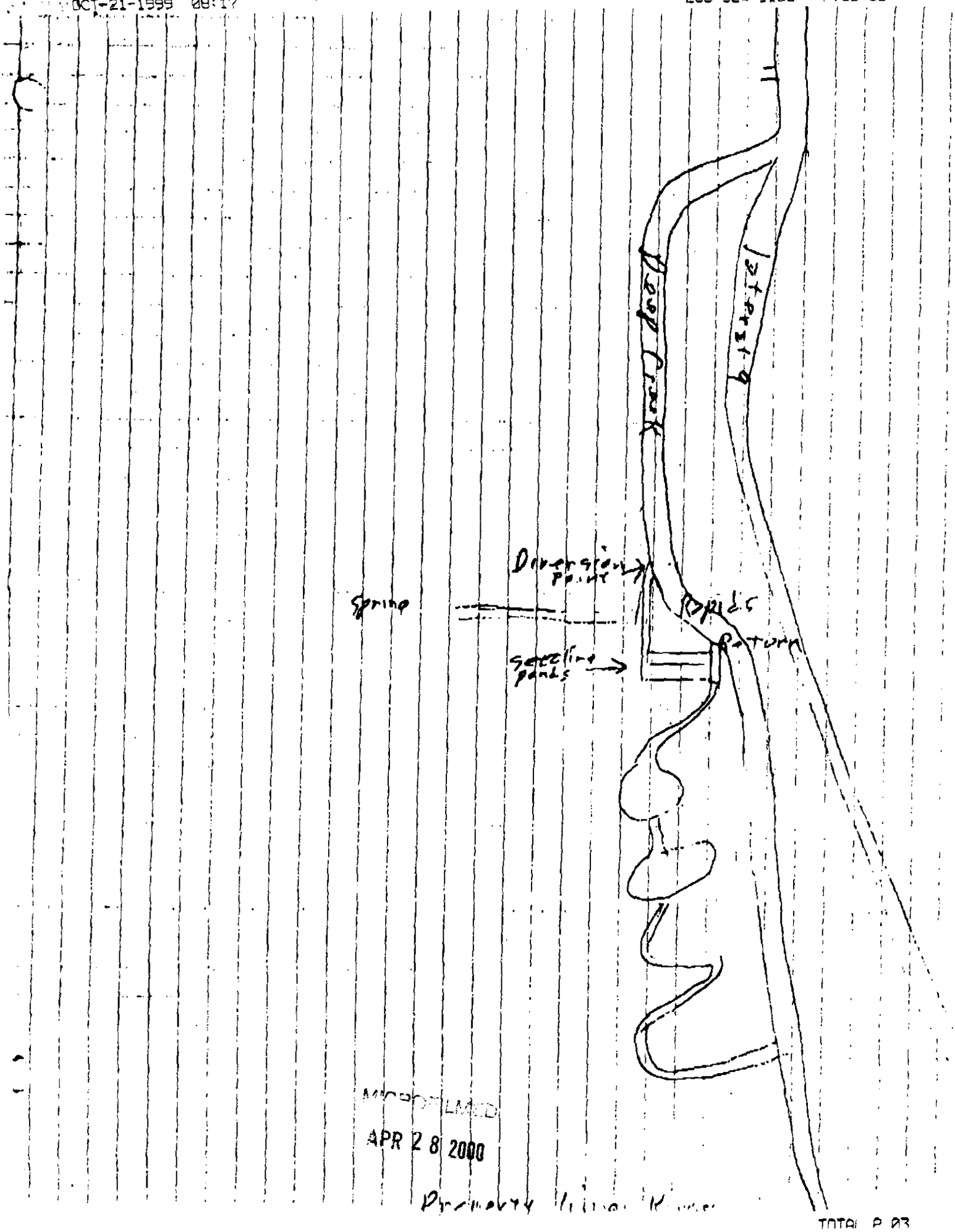
Sincerely,

Leo E. Ray

Leo E. Ray

MICHC
SEP 28 1999

FISH BREEDERS of IDAHO, INC. • P.O. BOX 478 • HAGERMAN, IDAHO 83332 • (208) 837-6114
FISH PROCESSORS, INC. FAX (208) 837-6254



MICROFILMED
APR 2 8 2000

Merritt, Allen

From: DAVE PARRISH [dparrish@IDFG.STATE.ID.US]
Sent: Tuesday, October 26, 1999 10:30 AM
To: amerritt@idwr.state.id.us
Cc: pampe@ag.state.id.us; CYNTHIA ROBERTSON
Subject: Leo Ray Water Right Protest - Deep Creek

Alan,

We are rapidly approaching the deadline for submitting a list of witnesses for the hearing on Leo's Deep Creek water right application, so, I'll give you an update on where we are with Leo.

Leo has sent us a letter saying he will: 1) not divert more than 50% of the stream; 2) screen his diversion down to 0.5" to prevent entrainment of fish; and 3) create additional wetland habitat (as per a hand drawn map). Peter Ampe has drafted a legal document which says we will withdraw our protest provided these conditions are met and they will become conditions of the water right. We are waiting for Leo to return the signed agreement.

David Parrish
Idaho Dept. of Fish and Game
Environmental Staff Biologist
dparrish@idfg.state.id.us
208-324-4359 work
208-324-1160 fax

MICROFILMED
APR 2 8 2000

BEFORE THE DEPARTMENT OF WATER RESOURCES
OF THE
STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR PERMIT NO. 47-08429	)	
	)	**NOTICE OF HEARING**
Leo &/or Judith Ray,	)	
Applicants	)	
	)	SOURCE: Deep Creek
Fred Kippes, Floyd Kaufman, ID. Dept of Fish & Game Twin Falls Canal Co.,	)	tributary to Snake River
Protestants	)	County: Twin Falls

On March 1, 1999 the Applicants, filed with the Department of Water Resources an application to appropriate the public waters of the State of Idaho. The Department has received protests against the approval of said application from the above captioned protestants.

The conference held by the department on September 20, 1999 did not resolve the matter of protest; THEREFORE, the Department has scheduled the matter for hearing on **Tuesday-November 9, 1999 at 9:00 a.m.** in the Obenchain Community Room, Obenchain Insurance Building, 264 Main Avenue South; Twin Falls, ID. Participants are cordially requested to use the **WEST entrance** to the building which faces the one-way Second Avenue South street.

The hearing will be held in accordance with provisions of chapters 2 and 17, Title 42 and Chapter 52, Title 67, Idaho Code, the adopted Rules of Procedure of the department and Water Appropriation Rules 40 and 45. A copy of the rules may be obtained from the department upon request. The presiding officer at the hearing will be L. Glen Saxton.

IT IS FURTHER NOTED, in accordance with IDAPA Rule of Procedure 37.01.01606, all parties have agreed to exchange witness lists and copies of documents that may be offered as exhibits to each party and to the presiding officer **on or before October 25, 1999.**

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 within ten (10) days prior to the hearing.

All parties to the matter will have the opportunity to respond and present information and argument on all issues involved.

Dated this 24th day of September,1999.

Allen D. Merritt
Southern Region Manager

MICROFILMED
APR 2 8 2000

CERTIFICATE OF MAILING

I hereby certify that on the 24th day of September, 1999 a true and correct copy of the foregoing Notice of Hearing was forwarded with all required charges prepared, by Certified U.S. Mail, to the parties listed:

Mary Baldwin
Secretary

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

MICROFILMED
APR 2 8 2000

CONFERENCE AND HEARING PROCEDURE

APPLICATION FOR PERMIT ISSUES

Section 42-203A, Idaho Code, requires the department to consider the following issues in connection with an application for permit:

1. Will the proposed appropriation injure other water rights?
2. Is the water supply sufficient for the purpose for which it is sought to be appropriated?
3. Was the application made in good faith or for delay or speculative purposes?
4. Does the applicant have sufficient financial resources with which to complete the proposed project?
5. Is the proposed appropriation in the local public interest, which is defined as the affairs of the people in the area directly affected by the proposed use?
6. Is the proposed use contrary to conservation of water resources within the state of Idaho?

BURDEN OF PROOF

The applicant has the initial burden of proof for issues 1, 2, 3, 4, and 6 above and must provide evidence for the department to evaluate these criteria. The initial burden of proof on issue 5 above lies with both the applicant and protestant as to factors of which they are most knowledgeable and cognizant. The applicant has the ultimate burden of persuasion, however, for this issue.

PROCEDURE

The department generally conducts an informal conference with the parties to determine the issues and to try to settle a protested matter before a hearing is scheduled. If a hearing is held the department will issue a written decision based on the hearing record.

CONFERENCE

The purpose of a pre-hearing conference is to provide the opportunity for the parties and the department to familiarize themselves with a contested matter and to attempt to resolve the matter. At the conference, the department may also formulate and simplify the issues, identify documents to avoid unnecessary proof, exchange proposed exhibits or prepared testimony, limit witnesses, discuss settlement or make settlement offers, schedule hearings, establish procedure at hearing and address other matters that may expedite orderly conduct and disposition of the proceeding or its settlement. The department may issue a "pre-conference statement order" which requires response to the inquiries.

HEARING

The department will tape record the hearing. Copies of a hearing tape are available upon request and the payment of the cost of reproducing the tape. The hearing likely will be conducted by a hearing officer appointed by the Director rather than by the Director himself. If so, the hearing officer will prepare a recommended order for the Director's consideration. Parties can file exceptions to a recommended order, briefs in support of the exceptions or may request oral argument. Parties may seek judicial review of any final order issued by the Director. Parties may by written stipulation waive the right to a recommended order, particularly when a shortened decision process is desirable or necessary. Such a waiver does not eliminate any rights of the parties in connection with the final order of the Director and judicial review of the order.

EXHIBITS

A party who plans to offer an exhibit as part of the hearing record must provide a copy of the proposed exhibit to the parties and to the hearing officer. As part of the conference a date may be set by which exchange of exhibits and witness lists must occur.

EFFECT OF FAILURE TO APPEAR AT A CONFERENCE OR HEARING

Failure to appear at the time and place set for a conference or hearing by the applicant or protestant(s) may allow the department to dismiss without prejudice the protest(s) or the application. Any and all cost incurred by reason of such non-appearance may be assessed against such non-appearing party.

AMERICANS WITH DISABILITIES ACT

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 (10) days prior to the hearing.

MICROFILMED
APR 2 8 2000

MAILING LIST
APPLICATION FOR PERMIT NO. 47-08429

Applicant:

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

Protestants:

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

Withdrawn 10/28/99

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

TWIN FALLS CANAL COMPANY

c/o NORMAN M SEMANKO ESQ
ROSHOLT ROBERTSON & TUCKER
PO BOX 1906
TWIN FALLS ID 83303-1906

Withdrawn 8/3/99

MICROFILMED
APR 28 2000

SENDER:

- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write "Return Receipt Requested" on the mailpiece below the article number.
- The Return Receipt will show to whom the article was delivered and the date delivered.

I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to: R: 47-08429

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

MICROFILM
APR 28 2000

4a. Article Number 1864

4b. Service Type
☐ Registered ☐ Insured
☑ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery 9/27/97

5. Signature (Addressee) Betty J. Kippes

6. Signature (Agent)

8. Addressee's Address (Only if requested and fee is paid)

PS Form 3811, December 1991 *U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

Is your RETURN ADDRESS completed on the reverse side?

Thank you for using Return Receipt Service.

UNITED STATES POSTAL SERVICE

Official Business

RECEIVED
SEP 28 1999
Department of Water Resources
Southern Region

MICROFILMED
APR 26 2000

PENALTY FOR PRIVATE
USE TO AVOID PAYMENT
OF POSTAGE, $300

U.S. MAIL

Print your name, address and ZIP Code here

IDAHO DEPARTMENT OF WATER RESOURCES
1341 FILLMORE STREET, SUITE 200
TWIN FALLS, ID 83301-3380

83301

Is your RETURN ADDRESS completed on the reverse side?

SENDER:

- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
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I also wish to receive the following services (for an extra fee):

1. ☐ Addressee's Address
2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to: Re: 47-08429

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

MICROFILMED
APR 28 2000

4a. Article Number 1863

4b. Service Type
☐ Registered ☐ Insured
☑ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery 4-28-99

5. Signature (Addressee) Judith K. Ray

8. Addressee's Address (Only if requested and fee is paid)

6. Signature (Agent)

PS Form 3811, December 1991 *U.S. GPO: 1992-323-402 **DOMESTIC RETURN RECEIPT**

Thank you for using Return Receipt Service.

UNITED STATES POSTAL SERVICE

Official Business

RECEIVED
SEP 29 1999
Department of Water Resource
Southern Region

PENALTY FOR PRIVATE
USE TO AVOID PAYMENT
OF POSTAGE, $300

U.S. MAIL

MICROFILMED
APR 28 2000

Print your name, address and ZIP Code here

IDAHO DEPARTMENT OF WATER RESOURCES
1341 FILLMORE STREET, SUITE 200
TWIN FALLS, ID 83301-3380

83301

Is your RETURN ADDRESS completed on the reverse side?

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2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to: Ro! 47-08429

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

APR 28 2000

4a. Article Number 1865

4b. Service Type
☐ Registered ☐ Insured
☑ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery 9-27-99

5. Signature (Addressee) X Ida Kaufmann

6. Signature (Agent)

8. Addressee's Address (Only if requested and fee is paid)

PS Form **3811**, December 1991 ☆U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

Thank you for using Return Receipt Service.

UNITED STATES POSTAL SERVICE

Official Business

PENALTY FOR PRIVATE USE TO AVOID PAYMENT OF POSTAGE, $300

US MAIL

RECEIVED
SEP 29 1999
Department of Water Resources
Southern Region

MICROFILMED
APR 28 2000

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IDAHO DEPARTMENT OF WATER RESOURCES
1341 FILLMORE STREET, SUITE 200
TWIN FALLS, ID 83301-3380

83301

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2. ☐ Restricted Delivery

Consult postmaster for fee.

3. Article Addressed to: R#: 47-08429

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

4a. Article Number 1866

4b. Service Type
☐ Registered ☐ Insured
☒ Certified ☐ COD
☐ Express Mail ☐ Return Receipt for Merchandise

7. Date of Delivery 9-27-99

5. Signature (Addressee) Ardella Reinke

6. Signature (Agent) Ardella Reinke

8. Addressee's Address (Only if requested and fee is paid)

PS Form 3811, December 1991 ★U.S. GPO: 1992—323-402 **DOMESTIC RETURN RECEIPT**

1. Return Receipt Service.

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UNITED STATES POSTAL SERVICE

Official Business

PENALTY FOR PRIVATE USE TO AVOID PAYMENT OF POSTAGE, $300

U.S. MAIL

RECEIVED
SEP 28 1999
Department of Water Resources
Southern Region

MICROFILMED
APR 28 2000

Print your name, address and ZIP Code here

IDAHO DEPARTMENT OF WATER RESOURCES
1341 FILLMORE STREET, SUITE 200
TWIN FALLS, ID 83301-3380

83301

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720
Boise, Idaho 83720-0098

Return Service Requested

NAME AND ADDRESS OF SENDER

Indicate type of mail
☐ Registered
☐ Insured
☐ COD
☐ Certified ☐ Express Mail

Check appropriate block for Registered Mail:
☐ With Postal Insurance
☐ Without Postal Insurance

Affix stamp here if issued as certificate of mailing or for additional copies of this bill.

POSTMARK AND DATE OF RECEIPT

FOR REGISTERED, INSURED, C.O.D., CERTIFIED, AND EXPRESS MAIL

Line	Number of Article	Name of Addressee, Street, and Post-Office Address	Postage	Fee	Handling Charge	Act. Value (If Regis.)	Insured Value	Due Sender if C.O.D.	R. R. Fee	S. D. Fee	S. H. Fee	Re
1	✓1863	ADM/9-24-99 Leo Ray Re: 47-08429	.33	1 25	1 40	2 98						
2	✓1864	Fred Kippes										
3	✓1865	Floyd Kaufman										
4	1866	(4) Carl Nellis - Id. F&G										
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PS Form 3877, Feb. 1982

Total Number of Pieces Listed by Sender	Total Number of Pieces Received at Post Office	POSTMASTER, PER (Name of receiving employee)

The full declaration of value is required on all domestic and international registere
The maximum indemnity payable for nonnegotiable documents under Express
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occurrence. The maximum indemnity payable on Express Mail
$500. The maximum indemnity payable is $25,000 fo
$400 for Insured Mail. Special handling charges a
parcels. Special delivery service also includes special ha

FORM MUST BE COMPLETED BY TYPEWRITER, INK OR BALL POINT PEN

☆ U.S. GOVERN

[redacted]

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 24, 1999

ATTN SANDI STANDLEY
OBENCHAIN COMMUNITY ROOM
264 MAIN AVE SOUTH
TWIN FALLS ID 83301

Dear Sandi:

This letter is to confirm the reservation of the Obenchain Main Avenue Community Room for Tuesday-November 9, 1999, from 9:00 a.m.- 5:00 p.m.

If you have any questions please feel free to contact me or Allen Merritt, the Southern Regional Office Manager.

Thank you very much for your assistance in this matter.

Very truly yours,

Mary Baldwin
Administrative Assistant

MICROFILMED

APR 2 8 2000

Merritt, Allen

From: Ampe, Peter [pampe@ag.state.id.us]
Sent: Monday, September 20, 1999 4:00 PM
To: 'Merritt, Allen'
Subject: RE: available dates for Leo Ray hearing:

that's fine.

-----Original Message-----
From: Merritt, Allen [SMTP:AMerritt@idwr.state.id.us]
Sent: Monday, September 20, 1999 3:56 PM
To: 'Ampe, Peter'
Subject: RE: available dates for Leo Ray hearing:

Pete, I hope the reason for not having 10/26 is because of the Sinclair Oil application conference. We have sent that notice out today as we talked this morning. Is that a problem?

-----Original Message-----
From: Ampe, Peter [mailto:pampe@ag.state.id.us]
Sent: Monday, September 20, 1999 3:33 PM
To: 'Allen Merritt'
Subject: available dates for Leo Ray hearing:

Just in case, I am not available for the hearing on the following days:
October 19 and 26
November 16.

Peter Ampe.

MICROFILMED
APR 2 8 2000

Merritt, Allen

From: Saxton, Glen
Sent: Monday, September 20, 1999 2:16 PM
To: Merritt, Allen
Subject: RE: Pre-hearing Conference for 47-08429

OK for Leo

Potential hearing dates which fit my schedule are as follows:

November 9 or 10 - I think I previously blocked out these out for S. Region but we didn't use them.
November 23
November 30 thru December 2 - We tentatively thought we might do Wybenga in this time period but the dates are still vacant.

Once dates will work, please let me know, so I can work other matters around the dates. Thanks. lgs

—Original Message—
From: Merritt, Allen
Sent: Monday, September 20, 1999 1:57 PM
To: Saxton, Glen
Cc: Merritt, Allen
Subject: Pre-hearing Conference for 47-08429

This day I conducted a pre-hearing conference for Leo Ray's application 47-08429 which proposes the development of some water quality ponds along side of Deep Creek. The ponds would divert water from Deep Creek and then settle out sediment & nutrients and then return the water to Deep Creek. The purpose of these ponds is to mitigate for a future fish facility covered under permit 47-08076. Mitigation is required since DEQ required no net increase in nutrients to the stream.

The application was protested by F&G, Fred Kippes & Floyd Kaufman. All were present at the conference.

Mr. Ray described the proposal and the protestants discussed their issues. They all could be classed a public interest issues.
Ray indicated that he was willing to condition his application to no more than 50% of flow in creek up to 10 cfs and also indicated that he was willing to also build a wetland on his property as additional mitigation.

F&G wanted to have diversion screened and was close to settling with Ray on their issues. They agreed to meet on land and may resolve issues.

Kippes was concerned with pollution in creek from proposed fish facility even thought that was a separate water right. His concern is that at times all water is diverted from stream by TFCC above Ray's reach, leaving only water left from Ray's springs to provide flow in stream. He fears that when these springs are developed the stream then becomes more of a sewer. He indicates his property is north or downstream from Ray's property and he plans on building a house which may be negatively impacted by the fish facility.

Kaufman was concerned about public interest and asked questions regarding what if nutrient management plan failed then who enforces fines, ect. and if facility forced to close then who cleans up mess.

No resolution of issues was found so we talked about scheduling a hearing. All agreed with 30 day notice they were pretty flexible. We agreed that witness lists and copies of exhibits would be exchanged 15 days before any hearing. It was felt that one day would be sufficient for the hearing. I told them that I would try to schedule one shortly after November 1st. Ray indicated he would probably be represented by attorney but didn't indicate who it was. I told him to let me know of his attorney's schedule.

Glen, please give me some dates and I'll try to set this up.

MICROFILMED

APR 2 8 2000

Merritt, Allen

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Sent: Monday, September 20, 1999 1:57 PM
To: Saxton, Glen
Cc: Merritt, Allen
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Glen, please give me some dates and I'll try to set this up.

MICROFILMED

APR 2 8 2000

RE: Application for Permit No. 47-08429, (Leo Ray)

PLACE: Conference Rm-ID Dept. Water Resources; Twin Falls, ID

DATE: Monday-September 20, 1999 at 10:00 a.m.

CONFERENCE OFFICER: Allen D. Merritt

ASSISTED BY:

ROSTER OF ATTENDANCE

NAME	ADDRESS	REPRESENTING
DAVID PARRISH	Box 428 JEROME, 83338	IDFG
Peter Ampe	Statehouse Boise	IDFG
Leo Ray	4647 D River Rd Buhl 83316	Leo Ray
Lloyd Kaufman		Lloyd Kaufman
Ted Kepler		Ted Kepler
	MICROFILMED	

APR 2 8 2000

FILE PROGRESS SUMMARY

APPLICANT: Leo A. Kay WATER RIGHT NO. 47-08429

INIT.	DATE	COMMENT
ael	2/1/99	Staffed to Jim Stanton
gp	3-2-99	To Marg for advertising
MB	3/8/99	Data entry.
MB	3/16/99	Adv. Sch – TN 4/1 & 4/8/99; 4/19/99
MB	4/12/99	Pub. aff rec. (4/9/99)
MB	4/12/99	Prot. Rec.
MB	6/8/99	Prot. ack. ltr sent + Notice of Protest ltr Sent
AM	7/23/99	Reg. for conf. calendar ltr. sent
AM	8/18/99	Pre-hrg. conf. Notice sent 9/20@10:00/IDWR

MICROFILMED

APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

August 19, 1999

NORMAN M SEMANKO
ROSHOLT ROBERTSON & TUCKER
PO BOX 1906
TWIN FALLS ID 83703-1906

Re: Application for Permit No. 47-08429

Dear Mr. Semanko:

This office acknowledges receipt of the withdrawal of your protest against the above referenced application.

Since there were multiple protestants, the concerns of the other protestants will need to be addressed by the Department before final processing of the application can be completed.

The Department will continue review of the application without further contact with you unless information is requested.

Please feel free to contact this office if you have any questions regarding this procedure.

Very truly yours,

Allen D. Merritt,P.E.

Southern Region Manager

AM:mb

Cc: Leo Ray

MICROFILMED
APR 28 2000

BEFORE THE DEPARTMENT OF WATER RESOURCES
OF THE
STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR PERMIT NO.47-08429	
Leo &/or Judith Ray,	NOTICE OF PRE-HEARING CONFERENCE
Applicants	
Fred Kippes, Floyd Kaufman, ID. Dept of Fish & Game ~~Twin Falls Canal Co.,~~	SOURCE: Deep Creek tributary to Snake River
Protestants	County: Twin Falls

On March 1, 1999 the Applicants, filed with the Department of Water Resources an application to appropriate the public waters of the State of Idaho. The Department has received protests against the approval of said application from the above captioned protestants.

The Department has set the matter of protest for conference on **Monday-September 20, 1999 at 10:00 a.m. in the Conference Room, ID Department of Water Resources, 1341 Fillmore St., Suite #200; Twin Falls, ID.**

The purpose of the conference is to formulate and simplify the issues, obtain admissions of fact and of documents which will avoid unnecessary proof, arrange for the exchange of proposed exhibits or prepared expert testimony prior to the hearing, limit the number of witnesses, consolidate the examination of witnesses, and advise the parties of the procedure which will be followed at any subsequent hearing.

The conference will be held in accordance with Chapter 2, Title 42, of the Idaho Code and the adopted Rules of Practice and Procedure of the Department of Water Resources.

The conference 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 conference, please advise the department within (10) days prior to the conference.

Dated this 18th day of August, 1999.

Allen D. Merritt, P.E.
Regional Manager

MICROFILMED

APR 2 8 2000

CERTIFICATE OF MAILING

I hereby certify that on the 18th day of August, 1999 a true and correct copy of the foregoing Notice of Pre-Hearing Conference was forwarded with all required charges prepared, by regular U.S. Mail, to the parties listed:

Mary Baldwin
Secretary

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

MICROFILMED
APR 2 8 2000

Merritt, Allen

From: Ampe, Peter [pampe@ag.state.id.us]
Sent: Wednesday, August 11, 1999 8:53 AM
To: 'Allen Merritt'
Cc: 'croberts'; 'dparrish'
Subject: App. # 47-08429

The only dates we have available in September for the pre-hearing conference are September 20, 22, 23, and 24.

Hopefully one of these days will work.

Peter Ampe

MICROFILMED
APR 2 8 2000

RECEIVED
AUG 03 1999
Department of Water Resources
Southern Region

Norman M. Semanko
ROSHOLT, ROBERTSON & TUCKER
P. O. Box 1906
Twin Falls, Idaho 83703-1906
Telephone: (208) 734-0700
Facsimile: (208) 736-0041
ISB # 4761
nms.99\protest\raywith

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR PERMIT NUMBER 47-08429; APPLICANT: LEO E. RAY and/or JUDITH RAY	**NOTICE OF WITHDRAWAL OF PROTEST**

****

TWIN FALLS CANAL COMPANY (hereinafter "TFCC"), by and through its attorneys, Rosholt, Robertson & Tucker, hereby withdraws its Notice of Protest with regard to Application for Permit No. 47-08429, subject to the request that the permit conditions include a provision noting that use of the water right may be subject to an agreement between the parties, as executed between TFCC and Applicant to resolve the protest.

SUBMITTED this 3 day of August, 1999.

ROSHOLT, ROBERTSON & TUCKER

By: _____
Norman M. Semanko

MICROFILMED
APR 28 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

July 23, 1999

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

RE: Protested Application for Permit 47-08429 in the name of Leo &/or Judith Ray

Dear Protestant:

Our office has been requested to schedule a pre-hearing conference for the above referenced application you have protested. The conference will be informal and may last 1 to 2 hours. It will be held at a time between 8am to 5pm, Monday through Friday, and be held our Twin Falls Office.

Please provide to me by letter, fax, phone call or e-mail (amerritt@idwr.state.id.us) a list of dates/times you may be available in the month of August to attend such a conference. Please let me know by July 31.

If you have questions, please feel free to contact our office.

Sincerely,

Allen Merritt, PE
Southern Region Manager

CC: Leo Ray

MICROFILMED
APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

July 23, 1999

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

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Sincerely,

Allen Merritt, PE
Southern Region Manager

CC: Leo Ray

MICROFILMED

APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

July 23, 1999

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

RE: Protested Application for Permit 47-08429 in the name of Leo &/or Judith Ray

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Sincerely,

Allen Merritt, PE
Southern Region Manager

CC: Leo Ray

MICROFILMED

APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

July 23, 1999

TWIN FALLS CANAL COMPANY
c/o NORMAN M SEMANKO ESQ
ROSHOLT ROBERTSON & TUCKER
PO BOX 1906
TWIN FALLS ID 83303-1906

RE: Protested Application for Permit 47-08429 in the name of Leo &/or Judith Ray

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If you have questions, please feel free to contact our office.

Sincerely,

Allen Merritt, PE
Southern Region Manager

CC: Leo Ray

MICROFILMED

APR 2 8 2000

STATE OF IDAHO
DIVISION OF
ENVIRONMENTAL QUALITY

RECEIVED
JUN 09 1999
Department of Water Resources

601 Pole Line Road, Suite 2 • Twin Falls, Idaho 83301-3035 • (208) 736-2190

Dirk Kempthorne, Governor
C. Stephen Allred, Administrator

June 8, 1999

Leo Ray
Fish Breeders of Idaho
P.O. Box 479
Hagerman, ID 83332

I
47-08429
Protested

Re: Deep Creek Fish Production Facility - Consent Order Development

Dear Mr. Ray:

It is our understanding that the water rights related to the referenced new fish propagation facility and its operation are being reviewed by the Idaho Department of Water Resources.

Since this is a new fish hatchery, the Division of Environmental Quality (DEQ) has been working with you on the development of a negotiated agreement that will be promulgated as a Consent Order pursuant to Idaho Code §§ 39-101. Terms and conditions in the Consent Order will address the design and operation of the new facilities to ensure compliance with Idaho Water Quality Standards and Wastewater Treatment Requirements (Idaho Water Quality Standards), IDAPA 16.01.02.001 through 16.01.02.299. The negotiated consent order will be implemented to address future activity and will be operated that a no net increase (NNI) in total phosphorus (TP) or total suspended solids (TSS) when the discharge water is compared to the source water. The new facility shall also be required to comply with NPDES permit limits and any additional limits developed as a result of a Total Maximum Daily Load (TMDL) and/or waste load allocations (WLA) for the watershed.

The Deep Creek facility shall be required to develop a Monitoring Plan and a Best Management Practices (BMP) plan. This plan will address monitoring requirements and BMP effectiveness that will ensure and document compliance with the NNI standard and Idaho Water Quality Standards.

The negotiated Consent Order and development of the Monitoring Plan and BMP Plan have taken some time to complete by DEQ and yourself. We believe delays in the development of the Consent Order are justified and should be completed in the next few weeks.

We appreciate your cooperation with us on the negotiated agreement, and look forward to having entry into the Consent Order completed in the near future. Should any questions arise, please feel free to contact me at (208) 736-2190.

Sincerely,

M. J. McMasters

Michael J. McMasters
Engineering Regional Manager

MJM/ml
cc: Doug Howard, Regional Administrator, DEQ, TFRO
Nick Cizmich, Water Quality Science Officer, DEQ, TFRO
Allen Merritt, Regional Manager, Idaho Department of Water Resources, Twin Falls
Dave Parrish, Idaho Department of Fish & Game, Jerome

H:\LETTERS\MIKE\CO-DC.DEL

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

June 8, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08429

Dear Applicants:

Enclosed are copies of protests filed against the above referenced application. The Department suggests you contact the protestant(s) directly to determine the exact nature of the protest(s) and, if possible, to resolve the matter without action by the Department.

Please note that your application is considered a contested case and subject to the Rules of Procedure adopted by the Department.

If you need a copy of these rules, please contact this office. The Rules of Procedure are also available on the Internet by using the IDWR Homepage at the following electronic address:

http://www.idwr.state.id.us/apa/idapa37/0101.htm

The attachment to this letter describes the issues which the Department must consider in taking action on an application. It also gives a brief description of the conference and hearing procedure followed by the Department in resolving protested applications.

If you wish to proceed with a Pre-hearing Conference &/or formal Hearing, please notify this office.

If you have any questions or if this office can be of further assistance, please feel free to contact us.

Very truly yours,

Allen D. Merritt, P.E.
Southern Region Manager

AM:MB

Enclosure(s)

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

June 8, 1999

NORMAN M SEMANKO ESQ
ROSHOLT ROBERTSON & TUCKER
PO BOX 1906
TWIN FALLS ID 83303-1906

RE: APPLICATION FOR PERMIT NO. 47-08429 - LEO &/OR JUDITH RAY

Dear Mr. Semanko:

The protest on behalf of the Twin Falls Canal Company against the approval of the above referenced application has been received and a copy has been sent to the applicant with the suggestion that he contact you directly to determine the exact nature of the protest and, if possible, to resolve the matter without action by the Department.

Please note that the application is considered a contested case and subject to the Rules of Procedure adopted by the Department.

If you need a copy of these rules, please contact this office. The Rules of Procedure are also available on the Internet by using the IDWR Homepage at the following electronic address:

http://www.idwr.state.id.us/apa/idapa37/0101.htm

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If you have any questions or if this office can be of further assistance, please feel free to contact us.

Very truly yours,

Allen D. Merritt, P.E.
Southern Region Manager

AM:MB

Enclosure(s)

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

June 8, 1999

FRED F KIPPES
BETTY J KIPPES
3951 N 1100 E
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08429 - LEO &/OR JUDITH RAY

Dear Protestant(s):

Your protest against the approval of the above referenced application has been received and a copy has been sent to the applicant with the suggestion that he contact you directly to determine the exact nature of the protest and, if possible, to resolve the matter without action by the Department.

Please note that the application is considered a contested case and subject to the Rules of Procedure adopted by the Department.

If you need a copy of these rules, please contact this office. The Rules of Procedure are also available on the Internet by using the IDWR Homepage at the following electronic address:

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If you have any questions or if this office can be of further assistance, please feel free to contact us.

Very truly yours,

Allen D. Merritt, P.E.
Southern Region Manager

AM:MB

Enclosure(s)

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

June 8, 1999

CARL NELLIS SUPERVISOR
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

RE: APPLICATION FOR PERMIT NO. 47-08429 - LEO &/OR JUDITH RAY

Dear Protestant(s):

Your protest against the approval of the above referenced application has been received and a copy has been sent to the applicant with the suggestion that he contact you directly to determine the exact nature of the protest and, if possible, to resolve the matter without action by the Department.

Please note that the application is considered a contested case and subject to the Rules of Procedure adopted by the Department.

If you need a copy of these rules, please contact this office. The Rules of Procedure are also available on the Internet by using the IDWR Homepage at the following electronic address:

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If you have any questions or if this office can be of further assistance, please feel free to contact us.

Very truly yours,

Allen D. Merritt, P.E.
Southern Region Manager

AM:MB

Enclosure(s)

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

June 8, 1999

FLOYD KAUFMAN
1119 E 38000 N
BUHL ID 83316

RE: APPLICATION FOR PERMIT NO. 47-08429 - LEO &/OR JUDITH RAY

Dear Protestant:

Your protest against the approval of the above referenced application has been received and a copy has been sent to the applicant with the suggestion that he contact you directly to determine the exact nature of the protest and, if possible, to resolve the matter without action by the Department.

Please note that the application is considered a contested case and subject to the Rules of Procedure adopted by the Department.

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If you have any questions or if this office can be of further assistance, please feel free to contact us.

Very truly yours,

Allen D. Merritt, P.E.
Southern Region Manager

AM:MB

Enclosure(s)

OK ✓ MB

RECEIVED

Norman M. Semanko
ROSHOLT, ROBERTSON & TUCKER
P. O. Box 1906
Twin Falls, Idaho 83703-1906
Telephone: (208) 734-0700
nms99/protest/ray

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR PERMIT NUMBER 47-08429; APPLICANT: LEO E. RAY and/or JUDITH RAY	**NOTICE OF PROTEST**

****

TWIN FALLS CANAL COMPANY (hereinafter "TFCC"), by and through its attorneys, Rosholt, Robertson & Tucker, files its Notice of Protest to the approval of the above-numbered Application for Permit filed by Leo E. Ray and/or Judith Ray. The basis for TFCC's protest is as follows:

1. The proposed diversion and use of the waters described in the aforesaid application may violate all or portions of the criteria set forth in Idaho Code Section 42-203A(5); and

Receipt # SC 22044
4/20/94
MB

2. The application is for diversion and use within TFCC's service area and therefore requires a written agreement with TFCC pursuant to that certain Stipulation for Dismissal Without Prejudice entered into between IDWR and TFCC in Case No. 69005, in the District Court of the Fourth Judicial District, in and for the County of Ada, and the Director's staff memorandum dated September 8, 1981; and

3. The application proposes to use TFCC shares as mitigation, but no permission for such use has been obtained from TFCC; and

4. For such other and further reasons as may be set forth at the hearing on this matter.

DATED this 19th day of April, 1999.

ROSHOLT, ROBERTSON & TUCKER

By: _____
Norman M. Semanko

CERTIFICATE OF MAILING

I hereby certify that on this 19th day of April, 1999, I served a copy of the foregoing NOTICE OF PROTEST, by hand delivery or by depositing same in the United States mail, postage prepaid, in an envelope, addressed to the following:

Leo E. Ray and/or Judith Ray — by U.S. Mail
4647-D River Road
Buhl, ID 83316

_____
Norman M. Semanko

IDAHO FISH & GAME
MAGIC VALLEY REGION
868 East Main Street
P.O. Box 428
Jerome, Idaho 83338-0428

Dirk Kempthorne / Governor

Jerry Mallet / Interim Director

April 16, 1999

RECEIVED
APR 19 1999
Department of Water Resources
Southern Region

Mr. Allen Merritt
Idaho Dept. of Water Resources
1341 Fillmore Street, Suite 200
Twin Falls, Idaho 83301-3380

RE: **Water Right Applications #47-08429 Leo Ray - Deep Creek**

Dear Allen,

We would like to protest the above referenced water right application for permit #47-08429 for year-around diversion of 10 cfs from Deep Creek to mitigate impacts of a new aquaculture facility. The reason for the protest is the appropriation could be detrimental to fish and wildlife, including associated habitats, and therefore, is not in the best interest of the general public of the State of Idaho. Our evaluation could change, however, based on the development of detailed plans for construction, operation, and monitoring of the wetland.

Deep Creek supports both native and introduced populations of fish, waterfowl, and miscellaneous riparian dependent wildlife. Survival of these species is dependent on adequate in-channel flow to maintain biological parameters. Removal of 10 cfs from Deep Creek, especially during the non-irrigation season, could result in flows which may not support dissolved oxygen levels, flowing water in pools, and interstitial substrate spaces which are essential habitat for fish and other aquatic organisms. This flow reduction, which we estimate represents between 30 and 50% of the average stream flow during non-irrigation season, will result in a substantial reduction in overall habitat available for fish and wildlife from the diversion point to the discharge point back to Deep Creek.

Water quality is also an issue that will be impacted by further diversions from Deep Creek and Mr. Ray's new fish hatchery. Deep Creek is currently recommended by DEQ to be added onto Idaho's Clean Water Act section 303(d) water quality limited list. We recognize this proposed diversion is intended to mitigate water quality impacts associated with the new aquaculture facility. However, we see two major flaws in that assumption: 1) wetland nutrient uptake does not occur on a year-around basis and therefore will not equal or exceed inputs from the aquaculture facility; and 2) further reducing flows between the intake and discharge will have negative impacts in the bypass reach due to a reduced ability of the river to assimilate the existing nutrient load.

MICROFILMED
APR 28 2000

In summary, at the water right protest deadline no detailed physical development plan, operational plan, or monitoring plan has been developed to assess water quality impacts from this diversion and associated wetland. We need this information to fully understand the impacts of this diversion on fish and wildlife.

Thank you for your consideration of this matter. If you have further questions please contact Dave Parrish, Natural Resource Biologist at this office.

Sincerely,

for Carl H. Nellis
Magic Valley Regional Supervisor

cc: IDFG-NRPB (Robertson)
State of Idaho A.G.'s Office (Ampe)
IDHW-DEQ-Twin Falls (McMasters)
L. Ray

MICROFILMED
FEB 25 2006

IDAHO FISH & GAME
MAGIC VALLEY REGION
868 East Main Street
P.O. Box 428
Jerome, Idaho 83338-0428

April 16, 1999

Dirk Kempthorne / Governor

Jerry Mallet / Interim Director

Mr. Allen Merritt
Idaho Dept. of Water Resources
1341 Fillmore Street, Suite 200
Twin Falls, Idaho 83301-3380

RECEIVED
APR 16 1999
Department of Water Resources
Southern Region

RE: **Water Right Applications #47-08429 Leo Ray – Deep Creek**

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MICROFILMED
Receipt # S08290041
4/16/99
AB

In summary, at the water right protest deadline no detailed physical development plan, operational plan, or monitoring plan has been developed to assess water quality impacts from this diversion and associated wetland. We need this information to fully understand the impacts of this diversion on fish and wildlife.

Thank you for your consideration of this matter. If you have further questions please contact Dave Parrish, Natural Resource Biologist at this office.

Sincerely,

for Carl H. Nellis
Magic Valley Regional Supervisor

cc: IDFG-NRPB (Robertson)
State of Idaho A.G.'s Office (Ampe)
IDHW-DEQ-Twin Falls (McMasters)
L. Ray

MICROFILMED
APR 2 6 2005

Receipt SO220 24
4/14/99
AB

RECEIVED
APR 14 1999
Department of Water Resources
Southern Region

april 12, 1999

To whom it may Concern,

We Protest

Leo E Rayes application

for Permit #47-08429

we are Concerned

that it would bring

seepage problems on

Our land

a Protest fee of

twenty five dollars is

inclosed. Sincerely

Floyd Kaufman
1119 E. 3800 N.
Buhl, ID 83316-6033

PROFILMED
APR 28 2000

Floyd Kaufman 1119 E 3800 N Buhl

April 8, 1999

Department of Water Resources
Southern Region
1341 Fillmore St.
Twin Falls, ID 83301

RECEIVED
APR 12 1999
Department of Water Resources
Southern Region

To Whom It May Concern:

We, the undersigned, protest the issuance of permit #47-08429.

Enclosed our check #8146 in the amount of $25.00 to cover the protest fee.

Respectfully,

Fred F. Kippes
Betty J. Kippes

3951N 1100E
Buhl, ID 83316

cc: Leo E. Ray and/or Judith Ray

Received 4-12-99 JS
Receipted " S022011
JS

MICROFILMED
APR 28 2000

Lee E. Kay

FORM NO.302A
REVISED 7/31/98

APPLICATION NO. 47-08429

STATE OF IDAHO
IDWR SOUTHERN REGION
APPLICATION FOR PERMIT ANALYSIS SHEET

INITIAL REVIEW BY Q F Stanton DATE 9-2-99

REQUIRED INFORMATION (Ck if OK)

- √ Name (If applicant is a corporation or partnership, names must be provided for the director, officers, & other partners.
- √ Address
- √ Source (see USGS quad for names of water sources)
- √ Point of diversion (10 Acres for spring, lot & block descriptions for subdivisions, local name, flow &/or volume.
- √ County
- √ Quantity (flow &/or volume)
- √ Period of use
- √ Nature of proposed use (include description of use)
- √ Description of diverting works.
- √ Time required for beneficial use of water.
- √ Place of use or acres irrigated.
- √ Map
- √ Signature (If applicant is corp., partnership, or municipality, title of signator is required)
- √ Fee
- √ Yes ___ No* In form to receipt?

++++PROPOSED PRIORITY DATE 3-1- 19,99

ADDITIONAL INFORMATION

- ___ Overlapping place of use(Describe source & relationship to present application on the back.
- ___ Overlapping point of diversion.
- √ Yes ___ No Is Source Surface Water? Process as non-consumptive use
  If Yes Send Copy to F&G.
  If Yes Field check/memo required.
  Field check/memo by_____
- ___ Yes ___ No Field report attached?
- ___ Yes √ No Critical Ground water area?
- ___ Yes √ No Groundwater management area?
- ___ Yes √ No Measurement District or Groundwater District?
  What District? _____
- ___ Yes √ No Send Dam safety information?
- ___ Yes √ No Send power requirement letter?
- ___ Yes √ No Send fish farm requirement letter?
- ___ Yes √ No Power residency affidavit attached?
- ___ Yes √ No Power efficiency form?
- ___ Yes √ No Within trustwater boundary?(If yes, attach trustwater supplementary analysis sheet.
- √ Yes ___ No Diversion greater than 5 cfs or 500 acre ft? (If yes,attach large diversion supplementary analysis sheet.
- ___ Yes √ No Is Application made to record Pre Nov 1987 Development?
  If Yes then request clear evidence of when use started.

* REQUEST THE FOLLOWING ADDITIONAL INFORMATION FROM THE APPLICANT:

_____

_____

_____

_____ Date Requested _____

	Date Sent	Comments Received

SEND COPIES TO:

___	Idaho Dept of Health & Welfare	_____	_____
___	USDI BLM	_____	_____
✓	Idaho Dept of Fish & Game	3/16/99	_____
___	USFS	_____	_____
___	Idaho Dept of Lands	_____	_____
___	Water Dist. No. _____	_____	_____
___	Adjudication Bureau Unit	_____	_____
___	_____	_____	_____
___	_____	_____	_____

No WD
Pam JS

PROCESSING ✓ Yes ___ No In form for Advertising?
___ Yes ___ No Statewide Advertising?
✓ Yes ___ No Fee amount, receipt date & No. recorded?

___ Yes ___ No Has all requested additional information been received?
If not, describe action taken: _____
_____

FINAL REGIONAL PROCESSING REVIEW
___ Yes ___ No Affidavit of publication received?
___ Yes ___ No Application published correctly? If not, record action taken.
_____
_____
___ Yes ___ No Publication dates and paper recorded?
Final date for protest: _____
___ Yes ___ No Protests received?
___ Yes ___ No Protested?
Describe Resolution: _____
_____
___ Yes ___ No Measuring device required?
___ Yes ___ No Access port required?
___ Yes ___ No Will water be delivered by watermaster? If yes, what dist? ____
___ Yes ___ No Special conditions codes:
_____

___ Yes ___ No Is Evaluation Memo Attached?
If yes; date of Memo _____

Date of priority recommended: _____

COMMENTS:

_____
_____
_____
_____

RECOMMEND _____ Approval _____ Denial

By _____ Date _____

NOTICE OF APPLICATION FOR WATER PERMIT

The following application has been filed to appropriate the public waters of the State of Idaho:

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

Application for Permit No. 47-08429

Source: Deep Creek tributary to Snake River

Diversion Pt(s): NW1/4SE1/4, S08, T10S, R14E; Twin Falls County.

Use: 1/1-12/31
Water Quality Improvement(10.0 cfs)
Diversion to Storage (10.0 cfs).
Storage for Water Quality Improvement(6.0 afa)

Total Diversion: 10.0 cfs

In: NW1/4SE1/4, S08, T10S, R14E; Twin Falls County

Date Filed: 03/01/99

Any protest against the proposed application(s) must be filed with the Department of Water Resources, Southern Region, 1341 Fillmore St., Suite 200; Twin Falls, ID 83301 together with a protest fee of $25.00 on or before April 19, 1999 to be considered by the Department in its decision to grant or deny any part of the proposed application(s). The protestant must also send a copy of the protest to the applicant.

Karl J. Dreher, Director

Published in the Times-News on 04/01 & 04/08/99.

RECEIVED

APR 09 1999

Department of Water Resources
Southern Region

Affidavit of Publication

STATE OF IDAHO
COUNTY OF TWIN FALLS } SS.

No 31333

I, Carole Williams being first duly sworn upon oath, depose and say that I am principal clerk of the TIMES-NEWS, published daily, at Twin Falls, Idaho, and do solemnly swear that a copy of the notice of advertisement, as per clipping attached, was published in the regular and entire issue of said newspaper, and not in any supplement thereof, for two consecutive weeks, commencing with the issue dated April 1, 19 99, and ending with the issue dated April 8, 19 99.

And I do further certify that said newspaper is a consolidation, effective February 16, 1942, of the Idaho Evening Times, published theretofore daily except Sunday, and the Twin Falls News, published theretofore daily except Monday, both of which newspapers prior to consolidation had been published under said names in said city and county continuously and uninterruptedly during a period of more than twelve consecutive months, and said TIMES-NEWS, since such 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 uninterruptedly.

And I further 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, to be published weekly, will be published; and that at the head of the editorial column of said combined newspapers, and in each issue thereof, Thursday is announced as the day on which said legal notices will be published.

STATE OF IDAHO
COUNTY OF TWIN FALLS

On this 8th day of April in the year of 1999, before me, a Notary Public, personally appeared Carole Williams, 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 he executed the same.

Irene R. Fettman
Notary Public for Idaho
Residing at Twin Falls, Idaho.
My commission expires: 5/19/2000

OK
RMB
4/12/99

MICROFILMED

SEP 2 6 2000

THE TIMES-NEWS - LEGAL
P.O. BOX 548, TWIN FALLS, 83303-0548

DEPT WATER RESOURCES

212230 0050 LEGAL 5 04/08/99 0

WATER RIGHT LEO & JUDITH RAY 04/01/99 04/08/99

4 THE TIMES NEWS LEGAL 2 LGL
FLAT CHARGE FC 54.36
TOTAL AD CHARGE 54.36

T-08429

OK mb 4/12/99

H2O right Ray 54.36 54.36*

RECEIVED
APR 09 1999
Department of Water Resources
Southern Region

THE TIMES-NEWS - LEGAL
P.O. BOX 548, TWIN FALLS, ID 83303-0548

H2O right Ray

050
212230 LEGAL 04/01/99 04/08/99 GROSS AMOUNT OF 54.36

WATER RIGHT LEO & JUDITH RAY 04/08/99 208-736-3033 DUE AFTER

__ VISA __ MASTERCARD

CREDIT CARD NUMBER EXPIRATION DATE: ___/___ SIGNATURE: _____

54.36

DEPT WATER RESOURCES
1341 FILLMORE, SUITE 200
TWIN FALLS, ID 83301

MICROFILMED
APR 28 2003

204000000021223000000000000000543600000054363

NOTICE OF APPLICATION FOR WATER PERMIT

The following application has been filed to appropriate the public waters of the State of Idaho:

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

Application for Permit No. 47-08429

Source: Deep Creek tributary to Snake River

Diversion Pt(s): NW1/4SE1/4, S08, T10S, R14E; Twin Falls County.

Use: 1/1-12/31
Water Quality Improvement(10.0 cfs)
Diversion to Storage (10.0 cfs)
Storage for Water Quality Improvement(6.0 afa)

Total Diversion: 10.0 cfs

In: NW1/4SE1/4, S08, T10S, R14E; Twin Falls County

Date Filed: 03/01/99

Any protest against the proposed application(s) must be filed with the Department of Water Resources, Southern Region, 1341 Fillmore St., Suite 200; Twin Falls, ID 83301 together with a protest fee of $25.00 on or before April 19, 1999 to be considered by the Department in its decision to grant or deny any part of the proposed application(s). The protestant must also send a copy of the protest to the applicant.

Karl J. Dreher, Director

Published in the Times News on 04/01 & 04/08/99.

MICROFILMED
APR 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

March 16, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

ATTENTION LEGALS
TIMES NEWS
PO BOX 548
TWIN FALLS ID 83301

Gentlemen:

Enclosed you will find a legal notice which we wish to have published in your newspaper. We have inserted the required publication dates.

We have attempted to submit this legal as camera ready. Please call me at your earliest convenience and prior to your staff re-typing the legal if it does not meet your specifications so I can possibly make adjustments.

If you cannot publish the notice on the proposed dates, please contact us immediately.

In order to receive payment, an affidavit of publication must be submitted to the Department along with the publication bill.

Very truly yours,

Mary Baldwin
Administrative Assistant

Enclosure

MICROFILMED
APR 2 8 2000

NOTICE OF APPLICATION FOR WATER PERMIT

The following application has been filed to appropriate the public waters of the State of Idaho:

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

Application for Permit No. 47-08429

Source: Deep Creek tributary to Snake River

Diversion Pt(s): NW1/4SE1/4, S08, T10S, R14E; Twin Falls County.

Use: 1/1-12/31

Water Quality Improvement	(10.0 cfs)
Diversion to Storage	(10.0 cfs)
Storage for Water Quality Improvement	(6.0 afa)

Total Diversion: 10.0 cfs

In: NW1/4SE1/4, S08, T10S, R14E; Twin Falls County

Date Filed: 03/01/99

Any protest against the proposed application(s) must be filed with the Department of Water Resources, Southern Region, 1341 Fillmore St., Suite 200; Twin Falls, ID 83301 together with a protest fee of $25.00 on or before April 19, 1999 to be considered by the Department in its decision to grant or deny any part of the proposed application(s). The protestant must also send a copy of the protest to the applicant.

Karl J. Dreher, Director

Published in the Times News on 04/01 & 04/08/99.

MICROFILMED
APR 2 8 2003

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

March 16, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

LEO E RAY &/OR
JUDITH RAY
4647-D RIVER RD
BUHL ID 83316

Re: Application for Permit No. 47-08429

Dear Applicant(s):

The Department of Water Resources acknowledges receipt of your water right application for permit. The application has been assigned the above referenced identification number. Please refer to this number in all further correspondence.

This office has scheduled advertising the application in the Times News for 04/01 & 04/08/99. A period of ten days following the second publication will be allowed for the submittal of protests.

If an application is protested you will be sent a copy of the protest. The protest must be resolved before the application is approved or denied. If the protest is not resolved voluntarily, this Department will conduct a conference and/or hearing on the matter.

If an application is not protested, it will be forwarded to our State Office in about five weeks. State office personnel will conduct a complete review prior to final processing of the application and will notify you of the outcome of this review. If a permit is issued, you will be sent a copy. A typical processing time for an unprotested application is about eight weeks.

Please feel free to contact this office if you have any questions regarding this procedure.

Very truly yours,

James E. Stanton
Sr. Water Resource Agent

JS:MB

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APR 23 2003

State of Idaho
DEPARTMENT OF WATER RESOURCES
1341 Fillmore Street, Suite 200, Twin Falls, ID 83301-3380
Phone: (208) 736-3033 FAX: (208) 736-3037

SOUTHERN REGION

March 16, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

ATTN DAVE PARRISH
ID DEPT OF FISH & GAME
PO BOX 428
JEROME ID 83338

Re: Application for Permit No. 47-08429 - Leo E. Ray

Dear Mr. Parrish:

The Department is seeking a written Comment &/or Recommendation from your agency regarding the above referenced application for surface water; a copy of the application is enclosed for your information and reference.

Regional review of an unprotested application can be completed as soon as the final protest period is past; therefore, your prompt response to this request is appreciated.

If you have any questions about an application, please contact this office or the applicant.

Very truly yours,

James E. Stanton
Sr. Water Resource Agent

JS:MB

Enclosure(s)

APR 2 3 1999

ACTION REQUIRED

3/16/99

FROM: MB

TO: Terry Blue

SCA Comment please

MICROFILM

APR 23 2000

State of Idaho
Department of Water Resources



ROSTER OF ATTENDANCE

IN THE MATTER OF APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO AND/OR JUDITH RAY

Date: November 9, 1999

Time: 9:00 a.m.

Location: Obenchain Community Room
Obenchain Insurance Building
264 Main Avenue South
Twin Falls, Idaho

Hearing Officer: L. Glen Saxton

* * *Please Print* * *

NAME	ADDRESS	REPRESENTING (Applicant, Protestant or Intervenor)
Leo E Ray	4647 D River Rd Buhl	Applicant
Lloyd Webb	Box 1768 T.F. ID.	Applicant
Ted Kryn	3951 N - 1100 E Burley	
Floyd Kaufman	1119 E - 3600 N Burley	

MICROFILMED
SEP 2 8 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

MEMORANDUM

To: L. Glen Saxton

From: Karl J. Dreher

RE: APPOINTMENT AS HEARING OFFICER - PROCEDURE RULE 410

Date: November 1, 1999

You are hereby appointed as hearing officer and are authorized to represent the department as provided by IDAPA Rule 37.01.01410 (Procedure Rule 410) in the following matter:

IN THE MATTER OF APPLICATION FOR PERMIT NO. 47-08429 IN THE NAME OF LEO AND/OR JUDITH RAY

Date: November 9, 1999

Time: 9:00 a.m.

Location: Obenchain Community Room
Obenchain Insurance Building
264 Main Avenue South
Twin Falls, Idaho

MICROFILMED
APR 2 8 2000

EXHIBIT LOG

RE: Leo Ray Application 47-08429
PLACE: Twin Falls, ID
DATE: 9:00 am , Wednesday, November 9, 1999
HEARING OFFICER: Glen Saxton
ASSISTED BY: Allen Merritt

APPLICANT			PROTESTANT		
EXHIBIT ID	DESCRIPTION	ENTERED?	EXHIBIT ID	DESCRIPTION	ENTERED?
1	Deep Cr Eff. Study	11/9/99 Yes	A	Upper Snake 10/25/99	11/9/99 Yes
2			B	Upper Snake 12/31/98	11/9/99 Yes
3			C		
4			D		
5			E		
6			F		
7			G		
8			H		
9			I		
10			J		
11			K		
12			L		
13			M		
14			N		
15			O		
16			P		
17			Q		
18			R		
19			S		
20			T		
21			U		
22			V		
23			W		
24			X		
25			Y		
26			Z		

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APR 2 8 2000

DEEP CREEK
FISH FARM EFFLUENT STUDY

FINAL REPORT

Leo Kay

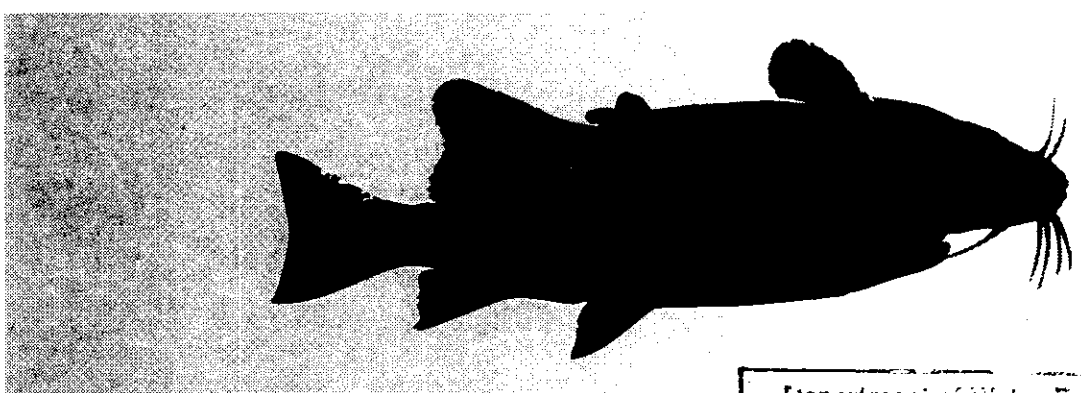
Department of Water Resources
APPLICANT'S
Exhibit 8
Date Admitted 6-11-97

From May 1991 to April 1992

Exhibits

by

Keya Collins
and
Ernest L. Brannon



Department of Water Resources
APPLICANT'S
Exhibit 1
Date Admitted 11/9/95

December 1993

Aquaculture Research Institute
University of Idaho
Moscow, Idaho 83844-2260

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Enter Book!

Technical Report 93-1

DEEP CREEK
FISH FARM EFFLUENT STUDY

FINAL REPORT

From May 1991 to April 1992

by

Keya Collins
and
Ernest L. Brannon

December 1993

Aquaculture Research Institute
University of Idaho
Moscow, Idaho 83844-2260

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Acknowledgements

The Aquaculture Research Institute, University of Idaho, acknowledges the cooperation of small farm operators Mr. Don Campbell, Mr. Jerry Zinn, Mr. Dick Kaes and Mr. Rod Griffith, who assisted in the study by providing access to their facilities. The study was made possible by the assistance of the Idaho Aquaculture Association and Cooperative Extension in helping fund the study. Also, the assistance of the University of Idaho Analytical Laboratory, the Hagerman Field Station of USFWS Tunison Fish Nutrition Laboratory, and Idaho Department of Health and Welfare, Division of Environmental Quality, for their assistance, laboratory use and advice with the study. The Twin Falls Canal Company is given special thanks for the information supplied on water sources and flows over the study period.

Executive Summary

Deep Creek, west of Buhl, Idaho, is a drainage covering approximately 14,600 hectares south of the Snake River, most of which is agricultural land. The stream is greatly influenced by irrigation return water entering the drainage from irrigated land served by the Twin Falls irrigation canal system, ranging from a few cfs during low winter flow to over 175 cfs in the peak of irrigation season.

Seep tunnels, built between 1920 to 1940, intercept and transfer irrigation water filtering through adjacent agriculture land to Deep Creek. Seep tunnel water represents the water quality characteristic of shallow ground water in the area. The seeps carry water nearly free of suspended solids material, though high in nitrate species. In contrast, during the irrigation season, the surface water entering Deep Creek contains high suspended solids, high concentrations of phosphate, and comparatively lower nitrate levels.

Fish farms rearing rainbow trout (*Oncorhynchus mykiss*) on Deep Creek added relatively small amounts of solid waste and nutrients to the system, with the primary contribution in the form of phosphorus species. Some farms with surface water sources showed a negative net contribution of suspended solids and nitrite/nitrate in the effluent, but would have exchanged some of the settled solids volume with fine organic material generated from rearing fish. **Farms on ground water demonstrated a net positive contribution of solids and a net negative contribution of nitrate species.** All farms showed a **positive increase in effluent levels of total phosphorus** from a mean of .02 to 0.06 mg/l. Contributions from the farms would amount to a little more than 5% of the phosphorus load measured at the mouth of Deep Creek.

Solids and dissolved nutrients can be significantly reduced by adding sufficient settling areas below the rearing ponds. Total flow settling ponds with rich algae and macrophyte flora appear to be most desirable for capturing nutrients. By including water reconditioning facilities in association with farm pond systems, fish farms can maintain good water quality, and in some cases even improve the quality over the source water.

Deep Creek Fish Farm Effluent Study

Introduction

The Environmental Protection Agency (EPA) requested trout farmers in Idaho to expand their effluent monitoring programs of suspended and settleable solids to include dissolved inorganic nitrogen as ammonia, nitrite, and nitrate; orthophosphate; and phosphorus, in the process of defining the nutrient loads generated by fish farms on the mid-Snake River, Idaho. The mainstream and large farm contributions were measured by Brockway and Robison (1992) and MacMillan (1992). Deep Creek in Twin Falls County, first studied by Litke (1988), was selected for the study to characterize the effluent from fish farms raising less than 100,000 pounds of rainbow trout (*Oncorhynchus mykiss*) per year. Farms raising < 100,000 lb/yr are classified as EPA permit type C farms (non-farm ponds with frequent cleaning), and EPA permit type D farms (farm ponds with batch production and cleaning). This study was conducted in place of effluent monitoring requirements of permit type C and D farm operations.

Background

Nearly 40 million pounds of trout are raised in southern Idaho annually, making Idaho the leading commercial trout producer in the nation, and contributing over $70,000,000 to the state's economy each year. The industry uses large quantities of high quality water in single-pass flow-through raceways from the Snake River Plain aquifer entering the mid-Snake over a distance of 40 kilometers, referred to as the Magic Valley.

Salmonid farming requires relatively large amounts of high quality water to provide sufficient oxygen for respiration and removal of waste material. For every kg of fish produced, over one kg of food is consumed, and nearly 0.4 kg of metabolized waste is produced in the form of soluble nutrients and solids present in the waste stream leaving the fish farm. The waste generated is very dilute, and hardly detectable to the eye, but because of the high flows leaving the farm, waste contributed to the receiving stream can accumulate over time and be a potentially significant quantity. The impact of fish farm effluent on the water quality of a receiving stream has received only limited attention, but the perception has been that

aquaculture wastes contribute a major portion of the pollution problems in the mid-Snake.

Community concern over the mid-Snake River water quality and its present designation as a water quality limited segment, aggravated by seven years of drought, prompted the Idaho Aquaculture Association (IAA) to address the quantity and composition of fish farm effluents, and their contribution to the water quality problems associated with the mid-Snake. This issue was addressed through a cooperative study with the Aquaculture Institute at the University of Idaho. The task was to characterize the effluents from small fish farming operations in the Snake River basin. Approximately 25 percent of Idaho's production occurs in small, family farm operations using surface water, irrigation return water, or ground water as their farm water source. This report is an assessment of the effluent coming from small trout farm operations, and its potential impact on the stream water quality.

Objectives

The objectives of the study were to:

1. Identify the nutrient load in the effluent of trout farm ponds, and
2. Quantify the non-nutrient and nutrient contributions of the effluent.

Study Approach

Waste generated from fish is directly correlated to feed quality and the amount fed. Nutrient load in the effluent from a fish farm, therefore, will be related to the number of feed units fed. However, the proportion of the waste that appears in the effluent from a farm will depend on operating procedures, opportunity for waste to settle, and the level of water reconditioning that takes place before discharge. The study approach, therefore, was to characterize the nutrient load, and then assess the level of water reconditioning that occurs within the farm facility before discharge of the effluent. Sites selected for assessment were to represent the various farm pond designs and operation procedures that are found in the Idaho trout industry.

Methods

Site Selection

Deep Creek, the watershed selected for the farm effluent study, in Twin Falls County, Idaho (Fig. 1), is a perennial stream near the town of Buhl, draining approximately 14,600 hectares south of the Snake River. The source water of Deep Creek is primarily surface run-off, but during the summer months stream flows are primarily irrigation return water from the Twin Falls irrigation canal system, contributing up to 175 cfs to the stream. The Deep Creek basin represents a multiple use system, including agriculture and fish farming, that is greatly enhanced by, if not entirely dependent on, water delivered by the irrigation canal. The small fish farm ponds have first use water at some locations, and others have second or third use irrigation return water containing nutrients from agriculture and aquaculture contributions.

Fish Farm Stations

Six fish farm sites, numbered from upper to lowermost on the stream, were selected to represent the water sources used for fish ponds on Deep Creek. This included source flows from seep tunnels, irrigation return, and creek water. Each water source was assessed on two farms, although in all other respects the farms were quite distinct from one another.

Farm sites #1 and #2 use seep tunnel water, which is low in phosphorus and suspended solids, although relatively high in nitrite/nitrate and specific conductivity. Seep tunnel water originates from irrigation seepage, and the cycle of availability closely follows the irrigation cycle. Flows varied from 2 to 5 cfs in farm #1, and from 5 to 8 cfs in farm #2.

Farm sites #3 and #5 utilize irrigation return water, but a quantity of ground water is included in the source. Suspended solids were markedly higher in the irrigation return water than in seep tunnel flows. Only part of the water available was used, and flows through the farm did not exceed 10 cfs during the irrigation season. A gradual decline in flow followed the irrigation season.

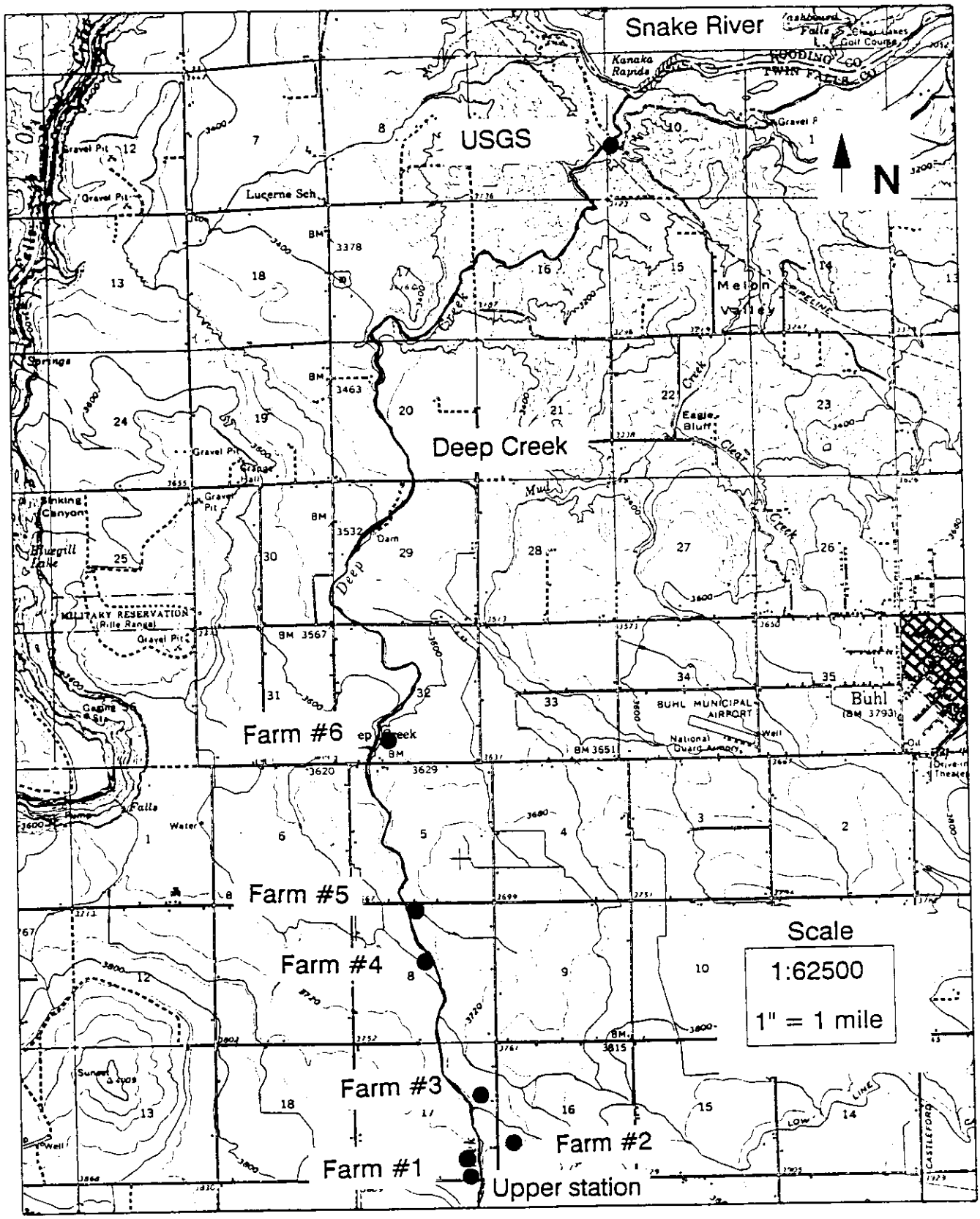


Figure 1. Deep Creek and fish farm locations in Twin Falls County, Idaho (USGS, Buhl Quadrangle, Idaho, 1959).

Farm sites #4 and #6 used Deep Creek water, which is a mixture of irrigation return and seep tunnel sources, but included substantial surface water from the basin as well. Water available from Deep Creek for farm use was much greater than the other two sources. Flows through these farms were as high as 30 cfs, with high suspended solids, and high summer temperatures from the large surface area of the basin.

Water source, flow levels, waste settling opportunity, and retention time were site variables considered in assessment of water quality in the farms. Settling opportunity included total flow settling ponds as well as quiescent zones in the raceways where fish were denied access by screens. The farms used Rangen trout diet in demand feeders, which allowed volitional feeding. Primary control on feeding level was exercised by the frequency and amount of feed placed in the feeders.

Main Stream Stations

Deep Creek has a substantial water quality data background collected from previous years (Litke, 1988), which provides comparative opportunities not available with some other systems. Two stations were selected to represent background water quality in Deep Creek. The upper station, located just below 3800 N. Rd. was immediately above the first fish farm, **eight miles from the Snake River**. The upper station includes some surface water, but predominantly return flow during the irrigation season from April to October. The lower site was the USGS station on the River Road, a quarter mile from the Snake River, below all fish farms and water diversions. Two major laterals (Fig. 1) withdraw up to half the flow from Deep Creek, depending on the season.

Sampling Protocol

All sites were sampled bi-weekly (twice/month) for field analysis. Samples were collected from the pond inflow, pre-settling (where practiced), and outflow of each farm, with replicate samples which provide statistical confidence in laboratory analysis. Every two months, samples were taken over a 24-hour period alternating between farms, to characterize diel patterns associated with feeding schedules.

Laboratory analyses were done bi-weekly on all water chemistry samples for ammonia, nitrite/nitrate, orthophosphate, and total phosphorus. Total Kjeldahl nitrogen and chloride analyses were done monthly.

Procedure

Sampling and analyses were performed in compliance with adopted Division of Environmental Quality sampling and analytical procedures, and Standard Methods (1985). Parameters measured are shown in Table 1. Measurements taken in the field included temperature, flow, conductivity, dissolved oxygen, and pH. Laboratory analyses were conducted for orthophosphate, phosphorus, ammonia, nitrite/nitrate, total Kjeldahl nitrogen, suspended solids, settleable solids and turbidity. Characteristics of these parameters and their implications on water quality are reviewed in Appendix A.

Four grab samples were taken at each station, two for chemical and two for solids analysis. Bottles used for chemical analysis were soap and acid washed, while bottles for solids analysis were soap cleaned and rinsed. The samples were collected approximately every two weeks without pre-notification of the farmer. Sampling usually started at the uppermost farms. Farms #1 & #2 were isolated and not influenced by other fish farms. Farms #3 to #6 received water in which fish farm effluent was present. The water source for farm #6 can be influenced by as many as seven fish farms. This sampling sequence lowered the chances that the survey would introduce pathogens in upstream farms.

Grab samples collected at the creek stations and at the fish farms included inflow, pre-settling (if present) and outflow sites. The samples were taken below the water surface by submerging the bottle after rinsing it five times at each station. After sampling, the bottles were placed immediately into a cooler and surrounded by ice. Total suspended solids, settleable solids and turbidity samples were usually analyzed on the day of sampling. Initially, 25 ml samples were used for total suspended solids, increased to 50 ml for the second and third sample days, and henceforth 100 ml per sample to completion of the project. The remaining samples were taken to the UI Analytical Lab for chemical analysis.

Duplicate samples were taken for the laboratory analysis. When results of a chemical analysis were below the detectable level (BDL), a value at one half of the detectable level was assumed and used for calculations. A paired t-test (α=.05) was applied to nutrient parameters between inflow and outflow samples, and between upper and lower creek stations. Correlation coefficients were calculated for nutrient components with amount of feed fed, and comparisons were done between predicted and actual nutrient loading based on feed fed, with the difference expressed as percent of predicted load.

Table 1. Parameters, equipment and procedures utilized for data collection in the Deep Creek fish farm study.

Parameter	Equipment & Storet/APHA Procedure
Temperature (°C)	Orion Oxygen Meter APHA
Dissolved oxygen (mg/l)	Orion Oxygen Meter APHA
Conductivity (µmhos)	YSI Conductivity Meter APHA
pH	Orion pH Meter APHA
Turbidity (NTU)	Cole-Palmer Nephrometer APHA
Settleable solids (ml/l)	Imhoff cones APHA
Suspended solids (mg/l)	Drying oven and Balance APHA
Orthophosphate (mg/l)	Analytical Lab, UI; 365.2
Total phosphorus (mg/l)	Analytical Lab, UI; 365.4
Ammonia-N (mg/l)	Analytical Lab, UI; 350.1, 353.2
Nitrite/nitrate-N (mg/l)	Analytical Lab, UI; 350.1, 353.3
Kjeldahl nitrogen (mg/l)	Analytical Lab, UI; 353.4
Chloride (mg/l)	Analytical Lab, UI; 325.3
Flow (cfs)	Flow Meter / weir
Feed rate (kg/crop)	provided by farmer

Results

Results of the study are presented with regard to water sources and trends. The sample data compiled from the study and the calculations are presented in tables for each farm in Appendices B through H. Water quality data from the upper station and the USGS station on Deep Creek are summarized in Appendix I, and lateral calculations appear in Appendix J. Quality control information is found in Appendix K.

Fish Farm Nutrient Contribution

Fish farm data are presented with regard to water sources used for the farming operation, including the seep tunnels, irrigation return water, and Deep Creek water. Sampling was conducted regardless of the operations underway at time of the visit. For example, if cleaning was being conducted, or fish were being harvested, samples were taken, and the influence of such activity was represented in the sample values at that time.

Farms on Seep Tunnel Water

Farm #1

Farm #1 lies along the west side of Deep Creek, and uses water from the uppermost seep tunnel entering the stream. Water passes serially through two dirt ponds, and settling takes place in the ponds, with no subsequent settling basin downstream to help capture solids that escape with the effluent. Two fish crops were harvested during the monitoring period.

A number of aquatic macrophytes grow year round in the water supply to the farm, within the rearing ponds, and in the outflow stream. Aquatic macrophytes listed below were collected in January 1992 and include horned pond weed (*Zannichellia palustris* L.), *Veronica* sp., watercress (*Rorippa nasturtium-aquaticum* L.) and sago pond weed (*Potamogeton pectinatus* L.). Macrophytes, especially sago pond weed, thrive within earthen rearing ponds, and pose potential problems with clogging screens. The aquatic macrophytes are manually cleared (demossing) prior to harvest in order to efficiently seine the fish.

Temperatures and flows at farm #1 were stable around 13°C and 5 cfs (Fig. 2). Some fluctuation was demonstrated during the early and late sampling dates when the water flows were low, during irrigation off season.

Dissolved oxygen was quite stable around 9 mg/l (Fig. 3), with a 1 to 4 mg/l difference occurring between the inlet and outlet of the farm. Oxygen was always sufficient to allow unrestrained fish growth.

Total phosphorus showed a mean net increase of **0.04 mg/l through farm** #1. During one sample day, cleaning (demossing) resulted in an increase in bottom disturbance and hence a resuspension of solids, and the phosphorus concentration went from 0.05 to 0.31 mg/l in the outflow. The phosphorus level during the spring grow-out period did not show the progressive increase demonstrated during the fall (Fig. 4), because there were two intermediate harvests which decreased the biomass.

Orthophosphate increased in concentration from **0.01 to 0.05 mg/l** over the fall grow-out period (Fig. 5). As with total phosphorus, the spring grow-out period didn't show an increase because the crop was reduced over the latter half of the period. Curiously, the orthophosphate background levels showed changes that didn't appear to be related to flows or irrigation cycle.

Ammonia levels showed a similar pattern as orthophosphate, decreasing during the spring grow-out period with decreased biomass, and increasing with biomass during the fall grow-out period (Fig. 6). The range was from 0 to over 0.3 mg/l. **Nitrite/nitrate lev**els were high in the water supply, **but a net decrease was demonstrated as water passed through the farm** (Fig. 7). Total Kjeldahl nitrogen showed high variability, without any relationship to the ammonia or nitrate levels (Fig. 8) and appears to be unrepresentative of rearing affects.

The pH ranged between 7.3 to 8, with little variability as water passed through the farm (Fig. 9). Similarly, conductivity (Fig. 10) and chloride (Fig. 11) levels remained fairly constant throughout the study.

Turbidity increased slightly as water passed through the farm (Fig. 12), and on one occasion increased markedly along with suspended solids (Fig. 13) from disturbance by demossing. The general contribution of suspended solids measured as mean dry weight of material in the water samples was low (1.1 mg/l), excluding the demossing value.

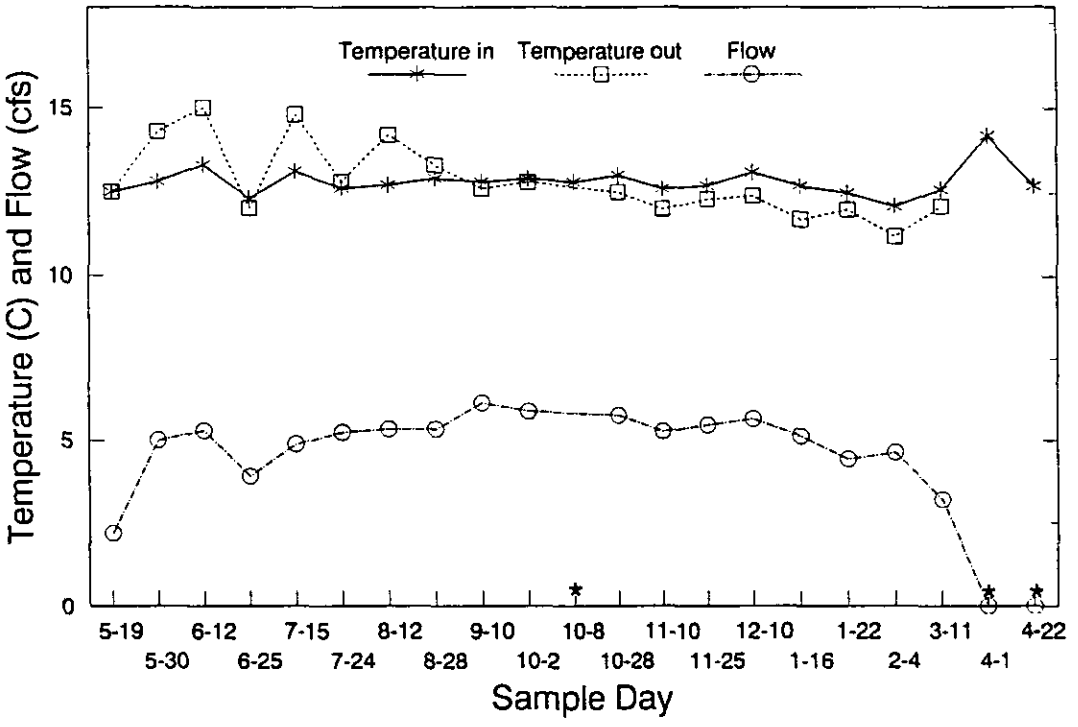


Figure 2. Sample temperatures and flows measured on Fish Farm #1.

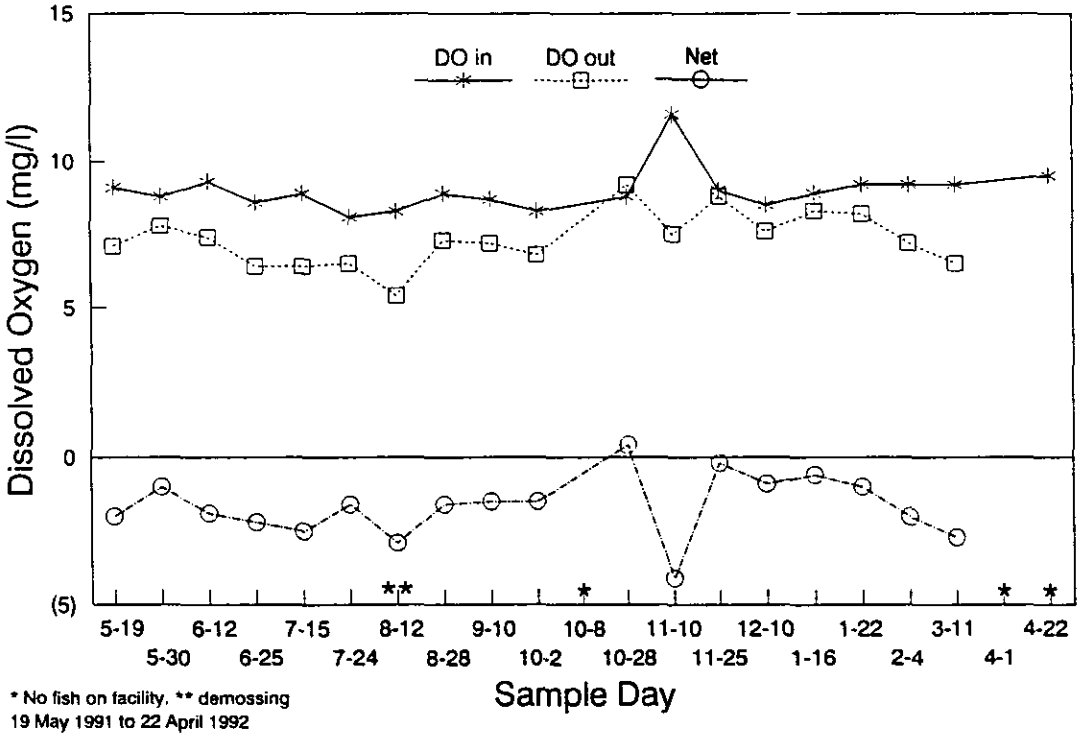


Figure 3. Dissolved oxygen concentrations measured on Fish Farm #1.

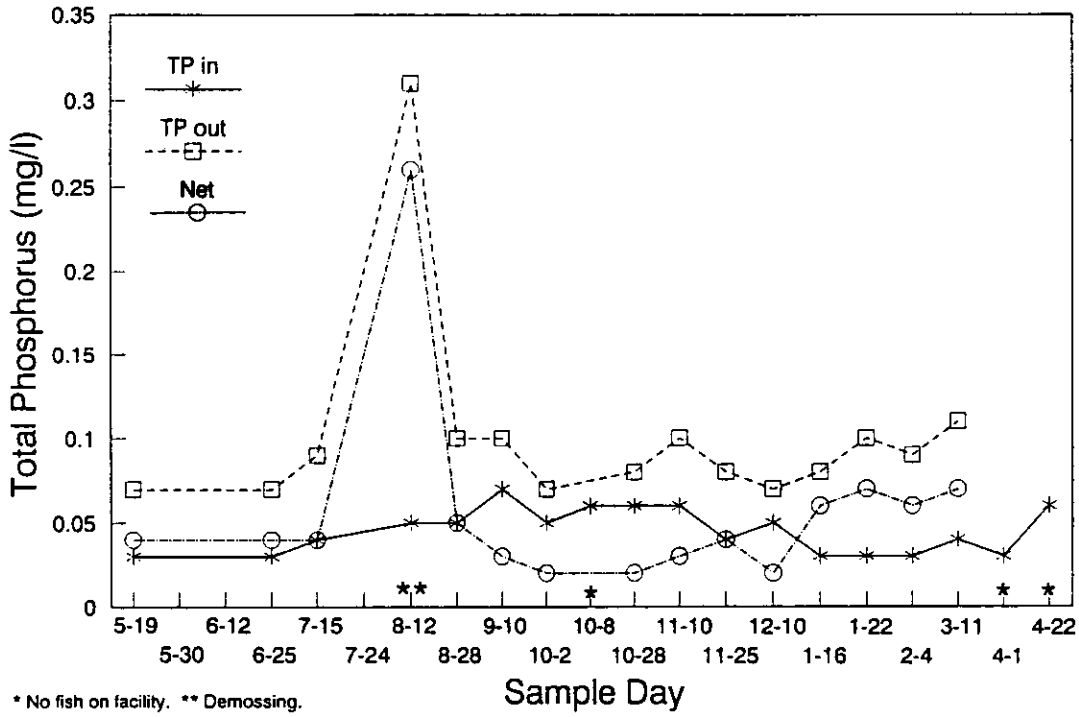


Figure 4. Total phosphorus concentrations measured on Fish Farm #1.

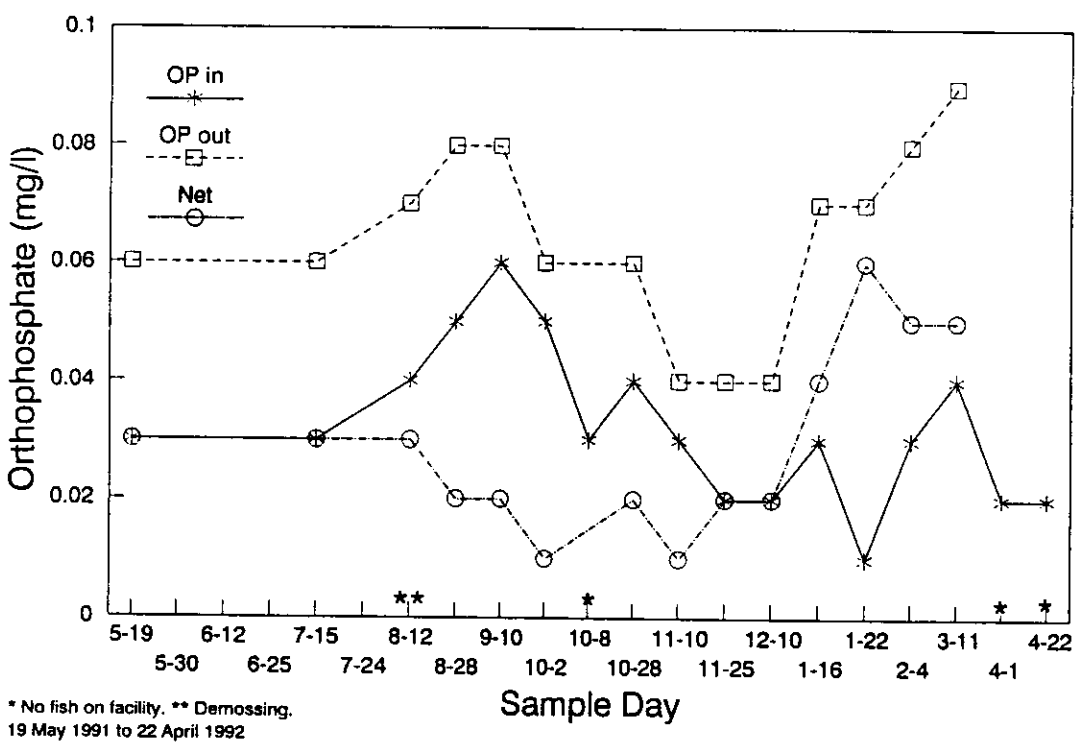


Figure 5. Orthophosphate concentrations measured on Fish Farm #1.

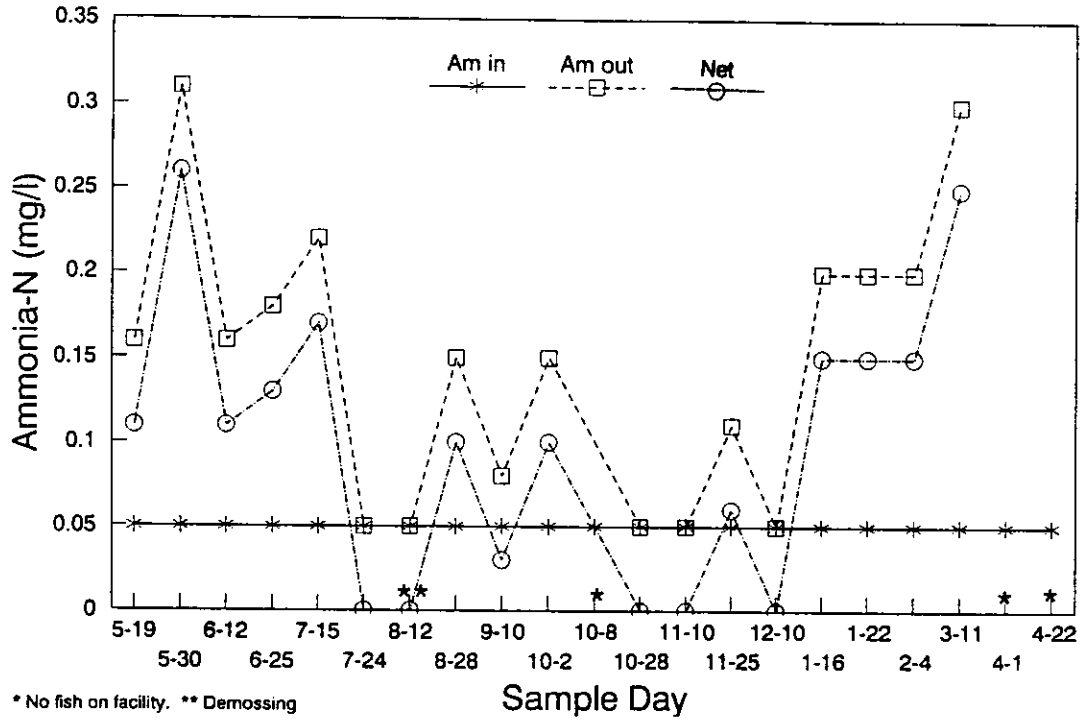


Figure 6. Ammonia-N concentrations measured on Fish Farm #1.

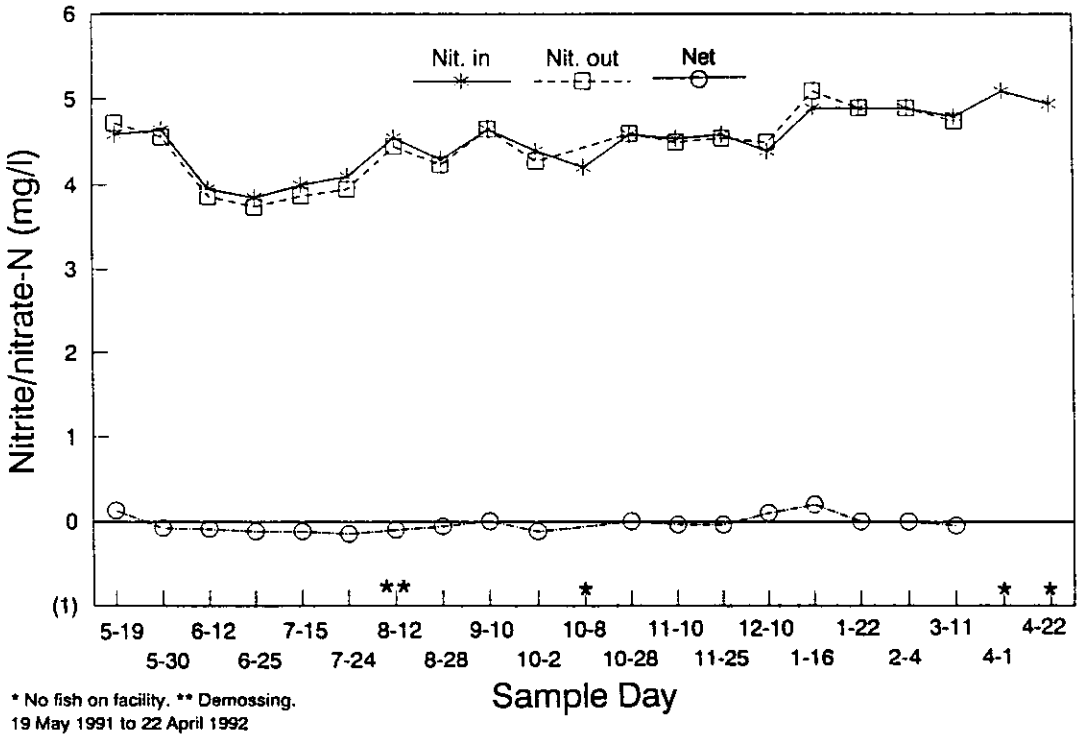


Figure 7. Nitrite/nitrate-N concentrations measured on Fish Farm #1.

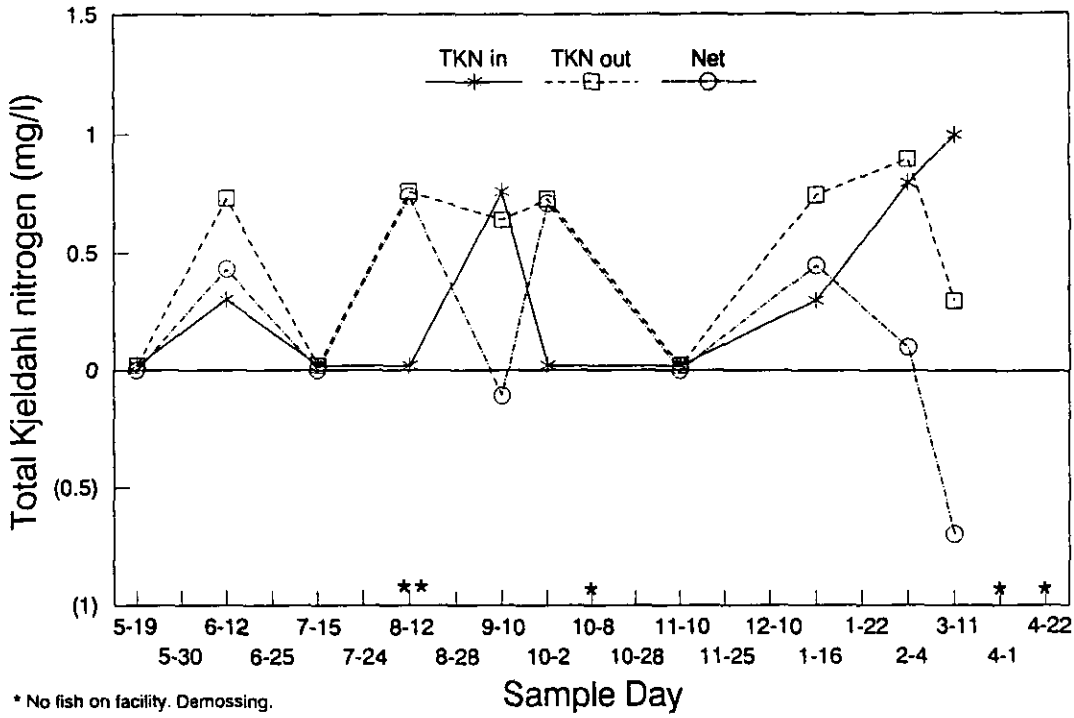


Figure 8. Total Kjeldahl nitrogen concentrations measured on Fish Farm #1.

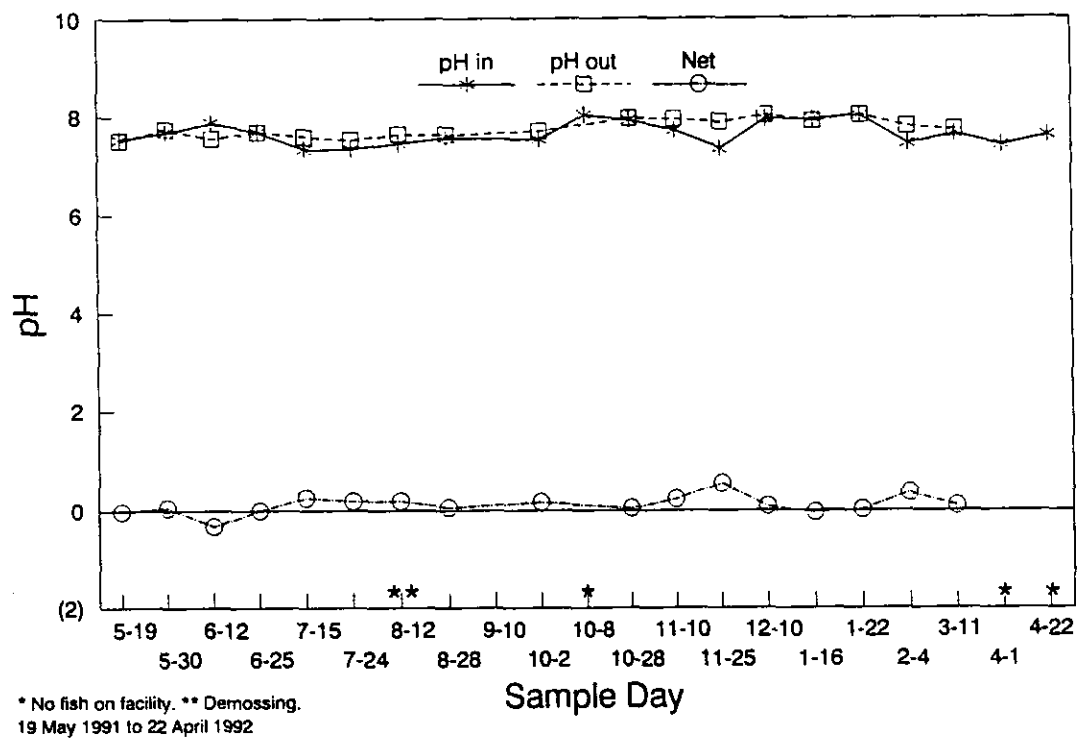


Figure 9. pH measured on Fish Farm #1.

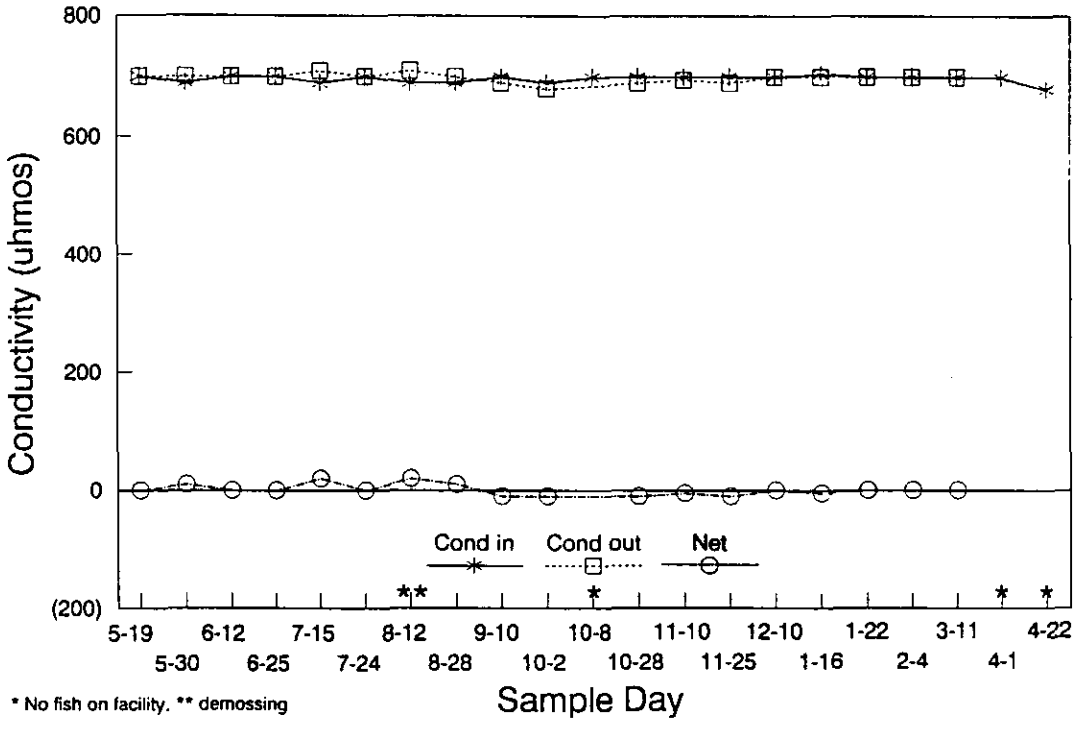


Figure 10. Specific conductance measured on Fish Farm #1.

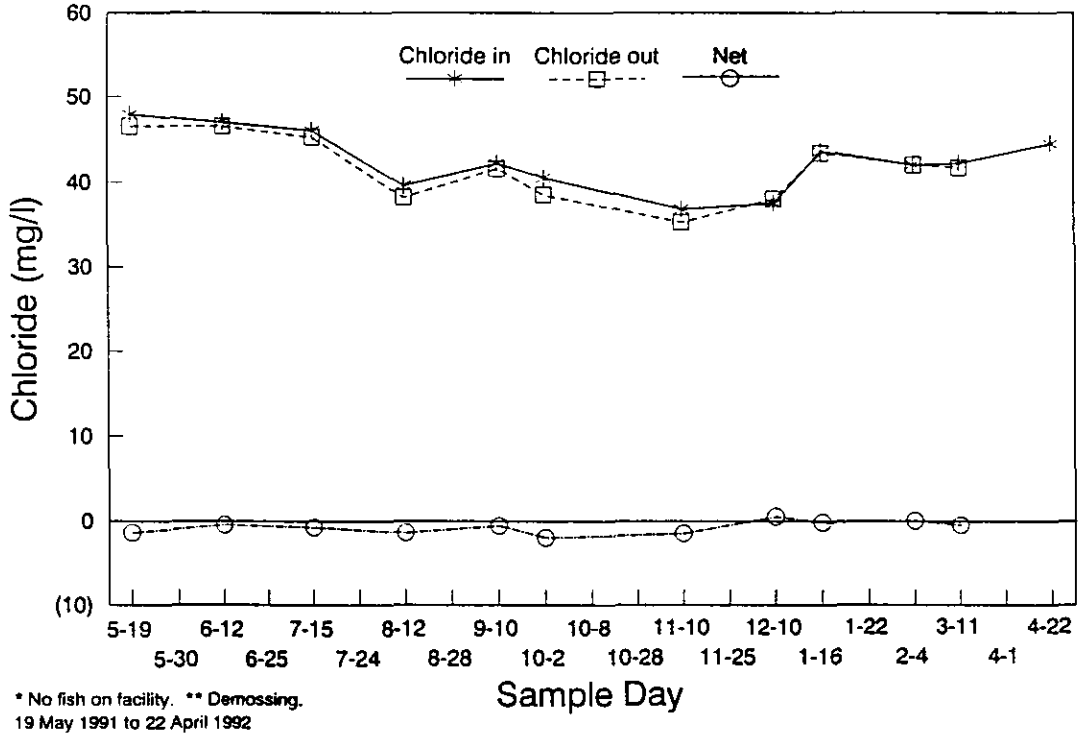


Figure 11. Chloride concentrations measured on Fish Farm #1.

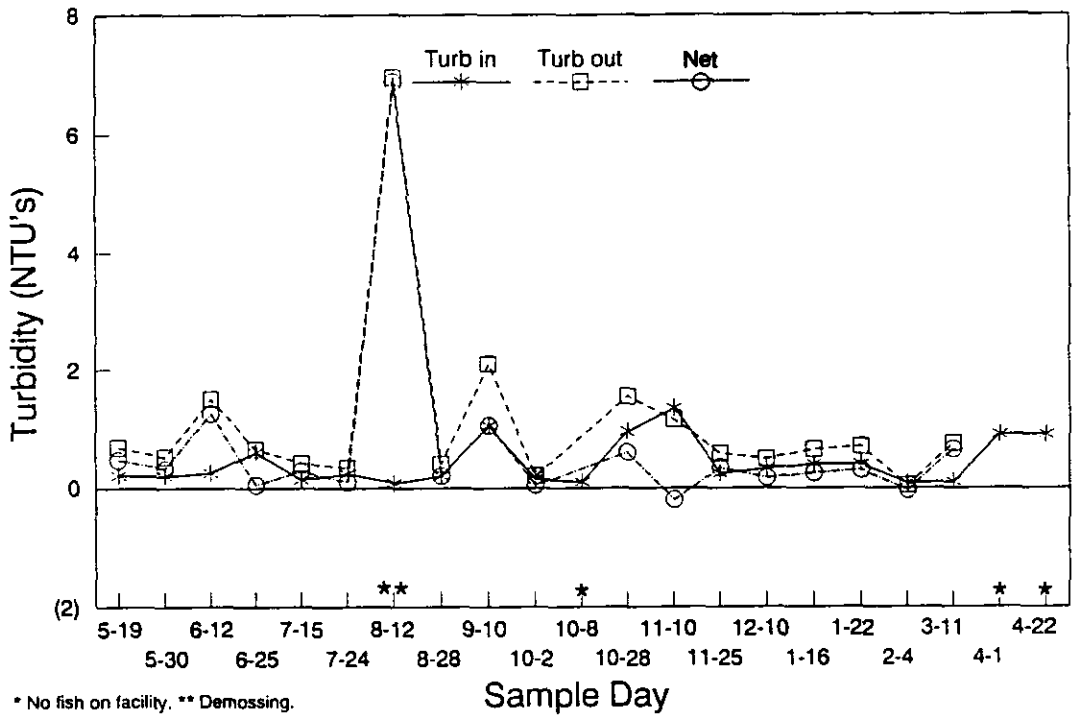


Figure 12. Turbidity measured on Fish Farm #1.

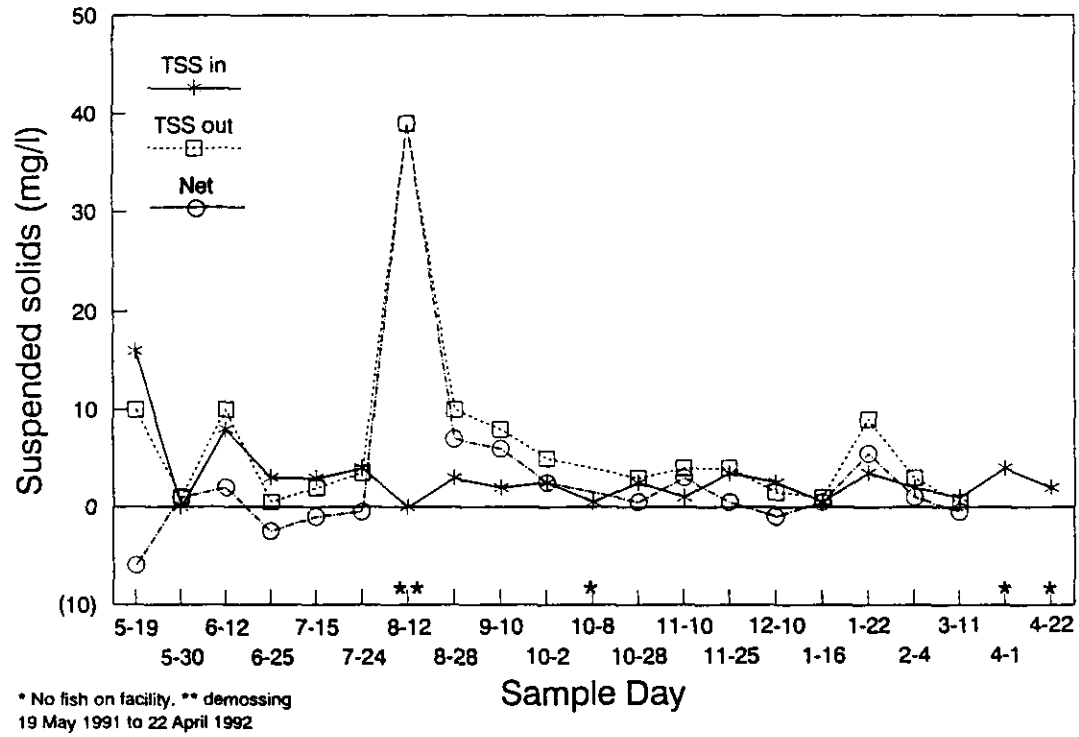


Figure 13. Total suspended solids concentrations measured on Fish Farm #1.

Farm #2

Farm #2 utilizes seep tunnel water with irrigation return water added intermittently. The seep tunnel stream flows through pasture prior to reaching the farm. Aquatic macrophytes are present within the seep stream above the farm and in the settling ponds. Sago pond weed is prevalent, water buttercup (*Ranunculus aquatilis*) and water parsnip (*Sium suave* L.) were also identified along with the plant species found on farm #1. Screens have to be cleaned frequently. The inflow channel is manually harvested several times a year to reduce macrophyte build-up.

During the monitoring period, one fish crop was harvested. The farm has 12 concrete raceways, although only eight were used during the study. Quiescent zones are present in the lower serial raceway sets. Two total-flow settling basins are also provided, one intermediate between the first and second sets of raceways, and the second below all rearing ponds. High macrophyte growth occurred in the lower settling basin.

The temperature in the farm varied around 13°C, decreasing as flow increased (Fig. 14). Greater flow variability was demonstrated in farm #2, from 4.5 to nearly 8 cfs, which suggested that the seep tunnel supplying the farm was more immediately sensitive to surface water patterns.

Dissolved oxygen was stable and most often above 9 mg/l (Fig. 15) at the intake, with a 3 mg/l mean difference occurring between the inlet and outlet of the farm. Oxygen level in the rearing units approached the threshold for restricted growth during the summer months. Oxygen recharge occurred between the lower rearing units and the outlet.

Total phosphorus showed a mean net increase through the farm of 0.05 mg/l. The phosphorus level increased only slightly with greater biomass over the single grow-out period (Fig. 16). Orthophosphate ranged from 0.01 to about 0.07 mg/l over the grow-out period (Fig. 17), with a mean concentration of 0.05 mg/l in the outflow, and 0.04 mg/l presettling. Orthophosphate levels in the water supply were variable.

Ammonia displayed an erratic pattern with large fluctuations unrelated to fish biomass (Fig. 18), and ranged from 0 to over 0.3 mg/l, similar to farm #1. A net decrease in nitrite/nitrate levels occurred as water passed through the farm (Fig. 19). Total Kjeldahl nitrogen also showed high variability, and little relationship with the ammonia pattern (Fig. 20).

The pH was stable between 7.5 and 8, with little change as water passed through the farm (Fig. 21). Conductivity (Fig. 22) was constant, and chloride (Fig. 23) showed a decreasing trend during irrigation.

Turbidity showed little change as water passed through the farm (Fig. 24). The maximum concentration measured 3.8 NTU. The level of suspended solids varied (Fig. 25), but the mean increase was low at <1.5 mg/l.

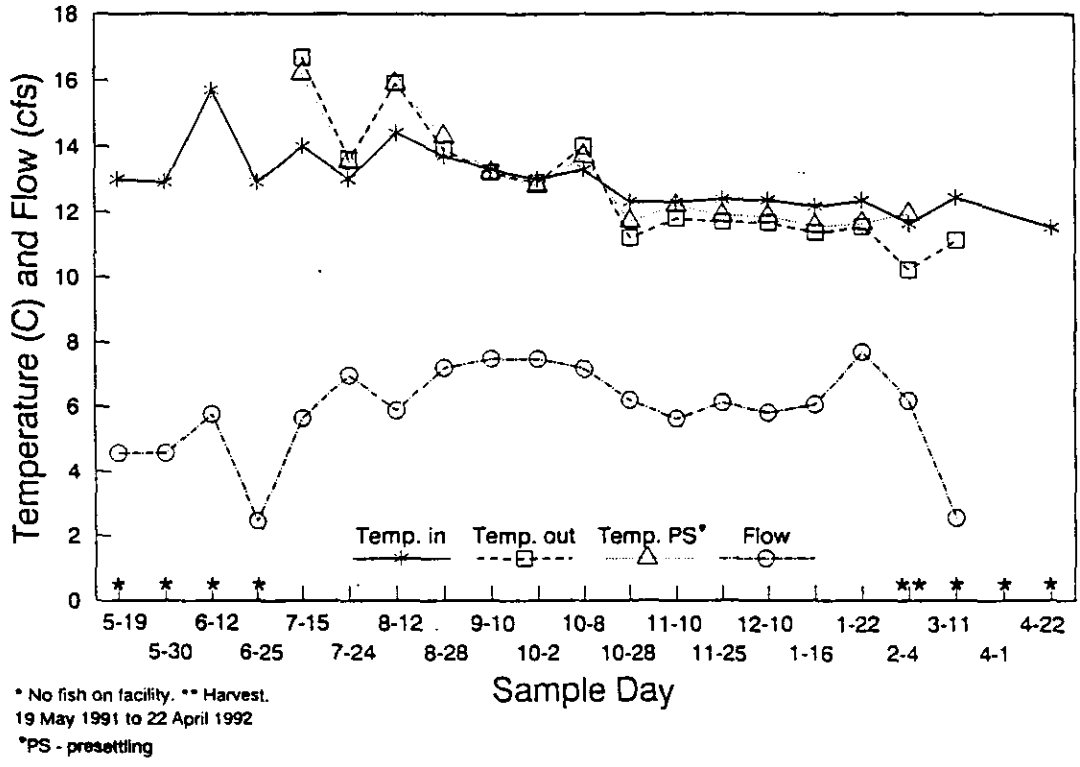


Figure 14. Sample temperatures and flows measured on Fish Farm #2.

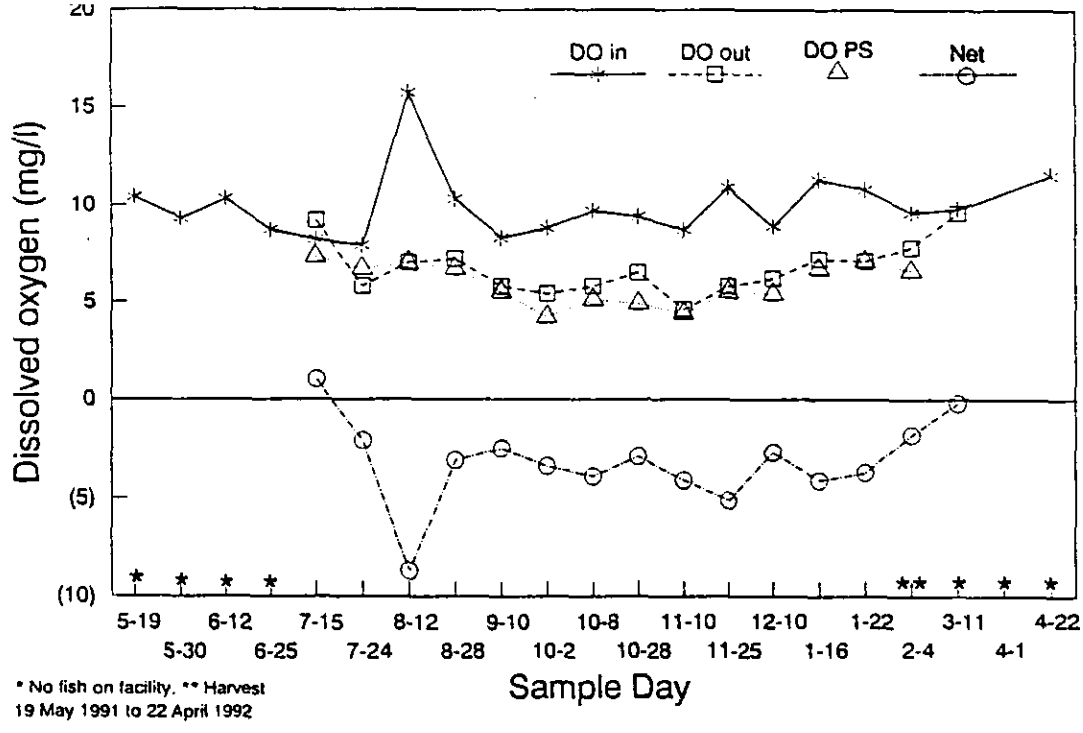


Figure 15. Dissolved oxygen concentrations measured on Fish Farm #2.

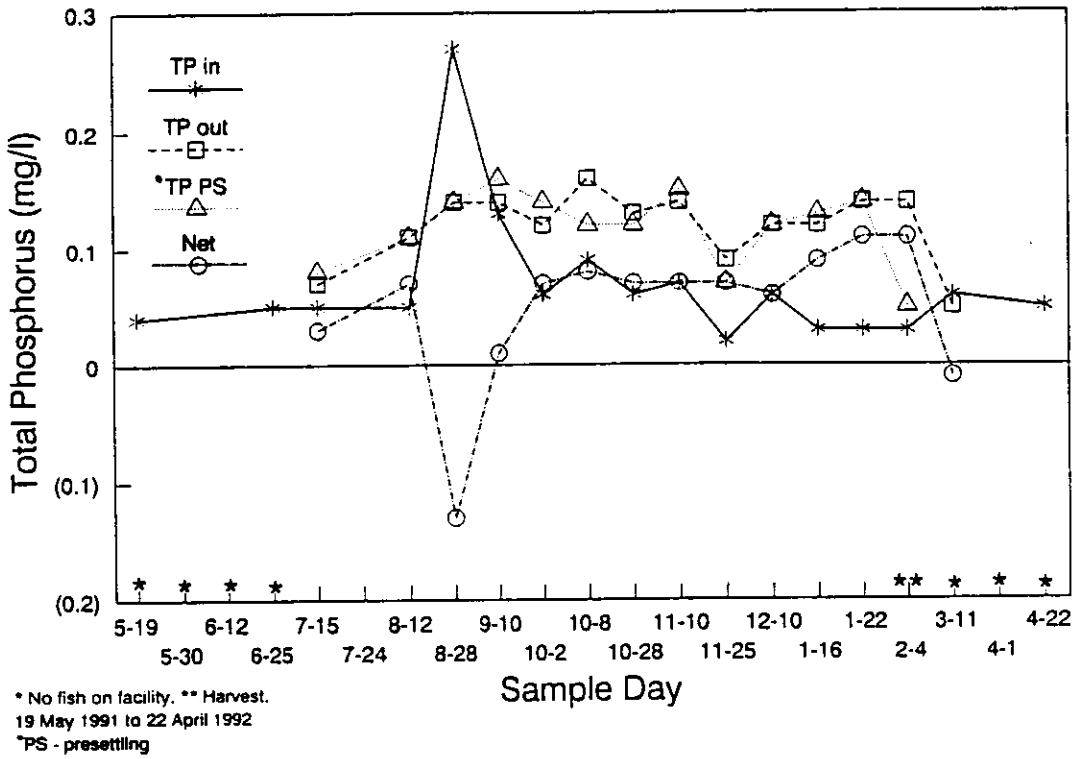


Figure 16. Total phosphorus concentrations measured on Fish Farm #2.

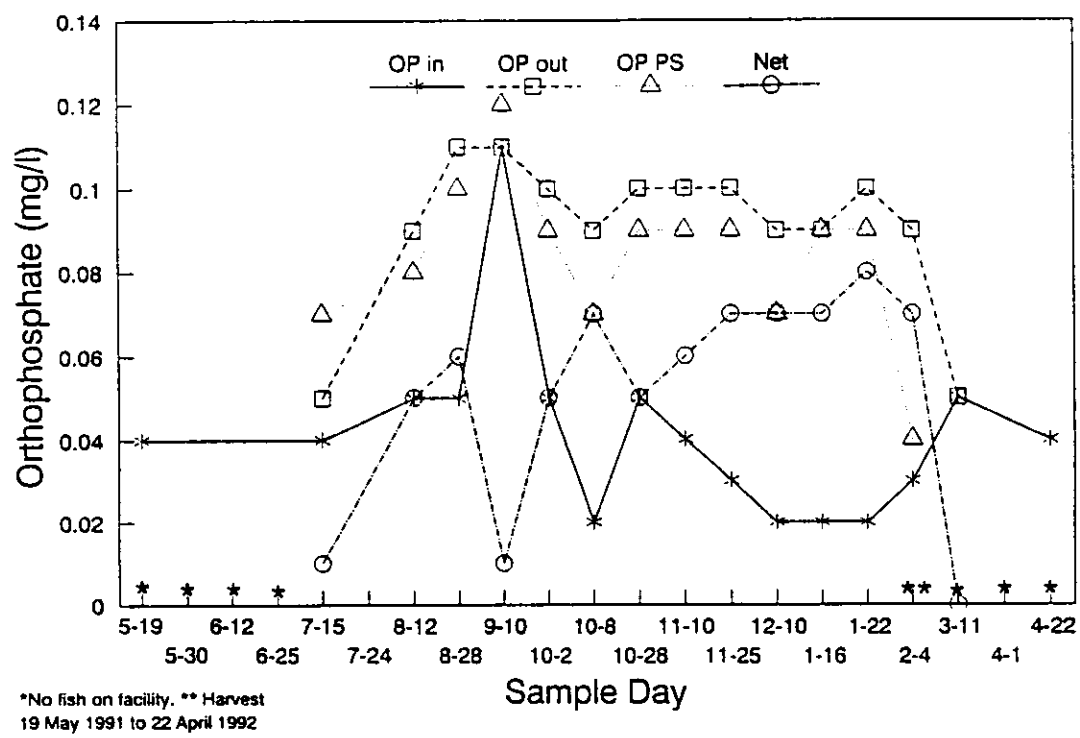


Figure 17. Orthophosphate concentrations measured on Fish Farm #2.

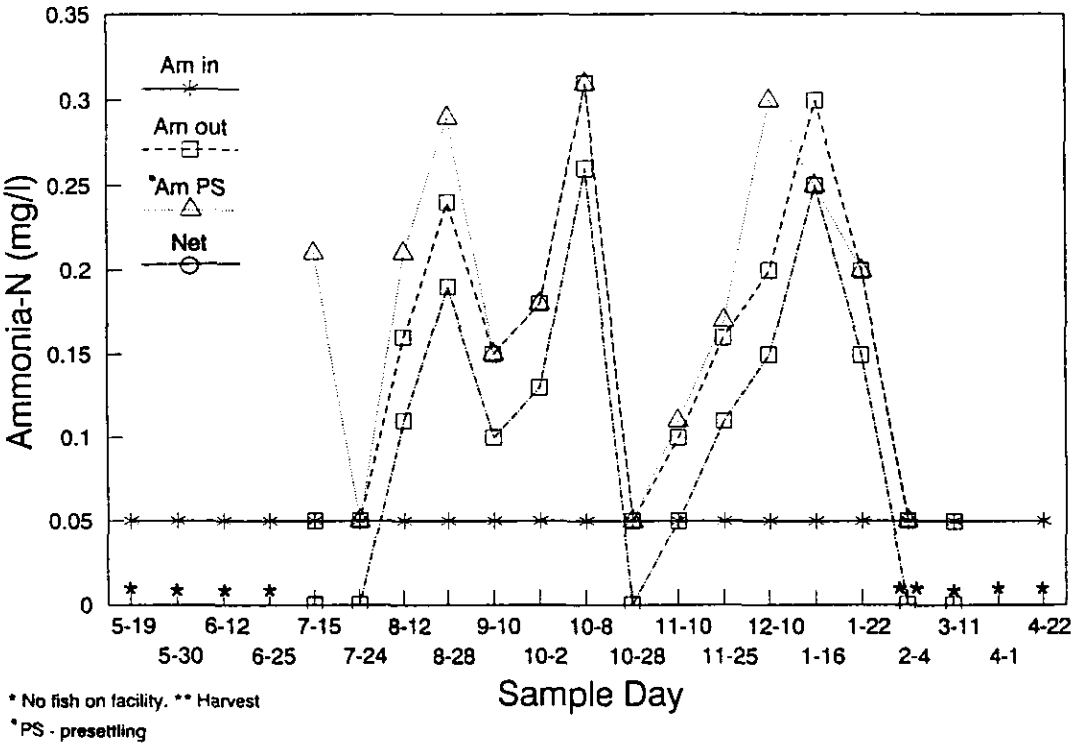


Figure 18. Ammonia-N concentrations measured on Fish Farm #2.

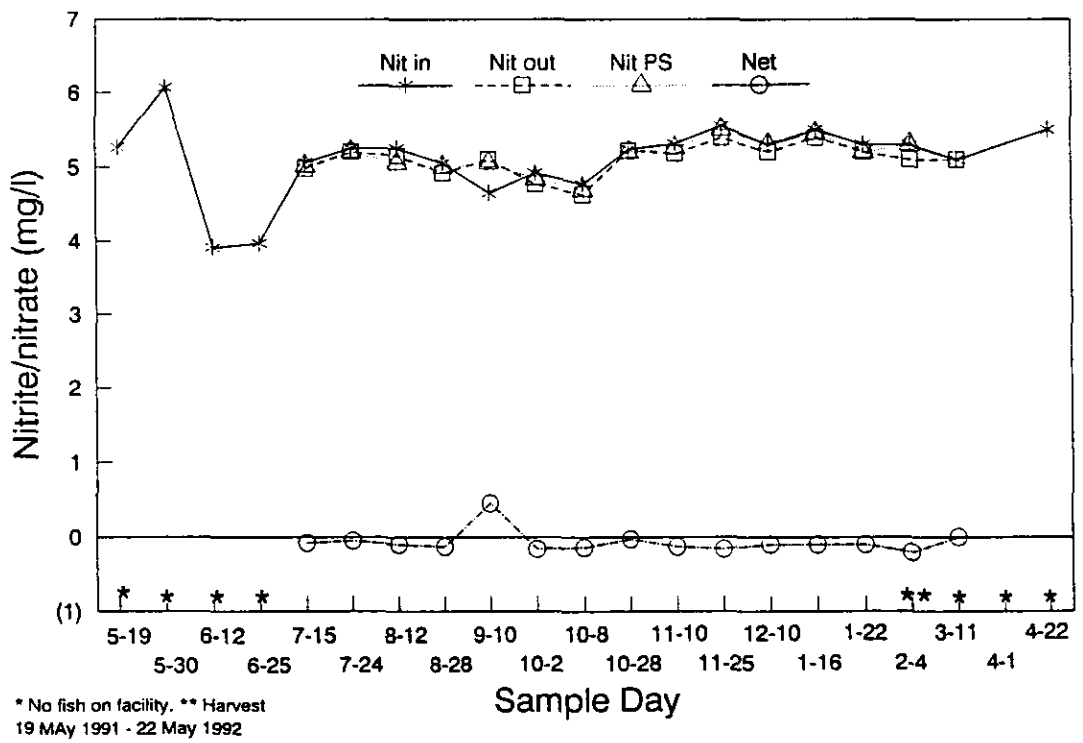


Figure 19. Nitrite/nitrate-N concentrations measured on Fish Farm #2.

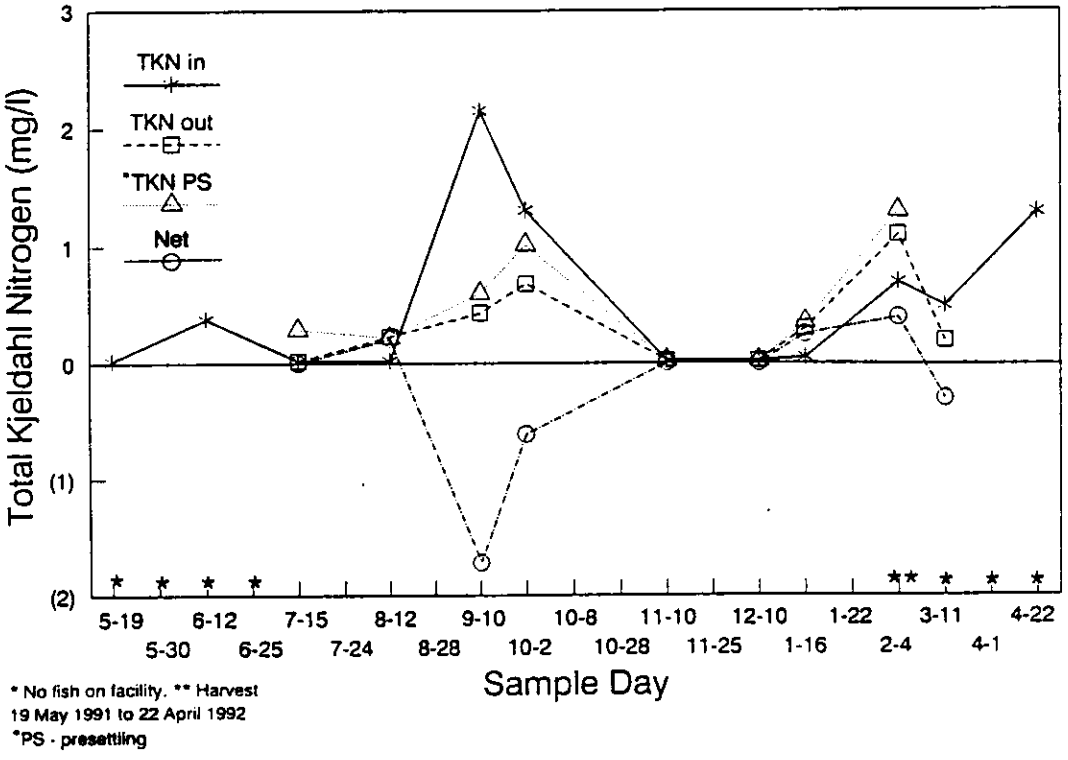


Figure 20. Total Kjeldahl nitrogen concentrations measured on Fish Farm #2.

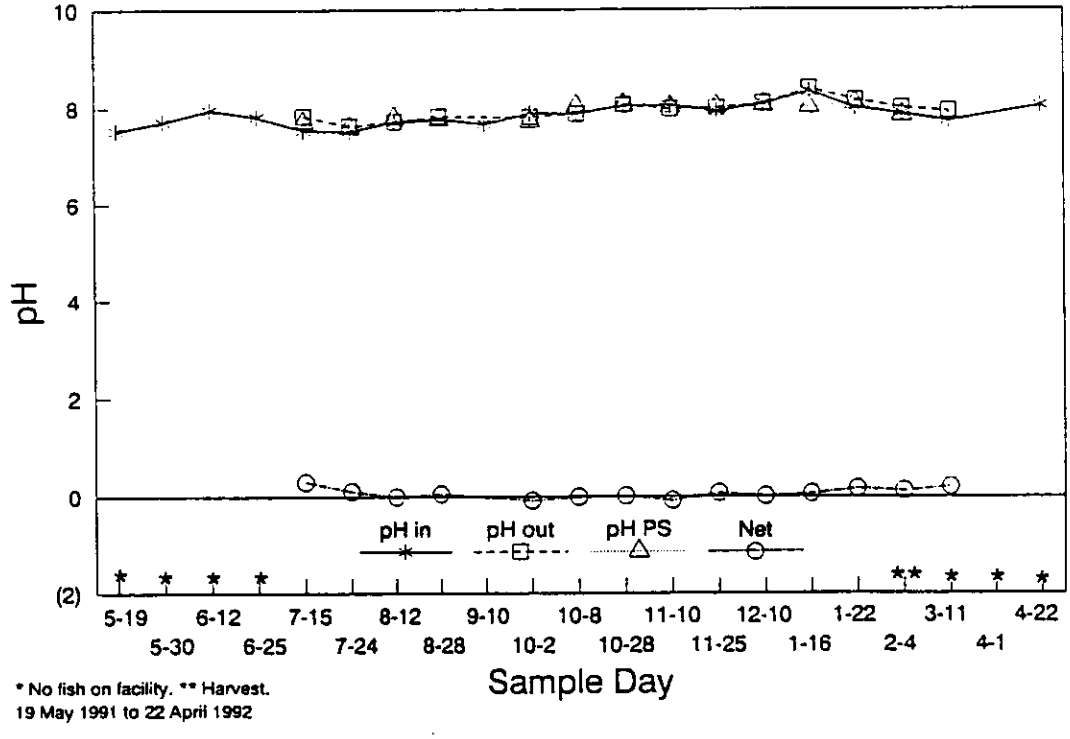


Figure 21. pH measured on Fish Farm #2.

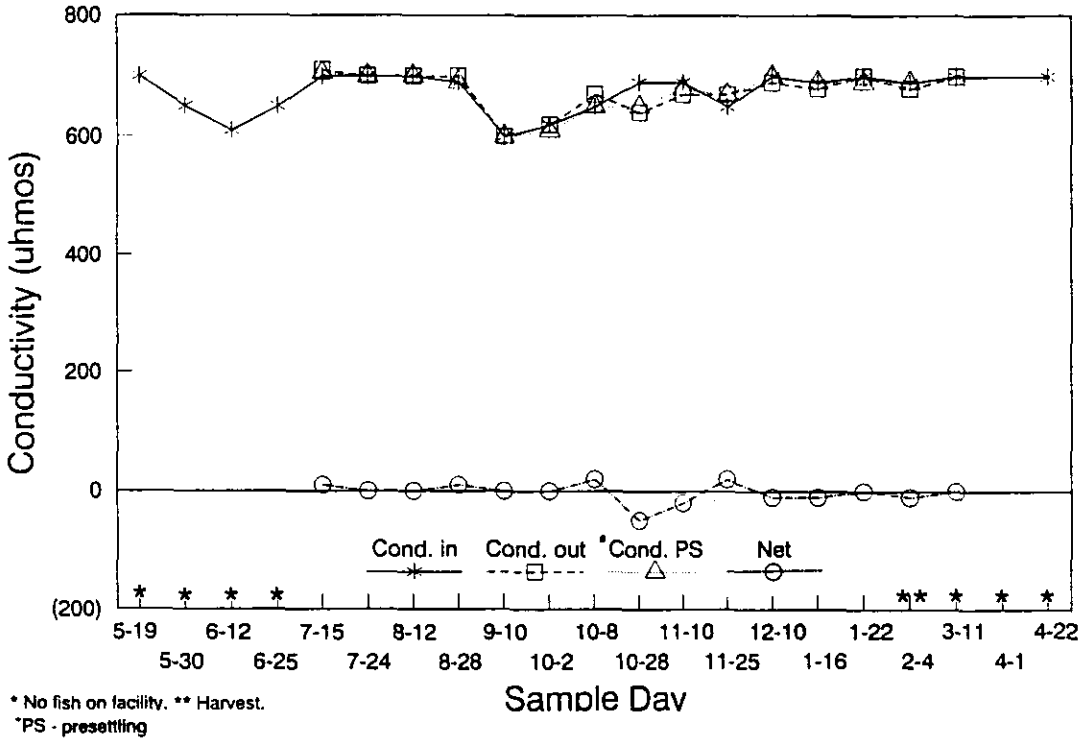


Figure 22. Specific conductance measured on Fish Farm #2.

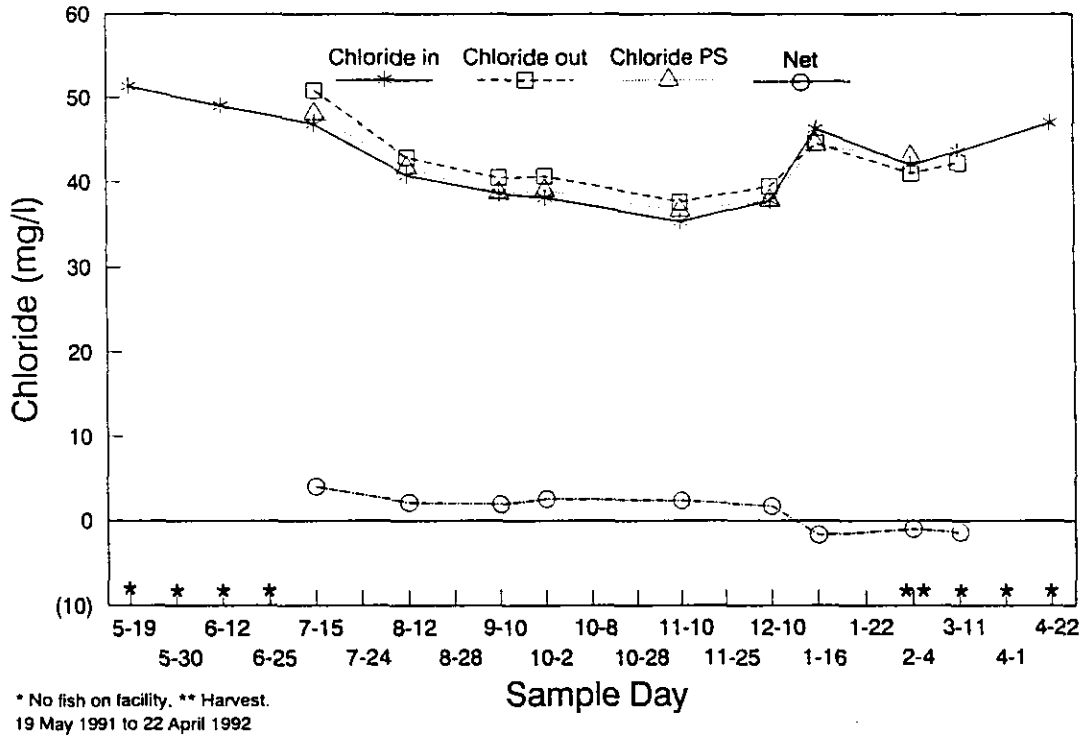


Figure 23. Chloride concentrations measured on Fish Farm #2.

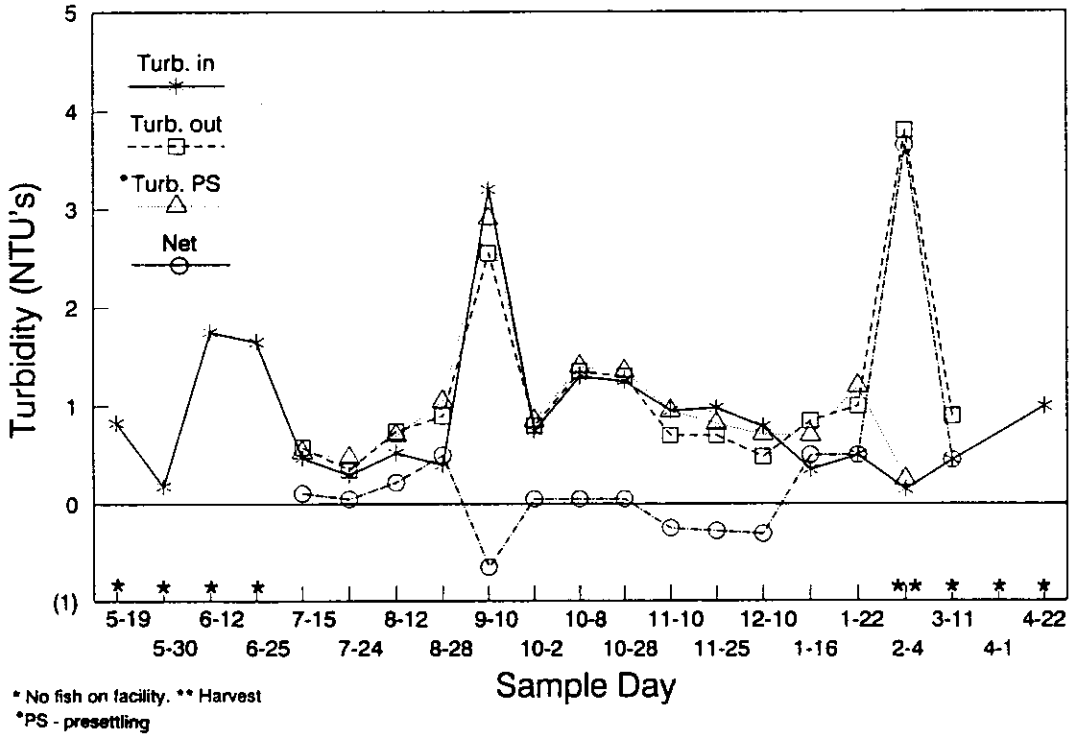


Figure 24. Turbidity measured on Fish Farm #2.

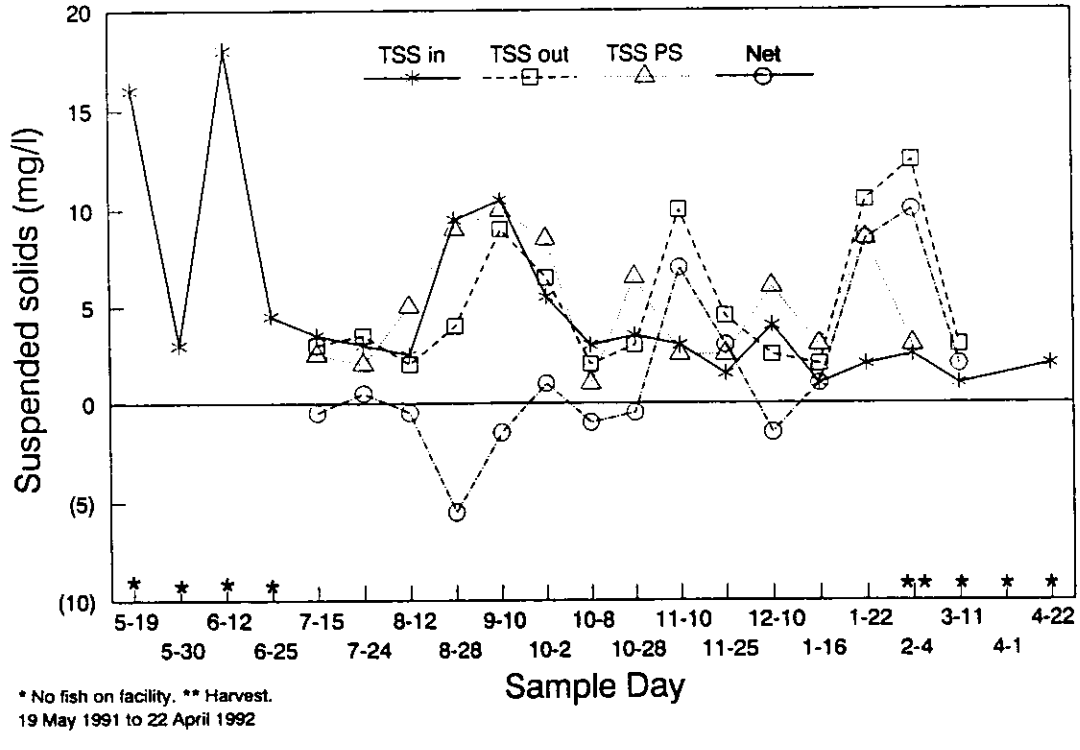


Figure 25. Total suspended solids concentrations measured on Fish Farm #2.

Farms on Irrigation Return Flow

Farm #3

Farm #3 is downstream approximately 0.2 miles from farm #2, and reuses some of the water discharged by farm #2 and irrigation return water. Eight paired concrete raceways in series are on the farm with a total flow dirt settling pond. Sago pond weed and other aquatic macrophytes from the water supply cause a serious build up on intake screens at this farm. Apron screens, designed to eliminate clogging, prevent the loss of flow through the farm. One crop was produced during the study period.

The temperature pattern in the farm was quite variable, but more stable during the rearing period starting in September (Fig. 26). Only minimum flow was put through the farm prior to that time. Flows during rearing ranged from 5 cfs to 10 cfs, and were controlled by a diversion facility on the supply stream.

Dissolved oxygen was stable during the rearing period (Fig. 27), with a 1.4 mg/l mean difference occurring between the inlet and outlet of the farm, and always at a sufficient level to provide for maximum growth.

Total phosphorus showed a net increase through farm #3 as the rearing period progressed, reaching a maximum of around 0.11 mg/l prior to harvest (Fig. 28). Orthophosphate level increased in concentration from 0.02 to about 0.08 mg/l in the outflow over the grow-out period (Fig. 29). Levels of total phosphorus in the water supply were greater than 0.15 mg/l, and settling appeared to have no effect on phosphorus species except at the highest concentration.

Ammonia showed a high degree of variability, but tended to increase with rearing biomass (Fig. 30), and went as high as 0.31 mg/l. Ammonia background levels up to 0.2 mg/l were measured. Nitrite/nitrate concentrations were high in the water supply and increased over the study period (Fig. 31), and no net contribution from trout rearing was detected. Total Kjeldahl nitrogen showed high variability, without relationship to the ammonia or nitrate levels (Fig. 32).

The pH varied between 7.6 and 8.8, with little change as water passed through the farm (Fig. 33). Conductivity (Fig. 34) and chloride (Fig. 35) levels varied with the season, but fish biomass on the farm had no influence on either.

Turbidity was generally unchanged as water passed through the farm (Fig. 36), but was variable in the water supply, dropping from 27.5 to 0.7 NTU over the sample period. Suspended solids (Fig. 37) showed a net decrease as water passed through the farm (-4 mg/l), with background levels as high as 52 mg/l during rearing.

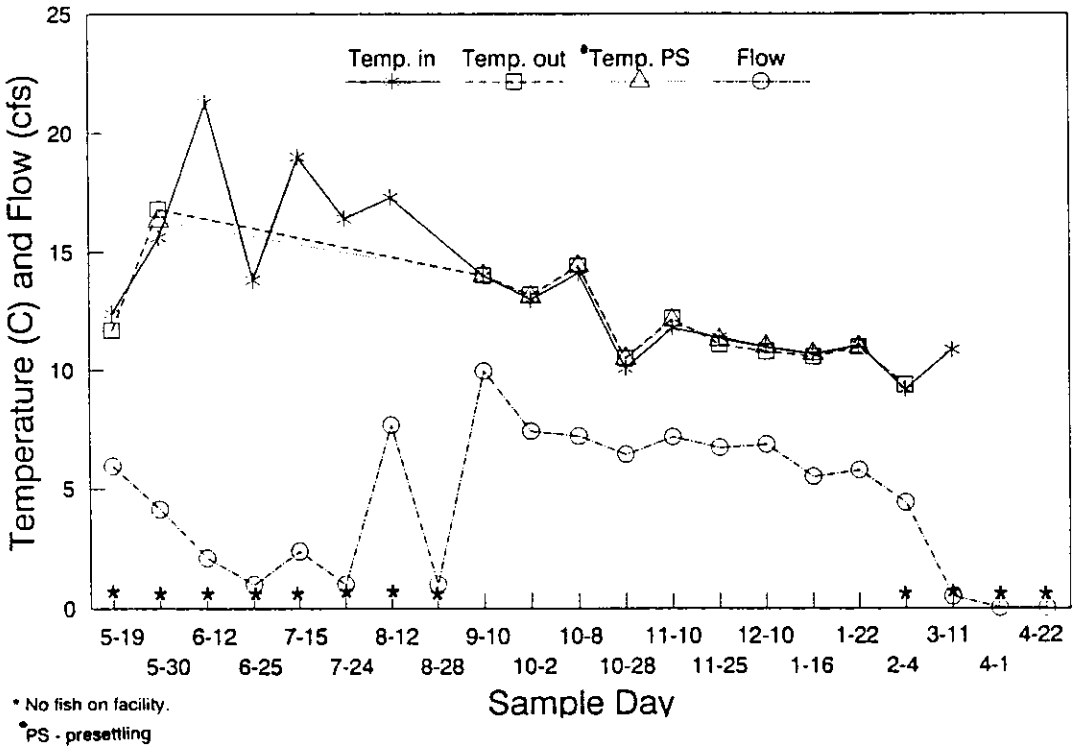


Figure 26. Sample temperatures and flows measured on Fish Farm #3.

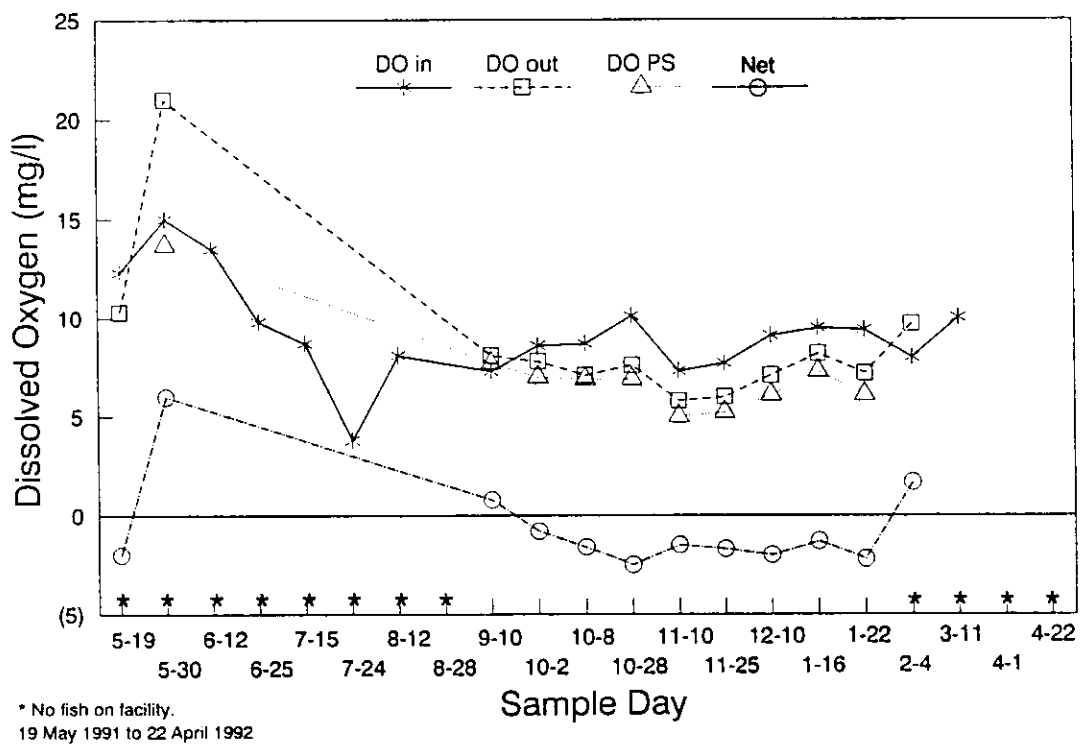


Figure 27. Dissolved oxygen concentrations measured on Fish Farm #3.

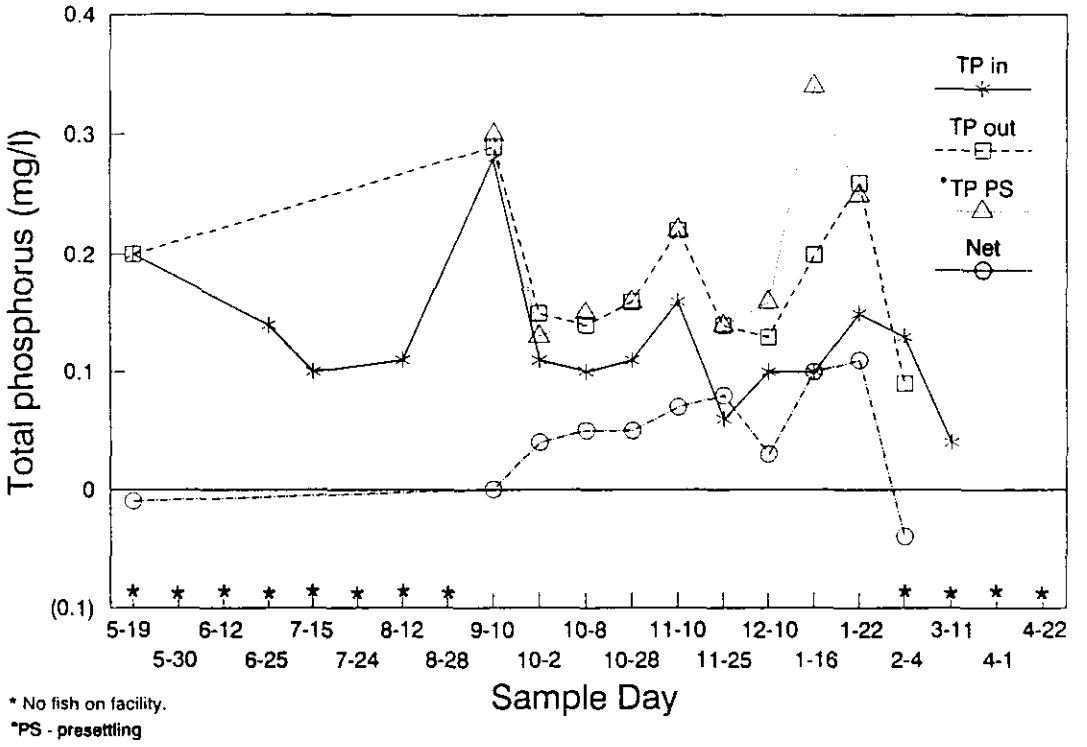


Figure 28. Total phosphorus concentrations measured on Fish Farm #3.

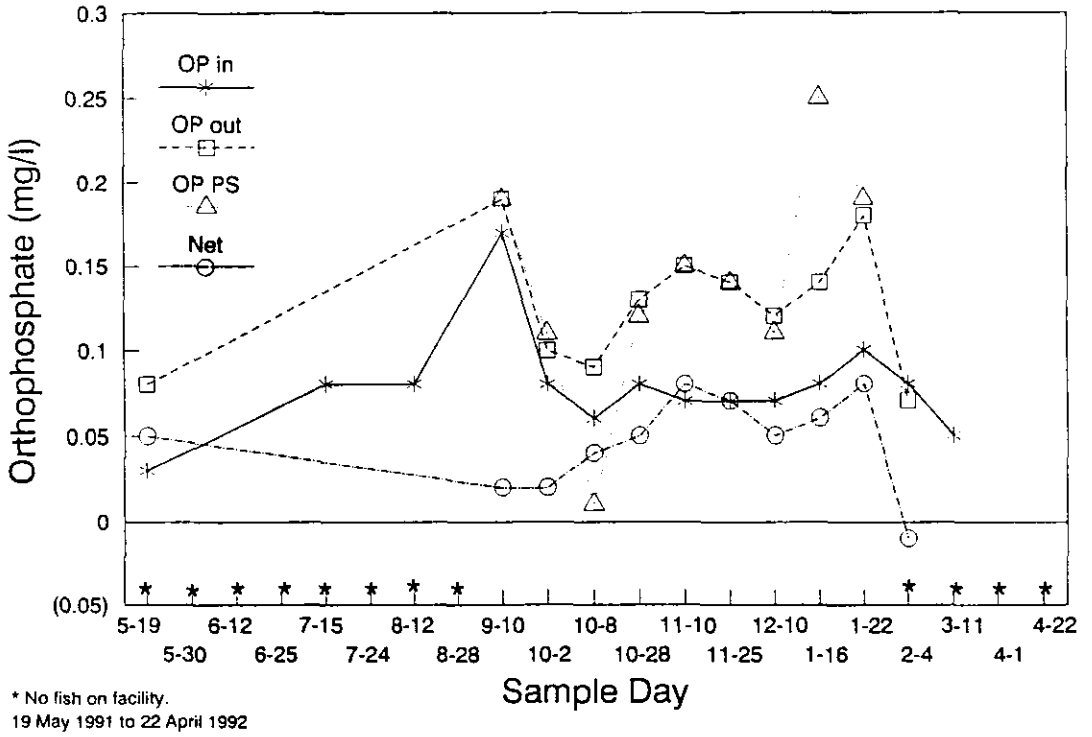


Figure 29. Orthophosphate concentrations measured on Fish Farm #3.

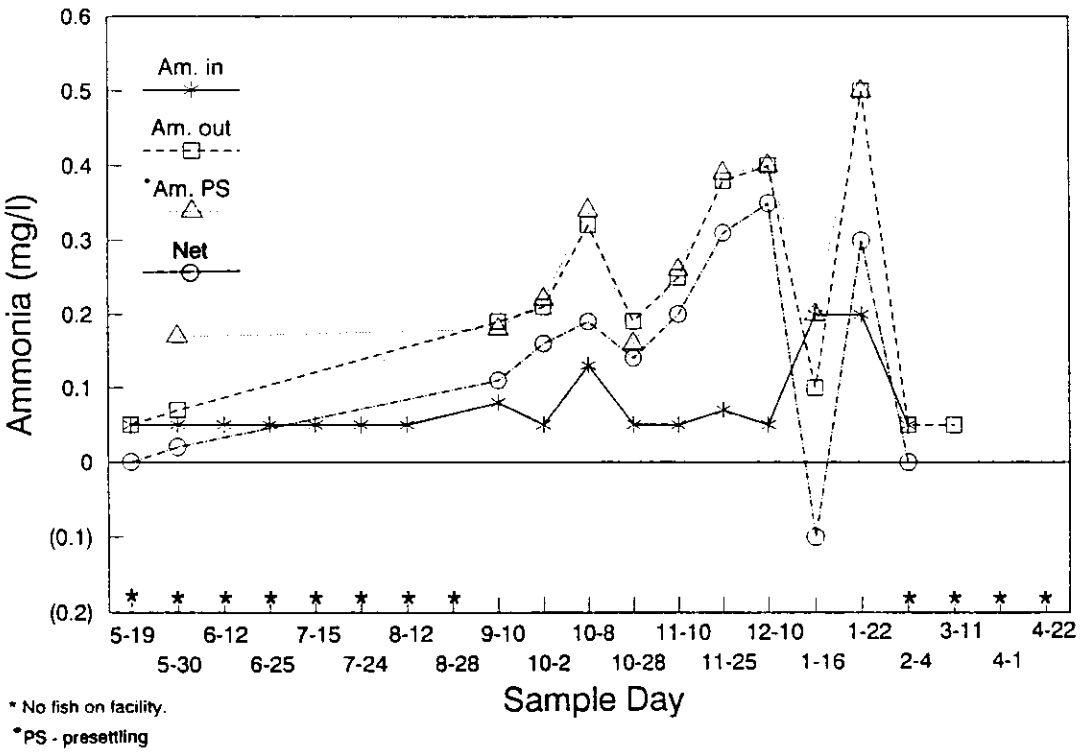


Figure 30. Ammonia-N concentrations measured on Fish Farm #3.

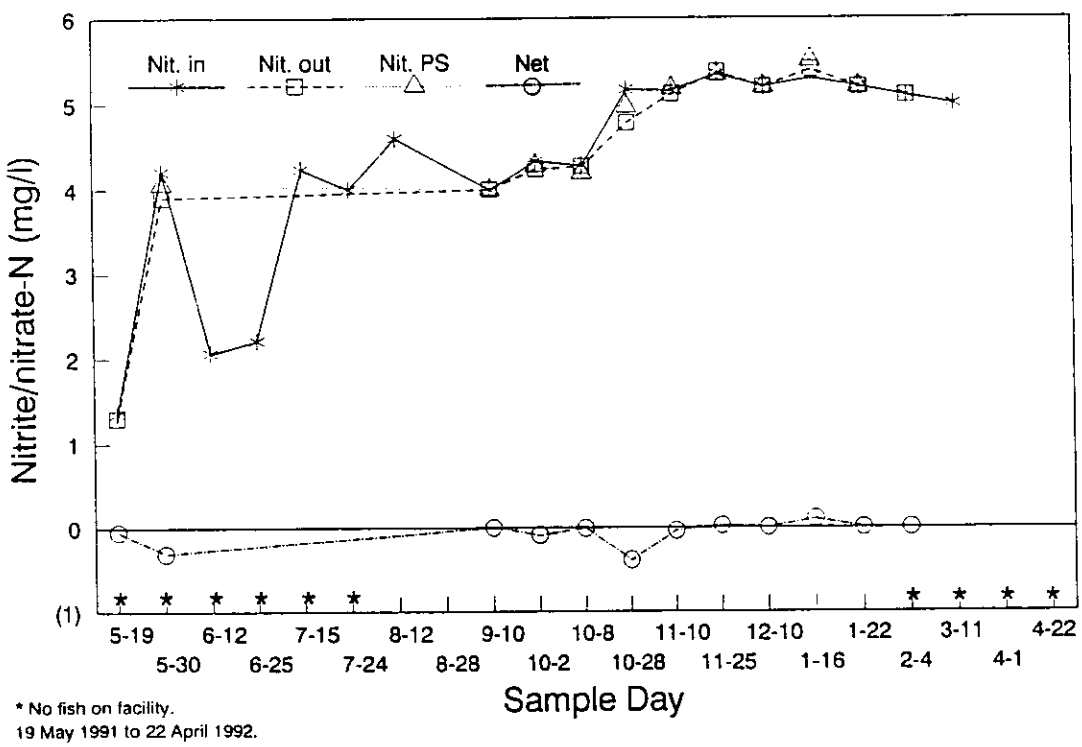


Figure 31. Nitrite/nitrate-N concentrations measured on Fish Farm #3.

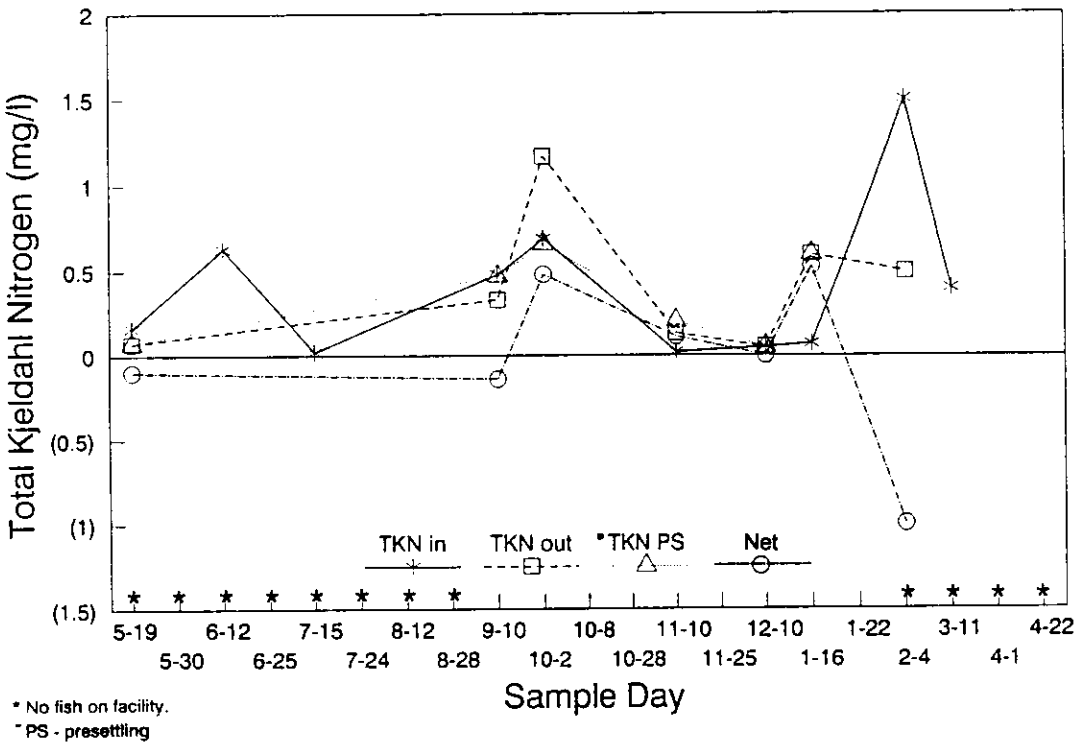


Figure 32. Total Keldahl nitrogen concentrations measured on Fish Farm #3.

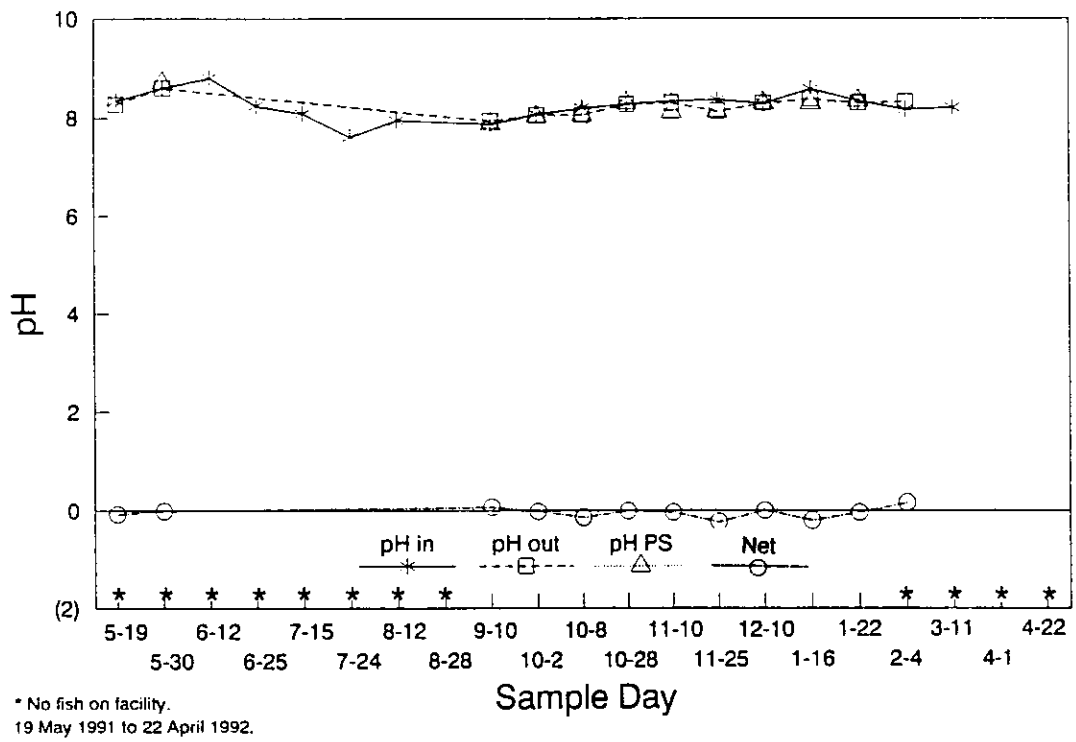


Figure 33. pH measured on Fish Farm #3.

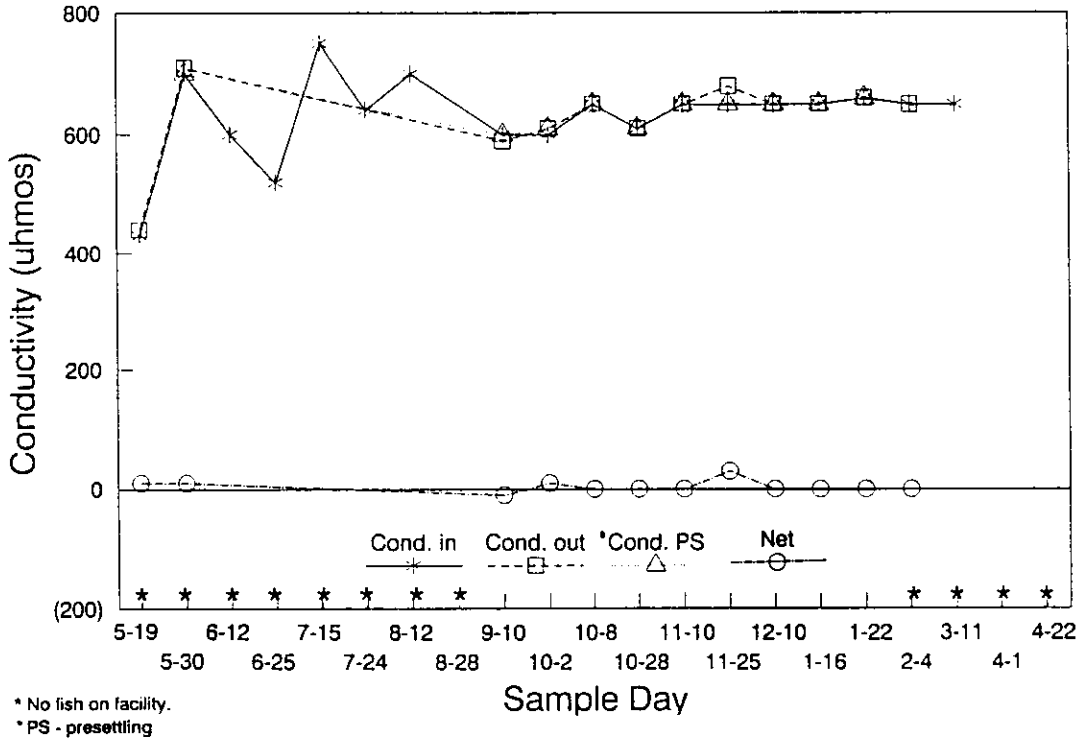


Figure 34. Specific conductance measured on Fish Farm #3.

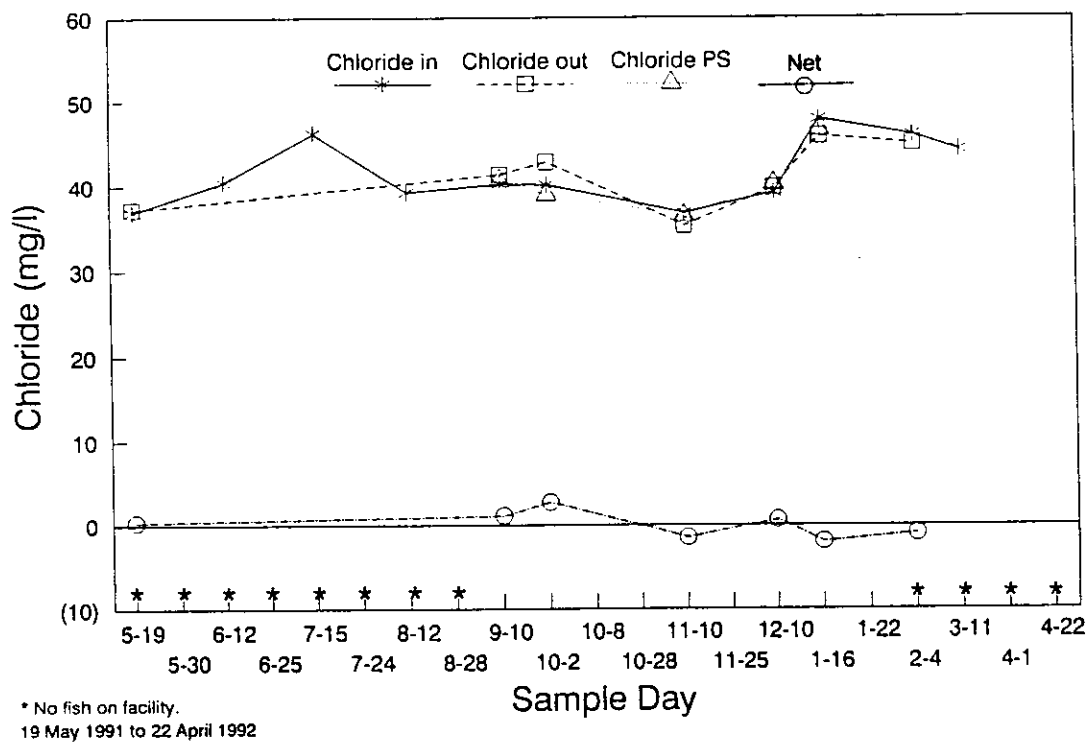


Figure 35. Chloride concentrations measured on Fish Farm #3.

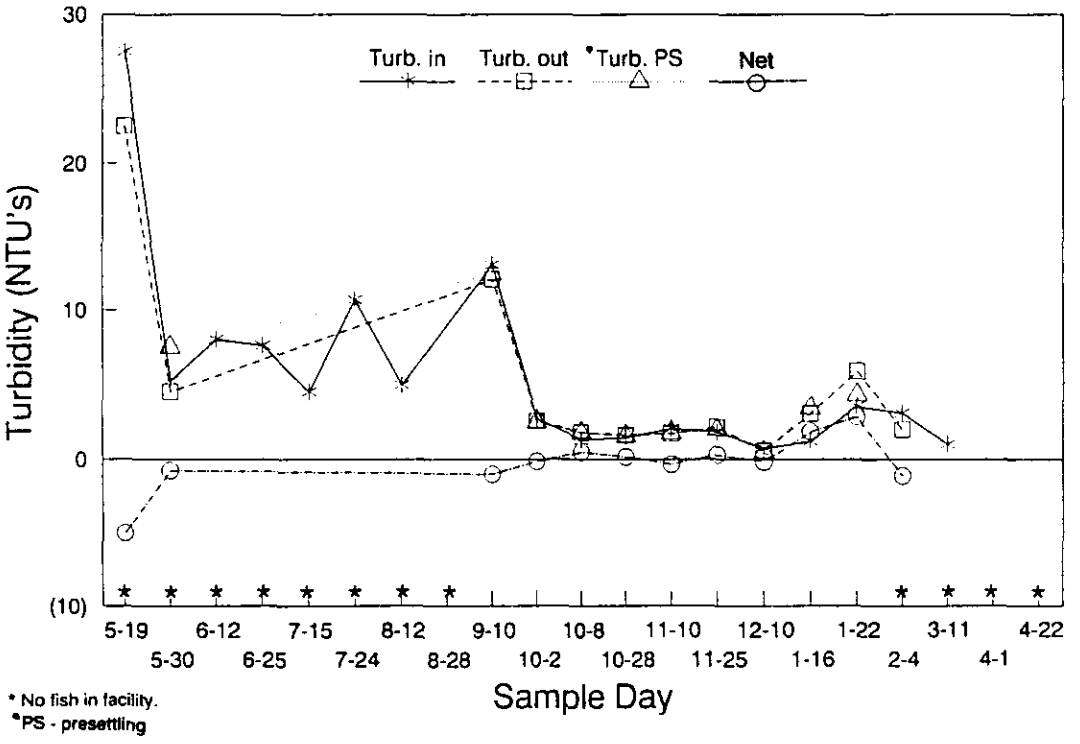


Figure 36. Turbidity measured on Fish Farm #3.

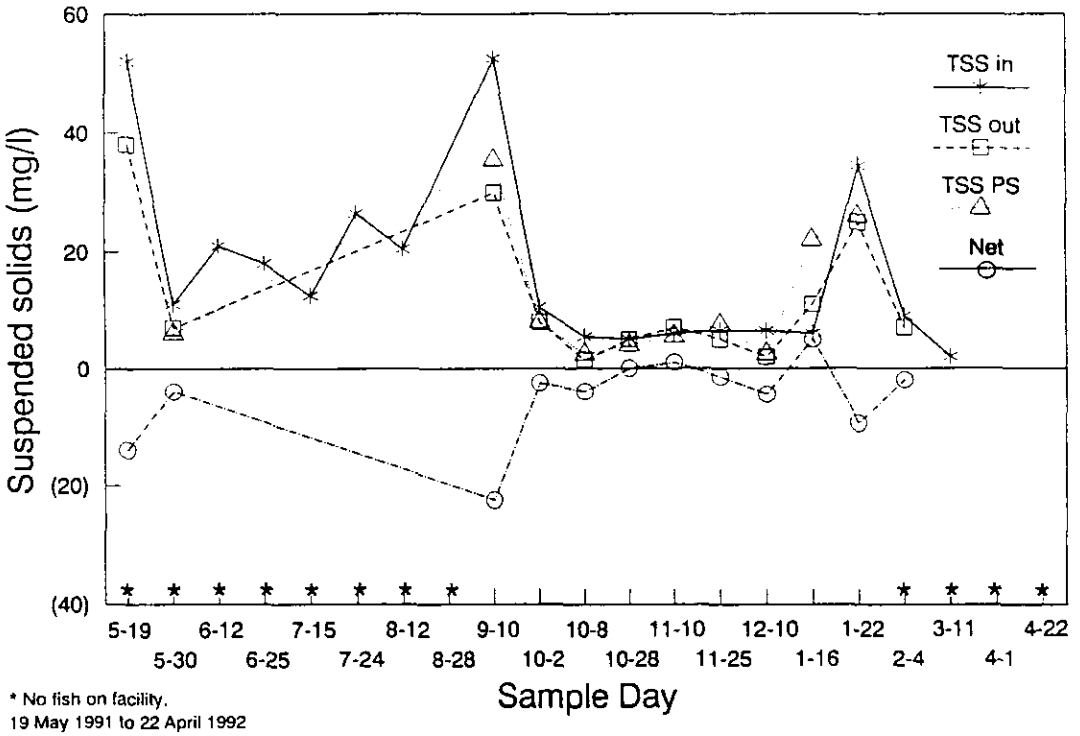


Figure 37. Total suspended solids concentrations measured on Fish Farm #3.

Farm #5

Farm #5 is one of the oldest farm ponds still operating in the Hagerman Valley. It is a large single earthen pond, with in-pond settling. No other settling facility is provided before the water enters Deep Creek. The source water is a combination of irrigation return flow and outflow water from another small fish farm upstream about 0.2 miles. Two fish crops were produced during the monitoring period.

The temperature and flow pattern in farm #5 decreased slightly over the season with means of 14°C (10.8 to 19°C) and 7.6 cfs (2.4 to 10.6 cfs) (Fig. 38). Fluctuation occurred primarily early and late in the season. Dissolved oxygen in the source water ranged between 6 and 10.8 mg/l (Fig. 39), with a 1 to 4 mg/l difference occurring between the inlet and outlet of the pond.

The mean net increase in total phosphorus during the first rearing period was 0.02 mg/l, and during the second rearing period a net increase up to and exceeding 0.05 mg/l (Fig. 40) was measured. Orthophosphate levels showed the same pattern, eventually increasing in concentration from 0.01 to 0.06 mg/l late in the grow-out period (Fig. 41).

Ammonia varied, but most often was very low (Fig. 42). The range of increase was from 0 to 0.25 mg/l, and was detectable in the source water. A slight net decrease was found in nitrite/nitrate as water passed through the farm (Fig. 43). Kjeldahl nitrogen showed high variability (Fig. 44) without any rearing affects.

The pH was just above 8, with minimal change as water passed through the farm (Fig. 45). Conductivity varied slightly over the season (Fig. 46), and was similar to farm #3. Mean chloride levels in farm #5 were 37.5 mg/l (Fig. 47), with a total net decrease over the sample year.

Turbidity fluctuated over the year, and generally decreased slightly as water passed through the farm (Fig. 48), but it was higher in the water supply early in the irrigation season. Suspended solids showed the same trend (Fig. 49) with a mean contribution of dry material at 1 mg/l.

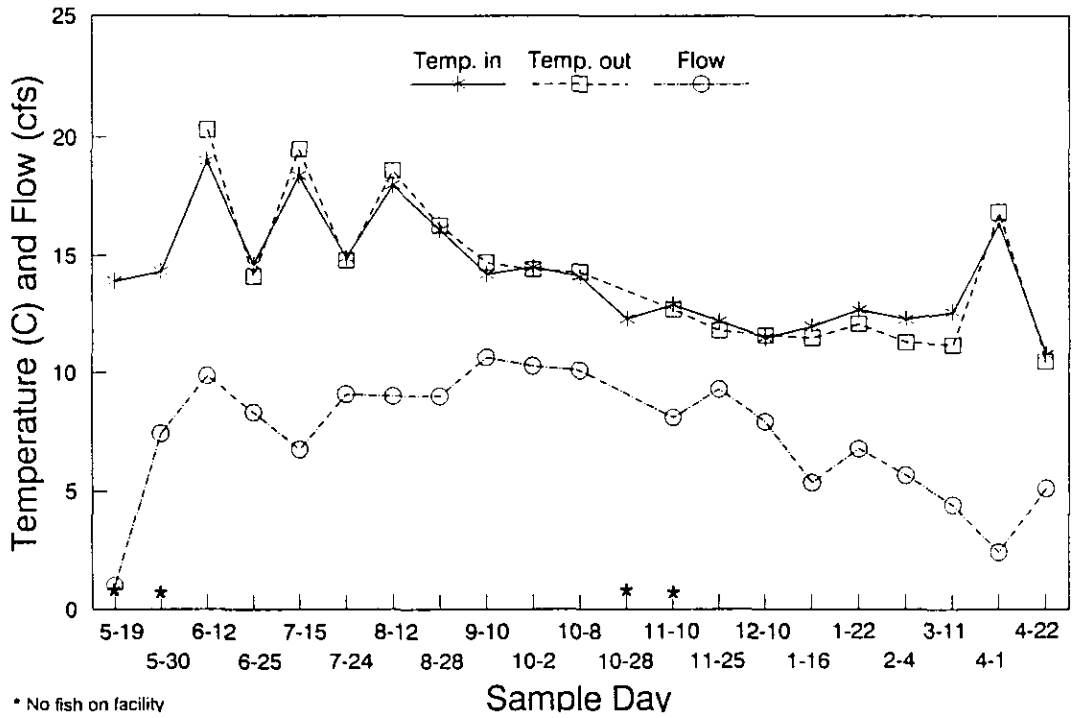


Figure 38. Sample temperatures and flows measured on Fish Farm #5.

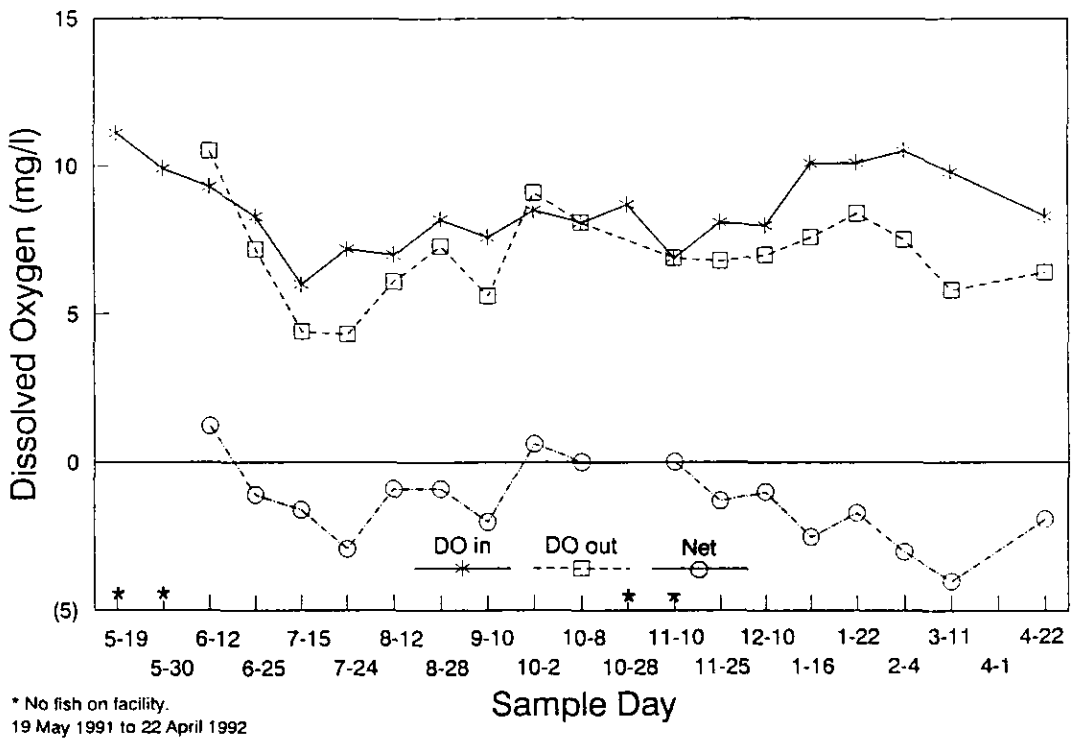


Figure 39. Dissolved oxygen concentrations measured on Fish Farm #5.

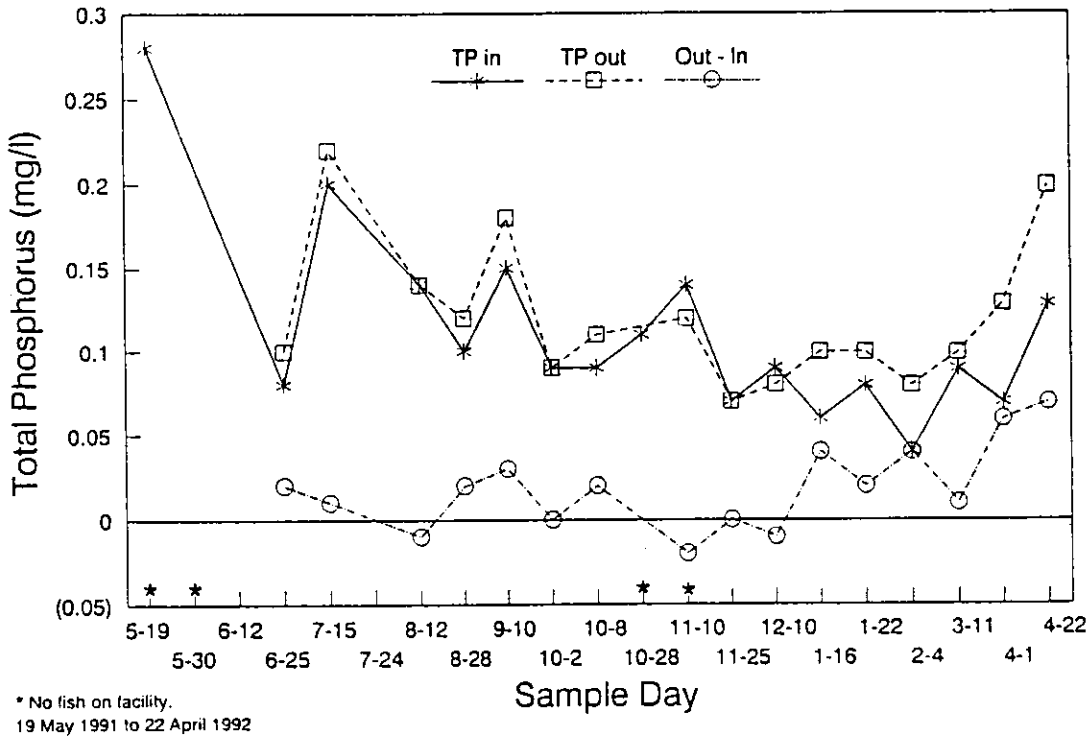


Figure 40. Total phosphorus concentrations measured on Fish Farm #5.

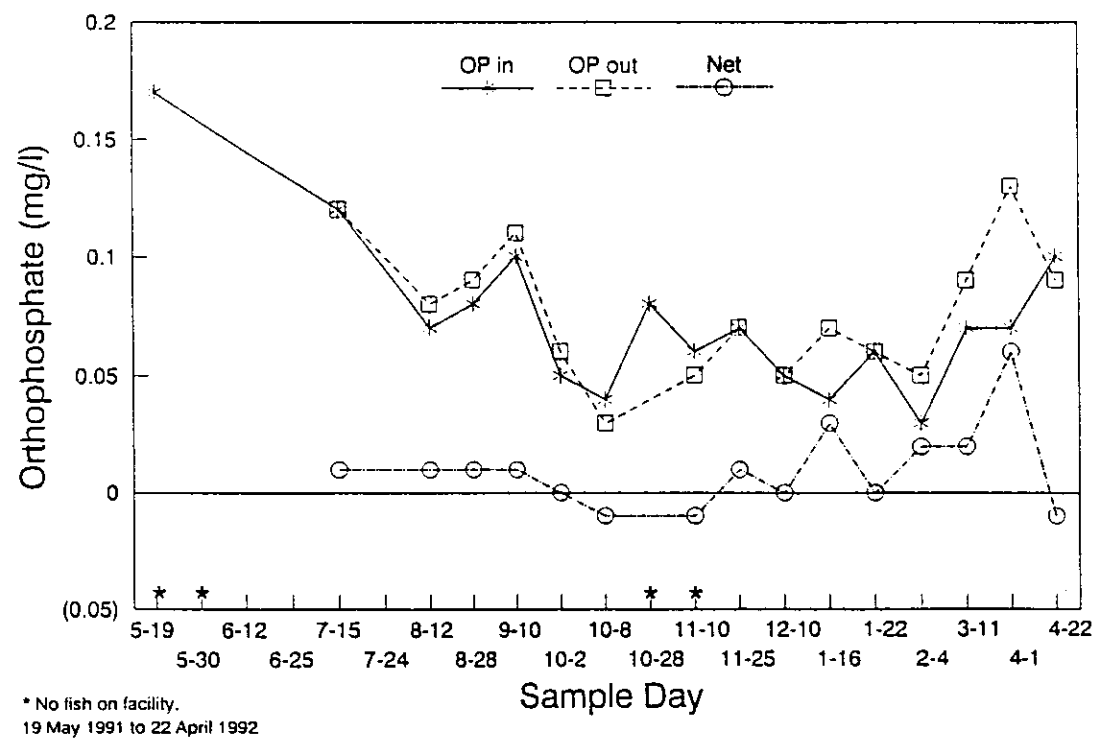


Figure 41. Orthophosphate concentrations measured on Fish Farm #5.

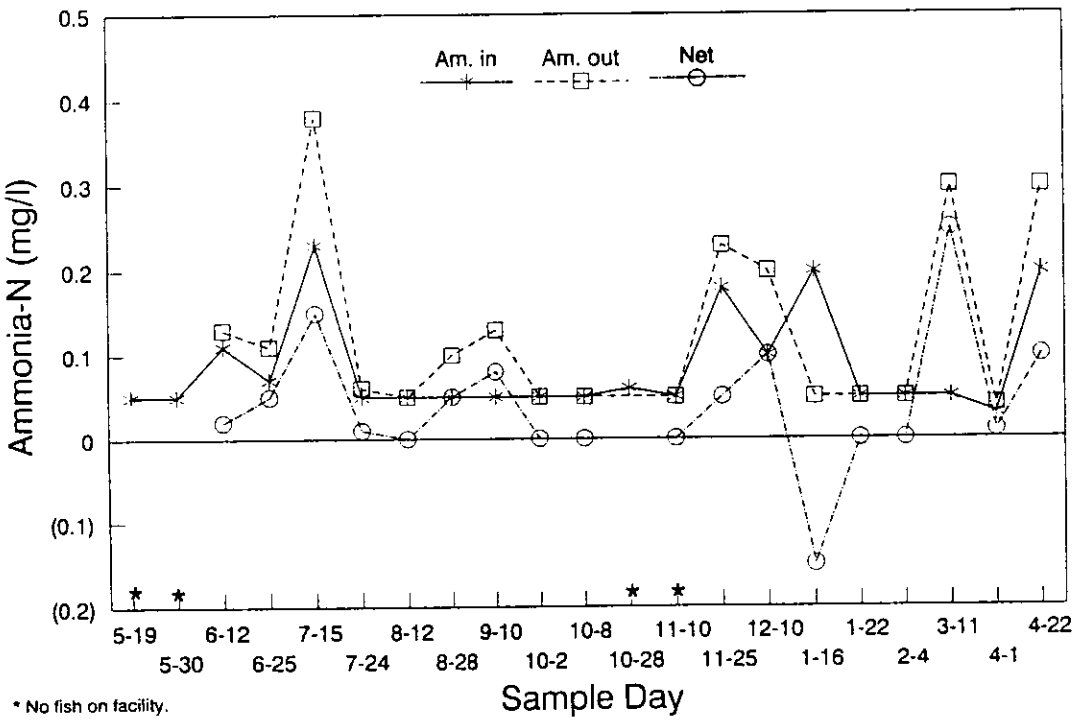


Figure 42. Ammonia-N concentrations measured on Fish Farm #5.

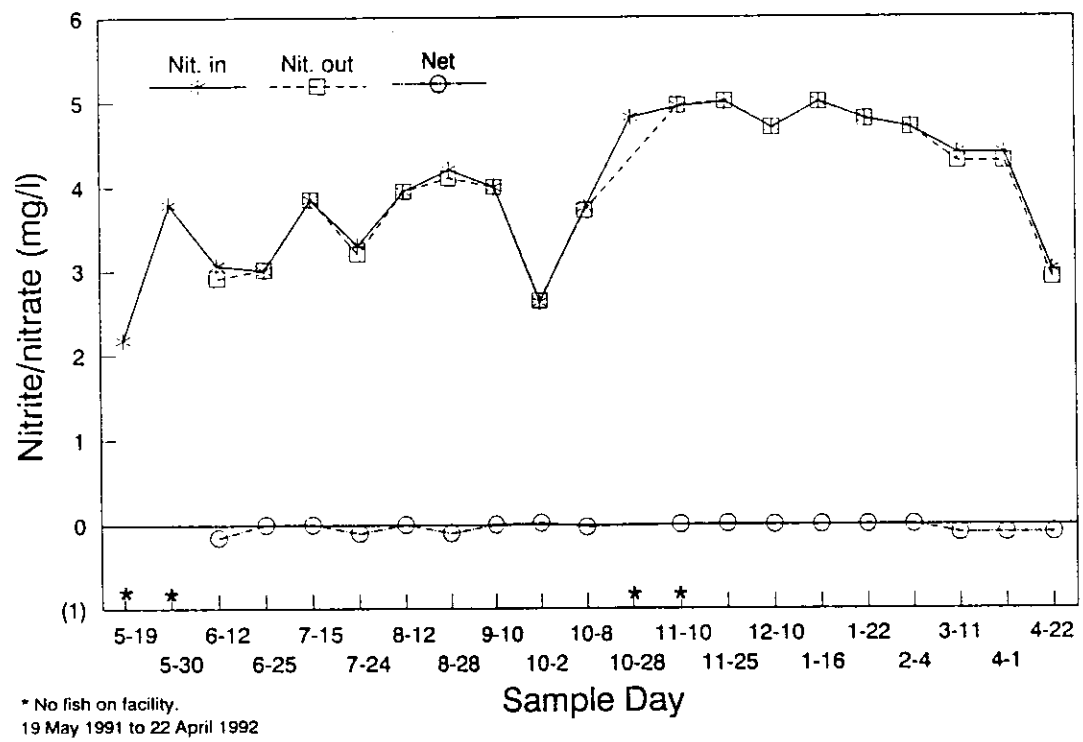


Figure 43. Nitrite/nitrate-N concentrations measured on Fish Farm #5.

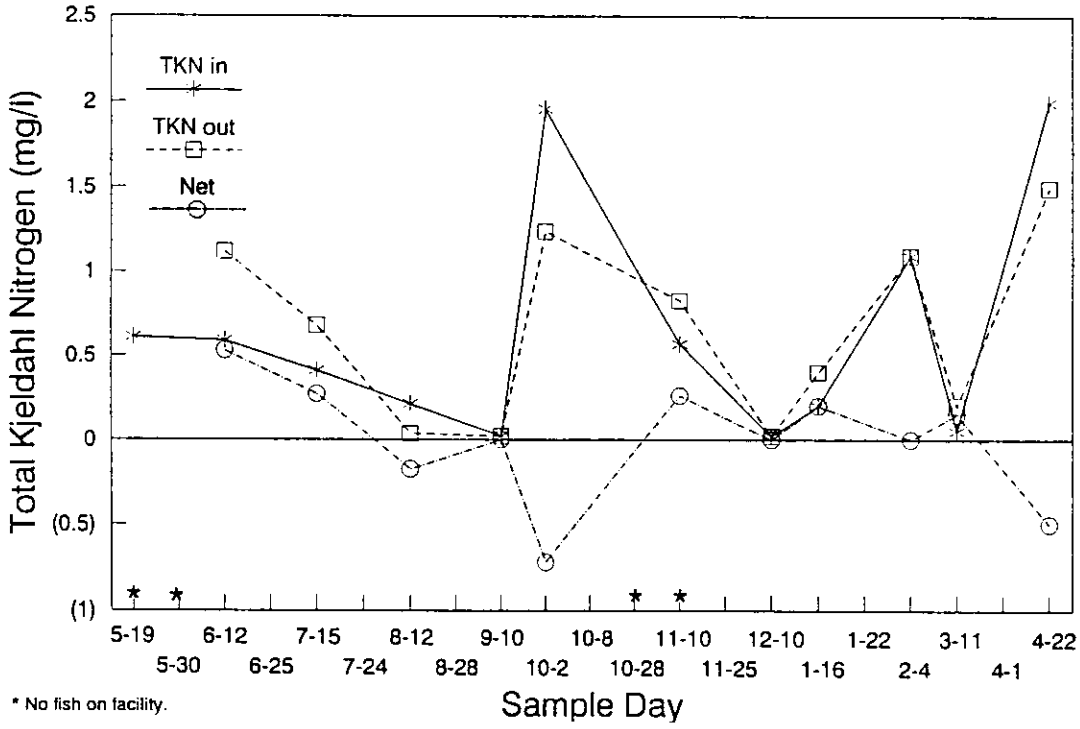


Figure 44. Total Kjeldahl nitrogen concentrations measured on Fish Farm #5.

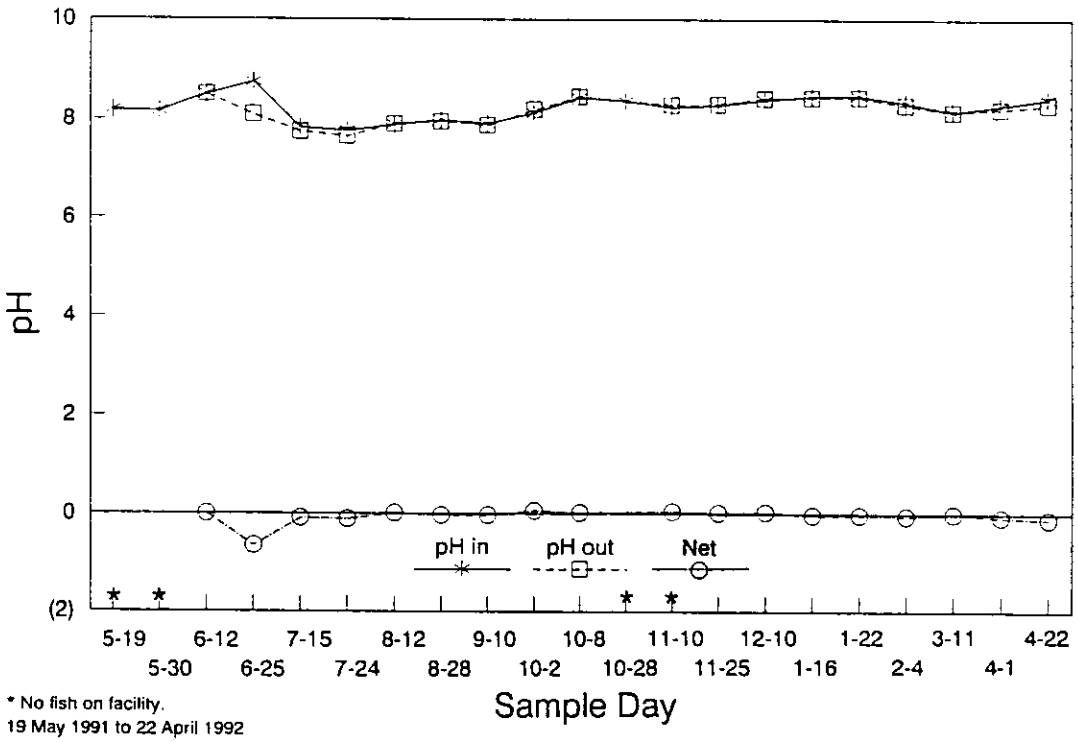


Figure 45. pH measured on Fish Farm #5.

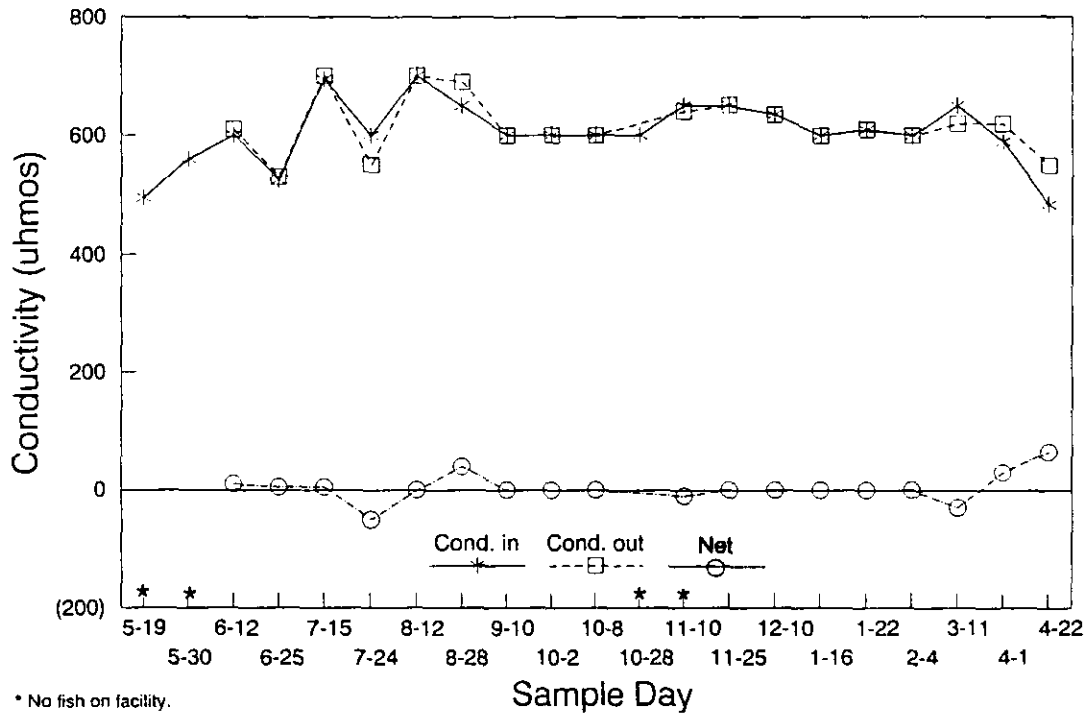


Figure 46. Specific conductance measured on Fish Farm #5.

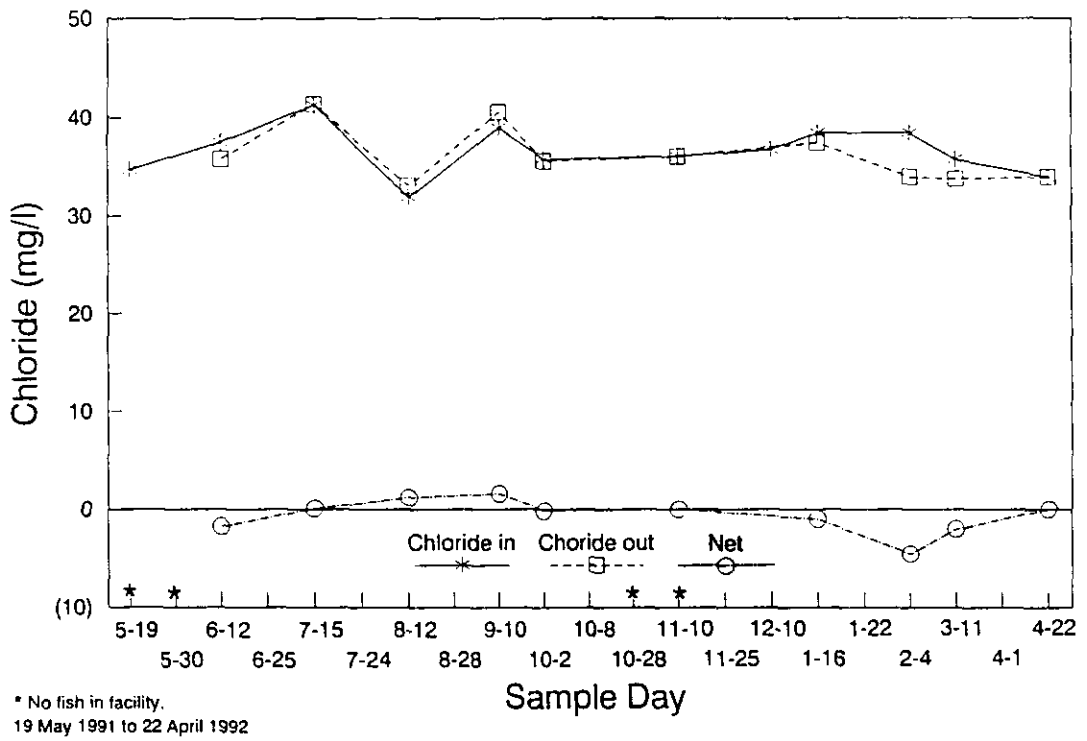


Figure 47. Chloride concentrations measured on Fish Farm #5.

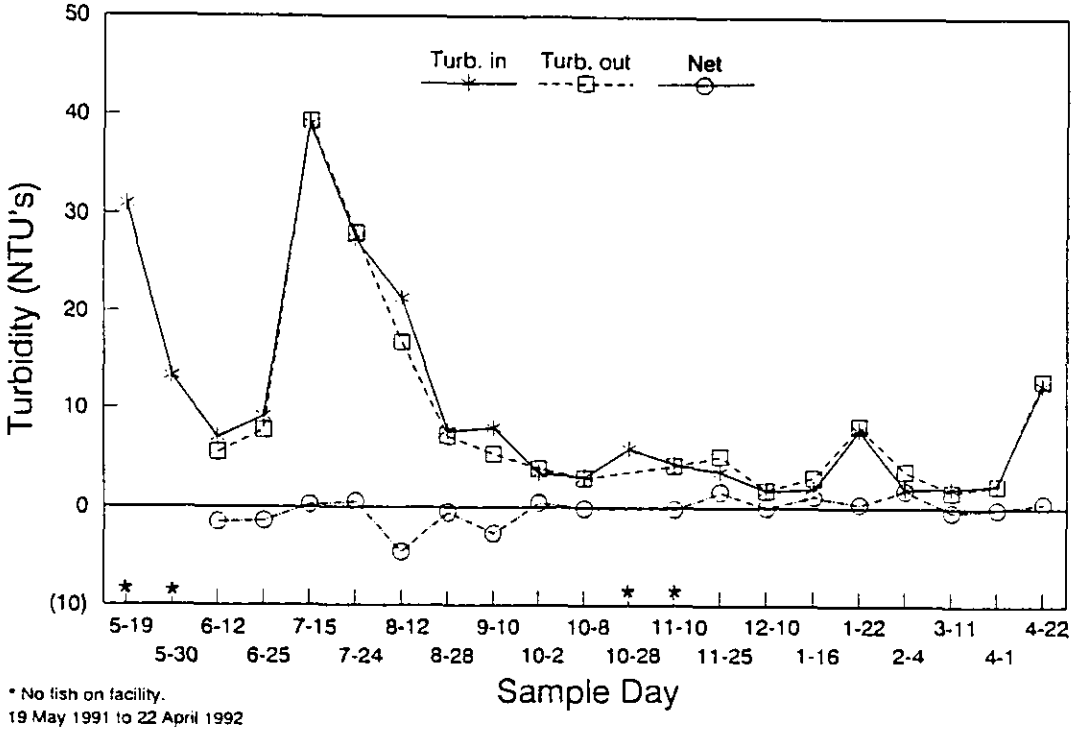


Figure 48. Turbidity measured on Fish Farm #5.

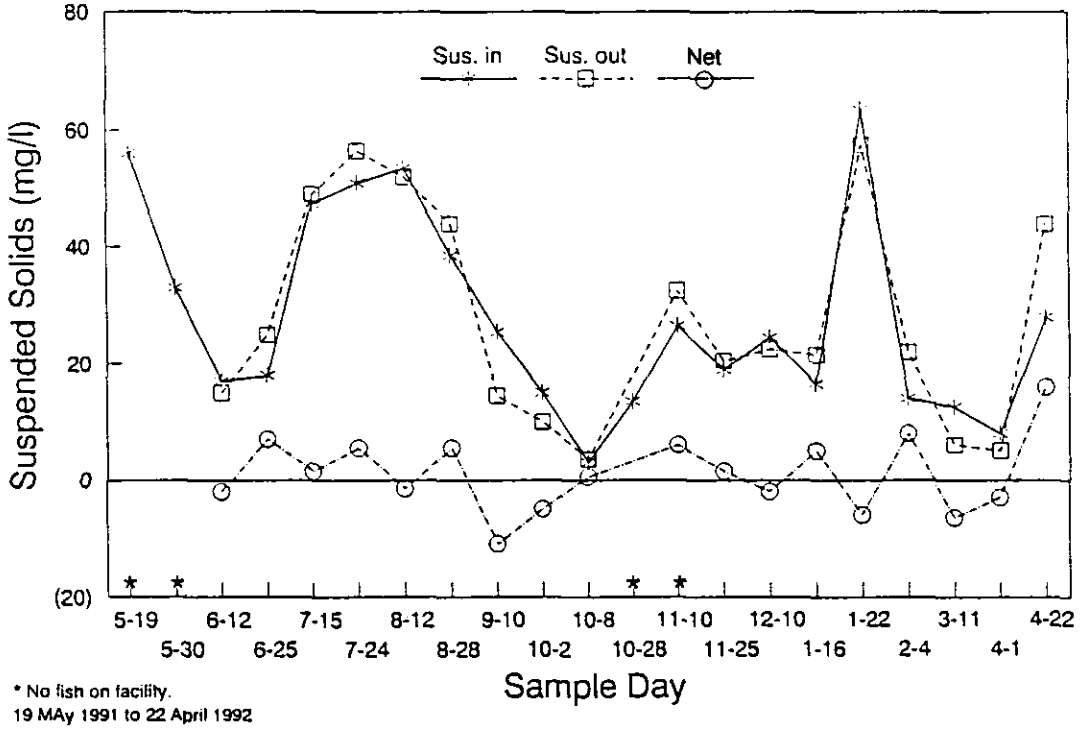


Figure 49. Total suspended solids concentrations measured on Fish Farm #5.

Farms on Creek Water:

Farm #4

Farm #4 lies on the west side of Deep Creek and takes water directly from the creek. The creek flows rise and fall with irrigation return flow, but weather conditions influence creek water temperatures more than the other farm water sources. This farm has six earthen ponds, arranged as two sets of three ponds in series. A total flow settling pond intercepts water from both sets of ponds. Overhead nets are installed to prevent predation by birds. Each set of ponds had a different grow-out schedule, with two crops grown out in one set and one crop grown out in the other.

Water temperatures and flows were quite variable depending upon the season and weather. Water temperatures ranged from 9.4 - 22.8°C while flows varied from 7.5 to 23.6 cfs, with the greatest flow during the irrigation season (Fig. 50). Irrigation appeared to greatly influence nutrient loads coming into the farm, especially the levels of solids and nitrite/nitrate.

Dissolved oxygen was quite stable and nearly at saturation in incoming water (Fig. 51). Differences between inflow and outflow were greater as the harvest period was approaching, but the concentration in the discharge never fell below 5.7 mg/l. Cool water at the harvest period still allowed sufficient oxygen present to maintain good growth, with discharge concentrations at about 7 mg/l.

Total phosphorus showed a mean net increase through farm #4 of 0.03 mg/l, and ranged from 0 to 0.08 mg/l over the period, even with an increase in biomass loading (Fig. 52). Orthophosphate level increased in concentration from 0 to 0.07 mg/l over the same period, with a mean of 0.03 mg/l (Fig. 53). Major differences in both phosphorus species were demonstrated in the water supply during the irrigation season, coinciding with the presence of increased suspended material. Presence of waterfowl was responsible for an abnormal increase in phosphorus species and suspended solids on the 16th of January.

Net ammonia concentrations were variable over the monitoring period (Fig. 54) and ranged from 0 to over 0.2 mg/l, except for the high point of 0.45 mg/l. The high point was not an anomaly because it appeared in two sample locations and may have been related to feeding or harvest events. Source water nitrite/nitrate levels demonstrated dramatic increases associated with the non-irrigation season (Fig. 55), but a slight net decrease as water passed through the farm. Kjeldahl nitrogen showed high variability (Fig. 56) and wasn't related to other patterns in the system.

The pH in the water supply was stable around 8.5 and decreased slightly as water passed through the farm (Fig. 57). Conductivity (Fig. 58) and chloride (Fig. 59) levels showed decreases related to the irrigation season, and reflected higher levels during the low flow periods.

Turbidity was much higher during the irrigation season, and demonstrated minimal increase from rearing activities as water passed through the farm (Fig. 60). Suspended solids also demonstrated the higher levels during the irrigation season (Fig. 61), with samples having a mean net reduction of -3.0 mg/l as water passed through the ponds during rearing, and a net decrease of -11.8 mg/l during irrigation.

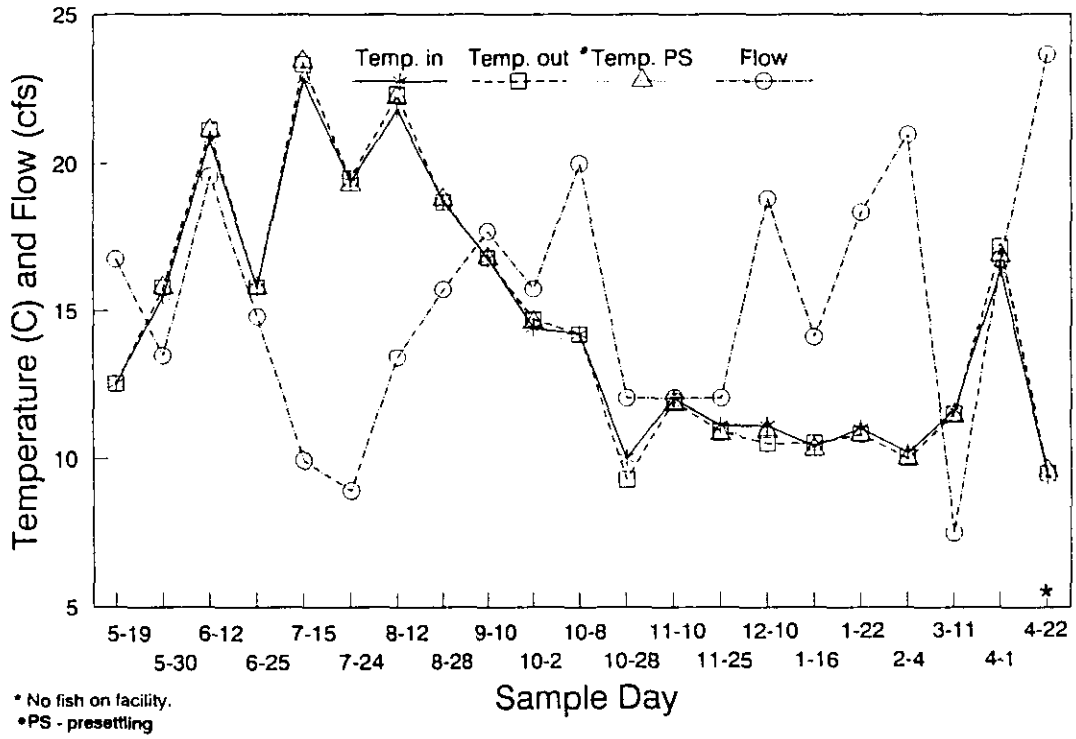


Figure 50. Sample temperatures and flows measured on Fish Farm #4.

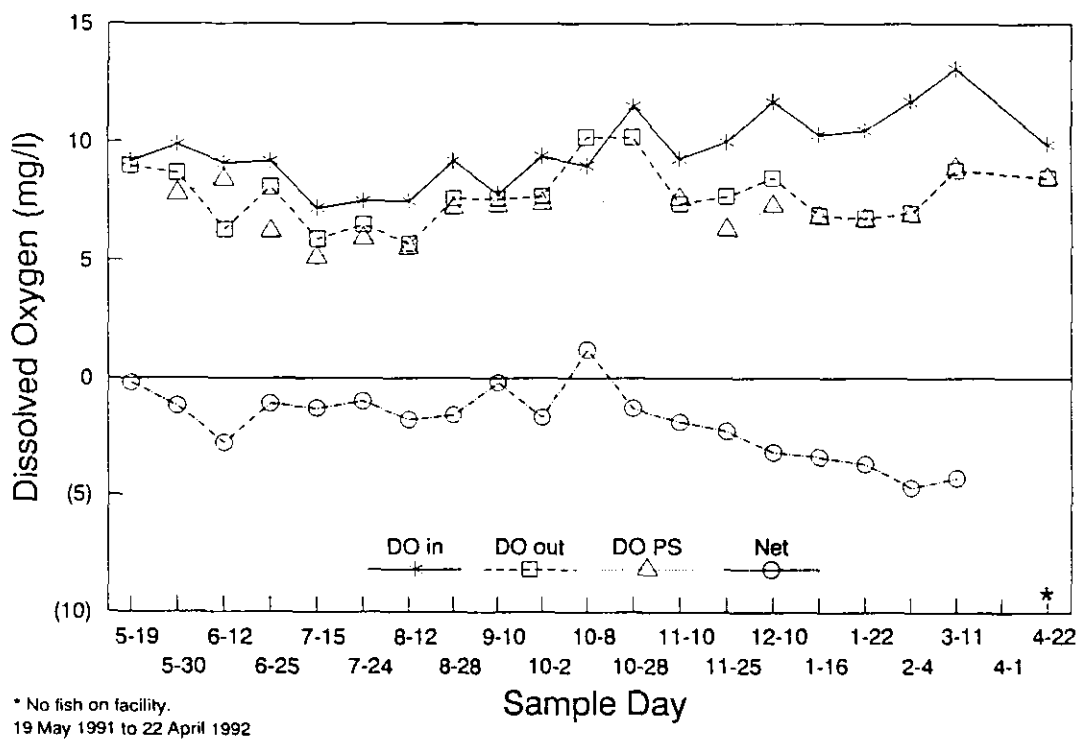


Figure 51. Dissolved oxygen concentrations measured on Fish Farm #4.

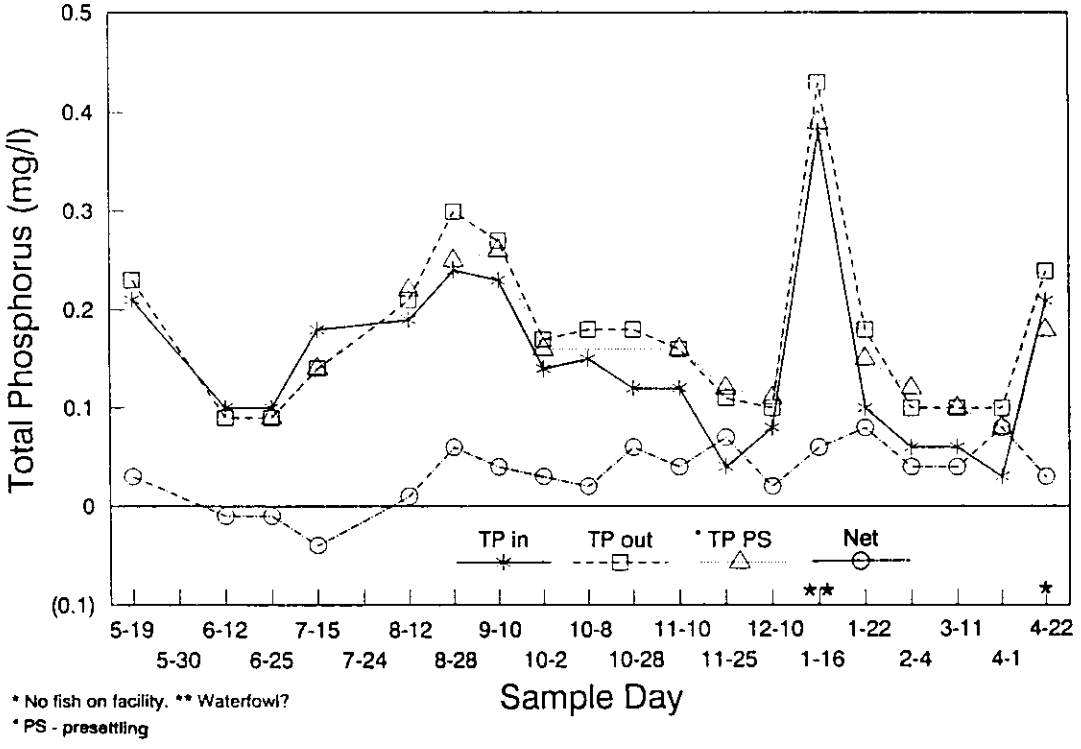


Figure 52. Total phosphorus concentrations measured on Fish Farm #4.

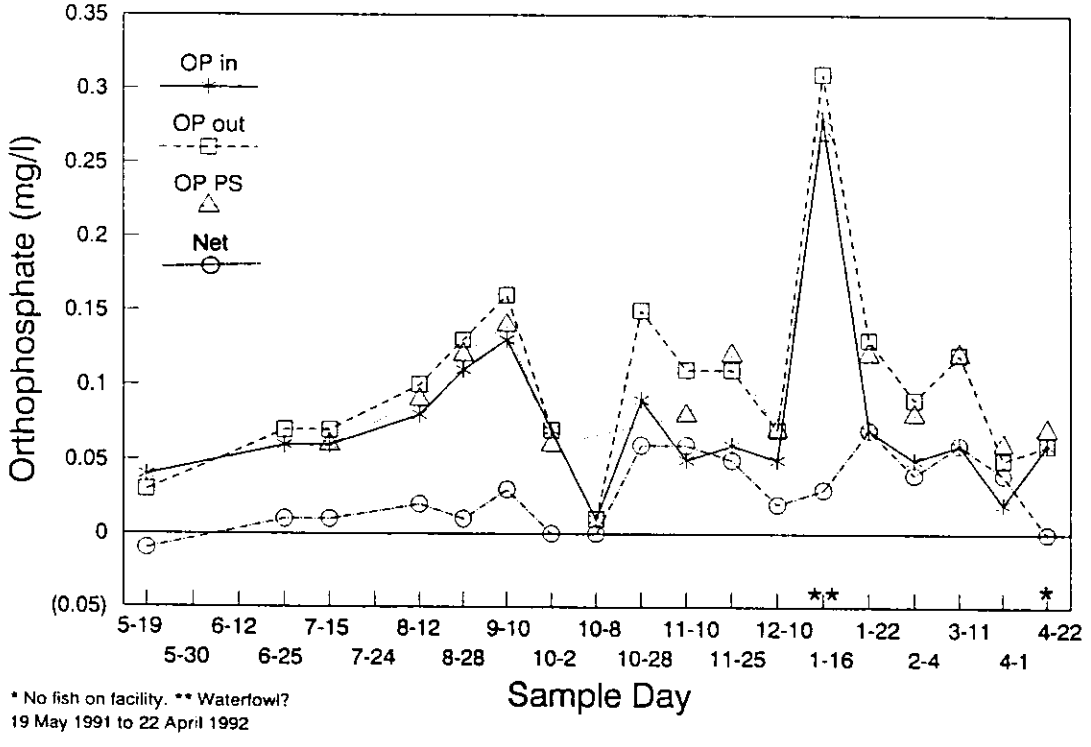


Figure 53. Orthophosphate concentrations measured on Fish Farm #4.

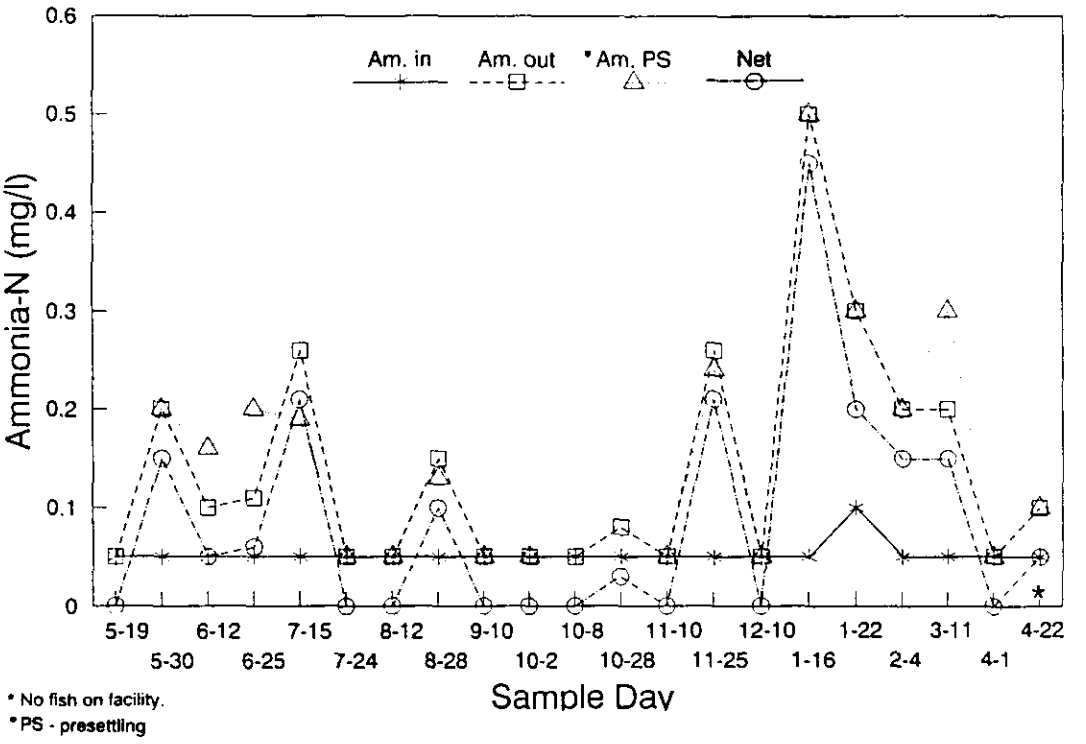


Figure 54. Ammonia-N concentrations measured on Fish Farm #4.

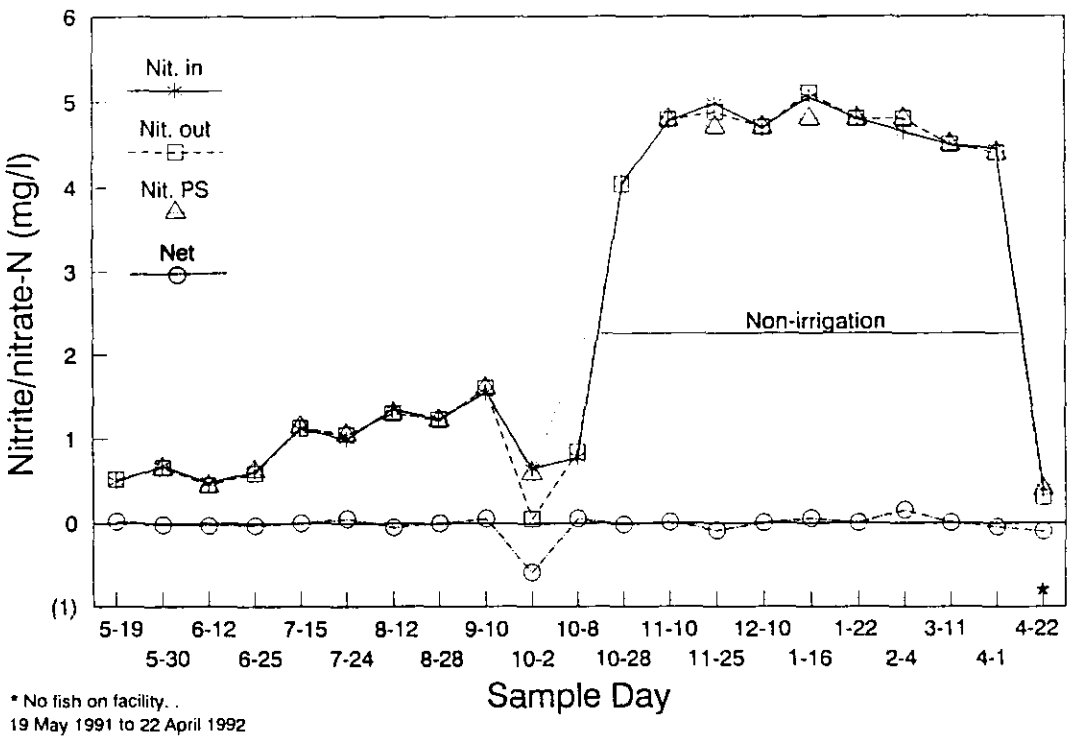


Figure 55. Nitrite/nitrate-N concentrations measured on Fish Farm #4.

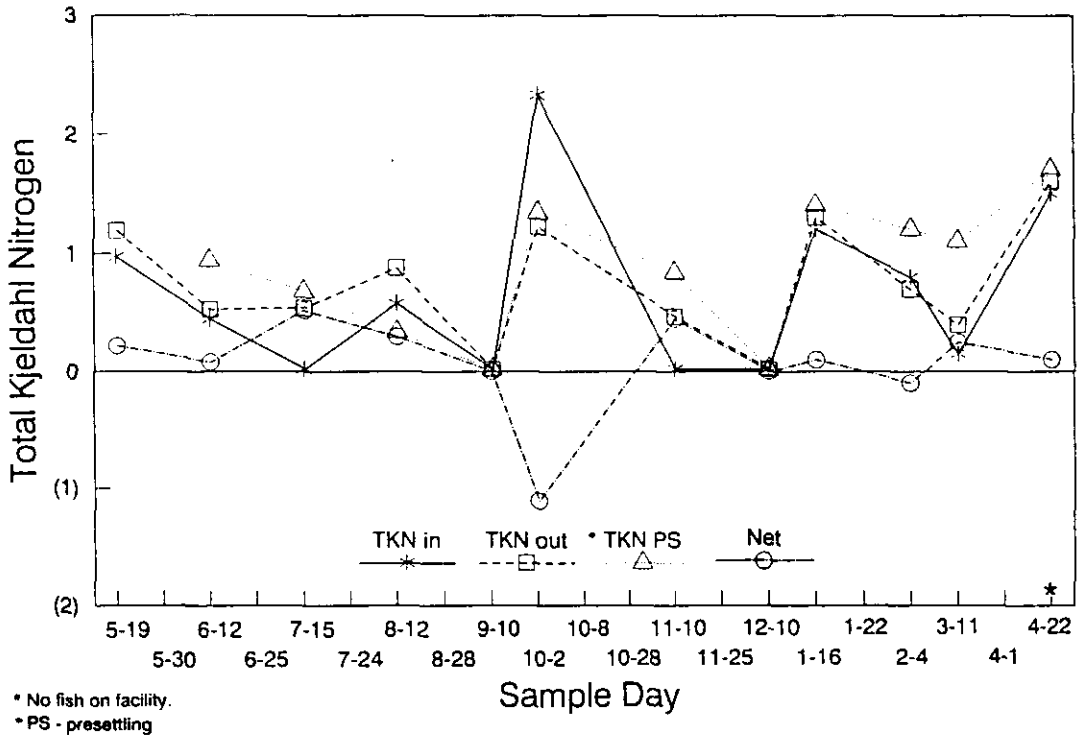


Figure 56. Total Kjeldahl nitrogen concentrations measured on Fish Farm #4.

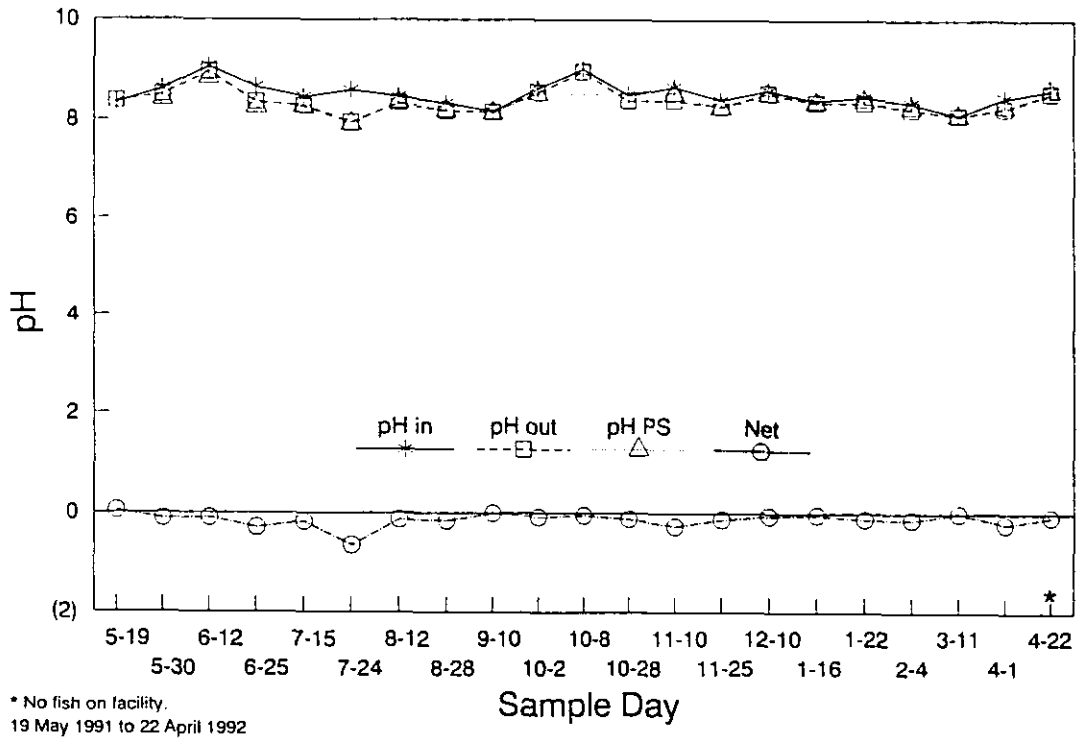
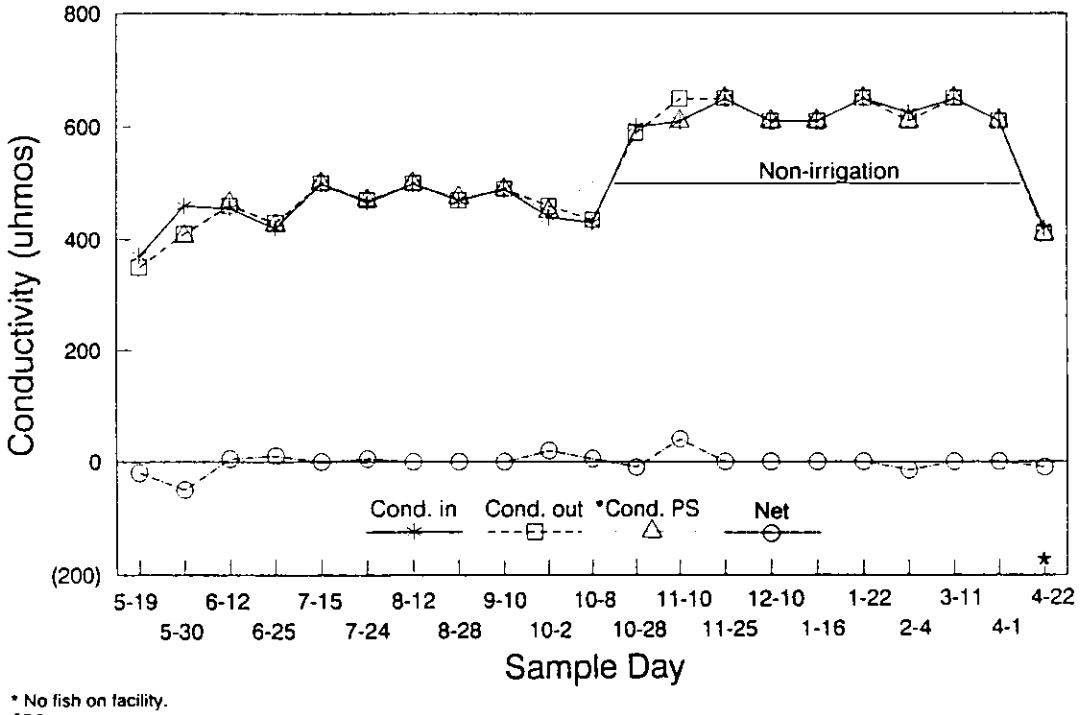
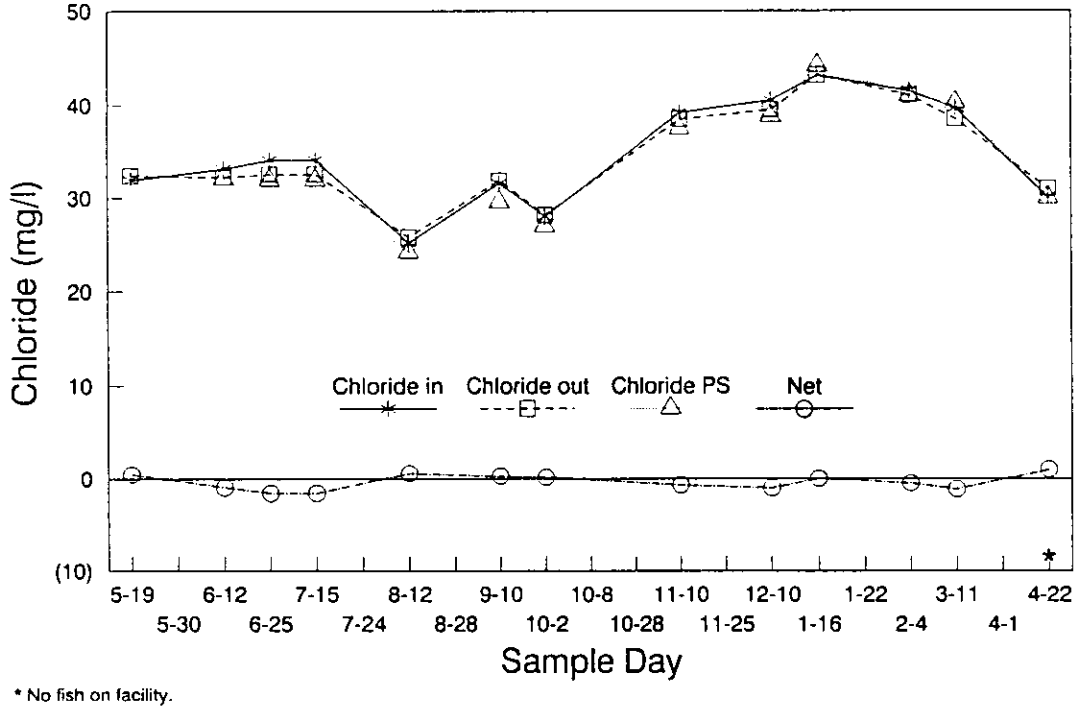


Figure 57. pH measured on Fish Farm #4.



* No fish on facility.
*PS - presettling

Figure 58. Specific conductance measured on Fish Farm #4.



* No fish on facility.
19 May 1991 to 22 April 1992

Figure 59. Chloride concentrations measured on Fish Farm #4.

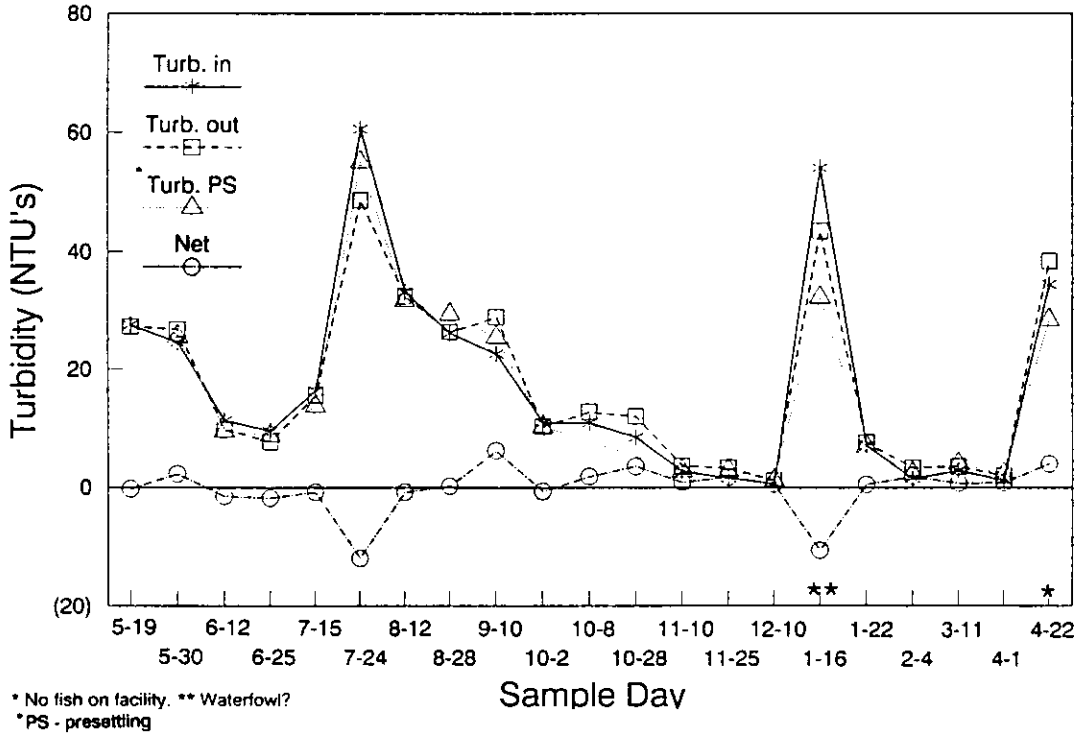


Figure 60. Turbidity measured on Fish Farm #4.

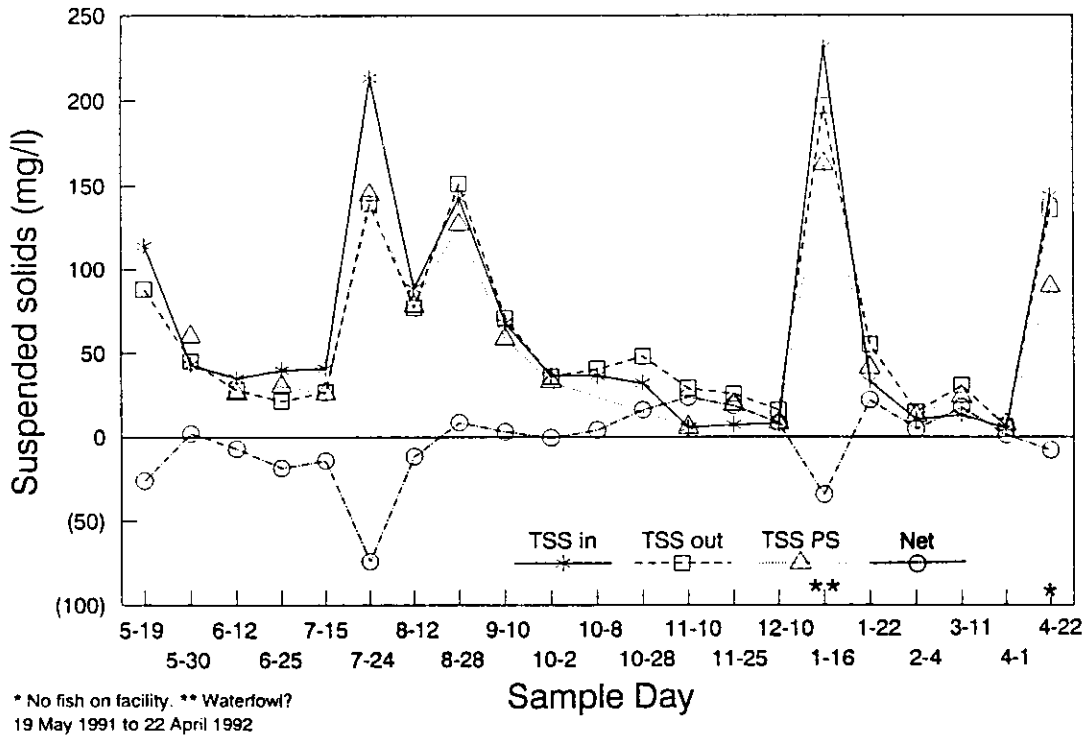


Figure 61. Total suspended solids concentrations measured on Fish Farm #4.

Farm #6

Farm #6 is the lowermost farm on the creek, and uses only creek water as its source of supply. The farm has two sets of three broad concrete raceways in series that empty into a large earth settling pond. The farm is below another fish farm (0.25 miles), and the intake channel is adjacent to cattle pasture along Deep Creek. Netting has been installed over the raceways to reduce predation by birds. Harvest conditions were the same as in farm #4, with each series of raceways on a different harvest schedule.

Temperatures ranged from 8.1 to 23.8°C and flows dropped from a high of 32 to 15 cfs over the course of the season (Fig. 62). Temperatures and flows correlated with ambient weather conditions and irrigation.

Dissolved oxygen was quite stable (Fig. 63) around saturation, with a difference no greater than 1.5 mg/l between the inlet and outlet of the farm. Levels were always sufficient to provide uninhibited growth, and remained high in the effluent entering the stream.

Total phosphorus showed a fairly level net contribution of around 0.05 mg/l and didn't increase markedly with biomass increases (Fig. 64). Orthophosphate level also was fairly constant, remaining <0.01 mg/l most of the time, but jumping up to 0.05 mg/l on one occasion (Fig. 65). Variability was high in background levels, and associated with flow and activities in the creek.

Ammonia showed a similar pattern as in farm #4, with high variability and higher levels around 0.25 mg/l during the non-irrigation season (Fig. 66). The outflow ranged from 0 to over 0.25 mg/l. Nitrite/nitrate-N levels were low coming into the farm during irrigation (mean 1.26 mg/l) and high during non-irrigation (mean 4.67 mg/l) (Fig. 67), with no net contribution from the farm (-0.02 mg/l). Total Kjeldahl nitrogen was highly variable (Fig. 68) and appeared to be unrelated to rearing events.

The pH (8.5) varied little over the year (Fig. 69). Conductivity (Fig. 70) and chloride (Fig. 71) levels mirrored changes related to the irrigation season,

and reflected higher levels during low flow periods, with little change related to rearing activities.

Turbidity again was much higher during the irrigation season, and demonstrated no increase from rearing activities as water passed through the farm (Fig. 72). Suspended solids also demonstrated the higher levels during the irrigation season (Fig. 73), with samples showing a mean net increase of 0.28 mg/l as water passed through the ponds during rearing.

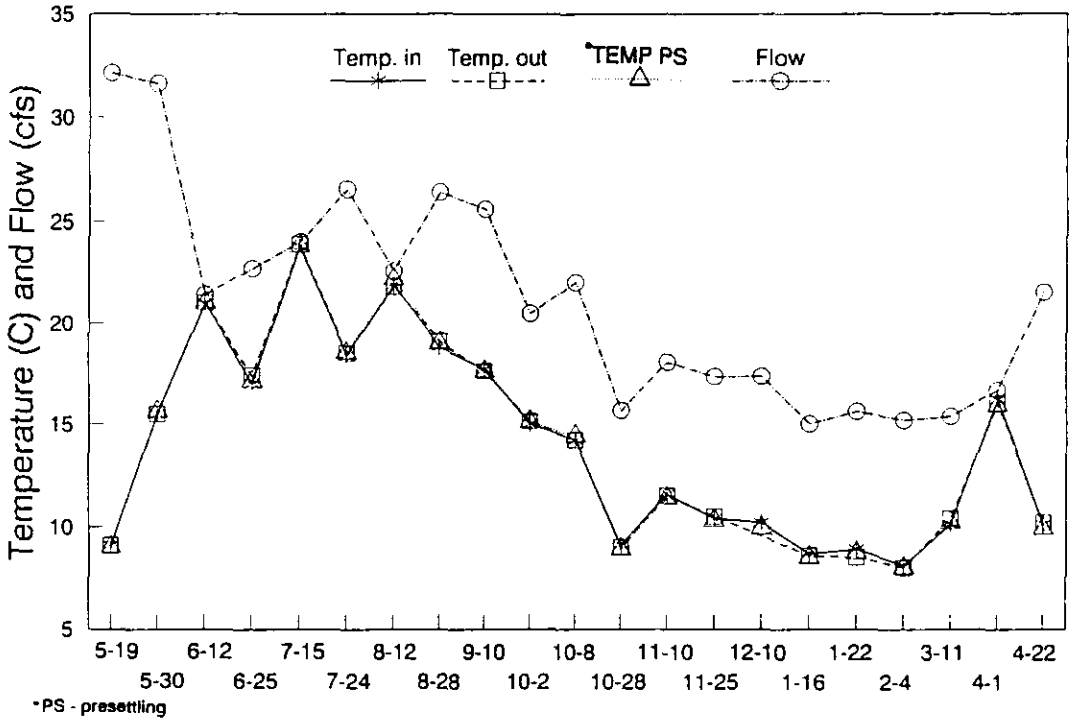


Figure 62. Sample temperatures and flows measured on Fish Farm #6.

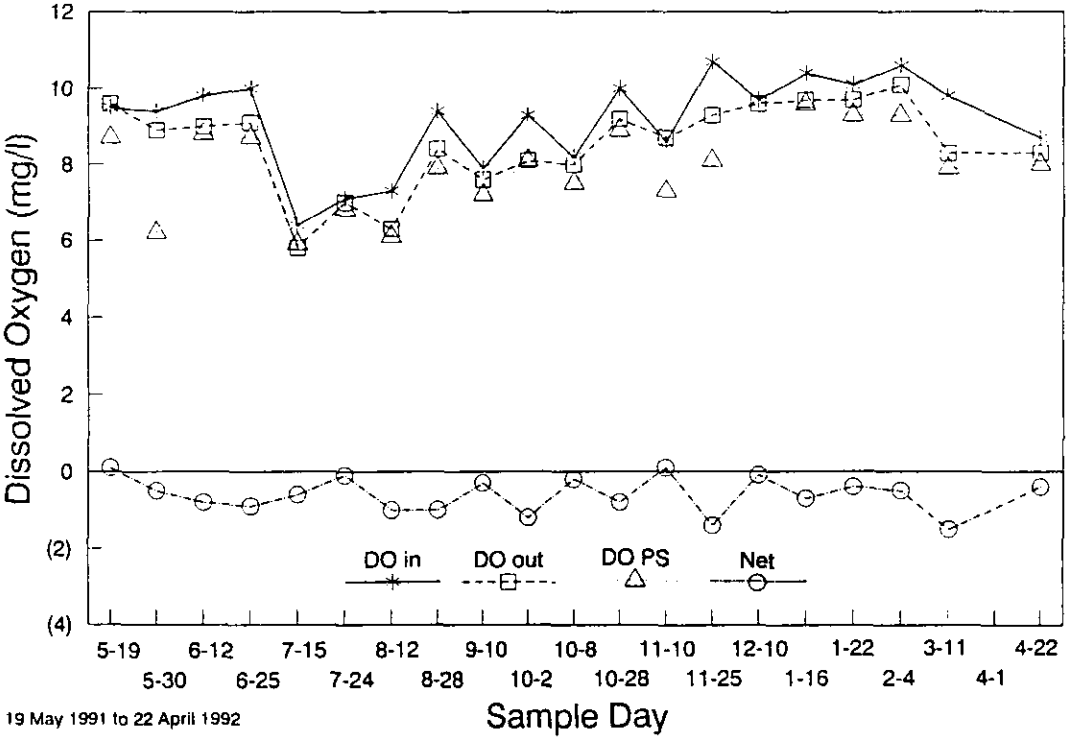


Figure 63. Dissolved oxygen concentrations measured on Fish Farm #6.

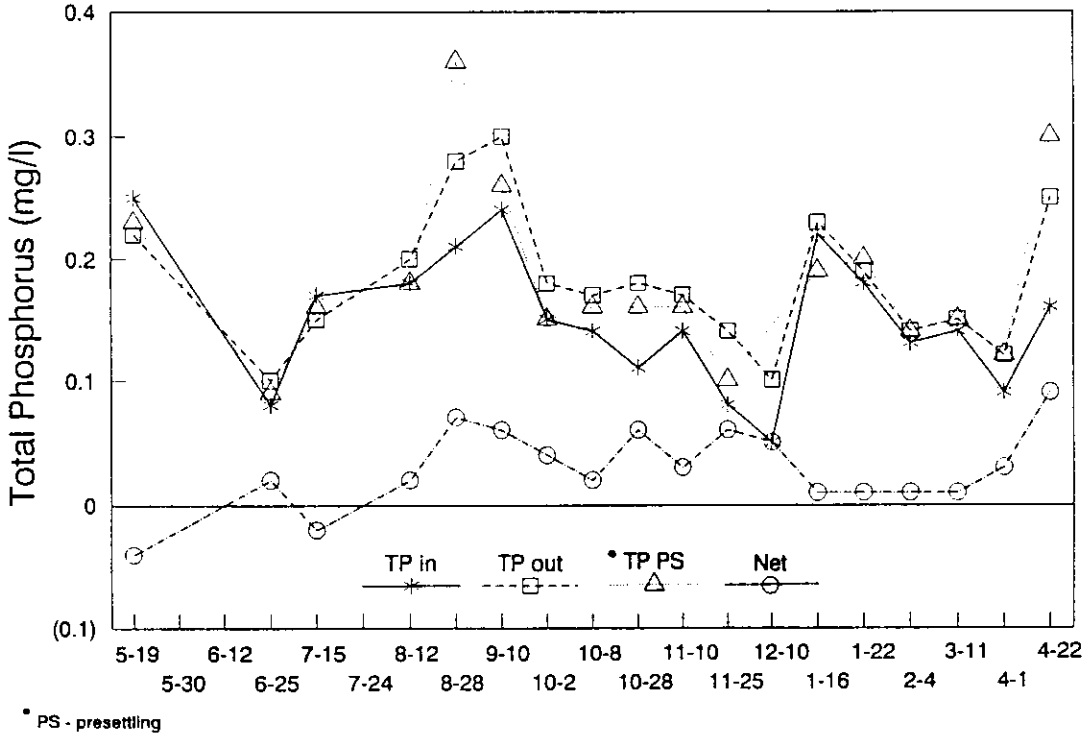


Figure 64. Total phosphorus concentrations measured on Fish Farm #6.

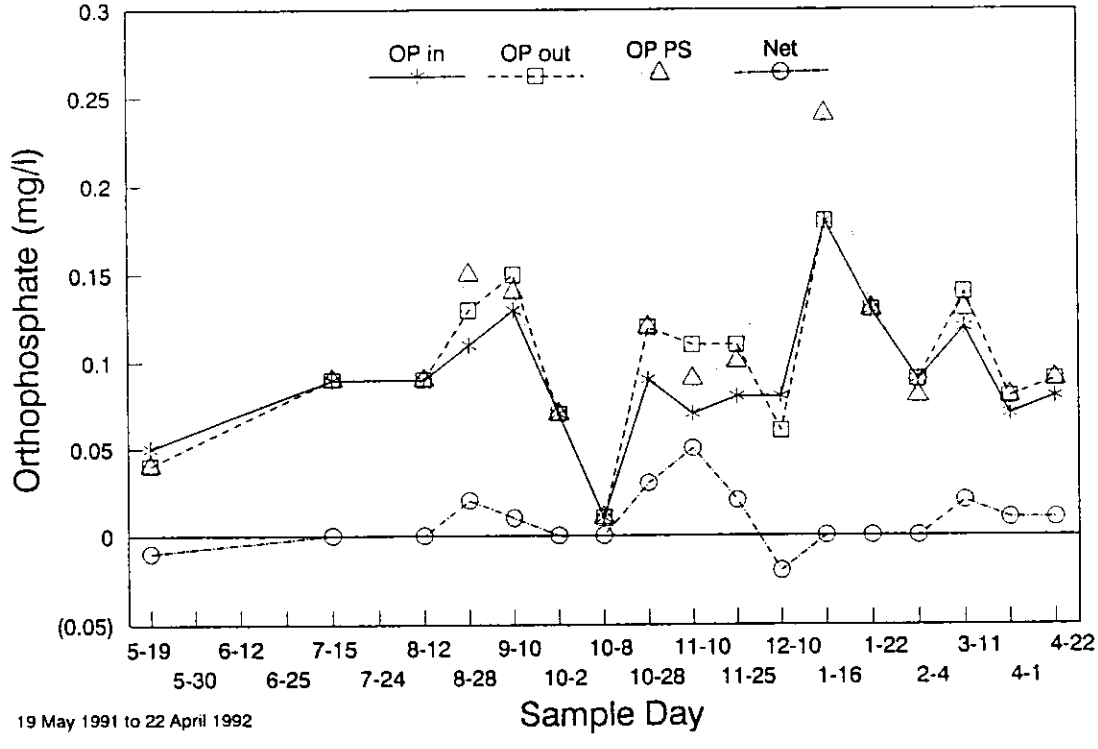


Figure 65. Orthophosphate concentrations measured on Fish Farm #6.

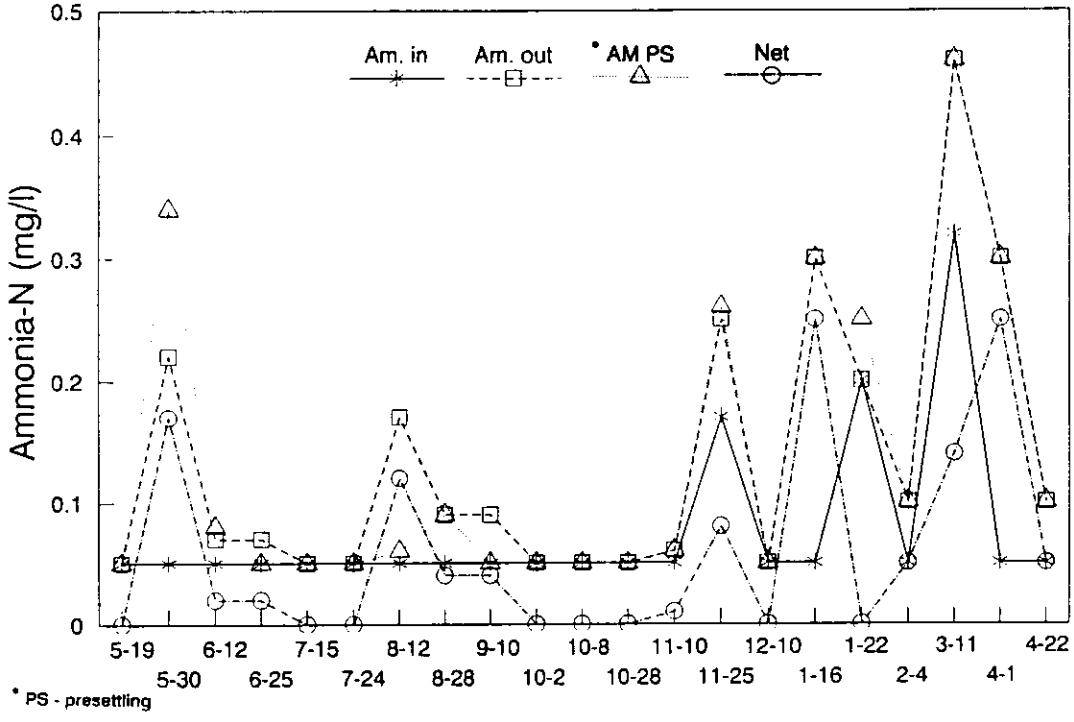


Figure 66. Ammonia-N concentrations measured on Fish Farm #6.

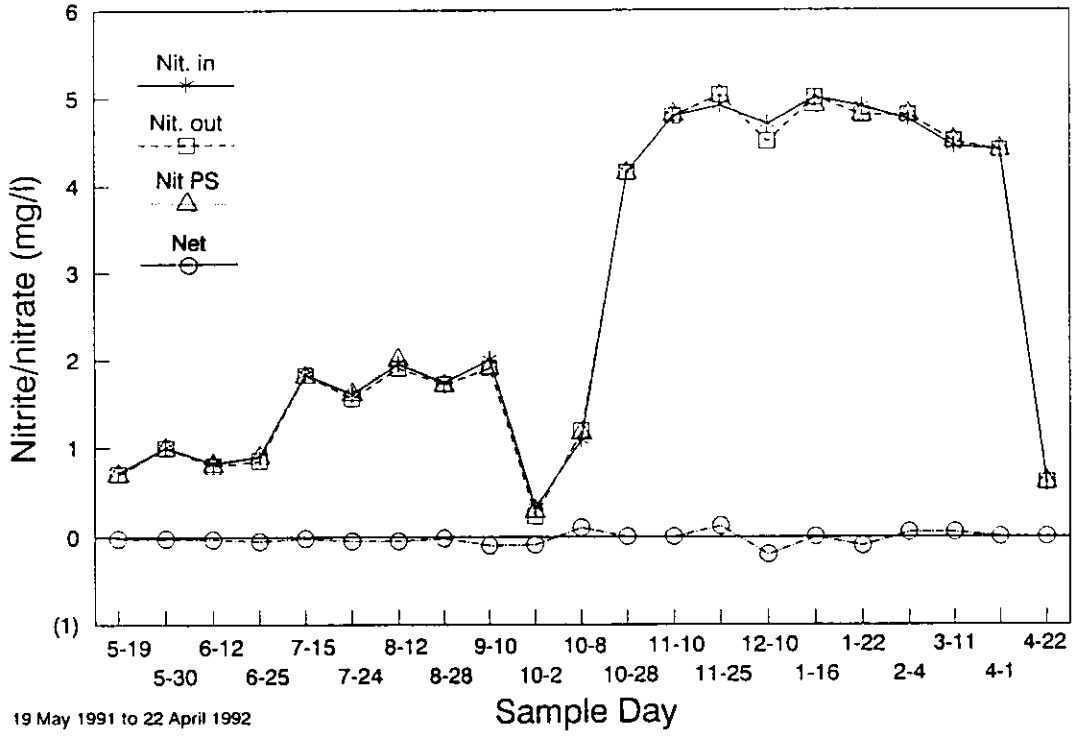


Figure 67. Nitrite/nitrate-N concentrations measured on Fish Farm #6.

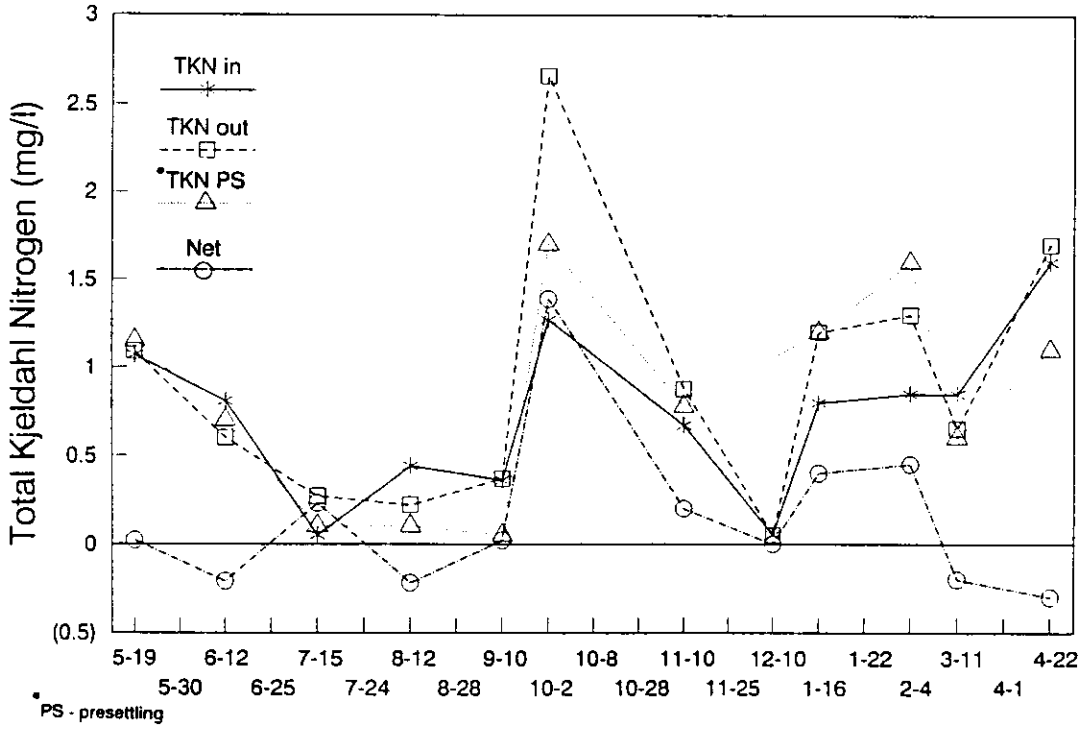


Figure 68. Total Keldahl nitrogen concentrations measured on Fish Farm #6.

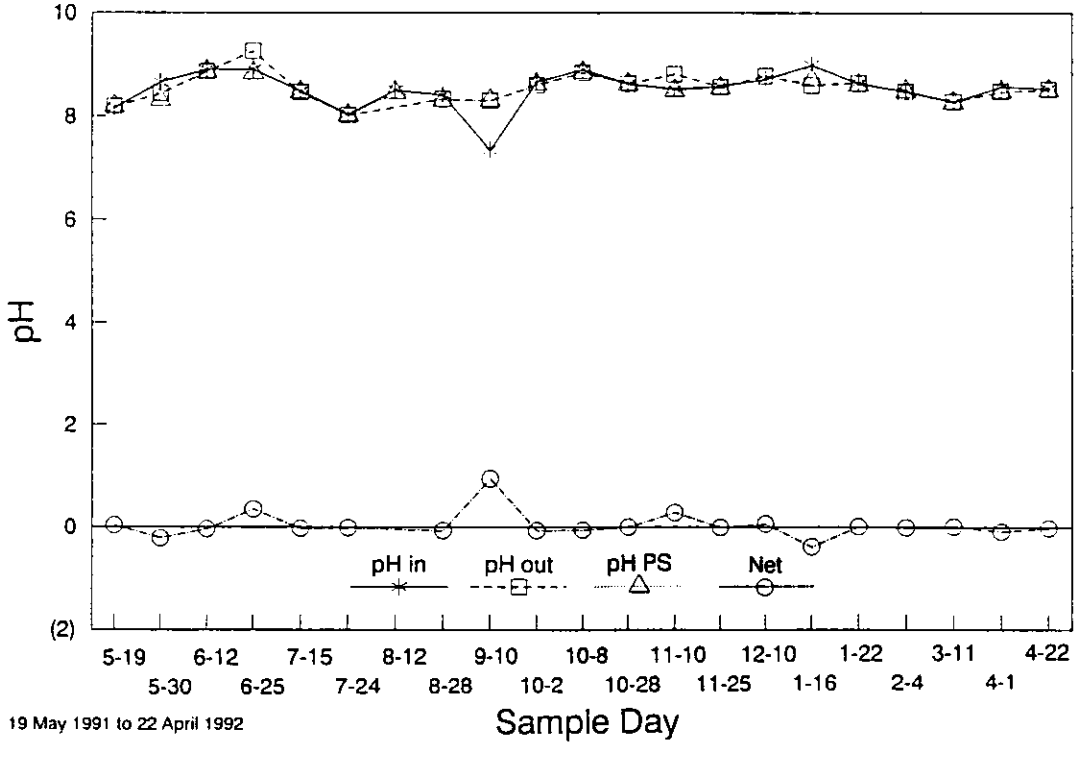


Figure 69. pH measured on Fish Farm #6.

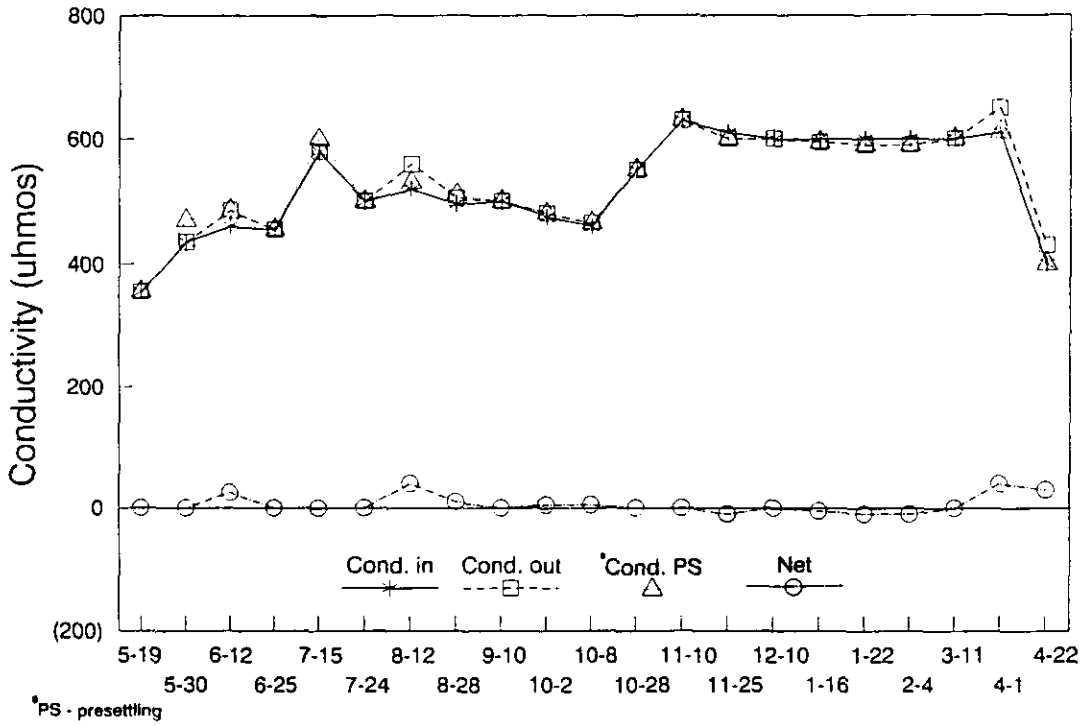


Figure 70. Specific conductance measured on Fish Farm #6.

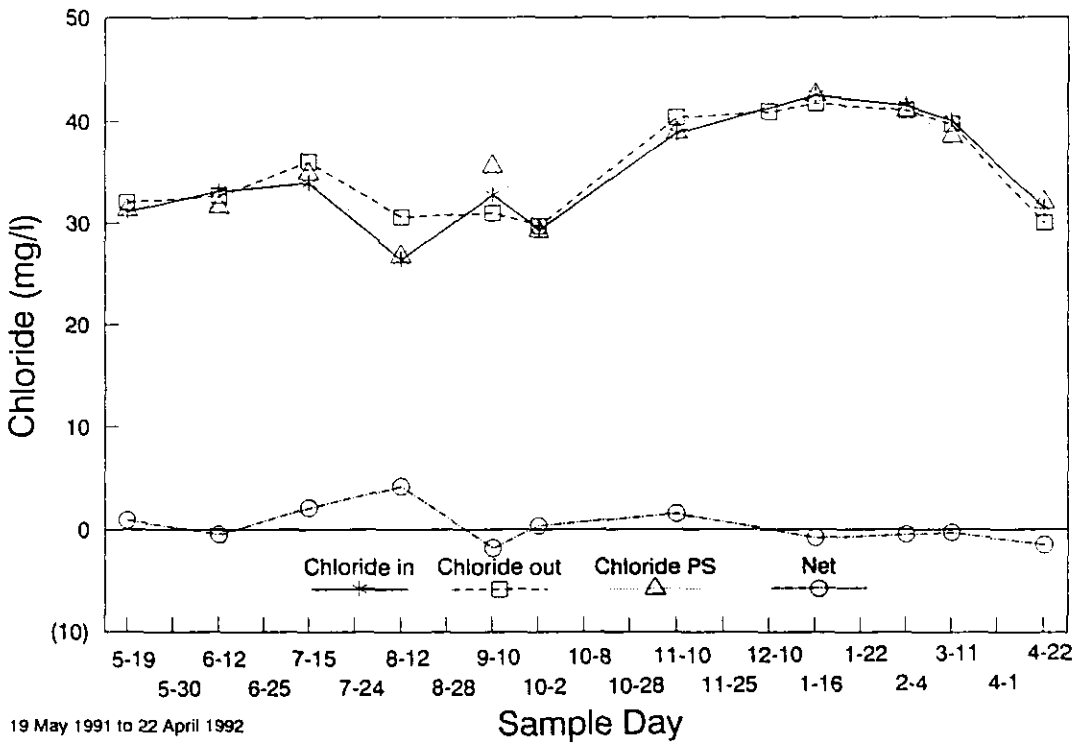


Figure 71. Chloride concentrations measured on Fish Farm #6.

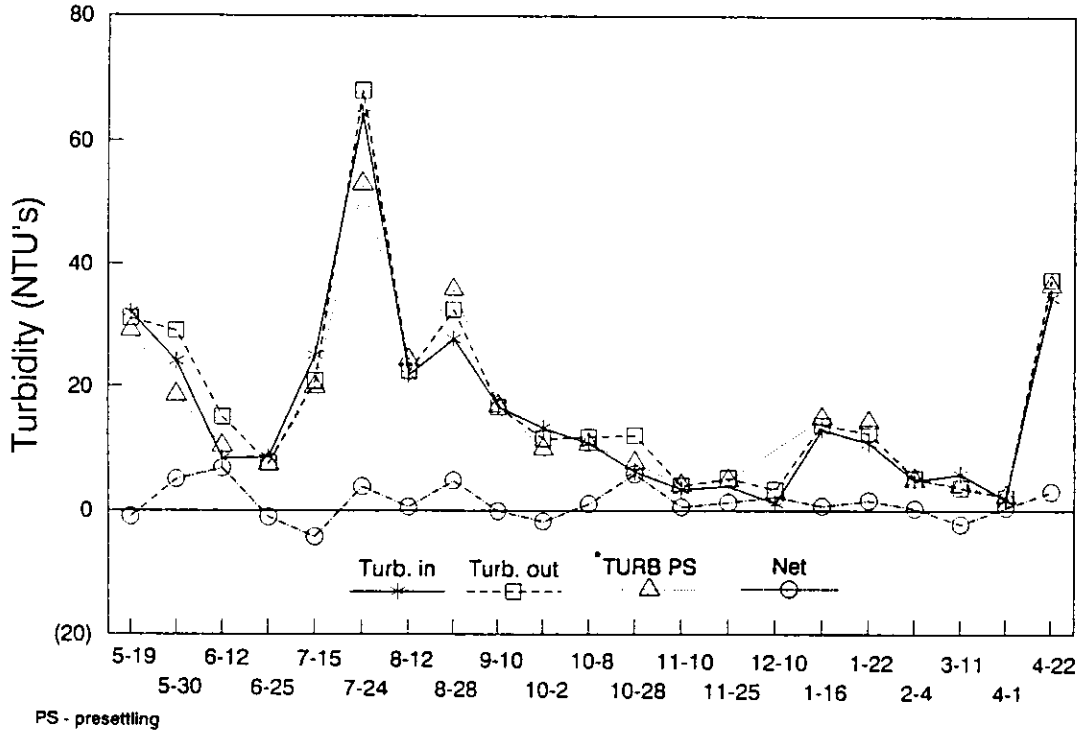


Figure 72. Turbidity measured on Fish Farm #6.

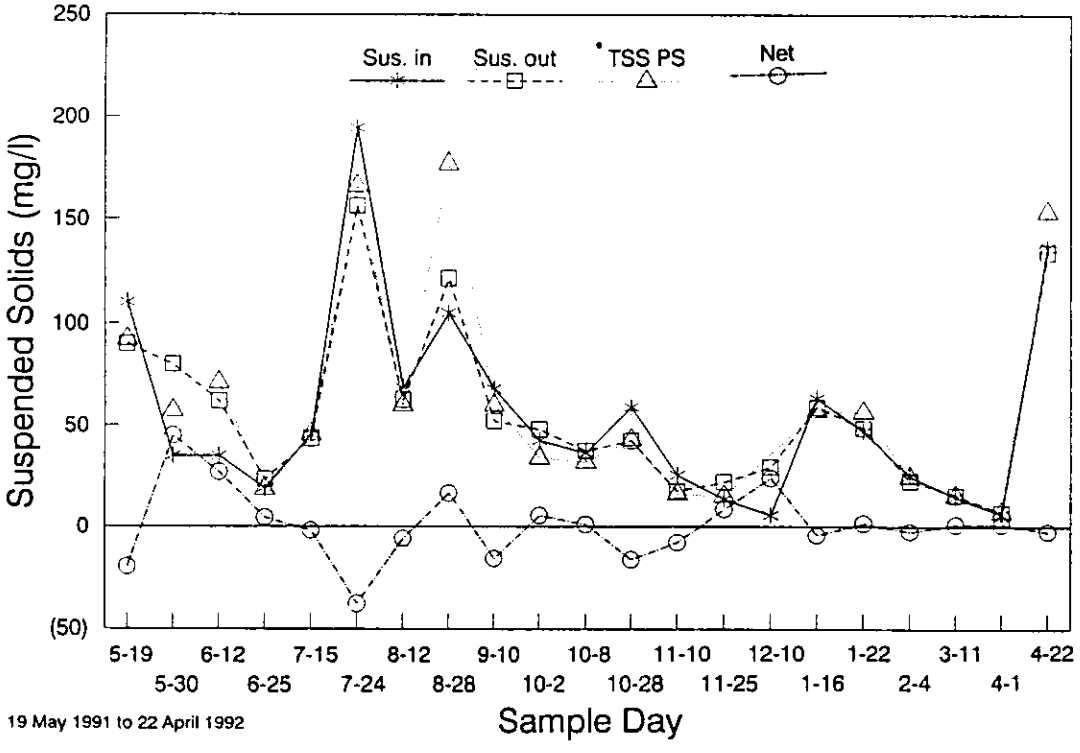


Figure 73. Total suspended solids concentrations measured on Fish Farm #6.

24 Hour Testing

Assessment of variability in test parameters was undertaken on four occasions at one of four farms (#1, 2, 3, & 6). Temperature, oxygen, pH, orthophosphate, suspended solids, settleable solids, ammonia, and nitrite/nitrate were examined at 2 to 4-hour intervals over the 24-hour period.

Temperature variation was related to time of year and source of water. Where a long exposure time occurred before the water entered the farm, temperature fluctuations were greater than in those situations where exposure time was minimal. Once the water was on the farm, changes were usually less than 1°C, except in the heat of the summer day when differences were as much as 2°C (Fig. 74).

Oxygen levels showed a consistent stable pattern throughout each of the 24-hour periods. Differences between inlet and presettling determinations were seldom more than 2 mg/l and were related to changes in saturation and temperature (Fig. 75).

The change in pH across the rearing area was minimal over the 24-hour period at all farms (Fig. 76). Ammonia showed a consistent difference between inlet and presettling samples from 0.1 to 0.3 mg/l, and was lower during the early morning. The level in the pond was fairly constant over the 24-hour period (Fig. 77), with differences between sample periods influenced by time of year. Nitrite/nitrate showed a stable pattern over the 24-hour period (Fig. 78), with differences between inlet and presettling samples very low.

Settleable solids, measured only at farm #2, did not demonstrate any detectable differences over the 24-hour period (App. H). Total suspended solids measured at farm #1 showed variation, with a difference between inlet and presettling from - 3 to + 7 mg/l, and a slight increase during mid-day (Fig. 79). Orthophosphate was measured only at farm # 6, and showed differences over the rearing area from -0.03 to +0.01 mg/l, and was unrelated to time of day (App. H).

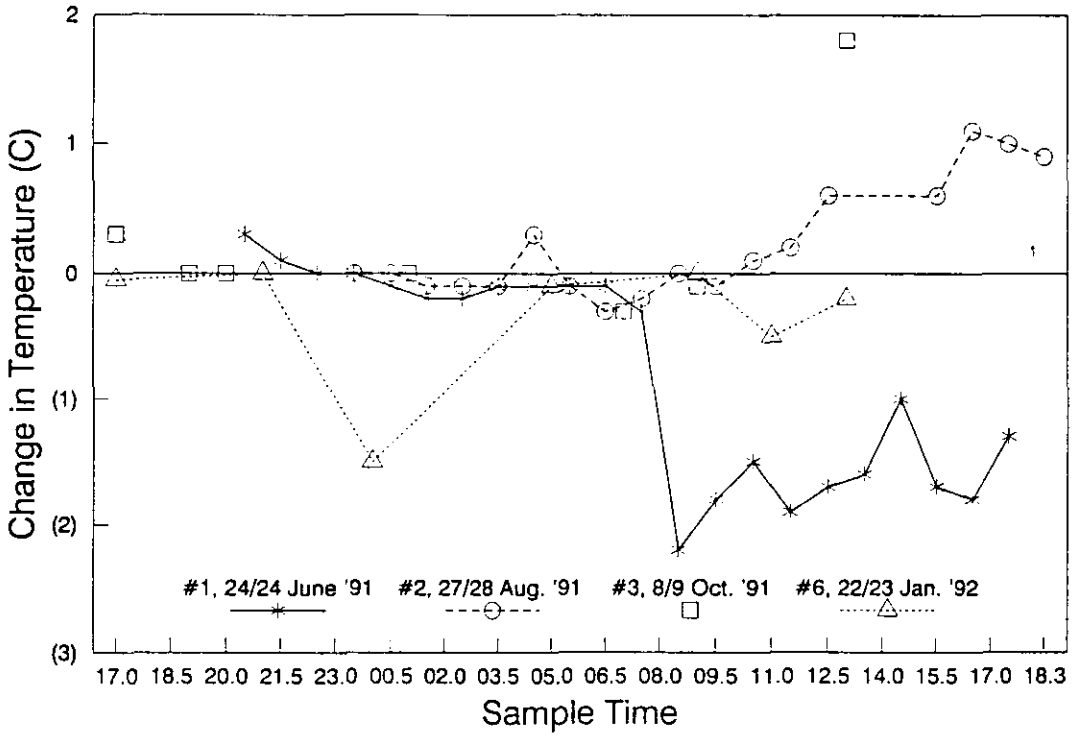


Figure 74. Temperature differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

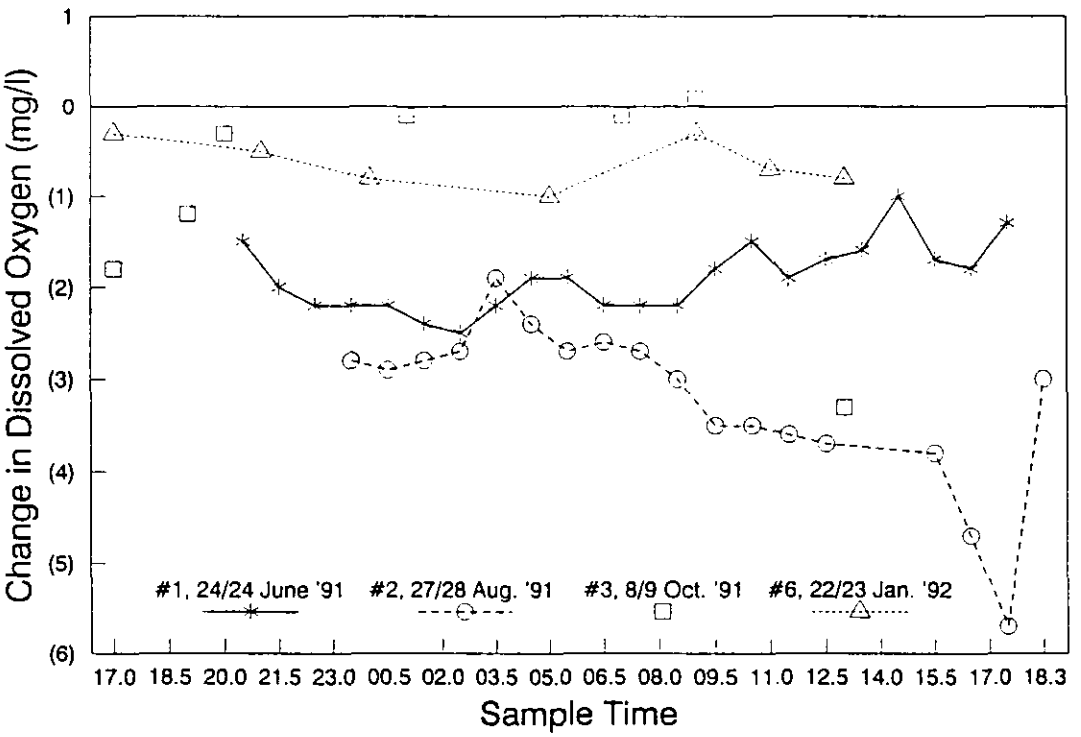


Figure 75. Dissolved oxygen differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

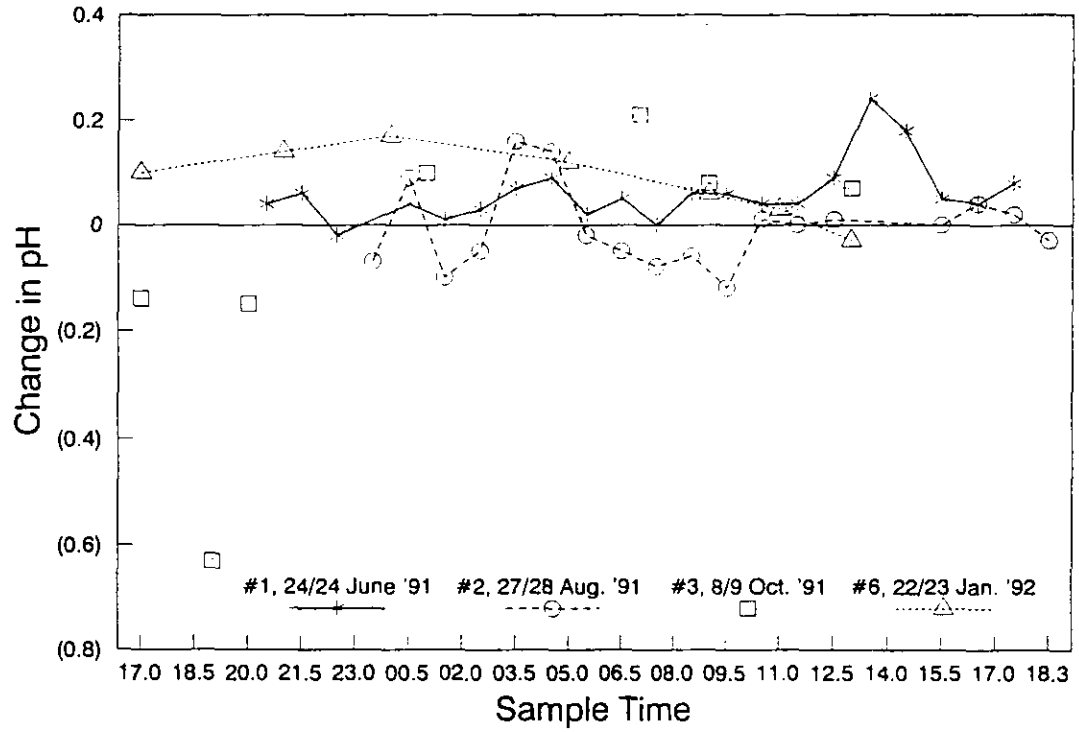


Figure 76. pH differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

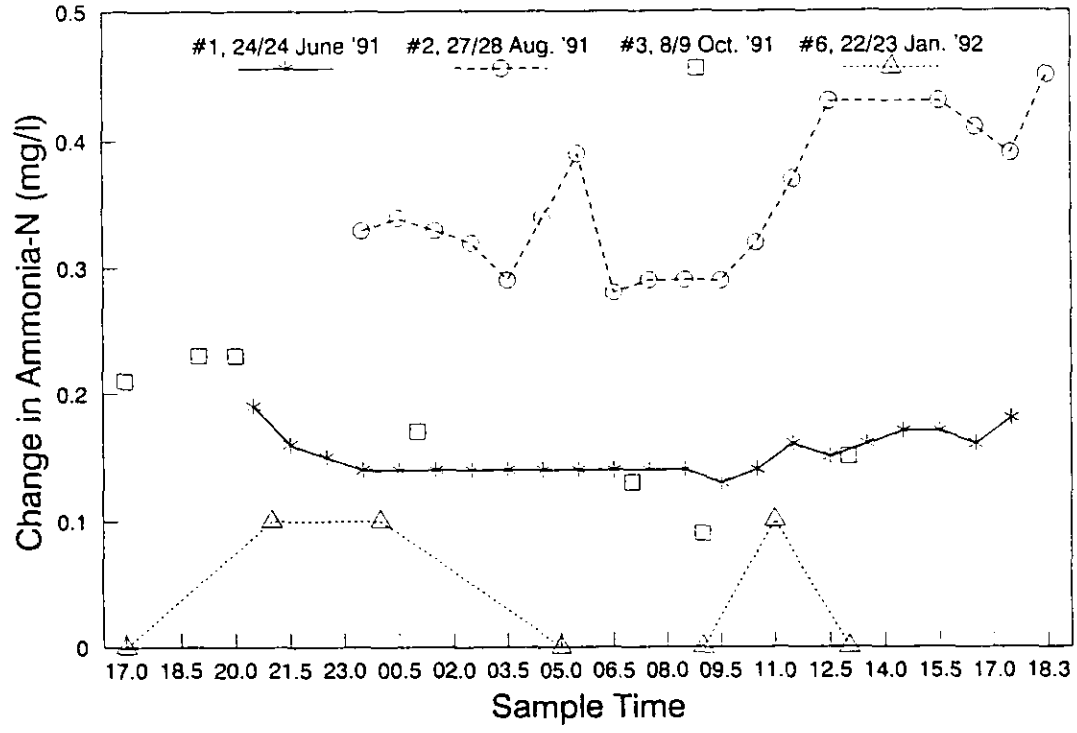


Figure 77. Ammonia-N differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

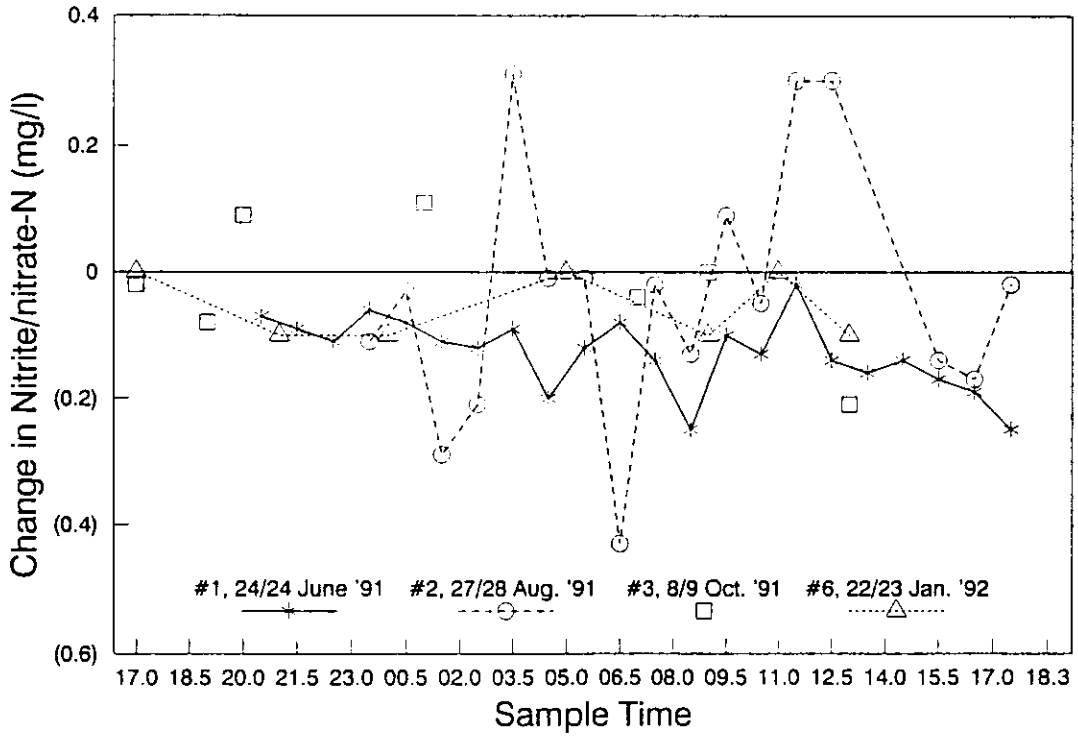


Figure 78. Nitrite/nitrate-N differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

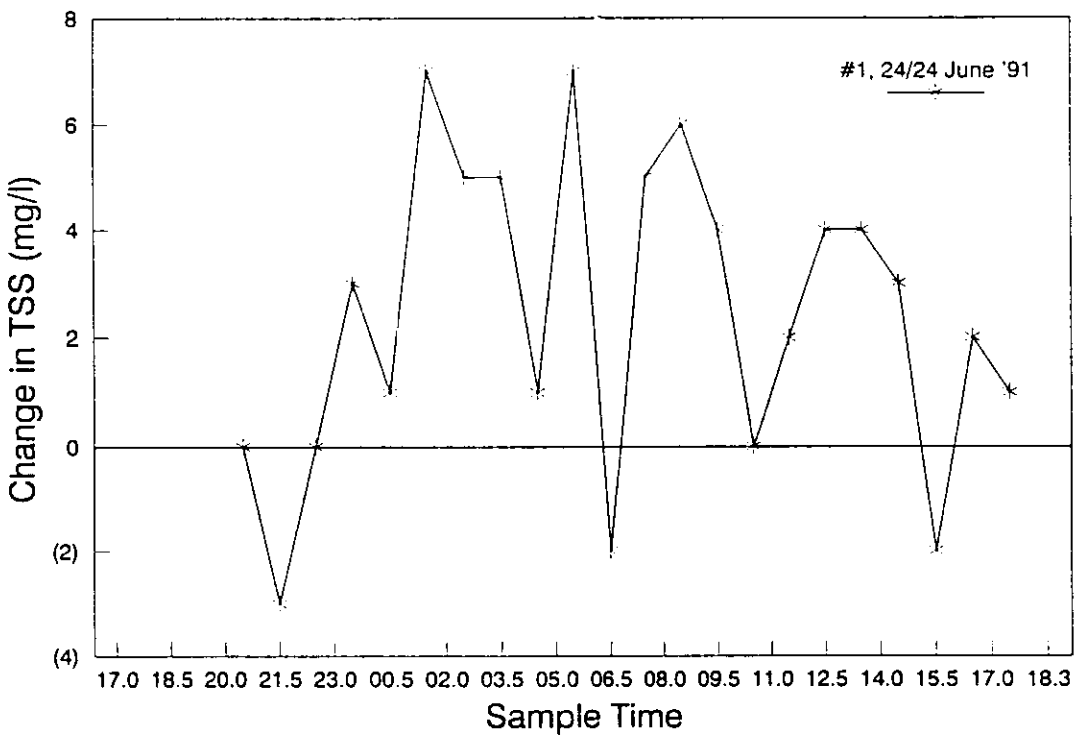


Figure 79. Total Suspended solids differences in rearing areas (Presettling - Inflow) across farms measured during the 24 hour testing.

Main Stream Deep Creek

Total contribution of suspended solids and nutrients in Deep Creek varied greatly because of the influence of irrigation and the amount of water being returned to the Snake River. Total flow in Deep Creek (Fig. 80) showed the expected increase, rising at the beginning of irrigation from about 50 cfs to a mean of 115 cfs, and dropping to 50 cfs by the first of November. Peak flow at the USGS station of 230 cfs occurred at the beginning of October, but the actual flow pattern and quantity were influenced by the amount of water drawn off by the laterals for irrigation and power generation. **Total contribution of solids and nutrients to the Snake River, based on concentration of the components and flow, were determined by adding the flows from Deep Creek plus the laterals, and are in excess of what was passing the USGS station.**

Temperature profiles for Deep Creek (Fig. 80) were a reflection of ambient temperatures, rising in May from about 8°C, reaching a maximum of 26°C in July and August, and gradually dropping to less than 5°C by December. When assessing the assimilative capacity of the system for nutrients, the effect of temperature has to be considered. Extremes in temperature were usually experienced at the upper station.

Dissolved oxygen in Deep Creek was often slightly below saturation (Fig. 81). There were times during the irrigation season that levels were measured well below saturation.

Total phosphorus (Fig. 82) increased in mean concentrations from 0.07 to 0.17 mg/l at the USGS station and 0.05 to 0.23 mg/l at the upper station from irrigation activities. Mean orthophosphate (Fig. 83) increased four fold at the upper station from 0.03 to 0.13 mg/l during irrigation, but was fairly constant at the USGS station from 0.06 to 0.07 mg/l for the same period.

Ammonia was below the detection limit in nearly all creek water samples, (Fig. 84) and reported as half the detection limit. Nitrite/nitrate tended to show the opposite trend in concentration gradient with flow (Fig. 85). Higher concentrations were demonstrated during the low flow period (4.5

mg/l) and dropped markedly during the irrigation season (2.0 mg/l). Total contribution of nitrite/nitrate during the high flow period, however, was still higher at the lower station because flow was proportionally higher. Total Kjeldahl nitrogen showed a high degree of variability (Fig. 86) and no correlation with flow, other nitrogen species, or between stations.

The pH at the USGS station was 8.7 ± 0.25 (Fig. 87). The upper station varied ± 1.4 around a mean pH of 8.6. Conductivity (Fig. 88) and chloride levels (Fig. 89) followed the same pattern as dissolved solids, higher during low flow periods and lower during irrigation, except at the USGS station where conductivity peaked during the mid-irrigation period.

Turbidity (Fig. 90) showed a pattern of variability that followed fairly close to the level of suspended solids in Deep Creek (Fig. 91). Suspended solids increased markedly during the irrigation season. The USGS station and the upper station both averaged a little over 43.5 mg/l, but during the irrigation season went well over 100 mg/l, and with a high degree of variability.

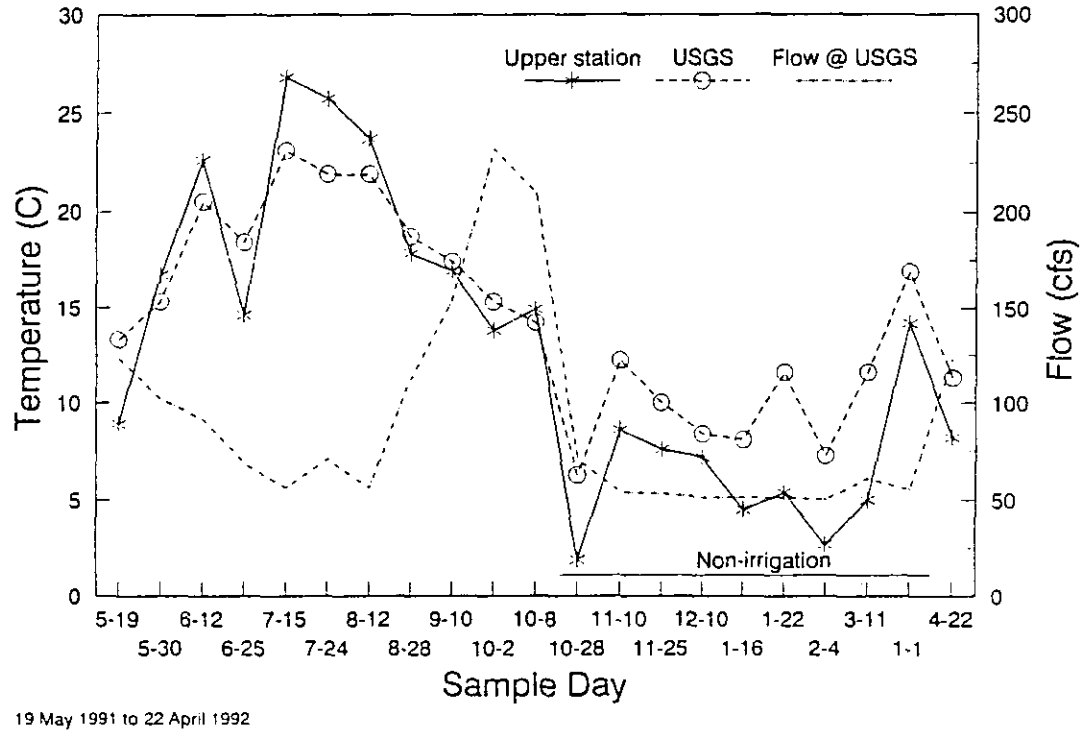


Figure 80. Sample temperatures and flows measured adjacent to Farm #1 and at the USGS station on Deep Creek.

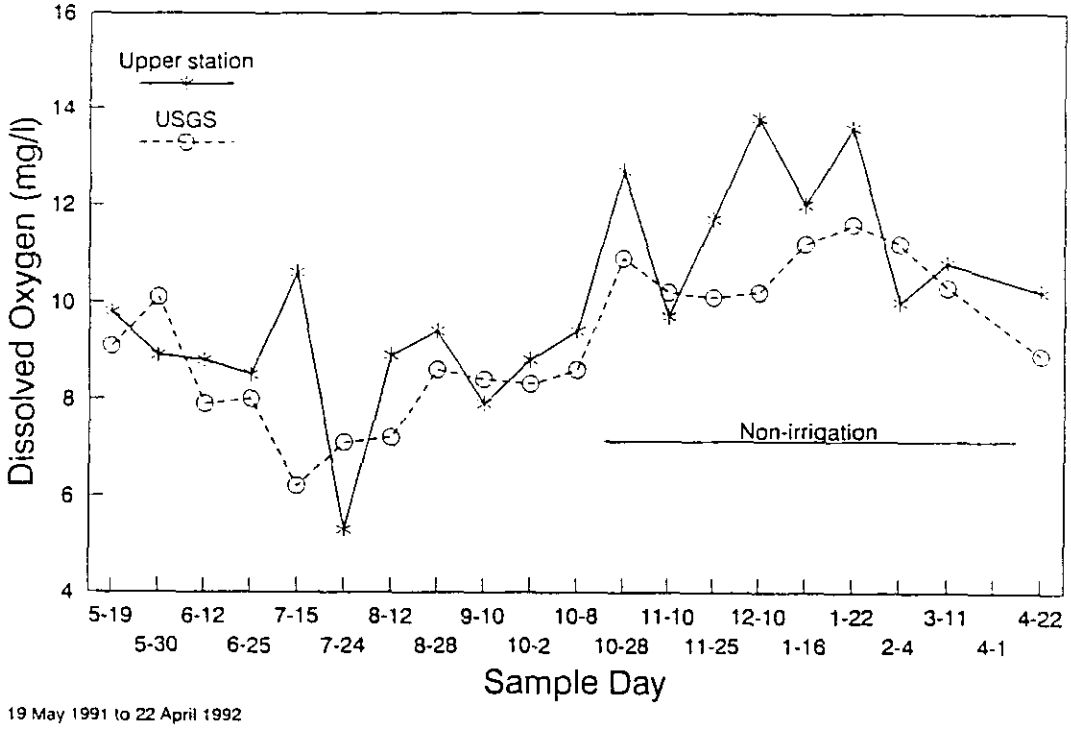


Figure 81. Dissolved oxygen concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

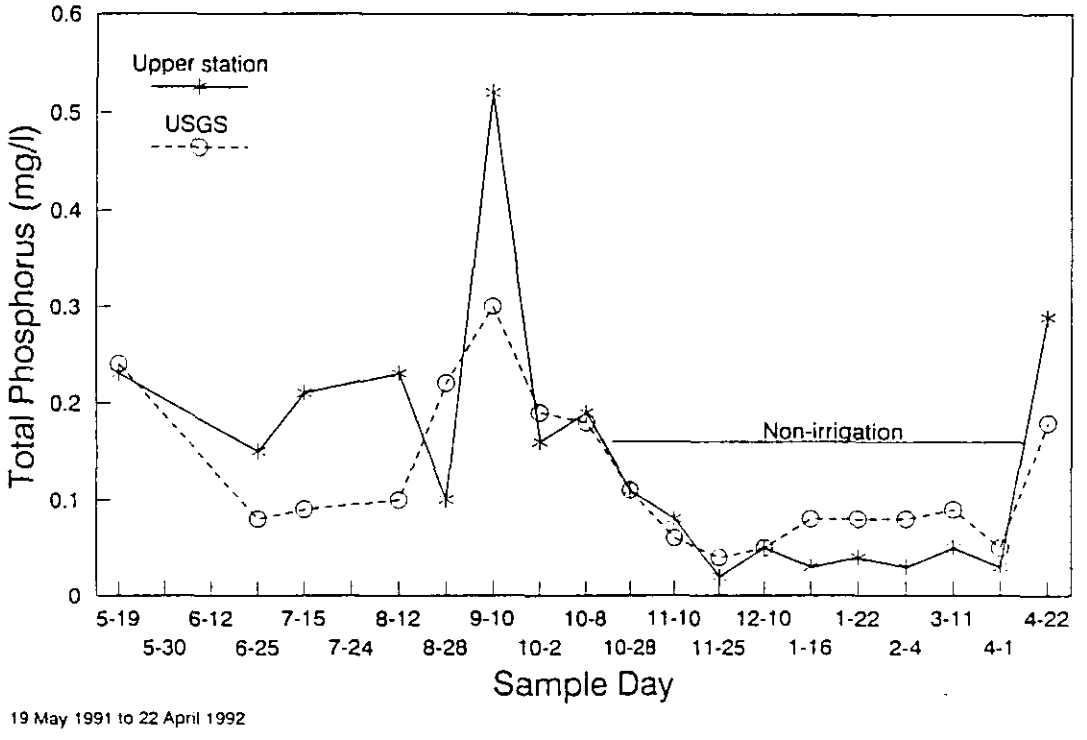


Figure 82. Total phosphorus concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

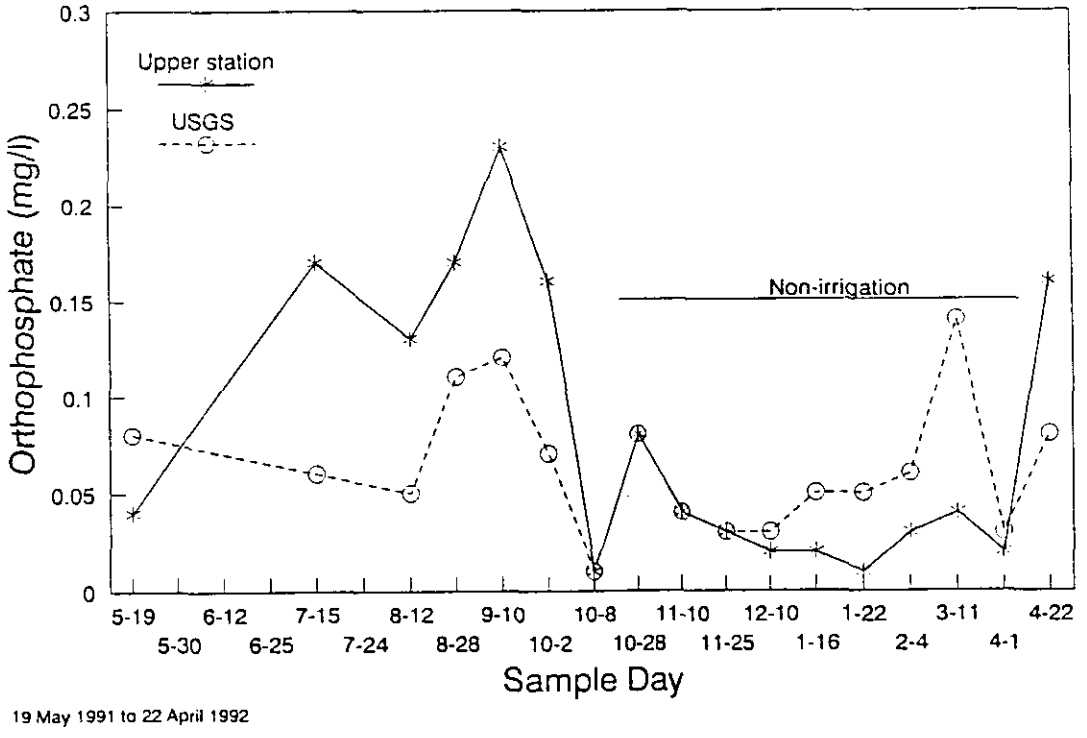


Figure 83. Orthophosphate concentrations measured adjacent to Farm #1 an at the USGS station on Deep Creek.

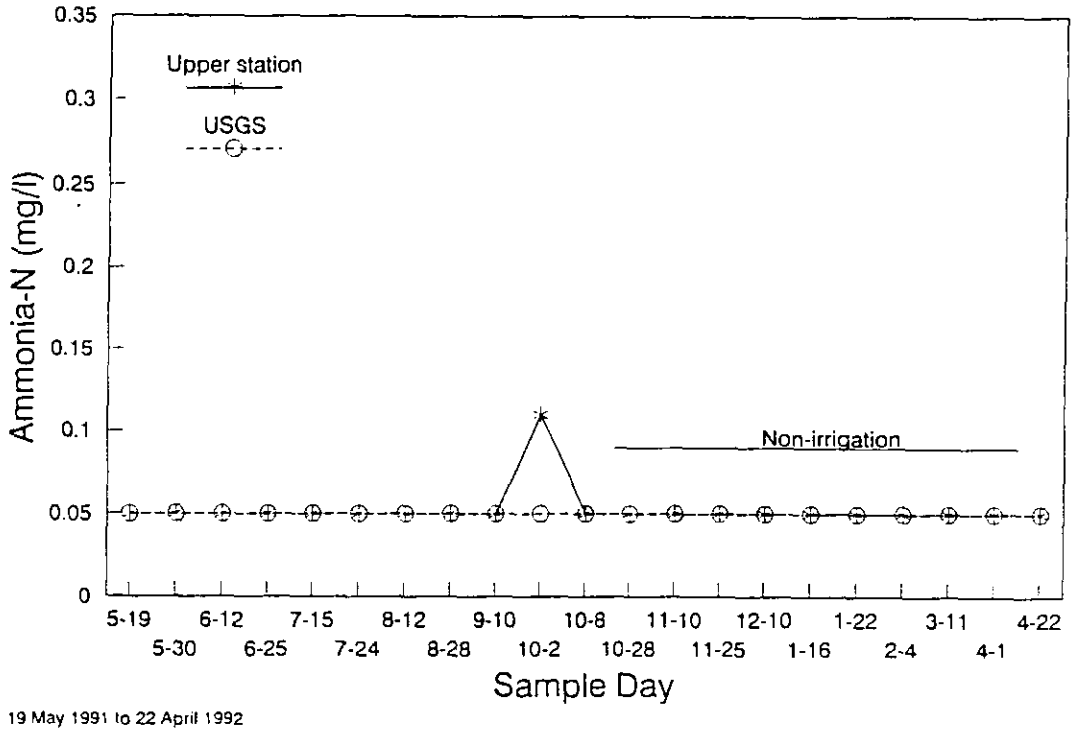


Figure 84. Ammonia-N concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

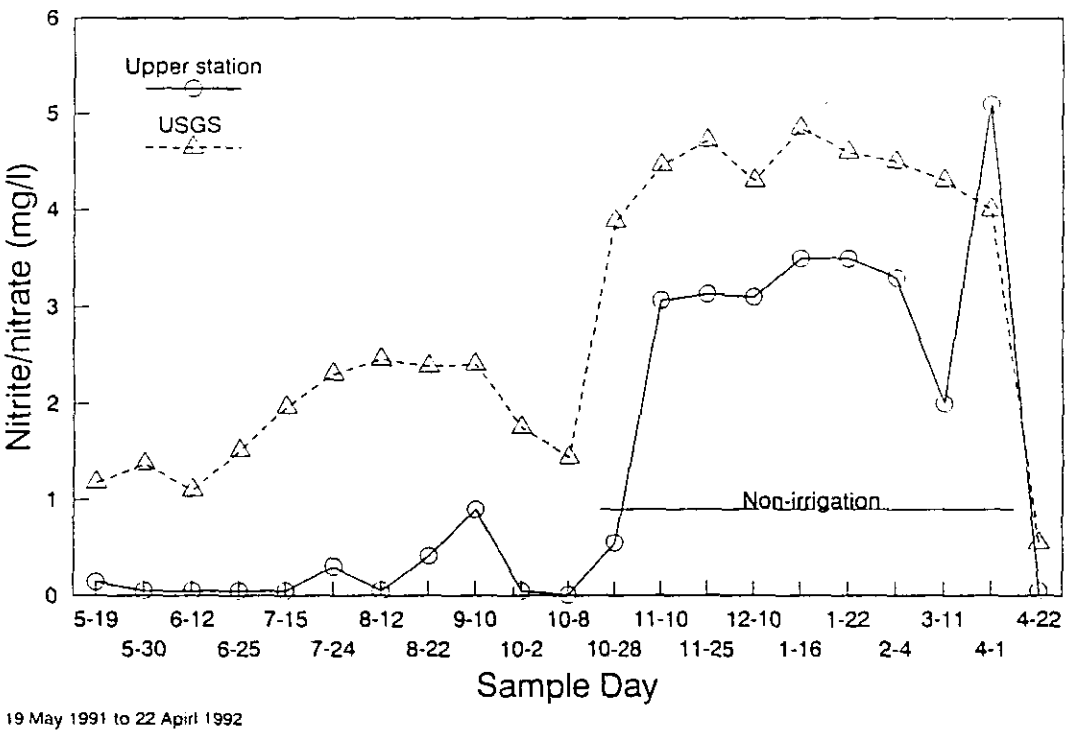


Figure 85. Nitrite/nitrate-N concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

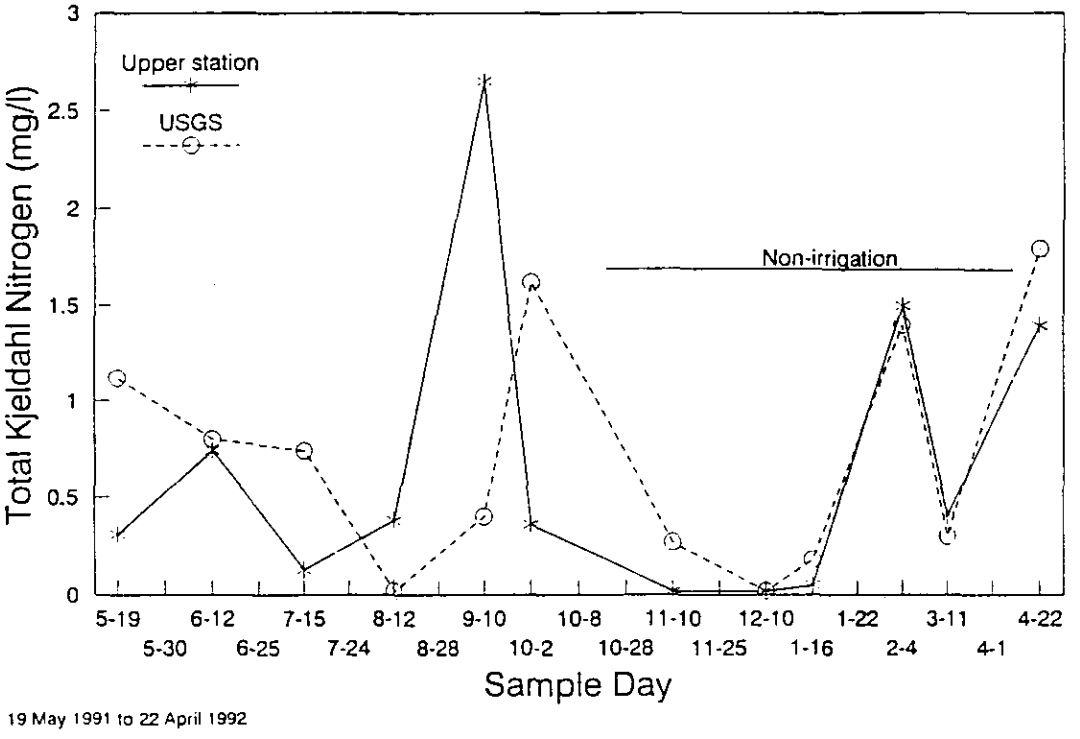


Figure 86. Total Kjeldahl nitrogen concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

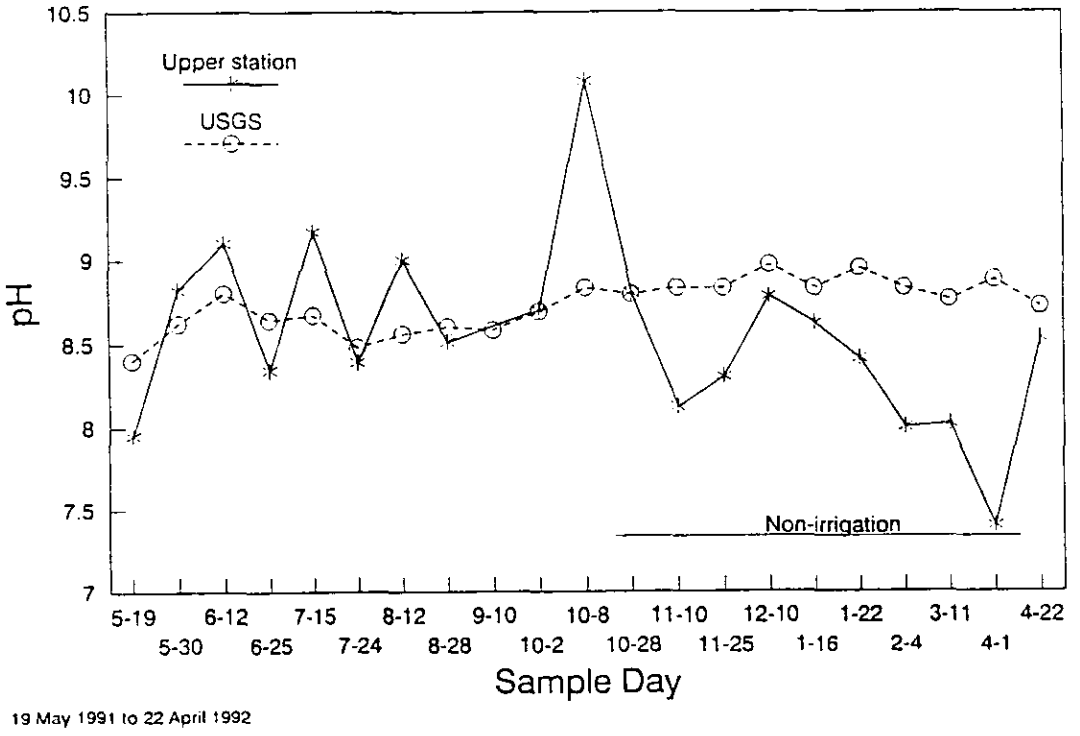


Figure 87. pH measured adjacent to Farm #1 and at the USGS station on Deep Creek.

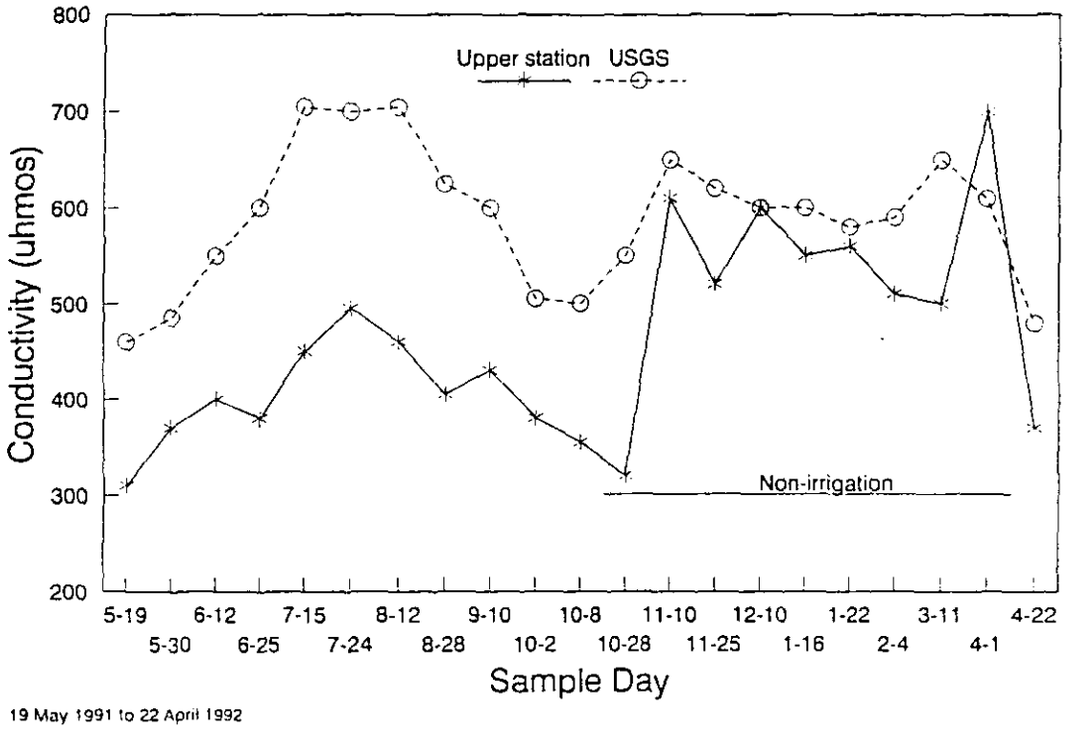


Figure 88. Specific conductance measured adjacent to Farm #1 and at the USGS station on Deep Creek.

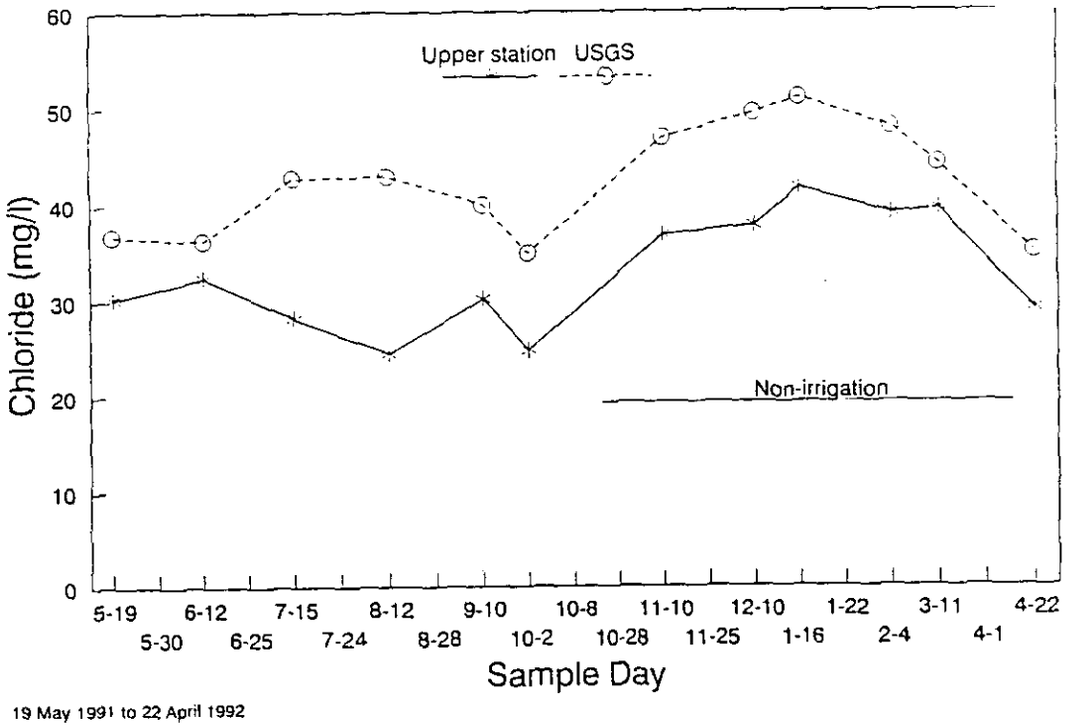


Figure 89. Chloride concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

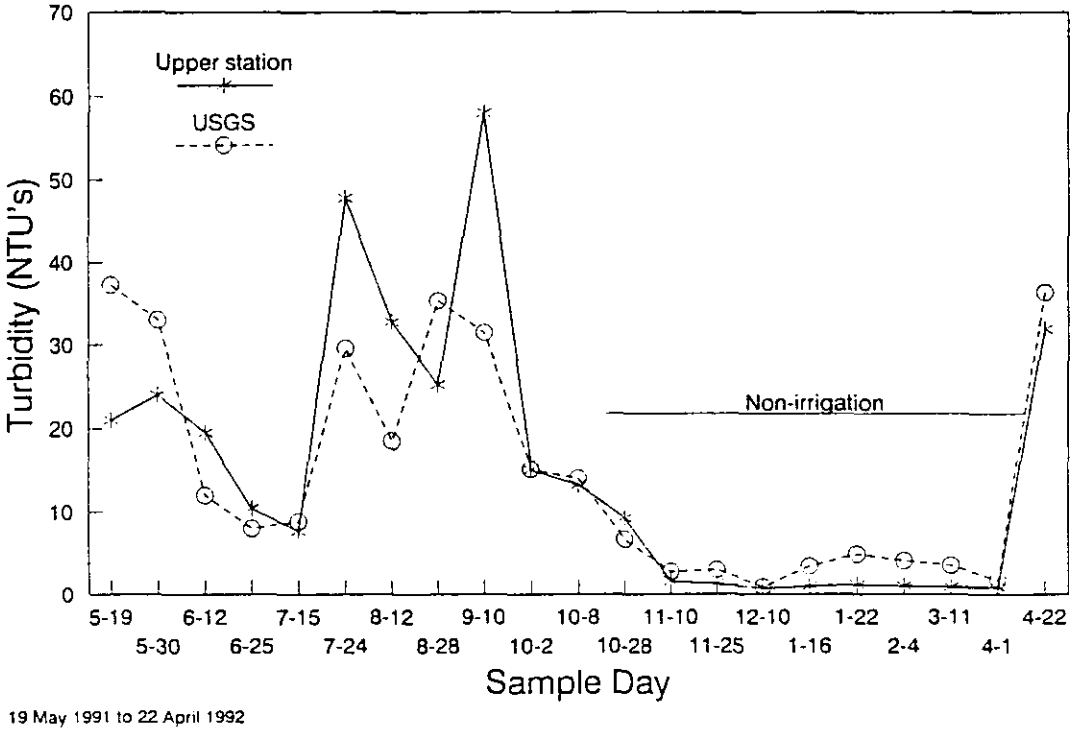


Figure 90. Turbidity measured adjacent to Farm #1 and at the USGS station on Deep Creek.

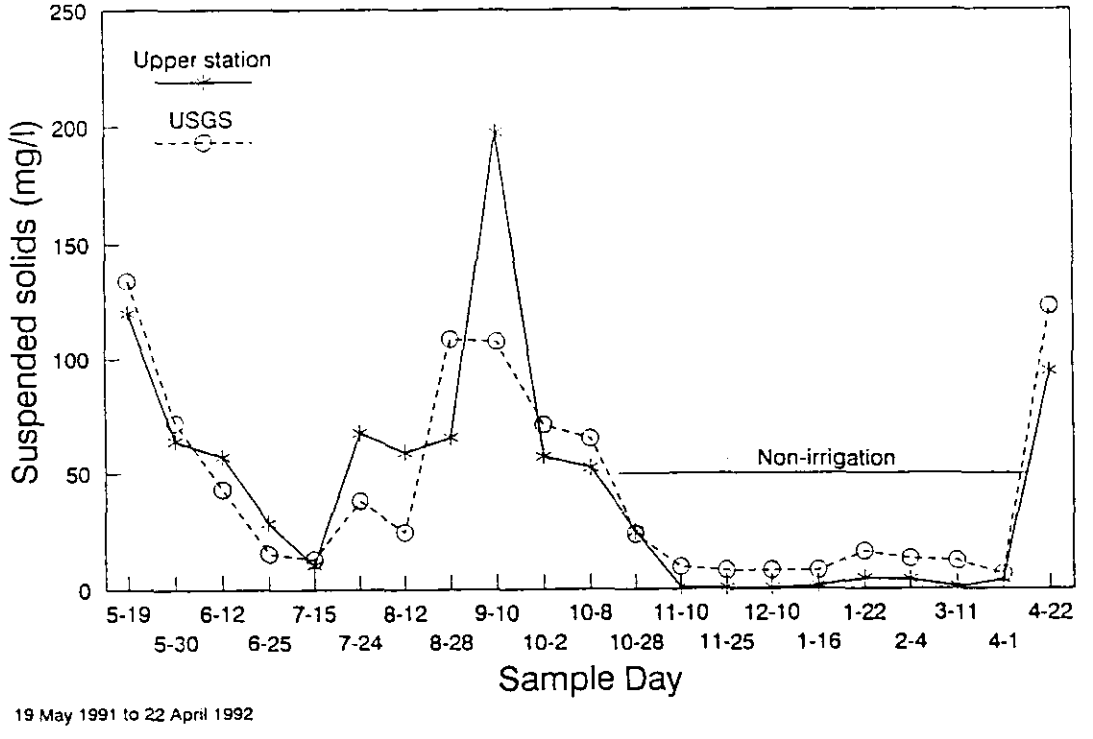


Figure 91. Total suspended solids concentrations measured adjacent to Farm #1 and at the USGS station on Deep Creek.

Statistics

A paired sample t-test (α=.05) was applied to the differences between inlet and outlet values of individual farms and between the upper station (US) and lower creek site (USGS). Ten parameters utilizing the measured concentrations during rearing were tested. The mean concentration change from the inflow to the outflow during rearing, the maximum and minimum ranges found during rearing, and the level of significance between outflow and inflow levels are shown in Table 2.

Total suspended solids were not significantly different at any farm site except for farm #2. In that case, although the actual levels were quite low, the small variation between sample sets made the differences significant. Seep tunnel water was very low in TSS, which allowed the contribution of fish farms to be better demonstrated. However, the highest mean concentration difference among all farms was <3.50 mg/l which is below the detection limit placed on suspended solids by most water quality laboratories. Statistically, suspended solids were not a problem.

The total phosphorus difference between outflow to inflow was significantly different on all the farms. Orthophosphate was significantly different for all but farm #6. This would be expected as a consequence of phosphorus in the feed and orthophosphate excretion by the fish as a byproduct of metabolized feed.

Ammonia showed significant effluent increases in all cases except on farm #5 where ammonia was not statistically different between the supply and effluent, and where nitrite/nitrate was significantly lower in the outlet. Nitrite/nitrate was not significantly different on any other farm. Total Kjeldahl nitrogen and electrical conductivity were not significantly different on any of the farms.

pH was significantly higher in the effluent of farm #1 and significantly lower in the effluent of farm #4, over source water, with slight differences on other farms. Chloride was found to be significantly lower only across farm #1 with a mean difference of -0.76 mg/l.

Slight but significant increases in the sample concentrations for nitrite/nitrate-N, electrical conductivity and chloride occurred between the mainstream upper station adjacent to farm #1 and the lower USGS station. This was consistent with the higher concentrations of ground water entering downstream from the upper station.

Table 2. Mean sample concentration differences during rearing, maximum and minimum concentrations found in either inflow or outflow and statistical information.

	TSS	TP	OP	AM	N/N	TKN	TURB	COND	pH	CHL
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	NTU	umhos		mg/l
		Seep Tunnel as Water Source								
Farm #1										
Mean conc. diff.	3.17	0.05	0.03	0.10	−0.03	0.15	0.71	0.56	0.11	−0.76
Minimum conc.	0.00	0.03	0.01	0.05	3.74	0.02	0.08	680.00	7.33	35.30
Maximum conc.	39.00	0.31	0.09	0.31	5.10	1.00	6.95	710.00	8.02	47.92
Ho: Out=In	ns	SD	SD	SD	ns	ns	ns	ns	SD	SD
Farm #2										
Mean conc. diff.	1.43	0.05	0.05	0.11	−0.07	−0.19	0.30	−2.86	0.06	1.49
Minimum conc.	1.00	0.02	0.02	0.05	3.91	0.02	0.15	600.00	7.53	35.30
Maximum conc.	12.50	0.27	0.11	0.31	5.55	2.15	3.80	710.00	8.40	50.87
Ho: Out=In	ns	SD	SD	SD	ns	ns	ns	ns	SD	ns
		Irrigation Return as Water Source								
Farm #3										
Mean conc. diff.	−4.28	0.06	0.05	0.18	−0.05	0.20	0.44	3.33	−0.07	0.18
Minimum conc.	1.50	0.06	0.06	0.05	1.30	0.02	0.56	430.00	7.61	35.28
Maximum conc.	52.50	0.29	0.19	0.50	5.40	1.50	13.10	710.00	8.59	47.90
Ho: Out=In	ns	SD	SD	SD	ns	ns	ns	ns	ns	ns
Farm #5										
Mean conc. diff.	0.79	0.02	0.01	0.04	−0.04	0.00	−0.26	4.41	−0.06	−0.65
Minimum conc.	3.00	0.04	0.03	0.05	2.18	0.02	1.65	485.00	7.66	31.90
Maximum conc.	63.50	0.22	0.13	0.50	5.01	2.00	39.30	700.00	8.75	41.40
Ho: Out=In	ns	SD	SD	ns	SD	ns	ns	ns	ns	ns
		Deep Creek as Water Source								
Farm #4										
Mean conc. diff.	−2.88	0.03	0.03	0.09	−0.03	0.06	−0.36	−0.50	−0.14	−0.39
Minimum conc.	5.00	0.03	0.01	0.05	0.05	0.02	0.66	350.00	7.95	25.20
Maximum conc.	231.50	0.43	0.31	0.50	5.10	1.30	53.95	650.00	9.06	43.20
Ho: Out=In	ns	SD	SD	SD	ns	ns	ns	ns	SD	ns
Farm #6										
Mean conc. diff.	0.28	0.03	0.01	0.07	−0.02	0.16	1.14	6.88	0.07	0.26
Minimum conc.	5.50	0.05	0.07	0.05	0.60	0.05	1.19	400.00	7.35	26.40
Maximum conc.	194.50	0.30	0.18	0.46	5.03	2.66	68.05	650.00	9.25	42.50
Ho: Out=In	ns	SD	ns	SD	ns	ns	ns	ns	ns	ns
		Annual Deep Creek Differences								
USGS – US										
Mean conc. diff.	0.24	−0.02	−0.02	0.00	1.46	0.06	−0.66	128.10	0.18	9.83
Minimum conc.	0.50	0.02	0.01	0.05	0.01	0.02	0.74	310.00	7.40	24.54
Maximum conc.	197.50	0.52	0.23	0.11	5.10	2.65	58.05	705.00	10.08	51.00
Ho: Out=In	ns	ns	ns	ns	SD	ns	ns	SD	ns	SD

Note: The minimums and maximums do not necesarily reprent the inflow/outflow respectively.
Dissolved oxygen was SD on all farms and creek, while temperature was ns except for the creek.
ns = not significantly different at the .05 level SD = significantly different at the .05 level

Discussion

The quality of water leaving fish farms is determined by several different factors. Most certainly operating procedures and the design of the facility can make a substantial difference in contribution of farm-generated nutrients in the effluent. However, it is important to point out that the primary source of nutrients in the effluent of a fish farm may not be from the fish rearing operation, but rather from the water supply itself. In the present study, taken as a whole, **there were more suspended solids coming into the farms than leaving the farms,** or a net reduction of sediments as water passed through the rearing ponds. Nitrite/nitrate levels showed a similar phenomenon. More nitrate was removed as water passed through the farms than was generated by the farms. Even the nutrients of most concern with regard to environmental quality were generated on the farm at levels less than what was contributed by the water supply. About 70% of the orthophosphate and total phosphorus in the effluent was present in the source water. Ammonia was the only nutrient-generated on the farm at levels greater than quantities contributed by the water supply. Therefore, when assessing the impact of fish farm effluent on environmental quality, it is critical to differentiate among the sources of nutrients, and not attribute an entire nutrient load just to farm operations.

The mode of impact of farm effluent on the receiving stream will be through alteration of physical or non-nutrient characteristics of the water and through alterations of nutrient levels carried in the water. The discussion will address the non-nutrient parameters first, since they have a major influence on the form in which nutrients occur, and then nutrient contributions will be covered with regard to amounts generated and their ultimate destination.

Non-nutrient Parameters

Temperature alterations through the fish farms occur as a function of surface area exposed, length of exposure, and temperature difference between air and water. The thermal properties of water buffer against rapid changes, and the fish farms did not change the temperature of the adjacent water source in this study, unless the entire stream passed

through the farm, and then temperatures were altered only slightly. During hot or cold weather, mid-day water temperature at the outlet of a farm operation could show a difference as much as 2°C, but most often the difference was negligible and insignificant ($\alpha = 0.05$).

Oxygen levels were decreased by as much as 2 mg/l over the length of the rearing raceways at the loading levels experienced in this study. This varied, since respiratory requirements of trout are determined by the biomass, age of fish, feeding level, and temperature. However, the level of oxygen recharge provided by falls between ponds recovered much of what was lost to respiration. Recharge efficiency also varied, since it is a function of the drop structure design that provides air/water surface exchange. Oxygen differences between inlet and outlet measurements were significant at the $\alpha = 0.05$ level.

Photosynthesis during the daylight hours increased the oxygen level well above saturation (max 176%) at times, and on occasion plant respiration at night caused oxygen to fall below saturation (min 70%) in surface water supplies. In these instances, effluent oxygen was sometimes higher than the inflow levels. On occasion, low oxygen approached concentrations that would limit production.

Conductivity and chloride levels showed minimal net differences as water passed through the farms. While dissolved nutrients might be expected to increase from feeding, settling of solids from the water column may have compensated for any increases related to metabolites. During periods of irrigation, the creek water conductivity ranged from 350-500 µmhos/cm, whereas irrigation returns and seep tunnel sources ranged from 600-700 µmhos/cm. During non-irrigation periods, the creek was 500-700 µmhos. Chloride concentrations ranged from 25 to 50 mg/l, but were inconsistent among farms. Net accumulations between inlet and outlet measurements were negative in farms # 1, 4, 5 and 6, and positive in farms # 2 and 3. No significant differences ($\alpha = 0.05$) due to rearing were found in chloride or conductivity levels.

pH would be expected to decrease under high density rearing conditions because of the increase in CO_2 from fish respiration. In this study the pH generally showed no alteration when passing through the farms. The pH in the Deep Creek water supplies tends toward the high range for acceptable fish rearing conditions, and that, with the high buffering capacity of the water, may be why little pH shift was observed through most farms. Lower pH, or more acidic water, will cause a shift from the molecular (toxic) form of ammonia to the ionic form, which decreases the potential deleterious effects of ammonia. The high pH observed in this study would allow molecular ammonia to be more readily removed in its gaseous form. Significant changes in pH were found on farm #1 (+), farm #2 (+), and farm #4 (-) at the $\alpha = 0.05$ level.

Examination of the non-nutrient parameters of the fish farm effluent demonstrates that little alteration in the environmental characteristics of the water source occurs by passing water through a fish farm when the operation is of the size included in this study. Alterations of environmental quality of the stream by fish farm effluent, therefore, remain primarily in its potential as a nutrient source.

Nutrient Parameters

Fish waste is a nutrient source to the receiving stream, the magnitude of which depends on the nature and relative volume of the waste. Fish generate organic waste, and **produce around 40% solids and soluble components for every pound of food fed** (Willoughby et al., 1972: Stechey and Trudell, 1990). **Most of that waste contribution can be removed before the effluent enters the receiving stream** by use of appropriate farm management practices that involve recapture of the solid waste material. Fish farm effluent nutrient contributions measured in the present study are an approximate representation of fish farm or farm pond operations of this size in Idaho.

Orthophosphate and phosphorus levels in the Deep Creek study showed high variability, with most of the variability related to the water sources even under maximum feeding conditions. As a measure of farm contribution, however, analysis showed increases between the pond inlet

and effluent samples ranged from .01 to .11 mg/l. The background total phosphorus levels in the water sources varied between 0.02 and 0.50 mg/l. Creek water carried the highest level of total phosphorus, but high levels were also associated with other events that caused increases in suspended solids. **Rearing induced a significant ($\alpha = 0.05$) increase in orthophosphate** and total phosphorus in most cases.

An interesting comparison of the study was the pre-settling and outlet values for phosphorus on those farms with settling ponds. Farm #2 showed a net increase in phosphorus as water passed through the settling pond. However, cattle had regular access to the pond, and escaped fish were residing in the settling pond which resulted in higher levels in the post-settling effluent than in the presettling measurements.

Farm #3 had a settling pond free of fish and other disturbances, and was effective in removing 57 kg of phosphorus, or 31% of the 186 kg generated annually on the farm. Operation management, through good settling pond design, appears to have good potential for phosphorus reduction in the effluent, most likely through settling of solid material that has sequestered phosphorus.

Farms #4 and #6 had settling ponds that were too small and too shallow to effectively reduce phosphorus in their effluents. Both farms showed a net addition of phosphorus in the effluent as water passed through settling ponds. It was apparent from the sample data that on some days the settling ponds were capturing phosphorus (as solids) because there were negative net differences between the presettling and outlet phosphorus levels. However, on other days after a temporary buildup, the settling ponds would appear to scour and total phosphorus determinations showed a net increase between presettling and outflow samples.

Total phosphorus contribution to the mid-Snake by Deep Creek, including laterals, was 23,533 kg. About 1275 kg, or **5.4%** of the total phosphorus entering the mid-Snake from Deep Creek drainage could be attributed to the six fish farms (totals calculated from tables in appendices B to G, I and J). Rearing contributed less than 50% of the TP in farm effluent (Fig. 92).

Orthophosphate, the nutrient most often associated with fish metabolism, showed an increase in the effluent in all cases (Fig. 93). Among the farms there was a mean increase in orthophosphate of 0.03 mg/l, which ranged from 0.01 to 0.05 mg/l over mean background levels of 0.03 to 0.10 mg/l in the various water supplies.

Again, settling ponds made a difference in orthophosphate capture. Farms #2 and #4 showed a net gain, and farms #3 and #6 showed a net loss between presettling and outlet water, with as much as 52% reduction. Percent efficiency of the settling pond in reducing orthophosphate, however, is not the point of this comparison, because the level of error is large when concentrations are so low in the first place, and most of the differences can be attributed to just a few of the determinations. The point is that settling ponds appear to have a potential benefit in reducing the level of orthophosphate in outlet water if care is taken to adequately size the pond and assure uniform velocities.

Annual contribution of orthophosphate to the mid-Snake from Deep Creek **amounted to 13,025 kg. Fish farm contribution to Deep Creek was calculated at 808 kg for the year, or 6.2%** of the total leaving the stream.

Ammonia produced by the fish is rapidly integrated into the environment as nitrate/nitrite or ammonia gas. Ammonia measurements in water samples from the farms showed large variability. Cause of the variability is thought to have been due to the level of feeding activity by the fish at the time water samples were taken. When fish were not feeding, ammonia levels dropped to background levels.

Background levels in the receiving streams were no higher below the farms than they were in the supplying stream. Although ammonia nitrogen increased from <0.05 mg/l up to 0.2 mg/l as water passed through the rearing ponds, effluent water reentering the stream was often between 50 and 100% recovered. Rearing contributed less that 50% of the effluent levels measured (Fig. 94). Ammonia dissipated rapidly, and the water quality recovered to background levels shortly after entering the stream.

For example, ammonia was never detectable at farm #4, only 1.0 to 1.5 miles downstream from the upper three fish farms, except in one case of high waterfowl density. Water samples taken at the USGS station, before Deep Creep discharged into the Snake River, never demonstrated detectable ammonia levels.

Nitrite/nitrate in the farm effluent was attributable almost totally to the water source. Nitrite/nitrate showed a slight decrease as it passed through the farm pond operations (Fig. 95), resulting in a combined annual capture of 1084 kg. Settling ponds made a difference. Rearing ponds in farms #2, #3, #4, and #6 accounted for 321 kg of captured nitrite/nitrate, while the settling ponds in those farms captured an additional 524 kg, for a total of 845 kg or nearly three times more efficient as just the rearing ponds. Settleable material will account for some of the nitrite/nitrate captured, but nutrients will also be taken up by macrophytes, algae and bacteria in the system. Total contribution of nitrite/nitrate to the mid-Snake from Deep Creek was 393,359 kg or 393 metric tons, annually.

Total suspended solids, or the measure of total filterable material in the water column, showed the greatest differences from farm design and operation routine, but were never statistically significant ($\alpha = 0.05$). In some instances, measurements showed marked decreases in the effluent compared to source water. Farms #3 and #4 showed a net decrease in suspended solids as water passed through the rearing ponds, and captured 13,403 kg and 23,588 kg of solids, respectively, over the year. The other four farms showed a net increase through the farm, with the net contribution of all farms amounting to 44,873 kg of suspended solids to Deep Creek. One farm was responsible for most of this contribution, and that contribution was associated with only three measurements that inflated the interpolations for contributions between sample days. Based on just sample day means, only farms using seep tunnel water showed a net increase in TSS (Fig. 96).

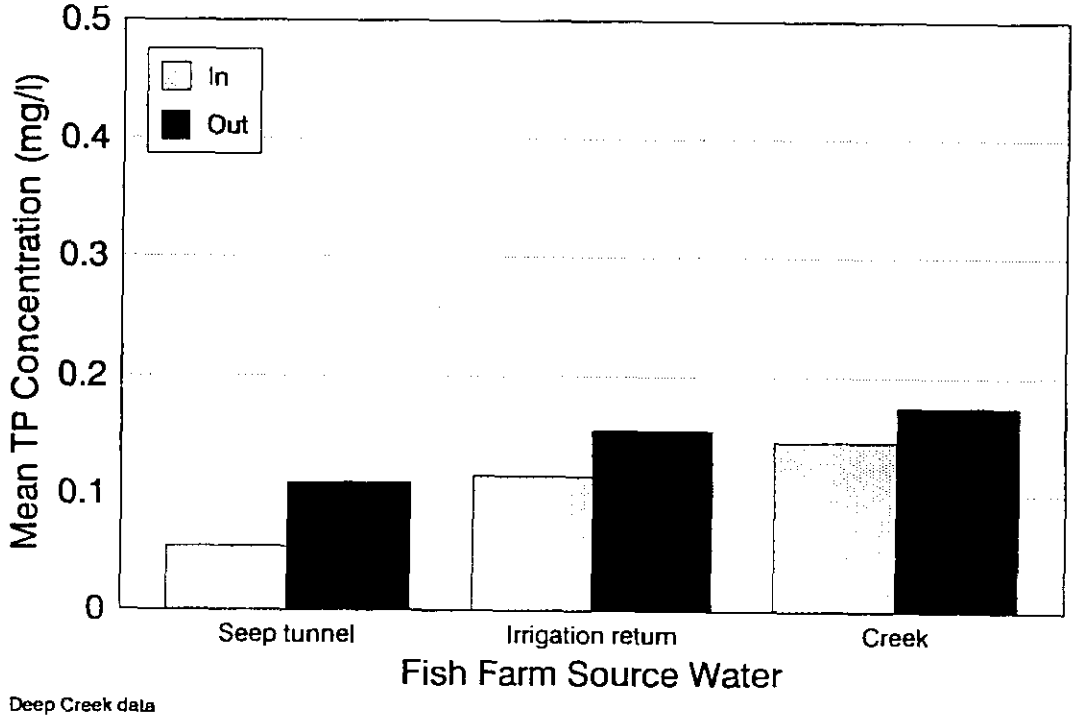
In general, settling ponds could help settle suspended material in the water supply. Farm #3 improved settling efficiency by 85% with the settling pond. Farm #4 showed a net decrease passing through the farm,

but presettling pond suspended solid measurements were 60% lower than outlet measurements, indicating that scouring in the settling pond was occurring. Farms #2 and #6 reduced suspended solids in their effluent by 40 and 17%, respectively, by running the effluent through settling ponds.

It should be pointed out that while a farm may reduce total suspended solids in the water passing through the facility, the composition of the solids leaving the ponds will be different than source water. Feeding adds organic solids to water passing through the system, so while there may be a net loss of suspended solids at slower velocities, some of the inorganic sediments may be replaced by organic sediments from feeding. However, even in the very clean water the level of increase in suspended solids was small. Farm #1 on seep tunnel water, for example, had an annual contribution of 5494 kg of suspended solids, which would equal only 13% of the total feed fed.

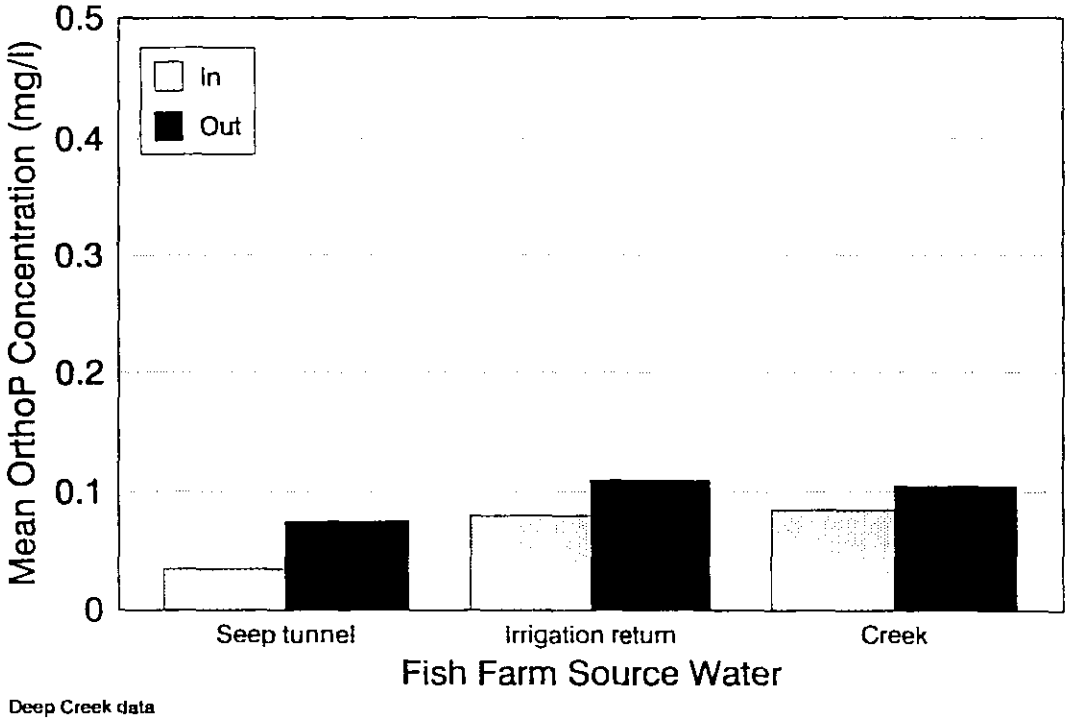
The amount of solids material carried in Deep Creek is so large that the contribution of the fish farms to the stream was negligible. The contribution of total suspended solids from Deep Creek to the mid-Snake would amount to 9,939,643 kg or 9,939 metric tons per year. Nearly all of the solids material was attributed to sources other than the 45 metric tons from the fish farms.

Analysis of nutrient parameters in fish farm effluent showed that the nutrients contributed to Deep Creek by fish farm operations occur at relatively low levels. Phosphorus species appear to be the main components of interest, and facility design and operations management can reduce their concentration in the effluent.



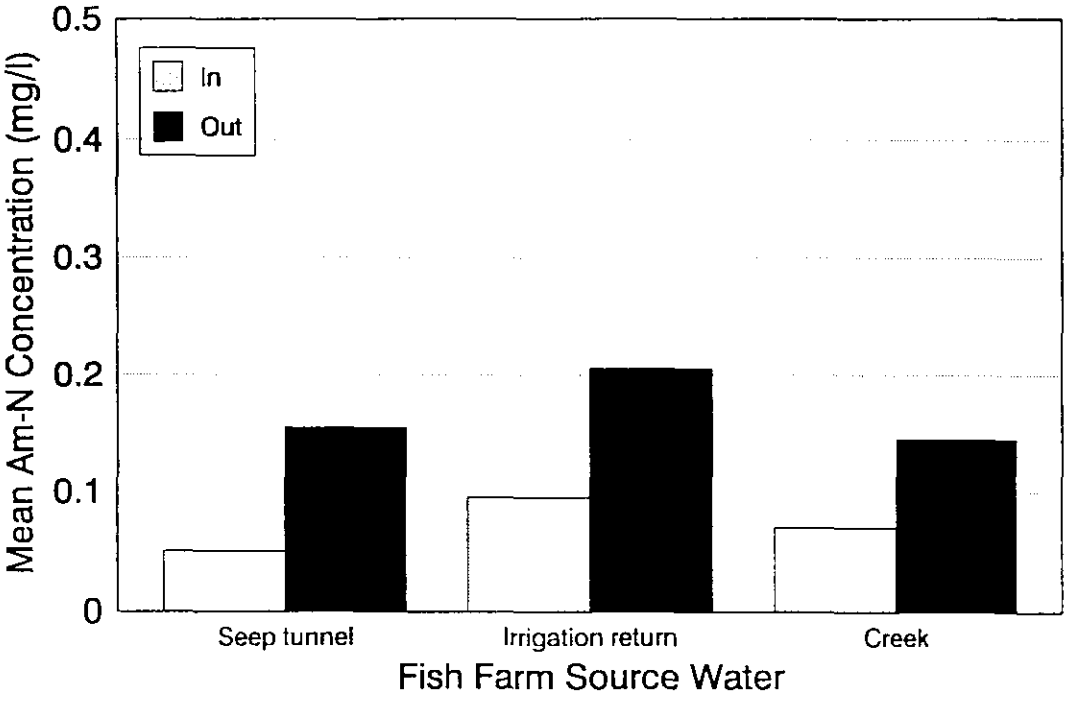
Deep Creek data
2 farms each
21 sample days

Figure 92. Mean total phosphorus in farm water supplies and effluent based on sample day concentrations.



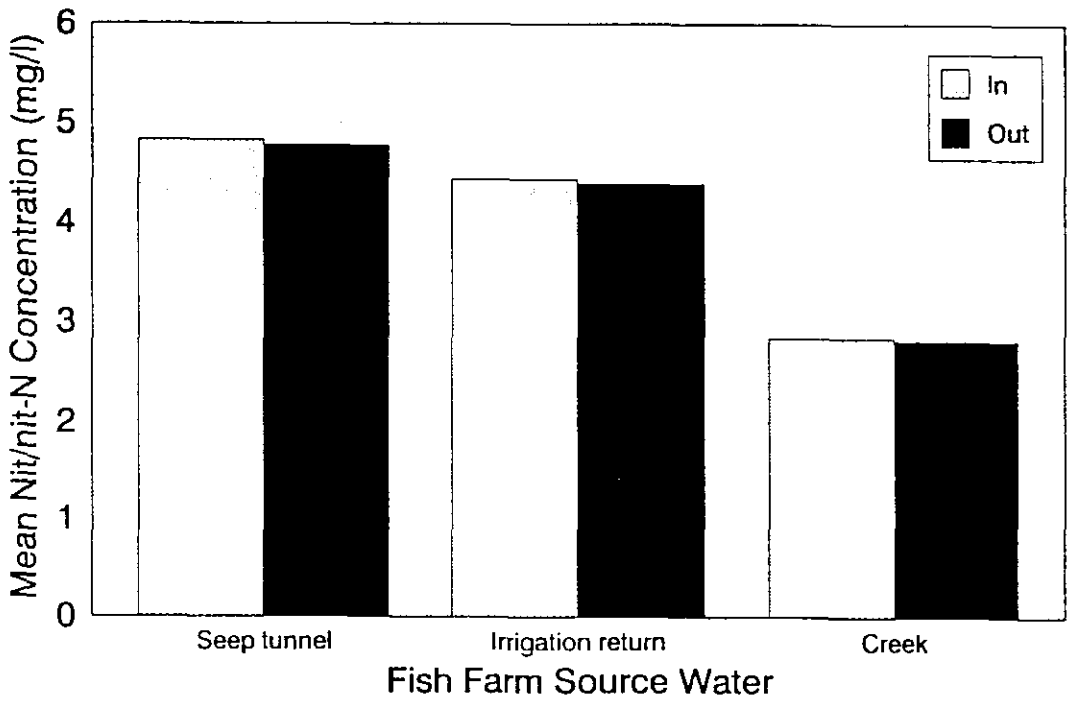
Deep Creek data
2 farms each
21 sample days

Figure 93. Mean orthophosphate in farm water supplies and effluent based on sample day concentrations.



Deep Creek data
2 farms each
21 sample days

Figure 94. Mean ammonia-N in farm water supplies and effluent based on sample day concentrations..



Deep Creek data
2 farms each
21 sample days

Figure 95. Mean nitrite\nitrate-N in farm water supplies and effluent based on sample day concentrations.

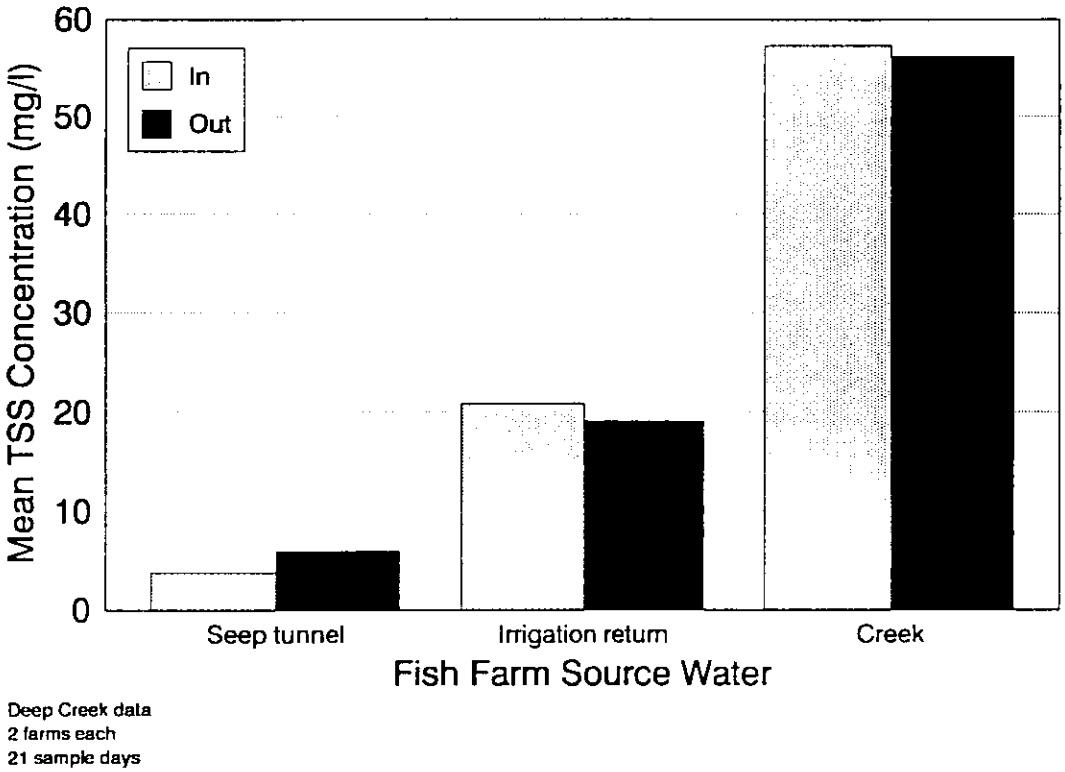


Figure 96. Mean total suspended solids in farm water supplies and effluent based on sample day concentration.

Most Effective Parameters for Analysis

The greatest problem with farmers monitoring the waste load in their effluent is the cost associated with the analysis of water samples. Monitoring even for the bare minimum of nutrient parameters identified in this study would take a substantial portion of the profit earned from small farm pond operations. In an effort to identify a monitoring procedure that will limit the costs to the farmer, the parameters undertaken in the study were evaluated for their suitability to adequately describe the waste, and the potential to substitute less expensive parameters for more expensive analyses.

Stability of the non-nutrient parameters measured as conductivity, chloride level, pH, and even oxygen and temperature are not altered enough to justify including them for waste stream characterization through a single-pass fish farm operation. Moreover, none of these parameters were correlated with the nutrient parameters, and thus ineffective as substitutes for describing the nutrient contribution. Although oxygen and temperature certainly are criteria of great importance to the farmer, they provide little additional information for regulators that have knowledge of the farm design and flows used. It is recommended that none of the non-nutrient parameters monitored in this study are necessary to include as critical criteria to assess effluent quality.

The nutrient parameters in this study that demonstrated related effects from rearing operations were suspended solids, ammonia, phosphorus, and orthophosphate. Ammonia showed a high degree of variability, but that variability may have been an accurate representation of what was occurring, because it appeared to drop rapidly when fish weren't feeding. The variability in ammonia concentrations, however, make its use as a reliable parameter uncertain. Total phosphorus was consistent, but background levels could account for up to 95% of the total contribution of phosphorus in the effluent, which confounds the precise determinations that would be desirable to assess fish-generated waste. Differences in nitrite/nitrate concentrations were so low that analysis wasn't informative about any water quality criteria associated with rearing. Total Kjeldahl nitrogen was extremely variable and showed no correlation with any rearing parameter.

It appears, therefore, that orthophosphate and suspended solids data provided the most descriptive information. These two parameters were the most effective to assess fish farm effluent quality, and in the interest of reducing the cost associated with water analysis, it is recommended that monitoring requirements on fish farm effluent should be limited to suspended solids and orthophosphate determinations as critical information.

Waste/Feed Model

To assist farmers in determining the amount of waste material contributed by their farm, methods that could be used to predict waste levels were sought. Since waste generation is directly related to the feed intake, data on feed fed and level of the different waste components measured were examined for correlations (Table 3). The analyses included 9 different crops of fish, and at least one per farm to represent the feed/nutrient relationship. The variables of highest correlation were orthophosphate, ammonia, and phosphate. Suspended solids and nitrite/nitrate were predictably low. Total Kjeldahl nitrogen tended to be biased because of the single high values, but replicate determinations were extremely variable.

Suspended solids are affected so greatly by the settling opportunity in the fish farm system that there was essentially no advantage from knowing feeding level (Fig. 97). Since suspended solids are considered a critical parameter, there appears to be no other means available but to sample the effluent for subsequent analysis. It needs to be pointed out, however, that if one was to predict the weight of suspended solids generated from the six farms based on published laboratory data per unit of feed fed, one comes up with an exaggerated estimate. Using just the published information on suspended solids generated from feed, one would estimate 123,234 kg, or over 6 times what was measured (19,637 kg) in the combined effluents (Table 4). Therefore, while it is difficult to know how much suspended solids will be in the effluent when settling opportunity is so variable among farms, the amount of suspended solid waste leaving the farms was much less than estimated from feeding level because of the positive effect settling has on removing solids.

Critical nutrients are another matter. Orthophosphate and ammonia are parameters with concentration levels highly correlated with rations fed (Table 3), and their contributions can be accurately predicted from the feeding rates on the farm. In other words, it would be as reliable to estimate orthophosphate and ammonia from feeding rates as it would be to depend on water sample analysis. It is recommended, therefore, that to determine orthophosphate and ammonia contributions in farm effluent, one should use feeding information rather than water analysis.

The question remains, however, what level of waste nutrient should be associated with a unit of feed? In the present study three waste components were examined with regard to measured amounts in the farm effluent against expected amounts based on metabolic analysis in the literature. The predicted amounts of ammonia (Fig. 98) and phosphorus (Fig. 99) were substantially higher than the measured amounts, whereas orthophosphate was reasonably close (Fig. 100).

Table 3. Nutrient levels measured per unit of feed fed on Deep Creek fish farms May 1991 to April 1992, (maximum nutrient loading used).

				Kg			
Farm #	Feed	TSS	TP	OP	Amm	N/N	TKN
1	41,600	5494	143	96	318	-83	407
2	84,875	3569	166	175	498	-68	-473
3	37,160	-7233	186	132	485	-26	493
4	162,700	-3646	393	299	1188	-214	4394
5	25,288	873	77	35	234	-156	4
6	59,156	20,601	230	117	768	111	1428
Total	410,779	19,657	1195	855	3489	-437	6253
r^2 /crop*		0.25	0.83	0.89	0.82	0.08	0.59

* r^2 = the correlation between mean weight of feed fed per day and the amount of nutrient generated per crop calculated from nutrient measurements and effluent flow.

Table 4. Amounts of waste nutrients predicted from the literature based on the feed fed compared to waste loads measured at all farm locations.

	Kg				
	Feed	TSS	TP	OP	Amm
Published conversion *		0.300	0.0076	0.0022	0.038
Predicted **	410,799	123,234	3122	904	15,733
Measured kg	410,779	19,657	1195	855	3489
Difference		103,577	1927	49	12,244
C_n ***		0.048	0.003	0.002	0.008

*(Publ. conversion rate for waste/feed unit fed)

**(Predicted kg waste from feed based on publ. conversion)

***(C_n = measured conversion waste/feed unit fed)

The analysis allows the development of a simple model to estimate the contribution of the critical nutrients in the effluent, based only on feed fed, regardless of flow rates, population inventory, or rate of biomass increase. Total waste load depends only on feed consumed, so the model follows the equation:

$$N\ kg = C_n \times kg\ feed/day,$$

Where: N = nutrient of concern
C_n = nutrient conversion constant

So: Using the C_n values listed in Table 3, if 250 kg of feed is fed on a farm, the total daily load of ammonia in the effluent will be:

$$N\ kg = .008 \times 250 = 2\ kg\ ammonia.$$

Based on the Deep Creek measured C_n for ammonia (.008), the estimated amount of ammonia in the farm pond effluent (2 kg) was 7.6 kg less than what is estimated (9.6 kg) in the literature from 250 kg of feed. The ammonia reaching the pond outlet is much lower than the metabolic ammonia produced, because it has been assimilated and exhausted in the pond.

Similarly, phosphorus (.003) and orthophosphate (.002) can be estimated using the same equation:

$$N\ kg = C_n \times kg\ feed/day$$

by substituting the C_n with P = .003 and for OP = .002:

$$N\ kg = .003 \times 250 = .75\ kg\ of\ phosphorus,\ and$$

$$N\ kg = .002 \times 250 = .50\ kg\ of\ orthophosphate.$$

However, the rate at which the waste load leaves the pond will depend on the flow through the farm. To report the waste component concentration in mg/l, it will be necessary to convert total nutrient of concern produced per day to its concentration in liters of flow per day. Total daily flow in cfs must be multiplied by liters per cubic foot (28.3) times the seconds per day (86,400) to convert flow to the proper units. Thus, in a farm producing .50 kg of orthophosphate from 250 kg of feed per day with a flow of 6 cfs, the concentration of orthophosphate in mg/l leaving the farm would be:

$$0.50\ kg/l\ /\ (28.317 \times 6 \times 86{,}400\ sec) = 0.034\ mg/l.$$

The 0.034 mg/l concentration of orthophosphate is expected in the effluent of a farm producing .50 kg of orthophosphate per day under the conditions found at Deep Creek farms.

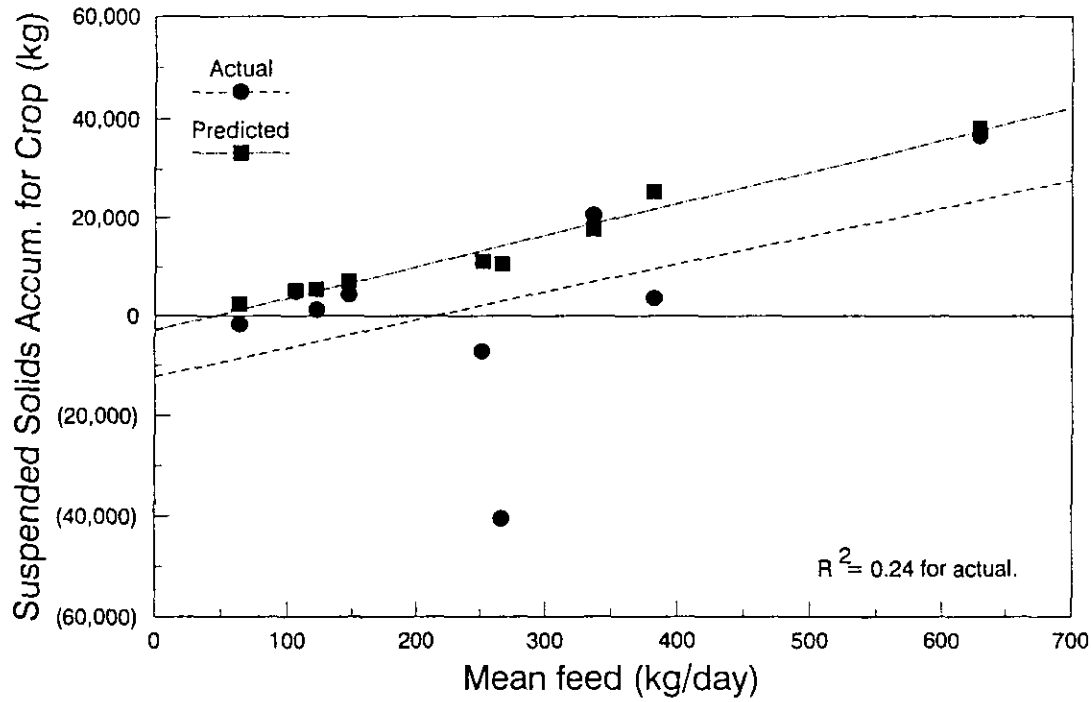


Figure 97. Actual vs. predicted total suspended solids loadings from the fish farm crops on mean feed per day.

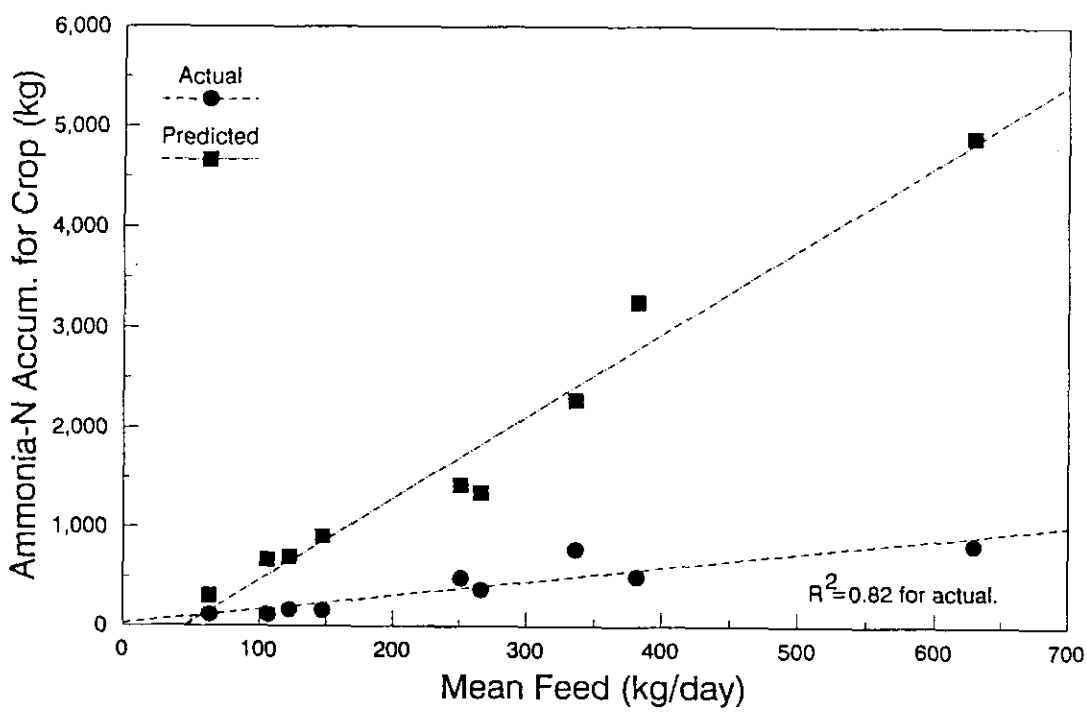


Figure 98. Actual vs. predicted ammonia-N loadings from the fish farm crops based on mean feed per day.

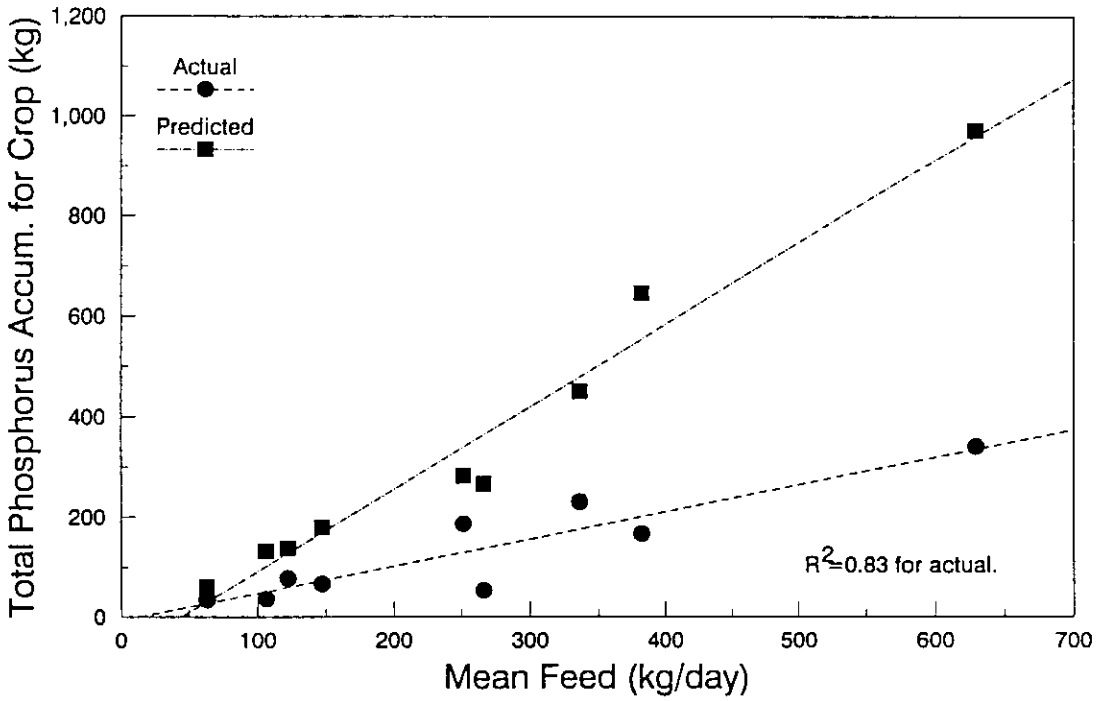


Figure 99. Actual vs. predicted total phosphorus loadings from the fish farm crops based on mean feed per day.

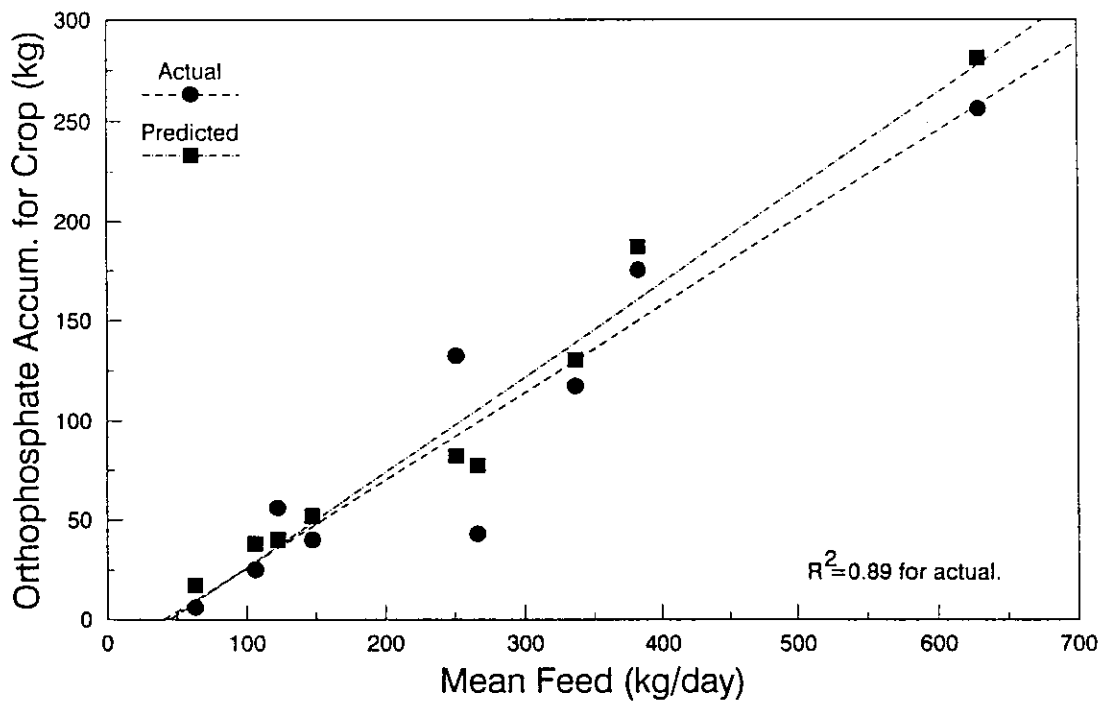


Figure 100. Actual vs. predicted orthophosphate loadings from the fish farm crops based on mean feed per day.

Nutrient Load and Contribution of Small Fish Farms

In addressing the objectives of the study to identify the nutrient load in the effluent of trout farm ponds, and to quantify the non-nutrient and nutrient contributions of the effluent, the results demonstrate that wastes generated in farm ponds are relatively small. In this study, the impacts of fish rearing operations on the non-nutrient effects of effluent water were minor, and thus its impact on the receiving stream as demonstrated would be nonexistent.

With regard to the nutrient parameters, this study demonstrated that fish farms with type C and D permits are a limited and selective source of nutrients, but the impact of such waste on the receiving stream must be carefully reassessed. Fish generate organic solid and soluble waste components. Most of that waste contribution can be removed before the effluent enters the receiving stream by use of appropriate management practices on the farm to recapture solid waste material. The nitrogen species generated may be sequestered to a large measure within the farm. The phosphorus components appeared to be the main contribution in this study, but even these can be reduced by appropriate measures. In all cases except for ammonia, the mean levels of waste in fish farm effluent were less than what was carried in the water supplying the farms. However, ammonia rapidly dissipated within a short distance downstream from the farm, and was never detectable at the mouth of Deep Creek.

The nutrient conversion constants (C_n) used in the Deep Creek study from measured nutrients generated from feed fed are believed applicable to small fish farm facilities in other systems. While different fish densities, feeding rates or less settling opportunity could affect the C_n values used to determine waste levels contributed, the level of variability in facility design and operations in this study is probably representative of small farm operations in general. Although, farms varied markedly in facility design, flows used, and even in the relative load of fish being carried, the wastes generated were not dissimilar between farms.

Attention given to settling ponds can have a substantial influence on improving effluent quality leaving a fish farm. Properly sized settling ponds will reduce solids, phosphorus, and nitrogen species in the waste stream. Settling ponds on Deep Creek farms were not sufficiently large or wide enough to maximize their efficiency, and in some cases only transferred the waste. Farm #3, however, had a settling pond that improved rearing effluent water considerably, and with expansion would represent a good model to demonstrate effectiveness of settling ponds.

Improving management practices on farm ponds may be difficult in some cases because the pond is attended primarily during stocking, feeding, and harvest operations. There is no cost benefit to the farmer for giving more attention to the farm operation. However, cleaning routine, location of the demand feeders, and a quiescent zone in the lower 20 feet of dirt ponds or at least 10 feet in raceways would provide substantial benefit in lowering contribution of waste to the receiving stream. Much of the waste contribution comes in pulses of activity by the fish. Reducing the effect of that activity by allowing sufficient distance between the fish and outlet of the pond will enhance recapture opportunity and reduction of waste material in the effluent.

Conclusions

1. The Deep Creek study showed that effluent water from fish farms using various water sources in the Deep Creek drainage was not markedly different than the quality of their water supplies. The nutrient contribution from the farms was less than the level of nutrients present in the water supplying the farms.

2. The high degree of variation in facility design and operating procedures witnessed in this study, did not transfer into variability in effluent quality. The farms demonstrated a great similarity in the composition of their effluent. This suggests that in the context of small farm or farm pond systems, the conclusions are applicable to farm pond systems in general.

3. Farms with ground (filtered) water sources made a positive net contribution of nutrients in their effluent over that of the water supply. Based on sample concentrations, total suspended solids, ammonia, and phosphorus/orthophosphate all increased as water passed through the farms. **Nitrite/nitrate showed a net decrease.**

4. Farms using surface water sources had a negative net contribution of suspended solids and nitrite/nitrate levels, and a positive net contribution of ammonia, and phosphorus/orthophosphate levels in their effluent.

5. Nitrogen and phosphorus species in the effluents were far less than predicted from the literature based on the feed consumed. The settling and biofiltration opportunities in the farm system appear to sequester the nutrients, and allow less waste to reach the receiving stream.

6. Phosphorus forms showed a mean net increase in the effluent from 0.01 to 0.06 mg/l. These levels contributed quantities that would be a little more than 5% of the phosphorus load measured at the mouth of Deep Creek.

7. Water reconditioning facilities in association with farm pond systems can function to maintain good effluent water quality, and in some cases even improve the effluent quality over the source water.

8. Solids and dissolved nutrients can be significantly reduced by incorporating sufficient settling areas below the rearing ponds. Total flow settling ponds with rich algae and macrophyte flora appear to be most desirable for capturing nutrients in farm pond systems.

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APPENDIX A

Water Quality Parameters

Water Temperature

Temperature is one of the most important natural water quality parameters in aquaculture. Metabolic functions of most aquatic organisms are regulated totally or in part by the temperature of their environment, and include respiration and digestion rates, and growth. Feeding rates of farmed fish are based on temperature, which in turn will affect the effluent nutrient loads. Temperature tolerance range for rainbow trout is 0.5 to 26 °C, though optimal temperatures are from 10.0 - 15.5 °C (Piper et al., 1982). Trout incubation temperatures should remain below 12 °C. Catfish optimum rearing temperatures range from 30 - 32 °C (Kilambi et al., 1970). Optimum spawning temperatures for catfish are 26 °C.

Dissolved Oxygen

Dissolved oxygen is another major parameter in water quality for aquaculture. The quantity of dissolved oxygen in solution at 100% saturation varies with temperature. Lower temperatures increase the quantity of oxygen that can be dissolved in a given volume of water (Table 5). Dissolved oxygen is also affected by elevation and salinity. The affect of temperature on dissolved oxygen is important in periods of warm weather when faunal activity increases the oxygen demand and the capacity for dissolve oxygen decreases. Respiration by aquatic plants and algae can reduce oxygen levels well below 3.0 mg/l when they shift from photosynthesis during the day to respiration at night. Levels below 5.8 mg/l can reduce food conversion in rainbow trout and increase waste generation (Klontz et al., 1983). However, conversion and growth are dependent on dissolved oxygen below 7.0 mg/l (Pederson, 1987).

pH

The pH is a measure of the hydrogen ion activity in a solution, or commonly the acidic or basic nature of a solution. When water exceeds pH 9 or falls below pH 5 it becomes toxic to fish. As pH increases, equilibrium between the molecular form of ammonia (NH_3 un-ionized) and the ammonium ion (NH_4^+, ionized form) shifts to the molecular ammonia which is the toxic form. However, ammonia will exhaust from the pond as gas when in the molecular form. The general trend in pH in rearing ponds will to decrease with the build up of carbon dioxide from fish respiration.

Table 5. Dissolved oxygen (mg/l) content at 100% saturation (compensated for temperature (C) and elevation (ft.), (after Klontz, 1991).

Water Temp.	Elevation (feet)									
(C)	0	500	1000	1500	2000	2500	3000	3500	4000	4500
0	14.60	14.34	14.09	13.84	13.59	13.35	13.11	12.88	12.65	12.43
1	14.20	13.95	13.70	13.46	13.22	12.98	12.75	12.53	12.30	12.08
2	13.81	13.57	13.33	13.09	12.86	12.63	12.41	12.19	11.97	11.76
3	13.45	13.21	12.97	12.74	12.52	12.29	12.07	11.86	11.65	11.44
4	13.09	12.86	12.63	12.41	12.19	11.97	11.76	11.55	11.34	11.14
5	12.76	12.53	12.31	12.09	11.87	11.66	11.46	11.25	11.05	10.85
6	12.44	12.21	12.00	11.78	11.57	11.37	11.17	10.97	10.77	10.58
7	12.13	11.91	11.70	11.49	11.29	11.09	10.89	10.69	10.50	10.32
8	11.83	11.62	11.41	11.21	11.01	10.81	10.62	10.43	10.25	10.06
9	11.55	11.34	11.14	10.94	10.75	10.55	10.37	10.18	10.00	9.82
10	11.28	11.08	10.88	10.68	10.49	10.31	10.12	9.94	9.76	9.59
11	11.02	10.82	10.63	10.44	10.25	10.07	9.89	9.71	9.54	9.37
12	10.77	10.57	10.38	10.20	10.02	9.84	9.66	9.49	9.32	9.15
13	10.53	10.34	10.15	9.97	9.79	9.62	9.44	9.27	9.11	8.95
14	10.29	10.11	9.93	9.75	9.58	9.40	9.24	9.07	8.91	8.75
15	10.07	9.89	9.71	9.54	9.37	9.20	9.02	8.87	8.71	8.56
16	9.86	9.68	9.51	9.34	9.17	9.00	8.84	8.68	8.53	8.37
17	9.65	9.48	9.31	9.14	8.98	8.81	8.66	8.50	8.35	8.20
18	9.45	9.28	9.12	8.95	8.79	8.63	8.48	8.32	8.17	8.03
19	9.26	9.09	8.93	8.77	8.61	8.46	8.30	8.15	8.01	7.86
20	9.08	8.91	8.75	8.59	8.44	8.29	8.14	7.99	7.84	7.70
21	8.90	8.74	8.58	8.42	8.27	8.12	7.98	7.83	7.69	7.55
22	8.73	8.57	8.41	8.26	8.11	7.96	7.82	7.68	7.54	7.40
23	8.56	8.40	8.25	8.10	7.96	7.81	7.67	7.53	7.39	7.26
24	8.40	8.25	8.10	7.95	7.81	7.66	7.52	7.39	7.25	7.12
25	8.24	8.09	7.95	7.80	7.64	7.52	7.38	7.25	7.12	6.99
26	8.09	7.95	7.80	7.66	7.52	7.38	7.25	7.11	6.98	6.86
27	7.95	7.80	7.66	7.52	7.38	7.25	7.11	6.98	6.86	6.73
28	7.81	7.66	7.52	7.39	7.25	7.12	6.99	6.86	6.73	6.61
29	7.67	7.53	7.39	7.26	7.12	6.99	6.86	6.74	6.61	6.49
30	7.54	7.40	7.26	7.13	7.00	6.87	6.74	6.62	6.50	6.38

Specific Conductance

Specific conductance measures the water's capacity to conduct an electrical current, and is an indicator of the quantity of dissolved mineral material in the water. The conductivity of most fresh waters ranges from 50 - 1000 µmhos/cm (APHA et al., 1989). There are no measured tolerances available for trout, although conductivity of distilled water would lack of salts required for ion exchange and the removal of wastes across the gills. The reference temperature for specific conductivity is 25°C, though 18°C is often used in limnological research (Wetzel, 1975). The specific conductivity changes approximately 2% per degree C change in temperature.

Turbidity, Settleable Solids, Total Suspended Solids

Turbidity is a measure of light interference from a water sample, the lower the turbidity the greater percent of light that can pass through the sample. Turbidity is an indication of water clarity and is measured in (NTUs). Settleable solids are measured in Imhoff cones. The quantity of solids which collects at the bottom of the liter-graduated cone in one hour is referred to as settleable solids. Total suspended solids (TSS) is a measure of suspended and settleable material collected from a known quantity of water passed through a filter and dried. Turbidity and TSS are not always correlated, and will depend on the type of material suspended. The recommended tolerances for salmonids are 50 NTU (Lloyd, 1987), settleable solids of <80 mg/l, and TSS <80.0 mg/l (Piper et al., 1982).

Ammonia, Nitrite/Nitrate, Total Kjeldahl Nitrogen

Ammonia species concentrations are reported as either mg/l or ppm nitrogen. Ammonia is also reported as NH_3-N (ammonia in ppm of nitrogen), as moles/liter and as NH_3-NH_4^+ (ammonia in ppm total ammonia). Ammonia is naturally excreted by fish as a by-product of basic metabolism. Fish farms contribute ammonia to the aquatic environment, but this is quickly lost through aeration and bacterial oxidation/ metabolism. Epiphytic bacteria on wetted surface areas of the pond assist in nitrification of ammonia to nitrite, and nitrite to harmless nitrate. Ammonia is usually reported as total ammonia, the combination of NH_3- (un-ionized) and NH_4^+ (ammonium ion) forms. The actual quantity of each

form is determined by the pH and temperature (Table 6). Molecular or un-ionized ammonia should not exceed .0125 mg/l (Piper et al., 1982).

Nitrite/nitrate nitrogen in some procedures is a single measurement. Nitrite which can be the most harmful to fish is usually rapidly oxidized to nitrate. Nitrite (NO_2-N) should not exceed 0.03 mg/l in soft water, or 0.06 mg/l in hard water (Piper et al., 1982). Toxicity of nitrite is reduced as hardness and or chloride concentrations increase. Nitrate can be harmful at moderate levels above 10 mg/l.

Total Kjeldahl nitrogen is a method in which to measure organic nitrogen found in a water sample. Total Kjeldahl nitrogen minus ammonia nitrogen provides an estimate of organic nitrogen. Organic nitrogen can be a limiting factor in aquatic systems. The degree of variability in the total Kjeldahl analysis, however, makes the parameter of limited use. Tolerance for total Kjeldahl nitrogen is not available.

Total Phosphorus, Orthophosphate

Phosphorus is essential for aquatic life and often regarded as a limiting factor in freshwater environments, with only certain species of phosphorus available for use by algae and aquatic plants. Total phosphorus is a common water quality parameter and includes both the dissolved and solid forms of phosphorus.

Dissolved phosphate and orthophosphate are other commonly used parameters often referred to as reactive phosphorus or dissolved phosphate. This form is readily assimilated by plants and often the limiting nutrient for plant growth. Bacterial breakdown of organic material increases the available phosphorus for utilization by rooted plants, algae and other aquatic organisms.

The quantity and species of phosphorus reported for water quality is dependent upon the analytical procedure that is performed on the sample by the laboratory. Commonly, total phosphorus (unfiltered) and orthophosphate (filtered) are utilized as water quality parameters.

Table 6. Percentage of un−ionized ammonia in aqueous solution at different pH values and temperatures, (Boyd and Tucker, 1992).

	Temperature (C)								
pH	16	18	20	22	24	26	28	30	32
7.0	0.30	0.34	0.40	0.46	0.52	0.60	0.70	0.81	0.95
7.2	0.47	0.54	0.63	0.72	0.82	0.95	1.10	1.27	1.50
7.4	0.74	0.86	0.99	1.14	1.30	1.50	1.73	2.00	2.36
7.6	1.17	1.35	1.56	1.79	2.05	2.35	2.72	3.13	3.69
7.8	1.84	2.12	2.45	2.80	3.21	3.68	4.24	4.88	5.72
8.0	2.88	3.32	3.83	4.37	4.99	5.71	6.55	7.52	8.77
8.2	4.49	5.16	5.94	6.76	7.68	8.75	10.00	11.41	13.22
8.4	6.93	7.94	9.09	10.30	11.65	13.20	14.98	16.96	19.46
8.6	10.56	12.03	13.68	15.40	17.28	19.42	21.83	24.45	27.68
8.8	15.76	17.82	20.08	22.38	24.88	27.64	30.68	33.90	37.76
9.0	22.87	25.57	28.47	31.37	34.42	37.71	41.23	44.84	49.02
9.2	31.97	35.25	38.69	42.01	45.41	48.96	52.65	56.30	60.38
9.4	42.68	46.32	50.00	53.45	58.86	60.33	63.79	67.12	70.72
9.6	54.14	57.77	61.31	64.54	67.63	70.67	73.63	76.39	79.29
9.8	65.17	68.43	71.53	74.25	76.81	79.25	81.57	83.68	85.85
10.0	74.78	77.46	79.92	82.05	84.00	85.82	87.52	89.05	90.58
10.2	82.45	88.48	86.32	87.87	89.27	90.56	91.75	92.80	93.84

The quantity and, in part, the form of phosphorus excreted by fish is dependent upon the phosphorus composition of the feed. The more common forms of phosphorus excreted by farm-raised fish are the soluble forms of organic P and PO_4^3 which can affect water quality directly (Lall, 1991) and utilized by algae and other aquatic organisms, whereas the particulates can settle to the bottom and undergo decomposition and release of nutrients into the system. The phosphorus tolerance limit for trout is 0.01 - 3.0 mg/l (Piper et al., 1986).

Chloride

Chloride is a major inorganic anion in water and waste water. This is a "stable" element and useful to measure dilution loss reaction ratios. Chloride is important for maintenance of acid-base balance, electrolyte regulation and excretion of waste products. For freshwater fish concentrations >400 mg/l may be harmful. Chloride is reported to be used by catfish farmers during periods of elevated nitrite levels. The chloride helps the fish to control the nitrite uptake (Aquacenter, 1993).

APPENDIX B

Farm #1 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #1 sample data and calculations.

Sample #	DATE	Sample Day #	F F #	Flow cfs	VOL l/day	TSS in mg/day	TSS out mg/day	TSS diff mg/l					TSS Load kg/day	Accum kg/crop
1	19 May 91	139	1	2.18	5332245.1	16.00	10.00	−6.00			−6.00		−31.99	
2	30 May	150	1	5	12229920.0	0.00	1.00	1.00			11	−27.5	12.23	−108.70
3	12 June	163	1	5.29	12939255.4	8.00	10.00	2.00			26	19.5	25.88	139.01
4	25 June	176	1	3.9	9539337.6	3.00	0.50	−2.50			−32.5	−3.25	−23.85	152.20
5	15 July	196	1	4.88	11936401.9	3.00	2.00	−1.00			−20	−35	−11.94	−205.65
6	24 July	205	1	5.24	12816956.2	4.00	3.50	−0.50			−4.5	−6.75	−6.41	−288.20
7	12 Aug	224	1	5.34	13061554.6	0.00	39.00	39.00	3.17	509.40	60.23	25.365	41.41	553.67
8	28 Aug	240	1	5.34	13061554.6	3.00	10.00	7.00	**(see below)		112	81.36	91.43	1616.36
9	10 Sept	253	1	6.14	15018341.8	2.00	8.00	6.00			78	84.5	90.11	2796.37
10	2 Oct	275	1	5.88	14382385.9	2.50	5.00	2.50			55	93.5	35.96	**4255.01**
11	8 Oct	281	NF*			0.50					2.0531617	1.7038602		
12	28 Oct	301	1	5.76	14088867.8	2.50	3.00	0.50			0.5	10	7.04	35.22
13	10 Nov	314	1	5.28	12914795.5	1.00	4.00	3.00			39	22.75	38.74	332.85
14	25 Nov	329	1	5.47	13379532.5	3.50	4.00	0.50			7.5	26.25	6.69	673.61
15	10 Dec	344	1	5.66	13844269.4	2.50	1.50	−1.00			−15	−3.75	−13.84	619.95
16	16 Jan 92	381	1	5.14	12572357.8	0.50	1.00	0.50			18.5	−9.25	6.29	480.12
17	22 Jan	387	1	4.44	10860169.0	3.50	9.00	5.50			33	18	59.73	678.17
18	4 Feb	400	1	4.64	11349365.8	2.00	3.00	1.00			13	42.25	11.35	1140.20
19	11 March	436	1	3.2	7827148.8	1.00	0.50	−0.50			−18	9	−3.91	**1238.82**
20	1 April	457	NF	0	0.0	4.00								
21	22 April	478	NF	0	0.0	2.00					0.5814814	0.8537037		
			ACCUMULATIVE LOADINGS DURING REARING OPERATIONS											5493.83
			MEAN	All samples		3.07	6.39	3.17	1.17				18.61	
			MEAN	Rearing		3.22	6.39	3.17	1.06	(w/out 39.00)			18.61	
			MEAN	Irrigation		3.67	8.09	4.32					20.26	
			MEAN	Non−irrigat		2.28	3.25	1.19					14.01	

*NF = No fish in facility

** demossing operations during sampling, this lasted only a few hours, the rearing mean was used for calculations

TP in	TP out	TP diff					TP load	Accum	OP in	OP out	OP diff				
mg/day	mg/day	mg/l					kg/day	kg/crop	mg/l	mg/l	mg/l				
0.03	0.07	0.04				0.04	0.21		0.03	0.06	0.03				
0.03	0.07	0.04				0.52	0.38	11.00							
0.04	0.09	0.04				0.87	0.52	20.01	0.03	0.06	0.03				
0.05	0.31	0.26	0.05	(0.31)	3.40	4.94	0.65	39.82	0.04	0.07	0.03				
0.05	0.10	0.05				0.808	0.66	50.32	0.05	0.08	0.02				
0.07	0.10	0.03				0.39	0.45	57.54	0.06	0.08	0.02				
0.05	0.07	0.02				0.44	0.29	**66.23**	0.05	0.06	0.01				
0.06						0.05888			0.03						
0.06	0.08	0.02				0.3	0.21	1.06	0.04	0.06	0.02				
0.06	0.10	0.03				0.39	0.39	4.95	0.03	0.04	0.01				
0.04	0.08	0.04				0.6	0.54	11.87	0.02	0.04	0.02				
0.05	0.07	0.02				0.3	0.28	17.96	0.02	0.04	0.02				
0.03	0.08	0.06				2.035	0.69	35.87	0.03	0.07	0.04				
0.03	0.10	0.07				0.42	0.76	40.23	0.01	0.07	0.06				
0.03	0.09	0.06				0.78	0.68	49.60	0.03	0.08	0.05				
0.04	0.11	0.07				2.52	0.55	**76.65**	0.04	0.09	0.05				
0.03									0.02						
0.06						0.05440			0.02						
								142.88							
0.04	0.10	0.06					0.48		0.03	0.06	0.03				
0.04	0.10	0.05	0.04	(w/o 0.26)			0.48		0.03	0.06	0.03				
0.05	0.11	0.05					0.45		0.04	0.07	0.02				
0.04	0.09	0.05					0.51		0.03	0.06	0.03				

OP Load	Accum	TURB in	TURB out	TURB diff			SET in	SET out	SET diff			AM in	AM out	AM diff		
kg/day	kg	NTU	NTU	NTU			ml/l	ml/l	ml/l			mg/l	mg/l	mg/l		
0.13		0.21	0.68	0.47			0.05	0.05	0.00			0.05	0.16	0.11		
		0.20	0.52	0.32			0.05	0.05	0.00			0.05	0.31	0.26		
		0.25	1.50	1.25			0.05	0.05	0.00			0.05	0.16	0.11		
		0.60	0.65	0.05			0.05	0.05	0.00			0.05	0.18	0.13		
0.37	14.35	0.14	0.42	0.28			0.05	0.05	0.00			0.05	0.22	0.17		
		0.24	0.34	0.10			0.05	0.05	0.00			0.05	0.05	0.00		
0.39	25.01	0.08	6.95	6.87			0.05	0.25	0.20			0.05	0.05	0.00		
0.31	30.65	0.20	0.40	0.20			0.05	0.05	0.00			0.05	0.15	0.10		
0.30	34.64	1.05	2.10	1.05			0.05	0.05	0.00			0.05	0.08	0.03		
0.14	39.82	0.15	0.20	0.05			0.05	0.05	0.00			0.05	0.15	0.10		
		0.10					0.05					0.05				
0.28	1.41	0.95	1.55	0.60			0.05	0.05	0.00			0.05	0.05	0.00		
0.13	4.08	1.35	1.15	−0.20			0.05	0.05	0.00			0.05	0.05	0.00		
0.27	7.06	0.24	0.58	0.34			0.05	0.05	0.00			0.05	0.11	0.06		
0.28	11.14	0.32	0.49	0.17			0.05	0.05	0.00			0.05	0.05	0.00		
0.50	25.56	0.40	0.65	0.25			0.05	0.05	0.00			0.05	0.20	0.15		
0.65	29.03	0.40	0.70	0.30			0.05	0.05	0.00			0.05	0.20	0.15		
0.51	36.58	0.08	0.04	−0.04			0.05	0.05	0.00			0.05	0.20	0.15		
0.39	56.34	0.10	0.75	0.65			0.05	0.05	0.00			0.05	0.30	0.25		
		0.90					0.05					0.05				
		0.90					0.05					0.05				
	96.16															
0.33		0.42	1.09	0.71			0.05	0.06	0.01			0.05	0.15	0.10		
0.33		0.39	1.09	0.71			0.05	0.06	0.01			0.05	0.15	0.10		
0.28		0.34	1.38	1.06			0.05	0.07	0.02			0.05	0.15	0.10		
0.38		0.53	0.74	0.26			0.05	0.05	0.00			0.05	0.15	0.10		

		AM load	Accum	N/N in	N/N out	N/N diff					N/N load	Accum	TKN in	TKN out
		kg/day	kg	mg/l	mg/l	mg/l					kg/day	kg	mg/l	mg/l
		0.59		4.59	4.72	0.13					0.69		0.02	0.02
		3.18	20.71	4.64	4.56	−0.08					−1.04	−1.90		
		1.42	50.63	3.95	3.86	−0.09					−1.16	−16.23	0.30	0.73
		1.24	67.95	3.85	3.74	−0.12					−1.10	−30.93		
		2.03	100.64	4.00	3.87	−0.13					−1.49	−56.82	0.02	0.02
		0.00	109.77	4.10	3.95	−0.15					−1.92	−72.19		
		0.00	109.77	4.55	4.45	−0.10					−1.31	−102.86	0.02	0.76
		1.31	120.22	4.30	4.24	−0.06					−0.78	−119.58		
		0.45	131.64	4.65	4.65	0.00					0.00	−124.67	0.76	0.64
		1.44	**155.29**	4.40	4.28	−0.12					−1.73	**−147.11**	0.02	0.73
				4.21										
		0.00	0.00	4.59	4.60	0.00					0.07	0.35		
		0.00	0.00	4.54	4.50	−0.04					−0.58	−2.97	0.02	0.02
		0.80	6.02	4.59	4.55	−0.04					−0.54	−11.34		
		0.00	12.04	4.40	4.50	0.10					1.38	−4.97	0.02	0.02
		1.89	46.93	4.90	5.10	0.20					2.51	67.16	0.30	0.75
		1.63	57.47	4.90	4.90	0.00					0.00	74.70		
		1.70	79.13	4.90	4.90	0.00					0.00	74.70	0.80	0.90
		1.96	**162.61**	4.80	4.75	−0.05					−0.39	**64.14**	1.00	0.30
				5.10										
				4.95										
			317.90									−82.97		
		1.09		4.52	4.45	−0.03					−0.41		0.30	0.44
		1.09		4.48	4.45	−0.03					−0.41		0.30	0.44
		1.17		4.35	4.23	−0.07					−0.98		0.19	0.48
		1.00		4.75	4.72	0.02					0.31		0.43	0.40

TKN diff					TKN load	Accum		Sample	TEMP		TEMP	TEMP	DO in	DO out	DO diff	
mg/l					kg/day	Kg	CFS	Time	in		out	diff	mg/l	mg/l	mg/l	
0.00					0.00		2.18	9.30	12.50		12.50	0.00	9.10	7.10	−2.00	
							5.00	15.45	12.80		14.30	1.50	8.80	7.80	−1.00	
0.43					5.56	66.77	5.29	15.15	13.30		15.00	1.70	9.30	7.40	−1.90	
							3.90	7.30	12.30		12.00	−0.30	8.60	6.40	−2.20	
0.00					0.00	158.57	4.88	15.15	13.10		14.80	1.70	8.90	6.40	−2.50	
							5.24	20.45	12.60		12.80	0.20	8.10	6.50	−1.60	
0.74					1.18	175.03	5.34	14.20	12.70		14.20	1.50	8.30	5.40	−2.90	
							5.34	10.40	12.90		13.30	0.40	8.90	7.30	−1.60	
−0.12					−1.73	167.03	6.14	18.30	12.80		12.60	−0.20	8.70	7.20	−1.50	
0.71					10.21	**280.78**	5.88	9.00	12.90		12.80	−0.10	8.30	6.80	−1.50	
								18.00	12.80							
							5.76	10.05	13.00		12.50	−0.50	8.80	9.20	0.40	
0.00					0.00	0.00	5.28	8.45	12.60		12.00	−0.60	11.60	7.50	−4.10	
							5.47	8.45	12.70		12.30	−0.40	9.00	8.80	−0.20	
0.00					0.00	0.00	5.66	13.00	13.10		12.40	−0.70	8.50	7.60	−0.90	
0.45					5.66	189.53	5.14	9.50	12.70		11.70	−1.00	8.90	8.30	−0.60	
							4.44	11.15	12.50		12.00	−0.50	9.20	8.20	−1.00	
0.10					1.13	254.06	4.64	9.50	12.10		11.20	−0.90	9.20	7.20	−2.00	
−0.70					−5.48	126.55	3.20	8.45	12.60		12.10	−0.50	9.20	6.50	−2.70	
							0.00	14.20	14.20							
							0.00	11.50	12.70				9.50			
						407.33										
0.15					1.50		4.44		12.80		12.81	0.07	8.99	7.31	−1.66	
0.15					1.50		4.93		12.73		12.81	0.07	8.97	7.31	−1.66	
0.29					2.54		4.47		12.78		13.43	0.64	8.77	6.83	−1.87	
−0.03					0.26		4.40		12.83		12.03	−0.64	9.30	7.91	−1.39	

	CON in	CON out	CON diff			pH	pH	pH			CHL in	CHL out	CHL diff			
	uhmos	uhmos	uhmos			In	out	diff			mg/l	mg/l	mg/l			
	700.00	700.00	0.00			7.54	7.52	−0.02			47.92	46.53	−1.39			
	690.00	700.00	10.00			7.68	7.74	0.06								
	700.00	700.00	0.00			7.88	7.56	−0.32			47.00	46.52	−0.48			
	700.00	700.00	0.00			7.69	7.69	0.00								
	690.00	710.00	20.00			7.33	7.59	0.26			46.06	45.28	−0.78			
	700.00	700.00	0.00			7.34	7.53	0.19								
	690.00	710.00	20.00			7.45	7.64	0.19			39.60	38.20	−1.40			
	690.00	700.00	10.00			7.56	7.62	0.06								
	700.00	690.00	−10.00								42.20	41.60	−0.60			
	690.00	680.00	−10.00			7.53	7.70	0.17			40.51	38.50	−2.01			
	700.00					8.02										
	700.00	690.00	−10.00			7.91	7.95	0.04								
	700.00	695.00	−5.00			7.71	7.94	0.23			36.80	35.30	−1.50			
	700.00	690.00	−10.00			7.33	7.87	0.54								
	700.00	700.00	0.00			7.93	8.01	0.08			37.50	38.00	0.50			
	705.00	700.00	−5.00			7.93	7.89	−0.04			43.60	43.40	−0.20			
	700.00	700.00	0.00			8.00	8.02	0.02								
	700.00	700.00	0.00			7.43	7.78	0.35			42.00	42.00	0.00			
	700.00	700.00	0.00			7.63	7.72	0.09			42.20	41.70	−0.50			
	700.00					7.40										
	680.00					7.59					44.50					

	696.90	698.06	0.56			7.64	7.75	0.11			42.49	41.55	−0.76			
	697.50	698.06	0.56			7.64	7.75	0.11			42.31	41.55	−0.76			
	694.17	635.45	3.64			7.60	6.86	0.06			43.97	42.77	−1.11			
	700.56	696.88	−3.75			7.70	7.90	0.16			40.42	40.08	−0.34			

	CHL kg/day	CHL Accum
	−7.41	
	−6.21	−163.47
	−9.31	−419.57
	−18.29	−805.92
	−9.01	−1201.73
	−28.91	**−1676.67**
	−21.13	−105.67
	−19.37	−368.95
	6.92	−555.70
	−2.51	−474.16
	0.00	−498.05
	−3.91	**−603.72**
		−2280.38
	−8.91	
	−9.93	
	−13.19	
	−3.78	

APPENDIX C

Farm #2 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #2 sample data and calculations.

Sample		Sample	F F	Flow	VOL	TSS in	TSS out	TSS diff	TSS PS	PS diff	PS Load	Accum	TSS Load	Accum
#	DATE	Day #	#	cfs	l/day	mg/day	mg/day	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg/crop
1	19 May 91	139	NF	4.56	11153687.0	16.00								
2	30 May	150	NF	4.56	11153687.0	3.00								
3	12 June	163	NF	5.77	14113327.7	18.00								
4	25 June	176	NF	2.45	5992660.8	4.50								
5	15 July	196	2	5.64	13795349.8	3.50	3.00	−0.50	2.50	−1.00	−13.80	−262.11	−6.90	−131.06
6	24 July	205	2	6.96	17024048.6	3.00	3.50	0.50	2.00	−1.00	−17.02	−400.80	8.51	−123.79
7	12 Aug	224	2	5.88	14382385.9	2.50	2.00	−0.50	5.00	2.50	35.96	−220.95	−7.19	−111.24
8	28 Aug	240	2	7.2	17611084.8	9.50	4.00	−5.50	9.00	−0.50	−8.81	−3.74	−96.86	−943.66
9	10 Sept	253	2	7.48	18295960.3	10.50	9.00	−1.50	10.00	−0.50	−9.15	−120.44	−27.44	−1751.64
10	2 Oct	275	2	7.48	18295960.3	5.50	6.50	1.00	8.50	3.00	54.89	382.70	18.30	−1852.27
11	8 Oct	281	2	7.17	17537705.3	3.00	2.00	−1.00	1.00	−2.00	−35.08	442.14	−17.54	−1850.00
12	28 Oct	301	2	6.2	15165100.8	3.50	3.00	−0.50	6.50	3.00	45.50	546.33	−7.58	−2101.20
13	10 Nov	314	2	5.63	13770889.9	3.00	10.00	7.00	2.50	−0.50	−6.89	797.30	96.40	−1523.91
14	25 Nov	329	2	6.13	14993881.9	1.50	4.50	3.00	2.50	1.00	14.99	858.11	44.98	−463.58
15	10 Dec	344	2	5.83	14260086.7	4.00	2.50	−1.50	6.00	2.00	28.52	1184.47	−21.39	−286.64
16	16 Jan 92	381	2	6.08	14871582.7	1.00	2.00	1.00	3.00	2.00	29.74	2262.34	14.87	−407.23
17	22 Jan	387	2	7.73	18907456.3	2.00	10.50	8.50	8.50	6.50	122.90	2720.26	160.71	119.52
18	4 Feb	400	2	6.22	15214020.5	2.50	12.50	10.00	3.00	0.50	7.61	**3568.55**	152.14	**2153.07**
19	11 Mar	436	NF	2.56	6261719.0	1.00	3.00	2.00					12.52	
20	1 April	457	NF											
21	22 April	478	NF			2.00								
ACCUMULATIVE LOADINGS DURING REARING OPERATIONS												3568.55		2153.07
MEAN	All samples					4.98	5.20	1.47	5.00	1.07	17.81		21.57	
MEAN	Rearing					3.93	5.36	1.43	5.00	1.07	17.81		22.21	
MEAN	Irrigation					6.75	4.29	−1.07	5.43	0.07	1.00		−18.45	
MEAN	Non−irrigat					2.31	6.00	3.69	4.57	2.07	34.62		56.58	

TP in	TP out	TP diff	TP PS	PS diff	PS Load	Accum	TP load	Accum	OP in	OP out	OP diff	OP PS	PS diff	PS Load	Accum
mg/day	mg/day	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg/crop	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg
0.04									0.04						
0.05															
0.05	0.07	0.03	0.08	0.03	0.41	7.86	0.39	7.47	0.04	0.05	0.01	0.07	0.02	0.31	5.90
0.05	0.11	0.07	0.11	0.06	0.86	25.74	0.93	26.06	0.05	0.09	0.05	0.08	0.03	0.43	16.28
0.27	0.14	−0.13	0.14	−0.13	−2.25	14.68	−2.24	15.65	0.05	0.11	0.06	0.10	0.04	0.77	25.86
0.13	0.14	0.01	0.16	0.03	0.55	3.65	0.18	2.30	0.11	0.11	0.01	0.12	0.01	0.18	32.03
0.06	0.12	0.07	0.14	0.08	1.46	25.79	1.19	17.39	0.05	0.10	0.05	0.09	0.04	0.73	42.10
0.09	0.16	0.08	0.12	0.03	0.61	32.02	1.32	24.91	0.02	0.09	0.07	0.07	0.05	0.88	46.92
0.06	0.13	0.07	0.12	0.07	0.99	48.02	1.06	48.68	0.05	0.10	0.05	0.09	0.04	0.61	61.76
0.07	0.14	0.07	0.15	0.09	1.17	62.03	0.96	61.84	0.04	0.10	0.06	0.09	0.05	0.69	70.18
0.02	0.09	0.07	0.07	0.05	0.75	76.43	1.05	76.94	0.03	0.10	0.07	0.09	0.06	0.82	81.52
0.06	0.12	0.06	0.12	0.06	0.86	88.47	0.86	91.23	0.02	0.09	0.07	0.07	0.05	0.71	93.06
0.03	0.12	0.09	0.13	0.10	1.41	130.44	1.34	131.82	0.02	0.09	0.07	0.09	0.07	1.04	125.51
0.03	0.14	0.11	0.14	0.11	1.99	140.63	2.08	142.08	0.02	0.10	0.08	0.09	0.07	1.32	132.60
0.03	0.14	0.11	0.05	0.02	0.30	**155.52**	1.67	**166.47**	0.03	0.09	0.07	0.04	0.02	0.23	**142.69**
0.06	0.05	−0.01							0.05	0.05	0.00				
0.05									0.04						
						155.52		166.47							142.69
0.07	0.12	0.05	0.12	0.05	0.70		0.83		0.04	0.09	0.05	0.08	0.04	0.67	
0.07	0.12	0.05	0.12	0.05	0.70		0.83		0.04	0.09	0.05	0.08	0.04	0.67	
0.08	0.12	0.02	0.12	0.02	0.28		0.30		0.05	0.09	0.04	0.09	0.03	0.55	
0.04	0.12	0.07	0.11	0.07	1.07		1.29		0.03	0.09	0.06	0.08	0.05	0.78	

OP Load	Accum	TURB in	TURB out	TURB diff	TURB PS	PS diff	SET in	SET out	SET diff	SET PS	PS diff	AM in	AM out	AM diff	AM PS	PS diff
kg/day	kg	NTU	NTU	NTU	NTU	NTU	ml/l	ml/l	ml/l	ml/l	ml/l	mg/l	mg/l	mg/l	mg/l	mg/l
		0.83					0.05					0.05				
		0.18					0.05					0.05				
		1.75					0.05					0.05				
		1.65					0.05					0.05				
0.17	3.15	0.47	0.58	0.11	0.53	0.06	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.21	0.16
		0.30	0.35	0.05	0.47	0.17	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
0.65	14.52	0.52	0.74	0.22	0.70	0.17	0.05	0.05	0.00	0.05	0.00	0.05	0.16	0.11	0.21	0.16
1.10	28.51	0.40	0.90	0.50	1.05	0.65	0.05	0.05	0.00	0.05	0.00	0.05	0.24	0.19	0.29	0.24
0.09	36.26	3.20	2.55	−0.65	2.90	−0.30	0.05	0.05	0.00	0.05	0.00	0.05	0.15	0.10	0.15	0.10
0.91	47.33	0.75	0.80	0.05	0.85	0.10	0.05	0.05	0.00	0.05	0.00	0.05	0.18	0.13	0.18	0.13
1.23	53.75	1.30	1.35	0.05	1.40	0.10	0.05	0.05	0.00	0.05	0.00	0.05	0.31	0.26	0.31	0.26
0.76	73.61	1.25	1.30	0.05	1.35	0.10	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
0.83	83.91	0.95	0.70	−0.25	0.95	0.00	0.05	0.05	0.00	0.05	0.00	0.05	0.10	0.05	0.11	0.06
1.05	97.98	0.98	0.70	−0.28	0.82	−0.16	0.05	0.05	0.00	0.05	0.00	0.05	0.16	0.11	0.17	0.12
1.00	113.34	0.79	0.48	−0.31	0.71	−0.09	0.05	0.05	0.00	0.05	0.00	0.05	0.20	0.15	0.30	0.25
1.04	151.06	0.35	0.85	0.50	0.70	0.35	0.05	0.05	0.00	0.05	0.00	0.05	0.30	0.25	0.25	0.20
1.51	158.72	0.50	1.00	0.50	1.20	0.70	0.05	0.10	0.05	0.05	0.00	0.05	0.20	0.15	0.20	0.15
0.99	**174.98**	0.15	3.80	3.65	0.25	0.10	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
		0.45	0.90	0.45			0.05	0.05	0.00			0.05	0.05	0.00		
		1.00					0.05					0.05				
	174.98															
0.87		0.89	1.13	0.31	0.99	0.14	0.05	0.05	0.00	0.05	0.00	0.05	0.15	0.10	0.18	0.13
0.87		0.85	1.15	0.30	0.99	0.14	0.05	0.05	0.00	0.05	0.00	0.05	0.16	0.11	0.18	0.13
0.69		1.03	1.04	0.05	1.13	0.14	0.05	0.05	0.00	0.05	0.00	0.05	0.16	0.11	0.20	0.15
1.02		0.68	1.22	0.54	0.85	0.14	0.05	0.06	0.01	0.05	0.00	0.05	0.14	0.09	0.16	0.11

PS Load	Accum	AM load	Accum	N/N in	N/N out	N/N diff	N/N PS	PS diff	PS Load	Accum	N/N load	Accum	TKN in	TKN out
kg/day	PS kg	kg/day	kg	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg	mg/l	mg/l
				5.26									0.02	
				6.07										
				3.91									0.38	
				3.97										
2.21	41.94	0.00	0.00	5.06	4.98	−0.08	5.01	−0.05	−0.70	−13.37	−1.05	−19.92	0.02	0.02
0.00	51.87	0.00	0.00	5.25	5.20	−0.05	5.20	−0.05	−0.85	−20.36	−0.85	−28.47		
2.23	73.05	1.51	14.35	5.25	5.15	−0.10	5.05	−0.20	−2.88	−55.78	−1.44	−50.22	0.02	0.23
4.23	124.70	3.35	53.20	5.05	4.92	−0.13	5.00	−0.04	−0.79	−85.13	−2.29	−80.04		
1.83	164.06	1.83	86.84	4.65	5.10	0.45	5.05	0.40	7.32	−42.71	8.23	−41.41	2.15	0.43
2.29	209.34	2.29	132.12	4.92	4.77	−0.16	4.84	−0.08	−1.46	21.69	−2.84	17.96	1.30	0.68
4.56	229.88	4.56	152.66	4.77	4.63	−0.14	4.69	−0.08	−1.40	13.09	−2.46	2.09		
0.00	275.48	0.00	198.26	5.24	5.22	−0.03	5.20	−0.04	−0.61	−7.01	−0.38	−26.25		
0.83	280.85	0.69	202.74	5.31	5.18	−0.13	5.25	−0.06	−0.83	−16.32	−1.79	−40.35	0.02	0.02
1.80	300.54	1.65	220.27	5.55	5.39	−0.16	5.50	−0.05	−0.75	−28.14	−2.40	−71.77		
3.57	340.78	2.14	248.68	5.30	5.20	−0.10	5.30	0.00	0.00	−33.76	−1.43	−100.46	0.02	0.02
2.97	461.75	3.72	357.03	5.50	5.40	−0.10	5.45	−0.05	−0.74	−47.52	−1.49	−154.35	0.05	0.30
2.84	479.19	2.84	376.70	5.30	5.20	−0.10	5.20	−0.10	−1.89	−55.42	−1.89	−164.49		
0.00	**497.62**	0.00	**395.13**	5.30	5.10	−0.20	5.30	0.00	0.00	**−67.71**	−3.04	**−196.56**	0.70	1.10
				5.10	5.10	0.00					0.00		0.50	0.20
				5.50									1.30	
	497.62		395.13							−67.71		−196.56		
2.10		1.75		5.11	5.10	−0.07	5.15	−0.03	−0.40		−1.01		0.54	0.30
2.10		1.75		5.17	5.10	−0.07	5.15	−0.03	−0.40		−1.08		0.53	0.35
2.48		1.93		4.97	4.96	−0.03	4.98	−0.02	−0.11		−0.38		0.86	0.28
1.71		1.58		5.32	5.22	−0.10	5.31	−0.04	−0.69		−1.55		0.26	0.33

TKN diff	PS diff	PS Load	Accum	Accum	TK load	Accum		Sample	TEMP	TEMP	TEMP	TEMP	DO in	DO out	DO diff	DO PS
mg/l	mg/l	kg/day	PS kg	PS kg	kg/day	kg	CFS	Time	in	PS	out	diff	mg/l	mg/l	mg/l	mg/l
							4.56	10.30	13.00				10.40			
							4.56	16.30	12.90				9.30			
							5.77	16.00	15.70				10.30			
							2.45	7.45	12.90				8.70			
0.00	0.29	0.26	3.66	69.46	3.93	74.70	5.64	16.00	14.00	16.20	16.70	2.70	8.20	9.20	1.00	7.30
							6.96	21.15	13.00	13.50	13.60	0.60	7.90	5.80	−2.10	6.70
0.21	0.22	0.20	2.88	160.91	3.16	174.04	5.88	15.15	14.40	15.90	15.90	1.50	15.70	7.00	−8.70	7.00
							7.20	11.30	13.70	14.30	13.90	0.20	10.30	7.20	−3.10	6.70
−1.72	0.60	−1.56	−28.45	−209.91	−31.47	−236.38	7.48	18.00	13.30	13.20	13.20	−0.10	8.30	5.80	−2.50	5.50
−0.61	1.01	−0.29	−5.31	−581.22	−11.25	−706.31	7.48	9.50	13.00	12.80	12.90	−0.10	8.80	5.40	−3.40	4.20
							7.17	17.30	13.30	13.70	14.00	0.70	9.70	5.80	−3.90	5.10
							6.20	10.40	12.30	11.70	11.20	−1.10	9.40	6.50	−2.90	4.90
0.00	0.02	0.00	0.00	−684.69	0.00	−925.72	5.63	9.25	12.30	12.20	11.80	−0.50	8.70	4.60	−4.10	4.40
							6.13	9.10	12.40	11.90	11.70	−0.70	10.90	5.80	−5.10	5.50
0.00	0.02	0.00	0.00	−684.69	0.29	−921.45	5.83	13.25	12.40	11.90	11.70	−0.70	8.90	6.20	−2.70	5.40
0.25	0.35	0.30	4.46	−602.15	3.72	−847.39	6.08	10.50	12.20	11.60	11.40	−0.80	11.30	7.20	−4.10	6.70
							7.73	11.50	12.40	11.70	11.60	−0.80	10.80	7.10	−3.70	7.10
0.40	1.30	0.60	9.13	**−473.05**	6.09	**−754.26**	6.22	9.25	11.70	12.00	10.30	−1.40	9.60	7.80	−1.80	6.60
−0.30					−1.88		2.56	9.40	12.50		11.20	−1.30	9.80	9.60	−0.20	
								14.45								
							0.03	12.20	11.60				11.50			
				−473.05		−754.26										
−0.18	0.42	−0.05	−1.51		−2.84		5.58		12.95	13.04	12.74	−0.12	9.93	6.73	−3.15	5.94
−0.19	0.47	−0.06	−1.70		−3.19		6.55		12.89	13.04	12.85	−0.04	9.89	6.53	−3.36	5.94
−0.58	0.47	−0.40	−6.81		−8.91		5.43		13.40	14.23	14.31	0.79	9.93	6.60	−3.24	6.07
0.07	0.42	0.23	3.40		2.52		5.80		12.28	11.86	11.36	−0.91	9.93	6.85	−3.08	5.80

PS diff	CON in	CON out	CON diff	CON PS	CON diff	pH	pH	pH	pH PS	pH	CHL in	CHL out	CHL diff	CHL PS	PS diff	PS Load
mg/l	uhmos	uhmos	uhmos	uhmos	uhmos	In	out	diff		diff	In	out	removed	mg/l	mg/l	kg/day
	700.00					7.53					51.34					
	650.00					7.72										
	610.00					7.96					49.01					
	650.00					7.82										
−0.90	700.00	710.00	10.00	705.00	5.00	7.54	7.84	0.30	7.71	0.17	46.84	50.87	4.03	48.08	1.24	17.11
−1.20	700.00	700.00	0.00	700.00	0.00	7.53	7.64	0.11	7.60	0.07						
−8.70	700.00	700.00	0.00	700.00	0.00	7.72	7.72	0.00	7.80	0.08	40.80	42.90	2.10	41.70	0.9	12.94
−3.60	690.00	700.00	10.00	690.00	0.00	7.77	7.83	0.06	7.77	0.00						
−2.80	600.00	600.00	0.00	600.00	0.00	7.68					38.60	40.50	1.90	38.70	0.1	1.83
−4.60	620.00	620.00	0.00	610.00	−10.00	7.90	7.82	−0.08	7.73	−0.17	38.16	40.70	2.54	39.00	0.84	15.37
−4.60	650.00	670.00	20.00	650.00	0.00	7.89	7.88	−0.01	8.04	0.15						
−4.50	690.00	640.00	−50.00	650.00	−40.00	8.05	8.06	0.01	8.06	0.01						
−4.30	690.00	670.00	−20.00	680.00	−10.00	8.06	7.98	−0.08	8.02	−0.04	35.30	37.64	2.34	36.63	1.33	18.32
−5.40	650.00	670.00	20.00	670.00	20.00	7.93	8.00	0.07	8.02	0.09						
−3.50	700.00	690.00	−10.00	700.00	0.00	8.09	8.10	0.01	8.06	−0.03	37.80	39.50	1.70	37.80	0	0.00
−4.60	690.00	680.00	−10.00	690.00	0.00	8.34	8.40	0.06	8.02	−0.32	46.30	44.60	−1.70	44.40	−1.9	−28.26
−3.70	700.00	700.00	0.00	690.00	−10.00	8.00	8.16	0.16	8.09	0.09						
−3.00	690.00	680.00	−10.00	690.00	0.00	7.88	8.00	0.12	7.85	−0.03	42.00	41.00	−1.00	43.00	1	15.21
	700.00	700.00	0.00			7.73	7.93	0.20			43.60	42.20	−1.40			
	700.00					8.04					47.00					

−3.96	674.00	675.33	−2.67	673.21	−3.21	7.86	7.95	0.07	7.91	0.01	43.06	42.21	1.17	41.16	0.44	6.57
−3.96	676.43	673.57	−2.86	673.21	−3.21	7.88	7.96	0.06	7.91	0.01	40.73	42.21	1.49	41.16	0.44	6.57
−3.77	664.17	671.43	5.71	665.00	−0.71	7.76	7.79	0.06	7.78	0.05	45.16	26.41	2.82	25.16	0.73	11.43
−4.14	688.75	678.75	−10.00	681.43	−5.71	8.01	8.08	0.07	8.02	−0.03	41.00	40.99	−0.01	40.46	0.11	1.32

Accum PS kg	CHL kg/day	Accum kg
325.02	55.60	1056.31
745.72	30.20	2257.49
959.94	34.76	3199.48
1149.12	46.47	4093.06
	35.49	5158.51
1805.96	32.22	5598.63
2080.69	24.24	6445.62
1557.95	−25.28	6426.39
1434.05	−15.21	**6041.68**
	−8.77	
1434.05		6041.68
	22.88	
	22.88	
	45.61	
	3.99	

APPENDIX D

Farm #3 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #3 sample data and calculations.

Sample #	DATE	Sample Day #	F F #	Flow cfs	VOL l/day	TSS in mg/day	TSS out mg/day	TSS diff mg/l	TSS PS mg/l	PS diff mg/l	PS Load kg/day	Accum PS kg	TSS Load kg/day	Accum kg/crop
1	19 May 91	139	NF	5.95	14553604.8	52.00	38.00	−14.00					−203.75	
2	30 May	150	NF	4.13	10101913.9	11.00	7.00	−4.00	6.00				−40.41	
3	12 June	163	NF	2.09	5112106.6	21.00								
4	25 June	176	NF	1	2445984.0	18.00								
5	15 July	196	NF	2.37	5796982.1	12.50								
6	24 July	205	NF	1	2445984.0	26.50								
7	12 Aug	224	NF	7.68	18785157.1	20.50								
8	28 Aug	240	NF	1	2445984.0									
9	10 Sept	253	3	9.96	24362000.6	52.50	30.00	−22.50	35.50	−17.00	−414.15	−2899.08	−548.15	−3837.02
10	2 Oct	275	3	7.42	18149201.3	10.50	8.00	−2.50	8.00	−2.50	−45.37	−7953.88	−45.37	−10365.71
11	8 Oct	281	3	7.21	17635544.6	5.50	1.50	−4.00	2.50	−3.00	−52.91	−8248.71	−70.54	−10713.46
12	28 Oct	301	3	6.44	15752137.0	5.00	5.00	0.00	4.00	−1.00	−15.75	−8935.30	0.00	−11418.88
13	10 Nov	314	3	7.18	17562165.1	6.00	7.00	1.00	5.50	−0.50	−8.78	−9094.77	17.56	−11304.73
14	25 Nov	329	3	6.725	16449242.4	6.50	5.00	−1.50	7.50	1.00	16.45	−9037.26	−24.67	−11358.06
15	10 Dec	344	3	6.86	16779450.2	6.50	2.00	−4.50	2.50	−4.00	−67.12	−9417.27	−75.51	−12109.42
16	16 Jan 92	381	3	5.5	13452912.0	6.00	11.00	5.00	22.00	16.00	215.25	−6676.89	67.26	−12261.92
17	22 Jan	387	3	5.78	14137787.5	34.50	25.00	−9.50	26.00	−8.50	−120.17	**−7232.86**	−134.31	**−13403.22**
18	4 Feb	400	NF	4.41	10786789.4	9.00	7.00	−2.00					−21.57	
19	11 Mar	436	NF	0.5	1222992.0	2.00								
20	1 April	457	NF	0.025										
21	22 April	478	NF	0.025										
ACCUMULATIVE LOADINGS DURING REARING OPERATIONS												−7232.86		−13403.22
MEAN	All samples					16.97	12.21	−4.88	11.95	−1.95	−49.26		−59.97	
MEAN	Rearing					14.78	10.50	−4.28	12.61	−2.17	−54.73		−90.41	
MEAN	Irrigation					23.00	11.63	−8.25	13.00	−7.50	−170.81		−75.68	
MEAN	Non−irrigat					9.44	8.86	−1.64	11.25	0.50	3.31		−24.46	

TP in	TP out	TP diff	TP PS	PS diff	PS Loa	Accum	TP LOAD	Accum	OP in	OP out	OP diff	OP PS	PS diff	PS Load	Accum
mg/day	mg/day	mg/l	mg/l	mg/l	kg/da	PS kg	kg/day	kg/crop	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg
0.20	0.20	−0.01		−0.20			−203.75		0.03	0.08	0.05		−0.03		
							−40.41								
0.14															
0.10									0.08						
0.11									0.08						
0.28	0.29	0.00	0.30	0.02	0.49	3.41	0.12	0.85	0.17	0.19	0.02	0.19	0.02	0.61	4.26
0.11	0.15	0.04	0.13	0.03	0.45	13.76	0.73	10.18	0.08	0.10	0.02	0.11	0.02	0.45	15.95
0.10	0.14	0.05	0.15	0.06	0.97	18.03	0.79	14.74	0.06	0.09	0.04	0.01	−0.05	−0.83	14.83
0.11	0.16	0.05	0.16	0.05	0.79	35.61	0.79	30.55	0.08	0.13	0.05	0.12	0.05	0.71	13.63
0.16	0.22	0.07	0.22	0.07	1.14	48.15	1.14	43.09	0.07	0.15	0.08	0.15	0.07	1.32	26.80
0.06	0.14	0.08	0.14	0.08	1.32	66.58	1.32	61.52	0.07	0.14	0.07	0.14	0.07	1.07	44.70
0.10	0.13	0.03	0.16	0.06	1.01	84.00	0.50	75.16	0.07	0.12	0.05	0.11	0.04	0.67	57.75
0.10	0.20	0.10	0.34	0.24	3.23	162.36	1.35	109.36	0.08	0.14	0.06	0.25	0.17	2.29	112.47
0.15	0.26	0.11	0.25	0.10	1.41	**186.18**	1.56	**128.95**	0.10	0.18	0.08	0.19	0.09	1.27	**132.06**
0.13	0.09	−0.04					−0.43		0.08	0.07	−0.01				
0.04									0.05						
						186.18		128.95							132.06
0.12	0.18	0.04	0.19	0.08	1.08		−19.69		0.08	0.13	0.05	0.13	0.05	0.76	
0.13	0.19	0.06	0.21	0.08	1.20		0.92		0.09	0.14	0.05	0.14	0.05	0.84	
0.15	0.19	0.03	0.15	0.03	0.64		−48.50		0.08	0.13	0.03	0.10	0.00	0.08	
0.11	0.17	0.06	0.21	0.10	1.48		0.89		0.07	0.13	0.05	0.16	0.08	1.22	

OP LOAD	Accum	TURB in	TURB out	TURB diff	TURB PS	PS diff	SET in	SET out	SET diff	SET PS	PS diff	AM in	AM out	AM diff	AM PS	PS diff
kg/day	kg	NTU	NTU	NTU	NTU	NTU	ml/l	ml/l	ml/l	ml/l	ml/l	mg/l	mg/l	mg/l	mg/l	mg/l
0.73		27.50	22.50	−5.00			0.05	0.05	0.00			0.05	0.05	0.00		
		5.25	4.50	−0.75	7.50	2.25	0.05	0.05	0.00	0.05	0.00	0.05	0.07	0.02	0.17	0.12
		8.00					0.05					0.05				
		7.60					0.05					0.05				
		4.50					0.05					0.05				
		10.70					0.05					0.05				
		4.95					0.05					0.05				
0.61	4.26	13.10	12.10	−1.00	12.45	−0.65	0.05	0.05	0.00	0.05	0.00	0.08	0.19	0.11	0.18	0.10
0.36	14.96	2.70	2.55	−0.15	2.50	−0.20	0.05	0.05	0.00	0.05	0.00	0.05	0.21	0.16	0.22	0.17
0.62	17.90	1.30	1.80	0.50	1.80	0.50	0.05	0.05	0.00	0.05	0.00	0.13	0.32	0.19	0.34	0.21
0.79	31.94	1.45	1.60	0.15	1.55	0.10	0.05	0.05	0.00	0.05	0.00	0.05	0.19	0.14	0.16	0.11
1.40	46.20	2.05	1.70	−0.35	1.75	−0.30	0.05	0.05	0.00	0.05	0.00	0.05	0.25	0.20	0.26	0.21
1.15	65.37	1.84	2.14	0.30	1.96	0.12	0.05	0.05	0.00	0.05	0.00	0.07	0.38	0.31	0.39	0.32
0.84	80.30	0.74	0.56	−0.17	0.50	−0.24	0.08	0.05	−0.02	0.24	0.17	0.05	0.40	0.35	0.40	0.35
0.81	110.75	1.20	3.05	1.85	3.40	2.20	0.05	0.05	0.00	0.20	0.15	0.20	0.10	−0.10	0.20	0.00
1.13	**124.48**	3.55	5.90	2.85	4.30	1.24	0.05	0.05	0.00	0.10	0.05	0.20	0.50	0.30	0.50	0.30
−0.11		3.10	2.00	−1.10			0.05	0.05	0.00			0.05	0.05	0.00		
		1.00					0.05						0.05			
	124.48															
0.76		5.58	5.03	−0.24	3.77	0.50	0.05	0.05	0.00	0.09	0.04	0.08	0.23	0.14	0.28	0.19
0.86		3.10	3.49	0.44	3.36	0.31	0.05	0.05	0.00	0.09	0.04	0.10	0.28	0.18	0.29	0.19
0.58		8.56	8.69	−1.28	6.06	0.47	0.05	0.05	0.00	0.05	0.00	0.06	0.17	0.10	0.22	0.15
1.02		1.87	2.42	0.50	2.24	0.52	0.05	0.05	0.00	0.12	0.06	0.10	0.27	0.17	0.32	0.21

PS Load	Accum	AM load	Accum	N/N in	N/N out	N/N diff	N/N PS	PS diff	PS Load	Accum	N/N load	Accum	TKN in	TKN out
kg/day	PS kg	kg/day	kg	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg	mg/l	mg/l
		0.00		1.35	1.30	−0.05					−0.73		0.16	0.07
		0.20		4.21	3.90	−0.31	4.06	−0.16			−3.13			
				2.06									0.63	
				2.21										
				4.24									0.02	
				4.00										
				4.60										
2.44	17.05	2.68	18.76	4.00	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.48	0.33
2.99	76.79	2.90	80.18	4.33	4.24	−0.09	4.28	−0.05	−0.91	−9.98	−1.63	−17.97	0.69	1.17
3.62	96.62	3.26	98.68	4.28	4.27	−0.01	4.19	−0.09	−1.59	−17.47	−0.18	−23.40		
1.65	149.31	2.13	152.57	5.17	4.78	−0.39	4.97	−0.20	−3.15	−64.84	−6.22	−87.38		
3.60	183.47	3.51	189.22	5.16	5.12	−0.04	5.18	0.02	0.35	−83.04	−0.79	−132.96	0.02	0.13
5.26	249.95	5.10	253.81	5.35	5.37	0.02	5.34	−0.01	−0.25	−82.25	0.25	−137.04		
5.87	333.47	5.87	336.10	5.20	5.20	0.00	5.20	0.00	0.00	−84.10	0.00	−135.19	0.05	0.05
0.00	442.12	−1.35	419.86	5.30	5.40	0.10	5.50	0.20	2.69	−34.33	1.35	−110.30	0.07	0.60
4.24	**484.53**	4.24	**458.24**	5.20	5.20	0.00	5.20	0.00	0.00	**−26.26**	0.00	**−106.26**		
		0.00		5.10	5.10	0.00							1.50	0.50
				5.00									0.40	
	484.53		458.24							−26.26		−106.26		
3.30		2.60		4.26	4.49	−0.07	4.79	−0.03	−0.32		−1.01		0.40	0.41
3.30		3.15		4.89	4.84	−0.05	4.87	−0.01	−0.32		−0.80		0.26	0.46
3.02		1.81		3.53	3.54	−0.09	4.13	−0.07	−0.83		−1.13		0.49	0.39
3.44		3.25		5.19	5.17	−0.05	5.23	0.00	−0.06		−0.90		0.41	0.26

TKN diff	PS	PS	TKN load	Accum	TKN load	Accum		Sample	TEMP	TEMP	TEMP	TEMP	DO in	DO out	DO diff	DO PS
mg/l	mg/l	diff	kg/day	PS kg	kg/day	kg	CFS	Time	in	PS	out	diff	mg/l	mg/l	mg/l	mg/l
−0.10	0.07	−0.10			−1.38		5.95	11.30	12.40		11.70	−0.70	12.30	10.30	−2.00	
							4.13	17.00	15.60	16.30	16.80	1.20	15.00	21.00	6.00	13.70
							2.09	16.45	21.30				13.50			
							1.00	8.45	13.80				9.80			
							2.37	16.45	19.00				8.70			
							1.00	21.30	16.40				3.80			
							7.68	15.45	17.30				8.10			
							1.00									
−0.14	0.47	−0.01	−0.12	−0.85	−3.53	−24.73	9.96	17.30	14.00	14.00	14.00	0.00	7.30	8.10	0.80	7.70
0.48	0.66	−0.03	−0.45	−7.18	8.71	32.24	7.42	10.30	13.00	13.10	13.20	0.20	8.60	7.80	−0.80	7.00
							7.21	17.00	14.10	14.40	14.40	0.30	8.70	7.10	−1.60	6.90
							6.44	11.05	10.08	10.50	10.50	0.42	10.10	7.60	−2.50	6.90
0.11	0.20	0.18	3.16	45.61	1.93	239.79	7.18	10.00	11.80	12.10	12.20	0.40	7.30	5.80	−1.50	5.00
							6.73	9.50	11.40	11.30	11.10	−0.30	7.70	6.00	−1.70	5.20
0.00	0.05	0.00	0.00	93.03	0.00	268.77	6.86	13.40	11.00	11.00	10.80	−0.20	9.10	7.10	−2.00	6.10
0.53	0.60	0.53	7.13	224.94	7.13	400.67	5.50	11.20	10.70	10.70	10.60	−0.10	9.50	8.20	−1.30	7.30
				317.63		**493.36**	5.78	12.20	11.10	11.00	11.00	−0.10	9.40	7.20	−2.20	6.10
−1.00					−10.79		4.41	10.00	9.20		9.40	0.20	8.00	9.70	1.70	
							0.50	10.00	10.90				10.00			
				317.63		493.36										
−0.02	0.34	0.10	1.62		0.30		4.91		13.50	12.44	12.14	0.18	9.27	8.83	−0.59	7.19
0.20	0.40	0.14	1.94		2.85		7.01		11.91	12.01	11.98	0.07	8.63	7.21	−1.42	6.47
0.06	0.30	−0.03	−0.29		1.27		4.88		15.69	14.45	14.02	0.20	9.58	10.86	0.48	8.83
−0.07	0.28	0.24	3.43		−0.43		5.42		10.77	11.10	10.80	0.05	8.89	7.37	−1.36	6.10

PS diff	CON in	CON out	CON diff	CON PS	CON diff	pH	pH	pH	pH PS	pH	CHL in	CHL out	CHL diff	CHL PS	CHL PS	CHL PS
mg/l	uhmos	uhmos	uhmos	uhmos	uhmos	In	out	diff		diff	mg/l	mg/l	mg/l	mg/l	diff mg/l	kg/day
	430.00	440.00	10.00			8.35	8.28	−0.07			36.91	37.22	0.31			
−1.30	700.00	710.00	10.00	700.00	0.00	8.62	8.61	−0.01	8.72	0.10						
	600.00					8.82					40.48					
	520.00					8.25										
	750.00					8.09					46.22					
	640.00					7.61										
	700.00					7.95					39.30					
0.40	600.00	590.00	−10.00	600.00	0.00	7.87	7.94	0.07	7.87	0.00	40.30	41.40	1.10	40.70	0.4	9.74
−1.60	600.00	610.00	10.00	610.00	10.00	8.08	8.06	−0.02	8.02	−0.06	40.18	42.88	2.70	39.00	−1.18	−21.42
−1.80	650.00	650.00	0.00	650.00	0.00	8.20	8.06	−0.14	8.06	−0.14						
−3.20	610.00	610.00	0.00	610.00	0.00	8.29	8.28	−0.01	8.30	0.01						
−2.30	650.00	650.00	0.00	650.00	0.00	8.35	8.31	−0.04	8.12	−0.23	36.80	35.28	−1.52	36.46	−0.34	−5.97
−2.50	650.00	680.00	30.00	650.00	0.00	8.37	8.14	−0.23	8.13	−0.24						
−3.00	650.00	650.00	0.00	650.00	0.00	8.30	8.30	0.00	8.30	0.00	39.20	39.80	0.60	40.20	1	16.78
−2.20	650.00	650.00	0.00	650.00	0.00	8.59	8.39	−0.20	8.30	−0.29	47.90	45.90	−2.00	46.60	−1.3	−17.49
−3.30	660.00	660.00	0.00	660.00	0.00	8.35	8.31	−0.04	8.35	0.00						
	650.00	650.00	0.00			8.17	8.33	0.16			46.00	45.00	−1.00			
	650.00					8.21					44.20					

−2.08	631.11	629.17	4.17	643.00	1.00	8.25	8.25	−0.04	8.22	−0.08	41.67	41.07	0.03	33.83	−0.24	−3.06
−2.17	635.56	638.89	3.33	636.67	1.11	8.27	8.20	−0.07	8.16	−0.11	40.88	41.05	0.18	40.59	−0.28	−3.67
−1.07	619.00	600.00	4.00	640.00	2.50	8.18	8.19	−0.03	8.17	−0.02	39.43	30.38	1.03	19.93	−0.19	−5.84
−2.75	646.25	650.00	4.29	645.00	0.00	8.33	8.29	−0.05	8.25	−0.12	42.82	33.20	−0.78	41.09	−0.21	−2.23

Accum PS	CHL	CHL
kg	kg/day	Accum
	4.51	
68.21	26.80	187.59
−60.17	49.00	1021.40
−594.22	−26.69	1456.41
−432.10	10.07	1207.01
−445.22	−26.91	895.50
−672.57		**545.73**
	−10.79	
−672.57		545.73
	3.71	
	6.45	
	26.77	
	−13.58	

APPENDIX E

Farm #4 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #4 sample data and calculations.

Sample #	DATE	Sample Day #	F F #	Flow cfs	VOL l/day	TSS in mg/day	TSS out mg/day	TSS diff mg/l	TSS PS mg/l	PS diff mg/l	PS Load kg/day	Accum PS kg	TSS Load kg/day	Accum kg/crop
1	19 May 91	139	4	16.77	41019151.7	114.00	88.00	−26.00				6156.59	−1066.50	−11731.48
2	30 May	150	4	13.46	32922944.6	43.00	45.00	2.00	60.00	17.00	559.69	12313.18	65.85	−17235.06
3	12 June	163	4	19.56	47843447.0	35.00	28.00	−7.00	26.00	−9.00	−430.59	13152.33	−334.90	−18983.94
4	25 June	176	4	14.80	36200563.2	40.00	21.50	−18.50	30.50	−9.50	−343.91	8118.10	−669.71	−25513.94
5	15 July	196	4	9.94	24313081.0	41.00	27.00	−14.00	26.00	−15.00	−364.70	1032.08	−340.38	−35614.87
6	25 July	206	4	8.94	21867097.0	213.50	139.50	−74.00	145.00	−68.50	−1497.90	−8280.88	−1618.17	−45407.61
7	12 Aug	224	4	13.40	32776185.6	88.50	77.00	−11.50	78.00	−10.50	−344.15	−24859.29	−376.93	−63363.44
8	28 Aug	240	4	15.74	38499788.2	143.00	151.50	8.50	127.00	−16.00	−616.00	−32540.47	327.25	−63760.86
9	10 Sept	253	4	17.72	43342836.5	68.00	71.00	3.00	58.50	−9.50	−411.76	**−40456.14**	130.03	**−60398.48**
10	2 Oct	275	4	15.76	38548707.8	36.50	36.00	−0.50	33.00	−3.50	−134.92	−1753.97	−19.27	−250.57
11	8 Oct	281	4	20.00	48919680.0	36.50	40.50	4.00					195.68	278.65
12	28 Oct	301	4	12.02	29400727.7	32.00	48.00	16.00					470.41	6939.55
13	10 Nov	314	4	12.02	29400727.7	5.50	29.00	23.50	5.50	0.00	0.00	−4384.92	690.92	14488.19
14	25 Nov	329	4	12.02	29400727.7	7.00	25.50	18.50	19.00	12.00	352.81	−1738.85	543.91	23749.42
15	10 Dec	344	4	18.82	46033418.9	8.00	16.00	8.00	8.00	0.00	0.00	907.22	368.27	30590.77
16	16 Jan 92	381	4	14.10	34488374.4	231.50	197.00	−34.50	163.00	−68.50	−2362.45	−42798.18	−1189.85	15391.51
17	22 Jan	387	4	18.37	44932726.1	33.00	55.00	22.00	41.00	8.00	359.46	−48807.15	988.52	14787.53
18	4 Feb	400	4	20.96	51267824.6	10.50	15.00	4.50	12.50	2.00	102.54	−45804.17	230.71	22712.49
19	11 Mar	436	4	7.53	18418259.5	13.00	30.50	17.50	24.00	11.00	202.60	−40311.71	322.32	32666.94
20	1 April	457	4	16.76	40994691.8	5.00	6.00	1.00	7.00	2.00	81.99	**−36667.60**	40.99	**36809.69**
21	22 April	478	NF	23.64	57823061.8	144.00	136.00	−8.00	89.50	−54.50	−3151.36		−462.58	
ACCUMULATIVE LOADINGS DURING REARING OPERATIONS												−77123.73		−23588.78
MEAN	All samples					64.21	61.10	−3.12	52.97	−11.81	−444.37		−81.12	
MEAN	Rearing					60.23	57.35	−2.88	50.82	−9.29	−285.13		−62.04	
MEAN	Irrigation					83.58	71.75	−11.83	67.35	−17.90	−673.56		−347.47	
MEAN	Non−irrigat					38.39	46.89	8.50	35.00	−4.19	−157.88		274.02	

Farm harvested and restocked between 10 Sept. and 2 Oct. 1992

TP in	TP out	TP diff	TP PS	PS diff	PS Load	Accum	TP Load	Accum	OP in	OP out	OP diff	OP PS	PS diff	PS Load	Accum
mg/day	mg/day	mg/l	mg/l	mg/l	kg/da	PS kg	kg/day	kg/crop	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg
0.21	0.23	0.03					1.03	11.28	0.04	0.03	−0.01				
0.10	0.09	−0.01					−0.24	20.72							
0.10	0.09	−0.01	0.09	−0.01	−0.36		−0.18	17.98	0.06	0.07	0.01				
0.18	0.14	−0.04	0.14	−0.04	−0.90		−1.00	6.21	0.06	0.07	0.01	0.06	0.00	0.05	
0.19	0.21	0.01	0.22	0.03	0.98		0.49	−0.87	0.08	0.10	0.02	0.09	0.01	0.33	
0.24	0.30	0.06	0.25	0.01	0.44		2.31	21.55	0.11	0.13	0.01	0.12	0.01	0.25	
0.23	0.27	0.04	0.26	0.03	1.30	**	1.73	**53.03**	0.13	0.16	0.03	0.14	0.02	0.65	**
0.14	0.17	0.03	0.16	0.02	0.77	10.02	1.16	15.03	0.07	0.07	0.00	0.06	−0.01	−0.19	−2.51
0.15	0.18	0.02					1.22	22.17	0.01	0.01	0.00				
0.12	0.18	0.06					1.91	53.51	0.09	0.15	0.06				
0.12	0.16	0.04	0.16	0.05	1.32	50.86	1.18	73.58	0.05	0.11	0.06	0.08	0.03	0.88	10.94
0.04	0.11	0.07	0.12	0.08	2.35	78.42	2.06	97.83	0.06	0.11	0.05	0.12	0.06	1.76	30.78
0.08	0.10	0.02	0.11	0.03	1.38	106.42	0.92	120.17	0.05	0.07	0.02	0.07	0.02	0.92	50.92
0.38	0.43	0.06	0.39	0.02	0.52	141.54	1.90	172.30	0.28	0.31	0.03	0.27	−0.01	−0.34	61.57
0.10	0.18	0.08	0.15	0.05	2.25	149.83	3.59	188.77	0.07	0.13	0.07	0.12	0.06	2.47	67.95
0.06	0.10	0.04	0.12	0.06	3.08	184.43	2.05	225.47	0.05	0.09	0.04	0.08	0.03	1.54	94.01
0.06	0.10	0.04	0.10	0.04	0.74	253.06	0.74	275.64	0.06	0.12	0.06	0.12	0.06	1.11	141.58
0.03	0.10	0.08	0.08	0.06	2.25	**302.50**	3.07	**340.26**	0.02	0.05	0.04	0.06	0.05	1.84	**187.32**
0.21	0.24	0.03	0.18				1.73		0.06	0.06	0.00	0.07			
						302.5+		393.29							187.83+
0.14	0.18	0.03	0.17	0.03	1.15		1.35		0.07	0.10	0.03	0.10	0.02	0.87	
0.14	0.17	0.03	0.17	0.03	1.15		1.33		0.07	0.10	0.03	0.11	0.02	0.87	
0.17	0.19	0.02	0.19	0.01	0.37		0.83		0.07	0.08	0.01	0.09	0.01	0.22	
0.11	0.16	0.05	0.15	0.05	1.74		1.94		0.08	0.13	0.05	0.12	0.04	1.27	

** Insufficient data

** Insufficient

OP LOAD	Accum	TURB in	TURB out	TURB diff	TURB PS	PS diff	SET in	SET out	SET diff	SET PS	PS diff	AM in	AM out	AM diff	AM PS	PS diff
kg/day	kg	NTU	NTU	NTU	NTU	NTU	ml/l	ml/l	ml/l	ml/l	ml/l	mg/l	mg/l	mg/l	mg/l	mg/l
−0.21		27.50	27.25	−0.25			0.05	0.10	0.05			0.05	0.05	0.00		
		24.50	26.75	2.25	25.50	1.00	0.10	0.12	0.02	0.13	0.02	0.05	0.20	0.15	0.20	0.15
	−2.26	11.25	9.75	−1.50	9.50	−1.75	0.05	0.05	0.00	0.05	0.00	0.05	0.10	0.05	0.16	0.11
0.40	1.32	9.50	7.70	−1.80	8.75	−0.75	0.85	0.05	−0.80	−1.65	−2.50	0.05	0.11	0.06	0.20	0.15
0.27	7.97	16.35	15.55	−0.80	13.75	−2.60	0.05	0.05	0.00	0.05	0.00	0.05	0.26	0.21	0.19	0.14
		60.55	48.60	−11.95	55.00	−5.55	0.25	0.13	−0.12	0.18	−0.08	0.05	0.05	0.00	0.05	0.00
0.49	18.60	33.10	32.30	−0.80	31.60	−1.50	0.13	0.12	−0.01	0.11	−0.02	0.05	0.05	0.00	0.05	0.00
0.56	27.00	26.10	26.30	0.20	29.30	3.20	0.10	0.11	0.01	0.12	0.02	0.05	0.15	0.10	0.13	0.08
1.30	**42.98**	22.60	28.80	6.20	25.40	2.80	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
0.00	0.00	10.90	10.25	−0.65	10.25	−0.65	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
0.00	0.00	10.90	12.75	1.85			0.05	0.05	0.00			0.05	0.05	0.00		
1.76	17.64	8.45	12.00	3.55			0.05	0.11	0.06			0.05	0.08	0.03		
1.62	39.62	2.75	3.65	0.90	2.80	0.05	0.05	0.05	0.00	0.05	−0.01	0.05	0.05	0.00	0.05	0.00
1.47	62.77	1.56	3.32	1.76	2.88	1.32	0.05	0.05	−0.01	0.05	0.00	0.05	0.26	0.21	0.24	0.19
0.92	80.70	0.66	1.20	0.54	1.15	0.49	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
1.03	116.87	53.95	43.35	−10.60	32.15	−21.80	0.60	0.53	−0.07	0.50	−0.10	0.05	0.50	0.45	0.50	0.45
2.92	128.74	7.10	7.60	0.50	7.00	−0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.30	0.20	0.30	0.20
2.05	161.05	1.50	3.35	1.85	2.35	0.85	0.05	0.05	0.00	0.05	0.00	0.05	0.20	0.15	0.20	0.15
1.11	217.86	2.85	3.55	0.70	4.05	1.20	0.05	0.05	0.00	0.05	0.00	0.05	0.20	0.15	0.30	0.25
1.43	**256.01**	1.23	2.00	0.78	2.30	1.07	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00
0.00		34.50	38.50	4.00	28.50	−6.00	0.13	0.14	0.01	0.07	−0.06	0.05	0.10	0.05	0.10	0.05
	298.99															
0.95		17.51	17.36	−0.16	16.24	−1.60	0.14	0.10	−0.04	0.00	−0.15	0.05	0.14	0.09	0.16	0.11
1.01		16.66	16.30	−0.36	15.51	−1.34	0.14	0.10	−0.04	0.00	−0.15	0.05	0.14	0.09	0.16	0.11
0.31		23.98	23.71	−0.27	23.76	−1.18	0.15	0.09	−0.07	−0.09	−0.26	0.05	0.10	0.05	0.12	0.07
1.59		8.89	8.89	0.00	6.84	−2.11	0.11	0.11	0.00	0.11	−0.01	0.06	0.19	0.13	0.21	0.15

data

PS Load	Accum	AM load	Accum	N/N in	N/N out	N/N diff	N/N PS	PS diff	PS Load	Accum	N/N load	Accum	TKN in	TKN out
kg/day	PS kg	kg/day	kg	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg	mg/l	mg/l
	54.32	0.00	0.00	0.50	0.52	0.02				−10.86	0.62	6.77	0.97	1.19
4.94	81.48	4.77	26.26	0.68	0.66	−0.02	0.65	−0.03	−0.99	−16.30	−0.66	6.53		
5.26	147.79	2.15	71.28	0.48	0.45	−0.03	0.44	−0.04	−1.91	−35.16	−1.44	−7.08	0.45	0.53
5.43	217.30	1.99	98.22	0.62	0.59	−0.03	0.62	0.01	0.18	−46.42	−1.09	−23.47		
3.40	305.63	5.11	169.18	1.12	1.13	0.00	1.14	0.02	0.49	−39.75	0.12	−33.11	0.02	0.54
0.00	322.65	0.00	194.71	1.00	1.05	0.05	1.05	0.05	1.09	−31.85	1.09	−27.04		
0.00	322.65	0.00	194.71	1.35	1.30	−0.05	1.30	−0.05	−1.64	−36.76	−1.64	−31.95	0.58	0.88
3.08	347.29	3.85	225.51	1.23	1.23	0.00	1.22	−0.01	−0.38	−52.95	0.00	−45.06		
0.00	**367.31**	0.00	**250.54**	1.55	1.60	0.05	1.60	0.05	2.17	**−34.86**	2.17	**−24.47**	0.02	0.02
0.00	0.00	0.00	0.00	0.65	0.05	−0.60	0.59	−0.06	−2.12	−27.56	−22.94	−298.17	2.33	1.22
		0.00	0.00	0.78	0.84	0.05					2.69	−358.91		
		0.88	8.82	4.06	4.04	−0.02					−0.59	−337.89		
0.00	0.00	0.00	14.55	4.78	4.79	0.01	4.79	0.01	0.44	−60.31	0.44	−338.84	0.02	0.47
5.44	40.79	6.17	60.86	4.98	4.88	−0.09	4.70	−0.27	−8.09	−117.64	−2.79	−356.48		
0.00	81.59	0.00	107.17	4.70	4.70	0.00	4.70	0.00	0.00	−178.28	0.00	−377.43	0.02	0.02
15.52	368.70	15.52	394.28	5.05	5.10	0.05	4.80	−0.25	−8.62	−337.79	1.72	−345.53	1.20	1.30
8.99	442.22	8.99	467.80	4.80	4.80	0.00	4.80	0.00	0.00	−363.65	0.00	−340.36		
7.69	550.62	7.69	576.20	4.65	4.80	0.15	4.80	0.15	7.69	−313.67	7.69	−290.37	0.80	0.70
4.60	771.93	2.76	764.35	4.50	4.50	0.00	4.50	0.00	0.00	−175.24	0.00	−151.95	0.15	0.40
0.00	**820.27**	0.00	**793.36**	4.45	4.40	−0.05	4.40	−0.05	−2.05	**−213.16**	−2.05	**−189.87**		
2.89		2.89		0.40	0.30	−0.10	0.40	0.00	0.00		−5.78		1.50	1.60
	1187.59		1043.90							−248.02		−214.34		
3.74		2.99		2.49	2.46	−0.03	2.58	−0.03	−0.76		−1.07		0.67	0.74
3.79		2.99		2.60	2.57	−0.03	2.71	−0.03	−0.81		−0.83		0.60	0.66
2.50		1.73		0.86	0.81	−0.05	0.90	−0.01	−0.31		−2.24		0.84	0.85
5.28		4.67		4.66	4.67	0.01	4.69	−0.05	−1.33		0.49		0.44	0.58

TKN diff	Pre-se	Pre-set	TK Add	ACCUM	TK load	Accum		Sample	TEMP	TEMP	TEMP	TEMP	DO in	DO out	DO diff	DO PS
mg/l		add	PS kg/day	PS kg	kg/day		CFS	Time	in	PS	out	diff	mg/l	mg/l	mg/l	mg/l
0.22				260.51	9.02	42.10	16.77	12.15	12.50		12.50	0.00	9.20	9.00	−0.20	
							13.46	17.30	15.50	15.80	15.80	0.30	9.90	8.70	−1.20	7.80
0.08	0.94	0.50	23.68	544.70	3.83	196.32	19.56	17.30	20.80	21.10	21.10		9.10	6.30	−2.80	8.40
							14.80	9.15	15.80	15.80	15.80		9.20	8.10	−1.10	6.20
0.52	0.68	0.66	16.05	1200.23	12.52	466.08	9.94	17.00	22.80	23.40	23.30	0.50	7.20	5.90	−1.30	5.10
							8.94	8.30	19.40	19.30	19.50	0.10	7.50	6.50	−1.00	5.90
0.30	0.34	−0.24	−7.87	1314.75	9.83	779.03	13.40	16.40	21.80	22.20	22.30	0.50	7.50	5.70	−1.80	5.50
							15.74	12.00	18.70	18.80	18.70	0.00	9.20	7.60	−1.60	7.20
0.00	0.02	0.00	0.00	**1200.69**	0.00	**921.61**	17.72	17.00	16.80	16.80	16.80	0.00	7.80	7.60	−0.20	7.30
−1.11	1.34	−0.99	−37.97	−493.62	−42.79	−556.26	15.76	11.30	14.40	14.60	14.70	0.30	9.40	7.70	−1.70	7.40
							20.00	19.15	14.20		14.20	0.00	9.00	10.20	1.20	
							12.02	11.45	10.00		9.30	−0.70	11.50	10.20	−1.30	
0.45	0.84	0.82	24.11	1253.65	13.08	680.33		10.40	12.00	11.80	11.90	−0.10	9.30	7.40	−1.90	7.60
							12.02	10.30	11.10	10.80	10.90	−0.20	10.00	7.70	−2.30	6.30
0.00	0.02	0.00	0.00	1615.28	0.00	876.58	18.82	14.05	11.10	10.90	10.50	−0.60	11.70	8.50	−3.20	7.30
0.10	1.40	0.20	6.90	1742.88	3.45	940.39	14.10	12.00	10.40	10.30	10.50	0.10	10.30	6.90	−3.40	6.80
							18.37	12.40	11.00	10.80	10.80	−0.20	10.50	6.80	−3.70	6.70
−0.10	1.20	0.40	20.51	2003.23	−5.13	924.45	20.96	10.50	10.20	10.00	10.00	−0.20	11.70	7.00	−4.70	6.90
0.25	1.10	0.95	17.46	2686.65	4.57	914.38	7.53	10.25	11.60	11.40	11.50	−0.10	13.10	8.80	−4.30	8.90
				3193.00		**1046.85**	16.76	14.50	16.40	16.90	17.20	0.80				
0.10	1.70	0.20	11.56		5.78		23.64	12.40	9.40	9.60	9.50	0.10	9.90	8.50		8.50
				4393.69		1968.46										
0.07	0.80	0.21	6.20		1.18		15.52		14.57	15.02	14.61	0.03	9.65	7.76	−1.92	7.05
0.06	0.79	0.23	6.29		0.76		14.67		14.83	15.34	13.94	0.03	9.64	7.72	−1.92	6.96
0.02	0.84	0.02	0.91		−0.26		15.81		16.84	17.74	17.02	0.18	8.74	7.65	−1.06	6.93
0.14	0.91	0.47	13.79		3.19		15.51		11.53	11.61	11.66	−0.13	11.01	7.91	−3.10	7.21

PS diff	CON in	CON out	CON diff	CON PS	CON dif	pH	pH	pH	pH PS	pH	CHL in	CHL out	CHL diff	CHL PS	CHL PS	CHL load
mg/l	uhmos	uhmos	uhmos	uhmos	uhmos	In	out	diff		diff	mg/l	mg/l	mg/l	mg/l	diff	PS kg/day
	370.00	350.00	−20.00			8.34	8.38	0.04			31.95	32.42	0.47			
−0.90	460.00	410.00	−50.00	405.00	−5.00	8.62	8.50	−0.12	8.40	−0.10						
2.10	455.00	460.00	5.00	465.00	5.00	9.06	8.96	−0.10	8.84	−0.12	33.19	32.26	−0.93	32.10	−1.09	−52.15
−1.90	420.00	430.00	10.00	425.00	−5.00	8.66	8.36	−0.30	8.25	−0.11						
−0.80	500.00	500.00	0.00	500.00	0.00	8.46	8.28	−0.18	8.25	−0.03	34.12	32.57	−1.55	31.95	−2.17	−52.76
−0.60	465.00	470.00	5.00	470.00	0.00	8.60	7.95	−0.65	7.91	−0.04						
−0.20	500.00	500.00	0.00	500.00	0.00	8.47	8.34	−0.13	8.35	0.01	25.20	25.80	0.60	24.20	−1.00	−32.78
−0.40	470.00	470.00	0.00	475.00	5.00	8.34	8.18	−0.16	8.18	0.00						
−0.30	490.00	490.00	0.00	490.00	0.00	8.17	8.16	−0.01	8.14	−0.02	31.60	31.90	0.30	29.60	−2.00	−86.69
−0.30	440.00	460.00	20.00	450.00	−10.00	8.64	8.56	−0.08	8.53	−0.03	28.02	28.19	0.17	27.00	−1.02	−39.32
	430.00	435.00	5.00			9.02	8.97	−0.05								
	600.00	590.00	−10.00			8.51	8.39	−0.12								
0.20	610.00	650.00	40.00	610.00	−40.00	8.67	8.40	−0.27	8.53	0.13	39.16	38.48	−0.68	37.50	−1.66	−48.81
−1.40	650.00	650.00	0.00	650.00	0.00	8.41	8.28	−0.13	8.25	−0.03						
−1.20	610.00	610.00	0.00	610.00	0.00	8.60	8.54	−0.06	8.52	−0.02	40.50	39.50	−1.00	38.80		
−0.10	610.00	610.00	0.00	610.00	0.00	8.40	8.36	−0.04	8.35	−0.01	43.20	43.20	0.00	44.20	1.00	34.49
−0.10	650.00	650.00	0.00	650.00	0.00	8.47	8.35	−0.12	8.39	0.04						
−0.10	625.00	610.00	−15.00	610.00	0.00	8.35	8.22	−0.13	8.24	0.02	41.50	41.00	−0.50	41.00	−0.50	−25.63
0.10	650.00	650.00	0.00	650.00	0.00	8.10	8.09	−0.01	8.09	0.00	39.65	38.50	−1.15	40.20	0.55	10.13
	610.00	610.00	0.00	610.00	0.00	8.46	8.24	−0.22	8.27	0.03						
0.00	420.00	410.00	−10.00	410.00	0.00	8.62	8.55	−0.07	8.59	0.04	30.00	31.00	1.00	30.00	0.00	

−0.35	525.48	524.52	−0.95	532.78	−2.78	8.52	8.38	−0.14	8.34	−0.01	34.84	34.57	−0.30	28.91	−0.49	−17.24
−0.37	530.75	530.25	−0.50	540.00	−2.94	8.52	8.38	−0.14	8.32	−0.02	35.28	34.89	−0.39	34.66	−0.79	−29.35
−0.33	451.67	448.75	−2.92	459.00	−1.00	8.58	8.43	−0.15	8.34	−0.04	30.58	30.59	0.01	29.14	−1.21	−43.95
−0.37	623.89	625.56	1.67	625.00	−5.00	8.44	8.32	−0.12	8.33	0.02	40.80	40.14	−0.67	40.34	−0.15	−7.46

Accum	CHL load	CHL
PS kg	kg/day	Accum
−573.64	19.28	212.07
−1199.44	−44.49	−90.52
−2930.43	−37.69	−1446.48
−4127.93	19.67	−1698.75
−6120.18	13.00	**−1186.05**
−511.16	6.55	85.19
−2537.87	−19.99	−1039.61
	−46.03	−2030.00
−3017.48	0.00	−1709.36
−2933.37	−25.63	−1952.88
−3212.44	−21.18	−2795.55
−2918.67		**−3409.80**
	57.82	
−9038.85		−3324.61
	−6.56	
	−12.41	
	4.88	
	−22.57	

APPENDIX F

Farm #5 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #5 sample data and calculations.

Sample		Sample	F F	Flow	VOL	TSS in	TSS out	TSS diff					TSS Load	Accum
#	DATE	Day #	#	cfs	l/day	mg/day	mg/day	mg/l					kg/day	kg/crop
1	19 May	139	NF	1.00	2445984.0	56.00								
2	30 May	150	NF	7.41	18124741.4	33.00								
3	12 June	163	5	9.86	24117402.2	17.00	15.00	−2.00					−48.23	−337.64
4	25 June	176	5	8.31	20313897.1	18.00	25.00	7.00					142.20	273.11
5	15 July	196	5	6.75	16510392.0	47.50	49.00	1.50					24.77	1942.74
6	25 July	206	5	9.08	22209534.7	51.00	56.50	5.50					122.15	2677.33
7	12 Aug	224	5	9.00	22013856.0	53.50	52.00	−1.50					−33.02	3479.52
8	28 Aug	240	5	9.00	22013856.0	38.50	44.00	5.50					121.08	4183.96
9	10 Sept	253	5	10.65	26049729.6	25.50	14.50	−11.00					−286.55	3108.40
10	2 Oct	275	5	10.28	25144715.5	15.00	10.00	−5.00					−125.72	−1426.58
11	8 Oct	281	5	10.10	24704438.4	3.00	3.50	0.50					12.35	**−1754.34**
12	28 Oct	301	NF			13.50								
13	10 Nov	314	NF	8.10	19812470.4	26.50	32.50	6.00					118.87	
14	25 Nov	329	5	9.30	22747651.2	19.00	20.50	1.50					34.12	477.70
15	10 Dec	344	5	7.93	19396653.1	24.50	22.50	−2.00					−38.79	442.66
16	16 Jan	381	5	5.35	13086014.4	16.50	21.50	5.00					65.43	935.44
17	22 Jan	387	5	6.78	16583771.5	63.50	57.50	−6.00					−99.50	833.22
18	4 Feb	400	5	5.65	13819809.6	14.00	22.00	8.00					110.56	905.09
19	11 Mar	436	5	4.40	10762329.6	12.50	6.00	−6.50					−69.96	1635.95
20	1 April	457	5	2.40	5870361.6	8.00	5.00	−3.00					−17.61	716.50
21	22 April	478	5	5.10	12474518.4	28.00	44.00	16.00					199.59	**2627.30**
ACCUMULATIVE LOADINGS DURING REARING OPERATIONS														872.97
MEAN						27.81	27.83	1.08					12.87	
MEAN	Rearing					26.76	27.56	0.79					6.64	
MEAN	Irrigation					29.70	31.35	1.65					12.86	
MEAN	Non−irrigat					22.00	23.44	0.38					12.89	

TP in	TP out	TP diff					TP load	Accum	OP in	OP out	OP diff					OP load
mg/day	mg/day	mg/l					kg/day	kg/crop	mg/l	mg/l	mg/l					kg/day
0.28									0.17							
0.08	0.10	0.02					0.41	8.13								
0.20	0.22	0.01					0.21	14.25	0.12	0.12	0.01					0.09
0.14	0.14	−0.01					−0.11	15.60	0.07	0.08	0.01					0.22
0.10	0.12	0.02					0.44	2.64	0.08	0.09	0.01					0.23
0.15	0.18	0.03					0.78	23.54	0.10	0.11	0.01					0.26
0.09	0.09	0.00					0.00	32.14	0.05	0.06	0.00					0.00
0.09	0.11	0.02					0.49	34.11	0.04	0.03	−0.01					−0.25
0.11									0.08							
0.14	0.12	−0.02					−0.30		0.06	0.05	−0.01					−0.20
0.07	0.07	0.00					0.00	0.00	0.07	0.07	0.01					0.11
0.09	0.08	−0.01					−0.19	−1.45	0.05	0.05	0.00					0.00
0.06	0.10	0.04					0.52	4.64	0.04	0.07	0.03					0.39
0.08	0.10	0.02					0.33	7.21	0.06	0.06	0.00					0.00
0.04	0.08	0.04					0.55	12.95	0.03	0.05	0.02					0.28
0.09	0.10	0.01					0.11	24.84	0.07	0.09	0.02					0.22
0.07	0.13	0.06					0.35	29.67	0.07	0.13	0.06					0.35
0.13	0.20	0.07					0.87	42.54	0.10	0.09	−0.01					−0.12
								76.65								
0.11	0.12	0.02					0.28		0.07	0.08	0.01					0.11
0.10	0.12	0.02					0.32		0.07	0.08	0.01					0.13
0.14	0.13	0.02					0.34		0.09	0.08	0.00					0.06
0.08	0.10	0.02					0.17		0.06	0.07	0.02					0.14

Accum	TURB in	TURB out	TURB diff			SET in	SET out	SET diff			AM in	AM out	AM diff			
kg	NTU	NTU	NTU			ml/l	ml/l	ml/l			mg/l	mg/l	mg/l			
	31.00					0.05					0.05					
	13.25					0.05					0.05					
	7.00	5.50	−1.50			0.05	0.05	0.00			0.11	0.13	0.02			
	9.15	7.75	−1.40			0.05	0.09	0.07			0.07	0.11	0.05			
3.63	39.05	39.30	0.25			0.05	0.05	0.00			0.23	0.38	0.15			
	27.50	28.05	0.55			0.05	0.05	0.05			0.05	0.06	0.01			
7.99	21.35	16.80	−4.55			0.09	0.11	0.02			0.05	0.05	0.00			
3.61	7.65	7.15	−0.50			0.05	0.05	0.00			0.05	0.10	0.05			
11.18	8.00	5.35	−2.65			0.05	0.05	0.00			0.05	0.13	0.08			
6.48	3.45	3.90	0.45			0.05	0.05	0.00			0.05	0.05	0.00			
5.49	3.05	2.95	−0.10			0.05	0.05	0.05			0.05	0.05	0.00			
	5.90					0.05					0.06					
	4.35	4.20	−0.15			0.06	0.05	−0.01			0.05	0.05	0.00			
1.59	3.60	5.18	1.58			0.05	0.05	0.00			0.18	0.23	0.05			
2.45	1.73	1.75	0.02			0.05	0.05	0.00			0.10	0.20	0.10			
9.71	1.93	3.10	1.17			0.05	0.05	0.00			0.20	0.05	−0.15			
10.89	7.90	8.30	0.40			0.05	0.12	0.07			0.05	0.05	0.00			
12.68	1.95	3.70	1.75			0.05	0.05	0.00			0.05	0.05	0.00			
21.53	2.00	1.65	−0.35			0.05	0.05	0.00			0.05	0.30	0.25			
27.49	2.40	2.30	−0.10			0.05	0.05	0.00			0.03	0.04	0.01			
29.88	12.50	13.00	0.50			0.05	0.09	0.05			0.20	0.30	0.10			
35.37																
	10.22	8.89	−0.26			0.05	0.06	0.02			0.08	0.13	0.04			
	9.42	9.16	−0.26			0.05	0.06	0.02			0.09	0.13	0.04			
	13.87	12.98	−0.90			0.05	0.06	0.02			0.09	0.14	0.05			
	3.53	3.77	0.54			0.05	0.06	0.01			0.09	0.12	0.03			

	AM load	Accum	N/N in	N/N out	N/N diff					N/N load	Accum	TKN in	TKN out	TKN diff	
	kg/day	kg	mg/l	mg/l	mg/l					kg/day	kg	mg/l	mg/l	mg/l	
			2.18									0.61			
			3.79												
	0.48	2.89	3.06	2.91	−0.15					−3.62	−25.32	0.59	1.12	0.53	
	0.91	11.97	3.00	3.01	0.00					0.10	−48.18				
	2.39	45.05	3.85	3.85	0.01					0.08	−46.34	0.41	0.68	0.27	
	0.22	58.13	3.30	3.20	−0.10					−2.22	−57.03				
	0.00	60.13	3.95	3.95	0.00					0.00	−77.02	0.21	0.04	−0.18	
	1.10	68.94	4.21	4.11	−0.10					−2.20	−94.63				
	2.08	89.64	4.00	4.00	0.00					0.00	−108.94	0.02	0.02	0.00	
	0.00	112.56	2.62	2.64	0.02					0.50	−103.41	1.96	1.24	−0.73	
	0.00	112.56	3.75	3.72	−0.03					−0.74	−104.86				
			4.82												
	0.00		4.95	4.96	0.00					0.10		0.57	0.83	0.26	
	1.02	14.33	5.00	5.01	0.01					0.23	3.18				
	1.94	36.56	4.70	4.70	0.00					0.00	4.89	0.02	0.02	0.00	
	−1.96	36.13	5.00	5.00	0.00					0.00	4.89	0.20	0.40	0.20	
	0.00	30.24	4.80	4.80	0.00					0.00	4.89				
	0.00	30.24	4.70	4.70	0.00					0.00	4.89	1.10	1.10	0.00	
	2.69	78.67	4.40	4.30	−0.10					−1.08	−14.48	0.05	0.20	0.15	
	0.06	107.54	4.40	4.30	−0.10					−0.59	−31.95				
	1.25	121.25	3.00	2.90	−0.10					−1.25	−51.21	2.00	1.50	−0.50	
		233.81									−156.07				
	0.68		3.97	4.00	−0.04					−0.59		0.64	0.65	0.00	
	0.72		3.98	3.95	−0.04					−0.63		0.65	0.65	0.00	
	0.84		3.47	3.43	−0.04					−0.93		0.83	0.76	−0.10	
	0.47		4.75	4.72	−0.02					−0.17		0.39	0.51	0.12	

		TKN load	Accum	CFS	Sample	TEMP		TEMP	TEMP	DO in	DO out	DO diff			CON in	CON out
		kg/day	Kg		Time	in		out	diff	mg/l	mg/l	mg/l			uhmos	uhmos
				1.00	11.45	13.90				11.10					495.00	
				7.41	18.00	14.30				9.90					560.00	
		12.78	89.48	9.86	18.15	19.00		20.30	1.30	9.30	10.50	1.20			600.00	610.00
					10.15	14.60		14.10	−0.50	8.30	7.20	−1.10			525.00	530.00
		4.46	373.94	6.75	17.45	18.40		19.50	1.10	6.00	4.40	−1.60			695.00	700.00
				9.08	9.00	14.90		14.80	−0.10	7.20	4.30	−2.90			600.00	550.00
		−3.85	382.41	9.00	16.45	18.00		18.60	0.60	7.00	6.10	−0.90			700.00	700.00
				9.00	13.00	16.10		16.30	0.20	8.20	7.30	−0.90			650.00	690.00
		0.00	326.55	10.65	16.20	14.20		14.70	0.50	7.60	5.60	−2.00			600.00	600.00
		−18.23	126.02	10.28	12.30	14.50		14.40	−0.10	8.50	9.10	0.60			600.00	600.00
			−1.59	10.10	18.30	14.10		14.30	0.20	8.10	8.10	0.00			600.00	600.00
					12.15	12.30				8.70					600.00	
		5.05		8.10	11.12	12.90		12.70	−0.20	6.90	6.90	0.00			650.00	640.00
				9.30	11.05	12.20		11.80	−0.40	8.10	6.80	−1.30			650.00	650.00
		0.00	0.00	7.93	14.35	11.50		11.60	0.10	8.00	7.00	−1.00			635.00	635.00
		2.62	48.42	5.35	12.35	12.00		11.50	−0.50	10.10	7.60	−2.50			600.00	600.00
				6.78	13.05	12.70		12.10	−0.60	10.10	8.40	−1.70			610.00	610.00
		0.00	73.28	5.65	11.25	12.30		11.30	−1.00	10.50	7.50	−3.00			600.00	600.00
		1.61	102.34	4.40	11.05	12.60		11.20	−1.40	9.80	5.80	−4.00			650.00	620.00
				2.40	15.15	16.40		16.90	0.50						590.00	620.00
		−6.24	5.26	5.10	13.25	10.80		10.50	−0.30	8.30	6.40	−1.90			485.00	550.00
			3.67													
		−0.16		7.63		14.27		14.26	−0.03	8.59	7.00	−1.35			604.52	616.94
		−0.16		7.60		14.37		14.35	−0.02	8.44	7.01	−1.44			611.18	615.59
		−1.85		8.02		15.46		15.75	0.29	7.85	6.90	−0.95			605.50	613.00
		1.86		6.24		12.83		12.39	−0.44	9.03	7.14	−1.93			623.13	621.88

CON diff			pH	pH	pH			CHL in	CHL out	CHL diff			CHL	CHL
uhmos			In	out	diff			mg/l	mg/l	mg/l			kg/day	Accum
			8.18					34.74						
			8.16											
10.00			8.50	8.50	0.00			37.53	35.82	−1.71			−41.24	−288.69
5.00			8.75	8.10	−0.65									
5.00			7.84	7.75	−0.09			41.30	41.40	0.10			1.65	−941.92
−50.00			7.77	7.66	−0.11									
0.00			7.90	7.91	0.01			31.90	33.10	1.20			26.42	−548.97
40.00			7.99	7.96	−0.03									
0.00			7.92	7.89	−0.03			39.00	40.60	1.60			41.68	293.01
0.00			8.14	8.20	0.06			35.79	35.62	−0.17			−4.27	704.46
0.00			8.44	8.46	0.02									**674.54**
			8.37											
−10.00			8.25	8.29	0.04			36.12	36.12	0.00			0.00	
0.00			8.29	8.31	0.02									
0.00			8.40	8.43	0.03			36.80	N/A					−366.41
0.00			8.47	8.44	−0.03			38.50	37.50	−1.00			−13.09	−1243.17
0.00			8.48	8.45	−0.03									
0.00			8.35	8.30	−0.05			38.50	34.00	−4.50			−62.19	−1958.29
−30.00			8.17	8.16	−0.01			35.80	33.80	−2.00			−21.52	−3465.13
30.00			8.29	8.22	−0.07									
65.00			8.42	8.31	−0.11			34.00	34.00	0.00			0.00	**−3917.15**
														−3242.61
3.61			8.24	8.19	−0.06			36.67	36.20	−0.65			−7.26	
4.41			8.24	8.18	−0.06			36.84	36.20	−0.65			−7.26	
7.50			8.17	8.07	−0.09			36.32	36.76	0.17			4.04	
−1.25			8.34	8.33	−0.01			37.14	35.36	−1.88			−24.20	

APPENDIX G

Farm #6 Sample Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Fish Farm #6 sample data and calculations.

Sample #	DATE	Sample Day #	F F #	Flow cfs	VOL l/day	TSS in mg/day	TSS out mg/day	TSS diff mg/l	TSS PS mg/l	PS diff mg/l	PS load kg/day	Accum PS kg	TSS Load kg/day	Accum kg/crop
1	19 May	139												
2	30 May	150	6	31.63	77366473.9	35.00	80.00	45.00	57.00	22.00	1702.06	18722.69	3481.49	38296.40
3	12 June	163	6	21.42	52392977.3	35.00	62.00	27.00	71.00	36.00	1886.15	42046.05	1414.61	70121.07
4	25 June	176	6	22.72	55572756.5	19.00	23.50	4.50	18.50	−0.50	−27.79	54125.39	250.08	80941.54
5	15 July	196	6	24.02	58752535.7	45.50	43.50	−2.00	45.50	0.00	0.00	53847.53	−117.51	82267.26
6	25 July	206	6	26.57	64989794.9	194.50	156.50	−38.00	166.00	−28.50	−1852.21	44586.48	−2469.61	69331.67
7	12 Aug	224	6	22.60	55279238.4	68.50	62.50	−6.00	60.00	−8.50	−469.87	23687.74	−331.68	44120.08
8	28 Aug	240	6	26.42	64622897.3	105.00	121.50	16.50	177.00	72.00	4652.85	57151.54	1066.28	49996.90
9	10 Sept	253	6	25.62	62666110.1	68.00	52.00	−16.00	60.00	−8.00	−501.33	**84136.42**	−1002.66	**50410.43**
10	2 Oct	275	NF	20.48	50093752.3	42.50	48.00	5.50	34.00	−8.50	−425.80		275.52	
11	8 Oct	281	NF	22.02	53860567.7	36.50	37.50	1.00	32.00	−4.50	−242.37		53.86	
12	28 Oct	301	NF	15.65	38279649.6	59.00	42.50	−16.50	43.00	−16.00	−612.47		−631.61	
13	10 Nov	314	6	18.06	44174471.0	25.50	17.50	−8.00	16.00	−9.50	−419.66	−4616.23	−353.40	−3887.35
14	25 Nov	329	6	17.34	42413362.6	13.50	22.00	8.50	15.00	1.50	63.62	−7286.51	360.51	−3833.97
15	10 Dec	344	6	17.34	42413362.6	5.50	29.50	24.00					1017.92	6504.29
16	16 Jan	381	6	15.00	36689760.0	63.50	59.00	−4.50	57.00	−6.50	−238.48	−11832.96	−165.10	22281.40
17	22 Jan	387	6	15.60	38157350.4	47.00	48.50	1.50	56.50	9.50	362.49	−11460.93	57.24	21957.79
18	4 Feb	400	6	15.17	37105577.3	25.00	22.50	−2.50	24.50	−0.50	−18.55	−9225.30	−92.76	21726.86
19	11 Mar	436	6	15.36	37570314.2	14.50	15.50	1.00	15.00	0.50	18.79	−9221.12	37.57	20733.38
20	1 April	457	6	16.66	40750093.4	6.00	7.00	1.00	7.00	1.00	40.75	−8596.00	40.75	21555.74
21	22 April	478	6	21.54	52686495.4	136.50	134.00	−2.50	153.50	17.00	895.67	**1236.41**	−131.72	**20600.60**
				ACCUMULATIVE LOADINGS DURING REARING OPERATIONS								85372.83		71011.03
				MEAN		52.28	54.25	1.98	58.34	3.61	253.36		137.99	
				MEAN	Rearing	54.53	54.81	0.28	62.83	5.03	292.83		−26.22	
				MEAN	Irrigation	71.45	74.64	3.18	79.50	8.05	510.67		226.24	
				MEAN	Non−irrigat	28.83	29.33	0.50	29.25	−2.50	−100.44		30.12	

*** Data from farm above Farm #6, not included in calculations.

NF – few or no fish in facility

TP in	TP out	TP diff	TP PS	PS diff	PS load	Accum	TP load	Accum	OP in	OP out	OP diff	OP PS	PS diff	PS load	Accum	OP load
mg/day	mg/day	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg/crop	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day
0.08	0.10	0.02	0.09	0.01	0.56	3.61	0.83	32.51								
0.17	0.15	−0.02	0.16	−0.01	−0.47	4.47	−1.09	29.98	0.09	0.09	0.00	0.09	0.00	0.00	0.00	−0.12
0.18	0.20	0.02	0.18	0.00	0.00	−2.11	1.11	39.93	0.09	0.09	0.00	0.09	0.00	0.00	0.00	0.00
0.21	0.28	0.07	0.36	0.15	9.73	75.69	4.39	83.93	0.11	0.13	0.02	0.15	0.04	2.42	19.39	1.00
0.24	0.30	0.06	0.26	0.02	1.25	**147.06**	3.76	**136.93**	0.13	0.15	0.01	0.14	0.01	0.63	**39.21**	0.94
0.15	0.18	0.04	0.15	0.01	0.25		1.75		0.07	0.07	0.00	0.07	0.00	0.00		0.00
0.14	0.17	0.02	0.16	0.02	1.08		1.35		0.01	0.01	0.00	0.01	0.00	0.00		0.00
0.11	0.18	0.06	0.16	0.05	1.91		2.49		0.09	0.12	0.03	0.12	0.03	1.15		1.15
0.14	0.17	0.03	0.16	0.02	0.88	9.72	1.33	14.58	0.07	0.11	0.05	0.09	0.02	0.88	9.72	1.99
0.08	0.14	0.06	0.10	0.02	0.85	22.71	2.54	43.60	0.08	0.11	0.02	0.10	0.02	0.64	21.12	1.06
0.05	0.10	0.05					2.12	78.59	0.08	0.06	−0.02					−0.85
0.22	0.23	0.01	0.19	−0.03	−1.10	16.14	0.37	124.61	0.18	0.18	0.00	0.24	0.06	2.20	94.89	0.00
0.18	0.19	0.01	0.20	0.02	0.76	15.13	0.38	126.86	0.13	0.13	0.00	0.13	0.00	0.00	101.50	0.00
0.13	0.14	0.01	0.14	0.02	0.56	23.71	0.37	131.75	0.09	0.09	0.00	0.08	−0.01	−0.37	99.09	0.00
0.14	0.15	0.01	0.15	0.01	0.56	43.87	0.56	148.57	0.12	0.14	0.02	0.13	0.01	0.38	99.17	0.75
0.09	0.12	0.03	0.12	0.03	1.22	62.63	1.22	167.33	0.07	0.08	0.01	0.08	0.01	0.41	107.39	0.41
0.16	0.25	0.09	0.30	0.14	7.38	**152.91**	4.74	**229.95**	0.08	0.09	0.01	0.09	0.01	0.53	**117.20**	0.53
						299.97		366.88							156.42	
0.14	0.18	0.03	0.18	0.03	1.59		1.66		0.09	0.10	0.01	0.10	0.01	0.55		0.40
0.15	0.18	0.03	0.19	0.03	1.71		1.62		0.10	0.11	0.01	0.12	0.01	0.64		0.44
0.17	0.20	0.04	0.21	0.04	2.47		2.11		0.08	0.09	0.01	0.09	0.01	0.51		0.34
0.13	0.16	0.03	0.15	0.02	0.71		1.26		0.10	0.11	0.01	0.12	0.02	0.66		0.50

Accum	TURB in	TURB out	TURB diff	TURB PS	PS diff	SET in	SET out	SET diff	SET PS	PS diff	AM in	AM out	AM diff	AM PS	PS diff	PS load
kg	NTU	NTU	NTU	NTU	mg/l	ml/l	ml/l	ml/l	ml/l	ml/l	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day
	24.00	29.00	5.00	18.50	−5.50	0.08	0.10	0.02	0.10	0.02	0.05	0.22	0.17	0.34	0.29	22.05
	8.25	15.00	6.75	10.25	2.00	0.05	0.10	0.05	0.75	0.70	0.05	0.07	0.02	0.08	0.03	1.57
	8.55	7.50	−1.05	7.40	−1.15	0.05	0.05	0.00	0.05	0.00	0.05	0.07	0.02	0.05	0.00	0.00
−6.70	25.00	20.80	−4.20	19.80	−5.20	0.05	0.05	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.00	0.00
	64.25	68.05	3.80	53.05	−11.20	0.25	0.23	−0.02	0.30	0.05	0.05	0.05	0.00	0.05	0.00	0.00
−8.34	21.80	22.35	0.55	24.20	2.40	0.11	0.10	−0.01	0.05	−0.06	0.05	0.17	0.12	0.06	0.01	0.55
−0.33	27.65	32.40	4.75	35.75	8.10	0.05	0.10	0.05	0.20	0.15	0.05	0.09	0.04	0.09	0.04	2.58
12.29	16.70	16.60	−0.10	16.80	0.10	0.30	0.06	−0.25	0.10	−0.20	0.05	0.09	0.04	0.05	0.00	0.00
	13.20	11.45	−1.75	9.85	−3.35	0.05	0.07	0.02	0.04	−0.01	0.05	0.05	0.00	0.05	0.00	0.00
	10.70	11.75	1.05	10.60	−0.10	0.06	0.04	−0.02	0.04	−0.02	0.05	0.05	0.00	0.05	0.00	0.00
	6.20	12.00	5.80	7.60	1.40	0.05	0.11	0.06	0.08	0.03	0.05	0.05	0.00	0.05	0.00	0.00
21.87	3.40	3.95	0.55	4.00	0.60	0.05	0.05	0.00	0.03	−0.02	0.05	0.06	0.01	0.06	0.01	0.44
44.73	3.86	5.14	1.28	4.82	0.96	0.05	0.03	−0.03	0.02	−0.03	0.17	0.25	0.08	0.26	0.09	3.82
46.32	1.19	3.35	2.16			0.05	0.05	−0.01			0.05	0.05	0.00	0.05	0.00	2.12
30.63	13.00	13.70	0.70	14.80	1.80	0.20	0.12	−0.08	0.18	−0.03	0.05	0.30	0.25	0.30	0.25	9.17
30.63	10.80	12.40	1.60	14.20	3.40	0.08	0.09	0.01	0.10	0.02	0.20	0.20	0.00	0.25	0.05	1.91
30.63	4.80	5.10	0.30	4.85	0.05	0.05	0.05	0.00	0.05	0.00	0.05	0.10	0.05	0.10	0.05	1.86
44.15	5.80	3.60	−2.20	4.00	−1.80	0.05	0.05	0.00	0.05	0.00	0.32	0.46	0.14	0.46	0.14	5.07
56.32	1.70	2.10	0.40	2.20	0.50	0.01	0.01	0.00	0.01	0.00	0.05	0.30	0.25	0.30	0.25	10.19
66.13	34.50	37.50	3.00	36.50	2.00	0.15	0.20	0.05	0.21	0.06	0.05	0.10	0.05	0.10	0.05	2.63
78.42																
	15.27	16.69	1.42	15.75	−0.26	0.09	0.08	−0.01	0.13	0.04	0.08	0.14	0.06	0.14	0.06	3.20
	15.70	16.85	1.14	16.84	0.17	0.10	0.08	−0.01	0.14	0.04	0.09	0.15	0.07	0.14	0.06	2.62
	23.15	24.76	1.62	22.06	−1.08	0.11	0.10	−0.01	0.17	0.06	0.05	0.09	0.04	0.09	0.04	2.67
	5.64	6.82	1.18	7.06	0.86	0.07	0.06	0.00	0.06	0.00	0.11	0.20	0.09	0.20	0.09	3.84

Accum	AM load	Accum	N/N in	N/N out	N/N diff	N/N PS	PS diff	PS load	Accum	N/N load	Accum	TKN in	TKN out	TKN diff	TKN PS
PS kg	kg/day	kg	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	PS kg	kg/day	kg	mg/l	mg/l	mg/l	mg/l
242.54	13.15	144.68	1.00	0.99	−0.02	0.98	−0.02	−1.55	−17.02	−1.16	−12.77				
396.08	0.79	235.27	0.82	0.79	−0.03	0.80	−0.01	−0.79	−32.19	−1.57	−30.53	0.81	0.60	−0.21	0.70
406.30	0.83	245.80	0.90	0.85	−0.05	0.89	−0.01	−0.56	−40.91	−2.78	−58.80				
406.30	0.00	254.14	1.83	1.82	−0.02	1.80	−0.03	−1.76	−64.09	−0.88	−95.40	0.05	0.27	0.23	0.10
406.30	0.00	254.14	1.60	1.55	−0.05	1.60	0.00	0.00	−72.90	−3.25	−116.06				
411.27	6.63	313.84	1.95	1.90	−0.05	2.00	0.05	2.76	−48.03	−2.76	−170.18	0.44	0.22	−0.22	0.10
436.38	2.58	387.59	1.73	1.71	−0.02	1.70	−0.03	−1.62	−38.84	−0.97	−200.04				
453.18	2.19	**418.64**	2.00	1.90	−0.10	1.90	−0.10	−6.27	**−90.07**	−6.27	**−247.08**	0.36	0.37	0.02	0.05
	0.00		0.32	0.23	−0.09	0.28	−0.04	−2.00		−4.51		1.27	2.66	1.39	1.70
	0.00		1.08	1.18	0.11	1.15	0.07	4.04		5.66					
	0.00		4.16	4.15	0.00	4.14	−0.02	−0.57		−0.19					
4.86	0.44	4.86	4.79	4.79	0.00	4.80	0.01	0.66	7.29	0.22	2.43	0.67	0.88	0.20	0.78
36.80	3.39	33.62	4.91	5.03	0.12	5.01	0.10	4.24	44.07	4.88	40.67				
81.34	0.00	59.07	4.70	4.50	−0.20					−8.48	13.63	0.05	0.05	0.00	
290.26	9.17	228.76	5.00	5.00	0.00	4.90	−0.10	−3.67	58.95	0.00	−143.30	0.80	1.20	0.40	1.20
323.50	0.00	256.28	4.90	4.80	−0.10	4.80	−0.10	−3.82	36.50	−3.82	−154.75				
347.96	1.86	268.34	4.75	4.80	0.05	4.80	0.05	1.86	23.75	1.86	−167.49	0.85	1.30	0.45	1.60
472.65	5.26	396.41	4.45	4.50	0.05	4.50	0.05	1.88	90.96	1.88	−100.28	0.85	0.65	−0.20	0.60
632.88	10.19	558.60	4.40	4.40	0.00	4.40	0.00	0.00	110.69	0.00	−80.56				
767.50	2.63	**693.23**	0.60	0.60	0.00	0.60	0.00	0.00	**110.69**	0.00	**−80.56**	1.60	1.70	−0.30	1.10
1220.68		1111.88							20.61		−327.64				
	2.96		2.79	2.77	−0.02	2.69	−0.01	−0.38		−1.11		0.77	0.98	0.18	0.79
	2.87		3.08	3.06	−0.02	2.97	−0.01	−0.47		−1.37		0.70	0.90	0.16	0.69
	2.62		1.26	1.23	−0.03	1.25	−0.01	−0.70		−1.68		0.75	0.97	0.15	0.63
	3.37		4.67	4.66	−0.01	4.67	0.00	0.07		−0.41		0.79	1.01	0.21	1.05

PS diff	PS load	Accum	TKN Load	Accum	CFS	Sample	TEMP	TEMP	TEMP	TEMP	DO in	DO out	DO diff	DO PS	PS	CON in
mg/l	kg/day	PS kg	kg/day	Kg		Time	in	PS	out	diff	mg/l	mg/l	mg/l	mg/l	diff	uhmos
					31.63	19.00	15.50	15.60	15.50	0.00	9.40	8.90	−0.50	6.20	−3.20	435.00
−0.11	−5.76	−138.32	−11.00	−264.06	21.42	19.30	21.00	21.00	21.00	0.00	9.80	9.00	−0.80	8.80	−1.00	460.00
					22.72		17.00	17.10	17.40	0.40	10.00	9.10	−0.90	8.70	−1.30	455.00
0.05	2.94	−184.94	13.22	−227.48	24.02	18.15	23.80	23.80	23.90	0.10	6.40	5.80	−0.60	5.90	−0.50	580.00
					26.57	9.30	18.40	18.50	18.50	0.10	7.10	7.00	−0.10	6.80	−0.30	500.00
−0.34	−18.79	−406.94	−12.16	−212.67	22.60	17.10	21.90	22.20	21.80	−0.10	7.30	6.30	−1.00	6.10	−1.20	520.00
					26.42	13.25	18.80	19.00	19.10	0.30	9.40	8.40	−1.00	7.90	−1.50	495.00
−0.30	−19.11	−956.61	0.94	−375.38	25.62	15.15	17.70	17.60	17.60	−0.10	7.90	7.60	−0.30	7.20	−0.70	500.00
0.435	21.79		69.63		20.48	13.00	15.00	15.10	15.10	0.10	9.30	8.10	−1.20	8.10	−1.20	475.00
					22.02	19.45	14.20	14.40	14.20	0.00	8.20	8.00	−0.20	7.50	−0.70	460.00
					15.65	12.30	9.10	8.90	9.00	−0.10	10.00	9.20	−0.80	8.90	−1.10	550.00
0.11	4.86	53.45	9.06	99.61	18.06	11.40	11.60	11.40	11.50	−0.10	8.60	8.70	0.10	7.30	−1.30	630.00
					17.34	11.30	10.40	10.30	10.50	0.10	10.70	9.30	−1.40	8.10	−2.60	610.00
			0.00	235.45	17.34	15.25	10.20	9.90			9.70	9.60	−0.10			600.00
0.4	14.68	707.88	14.68	506.95	15.00	13.00	8.70	8.50	8.60	−0.10	10.40	9.70	−0.70	9.60	−0.80	600.00
					15.60	13.20	8.90	8.70	8.50	−0.40	10.10	9.70	−0.40	9.30	−0.80	600.00
0.75	27.83	1111.68	16.70	805.00	15.17	11.50	8.10	8.00	8.00	−0.10	10.60	10.10	−0.50	9.30	−1.30	600.00
−0.25	−9.39	1443.53	−7.51	970.30	15.36	11.40	10.10	10.20	10.40	0.30	9.80	8.30	−1.50	7.90	−1.90	600.00
					16.66	15.30	16.20	15.90	16.00	−0.20						610.00
−0.5	−26.34	**1427.78**	−15.81	**480.58**	21.54	13.50	10.10	9.90	10.20	0.10	8.70	8.30	−0.40	8.00	−0.70	400.00
		471.17		105.20												
0.02	−0.73		7.77		20.56		14.34	14.30	14.57	0.02	9.13	8.48	−0.65	7.87	−1.23	534.00
−0.02	−3.23		7.07		20.09		14.56	14.81	14.79	0.04	9.10	8.46	−0.64	7.92	−1.14	547.50
−0.13	−7.55		7.47		24.09		17.58	17.65	17.66	0.08	8.50	7.86	−0.64	7.38	−1.12	480.00
0.25	9.49		8.23		16.24		10.37	10.20	10.31	−0.07	9.99	9.33	−0.66	8.63	−1.40	600.00

CON out	CON diff	CON PS	PS	pH	pH	pH	pH	pH	CHL in	CHL out	CHL diff	CHL PS	PS diff	PS	PS
uhmos	uhmos	uhmos	diff	In	out	diff	PS	diff	mg/l	mg/l	mg/l	mg/l	mg/l	kg/day	Accum
435.00	0.00	470.00	35.00	8.66	8.44	−0.22	8.32	−0.34							
485.00	25.00	485.00	25.00	8.90	8.86	−0.04	8.86	−0.04	33.19	32.72	−0.47	31.64	−1.55	−81.21	−1949.02
455.00	0.00	455.00	0.00	8.90	9.25	0.35	8.83	−0.07							
580.00	0.00	600.00	20.00	8.49	8.46	−0.03	8.46	−0.03	33.95	36.06	2.11	34.90	0.95	55.81	−2368.02
500.00	0.00	500.00	0.00	8.04	8.02	−0.02	8.02	−0.02							
560.00	40.00	530.00	10.00	8.51			8.46	−0.05	26.40	30.60	4.20	26.70	0.3	16.58	−1354.44
505.00	10.00	510.00	15.00	8.41	8.34	−0.07	8.30	−0.11							
500.00	0.00	500.00	0.00	7.35	8.30	0.95	8.31	0.96	32.80	31.00	−1.80	35.60	2.8	175.47	**1430.27**
480.00	5.00	480.00	5.00	8.67	8.60	−0.07	8.62	−0.05	29.37	29.72	0.35	29.20	−0.17	−8.52	
465.00	5.00	465.00	5.00	8.90	8.84	−0.06	8.85	−0.05							
550.00	0.00	550.00	0.00	8.63	8.63	0.00	8.62	−0.01							
630.00	0.00	630.00	0.00	8.53	8.81	0.28	8.50	−0.03	38.82	40.34	1.52	38.83	0.01	0.44	4.86
600.00	−10.00	600.00	−10.00	8.58	8.57	−0.01	8.55	−0.03							
600.00	0.00			8.72	8.78	0.06			N/A	40.90					
595.00	−5.00	595.00	−5.00	8.99	8.60	−0.39	8.71	−0.28	42.50	41.70	−0.80	42.50	0	0.00	19.66
590.00	−10.00	590.00	−10.00	8.64	8.65	0.01	8.61	−0.03							
590.00	−10.00	590.00	−10.00	8.49	8.48	−0.01	8.49	0.00	41.50	41.00	−0.50	41.00	−0.5	−18.55	−156.59
600.00	0.00	600.00	0.00	8.28	8.29	0.01	8.27	−0.01	40.00	39.70	−0.30	38.50	−1.5	−56.36	−1504.94
650.00	40.00	610.00	0.00	8.57	8.48	−0.09	8.48	−0.09							
430.00	30.00	400.00	0.00	8.54	8.52	−0.02	8.50	−0.04	31.50	30.00	−1.50	32.00	0.5	26.34	**−2135.20**
															−704.93
540.00	6.00	534.74	4.21	8.54	8.57	0.03	8.51	−0.02	35.00	35.28	0.28	35.09	0.08	11.00	
554.38	6.88	546.33	2.33	8.50	8.56	0.07	8.50	−0.02	35.00	35.79	0.26	31.90	0.11	13.17	
490.45	10.45	490.45	10.45	8.49	8.56	0.08	8.50	0.01	31.20	31.68	0.48	31.67	0.47	30.75	
600.56	0.56	595.63	−4.38	8.60	8.59	−0.02	8.53	−0.06	40.71	40.69	−0.02	40.21	−0.50	−18.62	

CHL kg/day	CHL Accum
−24.62	−590.99
123.97	1048.17
232.17	6034.14
−112.80	7765.06
17.53	
67.15	738.60
−29.35	2004.68
−18.55	1549.58
−11.27	1012.75
−79.03	−883.57
	6881.49

16.52	
15.02	
26.20	
1.99	

APPENDIX H

24 hour Sample Data

24 Hour Studies
24–25 June 1991 Farm #1

Time	Temp in	Temp out	Temp diff	DO in	DO out	DO diff.	Cond. In	Cond.Out	Cond Diff	pH In	pH Out	pH diff	TSS in
	(C)	(C)	(C)	(mg/l)	(mg/l)	(mg/l)	(uhmos)	(uhmos)	(uhmos)				(mg/l)
20.30	12.6	12.9	0.3	8.2	6.7	−1.5	640	700	60	7.58	7.62	0.04	2
21.30	12.4	12.5	0.1	8.4	6.4	−2	640	700	60	7.6	7.66	0.06	4
22.30	12.4	12.4	0	8.4	6.2	−2.2	700	690	−10	7.67	7.65	−0.02	4
23.30	12.3	12.3	0	8.4	6.2	−2.2	700	680	−20	7.62			2
24.30	12.2	12.1	−0.1	8.6	6.4	−2.2	700	700	0	7.65	7.69	0.04	4
1.30	12.2	12	−0.2	8.9	6.5	−2.4	700	700	0	7.68	7.69	0.01	0
2.30	12.2	12	−0.2	9	6.5	−2.5	700	700	0	7.65	7.68	0.03	2
3.30	12.1	12	−0.1	8.8	6.6	−2.2	700	700	0	7.64	7.71	0.07	2
4.30	12.1	12	−0.1	8.5	6.6	−1.9	700	700	0	7.66	7.75	0.09	4
5.30	12.1	12	−0.1	8.4	6.5	−1.9	700	700	0	7.67	7.69	0.02	1
6.30	12.1	12	−0.1	8.6	6.4	−2.2	700	700	0	7.64	7.69	0.05	4
7.30	12.3	12	−0.3	8.6	6.4	−2.2	700	700	0	7.69	7.69	0	2
8.30	12.4	12.3	−0.1	9	6.8	−2.2	700	700	0	7.68	7.74	0.06	3
9.30	12.6	12.9	0.3	8.9	7.1	−1.8	700	700	0	7.77	7.83	0.06	0
10.30	12.8	13.5	0.7	8.7	7.2	−1.5	700	700	0	7.75	7.79	0.04	3
11.30	12.9	14	1.1	8.9	7	−1.9	700	700	0	7.85	7.89	0.04	3
12.30	12.7	14.6	1.9	9.1	7.4	−1.7	700	705	5	7.73	7.82	0.09	1
13.30	13.1	14.8	1.7	8.6	7	−1.6	700	700	0	7.49	7.73	0.24	4
14.30	12.7	14	1.3	8.3	7.3	−1	700	700	0	7.53	7.71	0.18	1
15.30	12.5	13	0.5	8.4	6.7	−1.7	700	700	0	7.76	7.81	0.05	6
16.30	12.7	13.4	0.7	8.8	7	−1.8	700	700	0	7.79	7.83	0.04	2
17.30	12.6	13.5	0.9	8.7	7.4	−1.3	695	700	5	7.76	7.84	0.08	3
Mean	12.45	12.83	0.37	8.65	6.74	−1.90	694.32	698.86	4.55	7.68	7.74	0.06	2.59

TSS out	TSS diff.	NH3 In	NH3 Out	NH3 diff	Nt/Nt In	Nt/Nt out	Nt/Nt diff	Flow
(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(cfs)
2	0	0.05	0.24	0.19	3.79	3.72	−0.07	
1	−3	0.05	0.21	0.16	3.79	3.7	−0.09	
4	0	0.05	0.2	0.15	3.81	3.7	−0.11	3.3
5	3	0.05	0.19	0.14	3.8	3.74	−0.06	3.3
5	1	0.05	0.19	0.14	3.81	3.73	−0.08	3.9
7	7	0.05	0.19	0.14	3.93	3.82	−0.11	3.6
7	5	0.05	0.19	0.14	3.95	3.83	−0.12	3.6
7	5	0.05	0.19	0.14	3.92	3.83	−0.09	3.9
5	1	0.05	0.19	0.14	3.93	3.73	−0.2	3.6
8	7	0.05	0.19	0.14	3.88	3.76	−0.12	3.6
2	−2	0.05	0.19	0.14	3.85	3.77	−0.08	3.6
7	5	0.05	0.19	0.14	3.85	3.71	−0.14	3.9
9	6	0.05	0.18	0.13	3.8	3.55	−0.25	3.9
4	4	0.05	0.19	0.14	3.66	3.56	−0.1	3.9
3	0	0.05	0.21	0.16	3.73	3.6	−0.13	3.9
5	2	0.05	0.2	0.15	3.67	3.65	−0.02	3.6
5	4	0.05	0.21	0.16	3.73	3.59	−0.14	
8	4	0.05	0.22	0.17	3.76	3.6	−0.16	3.9
4	3	0.05	0.22	0.17	3.75	3.61	−0.14	3.6
4	−2	0.05	0.22	0.17	3.76	3.59	−0.17	3.3
4	2	0.05	0.21	0.16	3.72	3.53	−0.19	3.6
4	1	0.05	0.23	0.18	3.74	3.49	−0.25	3.3
5.00	2.41	0.05	0.20	0.15	3.80	3.67	−0.13	3.47

24 Hour Studies
27–28 August 1991 Farm #2

Time	Temp In	Temp PS	Temp diff	DO in	DO PS	DO diff	Cond in	Cond PS	Cond diff	pH In	pH PS	pH diff	Set in
	(C)	(C)	(C)	(mg/l)	(mg/l)	(mg/l)	(uhmos)	(uhmos)	(uhmos)				(ml/l)
23.30	13.1	13.1	0	8.3	5.5	−2.8	670	640	−30	7.64	7.57	−0.07	0.005
0.30	12.9	12.9	0	8.3	5.4	−2.9	650	650	0	7.59	7.68	0.09	0.005
1.30	12.9	12.8	−0.1	8.2	5.4	−2.8	650	650	0	7.58	7.48	−0.1	0.005
2.30	12.8	12.7	−0.1	8.2	5.5	−2.7	630	650	20	7.63	7.58	−0.05	0.005
3.30	12.7	12.6	−0.1	8.2	6.3	−1.9	630	620	−10	7.4	7.56	0.16	0.005
4.30	12.5	12.8	0.3	8.3	5.9	−2.4	650	650	0	7.56	7.7	0.14	0.005
5.30	12.7	12.6	−0.1	8.4	5.7	−2.7	650	620	−30	7.62	7.6	−0.02	0.005
6.30	12.8	12.5	−0.3	8.8	6.2	−2.6	650	650	0	7.63	7.58	−0.05	0.005
7.30	12.7	12.5	−0.2	8.5	5.8	−2.7	650	650	0	7.6	7.52	−0.08	0.005
8.30	12.8	12.8	0	8.7	5.7	−3	650	650	0	7.64	7.58	−0.06	0.005
9.30	13.2	13.1	−0.1	9.4	5.9	−3.5	680	650	−30	7.75	7.63	−0.12	0.005
10.30	13.3	13.4	0.1	9.8	6.3	−3.5	690	670	−20	7.76	7.77	0.01	0.005
11.30	13.7	13.9	0.2	10.3	6.7	−3.6	690	690	0	7.77	7.77	0	0.005
12.30	14.1	14.7	0.6	10.4	6.7	−3.7	700	700	0	7.77	7.78	0.01	0.005
13.30													
14.30													
15.30	14.6	15.2	0.6	11.3	7.5	−3.8	700	700	0	7.76	7.76	0	0.005
16.30	14.1	15.2	1.1	12	7.3	−4.7	700	710	10	7.72	7.76	0.04	0.005
17.30	14.1	15.1	1	12	6.3	−5.7	700	700	0	7.65	7.67	0.02	0.005
18.30	14	14.9	0.9	9.4	6.4	−3	700	700	0	7.72	7.69	−0.03	0.005
19.30													
20.30													
Mean	13.28	13.49	0.21	9.36	6.14	−3.22	668.89	663.89	−5.00	7.66	7.65	−0.01	0.01

Set PS	Set diff	NH3 In	NH3 PS	NH3 diff	Nt/Nt In	Nt/Nt PS	Nt/Nt diff	Flow
(ml/l)	(ml/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(cfs)
0.05	0.045	0.05	0.38	0.33	5.03	4.92	−0.11	7.76
0.005	0	0.05	0.39	0.34	5.11	5.08	−0.03	7.76
0.005	0	0.05	0.38	0.33	5.48	5.19	−0.29	7.76
0.005	0	0.05	0.37	0.32	5.41	5.2	−0.21	7.76
0.005	0	0.05	0.34	0.29	5.28	5.59	0.31	7.76
0.005	0	0.05	0.39	0.34	5.38	5.37	−0.01	7.76
0.005	0	0.05	0.44	0.39	5.38	5.37	−0.01	7.76
0.005	0	0.05	0.33	0.28	5.79	5.36	−0.43	7.76
0.005	0	0.05	0.34	0.29	5.38	5.36	−0.02	7.76
0.005	0	0.05	0.34	0.29	5.34	5.21	−0.13	7.76
0.005	0	0.05	0.34	0.29	5.21	5.3	0.09	7.76
0.005	0	0.05	0.37	0.32	5.27	5.22	−0.05	7.76
0.005	0	0.05	0.42	0.37	4.89	5.19	0.3	7.76
0.005	0	0.05	0.48	0.43	4.89	5.19	0.3	7.76
0.005	0	0.05	0.48	0.43	5.25	5.11	−0.14	7.76
0.005	0	0.07	0.48	0.41	5.11	4.94	−0.17	7.76
0.005	0	0.06	0.45	0.39	4.94	4.92	−0.02	7.76
0.005	0	0.05	0.5	0.45		4.91		7.76
0.01	0.00	0.05	0.40	0.35	4.95	5.19	−0.04	7.76

24 Hour Studies
8/9 October 1992 Farm #3

Time	Temp In	Temp PS	Temp diff	DO in	DO PS	DO diff	Cond in	Cond PS	Cond diff	pH in	pH PS	pH diff	
	(C)	(C)	(C)	(mg/l)	(mg/l)	(mg/l)	(uhmos)	(uhmos)	(uhmos)				
17.00	14.1	14.4	0.3	8.7	6.9	−1.8	650	650	0	8.2	8.06	−0.14	
18.00													
19.00	13.7	13.7	0	7.5	6.3	−1.2	650	650	0	8.77	8.14	−0.63	
20.00	12.7	12.7	0	6.4	6.1	−0.3	650	650	0	8.05	7.9	−0.15	
21.00													
22.00													
23.00													
24.00													
1.00	12.1	12.1	0	6.5	6.4	−0.1	650	650	0	7.92	8.02	0.1	
2.00													
3.00													
4.00													
5.00													
6.00													
7.00	11.5	11.2	−0.3	6.9	6.8	−0.1	600	600	0	7.85	8.06	0.21	
8.00													
9.00	11.7	11.6	−0.1	7.7	6.8	−0.9	600	600	0	7.94	8.02	0.08	
10.00													
11.00													
12.00													
13.00	14.2	16	1.8	9.1	5.8	−3.3	680	680	0	8.16	8.23	0.07	
14.00													
Mean	12.86	13.10	0.24	7.54	6.44	−1.10	640.00	640.00	0.00	8.13	8.06	−0.07	

		NH3 in (mg/l)	NH3 PS (mg/l)	NH3 diff (mg/l)	Nt/Nt in (mg/l)	Nt/Nt PS (mg/l)	Nt/Nt diff (mg/l)	Flow (cfs)
		0.14	0.35	0.21	4.3	4.28	−0.02	7.21
		0.11	0.34	0.23	4.35	4.27	−0.08	7.21
		0.11	0.34	0.23	4.46	4.55	0.09	7.21
		0.14	0.31	0.17	4.33	4.44	0.11	7.21
		0.11	0.24	0.13	4.15	4.11	−0.04	7.21
		0.09	0.18	0.09	3.96	3.96	0	7.21
		0.1	0.25	0.15	4.23	4.02	−0.21	7.21
		0.11	0.29	0.17	4.25	4.23	−0.02	7.21

24 Hour Studies
22–23 Jan 1992 Farm #6
Sunrise ~08.00 Sunset ~17.00

Time	Temp In	Temp PS	Temp diff	DO in	DO PS	DO diff	Cond in	Cond PS	Cond diff	pH in	pH PS	pH diff	Ortho in
	(C)	(C)	(C)	(mg/l)	(mg/l)	(mg/l)	(uhmos)	(uhmos)	(uhmos)				(mg/l)
17.00	10.2	9.7	−0.5	9.2	8.9	−0.3	600	600	0	8.4	8.5	0.1	0.11
18.00													
19.00													
20.00													
21.00	8	8	0	9.6	9.1	−0.5	600	600	0	8.35	8.49	0.14	0.1
22.00													
23.00													
24.00	8.4	6.9	−1.5	10.3	9.5	−0.8	575	575	0	8.21	8.38	0.17	0.1
1.00													
2.00													
3.00													
4.00													
5.00	6.9	6.8	−0.1	9.8	8.8	−1	580	580	0	8.35	8.47	0.12	0.13
6.00													
7.00													
8.00													
9.00	6.9	6.9	0	10.2	9.9	−0.3	580	580	0	8.46	8.52	0.06	0.12
10.00													
11.00	8	7.5	−0.5	9.9	9.2	−0.7	580	580	0	8.43	8.46	0.03	0.13
12.00													
13.00	8.9	8.7	−0.2	10.1	9.3	−0.8	600	590	−10	8.64	8.61	−0.03	0.13
14.00													
Mean	8.19	7.79	−0.40	9.87	9.24	−0.63	587.86	586.43	−1.43	8.41	8.49	0.08	0.12

Ortho PS (mg/l)	Ortho diff (mg/l)	NH3 in (mg/l)	NH3 PS (mg/l)	NH3 diff (mg/l)	Nt/Nt in (mg/l)	Nt/Nt PS (mg/l)	Nt/Nt diff (mg/l)	Flow (cfs)
0.09	−0.02	0.2	0.2	0	4.8	4.8	0	15
0.11	0.01	0.2	0.3	0.1	4.9	4.8	−0.1	15
0.1	0	0.2	0.3	0.1	4.9	4.8	−0.1	15
0.11	−0.02	0.3	0.3	0	4.9	4.9	0	15
0.13	0.01	0.3	0.3	0	4.9	4.8	−0.1	15
0.14	0.01	0.2	0.3	0.1	4.8	4.8	0	15
0.13	0	0.2	0.2	0	4.9	4.8	−0.1	15.6
0.12	0.00	0.23	0.27	0.04	4.87	4.81	−0.06	15.09

APPENDIX I

Deep Creek Sample Station Data

KEY

Sample #	Sample day order
Sample Day #	Numeric day of sample year (starts with 1 Jan. 1991 and continues into 1992)
FF #	Fish Farm Number
Flow	Weir measurement and calculated to cfs
VOL	Volume of water flowing through farm per day
TSS in	Total Suspended Solids in the sample of the inflow
TSS out	Total Suspended Solids in the sample of the outflow
TSS diff	Outflow concentration – Inflow concentration
TSS PS	Total Suspended Solids concentration in the sample presettling pond
PS diff	Presettling concentration – Inflow concentration
PS load	Quantity of TSS leaving the rearing area on a sample day (PS diff * VOL)
Accum PS	Total quantity of TSS leaving the rearing area during the rearing of the crop (Sample day B – Sample Day A) * ((PS load B + PS load A)/2)) This is corrected for harvest or stocking dates.
TSS Load	Quantity of TSS leaving the farm on sample day (Out – In * VOL)
Accum	Total quantity of TSS leaving the farm during the rearing of the crop (Sample day B – Sample Day A) * ((load B + load A)/2)) This is corrected for harvest or stocking dates.

in = Inflow
out = Outflow
PS = Presettling
NF = No fish present in the rearing facility
Sample Time = Time of day sample was collected
*TSS = Total Suspended Solids (mg/l)
*TP = Total Phosphorus (mg/l)
*OP = Orthophosphorus (mg/l)
*TURB = Turbidity (NTU's)
*SET = Settleable Solids (ml/l)
*AM = Ammonia–N (mg/l)
*N/N – Nitrite–N/Nitrate–N (mg/l)
*TKN = Total Kjeldahl Nitrogen (mg/l)
TEMP = Water temperature (C)
DO = Dissolved Oxygen (mg/l)
CON = Electrical Conductivity (uhmos)
pH = pH
*CHL = Chloride (mg/l)

* Note: Most chemical samples are mean between two samples. For calculations and reporting samples below the detection limit (BDL), one half the BDL is used. For values with more then 2 decimal places only two are shown.

ACCUMULATIVE LOADINGS DURING REARING OPERATIONS
The total accumulated loadings during rearing only
MEAN All Samples = Mean sample concentrations collected over the entire sample period
MEAN Rearing = Mean of the sample concentrations collected during periods of rearing
MEAN Irrigation = Mean sample concentrations collected during the irrigation season
MEAN Non–irrigation = Mean sample concentrations collected during periods of non–irrigation

Deep Creek upper sample station (US) adjacent to Farm #1 and the USGS station sample data and calculations.

Sample #		Sample Day		Flow (cfs) USGS	VOL l/day	TSS U S mg/l	TSS USGS mg/l	TSS per day mg/l		TSS USGS kg/d			
1	19 May	139		123.1	301100630.	120.00	134.00	14.00		40347.48			
2	30 May	150		101.9	249245769.	64.00	72.00	8.00		17945.70			
3	12 June	163		91.5	223807536	57.00	43.00	−14.00		9623.72			
4	25 June	176		69.12	169066414.	28.50	15.50	−13.00		2620.53			
5	15 July	196		56.26	137611059.	10.50	13.00	2.50		1788.94			
6	24 July	205		71.12	173958382.	67.50	38.00	−29.50		6610.42			
7	12 Aug	224		56.26	137611059.	59.00	24.50	−34.50		3371.47			
8	28 Aug	240		112.4	274928601.	65.50	108.50	43.00		29829.75			
9	10 Sept	253		153.4	375213945.	197.50	107.50	−90.00		40335.50			
10	2 Oct	275		232	567468288	57.00	71.00	14.00		40290.25			
11	8 Oct	281		209.2	511699852.	52.00	65.00	13.00		33260.49			
12	28 Oct	301		71.12	173958382.	24.50	23.50	−1.00		4088.02			
13	10 Nov	314		54.31	132841391.	1.00	9.50	8.50		1261.99			
14	25 Nov	329		53.34	130468786.	0.50	8.00	7.50		1043.75			
15	10 Dec	344		51.4	125723577.	0.50	8.00	7.50		1005.79			
16	16 Jan	381		51.4	125723577.	1.50	8.00	6.50		1005.79			
17	22 Jan	387		51.4	125723577.	4.50	16.00	11.50		2011.58			
18	4 Feb	400		50.43	123350973.	4.00	13.00	9.00		1603.56			
19	11 Mar	436		61.17	149620841.	1.00	12.00	11.00		1795.45			
20	1 April	457		55.28	135213995.	4.00	6.50	2.50		878.89			
21	22 April	478		123.1	301100630.	94.00	122.50	28.50		36884.83			
ACCUMULATIVE LOADINGS At USGS STATION						(TONNES)							
		MEAN annual		90.4385	221211298.	43.52	43.76	0.24		13219.23			
				MEAN	Irrigation	72.71	67.88	−4.83		21909.09			
				MEAN	Non−irrigat	4.61	11.61	7.00		1632.76			

Accum	TP	TP	TP		TP				TP	OP	OP	OP		OP		
SUS KG	U S	USGS	diff		USGS				Accum	U S	USGS	TOTAL		USGS		
	mg/l	mg/l	mg/l		kg/day				kg	mg/l	mg/l	mg/l		kg/day		
	0.23	0.24	0.01		72.26					0.04	0.08	0.04		24.09		
320612.49																
499813.72																
579401.36	0.15	0.08	−0.07		13.53				1587.11							
623496.10	0.21	0.09	−0.12		12.66				1848.96	0.17	0.06	−0.11		8.88		
661293.23																
756121.18	0.23	0.10	−0.13		13.07				2209.23	0.13	0.05	−0.08		6.88		
1021730.97	0.10	0.22	0.12		60.90				2800.98	0.17	0.11	−0.07		29.00		
1477805.11	0.52	0.30	−0.23		110.69				3916.29	0.23	0.12	−0.12		43.15		
2364688.33	0.16	0.19	0.02		104.98				6288.65	0.16	0.07	−0.10		36.89		
2585340.55	0.19	0.18	−0.02		89.55				6872.24	0.01	0.01	0.00		2.56		
2958825.67	0.11	0.11	0.00		19.14				7959.07	0.08	0.08	0.00		13.05		
2993600.77	0.08	0.06	0.02		7.97				8135.26	0.04	0.04	0.00		4.65		
3010893.85	0.02	0.04	0.03		5.22				8234.18	0.03	0.03	0.00		3.91		
3026265.39	0.05	0.05	−0.01		5.66				8315.75	0.02	0.03	0.01		3.14		
3063479.57	0.03	0.08	0.05		9.43				8594.86	0.02	0.05	0.03		6.29		
3072531.67	0.04	0.08	0.04		9.43				8651.43	0.01	0.05	0.04		6.29		
3096030.08	0.03	0.08	0.05		9.87				8776.86	0.03	0.06	0.03		7.40		
3157212.31	0.05	0.09	0.04		13.47				9196.87	0.04	0.14	0.10		20.95		
3185292.89	0.03	0.05	0.02		6.76				9409.25	0.02	0.03	0.01		4.06		
3581811.93	0.29	0.18	−0.11		52.69				10033.51	0.16	0.08	−0.08		24.09		
3581.81									10.03							
	0.14	0.12	−0.02		34.29					0.08	0.06	−0.02		14.43		
	0.23	0.17	−0.06		58.93					0.13	0.07	−0.06		21.94		
	0.05	0.07	0.03		9.66					0.03	0.06	0.02		7.75		

	Accum	TURB	TURB	TURB			SET	SET	SET			AMM	AMM	AMM	
	kg	U S	USGS	diff			U S	USGS	diff			U S	USGS	diff	
		NTU	NTU	NTU			ml/l	ml/l	ml/l			mg/l	mg/l	mg/l	
		21.00	37.25	16.25			0.10	0.12	0.02			0.05	0.05	0.00	
		24.00	33.00	9.00			0.14	0.10	0.04			0.05	0.05	0.00	
		19.50	12.00	−7.50			0.10	0.05	−0.05			0.05	0.05	0.00	
		10.40	8.00	−2.40			0.05	0.05	0.00			0.05	0.05	0.00	
	939.47	7.70	8.85	1.15			0.05	0.05	0.00			0.05	0.05	0.00	
		47.80	29.55	−18.25			0.05	0.05	0.00			0.05	0.05	0.00	
	1160.0	32.75	18.50	−14.25			0.05	0.05	0.00			0.05	0.05	0.00	
	1447.1	25.20	35.35	10.15			0.05					0.05	0.05	0.00	
	1916.1	58.05	31.45	−26.60			0.50	0.17	−0.33			0.05	0.05	0.00	
	2796.5	15.10	15.15	0.05			0.08	0.09	0.01			0.11	0.05	−0.06	
	2914.8	13.25	14.05	0.80			0.05	0.10	0.05			0.05	0.05	0.00	
	3070.9	9.25	6.70	−2.55			0.05	0.05	0.00			0.05	0.05	0.00	
	3185.9	1.60	2.80	1.20			0.05	0.05	0.00			0.05	0.05	0.00	
	3250.1	1.33	3.01	1.68			0.05	0.05	0.00			0.05	0.05	0.00	
	3303.1	0.74	0.94	0.20			0.05	0.05	0.00			0.05	0.05	0.00	
	3477.5	1.00	3.45	2.45			0.05	0.05	0.00			0.05	0.05	0.00	
	3515.2	1.20	4.90	3.70			0.05	0.05	0.00			0.05	0.05	0.00	
	3604.2	1.05	4.10	3.05			0.05	0.05	0.00			0.05	0.05	0.00	
	4114.4	0.90	3.55	2.65			0.05	0.05	0.00			0.05	0.05	0.00	
	4377.0	0.90	1.75	0.85			0.05	0.05	0.00			0.05	0.05	0.00	
	4672.5	32.00	36.50	4.50			0.05	0.21	0.14			0.05	0.05	0.00	
	4.67														
		15.46	14.80	−0.66			0.08	0.07	−0.01			0.05	0.05	0.00	
		25.56	23.30	−2.26			0.11	0.09	−0.01			0.05	0.05	0.00	
		2.00	3.47	1.47			0.05	0.05	0.00			0.05	0.05	0.00	

					N/N	N/N	N/N		N/N			N/N		TKN	TKN
					U S	USGS	diff		kg/day			Accum		U S	USGS
					mg/l	mg/l	mg/l					kg		mg/l	mg/l
					0.14	1.18	1.04		355.30					0.31	1.12
					0.05	1.37	1.32		340.22			3825.35			
					0.05	1.10	1.05		246.19			7637.01		0.74	0.80
					0.05	1.51	1.46		254.44			10891.1			
					0.05	1.96	1.91		269.03			16125.8		0.13	0.74
					0.30	2.30	2.00		400.10			19136.9			
					0.05	2.45	2.40		337.15			26140.8		0.38	0.02
					0.41	2.38	1.97		654.33			34072.6			
					0.90	2.40	1.50		900.51			44179.1		2.65	0.40
					0.05	1.75	1.70		993.07			65008.5		0.36	1.62
					0.01	1.44	1.44		736.85			70198.3			
					0.55	3.88	3.33		674.09			84307.6			
					3.06	4.46	1.41		592.47			92540.3		0.02	0.27
					3.13	4.72	1.60		615.81			101602.			
					3.10	4.30	1.20		540.61			110275.		0.02	0.02
					3.50	4.85	1.35		609.76			131557.		0.05	0.18
					3.50	4.60	1.10		578.33			135121.			
					3.30	4.50	1.20		555.08			142488.		1.50	1.40
					2.00	4.30	2.30		643.37			164061.		0.40	0.30
					5.10	4.00	−1.10		540.86			176495.			
					0.05	0.55	0.50		165.61			183913.		1.40	1.80
												183.91			
					1.40	2.86	1.46		523.96					0.66	0.72
					0.18	1.70	1.52		471.07					0.85	0.93
					3.03	4.40	1.38		594.49					0.40	0.43

TKN diff mg/l				TKN kg/day	USGS Accum kg	CFS	Time USGS	Temp. U S		Temp. USGS	Temp. diff	DO U S mg/l	DO USGS mg/l	DO diff mg/l		
0.81				335.73		123.1	13.00	8.90		13.30	4.4	9.80	9.10	−0.70		
						101.9	20.30	16.70		15.30	−1.4	8.90	10.10	1.20		
0.06				177.93	6163.85	91.5	20.15	22.60		20.50	−2.1	8.80	7.90	−0.90		
						69.12	15.00	14.60		18.40	3.8	8.50	8.00	−0.50		
0.61				101.83	10779.88	56.26	19.00	26.80		23.10	−3.7	10.60	6.20	−4.40		
						71.12	20.00	25.70		21.90	−3.8	5.30	7.10	1.80		
−0.36				2.75	12244.06	56.26	19.00	23.70		21.90	−1.8	8.90	7.20	−1.70		
						112.4	13.45	17.80		18.70	0.9	9.40	8.60	−0.80		
−2.25				150.09	14460.21	153.4	15.10	16.90		17.40	0.5	7.90	8.40	0.50		
1.27				919.30	26223.43	232	13.50	13.80		15.30	1.5	8.80	8.30	−0.50		
						209.2	20.30	14.90		14.20	−0.7	9.40	8.60	−0.80		
						71.12	8.30	1.90		6.30	4.4	12.70	10.90	−1.80		
0.25				35.87	44849.17	54.31	12.25	8.60		12.20	3.6	9.70	10.20	0.50		
						53.34	13.05	7.60		10.00	2.4	11.70	10.10	−1.60		
0.00				2.51	45424.89	51.4	16.05	7.20		8.40	1.2	13.80	10.20	−3.60		
0.13				22.00	45878.44	51.4	14.50	4.50		8.10	3.6	12.00	11.20	−0.80		
						51.4	13.40	5.40		11.60	6.2	13.60	11.60	−2.00		
−0.10				172.69	47728.02	50.43	12.25	2.70		7.30	4.6	10.00	11.20	1.20		
−0.10				44.89	51644.42	61.17	12.20	5.00		11.60	6.6	10.80	10.30	−0.50		
						55.28	16.05	14.20		16.90	2.7					
0.40				541.98	63968.63	123.1	16.35	8.20		11.30	3.1	10.20	8.90	−1.30		
					63.97											
0.06				208.96		90.44		12.75		14.46	1.71	10.04	9.21	−0.84		
0.08				318.51		116.61		17.55		17.61	0.06	8.88	8.20	−0.68		
0.03				55.59		55.54		6.34		10.27	3.92	11.79	10.71	−1.08		

CON	CON	CON			pH	pH	pH			CHL	CHL	CHL	CHL	CHL
U S	USGS	diff			U S	USGS	diff			U S	USGS	diff	USGS	Accum
uhmos	uhmos	uhmos								mg/l	mg/l	mg/l	kg/day	kg
310.00	460.00	150.00			7.95	8.4	0.45			30.24	36.76	6.52	11068.46	
370.00	485.00	115.00			8.82	8.62	−0.20							
400.00	550.00	150.00			9.1	8.8	−0.30			32.42	36.29	3.87	8121.98	230285.22
380.00	600.00	220.00			8.34	8.64	0.30							
450.00	705.00	255.00			9.17	8.67	−0.50			28.22	42.80	14.58	5889.75	461478.74
495.00	700.00	205.00			8.39	8.48	0.09							
460.00	705.00	245.00			9	8.56	−0.44			24.54	43.00	18.46	5917.28	626777.15
405.00	625.00	220.00			8.51	8.6	0.09							
430.00	600.00	170.00				8.58				30.20	40.00	9.80	15008.56	930201.73
380.00	505.00	125.00			8.7	8.69	−0.01			24.82	34.94	10.12	19827.34	1313396.63
355.00	500.00	145.00			10.08	8.83	−1.25							
320.00	550.00	230.00			8.8	8.79	−0.01							
610.00	650.00	40.00			8.12	8.83	0.71			36.80	46.92	10.12	6232.92	1821571.70
520.00	620.00	100.00			8.3	8.83	0.53							
600.00	600.00	0.00			8.78	8.97	0.19			37.80	49.45	11.65	6217.03	2008320.93
550.00	600.00	50.00			8.62	8.83	0.21			41.70	51.00	9.30	6411.90	2241956.20
560.00	580.00	20.00			8.41	8.95	0.54							
510.00	590.00	80.00			8	8.83	0.83			39.00	48.00	9.00	5920.85	2359117.32
500.00	650.00	150.00			8.02	8.76	0.74			39.50	44.20	4.70	6613.24	2584730.90
700.00	610.00	−90.00			7.4	8.88	1.48							
370.00	480.00	110.00			8.53	8.72	0.19			29.00	35.00		10538.52	2944917.93
														2944917.93
460.71	588.81	128.10			8.55	8.73	0.18			32.85	42.36	9.83	8980.65	
400.42	576.25	175.83			8.78	8.63	−0.14			28.49	38.40	10.56	10910.27	
541.11	605.56	64.44			8.27	8.85	0.58			38.96	47.91	8.95	6279.19	

APPENDIX J

Lateral Calculations

Estimated loadings leaving Deep Creek at Laterals 9 and 10, utilizing the inflows of Farm #4 and #6.

		Sample Day	Day #		Estimated Flow Lat. 9 (cfs)	l/day	Estimated Flow Lat. 10 (cfs)	l/day	TSS in F. #4	TSS load kg/day	Accum kg	TSS in F. #6	TSS load kg/day
1		19 May	139		50	1E+08	100	2E+08	114.00	13942.11		110.00	26905.82
2		30 May	150		50	1E+08	100	2E+08	43.00	5258.87	105605.	35.00	8560.94
3		12 June	163		50	1E+08	110	3E+08	35.00	4280.47	167611.	35.00	9417.04
4		25 June	176		55	1E+08	120	3E+08	40.00	5381.16	230411.	19.00	5576.84
5		15 July	196		60	1E+08	130	3E+08	41.00	6017.12	344394.	45.50	14468.00
6		24 July	205		65	2E+08	140	3E+08	213.50	33944.14	524220.	194.50	66604.14
7		12 Aug	224		65	2E+08	150	4E+08	88.50	14070.52	980359.	68.50	25132.49
8		28 Aug	240		65	2E+08	160	4E+08	143.00	22735.42	1274807	105.00	41092.53
9		10 Sept	253		60	1E+08	150	4E+08	68.00	9979.61	1487454	68.00	24949.04
10		2 Oct	275		50	1E+08	130	3E+08	36.50	4463.92	1646333	42.50	13514.06
11		8 Oct	281		45	1E+08	120	3E+08	36.50	4017.53	1671778	36.50	10713.41
12		28 Oct	301		0	0	90	2E+08	32.00	0.00	1711953	59.00	12988.18
13		10 Nov	314		0	0	80	2E+08	5.50	0.00	1711953	25.50	4989.81
14		25 Nov	329		0	0	70	2E+08	7.00	0.00	1711953	13.50	2311.45
15		10 Dec	344		0	0	60	1E+08	8.00	0.00	1711953	5.50	807.17
16		16 Jan	381		0	0	50	1E+08	231.50	0.00	1711953	63.50	7766.00
17		22 Jan	387		0	0	50	1E+08	33.00	0.00	1711953	47.00	5748.06
18		4 Feb	400		0	0	50	1E+08	10.50	0.00	1711953	25.00	3057.48
19		11 Mar	436		0	0	50	1E+08	13.00	0.00	1711953	14.50	1773.34
20		1 April	457		0	0	50	1E+08	5.00	0.00	1711953	6.00	733.80
21		22 April	478		50	1E+08	100	2E+08	144.00	17611.08	**1896869**	136.50	33387.68
				Estimated accumulated loadings leaving through the laterals (kg)							1896869		
				EstimatedMean		8E+07	98.10	2E+08	64.214	6747.71		55.02	15261.78

Accum	TP in	TP load	Accum	TP in	TP load	Accum	OP in	OP load	Accum	OP in	OP load	Accum	N/N in	N/N loa	Accum
kg	F. #4	kg/day	kg	F. #6	kg/day	kg	F. #4	kg/day	kg	F. #6	kg/day	kg	F. #4	kg/da	kg
	0.21	25.07		0.25	61.15		0.04	4.28		0.05	12.23		0.50	61.15	
195067.224													0.68	83.16	793.72
311924.109													0.48	58.70	1715.8
409384.342	0.10	12.78	220.96	0.08	23.48	1565.6							0.62	82.74	2635.2
609832.730	0.18	25.98	608.53	0.17	53.42	1257.9	0.06	8.51	364.586	0.09	29.57	1191.3	1.12	164.37	5106.2
974657.359	0.18	25.98	842.33										1.00	158.99	6561.3
1846155.34	0.19	30.21	1376.1	0.18	66.04	2930.4	0.08	12.72	661.822	0.09	33.02	2067.6	1.35	214.64	10110.
2375955.47	0.24	37.92	1921.1	0.21	81.99	3310.0	0.11	18.05	907.937	0.11	44.03	2684.0	1.23	195.56	13392.
2805225.67	0.23	33.75	2387.0	0.24	88.06	4415.2	0.13	18.34	1144.47	0.13	47.70	3280.2	1.55	227.48	16142.
3228319.75	0.14	17.12	2946.6	0.15	46.11	5891.0	0.07	7.95	1433.71	0.07	20.67	4032.2	0.65	78.88	19512.
3301002.16	0.15	16.51	3047.5	0.14	41.09	6152.6	0.01	0.55	1459.20	0.00	0.29	4095.1	0.78	85.85	20006.
3538018.01	0.12	0.00	3212.6	0.11	24.22	6805.7	0.09	0.00	1464.71	0.09	19.81	4296.2	4.06	0.00	20864.
3654874.90	0.12	0.00	3212.6	0.14	27.40	7141.2	0.05	0.00	1464.71	0.07	12.72	4507.6	4.78	0.00	20864.
3709634.36	0.04	0.00	3212.6	0.08	13.70	7449.4	0.06	0.00	1464.71	0.08	13.70	4705.7	4.98	0.00	20864.
3733024.09	0.08	0.00	3212.6	0.05	7.34	7607.1	0.05	0.00	1464.71	0.08	11.74	4896.5	4.70	0.00	20864.
3891627.80	0.38	0.00	3212.6	0.22	26.91	8240.6	0.28	0.00	1464.71	0.18	22.01	5521.0	5.05	0.00	20864.
3932169.99	0.10	0.00	3212.6	0.18	22.01	8387.4	0.07	0.00	1464.71	0.13	15.90	5634.7	4.80	0.00	20864.
3989406.01	0.06	0.00	3212.6	0.13	15.29	8629.9	0.05	0.00	1464.71	0.09	11.01	5809.6	4.65	0.00	20864.
4076360.75	0.06	0.00	3212.6	0.14	16.51	9202.2	0.06	0.00	1464.71	0.12	14.68	6271.9	4.50	0.00	20864.
4102685.65	0.03	0.00	3212.6	0.09	11.01	9491.2	0.02	0.00	1464.71	0.07	8.56	6515.9	4.45	0.00	20864.
4460961.15	0.21	25.68	**3482.3**	0.16	39.14	**10017.**	0.06	7.34	**1541.76**	0.08	19.57	**6811.2**	0.40	**48.92**	**21378.**
4460961.15			3482.3			10017.			1541.76			6811.2			21378.
	0.15	13.21		0.15	36.94		0.07	4.57		0.09	19.84		2.490	69.54	

N/N in F. #6	N/N load kg/day	Accum kg	TKN in F. #4	TKN load kg/day	Accum kg	TKN in F. #6	TKN load kg/day	Accum kg	CHL in F. #4	CHL load kg/day	Accum kg	CHL in F. #6	CHL load kg/day	Accum kg
0.72	176.11		0.97	118.63		1.07	261.72		31.95	3907.46		31.17	7624.13	
1.00	244.60	2313.9												
0.82	219.28	5329.1	0.45	55.03	2083.97	0.81	217.94	5755.	33.19	4059.11	95598.	33.19	8930.04	198650
0.90	264.17	8471.5												
1.83	581.90	16932.	0.02	2.94	3040.48	0.05	15.90	9614.	34.12	5007.42	245196	33.95	10795.35	524119
1.60	547.90	22016.												
1.95	715.45	34018.	0.58	92.21	4372.56	0.44	161.43	12096	25.20	4006.52	371391	26.40	9686.10	810859
1.73	675.09	45142.												
2.00	733.80	54300.	0.02	2.94	5752.22	0.36	132.08	16352	31.60	4637.59	496731	32.80	12034.24	1E+06
0.32	101.75	63491.	2.33	284.96	8919.03	1.27	403.83	7067.	28.02	3426.82	585439	29.37	9339.01	1E+06
1.08	315.53	64743.												
4.16	914.68	77045.												
4.79	936.32	89076.	0.02	0.00	14475.7	0.67	131.10	17498	39.16	0.00	652262	38.82	7596.25	2E+06
4.91	840.68	102404												
4.70	689.77	113882				0.05	7.34	19574	40.50	0.00	652262			
5.00	611.50	137956	1.20	0.00	14475.7	0.80	97.84	2543.	43.20	0.00	652262	42.50	5197.72	2E+06
4.90	599.27	141588												
4.75	580.92	149259	0.80	0.00	14475.7	0.85	103.95	4460.	41.50	0.00	652262	41.50	5075.42	2E+06
4.45	544.23	169512	0.15	0.00	14475.7	0.85	103.95	8203.	39.65	0.00	652262	40.00	4891.97	2E+06
4.40	538.12	180876												
0.60	146.76	**188068**	1.50	183.45	**82071.0**	1.60	391.36	**18604**	30.00	3668.98	**729311**	31.50	7704.85	**3E+06**
		188068			82071.0			18604			**729311**			3E+06
2.6945	522.75		0.7309	67.2867		0.735	169.03		34.840	2392.8		34.65	8079.55	

APPENDIX K

Quality Control Data

Quality Control

Quality control was exercised by sampling in duplicate at all stations. On rare occasions samples were rejected. In one case total phosphorus was highly variable and later found to have been caused by a laundry detergent mistakenly used for cleaning glassware.

When sampling some of the sites, cleaning or harvesting operations were underway. On those occasions samples were taken for analysis and used in calculating nutrient contributions. However, since such operations were not frequent, the farm mean was used in estimating farm contribution for the remainder of the period.

Variability in sample analysis associated with laboratory techniques is shown in Tables 6 and 7. Specifically, the quality control showed low variability in standards from known concentrations, and indicated that variation due to laboratory technique was minimal.

Variability between duplicate samples for the various parameters tested are shown in Figs. 101 to 108. For each parameter the ranges and mean differences are given for all paired samples on all sample days, and in all cases, excepting chloride and turbidity sample sets, were very close. Variability between duplicate samples can be attributed to sampling technique, but also to the patchiness of the water sampled. While mixing within the pond should eliminate some patchiness, the time element between samples and the distribution of fish in a pond could result in variation detectable by slight differences between duplicate samples.

ammonia				
	27 #1	26 #1	27 #2	26 #2
Known #'s	0.499	18	6.8	4.2
date				
6/4/92	0.4			
5/15/92		18.8		
5/5/92	0.5			
5/7/92	0.412		5.9	
4/9/92	0.47			4.12
4/20/92	0.48			4.08
4/20/92	0.51			4.24
4/24/92	0.63			
4/24/92	0.25			
4/24/92	0.49			
4/24/92	0.8			
3/13/92				4
3/13/92				3.94
3/13/92				4.06
3/13/92				4.08
3/27/92				3.92
3/18/92				3.92
2/24/92				4.09
2/24/92				3.84
2/24/92				4.06
2/24/92				4.04
2/24/92				3.94
2/19/92				4.06
				4.06
2/12/92				4.36
2/7/92				3.98
				3.98
1/3/92				3.64
				3.88
1/16/92				4.08
1/16/92				4.04
				4.04
1/22/92				3.8
				3.8
				3.76
1/24/92				4.18
				3.82
				4.38

Ortho Phosphate		nut.2185	wpo26-91	
	epa27#1	apg #2	epa26#2	epa27#2
date				
known->	0.73	4.315	0.32	3.3
6/5/92		4.312		3.201
				3.24
6/4/92		3.172		4.337
4/15/92	0.659		0.336	
4/20/92	0.67		0.326	
4/8/92			0.324	
4/9/92	0.623		0.331	
3/16/92		4.32	0.305	
		5.45	0.42	
2/11/92		4.29	0.3	
2/13/92		4.76		
2/21/92		4.25	0.275	
1/16/92			0.266	
1/21/92			0.29	
1/24/92		4.2	0.24	
12/13/91		4.14	0.335	
12/13/91		4.5	0.31	
12/6/91		4.2	0.27	
	Ave	4.32673	0.30914	

Table 7. Known EPA standards versus the laboratory standards for ammonia-N and orthophosphate.

nitrate					
	27 #1	27 #2	26 #1		26 #2
Known	9.1	0.33	8		10
date					
6/4/92	7.48	0.34			
6/5/92	8.36				
5/28/92	7.46	0.57			
5/28/92		0.23			
5/15/92			8.2		
5/5/92	7.76	0.27			
5/5/92	8.1				
5/7/92	8.08	0.22			
5/7/92	8.5				
4/3/92					
4/3/92					
4/7/92					
4/7/92					
4/9/92	9.1				10.3
4/17/92					
4/20/92	8.12	0.32			10.2
4/20/92	8.44				10.2
4/24/92	8.04	0.2			
4/24/92	8.18				
4/24/92	8.28	0.51			
4/24/92	9.92				
4/30/92	8.08	0.4			
3/11/92					10.2
3/11/92					9.94
3/13/92					10.1
3/13/92					10
3/13/92					10.1
3/13/92					10
3/20/92					9.98
3/20/92					10.2
3/20/92					10.7
3/20/92					10.7
3/20/92					10.3
3/27/92					10.3
3/18/92					10.2
2/24/92					10.6
2/24/92					11
2/24/92					9.73
2/24/92					10.3
2/24/92					8.16
2/24/92					8.4
2/19/92					10.4
2/19/92					10.3
2/13/92					10.7
2/11/92					10.7
2/7/92					9.96
2/7/92					9.76
1/6/92					10.2
1/6/92					10.3
1/16/92					10
1/16/92					9.5
1/16/92					9.6
1/22/92					9.98
1/22/92					10.2
1/22/92					10
1/24/92					9.98
1/24/92					10.1
1/24/92					10.3
1/28/92					9.94
1/28/92					8.8
1/28/92					9
1/29/92					9.88

kjeldahl				
	27 #3	apg #4	apg 8227-8229	
Known #'s	17	1.343	2.64	
date				
6/8/92	23.26	1.46		
5/13/92	15.56	1.71		
5/12/92	13.68	1.73		
5/14/92	15.68	2.08		
4/10/92	15.33	1.32		
4/28/92	17.72	1.66		
3/19/92	17.16			
3/19/92	16.18			
2/28/92		17.22		
		16.62		
2/18/92		18		
		17.7		
1/27/92			2.92	
			2.84	
			3.1	

Table 8. Known EPA standards versus the laboratory standards for nitrite/ nitrate-N and total Kjeldahl nitrogen.

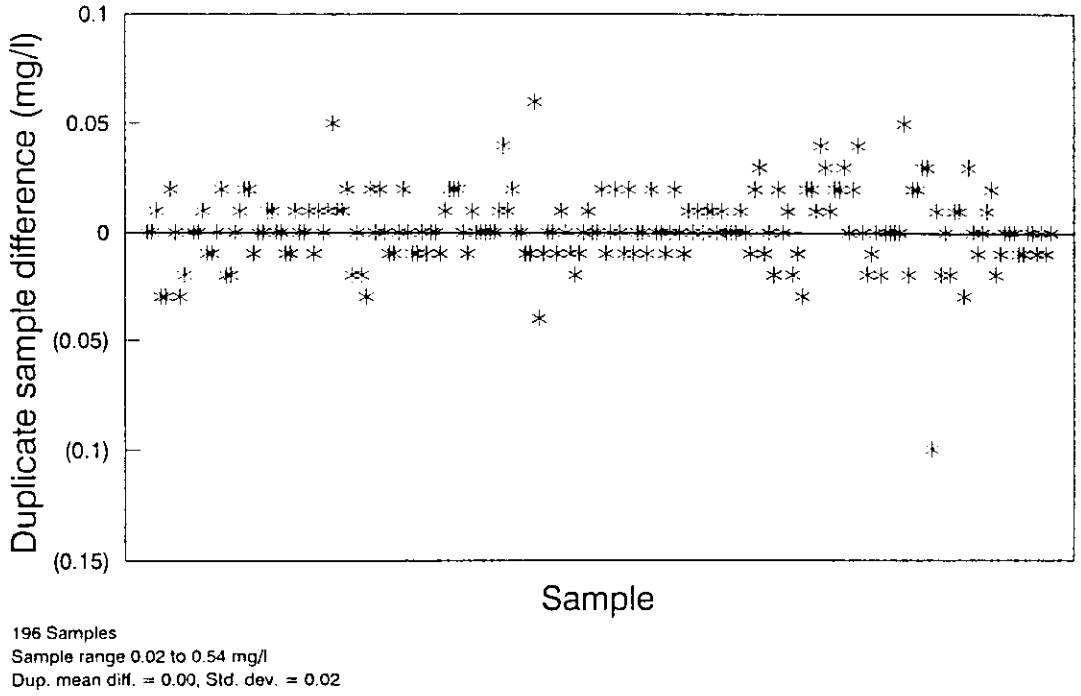


Figure 101. Total phosphorus duplicate sample differences for the sample period.

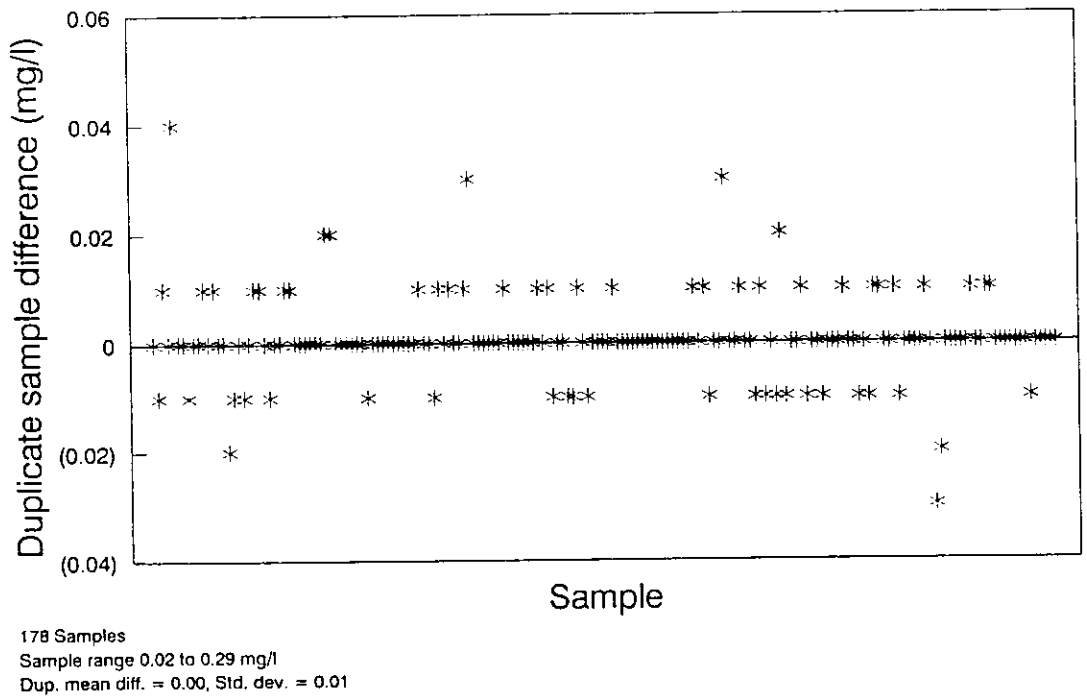


Figure 102. Orthophosphate duplicate sample differences for the sample period.

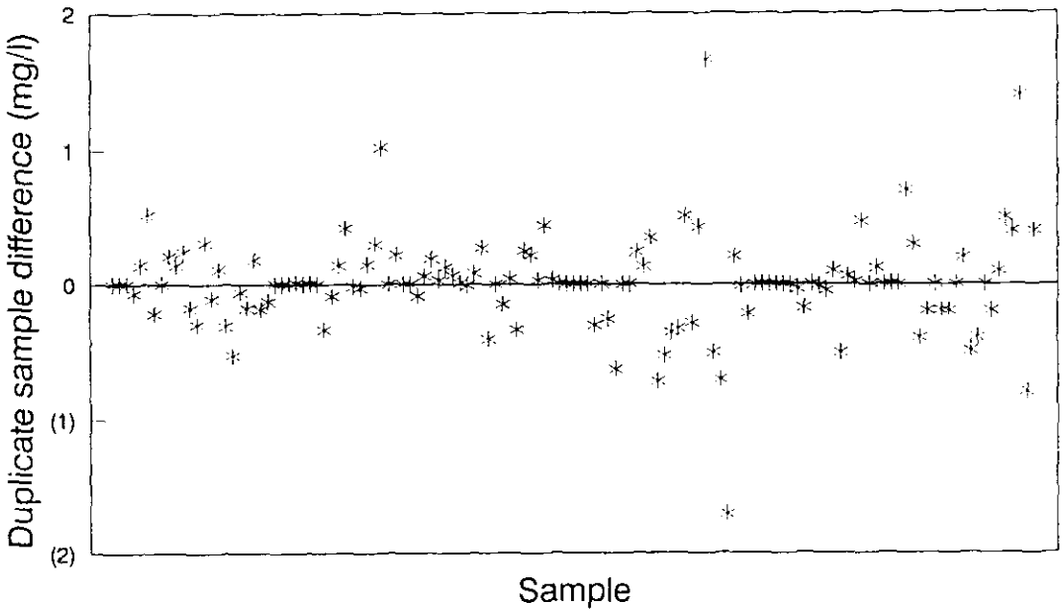


Figure 103. Nitrite/nitrate-N duplicate sample differences for the sample period.

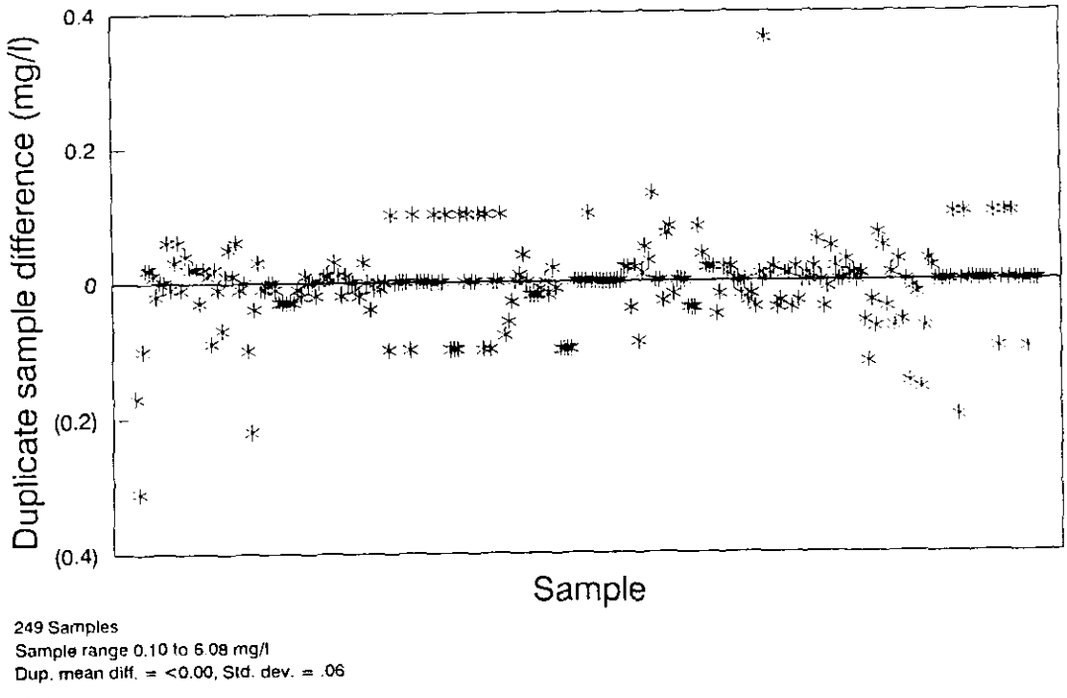


Figure 104. Total Kjeldahl nitrogen duplicate sample differences for the sample period.

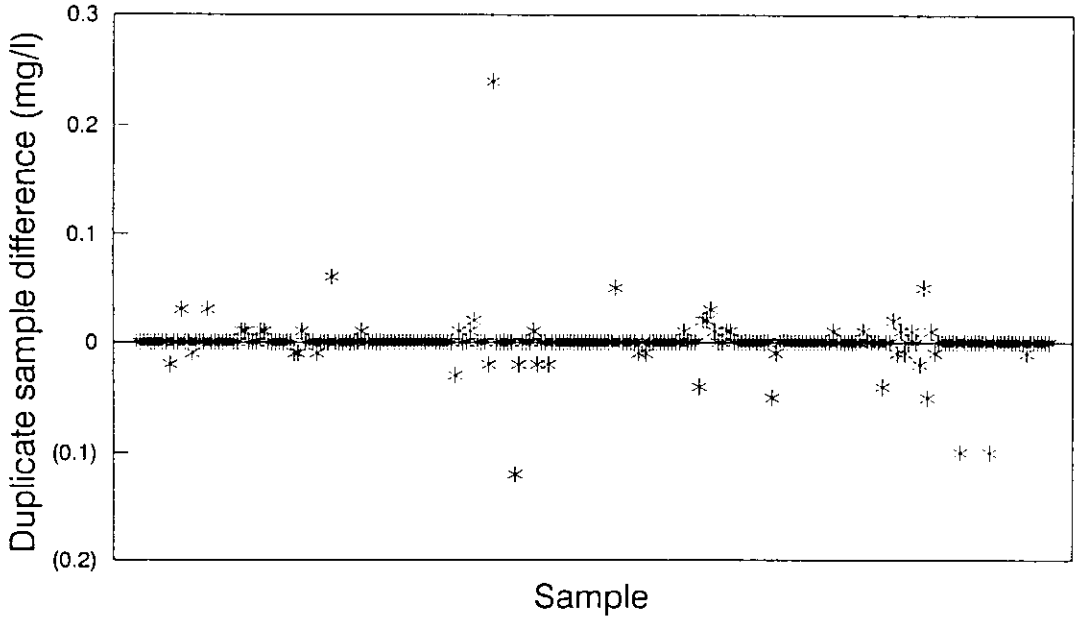


Figure 105. Ammonia-N duplicate sample differences for the sample period.

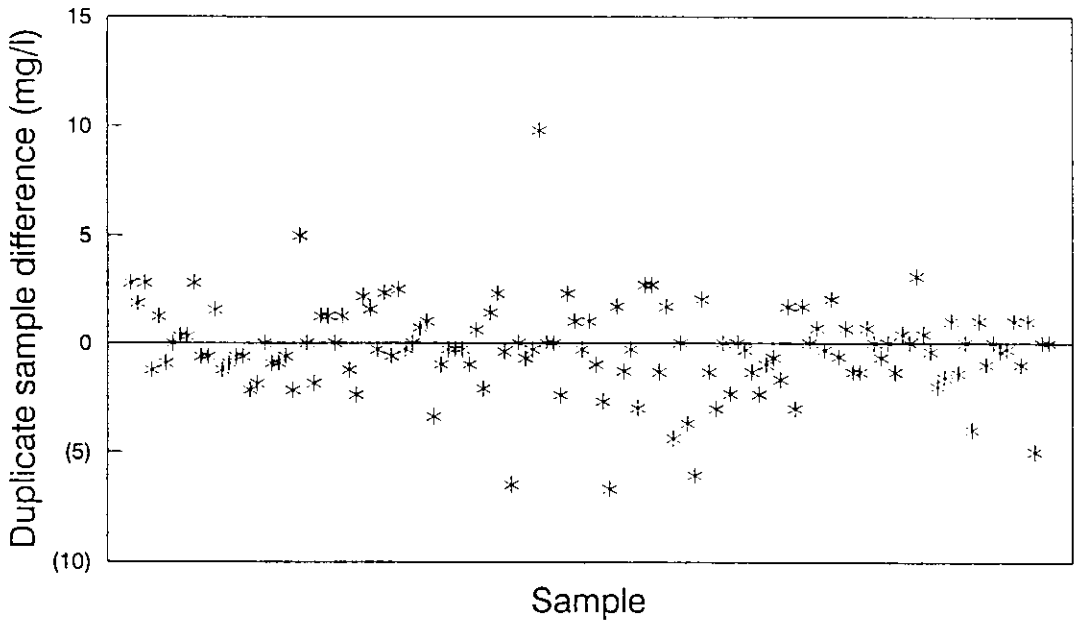


Figure 106. Chloride duplicate sample differences for the sample period.

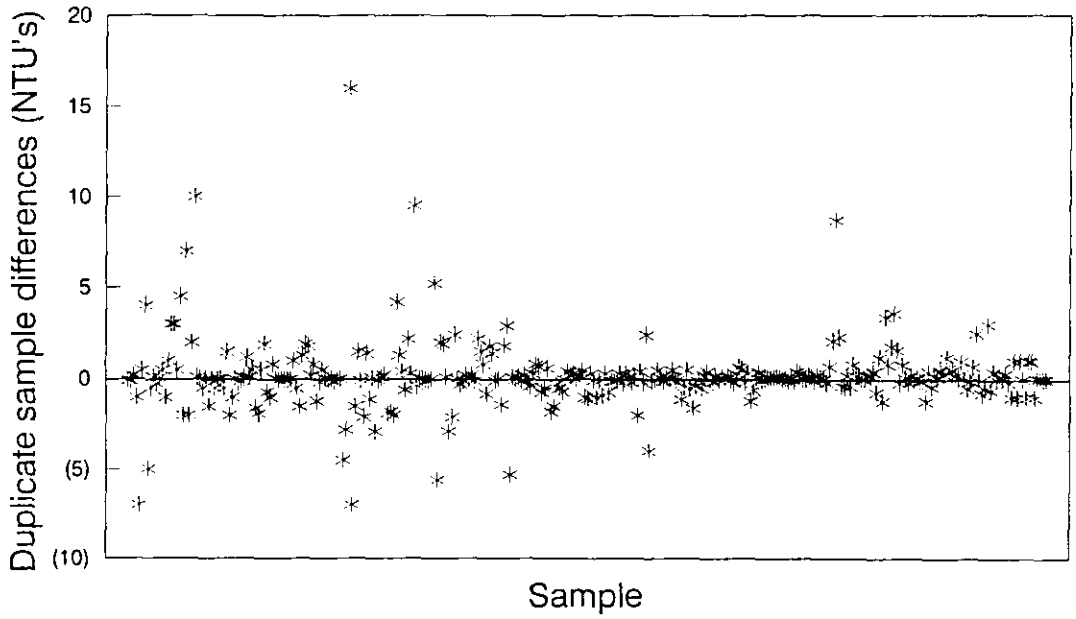


Figure 107. Turbidity duplicate sample differences for the sample period.

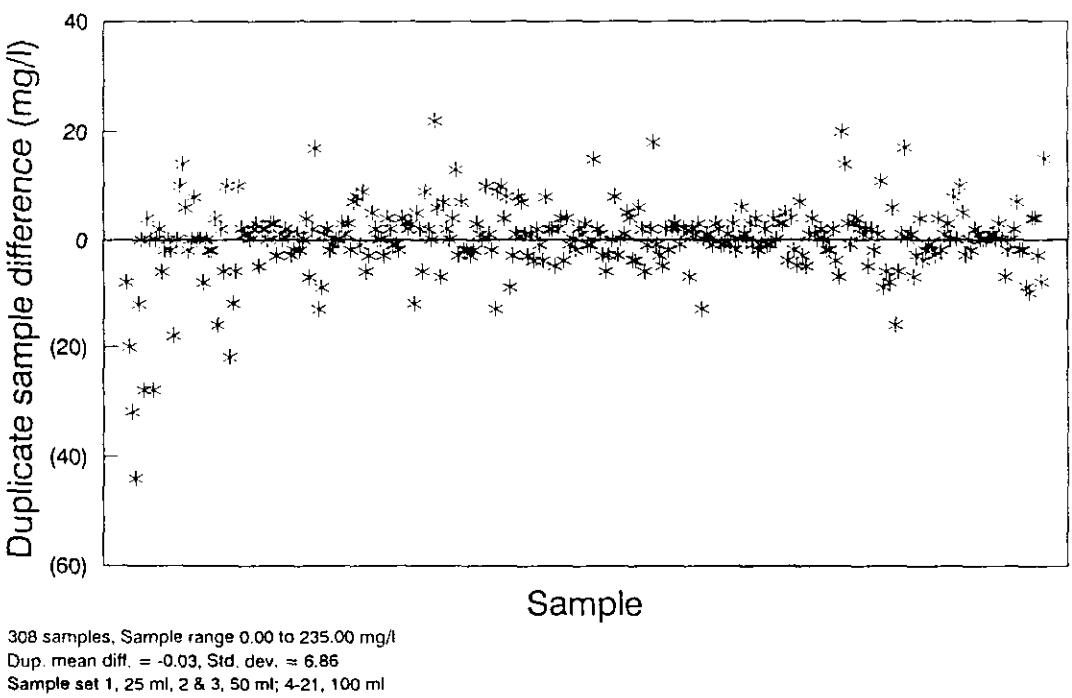


Figure 108. Total suspended solids duplicate sample differences for the sample period.

Eliminated phosphorus samples:

These paired samples, taken 12 June 1991, for phosphorus and orthophosphate were eliminated. Vials were contaminated with laundry detergent

Sample #	Location pairs	Orthophosphate (mg/l)	Total phosphorus (mg/l)
101	Farm #1 inflow	.15	2.2
102		.18	1.9
105	Farm #1 outflow	.17	2.4
106		.18	1.8
107	Upper creek	.12	0.2
108		.12	3.5
201	Farm #2 inflow	.16	2.7
202		.21	2.9
301	Farm #3 inflow	.20	2.3
302		.20	0.2
401	Farm #4 inflow	.10	0.2
402		.12	1.4
403	Farm #4 pre-set.	.11	0.1
404		.13	1.5
405	Farm #4 outflow	.12	1.0
406		.12	1.1
501	Farm #5 inflow	.23	1.8
502		.25	1.6
505	Farm #5 outflow	.24	1.1
506		.27	0.5
601	Farm #6 inflow	.16	0.2
602		.16	0.5
603	Farm #6 pre-set.	.15	1.2
604		.15	1.1
605	Farm #6 outflow	.16	0.5
606		.16	1.9
807	Deep Creek - USGS	.14	3.5
808		.14	0.3

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Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts



by

R. Brett Barry

June 1996

Department of Water Resources
APPLICANT'S
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Identified 3-17-2000

Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

with a

Major in Civil Engineering

in the

College of Graduate Studies

University of Idaho

by

R. Brett Barry

June 1996

Major Professor: Charles E. Brockway, Ph.D.

AUTHORIZATION TO SUBMIT

THESIS

This thesis of R. Brett Barry, submitted for the degree of Master of Science with a major in Civil Engineering and titled "Irrigation Return Flow Water Quality in the Twin Falls and Northside Irrigation Tracts," has been reviewed in final form, as indicated by the signatures and dates given below. Permission is now granted to submit final copies to the College of Graduate Studies for approval.

Major Professor _____ Date 5/31/96
Charles E. Brockway

Committee Members _____ Date 5/31/96
John I. Finnie

_____ Date 5/31/96
W. Howard Neibling

Department Administrator _____ Date 5/31/96
Howard S. Peavy

Discipline's College Dean _____ Date 6/4/96
David M. Woodall

Final Approval and Acceptance by the College of Graduate Studies

_____ Date 7/22/96
Jeanine M. Shreeve

ABSTRACT

Irrigation return flows from the Twin Falls and Northside Canal Companies convey sediment and nutrients to the Middle Snake River, a water quality "limited" stream. A water quality monitoring network was established to document the sediment and nutrient loads on sixteen irrigation return flows during the 1995 irrigation season. Approximately, 18,153 tons of suspended sediment, 5.0 tons of ammonia nitrogen, 74 tons of organic nitrogen of which 5.0 tons was ammonia nitrogen, 108 tons of nitrite+nitrate nitrogen, and 36 tons of total phosphorus of which 11.6 tons was dissolved ortho phosphate was discharged from these drains into the Middle Snake River. These loads were compared to baseline loads from the same irrigation return flows in 1990-91. As part of a management plan, the canal companies have actively been developing water quality facilities to treat irrigation return flows. A procedure was developed to determine the effect of these water quality facilities on sediment loading from the Twin Falls and Northside Irrigation Tracts. On the sixteen monitored drains, it was estimated that the sediment loading can be reduced 47% from the 1990-91 levels and 39% from the 1995 levels through the implementation of water quality facilities.

ACKNOWLEDGMENTS

I would like to thank my parents, Gordon and Mary Lu, for their support and encouragement throughout my education. I will be forever grateful. I would like to thank Charles E. Brockway for establishing this opportunity, for his criticism, and his words of encouragement. I would also like to thank the staff at the University of Idaho Kimberly Research and Extension Center for the use of their facility and research equipment. The Twin Falls and Northside Canal Companies also provided funding and were extremely helpful.

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CHAPTER 1
INTRODUCTION

Nonpoint source pollution is the most significant cause of water pollution in the United States today. It is the result of contaminated runoff from a number of sources including industrial and construction sites, forestry and mining operations, and agricultural and urban areas. Sediment and nutrients are the most common pollutants of this contaminated runoff. The result can be a degraded water resource that facilitates algae blooms and aquatic weed growth. This, in turn, can increase turbidity, increase diurnal oxygen cycles, and alter habitat conditions. A number of industries have developed methods called Best Management Practices (BMPs) to control nonpoint source pollution. A BMP can be as simple as placing mulch at a site or as complicated as developing a constructed wetland.

Problem Statement

Canal companies, such as the Twin Falls and Northside Canal Companies in Idaho, have the responsibility to deliver water to individuals yet have limited control over the amount and quality of the water returning to their system. Sediment and nutrient losses from individual farms enter natural and constructed drains within these irrigation tracts. These drains, defined as irrigation return flows, enter directly into the Middle Snake River and tributaries of the Snake River. These irrigation return flows convey sediment, nutrients, fertilizers, pesticides, and other constituents. A majority of the surface irrigation return flows only flow during the irrigation season between April 15 and October 15. Irrigation return flows are classified as nonpoint source pollution by the Clean Water Act and do not have associated discharge limits under the National Pollution Discharge Elimination System. Eighteen irrigation return flows from the Twin Falls and Northside tracts discharged an estimated 21,000 tons of sediment and 37 tons of total phosphorus during a 13 month period in 1990-91 (Brockway and Robison, 1992). This nonpoint source pollution along with pollution from aquaculture facilities, confined feeding operations, and wastewater effluents have contributed to the current water quality condition in the Middle Snake River. The water quality

conditions in the Middle Snake River often impair water quality and even violate water quality standards designed to protect the declared beneficial uses (IDHW, 1995).

The Twin Falls and Northside Canal Companies, as part of the Irrigators Water Quality Committee (IWQC), have set a goal of reducing sediment by 27% and phosphorus by 10% by the year 2000. These goals are part of irrigated agriculture industry's nutrient management plan submitted by the IWQC to Idaho Department of Health and Welfare Division of Environmental Quality (IDHW/DEQ). The baseline loads were determined to be the 1990-91 load base.

As part of their management actions and their specific nutrient management plan, the canal companies jointly contracted with the University of Idaho for an initial two year period beginning July 1, 1992. The initial study focused on three subject areas: water quality extension and education program, water quality improvement facility program, and irrigation water quality monitoring program. The water quality extension and education program focused on methods and procedures to educate and train water users, canal company staff, and the general public. The water quality improvement facility program focused on developing an inventory of return flows that enter directly into the Snake River or its tributaries. This inventory also included documenting current and potential Water Quality Improvement (WQI) facilities. The irrigation water quality monitoring program developed and initiated a general monitoring program. The monitoring program established general water quality levels entering the systems, within the systems, and finally leaving the systems. It also established water quality monitoring stations on the Snake River to document the general water quality trend in the river. The initial contract was renewed for a two year period beginning July 1, 1994. The following study is funded from this contract.

Objectives and Needs

The objectives and needs of this study were as follows:

1) Document sediment and nutrient loads on major irrigation return flow drains entering directly into the Snake River during the 1995 irrigation season
2) Assess the changes in sediment and phosphorus loads from the '90-91 load base
3) Develop and complete a procedure to evaluate the effects of water quality improvement facilities on irrigation return flows in the Northside and Twin Falls Irrigation Tracts

A water quality monitoring network was developed on the return flows in order to determine the 1995 irrigation season loads. The loading results assisted in determining if the goals of the IWQC will be achieved. This monitoring network when combined with a monitoring network initiated and developed by the Division of Environmental Quality (DEQ) documented the 1995 sediment loads from irrigated agriculture.

One goal of this evaluation procedure was to estimate the total percentage of sediment reduction that can be achieved through water quality facilities. The evaluation procedure and loading estimates will assist the canal companies in prioritizing facilities construction on irrigation return flow drains. By prioritizing, the canal companies can make sound management decisions during the non-irrigation season to construct facilities to maximize sediment and phosphorus removal at minimum cost. These facilities need to be strategically located to be effective. If the evaluation procedure indicates that the proposed reductions will not be achieved, the canal companies can use the information on planning further treatment facilities and advocating alternative best management practices.

The results of the study are of value to other agencies as well. Sediment and nutrient results can be used to define future research needs. For example, DEQ can use the 1995 loading results as new inputs to the current water quality model for the Middle Snake River, RB10. DEQ can also use the results to develop a future monitoring program that will evaluate the

effectiveness of the Nutrient Management Plan. The evaluation procedure could possibly be initiated by other irrigation districts to determine the effect of WQI facilities on their systems.

Project Study Area

The Middle Snake River, defined as the 94 mile reach between Milner Dam and King Hill, receives significant amounts of point and nonpoint sources of pollution. The Middle Snake River was classified as "water quality limited" in 1990 by the Idaho Department of Health and Welfare, Division of Environmental Quality and as a "protected reach" by the Idaho Department of Water Resources (IDHW, 1995). The Clean Water Act requires states to develop total maximum daily loads (TMDL) for "water quality limited" segments of rivers. In lieu of the TMDL process, Division of Environmental Quality (DEQ) with the cooperation of a number of industries that contribute to this classification have developed a Nutrient Management Plan for the Middle Snake River. The Nutrient Management Plan was developed in accordance with the provisions of the Nutrient Management Act passed in 1989 by the Idaho Legislature.

The discharge in the Middle Snake River is dependent upon upstream storage and irrigation diversion rights in the Upper Snake River. The discharge is highly variable. During dry water years, the flow below Milner Dam may be low as 200 cfs, while in surplus water years it may be as high as 20,000 cfs. Upstream storage and irrigation diversion rights are managed by the U.S. Bureau of Reclamation and Water District No. 1.

Beginning at Milner Dam, the Middle Snake River starts to flow through the incised canyon in the basalts of the Snake River Plain. In some areas, the elevation of the river drops below the elevation of nearby aquifers, resulting in significant amounts of spring flow. The springs discharge approximately 6,000 cfs to the Middle Snake River. Some irrigation return flows and tributaries discharge year round due to significant amounts of ground water discharge, defined as sub-surface return flow, from these nearby aquifers. The major tributaries include

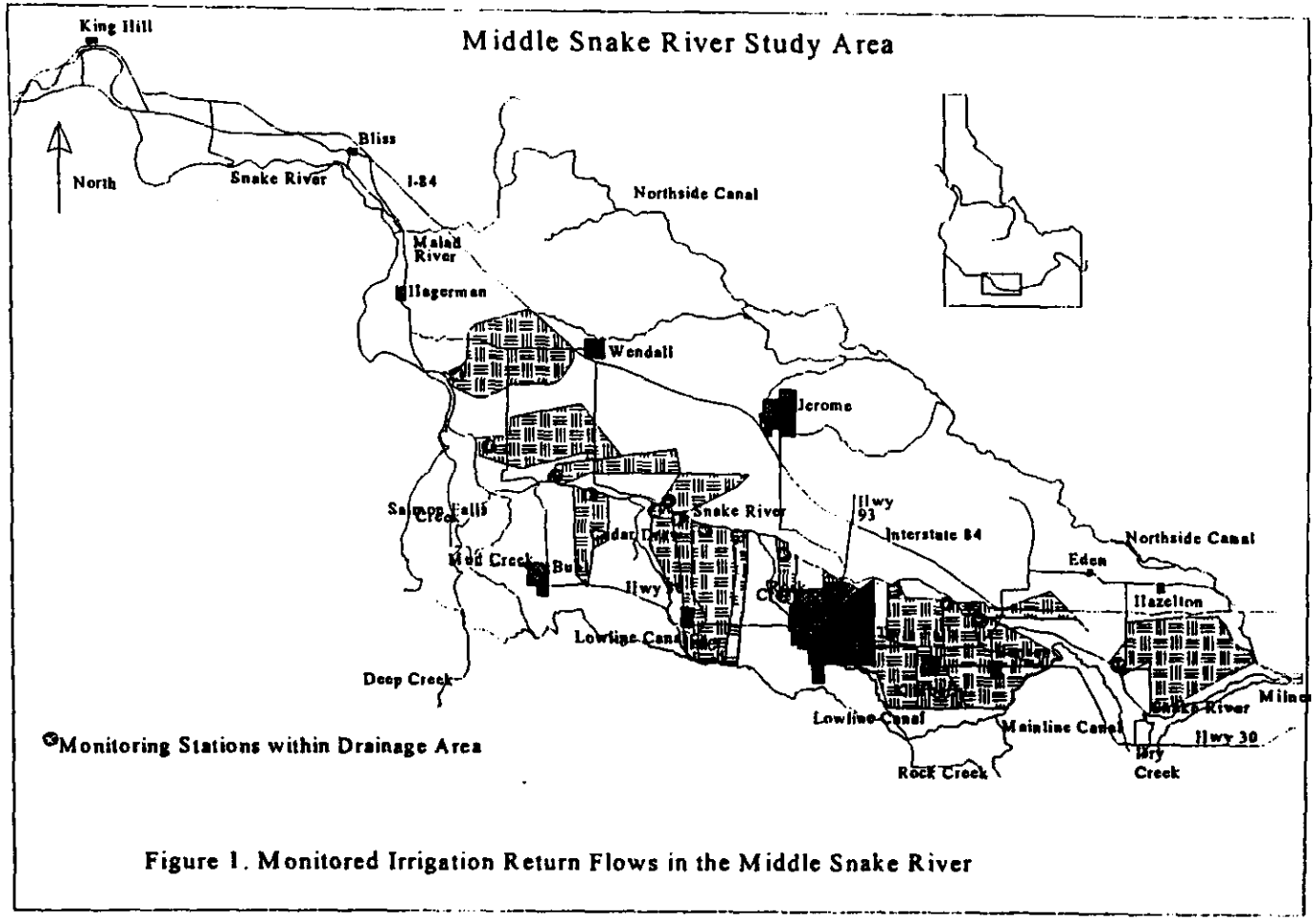


Figure 1. Monitored Irrigation Return Flows in the Middle Snake River

Rock Creek, Cedar Draw Creek, Mud Creek, Deep Creek, Salmon Falls Creek, and the Malad River. These tributaries also convey irrigation return flows during the irrigation season. Twin Falls and Northside Canal Companies supply irrigation water to approximately 200,000 and 162,000 acres, respectively. The canal companies divert water from the Snake River at Milner Dam. These companies use traditional gravity diversion systems that flow in open channels along contours. Approximately 80% of the individual farmers in the Northside Canal Company irrigation tract use sprinkler irrigation. Contrarily, the majority of individual farmers in the Twin Falls Canal Company use surface irrigation by means of corrugates. The study project area is shown in Figure 1. This figure also illustrates the irrigation return flow monitoring stations and their corresponding drainage area. The farmers grow a number of crops including potatoes, corn, sugarbeets, dry beans, small grains, and alfalfa. The soils on the tract are loessal in origin, with soil depth varying between 20 and 40 inches (Lewis et al, 1991). A majority of the soil can be classified as a Portneuf silt-loam, which can be highly erodible. The climate is considered semi-arid with annual precipitation close to 10 inches a year.

CHAPTER 2
REVIEW OF LITERATURE

The canal companies in the Middle Snake River have recognized the problems associated with irrigation return flows since the early 1970's and have cooperated with agencies in conducting research. A number of research studies including the Rural Clean Water Program (RCWP) in Rock Creek (Yankey et al, 1991) and the LQ Drain Demonstration Project (Brockway et al, 1980) have been completed in the study area. Research efforts have focused on developing and implementing best management practices, designing facilities for treating irrigation return flows, documenting sediment and nutrients loading from return flows, and completing sediment and nutrient balances on the irrigation tracts.

Furrow erosion is dependent on a number of variables including crop type, topsoil characteristics, irrigation management, and hydraulic characteristics of the furrow. The magnitude of annual soil losses can be up to 30 tons per acre (Koluvek et al, 1993). An annual soil loss of 30 tons per acre is equivalent to one inch of topsoil loss per acre every 5 years.

If designed properly, furrow irrigation meets the crop evapotranspiration (ET) requirements while yielding minimal runoff to the tail water collection ditch. However, this is very difficult to achieve due to soil, slope, and irrigation furrow variability. Water in excess of the ET requirements percolates downward through the soil. The water percolating through the soil can carry original/transformed solutes that percolate into shallow ground water systems and eventually discharge back into a receiving stream. These return flows are called sub-surface irrigation return flows. The tailwater, or runoff, from the lower end of the field enters drains and also carries solutes and other applied chemicals. The solutes are found both in the water column and attached to the individual soil particles. This runoff is highly variable in concentration and quantity and is reused many times by downstream irrigators. Approximately 6000 farms within the Twin Falls and Northside Tracts have a discharge to one or more points in a return flow channel.

Best Management Practices

A majority of best management practices (BMPs) have centered around controlling furrow erosion on the farm. These practices include modifying traditional crop management and water management and also implementing new control techniques. Some crop management practices that reduce erosion from fields include modifying the furrow's hydraulic characteristics, cultivating only when necessary, and changing the crop sequence. Water management practices include pump-back systems and converting to sprinkler irrigation. Control techniques that have been proven effective include sediment basins and vegetative filters.

Furrow hydraulic characteristics can be changed by shortening the run length and reducing the slope (Carter, 1976). Both techniques are effective in reducing erosion. However, farmers have resisted implementing them due to the additional labor and management requirements. For example, shorter run lengths may interfere with tillage operations and decrease irrigation durations. Tillage operations break up the soil and facilitate erosion during the next irrigation set. Minimizing the number of tillage operations and leaving some crop residue also reduce erosion. Leaving crop residues improves the long-term health of the soil by reducing crust formation, improving soil aeration, and improving soil infiltration.

Tailwater reuse systems such as a pump-back system allow sedimentation in the catchment basin while effectively managing water use. The conversion from furrow irrigation to sprinkler irrigation allows a more efficient water application rate and essentially eliminates erosion. Both of these practices add considerable costs to the irrigation system. However, pump-back systems and properly designed sprinkler systems can virtually eliminate sediment and phosphorus losses (Carter et al, 1993).

Sediment basins of all sizes and shapes have been constructed near the end of fields to remove sediment. The most effective basins are minibasins receiving runoff from 10 to 15 furrows. Removal efficiencies between 70-90% have been documented because sediment inflow

concentrations can be high and detention time can be up to several hours (Carter, 1976). Vegetative filters are dense vegetation at the end of fields that facilitate sedimentation in the runoff. Removal efficiencies depend upon a number of factors including vegetation type, density, and runoff characteristics such as flow rate and concentration (Carter et al, 1993).

If these traditional erosion controls can be so efficient, why is significant erosion still occurring? These best management practices are strictly voluntary by individual farmers and farmers have been reluctant to implement them entirely. A majority of the farmers feel the economic and philosophical inducements are not great enough to justify the additional effort and expense. This reluctance has left canal companies no recourse but to treat irrigation return flows with water quality improvement facilities until best management practices are implemented to the necessary degree.

Large sediment basins have been used effectively to treat irrigation return flows before reaching a receiving stream. The removal efficiencies depend primarily on the overflow rate (discharge divided by pond surface area), detention time of the basin, and inflow sediment concentrations. The sediment ponds are usually designed to provide maximum velocity reduction early in the basin and provide adequate storage space for the particles. This is facilitated when the depth of the pond is deeper near the inlet. In order to maintain a constant area and velocity distribution, the pond's width should increase toward the outlet. Pond design is usually based upon Stokes' Law and numerous computer models have been written to predict removal efficiencies based upon the flow rate and particle size distribution of the influent. Sediment removal efficiencies on return flows generally range from 60-75%. A 60 x 500 x 5 ft pond monitored from 1972-74 in southern Idaho removed about 70% of incoming sediment from a 10 cfs stream (Brown et al, 1981). This same pond removed 25-33% of the incoming total phosphorus. The phosphorus removed represents the phosphorus attached to the sediment, the pond has no effect on soluble phosphorus. Also, large sediment ponds do not affect nitrogen concentrations.

Total phosphorus in return flows consists of orthophosphate, hydrolyzable, organic phosphorus, and soil attached phosphorus. Hydrolyzable and organic phosphorus concentrations in return flows are very low in filtered and nonfiltered samples and can be considered negligible (Carter et al, 1974). Dissolved ortho phosphate is considered to be the phosphorus form available to vegetation. Therefore, the difference between total phosphorus and ortho phosphate represents the concentration of phosphorus attached to the sediment.

Generally, phosphorus is tightly held by most soils. The amount of phosphorus in solution depends on the equilibrium conditions between the concentrations of soluble phosphorus and attached phosphorus. Even though sediments have a great capacity to adsorb phosphorus under some conditions, they may represent a vast reservoir that keeps soluble phosphorus concentrations nearly constant (Carter et al, 1974). Generally, ortho phosphate concentrations in return flows range from 0.04 to 0.10 mg/L while total phosphorus concentrations can exceed 1.0 mg/L when sediment concentrations are high. Total phosphorus concentrations are directly related to sediment concentrations while filtered ortho phosphate concentrations are independent of sediment concentrations. Carter and others (1976) computed an R^2 value of 0.89 in a correlation of sediment and total phosphorus concentrations in irrigation water in the study area. The mean dissolved ortho phosphate concentrations in drainage tunnels in the Twin Falls Irrigation Tracts in 1969 was 0.012 mg/L (Carter et al, 1971). This low value affirms that the percolating waters carry away little or no ortho phosphate.

The Environmental Protection Agency (EPA) does not have total phosphorus recommendations for streams entering a riverine system. However, the EPA recommends a total phosphorus concentration below 0.05 mg/L on streams entering reservoirs to prevent the development of biological nuisances and control eutrophication (EPA, 1986).

Nitrogen is difficult to assess because it occurs in many forms and can be fixed biologically or lost to the atmosphere. It is difficult to relate to sediment and less likely to be bound to the sediment. Idaho Department of Health and Welfare (IDHW, 1995) recommends a

concentration limit of inorganic nitrogen of 0.30 mg/L as an indicator for stream eutrophication. Total Kjeldahl Nitrogen is the sum of ammonia and organic nitrogen. The organic nitrogen is degraded to the ammonia form and ammonia is eventually oxidized to the nitrite and nitrate form. Vegetation can take up the ammonia and nitrate forms. Nitrite and nitrate concentrations are much higher in return flows with subsurface return flow. Perennial return flow streams can have nitrite+nitrate concentrations between 4-6 mg/L during the non-irrigation season and concentrations as low as 0.5 mg/L during the irrigation season (depending on dilution). Ammonia and Kjeldahl nitrogen concentrations are less variable and typically range from 0.03-0.20 mg/L and 0.50-1.0 mg/L throughout the year.

Sediment and Nutrient Balances

During the 1971 irrigation season a large-scale study of mass balances of sediment and nutrients within the Northside and Twin Falls irrigation tracts was conducted. This study was completed by the Agricultural Research Service (USDA-ARS) in Kimberly, ID. The results presented in Table 1 are from Carter et al. (1974) and Brown et al. (1974).

Table 1. Mass Balances of Sediment and Phosphorus in Twin Falls and Northside Irrigation Tracts

Tract	Size (acres)	Source	Soluble P (tons)	Total P (tons)	Suspended Solids (tons)
Twin Falls	202,000	Inflow	31.5	208	83,600
		Outflow	28.4	104	125,200
Northside	160,000	Inflow	37.9	176	63,100
		Outflow	5.2	21.3	13,300

The Northside tract retained 0.31 tons/acre of sediment that season from supply while retaining almost 90% of the total phosphorus diverted into the system. Contrarily, the Twin Falls tract contributed 0.21 tons/acre of sediment while retaining 50% of the total phosphorus.

The study also indicated that significant amounts of sediment are removed from the drains, resulting in expensive cleaning costs. This study accounted for both irrigation return flows that flow directly into the Snake River and tributaries of the Snake River that carry return flow. From these results it appears these irrigation diversions benefit the Middle Snake River. However, because of the diversion and increased concentrations of pollutants in return flows, the Snake River experiences elevated concentrations of pollutants. These results also do not account for sub-surface irrigation return flows that can have high nitrite+nitrate nitrogen concentrations.

Sediment and Nutrient Loadings

An extensive study by Brockway and Robison (1992) estimated sediment and nutrient loadings from various sources within the Middle Snake River. The loadings from agricultural nonpoint source pollution were estimated from a monitoring network that was comprised of eighteen irrigation return flow stations and nine tributary stations. The stations were monitored approximately bi-weekly for a 13 month period. The authors did not attempt to estimate what percentage of annual sediment and nutrient loadings in the tributaries can be attributed to irrigated agriculture. The results from the 13 month study are summurized in Table 2.

Table 2. Suspended Sediment and Nutrient Loadings in Irrigation Return Flows and Tributaries Between June 1990 and July 1991

	Suspended Solids (tons)	Total Phosphorus (tons)	Nitrite+Nitrate Nitrogen (tons)
Irrigation Return Flows	21,000	37	189
Tributaries	53,000	219	3,600

It was estimated by the authors that these stations comprise 70% of the total discharge from irrigation return flows entering directly into the Snake River. The study was conducted during an extensive drought period but irrigation supplies were near normal due to upstream storage. Irrigation return flows are highly variable with respect to pollutant concentrations and discharge. Because of these variabilities, confidence levels with respect to these loadings are difficult to determine. The results also indicate that when the sediment concentrations are great, the soluble phosphorus (ortho phosphate) comprises a small fraction of the total phosphorus. Therefore, limiting the amount of sediment returning to the river will also limit the amount of phosphorus returning.

Sediment entering the Snake River increases its sediment load. The sediment will be deposited when the transport capacity of the Snake River becomes less than the sediment load in the river. The deposited sediment provides a bed for attached macrophytes and algae to grow. With nutrient concentrations in excess of limiting, sufficient light availability, and slow current velocities, the Snake River becomes prone to excessive aquatic growth in shallow areas.

Other investigators besides Brockway and Robison (1992) have conducted research projects in the agricultural watersheds to describe the sediment and nutrient concentrations and loadings. The Division of Environmental Quality (DEQ) has also investigated the tributary drains to obtain background water quality information. In the 1980's, the DEQ used an "above and below" monitoring strategy to assess the agricultural impacts to the East Perrine Coulee, Rock Creek, Cedar Draw Creek, Deep Creek, and Mud Creek.

East Perrine Coulee is a natural drainage in the western portion of the Twin Falls tract. The drainage parallels Rock Creek to the east. The East Perrine Coulee drains approximately 18.8 square miles. DEQ developed two sampling stations in 1985 to assess the water quality in the stream. The "near mouth" sampling station estimated the drain contributed 7,322 tons of suspended sediment between May and October of 1985 (Clark, 1987). This estimate was based on 20 sampling visits during this six month period. Suspended sediment and total

phosphorus concentrations at the "near mouth" station increased substantially over the source water of the Twin Falls Main Canal (monitored between 1980-82 as part of Rock Creek RCWP). During this monitoring period suspended sediment concentrations ranged from 14-1722 mg/L with a mean of 525 mg/L while total phosphorus concentrations ranged from 0.13-2.23 mg/L with a mean of 0.69 mg/L (Clark, 1987). Brockway and Robison (1992) estimated the East Perrine contributed 2,994 tons of suspended sediment and 5.45 tons of total phosphorus between June 1990 and July 1991.

Rock Creek is a natural stream originating south of Twin Falls in U.S. Forest Service property. It flows northwest about 42 miles to the Snake River. Historically, Rock Creek has been a severely degraded stream resulting from a number of point and nonpoint sources. It was selected as one of 20 Rural Clean Water Projects (RCWP) in the nation in 1980. The RCWP was an interagency effort that used a number of best management practices to reduce the sediment and nutrients loadings into Rock Creek. The suspended sediment loadings have decreased 75% at the lower end of Rock Creek between 1982 and 1990, from 22,464 to 5,541 tons (Yankey et al, 1991). Also during this same period, total phosphorus loadings decreased 68%, from 30.7 tons to 9.9 tons. Brockway and Robison (1992) estimated that Rock Creek contributed 4,318 tons sediment and 10.3 tons of total phosphorus into the Snake River between January 1991 to July 1991.

Cedar Draw Creek originates at the Low Line Canal northwest of Filer and travels northeast to its confluence with the Snake River at river mile 599.1. Cedar Draw drains approximately 24.4 square miles and consists primarily of surface irrigated farmland. This natural stream has very little runoff and the majority of the inflow during the irrigation season is from irrigated agriculture. Springs and seepage tunnels are the primary sources of the winter time flows. A number of commercial fish production facilities utilize both the ground water and surface water in this watershed. Cedar Draw has historically contributed high sediment concentrations and high sediment loads into the Snake River. A water quality study was conducted by the DEQ between 1982 and 1988 to measure the effectiveness of best management practices in the Cedar Draw watershed. The study indicated that sediment and

nutrient concentrations at the mouth exhibited substantial reductions from 1982 to 1988. However, the concentrations still exceeded criteria recommended to prevent eutrophication and biological nuisances. Sediment and nutrient loading estimates were not a goal of this project and calculations are hampered by a small sampling size. However, DEQ estimated Cedar Draw discharged sediment values during the irrigation season of 7877 tons in 1983 (n=9), 15,965 tons in 1984 (n=9), and 8764 tons in 1987 (n=13) (Clark and Litke, 1991). The sediment loading estimates during 1982, 1985, 1986, and 1988 are not referenced because of the irregularity of sampling or a very small sampling size. Brockway and Robison (1992) estimated that Cedar Draw contributed 18,577 tons of sediment into the Snake River between June 1990 and July 1991 (n=27).

Mud Creek is located in western portion of the Twin Falls Canal Company (TFCC) tract. Mud Creek originates south of Buhl from numerous laterals in the Low Line Canal. The water is later diverted from Mud Creek by TFCC for irrigation purposes. There are approximately 24,000 acres in the Mud Creek watershed. Brockway and Robison (1992) estimated Mud Creek contributed 5,539 tons of sediment to the Snake River between June 1990 and July 1991. The Division of Environmental Quality (DEQ) conducted an extensive water quality study in 1986 to document current water quality conditions, agricultural practices, and critical agricultural subbasins within Mud Creek and Deep Creek, an adjacent tributary (Litke, 1988). DEQ estimated Mud Creek contributed 3,660 tons of sediment during the irrigation season in 1986 (Litke, 1988). The study indicated that the Silo Creek agricultural subbasin accounted for 94% of the suspended sediment load. There is a current state water quality project in Silo Creek.

Deep Creek is also located in the western portion of the Twin Falls Canal Company tract. Deep Creek originates southeast of Castleford and travels northward to its confluence with the Snake River at river mile 592.0. The Deep Creek drainage is approximately 36,000 acres and lies between the Salmon Falls Creek drainage and the Mud Creek drainage. The TFCC uses the upper part of Deep Creek as part of their distribution system as return flows and diversions enable water to be delivered to acres northwest of Castleford. DEQ estimated that

5,150 tons of sediment were discharged from Deep Creek during the irrigation season in 1986 (Litke, 1988). This study also indicated inorganic nitrogen and total phosphorus levels exceeded recommended limits to prevent nuisance plant growth. Five monitored agricultural subbasins transported an estimated 8,305 tons of sediment to Deep Creek during the irrigation season. Based on these estimated loadings, Deep Creek was a sediment sink in 1986. A majority of the sediment is deposited behind Lateral 10 Diversion, this diversion lateral runs through a hydroplant facility before returning into Salmon Falls Creek. The results also indicate that 90% of the sediment load from the subbasins arise from two agricultural subbasins located in the upper region of the Deep Creek watershed. Brockway and Robison (1992) estimated Deep Creek contributed 8,317 tons of to the Snake River between June 1990 and July 1991.

CHAPTER 3
METHODOLOGY

Water Quality Monitoring

There were a total of sixteen monitoring stations on irrigation return flows that directly enter the Snake River. These sixteen stations were monitored in the 1990-91 study by Brockway and Robison (1992). Two stations included in the 1990-91 study, Southside 43 Drain and Northside S29 Drain, were dropped from this study. These stations comprised less than 1% of the total monitored load in 1990-91. The purpose of this monitoring network was to document the current 1995 loads and assess the changes from the 1990-91 study.

Three stations, the Main Perrine Coulee, West Perrine Coulee and S19/S Drain, were sampled on the canyon floor during the 1990-91 study. During 1995, these stations were sampled on the canyon rim. Two sharp crested weirs with wooden bulkheads were installed by the Twin Falls Canal Company on the canyon rim at the Main Perrine Coulee and West Perrine Coulee. The S19/S Drain has been rerouted for the development of a hydro power plant facility. These changes made the sampling on these drains more accessible and faster, allowing decreased travel time on the monitoring route. Field inspections during the week of March 20 identified each drain and the sampling point.

Station List

IR02N	Northside A Drain
IR03S	Southside A10 Drain
IR04N	Northside C55 Drain
IR07S	Southside Twin Falls Coulee
IR11S	Southside East Perrine Coulee
IR12ST	Southside Main Perrine Coulee
IR16ST	Southside West Perrine Coulee
IR20S	Southside 30 Drain
IR21S	Southside Pigeon Cove Hydro Plant -- LQ/LS Drains
IR22S	Southside LS2/39A Drain
IR23NT	Northside N42 Drain
IR24S	Southside 39 Drain

IR29S	Southside I Drain
IR30N	Northside J8 Drain
IR39NP	Northside S19/S Drain
IR42N	Northside W26 Drain

The exact location of the monitoring stations were located on USGS Topographic Maps and described in Appendix A.

The water quality parameter package was similar to that of previous studies conducted at the University of Idaho Kimberly Research and Extension Center. The package included six field measurements and six laboratory parameters. The field measurements include air temperature, water temperature, electrical conductivity, pH, dissolved oxygen, and discharge. The laboratory parameters included total suspended solids, total phosphorus, dissolved ortho phosphate as phosphorus, ammonia as nitrogen, total Kjeldahl nitrogen, and total nitrite and nitrate as nitrogen.

The portable water quality electronic instruments used include a pH wand, a total dissolved solids wand, dissolved oxygen meter, and a metal thermometer probe. The pH wand was a pocket size instrument produced by Cole-Parmer Instrument Company, Model 05830-00. The wand has a range of 0.00 to 14.00 pH, a resolution of 0.01 pH, and an accuracy of 0.01 pH. The total dissolved solids (TDS) wand was also pocket size and produced by Cole-Parmer Instrument Company, Model 19800-10. The TDS wand has a range of 0 - 1990 uS and a resolution of 10 uS. The dissolved oxygen meter was handheld system produced by YSI Incorporated, Model 55 Dissolved Oxygen Handheld System Meter. The meter measures dissolved oxygen concentrations between 0 - 20 mg/L with a resolution of 0.01 mg/L and an accuracy of 0.3 mg/L. This meter also measures the temperature of the water. It has measurement range between -5 to 45° C, a resolution of 0.1° C, and an accuracy of 0.4° C. The metal thermometer probe has an accuracy of 0.1° C and is used to measure the air temperature. The water quantity, or discharge, measurements were made with an OTT propeller type meter.

Water quality supplies used for monitoring include 1 liter plastic cubicontainers, 70 ml plastic vials, 60 ml plastic syringes, 47 mm plastic filter holders, and 0.45 μm filter membranes. Other supplies include two coolers, splitting churn (bucket, churn, and valve), and dipping bucket.

It was imperative that the water quality sample collected be representative of the water mass. The return flows are usually no more than 15 feet in width and 5 feet in depth. Because of the relatively small cross section, a grab sample in the return flows accurately represents the actual constituents in the water. A collection volume of 10 to 15 gallons allows sufficient representation of the water quality parameters while allowing convenient handling and sampling.

Sample collection involved a number of preparation steps before entering the field to collect the sample. These steps include a numbering and labeling system for all sample containers, obtaining transport containers and field data sheets, calibrating equipment, and adding chemical preservatives to the appropriate containers. The numbering and labeling system combined with the data sheets allow sufficient information to provide positive sample identification at a later date.

Each cubicontainer was identified with a pre-numbered label and color dot. The total suspended solids (TSS) cubicontainer was identified with a blue color dot while the nitrogen (N) series cubicontainer was identified with a yellow color dot. The N series was also pretreated with 2 ml of sulfuric acid, H_2SO_4. The cubicontainers used to collect the sample were plastic and have 1000 ml volume. A 70 ml volume plastic vial was identified with a pre-numbered label but no color dot. The vial was used for the analysis of dissolved ortho phosphate (PO_4) and nitrite+nitrate nitrogen (NO_3+NO_2). All portable water quality instruments were calibrated to known stock solutions in the University of Idaho-Kimberly laboratory before entering the field. Two coolers were used to transport the samples on ice from the field back to the laboratory.

After gaining access and arriving at the site, the following procedures were performed:

1. Note arrival conditions, site information, label information on field sheets
2. Set out cubicontainers, vial, filter, and syringe
3. Place metal thermometer in the shade
4. Triple rinse the dipping bucket and churn splitter downstream of the sampling point
5. Collect ten to fifteen gallons of sample volume in churn splitter with the dipping bucket
6. Quickly churn sample and extract 20-30 ml for pH and EC field measurements
7. Churn sample and extract 1 liter TSS cubicontainer sample (blue)
8. Churn sample and extract 1 liter Nitrogen series (N) cubicontainer sample (yellow)
9. Churn sample and extract syringe volume twice to rinse syringe, filter, and vial
10. Churn sample and extract syringe volume for PO_4 and NO_3+NO_2 vial sample
11. Use dissolved oxygen meter and record DO of remaining sample in churn splitter
12. Record other field parameters on field sheet
13. Place all samples on ice in coolers
14. Collect flow data by sticking checkboards, reading staff gages, or current metering stream

The monitoring route took approximately two days. The samples collected after the first day were preserved by refrigeration. After completing the monitoring route on the second day, the samples were packed with fresh ice into new coolers and shipped to the U.S. Bureau of Reclamation Pacific Northwest Regional Laboratory via Pony Express Delivery Company.

The frequency of the sampling was bi-weekly. Obviously, weekly samples would provide better accuracy of the total loads entering the system. However, a number of constraints including the total number of sites, laboratory ability to process samples, distance between sites, and budget restrictions limited the frequency to every two weeks.

The chemical parameter analysis was performed by the U.S. Bureau of Reclamation Pacific Northwest Regional Laboratory in Boise, Idaho. This laboratory is approved by the Environmental Protection Agency (EPA). Laboratory methods used follow procedures documented and printed by the EPA in Methods for Chemical Analysis of Water and Wastes (1983). All laboratory results were reported in mg/L.

Total Suspended Solids: The test procedure corresponding to Method 160.2 was used. This method qualifies for STORET parameter number 530 and has a minimum detection level of 1 mg/L. The recommended maximum holding time for this measurement is 7 days.

Total Phosphorus: The test procedure corresponding to Method 365.3 was used. This method qualifies for STORET parameter number 665 and has a minimum detection level of 0.01 mg/L. The sample container will be preserved with 2 ml of sulfuric acid (H_2SO_4) to prevent biological and chemical changes in the collected sample. The recommended maximum holding time is 28 days. The sample container will also contain the sample volume used for the analysis of total ammonia and total Kjeldahl nitrogen.

Dissolved Ortho Phosphate: The test procedure was the same as the total phosphorus analysis method (353.3). This method qualifies for STORET parameter number 671 and has a minimum detection level of 0.003 mg/L. The recommended maximum holding time is 48 hours. The sample container will also contain the sample volume used for the analysis of nitrate+nitrite nitrogen. The sample volume will be filtered in the field with a 4.7 cm filter with a 0.45 micron pore size.

Total Ammonia Nitrogen: The test procedure corresponding to Method 350.3 was used. This method qualifies for STORET parameter number 610 and has a minimum detection level of 0.01 mg/L. The recommended maximum holding time is 28 days. The sample container will also contain the sample volume used for the analysis of total phosphorus and total Kjeldahl nitrogen. Therefore, the sample container will contain 2 ml of H_2SO_4 as a preservative.

Total Kjeldahl Nitrogen: The test procedure corresponding to Method 351.2 will be used. This method qualifies for STORET parameter number 625 and has a minimum detection level of 0.03 mg/L. The recommended maximum holding time is 28 days. The sample container will also contain the sample volume used in the analysis of total phosphorus and total ammonia nitrogen. Therefore, the sample will contain 2 ml of H_2SO_4 as a preservative.

Total Nitrate+Nitrite Nitrogen: The test procedure corresponding to Method 353.2 will be used. This method qualifies for STORET parameter number 630 and has a minimum detection level of 0.01 mg/L. The recommended maximum holding time is 28 days. The sample container will also contain the sample volume used in the analysis of dissolved ortho phosphate. The sample volume will be filtered in the field with a 4.7 cm filter with a 0.45 micron pore size.

The quality control and assurance (QA/QC) program was an integral part of the study. It consisted of duplicate samples, spiked samples, and blank samples. For every bi-weekly

sampling, one set of three samples (duplicate, spike, blank) were submitted with the other samples. This amounts to one QA/QC set per 17 stations. The Southside I Coulee was the site for the QA/QC. This site is adjacent to a developed road and was very accessible. A spiking solution containing 2,000 mg/L of nitrite nitrogen, 1,000 mg/L of ammonia nitrogen, and 500 mg/L of total phosphorus was used. The QA/QC sample sets were sent to the laboratory along with the irrigation return flow samples. These guidelines are consistent with quality assurance sample procedures recommended by DEQ (Bauer et al, 1986) and similar to the procedures used by Brockway and Robison (1992).

All data, including field measurements and laboratory analytical results, were entered into a data base at the University of Idaho Water Resources Research Institute-Kimberly Research and Extension Center. An existing data base containing historical water quality data in the Middle Snake River Reach was extended to include the results from this study. This facilitates ready access to the data and enables historical and current data to be compared. It also provides a secure archive for future retrieval.

Sediment and nutrient loads for each drain were calculated by multiplying the constituent concentration and water discharge for each sampling visit. The total loads were determined by interpolating concentrations and discharges between the bi-weekly sampling visits. Water quality concentrations below the minimum detection limit (MDL) were handled in loading calculations by substituting a value halfway between the minimum detection limit and zero (MDL/2). The quality assurance and control results were analyzed using procedures documented by Bauer, Dodds, and Clark (1986). These procedures included calculating the percent recovery of spiked samples and the relative range of duplicate samples. These results provide accuracy and precision estimates and provide a measure of the quality of the data set.

Comparison of 1990-91 and 1995 loading results

Sediment and phosphorus loading in irrigation return flows are highly variable and comprise two parameters, flow rate and concentration. Recognizing that loading rates calculated using the methodology of this study are only estimates and that sample sizes are small, no major statistical analysis was conducted. Comparisons were made from bar graphs illustrating the differences between the '90-'91 and '95 total suspended solids loading, total phosphorus loading, and total runoff.

Of the 18 monitored return flows identified in the '90-91 Brockway and Robison (1992) report, 6 return flows have significant sub-surface return flow in the winter months. These 6 drains were monitored during the winter months of the '90-91 season. In 1995, 16 irrigation return flow stations were monitored during the irrigation season. However, these stations were only monitored from approximately mid-April to mid-October. In order to compare the '90-91 loads to the '95 loads, the non-irrigation season loadings on the 6 return flows need to be excluded. A time period of April 15 to October 31 (199 days), was selected as the period attributed to loadings during the irrigation season. The '90-'91 suspended sediment and total phosphorus loads were recalculated to reflect irrigation season loading only.

Estimating the Effects of Water Quality Facilities on Irrigation Return Flows in the Twin Falls and Northside Irrigation Tracts

Water quality facilities constructed by the canal companies on irrigation return flows have the potential to reduce sediment and nutrient loads before reaching the receiving stream. These facilities can range from a simple large sediment pond to a complex constructed wetlands. The combined effects of existing and future facilities is unknown in a majority of irrigation tracts. The Twin Falls and Northside Canal Companies began constructing water quality facilities such as large sediment ponds and constructed wetlands on irrigation return flows in 1992. As one of their measures undertaken to assist in reducing agricultural contributions of sediment and nutrients, the canal companies will continue to develop water quality facilities.

A procedure was developed to evaluate the effects of existing facilities and potential facilities on return flows.

This procedure does not evaluate the effects of ponds constructed by water users on their individual properties. However, it does include ponds near the river that the canal company assists in cleaning when required. Also, this procedure does not evaluate the effect of water user education and best management practice implementation or the effect of canal company personnel education on return flow loading. The water quality facilities are assumed to be located close to the end of the drain or lateral, near the confluence with the receiving stream. A location close to the confluence assumes the stream has limited opportunity to respond to the reduced load and possibly scour out bed and bank material. Also, no additional field runoff is possible.

The first step in order to evaluate the effects of water quality improvement facilities on irrigation return flows was to document the number and location of the majority of return flows in the Twin Falls and Northside irrigation tracts. Return flows entering the mainstem reach of the Snake River or a tributary of the Snake River were documented. The documented return flows were categorized according to the canal company and confluence location.

The next step was to review historical loading records of irrigation return flows in the study area. This assisted in prioritizing the water quality irrigation return flows with the heaviest contributions of sediment and nutrients. Therefore, a water quality monitoring network was designed based on this prioritization. This study monitored the major irrigation return flows directly entering into the Snake River. The tributaries of the Middle Snake River were monitored by Division of Environmental Quality (DEQ) South Central Regional Office. These monitoring networks documented the majority of agricultural runoff in the study area. There are other smaller poorly defined irrigation return flows in the study area, but budget and time constraints made it unfeasible for all return flows to be monitored. Their loadings were

estimated using other techniques. Coordinated monitoring meetings with DEQ personnel before the irrigation season facilitated this cooperated effort.

It is important that the water quality monitoring network include a station list, monitoring parameter package, laboratory analysis package, and field sample collection methods. A monitoring station list developed in this study was described in Water Quality Monitoring. A station description identifying the sampling point location by elevation, latitude, longitude, and section and a general description describing access to the site and other important features were included in Appendix A. The monitoring parameter package and laboratory analysis package used in this study were also described in Water Quality Monitoring. The monitoring package included the electronic instruments and supplies and the field sample collection methods used to collect the samples. The laboratory analysis package described the laboratory performing the chemical analysis and the test procedure method used by laboratory personnel.

The monitoring network DEQ conducted consisted of stations on the Snake River and tributary stations of the Snake River during 1995. The tributary stations monitored near the confluence with the Snake River include East Perrine Coulee, Rock Creek, Cedar Draw Creek, Mud Creek, Deep Creek, and Salmon Falls Creek. These tributaries contain a number of agricultural subbasins. Monitoring frequency was limited to approximately biweekly during the nonirrigation season and weekly during the irrigation season. The DEQ used a collection procedure very similar to the University of Idaho but laboratory analysis was performed by IDHW Regional Laboratory in Boise, Idaho. The suspended sediment loading rates from these tributaries were calculated using DEQ data. The individual sediment data and discharge collected by DEQ are located in Appendix D along with the loading computations. East Perrine Coulee was the only station duplicated between DEQ and this study. The differences between the monitored results at this station were compared.

The tributaries have discharge and sediment concentrations high enough that on-line water quality facilities are not feasible. Therefore, treatment of agricultural runoff in the tributaries

needs to be located in the agricultural subbasins. The DEQ tributary loading estimates can be distributed over the subbasins according to a number of techniques. The technique used in this study assumed that the tributaries are in equilibrium and distribute the loading rates according to the percentages of a regression based equation. In equilibrium, the assumption of no net deposition or scour occurs in the tributaries and total load inputs from the agricultural subbasins equal the total load outputs at the confluence with the Snake River.

During the Brockway and Robison study (1992), regression equations were developed using return flow loadings and the land use data of total area, amount of surface irrigation, and drain length. The overall match was fair and R^2 values ranged from 0.645 for suspended sediment to 0.726 for total phosphorus (Brockway and Robison, 1992). The regression equation for sediment loading was used to calculate loading rates in the agricultural subbasins of the tributaries. The total load predicted from the regression equations did not equal the monitored load at the confluence. Therefore, sediment loading in the agricultural subbasins were adjusted according to the regression percentages to equal the total monitored load at the confluence. The sediment regression loading equation was also used to predict loading in other nonmonitored return flows that enter directly into the Snake River.

In order to evaluate attainable water quality improvement due to water quality facilities on irrigation return flows, water quality facilities already constructed in Northside and Twin Falls Irrigation Tracts were documented. An "applicable" facility, a facility likely to be constructed in the future, was defined. Monitoring data on the sediment removal performance of some of these facilities was researched. The actual removal rates were compared to the predicted removal rates of a computer model. The computer model predicted removal rates of the facilities by using the measured sediment inflow concentrations, discharge, measured surface area, and assumed sediment particle size distribution. A removal rate for this "applicable" facility was formulated.

Based on the estimated loading, discharge, and sediment concentrations of irrigation return flows, known site conditions near the confluence, and by assuming construction of an

"applicable" facility, the potential reduction of sediment from these return flows was estimated. This potential reduction estimate is based only on the effect of water quality facilities constructed by the canal companies, it does not include the effect of education and implementation of BMPs and other erosion controls by water users, water masters, and ditch riders.

CHAPTER 4
RESULTS

Monitored Irrigation Return Flows Results

The total suspended solids and nutrient loadings from the monitored return flows in the 1995 irrigation seasons are summarized in Table 3 along with 1990-91 monitored results. The individual water quality data reports and loading computations for each station are contained in Appendix B and Appendix C, respectively. The mean, maximum, minimum, and standard deviation of each laboratory parameter for each station are summarized in the water quality data reports in Appendix B. These loadings are estimates recognizing that the return flows loadings are highly variable in runoff and parameter concentration.

The Southside Pigeon Cove Drain contributed the highest loads in both sediment and phosphorus. Combining the Pigeon Cove Drain, East Perrine Coulee, LS2/39A Drain, and 39 Drain accounts for 81% of total monitored sediment load. Smaller drains such as A Drain, A10 Drain, C55 Drain, Twin Falls Coulee, and West Perrine Coulee each account for less than 1% of the total monitored sediment load.

Total phosphorus and sediment concentrations are directly related as discussed in Chapter 2. The drains with the highest sediment loadings also generally had the highest total phosphorus loadings. However, some drains had very high total phosphorus loadings for their corresponding sediment load. These results indicate these drains, which include the East Perrine Coulee, S19/S Drain, and J8 Drain, have other input sources of phosphorus besides agricultural return flow.

The drains with significant sub-surface return flow such as Pigeon Cove Drain, East Perrine Coulee, I Coulee, LS2/39A Drain, and 39 Drain all exhibited nitrite+nitrate nitrogen loadings much greater than the other monitored drains. These six drains accounted for over 95% of total monitored nitrite+nitrate load.

Table 3. Suspended Solids and Nutrient Loads from Monitored Irrigation Return Flows During 1990-91 and 1995 Irrigation Season ('90-91 Results from Brockway and Robison (1992))

ID	Station	Total Runoff AF		Suspended Solids tons		Ammonia Nitrogen tons		Kjeldahl Nitrogen tons		NO2+NO3 Nitrogen tons		Total Phosphorus tons		Ortho Phosphate tons	
		90-91	95	90-91	95	90-91	95	90-91	95	90-91	95	90-91	95	90-91	95
IR02N	A Drain	3643	2562	918	57	0.28	0.07	2.94	1.04	0.70	0.10	1.23	0.33	0.19	0.17
IR03S	A10 Drain	1857	1750	148	53	0.15	0.04	1.45	0.65	0.50	0.44	0.45	0.34	0.22	0.22
IR04N	C55 Drain	3056	1919	178	69	0.25	0.07	1.71	0.84	0.99	0.27	0.58	0.29	0.24	0.13
IR07S	Twin Falls Coulee	3311	1017	646	72	0.16	0.02	2.65	0.69	0.64	0.07	1.01	0.27	0.24	0.13
IR11S	East Perrine Coulee	15590	12203	2253	1444	2.01	0.80	14.85	8.18	33.04	31.62	4.11	3.29	1.52	1.19
IR12ST	Main Perrine Coulee	5915	4484	1509	702	0.42	0.21	5.05	4.34	2.56	0.94	2.34	1.51	0.45	0.34
IR16ST	West Perrine Coulee	1015	1729	322	83	0.07	0.08	1.29	1.11	0.29	0.25	0.44	0.38	0.09	0.17
IR20S	30 Drain	2434	1464	801	318	0.17	0.03	1.71	1.34	1.02	0.16	0.99	0.53	0.22	0.11
IR21S	Pigeon Cove Drain	16135	21643	5766	9247	1.42	0.57	15.95	17.97	33.94	44.29	7.71	12.83	1.47	2.07
IR22S	LS2/39A Drain	3190	4699	1472	1516	0.28	0.17	3.66	3.94	4.66	8.73	1.84	2.07	0.34	0.39
IR23NT	N42 Drain	3913	6058	144	253	0.43	0.25	2.82	3.91	0.81	0.30	0.71	1.19	0.39	0.52
IR24S	39 Drain	2950	3137	2207	2425	0.32	0.12	4.01	4.06	5.90	5.57	2.27	2.86	0.31	0.32
IR29S	I Coulee	4524	4108	920	705	0.46	0.11	4.53	3.07	12.12	12.70	1.46	1.47	0.56	0.46
IR30N	J8 Drain	3033	5649	157	207	0.21	1.26	2.15	4.82	0.44	0.26	0.54	1.77	0.26	1.18
IR39NP	S19/S Drain	21653	17069	1250	767	1.86	1.07	18.48	13.74	4.46	1.94	6.02	5.96	2.97	3.89
IR42N	W26 Drain	7210	6333	711	234	0.56	0.10	4.31	3.84	1.21	0.12	1.29	0.85	0.48	0.28
	Totals	99427	95825	19402	18153	9.1	5.0	87.6	73.5	103.3	107.8	33.0	35.9	9.9	11.6

The percent recovery of spiked samples and the relative recovery of duplicate samples are summarized in Table 5. The percent recovery means for all the parameters are between 95 and 102 percent. The parameter with the best recovery is ammonia nitrogen with a mean recovery of 100.4% and a standard deviation of 5.5%. Dissolved ortho phosphate exhibited the worst recovery with a mean of 97.5% and a standard deviation of 10.8%. The percent relative recovery for the parameters ranged from excellent at 0.0% for ammonia nitrogen to good at 11.1% for total Kjeldahl nitrogen. The blank samples exceeded the minimum detection level very few times. When exceedance did occur, the concentrations were just above the minimum detection level. Overall, the quality assurance and quality control results indicate that little or no contamination occurs from sample containers, during sampling and holding time, and during laboratory analysis.

Changes between 1990-91 and 1995 Sediment and Total Phosphorus Loads

Before assessing the changes, the nonirrigation season loading was excluded from the 90-91 monitoring results (Brockway and Robison, 1992). There were six return flows which contain significant subsurface return flow and were monitored over the 13 month period in 90-91. The following table illustrates the differences between the total loading and irrigation season loading for these six return flows. Similar adjustments were made for the other monitored parameters on these six return flows and summarized in Table 3.

Table 4. Suspended Solids and Total Phosphorus Loading Adjustments for the 1990-91 Monitoring Season

	Total TSS Loading for 13 months	TSS Irrigation Season Loading	Total TP Loading for 13 months	TP Irrigation Season Loading
East Perrine Coulee	2994	2253	5.45	4.11
Main Perrine Coulee	1586	1509	2.55	2.34
LQ/LS Drain	6368	5765	8.97	7.71
LS2/39A Drain	1481	1472	1.87	1.84
39 Drain	2211	2207	2.29	2.27
I Drain	1187	920	2.31	1.46

Table 5. Quality Assurance and Quality Control Results

Date	Spiked Samples					Duplicate Samples											
	NOx	NH4	TKN	TP	PO4	TSS		NOx		NH4		TKN		TP		PO4	
	Percent Recovery					MV	%RR	MV	%RR	MV	%RR	MV	%RR	MV	%RR	MV	%RR
4/25/95						29	3.5	2.19	0.0	0.02	0	0.51	9.9	0.17	0.0	0.09	0.0
5/9/95	80	102	90	104	68	78	5.1	1.73	0.0	0.03	0	0.68	48.2	0.26	3.9	0.11	1.8
5/23/95	106				103	87	3.9	1.43	0.7	0.02	0	0.48	8.3	0.22	13.3	0.10	2.0
6/6/95	102	102	104	94	101	242	7.0	1.55	0.6	0.04	0	0.48	6.2	0.37	0.0	0.06	0.0
6/19/95	87	106	103	99	82	122	3.3	1.68	0.6	0.02	0	0.56	9.0	0.24	0.0	0.07	3.0
7/4/95	103	105	108	96	105	141	1.4	1.90	1.1	0.02	0	0.44	0.0	0.27	7.4	0.08	0.0
7/17/95	100	104	121	90	102	133	3.8	2.03	0.0	0.02	0	0.54	3.7	0.27	7.3	0.09	1.1
7/31/95	96	95	89	91	97	220	0.5	2.06	0.5	0.03	0	0.81	32.1	0.38	2.3	0.10	0.0
8/14/95	100	110	94	94	100	216	0.0	2.48	0.4	0.03	0	0.81	7.4	0.37	1.6	0.09	1.2
8/28/95	99	92	102	85	103	127	1.6	2.55	5.5	0.01	0	0.52	1.9	0.28	2.5	0.10	1.0
9/11/95	99	98	98	100	102	126	0.8	2.74	0.4	0.02	0	0.57	10.5	0.26	7.8	0.07	1.4
9/25/95	101	97	115	99	102	92	0.0	2.83	0.7	0.01	0	0.40	10.0	0.21	2.4	0.08	0.0
10/9/95	101	93	97	97	104	56	0.0	3.06	0.7	<0.01		0.29	6.9	0.15	3.2	0.06	0.0
10/23/95	99	101	103	100	99	89	3.4	3.48	1.4	<0.01		0.52	1.9	0.19	2.7	0.05	0.0
Average	97.8	100.4	102.0	95.7	97.5		2.4		0.9		0.0		11.1		3.9		0.8
St. Dev.	7.1	5.5	9.5	5.4	10.8		2.2		1.4		0.0		13.1		3.8		1.0
Count	13	12	12	12	13		14		14		12		14		14		14

Blank Samples
Minium Detection Limit (MDL)

	TSS	NOx	NH4	TKN	TP	PO4
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	1	0.01	0.01	0.03	0.010	0.003
Observations	14	14	14	14	14	14
Number Exceeding MDL	1	2	0	3	1	3
Average of Exceedances	2	0.100	0	0.040	0.012	0.005

The changes between the '90-91 and '95 total suspended sediment loading, total phosphorus loading, and total runoff are shown graphically in Figures 2-4 and summarized in Table 3. The percent changes between these time periods are illustrated next to the graphs. Changes in sediment loadings ranged from a 94% reduction at the Northside A Drain to a 60% increase at the Southside Pigeon Cove Drain. Generally, suspended sediment loadings were reduced or stayed constant with the exception of three drains; LQ/LS Drain (IR21S), N42 Drain (IR23NT), and J8 Drain (IR30N). Also, suspended sediment loading reductions were generally higher than total runoff reductions, indicating that on field BMPs and water user education are assisting in keeping the sediment on the field. Total runoff in the drains generally decreased indicating water conservation education of water users and canal company personnel has been beneficial. However, increases of sediment loading at the N42 Drain (76%) and J8 Drain (32%) can be associated with increases of runoff of 55% and 86%, respectively.

The 60% increase in sediment loading at the LQ/LS Drain cannot be attributed to a 44% increase in total runoff. During the '95 monitoring, a major discrepancy was found in the discharge rating curve used by the operator of the hydro plant in '90-91. The discharge rating curve was found to be about 35% low in estimating discharge from the plant. Most likely, total runoff increased about 10% from '90-91 and sediment loading increased about 26% from '90-91.

Total phosphorus loadings changes ranged from a 74% reduction at the A Drain to a 228% increase at the J8 Drain. This alarming increase may be attributed to other phosphorus sources such as the city of Jerome wastewater effluent, combined feeding operations, or stormwater runoff. Similarly, the S19/S Drain, adjacent to the J8 Drain, exhibited just a 1% decrease in total phosphorus while decreasing sediment by 39%. The above sources may also be affecting the phosphorus loading in this drain. With the exceptions of J8 Drain and S19/S Drain, the loading results indicate that controlling the amount of sediment returning to the Snake River also controls the amount of total phosphorus returning as well.

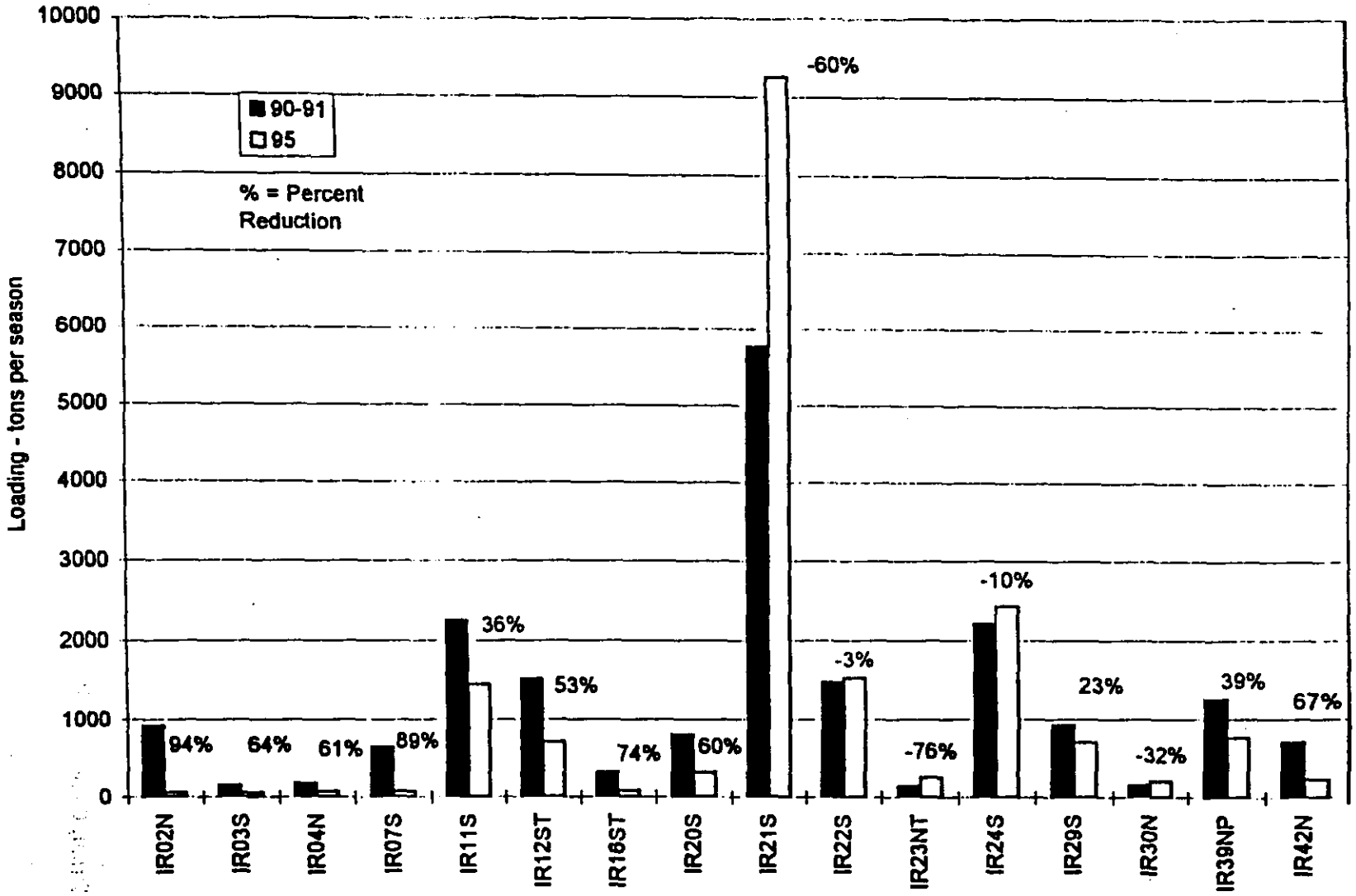


Figure 2. Total Suspended Solid Loads in Monitored Irrigation Return Flows from 1990-91 and 1995 Irrigation Seasons

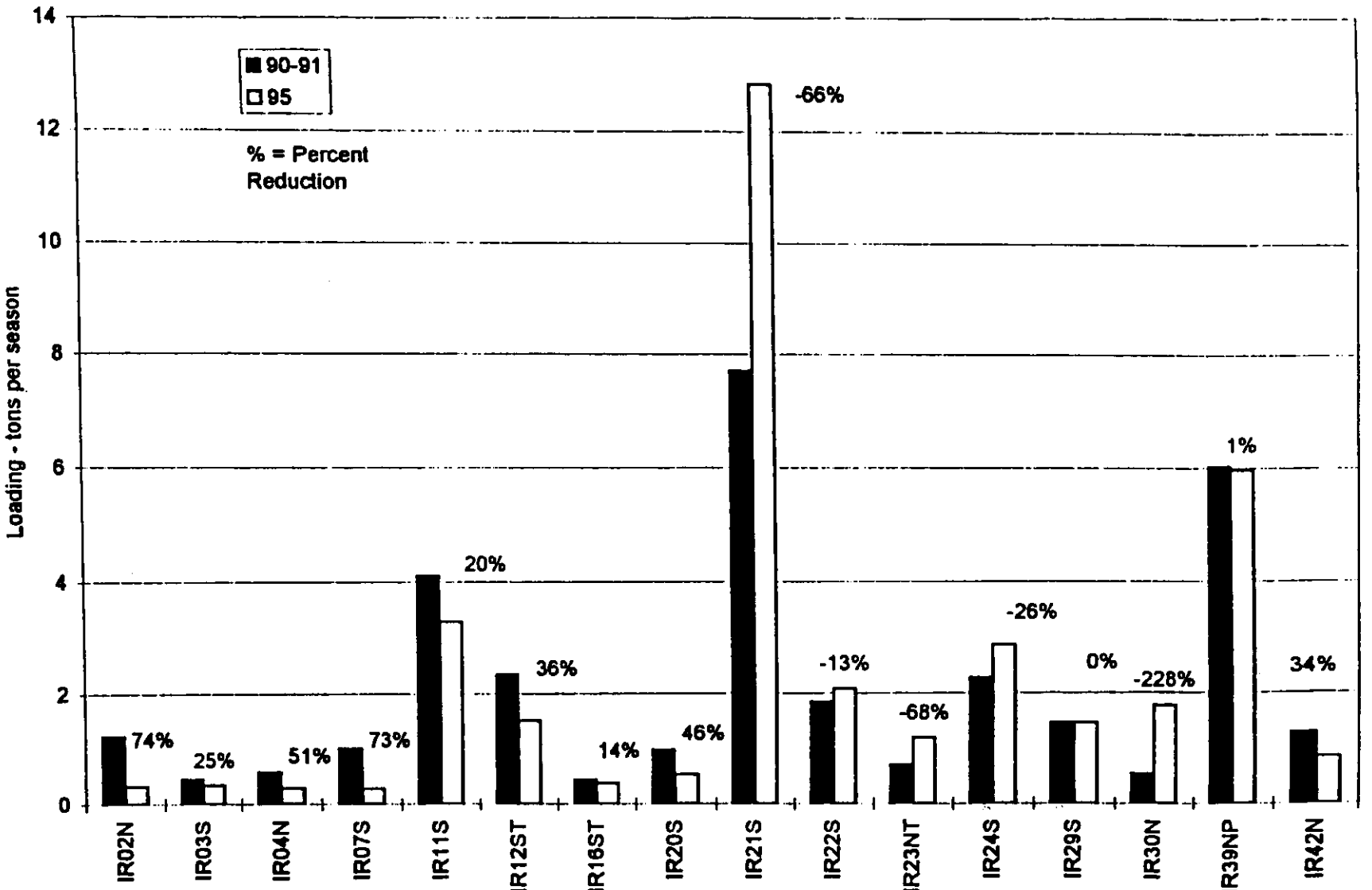


Figure 3. Total Phosphorus Loads in Monitored Irrigation Return Flows from 1990-91 and 1995 Irrigation Seasons

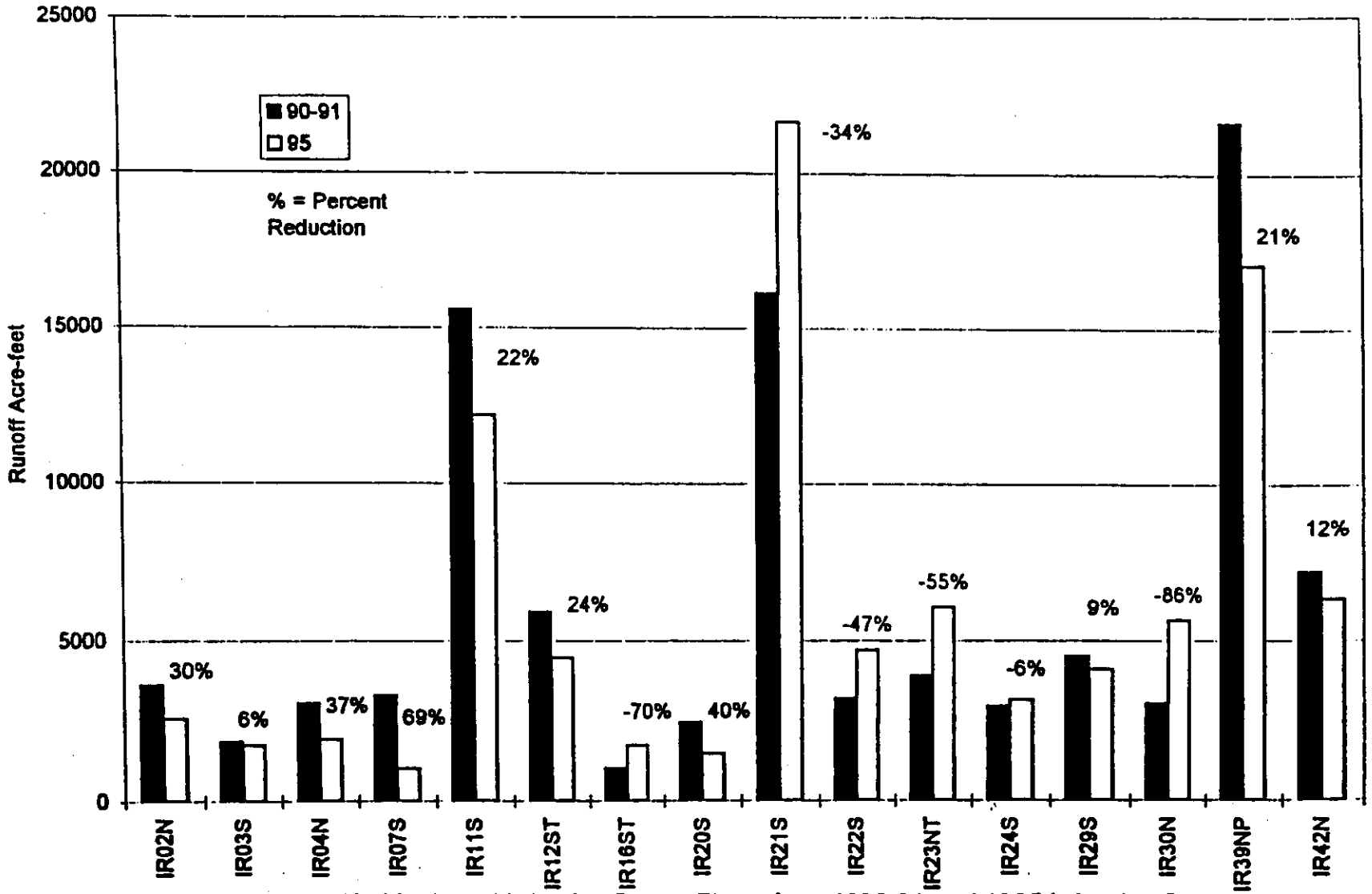


Figure 4. Total Runoff in Monitored Irrigation Return Flows from 1990-91 and 1995 Irrigation Seasons

Unmonitored Irrigation Return Flows

There are a number of irrigation return flows in the study area that were unmonitored by this study. In order to predict the effects the water quality facilities on irrigation return flows, sediment loadings, sediment concentrations, and discharge need to be estimated. Sediment loading in the some of the tributaries during the irrigation season can be attributed to irrigation return flows from the unmonitored agricultural subbasins. The Division of Environmental Quality (DEQ) monitored tributaries in the study area during the 1995 irrigation season. DEQ used a monitoring and laboratory package similar to the packages discussed in Water Quality Monitoring of this study. This DEQ data is preliminary and subject to revision. However, no major revisions are expected and preliminary data is considered sufficient for this study. The sediment concentrations and discharge of the DEQ monitored tributaries are located in Appendix D along with the loading computations.

Table 6. Suspended Solids Loading in Tributaries During the Irrigation Season-DEQ

	Suspended Solids tons
East Perrine	1394
Rock Creek	11635
Cedar Draw Creek	9979
Mud Creek	1672
Deep Creek	4968
Salmon Falls Creek	5063

Of the tributaries, East Perrine was classified as a return flow and monitored in this study. Between April 15 and October 31, the monitoring of this study estimated the East Perrine Coulee discharged 1444 tons of suspended sediment while DEQ estimated it contributed 1394 tons. This difference is within the desired accuracy considering the sample frequency, the variability of the stream's flow and concentrations, possible errors in laboratory analysis, and possible collection errors.

Rock Creek has a number of agricultural return flows entering primarily from the west. Five agricultural subbasins within in the Rock Creek Drainage account for the majority of the return flow. Rock Creek discharged approximately 11,635 tons of sediment during the 1995 irrigation season. The baseline loading in 1982 estimated from Rock Creek Rural Clean Water Program was 22,464 tons during the irrigation season. At the end of the 10 year program, 5,541 tons of sediment were discharged, a 75% reduction. Between January and July of 1991, Rock Creek contributed 4,318 tons of sediment. This loading is similar to the 1995 loading during the same time period. Because the farmers in the agricultural subbasins have implemented best management practices and the return flows already have existing sediment ponds, it is unlikely any further implementation of water quality facilities will be effective. However, cleaning the already existing ponds would be beneficial.

During the irrigation season, Cedar Draw Creek, Mud Creek, and Deep Creek sediment loadings are due to agricultural runoff. Because on line water qualities are unfeasible on these creeks, improvement facilities need to be located in the agricultural subbasins. Agricultural subbasins loading estimates in Table 7 are based on the following regression equation (Brockway and Robison, 1992):

$$TSS = 95.0*AREA + 18.5*SURF - 35.4*DRAN \quad \text{(Equation 1)}$$

TSS = Total Suspended Solids, tons
SURF = Surface irrigated land in AREA, percent
DRAN = Return flow drain length, miles
$R^2 = 0.65$

Discharges in the agricultural subbasins are estimated from previous investigations and known site conditions. Sediment concentrations are calculated based on the loading and discharge estimates.

The measured load of Cedar Draw Creek was 10,026 tons of sediment during the irrigation season. Cedar Draw Creek is composed primarily of three agricultural subbasins that enter from the west; E Drain East, F Drain, and the 110 Drain. Lateral 11A is a smaller poorly defined subbasin. The total predicted loads from Equation 1 of the three primary agricultural subbasins equaled 5,844 tons, much less than the measured load at the confluence. Therefore,

Table 7. Predicted Loading Rates in Agricultural Subbasins in Cedar Draw Creek, Deep Creek, and Mud Creek

		TSS Adjusted Loading tons	TSS Loading tons	Area Square Miles	Area Surface Irrigated % of total	Drainage Length miles	Estimated Discharge cfs	Sediment Conc. mg/L
Cedar Draw								
	E Drain	3520	2051	6.7	85	4.45	40	164
	F Drain	3212	1872	6.6	80	6.53	8	748
	I 10 Drain	3294	1920	6.0	85	6.28	10	614
			5844					
DEQ Monitored Load	10026							
Deep Creek								
	Lat 65 Complex	1125	2152	8.0	80	2.5	25	84
	HP/LP Drain	1272	2431	10.6	85	4.3	45	53
	Lat 9A	766	1464	1.4	75	1.6	8	178
	Lat 57A	702	1342	0.8	70	0.8	10	131
	Lat 60A	749	1431	1.1	75	1.7	12	116
	N1 Drain	196	374	1.2	20	3.1	10	36
	N2 Drain	159	304	1.4	15	3.0	10	30
			9497					
DEQ Monitored Load	4968							
Mud Creek								
	O Coulee	251	1396	2.15	70	2.9	10	47
	Lat 58	265	1472	3.43	70	4.2	10	49
	L Drain	222	1235	2.32	65	5.3	10	41
	K Coulee	114	635	2.70	30	5.0	5	42
	J Coulee	170	946	4.37	40	5.9	5	63
	I6 Drain	276	1534	3.54	75	5.4	25	21
	I1 Drain	174	966	2.82	50	6.4	15	22
	I2 Drain	201	1119	1.70	60	4.3	10	37
			9305					
DEQ Monitored Load	1672							

the predicted loads were increased according to the percentages of Equation 1 to equal 10,026 tons.

Mud Creek and Deep Creek are very unique tributaries. The Twin Falls Canal Company uses the upper part of Mud Creek and Deep Creek as part of their distribution system. The streams forming Mud Creek during the irrigation season represent the water quality in the Low Line Canal while the streams forming Deep Creek represent the water quality in the High Line Canal. It is unlikely any water quality facilities would be effective because little return flow has entered these streams before reaching Mud Creek and Deep Creek. The return flows listed in these drains in Table 7 represent streams entering the lower part of watershed that carry significant agricultural runoff. There is potential to implement water quality facilities on these streams. There are also a number of irrigation diversions on Mud Creek and Deep Creek.

A number of agricultural subbasins in Deep Creek and Mud Creek have poorly defined drainage area. This is because of interference of laterals and other man made channels within the normal watershed. Therefore, some nearby drains were consolidated into one such as the Lat 65 Complex in Deep Creek. Equation 1 produced a total load result that differed largely from the measured load at the confluence. Therefore, the loads were increased or decreased according to the percentages of Equation 1 to equal the measured load. This technique is used only to determine a 'relative' distribution of loads in the agricultural subbasins from the measured load at the confluence. In these unique tributaries, using only the regression equation alone would produce unrepresentative sediment loadings in the agricultural subbasins.

The percentage of agricultural runoff in Salmon Falls Creek is minute compared to other tributaries in the study area. Therefore, distributing the total monitored load at the confluence over the agricultural subbasins would give unreasonable results. There are four primary agricultural subbasins with return flows that discharge into Salmon Falls Creek. These return flows were monitored during the 1993 irrigation season by the Idaho Water Resources

Research Institute (IWRRI) at the Kimberly Research and Extension Center. Also, a small agricultural influenced tributary, Dry Creek was monitored by IWRRI in 1993. It is unlikely that loading rates have changed significantly enough since 1993 to warrant monitoring or predicting loading from these return flows or Dry Creek. The estimated suspended sediment loading, average discharge, and average suspended sediment concentration from these monitoring results are presented in Table 8.

Table 8. Measured Sediment Loading from Irrigation Return Flows Entering Salmon Falls Creek and from Dry Creek (unpublished data, IWRRI)

	Loading tons	Mean Discharge cfs	Mean Suspended Sediment Conc. mg/L
Lateral 3	173	2.0	38
Lateral 4C	88	3.3	57
Lateral 5A2/5A Complex	399	6.5	135
Lateral 10 (Above forebay)	150	40.0	80
Dry Creek	223	9.6	49

There are a number of other drains that enter directly into the Snake River and carry significant amounts of return flow. These drainage areas were identified and irrigation season loads were predicted in Brockway and Robison (1992). The predicted suspended solids loading from Brockway and Robison (1992) and an estimated discharge (unpublished, IWRRI) are summarized in Table 9.

Table 9. Predicted Sediment Loading from Unmeasured Drains Directly Entering the Snake River

		Loading tons	Mean Discharge cfs	Mean Suspended Sediment Concentration mg/L
UM01S	Lat 39 East	458	3	284
UM03N	PC Drain	486	3	302
UM04N	C33 Drain	666	3	414
UM05N	K Drain	429	2	400
UM05.25N	K(a) Drain	322	2	300
UM05.50N	K(b) Drain	348	2	324
UM05.75N	K(c) Drain	463	3	288
UM06N	N34 Drain	409	2	381
UM07N	N30 Drain	721	4	336
UM08N	N23 Drain	446	2	416
UM09N	S42 Drain	875	4	408

Observed Effects of Water Quality Facilities on Return Flows in the Study Area

The Northside A Drain and the Northside C55 Drain provide an example of the effects that water quality facilities have on return flows. Both drains are located in the eastern part of the Northside Canal Company and exhibit similar hydraulic characteristics. During the 1990-91 study, the Northside C55 drain flowed through a large regulation pond. This pond effectively reduced sediment prior to entering the Snake River. This pond also operated effectively in 1995. The total sediment loading reduced 61% from 178 tons to 69 tons. This reduction can be mainly attributed to the 41% less runoff volume in 1995. However, the Northside A Drain loading changes can be attributed to mainly the construction of two sediment ponds near the canyon spill. These sediment ponds, not present in 1991, effectively reduced sediment and phosphorus concentrations. Even though runoff volume decreased 31%, sediment concentrations and total phosphorus concentrations were significantly lower. This resulted in 94% less sediment and 74% less total phosphorus reaching the Snake River.

Another example of the effects of water quality facilities include the Southside West Perrine Coulee. Prior to the 1995 study, two large sediment ponds were constructed near the canyon spill. These two ponds operated effectively and helped reduce the amount of sediment discharged into the Snake River. The total sediment loading reduced 74% from 322 tons to 83 tons. Total runoff volume increased 71% from the '90-91 study. This can be partly attributed to sampling location. As stated before, the West Perrine Coulee monitoring station changed from the canyon floor to near the canyon rim in 1995. Most likely, the runoff in the 90-91 study was not completely measured as runoff begins to disperse near the Snake River. However, mean suspended sediment concentration decreased from 223 mg/L to 34 mg/L, a change of 85%. This indicates the sediment ponds are very effective in decreasing sediment.

The Northside Canal Company also constructed a water quality facility on the S19 Drain and the S Drain. The drains were rerouted near the canyon rim to join at a large sediment pond before reaching the penstock of hydro plant. Water quality monitoring of this facility during the 1994 irrigation season indicated removal efficiencies of up to 65% for suspended sediment/

and 20% for total phosphorus (unpublished data, IWRRI). Total sediment loading from this drain decreased 39% while runoff increased 21%.

Water quality facilities would be effective on drains without existing ponds. For example, the Pigeon Cove Hydroplant station, or the LQ/LS Drains, contributed 9247 tons of sediment during the irrigation season. This total loading increased 60% from the 90-91 study. A 44% increase in total runoff explains most of the loading increase but sediment concentrations of up to 849 mg/L indicate a water quality facility would be very effective in reducing the total load reaching the Snake River. The LQ/LS Drains meet in the penstock before dropping into the pelton wheel. Therefore, facilities on both drains would help alleviate the problem.

Some water quality improvement facilities constructed by the Twin Falls and Northside Canal Companies have been monitored by the University of Idaho on an irregular frequency. The monitoring results in Table 10 summarize the suspended sediment removal efficiencies during the 1994 irrigation season.

Table 10. WQ Facilities Improvement Performance (unpublished data, IWRRI)

	TSS Inlet	TSS Outlet	Flow	Pond Area	Overflow Rate	Efficiency
	mg/L	mg/L	cfs	ft^2	ft/s	%
CSI Pond	55	28	5.0	51,800	9.65E-05	49
370' x 140'	25	20	----		-------	20
	34	15	2.7		5.27E-05	56
Kasel Ponds	183	118	22.0	22,800	9.65E-04	36
380' x 60'	1372	269	18.0		7.89E-04	80
Norris Pond	94	48	1.1	39,600	2.78E-05	49
330' x 120'	943	289	6.8		1.72E-04	69
	88	27	1.0		2.52E-05	69
TNC Sed. Pond	15	3	7.7	36,000	2.14E-04	80
720' x 50'						

The removal efficiency of these facilities range from 20 to 80%. The measured removal efficiencies indicate the performance of "practical" facilities constructed in the study area. Efficiencies of these settling basins were predicted based on a mathematical model developed by Lindgren (1978). The inputs into the model consisted of the dimensional surface area of the pond, flow rate, measured inflow concentration, and a representation particle size distribution. The predicted efficiencies of these facilities were between 80-90%, differing considerably from the measured efficiencies. This can be attributed to differences between a facility and an ideal basin. These facilities have nonideal inlet structures, violate constant horizontal velocity assumption, are nonrectangular, and have nonideal outlet structures. The facilities constructed by the canal companies have very simple inlet and outlet works with no baffle system to deflect flows. The facilities differ considerably from ideal settling basins. Typically, water quality facilities similar to those that have been constructed will remove between 50-60% of the annual incoming sediment.

Predicted Effects of Water Quality Facilities on Return Flows in the Study Area

The major irrigation return flows which have been monitored or predicted are listed in Table 11. These return flows constitute the majority of return flows in the study area. The smaller, poorly defined return flows in the study area that are impractical for treatment are not listed. Some return flows already have existing sediment removal facilities. Therefore, additional removal on these drains will have to come through reductions in runoff or through the implementation of on field BMPs. Also, if the existing facility is undersized, additional removal could be achieved if the facility is enlarged. The return flows which do not have existing sediment removal facilities, a typical 40,000 ft^2 water quality facility was applied. The efficiency of the "applicable" facility was estimated based on the flow rate and sediment concentration of each individual drain. Engineering judgement was also used in formulating the removal efficiency. The return flows are categorized according to confluence location and canal company.

Table 11. Estimated Sediment Removal Efficiencies if "Applicable" Facilities Are Implemented

Twin Falls Canal Company

Drain	Load tons	Existing Facility	Removal Efficiency	Final Load tons
Dry Creek	223	None	0%	223
A10 Drain	53	Pond/Wetland	0%	53
Twin Falls Coulee	72	None	40%	43
East Perrine	1444	Ponds	15%	1227
Lat 39	458	None	60%	183
Main Perrine	702	Yes	15%	599
West Perrine	83	Pond	0%	83
30 Drain	318	None	60%	127
LQ/LS Drain	9247	None	40%	5548
LS2/39A Drain	1516	None	60%	606
39 Drain	2425	None	60%	970
Cedar Draw Creek				
E Drain	3520	None	30%	2464
F Drain	3212	Pond	30%	2248
I 10 Drain	3294	None	60%	1318
I Drain	705	None	60%	282
Mud Creek				
O Coulee	251	None	30%	176
Lat 58	265	None	30%	80
L Drain	222	Pond	0%	222
K Coulee	114	None	40%	68
J Coulee	170	Pond	0%	170
16 Drain	276	Ponds	0%	276
I1 Drain	174	None	10%	157
I2 Drain	201	None	30%	141
Deep Creek				
Lat 65 Complex	1125	None	30%	788
HP/LP Drain	1272	None	15%	1081
Lat 9A	766	None	60%	306
Lat 57A	702	None	60%	280
Lat 60A	749	None	60%	300
N1 Drain	196	Ponds	15%	167
N2 Drain	159	None	15%	135
Salmon Falls Creek				
Lat 3	173	Pond	10%	156
Lat 4C	88	Pond	0%	88
Lat 5A2/5A	399	None	60%	160
Lat 10 Hydro	150	Ponds	0%	150

Northside Canal Company

A Drain	57	Ponds	0%	57
PC1 Drain	486	Pond	0%	486
C55 Drain	69	Ponds	0%	69
C33 Drain	666	None	60%	266
K Drain	429	None	60%	172
K (a) Drain	322	None	60%	129
K (b) Drain	348	None	60%	139
K (c) Drain	463	None	60%	185
N34 Drain	409	Pond	0%	409
N30 Drain	721	Pond	0%	721
N42 Drain	253	Pond	0%	253
N23 Drain	446	None	60%	178
J8 Drain	207	Ponds	0%	207
S42 Drain	875	Pond	30%	613
S/S19 Drain	767	Pond	0%	767
W26 Drain	234	None	15%	199
Totals	41,477			25,708

The present load sediment load can be reduced 38% from 41,477 tons to 25,708 tons through the implementation of on-line water quality facilities on return flow drains. Accounting for monitored drains only, a final loading of 11,091 tons can be achieved, a 39% reduction from the '95 loading and a 47% reduction from the '90-91 loading. This reduction does not take into account the effect of water user and canal company personnel education or the effect of on field BMP implementation on return flows.

Using the regression equation exclusively to predict sediment loading in the unmeasured drains that discharge directly into the Snake River gave unreasonably high results. This is because regression equations are based on watershed characteristics that are difficult to quantify. These high loading rates combined with a known low flow rate results in high mean sediment concentrations. Therefore, implementing an "applicable" facility on these drains will give hypothetically high removal efficiencies. The reductions associated in the indicator drains, or the monitored drains in this study, better reflect what can be achieved by the implementation of water quality facilities.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

The Middle Snake River is classified as "water quality limited" because of the existing water quality conditions. Agricultural runoff along with other industry activities such as fish rearing facilities and hydropower development have in part contributed to this classification. Irrigation return flows from the Twin Falls and Northside Canal Companies convey sediment and nutrients into the Middle Snake River and its tributaries. A water quality monitoring network on 16 irrigation return flows that enter directly into the Middle Snake River was conducted during the 1995 irrigation season. Approximately, 18,153 tons of suspended sediment, 74 tons of organic nitrogen of which 5.0 tons was ammonia nitrogen, 108 tons of nitrate+nitrite nitrogen, and 36 tons of total phosphorus of which 11.6 tons was dissolved ortho phosphate was discharged from these drains into the Middle Snake River.

The variability in water quality parameters and discharge hamper the certainty of these loading estimates. Loading values are highest early in the irrigation season. This is because water users and water masters are adjusting water deliveries due to variability of weather and crop requirements. Also, runoff from the initial irrigation is usually higher in pollutant concentrations. These factors contribute to early season loading pulses that may constitute a majority of the overall loading. These pulses may go undetected depending on the sampling route and frequency.

The 1995 suspended solid and phosphorus loading results showed a general decreasing trend from the 1990-91 loading results. Only three drains, Pigeon Cove Drain, N42 Drain, and J8 Drain showed significant increases in sediment loading. These increases can be attributed to increase in total runoff and slight increases in mean concentrations. Two adjacent drains, J8 Drain and S19/S Drain, had high total phosphorus loadings when compared to the corresponding sediment load. This indicates other phosphorus sources such as combined feeding operations, wastewater effluent, or stormwater runoff may be contributing to the monitored load.

Estimating return flow loading from nonmonitored agricultural areas is very difficult. It is very difficult to determine watershed characteristics because of the interference of manmade channels within normal watersheds. Also, return flows are continually being mixed with delivery water throughout the watersheds. Water management in the Twin Falls and Northside Canal Company delivery system is dynamic, continually changing. These factors contribute to the inaccuracy of predicting unmeasured return flows based on regression equations.

It is difficult to quantitatively assess sediment reduction activities and measures on return flow loading. The effect of measures such as water conservation education on water users and canal company personnel can not be quantitatively assessed. However, water quality data on some facilities indicate effective performance in reducing sediment concentrations. Also, total runoff in the majority of the drains have decreased, indicating increased awareness of water conservation by the general public, water users, and water masters.

The solution to reducing irrigation return flow runoff lies on the field with BMPs and educational training of water users. But, until best management practices are implemented by individual farmers to the extent necessary, the Twin Falls and Northside Canal Companies have no recourse but to treat return flows with water quality facilities. If water quality facilities recommended in Table 11 are constructed and current water quality facilities are maintained, approximately 25,708 tons of sediment will be discharged from return flows annually. This represents a 38% decrease from present loading levels.

To better predict the certainty of irrigation return flow loading, it would be beneficial to alternate the monitoring frequency and sampling time. Monitoring during this study was conducted early in the week, usually on a Monday or Tuesday, and during the early morning to mid afternoon. Monitoring could be conducted every 8 or 15 days at different sampling times. This would aid in defining the daily and weekly variations of discharge and the water

quality parameters. Also, a shorter sampling frequency in the early irrigation season would assist in determining the certainty and accuracy of the early season loads.

The monitored drains in this study are the indicator drains used by the canal companies and regulatory agencies to determine if the proposed Nutrient Management Plan reductions are accomplished. Based on the '95 monitored results and the efficiency of existing water quality facilities, the proposed goals of reducing sediment and phosphorus by 27% and 10% can be achieved. The canal companies need to aggressively pursue implementing water quality facilities on the Pigeon Cove Drain, LS2/39A Drain, and 39 Drain. Site inspections have concluded that there is sufficient area near the confluence at these drains for typical water quality facilities to be constructed. Also, current water quality facilities need to be cleaned regularly to maintain their efficiency.

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Appendix A
Monitoring Station Descriptions

Elevation (ft), river mile, latitude, and longitude of irrigation return flow monitoring stations were all located from USGS 7.5 Quadrangle Maps. The stations were originally described in Brockway and Robison (1992). The sampling point of three stations, Southside Main Perrine Coulee, Southside West Perrine Coulee, and Northside S19/S Drain, have been relocated from the canyon floor to the canyon rim. These stations have new descriptions.

IR02N Northside A Drain STORET: 2060289

Elevation: 4030 River Mile: 627.6
Latitude: 42° 32' 06" Longitude: 114° 10' 35"
USGS Township/Range/Section: T10S R19E S24 DCA

The sampling location is on the canyon rim, approximately 40 yards upstream from the spill over. This station is reached by exiting on the Valley road interchange with I-84, east of the Travelers Oasis. Take Valley road south for approximately 2.6 miles to Mr. Cutler's farm, a white house with blue trim. Take the farm road until you cross the drain. Follow the drain on foot for approximately 300 yards to a large sediment pond which has been constructed since 1990-91. Sampling station was located downstream of this pond and flow was measured using current meter methods.

IR03S Southside A10 Drain STORET: 2060290

Elevation: 3830 River Mile: 619.5
Latitude: 42° 34' 15" Longitude: 114° 19' 08"
USGS Township/Range/Section: T10S R18E S11 BCC

The sampling location is on the canyon rim. Prior to the sampling location, the drain flows through approximately 0.5 miles of wetlands with cattails and large sediment ponds. Access is from a farm road 1/8 mile east of the intersection of 3700 east and 3900 north (Addison Ave). Take the farm road north along the edge of the field and walk to canyon's edge. The stream was sampled near the canyon edge. Flow was measured at a pond discharge structure using the head over the discharge pipe and the glory hole discharge equation.

IR04N Northside C55 Drain STORET: 2060291

Elevation: 3850 River Mile: 619.0
Latitude: 42° 34' 38" Longitude: 114° 19' 43"
USGS Township/Range/Section: T10S R18E S03 DDC

The sampling location is on the canyon rim, approximately a quarter of a mile from the spill over. The sampling location is immediately downstream of a farm pond. Access is from a farm road at the intersection of 1000 south and 1000 east. Flow was measured using current meter methods.

IR07S Southside Twin Falls Coulee STORET: 2060294

Elevation: 3750 River Mile: 618.0
Latitude: 42° 35' 22" Longitude: 114° 21' 01"
USGS Township/Range/Section: T10S R18E S04 DAC

The sampling location is on the canyon rim near the spill over. This station is reached overland by foot for 0.75 miles from the intersection of Falls Avenue East road and 3600 east. Prior to the sampling site, the return flow stream travels approximately a half of a mile through grazed pasture. Flow was measured using current meter methods.

IR11S Southside East Perrine Coulee STORET: 2060301

Elevation: 3640 River Mile: 612.9
Latitude: 42° 35' 31" Longitude: 114° 25' 41"
USGS Township/Range/Section: T09S R17E S35 DCD

The sampling location is on the canyon rim, 100 ft above the hydro power plant penstock inlet. This station is reached from Pole Line Road East. The flow was measured using current metering methods off a wooden beam placed across the stream.

IR12ST Southside Main Perrine Coulee on Canyon Rim STORET: 2060302

Elevation: 3610 River Mile: 610.9
Latitude: 42° 36' 05" Longitude: 114° 27' 56"
USGS Township/Range/Section: T09S R17E S33 CAD

The sampling location is on the canyon rim near Pole Line Road West. The Twin Falls Canal Company constructed a sharp crested weir approximately 150 ft upstream from the canyon rim in the spring of 1995. The stream was sampled downstream of the weir and flow was estimated using a weir equation. Access is from a farm road just east of the junction of the return flow stream and Pole Line Road West.

IR16ST Southside West Perrine Coulee on Canyon Rim STORET: 2060308

Elevation: 3580 River Mile: 609.2
Latitude: 42° 36' 30" Longitude: 114° 30' 07"
USGS Township/Range/Section: T09S R17E S30 DAD

The sampling location is on the canyon rim, upstream from the rim approximately a half of a mile. The Twin Falls Canal Company constructed a sharp crested weir in the spring of 1995. The stream was sampled downstream from the weir and flow was estimated using a weir equation. Two large sediment ponds have also recently been constructed upstream of the weir. Access is from a farm road at the intersection of 4200 north and 2800 east.

IR20S Southside 30 Drain STORET: 2060312

Elevation: 3500 River Mile: 605.3
Latitude: 42° 37' 55" Longitude: 114° 33' 33"
USGS Township/Range/Section: T09S R16E S22 ADB

The sampling location is on the canyon rim, approximately 100 ft from the spill over. Flow was measured using current meter methods. Access is from a gravel road at the intersection of 4300 north and 2450 east.

IR21S Southside Pigeon Cove Hydro Plant LQ/LS Drains STORET: 2060313

Elevation: 3000 River Mile: 603.6
Latitude: 42° 38' 25" Longitude: 114° 35' 23"
USGS Township/Range/Section: T09S R16E S16 CCA

The sampling location is near the mouth at the tailrace of the Pigeon Cove Hydro Plant. Flow was estimated from a rating curve relating discharge and power production records. Access is from the power plant road at the intersection of 4400 north and 2300 east.

IR22S Southside LS2/39A Drain STORET: 2060314

Elevation: 3010 River Mile: 602.2
Latitude: 42° 38' 52" Longitude: 114° 36' 53"
USGS Township/Range/Section: T09S R16E S18 ADA

The sampling location is on the canyon floor, approximately 75 yards from the confluence. This location is just downstream from a farm road culvert. Access is through Crystal Springs Ranch at the bottom of Crystal Springs grade. Flow was estimated using current meter methods.

IR23NT Northside N42 Drain on Canyon Rim STORET: 2060316

Elevation: 3420 River Mile: 601.4
Latitude: 42° 39' 12" Longitude: 114° 37' 47"
USGS Township/Range/Section: T09S R16E S07 DAD

The sampling location is on the canyon rim, approximately 100 yards from the spill over. The sampling location is just downstream from a large sediment pond. The flow was estimated using a weir equation at the outlet check structure of the pond. Access is from a farm road, approximately 1/4 mile west from the intersection of 400 south and 500 west.

IR24S Southside 39 Drain STORET: 2060317

Elevation: 2990 River Mile: 600.9
Latitude: 42° 39' 16" Longitude: 114° 38' 14"
USGS Township/Range/Section: T09S R15E S12 DDB

The sampling location is on the canyon floor, approximately 100 yards from the confluence. This location is adjacent to the old Crystal Springs Ranch homestead. Access is similar to IR22S, through Crystal Springs Ranch at the bottom of Crystal Springs grade. Flow was estimated using current meter methods.

IR29S Southside I Drain STORET: 2060322

Elevation: 3000 River Mile: 598.0
Latitude: 42° 39' 42" Longitude: 114° 41' 25"
USGS Township/Range/Section: T09S R15E S10 BCA

The sampling location is on the canyon floor, approximately 20 yards from the confluence and just downstream from a culvert crossing River Road. Access is from River Road between Crystal Springs grade and Clear Lakes grade. Flow was measured using current meter methods.

IR30N Northside J8 Drain STORET: 2060323

Elevation: 3295 River Mile: 595.1
Latitude: 42° 40' 38" Longitude: 114° 44' 32"
USGS Township/Range/Section: T09S R15E S06 BDA

The sampling location is on the canyon rim, approximately 15 yards from the spill over. This return flow travels through a pond complex prior to reaching the sampling location. Access is south on a farm road from the intersection of 3600 south and 1800 east. Flow was estimated by applying a weir equation at the pond bypass check structure and using flow depth measurements in the trapezoidal flume at the pond inlet.

IR39NP Northside S19/S Drain STORET: 2060333

Elevation: 3180 River Mile: 588.8
Latitude: 42° 41' 57" Longitude: 114° 49' 08"
USGS Township/Range/Section: T08S R14E S28 DCB

Sampling location is on the canyon rim at the hydro power plant penstock inlet. This location is approximately 3/8 of a mile downstream from the S19/S Pond Complex. Access is from the Box Canyon road through private property. Flow was estimated from a sharp crested weir at the tailrace of the power plant.

IR42N Northside W26 Drain STORET: 2060338

Elevation: 3145 River Mile: 584.3
Latitude: 42° 45' 29" Longitude: 114° 50' 47"
USGS Township/Range/Section: T08S R14E S05 CBD

Sampling location is on the canyon floor downstream of a culvert crossing the county road, approximately 1/2 of mile from the confluence. Flow was measured using current meter methods.

Appendix B
Irrigation Return Flow Water Quality Monitoring Data

IR02N Northside Canal A Drain

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/18/95	915	na	na	0.0	na	na	na	na	na	na	na	na	na
5/2/95	1422	12.6	14.6	10.4	400	9.9	8.4	72	0.02	0.65	0.01<	0.17	0.03
5/16/95	1030	13.9	17.5	3.4	460	9.3	8.8	17	0.03	0.39	0.01	0.07	0.03
5/31/95	852	17.0	16.1	5.8	420	8.4	8.6	8	0.02	0.24	0.01<	0.06	0.03
6/13/95	1140	na	na	0.0	na	na	na	na	na	na	na	na	na
6/27/95	1210	21.7	22.8	13.0	380	8.3	8.8	8	0.04	0.2	0.01<	0.04	0.02
7/10/95	1600	23.6	25.5	1.7	340	8.5	9.0	8	0.01<	0.24	0.01<	0.04	0.01
7/25/95	1440	24.8	31.5	6.0	350	9.4	8.9	11	0.02	0.22	0.01	0.09	0.05
8/8/95	1315	19.5	21.5	na	340	9.6	8.9	13	0.01<	0.24	0.01<	0.09	0.06
8/22/95	1330	22.3	28.7	8.8	390	9.1	8.7	20	0.02	0.28	0.01	0.10	0.07
9/4/95	1300	20.4	20.9	16.3	390	7.5	8.5	11	0.03	0.26	0.08	0.10	0.06
9/19/95	1200	17.8	21.6	14.1	390	9.7	8.8	4	0.01<	0.21	0.04	0.09	0.06
10/3/95	1400	12.0	16.6	12.9	400	10.0	9.0	4	0.01	0.21	0.01<	0.08	0.05
10/17/95	1400	11.4	20.2	10.0	420	9.3	9.2	4	0.01	0.28	0.07	0.06	0.03
			Mean	7.9			Count	12	9.0	12.0	6.0	12	12
							Mean	15	0.022	0.285	0.037	0.083	0.042
							Std. Dev.	19	0.010	0.126	0.032	0.035	0.019
							Maximum	72	0.040	0.650	0.080	0.170	0.070
							Minimum	4	0.010	0.200	0.010	0.040	0.010

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR03S Southside A10 Drain

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/18/95	1545	na	na	0	na	na	na	na	na	na	na	na	na
5/2/95	1610	12.8	18.4	7.7	490	8.3	7.8	58	0.02	0.37	0.08	0.16	0.10
5/16/95	1235	13.7	21.2	2.3	460	8.9	9.4	4	0.01	0.29	0.03	0.09	0.06
5/31/95	1130	na	na	0.0	na	na	na	na	na	na	na	na	na
6/13/95	1210	19.1	30.0	5.3	410	7.6	7.9	4	0.01	0.16	0.06	0.08	0.07
6/27/95	1520	21.8	24.1	4.3	410	6.5	8.1	8	0.02	0.16	0.73	0.13	0.11
7/10/95	1420	22.6	30.4	4.3	380	6.0	7.9	19	0.01<	0.16	0.10	0.16	0.11
7/24/95	1435	22.4	30.8	7.0	380	6.5	8.1	16	0.02	0.21	0.21	0.16	0.11
8/7/95	1510	22.9	26.2	2.8	390	7.2	8.2	106	0.01	0.44	0.20	0.31	0.13
8/21/95	1545	21.4	27.5	4.5	340	7.0	8.0	24	0.03	0.42	0.09	0.15	0.09
9/4/95	1530	20.6	20.1	5.7	390	7.4	8.2	14	0.02	0.32	0.12	0.14	0.09
9/18/95	1725	19.4	27.5	6.3	390	7.3	8.0	12	0.01	0.40	0.12	0.14	0.09
10/2/95	1625	12.6	16.0	9.4	400	8.1	8.4	13	0.01	0.18	0.26	0.13	0.09
10/17/95	1545	11.1	18.8	6.4	440	9.0	7.9	5	0.01	0.28	0.22	0.09	0.08
			Mean	4.7			Count	12	11	12	12	12	12
							Mean	24	0.02	0.28	0.19	0.15	0.09
							Std. Dev.	30	0.01	0.11	0.19	0.06	0.02
							Maximum	106	0.03	0.44	0.73	0.31	0.13
							Minimum	4	0.01	0.16	0.03	0.08	0.06

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR04N Northside C55 Drain

Date	Time	Temperature Air (Degrees C)	Temperature Water (Degrees C)	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia (mg/L - N)	Nitrogen Organic (mg/L - N)	Nitrogen NO2+NO3 (mg/L - N)	Phosphorus Total (mg/L - P)	Phosphorus Ortho (mg/L - P)
4/18/95	1535	na	na	0	na	na	na	na	na	na	na	na	na
5/2/95	1516	12.1	15.3	8.0	450	9.6	8.3	71	0.02	0.51	0.04	0.16	0.03
5/16/95	1147	na	na	0.0	na	na	na	na	na	na	na	na	na
5/31/95	958	17.0	19.4	10.4	420	8.7	8.7	30	0.01	0.28	0.01<	0.08	0.02
6/13/95	1110	na	na	0.0	na	na	na	na	na	na	na	na	na
6/27/95	1500	na	na	0.0	na	na	na	na	na	na	na	na	na
7/11/95	1345	22.8	27.0	0.2	390	9.6	8.8	4	0.02	0.3	0.01<	0.09	0.06
7/25/95	1625	24.5	31.4	9.7	390	8.4	8.8	25	0.04	0.28	0.17	0.12	0.06
8/8/95	1430	19.8	23.0	9.2	330	9.1	8.9	42	0.05	0.46	0.06	0.13	0.05
8/21/95	1430	22.4	30.6	6.1	350	8.8	8.7	27	0.02	0.34	0.02	0.12	0.06
9/4/95	1445	21.1	19.8	7.4	400	7.8	8.6	10	0.05	0.31	0.09	0.09	0.06
9/18/95	1625	20.5	28.7	7.0	380	9.7	8.7	6	0.01	0.18	0.12	0.09	0.06
10/2/95	1500	12.3	19.0	6.0	410	10.2	8.8	4	0.02	0.19	0.27	0.10	0.07
10/16/95	1555	12.2	18.8	11.3	410	9.4	8.7	4	0.02	0.28	0.26	0.09	0.06
			Mean	5.8			Count	10	10	10	8	10	10
							Mean	22	0.026	0.313	0.129	0.107	0.053
							Std. Dev.	22	0.02	0.10	0.10	0.02	0.02
							Maximum	71	0.05	0.51	0.27	0.16	0.07
							Minimum	4	0.01	0.18	0.02	0.08	0.02

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR07S Twin Falls Coulee

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/18/95	1625	10.0	12.9	1.8	460	10.6	8.7	182	0.02	1.77	0.01<	0.32	0.04
5/2/95	1645	17.1	18.8	3.7	500	8.4	8.0	32	0.03	0.57	0.01<	0.21	0.11
5/16/95	1603	19.8	29.7	5.0	460	8.6	8.9	26	0.01	0.44	0.01<	0.12	0.04
5/31/95	1200	20.3	28.3	3.2	410	8.6	8.6	32	0.02	0.27	0.01	0.13	0.05
6/13/95	1530	22.3	29.4	3.4	420	8.3	8.4	12	0.01<	0.38	0.01	0.16	0.07
6/27/95	1610	na	na	0	na	na	na	na	na	na	na	na	na
7/10/95	1720	22.3	24.5	2.9	430	8.9	8.5	19	0.01	0.44	0.01	0.16	0.10
7/24/95	1550	25.2	29.7	3.6	380	7.1	8.5	93	0.03	0.51	0.14	0.25	0.11
8/8/95	1530	na	na	0	na	na	na	na	na	na	na	na	na
8/22/95	1540	24.2	27.7	2.1	420	7.1	8.1	14	0.02	0.48	0.02	0.21	0.14
9/5/95	1550	23.1	23.1	6.8	410	7.3	8.3	104	0.02	0.61	0.08	0.30	0.15
9/19/95	1415	19.4	22.7	0.6	410	9.8	8.6	7	0.01<	0.25	0.01<	0.14	0.09
10/3/95	1600	11.3	9.7	1.0	410	9.2	8.4	8	0.02	0.32	0.13	0.15	0.11
10/17/95	1640	12.9	20.1	6.7	450	9.5	8.3	60	0.01<	0.40	0.16	0.16	0.08
			Mean	2.9			Count	12	9	12	8	12	12
							Mean	49	0.02	0.54	0.07	0.19	0.09
							Std. Dev.	53	0.01	0.40	0.07	0.07	0.04
							Maximum	182	0.03	1.77	0.16	0.32	0.15
							Minimum	7	0.01	0.25	0.01	0.12	0.04

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR11S Southside East Perrine Coulee

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/18/95	832	10.0	8.2	7.7	950	10.4	8.2	4	0.04	0.17	4.47	0.04	0.03
5/1/95	1606	10.9	9.8	40.4	570	9.5	8.6	324	0.08	1.14	0.94	0.51	0.08
5/16/95	1319	15.2	21.5	27.4	630	10.2	8.8	44	0.02	0.48	1.22	0.15	0.07
5/30/95	1500	20.0	28.1	35.4	630	9.3	8.7	42	0.04	0.28	1.27	0.10	0.04
6/12/95	1700	22.4	32.4	31.2	550	8.5	8.8	26	0.04	0.43	1.09	0.10	0.05
6/26/95	1640	23.2	33.7	17.3	560	9.7	8.6	30	0.05	0.34	1.51	0.12	0.06
7/5/95	1110	16.8	25.1	23.3	590	9.3	8.6	60	0.03	0.50	1.44	0.20	0.08
7/18/95	1430	31.2	19.9	24.1	590	8.8	8.2	95	0.06	0.60	1.71	0.26	0.10
8/1/95	1405	19.7	30.4	25.8	590	9.5	8.2	107	0.07	0.57	2.28	0.26	0.10
8/15/95	1535	20.6	30.9	37.0	640	9.6	8.2	176	0.08	0.65	2.31	0.32	0.09
8/29/95	1525	19.4	24.4	34.5	710	9.0	8.2	86	0.04	0.47	2.45	0.20	0.08
9/12/95	1020	15.0	18.1	48.8	620	8.9	8.1	56	0.04	0.32	1.91	0.17	0.08
9/26/95	1415	15.3	19.8	40.3	680	10.0	8.3	31	0.05	0.26	2.47	0.12	0.08
10/10/95	1317	13.5	na	41.2	780	10.6	8.4	26	0.03	0.36	2.70	0.10	0.05
10/24/95	1400	11.5	14.5	39.0	740	11.2	8.3	34	0.04	0.52	2.68	0.08	0.04
			Mean	31.6			Count	15	15	15	15	15	15
							Mean	76	0.05	0.47	2.03	0.18	0.07
							Std. Dev.	81	0.02	0.23	0.90	0.12	0.02
							Maximum	324	0.08	1.14	4.47	0.51	0.10
							Minimum	4	0.02	0.17	0.94	0.04	0.03

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR12ST Main Perrine Coulee at Poleline Road nr Twin Falls

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/18/95	1000	9.2	7.4	22.6	440	10.4	8.9	230	0.02	1.91	0.01	0.45	0.01
5/1/95	1715	12.3	11.3	40.8	430	8.9	8.8	273	0.09	1.20	0.16	0.48	0.07
5/16/95	1500	19.4	24.3	5.1	460	12.5	9.4	15	0.01	0.30	0.01	0.07	0.02
5/30/95	1240	17.6	25.1	21.1	440	9.9	8.9	52	0.01	0.33	0.01<	0.11	0.02
6/12/95	1610	23.2	29.8	11.4	410	9.8	8.8	57	0.04	0.56	0.19	0.16	0.07
6/26/95	1545	28.0	33.5	1.8	380	11.6	9.4	15	0.02	0.26	0.03	0.09	0.04
7/5/95	1020	18.1	22.2	18.6	370	9.4	8.7	73	0.01	0.60	0.09	0.17	0.05
7/18/95	1325	21.9	29.1	14.1	380	10.1	8.6	46	0.02	0.45	0.2	0.19	0.09
8/1/95	1330	23.7	27.2	4.4	370	9.8	9.0	25	0.02	0.28	0.29	0.14	0.08
8/15/95	1330	22.4	30.1	7.2	400	10.0	8.9	36	0.03	0.38	0.16	0.15	0.06
8/29/95	1455	23.2	25.1	5.0	430	9.0	9.0	22	0.01	0.36	0.18	0.14	0.08
9/12/95	940	17.9	17.0	8.0	430	8.2	8.4	64	0.02	0.32	0.27	0.17	0.06
9/26/95	1300	17.4	20.1	6.7	430	9.5	8.8	22	0.01	0.30	0.43	0.11	0.06
10/10/95	1420	20.6	na	8.0	500	9.3	7.1	12	0.01<	0.28	0.37	0.10	0.06
10/24/95	1520	12.6	16.0	9.0	450	10.4	8.9	75	0.01<	0.82	0.13	0.17	0.02
			Mean	12.3			Count	15	13	15	14	15	15
							Mean	68	0.02	0.56	0.18	0.18	0.05
							Std. Dev.	78	0.02	0.45	0.13	0.12	0.03
							Maximum	273	0.09	1.91	0.43	0.48	0.09
							Minimum	12	0.01	0.26	0.01	0.07	0.01

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR16ST West Perrine Coulee on Canyon Rim nr Twin Falls

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/18/95	1100	na	na	0	na	na	na	na	na	na	na	na	na
5/1/95	1756	12.2	11.4	6.0	450	10.0	9.0	141	0.07	1.16	0.11	0.39	0.09
5/15/95	1743	15.9	19.4	3.9	460	8.9	8.8	20	0.01	0.56	0.01<	0.14	0.06
5/30/95	1210	18.1	25.4	6.6	450	9.7	8.6	57	0.02	0.46	0.01<	0.13	0.04
6/12/95	1300	20.6	28.0	6.0	420	10.1	8.8	11	0.02	0.26	0.07	0.09	0.05
6/26/95	1200	20.9	30.3	7.1	370	8.6	8.5	10	0.03	0.24	0.01<	0.07	0.04
7/5/95	945	17.5	18.5	5.1	400	6.4	8.3	12	0.06	0.41	0.04	0.17	0.12
7/18/95	1230	20.2	27.6	4.0	380	7.8	8.2	22	0.07	0.45	0.16	0.17	0.09
8/1/95	1240	19.2	28.7	2.8	390	7.1	8.2	19	0.08	0.41	0.23	0.20	0.14
8/15/95	1215	19.4	29.1	2.8	370	8.6	7.9	55	0.04	0.40	0.12	0.20	0.08
8/29/95	1400	20.3	25.2	5.3	410	8.7	8.5	26	0.02	0.46	0.13	0.16	0.09
9/12/95	1540	20.1	27.9	6.7	420	8.9	8.6	19	0.02	0.36	0.18	0.15	0.09
9/26/95	1145	14.1	17.0	5.0	420	8.5	8.5	15	0.02	0.33	0.24	0.11	0.06
10/10/95	1205	10.1	na	2.0	440	9.9	8.5	22	0.01	0.38	0.23	0.11	0.05
10/24/95	1225	7.0	13.7	3.9	430	11.9	8.8	44	0.01<	0.86	0.03	0.17	0.02
			Mean	4.5			Count	14	13	14	11	14	14
							Mean	34	0.04	0.48	0.14	0.16	0.07
							Std. Dev.	34	0.03	0.25	0.08	0.08	0.03
							Maximum	141	0.08	1.16	0.24	0.39	0.14
							Minimum	10	0.01	0.24	0.03	0.07	0.02

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR20S Southside 30 Drain

Date	Time	Temperature Air (Degrees C)	Temperature Water (Degrees C)	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia (mg/L - N)	Nitrogen Organic (mg/L - N)	Nitrogen NO2+NO3 (mg/L - N)	Phosphorus Total (mg/L - P)	Phosphorus Ortho (mg/L - P)
4/25/95	954	9.3	13.2	7.1	460	10.2	7.8	193	0.02	0.94	0.01<	0.34	0.01
5/9/95	1301	15.9	20.7	6.0	480	8.8	8.7	151	0.01	0.60	0.05	0.26	0.05
5/23/95	1106	14.7	18.9	3.2	420	8.9	8.6	102	0.01<	0.38	0.01<	0.20	0.06
6/6/95	1600	14.7	14.8	2.7	430	8.9	8.3	145	0.02	0.37	0.10	0.19	0.04
6/20/95	1250	na	na	0.0	na	na	na	na	na	na	na	na	na
7/4/95	1520	22.4	27.2	4.8	310	7.5	8.8	160	0.02	0.78	0.03	0.24	0.05
7/18/95	1130	20.6	23.8	4.7	380	8.5	8.5	248	0.01	0.60	0.14	0.43	0.06
8/1/95	1135	19.4	26.0	2.9	380	8.6	8.5	318	0.02	0.60	0.17	0.47	0.09
8/15/95	1430	21.7	29.5	4.3	350	8.3	8.6	219	0.03	0.60	0.07	0.32	0.06
8/29/95	1305	19.8	25.8	5.2	390	8.5	8.5	184	0.01	0.74	0.05	0.27	0.09
9/12/95	1450	19.6	26.5	4.6	390	8.6	8.2	67	0.02	0.66	0.12	0.19	0.09
9/25/95	1550	16.3	22.0	1.4	400	9.0	8.6	58	0.01	0.40	0.23	0.18	0.08
10/9/95	1630	12.0	18.1	4.2	420	9.8	8.8	76	0.01<	0.38	0.18	0.17	0.05
10/23/95	1530	7.8	16.2	10.8	410	11.5	8.9	123	0.01<	1.21	0.05	0.21	0.02
			Mean	4.4			Count	13	10	13	11	13	13
							Mean	157	0.017	0.635	0.108	0.267	0.058
							Std. Dev.	76	0.007	0.244	0.065	0.097	0.026
							Maximum	318	0.030	1.210	0.230	0.470	0.090
							Minimum	58	0.010	0.370	0.030	0.170	0.010

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR21S Pigeon Cove Hydro Power -- LQ/LS Drains

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/25/95	1033	10.5	15.7	25.0	650	10.3	7.8	270	0.03	1.08	1.58	0.40	0.05
5/10/95	830	12.7	14.3	61.6	560	9.5	8.3	153	0.03	0.56	0.80	0.30	0.08
5/23/95	1020	13.7	17.0	40.5	540	9.4	8.3	197	0.01	0.40	1.10	0.30	0.07
6/6/95	1020	11.4	13.0	70.5	500	9.9	8.4	192	0.03	0.43	0.75	0.29	0.05
6/20/95	845	13.3	11.3	59.8	530	9.4	8.3	135	0.02	0.39	0.99	0.24	0.06
7/5/95	835	15.8	17.0	71.4	450	9.1	8.1	212	0.02	0.52	1.01	0.36	0.07
7/18/95	815	16.5	17.9	54.4	570	8.7	8.2	361	0.02	0.80	1.44	0.54	0.08
8/1/95	840	15.5	15.2	70.5	550	8.9	8.2	849	0.03	0.95	1.38	0.98	0.10
8/15/95	820	15.1	15.3	59.8	580	9.0	8.2	848	0.04	1.00	1.70	0.89	0.07
8/29/95	840	15.0	16.9	61.8	600	9.0	8.1	331	0.01<	0.70	1.76	0.48	0.08
9/12/95	830	13.8	11.4	62.5	610	9.2	8.1	282	0.01	0.60	1.84	0.41	0.08
9/26/95	830	12.7	12.1	70.5	620	9.5	8.1	164	0.01	0.38	2.23	0.27	0.06
10/10/95	935	9.6	8.7	60.7	690	10.2	8.3	110	0.01<	0.52	2.38	0.24	0.06
10/24/95	840	8.9	5.1	55.3	730	10.4	8.2	48	0.01<	0.43	2.66	0.13	0.04
			Mean	58.9			Count	14	11	14	14	14	14
							Mean	297	0.02	0.63	1.54	0.42	0.07
							Std. Dev.	249	0.01	0.24	0.59	0.24	0.02
							Maximum	849	0.04	1.08	2.66	0.98	0.10
							Minimum	48	0.01	0.38	0.75	0.13	0.04

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR22S Southside LS2/39A Drain

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/25/95	1138	12.1	16.7	10.1	720	9.2	8.4	196	0.03	0.94	1.90	0.33	0.03
5/9/95	933	11.2	14.9	13.9	650	9.9	8.6	162	0.03	0.62	1.29	0.29	0.06
5/23/95	840	13.0	16.5	12.7	630	9.1	8.5	112	0.03	0.48	1.35	0.16	0.03
6/6/95	850	10.1	8.3	17.9	550	10.0	8.5	159	0.04	0.44	0.93	0.26	0.04
6/20/95	1000	13.3	15.4	10.6	590	9.3	8.5	43	0.04	0.34	0.84	0.11	0.04
7/5/95	1320	19.3	30.3	13.0	510	8.0	8.6	98	0.02	0.43	1.13	0.20	0.08
7/18/95	900	16.7	19.5	14.1	540	8.9	8.5	255	0.03	0.70	1.04	0.32	0.06
8/1/95	940	15.0	19.2	13.4	580	9.2	8.2	428	0.03	0.82	1.29	0.58	0.08
8/15/95	955	15.4	22.5	11.7	570	8.9	8.5	1080	0.05	1.66	1.47	0.97	0.09
8/29/95	1020	17.2	20.2	14.7	600	8.8	8.5	421	0.02	0.84	1.32	0.57	0.09
9/12/95	1300	16.1	21.2	11.3	620	9.6	8.5	95	0.02	0.34	1.56	0.21	0.08
9/26/95	920	11.6	14.3	16.5	580	9.7	8.5	74	0.01	0.33	1.69	0.16	0.06
10/10/95	1135	9.6	16.0	10.6	680	10.5	8.6	40	0.01<	0.42	2.12	0.12	0.05
10/24/95	955	6.1	7.1	7.8	700	11.5	8.6	40	0.01<	0.42	2.53	0.14	0.04
			Mean	12.7			Count	14	12	14	14	14	14
							Mean	229	0.03	0.63	1.46	0.32	0.06
							Std. Dev.	276	0.01	0.36	0.47	0.24	0.02
							Maximum	1080	0.05	1.66	2.53	0.97	0.09
							Minimum	40	0.01	0.33	0.84	0.11	0.03

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR23NT Northside N42 Drain / On canyon rim

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/25/95	1800	na	na	0.0	na	na	na	na	na	na	na	na	na
5/8/95	1530	16.0	17.0	22.6	490	10.0	8.6	62	0.01	0.80	0.03	0.24	0.06
5/22/95	1240	17.0	18.4	14.8	440	8.6	8.5	33	0.01	0.45	0.01	0.15	0.06
6/5/95	920	17.8	18.3	24.1	440	8.0	8.1	36	0.07	0.43	0.02	0.12	0.06
6/19/95	1000	16.6	13.5	28.5	370	8.8	8.6	35	0.01	0.37	0.01<	0.12	0.04
7/4/95	840	17.2	16.4	19.6	380	8.2	8.2	36	0.02	0.46	0.02	0.12	0.05
7/17/95	845	20.4	21.1	18.4	400	7.2	8.2	22	0.06	0.37	0.06	0.12	0.06
7/31/95	910	17.4	15.3	19.1	370	7.8	8.3	31	0.05	0.42	0.15	0.19	0.11
8/14/95	920	17.1	15.3	17.6	330	7.9	7.5	27	0.04	0.52	0.01<	0.14	0.07
8/28/95	1545	23.3	28.5	13.7	390	9.5	8.7	16	0.010<	0.46	0.02	0.14	0.07
9/11/95	930	16.2	16.5	17.6	410	8.2	8.2	16	0.04	0.40	0.06	0.13	0.08
9/25/95	920	11.8	10.6	16.9	380	9.0	8.6	8	0.02	0.26	0.04	0.09	0.06
10/9/95	1000	10.0	14.2	14.1	400	10.4	8.8	10	0.010<	0.48	0.01<	0.09	0.02
10/23/95	940	3.8	0.9	3.8	410	11.2	8.9	7	0.02	0.50	0.01<	0.08	0.02
			Mean	16.5			Count	13	11	13	9	13	13
							Mean	26	0.032	0.455	0.046	0.133	0.058
							Std. Dev.	15	0.021	0.124	0.043	0.043	0.024
							Maximum	62	0.070	0.800	0.150	0.240	0.110
							Minimum	7	0.010	0.260	0.010	0.080	0.020

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR24S Southside 39 Drain

Date	Time	Temperature Air Degrees C	Temperature Water Degrees C	Discharge cfs	Electrical Conductivity mohms	pH	Dissolved Oxygen mg/L	TSS mg/L	Nitrogen Ammonia mg/L - N	Nitrogen Organic mg/L - N	Nitrogen NO2+NO3 mg/L - N	Phosphorus Total mg/L - P	Phosphorus Ortho mg/L - P
4/25/95	1223	12.1	17.0	4.3	570	9.1	8.3	4803	0.06	6.00	1.50	4.50	0.06
5/9/95	1010	12.0	16.6	7.6	520	9.8	8.6	507	0.03	0.91	0.63	0.66	0.06
5/23/95	930	13.1	16.4	11.8	470	9.2	8.6	1260	0.02	1.23	0.51	1.30	0.08
6/6/95	1145	11.5	13.1	15.6	470	9.8	8.4	425	0.03	0.55	0.67	0.45	0.05
6/20/95	1115	14.9	17.5	9.8	480	9.0	8.6	214	0.02	0.57	0.90	0.29	0.04
7/5/95	1410	22.0	31.9	5.3	450	8.7	8.7	216	0.09	0.86	1.36	0.35	0.07
7/18/95	1010	18.5	21.3	10.5	480	8.6	8.6	459	0.03	1.04	1.27	0.77	0.16
8/1/95	1030	17.2	19.2	5.5	490	8.9	8.6	710	0.05	0.91	1.52	0.78	0.11
8/15/95	1050	17.0	23.8	8.6	470	8.6	8.6	1230	0.07	1.90	1.48	1.35	0.08
8/29/95	1200	17.4	25.2	5.6	560	8.6	8.6	434	0.01	1.30	2.20	0.56	0.08
9/12/95	1350	18.6	22.8	8.7	500	8.6	8.5	253	0.02	0.60	1.32	0.41	0.09
9/26/95	1025	13.0	15.7	8.1	530	9.7	8.6	104	0.010<	0.38	2.07	0.19	0.08
10/10/95	1030	13.1	9.2	9.5	620	10.4	8.6	45	0.010<	0.42	2.43	0.15	0.06
10/24/95	1050	7.3	8.5	8.5	570	10.9	8.6	50	0.010<	0.64	2.14	0.10	0.03
			Mean	8.5			Count	14	11	14	14	14	14
							Mean	765	0.039	1.236	1.429	0.847	0.075
							Std. Dev.	1224	0.025	1.431	0.615	1.120	0.032
							Maximum	4803	0.090	6.000	2.430	4.500	0.160
							Minimum	45	0.010	0.380	0.510	0.100	0.030

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR29S Southside I Coulee

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/25/95	1513	14.5	19.3	6.5	750	8.5	7.8	28	0.02	0.48	2.19	0.17	0.09
5/9/95	1058	13.1	17.3	12.3	680	9.7	8.6	76	0.03	0.85	1.73	0.26	0.12
5/23/95	1210	14.3	19.9	11.4	630	9.0	8.7	84	0.02	0.50	1.43	0.21	0.10
6/6/95	1315	12.4	17.0	15.5	620	9.5	8.4	233	0.04	0.47	1.56	0.37	0.06
6/19/95	1430	16.0	18.1	7.9	620	8.9	8.7	120	0.02	0.58	1.68	0.24	0.07
7/4/95	1315	18.1	25.7	8.2	610	8.8	8.8	140	0.02	0.44	1.91	0.26	0.08
7/17/95	1415	20.8	28.4	11.5	610	9.4	8.7	130	0.02	0.53	2.03	0.28	0.09
7/31/95	1415	19.3	25.1	10.4	610	9.1	8.6	219	0.03	0.94	2.06	0.39	0.10
8/14/95	1400	17.7	21.0	8.4	560	8.9	8.6	216	0.03	0.84	2.48	0.38	0.09
8/28/95	1030	16.1	17.8	11.3	720	9.2	8.5	128	0.01	0.53	2.48	0.28	0.10
9/11/95	1400	17.2	24.5	8.0	740	8.8	8.6	125	0.02	0.54	2.74	0.25	0.07
9/25/95	1430	14.5	20.6	16.5	700	8.9	8.6	92	0.01	0.38	2.84	0.21	0.08
10/9/95	1445	13.1	17.3	16.3	760	9.4	8.6	56	0.01<	0.30	3.07	0.16	0.06
10/23/95	1410	11.0	14.8	15.9	750	10.2	8.6	87	0.01<	0.52	3.50	0.19	0.05
			Mean	11.4			Count	14	12	14	14	14	14
							Mean	124	0.02	0.56	2.26	0.26	0.08
							Std. Dev.	62	0.01	0.18	0.61	0.07	0.02
							Maximum	233	0.04	0.94	3.50	0.39	0.12
							Minimum	28	0.01	0.30	1.43	0.16	0.05

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR30N Northside J8 Drain

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/24/95	1720	17.0	23.7	9.0	500	9.2	8.7	120	0.03	1.31	0.01	0.61	0.16
5/8/95	1426	15.1	22.2	26.7	520	9.8	8.5	108	1.12	2.48	0.06	0.70	0.46
5/22/95	1157	17.7	17.6	10.7	450	8.7	8.7	26	0.02	0.32	0.02	0.13	0.07
6/5/95	1020	18.7	22.4	18.8	430	8.5	8.7	16	0.03	0.24	0.01<	0.12	0.09
6/19/95	910	16.5	14.3	19.4	400	8.9	8.7	23	0.02	0.36	0.02	0.17	0.11
7/4/95	920	17.2	19.3	6.7	380	8.2	8.8	4	0.02	0.31	0.04	0.16	0.13
7/17/95	930	20.6	23.4	13.2	400	8.8	8.5	6	0.04	0.38	0.09	0.19	0.14
7/31/95	955	17.7	18.4	12.5	370	8.7	8.5	9	0.02	0.27	0.09	0.14	0.10
8/14/95	1000	17.3	16.3	22.0	310	9.2	8.5	16	0.02	0.42	0.01<	0.12	0.08
8/28/95	1445	22.2	27.2	12.9	380	10.9	8.9	5	0.01<	0.31	0.01<	0.15	0.12
9/11/95	1015	16.6	17.0	22.2	400	9.0	8.5	8	0.02	0.29	0.06	0.17	0.13
9/25/95	1010	11.6	11.9	17.3	380	9.6	8.7	3	0.01	0.26	0.02	0.12	0.10
10/9/95	1400	10.9	18.6	16.2	410	11.4	9.0	10	0.01<	0.37	0.01	0.17	0.11
10/23/95	1030	na	na	0.0	na	na	na	na	na	na	na	na	na
			Mean	14.8			Count	13	11	13	10	13	13
							Mean	27	0.12	0.56	0.04	0.23	0.14
							Std. Dev.	39	0.33	0.64	0.03	0.19	0.10
							Maximum	120	1.12	2.48	0.09	0.70	0.46
							Minimum	3	0.01	0.24	0.01	0.12	0.07

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR39NP S19/S Drain

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/24/95	1630	15.0	23.3	58.2	480	12.1	8.6	106	0.02	1.34	0.01<	0.52	0.23
5/8/95	1307	13.8	19.7	69.7	500	11.3	8.7	55	0.02	1.20	0.06	0.39	0.20
5/22/95	1115	17.2	18.5	68.4	450	8.3	8.5	44	0.16	0.60	0.03	0.26	0.18
6/5/95	1130	19.1	20.0	67.0	430	8.0	8.7	35	0.06	0.41	0.04	0.22	0.16
6/19/95	1100	16.7	12.9	56.3	410	8.5	7.9	22	0.03	0.37	0.08	0.24	0.18
7/4/95	1010	17.5	20.1	46.8	380	7.9	8.8	37	0.03	0.43	0.08	0.20	0.13
7/17/95	1020	21.4	23.6	35.2	400	6.4	8.1	38	0.07	0.57	0.08	0.21	0.12
7/31/95	1045	18.3	19.1	48.7	380	7.8	8.2	31	0.05	0.44	0.31	0.25	0.19
8/14/95	1050	18.1	19.5	38.5	310	7.9	8.6	17	0.04	0.46	0.03	0.15	0.12
8/28/95	1145	20.6	21.9	38.0	400	8.0	8.5	7	0.010<	0.34	0.01<	0.21	0.15
9/11/95	1100	17.3	17.4	29.2	400	7.9	8.6	8	0.03	0.31	0.18	0.20	0.17
9/25/95	1110	13.1	18.1	29.7	390	9.0	8.7	3	0.01	0.26	0.11	0.20	0.15
10/9/95	1040	10.5	16.2	32.4	420	10.3	8.8	10	0.010<	0.60	0.07	0.21	0.15
10/23/95	1115	5.4	7.2	49.9	420	12.2	8.7	26	0.01	0.94	0.16	0.32	0.20
			Mean	47.7			Count	14	12	14	12	14	14
							Mean	31	0.044	0.591	0.103	0.256	0.166
							Std. Dev.	26	0.041	0.334	0.080	0.096	0.032
							Maximum	106	0.160	1.340	0.310	0.520	0.230
							Minimum	3	0.010	0.260	0.030	0.150	0.120

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

IR42N Northside W26 Drain

Date	Time	Temperature Air	Temperature Water	Discharge	Electrical Conductivity	pH	Dissolved Oxygen	TSS	Nitrogen Ammonia	Nitrogen Organic	Nitrogen NO2+NO3	Phosphorus Total	Phosphorus Ortho
		Degrees C		cfs	mohms		mg/L	mg/L	mg/L - N			mg/L - P	
4/24/95	1450	15.4	26.3	20.1	470	9.8	8.4	84	0.02	1.28	0.01<	0.19	0.01
5/8/95	1030	12.7	16.3	38.0	490	10.3	8.6	74	0.01	0.66	0.02	0.16	0.03
5/22/95	1000	16.7	17.9	17.9	440	8.7	8.4	20	0.01	0.28	0.01<	0.05	0.01
6/5/95	1250	19.0	17.6	8.4	410	8.7	8.7	10	0.03	0.22	0.01	0.10	0.06
6/19/95	1140	16.8	14.5	25.8	370	8.9	8.5	23	0.01	0.36	0.01	0.09	0.03
7/4/95	1130	18.1	24.1	17.7	350	9.3	8.8	16	0.01	0.31	0.01<	0.06	0.02
7/17/95	1210	21.5	28.6	3.3	360	9.0	8.0	7	0.01<	0.31	0.01<	0.06	0.03
7/31/95	1250	19.2	24.6	13.6	340	9.5	8.9	10	0.02	0.28	0.02	0.08	0.05
8/14/95	1140	17.8	19.6	18.7	300	9.7	8.6	20	0.02	0.50	0.01<	0.09	0.05
8/28/95	1340	21.0	24.5	12.9	380	10.2	8.8	8	0.01<	0.32	0.03	0.10	0.06
9/11/95	1225	17.6	22.3	19.4	400	9.9	8.6	10	0.02	0.31	0.04	0.09	0.05
9/25/95	1300	13.5	20.9	16.5	380	8.9	8.8	7	0.01<	0.32	0.01<	0.08	0.04
10/9/95	1255	9.6	14.5	19.0	400	11.0	8.8	11	0.01<	0.48	0.01<	0.09	0.01
10/23/95	1300	5.4	12.2	12.0	400	12.4	8.7	10	0.01<	0.50	0.01<	0.07	0.01
			Mean	17.4			Count	14	9	14	6	14	14
							Mean	22	0.017	0.438	0.022	0.094	0.033
							Std. Dev.	25	0.007	0.270	0.012	0.038	0.019
							Maximum	84	0.030	1.280	0.040	0.190	0.060
							Minimum	7	0.010	0.220	0.010	0.050	0.010

A number with a less than sign (<) indicates that the value is below the minimum detection limit (MDL)

Appendix C
Irrigation Return Flow Sediment and Nutrient Loading Computations

IR02N Northside Canal A Drain

			Sediment			Ammonia			T.Kjeld. N			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc. tons	Conc. mg/L	Load lb/day	Acc. tons	Conc. mg/L	Load lb/day	Acc. tons	Conc. mg/L	Load lb/day	Acc. tons	Conc. mg/L	Load lb/day	Acc. tons	Conc. mg/L	Load lb/day	Acc. tons
4/18/95		0.0	0	0		0	0		0	0		0	0		0	0		0	0	
5/2/95	14	10.4	72	4039	14	0.02	1.1	0.00	0.65	36	0.13	*0.01*	0.3	0.00	0.17	9.5	0.03	0.03	1.7	0.01
5/16/95	14	3.4	17	312	29	0.03	0.6	0.01	0.39	7	0.28	0.01	0.2	0.00	0.07	1.3	0.07	0.03	0.6	0.01
5/31/95	15	5.8	8	250	31	0.02	0.6	0.01	0.24	8	0.34	*0.01*	0.2	0.00	0.06	1.9	0.08	0.03	0.9	0.02
6/13/95	13	0.0	0	0	32	0.00	0.0	0.02	0	0	0.36	0.00	0.0	0.00	0	0.0	0.09	0	0.0	0.02
6/27/95	14	13.0	8	561	34	0.04	2.8	0.03	0.20	14	0.41	*0.01*	0.4	0.01	0.04	2.8	0.10	0.02	1.4	0.03
7/10/95	13	1.7	8	73	36	*0.01*	0.0	0.04	0.24	2	0.46	*0.01*	0.0	0.01	0.04	0.4	0.11	0.01	0.1	0.03
7/25/95	15	6.0	11	356	38	0.02	0.6	0.04	0.22	7	0.50	0.01	0.3	0.01	0.09	2.9	0.12	0.05	1.6	0.04
8/8/95	14	0.0	13	0	39	*0.01*	0.0	0.04	0.24	0	0.52	*0.01*	0.0	0.01	0.09	0.0	0.13	0.06	0.0	0.04
8/22/95	14	8.8	20	949	42	0.02	0.9	0.04	0.28	13	0.57	0.01	0.5	0.01	0.10	4.7	0.15	0.07	3.3	0.06
9/4/95	13	16.3	11	967	49	0.03	2.6	0.06	0.26	23	0.69	0.08	7.0	0.04	0.10	8.8	0.19	0.06	5.3	0.08
9/19/95	15	14.1	4	304	53	*0.01*	0.4	0.07	0.21	16	0.83	0.04	3.0	0.07	0.09	6.8	0.25	0.06	4.6	0.12
10/3/95	14	12.9	4	278	56	0.01	0.7	0.07	0.21	15	0.94	*0.01*	0.3	0.09	0.08	5.6	0.29	0.05	3.5	0.15
10/17/95	14	10.0	4	216	57	0.01	0.5	0.07	0.28	15	1.04	0.07	3.8	0.10	0.06	3.2	0.33	0.03	1.6	0.17
Total					57			0.07			1.04			0.10			0.33			0.17

IR03S Southside A10 Drain

4/18/95		0	0	0		0	0.00		0	0.0		0	0.0		0	0.0		0	0.0	
5/2/95	14	7.7	58	2406	8	0.02	0.83	0.00	0.37	15.3	0.05	0.08	3.3	0.01	0.16	6.6	0.02	0.10	4.1	0.01
5/16/95	14	2.3	4	50	17	0.01	0.13	0.01	0.29	3.6	0.12	0.03	0.4	0.02	0.09	1.1	0.05	0.06	0.8	0.03
5/31/95	15	0.0	0	0	17	0.00	0.00	0.01	0	0.0	0.13	0	0.0	0.03	0	0.0	0.05	0	0.0	0.03
6/13/95	13	5.3	4	114	18	0.01	0.29	0.01	0.16	4.6	0.15	0.06	1.7	0.03	0.08	2.3	0.06	0.07	2.0	0.04
6/27/95	14	4.3	8	187	19	0.02	0.47	0.01	0.16	3.7	0.18	0.73	17.0	0.10	0.13	3.0	0.08	0.11	2.6	0.06
7/10/95	13	4.3	19	444	21	*0.01*	0.12	0.01	0.16	3.7	0.20	0.10	2.3	0.16	0.16	3.7	0.10	0.11	2.6	0.07
7/24/95	14	7.0	16	601	24	0.02	0.75	0.02	0.21	7.9	0.24	0.21	7.9	0.20	0.16	6.0	0.14	0.11	4.1	0.10
8/7/95	14	2.8	106	1584	32	0.01	0.15	0.02	0.44	6.6	0.29	0.20	3.0	0.23	0.31	4.6	0.17	0.13	1.9	0.12
8/21/95	14	4.5	24	585	40	0.03	0.73	0.02	0.42	10.2	0.35	0.09	2.2	0.25	0.15	3.7	0.20	0.09	2.2	0.13
9/4/95	14	5.7	14	430	43	0.02	0.61	0.03	0.32	9.8	0.42	0.12	3.7	0.27	0.14	4.3	0.23	0.09	2.8	0.15
9/18/95	14	6.3	12	409	46	0.01	0.34	0.03	0.40	13.6	0.50	0.12	4.1	0.30	0.14	4.8	0.26	0.09	3.1	0.17
10/2/95	14	9.4	13	662	50	0.01	0.51	0.03	0.18	9.2	0.58	0.26	13.2	0.36	0.13	6.6	0.30	0.09	4.6	0.20
10/17/95	15	6.4	5	173	53	0.01	0.35	0.04	0.28	9.7	0.65	0.22	7.6	0.44	0.09	3.1	0.34	0.08	2.8	0.22
Total					53			0.04			0.65			0.44			0.34			0.22

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR04N Northside C55 Drain

Date	Days	Flow (cfs)	Sediment Conc. mg/L	Sediment Load lb/day	Sediment Acc tons	Ammonia Conc. mg/L	Ammonia Load lb/day	Ammonia Acc tons	T. Kjeld. N Conc. mg/L	T. Kjeld. N Load lb/day	T. Kjeld. N Acc tons	Nitrite+Nitrate N Conc. mg/L	Nitrite+Nitrate N Load lb/day	Nitrite+Nitrate N Acc tons	Total Phosphorus Conc. mg/L	Total Phosphorus Load lb/day	Total Phosphorus Acc tons	Ortho Phosphate Conc. mg/L	Ortho Phosphate Load lb/day	Ortho Phosphate Acc tons
4/18/95		0	0	0		0	0		0	0		0	0		0	0		0	0	
5/2/95	14	8.0	71	3064	11	0.02	0.9	0.00	0.51	22.0	0.08	0.04	1.7	0.01	0.16	6.9	0.02	0.03	1.3	0.00
5/16/95	14	0.0	0	0	21	0	0.0	0.01	0	0.0	0.15	0.00	0.0	0.01	0	0.0	0.05	0	0.0	0.01
5/31/95	15	10.4	30	1683	28	0.01	0.6	0.01	0.28	15.7	0.21	*0.01*	0.3	0.01	0.08	4.5	0.07	0.02	1.1	0.01
6/13/95	13	0.0	0	0	33	0	0.0	0.01	0	0.0	0.26	0.00	0.0	0.01	0	0.0	0.08	0	0.0	0.02
6/27/95	14	0.0	0	0	33	0	0.0	0.01	0	0.0	0.26	0.00	0.0	0.01	0	0.0	0.08	0	0.0	0.02
7/11/95	14	0.2	4	4	33	0.02	0.0	0.01	0.30	0.3	0.27	*0.01*	0.0	0.01	0.09	0.1	0.08	0.06	0.1	0.02
7/25/95	14	9.7	25	1308	38	0.04	2.1	0.02	0.28	14.6	0.32	0.17	8.9	0.05	0.12	6.3	0.10	0.06	3.1	0.03
8/8/95	14	9.2	42	2084	50	0.05	2.5	0.03	0.46	22.8	0.45	0.06	3.0	0.09	0.13	6.5	0.15	0.05	2.5	0.05
8/21/95	13	6.1	27	888	59	0.02	0.7	0.04	0.34	11.2	0.56	0.02	0.7	0.10	0.12	3.9	0.18	0.06	2.0	0.06
9/4/95	14	7.4	10	399	64	0.05	2.0	0.05	0.31	12.4	0.64	0.09	3.6	0.11	0.09	3.6	0.21	0.06	2.4	0.08
9/18/95	14	7.0	6	227	66	0.01	0.4	0.06	0.18	6.8	0.71	0.12	4.5	0.14	0.09	3.4	0.23	0.06	2.3	0.09
10/2/95	14	6.0	4	129	67	0.02	0.6	0.06	0.19	6.1	0.75	0.27	8.7	0.19	0.10	3.2	0.25	0.07	2.3	0.11
10/16/95	14	11.3	4	244	69	0.02	1.2	0.07	0.28	17.1	0.84	0.26	15.8	0.27	0.09	5.5	0.29	0.06	3.7	0.13
Total					69			0.07			0.84			0.27			0.29			0.13

IR07S Twin Falls Coulee

4/18/95		1.8	182	1767		0.02	0.19		1.77	17.2		*0.01*	0.0		0.32	3.1		0.04	0.39	
5/2/95	14	3.7	32	639	8	0.03	0.60	0.00	0.57	11.4	0.10	*0.01*	0.1	0.00	0.21	4.2	0.03	0.11	2.20	0.01
5/16/95	14	5.0	26	701	13	0.01	0.27	0.01	0.44	11.9	0.18	*0.01*	0.1	0.00	0.12	3.2	0.05	0.04	1.08	0.02
5/31/95	15	3.2	32	552	18	0.02	0.35	0.01	0.27	4.7	0.24	0.01	0.2	0.00	0.13	2.2	0.07	0.05	0.86	0.03
6/13/95	13	3.4	12	220	20	*0.01*	0.09	0.01	0.38	7.0	0.28	0.01	0.2	0.00	0.16	2.9	0.09	0.07	1.28	0.03
6/27/95	14	0	0	0	21	0.00	0.00	0.01	0	0.0	0.31	0.00	0.0	0.00	0	0.0	0.10	0	0.00	0.04
7/10/95	13	2.9	19	297	22	0.01	0.16	0.01	0.44	6.9	0.33	0.01	0.2	0.00	0.16	2.5	0.11	0.10	1.56	0.04
7/24/95	14	3.6	93	1806	29	0.03	0.58	0.01	0.51	9.9	0.39	0.14	2.7	0.01	0.25	4.9	0.13	0.11	2.14	0.06
8/8/95	15	0	0	0	36	0.00	0.00	0.02	0	0.0	0.42	0.00	0.0	0.03	0	0.0	0.15	0	0.00	0.07
8/22/95	14	2.1	14	159	37	0.02	0.23	0.02	0.48	5.4	0.44	0.02	0.2	0.03	0.21	2.4	0.16	0.14	1.59	0.07
9/5/95	14	6.8	104	3814	51	0.02	0.73	0.02	0.61	22.4	0.54	0.08	2.9	0.04	0.30	11.0	0.21	0.15	5.50	0.10
9/19/95	14	0.6	7	23	64	*0.01*	0.02	0.02	0.25	0.8	0.62	*0.01*	0.0	0.05	0.14	0.5	0.25	0.09	0.29	0.12
10/3/95	14	1.0	8	43	64	0.02	0.11	0.02	0.32	1.7	0.63	0.13	0.7	0.05	0.15	0.8	0.25	0.11	0.59	0.12
10/17/95	14	6.7	60	2168	72	*0.01*	0.18	0.02	0.40	14.5	0.69	0.16	5.8	0.07	0.16	5.8	0.27	0.08	2.89	0.13
Total					72			0.02			0.69			0.07			0.27			0.13

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR11S Southside East Perrine Coulee

			Sediment			Ammonia			T. Kjeld. N			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons
4/18/95		7.7	4	166		0.04	1.7		0.17	7.1		4.47	185.6		0.04	1.7		0.03	1.2	
5/1/95	13	40.4	324	70602	230	0.08	17.4	0.06	1.14	248.4	0.8	0.94	204.8	1	0.51	111.1	0.4	0.08	17.4	0.1
5/16/95	15	27.4	44	6503	519	0.02	3.0	0.14	0.48	70.9	2.0	1.22	180.3	3	0.15	22.2	0.9	0.07	10.3	0.2
5/30/95	14	35.4	42	8019	570	0.04	7.6	0.18	0.28	53.5	2.5	1.27	242.5	4	0.10	19.1	1.0	0.04	7.6	0.2
6/12/95	13	31.2	26	4375	610	0.04	6.7	0.22	0.43	72.4	2.9	1.09	183.4	6	0.10	16.8	1.1	0.05	8.4	0.3
6/26/95	14	17.3	30	2799	635	0.05	4.7	0.26	0.34	31.7	3.2	1.51	140.9	7	0.12	11.2	1.2	0.06	5.6	0.3
7/5/95	9	23.3	60	7540	659	0.03	3.8	0.28	0.50	62.8	3.4	1.44	181.0	7	0.20	25.1	1.3	0.08	10.1	0.4
7/18/95	13	24.1	95	12349	723	0.06	7.8	0.32	0.60	78.0	3.9	1.71	222.3	9	0.26	33.8	1.5	0.10	13.0	0.4
8/1/95	14	25.8	107	14890	819	0.07	9.7	0.38	0.57	79.3	4.5	2.28	317.3	11	0.26	36.2	1.7	0.10	13.9	0.5
8/15/95	14	37.0	176	35124	994	0.08	16.0	0.47	0.65	129.7	5.2	2.31	461.0	13	0.32	63.9	2.1	0.09	18.0	0.6
8/29/95	14	34.5	86	16003	1173	0.04	7.4	0.55	0.47	87.5	5.9	2.45	455.9	17	0.20	37.2	2.4	0.08	14.9	0.8
9/12/95	14	48.8	56	14740	1280	0.04	10.5	0.61	0.32	84.2	6.6	1.91	502.7	20	0.17	44.7	2.7	0.08	21.1	0.9
9/26/95	14	40.3	31	6738	1355	0.05	10.9	0.69	0.26	56.5	7.0	2.47	536.9	24	0.12	26.1	3.0	0.08	17.4	1.0
10/10/95	14	41.2	26	5778	1399	0.03	6.7	0.75	0.36	80.0	7.5	2.70	600.0	28	0.10	22.2	3.2	0.05	11.1	1.1
10/24/95	14	39.0	34	7152	1444	0.04	8.4	0.80	0.52	109.4	8.2	2.68	563.8	32	0.08	16.8	3.3	0.04	8.4	1.2
Total					1444			0.80			8.2			32			3.3			1.2

IR12ST Main Perrine Coulee at Poleline Road nr Twin Falls

4/18/95		22.6	230	28037		0.02	2.4		1.91	232.8		0.01	1.2		0.45	54.9		0.01	1.22	
5/1/95	13	40.8	273	60077	286	0.09	19.8	0.07	1.20	264.1	1.6	0.16	35.2	0.12	0.48	105.6	0.52	0.07	15.40	0.05
5/16/95	15	5.1	15	413	513	0.01	0.3	0.15	0.30	8.3	2.6	0.01	0.3	0.25	0.07	1.9	0.92	0.02	0.55	0.11
5/30/95	14	21.1	52	5918	535	0.01	1.1	0.15	0.33	37.6	2.8	*0.01*	0.6	0.25	0.11	12.5	0.98	0.02	2.28	0.12
6/12/95	13	11.4	57	3505	566	0.04	2.5	0.16	0.56	34.4	3.0	0.19	11.7	0.29	0.16	9.8	1.05	0.07	4.30	0.15
6/26/95	14	1.8	15	146	579	0.02	0.2	0.17	0.26	2.5	3.2	0.03	0.3	0.34	0.09	0.9	1.09	0.04	0.39	0.16
7/5/95	9	18.6	73	7324	596	0.01	1.0	0.18	0.60	60.2	3.3	0.09	9.0	0.36	0.17	17.1	1.13	0.05	5.02	0.17
7/18/95	13	14.1	46	3498	631	0.02	1.5	0.18	0.45	34.2	3.6	0.20	15.2	0.44	0.19	14.4	1.23	0.09	6.84	0.21
8/1/95	14	4.4	25	593	645	0.02	0.5	0.19	0.28	6.6	3.8	0.29	6.9	0.51	0.14	3.3	1.29	0.08	1.90	0.24
8/15/95	14	7.2	36	1398	652	0.03	1.2	0.20	0.38	14.8	3.8	0.16	6.2	0.56	0.15	5.8	1.32	0.06	2.33	0.26
8/29/95	14	5.0	22	593	659	0.01	0.3	0.20	0.36	9.7	3.9	0.18	4.9	0.60	0.14	3.8	1.36	0.08	2.16	0.27
9/12/95	14	8.0	64	2762	671	0.02	0.9	0.21	0.32	13.8	4.0	0.27	11.7	0.66	0.17	7.3	1.40	0.06	2.59	0.29
9/26/95	14	6.7	22	795	683	0.01	0.4	0.21	0.30	10.8	4.1	0.43	15.5	0.75	0.11	4.0	1.43	0.06	2.17	0.31
10/10/95	14	8.0	12	518	688	*0.01*	0.2	0.21	0.28	12.1	4.2	0.37	16.0	0.86	0.10	4.3	1.46	0.06	2.59	0.32
10/24/95	14	9.0	75	3641	702	*0.01*	0.2	0.21	0.82	39.8	4.3	0.13	6.3	0.94	0.17	8.3	1.51	0.02	0.97	0.34
Total					702			0.21			4.3			0.94			1.51			0.34

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR16ST West Perrine Coulee on Canyon Rim nr Twin Falls

			Sediment			Ammonia			T. Kjeld. N			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons
4/18/95		0	0	0		0	0		0	0		0	0.0		0	0.0		0	0.0	
5/1/95	13	6.0	141	4563	15	0.07	2.3	0.01	1.16	37.5	0.12	0.11	3.6	0.01	0.39	12.6	0.04	0.09	2.9	0.01
5/15/95	14	3.9	20	421	32	0.01	0.2	0.02	0.56	11.8	0.29	*0.01*	0.1	0.02	0.14	2.9	0.10	0.06	1.3	0.02
5/30/95	15	6.6	57	2029	41	0.02	0.7	0.02	0.46	16.4	0.40	*0.01*	0.2	0.03	0.13	4.6	0.12	0.04	1.4	0.03
6/12/95	13	6.0	11	356	49	0.02	0.6	0.02	0.26	8.4	0.48	0.07	2.3	0.03	0.09	2.9	0.15	0.05	1.6	0.04
6/26/95	14	7.1	10	383	52	0.03	1.1	0.03	0.24	9.2	0.54	*0.01*	0.2	0.04	0.07	2.7	0.17	0.04	1.5	0.06
7/5/95	9	5.1	12	330	53	0.06	1.7	0.04	0.41	11.3	0.59	0.04	1.1	0.04	0.17	4.7	0.18	0.12	3.3	0.07
7/18/95	13	4.0	22	475	56	0.07	1.5	0.05	0.45	9.7	0.66	0.16	3.5	0.06	0.17	3.7	0.21	0.09	1.9	0.08
8/1/95	14	2.8	19	287	59	0.08	1.2	0.06	0.41	6.2	0.71	0.23	3.5	0.08	0.20	3.0	0.24	0.14	2.1	0.10
8/15/95	14	2.8	55	831	63	0.04	0.6	0.06	0.40	6.0	0.76	0.12	1.8	0.10	0.20	3.0	0.26	0.08	1.2	0.11
8/29/95	14	5.3	26	743	68	0.02	0.6	0.07	0.46	13.1	0.82	0.13	3.7	0.12	0.16	4.6	0.28	0.09	2.6	0.12
9/12/95	14	6.7	19	687	73	0.02	0.7	0.07	0.36	13.0	0.91	0.18	6.5	0.16	0.15	5.4	0.32	0.09	3.3	0.14
9/26/95	14	5.0	15	405	77	0.02	0.5	0.08	0.33	8.9	0.99	0.24	6.5	0.20	0.11	3.0	0.35	0.06	1.6	0.16
10/10/95	14	2.0	22	237	79	0.01	0.1	0.08	0.38	4.1	1.04	0.23	2.5	0.23	0.11	1.2	0.36	0.05	0.5	0.17
10/24/95	14	3.9	44	926	83	*0.01*	0.1	0.08	0.86	18.1	1.11	0.03	0.6	0.25	0.17	3.6	0.38	0.02	0.4	0.17
Total					83			0.08			1.11			0.25			0.38			0.17

IR20S Southside 30 Drain

4/25/95		7.1	193	7391		0.02	0.77		0.94	36.0		*0.01*	0.2		0.34	13.0		0.01	0.4	
5/9/95	14	6.0	151	4887	43	0.01	0.32	0.00	0.60	19.4	0.2	0.05	1.6	0.01	0.26	8.4	0.08	0.05	1.6	0.01
5/23/95	14	3.2	102	1761	66	*0.01*	0.09	0.01	0.38	6.6	0.3	*0.01*	0.1	0.01	0.20	3.5	0.12	0.06	1.0	0.02
6/6/95	14	2.7	145	2112	80	0.02	0.29	0.01	0.37	5.4	0.3	0.10	1.5	0.02	0.19	2.8	0.14	0.04	0.6	0.02
6/20/95	14	0.0	0	0	87	0.00	0.00	0.01	0.00	0.0	0.3	0.00	0.0	0.02	0.00	0.0	0.15	0.00	0.0	0.02
7/4/95	14	4.8	160	4142	102	0.02	0.52	0.01	0.78	20.2	0.4	0.03	0.8	0.03	0.24	6.2	0.17	0.05	1.3	0.03
7/18/95	14	4.7	248	6287	138	0.01	0.25	0.01	0.60	15.2	0.5	0.14	3.5	0.04	0.43	10.9	0.23	0.06	1.5	0.04
8/1/95	14	2.9	318	4974	178	0.02	0.31	0.01	0.60	9.4	0.6	0.17	2.7	0.06	0.47	7.4	0.29	0.09	1.4	0.05
8/15/95	14	4.3	219	5079	213	0.03	0.70	0.02	0.60	13.9	0.7	0.07	1.6	0.08	0.32	7.4	0.35	0.06	1.4	0.06
8/29/95	14	5.2	184	5161	249	0.01	0.28	0.02	0.74	20.8	0.8	0.05	1.4	0.09	0.27	7.6	0.40	0.09	2.5	0.07
9/12/95	14	4.6	67	1662	273	0.02	0.50	0.02	0.66	16.4	1.0	0.12	3.0	0.10	0.19	4.7	0.44	0.09	2.2	0.09
9/25/95	13	1.4	58	438	279	0.01	0.08	0.03	0.40	3.0	1.0	0.23	1.7	0.12	0.18	1.4	0.46	0.08	0.6	0.10
10/9/95	14	4.2	76	1722	287	*0.01*	0.11	0.03	0.38	8.6	1.1	0.18	4.1	0.14	0.17	3.9	0.48	0.05	1.1	0.10
10/23/95	14	10.8	123	7165	318	*0.01*	0.29	0.03	1.21	70.5	1.3	0.05	2.9	0.16	0.21	12.2	0.53	0.02	1.2	0.11
Total					318			0.03			1.3			0.16			0.53			0.11

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR21S Pigeon Cove Hydro Power – LQ/LS Drains

			Sediment			Ammonia			T. Kjeld. N.			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons
4/25/95		25.0	270	36408		0.03	4.0		1.08	145.6		1.58	213.1		0.40	53.9		0.05	6.7	
5/10/95	15	61.6	153	50835	327	0.03	10.0	0.05	0.56	186.1	1.2	0.80	265.8	1.8	0.30	99.7	0.6	0.08	26.6	0.1
5/23/95	13	40.5	197	43034	632	0.01	2.2	0.09	0.40	87.4	2.1	1.10	240.3	3.4	0.30	65.5	1.1	0.07	15.3	0.3
6/6/95	14	70.5	192	73009	1038	0.03	11.4	0.14	0.43	163.5	3.0	0.75	285.2	5.3	0.29	110.3	1.7	0.05	19.0	0.4
6/20/95	14	59.8	135	43543	1446	0.02	6.5	0.20	0.39	125.8	4.0	0.99	319.3	7.4	0.24	77.4	2.4	0.06	19.4	0.5
7/5/95	15	71.4	212	81644	1916	0.02	7.7	0.26	0.52	200.3	5.2	1.01	389.0	10.1	0.36	138.6	3.2	0.07	27.0	0.7
7/18/95	13	54.4	361	105924	2525	0.02	5.9	0.30	0.80	234.7	6.7	1.44	422.5	12.7	0.54	158.4	4.2	0.08	23.5	0.9
8/1/95	14	70.5	849	322838	4026	0.03	11.4	0.36	0.95	361.2	8.7	1.38	524.8	16.0	0.98	372.7	6.0	0.10	38.0	1.1
8/15/95	14	59.8	848	273517	6113	0.04	12.9	0.44	1.00	322.5	11.1	1.70	548.3	19.8	0.89	287.1	8.3	0.07	22.6	1.3
8/29/95	14	61.8	331	110333	7457	*0.01*	1.7	0.50	0.70	233.3	13.1	1.76	586.7	23.7	0.48	160.0	9.9	0.08	26.7	1.5
9/12/95	14	62.5	282	95064	8176	0.01	3.4	0.51	0.60	202.3	14.6	1.84	620.3	28.0	0.41	138.2	10.9	0.08	27.0	1.6
9/26/95	14	70.5	164	62362	8727	0.01	3.8	0.54	0.38	144.5	15.8	2.23	848.0	33.1	0.27	102.7	11.8	0.06	22.8	1.8
10/10/95	14	60.7	110	36014	9071	*0.01*	1.6	0.56	0.52	170.2	16.9	2.38	779.2	38.8	0.24	78.6	12.4	0.06	19.6	2.0
10/24/95	14	55.3	48	14317	9247	*0.01*	1.5	0.57	0.43	128.3	18.0	2.66	793.4	44.3	0.13	38.8	12.8	0.04	11.9	2.1
Total					9247			0.57			18.0			44.3			12.8			2.1

IR22S Southside LS2/39A Drain

4/25/95		10.1	196	10677		0.03	1.6		0.94	51.2		1.90	103.5		0.33	18.0		0.03	1.6	
5/9/95	14	13.9	162	12146	80	0.03	2.2	0.01	0.62	46.5	0.34	1.29	96.7	0.70	0.29	21.7	0.14	0.06	4.5	0.02
5/23/95	14	12.7	112	7672	149	0.03	2.1	0.03	0.48	32.9	0.62	1.35	92.5	1.36	0.16	11.0	0.25	0.03	2.1	0.04
6/6/95	14	17.9	159	15351	230	0.04	3.9	0.05	0.44	42.5	0.88	0.93	89.8	2.00	0.26	25.1	0.38	0.04	3.9	0.07
6/20/95	14	10.6	43	2458	292	0.04	2.3	0.07	0.34	19.4	1.10	0.84	48.0	2.48	0.11	6.3	0.49	0.04	2.3	0.09
7/5/95	15	13.0	98	6872	327	0.02	1.4	0.08	0.43	30.2	1.29	1.13	79.2	2.96	0.20	14.0	0.57	0.08	5.6	0.12
7/18/95	13	14.1	255	19393	413	0.03	2.3	0.10	0.70	53.2	1.56	1.04	79.1	3.47	0.32	24.3	0.69	0.06	4.6	0.15
8/1/95	14	13.4	428	30934	589	0.03	2.2	0.11	0.82	59.3	1.95	1.29	93.2	4.08	0.58	41.9	0.92	0.08	5.8	0.19
8/15/95	14	11.7	1080	68155	935	0.05	3.2	0.13	1.66	104.8	2.52	1.47	92.8	4.73	0.97	61.2	1.28	0.09	5.7	0.23
8/29/95	14	14.7	421	33380	1291	0.02	1.6	0.15	0.84	66.6	3.12	1.32	104.7	5.42	0.57	45.2	1.66	0.09	7.1	0.27
9/12/95	14	11.3	95	5790	1428	0.02	1.2	0.16	0.34	20.7	3.43	1.56	95.1	6.12	0.21	12.8	1.86	0.08	4.9	0.31
9/26/95	14	16.5	74	6586	1471	0.01	0.9	0.16	0.33	29.4	3.61	1.69	150.4	6.98	0.16	14.2	1.95	0.06	5.3	0.35
10/10/95	14	10.6	40	2287	1502	*0.01*	0.3	0.17	0.42	24.0	3.79	2.12	121.2	7.93	0.12	6.9	2.03	0.05	2.9	0.38
10/24/95	14	7.8	40	1683	1516	*0.01*	0.2	0.17	0.42	17.7	3.94	2.53	106.4	8.73	0.14	5.9	2.07	0.04	1.7	0.39
Total					1516			0.17			3.94			8.73			2.07			0.39

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR23NT Northside N42 Drain / On canyon rim

			Sediment			Ammonia			T. Kjeld. N			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons
4/25/95		0.0	0	0		0	0.00		0	0		0	0		0	0		0	0	
5/8/95	13	22.6	62	7558	25	0.01	1.22	0.00	0.80	97.5	0.3	0.03	3.7	0.01	0.24	29.3	0.10	0.06	7.3	0.02
5/22/95	14	14.8	33	2634	60	0.01	0.80	0.01	0.45	35.9	0.8	0.01	0.8	0.03	0.15	12.0	0.24	0.06	4.8	0.07
6/5/95	14	24.1	36	4680	86	0.07	9.10	0.05	0.43	55.9	1.1	0.02	2.6	0.04	0.12	15.6	0.34	0.06	7.8	0.11
6/19/95	14	28.5	35	5380	121	0.01	1.54	0.08	0.37	56.9	1.5	*0.01*	0.8	0.05	0.12	18.4	0.46	0.04	6.1	0.16
7/4/95	15	19.6	36	3806	155	0.02	2.11	0.10	0.46	48.6	1.9	0.02	2.1	0.06	0.12	12.7	0.57	0.05	5.3	0.20
7/17/95	13	18.4	22	2183	175	0.06	5.95	0.12	0.37	36.7	2.2	0.06	6.0	0.09	0.12	11.9	0.65	0.06	6.0	0.24
7/31/95	14	19.1	31	3194	194	0.05	5.15	0.16	0.42	43.3	2.5	0.15	15.5	0.16	0.19	19.6	0.76	0.11	11.3	0.30
8/14/95	14	17.6	27	2563	214	0.04	3.80	0.19	0.52	49.4	2.8	*0.01*	0.5	0.22	0.14	13.3	0.88	0.07	6.6	0.36
8/28/95	14	13.7	16	1182	227	*0.01*	0.37	0.21	0.46	34.0	3.1	0.02	1.5	0.23	0.14	10.3	0.96	0.07	5.2	0.40
9/11/95	14	17.6	16	1519	236	0.04	3.80	0.22	0.40	38.0	3.3	0.06	5.7	0.25	0.13	12.3	1.04	0.08	7.6	0.45
9/25/95	14	16.9	8	729	244	0.02	1.82	0.24	0.26	23.7	3.5	0.04	3.6	0.28	0.09	8.2	1.11	0.06	5.5	0.49
10/9/95	14	14.1	10	761	250	*0.01*	0.38	0.25	0.48	36.5	3.7	*0.01*	0.4	0.30	0.09	6.8	1.16	0.02	1.5	0.52
10/23/95	14	3.8	7	143	253	0.02	0.41	0.25	0.50	10.2	3.9	*0.01*	0.1	0.30	0.08	1.6	1.19	0.02	0.4	0.52
Total					253			0.25			3.9			0.30			1.19			0.52

IR24S Southside 39 Drain

4/25/95		4.3	4803	111396		0.06	1.39		6.00	139.2		1.50	34.8		4.50	104.4		0.06	1.4	
5/9/95	14	7.6	507	20783	463	0.03	1.23	0.01	0.91	37.3	0.62	0.63	25.8	0.21	0.66	27.1	0.46	0.06	2.5	0.01
5/23/95	14	11.8	1260	80194	816	0.02	1.27	0.02	1.23	78.3	1.02	0.51	32.5	0.42	1.30	82.7	0.84	0.08	5.1	0.04
6/6/95	14	15.6	425	35760	1222	0.03	2.52	0.03	0.55	46.3	1.46	0.67	56.4	0.73	0.45	37.9	1.27	0.05	4.2	0.07
6/20/95	14	9.8	214	11312	1387	0.02	1.06	0.04	0.57	30.1	1.73	0.90	47.6	1.09	0.29	15.3	1.45	0.04	2.1	0.09
7/5/95	15	5.3	216	6175	1452	0.09	2.57	0.06	0.86	24.6	1.93	1.36	38.9	1.42	0.35	10.0	1.55	0.07	2.0	0.11
7/18/95	13	10.5	459	25995	1557	0.03	1.70	0.07	1.04	58.9	2.20	1.27	71.9	1.78	0.77	43.6	1.72	0.16	9.1	0.15
8/1/95	14	5.5	710	21062	1721	0.05	1.48	0.08	0.91	27.0	2.50	1.52	45.1	2.18	0.78	23.1	1.96	0.11	3.3	0.19
8/15/95	14	8.6	1230	57055	1995	0.07	3.25	0.10	1.90	88.1	2.91	1.48	68.7	2.58	1.35	62.6	2.26	0.08	3.7	0.21
8/29/95	14	5.6	434	13109	2240	0.01	0.30	0.11	1.30	39.3	3.35	2.20	66.5	3.06	0.56	16.9	2.53	0.08	2.4	0.23
9/12/95	14	8.7	253	11872	2328	0.02	0.94	0.12	0.60	28.2	3.59	1.32	61.9	3.51	0.41	19.2	2.66	0.09	4.2	0.26
9/26/95	14	8.1	104	4544	2385	*0.01*	0.22	0.12	0.38	16.6	3.74	2.07	90.4	4.04	0.19	8.3	2.76	0.08	3.5	0.29
10/10/95	14	9.5	45	2306	2409	*0.01*	0.26	0.12	0.42	21.5	3.88	2.43	124.5	4.79	0.15	7.7	2.81	0.06	3.1	0.31
10/24/95	14	8.5	50	2292	2425	*0.01*	0.23	0.12	0.64	29.3	4.06	2.14	98.1	5.57	0.10	4.6	2.86	0.03	1.4	0.32
Total					2425			0.12			4.06			5.57			2.86			0.32

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR29S Southside I Coulee

Date	Days	Flow (cfs)	Sediment Conc. mg/L	Sediment Load lb/day	Sediment Acc tons	Ammonia Conc. mg/L	Ammonia Load lb/day	Ammonia Acc tons	T. Kjeld. N Conc. mg/L	T. Kjeld. N Load lb/day	T. Kjeld. N Acc tons	Nitrite+Nitrate N Conc. mg/L	Nitrite+Nitrate N Load lb/day	Nitrite+Nitrate N Acc tons	Total Phosphorus Conc. mg/L	Total Phosphorus Load lb/day	Total Phosphorus Acc tons	Ortho Phosphate Conc. mg/L	Ortho Phosphate Load lb/day	Ortho Phosphate Acc tons
4/25/95		6.5	28	982		0.02	0.7		0.48	16.8		2.19	76.8		0.17	6.0		0.09	3.2	
5/9/95	14	12.3	76	5042	21	0.03	2.0	0.01	0.85	56.4	0.3	1.73	114.8	0.7	0.26	17.2	0.1	0.12	8.0	0.04
5/23/95	14	11.4	84	5165	57	0.02	1.2	0.02	0.50	30.7	0.6	1.43	87.9	1.4	0.21	12.9	0.2	0.10	6.1	0.09
6/6/95	14	15.5	233	19479	143	0.04	3.3	0.04	0.47	39.3	0.8	1.56	130.4	2.1	0.37	30.9	0.3	0.06	5.0	0.13
6/19/95	13	7.9	120	5113	223	0.02	0.9	0.05	0.58	24.7	1.0	1.68	71.6	2.8	0.24	10.2	0.5	0.07	3.0	0.15
7/4/95	15	8.2	140	6192	265	0.02	0.9	0.06	0.44	19.5	1.2	1.91	84.5	3.4	0.26	11.5	0.6	0.08	3.5	0.18
7/17/95	13	11.5	130	8064	312	0.02	1.2	0.06	0.53	32.9	1.4	2.03	125.9	4.1	0.28	17.4	0.6	0.09	5.6	0.21
7/31/95	14	10.4	219	12285	383	0.03	1.7	0.07	0.94	52.7	1.6	2.06	115.6	4.9	0.39	21.9	0.8	0.10	5.6	0.25
8/14/95	14	8.4	216	9786	460	0.03	1.4	0.08	0.84	38.1	2.0	2.48	112.4	5.7	0.38	17.2	0.9	0.09	4.1	0.28
8/28/95	14	11.3	128	7801	522	0.01	0.6	0.09	0.53	32.3	2.2	2.48	151.2	6.6	0.28	17.1	1.0	0.10	6.1	0.32
9/11/95	14	8.0	125	5394	568	0.02	0.9	0.10	0.54	23.3	2.4	2.74	118.2	7.6	0.25	10.8	1.1	0.07	3.0	0.35
9/25/95	14	16.5	92	8188	615	0.01	0.9	0.10	0.38	33.8	2.6	2.84	252.7	8.9	0.21	18.7	1.2	0.08	7.1	0.38
10/9/95	14	16.3	56	4923	661	*0.01*	0.4	0.11	0.30	26.4	2.8	3.07	269.9	10.7	0.16	14.1	1.4	0.06	5.3	0.43
10/23/95	14	15.9	87	7461	705	*0.01*	0.4	0.11	0.52	44.6	3.1	3.50	300.2	12.7	0.19	16.3	1.5	0.05	4.3	0.46
Total					705			0.11			3.1			12.7			1.5			0.46

IR30N Northside J8 Drain

Date	Days	Flow (cfs)	Sediment Conc. mg/L	Sediment Load lb/day	Sediment Acc tons	Ammonia Conc. mg/L	Ammonia Load lb/day	Ammonia Acc tons	T. Kjeld. N Conc. mg/L	T. Kjeld. N Load lb/day	T. Kjeld. N Acc tons	Nitrite+Nitrate N Conc. mg/L	Nitrite+Nitrate N Load lb/day	Nitrite+Nitrate N Acc tons	Total Phosphorus Conc. mg/L	Total Phosphorus Load lb/day	Total Phosphorus Acc tons	Ortho Phosphate Conc. mg/L	Ortho Phosphate Load lb/day	Ortho Phosphate Acc tons
4/24/95		9.0	120	5825		0.03	1.5		1.31	63.6		0.01	0.5		0.61	29.6		0.16	8	
5/8/95	14	26.7	108	15553	75	1.12	161.3	0.57	2.48	357.1	1.5	0.06	8.6	0.03	0.70	100.8	0.46	0.46	66	0.26
5/22/95	14	10.7	26	1501	135	0.02	1.2	1.14	0.32	18.5	2.8	0.02	1.2	0.07	0.13	7.5	0.84	0.07	4	0.51
6/5/95	14	18.8	16	1622	145	0.03	3.0	1.15	0.24	24.3	2.9	*0.01*	0.5	0.07	0.12	12.2	0.90	0.09	9	0.55
6/19/95	14	19.4	23	2407	160	0.02	2.1	1.17	0.36	37.7	3.2	0.02	2.1	0.08	0.17	17.8	1.01	0.11	12	0.62
7/4/95	15	6.7	4	145	169	0.02	0.7	1.18	0.31	11.2	3.3	0.04	1.4	0.09	0.16	5.8	1.10	0.13	5	0.68
7/17/95	13	13.2	6	427	171	0.04	2.8	1.19	0.38	27.1	3.5	0.09	6.4	0.12	0.19	13.5	1.16	0.14	10	0.73
7/31/95	14	12.5	9	607	175	0.02	1.3	1.21	0.27	18.2	3.6	0.09	6.1	0.16	0.14	9.4	1.24	0.10	7	0.79
8/14/95	14	22.0	16	1899	183	0.02	2.4	1.22	0.42	49.8	3.9	*0.01*	0.6	0.19	0.12	14.2	1.32	0.08	9	0.85
8/28/95	14	12.9	5	348	191	*0.01*	0.3	1.23	0.31	21.6	4.1	*0.01*	0.3	0.19	0.15	10.4	1.41	0.12	8	0.91
9/11/95	14	22.2	8	958	196	0.02	2.4	1.24	0.29	34.7	4.3	0.06	7.2	0.22	0.17	20.4	1.52	0.13	16	0.99
9/25/95	14	17.3	3	280	200	0.01	0.9	1.25	0.26	24.3	4.5	0.02	1.9	0.25	0.12	11.2	1.63	0.10	9	1.08
10/9/95	14	16.2	10	874	204	*0.01*	0.4	1.26	0.37	32.3	4.7	0.01	0.9	0.26	0.17	14.9	1.72	0.11	10	1.15
10/23/95	14	0.0	0	0	207	0.00	0.0	1.26	0	0.0	4.8	0.00	0.0	0.26	0	0.0	1.77	0	0	1.18
Total					207			1.26			4.8			0.26			1.77			1.18

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

IR39NP S19/S Drain

			Sediment			Ammonia			T. Kjeld. N			Nitrite+Nitrate N			Total Phosphorus			Ortho Phosphate		
Date	Days	Flow (cfs)	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons	Conc. mg/L	Load lb/day	Acc tons
4/24/95		58.2	106	33275		0.02	6.3		1.34	420.6		*0.01*	1.6		0.52	163.2		0.23	72	
5/8/95	14	69.7	55	20677	189	0.02	7.5	0.05	1.20	451.1	3.1	0.06	22.6	0.08	0.39	146.6	1.1	0.20	75	0.5
5/22/95	14	68.4	44	16233	318	0.16	59.0	0.28	0.60	221.4	5.4	0.03	11.1	0.20	0.26	95.9	1.9	0.18	66	1.0
6/5/95	14	67.0	35	12648	419	0.06	21.7	0.56	0.41	148.2	6.7	0.04	14.5	0.29	0.22	79.5	2.5	0.16	58	1.4
6/19/95	14	56.3	22	6681	487	0.03	9.1	0.67	0.37	112.4	7.6	0.08	24.3	0.43	0.24	72.9	3.1	0.18	55	1.8
7/4/95	15	46.8	37	9340	547	0.03	7.6	0.73	0.43	108.5	8.4	0.08	20.2	0.59	0.20	50.5	3.5	0.13	33	2.2
7/17/95	13	35.2	38	7215	601	0.07	13.3	0.80	0.57	108.2	9.1	0.08	15.2	0.71	0.21	39.9	3.8	0.12	23	2.3
7/31/95	14	48.7	31	8143	654	0.05	13.1	0.89	0.44	115.6	9.9	0.31	81.4	1.05	0.25	65.7	4.2	0.19	50	2.6
8/14/95	14	38.5	17	3530	695	0.04	8.3	0.97	0.46	95.5	10.7	0.03	6.2	1.35	0.15	31.1	4.5	0.12	25	2.9
8/28/95	14	38.0	7	1435	713	*0.01*	1.0	1.00	0.34	69.7	11.2	*0.01*	1.0	1.38	0.21	43.0	4.8	0.15	31	3.1
9/11/95	14	29.2	8	1260	722	0.03	4.7	1.02	0.31	48.8	11.7	0.18	28.3	1.48	0.20	31.5	5.1	0.17	27	3.3
9/25/95	14	29.7	3	481	728	0.01	1.6	1.04	0.26	41.7	12.0	0.11	17.6	1.64	0.20	32.0	5.3	0.15	24	3.4
10/9/95	14	32.4	10	1748	736	*0.01*	0.9	1.05	0.60	104.9	12.5	0.07	12.2	1.75	0.21	36.7	5.5	0.15	26	3.6
10/23/95	14	49.9	26	6998	767	0.01	2.7	1.07	0.94	253.0	13.7	0.16	43.1	1.94	0.32	86.1	6.0	0.20	54	3.9
Total					767			1.07			13.7			1.94			6.0			3.9

IR42N Northside W26 Drain

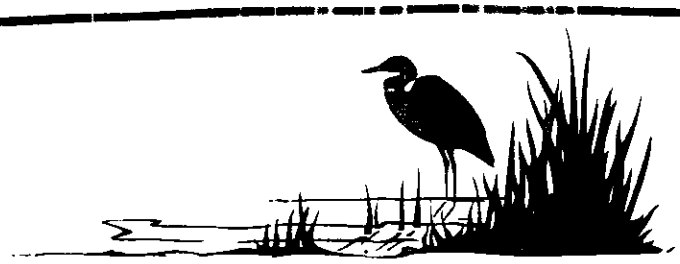
4/24/95		20.1	84	9107		0.02	2.2		1.28	138.8		*0.01*	0.5		0.19	20.6		0.01	1.1	
5/8/95	14	38.0	74	15167	85	0.01	2.0	0.01	0.66	135.3	0.96	0.02	4.1	0.02	0.16	32.8	0.19	0.03	6.1	0.03
5/22/95	14	17.9	20	1931	145	0.01	1.0	0.03	0.28	27.0	1.53	*0.01*	0.5	0.03	0.05	4.8	0.32	0.01	1.0	0.05
6/5/95	14	8.4	10	453	153	0.03	1.4	0.03	0.22	10.0	1.66	0.01	0.5	0.04	0.10	4.5	0.35	0.06	2.7	0.06
6/19/95	14	25.8	23	3201	166	0.01	1.4	0.04	0.36	50.1	1.87	0.01	1.4	0.04	0.09	12.5	0.41	0.03	4.2	0.09
7/4/95	15	17.7	16	1527	184	0.01	1.0	0.05	0.31	29.6	2.17	*0.01*	0.5	0.05	0.06	5.7	0.48	0.02	1.9	0.11
7/17/95	13	3.3	7	125	189	*0.01*	0.1	0.06	0.31	5.5	2.28	*0.01*	0.1	0.05	0.06	1.1	0.50	0.03	0.5	0.12
7/31/95	14	13.6	10	734	192	0.02	1.5	0.06	0.28	20.5	2.37	0.02	1.5	0.06	0.08	5.9	0.53	0.05	3.7	0.13
8/14/95	14	18.7	20	2017	202	0.02	2.0	0.07	0.50	50.4	2.62	*0.01*	0.5	0.06	0.09	9.1	0.58	0.05	5.0	0.16
8/28/95	14	12.9	8	557	211	*0.01*	0.3	0.08	0.32	22.3	2.87	0.03	2.1	0.07	0.10	7.0	0.63	0.06	4.2	0.20
9/11/95	14	19.4	10	1046	216	0.02	2.1	0.09	0.31	32.4	3.07	0.04	4.2	0.09	0.09	9.4	0.69	0.05	5.2	0.23
9/25/95	14	16.5	7	623	222	*0.01*	0.4	0.10	0.32	28.5	3.28	*0.01*	0.4	0.11	0.08	7.1	0.75	0.04	3.6	0.26
10/9/95	14	19.0	11	1127	228	*0.01*	0.5	0.10	0.48	49.2	3.55	*0.01*	0.5	0.11	0.09	9.2	0.81	0.01	1.0	0.28
10/23/95	14	12.0	10	647	234	*0.01*	0.3	0.10	0.50	32.4	3.84	*0.01*	0.3	0.12	0.07	4.5	0.85	0.01	0.6	0.28
Total					234			0.10			3.84			0.12			0.85			0.28

A number in italics indicates the value is the minimum detection limit - - (MDL), 1/2 of the MDL is used for load calculations

Appendix D
Tributary Sediment Loading Computations-DEQ Data

		East Perrine Coulee				Rock Creek				Cedar Draw Creek			
	Days	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons
4/17/95		5.3	6	172		129	48	33398		121	116	75706	
4/24/95	7	20.2	114	12421	22	126	59	40097	129	70	96	36246	196
5/2/95	8	37.0	208	41510	130	188	72	73009	355	200	304	327938	924
5/8/95	6	66.0	130	46278	262	346	306	571064	1321	272	153	224465	1753
5/15/95	7	33.8	82	14949	369	314	150	254044	2765	215	118	136838	2385
5/22/95	7	21.7	51	5969	405	224	107	129276	3436	71	56	21445	2662
5/31/95	9	29.2	54	8505	438	197	102	108381	3970	133	86	61693	2849
6/5/95	5	30.3	64	10459	462	187	125	126078	4263	229	88	108694	3062
6/12/95	7	25.8	25	3479	486	445	169	405634	5194	294	105	166504	3544
6/19/95	7	22.6	20	2438	496	298	114	183235	6225	181	56	54671	3931
6/26/95	7	28.2	26	3955	508	206	66	73333	6674	116	35	21898	4065
7/5/95	9	23.0	36	4466	526	185	42	41909	6933	162	56	48932	4224
7/10/95	5	15.3	17	1403	534	177	59	56327	7056	71	41	15701	4305
7/17/95	7	17.3	93	8678	551	183	53	52314	7246	85	44	20172	4368
7/24/95	7	25.9	157	21932	605	193	80	83279	7483	81	12	5243	4412
7/31/95	7	32.6	196	34464	704	205	76	84034	7776	121	147	95938	4589
8/7/95	7	30.0	174	28155	813	213	91	104546	8106	147	151	119724	4967
8/14/95	7	33.8	195	35550	925	217	128	149816	8551	157	200	169362	5473
8/21/95	7	26.3	118	16739	1016	219	95	112216	9010	159	349	299302	6293
8/28/95	7	47.6	119	30552	1099	233	72	90485	9364	104	123	68996	6937
9/6/95	9	53.0	65	18581	1210	239	55	70900	9727	177	102	97378	7312
9/11/95	5	55.8	44	13243	1249	249	43	57750	9888	234	132	166601	7642
9/18/95	7	61.0	34	11187	1292	241	36	46796	10071	243	126	165145	8222
9/25/95	7	42.4	28	6403	1323	276	37	55081	10249	273	138	203203	8867
10/3/95	8	30.7	26	4305	1344	271	29	42389	10444	243	43	56359	9386
10/10/95	7	34.0	22	4034	1359	249	34	45663	10598	253	35	47761	9568
10/16/95	6	29.7	12	1922	1368	339	66	120679	10848	232	40	50054	9715
10/23/95	7	40.1	28	6056	1382	455	64	157065	11334	173	47	43856	9879
10/30/95	7	14.4	14	1087	1394	210	13	14725	11635	150	16	12945	9979
Totals					1394				11635				9979

		Mud Creek				Deep Creek				Salmon Falls Creek			
	Days	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons	Flow cfs	Conc. mg/L	Load lb/day	Acc. tons
4/17/95		55	26	7713		119	87	55841		117	42	26505	
4/24/95	7	44	26	6170	24	79	116	49428	184	152	80	65588	161
5/2/95	8	89	90	43204	123	58	142	44423	372	192	146	151196	595
5/8/95	6	130	76	53290	268	157	179	151579	666	359	277	536367	1626
5/15/95	7	116	46	28781	411	140	286	215964	1309	239	68	87659	2718
5/22/95	7	159	24	20582	498	77	62	25750	1732	84	11	4984	2880
5/31/95	9	87	26	12201	572	57	25	7686	1807	103	15	8333	2910
6/5/95	5	104	26	14585	605	120	63	40776	1868	120	23	14887	2939
6/12/95	7	132	32	22783	670	230	246	305176	2473	217	58	67885	3084
6/19/95	7	117	21	13252	733	140	69	52103	3099	141	243	184805	3526
6/26/95	7	109	16	9407	773	117	46	29029	3241	118	32	20367	3885
7/5/95	9	106	22	12578	823	94	24	12168	3333	114	6	3689	3939
7/10/95	5	87	26	12201	854	59	4	1273	3350	52	8	2244	3947
7/17/95	7	99	25	13349	898	55	3	890	3354	68	3	1100	3953
7/24/95	7	91	20	9817	939	88	12	5696	3365	110	6	3560	3961
7/31/95	7	109	33	19401	990	121	81	52864	3468	99	7	3738	3974
8/7/95	7	96	28	14498	1049	64	17	5868	3571	124	7	4682	3988
8/14/95	7	107	32	18468	1107	76	41	16807	3610	114	8	4919	4005
8/21/95	7	116	27	16893	1169	77	18	7476	3653	122	8	5264	4023
8/28/95	7	123	28	18576	1231	93	32	16052	3694	119	9	5777	4042
9/6/95	9	130	22	15426	1307	108	31	18058	3771	154	22	18274	4096
9/11/95	5	138	21	15631	1346	125	35	23597	3823	128	18	12427	4135
9/18/95	7	147	24	19029	1407	164	157	138877	4107	153	31	25582	4201
9/25/95	7	149	19	15270	1467	154	32	26580	4397	158	21	17896	4277
10/3/95	8	146	20	15750	1529	139	17	12745	4475	210	55	62297	4438
10/10/95	7	132	16	11392	1576	138	18	13398	4521	200	32	34520	4607
10/16/95	6	149	12	9644	1608	158	27	23010	4576	241	45	58495	4747
10/23/95	7	139	16	11996	1646	221	83	98937	4789	266	36	51650	4940
10/30/95	7	126	4	2718	1672	62	9	3010	4968	184	19	18856	5063
Totals					1672				4968				5063



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The Upper Snake Rock Watershed Management Plan

(or Upper Snake/Rock Creek Watershed Management Plan)

The Upper Snake Rock Subbasin Assessment

&

The Upper Snake Rock Total Maximum Daily Load

Prepared by:

Dr. Balthasar B. Buhidar, Ph.D.
and the Water Quality Protection Staff of
Idaho Division of Environmental Quality-Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

&

The Middle Snake River Technical Advisory Committee
of
The Middle Snake River Watershed Advisory Group
c/o Idaho Division of Environmental Quality
Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

Department of Water Resources
APPLICANT'S
Exhibit 3
3-17-2000

FINAL PLAN SUBMITTED TO USEPA
December 20, 1999

Finally, the 1994 and 1996 §303(d) lists identified the level of beneficial support status for various reservoirs and lakes in HUC 17040212. These are identified in Table 28.

Table 28 1994 & 1996 Beneficial support status for the reservoirs and lakes

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
Bliss Reservoir	AG	CW/SS	PC/SC	
Lower Salmon Falls Reservoir	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 372.00)	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 373.00)	AG/CW	PC/SC		SS
Shoshone Falls Reservoir	AG/CW/PC/SC			SS
Twin Falls Reservoir	AG	PC/SC/CW/SS		
Murtaugh Lake	AG		PC/SC/CW/SS	
Pioneer Reservoir	AG	PC/SC/SS	CW	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning.

2.2.2.5 TRIBUTARIES

The results of the Idaho surveyed waters by USEPA for meeting state water quality standards within Upper Snake Rock for the aquatic life beneficial use show that about 1% of the waters are good, about 28% were threatened, about 51% were partially supporting, and about 19% were not supporting this benefical use (*www.epa.gov /surf/IWI/17040212/Drivers-us.html*). Water quality concern sources and the status for these tributaries are summarized in Table 29.

Table 29 Literature sources defining water quality concerns for the indicated waterbody

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Alpheus Creek	405.00	X		X		X			X	(X)	X	X	X
Billingsley Creek	384.00	X	X	X		X	(X)		X	X	X	X	X
Blind Canyon Creek	389.00	X	X	X			(X)		X	(X)	X	X	X
Cedar Draw	397.00	X		X		X	X		X	(X)			X
Clear Springs	395.00	X	X	(X)	X		(X)		X	(X)	X	X	X
Clover Creek	379.00	X	X	X	X	X	X		X	(X)	X	X	X
Cottonwood Creek	403.00	X	X	X	X	X	(X)		X	(X)	X	X	X
Crystal Springs	398.00	X	X	X		X	(X)		X	(X)	X	X	X
Deep Creek	392-93	X		X		X			X	(X)			X
Dry Creek	408.00	X	X	X			(X)		X	(X)	X	X	X
Dry Creek, West Fork	411.00	X		X			(X)		X	(X)	X	X	X

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
McMullen Creek	404.00	X	X	X			(X)			(X)	X	X	X
Mud Creek	394.00	X		X			X		X	(X)			X
Riley Creek	385.00	X	X	X		X	(X)		X	(X)	X	X	X
Rock Creek	400.00	X	X	X		X	(X)		X	(X)	X	X	X
Sand Springs Creek*	386.00	X	X	X			(X)		X	(X)	X	X	X
Toolbox Creek													X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement.* (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program.* 91 = *1993 Idaho Agricultural Pollution Abatement Plan.* 92 = *1992 Idaho Water Quality Status Report.* 94 = *1994 Idaho Water Quality Status Report.* 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994.* 303(d) Listed Streams: 92 = *1992 §303(d) List.* X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C.* 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D.* 98 = 1998 §303(d) List. Sand Springs Creek is sometimes referred to as Thousand Springs Creek.

Additional sources beyond those identified in the previous Table that define the cause of concern and status of the waterbody are referenced as follows:

1. BILLINGSLEY CREEK

In 1991 the IDFG responded to the then-proposed reissuance of the NPDES aquaculture permits on seven aquaculture farms (002499-6; 002704-9; 002303-5; 000073-6; 002440-6; 002497-0; and 000086-8) on Billingsley Creek. In general, IDFG was concerned over the number of aquaculture facilities, such that cumulative impacts were being seen on Billingsley Creek. Sampling in Billingsley Creek indicated that a high percentage of fish were wild rainbow trout, wild brown trout, and hatchery rainbow trout (IDFG 1991). The water quality concerns and status of Billingsley Creek are further substantiated in the following reports: *IDHW, WQ Status Report No. WQ-21, Billingsley Creek (Gooding County), Problem Assessment; Billingsley Creek, NPDES Permits, 1991; IDHW, WQ Status Report No. 64, Billingsley Creek, 1984;* and, *IDHW, Upper Snake River Basin Status Report, 1991.* Historically, agricultural nonpoint sources have affected Billingsley Creek slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]).

2. CEDAR DRAW

The water quality concerns and status of Cedar Draw Creek are further substantiated in the following reports: *IDHW, Water Quality Status Report No. 100, 1991* and *IDHW, 1980, Channel Stability Evaluation for Cedar Draw.* It should be noted that IDAPA 16.01.02.280 identifies Cedar Draw as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. It is not "exempt" from water quality regulations that recognize Cedar Draw as having designated beneficial uses (IDAPA 16.01.02.150[Map Code hh]). Historically, agricultural nonpoint sources affect Cedar Draw (from the source to the mouth) severely from irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 2]).

3. CLOVER CREEK

The water quality concerns and status of Clover Creek are further substantiated in the following field monitoring reports: (1) Monitoring conducted by USBLM during 1993-1994 at the sites of Dry Creek,

15. VINYARD CREEK

As previously described, there is a channel carrying irrigation return water that enters Vinyard Creek approximately midway between the waterfall and the confluence with Twin Falls Reservoir. IDEQ-TFRO has reported a peak discharge for the irrigation return channel of 14.6 cfs in 1986, and an annual deposition of approximately 707 metric tons of sediment into the Twin Falls Reservoir (IDHW 1989a). This channel was re-routed in 1990 by constructing a rock and earthen embankment at the inflow of the pipe in order to pool the irrigation return water for re-route into the pipe (IPC 1997b [p 4]). At the point where the historical creek channel and the irrigation return joined, this has been re-routed so that Vinyard Creek discharges water from Vinyard Lake only. The irrigation return discharges only irrigation return water to Twin Falls Reservoir just downstream from where Vinyard Creek discharges. Fish species collected by IPC biologists in 1996 included: cutthroat trout, rainbow trout, rainbow-cutthroat trout hybrid, speckled dace, reside shiner, Utah sucker, and mottled sculpin (IPC 1997b [p 4]). Vinyard Creek has historically supported a unique population of cutthroat trout. Additionally, the stream has likely provided a spawning, rearing, and adult habitat for cutthroat trout, rainbow trout, and rainbow-cutthroat trout hybrids (IPC 1997b [p 4]).

Finally, the 1994 and 1996 §303(d) lists identified the level of benefical support status for various tributaries in HUC 17040212. These are identified in Table 35.

Table 35 1994 & 1996 Beneficial support status for tributaries

SEGMENT NAME	FS	T	PS	NS	NA
DEEP CREEK					
Deep Ck (Low Line Canal to SR)	AG	PC/SC	CW/SS		
Deep Ck (HW to LowLineCanal)	AG	PC/SC	CW/SS		
MUD CREEK					
Mud Ck (T09SR14ES33 to SR)	AG	PC/SC	CS/SS		
Mud Ck (HW to T09SR14ES33)	AG	PC/SC	CW/SS		
ROCK CREEK					
Rock Ck (Cottonwood Ck to SR)	AG	PC/SC	CW/SS		
Rock Ck (5th Fork to McMullen Ck)	AG		CW/SS/PC/SC		
MCMULLEN CREEK					
Cottonwood Ck to Rock Ck	AG	PC/SC/CW/SS			
Donahue Ck to N. Cottonwood Ck	AG	PC/SC/CW		SS	
HW to Donahue Ck	AG	PC/SC/CW	SS		
COTTONWOOD CREEK & NORTH COTTONWOOD CREEK					
McMullen Ck to N. Cottonwood Ck	AG	PC/SC	CW	SS	
HW to Dry Cottonwood Ck	AG	PC/SC	CW	SS	
DRY CREEK					
Murtaugh Lake to SR	AG	PC/SC/CW/SS			

SEGMENT NAME	FS	T	PS	NS	NA
EF Dry Creek to Murtaugh Lake	AG	PC/SC	CW/SS		
NF Dry Creek to EF Dry Creek	AG	PC/SC	CW/SS		
HW to WF Dry Creek	AG	PC/SC	CW/SS		
HW to Dry Creek	AG	PC/SC	CW/SS		
HW to MF Dry Creek	AG	PC/SC	CW/SS		
CLOVER CREEK					
Dry Creek to SR	AG	PC/SC/CW/SS			
Pioneer Reservoir to Dry Creek	AG	PC/SC/CW/SS			
Calf Creek to Pioneer Reservoir	AG	PC/SC/CW/SS			
T4SR13ES31 to Calf Creek	AG	PC/SC/CW/SS			
Cottonwood Ck to T4SR13ES31	AG	PC/SC/CW/SS			
Squaw Creek to Catchall Creek	AG	PC/SC/CW/SS			
Deer Creek to Squaw Creek	AG	PC/SC/CW/SS			
HW to Deer Creek	AG	PC/SC/CW/SS			
Catchall Ck to Cottonwood Creek	AG	PC/SC/CW/SS			
OTHER TRIBUTARIES					
Niagara Springs (T9SR15ES11)	DW		PC/SC/CW/SS		
Crystal Springs (T9SR15ES12)			AG/PC/SC/CW/SS		
Cedar Draw (HW to SR)	AG	PC/SC/CW/SS			
Billingsley Creek (HW to SR)	AG/DW	PC/SC/CW/SS			
Cedar Draw Ck (HW to SR)	AG				CW/SS/PC/SC
Perrine Coulee (Low Line Canal to SR)	AG	PC/SC/CW		SS	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. SR = Snake River. HW = Headwaters. Ck = Creek. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning. EF = East Fork. WF = West Fork. NF = North Fork. Lk = Lake. FS = Full support. T = Threatened. PS = Partial support. NS = Not supporting. NA = Not assessed.

2.2.2.6 BENEFICIAL USE RECONNAISSANCE PROJECT DATA

In addition to the data previously described in §2.2.1.1 through §2.2.1.4, information was collated from the Beneficial Use Reconnaissance Project (BURP) in the Twin Falls Regional Office of IDEQ for the streams on the §303(d) list. Tables 37 and 38 provide an indication of why these streams are not fully supporting their beneficial uses. Dry streams are not included. The ecoregional geographic area is the Snake River Basin/High Desert. Although traditional water quality monitoring for chemical parameters has its benefits, biomonitoring (as BURP) goes beyond the chemistry and centers on the ecological status of the beneficial use (IDEQ 1998). However, BURP monitoring encompasses a small fraction of a watershed and at only one moment in time, usually during late summer. It does not account for seasonality. The process used to assess the beneficial use support covers both a chemical and a biological process known as IDEQ's Bioassessment

TRIBUTARY	MINIMUM FLOW, cfs	MEAN FLOW, cfs	MAXIMUM FLOW, cfs
Cedar Draw	2.91	130.44	505.38
Mud Creek	29.55	102.09	295.60
Deep Creek	14.78	92.38	314.78
Salmon Falls Creek	35.00	146.22	363.00
Billingsley Creek	39.94	120.78	189.28
Malad River	1.30	306.42	2790.00
Clover Creek	2.30	30.39	300.00
TOTAL FLOW	197.29	1177.90	5330.12
Prepared by IDEQ-TFRO. It is highly unlikely that all maximum flows coincide in time.			

Implications and characteristics from these loading Tables per parameter per tributary are summarized in Table 53. TP/TSS and SRP/TP ratios are converted to percentages (multiplying by 100) and are based on the overall mean of Years 1990 through 1997 per parameter. Total inorganic nitrogen (TIN) and total organic nitrogen (TON) are also described.

Table 53 Select characteristics per indicated stream

TRIBUTARY	PERCENT as TP/TSS x 100	PERCENT as SRP/TP x 100	TIN in tons/yr (% of TN)	TON in tons/yr (% of TN)	TN tons/year
East Perrine Coulee	0.21	32.4	69.3 (78.8)	18.7 (21.2)	88.0
Rock Creek	0.26	46.1	448.7 (78.7)	121.4 (21.3)	570.1
Cedar Draw	0.25	33.6	228.8 (75.7)	73.6 (24.3)	302.4
Mud Creek	0.44	50.6	258.0 (83.8)	49.8 (16.2)	307.8
Deep Creek	0.29	34.7	208.6 (78.5)	57.1 (21.5)	265.7
Salmon Falls Creek	0.27	44.6	392.1 (86.6)	60.6 (13.4)	452.7
Billingsley Creek	1.48	59.3	138.0 (88.7)	17.6 (11.3)	155.6
Malad River	0.20	33.2	64.3 (28.0)	165.4 (72.0)	229.7
Clover Creek	0.39	46.7	1.45 (24.6)	4.45 (75.4)	5.9
Prepared by IDEQ-TFRO. TIN=Total Inorganic Nitrogen = NOX + NH3; TON = Total Organic Nitrogen = TKN - NH3; TN = Total Nitrogen = TON + TIN. Billingsley Creek based on 1990 to 1996 values. TP/TSS and SRP/TP ratio based on 8 year mean.					

The TP/TSS percentage is used as a way to ascertain the amount of TP there is in the system in relationship to the amount of TSS that exists. These percentages are then ranked numerically from high to low to determine which stream has the most TP in relationship to TSS. The ranking indicates that Billingsley Creek was greatest (1.48%), followed by Mud Creek (0.44%), Clover Creek (0.39%), Deep Creek (0.29%), Salmon Falls Creek (0.27%), Rock Creek (0.26%), Cedar Draw (0.25%), East Perrine Coulee (0.21%), and Malad River (0.20%). The SRP/TP percentage which is used to determine the numerical ranking (from high to low) based on the most SRP that is present in relationship to the TP. It indicates that Billingsley Creek was greatest (59.3%), followed by Mud Creek (50.6%), Clover Creek (46.7%), Rock Creek (46.1%), Salmon Falls Creek (44.6%), Deep Creek (34.7%), Cedar Draw (33.6%), Malad River (33.2%), and East Perrine Coulee

(32.4%). With the exception of the Malad River and Clover Creek, all tributaries had TIN values (75.7 - 88.7%) that were much greater than the TON values. The ranking of the tributaries with the most total nitrogen was Rock Creek (570.1 tons/year), followed by Salmon Falls Creek (452.7 tons/year), Mud Creek (307.8 tons/year), Cedar Draw (302.4 tons/year), Deep Creek (265.7 tons/year), Malad River (229.7 tons/year), Billingsley Creek (155.6 tons/year), East Perrine Coulee (88.0 tons/year), and Clover Creek (5.9 tons/year).

1. INORGANIC NITROGEN (NITRITE + NITRATE as NOX)

Samples which were at a protective level for salmonid fish (<0.06 mg/L NOX) and below the suggested prevention level (<0.3 mg/L NOX) for the development of biological nuisances and the acceleration of cultural eutrophication are summarized in Table 54.

Table 54 Inorganic nitrogen (NOX) for protection of salmonid fish and prevention of biological nuisances

Tributaries	Salmonid Fish Protection #<0.06 mg NOX/L per N	% Protected	Biological Nuisance Prevention #<0.30 mg NOX/L per N	% Prevention
East Perrine Coulee	0 out of 225	0.0	0 out of 225	0.0
Rock Creek	0 out of 288	0.0	1 out of 288	0.3
Cedar Draw	1 out of 277	0.4	2 out of 277	0.7
Mud Creek	0 out of 277	0.0	0 out of 277	0.0
Deep Creek	0 out of 275	0.0	1 out of 275	0.4
Salmon Falls Creek	0 out of 270	0.0	0 out of 270	0.0
Billingsley Creek	0 out of 387	0.0	1 out of 387	0.3
Malad River	23 out of 80	28.8	39 out of 80	48.9
Clover Creek	4 out of 17	23.5	17 out of 17	100.0
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.				

2. UN-IONIZED AMMONIA

A summary of un-ionized ammonia ($NH_3°$) exceedences is detailed in Table 55 for the tributaries listed. Toxic exceedences were considered as values ≥ 0.020 mg $NH_3°$/L which are not protective for fisheries relative to eutrophication concerns. The data indicates that Clover Creek has major exceedences (>10%) whereas the other waterbodies have none or minor exceedences (<10%).

Table 55 Un-ionized ammonia exceedences in tributaries of Upper Snake Rock from 1990 through 1997

Tributaries	% Un-ionized of Total Ammonia	Number of Un-ionized Samples per N	Specific Dates and Concentrations
East Perrine Coulee	0.0	0 out of 278	None found
Rock Creek	0.7%	2 out of 288	03-18-91 = 0.035 07-01-91 = 0.058
Cedar Draw	1.8%	5 out of 277	7/24/1990; 9/3/1990; 3/19/1991; 7/22/1997; 8/4/1997
Mud Creek	1.4%	4 out of 277	7/10/1990; 9/3/1990; 3/19/1991; 7/22/1997; 8/4/1997

Tributaries	% Un-ionized of Total Ammonia	Number of Un-ionized Samples per N	Specific Dates and Concentrations
Deep Creek	1.8%	5 out of 275	3/20/1991; 6/12/1991; 7/1/1991; 7/8/1991/ 7/10/1991
Salmon Falls Creek	0.0	0 out of 270	None found
Billingsley Creek	2.4%	10 out of 417	3/30/1992; 5/27/1992; 6/30/1992; 7/28/1992; 5/23/1994; 8/29/1995; 4/16/1996 (on 4 separate sites)
Malad River	0.0	0 out of 88	None found
Clover Creek	2.4%	1 out of 42	2/12/1997

Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring. The un-ionized fraction of total ammonia was calculated from the equilibrium stoichiometric relationship NH3 + nH2O = NH3:nH2O = NH4 + OH + (n-1)H2O. Most water quality models predict the concentration of measured ammonia in units of weight/volume as a resultant of processes of nitrification, ammonification, respiration, and assimilation. Therefore, un-ionized NH3, mg/L = (X)/(1+R), where X = total ammonia, mg/L; R = 10^Exponent; Exponent = (0.09018)+(2729.92/C+273.15)-(pH); C = degrees Centrigrade (USEPA 1985 [pp 261-264].

3. TOTAL PHOSPHORUS (TP)

Samples at or below the water quality target of 0.075 mg/L TP for the suggested preliminary prevention level for the development of biological nuisances and the acceleration of cultural eutrophication are listed in Table 56. Overall, the Deep Creek, Salmon Falls Creek, Billingsley Creek, Malad River, and Clover Creek had the highest ranking in terms of the number of samples that were less the 0.075 mg/L TP. However, all tributaries had a sufficient number of samples that exceeded the 0.075 mg/L TP level.

Table 56 Total phosphorus in tributaries of Upper Snake Rock

Tributaries	Number ≤ 0.075 mg/L TP	% ≤ 0.075 mg/L	% > 0.075 mg/L
East Perrine Coulee	14 out of 225	6.2	93.8
Rock Creek	20 out of 288	6.9	93.1
Cedar Draw	12 out of 277	4.3	95.7
Mud Creek	11 out of 277	4.0	96.0
Deep Creek	71 out of 275	25.8	74.2
Salmon Falls Creek	120 out of 270	44.4	55.6
Billingsley Creek	135 out of 387	34.9	65.1
Malad River	51 out of 80	63.8	36.2
Clover Creek	9 out of 17	52.9	47.1

Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.

4. TOTAL SUSPENDED SOLIDS (TSS)

Table 57 summarizes on a per-tributary basis the number of samples that exceed the preliminary 52 mg/L TSS instream target, and 80 mg/L daily maximum. Additionally, the percentage of samples that are above the proposed instream target is also calculated and summarized.

Table 57 Total suspended solids (TSS) that exceed the proposed instream target of 52 mg/L

Tributary	Number of TSS values > 52 mg/L	Number of TSS values > 80 mg/L	Percent of TSS values > 52 mg/L	Percent of TSS values > 80 mg/L
East Perrine Coulee	152 out of 225	111 out of 225	70.7	49.3
Rock Creek	125 out of 288	72 out of 288	43.4	25.0
Cedar Draw	152 out of 277	111 out of 277	54.9	40.1
Mud Creek	55 out of 277	21 out of 277	19.9	7.6
Deep Creek	81 out of 275	43 out of 275	29.5	15.6
Salmon Falls Creek	60 out of 270	16 out of 270	22.2	5.9
Billingsley Creek	0 out of 417	0 out of 417	0.0	0.0
Malad River	8 out of 79	2 out of 80	10.1	2.5
Clover Creek	0 out of 17	0 out of 17	0.0	0.0
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.				

5. TURBIDITY (NTU) AND TOTAL SUSPENDED SOLIDS (TSS)

Table 58 summarizes on a per tributary basis relationship/correlation between turbidity (as NTU) versus TSS. Their statistical significance is provided as well as what the estimated turbidity reading would be given 52 mg/L TSS.

Table 58 NTU versus TSS on a tributary basis and its significance

Tributary	NTU versus TSS equation	Parameters of Significance r^2	F-ratio	p	Equivalent NTU at 52 mg/L TSS
East Perrine Coulee	NTU=0.547TSS + 13.235	0.847	568.2	0.000	41.7
Rock Creek	NTU=0.530TSS + 3.535	0.893	1124.3	0.000	31.1
Cedar Draw	NTU=0.387TSS + 19.738	0.722	300.0	0.000	39.9
Mud Creek	NTU=0.219TSS + 23.685	0.267	21.1	0.000	35.1
Deep Creek	NTU=0.392TSS + 10.839	0.821	562.6	0.000	31.2
Salmon Falls Creek	NTU=0.881TSS - 4.471	0.770	388.6	0.000	41.3
Billingsley Creek	NTU=1.237TSS + 1.401	0.758	560.7	0.000	54.6
Malad River	NTU=0.075TSS + 0.579	0.332	9.6	0.003	4.5
Clover Creek	NTU=0.862TSS + 4.534	0.647	10.8	0.005	49.4
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.					

Temporal variation by Julian Day per NTU or TSS was also examined in order to account for the varying time periods from year-to-year from 1990 to 1997. Since NTU is correlated to TSS (as demonstrated in Table 58), it was necessary to know if NTU and/or TSS are increasing or decreasing from year-to-year. These are summarized as follows:

1. East Perrine Coulee has a weak increasing trend for NTU (NTU = 0.015 JULIAN

+ 51.147, r^2 = 0.159, *F*-ratio = 5.8, p = 0.017) while TSS appears to be stationary (r^2= 0.058, *F*-ratio = 0.7, p = 0.390).

2. Rock Creek has a weak increasing trend for both NTU (NTU = 0.010 JULIAN + 23.718, r^2 = 0.189, *F*-ratio = 10.6, p = 0.001) and TSS (TSS = 0.011JULIAN + 49.962, r^2 0.123, *F*-ratio = 4.4, p = 0.038).

3. Cedar Draw has an increasing trend in NTU (NTU = 0.017JULIAN + 26.344, r^2 = 0.297, *F*-ratio = 26.6, p = 0.000) and a TSS that appears stationary (r^2 = 0.034, *F*-ratio = 0.3, p = 0.568).

4. Mud Creek has a stationary NTU (r^2 = 0.042, *F*-ratio = 0.5, p = 0.482) but a weak decreasing TSS trend (TSS = -0.005JULIAN + 47.339, r^2 = 0.143, *F*-ratio = 5.8, p = 0.017).

5. Deep Creek has an increasing trend for NTU (NTU = 0.017JULIAN + 5.010, r^2 = 0.338, *F*-ratio = 35.2, p = 0.000) but a weak stationary trend for TSS (r^2 = 0.105, *F*-ratio = 3.1, p = 0.081).

6. Salmon Falls Creek has both a weak increasing trend for NTU (NTU = 0.008JULIAN + 14.264, r^2 = 0.152, *F*-ratio = 6.3, p = 0.012) and TSS (TSS = 0.007JULIAN + 25.207, r^2 = 0.148, *F*-ratio = 6.0, p = 0.015).

7. Billingsley Creek has a decreasing NTU trend (NTU = -0.004JULIAN + 13.075, r^2 = 0.161, *F*-ratio = 11.0, p = 0.001) but a stationary TSS trend (r^2 = 0.010, *F*-ratio = 0.04, p = 0.842).

8. Malad River has both an increasing trend for NTU (NTU = 0.002JULIAN - 0.037, r^2 = 0.321, *F*-ratio = 8.8, p = 0.004) and for TSS (TSS = 0.012JULIAN + 7.141, r^2 = 0.464, *F* = 21.1, p = 0.000).

9. Clover Creek has a decreasing NTU trend (NTU = -0.089JULIAN + 260.858, r^2 = 0.626, *F*-ratio = 9.7, p = 0.007) and a stationary TSS trend (r^2 = 0.374, *F*-ratio = 2.4, p = 0.139).

2.2.4.3 TRIBUTARY FECAL BACTERIA DATA ASSESSMENT

Table 59 describes per indicated tributary the bacteria assessment based on bacteria monitoring from 1990 through 1997. Assessment is based on the number of instantaneous samples that had exceedences greater than 500 colonies/100 mL of water for primary contact recreation (PCR), and the number of instantaneous samples that had exceedences greater than 800 colonies/100 mL of water for secondary contact recreation (SCR) from 1990 through 1997. See IDAPA §16.01.02.100.03.a and 16.01.02.250.01.a for primary contact recreation, and IDAPA §16.01.02.100.03.b and 16.01.02.250.01.b for secondary contact recreation. A weighted means analysis was also conducted between the fecal value for PCR and the fecal value for SCR to arrive at a weighted means value for ranking of the tributaries according to both criteria. Finally, a comparison of the geometric mean and the arithmetic mean of the fecal data was conducted as irrigation season versus nonirrigation season versus overall year.

Table 59 Bacteria assessment summary of primary and secondary contact recreation (1990-1997) on tributaries

Tributaries	Primary Contact Recreation % Samples > 500 Fecal Colonies	Secondary Contact Recreation % Samles > 800 Fecal Colonies	% Weighted Means Assessment Analysis (PCR+SCR)	Means Comparisons Geomean (Arithmetic Mean)		
				Overall Means	Irrigation Means	Non Irrigation
East Perrine Coulee	66/225 = 29.3%	30/225 = 13.3%	24.3% (N=96)	270(731)	410(970)	96(143)
Rock Creek	69/246 = 28.0%	42/246 = 17.1%	23.9% (N=111)	214(467)	398(583)	58(223)
Cottonwood Creek	4/36 = 11.1%	1/36 = 2.8%	7.0% (N=36)	40(181)	69(220)	6(43)
Cedar Draw	80/225 = 35.6%	35/225 = 15.6%	29.5% (N=115)	233(664)	541(937)	36(58)
Mud Creek	111/227 = 48.9%	77/227 = 33.9%	42.8% (N=188)	413(750)	725(1006)	123(198)
Deep Creek	36/224 = 16.1%	13/224 = 5.8%	13.4% (N=49)	146(305)	289(396)	30(97)
Salmon Falls Creek	17/270 = 6.3%	11/270 = 4.1%	5.4% (N=28)	96(867)	127(184)	54(2278)
Billingsley Creek	44/421 = 10.5%	27/421 = 6.4%	8.9% (N=71)	81(437)	77(511)	87(351)
Malad River	5/23 = 21.7%	5/23 = 21.7%	21.7% (N=10)	45(3571)	63(4913)	26(1382)
Clover Creek	2/17 = 11.8%	0/17 = 0%	11.8% (N=2)	48(95)	41(79)	156(213)

Prepared by IDEQ-TFRO. FECAL COLI. = FECAL COLIFORM. Weighted means assessment analysis = [(N1 x %1) + (N2 x %2)] / NT; where, N1 = population of Primary Contact Recreation (PCR) sample, N2 = population of Secondary Contact Recreation (SCR) Sample. Cottonwood Creek fecal coliform data based on 1997 monitoring.

Ranking the fecal coliform samples in the primary and secondary contact recreation areas according to % exceedence provides the following assessment:

1. For primary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (48.9%), Cedar Draw (35.6%), East Perrine Coulee (29.3%), Rock Creek (28.0%), Malad River (21.7%), Deep Creek (16.1%), Clover Creek (11.8%), Billingsley Creek (10.5%), and Salmon Falls Creek (6.3%).

2. For secondary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (33.9%), Malad River (21.7%), Rock Creek (17.1%), Cedar Draw (15.6%), East Perrine Coulee (13.3%), Billingsley Creek (6.4%), Deep Creek (5.8%), Salmon Falls Creek (4.1%), and Clover Creek (0%).

3. For a weighted means analysis of primary and secondary contact recreation values to rank the tributaries from the most-to-least exceedences are: Mud Creek (42.8%), Cedar Draw (29.5%), East Perrine Coulee (24.3%), Rock Creek (23.9%), Malad River (21.7%), Deep Creek (13.4%), Clover Creek (11.8%), Billingsley Creek (8.9%), and Salmon Falls Creek (5.4%).

4. The means comparison of the geometric mean to the arithmetic mean indicates that in most cases, the irrigation season had fecal coliform levels much greater than the nonirrigation season. Exceptions to this are Salmon Falls Creek which increases when comparing its arithmetic mean and Clover Creek which increases in both geometric and arithmetic means.

2.2.5 IDENTIFICATION OF ANY DATA GAPS

"Generally, monitoring programs are financially constrained to a limited number of sampling days. It is difficult to make inferences about a monthly or biweekly monitoring program from these types of results (EPA 1997)."

2.3 POLLUTANT SOURCE INVENTORY

Table 60 summarizes the pollutant sources within the Upper Snake Rock subbasin for specific streams listed on the 303(d) list or which are known to be impaired. For point sources, the number of aquaculture, public owned treatment works (POTW), and food processing facilities are identified. For nonpoint sources, a simple YES or NO tells if the stream is affected by the particular nonpoint source activity based on known historical information. Nonpoint sources include grazing, agriculture, forestry, CFOs, recreation, and FERC licensed facilities. During TMDL development the IDEQ-TFRO and the Mid-Snake WAG/TAC will determine the extent to which these sources affect the various water bodies.

TABLE 60 General inventory of point and nonpoint sources

WATERBODY IDENTIFICATION	INVENTORY OF POINT AND NONPOINT SOURCES									
	POINT SOURCES				NONPOINT SOURCES					
	A/Q	POTW	FOOD	INDUS	FERC	GRAZE	AG	FOREST	CFOs	REC
Alpheus Creek	0	0	0	0	0	0	0	0	0	Yes
Billingsley Creek	8	0	0	0	2	Yes	Yes	0	Yes	Yes
Blind Canyon Creek	1	0	0	0	1	Yes	Yes	0	Yes	0
Cedar Draw	9	1	0	0	2	Yes	Yes	0	Yes	Yes
Clear Springs	5	0	0	0	1	0	Yes	0	Yes	Yes
Clover Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Cottonwood Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Crystal Springs	1	0	0	0	0	0	Yes	0	Yes	Yes
Deep Creek	6	0	0	0	1	Yes	Yes	0	Yes	Yes
Dry Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Dry Creek, West Fork	0	0	0	0	0	Yes	0	0	0	Yes
McMullen Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Mud Creek	10	1	0	0	2	Yes	Yes	0	Yes	Yes
East Perrine Coulee	0	0	0	0	1	Yes	Yes	0	Yes	Yes
Riley Creek	2	0	0	0	0	0	Yes	0	0	Yes
Rock Creek	8	0	1	2	2	Yes	Yes	0	Yes	Yes
Sand Springs Creek	1	0	0	0	1	0	Yes	0	0	Yes
Middle Snake River	37	4	2	0	18	Yes	Yes	0	Yes	Yes
Tool Box Creek	0	0	0	0	0	Yes	0	0	0	Yes
Total No. Facilities	88	6	3	2	31	?	?	?	?	?
% Streams Affected	50%	14%	9%	5%	45%	77%	84%	0%	74%	91%

Prepared by IDEQ-TFRO: A/Q = Aquaculture; POTWs = Privately owned treatment works or sewage treatment plants; FOOD = Food processors; FERC = FERC-type facilities for power generation and/or damming; INDUS = Industrial-type facilities; GRAZE = Grazing; AG = both irrigated and nonirrigated agriculture; FOREST = Forestry; CFOs = Confined Feeding Operations; REC = Recreation.

3.0.3 NONPOINT SOURCE DRIVEN STREAMS

As previously noted, the following 12 segments are strictly nonpoint source driven: Alpheus Creek, Clover Creek, Cottonwood Creek (as part of the Rock Creek Complex), Dry Creek (all three segments: Medley Creek to the Snake River, Headwaters to Medley Creek, and Headwaters to Dry Creek), and McMullen Creek (as part of the Rock Creek Complex). The allocation of loadings for these streams will be based on the stream corridor approach model.

3.0.4 POINT AND NONPOINT SOURCE DRIVEN STREAMS

The remainder of the water quality limited stream segments are affected by both point and nonpoint sources. These streams include: Billingsley Creek, Blind Canyon Creek, Clear Springs, Crystal Springs, Riley Creek, Rock Creek, and Thousand Springs Creek. The Middle Snake River and the five reservoirs are affected by both point and nonpoint sources.

3.1 INSTREAM WATER QUALITY TARGET(S)

Instream water quality targets were identified for the pollutants of concern and are defined in the following sections. Pursuant to IDAPA 16.01.02.400(01)(b) for point sources, failure to meet general or specific water quality criteria is a violation of the water quality standards except in an area defined as a mixing zone (IDAPA 16.01.02.003(59): "a defined area ... of the receiving water surrounding or adjacent to a wastewater discharge where the receiving water, as a result of the discharge, may not meet all applicable water quality criteria or standards. It is considered a place where wastewater mixes with receiving water and not as a place where effluents are treated." (See IDAPA 16.01.02.060 for Mixing Zone Policy.) For site-specific surface water quality criteria, IDAPA 16.01.02.275(a)(iv) allows for water quality criteria to be "derived to protect and maintain existing ambient water quality." Surface water quality within any stream segment that can be demonstrated to be below the instream water quality target will be considered for site-specific criteria development after Year 5 of plan implementation. Site-specific criteria "shall not impair designated or existing beneficial uses year-round (or seasonally for seasonal dependent criteria) and shall prevent acute and chronic toxicity outside of approved mixing zones (IDAPA 16.01.02.275(c)."

3.1.1 SUSPENDED SEDIMENTS, LOAD CAPACITY, AND SUBSTRATE SEDIMENTS

This section is about sediment and how IDEQ-TFRO proposes to deal with it in terms of pollution reduction measures. Suspended sediment (as total suspended solids) is defined as an instream target that is correlated to load capacity (or assimilative capacity). Reductions in suspended sediment will lead to attainment of beneficial uses and State water quality standards. A substrate sediment target, although desirable under certain conditions, is not suggested at this time due to a lack of scientific and legally defendable data. Contaminated sediment affected by toxic substances (such as heavy metals) is not known to be a problem in the Middle Snake River or its tributaries, and therefore will not be addressed in this TMDL at this time.

SUSPENDED SEDIMENTS AND LOAD CAPACITY

See Appendix D, *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan*, for discussion on instream targets. As discussed in the subbasin assessment (§2.2.3.3, item 5, Sediment and "Settable Substances") sediment is the most common nonpoint source pollutant in the Upper Snake Rock subbasin affecting beneficial uses of salmonid spawning and cold water biota. However, sediment is a narrative standard in the State water quality standards, thus no numeric criteria is cited. A

narrative standard for sediment is necessary to accommodate the vast ranges of sediment conditions which exist in various streams. IDEQ researched and selected an instream water quality target of 52 mg/L for use on both tributaries and the Middle Snake River. This is based on the severity of effects of sediment and its relationship to the duration of exposure of TSS to fisheries, and the amount of protection that fish and other aquatic biota are afforded with this concentration. A TSS concentration of < 80 mg/L TSS affords a moderate-to-high protection level with a none-to-slightly reduced fisheries. Target concentrations at 80 mg/L TSS sustained for 30 or more days consecutively may result in lethal or paralethal effects on fisheries. Therefore, IDEQ-TFRO has determined the quantification of the narrative standard by proposing a preliminary instream water quality target of 52 mg/L TSS as a monthly average concentration with a maximum daily concentration of 80 mg/L TSS (see CH2MHILL 1998 for additional information). The 52 mg/L will also serve as the load capacity for any stream in the Upper Snake Rock subbasin. The 52 mg/L TSS instream target is an appropriate preliminary target for protecting fisheries from excessive sediments > 80 mg/L. The 52 mg/L TSS instream target is a preliminary target that will be used to bring all industries into compliance within 5 years of plan effectiveness, and held for an additional 5 years to determine the effects of such reductions. This target supports a "good fishery (EIFAC 1964; NAS/NAE 1973)," and a "regional comparison for a high level of protection for cold water biota (IDHW 1991a [p 13])," thus meeting a quantity for supporting designated beneficial uses and State water quality standards for excess sediment. IDEQ-TFRO considers the 52 mg/L monthly average and the 80 mg/L maximum daily concentrations as a valid interpretation of Idaho's narrative sediment criteria for the Middle Snake River and its surface waterbodies (tributaries and irrigation return flows), and thus meets the requirements of the Clean Water Act.

Application of the load capacity (52 mg/L TSS), the instream target (52 mg/L TSS), and existing conditions to various flow scenarios is summarized below for the various Middle Snake River segments based on the information compiled and summarized in Appendix D. Additionally, it was assessed from statistical analysis of existing data, that unlike total phosphorus which dilutes more readily under high flow conditions, TSS increases substantially. Flow information from USGS was used for design flow analysis in the comparison of low flow, mean flow, and high flow conditions for the development of sediment rating curves.

Segment Site	Minimum Load (based on Low Q)	Mean Load (based on Mean Q)	Maximum Load (based on High Q)
≤ 52 mg/L TSS as the Instream Target and Load Capacity, tons/year			
Milner Dam	18,721.3	197,443.2	482,457.2
Pillar Falls	58,619.2	242,302.8	544,452.3
Crystal Spgs	94,731.8	281,228.7	583,327.1
Box Canyon	182,762.9	368,901.7	668,749.5
Gridley Bridge	277,699.3	466,140.0	773,609.2
Shoestring	341,382.4	568,186.4	900,157.1
King Hill	377,699.7	583,020.2	924,249.2
Overall Range	358,978.4	385,577.0	441,792.0
Average Conditions Based on 1990-1998 Compiled Data			
Milner Dam	5,261.1	62,491.0	179,994.4
Pillar Falls	13,487.9	71,497.9	218,853.9
Crystal Spgs	24,422.0	102,768.9	314,861.7
Box Canyon	65,133.5	183,773.4	485,883.9

Overall Range = (King Hill - Milner Dam). See Appendix D, Technical Support Document, §2.

Gridley Bridge	63,620.2	186,809.1	526,709.5
Shoestring	28,297.9	196,950.4	659,509.1
King Hill	110,104.6	300,426.8	819,996.0
Overall Range	104,843.5	237,935.8	640,001.6

Overall Range = (King Hill - Milner Dam) See Appendix D, Technical Support Document, §2.

Estimate % Reduction (% R) Based on Site and Overall Range Basis

Milner Dam	71.9%	68.3%	62.7%
Pillar Falls	77.0%	70.5%	59.8%
Crystal Spgs	74.2%	63.5%	46.0%
Box Canyon	64.4%	50.2%	27.3%
Gridley Bridge	77.1%	59.9%	31.9%
Shoestring	91.7%	65.3%	26.7%
King Hill	70.8%	48.5%	11.3%
Overall Range	70.8%	38.3%	(-44.9%)

In comparing average conditions versus the load capacity targets at Milner Dam there is a 71.9% less TSS under low flow years, a 68.3% less TSS for mean flow years, and a 62.7% less TSS for high flow years. Under low flow conditions the least amount of TSS loads occur in the river system because the TSS concentration stays relatively the same with a range from 4.3 mg/L to 18.5 mg/L (with a mean of 12.8 mg/L and a variance of 14.2 mg/L). Under high flow conditions a worse-case scenario occurs for TSS loads because TSS concentrations increase from upstream to downstream with a range of 19.4 mg/L to 46.1 mg/L (with a mean of 32.3 mg/L and a variance of 26.7 mg/L). This increase in TSS concentration under high flow conditions creates extreme TSS load conditions for the river system. In essence, the condition reflects a saturation of TSS creating high turbidity in the water. Therefore, reductions in TSS load inputs from existing conditions to a level below 52 mg/L TSS will lead to significant load reductions which will reduce the buildup potential for washload (< 0.062 mm particles) in the substrate. If those reductions are reasonably maintained during mean and high flow conditions, then conditions in the river system will improve dramatically, thus leading to attainment of beneficial uses and State water quality standards. However, the impacts from TSS under high flow conditions cannot be dismissed. In a managed system, such as is the case with the Middle Snake River, high flows can be a paradox: on the one hand they are necessary to scour and clean up the system of TSS buildup; on the other hand, they can be potentially detrimental to water quality due to substantial TSS increase. A view of the overall range indicates that TSS reductions occur under low and average flow conditions. But under high flow conditions there is a net increase (-44.9%) in the amount of sediment being transported and stirred up in the water column.

Therefore, IDEQ-TFRO will continue to assess the impacts of TSS under various flow regimes, and will investigate what options may be available in the management of excessive high flows such that TSS does not continue to be an accumulative impactor to the system as evidenced in the data already collected. This does not mean that high flows are the main source of higher TSS values in the downstream reaches of the Middle Snake River. Rather, it indicates that managed high flows will potentially aid in retarding some of the excessive sediments that appear to accumulate in the downstream segments. Reductions from nonpoint source inputs are still a serious consideration and are addressed in the 52 mg/L TSS average monthly limit and the 80 mg/L TSS maximum daily limit.

SUBSTRATE SEDIMENTS

There is no question that fine sediment and its accumulation is detrimental to salmonid spawning since it limits the quality and quantity of inter-gravel spaces that are critical for egg incubation. Fine sediment and availability of living space have direct affects on both fisheries and macroinvertebrates (IDHW 1999 [p 3]). Thus, sediment can impact aquatic environments and species by physically covering their habitat, adding nutrient loading, and potentially creating hypoxic or anoxic conditions. In the Upper Snake Rock subbasin, as previously discussed, the principal sources of total suspended sediment load to the Middle Snake River are surface waterbodies (tributaries and irrigation return drains). IDEQ-TFRO has discussed substrate sediment targets for the Middle Snake River with USEPA to aid with the recovery of the endangered mollusc species. IDEQ-TFRO has also discussed this issue with the Middle Snake River TAC on a number of occasions, with the consensus that little scientific information exists to quantify reasonable substrate targets. USEPA and USFWS are ill-prepared at this time to provide technical guidance in the development of these targets because of insufficient scientific information that is specific for the Middle Snake River and its tributaries, particularly in defining targets that are reasonable and achievable with linkage to the protection of the endangered mollusc species. There is also no current or historical information that can provide direction as to what level or levels of sediment are permissible for the viability of aquatic species and their related environments.

It seems reasonable and prudent that as a consequence of the imposed NPDES permit limits for TSS on aquaculture facilities, municipalities, and food processors, that a regular review of the effectiveness of TSS concentration reductions (and consequently TSS load reductions) under the more stringent TSS limits would provide a pathway for USEPA and USFWS to determine if the implementation of BMPs by point sources will lead to the success of the reduction of TSS loadings to the Middle Snake River and its tributaries. Therefore, IDEQ-TFRO will conduct regular reviews of the effectiveness of TSS reductions for both point source and nonpoint sources, and provide this information to the Middle Snake River TAC and WAG, as well as the USEPA and USFWS.

Substrate sediment targets are inappropriate in the Middle Snake River or its tributaries because fine bedload materials (sands, small gravel, silt, and clay fractions) are derived from largely the same sources as the measured suspended sediment materials. Using TSS is a sufficient "surrogate" for the total sediment load because its true substrate sediment comprises a smaller percentage when compared to TSS. TSS comprises a much larger percentage of the total sediment load. Thus, actions taken to reduce suspended sediment load (as TSS) will also reduce the fine bed material load (or more appropriately the "washload") that is commensurate to or greater than TSS reductions. In the Middle Snake River system there is minimal bedload substrate; washload is predominant. Smaller sediment sizes require less energy to be dis-lodged and transported and are thus less easily trapped or kept in place under average-to-high flow conditions. BMPs will need to be developed (on site specific areas within each surface waterbody) that address surface erosion (comprised mostly of silts and clay) which eventually are transported into the river system.

As previously described in the subbasin assessment (§2.2.3.3, item 5, Sediment and "Settable Substances"), the Falter Study (Falter *et al.* 1995; Falter *et al.* 1996) indicated that the Crystal Springs and Box Canyon sites (limited to depositional sites with weedbeds and deep pools) were dominated by fines (< 0.075 mm). Falter's results can be compared to GeoSea® Consulting's Study (McLaren 1998) which indicate that in 1997 the sediment particle size was mostly sand and gravel (due to high flushing flows in 1996 and 1997), whereas in 1993-1994 it was mostly silt and clay or muddy sediment (due to low flow conditions). USGS's substrate study in 1993-1995 on substrate size, embeddedness, and substrate fines (< 6 mm) (USGS 1997a) showed the similarity between Rock Creek and the Middle Snake River, thus indicating that the substrate character of sediment inputs is similar to the substrate character of the river. A decrease in the suspended sediment (as

TSS) in the surface waterbody inputs will result in a decrease in the fines and embeddedness of such waterbodies. This in turn will also help to reduce the fines and embeddedness of the Middle Snake River. Below is a comparison of these three studies:

1993-1994 FALTER STUDY

YEAR	LOCATION	SAND	SILT	CLAY
1993	Crystal Springs & Box Canyon	56.7%	40.0%	3.3%
1993	Crystal Springs & Box Canyon	53.6-61.4%	36.5-43.6%	2.1-4.5%
1994	Crystal Springs & Box Canyon	53.6%	39.8%	5.5%
1994	Crystal Springs & Box Canyon	51.2-72.1%	25.2-41.2%	2.7-6.2%

1993-1995 USGS STUDY

YEAR	LOCATION	SUBSTRATE	EMBEDD	FINES
1993	Snake River near Buhl	3.1%	80.0%	76.0%
1993	Snake River at King Hill	2.1%	47.0%	38.0%
1994	Snake River at King Hill	2.1%	47.0%	38.0%
1995	Snake River at King Hill	2.1%	47.0%	38.0%
1993	Rock Creek at Twin Falls	3.5%	74.0%	35.0%
1994	Rock Creek at Twin Falls	2.2%	74.3%	29.0%
1995	Rock Creek at Twin Falls	3.3%	90.0%	29.0%

1997 GeoSea® STUDY

YEAR	LOCATION	SAND/GRAVEL	SANDY MUD	MUD
1997	Middle Snake River	45%	47%	8%

These were the only studies that could be found that describe sediment conditions on the Middle Snake River for the period 1990-1998. In effect, macrophyte habitat buildup in the Middle Snake River will increase as flows decrease and fine deposits from tributaries and irrigation returns maintain dominance over the traction transport of the river bed. In conjunction with GeoSea® Consulting's Study, IDEQ-TFRO has also determined the growth of macrophyte habitat can be controlled by periodic flushing of the river. Erosion of the macrophyte habitat appears to begin at an average flow range of 1,000-1,300 cfs, which is typical of river systems that have silt and clay deposits comprising the major sediment fraction. An average flow of 6,000 cfs from June to October would increase velocities sufficiently to reduce macrophytic growth (SRBWC 1994 [p L-1]). At an average of 10,000 cfs erosion of fine grained material (sand, silt, clay fractions) occurs and is added to the river as suspended load.

In addition to these studies, IDEQ-TFRO also confirms GeoSea® Consulting's Study that muddy sediments are most frequently found along the shallow sides of the river. IDEQ-TFRO confirmed this through visitation of 13 monitoring sites on the Middle Snake River. In fact, muddy sediments tend to increase from upstream to downstream as shown in §3.5.07, Table 105, since the TSS increases accordingly. Muddy sediment is carried mostly in suspension and is deposited along the upper levels of the river sides where friction reduces flow velocities. Sandy sediments, on the other hand, appear to be carried by traction along the river bottom in deeper water. Prior to the flushing flows of 1996-1997, the main channel in depths below a few feet was comprised of higher levels of silt and clay. In a rating of proper functioning condition USBLM considers channel bottom silt and clay fractions of wadable streams as: < 10% optimal; 10-30% suboptimal; 30-50% marginal; and, > 50% poor. Discussions with USBLM and USFS suggest that application of this characterization to managed large rivers may have some merit, but there is insufficient information to support

this hypothesis. Thus, the Middle Snake River from 1993-1994 (low flow conditions) had 40-43% fines (as silt and clay) which indicate a sub-optimal condition; whereas, in 1997 (high flow conditions) the fines (as silt and clay) were 8% which indicates an optimal condition. Does this mean that <10% fines (as silt and clay) in the Middle Snake River is a reasonable substrate target for protection of aquatic life? Without the additional collection of substrate sediment and macroinvertebrate information it is uncertain at this time if any estimated value (of fines) is scientifically correct and legally defendable. The implication, however, is worth pursuing since Rowe *et al.* suggest that a concentration of subsurface sediment (<0.85 mm) should not exceed 10% (IDEQ 1998e [p 14]).

Therefore, IDEQ-TFRO is not prepared at this time to propose substrate targets for the Middle Snake River or its tributaries because of the managed condition of the river system; the nature of the input sediments; the lack of appropriate substrate sediment research information; and, because IDEQ-TFRO strongly believes that suspended sediment (as TSS) is an appropriate surrogate for substrate sediment reduction. However, IDEQ-TFRO will continue to actively assess and evaluate current and any additional data that defines substrate sediments and will consider a joint-study with USEPA and USFWS so that this issue can be resolved over the next 5 years. In the meantime, monitoring of the Middle Snake River will continue to be a priority of IDEQ-TFRO over the next 10 years of plan implementation, as well as the development and incorporation of a trend monitoring plan which has been developed by the Mid-Snake TAC for periodic ecosystem evaluation as it relates to the TMDL.

3.1.2 TOTAL PHOSPHORUS

See Appendix D for discussion on instream targets. "In streams, phosphorus occurs primarily as phosphate and can be either dissolved, incorporated in organisms, or attached to particles in the water or in bottom sediments (USGS 1994 [chapter 4])." As described in §2.2.3.3, total phosphorus should not exceed 0.05 mg/L TP in streams where it enters a lake or reservoir to prevent the development of biological nuisances and to control accelerated or cultural eutrophication. To prevent plant nuisances in flowing waters not discharging directly to lakes or impoundments, a desired goal of 0.100 mg/L TP is suggested ("Gold Book" and "Blue Book" value). For a lake or a reservoir, the suggested goal is 0.025 mg/L TP. Because of the modified flow regime with run-of-the-river impoundments, the Mid-Snake TMDL uses a water quality target of 0.075 mg/L TP at the Gridley Bridge, Hagerman, Idaho site. This represents a value between 0.050 and 0.100 mg/L TP. Since excess nutrients is a narrative standard in the State Water Quality Standards, no numeric criteria is cited. Therefore, IDEQ selected for TP an instream water quality target of 0.100 mg/L on tributaries and 0.075 mg/L on the Middle Snake River. SRP is not being considered as a separate TMDL since TP accounts for all the phosphorus in the system, implying that reductions in TP will also produce reductions in SRP. *This water quality target (0.075 mg/L TP) is now proposed as a representative average of the whole Middle Snake River system, assuming that the water quality pollution targets by the various water user industries are implemented over a 10-year period*. This water quality target assumes that water pollution targets by the various water user industries will be implemented over a 10-year period. It is not a target that is assumed to be completely protective of the resource or the designated beneficial uses, or the final target in total phosphorus reductions for the Middle Snake River. But it is a target that industries and agencies agreed would be a starting point for targeting of phosphorus reductions to reduce nuisance aquatic plant growth at select portions of the river where most nuisance plant growths are known to exist, and where the swimmability and boatability of the river could be restored.

The instream target of 0.075 mg/L for the Middle Snake River was never suggested or implied for application to tributary waters that feed to the Middle Snake River because it was always assumed that these smaller tributaries were not modified flow regime systems. As previously described, a water quality target of 0.100

mg/L (or less) for all other tributaries throughout their entire length, from their source water (if applicable) to their discharge with the Middle Snake River seems appropriate. Thus, tributaries or streams discharging to the Middle Snake River are to discharge at TP concentrations not exceeding 0.100 mg/L. From upstream to downstream the overall target of the Middle Snake River is 0.075 mg/L. These criteria are preliminary targets that will be used to bring all industries into compliance within 5 years of plan effectiveness, and held for an additional 5 years to determine the effects of such reductions. The 0.100 mg/L instream target is appropriate for the tributaries because the water regimes are flowing systems, and the instream target will prevent nuisance algal growths.

Total phosphorus allocations defined in the Mid-Snake TMDL shall continue to be enforced for those industries that have wasteload or load allocations. For point source industries, such as aquaculture, which have a portion of the facilities defined as TBD (To Be Determined), these wasteload allocations will not be defined until after 3 years of monitoring. Permits for point source industries are described in Table 81 as to when they were signed, when they became effective, and when they will expire. Under the TMDL, a permit may be re-opened to incorporate provisions of the TMDL that better describes the wasteload allocations. This has always been the intent for wasteload allocations for point sources.

Table 81 Permitted industries permit signing, effectiveness, and expiration under the Mid-Snake TMDL

Industry or Facility	*Permit Signed*	*Permit Effectiveness*	*Permit Expiration*
Aquaculture Industry	August 19, 1999	September 10, 1999	September 10, 2004
City of Buhl	July 29, 1999	August 31, 1999	August 31, 2004
City of Filer	July 29, 1999	August 31, 1999	August 31, 2004
City of Hagerman	July 29, 1999	August 31, 1999	August 31, 2004
City of Hansen	July 29, 1999	August 31, 1999	August 31, 2004
City of Jerome	July 29, 1999	August 31, 1999	August 31, 2004
City of Twin Falls	July 29, 1999	August 31, 1999	August 31, 2004
J.R. Simplot-Burley	July 29, 1999	August 31, 1999	August 31, 2004
McCains-Burley	July 29, 1999	August 31, 1999	August 31, 2004
Prepared by IDEQ-TFRO. Permits will be re-opened after 3 years of monitoring for assessment of wasteload allocations and incorporation of those wasteloads as permit limits for the defined parameter.			

For nonpoint source industries, like irrigated agriculture, load allocations defined in the Mid-Snake TMDL will continue to be enforced with the provision that if any of the 18 named agricultural drains meets its defined goals for TP reductions but is still above the level imposed by the Upper Snake Rock TMDL, then they will have to reduce additionally to the level defined in the Upper Snake Rock TMDL.

3.1.3 PATHOGENS

For pathogens the development of specific BMPs by the land management agencies during the implementation phase of the TMDL process for Upper Snake Rock will be used to demonstrate reductions towards State Water Quality Standards. The Idaho Rules and Regulations instantaneous limits of 500 and 800 colonies/100 mL (primary and secondary contact recreation) will continue to be used, unless changes in the regulations allow for *E. Coli* to be used instead of fecal coliform. Additionally, reductions in TSS will also

show reductions in fecal coliform bacteria levels. See Appendix D. See also §2.2.4.3 of sub basin assessment. Therefore, a TMDL for the Middle Snake River on pathogens will not be proposed at this time since it can be demonstrated that the river is meeting State Water Quality Standards for primary and secondary contact recreation. For tributaries, primary contact recreation exceedences are 430 out of 1878 total samples (or 22.9%), and for secondary contact recreation exceedences are 240 out of 1878 total samples (or 12.8%). Therefore, a TMDL is proposed that brings the percent of samples with fecal coliform bacteria exceedences down to a level that is less than 10.0% of the samples taken during a 30-day period for a particular stream for both primary and secondary contact recreation. This will require the development of a monitoring plan for the tributaries which the Mid-Snake WAG, the Mid-Snake TAC, and IDEQ-TFRO will develop during the implementation phase of the TMDL process. The following list summarizes the recommended actions based on the subbasin assessment §2.2.4.3 tributary fecal bacteria data and assessment. Recommendations are defined as follows: "No action required" means no TMDL or BMP plan will be required; "TMDL required" is specific for natural waterbodies and means that whether listed for bacteria or not, the waterbody needs to have a TMDL for bacteria; "Monitoring required" means that IDEQ-TFRO will conduct monitoring for pathogens within 24 months of TMDL acceptance and as a result of the monitoring will provide a pathogen assessment; and, "Action required" is specific for manmade waterways and implies that a BMP plan will need to be developed for this waterway that specifically looks at pathogen reductions to State water quality standards (an instream target of 400 cfu/100 mL) and that at the point of discharge to the natural waterway will have a TMDL for pathogens.

Surface Waterbody	***Listed for Bacteria?***	***Designation***	***Recommendation***
	303(d) LISTED STREAMS		
Alpheus Creek	No	DW	No action required
Billingsley Creek	No	DW, PCR, SCR	***TMDL required***
Blind Canyon Creek	Yes	SCR	Monitoring required
Clear Springs	No	SCR	Monitoring required
Clover Creek	No	PCR, SCR	***TMDL required***
Cottonwood Creek	Yes	SCR	***TMDL required***
Crystal Springs	No	SCR	Monitoring required
Dry Creek, Medley to SR	Yes	SCR	Monitoring required
Dry Creek, HW to Medley	Yes	SCR	Monitoring required
Dry Creek, West Fork	Yes	SCR	Monitoring required
Ellison Creek	Yes	SCR	No action required
McMullen Creek	Yes	SCR	Monitoring required
Riley Creek	Yes	DW, PCR, SCR	Monitoring required
Rock Creek (**)	Yes	PCR (*),SCR	***TMDL required***
Thousand Springs	No	SCR	Monitoring required
Vinyard Creek	Yes	SCR	No action required
Bliss Reservoir	No	PCR, SCR	No action required
Lower Salmon Falls Reservoir	No	PCR, SCR	No action required
Pioneer Reservoir	Yes	PCR, SCR	Monitoring required
Shoshone Falls Reservoir	No	PCR, SCR	No action required
Upper Salmon Falls Reservoir	No	PCR, SCR	No action required
Middle Snake River,			
Milner to Murtaugh	Yes	PCR, SCR	No action required
Murtaugh to King Hill	No	PCR, SCR	No action required

* = Protected for future use.

Recommendations based on assessments found in §2.2.4.1; 2.2.4.3; 3.0.2.1; 3.0.2.2; 3.0.2.3; 3.5. Where no monitoring information was available, then a monitoring plan will be developed and applied over the next 24 months to assess pathogen

impacts.

ADDITIONAL NATURAL SURFACE WATERBODIES NOT ON 303(d) LIST

Cedar Draw (**)	No	SCR	***TMDL required***
Mud Creek	No	SCR	***TMDL required***
Deep Creek (**)	No	SCR	***TMDL required***
Salmon Falls Creek	No	PCR, SCR	No action required
Malad River	No	PCR, SCR	***TMDL required***

**IDAPA 16.01.02.280 protects for water quality Rock Creek, Cedar Draw, and Deep Creek as used by the Twin Falls Canal Company as spillways, collection and conveyance facilities. This implies that water quality will be protected even under those conditions when the canal company uses it as a manmade conveyance. Thus, natural streams which have canalways that discharge to them shall be water quality protected even during the irrigation season, implying that discharges to them shall meet beneficial uses or State water quality standards. Recommendations based on assessments found in §2.2.4.1; 2.2.4.3; 3.0.2.1; 3.0.2.2; 3.0.2.3; 3.5.

MANMADE WATERBODIES

Drain/(%Exceedence)	***Pathogen Listing?***	***Designation***	***Recommendation***
North Side Canal Company Drains (Phase 1 Study)			
A Drain (16.7%)	No	Manmade Waterway	Action required
C55 Drain (5.6%)	No	Manmade Waterway	No action required
N42 Drain (36.4%)	No	Manmade Waterway	Action required
N42 Drain (Rim) (72.8%)	No	Manmade Waterway	Action required
J8 Drain (18.9%)	No	Manmade Waterway	Action required
S29 Drain (11.8%)	No	Manmade Waterway	Action required
S19/S Drains (36.8%)	No	Manmade Waterway	Action required
W26 Drain (11.1%)	No	Manmade Waterway	Action required
Twin Falls Canal Company Drains (Phase 1 Study)			
A10 Drain (35.3%)	No	Manmade Waterway	Action required
Twin Falls Coulee (33.3%)	No	Manmade Waterway	Action required
East Perrine Coulee (14.8%)	No	Manmade Waterway	Action required
Main Perrine Coulee (11.5%)	No	Manmade Waterway	Action required
West Perrine Coulee (22.2%)	No	Manmade Waterway	Action required
43 Drain (35.7%)	No	Manmade Waterway	Action required
30 Drain (16.7%)	No	Manmade Waterway	Action required
LQ/LS Drains (34.5%)	No	Manmade Waterway	Action required
LS2/39A Drain (33.3%)	No	Manmade Waterway	Action required
39 Drain (27.6%)	No	Manmade Waterway	Action required
I Drain (41.4%)	No	Manmade Waterway	Action required
N Drain (3.6%)	No	Manmade Waterway	No action required

DW = Drinking Water. PCR = Primary contact recreation. SCR = Secondary contact recreation.
Recommendations based on data found in the Phase 1 Study report.

Appendix D provides additional technical information on the linkage between bacteria and TSS. As a consequence of TSS reductions, it is anticipated that fecal coliform will be reduced as well. However, BMPs that specifically look at minimizing fecal coliform impacts due to land use will be assessed by the land management agencies during the implementation phase of the TMDL. These BMPs will be used to help develop specific farm plans that contain a pathogen management component that addresses specific actions for pathogen reduction in conjunction with other nonpoint source reductions. These plans will be developed

during the implementation phase of the TMDL. Where land management falls under the authority of the USFS or USBLM, it is expected that appropriate measures will be conducted by those agencies "to protect and maintain water quality where standards are met or surpassed, and restore water quality limited water bodies within their jurisdiction to conditions that meet or surpass standards for designated beneficial uses (USFS & USBLM & USEPA 1999 [p 1])." Where the land management falls under the authority of the Idaho Department of Lands (IDL), IDEQ will cooperate with that agency to develop a land management plan that will restore or help to bring restoration to a water quality limited stream. If the land management falls under the authority of private ownership, IDEQ will cooperate with NRCS, the Idaho Soil Conservation Commission, and the local soil conservation districts, and property owners to develop specific BMPs that will remediate the water quality limited stream. IDEQ-TFRO will annually assess all BMPs considered for inclusion for farm and/or allotment plans, and will make such assessments with the various land management agencies. Any BMP that is determined by IDEQ-TFRO in conjunction with the land management agency to be inadequate for water quality protection will be subject to removal from the farm and/or allotment plan, and will be replaced by another BMP that protects the water quality limited stream or stream segment. At all times, IDEQ-TFRO will be subject to all the rules governing nonpoint source activities as defined in IDAPA 16.01.02.350.

3.1.4 UN-IONIZED AMMONIA

See the Appendix D for additional information. No concentration greater than 0.020 mg/L of un-ionized ammonia is recommended at any time or place (USEPA 1972 [p 187]). In terms of assessing un-ionized NH3, IDEQ-TFRO used the total number of samples collected and categorized un-ionized ammonia as follows: (1) if the percent un-ionized ammonia of the total number of samples was zero, this was reported as *No Exceedences Found*; (2) if the percent un-ionized ammonia of the total number of samples was < 10.0, this was reported as *Minor Exceedences Found*; and, (3) if the percent un-ionized ammonia of the total number of samples was 10.0 or more, this was reported as *Major Exceedences Found*. Only stream segments with *Major Exceedences Found* will be considered for a TMDL. Precedence for this assessment approach is in *Guidelines for Preparation of the 1996 State Water Quality Assessments (305(b))* (USEPA 1995d).

For un-ionized NH3 no instream target is proposed at this time on the Middle Snake River. In § 2.2.4.1, item 2, of the sub basin assessment, it was demonstrated that of 1498 samples collected, only 5 samples (or 0.3%) exceeded the protective level (based on State water quality standards) for fisheries. These exceedences occurred in 1991, 1992, and 1995. Additionally, Table 51 summarizes the % Exceedences on a per-reach basis on the Middle Snake River. Only four reaches (Milner Dam, Murtaugh Bridge, Twin Falls Dam, and Crystal Springs) had exceedences but these were well in the minor exceedences level. IDEQ-TFRO proposes no instream target at this time. However, this parameter will continue to be reviewed based on monitoring information and a TMDL may be developed in the future if major exceedences result in the total number of samples collected.

For the tributaries, a summary of un-ionized ammonia exceedences is detailed in §2.2.4.2, item 2. These exceedences represent a fraction of all the tributaries (only 9). Some of the data is not reflective of 9 years, while some is reflective of a smaller portion of a single year. As a whole, the range of exceedences is from 0.0% to 2.4% of un-ionized ammonia. Therefore, in 2212 total samples (for all 9 tributaries) there were 27 un-ionized ammonia exceedences, or 1.2% of the total sample population. Individually and as summarized in Table 55, tributary streams have the following un-ionized ammonia exceedences (as a percent of the total number of samples collected): (Major exceedence tributaries are bolded in black; N_{TOTAL} is the total number of samples in the population; and, $N_{Un\text{-}ionized}$ is the total number of samples where un-ionized NH3 >= 0.020 mg/L).

DATA AS COLLECTED BY IDEQ-TFRO FROM 1990-1998:

Tributary	N_{TOTAL}	$N_{Un-ionized}$	% of Total	IDEQ-TFRO Assessment
East Perrine Coulee	278	0	0.0	No exceedences found
Rock Creek	288	2	0.7%	Minor exceedences found
Cedar Draw	277	5	1.8%	Minor exceedences found
Mud Creek	277	4	1.4%	Minor exceedences found
Deep Creek	275	5	1.8%	Minor exceedences found
Salmon Falls Creek	270	0	0.0	No exceedences found
Billingsley Creek	417	10	2.4%	Minor exceedences found
Malad River	88	0	0.0	No exceedences found
Clover Creek	42	1	2.4%	Minor exceedences found
Overall Total	2212	27	1.2%	Minor exceedences found

No un-ionized ammonia TMDL will be done on any tributaries at this time. However, as a consequence of TSS reductions it is expected that acceptable levels of un-ionized ammonia will be reduced as well due to the following:

1. Reduction in TSS levels aids in reduced runoff of associated particulates such as total ammonia nitrogen. Reduction in total ammonia nitrogen will also reduce un-ionized ammonia levels as a consequence. In the Middle Snake River system, a synergistic relationship exists between total ammonia load (in tons/year) and TSS load (in tons/year). That relationship is best described statistically per river segment as follows:

Segment Site	Equation	N	r^2	F-ratio	p value
Milner Dam	TSS=(640.021085xNH3)+17671.5	217	0.662	191.1	0.000000
Pillar Falls	TSS=(83.181116xNH3)+4.9074.1	208	0.325	24.3	0.000002
Crystal Springs	TSS=(682.779413xNH3)-58590.5	300	0.511	105.5	0.000000
Box Canyon	TSS=(834.483746xNH3)-252767.0	176	0.723	190.3	0.000000
Gridley Bridge	TSS=(870.638625xNH3)-172144.0	205	0.762	282.0	0.000000
Shoestring	TSS=(1934.794139xNH3)-301854.0	143	0.884	506.2	0.000000
King Hill	TSS=(754.697364xNH3)+11039.8	161	0.724	175.3	0.000000

TSS = TSSLOAD (tons/year); NH3=NH3LOAD (tons/year)

Since a 33.6% average annual reduction in TSS would be expected in the Middle Snake River system from land use management stgrategies (see §3.5.07 for TSS Loading Analysis Summary), a comparable 10.1% reduction in total ammonia nitrogen would be expected in the Pillar Falls to King Hill area. The Milner Dam to Pillar Falls segment does not have problems with un-ionized ammonia.

2. Typical organic nitrogen content in sediment is about 1.2 mg/g of associated sediment (Calow & Petts 1992 [Volume I, p 92, Table 92]). Since organic nitrogen content (as total organic nitrogen or TON) is the difference between total Kjeldahl nitrogen and total ammonia nitrogen, and since total ammonia will be reduced synergistically as TSS is reduced in the system, it is anticipated that values < 1.2 mg/g organic nitrogen content of associated sediment will be found. Un-ionized values < 0.020 mg/L would be expected to be found at levels < minor-to-none exceedences.

In additon to tributaries, un-ionized ammonia exceedences from irrigation canal drains were also considered.

These drains were monitored in the Phase 1 Study (1990-1991) and are described as follows: (Major exceedence waterbodies are bolded in black).

IRRIGATION CANAL DRAINS FROM PHASE 1 STUDY:

Tributary	N_{TOTAL}	$N_{Un\text{-}ionized}$	% of Total	IDEQ-TFRO Assessment
	NORTHSIDE CANAL COMPANY DRAINS			
A Drain	18	0	0.0	No exceedences found
C55 Drain	18	0	0.0	No exceedences found
S29 Drain	17	0	0.0	No exceedences found
N42 Drain	11	0	0.0	No exceedences found
N42 Drain (Canyon)	18	1	5.6	No exceedences found
J8 Drain	16	1	6.3	Minor exceedences found
S19 & S Drains	19	0	0.0	No exceedences found
W26 Drain	18	0	0.0	No exceedences found
Overall Total	135	2	2.7	Minor exceedences found
	TWIN FALLS CANAL COMPANY DRAINS			
A10 Drain	17	0	0.0	No exceedences found
Twin Falls Coulee	18	0	0.0	No exceedences found
Main Perrine Coulee	26	1	3.8	Minor exceedences found
West Perrine Coulee	18	1	5.6	Minor exceedences found
43 Drainage	14	0	0.0	No exceedences found
30 Drain	18	1	5.6	Minor exceedences found
LQ and LS Drains	29	0	0.0	No exceedences found
LS2/39A Drain	27	0	0.0	No exceedences found
39 Drain	29	1	3.4	Minor exceedences found
I Drain	29	5	17.2	***Major exceedences found***
N Drain	28	0	0.0	No exceedences found
Overall Total	253	9	3.6	Minor exceedences found

See Appendix D, Technical Support Document, Sub appendix XIII for calculations for both canal companies.

Manmade waterbodies where un-ionized ammonia have been found as a major exceedence will reduce to a level that when they discharge to a natural waterbody, they will be in the minor or no exceedence category. It is understood that reductions in TSS will produce reductions in total ammonia nitrogen which translates to reductions in un-ionized ammonia.

3.1.5 NOX

Nitrogen as Nitrite+Nitrate (NOX) can be a key eutrophication pollutant in lakes because NOX that enters the waterbody tends to be recycled within the lake and builds up over a period of time. By contrast, the Middle Snake River and its tributaries are flowing systems in which nutrients are always entering or leaving at any given section. Accumulations tend to occur only in sediment or in slack water, and the effects of these accumulations are normally moderated by the periodic flushing action of high flow events (USEPA 1993 [p 13]). In the State of Idaho there is no water quality standard for NOX. Thus, the State can only control it as it relates to nuisance aquatic vegetation as a limiting nutrient. Since NOX is not a limiting nutrient in either the Middle Snake River or its tributaries, and since there is no nuisance aquatic vegetation because of NOX, there is no proposed instream target at this time. However, this parameter will continue to be reviewed based on

monitoring information and a TMDL may be developed in the future if mean loads within the river and its tributaries increase significantly above where the current 1990-1998 mean load exists. See Appendix D. See also § 2.2.4.1 (1) of the sub basin assessment. Additionally, NOX is not considered a toxic pollutant on fisheries at current levels.

3.1.6 PESTICIDES

The only water quality limited stream segment listed for pesticide pollutants is Cottonwood Creek, from its headwaters to where it discharges to Rock Creek. A literature survey of work done by various agencies and organizations was conducted, and no anecdotal evidence of pesticides being discharged to the Cottonwood Creek was found. It is possible that the original listing was in error, but there is no way to confirm this. IDEQ-TFRO sampled in 1999 (June, July, and August) when the potential for pesticide impact to Cottonwood Creek was greatest. Two sampling sites were selected: above the area of impact (to serve as background), and immediately below the area of impact (to demonstrate response). Based on the type of pesticides used for land use in the North Cottonwood-McMullen 5th Field HUC (17040212-23), and consulting with the IDHW-Lab in Boise, Idaho, it was determined that three pesticide groups be tested in the receiving water: organochlorine insecticides (USEPA Method 508/8080), herbicides (USEPA Method 505.1/8150), and organophosphates (USEPA Method 507/8140). Laboratory results are noted in Table 82.

Table 82 Pesticide results on Cottonwood Creek instream water

Sites on Cottonwood Creek	*June 1999*	*July 1999*	*August 1999*
Upstream	None Detected	None Detected	None Detected
Downstream	None Detected	None Detected	None Detected

Methods 515.1 (herbicides), 525.2 (Phthalates, PAH), PAH (550.1), 507 (organophosphates) and 508 (organochlorine insecticides) total up to 140 compounds. Site inspection of the zone of impact indicates that the potential for pesticide entry into Cottonwood Creek is minimal. Diverted stream within the zone of impact is used for irrigation and grazing purposes. Cottonwood Creek at the end of zone of impact is plumbed through a riparian area that is filled with a myriad of wildlife.

Instream water quality analysis for pesticides indicates that no pesticides (as herbicides, organophosphates, or organochlorine insecticides) were detected. Therefore, it is recommended that pesticides, as a parameter, be removed as a pollutant from the 303(d) list for Cottonwood Creek.

3.1.7 OIL AND GREASE

Only one stream segment is listed for oil and grease: Rock Creek. This listing was a result of previous historical practices that allowed the discharge of the Twin Falls POTW and various other point sources into Rock Creek. These sources no longer discharge to Rock Creek. Joint monitoring conducted by IDEQ-TFRO and the City of Twin Falls demonstrates that oil and grease is no longer a contaminant of Rock Creek. The monitoring was done on Rock Creek (between the Amalgamated Sugar Company and Rock Creek Park) in 1997. The results indicate that oil and grease levels were always < 4 mg/L. Monitoring at the two sites (and a third site on the 4th Fork of Rock Creek for background) was immediately downstream of two storm drains that would likely show exceedences (> 5 mg/L). The monitoring was bi-monthly for the entire year (1997) and covered the fall and winter quarters when oil and grease would be most prevalent. No oil and grease exceedences were noted. Therefore, IDEQ-TFRO proposes that oil and grease be "de-listed" from the 303(d) list as a pollutant of Rock Creek. No TMDL for oil and grease will be proposed. See §3.2.3, item 3, Facilities that Discharge, Oil and Grease for more information.

3.1.8 TEMPERATURE

There are definite inconsistencies between water temperatures that exceed criteria in the Idaho water quality standards and fish data that indicate viable, self-sustaining assemblages exist. These inconsistencies include a number of physical factors such as regional, climatic and species diversity, and temporal air temperature variations which deter the use of one single temperature value for a large regional area. The National Academy of Sciences (1973) has concluded that "no single temperature requirement can be applied to ... large regional areas; the requirements must be closely related to each body of water and to its particular community of organisms." Because of these inconsistencies or variations, an aquatic life, salmonid spawning, and temperature regime study is to be developed and conducted by IDEQ statewide to comprehensively document the uniform criteria issue, and support development of water quality criteria to protect salmonid spawning that takes into account natural environmental diversity. This issue is complex but a protocol for measuring, reporting, and evaluating stream temperature will be developed to establish a temperature record acceptable for comparison to criteria. The study will be aimed at producing new temperature criteria for proposal in year 2000. Thus, all streams that would be listed for temperature on the 1998 303(d) list, (including carryovers from 1996, and additions), will be placed on a separate list. Therefore, TMDLs will be postponed for streams on this list for 18 to 24 months, to allow for completion of the study and the development of new water quality standards.

3.1.9 DISSOLVED OXYGEN

See Appendix D. Violations in temperature criteria on the Middle Snake River or its tributaries are not necessarily linked to violations in DO. Additionally, under the terms specified in IDAPA 16.01.02.276, waters discharged from dams, reservoirs, and hydropower facilities are not subject to the provisions of subsection 250.02.c.i (DO standard of 6.00 at all times for lakes and reservoirs for cold water biota) or subsection 250.02.d.i (intergravel DO at 5.00 mg/L one day minimum and water column DO at 6.00 mg/L at one day minimum for salmonid spawning). Subsection 276.02 (from June 15 to Oct 15 a 30-day mean of 6.00 mg/L, a 7-day mean minimum of 4.70 mg/L, and an instantaneous minimum of 3.50 mg/L), subsection 276.03 (modified DO periods for certain fisheries), and subsection 276.04 (DO below American Falls Dam) shall apply to all waters below dams, reservoirs, and hydroelectric facilities as far downstream as the point of measurement as defined in subsection 276.05 (a representative, thoroughly mixed area downstream of the discharge but as close to the facility as practical). Downstream of the point of measurement, all discharges to the waters shall be subject to the provisions of subsections 250.02.c.i and subsection 250.02.d.i (as previously cited).

A contract study conducted by ERI in 1996 at three locations on the Middle Snake River demonstrated that within and outside the macrophyte beds there were no violations of the DO standard as had been demonstrated previously by Falter (Falter 1994; Falter 1995; Falter 1996). Falter's work was done during the lowest flow years and within the most dense macrophyte beds, whereas the ERI study was conducted during a high flow event. IDEQ-TFRO personnel indicate that during the 1990-1993 time period, approximately 75% of the localized nuisance areas in the Middle Snake River (not of the entire river system) were covered with heavy dense macrophytes, 20% were least dense, and about 5% had no macrophytes (McMasters 1999). Falter's work showed only two years during which violations occurred: (1) 1992 values showed diel DO within heavily weeded areas to fall below 6.00 mg/L in 5 transects, especially in late summer as the weeds became senescent, although some of the areas demonstrated DO levels > 6.00; (2) 1993 July mean DO values declined to less than 6.30 mg/L with a minimum single value of 5.70 mg/L in one transect; (3) 1994 July mean DO values declined to 8.40 mg/L with a minimum single value of 7.50 mg/L in one transect; and, (4) the lower profile in the water column showed lower DO values than at the surface, indicating that the DO level

approximates the level of that DO in the water that is in contact with the atmosphere. The main reason for lower DO levels in the weedbeds versus outside the weedbeds is the decomposition of senescent vegetation and respiration of the plant biomass.

USGS and IDEQ-TFRO non-diehl monitoring studies indicate no violations of the instantaneous water quality standard. Even when the data is statistically segregated for low- versus high-flow years, violations of the DO standard never occurred. It is evident that in the Middle Snake River, and to some extent its tributaries, in the absence of substances that cause the depletion of DO, the DO concentration in stream water approximates the saturation level for oxygen in water in contact with the atmosphere and decreases with increasing water temperature. But these decreases are from about 14 mg/L at freezing to about 7 mg/L at 30°C. This is substantiated to some extent by correlation equations developed from monitoring data from USGS and IDEQ-TFRO. DO estimates at 25°C range from 6.72 - 7.45 mg/L which corresponds closely to the 7mg/L DO level at 30°C.

Thus, it may be concluded that a DO sag < 6.00 mg/L occurs only in the most heavily dense macrophyte beds. These same beds occur in localized areas within the Middle Snake River where the water is most shallow, where the water has minimal velocity, and where the water year is under low flow conditions. 1992 was the most heavily impacted macrophyte year and was also the lowest flow year of record from 1988 to 1995. Thus, macrophyte density and DO sags < 6.00 mg/L may be correlated to flow, implying that under extremely low flow conditions the worst case scenario for DO may potentially occur. A water year of record similar to 1992 may occur once-in-16 years (1983 - 1998) or a 6.3% chance that it would occur within a 16 year period. Since the Middle Snake River was modeled under RBM10 for the worse case scenario, the model predicts that with TP reductions approximating an instream value of 0.075 mg/L TP would result in a DO value of about 8.56 mg/L (See Chapter 4, Table 36, p. 91 of the Mid-Snake TMDL) which is well above the State's water quality standard. It is estimated that imposed TP reductions under the Mid-Snake TMDL will cause plant biomass to decrease between 20-60%, thus leading to levels below those considered to be "nuisance" and will likely restore beneficial uses. Therefore, no TMDL is proposed for DO on the Middle Snake River or its tributaries at this time.

3.2 SUMMARY OF NPDES PERMIT LIMITS ON POINT SOURCES

This section describes the NPDES permit limits for aquaculture, food processors, and municipalities. The State of Idaho under its Administrative Procedures Act has designated uses for a number of waterbodies that the State determines can be attained in the future. "Attainable uses" are those uses (based on the State's system of water use classification) that can be achieved when effluent limits for point sources under the Clean Water Act's Section 301(b)(1)(A) and (B) and Section 306 are implemented for point source discharges and when cost-effective and reasonable BMPs are implemented for nonpoint sources (USEPA 1991 [p 29]). Therefore, effluent permit limits are so written to meet designated beneficial uses and/or to meet State water quality standards.

3.2.1 AQUACULTURE

Aquaculture wastes consist of uneaten fish feed, fecal material, and other excretory wastes. The characteristics and impacts of wastes from aquaculture operations vary according to the type and siting of the aquaculture system. Aquaculture systems that are relatively open to natural waters have the greatest potential to cause environmental degradation from waste discharges (Goldburg & Triplett 1997 [p 35-36]).

3.5.1 PATHOGENS

Fecal coliform bacteria problems were assessed in §2.2.4.1, item 6, for the Middle Snake River and in §2.2.4.3 for its tributaries. The assessment for the Middle Snake River indicates that the river is meeting State water quality standards for primary contact recreation and secondary contact recreation though minor exceedences of the instantaneous fecal coliform standard (500 cfu/100 mL and 800 cfu/100 mL, respectively) occur infrequently. IDEQ-TFRO proposes that those segments of the Middle Snake River listed on the 303(d) list for pathogens be de-listed. Those segments include: Bliss Reservoir (waterbody 2370); Snake River from Milner Dam to Murtaugh (waterbody 2378); and, Snake River from Murtaugh to Twin Falls Reservoir (waterbody 2377).

Several waterbodies at the time of data collection on the sub basin assessment were found to not have any pathogen information. IDEQ-TFRO will be sampling these and making an assessment on their pathogen status over the next 12-24 months. Those waterbodies include: Pioneer Reservoir; Riley Creek; Blind Canyon Creek; McMullen Creek; Dry Creek, West Fork to Murtaugh Lake; and, Dry Creek, from the headwaters to Dry Creek main stem. Several waterbodies at the time of data assessment on the sub basin assessment were discovered to have major exceedences in fecal coliform bacteria. However, these waterbodies are not listed for pathogens in the 303(d) list. IDEQ-TFRO will submit these to USEPA for addition of the pathogen pollutant to the waterbody which are already listed. These waterbodies include: Billingsley Creek and Clover Creek. The remainder of the waterbodies include those which are listed (in the 1996 and 1996 303(d) lists) for pathogens and which had information on fecal coliform bacteria. Billingsley Creek and Clover Creek are included in this group for TMDL development. These waterbodies include: Billingsley Creek, Clover Creek, Rock Creek, Cotonwood Creek, Cedar Draw Creek, Mud Creek, Deep Creek, and the Malad River. Although the Malad River will be considered here because it is a tributary to the Middle Snake River, it will have its TMDL development in the Year 2001 when the Big Wood River sub basin has its TMDL developed. Its sub basin assessment will commence in the Year 2000.

IDEQ-TFRO chose to protect for primary contact recreation (or < 500 cfu/100 mL instantaneous fecal coliform bacteria). This is the load capacity. By selecting the primary contact recreation target, it will protect for secondary contact recreation. Within the guidelines established for bacteria assessment in the 1996 305(b) report, the overall goal is to reduce bacteria to a level that is < 10% of the total number of samples taken in a single year. The overall endpoint of the pathogen TMDL for natural tributaries will be to reduce the percent of samples over the applicable criteria by 63.9% (as an overall average) to achieve an instream target of 400 cfu/100 mL (which is well below the criteria of 500 cfu/100 mL). Thus, the MOS is 100 cfu/100 mL. Because the major exceedences occur principally during the irrigation season (March through October), monitoring of the waterbodies will occur year-round so that comparisons between irrigation versus non irrigation season can be assessed. The monitoring protocol for this TMDL is a monthly sample on a yearly basis. If an instantaneous reading exceeds the 400 cfu/100 mL (instream target), then re-sampling of the watebody will occur four more times spread evenly over a 30-day period for the purposes of calculating a geometric mean (to achieve a geometric mean target of 50 cfu/100 mL). As data is collected, seasonality considerations will be defined and potentially established for each season based on TMDL curves developed for each season and further evaluated annually during the Years 2000-2009. During the implementation phase of this TMDL, land management agencies will provide guidance as to site-specific BMPs that will effectively reduce the pathogens, such that in conjunction with TSS reductions, pathogen reductions will occur and eventually reach beneficial uses and/or State water quality standards by Year 2004.

BACTERIA TMDL

Reduction

PATHOGEN TMDL: TRIBUTARIES

WATERBODY NAME	EXISTING CONDITIONS %>500 cfu/100 mL	IRRIGATION MEAN, cfu/100 mL	NON IRRIGATION MEAN, cfu/100 mL	YEAR 2004 TARGET cfu/100 mL	%R
Billingsley Creek	10.5%	511	351	400	21.7%
Clover Creek	11.8%	213	79	400	62.9%*
Rock Creek	28.0%	583	223	400	31.4%
Cottonwood Creek	11.1%	220	43	400	80.5%*
Cedar Draw	35.6%	937	58	400	57.3%
Mud Creek	48.9%	1,006	198	400	90.1%
Deep Creek	16.1%	396	97	400	75.5%*
Malad River	21.7%	4,913	1,382	400	91.9%
Overall Mean	23.0%	1,097	304	400	63.9%

POINT SOURCES

Aquaculture Facilities:	Do not have any permit limits for pathogens at this time. Fecal coliform bacteria is not considered a constituent of the effluent.
City of Twin Falls:	NPDES limit is 100 cfu/100 mL AML and 200 cfu/100 mL average weekly limit.
City of Buhl:	NPDES limit is 200 cfu/100 mL AML and 200 cfu/100 mL average weekly limit.
City of Filer:	NPDES limit is 200 cfu/100 mL AML and 200 cfu/100 mL average weekly limit.
City of Hagerman:	NPDES limit is 200 cfu/100 mL AML and 200 cfu/100 mL average weekly limit: Oct 1 - Apr 30 NPDES limit is 50 cfu/100 mL AML and 200 cfu/100 mL average weekly limit: May 1 - Sep 30
City of Hansen:	NPDES limit is 50 cfu/100 mL AML and 100 cfu/100 mL average weekly limit: May 1 - Sep 30 NPDES limit is 200 cfu/100 mL AML and 200 cfu/100 mL average weekly limit: Oct 1 - Apr 30
City of Jerome:	NPDES limit is 200 cfu/100 mL AML and 200 cfu/100 mL average weekly limit

*For the natural tributaries, %>500 = The % of exceedences > 500 cfu/100 mL. %R = % Reduction and is based on Year 2004 Target (400) divided by the irrigation mean value x 100%, except for those %R values with an asterick. These have irrigation values < 400, so their %R was calculated as the non irrigation mean value divided by the irrigation mean value x 100%. The overall Year 2004 target (400) divided by the overall irrigation mean value (1,097) x 100% is equivalent to 63.5% overall %R, which is close to the value 63.9%.

Banbury Springs	154.3	154.3	154.3	
Briggs Creek Springs	106.6	106.6	106.6	
Box Canyon Springs	83.1	83.1	83.1	
Unaccounted Springs	(236.7)	(236.7)	(236.7)	
Sub Total B	**1,375.3**	**1,375.3**	**1,375.3**	**0.0%**
Surface Waterbodies				
Cedar Draw	12,066.3	5,721.0	5,721.0	
Filer POTW	2.1	2.1	2.1	
Rainbow (Filer) FH	25.3	25.3	25.3	
Rainbow Processing	0.04	0.04	0.04	
Yoder FH	17.5	17.5	17.5	
SEAPAC Processing	Land Application	0.0	0.0	
Cedar Draw FH	39.6	39.6	39.6	
Olson FH	7.6	7.6	7.6	
Stutzman FH	2.4	2.4	2.4	
Tunnel Creek FH	35.8	35.8	35.8	
Leo Martins FH	29.5	29.5	29.5	
Sub Total	12,226.1	5,880.8	5,880.8	
Mud Creek	5,809.5	5,809.5	5,809.5	
Buhl POTW	28.8	28.8	28.8	
Rainbow (Buhl) FH	16.3	16.3	16.3	
W&W FH	20.0	20.0	20.0	
White's FH	7.9	7.9	7.9	
Buhl Trout Rearing FH	6.7	6.7	6.7	
Buhl Trout FH	9.9	9.9	9.9	
Jukers FH	10.6	10.6	10.6	
RCP FH	3.5	3.5	3.5	
First Ascent FH	35.3	35.3	35.3	
Rock Ridge FH	4.0	4.0	4.0	
Mi Vida Loca VH	7.9	7.9	7.9	
Sub Total	5,960.4	4,965.4	4,965.4	
Deep Creek	5,646.4	4,480.0	4,480.0	
McMullen Creek[3]	Est = 257.9	33.3% R = 172.0	172.0	
Cottonwood Creek[3]	Est = 148.3	33.3% R = 98.9	98.9	
Deep Creek Trout FH	31.1	31.1	31.1	
Boswell Trout FH	33.2	33.2	33.2	
Peter's FH	20.3	20.3	20.3	
Cox FH	30.7	30.7	30.7	
Dotana FH	10.2	10.2	10.2	
Howell FH	19.0	19.0	19.0	
Sub Total	6,197.1	4,895.4	4,895.4	

Point Sources Discharging Directly to the Middle Snake River: MEET PERMIT LIMIT WHICH IS LOAD CAPACITY				
Magic Valley FH	43.7	26.2	26.2	
Rim View FH	81.0	48.6	48.6	
IPC/Niagara Springs FH	33.0	19.8	19.8	
Gary Wright FH	3.3	2.0	2.0	
Catfish/FBI FH	10.7	6.4	6.4	
Kaster Trout FH	29.3	17.6	17.6	
Box Canyon FH	177.4	106.5	106.5	
Briggs Creek FH	13.6	8.2	8.2	
Sub Total A	**392.0**	**235.3**	**235.3**	**40.0%**
Spring Sources: MEET LOAD CAPACITY AND DON'T REDUCE				
Unseen Underground Seeps	11.9	11.9	11.9	
Niagara Springs	3.3	3.3	3.3	
Clear Lakes Springs Snake River FH Clear Lakes Process Middle FH Clear Lakes FH	5.6 59.4 IN DEVELOPMENT 108.7 96.3 Sub Total = 270.0	5.6 35.7 IN DEVELOPMENT 65.2 57.8 Sub Total = 164.3	5.6 35.7 IN DEVELOPMENT 65.2 57.8 Sub Total = 164.3	
Banbury Springs	13.0	13.0	13.0	
Briggs Creek Springs	9.0	9.0	9.0	
Box Canyon Springs	7.0	7.0	7.0	
Unaccounted Springs	20.0	20.0	20.0	
Sub Total B	**334.2**	**228.5**	**228.5**	**31.6%**
Surface Waterbodies: Includes Natural Tributaries and Manmade Canals				
Cedar Draw	119.8	62.1	62.1	
Mud Creek	94.4	52.4	52.4	
Deep Creek	78.6	51.7	51.7	
Blind Canyon Creek	36.6	23.4	23.4	
I Drain	12.8	6.2	6.2	
J8 Drain	6.4	4.9	4.9	
N Drain	2.7	2.4	2.4	
S29 Drain	2.3	1.4	1.4	

STATE OF IDAHO
DIVISION OF
ENVIRONMENTAL QUALITY

601 Pole Line Road, Suite 2 • Twin Falls, Idaho 83301-3035 • (208) 736-2190

Dirk Kempthorne, Governor
C. Stephen Allred, Administrator

August 23, 1999

RECEIVED
FEB 17
Department of Water Resources

RECEIVED
AUG 25 1999

Leo Ray
Big Bend Trout Company
P.O. Box 479
Hagerman, ID 83332

Re: Consent Order for the Deep Creek Facility

Dear Mr. Ray:

Enclosed you will find the signed Deep Creek Facility Consent Order signed by Idaho Department of Health and Welfare - Division of Environmental Quality (DEQ) Administrator C. Stephen Allred. The effective date of the Consent Order is August 11, 1999.

The following sections in the Consent Order require actions that must be taken on a established schedule:

Section # 13 - A meeting with the DEQ staff will be conducted within sixty (60) days of the effective date of the Consent Order to resolve and correct details related to plan and specification for the proposed hatchery and waste management facilities.

Section # 10 - A Water Quality Monitoring Plan (Monitoring Plan) shall be submitted and approved by IDEQ prior to initiation of fish rearing.

Section # 9 - A best management practices plan (BMP Plan) shall be submitted and approved by IDEQ prior to the initiation of fish rearing.

DEQ will work with you to ensure compliance with the terms and conditions of the Consent Order.

Please feel free to contact me at my office, 736-2190, should any questions or concerns arise.

Sincerely,

Michael J. McMasters
Regional Manager-Engineering

Department of Water Resources
APPLICANT'S
Exhibit 4
Date Admitted 3-17-2000

MJM/ml
cc: Doug Howard, Regional Administrator, DEQ, Twin Falls
Doug Conde, Attorney General's Office, DEQ, Boise
Rob Sharpnack, Water Quality Science Officer, DEQ, Twin Falls
Nick Cizmich, Water Quality Science Officer, DEQ, Twin Falls
Greg Misbach, Technical Engineer I, DEQ, Twin Falls

MICROFILMED

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AUG 17 1999

IDAHO DEPARTMENT OF HEALTH AND WELFARE
DIVISION OF ENVIRONMENTAL QUALITY

In the matter of:)	CONSENT ORDER
Big Bend Trout Inc.)	
for the "Deep Creek Trout Hatchery")	IDAHO CODE §§ 39-101 *et seq.*
)	

1. Pursuant to Idaho Code §§ 39-101 *et seq.* (Idaho Environmental Protection and Health Act), the Idaho Department of Health and Welfare (IDEQ) enters into this Consent Order with Big Bend Trout Inc. ("Big Bend") for the Deep Creek Trout Hatchery proposed for construction. It will be a new facility that will discharge directly to Deep Creek, which in turn discharges to the Middle Snake River. The Middle Snake River is a 94-mile reach of the Snake River located generally between Milner Dam and King Hill, Idaho.

2. Big Bend is owned and operated by Leo Ray. The Deep Creek facility is proposed to be located in Twin Falls County, Idaho. The Deep Creek Trout Hatchery would divert water from two separate spring sources: the Cox Tunnel (approximately 5-8 cfs) and an unnamed spring (approximately 1-4 cfs) for a total of 6-12 cfs. An application for an NPDES Permit has been submitted to the United State Environmental Protection Agency (USEPA) for the proposed facility. Plans and specifications pursuant to Idaho Code §§ 39-118 have been submitted to IDEQ.

3. Big Bend agrees to all the terms and conditions of the Consent Order without the issuance of a Notice of Violation or the holding of a compliance conference under Idaho Code §§ 39-108. IDEQ agrees that this Consent Order is entered into to address future activity, and is not based on a present violation asserted against Big Bend by IDEQ, or any third party. Nevertheless, Big Bend expressly agrees that the terms of the Consent Order are enforceable under State law.

4. Water quality conditions in the Middle Snake River watershed (Hydrologic Unit Code 17040212) are eutrophic as a result of cumulative loadings and impacts from nutrients (phosphorus and nitrogen), sediment, and organic solids from point and nonpoint pollutant sources. Violations of Idaho's Water Quality Standards and Wastewater Treatment Requirements (Idaho Water Quality Standards), IDAPA 16.01.02.001 through 16.01.02.299 are presently occurring in the Middle Snake River and its tributaries. As a result of the violations, the Middle Snake River was listed in 1990 by IDEQ as water quality limited under § 303(d) of the Federal Water Pollution Control Act (33 U.S.C. § 1313). As a result of the listing, the IDEQ has developed a total maximum daily load (TMDL) for the Middle Snake River, which has been approved by USEPA. All industries impacting water quality on the Middle Snake River, including the aquaculture industry, developed industry specific management plans to reduce water quality impacts in the watershed. These plans were used by IDEQ in developing the Middle Snake River TMDL.

5. The Middle Snake River TMDL provides for a wasteload allocation (WLA) of certain pollutants for existing aquaculture facilities. The Deep Creek Trout Hatchery is a new facility that was not included in the Mid-Snake TMDL. In order to construct and operate this facility, there can be no net increase (NNI) in total phosphorus (TP) or total suspended solids (TSS) when the discharge water is compared to the source water. Compliance with the NNI standard shall be determined based upon an annual average (with a minimum of twelve samples per year, or one sample per month).

The Monitoring Plan, required and described in more detail below, shall identify specifically the sampling points and methodology to be used in determining NNI.

6. Deep Creek is currently proposed to be included on the State of Idaho 1998 303(d) list. This list has not been approved by USEPA yet. In addition, TMDLs and WLAs will be developed in the future for pollutants, including but not limited to sediment, for the Middle Snake River watershed. USEPA also may issue an NPDES permit for the Deep Creek Trout Hatchery for which IDEQ must provide a § 401 certification. Pollutant trading may also be available under certain circumstances in the future. The parties hereto recognize that the NNI limitations set forth in this Consent Order may be modified or additional or different limitations may be imposed, as a result of (a) the future development of TMDLs and/or WLAs for Deep Creek or the Middle Snake River, (b) the USEPA NPDES permit and the State's § 401 certification, or (c) pollutant trading. The parties further recognize and agree that nothing in this Consent Order limits IDEQ's authority or discretion to impose different or additional limitations regarding the Deep Creek Trout Hatchery when IDEQ reviews any NPDES permit under § 401 of the Clean Water Act or when IDEQ develops additional TMDLs and/or WLAs.

7. Big Bend shall at all times meet the NNI standard with respect to TP and TSS discharged from the Deep Creek facility.

8. Big Bend intends to meet the NNI standard by removing TP and TSS from Deep Creek above the point of discharge for the Deep Creek Trout Hatchery. Removal is intended to be accomplished through the use of settling ponds that treat Deep Creek water for removal of nutrients, sediments, and other pollutants of concern. The method by which Big Bend intends to meet the NNI standard shall be fully described in the best management practices plan and plans and specifications described below.

9. In order to achieve the NNI standard, Big Bend shall construct, operate and maintain the facility in accordance with IDEQ approved best management practices plan ("BMP Plan"). The BMP Plan shall be submitted to and approved by IDEQ prior to initiation of fish rearing. The BMP Plan shall include operational, management, and mitigation actions to reduce loadings or to reduce or cease production to ensure compliance with the NNI standard and this Consent Order. Once approved, the BMP Plan shall be incorporated into and enforceable as a part of this Consent Order.

10. In order to ensure compliance with the NNI standard and terms and conditions of this Consent Order, Big Bend shall implement an IDEQ approved water quality monitoring plan ("Monitoring Plan") and a program that documents whether Big Bend is complying with the NNI standard. The Monitoring Plan will include monitoring for total phosphorus, total suspended solids, and flow, and shall include a specific description of sampling locations and the analysis and methodology used to ensure compliance with the NNI standard. The Monitoring Plan shall be submitted to and approved by IDEQ prior to initiation of fish rearing. Once approved by IDEQ, the Monitoring Plan shall be incorporated into and enforceable as a part of this Consent Order. Big Bend must continue to demonstrate, through water quality monitoring and reporting, that it is meeting the NNI standard with respect to TP and TSS.

11. Big Bend acknowledges the right of IDEQ to enter the facility at such times as IDEQ considers suitable to inspect and conduct monitoring at the facility to determine compliance with the Consent Order and BMP/Monitoring Plans.

12. Big Bend shall submit to IDEQ quarterly reports and a yearly summary report for the Deep Creek Trout Hatchery, including all information and data required by the BMP and Monitoring Plans. It shall be a violation of this Consent Order if the NNI standard is violated. In addition, if monitoring indicates that the NNI standard is being violated as described in the Monitoring Plan, Big Bend shall, within 48 hours, notify the IDEQ and immediately implement actions to reduce loading to Deep Creek from the hatchery as set forth in the BMP Plan. Big Bend shall monitor and continue to monitor until BMP effectiveness is achieved and compliance with the NNI standard can be demonstrated.

13. Big Bend has submitted engineering plans and specifications for the design and waste treatment system of the proposed Deep Creek Trout Hatchery. The plans have been reviewed by IDEQ, but a number of details related to the plans and specifications need to be resolved prior to construction. A meeting with IDEQ plan review staff and Leo Ray (and/or his architectural assignee) will be conducted within sixty (60) days of the effective date of this Consent Order to resolve and correct details related to the plans and specifications for the proposed hatchery. Big Bend shall not begin construction prior to IDEQ approval of the plans and specifications.

14. Big Bend shall obtain all the necessary permits, water rights, and other approvals or authorizations prior to construction and operation of the water diversions and hatchery facility.

15. Big Bend shall comply with any future effluent discharge limitation required by USEPA NPDES permit, including effluent limitations established through watershed planning/TMDL development as a result of the Mid-Snake TMDL, the Upper Snake Rock TMDL or a TMDL for Deep Creek.

16. If Big Bend fails to comply with the terms and conditions of this Consent Order, Big Bend shall incur a stipulated penalty of one thousand dollars ($1,000) for each violation of this Consent Order and for each day that Big Bend fails to comply with the terms of the Consent Order. This Consent Order does not exempt Big Bend from additional penalties that USEPA may choose to enforce under any applicable authority.

17. Big Bend recognizes that failure to comply with the terms of this Consent Order may result in an administrative or court action for specific performance of this Consent Order, monetary penalties in addition to those set forth in Paragraph 16 of this Consent Order, assessment of costs, attorney fees, and other relief as the court or administrative forum considers to be just and reasonable under the circumstances.

18. The terms and conditions of this Consent Order, including without limitation the NNI standard, may be modified only by a writing executed by Leo Ray and representatives of IDEQ.

19. This Consent Order shall not in any way affect Big Bend's obligation to comply with any provision of the Idaho Water Quality Standards or any applicable local, state or federal laws.

20. All work undertaken in accordance with this Consent Order shall not deviate from approved plans and specifications or plans without prior notification and written approval by IDEQ.

21. This Consent Order does not constitute an approval or authorization from any other local, state or federal agency.

22. All communications required by this Consent Order shall be addressed to Doug Howard, Regional Administrator, Twin Falls Regional Office, Idaho Division of Environmental Quality, 601 Pole Line Road, Suite 2, Twin Falls, Idaho 83301-3035, (208) 736-2190.

23. This Consent Order shall bind Big Bend, its successors, and assignees, and IDEQ, until modified or terminated in a manner authorized by law.

DATED this 11 day of August 1999

By: C Stephen Allred

C. Stephen Allred, Administrator
Idaho Division of Environmental Quality
Idaho Department of Health and Welfare

DATED this 3 day of August 1999

By: Leo E Ray

Leo Ray, Owner and Operator
Big Bend Trout Company

RECEIVED

FEB 17 2000

Department of Water Resources

PERMIT NO. _____

AGREEMENT

THIS AGREEMENT, entered this 15 day of April, 1999, between the Twin Falls Canal Company, a Carey Act operating company, incorporated and existing under the laws of the State of Idaho, hereinafter referred to as "Company", and Leo F. Ray, hereinafter "Water User".

WITNESSETH

WHEREAS, the Company owns, operates and maintains an irrigation water delivery system in Twin Falls County, Idaho, that provides irrigation water to approximately 200,000 acres; and

WHEREAS, the Water User has filed an Application for Permit with the Idaho Department of Water Resources (IDWR), being #_____, a true and correct copy of which is attached hereto as Exhibit "A", for the nonconsumptive use of waters within the Company's system for fish propagation purposes on the real property described on Exhibit "B"; and

WHEREAS, the parties recognize that within the Company delivery system, constructed drains and natural channels are used as integral parts of the delivery system and that runoff and seepage water collected in such drains and channels is used to supply water to shareholders within the project; and

WHEREAS, the parties further recognize that the waters available within the Company's delivery system are subject to a first and prior right of the Company to use and supply such waters to its stockholders for irrigation purposes; and

WHEREAS, the Water User desires to enter into an agreement with the Company providing for coordination of the proposed nonconsumptive use with the Company's existing operation;

NOW, THEREFORE, in consideration of the mutual and independent covenants hereinafter stated the parties agree as follows:

1. Upon the execution of this Agreement, Company shall forbear and refrain from protesting or otherwise contesting Water User's Application for Permit, Exhibit A.

Department of Water Resources
APPLICANT'S
Exhibit 5
Date Admitted 3-17-2000

Water User acknowledges that Water User may not divert water under said permit until this written agreement (the Agreement) with the Company is filed with the IDWR and agrees that a default by Water User under the Agreement shall render the Agreement voidable, at the option of the Company, and, if the Agreement is voided, then, and in that event, Water User shall not be entitled to divert water pursuant to the Permit.

2. Prior to the constructing, repairing, or remodeling of any facility, or portion thereof, for use in conjunction with Water User's fish propogation operation, Water User shall provide the Company with copies of all plans, blueprints, and site drawings and allow the Company to have input into the design of such facility to insure that the operation of such facility, when constructed, repaired or remodeled, will not adversely affect the operation of the Company. Water User shall not be allowed to divert any water from the proposed diversion on the Company's delivery system until the Company has reviewed and given written approval to the construction, repair or remodeling plans submitted by Water User.

3. Water User shall implement such procedures as are necessary to insure that any construction, repair, and/or remodeling of Water User's facility, as well as the day-to-day operation of the facility, shall not:

(a) interfere or affect the Company's delivery of water to Company stockholders or other water users at any time;

(b) block any rights of way or traditional accesses of the Company;

(c) cause any erosion to Company's delivery system;

(d) cause excessive evaporation;

(e) cause water pollution, or otherwise violate any local, state or federal laws, rules or regulations relating to water quality;

(f) block existing drainage or seepage flows or cause drainage and seepage problems on Company or adjacent properties;

(g) impair the easement and right of way of the Company for the full flow of water for irrigation, drainage, system operation or maintenance; or

(h) impair operation, maintenance, construction and reconstruction of Company facilities.

4. Water User understands and agrees that the waters within the Company's delivery system are subject to a first and prior right of the Company; that the Water User has no right to expect or demand that the Company deliver or supply a given quantity or quality of water even though Water User may have filed on the same with the IDWR; and that the Company shall have no responsibility or liability for cessation, fluctuation, increase, or reduction of water flows for any reason.

5. Water user understands and agrees that it may not rely upon or expect consistent water flows within the delivery system as the Company, in order to (i) fulfill its delivery obligations, (ii) repair and/or maintain its delivery system, and/or (iii) otherwise respond to natural or man made exigencies, such as drought, floods or canal breaks, may change the manner of use or management of such water flows which may affect the availability of water within the reach or segment of the delivery system where the Water User's diversion is located.

6. It is understood and agreed that the Water User will cause no interruption or interference in water deliveries or damage to said canals or ditches during construction, repair, or remodeling, or in subsequent operations of the facility. It is understood and agreed that any contractor or contractors employed by Water User shall be an agent of Water User and not an independent contractor and Water User shall be liable as principal therefor.

7. Water User understands and acknowledges that the primary use of the water within the Company delivery system is for irrigation and that, in conjunction with such use, as well as with the Company's operation and maintenance of its water delivery system, the water within the delivery system may contain agricultural chemicals, including but not limited to, fertilizers, pesticides, (including, but not limited to, those categories of pesticides defined in Idaho Code §22-3401[3]) and sediment, which may render such waters unsuitable for fish propagation purposes. Water user has independently examined and considered the acceptability of such waters for the use intended, acknowledges that future water quality and quantity may change, and accepts such waters, now and in the future, "AS IS" and agrees that the Company does not warrant or represent that the waters within its delivery system are suitable for the intended use.

8. To the extent that Water User's operation and maintenance of its facility and/or use of the waters for any purpose results in any additional costs or expenses to the Company for operation or maintenance of its delivery system, including but not limited to additional work or costs related to the removal or eradication of aquatic or other weeds, Water User agrees to indemnify and reimburse the Company for any such costs or expenses within thirty (30) days of the receipt by Water User of a statement or bill from the Company relating to such costs or expenses.

9. Water user shall at all times keep his facility in good repair, including all diversions and discharge structures and insure that the Company's delivery system is not adversely affected by Water User's use of the water diverted. Should the Water User, at any time, cease to use such facility or otherwise abandon its use, Water User shall indemnify and/or reimburse the Company for any costs or expenses incurred for any modification, repairs or replacement of canals, ditches, diversions, or discharge structures and rights of way caused by such nonuse or abandonment.

10. Water user understands and acknowledges that its use of the water under the above-referenced permit is or may be subject to local, state and/or federal laws, rules or regulations relating to, among other things, water quality. Water user agrees that it shall be, and remains, responsible for complying with any such laws, rules or regulations and it shall indemnify and hold the Company harmless of, and from, any costs, expenses, fines, penalties, or assessments incurred by reason of Water User's failure to fully comply with such laws, rules or regulations.

11. Water user waives, releases and relinquishes any claim or claims Water User may now or hereafter have against the Company for loss or damage that arises out of, relates to, or arises in connection with Water User's facility, or the fish raised or to be raised at such facility, irrespective of whether such loss relates to the quantity (paragraphs 4 and 5) or quality (paragraph 7) of water available to Water User's facility from the Company's delivery system, and regardless of whether such loss or damage results from an act, omission or negligence of the Company.

12. During the term of this Agreement, Water User shall secure and continuously carry comprehensive general liability insurance for both bodily injury and property damage equivalent to the amount of one million dollars ($1,000,000.00) combined single limit. Such insurance shall include an endorsement naming Company as an additional insured under this

Agreement, and include a provision stating that such liability policies shall not be cancelled or their limits of liability reduced without thirty (30) days written notice to Company, and Company's written approval of said change.

13. It is further agreed that the Water User will indemnify and save harmless the Company for and against all claims, suits, damages, costs, losses, fines, penalties, assessments, and expenses in any manner resulting from or arising out of the construction, operation, maintenance, renewal, repair, remodeling, use or existence of the Water User's facilities, whether heretofore or hereafter made, including Company's attorneys' fees and including damage to crops of others resulting from interference with the delivery of water by the Company.

14. The failure or refusal of Water User to comply with any provision herein shall constitute a default and shall entitle the Company to petition to reinstate or assert its protest with the IDWR, or alternatively, to seek specific performance and/or damages from the Water User for such failure or refusal to so comply. In the event the Company is required to initiate either administrative or legal action to enforce its rights under this Agreement, the Water User shall indemnify and reimburse the Company for any and all costs and expenses incurred by the Company in enforcing its rights, including attorney's fees and costs.

15. The parties hereby bind themselves, their heirs, successors, assigns, lessees, and legal representatives; provided that any assignment, sale, lease or other conveyance of Water User's interest in the facility or right to the use of the water shall not bind or otherwise affect the Company's right to reinstate its protest or to contest the water use at the facility, unless such assignment, sale, lease or other conveyance is approved by the Company and the successor, lessee or grantee of such interest agrees, in writing, to the terms and conditions of this Agreement.

16. This Agreement shall at all times be construed as a covenant running with the land and shall be a burden upon the property described on Exhibit B.

17. This Agreement contains the entire understanding and agreement of the parties hereto with respect to the subject matter hereof, and no prior written or oral agreement or understanding pertaining to any such matter shall be effective for any purpose. This Agreement may not be amended, modified, altered, changed, subtracted from, or added to except by an agreement in writing signed by the parties to this Agreement or their respective successors in interest.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed this ___ day of _____, 19___.

TWIN FALLS CANAL COMPANY

By: _____
PRESIDENT

ATTEST:

_____
SECRETARY

WATER USER

X Lee Roy

_____

STATE OF IDAHO)
) ss.
County of Twin Falls)

On this 11 day of May, 1999, before me, a Notary Public, in and for said County and State, personally appeared Charles H. Coiner, Jr. and Dan Shewmaker, known or identified to me to be the President and Secretary, respectively, of TWIN FALLS CANAL COMPANY, the corporation that executed the foregoing instrument, and acknowledged to me that such corporation executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

_____
NOTARY PUBLIC FOR IDAHO
Residing at: Twin Falls
My commission expires: 5/10/2003

STATE OF IDAHO)
) ss.
County of Twin Falls)

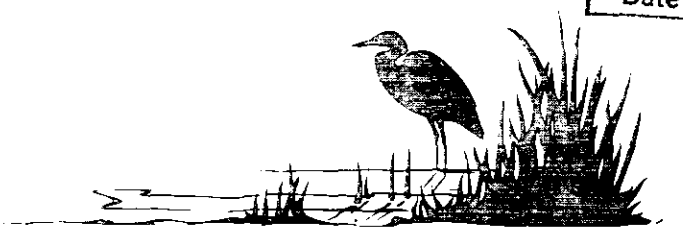
On this 15 day of April, 1999, before me, a Notary Public, in and for said County and State, personally appeared Leo E. Ray ~~and~~ _____, known or identified to me to be the individual~~s~~ whose name~~s~~ ~~are~~ is subscribed to the within instrument, and acknowledged to me that ~~they~~ he executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

Doris L. Turney
NOTARY PUBLIC FOR IDAHO
Residing at: Twin Falls
My commission expires: 5/10/2003

1428m

Department of Water Resources
PROTESTANT'S
Exhibit A
Date Admitted 11/5/99



The Upper Snake Rock Watershed Management Plan

(or Upper Snake/Rock Creek Watershed Management Plan)

The Upper Snake Rock Subbasin Assessment

&

The Upper Snake Rock Total Maximum Daily Load

Prepared by:

Dr. Balthasar B. Buhidar, Ph.D.
and the Water Quality Protection Staff of
Idaho Division of Environmental Quality-Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

&

The Middle Snake RiverTechnical Advisory Committee
of
The Middle Snake River Watershed Advisory Group
c/o Idaho Division of Environmental Quality
Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

October 25, 1999
Public Review Draft

SPR 2 8 2005

Cover + Table of Contents Only

PREPARERS AND CONTRIBUTORS

The Middle Snake River Technical Advisory Committee of the Middle Snake River Watershed Advisory Group was instrumental in the preparation of the Upper Snake Rock Subbasin Assessment (or SBA) and in providing technical comments on the TMDL development portion. The SBA was prepared by the principle writer, Dr. Balthasar B. Buhidar, Ph.D., who wrote it to satisfy the Idaho Division of Environmental Quality's Suggested TMDL Outline. Maps and figures were prepared by Rob Sharpnack, IDEQ-TFRO.

A Preliminary Draft No. 1 was prepared for internal IDEQ-Twin Falls Regional Office and IDEQ-Central Office Boise beginning April 30, 1998. From comments received with additonal extensive research, a Public Review Draft No. 1 was prepared on June 17, 1998 and presented to the Middle Snake River TAC. Preliminary comments from the TAC were solicited and due by July 2, 1998, with additional comments by July 15, 1998. A presentation was made to the Middle Snake River WAG on July 15, 1998 with a solicitation of comments from the WAG. A presentation was also made to the Upper Snake Basin Advisory Group on August 5, 1998 with a solicitation of comments from the BAG. These comments were incorporated into Public Review Draft No. 2 on September 1, 1998. With additional comments coming in from the TAC, the WAG, the BAG, and additional research conducted a preliminary final Public Review Draft No. 3 was prepared on September 18, 1998. This draft was forwarded one more time to IDEQ-Central Office Boise for a second final review. Their review was finished on December 18, 1998. All comments where appropriate were incorporated into a Proposed Final Draft, dated December 31, 1998. The final proposed draft was presented to the TAC and the WAG on February 17, 1999. Minor corrections and updating of information occured on April 30, 1999. The Upper Snake BAG received a similar presentation on October 6, 1999. The proposed final draft was finalized on October 25, 1999. A 30-day public comment period followed beginning November 1, 1999. Submission to USEPA-Boise was December 20, 1999 (tentative).

The subbasin assessment was intended to be iterative during the TMDL development phase, so that the assessment and the final TMDL would complement each other in content when final submittal to USEPA-Boise/Seattle. Preliminary final TMDL development was intended to be finished by August 31, 1999, allowing four additional months for legal review and biopolitical assessment.

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ACRONYMS AND GLOSSARY

The acronyms and glossary used in this document are summarized in the following list. The list is only inclusive for those terms used in this subbasin assessment and TMDL development.

TERM	*DEFINITION*
Acute toxicity	The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose.
ArcView™	ArcView is a computer Windows based program made by Environmental Systems Research Institute, Inc. (ESRI) for the creation of GIS-type maps.
Biopolitics	The integral relationship between the human institution of politics and the natural elements of the environment, such that no matter how scientific or technically correct certain processes or guidelines may seem, they are without foundation until accepted and established through the existing political system.
BSU	Boise State University (Boise, Idaho)
BURP	Beneficial Use Reconnaissance Project of IDEQ.
Ephemeral Stream	A stream which functions as a drainage channel which is normally dry but carries water in response to storms or annual snowmelt. There is no IDAPA definition. USBLM describes ephemeral streams as streams which last for brief periods of time. Many ephemeral streams do not appear on USGS maps as blue lines.
Epiphyte	Plants living on another plant or partly within the plant but nonparasitically, deriving its nutrients from the air, water, or debris accumulating around it.
GIS™	Geographic Information System (by ArchView)
HUC	Hydrologic Unit Code (USGS designation)
HUC 3rd Field	Basin hydologic unit (made up of several subbasins)
HUC 17040212	Upper Snake Rock Subbasin (8 digit HUC)
HUC 4th Field	Subbasin hydrologic unit
HUC 5th Field	Watershed hydrologic unit (a sub component of 4th Field HUCs)
HUC 6th Field	Subwatershed hydrologic unit (a sub component of 5th Field HUCs)
IDA	Idaho Department of Agriculture
IDL	Idaho Department of Lands
IDEQ	Idaho Division of Environmental Quality
IDFG	Idaho Department of Fish and Game
ISCC	Idaho Soil Conservation Commission

TERM	DEFINITION
ISU	Idaho State University (Pocatello, Idaho)
IDWR	Idaho Department of Water Resources
Intermittent Stream	IDAPA 16.01.02.003.50 defines intermittent stream(s) as "a stream which has a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 hydrologically-based design flow of less than one-tenth (0.1) cfs is considered intermittent. Streams with perennial pools which create significant aquatic life uses are not intermittent." USBLM describes intermittent streams as streams which have periodic interruptions in a normal pattern or process. USDA FS describes intermittent streams as streams in contact with the ground water table that flow only certain times of the year, such as, when the ground water table is high or when it receives water from springs or from some surface source such as melting snow in mountainous areas. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available streamflow (USDA FS 1997d).
IWRRI	Idaho Water Resources Research Institute is an institute of the University of Idaho (Moscow) with offices statewide. One of those offices is at the Kimberly Research and Extension Center in Kimberly, Idaho.
LA	Load allocations for nonpoint source industries.
LC	Load Capacity = TMDL = Assimilative Capacity = WLA + LA + MOS
Man-made water body	IDAPA 16.01.02.003.57 defines man-made waterways as "canals, flumes, ditches, and similar features, constructed for the purpose of water conveyance." In Upper Snake Rock there are many natural stream drainage channels which have been converted into man-made waterways.
Mid-Snake TAC	Middle Snake River Technical Advisory Committee
Mid-Snake WAG	Middle Snake River Watershed Advisory Group
MOS	Margin of Safety in a TMDL
Nonpoint Source	Any unconfined and diffuse source of contamination, such as stormwater or snowmelt runoff, or atmospheric pollution. Legally, a nonpoint source of water pollution is any source of water pollution that does not meet the definition of "point source" in section 502(14) of the Clean Water Act. (USEPA 1997k [p. xii])
NRCS	Natural Resources Conservaton Service
Perennial Stream	A stream which flows year-round in most years. There is no IDAPA definition. USBLM describes perennial streams as streams which have uninterrupted flow from year to year. USDA FS describes perennial streams as streams that flow continuously throughout the year (permanently) (USDA FS 1997d).

TERM	DEFINITION
Point Source	Any discernable, confined or discrete conveyence (pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation (CAFO), or vessel or other floating craft from which pollutants are or may be discharged. (USEPA 1997k)
QA/QC	Quality Assurance/Quality Control
SBA	Subbasin Assessment
SCC	Soil Conservation Commission (the equivalent of ISCC)
SCD	Soil Conservation District
TFRO	Twin Falls Regional Office
TMDL	Total maximum daily load. The standard formula for a TMDL is: TMDL = Loading Capacity = Assimilative Capacity = Point Source Wasteloads + Nonpoint Source Loads + Margin of Safety.
UI or U of I	University of Idaho (Moscow, Idaho)
Upper Snake BAG	Upper Snake Basin Advisory Group
USBLM	United States Bureau of Land Management
USDA/ARS	United States Department of Agriculture/Agriculture Research Service
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WLA	Wasteload allocations for point source facilities.

THE UPPER SNAKE ROCK SUBBASIN ASSESSMENT for SURFACE WATERS of HYDROLOGIC UNIT CODE 17040212

2.0 INTRODUCTION

The Upper Snake Rock Subbasin Assessment describes Hydrologic Unit Code (HUC) 17040212 for those water bodies that are water quality limited and listed on the 1996 §303(d) list of the Clean Water Act. Included in those water quality limited streams (or stream segments) are the fourteen (14) stream segments of the Middle Snake River (already addressed by the Mid-Snake TMDL for total phosphorus) and Billingsley Creek (already addressed by the Billingsley Creek TMDL for total phosphorus). Important to the Middle Snake River system is its managed flow. Although the IDEQ does not consider flow to be a pollutant for TMDL development, it nevertheless affects how the river functions. Reduced flows reduces loading capacity and intensifies the effects of pollutant loading, particularly under seasonal low flow conditions.

2.0.1 IDENTIFICATION SYSTEM

The identification system used in this subbasin assessment follows the Hydrologic Unit Codes (HUCs) used by the U.S. Geological Survey (USGS). The Upper Snake Rock subbasin (or HUC 17040212) is a 4th field hydrologic unit that represents a geographic area in the Upper Snake Basin such that "it is a distinct hydrologic feature (Gregory and Walling 1973)." Figure 1 shows HUC 17040212 in relationship to other adjacent HUCs in southern Idaho. Figure 2 shows the 38 watersheds (or 5th field HUCs) in HUC 17040212. Figure 3 shows the overall Upper Snake Basin and where HUC 17040212 is located in relation to it. Figures 1, 2, 3 are located at the end of this section of the subbasin.

2.0.2 COMPILATION OF DATABASES

The IDEQ-TFRO, reviewed a substantial amount of information from GIS coverages, databases from various internet sources, published water quality reports and maps, and data information requests from such sources as the U.S. Bureau of Land Management (USBLM), U.S. Forest Service (USFS), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), U.S. Department of Agriculture/Agricultural Research Service (USDA/ARS), Natural Resources Conservation Service (NRCS), Idaho Department of Fish and Game (IDFG), Idaho Department of Lands (IDL), Idaho Department of Water Resources (IDWR), Idaho Department of Agriculture (IDA), Soil Conservation Commission (SCC), various Soil Conservation Districts (SCDs), University of Idaho (U of I), Idaho State University (ISU), Boise State University (BSU), and various industries and organizations from the Upper Snake Rock subbasin.

As a primary concern, compilation and review of existing data (either as historical or recent) centered on the characterization of pollutant loads from all sources within Upper Snake Rock, so that the development of the "Upper Snake Rock TMDL" could readily be obtained from the loading descriptions provided in this subbasin assessment. Where technology-based controls are inadequate to achieve water quality standards, it is expected that the eventual TMDL will provide more stringent water quality-based controls in order to meet state water quality standards. Post-SBA includes the development of the Upper Snake Rock "TMDL," which will be structured on wasteload allocations (WLAs) for point sources, load allocations (LA s) for nonpoint sources, and a margin of safety (MOS): TMDL = WLA + LA + MOS. The MOS will account for scientific uncertainty in establishing the TMDL due to insufficient or poor-quality data, or a lack of knowledge about the relation between the receiving water quality and the effects of pollutant loading rates. It is expected that when the TMDL is developed, the loading capacity (LC) or assimilative capacity of all water quality limited

waterbodies will be identified as *the greatest amount of pollutant loading that a water body can receive without violating water quality standards* (USEPA 1997k).

Sediment will be shown to be the prinicipal pollutant in Upper Snake Rock. It is a highly complex pollutant to assess, particularly for more than one affected water body. The model used in this assessment for the eventual development of a TMDL was a simple mass balance using average annual loadings. No attempt was made at this time to view the Upper Snake Rock "TMDL" as a complex water quality model, so as to simulate rainfall events, cumulative chemical fate, or transport (USEPA 1996k). Perhaps at some point in the future, consideration for such complex modeling may be realized, but at this point it is not an effort that IDEQ or the Mid-Snake Technical Advisory Committee considered feasible under current time and financial constraints. Additionally, information on river flow as it relates to sediment transport dynamics and nutrient assimilation is also included. Flow, both as quantity and velocity, is a key component in the overall river system and is vital to the biological community, not only from a water quality perspective, but also for biological transport as it relates to the genetic interchange between aquatic animal populations and their reproductive needs.

2.0.3 QUALITY ASSURANCE/QUALITY CONTROL OF DATA

The data information sources provided to IDEQ-TFRO and used in this subbasin assessment were scrutinized for quality assurance/quality control (QA/QC). As the majority of the data were collected under field conditions and transported for analysis to a laboratory, the following protocols were used to ascertain a minimum level of compliance for QA/QC field and laboratory considerations: (1) The data were reviewed for use of blanks, spikes, and duplicates as a minimum protocol; (2) Under QA all data had to be ensured to be scientifically valid, defensible, and of known precision and accuracy both in the field and in the laboratory so as to withstand scientific and legal challenges; (3) QC samples were introduced into the process to monitor performance of the system from the field collection to the final laboratory analysis; and, (4) In all databases reviewed, it had to be demonstrated that a QA/QC plan was enforced throughout the life of the project. As a consequence, a preliminary database was developed for the Middle Snake River and for the other water quality limited water bodies by IDEQ-TFRO, which will be incorporated over the next ten (10) years for use by the Mid-Snake Technical Advisory Committee's *Trend Monitoring Plan*.

2.0.4 PUBLIC ADVISORY COMMITTEE INVOLVEMENT

As part of the public's involvement in the development of this subbasin assessment, the Middle Snake River Watershed Advisory Group's (Mid-Snake WAG) Technical Advisory Committee (TAC) was instrumental in the review of the document. The document was prepared by the IDEQ-TFRO, with supplemental comments and review by IDEQ-Central Office, and the Mid-Snake WAG's TAC. The subbasin assessment was provided to the Mid-Snake WAG (as the general membership) and the Upper Snake Basin Advisory Group (Upper Snake BAG) for their review and comments before submission to the USEPA.

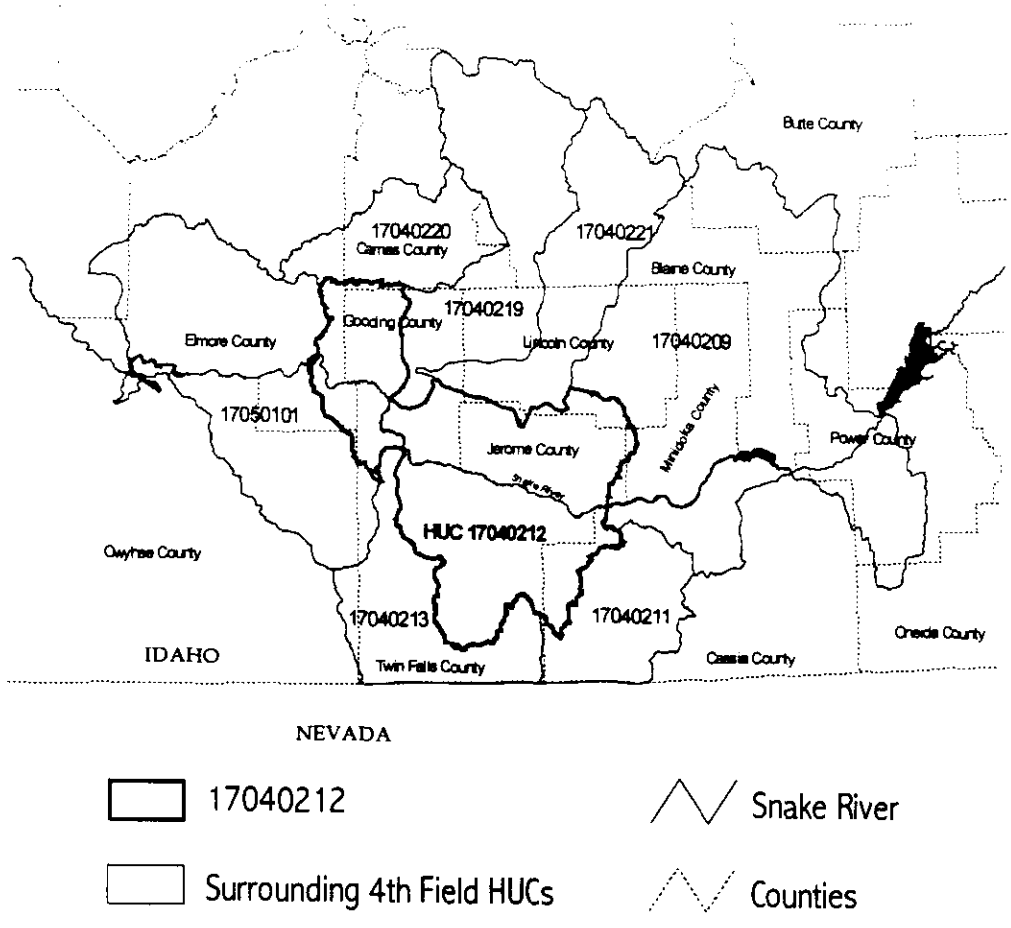
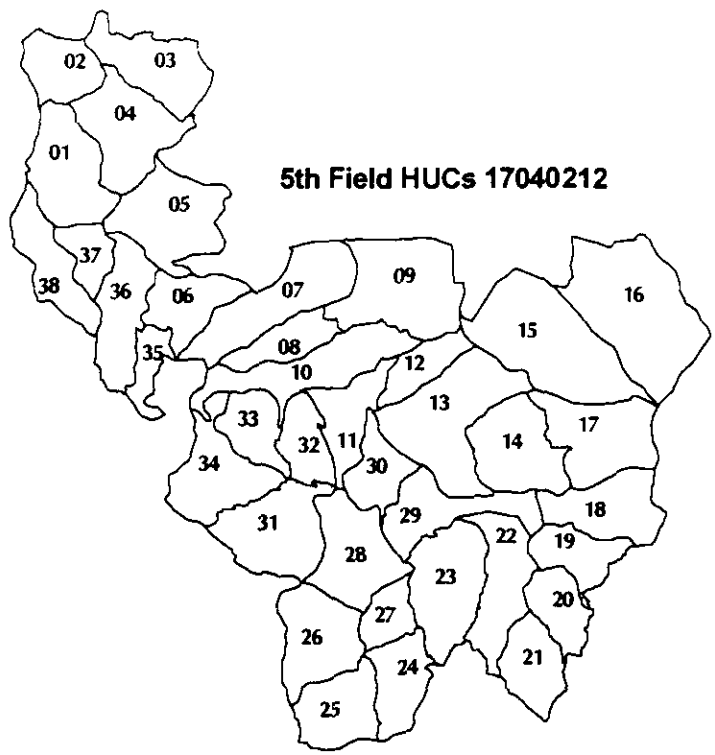


Figure 1 Hydrologic Unit Code (HUC) 17040212

17040212 _ _



01) Lower Clover Creek
02) Dry Creek
03) Upper Clover Creek
04) Calf-Clover
05) Bliss
06) Hagerman
07) Wendell
08) Wendell South
09) Notch Butte
10) Jerome
11) Canyon
12) Falls City
13) Shoshone Falls
14) Twin Falls
15) Milner-Gooding Canal
16) Kimama Butte
17) Caldron Linn
18) Lake Murtaugh
19) Lower Dry Creek
20) Dry Creek
21) Upper Rock Creek
22) Rock Creek
23) North-Cottonwood McMullen
24) Soldier
25) Rogerson
26) Deep Creek
27) Nat-Soo-Pah
28) Hollister
29) Hub Butte
30) Lower Rock Creek
31) Clover
32) Filer
33) Buhl
34) Castleford
35) Yahoo Creek
36) Tuana Gulch
37) Ticeska
38) Pasadena

Figure 2 Fifth Field HUCs in 17040212

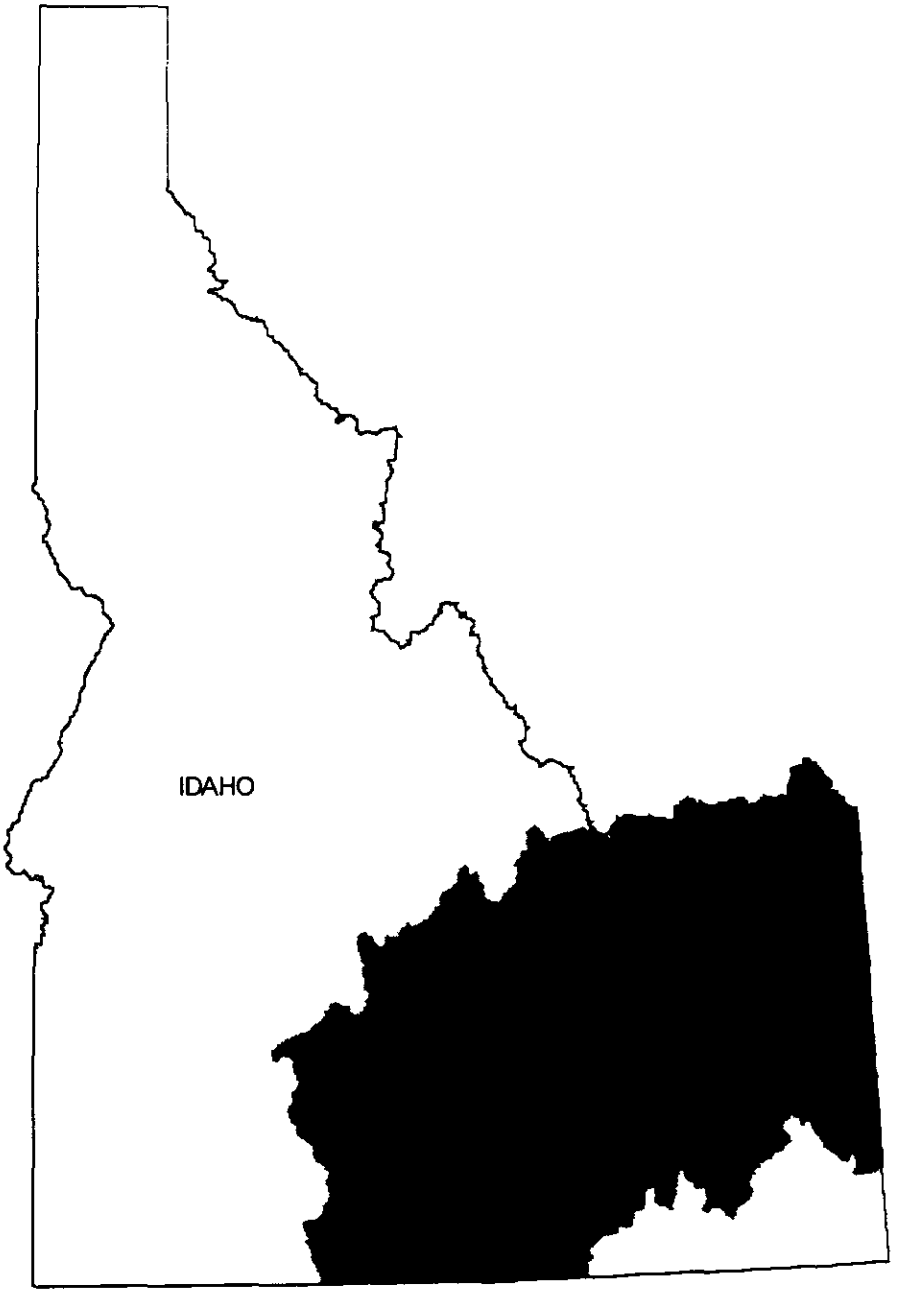


Figure 3 HUC 17040212 in the Upper Snake Basin

2.1 CHARACTERIZATION OF THE WATERSHED

The characterization of the Upper Snake Rock subbasin (or Upper Snake/Rock Creek subbasin) will be based on its physical and biological characteristics and how these characteristics interplay with ecoregional and hydrological traits. The Upper Snake Rock subbasin is complex in its ecoregional and hydrological traits principally due to its continual evolving physical and highly varied biological characteristics. Part of that complexity is the issue of sediment pollution in the waterbodies which is affected by soil characteristics, climate, vegetation, topography, and human activities (Sing *et al.* 1988 [p 260]). This complexity is described and discussed in the following subsections relative to sediment yield sources: natural sources (erosion, sheet erosion, rill erosion, gully erosion, massive runoff), artificial sources (human activities such as agricultural tillage, domestic animal grazing, highway construction and maintenance, timber cutting, mining, urbanization, and recreational land development), channel sources (stream bed, stream banks, hydraulic structure construction, channelization, dredging, dam breaches, mining of gravels), and disaster sources (natural disasters, extra-large storms creating excessive floods, earthquakes causing slides and mudflows, fires, and droughts) (Sing *et al.* 1988 [p 260]).

2.1.1 SUBBASIN OVERALL GENERAL CHARACTERISTICS

The Middle Snake River traverses the Upper Snake Rock subbasin from Milner Dam (RM 638.5) to the town of King Hill, Idaho (RM 546.0). It extends 92.5 miles dropping from an elevation of 4135 feet at Milner Dam to 2498 feet at King Hill. Those Idaho counties making up HUC 17040212 are listed in Table 1.

Table 1 Estimated breakdown of HUC 17040212 in the indicated county

County	*% in HUC 17040212*	*County*	*% in HUC 17040212*
Jerome (M)	90%	Elmore (E)	3%
Twin Falls (UH)	60%	Owyhee (E)	1%
Gooding (W & SE)	60%	Minidoka (NW)	1%
Cassia (NW)	5%	Lincoln (SW & S)	1%
Camas (S)	3%		

Prepared by IDEQ-TFRO. NW = Northwestern portion; E = Eastern portion; S = Southern portion; SE = South eastern portion; SW = South western portion; W = Western portion; UH = Upper Half; M = Majority of county.

It is an unusually geographically structured drainage. Although Salmon Falls Creek and the Big Wood River (Malad River) drain into the Middle Snake River, they are not included in the drainage of Upper Snake Rock because they are considered separate and distinct subbasins. As defined in the Mid-Snake TMDL (IDEQ 1997b), the Upper Snake Rock subbasin describes 53.5% of the Middle Snake River Watershed Management Area (or 2438 square miles). The other portion of the management area (46.5%), or the Salmon Falls Creek drainage (2120 square miles), will be covered in a separate TMDL. Assigned water quality parameter loadings may occur for the mouth of the tributaries discharging to the Middle Snake River in Upper Snake Rock.

The Interior Columbia Basin Ecosystem Management Project has distinguished the Upper Snake Rock subbasin as a Category 3 Subbasin, such that it may be described by the following general characteristics:

1. "This subbasin may support populations of key salmonids or have other important aquatic values, such as threatened and endangered species, narrow endemics, and introduced or hatchery supported sport fisheries (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

2. "In general this subbasin is strongly fragmented by extensive habitat loss or disruption throughout the component watersheds, and most notably through disruption of the mainstream corridor (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

3. "Major portions of this subbasin are often associated with private and agricultural lands not managed by the Forest Service or USBLM (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

4. "Although important and unique aquatic resources exist, they are usually localized (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

5. "Opportunities for restoring connectivity among watersheds, full expression of life histories, or other large-scale characteristics of fully functioning and resilient aquatic ecosystems are limited or nonexistent in the near future (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

6. "Opportunities for management of aquatic resources in this subbasin is primarily in conserving remaining habitats in specific locations, rather than restoration of a more functional mosaic (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

7. "Although there may be greater flexibility in land-use management for subbasin areas outside of critical watersheds, some management conflicts may arise (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

8. "Because the remaining aquatic resources are often strongly isolated, risks of local extinction may be high (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

9. "Land-use activities within this subbasin may call for extreme caution to not aggravate present conditions (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

10. "Conservation of the remaining productive areas may require a disproportionate contribution from Federal management agencies, because these subbasins often include large areas of non-Federal land (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

Additionally, those lands administered by the Forest Service and Bureau of Land Management in Upper Snake Rock may be categorized according to integrated ecological measures. These measures are summarized as follows:

1. Low Composite Ecological Integrity: Ecological integrity describes the wholeness and resiliency of an ecological system (such as the Upper Snake Rock subbasin). An ecological system with a low integrity functions poorly because it does not have all its parts and processes intact. Such a system does not readily rebound quickly after wildfires, floods, road building, and other disturbances. In general, the more the ecological system has been altered, the lower its integrity. A low-integrity area may not be highly degraded, but may be filling societal needs including agricultural lands and roads related to recreational areas (USDA FS & USDI/BLM 1997b [p 8]).

2. Low Aquatic Integrity: An ecological system with low aquatic integrity does not possess a full complement of native fishes and other aquatic species that are well distributed in high-quality, well-connected habitats (USDA FS & USDI/BLM 1997b [pp 10-11]).

3. High Rangeland Hydrologic Integrity: An ecological system with high rangeland hydrologic integrity has a network of streams where upland, flood-plain, and riparian areas have resilient vegetation. These networks support diverse and productive aquatic and terrestrial environments (USDA FS & USDI/BLM 1997b [p 11]).

4. Low Rangeland Integrity: An ecological system with low rangeland integrity does not have a mosaic of plant and animal communities that are well-connect. The habitat is not high quality because of poor diverse assemblages of native and desired nonnative species (USDA FS & USDI/BLM 1997b [p 11]).

5. Forest Integrity & Forest Hydrologic Integrity: Because of the low percentage of forest habitat (in terms of land use), no forest integrity ratings are assigned to the Upper Snake Rock subbasin (USDA FS & USDI/BLM 1997b [pp 10-11]).

2.1.1.1 5TH FIELD HUC CHARACTERISTICS

The Upper Snake Rock subbasin is cartographically subdivided into 38 watersheds (or 5th order HUCs). These are described in Table 2 with their appropriate name and 5th order HUC number. Figure 2 illustrates the 38 watersheds in Upper Snake Rock subbasin. See §2.0, Figure 2.

Table 2 5th order HUCs of Upper Snake Rock 17040212

5th Order Number	*Watershed Name*	*Total Acres*	*5th Order Number*	*Watershed Name*	*Total Acres*
1704021201	Lower Clover Creek	50758	1704021220	Dry Creek	25698
... 02	Dry Creek	30286	... 21	Upper Rock Creek	31935
... 03	Upper Clover Creek	44761	... 22	Rock Creek	43737
... 04	Calf-Clover	53750	... 23	North Cottonwood-McMullen	54547
... 05	Bliss	56284	... 24	Soldier	32066
... 06	Hagerman	31927	... 25	Rogerson	37558
... 07	Wendell	58719	... 26	Deep Creek	46341
... 08	Wendell South	24319	... 27	Nat-Soo-Pah	18628
... 09	Notch Butte	68825	... 28	Hollister	49067
... 10	Jerome	53027	... 29	Hub Butte	41009
... 11	Canyon	30939	... 30	Lower Rock Creek	25957
... 12	Falls City	21880	... 31	Clover	54088
... 13	Shoshone Falls	73777	... 32	Filer	24572
... 14	Twin Falls	48758	... 33	Buhl	25958

5th Order Number	Watershed Name	Total Acres	5th Order Number	Watershed Name	Total Acres
.. 15	Milner-Gooding Canal	87798	.. 34	Castleford	47756
.. 16	Kimama Butte	95944	.. 35	Yahoo Creek	16059
.. 17	Caldron Linn	53225	... 36	Tuana Gulch	41865
.. 18	Lake Murtaugh	43181	... 37	Ticeska	18588
.. 19	Lower Dry Creek	27620	... 38	Pasadena	35387
Prepared by IDEQ-TFRO from USGS GIS maps. There are two Dry Creek watersheds in the Upper Snake Rock subbasin: 17040212-02 and 17040212-20, which are indicated in gray in the table.					

2.1.1.2 CLIMATOLOGY: PRECIPITATION, HUMIDITY, TEMPERATURE

The climate of Upper Snake Rock is semiarid with low annual rainfall, moderately hot, dry summers, moderate to cold winters, and relatively windy springs.

Average annual precipitation is 10.5 inches and may vary from 50 to 150% of the mean. See Figure 4 at the end of §2.1. The figure illustrates that over 95% of the subbasin is in the 10.5 inches as average annual precipitation, while higher precipitation may be found in the uppermost northern boundary (Mount Bennett Hills) and the lowermost southern boundary (Sawtooth National Forest). In general, precipitation is fairly consistent throughout the year, except July through September, when the total for the three months may be less than 1 inch. More recently, from 1991 to 1996 the higher precipitation quarters were winter and spring, with values of 3.35" and 3.82", respectively (or a total of 7.17"). The lower precipitation quarters were summer and fall at 1.92" and 2.11", respectively (or a total of 4.03"). The higher average annual precipitation (11.20") when compared to the historical normal (10.5") was due to the above normal rains and snows of winter and spring (AgriMet 1994).

Relative humidity from 1991 to 1996 averaged 62.4%. Winter and spring for the same time period averaged 73.4% and 60.7%, respectively (or 67.0% average). Summer and fall averaged 53.8% and 61.8%, respectively (or 57.8% average)(AgriMet 1994).

Average annual air temperature ranges from 40 to 51°F. January and July are typically the coldest and warmest months with average temperatures of 29.4°F and 72.7°F, respectively. During the summer, temperatures in excess of 100°F are common. More recently, from 1991 to 1996 the higher annual air temperatures in the spring were principally due to higher than normal temperatures in 1992 and 1994 when compared to those year's mean air temperature (AgriMet 1994).

2.1.1.3 POPULATION AND RECREATION

Much growth has occured in the population of Upper Snake Rock since 1990. Table 3 summarizes the projected estimates through the year 2010 for the three largest counties in the Upper Snake Rock subbasin as compared to the more expansive South Central Region (which includes eight counties).

Table 3 Major counties in Upper Snake Rock subbasin and their actual and projected populations

County	1970 (census)	1980 (census)	1990 (census)	2010 (projected)
Gooding	8645	11874	11633	12512
Incorporated	4271	5215	5568	5726
Unincorporated	4374	6659	6065	6786
Jerome	10253	14840	15138	17095
Incorporated	4922	6616	7237	7986
Unincorporated	5331	8224	7901	9109
Twin Falls	41807	52927	53580	59967
Incorporated	28389	32340	36290	40641
Unincorporated	13418	20587	17290	19326
SC Region vs Tricounty Area	102987 vs 60705	135367 vs 79641	136831 vs 80351	155901 vs 89574
Incorporated	60081 vs 37582	69673 vs 43339	79265 vs 49095	89021 vs 54353
Unincorporated	42906 vs 23123	65694 vs 36302	57566 vs 31256	66880 vs 35221

Prepared by DEQ-TFRO. Land use values for incorporated versus unincorporated is based on the number of persons living in these areas of the county, tricounty, or region. SC = South Central and includes Blaine, Camas, Cassia, Gooding, Jerome, Lincoln, Minidoka, and Twin Falls counties. The Tricounty Area includes only Gooding, Jerome, and Twin Falls counties (IDC 1993).

From these figures it is estimated that in the 40 years up to year 2010, the tricounties will experience a 47.6% population increase as the South Central Region increases by 51.4%, with the tricounties making up 57.5% of the region's total. Incorporated portions of the tricounties will increase by 44.6% as the region increases by 48.2%, and the tricounties will make up 61.1% of the region's total. Unincorporated portions of the tricounties will increase by 52.3% as the region increases by 55.9%, and the tricounties will make up 52.7% of the region's total. See Figure 5 at the end of §2.1 for an illustration of the human population according to the major towns and cities.

"The population of a community and rate of change of that population are often used as indicators of economic diversity, economic resiliency, community vitality, and whether the community is prospering or in decline. Economists use population growth as a proxy for economic growth (USDA/USBLM 1997a [Vol 1, p 196]; Haynes & Horne 1996). Communities with larger populations lead to more businesses such that many industries are represented with many firms in each industry. Population growth is usually associated with economic growth and vice versa. As a measure of economic diversity, the statistical Shannon-Weaver Diversity Index is used to characterize the economic resiliency as low, moderate, or high rating (USDA/USBLM 1997a [Vol 1, p 196]; Alward 1996). Table 4 describes the index per indicated county in the Upper Snake Rock subbasin.

Table 4 Economic resiliency ratings of the Upper Snake Rock tri-county area

County	Economic Resiliency Rating
Jerome	Moderate
Gooding	Moderate
Twin Falls	High

Prepared by IDEQ-TFRO from the *Interior Columbia Basin Ecosystem Management Project*. This index was also used to score timber/forage importance, such that the % Timber from National Forests in the three counties was not applicable (or zero), and the % Forage from Federal Land was 1, 1, and 8 for Jerome, Gooding, and Twin Falls counties, respectively (USDA/USBLM 1997a [Vol 1, pp 183-184]).

Because of population growth, recreational areas in Upper Snake Rock have become more prominent in the last few years due to their accessibility, commercial advertisement, and development. As the population experiences the more unaccessible water areas of Upper Snake Rock, and as commercial development grows into those areas, water quality concerns will need to be addressed as well. Even now, many recreational areas are having an effect on water quality due to degradation of their stream banks. Storm water runoff in the City of Twin Falls and in agricultural rural areas is becoming more of a public concern because of erosion and its contribution to sediment pollution.

2.1.2 ECOREGION CONSIDERATION

Over 95% of Upper Snake Rock comprises an ecoregional area known as the Snake River Basin/High Desert, as defined by Omernik (Omernik 1986). Less than 5% of Upper Snake Rock is considered a Northern Basin and Range ecoregion; specifically for the higher elevation headwater sources for Clover Creek (in the Mount Bennett Hills) and the Rock Creek Complex (in the Sawtooth National Forest). According to Omernik's ecoregional descriptors three general characteristics predominate as to land form, vegetation, and land use. These will be discussed in the following sub-sections.

2.1.2.1 TOPOGRAPHY

In general, Upper Snake Rock has a land-surface form or topography that consists of tablelands with medium to high relief. Its plains have hills or low mountains. The Snake River Canyon is a steep-sided trench, cut into the relatively flat, surrounding plain. Table 5 summarizes the width of the main channel, its slope (feet/River Mile), elevations, and elevation drop of the Middle Snake River at various river mile locations or reaches. The Middle Snake River may be segregated into three "reaches" or segments according to slope: an "upper reach" (from river miles 619 to 638); a "middle reach" (from river miles 559 to 618); and, a "lower reach" (from river miles 545 to 558). The smallest width is estimated at 50 feet, and the widest width is estimated at 1500 feet.

Table 5 Width of the Middle Snake River (channel) at various "reaches"

River Miles	*River width, feet*			*"Reach" Miles*	*Slope ft/RM*	*Elevation feet*	*Elevation Drop feet*
	Mean	*Max*	*Min*				
638-619	103	225	50	20	29.5	4135-3380	755
618-559	441	1500	100	60	15.2	3380-2580	800
558-545	254	600	150	14	7.7	2580-2497	83
Prepared by IDEQ-TFRO							

Shoshone Falls stands as a 212-foot-tall natural waterfall located about 2.7 miles downstream of Twin Falls Dam. It is recognized as a natural barrier to upstream migration of native species of fish (FERC 1997a).

The elevation within Upper Snake Rock also describes the varying topography of the subbasin. In the northwestern portion of the subbasin the Clover Creek drainage begins at 6400 feet in the Mount Bennett Hills and drains southwestward to the Middle Snake River at about 3000 feet. In the southeastern portion of the subbasin the Rock Creek drainage begins at 7700 feet in the Sawtooth National Forest and drains northward to the Middle Snake River at about 3500 feet. Generally speaking the topography of the subbasin is such that drainage moves towards the Middle Snake River, whether it be from natural drainage or the myriad of constructed canals, drains, and laterals. It is for this reason that the Upper Snake Rock subbasin is

sometimes called the "Mid-Snake subbasin." See Figure 6 at the end of §2.1 for a view of the topography of Upper Snake Rock.

2.1.2.2 POTENTIAL NATURAL VEGETATION

In general, there are two types of natural vegetation in Upper Snake Rock: sagebrush-grass vegetation that predominates the entire subbasin and riparian vegetation in the tributaries and Snake River Canyon. The advent of irrigation canals changed some of the sagebrush-grass vegetation to agricultural crops and pastureland, and in some locations has provided a means by which some riparian and grassland plants have established due to incidental leekage.

SAGEBRUSH-GRASS VEGETATION ZONE

Upper Snake Rock is a sagebrush steppe (made up of sagebrush and wheatgrass) with salt bush /greasewood. The HUC is 54% rangeland. The HUC is part of the Snake River Plain which occupies approximately 22500 square miles and supports a sagebrush or a *SAGEBRUSH-GRASS VEGETATION ZONE*. Big sagebrush (*Artemisia tridentata*) and bluebunch wheatgrass (*Agropyron spicatum*) are the dominant shrub and grass species in this zone. Most of the "sagebrush" zone is found at elevations from 2000 to 7000 feet. Where sagebrush dominates below 7000 feet, annual precipitation characteristically varies between 8 and 20 inches (Wright 1979; Cronquist 1972; West 1983). Currently, large tracts of native rangelands have been converted to non-native crested wheatgrass monocultures in response to fire restoration by the USBLM and private land-owners. Sagebrush directly influences the soil microclimate by accumulating litter (litter, moss lichen) to a much greater depth when compared to adjacent grass or sparse vegetation; by insulating through its plant canopy and affecting the amount of radiant energy that reaches the surface of the soil or understory vegetation; and, by having a significant effect on the soil-water potential due both to the shading effects of the canopy and insulating effects of the litter (Wight *et al.* 1991).

RIPARIAN VEGETATION IN THE TRIBUTARIES AND SNAKE RIVER CANYON

Since forests are minimal in Upper Snake Rock subbasin (comprising less than 5%), riparian areas and wetlands become most critical and important plant communities because of their vegetative diversity and value to wildlife. These communities vary from emergent herbaceous wetlands, associated with springs and seeps, to forest-scrub areas, containing small trees and understories of shrubs (FERC 1997a). In river and tributary canyons, little vegetation occurs on the basalt cliffs and talus slopes because of the steep walls and the lack of soil and organic material which limits the establishment of vegetation (Smithman 1983; Brinson *et al.* 1981). Where they do occur in the Middle Snake River and the tributaries, they occur primarily as a narrow fringe along the flood zone, near springs, and in low areas near the river (such as between Milner Dam and Auger Falls) (FERC 1987). Agricultural land use, commercial land development, and more diversified year-round recreational use have drastically changed many riparian "buffer zones" in Upper Snake Rock over the last twenty years by drawing the population closer to the edges of streams and tributaries. Because of this, sediment trapping has been minimized, nutrient retention and removal through filtering has been minimized, wildlife habitat in areas with woody vegetation have been reduced (FERC 1990). With regard to the irrigation canal system, some irrigation return flows have increased the riparian area and vegetation by providing a water source via a sediment delta (Robison 1998).

2.1.2.3 LAND USE AND OWNERSHIP

In general, Upper Snake Rock has 54% shrubland grazing land and 41% of agricultural land (both irrigated and dryland) (ArchView 1996). These are the principle cultural land use types which affect water quality.

Other land use types include forestry, urbanization, construction and development, but as a total represent less than 5%. Urban areas, in particular, should not be discounted as potent pollution sources. As much as 75% of the economy of southern Idaho is driven by agriculture (Hazen 1997a). Current land use for Upper Snake Rock in comparison to adjacent HUCs are described in Table 6. See also Figure 7 at the end of §2.1 for a description of land use and ownership in Upper Snake Rock. It shows the concentration of agriculture (dryland and irrigated) close to the Middle Snake River and rangeland further away from the Middle Snake River.

Table 6. Land use estimates for the IDEQ-TFRO

HUC	NAME	LANDUSE TYPE	FOREST	RANGE	AG	URBAN	OTHER	TOTAL
17040209	Lake Walcott	% Sq.Miles Acres	4 151 96100	54 1982 1260000	25 919 584000	1 24 15300	16 593 377000	100 3669 2332400
17040210	Raft River	% Sq.Miles Acre	24 350 225000	50 741 476000	25 371 238000	0 7 4220	0 1 470	99 1470 943690
17040211	Goose Creek	% Sq.Miles Acres	38 440 284000	44 500 323000	18 208 134000	0 2 1140	0 1 357	100 1150 742497
17040212	Upper Snake Rock	% Sq.Miles Acres	3 73 46300	54 1322 833000	41 1006 634000	1 31 19700	0 6 3880	99 2438 1536880
17040213	Salmon Falls	% Sq.Miles Acres	8 178 115000	85 1808 1170000	6 130 84000	0 1 616	0 3 1970	99 2120 1371586
17040219	Malad River	% Sq.Miles Acres	24 353 218000	63 917 567000	10 148 91600	1 10 6270	2 30 18500	100 1458 901370
17040220	Camas Creek	% Sq.Miles Acres	6 38 23900	70 468 298000	25 165 105000	0 1 432	0 0 100	101 672 427432
17040221	Little Wood River	% Sq.Miles Acres	5 56 35700	67 753 482000	17 189 121000	0 4 2390	11 118 75400	100 1120 716490

Prepared by DEQ-TFRO. HUC 17040212 is generally reported to have an area of 2440 square miles according to USGS.

Idaho's Magic Valley economy remains very dependent on natural resources. Because the area has an overall elevation of 4000 feet, a moderate-to-long growing season (April to September) when compared to other parts of Idaho, and an average of 9-10 inches of average annual precipitation, it is very dependent on irrigation diversions from surface and ground water. The primary irrigation companies for the area have a major portion of their water rights as "natural flow" with supplemental storage rights (Robison 1998).

2.1.2.4 SOILS AND GEOLOGY

"Soils certainly owe more to climate and vegetation than to bedrock (Lambert 1998)." In Upper Snake Rock alkalization of the area lets the soil water bring salts and alkalis to the surface, then evaporating to leave a

whitish crush. This alkalization and evaportation has produced salty desert soils (or Aridisols) in many areas of Upper Snake Rock. In general, Upper Snake Rock has soils that are 87% Aridisols and 13% Mollisols. Aridisols are mineral soils that have developed in dry regions, are light colored, low in organic matter, and may have accumulations of soluble salts and lime. The lower the precipitation, the more likely these accumulations are to be near the surface. The vegetation found on aridisols are important contributors to the western livestock industry (USBLM 1991). Of the Aridisols and Mollisols in Upper Snake Rock, about 35% are loess (or buff-colored calcareous silt transported as wind deposits), while the remaining 63% contains residium (or residual soil that is developed from the weathering of rock directly beneath it), colluvium (loose and incoherent deposits at the foot of a slope or cliff brought there by gravity), and alluvium (deposits of silt or silty clay laid down during times of flooding). The loessal soils are composed of wind-blown particles from a variety of sources, and have a type of structure highly susceptible to water and wind erosion, particularly when vegetation cover is removed (Malde 1965; Alt & Hyndman 1989; Fenneman 1931; Freeman *et al.* 1945; Cronquist *et al.* 1972; Myers 1996; FERC 1990). See Figure 8 and Figure 9 for the soils and geology of Upper Snake Rock, respectively.

A summary of the more prominent soil characteristics and the properties of the more prominant soil series are described in Table 7. The topography of Upper Snake Rock is correlated to the particular soil series. The majority of the soils may be classified as a Portneuf silt-loam loessal aridisols which are characteristically highly erodible soils.

Table 7. Summary of soil characteristics and properties in HUC 17040212

SOIL SERIES	MEAN SOIL DEPTH inches	PARENT MATERIAL	Ppt as AMP	ELEVATION (Average) feet	SAGEBRUSH	WHEATGRASS	BLUEGRASS	RABBITBRUSH	NEEDLEGRASS	JUNEGRASS	BALSAM ROOT	HAWKS BEARD	FESCUE	WINTER FAT	SHADESCALE	RICEGRASS	SQUIRRELTAIL	LAND USE R	LAND USE IC
Gooding	50"	A over L over B	9 "	3500'	X	X	X											X	X
Portneuf	50"	L	9 "	3600'	X	X	X	X	X	X								X	X
Trevino	15"	L over B	9 "	3500'	X	X	X		X		X	X						X	X
Garbutt	60 "	A	8 "	3700'			X		X					X	X	X	X	X	X
Duric C.	30"	A over R	16 "	6300'	X	X	X						X					X	
MEAN	41"	A & L	10.2"	4120'	X	X	X		X										

Prepared by DEQ-TFRO. Duric C. = Duric Cryoborolis; Ppt = Annual Mean Precipitation (AMP); Land Use: R = Rangeland; IC = Irrigated Cropland. Of the ten soil orders which have worldwide distribution (USDA/SCS 1984), three are found in the Upper Snake Rock subbasin: aridisols (light-colored soils of dry regions), mollisols (dark-surfaced soils formed under grass), and vertisols (soils dominated by swelling clays). On a tri-county basis, the following is their distribution: (1) Twin Falls County: Mesic Aridisols (Map Units 38, 48, and 54), Xeric Frigid Mollisols (Map Unit 59), and Udic Cryic Mollisol (Map Unit 22); (2) Jerome County: Mesic Aridisols (Map Units 38, 42, 44, and 46); and, (3) Gooding County: Mesic Aridisols (Map Units 42 and 54) and Xeric Mesic Vertisols (Map Unit 47; General Soil Map Idaho, 1984).

PROJECT NAME and FERC No.	RIVER MILE	RESERVOIR DESCRIPTION Distance, RM	Capacity, acre-feet	Elevation, feet msl	OWNER

Prepared by DEQ-TFRO. Based on FERC 1997a, and the individual FERC or NPDES license applications. IPC = Idaho Power Company; TFCC = Twin Falls Canal Company; NSCC = North Side Canal Company. msl = mean sea level. Twin Falls Dam, Shoshone Falls Dam, and Upper Salmon Falls Dam do not store water nor load follow, meaning they have no effect on discharge in the Middle Snake River on either a diel or seasonal basis. Lower Salmon Falls Dam and Bliss Dam load follow but do not alter their flows outside of a diel timeframe.

In the Middle Snake River the flow is principally influenced by snowmelt, springs, and seeps discharging from the Snake River Plain Aquifer, irrigation diversion, irrigation returns, and reservoir storage management by the USBOR above Milner Dam. Overall, the principal source of streamflow is snowmelt, which occurs primarily during the spring and early summer months. The aquifer is recharged by streamflow, by precipitation directly onto the plain, and by the percolation of irrigation water. Most of the groundwater discharged from the aquifer occurs in the 92-mile reach of the Middle Snake River between Milner reservoir and King Hill, Idaho. Most of the spring water enters the river through numerous large springs where the aquifer discharges through seams or cracks in the basalt layers of the canyon walls (FERC 1990).

Historic annual mean discharge volumes of the Middle Snake River at various sites from water year 1990 through water year 1997 are summarized in Table 10 with a comparison to water year 1990. The years 1991 and 1992 are considered "baseline" for the Mid-Snake TMDL and are so used in this assessment.

Table 10 Middle Snake River annual mean flow (Q) as affected by irrigation return flows and spring sources (WYs 1990 - 1997)

SNAKE RIVER USGS GAGE	RIVER MILE LOCATION	WATER YEAR ANNUAL MEAN Q cfs 1990	1991	1992	1993	1994	1995	1996	1997	DIVERSION IRRIGATION ACREAGES
Milner 13088000	638.7	2743	2707	2671	2647	2630	2617	2656	2750	A: 1,990,000 GW: 504,000 B: 436,000
Kimberly 13090000	617.2	3136	3100	3065	3041	3025	3013	3051	3139	A: 2,020,000 GW: 537,000 B: 364,000
Buhl 13094000	596.8	5306	5238	5169	5117	5077	5045	5088	5208	A: 2,030,000 GW: 542,000 B: 230,000
Hagerman 13135000	572.5	9207	9148	9079	9027	8984	8949	8979	9079	A: 2,330,000 GW: 665,000 B: 83,000
Bliss 13153776	559.0	8774*	8717*	7377	7861	8093	8381	9378	10460	A: NMIR GW: NMIR B: NMIR
King Hill 13154500	546.6	10890	10860	10810	10780	10750	10730	10750	10820	A: 2,450,000 GW: 675,000 B: NMIR
NET DIFFERENCE FROM MILNER TO KING HILL IN 92.1 MILES		8147	8153	8139	8133	8120	8113	8094	8070	

SNAKE RIVER USGS GAGE	RIVER MILE LOCATION	WATER YEAR ANNUAL MEAN Q cfs 1990	1991	1992	1993	1994	1995	1996	1997	DIVERSION IRRIGATION ACREAGES

Prepared by DEQ-TFRO. American Falls Reservoir was unregulated from 1909-1926 and had a historic annual mean Q of 5206 cfs. After construction of the dam the historic annual mean Q was 2656 cfs. All sites are regulated by American Falls Reservoir, Lake Walcott, and Milner "Lake." A = diversions above the gage station for irrigation; GW = a portion of the diversions above the gage station which use withdrawals from groundwater for irrigation; B = diversions below the gage station for irrigation; NMIR = Not Mentioned In USGS Record. * = This value was calculated by taking the average value for Hagerman (1992-1997), which is 9016.2, and Bliss (1992-1997), which is 8591.7 cfs. A ratio is developed, such that 9016.2/8591.7=1.0494; thus, Hagerman values in 1990 & 1991 are divided by 1.0494 to give 8774 and 8717 cfs, respectively. Average WY based on the following USGS protocols: 13088000 = from WY1927; 13090000 = from WY1924; 1309400 = from WY1947; 13135000 = from WY1938; 13153776 = from WY1992; and, 13154500 = from WY1909. There is no statistical difference within the values of each gaging station based on a t-test. Additionally, the net difference versus the Bliss gaging station, and Bliss versus Hagerman, are not significantly different according to a t-test. All other possibilities are significant.

Statistically speaking, the values in Table 9 indicate that the net difference from Milner to King Hill or any of the individual USGS Gage location stations from WY1990 to WY1997 are not increasing or decreasing in their flow values from year to year. It should be noted that from 1987 through 1993, drought conditions caused flows to reach values below 2500 cfs below Milner Dam to the Buhl area during the irrigation season. Previous drought conditions occured in the 1930s and the 1960s.

The impact of the water management above Milner Dam on the water quality in the Middle Snake River may be summarized as follows:

1. During low flow years in the Middle Snake River, sediment has a tendency to fall out and accumulate in pooled stream areas. Because of low flows, very little processing of waste in the water column occurs. Additonally, low flows result in low velocity thus potentially producing increased temperatures in the water column in conjunction with already elevated water temperatures in agricultural return flows.

2. During high flow years in the Middle Snake River, sediment has a tendency to move more readily from upstream to downstream, thus reducing the amount of accumulation that may occur in pooled stream areas. In fact, Table 11 shows the results of a bathymetric study conducted on the Middle Snake River before-and-after a period of high flows (1996) at three separate reaches: Thousand Springs, Niagara Springs, and Pigeon Cove. The results indicate that high flows in the spring and summer (of 1996) resulted in the moving of a fair amount of sediment out of these reaches, particularly the Niagara Springs and Pigeon Cove areas.

Table 11 1996 Bathymetric study of the Middle Snake River

RIVER REACH	SEGMENT LENGTH feet	VOLUME BEFORE 1996 yds	VOLUME AFTER 1996 yds	NET CHANGE yds	RIVER MILE
Thousand Springs	500	2462.2	866.6	1598.6	584.3
Niagara Springs	600	7183.5	205.7	6977.8	598.8
Pigeon Cove	600	4093.5	70.4	4028.1	602.8

Prepared by IDEQ-TFRO. Volume Below and Volume Above is the calculated volume below and above the river bottom as it was surveyed in September 1996 in each of the three areas. Volume Below represents material lost or scoured since the 1996 survey. Volume Above represents material deposited above the 1996 level. To determine the actual amount of sediment that is present in the system, you would need a sub bottom profiler that would penetrate the depth-to-bedrock level so as to calculate the amount of sediment (Ralston and Associates 1996). Reference line = 1996 survey.

3. Because of higher and possible scouring flows (particularly at flows > 20,000 cfs), processing of waste throughout the water column is potentially increased. This is especially true during the off-irrigation winter season when diversions for irrigation are minimal to none. Relatively speaking, higher flows provide higher velocities which in turn provide decreased temperatures in the water column. Table 12 compares the non-irrigation season (October 16 to April 14) against the irrigation season (April 15 to October 15) from 1990 to 1997, and shows that during the drought years (1990-1995) the net difference (highest flow - lowest flow) in the off-season (October 16 to April 14) flows were relatively low when compared to 1996-1997 which had relatively higher scouring flows. Average flows (1990-1997, 1990-1995, 1996-1997) show that irrigation season flows were greater than non-irrigation season flows. 1996-1997 had an unusually higher level of precipitation when compared to 1990-1995.

Table 12 Seasonal flows past Milner Dam (USGS 13088000)

WATER YEAR	OCT 16 to APR 14 RANGE of Q, cfs	NET DIFFERENCE (HIGH - LOW)	APR 15 to OCT 15 RANGE of Q, cfs	NET DIFFERENCE (HIGH - LOW)
1990	2.7 - 2060	2057.3	0.85 - 612	611.2
1991	1.4 - 1590	1588.6	2.70 - 827	824.3
1992	17 - 1300	1283.0	1.10 - 209	207.9
1993	80 - 998	918.0	12 - 8460	8448.0
1994	213 - 291	78.0	221 - 246	25.0
1995	225 - 237	12.0	220 - 12,400	12180.0
1996	230 - 20,000	19770.0	220 - 17,200	16980.0
1997	239 - 20,600	20361.0	236 - 31,200	30964.0
1990-1995 Avg Drought Years	989.5		3,716.1	
1996-1997 Avg High Flow Years	20,065.5		23,972.0	
1990-1997 Overall Average	5758.5 Non-irrigation Season		8780.1 Irrigation Season	

Prepared by IDEQ-TFRO. Net Difference = Highest Flow - Lowest Flow = Range.

4. Table 13 compares the main portions of the seasonal irrigation/non-irrigation period between the major months of irrigation (May through September) versus non-irrigation (November through March). This comparison indicates that with the exception of 1993-1995, the average flows during the non-irrigation period were relatively greater than the average flows during the irrigation period. The years 1993-1995 indicate that the average flows during the non-irrigation period were relatively less or the same as the average flows during the irrigation period.

Table 13 Seasonal flows past Milner Dam (USGS 13088000): mean monthly flows (Q, cfs)

WY	NON-IRRIGATION PERIOD MONTHS Nov	Dec	Jan	Feb	Mar	Nonirrg Mean	IRRIGATION PERIOD MONTHS May	June	July	Aug	Sept	Irrg Mean
1990	1335	1388	889	743	91.5	889.3	2.81	2.27	345	283	109	148.4
1991	653	643	1333	678	87.4	678.9	10.4	13.0	484	542	210	251.9
1992	692	1025	1173	729	263	776.4	7.28	1.65	1.52	2.03	56.2	13.7
1993	306	220	222	223	224	239.0	217	2402	228	224	221	658.4
1994	224	225	225	235	232	228.2	230	228	226	228	225	227.4
1995	229	230	228	228	228	228.6	3560	3265	228	227	242	1504.4
1996	2316	3136	4449	7380	16650	6786.2	5488	7058	2031	1541	515	3326.6
1997	2181	3503	8968	18740	19930	10664.4	8405	23580	3182	3899	6778	9166.8
90-95 MEAN						506.7						467.4
96-97 MEAN						8725.3						6247.7
90-97 MEAN						2561.4						1912.5

Prepared by IDEQ-TFRO. WY = USGS Water Year (October 1 to September 30). Irrg Mean = Irrigation period mean. Nonirrg Mean = Non-irrigation period mean.

5. Tributaries in Upper Snake Rock are affected by irrigation return flows, particularly if the irrigation return drains discharge directly to the tributary. During high flow years, the amount of waste appears to be relatively greater than low flow years. Some evidence exists that indicates that during low flow years water quality improvements may be demonstrated due to better water management by the water users. But in general, irrigation return flows with poor water quality degrade the water quality in tributaries and the Middle Snake River.

2.1.3.3 WATER RIGHTS, MANAGEMENT, AND STORAGE

The State of Idaho has statutory authority in administering water rights within its boundaries. Under the prior appropriation doctrine, natural flow rights in Idaho are satisfied in order of priority based on date ("first in time is first in right"). When the water supply is limited, a water right holder with an earlier natural flow right (or "senior" water right) may receive full supply, whereas a water right holder with a later or more recent date (or "junior" water right) may not receive full supply. Diversion rights for irrigation are appurtenant to the lands (belong to those lands), whereas diversion rights for other purposes (such as power, municipal, and industrial water supply) are not. Thus, storage reservoirs (like American Falls, Jackson Lake, Palisades) are constructed and operated to change the flow regime for irrigation purposes (USBOR 1996-1997) to provide for the water rights. Table 14 describes the spaceholder contracts (through November 1995) in the American Falls, Jackson Lake, and Palisades storage facilities for the specific canal companies in Upper Snake Rock subbasin. The two primary canal companies in Upper Snake Rock have their water rights based on primarily natural flow with supplemental storage rights (Robison 1998).

Table 14 Current spaceholder contracts (November 1995, acre-feet)

SPACEHOLDER	AMERICAN FALLS	JACKSON LAKE	PALISADES	TOTAL
American Falls Reservoir District	274,338 (NSCC) 148,747 (TFCC)	0 0	0 0	423,085
MID	44,951	0	44,500	89,451
NSCC	116,471	312,007	116,600	545,078
TFCC	0	97,183	0	97,183
TOTAL (and %)	584,507 (50.6%)	409,190 (35.4%)	161,100 (14.0%)	1,154,797

NSCC = North Side Canal Company; TFCC = Twin Falls Canal Company. MID = Milner Irrigation District. A spaceholder contract is defined as a type of repayment contract in which storage space is purchased in contrast to purchasing a specific amount of water. The amount of water that accumulates in that storage space belongs to the purchaser. Storage season is normally defined as beginning October 1 and extending to the date that no more water is available for storage. The irrigation season is defined in spaceholder contracts as April 1 to October 31, although the actual water may not be used till April 15 to October 15. A water year (or WY) begins on October 1 and extends to September 30 the following year (USBOR 1996-1997).

2.1.3.4 SPRINGS, SEEPS, AND GROUND WATER

In addition to tributary streams, springs and seeps provide a significant contribution to the flow of the Middle Snake River. Numerous springs and seeps emerge from the Snake River canyon walls from Milner Dam to King Hill. The greatest number of springs are located in the Thousand Springs area of the Hagerman valley and run year-round. On an annual basis, over 60% of the total streamflow measured at King Hill is from groundwater discharge or irrigation returns (IDHW 1983). Additionally, USGS has allocated spring discharges into the Middle Snake River to north and south side sources: 90% of the spring discharges come from springs north of the river; and, 10% of the spring discharges come from springs south of the river (Robison 1998). Because spring water comprises such a large amount of the total streamflow in the Middle Snake River, it has an obvious beneficial effect on water quality. Additionally, the decline in average spring flows (since the 1950s) is credited to increased groundwater pumping, change from furrow to sprinkler irrigation, changes in water management, and traditional drought conditions. Average discharge at Thousand Springs was around 4000 cfs in the early 1900s and increased to almost 7000 cfs in the 1950s. It has since decreased to about 5000 cfs (USBOR 1996-1997). See Figure 12 at the end of §2.1 for a view of the Snake River Plain Aquifer in relationship to Upper Snake Rock.

Ecosystems Research Institute in a short-term study of twelve springs in the Hagerman area concluded that in general there is little variability from fall to spring in the overall aquifer discharge flow and water quality characteristics within a single year, although individual springs may show some significant differences. Twelve (12) springs were sampled in September 1996 and in March 1997. The sites ranged from Blue Lakes Spring, which enters the Middle Snake River near the town of Twin Falls (RM 610.5) to the Malad springs complex, which enters the Middle Snake River below Lower Salmon Falls Reservoir (RM 571.5). Discharge from the springs ranged from about 100 cfs at Banbury and Box Springs to over 1400 cfs at the Malad River. Table 15 illustrates the various springs, their discharge, their various water quality parameters, and the statistics demonstrating the level of variability from the springs.

Table 15. DISCHARGE AND WATER QUALITY PARAMETERS OF SPRING SOURCES IN THE MID-SNAKE.

NAME	RM	DISCHARGE, cfs		TSS, mg/L		TP, mg/L		NOX, mg/L		NH3, mg/L	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
BLSp	610.5	172	159	2	<3	0.015	0.018	2.13	2.07	0.028	<0.025

NAME	RM	DISCHARGE, cfs		TSS, mg/L		TP, mg/L		NOX, mg/L		NH3, mg/L	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
CrSp	600.5	452	432	2	<3	0.017	0.021	3.09	2.85	0.036	<0.025
NSp	599.0	287	234	<3	<3	0.014	0.021	2.52	2.81	0.035	<0.025
ClrSp	593.0	528	456	<2	<3	0.016	0.018	1.80	1.68	0.028	<0.025
BgSp	590.3	110	101	-	<3	0.066	0.057	1.42	2.08	0.041	0.075
BbSp	589.0	108	108	2	<3	0.014	0.017	1.43	1.58	0.037	0.059
BoxSp	587.7	357	328	<2	<3	0.013	0.019	1.02	1.24	0.034	0.028
BHSp	587.5	UTA	UTA	<2	<3	0.015	0.018	1.30	1.23	0.031	<0.025
ThSp	584.2	659	632	2	<3	0.016	0.019	1.60	1.58	0.030	<0.025
MMSp	583.6	145	139	<2	<3	0.013	0.017	1.05	1.09	0.031	0.026
MgSp	582.7	UTA	UTA	<2	<3	0.015	0.017	0.847	0.758	0.033	0.052
MldSp	571.5	1419	1580	-	-	0.030	0.043	1.12	1.29	0.030	0.026
TOTAL		4237	4169								
OVERALL MEAN		423.7	416.9	1.45	1.50	0.020	0.024	1.611	1.688	0.033	0.028
% DIFFERENCE		1.6 %		3.3 %		20.0 %		4.8 %		17.9 %	
t-Test (*p* value) Significance		0.741 Not Significant		0.758 Not Significant		0.036 Not Significant		0.288 Not Significant		0.441 Not Significant	

Prepared by IDEQ-TFRO. BLSp = Blue Lakes Spring; CrSp = Crystal Spring; Nsp = Niagara Spring; ClrSp = Clear Spring; BgSp = Briggs Spring; BbSp = Banbury Spring; BoxSp = Box Spring; BHSp = Blue Heart Spring; ThSp = Thousand Springs; MMSp = Mini Miller Spring; MgSp = Magic Springs; MldSp = Malad Springs. UTA = Unable to Access. A *t*-Test (with a Bonferroni adjustment) was calculated showing, with the exception of TP, that there was no significant difference between the fall and spring databases ($p>0.010$). "-" excluded from data set due to field sampling contamination.

2.1.3.5 CANAL SYSTEMS

In Upper Snake Rock, there are two major canal companies that irrigate tracts on the south and north sides of the Middle Snake River: Twin Falls Canal Company (TFCC) and North Side Canal Company (NSCC), respectively.

The Twin Falls area (or Twin Falls tract) is predominantly irrigated by the Twin Falls Canal Company (TFCC), the largest irrigation company in the state of Idaho. The TFCC diverts an average of 1.1 million acre-feet/year from the Middle Snake River. The irrigation water is delivered to the area by gravity feed via the High Line and Low Line canals. Approximately 202,000 acres are serviced by the TFCC. It is estimated that about 85-90% of irrigation in the Twin Falls tract is surface irrigated (primarily furrow irrigation) with sprinkler irrigation making up the balance (Cosgrove *et al.* 1997; Haye 1998; Barry 1996 [pp 5,7]).

The Hazelton-Jerome-Wendell-Gooding area (or Northside tract) is predominantly irrigated by the North Side Canal Company (NSCC). The NSCC diverts an average of 1.2 million acre-feet/year from the Middle Snake River. The irrigation water is delivered to the area by gravity feed via the Main Canal. Approximately 160,000 acres are serviced by the NSCC. It is estimated that about 80% of irrigation is primarily sprinkler irrigation (Heaps 1998; Barry 1996 [pp 5,7]).

Approximately 6000 farms within the Twin Falls and Northside Tracts have a discharge to one or more points in a return flow channel. It should be noted that at Milner Dam there are ten (10) different Loads "leaks" or discharges: (1) Middle Snake River, (2) Milner Hydro Plant, (3) North Side Canal Company, (4) Twin Falls Canal Company, (5) Milner-Gooding Canal, (6) "Cross-cut" canal, (7) A-Lateral, (8) PA-Lateral, (9) Milner Irrigation Pumping Plant, and (10) A & B Irrigation Pumping Plant. See Figure 13 illustrates the canal system in Upper Snake Rock.

2.1.3.6 TRIBUTARIES

Because of the hydrologic and geomorphic structure of Upper Snake Rock, in general all perennial tributaries eventually discharge to the Middle Snake River, whether directly or indirectly. The major tributaries to the Middle Snake River (from upstream to downstream) in Upper Snake Rock include:

Dry Creek (Murtaugh)	Salmon Falls Creek
Vinyard Creek	Sand (Thousand) Springs Creek
Perrine Coulee System (East and Main)	Riley Creek
Warm Springs Creek	Fossil Gulch
Rock Creek	Peters Gulch
Crystal Springs (Lake)	Billingsley Creek
Cedar Draw	Birch Creek
Niagara Springs Creek	Malad River
Clear Lakes	Tuana Gulch
Mud Creek	Cassia Gulch
Deep Creek	Little Pilgrim Gulch
Briggs Creek	Big Pilgrim Gulch
Blind Canyon Creek	Deer Gulch
Box Canyon Creek	Clover Creek

Included in this "other" category are an additional 54 unnamed streams (which are intermittent) and over 200 spring sources which eventually drain into the Middle Snake River. See Figure 10 and Appendix C for an illustration of the major tributaries to the Middle Snake River. See also Figure 14 for a summary list of the water quality limited stream segments in Upper Snake Rock. "Some of the perennial tributaries are simply depressions or at best ephemeral streams prior to the development of irrigation in the subbasin. There is some evidence to suggest that irrigation development in the subbasin increased aquifer recharge above the natural amount. Some of the south side perennial streams fed by springs or seeps would be be perennial without surface irrigation. As irrigation methods change, the flows from these springs or seeps will change and most likely decrease (Robison 1998)."

DRY CREEK (MURTAUGH)

The portion of Dry Creek that discharges Murtaugh Lake to the Middle Snake River (at RM 630.6) is no longer an intermittant small stream, because enough seepage from Murtaugh Lake enters the stream below the dam to maintain water in Dry Creek on a year-round basis. From Murtaugh Lake to the Milner Low Lift Main Canal, Dry Creek has been completely altered into an agricultural return drain, completely changing the natural contour of the stream. From Murtaugh Lake to between 2800 North and 2900 North, Dry Creek has been completely altered into an irrigation delivery system and drain. The portion of Dry Creek above the Milner Low Lift Main Canal to its headwaters is considered a major tributary. This portion has its headwaters in the Dry Creek watershed, crosses the Lower Dry Creek watershed, and ends in the Lake Murtaugh watershed. Associated tributaries include: (1) West

Fork of Dry Creek: (2) Middle Fork of Dry Creek (with its associated tributary Coyote Creek): (3) East Fork of Dry Creek (with its associated tributary Coal Pit Creek); (4) Medley Creek: (5) Cold Spring Creek; and (6) Dry Creek main stem. It drains approximately 79,496 acres of predominantly rangeland and some irrigated-gravity flow agricultural fields. It should also be noted that presently a significant amount of spring runoff water from Dry Creek is diverted for ground water recharge via the South West Irrigation District. See Figure 15 for an illustration of the Dry Creek (Murtaugh Lake) Complex in Upper Snake Rock.

VINYARD CREEK

Vinyard Creek is also known as the Devil's Washbowl Spring and is located 0.5 miles upstream from the Twin Falls of the Snake River (USGS WY1997 [p 164]). It is located on the north side of the Middle Snake River in Jerome County. The source of the stream is a large spring which feeds a small lake that overflows (via a waterfall) to form Vinyard Creek. The creek flows for approximately 570 meters through a canyon (called Box Canyon) before it discharges to the Twin Falls Reservoir at Rivermile 618.0. The creek drains a 4004 hectare watershed that is totally irrigated from groundwater sources and the Middle Snake River (IPC 1997b [p 3]). The maximum daily discharge (1950-1959) is 27.5 cfs during the month of October. This has changed to 19 cfs (1986-1997) for the month of September. The average annual discharge is 22.3 cfs (1950-1959) which has now changed to 14.7 cfs (1986-1997). According to IPC, peak discharge in 1996 was 14.8 cfs (range 9.9 - 14.8 cfs) which is less than the average reported by USGS (IPC 1997b [p 3]). There is a channel carrying irrigation return water that used to enter Vinyard Creek approximately midway between the waterfall and the confluence with the Twin Falls Reservoir. This has since been re-routed so that the irrigation canal discharges directly to the Middle Snake River at Rivermile 617.9.

PERRINE COULEE SYSTEM

The Perrine Coulee System encompasses a natural drainage (Perrine Creek) interconnected with an irrigation canal system (Twin Falls Canal Company) and a storm drainage (City of Twin Falls). It drains into the Middle Snake River at two locations: East Perrine Coulee at RM 612.7 (elevation 3130 feet) and Perrine Coulee Falls at RM 610.9 (elevation 3130 feet). The Perrine Coulee System does not have associated tributaries. It drains approximately 22,400 acres of irrigated-gravity flow agricultural land and urban land.

Aside from the main drainage (known as the Perrine Coulee), three drainages of importance exist: (1) Perrine #1, (2) Perrine #2, and (3) Perrine #3. Perrine #s 1 and 2 are located parallel and east of the main Perrine Coulee. Perrine #3 lies parallel and west of the main coulee. All drainages drain to the north-northwest. According to the Twin Falls Canal Company, there are 19 linear miles of riparian areas in the Perrine Coulee "watershed," of which 3 miles are considered urban and 16 miles non-urban. The Twin Falls Canal Company diverts 125 cfs into the Perrine system, but calculates 176.8 cfs as actual use throughout the system. Additionally, TFC-1, TFC-2, and TFC-3 are natural drainages (termed coulees or laterals) fed by field runoff following natural land slopes but adjusted to follow farm and field boundaries. These natural drainages are significant because they accumulate in the large southwest areas of the Perrine Coulee System, which enters the Perrine Coulee drainage downstream (SRSCD 1998). See Figure 16 for an illustration of the Perrine Coulee System.

ROCK CREEK COMPLEX

The Rock Creek Complex is made up of the main Rock Creek System, McMullen Creek, and North Cottonwood Creek. The main Rock Creek System has its headwaters in the Upper Rock Creek and the Rock Creek 5th Field HUC watersheds. After being joined by McMullen Creek and North Cottonwood Creek, it traverses the Hub Butte 5th Field HUC watershed and then follows the eastern portion of Lower Rock Creek 5th Field HUC watershed until it drains into the Middle Snake River at RM 606.4 (elevation 2990 feet). It drains approximately 197,185 acres rangeland, irrigated-gravity flow, and forested ground. Rock Creek has the following associated tributaries from the headwaters to Rock Creek town:

(1) Rock Creek main stem, Wooden Shoe Creek, Deer Creek, and Little Creek (with associated Bluff Creek and Niles Gulch);

(2) Harrington Fork main stem, Dry Fork, and East Line;

(3) Fourth Fork main stem, Narrow Creek (with associated North Fork and South Fork), Mountain View Creek, Thompson Creek, Elk Butte Creek, and Pike Mountain Creek;

(4) Third Fork main stem, Cotton Creek, AH Creek, Martindale Fork, Little Fork (with associated Trail Canyon, Middle Fork, Little Fork Spring Creek, and Telephone Canyon), Second Fork main stem, and First Fork main stem (with associated Bear Gulch);

(5) Fifth Fork main stem, Dooddlelink Creek, Lucky Gulch, Trail Gulch, Crockett Spring Creek, Secret Creek, Indian Spring Creek, Jones Fork Creek (with associated Joes Spring Creek), and Toolbox Creek;

(6) Cottonwood Creek main stem, McMullen Creek (with associated Donahue Creek), North Cottonwood Creek, Dry Cottonwood Creek (with associated Burnt Creek). These streams are used for irrigation and then are intercepted by the High Line Canal. McMullen Creek in particular is a seasonal stream. It discharges directly into the High Line Canal. There is a diversion to Cottonwood Creek via the Twin Falls Canal Company flume. The closer McMullen Creek gets to Rock Creek, little bits of seep water discharge into McMullen Creek, thus making the lowest portion of McMullen Creek, near Rock Creek, perennial. The typical historical trend for McMullen Creek below the canyon is:

Spring: high flows due to snow pack from February till June 15th.
Low Flow: from June 15th till about July 15th.
After July 15th: its pretty much dried out.

In the canyon to the headwaters area, five miles upstream in the canyon McMullen Creek dissipates back into the ground. There are small springs that feed out from the headwaters area (known as McMullen Narrows). Access is very limited in the canyon portion of the stream.

Cottonwood Creek is similar to McMullen Creek in that it is intermittant. It has some artesian sources and is very swampy ground. North Cottonwood Creek is strictly reservoir water after June 15th.

Rock Creek has two small tributaries: Deadman Gulch, between Rock Creek town and the confluence with the Middle Snake River; and, Silo Creek which emanates from Slaughterhouse Gulch. Of note, Rock Creek has numerous irrigation return flows and several outlets to seepage tunnels between Rock Creek town and its confluence. Above Rock Creek town most of the stream flow is diverted for irrigation. See Figure 17 for an illustration of the Rock Creek Complex.

CEDAR DRAW

Cedar Draw has its headwaters in the upper portion of the Hollister watershed and traverses the eastern portion of the Filer watershed until it drains into the Middle Snake River at RM 599.1 (elevation 2980 feet). It drains approximately 73,639 acres of irrigated-gravity flow and urban ground. Cedar Draw has Desert Creek as an associated tributary that connects to the Main Canal. The High Line Canal blocks flow in Cedar Draw above the High Line Canal. Flow in Cedar Draw below the High Line Canal is blocked by the Low Line Canal, which forms Cedar Draw Lake. The portion of Cedar Draw below the Low Line Canal to the Middle Snake River is fed by seepage tunnels and is the only portion with year-round flow. See Figure 18 for an illustration of the Cedar Draw tributary.

MUD CREEK

Mud Creek has its "headwaters" in the Low Line Canal (of the Twin Falls Canal Company) in the Buhl watershed and traverses the western portion of the watershed till it drains into the Middle Snake River at RM 591.5 (elevation 2900 feet). It drains approximately 25,958 acres of irrigated-gravity flow agricultural land. Mud Creek has the following associated tributaries: Clear Creek, Silver Creek, Silo Creek, and other minor tributaries (seeps, seep tunnels, and springs) in Melon Valley. Because the Low Line Canal functions as the "headwaters," during the irrigation season (April to September) the majority of the flow may be attributed to irrigation return flows. Off-season flows are attitributed to spring seeps and rainfall/snow. See Figure 18 for an illustration of the Mud Creek tributary.

DEEP CREEK

Deep Creek is divided into two portions: an Upper Deep Creek and a Lower Deep Creek. The irrigation canal system of Twin Falls Canal Company keeps these two portions segregated throughout much of the year. Upper Deep Creek has its headwaters in the Clover watershed and traverses the western portion of the watershed, draining approximately 54,088 acres of rangeland. Upper Deep Creek has associated tributaries: (1) South Fork of Deep Creek; (2) North Fork of Deep Creek; (3) Emerson Spring Creek; (4) Soldier Creek; (5) Green Creek; and (6) Cottonwood Creek. Upper Deep Creek is used for irrigation and if there is any irrigation left, it flows into the Salmon River Canal Company canal. Lower Deep Creek has its "headwaters" in the Castleford watershed. The portion of Deep Creek above the High Line Canal is blocked by the High Line Canal. Flow above the High Line Canal seldom occurs and is only due to extreme snowmelt conditions that last occurred in 1984. Therefore, the High Line Canal acts as "headwaters" into Deep Creek which eventually drains into the Middle Snake River at RM 591.4 (elevation 2900 feet). Excess flow from the Low Line Canal spills into Deep Creek. Flow in Deep Creek between the High Line and the Middle Snake River is partially diverated at several locations by the Twin Falls Canal Company. Deep Creek drains approximately 47,756 acres of irrigated-gravity flow agricultural land. See Figure 18 for an illustration of the Deep Creek tributary.

SALMON FALLS CREEK

Salmon Falls Creek drains from the Salmon Falls subbasin (HUC 17040213) into the Middle Snake River at RM 586.2 (elevation 2923 feet). It drains for the most part approximately 1,371,586 acres of rangeland and irrigated agriculture from both Nevada and Idaho. Salmon Dam separates the watershed on Salmon Falls Creek. On only three occasions since the dam was built in 1911 has any water been released by Salmon Dam down the canyon to the Middle Snake River.

BILLINGSLEY CREEK

Billingsley Creek has its headwaters in the Hagerman watershed and drains into the Middle Snake River at RM 573.8 (elevation 2804 feet). It drains approximately 31,927 acres of irrigated-sprinkler ground and rangeland. Billingsley Creek does not have any associated tributaries and is largely a spring fed stream. See Figure 19 for an illustration of the Billingsley Creek tributary.

MALAD RIVER

Malad River drains from the Camas Creek HUC (17040220), the Big Wood River subbasin (HUC 17040219), and the Little Wood River subbasin (HUC 17040221) into the Middle Snake River at RM 571.4 (elevation 2776 feet). It drains for the most part approximately 427,432 acres of the Camas Creek HUC, 901,370 acres of the Big Wood River HUC, and 716,490 acres of the Little Wood River HUC, or a total of 2,045,292 acres.

CLOVER CREEK

Clover Creek has its headwaters in the Upper Clover Creek watershed, traverses through the lower portion of Calf-Clover watershed, and then drains into the Middle Snake River via the Lower Clover Creek watershed at RM 547.6 (elevation 2533 feet). Including its tributaries, it drains approximately 179,555 acres of prinicipally rangeland, with minor irrigated-gravity flow and irrigated-sprinkler agricultural land. Clover Creek has the following associated tributaries: (1) Hog Creek; (2) Dry Creek (with associated Thorn Creek, East Dempsey Creek, and West Dempsey Creek); (3) Calf Creek; (4) Cottonwood Creek; (5) East Fork of Clover Creek; (6) Squaw Creek; and (7) Deer Creek. See Figure 20 for an illustration of the Clover Creek Complex.

CRYSTAL SPRINGS LAKE

Crystal Springs Lake is a natural spring fed lake with an outfall that discharges to the Middle Snake River at RM600.4. It is a small (8 acre) shallow lake (existing mean depth of less than 3 m) that historically has received effluent discharges from a private commerical fish hatchery (USBLM 1985b). Historically, the lake received about 450-525 cfs of spring flows from the Snake Plain Aquifer. Flow from the springs averages (from 1950 to 1982) 450 to 550 cfs with maximum flows in September, October, and November, and barely enough flows to cover water rights during March, April, and May. The lake is located along the sourthwestern edge of the Snake Plain in the Thousand Springs area of the Snake River canyon. Soils in the vicinity of the lake and along the western edge of the Snake Plain may be characterized as predominantly fine sandy loams and silty clay loams with moderate to high erosion potentials. Land use is diverse and includes irrigated agriculture, grazing, fish propagation, and some residential development. No surface runoff or irrigation return flows from agricultural lands reach the lake. Historically, some soil erosion occurred near the lake as a result of hatchery construction activities with some sediment reaching the lake. These areas have since been stabilized and the sediment has been eliminated. Most recreational use of the lake at present is for fishing by bank fishermen who fish from the hatchery outfall structure or lake outlet bridge area.

The hydraulic characteristics of the lake include: 7.8 acres of surface area; 16.0 feet maximum depth; 5.8 feet average depth; 45.20 acre feet volume; 1475 feet maximum length; 350 feet maximum width; 175 feet minimum width; and, 6.8 hours/0.3 days as hydraulic retention time at 80 cfs inflow (IDHW 1990 [p 3]). With a hydraulic retention time of 6.8 hours/0.3 days at 80 cfs inflow, there is little opportunity for a phytoplankton community to develop. Even with with total phosphorus which would promote eutrophic conditions, the rapid flushing rate precludes phytoplankton blooms in the lake (IDHW 1990 [p 30]).

Historically, the lake was entirely spring fed with virtually no definitive watershed. Spring flows entered the lake directly on the north side, with water flowing through the lake to the Middle Snake River. At present, most of these flows are diverted away from the lake with a portion of the flow (0-80 cfs) returning to the lake after use in a nearby fish hatchery. No other surface water flows enter the lake.

BOX CANYON

The upper two-thirds of Box Canyon (or 117.5 acres) including the existing diversion structure) is privately owned, as is the mouth of Box Canyon Creek. The remainder (or 26.2 acres) is public (federal) land managed by the U.S. Bureau of Land Management. Box Canyon Creek discharges to the Middle Snake River at RM587.8 (although USGS records the mouth at RM588.8 in their water year resource books). It is the 11th largest spring in the United States. Numerous springs emerge from the creek bed throughout the 1.4 mile water course. The average discharge of Box Canyon (measured at the mouth) is 852 cfs (USGS WY1968). In the 1950s the creek flowed at 850 cfs at its confluence with the Middle Snake River. In the 1980s there was one diversion (300 cfs) from the creek and extensive deep well pumping of the Snake River Plain Aquifer for agricultural irrigation, stream flow at the mouth is approximately 400 cfs, which has reduced the natural dilution and instream flow values of the lower stream as well as the adjacent habitat in the Middle Snake River (Langenstein & Bowler 1989). More current USGS gage readings indicate that for the water years 1995-1997, the average discharge to the Middle Snake River is 329, 336, and 347 cfs, respectively (USGS WY1995, WY1996, WY1997). The main spring emerges at the foot of a cliff at the head of a deep, narrow alcove canyon. Many other springs and seeps enter the outflow channel above and below the USGS gage. The head of Box Canyon contains a large alcove pool (about 0.5 hectare) where the initial springs emerge. Below this pool, the creek rapidly descends approximately 804.6 m (about 0.5 miles) to a large waterfall approximately 12.2 m (or 40 ft) across and 3.7 m (or 12 ft) high. This waterfall is sufficiently high to be a barrier to some fish species, but it is estimated that salmon and steelhead from the Middle Snake River could have historically passed this mark (IPC 1998). The waterfall is sufficiently high to also be a barrier to at least one endemic species, the Shoshone sculpin (*Cottus greenei*) which occurs in the lower canyon, while its congener, the Mottled sculpin (*Cottus bairdi*) is found both above and below the waterfall. Other species of endangered or threatened species include: the Bliss Rapids Snail, the Utah or Desert Valvata Snail, the Giant Columbia River Limpet, Shoshone sculpin, and an undescribed Lanx species. These species are not uniformly distributed throughout the canyon, and each occupy unique habitats and may be affected by the barrier presented by the falls (Langenstein & Bowler 1989). See Figure 21 for an illustration of the Box Canyon tributary.

BLIND CANYON

Blind Canyon is entirely in private ownership (54.3 acres). It is situated immediately upstream of Box Canyon. The average discharge is 12.8 cfs (USGS WY1968) and it discharges to the Middle Snake River at RM588.1. Blind Canyon is fed by numerous springs originating throughout the canyon. The topography of Blind Canyon is similar to Box Canyon. See Figure 21 for an illustration of the Blind Canyon tributary.

BRIGGS SPRINGS CREEK

Briggs Springs Creek is entirely in private ownership. The average disharge measured at Briggs Creek was 109.7 cfs (USGS WY1968) and discharges to the Middle Snake River at RM590.3).

RILEY CREEK

Riley Creek was classified as a Class A stream in southwestern Gooding County in 1977 (IDHW 1977b). It is entirely spring fed during the non-irrigation season. More than 20 springs discharge from the Snake Plain Aquifer to the creek. The creek discharges to the Middle Snake River at RM582.9. More than 20 springs discharge from the Snake Plain Aquifer to the creek. The creek's discharge increases to about 300 cfs in the less than two miles distance to its mouth (IDHW 1977b).

2.1.4 BIOLOGICAL CONSIDERATIONS

This section covers fisheries, macroinvertebrates, aquatic fowl, aquatic endangered species, and aquatic macrophytes.

2.1.4.1 FISHERIES

The fish fauna in the Upper Snake Basin, and specifically the Middle Snake River, consists primarily of native coldwater species in the families *Salmonidae* (trout), *Acipenseridae* (sturgeon), *Cottidae* (sculpins), *Cyprinidae* (minnows), and *Catostomidae* (suckers) (USGS 1997a), although other families are noted: *Petromyzontidae* and *Percopsidae*. Indigenous fishes are represented by 26 species in five families. Thirteen additional species have been introduced, primarily to enhance sport-fishing opportunities (Maret *et al.* 1995). Following the construction of large hydroelectric facilities on the main-stem of the Middle Snake River (i.e., Bliss Dam, Lower Salmon Falls Dam, Upper Salmon Falls Dam, Shoshone Falls Dam), salmon, steelhead, and Pacific lamprey were extirpated from the region between King Hill and Shoshone Falls (USGS 1997a).

Until the twentieth century, three anadromous species frequented the Middle Snake River and its tributaries as far upstream as Shoshone Falls. These include: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Onchorhynchus mykiss*), and the lamprey (*Lampetra tridentata*) (Myers 1996; FERC 1990; Everman 1896). All three runs of Chinook salmon (spring, summer, and fall) were at one time found in the Middle Snake River system. Spring and summer runs were the most prevalent with little historical information regarding use of the system by fall chinook salmon, although some references cite this run as occuring in the Middle Snake River (see *Fishes of Idaho* by James Simpson and Richard Wallace, p. 67).

Although sockeye salmon (*Oncorhynchus nerka*) are occasionally mentioned in various sources (Myers 1996; FERC 1990; Everman 1896) as existing in the Middle Snake River system, sockeye historically resided only in the Payette River system and the Salmon River system, in Idaho. Sockeye have specific habitat requirements which include a lake or other "impoundment" immediately below their spawning streams (for example Redfish Lake, Alturas Lake, Yellow Belly Lake, Pettit Lake, Payette Lake, Little Payette Lake). No spawning streams with an associated lake exist within the Middle Snake River system.

Native non-anadromous species include: white sturgeon (*Acipenser transmontanus*), rainbow trout as steelhead (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), mountain whitefish (*Prosopium williamsoni*), northern squawfish (*Prychocheilus oregonensis*), suckers (*Catostomus* spp.), shiner (*Richardsonius* spp.), dace (*Rhinichthys* spp.), peamouth (*Mylocheilus* spp.) and bull trout (*Salvelinus confluencus*). There are closely related anadromous species of both white sturgeon and bull trout (see next paragraph). Not a great deal is known about historic existence or movements of these "potentially" anadromous species prior to damming of the Snake and Columbia Rivers. Additionally, some ichthyologists and geneticists believe the native redband trout found downstream of Shoshone Falls are a residualized form of anadromous steelhead (IDFG 1998b). White sturgeon do not migrate above Shoshone Falls, thus inhabiting the Snake River from Shoshone Falls downstream to the confluence of the Columbia River (FERC 1997b [pp 2, 4]).

IDFG notes that bull trout have been documented within the Rock Creek and Salmon Falls Creek drainages. It is possible that remnant, isolated populations still exist within the Rock Creek drainage. Bull trout distribution in the Middle Snake River system, like other areas of Idaho, paralleled distribution of anadromous fish species. Any of the perennial tributaries below Shoshone Falls, containing anadromous fish, probably also contained bull trout. Within the Rock Creek drainage, due to water quality degradation and migration barriers, bull trout could only exist in headwater areas as isolated remnant populations (IDFG 1998b).

Other species (of which their reproductive and population status in the Middle Snake River is unknown at this time) includes the following native and non-native fish species of the Middle Snake River:

1. Native Fish Species: Leatherside chub (*Gila copei*), Utah chub (*Gila atraria*), Chiselmouth (*Arocheilus alutaceus*), Mottled sculpin (*Cottus bairdi*), Shoshone sculpin (*Cottus greenei*), and Mountain whitefish (*Prosopium williamsoni*).

2. Non-native Fish Species: Brown bullhead (*Ictalurus nebulosus*), Black bullhead (*Ictalurus melas*), Channel catfish (*Ictalurus punctatus*), Smallmouth bass (*Micropterus dolomieui*), Yellow perch (*Perca flavescens*), and Carp (*Cyprinus carpio*).

Mountain whitefish, as a native fish species of the Middle Snake River, are probably the most widely distributed native fish species of the family *Salmonidae* found in Idaho. They have persisted, without population augmentation or special management, in the Middle Snake River drainage. Little is known about local population other than they are widely distributed with the Middle Snake River reach, and they are commonly sampled near flowing riverine habitats (IDFG 1998b).

Table 16 describes the fish species occuring in the Middle Snake River reach by drainage, as the Snake River below Shoshone Falls (Sb) and the Snake River above Shoshone Falls (Sa), and by origin, as native or introduced species.

Table 16 List of fishes in the Middle Snake River drainage

FAMILY TAXONOMY		***SPECIES TAXONOMY***		***Sb***	***Sa***
Common Name	***Scientific Name***	***Common Name***	***Scientific Name***		
NATIVE ORIGIN					
Sturgeon	*Acipenseridae*	White sturgeon	*Acipenser transmontanus*	X	X[1]

FAMILY TAXONOMY Common Name	FAMILY TAXONOMY Scientific Name	SPECIES TAXONOMY Common Name	SPECIES TAXONOMY Scientific Name	Sb	Sa
Trout	*Salmonidae*	Mountain whitefish	*Prosopium williamsoni*	X	X
		Chinook salmon	*Oncorhynchus tshawytscha*	X	
		Cutthroat trout Yellowstone	*Oncorhynchus clarki bouvieri*	X	X
		Cutthroat trout Finespotted	*Oncorhynchus clarki ssp.*		X
		Rainbow trout	*Oncorhynchus mykiss*	X	X[1]
		Redband trout	*Oncorhynchus mykiss gairdneri*	X	
		Bull trout	*Salvelinus confluentus*	X	
Minnow	*Cyprinidae*	Chiselmouth	*Acrochellus alutaceus*	X	
		Utah chub	*Gila atraria*	X	X
		Leatherside chub	*Gila copei*	X	X
		Peamouth	*Mylocheilus caurinus*	X	
		Northern squawfish*	*Ptychocheilus oregonensis*	X	
		Longnose dace	*Rhinichthys cataractae*	X	X
		Speckled dace	*Rhinichthys osculus*	X	X
		Redside shiner	*Richardsonius balteatus*	X	X
Sucker	*Catostomidae*	Utah sucker	*Catostomus ardens*		X
		Bridgelip sucker	*Catostomus columbianus*	X	
		Largescale sucker	*Catostomus macrocheilus*	X	
		Mountain sucker	*Catostomus platyrhynchus*	X	X
Sculpin	*Cottidae*	Mottled sculpin	*Cottus bairdi*	X	X
		Shorthead sculpin	*Cottus confusus*	X	
		Shoshone sculpin	*Cottus greenei*	X	
		Wood River sculpin	*Cottus leiopomus*	X	
INTRODUCED ORIGIN					
Trout	*Salmonidae*	Coho salmon	*Oncorhynchus kisutch*	X	X
		Golden trout	*Oncorhynchus aguabonita*	X	X
		Brown trout	*Salmo trutta*	X	X
		Atlantic salmon	*Salmo salar*	X	
		Blueback trout	*Salvelinus alpinus oquassa*	X	

FAMILY TAXONOMY		SPECIES TAXONOMY		Sb	Sa
Common Name	Scientific Name	Common Name	Scientific Name		
		Brook trout	*Salvelinus fontinalis*	X	X
		Lake trout	*Salvelinus namaycush*	X	X
		Arctic grayling	*Thymallus arcticus*	X	X
Pike	*Eocidae*	Tiger muskie	*Esox lucius x E. masquinongy*	X	
Minnow	*Cyprinidae*	Goldfish	*Carassius auratus*	X	
		Carp	*Cyprinus carpio*	X	X
		Grass carp	*Ctenopharyngodon idella*	X	X
		Tui chub	*Gila bicolor*	X	
		Spottail shiner	*Notropis hudsonius*	X	X
		Fathead minnow	*Pimephales promelas*	X	X
Catfish	*Ictaluridae*	Black bullhead	*Ameiurus melas*	X	
		Brown bullhead	*Ameiurus nebulosus*	X	X
		Yellow bullhead	*Ameiurus natalis*	X	X
		Blue catfish	*Ictalurus furcatus*	X	X
		Channel catfish	*Ictalurus punctatus*	X	X
		Tadpole madtom	*Noturus gyrinus*	X	
		Flathead catfish	*Pylodictis olivaris*	X	
Livebearer	*Poeciliidae*	Mosquitofish	*Gambusia affinis*		X
Sunfish	*Centrarchidae*	Pumpkinseed	*Lepomis gibbosus*	X	X
		Warmouth	*Lepomis gulosus*	X	
		Bluegill	*Lepomis macrochirus*	X	X
		Smallmouth bass	*Micropterus dolomieu*	X	X
		Largemouth bass	*Micropterus salmoides*	X	X
		Black crappie	*Pomoxis nigromaculatus*	X	X
		White crappie	*Pomoxis annularis*	X	
Perch	*Percidae*	Yellow perch	*Perca flavescens*	X	X
		Walleye	*Stizostedion vitreum*	X	X
Loach	*Cobitidae*	Oriental weatherfish	*Misgurnus anguillicaudatus*	X	
Shad	*Clupeidae*	American shad	*Alosa sapidissima*	X	

FAMILY TAXONOMY		SPECIES TAXONOMY		Sb	Sa
Common Name	Scientific Name	Common Name	Scientific Name		

Prepared by IDEQ-TFRO. Adapted from IDFG 1996. Sb = Below Shoshone Falls. Sa = Above Shoshone Falls. 'X' = Introduced native fish. In addition to the above introduced species, there are three species of the Cichlid family (*Cichlidae)* which are introduced Sb specifically confined to geothermal waters: Mozambique (Java) tilapia (*Tilapia mossambica*), Redbelly (Zill's) tilapia (*Tilapia zilli*), and Convict cichlid (*Cichlasoma nigrofasciatum*). *At the time of this writing, an international committee of fish experts had agreed to change the common name of the "squawfish" to avoid use of a term that many American Indian women find offensive and derogatory. The new name proposed is "pikeminnows," and won't be final until publication in the American Fisheries Society journal. Table verified by IDFG-Jerome for the Upper Snake Rock subbasin

A knowledge of fisheries management in the Middle Snake River is important to understanding the diversified nature of the native and introduced species of fish. The major responsibility of the IDFG fisheries activities is to provide continued supplies of game fish for sport fishermen. Primary fish species from a management standpoint include: native sport fish, including rainbow trout, cutthroat trout, bull trout, steelhead (rainbow trout), chinook salmon, kokanee salmon, whitefish, and white sturgeon. Two of these, steelhead and chinook salmon, migrate to the ocean to complete a portion of their life cycle (i.e., they are "anadromous" species). Introduced game fish, such as brown trout, lake trout, brook trout, landlocked coho and chinook salmon, bass, sunfish, perch, crappie, catfish, walleye, northern pike, and tiger muskie, provide sport fisheries where habitat conditions are unsuitable for native species and also provide a diversity of angling opportunity. It should be noted that the most preferred species of fish sought by anglers in Idaho, based on a 1994 study, were 67% for coldwater (mostly rainbow trout or any trout) and 33% for warmwater (mostly any bass). Most waters suitable for establishment of a warmwater fishery have received introductions. Regulations were developed to improve the quality of bass and provide some trophy opportunity. Additonal species were introduced to existing warmwater fisheries to diversity opportunity and provide forage. During the next five-year period (1996-2000), the primary emphasis by IDFG will be on management to improve existing warmwater fisheries. Addition of habitat structure and fish concentration devices will be used to improve catch rates for bluegill and crappie. Regulations will be used to provide quality and trophy bass fishing opportunities. Further evaluation of forage needs for bass and other species will be made, and forage introduced where needed. Additional species will be added to diversity fisheries in some cases. Areas with warmwater or mixed water fisheries are fairly numerous in the main Middle Snake River, and are described in Table 17:

Table 17 IDFG water types by river segment

MIDDLE SNAKE RIVER SEGMENT	IDFG MANAGEMENT GOALS
Bliss Reservoir	Warm Water
Bliss Pool to Lower Salmon Falls Dam	Mixed Water
Lower Salmon Falls Reservoir	
Upper Salmon Falls Reservoir	
Upper Salmon Falls Pool to Shoshone Falls	
Shoshone Falls Reservoir	
Shoshone Falls Reservoir to Twin Falls Dam	
Twin Falls Reservoir	Cold Water
Twin Falls Reservoir to Murtaugh Bridge	
Murtaugh Bridge to Milner Dam	

MIDDLE SNAKE RIVER SEGMENT	IDFG MANAGEMENT GOALS

Prepared by IDEQ. These water types are IDFG's fisheries management for the segments on the Middle Snake River. Warm water fisheries are supported by warm water or cool water game fish including bass, crappie, sunfish, catfish, northern pike, tiger muskie, walleye, and yellow perch. Mixed water fisheries are supported by a combination of cold water and warm water fish species. Cold water fisheries are supported by resident populations of salmonid game fish, including trout, char, non-anadromous salmon (kokanee, coho, chinook), and whitefish. Anadromous fisheries are supported by anadromous salmonids (steelhead trout, chinook salmon, and sockeye salmon).

According to IDFG, a great demand exists for mixed waters in the populated portions of the drainage. The Middle Snake River has the greatest potential for increasing angler opportunity of any major water in the southern portion of Idaho. Lack of flows, especially during irrigation season, apparently deteriorating water quality, and loss of spawning areas appear to be the factors most significantly affecting fish populations in the Middle Snake River. Should water become available, IDFG will make every effort to improve summer flows (IDFG 1996 [pp 2-3, 23-24, 35, 58, 197-198]).

Finally, IDAPA 16.01.02.250(02. Aquatic Life)(c. Cold water biota)(iv.Time periods for salmonid spawning and incubation) defines the time periods for salmonid spawning and incubation for cold water biota stream segments. These are listed in Table 18.

Table 18 Time periods for salmonid spawning and incubation on cold water biota stream segments

FISH SPECIES	J	F	M	A	M	J	J	A	S	O	N	D
Chinook salmon (spring): native species	... April 1st							August 1st to ...				
Chinook salmon (summer): native species	... June 15th							August 15th to ...				
Steelhead trout: native species		February 1st to July 15th										
Redband trout: native species			March 1st to July 15th									
Cutthroat trout: native species				April 1st to August 1st								
Bull trout: native species	... April 1st								September 1st to ...			
Rainbow trout: native species	January 15th to July 15th											
Mountain whitefish: native species	... March 15th									Oct 15th to ...		
Brown trout: introduced species	... April 1st									Oct 1st to ...		
Brook trout: introduced species	... June 1st									Oct 1st to ...		

Prepared by IDEQ-TFRO. Months of the year symbolized by first letter of month's name. Fall Chinook salmon may not occur on the Middle Snake River and is not included in this table. Sockeye salmon, sunapee trout, Golden trout, Kokanee salmon, lake trout, and arctic grayling do not occur on the Middle Snake River and are not included in this table. Contents of table verified by IDFG-Jerome for the Upper Snake Rock subbasin.

2.1.4.2 MACROINVERTEBRATES

The aquatic insect fauna in the Middle Snake River is dominated by two orders, *Diptera* (flies) and *Trichoptera* (caddisflies) (FERC 1990). Caddisflies have been reported as the predominant taxa in benthic invertebrate samples collected at most river sites (Falter *et al.* 1976). A study (1978-1979) conducted on the Middle Snake River area (including some of the tributaries) found the greatest number of macroinvertebrate taxa in the Milner area (30.2%), Rock Creek (20.0%), and the Malad River (25.3%), and that the most common taxa were *Trichoptera* (51.8%), *Amphipoda* (17.4%), *Gastropoda* (15.0%), and *Diptera* (7.6%) (Bauer 1986). The

phosphorus losses are attributed to two reasons: (1) direct excretion by the plants, or (2) eventual loss by death and decomposition. Sediment phosphorus is controlled to a great extent by the amount of dissolved oxygen present. When the sediment-water interface becomes anoxic, phosphate passes rapidly into the water above. Anoxic sediments release phosphate at rates as much as 1000 times faster than releases from oxygenated sediments. This is attibutable to both classical chemical bonding and physiochemical sorptive mechansims (Goldman 1983 [pp 137-140]).

Table 20 Three major species of aquatic plants on the Crystal Springs reach of the Middle Snake River

SITE	NAME	CHARACTERIZATION OF DRY BIOMASS AS % OF TOTAL SPECIES PER INDICATED PLANT SPECIES		
	1992 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	*Ceratophyllum spp.*	*Potamogeton spp.*	*Epiphytes spp.*
1	Above the weedbed areas	25.4	0.8	73.7
2	Right/Left channel around island in weeds	36.9	15.8	47.0
3	Large cross-channel weedbed	28.4	7.1	63.3
	AVERAGE OF 3 SITES:	30.2	7.9	61.3
	1993 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	*Ceratophyllum spp.*	*Potamogeton spp.*	*Epiphytes spp.*
1	Upstream from Crystal Springs Hatchery	11.7	84.1	4.1
2	Across channel from Crystal Springs Hatchery	77.3	2.5	18.4
3	Right side of island 50m into the channel	22.0	53.1	24.9
4	Left channel midway down the island	7.4	83.9	8.7
5	Bottom end of Magic Valley Steelhead	43.3	32.8	23.8
6	100m downstream from Site 5	29.3	42.2	27.8
7	200m downstream from Site 5	46.7	17.3	35.8
	AVERAGE OF 7 SITES:	34.0	45.1	20.5
	1994 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	*Ceratophyllum spp.*	*Potamogeton spp.*	*Epiphytes spp.*
2	Across channel from Crystal Springs Hatchery	50.8	15.4	31.2
5	Downstream from Magic Valley Steelhead	78.6	21.5	0.0
7	200m downstream from Site 5	27.6	28.3	43.9
R	Between Sites 2 and 7	17.0	51.4	31.5
	AVEAGE OF 4 SITES:	43.5	29.2	26.7

Prepared by IDEQ-TFRO. *Falter et al., 1994; Falter et al., 1995; Falter et al., 1996.*

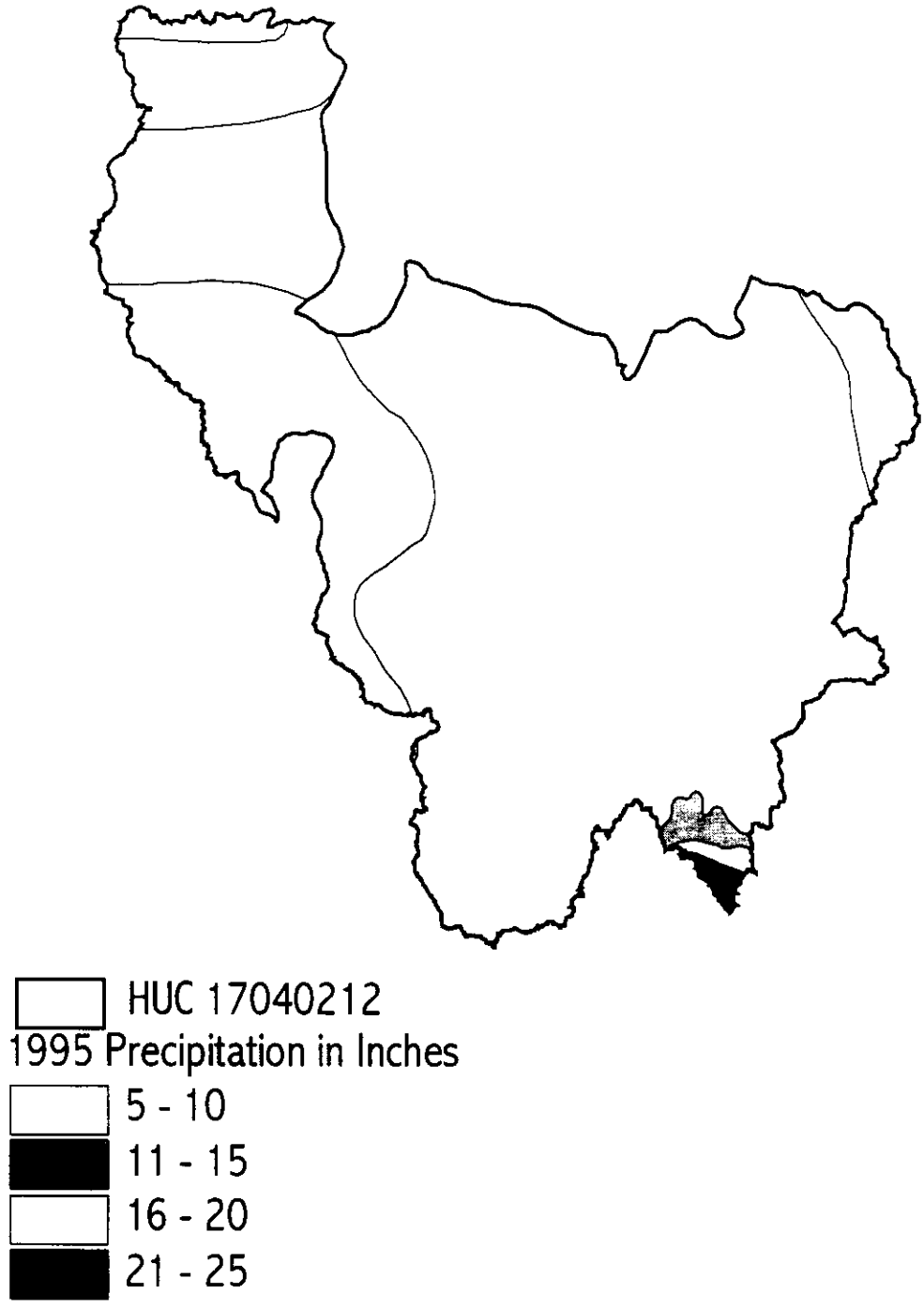


Figure 4 Precipitation in Upper Snake Rock

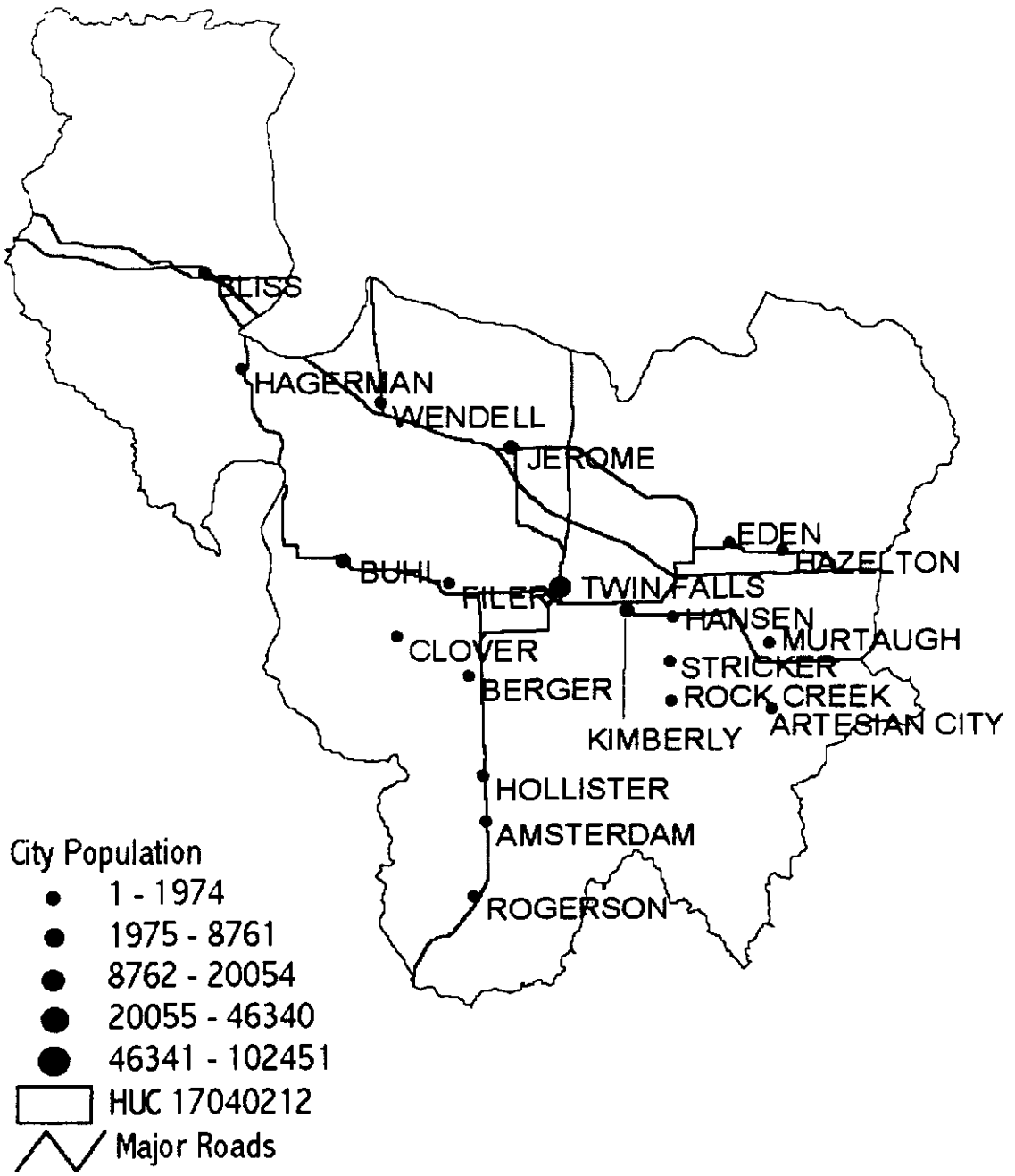


Figure 5 Human population centers in Upper Snake Rock

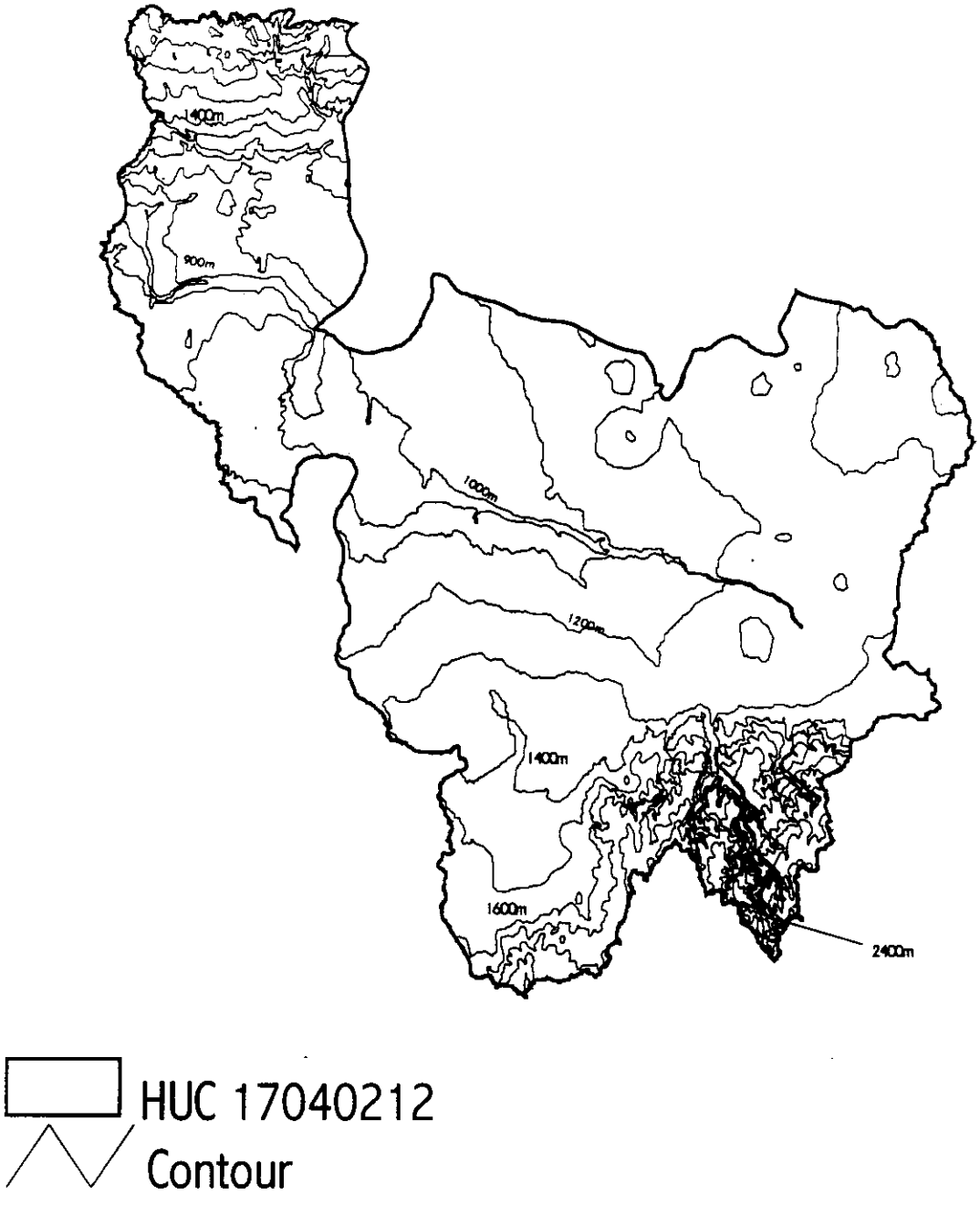


Figure 6 Topography of Upper Snake Rock

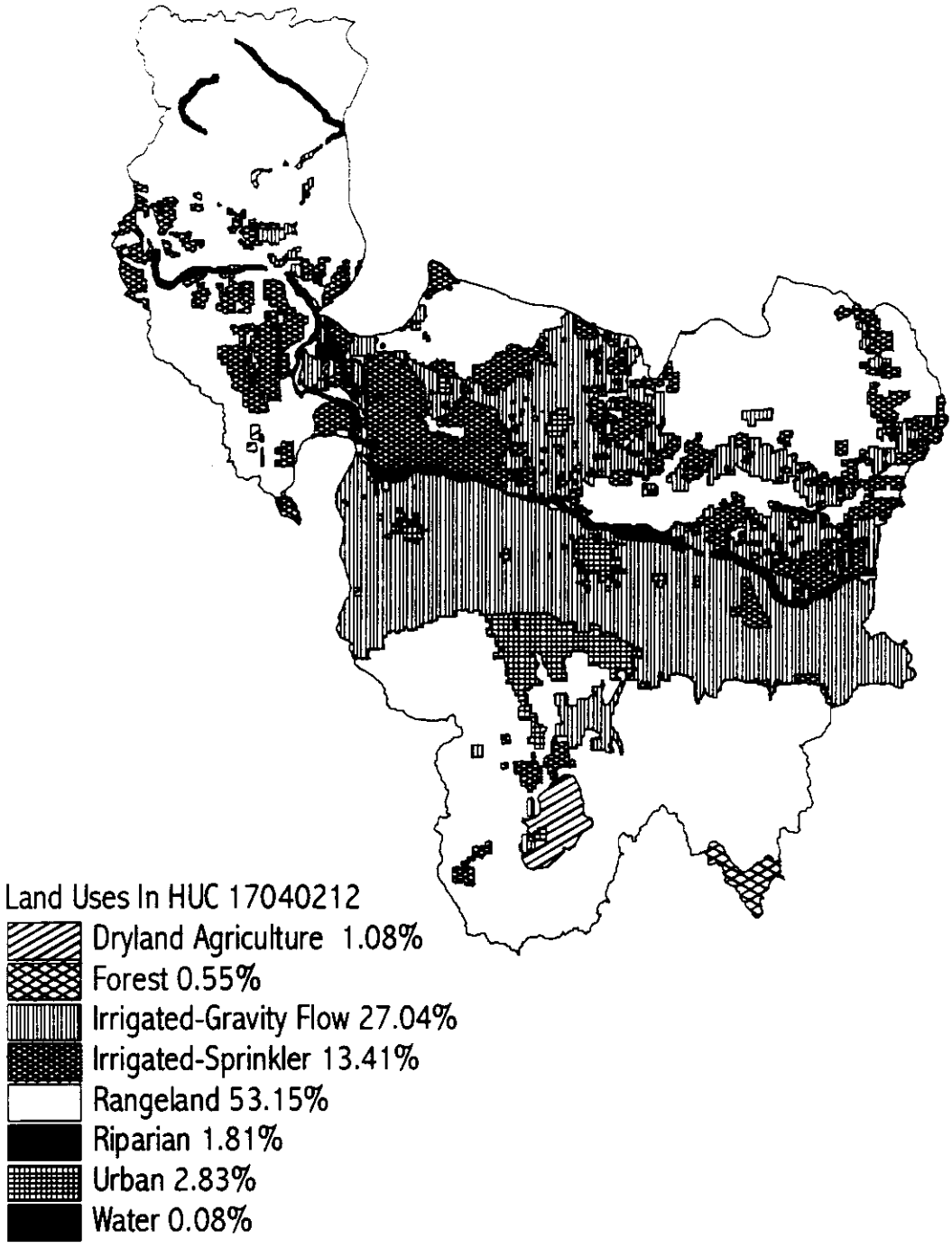


Figure 7 Landuse and ownership in Upper Snake Rock

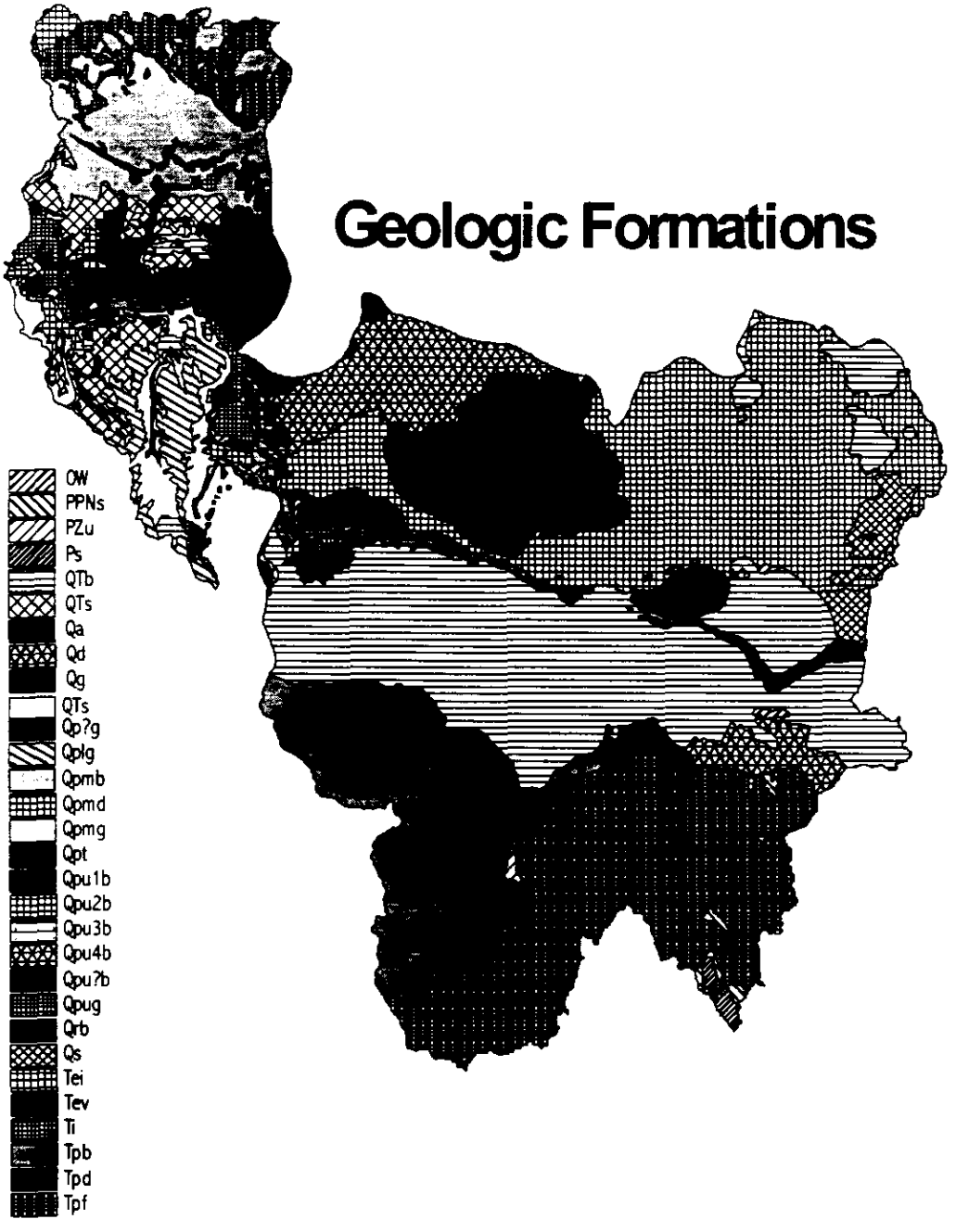


Figure 8 Soils of Upper Snake Rock



Figure 9. General geology of Upper Snake Rock

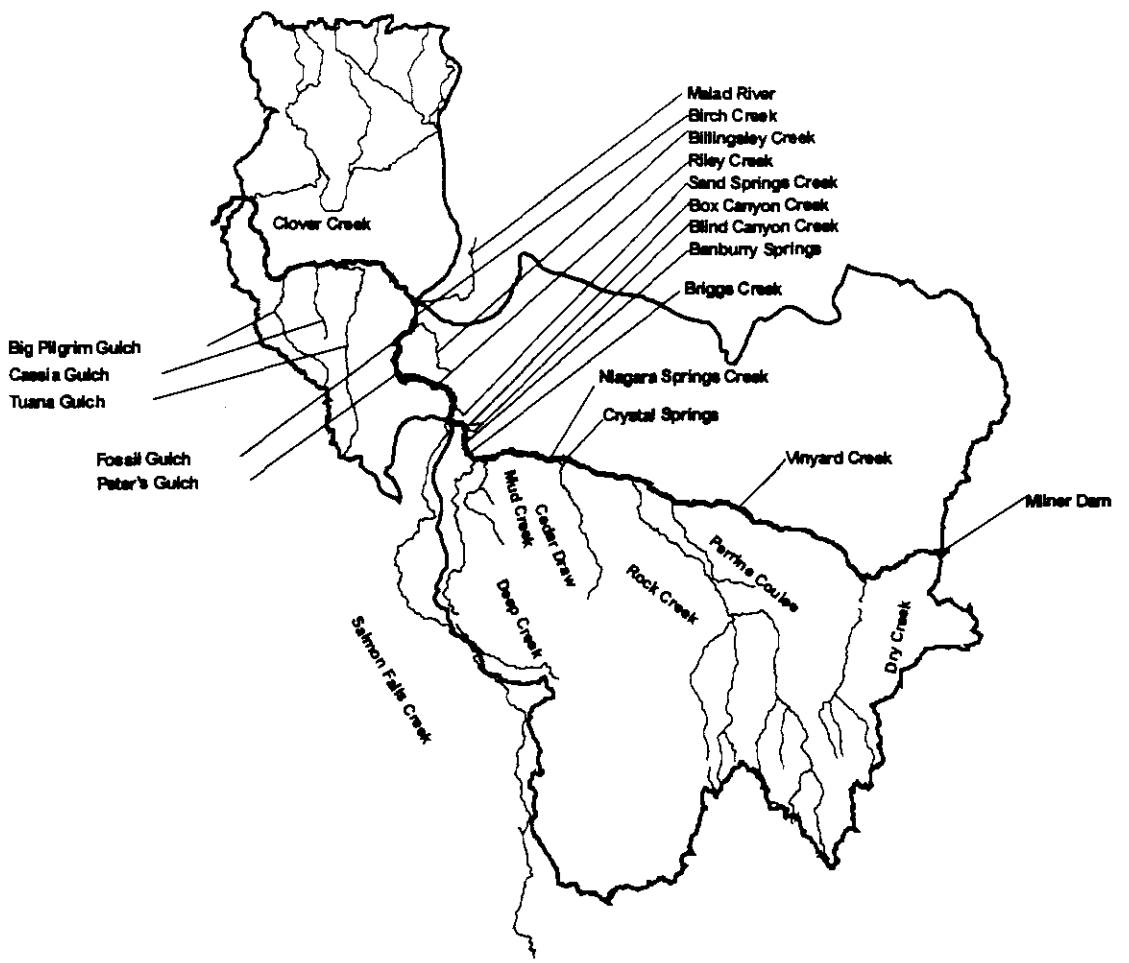


Figure 10 Summary of various tributary inputs into the Middle Snake River

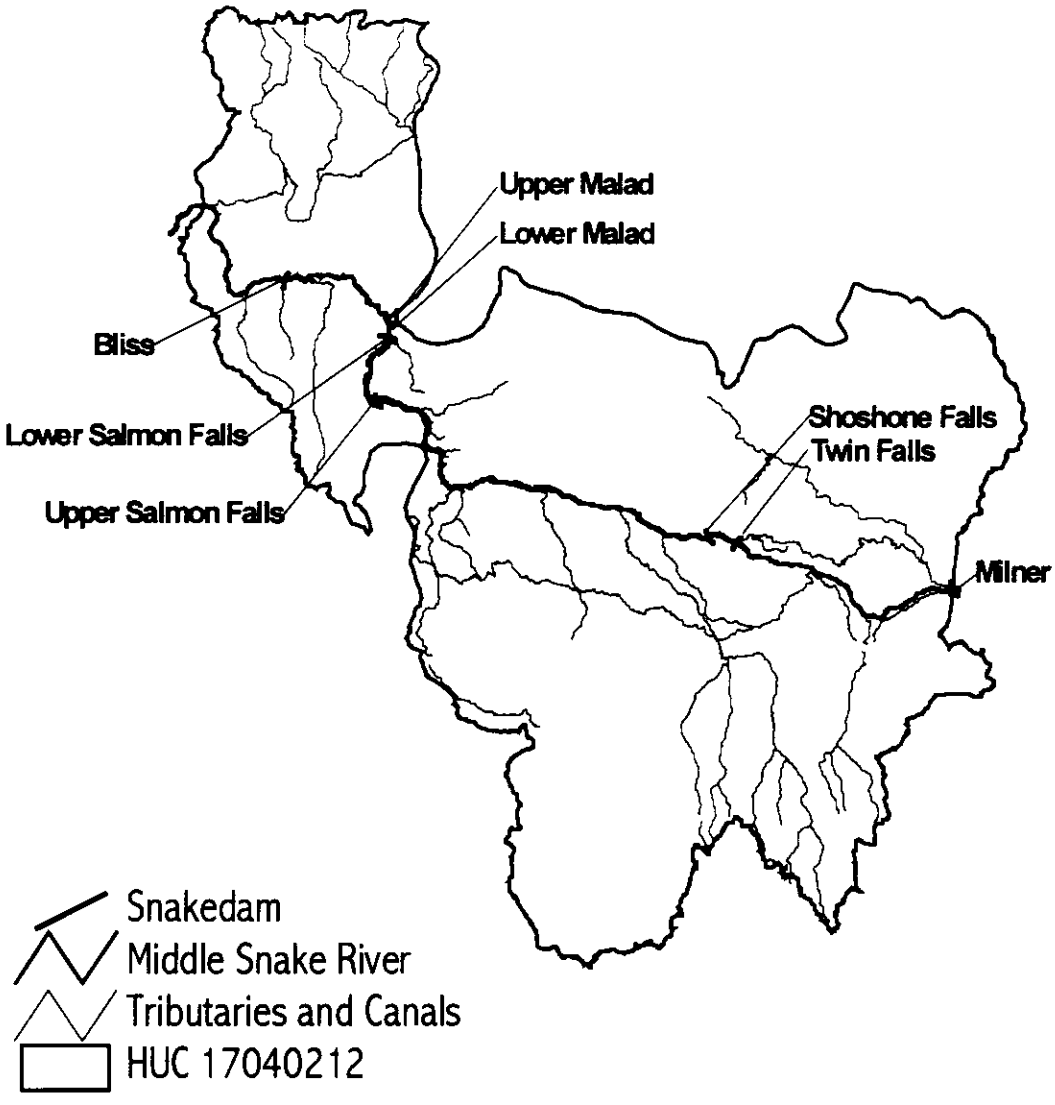
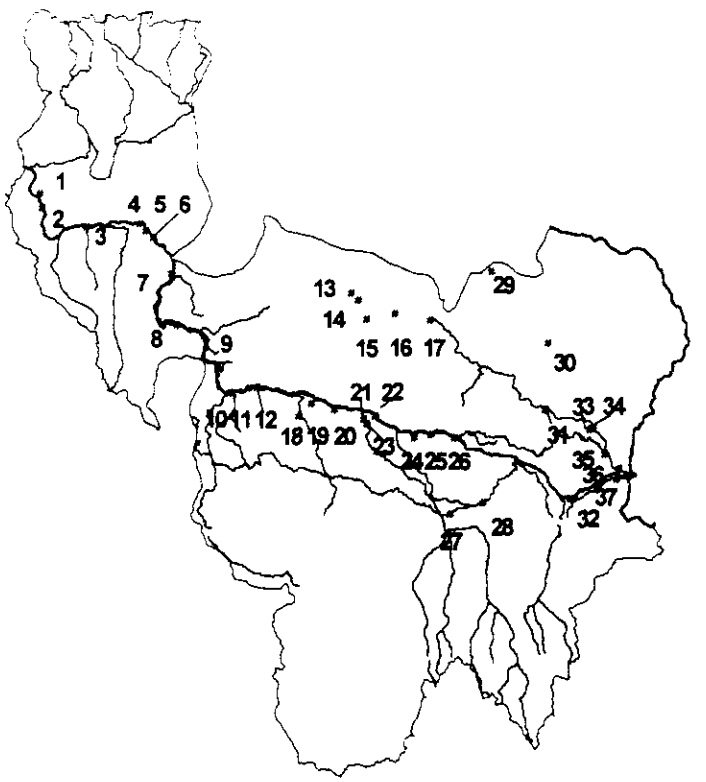


Figure 11a Major impoundments on the Middle Snake River



1. Freeway Drop
2. Dike
3. Bliss
4. A. J. Wiley
5. Stevenson No. 2
6. Stevenson No. 1
7. Lower Salmon
8. Upper Salmon Falls
9. Blind Canyon
10. Kanaka Rapids
11. Empire
12. Boulder Rapids
13. North Side Jerome
14. North Side Jerome
15. North Side Jerome
16. North Side Jerome
17. North Side Jerome
18. Cedar Draw Creek
19. Sahko
20. LQ-LS Drains
21. Rock Creek
22. Auger Falls*
23. Rock Creek No. 2
24. Kasel-Witherspoon
25. Shoshone Falls
26. Twin Falls
27. Lower Low Line
28. Low Line Canal Drop
29. Dietrich Drop
30. Mile-28 Water Power
31. Wilson Lake
32. Star Falls*
33. Hazelton A
34. Hazelton B
35. Bypass
36. Milner
37. Milner

* Proposed Projects

Figure 11b Additional power generation projects near the Middle Snake River



Figure 12 The Eastern Snake River Plain Aquifer in Upper Snake Rock

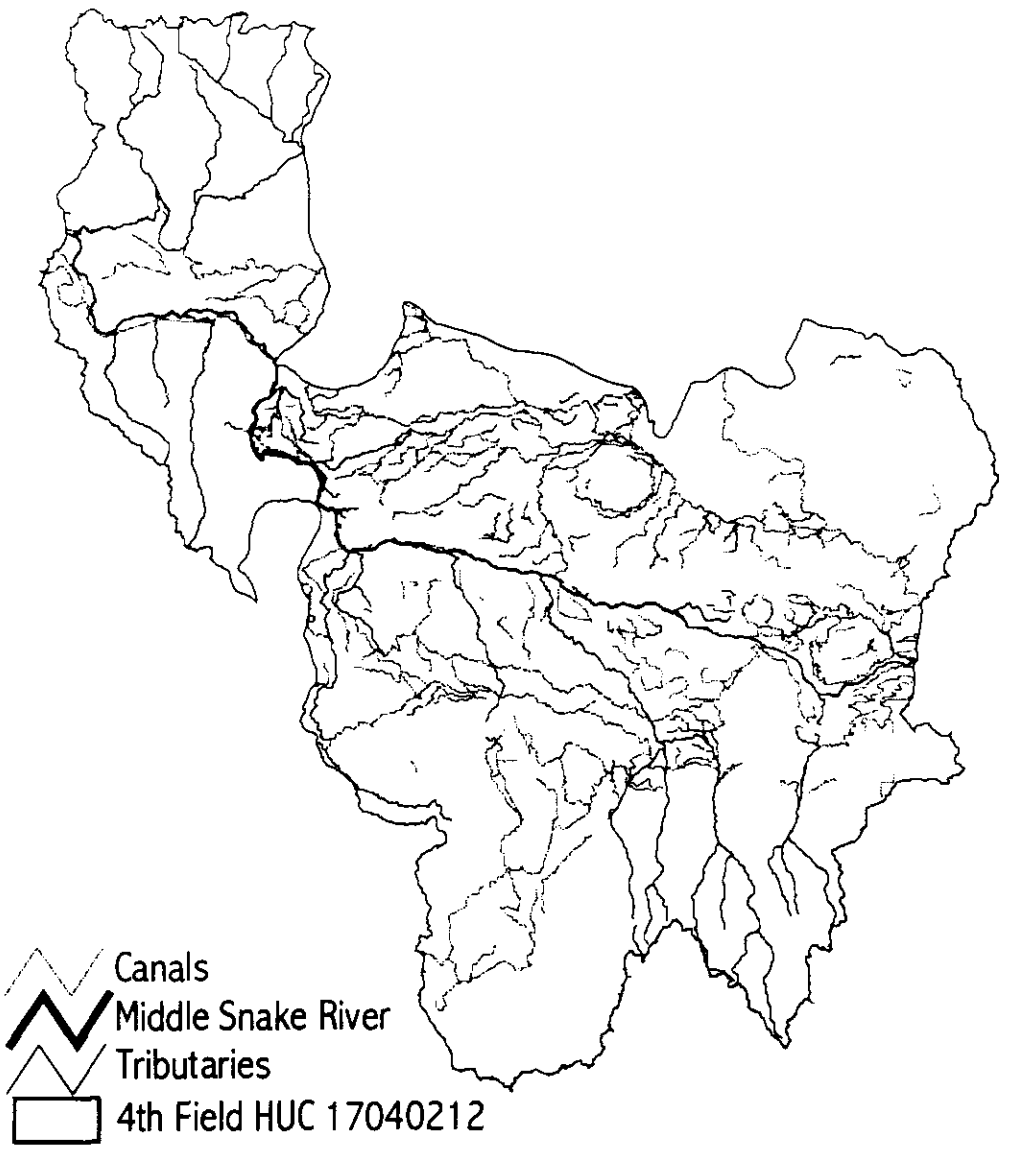
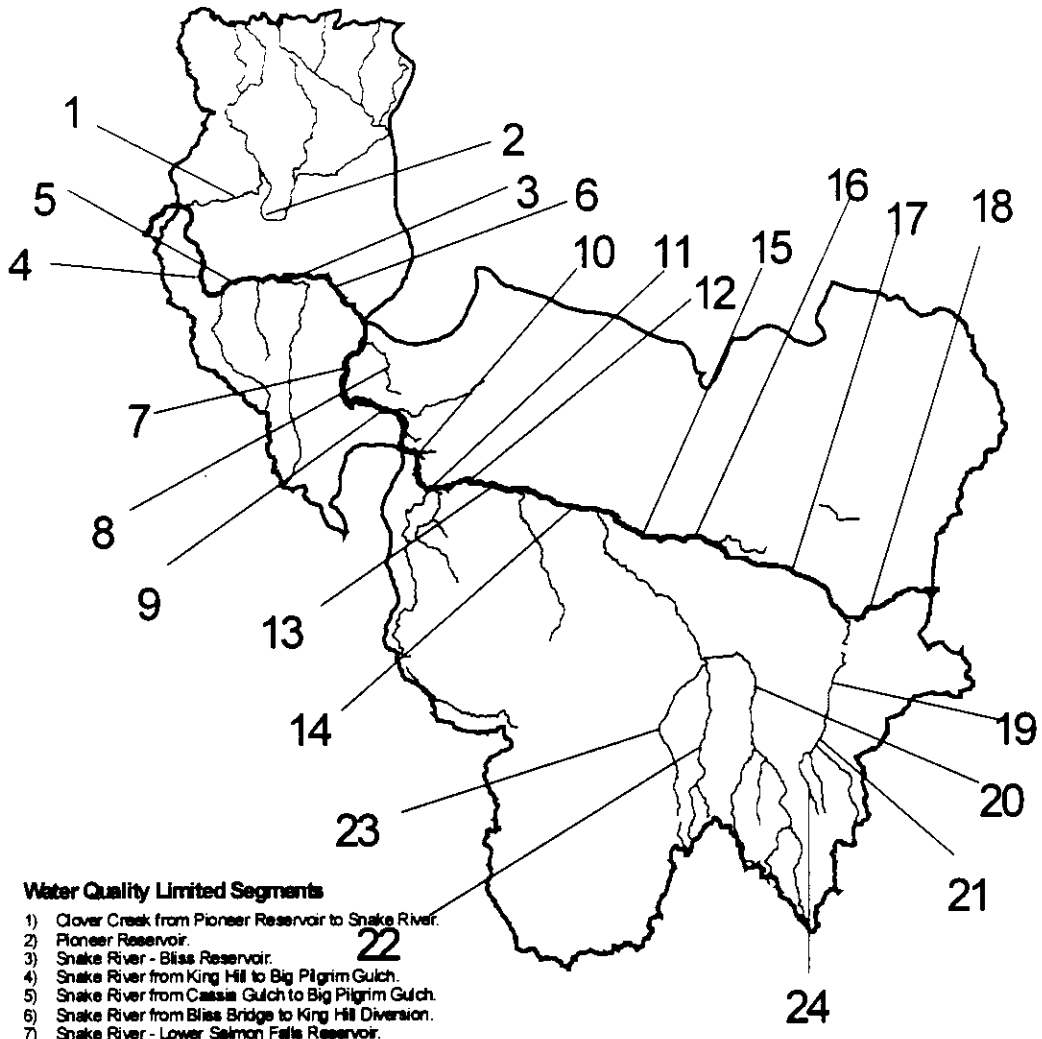


Figure 13 Canal system integration with tributaries and the Middle Snake River



Water Quality Limited Segments

1) Clover Creek from Pioneer Reservoir to Snake River.
2) Pioneer Reservoir.
3) Snake River - Bliss Reservoir.
4) Snake River from King Hill to Big Pilgrim Gulch.
5) Snake River from Cassia Gulch to Big Pilgrim Gulch.
6) Snake River from Bliss Bridge to King Hill Diversion.
7) Snake River - Lower Salmon Falls Reservoir.
8) Billingsley Creek from headwaters to Snake River.
9) Snake River - Upper Salmon Falls Reservoir.
10) Blind Canyon Creek from headwaters to Snake River.
11) Snake River from Deep Creek to Mud Creek.
12) Snake River from Mud Creek to Clear Lakes Bridge.
13) Snake River from Clear Lakes Bridge to Cedar Draw.
14) Snake River fromn Cedar Draw to Rock Creek.
15) Snake River from Rock Creek to Shoshone Falls.
16) Snake River - Shoshone Falls Reservoir.
17) Snake River from Twin Falls Reservoir to Murtaugh.
18) Snake River from Murtaugh to Milner Dam.
19) Dry Creek from Medley Creek to Snake River.
20) Rock Creek from Rock Creek Town to Snake River.
21) Dry Creek from headwaters to Medley Creek.
22) McMullen Creek from headwaters to Cottonwood Creek.
23) Cottonwood Creek from headwaters to Rock Creek.
24) West Fork of Dry Creek from headwaters to Dry Creek.

Water Quality Limited Segments Not Shown

25) Alpheus Creek from headwaters to Snake River.
26) Clear Springs from headwaters to Snake River.
27) Crystal Springs from headwaters to Snake River.
28) Ellison Creek from headwaters to Snake River.
29) Riley Creek from headwaters to Snake River.
30) Thousand Springs Creek from headwaters to Snake River.
31) Vinyard Creek from headwaters to Snake River.

Figure 14 Water quality limited stream segments of Upper Snake Rock

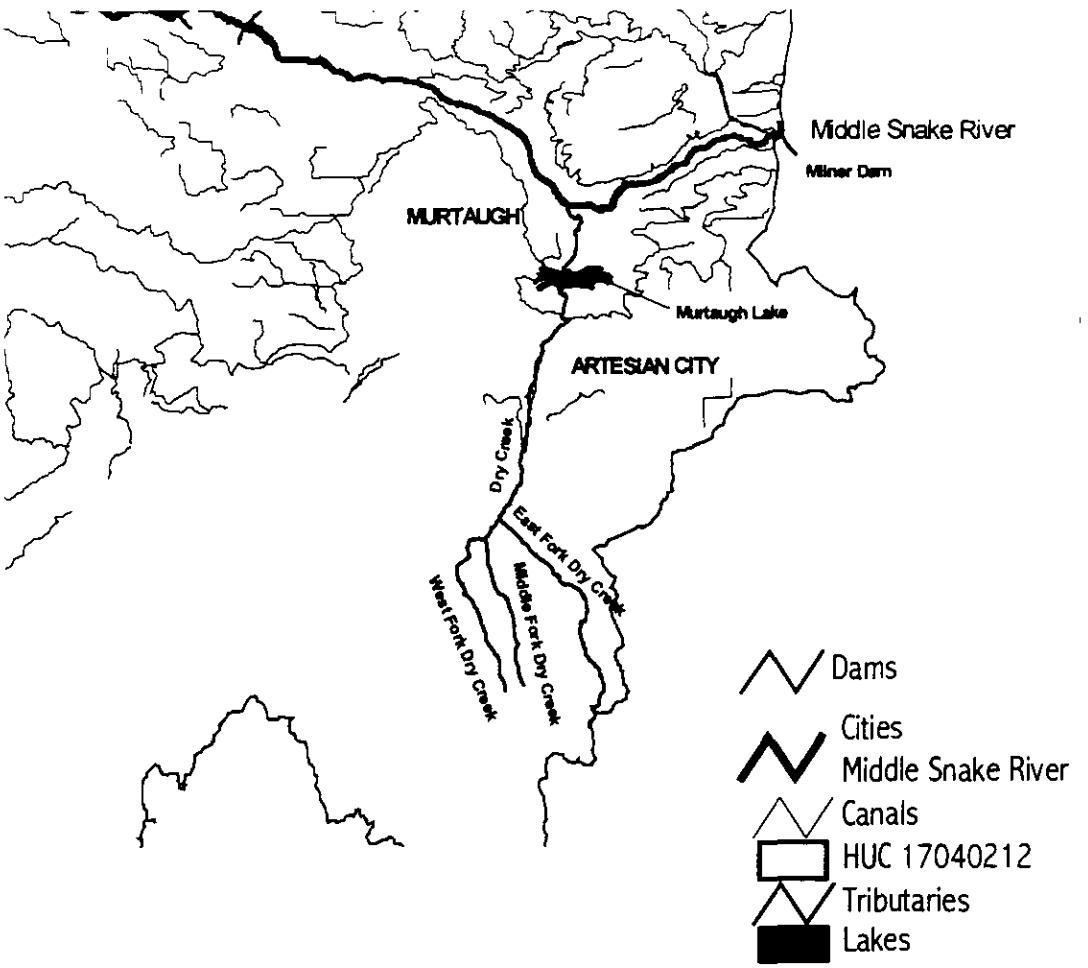


Figure 15 Dry Creek (Murtaugh) Complex of Upper Snake Rock

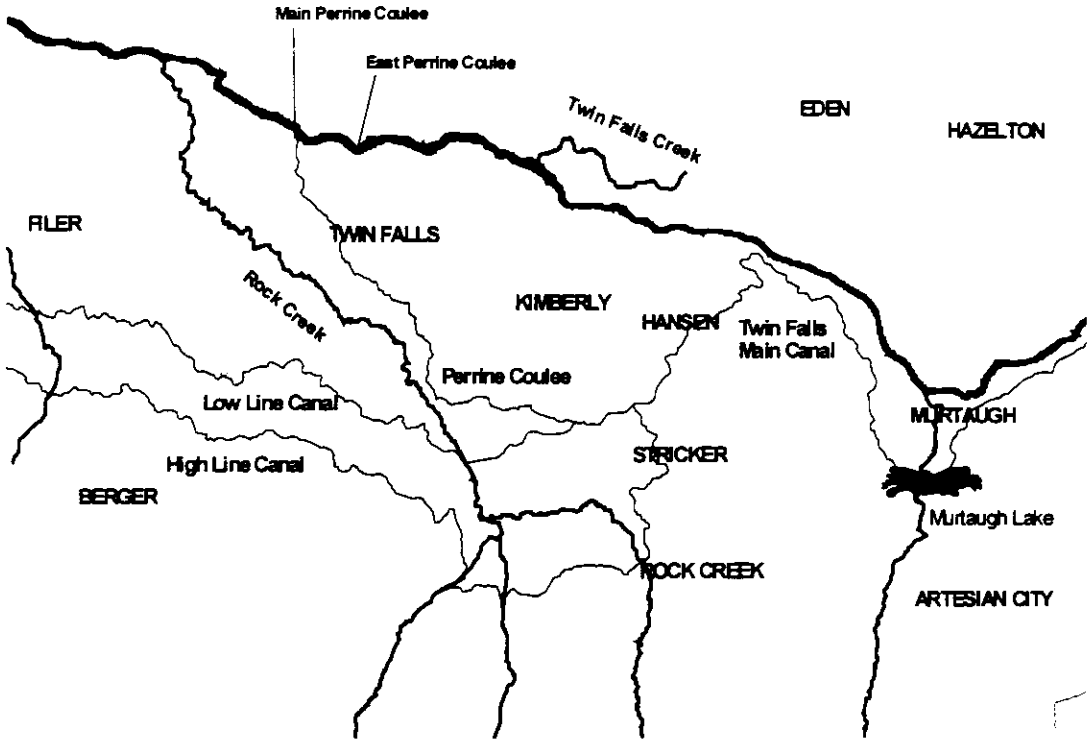


Figure 16 The Perrine Coulee System of Upper Snake Rock

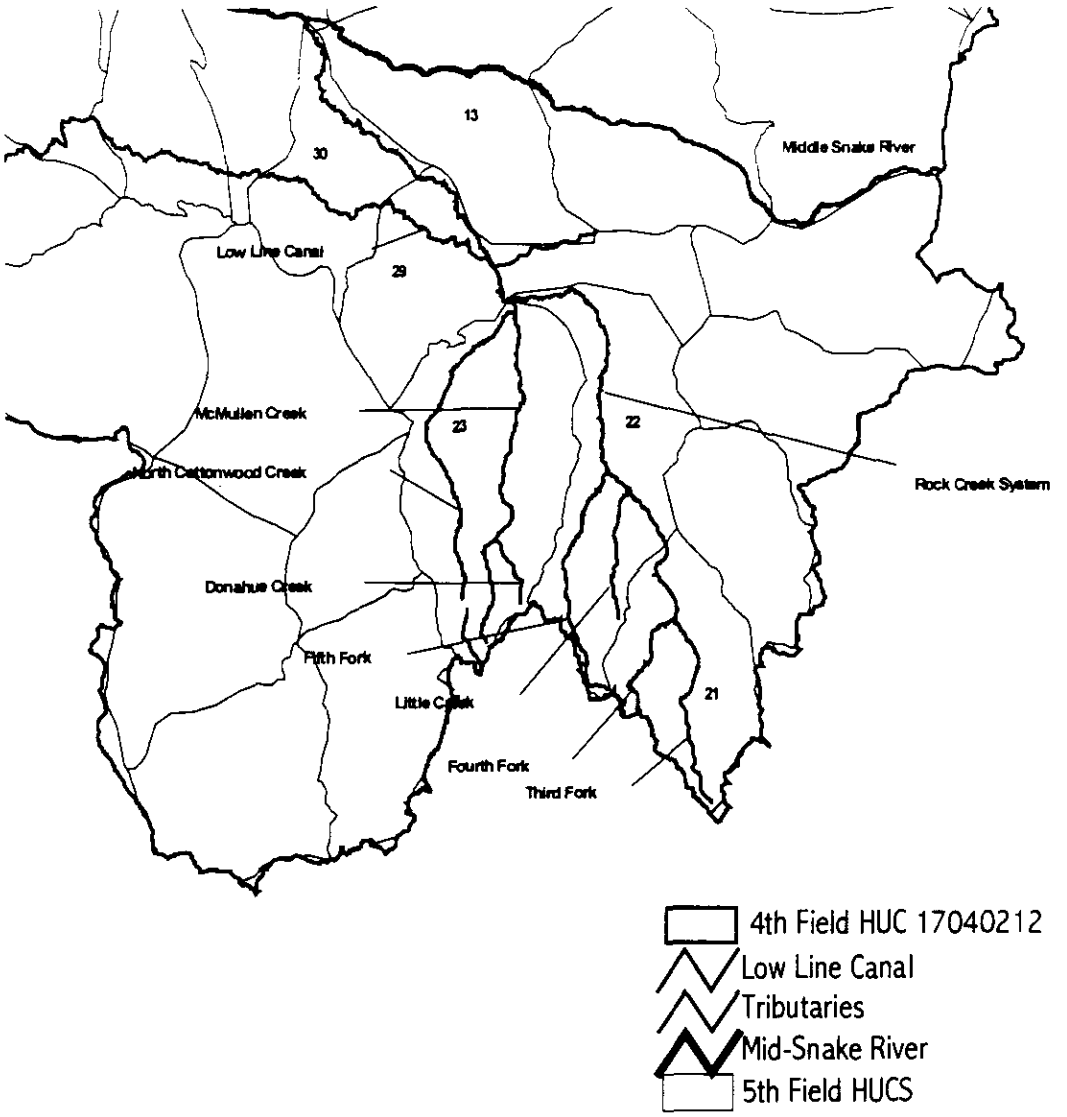


Figure 17 The Rock Creek Complex of Upper Snake Rock

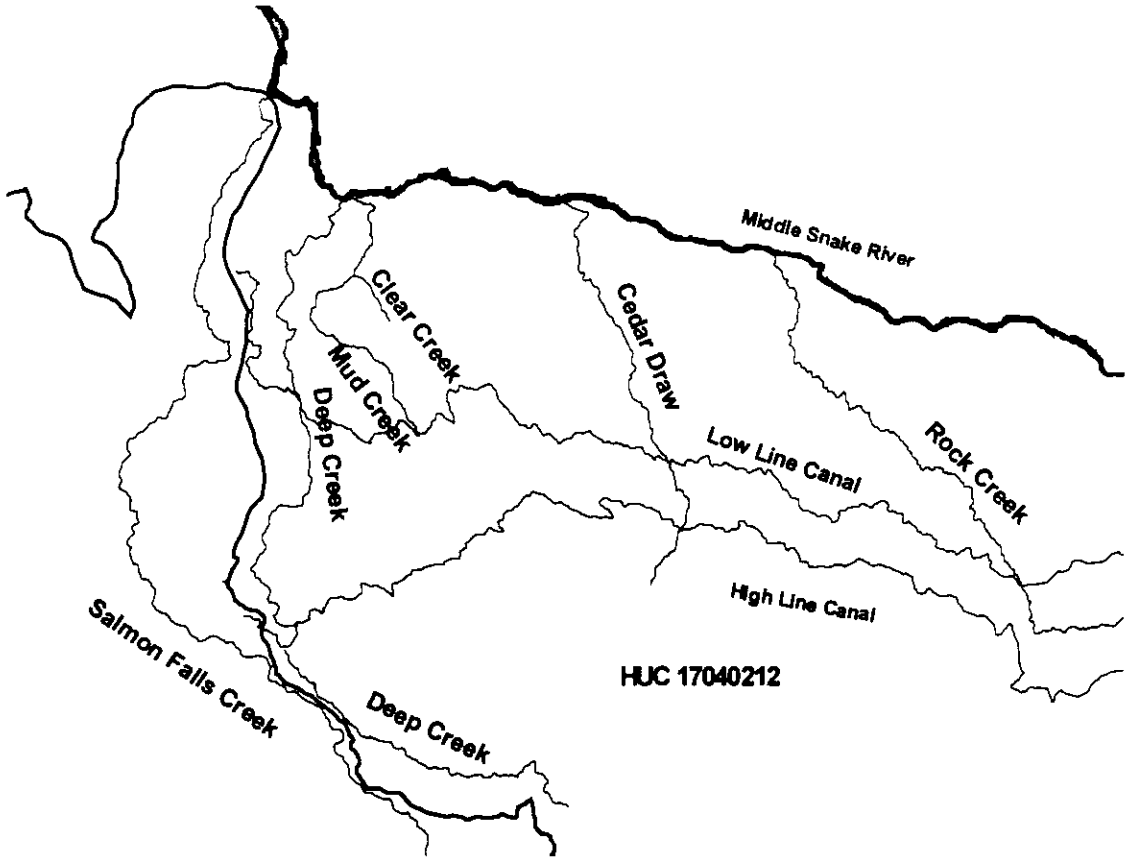


Figure 18 Cedar Draw, Mud Creek, and Deep Creek in Upper Snake Rock

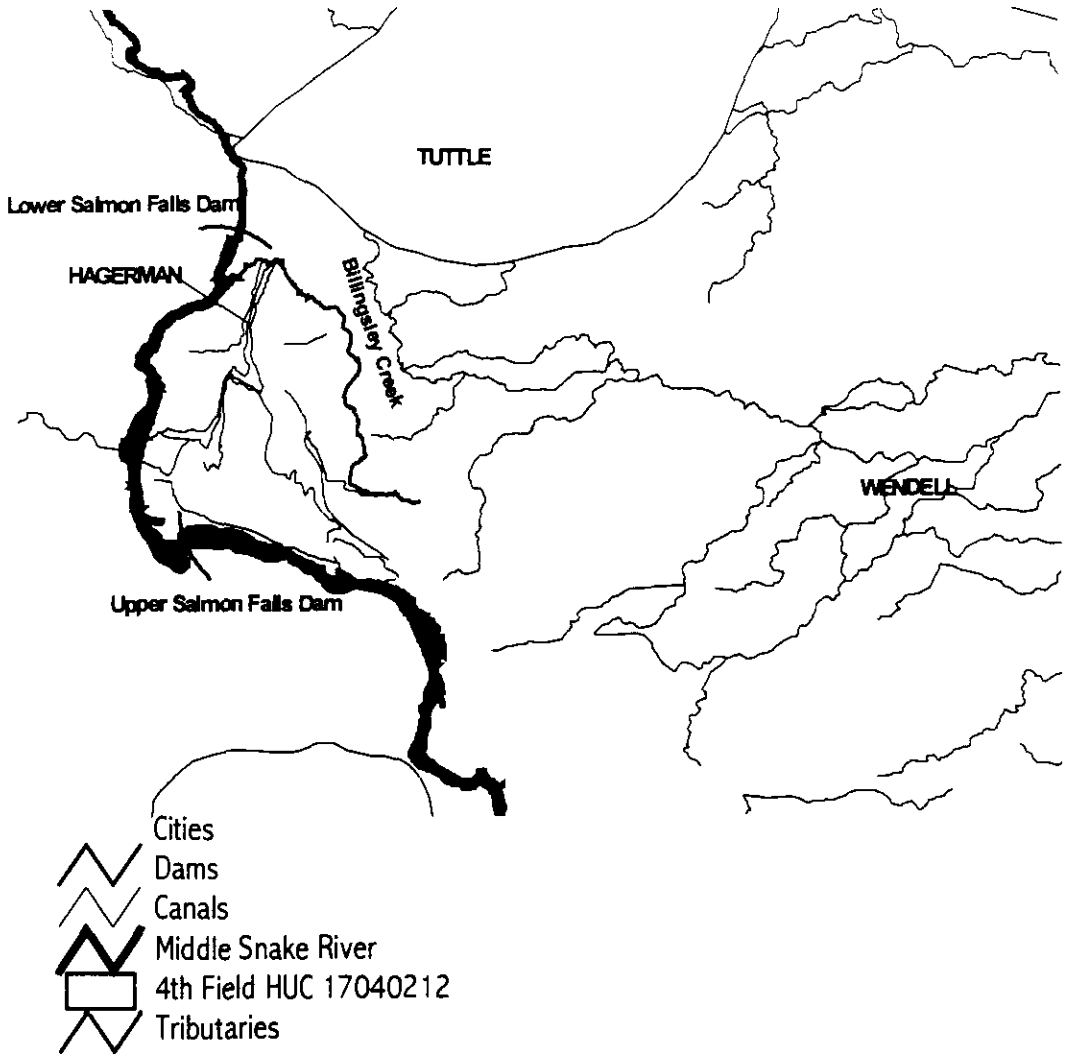


Figure 19 Billingsley Creek in Upper Snake Rock

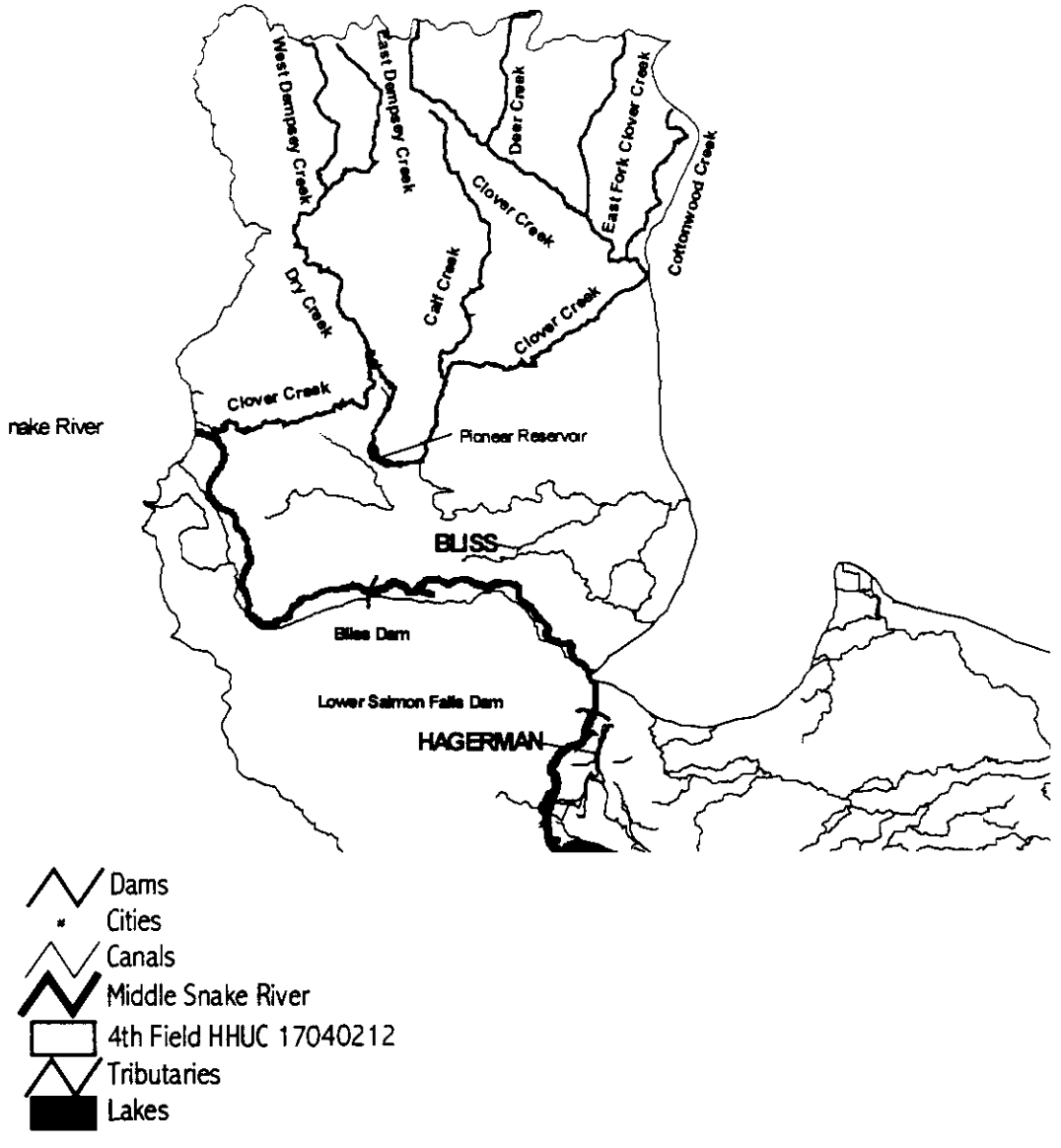


Figure 20 The Clover Creek Complex of Upper Snake Rock

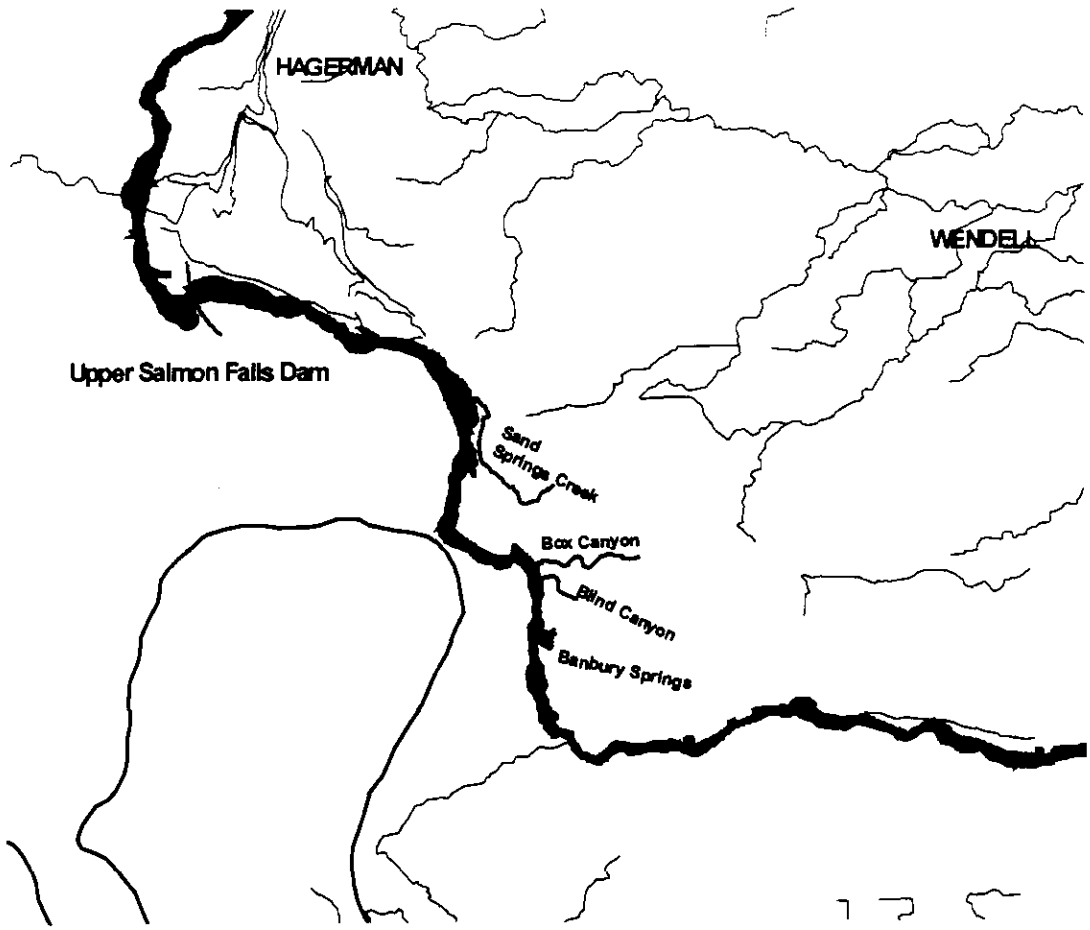


Figure 21 Box Canyon, Blind Canyon, and Sand Springs Creek.

2.2 WATER QUALITY CONCERNS AND STATUS

Sixteen (16) tributaries, five (5) reservoirs, and ten (10) river segments on the Middle Snake River from the Upper Snake Rock subbasin are listed in TABLE 22 (for a total of 31 waterbodies). The table reflects the 1996 303(d) list (which was a continuation of the 1994 list. The overall basis on which these streams were selected as water quality limited stream segments was based on best professional judgment (BPJ). BPJ assessment included evaluating the designated beneficial uses on a hydrologic unit basis (HUC) as being full support, threatened, partially supporting, not supporting, not being attained, or not assessed.

TABLE 22. 1996 POLLUTANTS/STRESSORS OF WATER QUALITY IMPAIRED STREAMS IN UPPER SNAKE ROCK.

STREAM NAME (STREAM MILES)	BOUNDARIES	POLLUTANTS/STRESSORS S	N	DO	NH3	FA	T	TM	PG	PC	O
TRIBUTARIES											
Alpheus Creek	From headwaters to the Snake River	X	X	X							
Billingsley Creek	From headwaters to the Snake River	X		X	X	X					
Blind Canyon Creek	From headwaters to the Snake River	X	X	X	X	X			X		
Clear Springs	From headwaters to the Snake River	X	X	X	X						
Clover Creek	From Pioneer Reservoir to the Snake River	X									
Cottonwood Creek	From headwaters to Rock Creek	X	X		X	X			X	X	
Crystal Springs	From headwaters to Snake River	X	X	X	X	X					
Dry Creek	From Medley Creek to Snake River	X				X		X	X		
Dry Creek	From headwaters to Medley Creek	X				X		X	X		
Dry Ck, West Fork	From headwaters to Dry Creek	X	X	X		X			X		
Ellison Creek	From headwaters to Snake River	X	X	X	X	X			X		
McMullen Creek	From headwaters to Cottonwood Creek	X	X	X		X		X	X		
Riley Creek	From headwaters to Snake River	X	X	X	X				X		
Rock Creek	From Rock Creek Town to Snake River	X	X	X	X	X			X		X
Thousand Springs Creek	From headwaters to Snake River	X	X			X					
Vinyard Creek	From headwaters to Snake River	X	X	X	X				X		
RESERVOIRS											
Bliss Reservoir	The entire reservoir	X		X	X	X			X		
Lower Salmon Falls Reservoir	The entire reservoir	X		X		X					
Pioneer Reservoir	The entire reservoir	X	X	X	X	X	X		X		
Shoshone Falls Reservoir	The entire reservoir	X		X		X					
Upper Salmon Falls Reservoir	The entire reservoir	X		X		X					
ON THE MIDDLE SNAKE RIVER = 61.80 miles											

STREAM NAME (STREAM MILES)	BOUNDARIES	POLLUTANTS/STRESSORS S	N	DO	NH3	FA	T	TM	PG	PC	O
Middle Snake River (8.53 miles)	From Milner Dam to Murtaugh	X		X		X		X	X		
Middle Snake River (7.27 miles)	From Cedar Draw to Rock Creek	X					X				
Middle Snake River (6.10 miles)	From Clear Lakes Bridge to Cedar Draw	X					X				
Middle Snake River (0.11 miles)	From Deep Creek to Mud Creek	X					X				
Middle Snake River (9.31 miles)	From King Hill to Big Pilgrim Gulch	X					X				
Middle Snake River (1.33 miles)	From Mud Creek to Clear Lakes Bridge	X					X				
Middle Snake River (8.25 miles)	From Shoshone Falls to Rock Creek	X					X				
Middle Snake River (3.47 miles)	From Cassia Gulch to Big Pilgrim Gulch	X	X				X				
Middle Snake River (5.78 miles)	From Bliss Bridge to King Hill Diversion	X									
Middle Snake River (11.65 miles)	From Murtaugh to Twin Falls Reservoir	X		X	X				X		

S = Sediment; N = Nutrients; DO = Dissolved Oxygen; NH3 = Ammonia; FA = Flow Alteration; T = Temperature; TM = Thermal Modification; PG = Pathogens; PC = Pesticides; O = Oil and Grease. Temperature and Thermal Modification mean essentially one in the same thing and may be combined.

2.2.1 GENERAL INFORMATION ON POINT AND NONPOINT SOURCES

Two major sources of pollutants are identified in Upper Snake Rock: point and nonpoint source. Point sources include: aquaculture, food processors, municipalities, and industrials. Their pollutants as defined in their permits include: ammonia; BOD; biological wastes; deleterious materials; fecal coliform and other bacteria; floating, suspended or submerged matter; nutrients, including phosphorus and nitrogen compounds; oil and grease; oxygen-demanding materials; residual disinfectants, including total residual chlorine; residual disease control drugs and other chemicals; residual feed and nutritional supplements; sediment; settable solids; temperature and pH; total suspended solids; toxic substances; and turbidity (USEPA 1997b-i).

For Upper Snake Rock, the nonpoint sources include: irrigated and nonirrigated agriculture, grazing, confined feeding operations (CFOs), NPDES permitted CAFOs, urban runoff/storm sewers, and recreation. Their pollutants include: sediment, nutrients, pathogens, salts, toxics substances, petroleum products, and pesticides are the pollutants contributed to surface and ground water (USEPA 1997k [pp xii, 1-4])." "Pollutants-of-concern resulting from these [nonpoint source] activities include sediment, bacteria, nutrients, organic enrichment, and pesticides (IDHW 1991b [p2])." "In 1988 IDEQ conducted an assessment of non-point source pollution in Idaho [*and concluded that*] the primary non-point source activities in the region are agriculture, hydrologic modification, forest practices, and some construction and mining. Agriculture is by far the greatest source of non-point source pollution to...river impoundments (IDHW 1991b [p2])."

In the Mid-Snake TMDL (IDEQ 1997b) irrigated and nonirrigated agriculture, CFOs, NPDES permitted CAFOs, and urban runoff/storm sewers are discussed and defined. Grazing was not defined and was referenced as "to be defined more fully within five years of the final plan (IDEQ 1997b [p 73])." The "final plan" is the Mid-Snake TMDL, but also includes the Upper Snake Rock TMDL. One of the priniciple concerns of over-grazing is the degradation of riparian sites. Livestock grazing in riparian areas is a controversial issue (UI-IFWRPAG 1997 [p 6]). "Grazing by livestock has had the most destructive effect upon riparian vegetation (Platts 1983 [p 83]; Armour *et al.* 1991 [p 7])." Exclusion of grazing animals from the affected areas may not completely allow riparian habitats and revegetation programs to recover. For the grazing industry, the following concerns which ultimately affect water quality need to be considered:

1. VEGETATION FOR STREAMSIDE COVER

Many studies have documented that salmonid abundance declines as stream cover is reduced, and that it increases as stream cover is added. Stream cover is highly significant in determining fish biomass and fish populations. Thus, trees, brush, grasses, and forbs each play an important role in building and maintaining productive streams: trees to provide shade and streambank stability; brush to provide cover for streambank protection and stability; and, grasss and forbs to provide vegetative mats and sod banks that reduce surface erosion and mass wasting of streambanks (Platts 1983 [p 184]).

2. VEGETATION FOR STREAMBANK STABILITY

The elimination of streamside vegetation and the caving in of overhanging streambanks by animals are the principal factors contributing to the decline of native trout populations in western streams (Armour *et al.* 1991 [p 7]). Streambank erosion or collapsing have been going on since banks were first formed by glaciation, floods, drought, debris flows, and ice flows, but this for the most part occured over prolonged time and in equilibrium with bank rebuilding processes so that as banks were naturally being eroded there were just as many banks being built. During the past century this state of equilibrium has been upset by altering the banks much faster then they can be rebuilt (Platts 1983 [p 185]). Several studies have noted that the average stream temperature dropped 12°F in an enclosure that was ungrazed for 10 years (Armour *et al.* 1991 [p 9]).

3. VEGETATION FOR STREAM TEMPERATURE CONTROL

Streamside vegetation shades the stream and reduces water temperatures. Solar radiation accounts for about 95% of the heat input into Intermountain West streams during the midday periods in mid-summer. Because streamside vegetation has been reduced and helped to increase summer stream temperatures, there has been a gradual shift in the management of game fish to less non-game fish tolerant to higher stream temperatures. Streams in the west that have had a change in the riprarian plant forms (from brush to grass), are often too warm in the summer and too cold in the winter (Platts 1983 [pp 186-187]). Additionally, several studies have attributed high *E. coli* counts in streams to livestock. Mortality for rainbow trout can exceed 75% when sediments elevate to 200 mg/L, which is a common occurrence in streams damaged by improperly managed grazing (Armour *et al.* 1991 [p 9]).

4. VEGETATION FOR FISH PRODUCTION

Streamside vegetation provides habitat for terrestrial insects, which are an important part of the fish diet. The vegetation also provides direct organic material to the stream which makes up 50% of the stream's nutrient energy supply for the food chain. Removal of streamside vegetation can affect the diet of fish by reducing both the terrestrial and aquatic insect production (Platts 1983 [p 187]). Additionally, stream-channel sedimentation caused by soil erosion has been recognized as a major watershed-fisheries problem (Armour *et al.* 1991 [p 7]).

5. VEGETATION FOR CHANNEL HYDROLOGY CHANGES

Livestock grazing can affect the riparian environment by changing and reducing vegetation or by actual elimination of riparian areas by channel wideing, channel aggradation, or lowering of the water table. Areas heavily grazed by sheep have been found to be four times as wide when compared to adjacent areas lightly grazed. Studies have shown that livestock grazing on the vegetative cover causes caving in of overhanging streambanks (thus causing the streams to widen), probably affecting

fish populations. Vegetation influences hydrologic conditions within a watershed. Any activity, including grazing, that decreases vegetation can result in adverse hydrological conditions (Armour *et al.* 1991 [p 9-10]).

6. VEGETATION FOR REDUCTION IN NUTRIENT LOSSES

The highest concentration of nutrients in stream water samples is highest when cattle are present in a watershed (Jawson *et al.* 1982 [p 630]). Moderate grazing intensities generally do not increase nutrient concentrations in surface runoff or stream water. In fact, grazing intensity is the most important variable affecting response of upland range to cattle grazing (UI-IFWRPAG 1997 [p 13]).

2.2.2 WATER QUALITY LIMITED SEGMENTS OCCURRING IN THE SUBBASIN

As previously described in §2.1.2.1, "...the topography [*of Upper Snake Rock*] is such that the majority of the subbasin drains into the Middle Snake River, whether it be from natural drainage or the myriad of miles of canal drains and laterals." By definition, all of the waters in the Upper Snake Rock subbasin drain towards the Middle Snake River (with some minor exceptions). See also §2.1.3.6. Therefore, it may be concluded that the water quality of the tributaries or any discharging waterbody to the Middle Snake River will directly effect the water quality of the Middle Snake River.

Initially, the IDEQ-TFRO will do a total maximum daily load (TMDL) on water quality limited streams that are listed on the 1996 303(d) list, whether they be perrenial or intermmitent (or ephemeral). According to §39-3602.27, a TMDL means "a plan for a water body not fully supporting designated beneficial uses and includes the sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources, and natural background levels of the pollutant impacting the water body." And, the definition of water quality limited streams applies only when water is present in the stream. Then, §39-3602.28 defines "waters or water body" as "the accumulations of surface water, natural and artificial, public and private, or parts thereof which are wholly or partially within, flow through or border upon this state...and shall not include municipal or industrial wastewater treatment or storage structures or private reservoirs, the operation of which has no effect on waters of the state." Therefore, man-made waterways will not be considered for TMDL development at this time.

As part of the development of the subbasin assessment, 303(d) listed waterbodies were classified according to USGS hydrological GIS coverages (ArchView 1996). The coverage indicates whether a waterbody is intermittent, perennial, or man-made. Unless the IDEQ had evidence contrary to the USGS data, the USGS designation was used for waterbody typing.

2.2.2.1 THE MIDDLE SNAKE RIVER

The Middle Snake River and its tributaries have altered streamflow dynamics. These have created changes in the balance of erosion/transport and deposition reaches and increased the levels of seasonal suspended sediment. The flows in the Middle Snake River are highly regulated for agricultural irrigation. Under extreme low flow conditions the water quality is adversely impacted (USDA & USDI/BLM 1997a). In fact, where excess irrigation occurs: "erosion washes soil away...and water-borne silt contaminates the rest of the irrigation system, the river, and the groundwater (Palmer 1991)." The published sources for water quality concerns and the status of those segments on the Middle Snake River listed on the §303(d) list are summarized in Table 23. These literature sources are used as the basis for which the segments are listed.

TABLE 23. SOURCES DEFINING WATER QUALITY CONCERNS FOR THE MIDDLE SNAKE RIVER

STREAM SEGMENT	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
MIDDLE SNAKE RIVER													
Milner Dam to Murtaugh	378	X	X	X	X	X	(X)	X	X	(X)	X	X	X
Cedar Drw to Rock Creek	374			X		X	X	X	X	(X)	X	X	X
Clear Lakes Bdg to Cedar Drw	-			X		X	X	X	X	(X)	X	X	X
Deep Creek to Mud Creek	-	X		X		X	X	X	X	(X)	X	X	X
King Hill to Big Pilgrim Gch	371	X		X		X	X	X	X	(X)	X	X	X
Mud Creek to Clear Lakes Bdg	-			X		X	X	X	X	(X)	X	X	X
Rock Creek to Shoshone Falls	374.1	X		X		X	X	X	X	(X)	X	X	X
Cassia Gch to Big Pilgrim Gch	-			X		X	X	X	X	(X)	X	X	X
Bliss Bridge to King Hill Divrs	369	X	X	X	X	X	(X)	X	X	(X)	X	X	X
Murtaugh to Twin Falls Reserv	372	X	X	X		X	(X)	X	X	(X)	X	X	X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement*. (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program*. 91 = *1993 Idaho Agricultural Pollution Abatement Plan* based on the *1979 Appendix of the Idaho Agricultural Pollution Abatement Plan*. 92 = *1992 Idaho Water Quality Status Report*. 94 = *1994 Idaho Water Quality Status Report*. 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994*. 303(d) Listed Streams: 92 = *1992 §303(d) List*. X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C*. 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D*. 98 = 1998 §303(d) List. Reserv = Reservoir. Bdg = Bridge. Drw = Draw. Gch = Gulch. Divrs = Diversion.

The 1994 and 1996 §303(d) lists identified the level of benefical support status for the Middle Snake River according to various segments on the river. These are identified in Table 24.

TABLE 24. 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR THE MIDDLE SNAKE RIVER.

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
King Hill to Pilgrim Gulch	AG	PC/SC	CW/SS	
Cassia Gulch to Big Pilgrim Gulch	AG/PC/SC		CW/SS	
Malad River to Bliss Reservoir	AG	PC/SC	CW/SS	
Lower Salmon Falls to Malad River	AG	PC/SC	CW/SS	
Hwy 30 to Upper Salmon Falls Power Plant	AG		CW	PC/SC/SS
Salmon Falls Creek to Highway 30	AG	PC/SC	CW	SS
Box Canyon to Salmon Falls Creek	AG	PC/SC	CW	SS
Deep Creek to Box Canyon	AG	PC/SC	CW	SS
Deep Creek to Mud Creek	AG	PC/SC	CW	SS
Clear Lakes Bridge to Mud Creek	AG	PC/SC	CW	SS
Cedar Draw to Clear Lakes Bridge	AG	PC/SC	CW	SS

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
Rock Creek to Cedar Draw	AG	PC/SC	CW	SS
Auger Falls to Shoshone Falls Power Plant	AG	PC/SC/CW/SS		
Shoshone Falls PP to Shoshone Falls Rsrvoir	AG	PC/SC/CW/SS		
Twin Falls Creek to Shoshone Falls Reservoir	AG	PC/SC/CW	SS	
Hansen Bridge to Twin Falls Reservoir	AG	PC/SC	CW/SS	
Dry Creek to Hansen Bridge	AG		CW/SS/PC/SC	
Milner Lake to Dry Creek	AG		CW/SS/PC/SC	

Prepared by IDEQ-TFRO. Based on the 1994 and 1996 §303(d) lists. PP = Power Plant. Rsrvoir = Reservoir. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning.

Additionally, agricultural nonpoint sources have historically affected the listed segments of the Middle Snake River as indicated in Table 25.

TABLE 25. AGRICULTURAL NONPOINT SOURCE EFFECTS ON THE MIDDLE SNAKE RIVER.

MIDDLE SNAKE RIVER SEGMENTS	IRRIGATED CROPLAND			LIVESTOCK GRAZING		
	Slight	Moderate	Severe	Slight	Moderate	Severe
Milner Dam to Murtaugh			Sediment	X		
Murtaugh to Twin Falls Reservoir			Sediment	X		
Shoshone Falls to Rock Creek			Sediment	X		
Cedar Draw to Rock Creek			Sediment	X		
Clear Lakes Bridge to Cedar Draw			Sediment	X		
Mud Creek to Cedar Draw			Sediment	X		
Deep creek to Mud Creek			Sediment	X		
Cassia Gulch to big Pilgrim Gulch		Sediment		X		
King Hill to Big Pilgrim Gulch		Sediment		X		
Bliss Bridge to King Hill Diversion		Sediment		X		

Prepared by IDEQ-TFRO. Dryland cropland was shown to not directly affect the Middle Snake River. Descriptors of Irrigated Cropland and Livestock Grazing provided by Soil Conservation Commission and Soil Conservation Districts from *Soil Conservation Commission, 1979, Idaho Agricultural Pollution Abatement Plan, Tables 2 & 3.* An X describes the general effect but not the specific agricultural effect from sediment.

Point source industries (like aquaculture, food processors, municipalities, and industrials) also contribute pollution. In general, "the Middle Snake River exhibits severe eutrophication from nutrient enrichment (www._____ 1997h)" that comes from both point and nonpoint sources. This eutrophication appears to be heightened during low flow/drought years, because during the 1996-1997 water years (years in which high flows were very characteristic) eutrophication and nuisance macrophytes were not as evident in those locations (Crystal Springs, Niagara Springs, Box Canyon) previously known to be severely afflicted by water quality problems.

Thus, the degradation of water quality on the Middle Snake River is caused by flow modifications, agricultural

and hatchery produced rainbow trout (although it could be argued that hatchery reared fish are a good source to supplement the limited resource). The practice of using reservoir storage to follow short-term peaks in power demand (known as "load following") adds further impacts. The resulting changes in river levels degrade downstream riparian areas and adversely affect fish populations. Load following activities create river velocities that may cause undue expenditure of energy during winter months, provide false spawning cues, increase drift of aquatic insects, and deteriorate habitat for macro-invertebrates. "The Lower Salmon Falls and Bliss Projects are operated in load-following manner, and as a result, the impoundments have fluctuated by as much as 6 feet and 5 feet, respectively, over a 24-hour period (FERC 1998 [p 41])."

4. According to USEPA, lakes and reservoirs in Upper Snake Rock when surveyed for meeting state water quality standards indicated that about 11% were threatened, about 60% were partially supporting, and about 28% were not supporting their aquatic life use (www._____ 1997 [/IDlakes-us.html]). The most prevalent causes of pollution of the surveyed acres were: about 100% of the time was siltation and nutrients, about 90% of the time was flow alteration, and about 78% of the time was pathogens and organic enrichment/low dissolved oxygen. The most prevalent sources of pollution of the surveyed acres were: about 100% of the time was agriculture and hydromodification (www._____ 1997 [/Idlakes-cs.html]). See also IDHW 1989b for a review of nonpoint source affects on reservoirs and lakes.

5. "Cold water biota and salmonid spawning have been reported as impaired...Agriculture is the main non-point source activity affecting lakes [and reservoirs] in this region. Pollutants of concern include nutrients, sediment, bacteria, and organic wastes. Water level fluctuations from irrigation water draw-downs have also impacted water quality by increasing temperatures and decreasing dissolved oxygen in some [lakes and] reservoirs (IDHW 1991b)." It should be noted that, according to Idaho Power Company, none of the mainstem Middle Snake River reservoirs drawn down for irrigation. However, "the Lower Salmon Falls and Bliss Projects are operated in load-following manner, and as a result, the impoundments have fluctuated by as much as 6 feet and 5 feet, respectively, over a 24-hour period (FERC 1998 [p 41])."

6. Ecosystems Research Institute studied the primary productivity (PP) and respiration (R) of the Middle Snake River at three reservoirs: Twin Falls, Shoshone Falls, and Upper Salmon Falls reservoirs in 1997. PPR was measured in each reservoir using the light bottle/dark bottle method, so as to use simplified stoichiometric relationships between the carbon fixed and the oxygen produced through photosynthesis, and the carbon and oxygen consumed during respiration. Average extinction coefficients for each reservoir on each date of sampling, and incident light recordings from the continuous light monitoring were used to determine the light intensity at each incubation depth throughout the water column throughout the day. Table 27 shows the average results on a monthly basis for the extinction coefficient and the depth to 1% light within each reservoir.

TABLE 27 MEAN EXTINCTION COEFFICIENTS AND MEAN DEPTH TO 1% LIGHT PER RESERVOIR.

MONTH	TWIN FALLS		SHOSHONE FALLS		UPPER SALMON FALLS	
	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%
May 1996	1.863 ± 0.154	2.5 ± 0.2	1.755 ± 0.264	2.7 ± 0.4	1.942 ± 0.144	2.4 ± 0.2
Jun 1996	1.387 ± 0.039	3.4 ± 0.1	1.366 ± 0.065	3.4 ± 0.2	1.717 ± 0.106	2.8 ± 0.3
Jul 1996	1.024 ± 0.108	4.6 ± 0.4	1.210 ± 0.153	3.8 ± 0.5	1.275 ± 0.128	3.7 ± 0.4
Aug 1996	—	—	—	—	0.978 ± —	4.7 ± —
Sep 1996	1.266 ± 0.248	3.7 ± 0.7	0.982 ± 0.108	4.7 ± 0.5	0.985 ± 0.248	4.9 ± 1.1

MONTH	TWIN FALLS		SHOSHONE FALLS		UPPER SALMON FALLS	
	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%
Oct '996	1 106 ± 0 281	4 3 ± 1 0	0 869 ± 0 118	5 4 ± 0 7	0 753 ± 0.114	6 2 ± 0 9
Prepared by IDEQ-TFRO ERI '997						

In general, light extinction in the reservoirs were quite high for most of the study period (May through October). For all three reservoirs extinction coefficients averaged 1.755 to 1.942 in May, then declined to averages of 0.753 to 1.106 in October, which translate to a 1% light depth of about 2.4 to 2.7 meters in May to 4.3 to 6.2 meters in October. Net primary productivity peaked at over 400 mg C/m^3/hr in early May and reached a maximum rate of about 250 mg C/m^3/hr for most of the summer. By September, the peak rate had fallen to about 120 C/m^3/hr. Total net primary production in Upper Salmon Falls Reservoir peaked in early May at almost 7000 kg C/day, and declined to a low of 1400 kg C/day by the end of the season. In contrast, both Twin and Shoshone Falls reservoirs varied between 300 and 1000 kg C/day through most of the season, dipping to negative values on one date in mid-July. When averaged over the entire reservoir volume, Upper Salmon Falls had higher rate of carbon fixation than the other two reservoirs. These values indicate that the Middle Snake River is autotrophic during the summer, and marginally heterotrophic during the spring and fall. Spring is the period of highest net primary productivity, with relatively low respiration rates due to low temperatures, but high gross production rates due to increasing light and high nutrients (ERI 1997).

7. Water quality in the Middle Snake River has deteriorated because of point and nonpoint sources, compounded by managed, altered, or reduced flows and velocities, which have yielded extensive growths of nuisance aquatic vegetation, degraded stream habitat, and elevated water temperatures. The high rates of primary productivity (as shown in item 6 above) and decomposition of aquatic vegetation causes fluctuations in dissolved oxygen that often violate Idaho water quality standards. In fact, oxygen deficits occur when "the amount of oxygen lost from the hypolimnion (the deeper, relatively cold, undisturbed region of the water column) during summer stratification not only increases with depth, but becomes increasingly depleted as the summer stratification period progresses (Wetzel 1975 [pp 137-141])." These conditions have resulted in the loss of native cold-water species (such as trout and white sturgeon) and have favored exotic and pollution tolerant species. As previously stated, hydroelectric projects do not add nutrients to the river. Instead nutrient processing is intensified and flushing of pollutants downstream is reduced. The impoundments behind the dams may have significant impacts on the ability of the river to process sediment and nutrients. Thus, the dams on the Middle Snake River (particularly Upper Salmon Falls and Lower Salmon Falls dams) have added to the water quality problems of the river in two ways: (1) the river's capacity to process nutrients has been altered to encourage plant growth, and (2) the reservoirs have created large shallows and areas of sediment deposition that are ideal for aquatic weeds. As part of the §401 Water Quality Certification for hydroelectric impoundments on the Middle Snake River under a consent order, the Idaho Power Company shall take certain specific actions to mitigate water quality impacts and achieve in conjunction with other proposed actions compliance with Idaho water quality standards.

8. The Middle Snake River dams have affected recreation by inundating or dewatering unique features such as cascades and rapids. Access to certain areas of the river have also become more difficult. According to the Idaho Department of Parks and Recreation, recreation impacts are not distinct from other categories of impacts because good water quality as well as fishing, hunting, and wildlife viewing opportunities are all essential components of recreation. Reasonable access to the river for a growing population and protection of the river's special attractions (including the remaining springs and waterfalls and the river itself) are key issues that have been impacted by the degraded water quality.

For the reservoirs the following additional sources provide water quality concerns and status of the indicated water body:

1. BLISS RESERVOIR

The water quality concerns and status of Bliss Reservoir are further substantiated in the *Idaho Power Company, New License Application for Bliss FERC Project No. 1975, 1995, pp. E2-17 to E2-20.* As prevously noted, this reservoir is listed for sediment, nutrients, dissolved oxygen, flow alteration, ammonia, and pathogens as pollutants and/or stressors of concern.

2. LOWER SALMON FALLS RESERVOIR

The water quality concerns and status of Lower Salmon Falls Reservoir are further substantiated in the *Idaho Power Company, New License Application for Lower Salmon Falls FERC Project No. 2061, 1995, pp. E2-17 to E2-20.* This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

3. UPPER SALMON FALLS RESERVOIR

The water quality concerns and status of Upper Salmon Falls Reservoir are further substantiated in the *Idaho Power Company , New License Application for Upper Salmon Falls FERC Project No. 2777, 1995, pp. E2-15 to E2-18.* Additionally, contract studies conducted on Upper Salmon Falls Reservoir indicate it is well mixed, nearly isothermal throughout the water column and along the longitudinal axis. Temperatures seldom vary by more than 1°C (ERI 1997). This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

4. SHOSHONE FALLS RESERVOIR

The water quality concerns and status of Shoshone Falls Reservoir are further substantiated in the *Idaho Power Company, New License Application for Shoshone Falls FERC Project No. 2778, 1997, pp. E2-1 to E2-15*; and, the *1983 Idaho Agriculture Pollution Abatement Plan*. Additionally, contract studies conducted on Shoshone Falls Reservoir indicate it is well mixed, nearly isothermal throughout the water column and along the longitudinal axis. Temperatures seldom vary by more than 1°C (ERI 1997). This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

5. TWIN FALLS RESERVOIR

The Twin Falls Reservoir is not specifically listed as a reservoir-segment on the 303(d) list, but it is included in the Middle Snake River segment (from Murtaugh to Twin Falls Reservoir). Several agency reports indicate that from Twin Falls Reservoir to Bliss Reservoir, the impoundments are exhibiting nonpoint source impacts from irrigated crop production and animal holding areas. Runoff from irrigated crop production, rangeland, pastureland, animal holding areas, feedlots, dredging, urban runoff from combined sewers and surface runoff, some construction, surface mining, land development, and its flow modification affect the watershed detrimentally. The Snake River between Bliss Reservoir and King Hill Dam is primarily impacted from irrigated crop production, rangeland, flow modification, and streambank modification (IDHW 1989b [p 37]). As a Middle Snake River segment it is listed for sediment, nutrients, dissolved oxygen, ammonia, and pathogens as pollutants and/or stressors of concern.

6. PIONEER RESERVOIR

Pioneer Reservoir is a man-made reservoir that is functions as a nonpoint source sink for the Clover Creek drainage prior to discharge to the Middle Snake River. It is highly affected by nonpoint sources of pollution. This reservoir is listed for sediment, nutrients, dissolved oxygen, flow alteration, ammonia, pathogens, and thermal modification as pollutants and/or stressors.

According to IDFG, "Upper Salmon Falls, Lower Salmon Falls, and Bliss Reservoirs have collectively inundated over 1055 acres of terrestrial and riverine habitat. Combined, the three reservoirs stretch over 12.6 miles of the Middle Snake River, inundating over 25 miles of riparian vegetation and associated uplands, with an estimated loss of 365 riparian species habitat units and 1320 upland species habitat units. In places where riparian vegetation has recolonized areas along reservoirs, it has been predominated by the non-native shrub, Russian Olive. Idaho Power Company has described the existing nongame bird community in detail and points out that bird densities average 22 times higher in riparian habitat than upland habitat, although no information is provided for comparing impounded versus unimpounded areas (FERC 1997b [Appendix A, pp 1, 3])."

Finally, the 1994 and 1996 §303(d) lists identified the level of benefical support status for various reservoirs and lakes in HUC 17040212. These are identified in Table 28.

TABLE 28 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR THE RESERVOIRS AND LAKES.

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
Bliss Reservoir	AG	CW/SS	PC/SC	
Lower Salmon Falls Reservoir	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 372.00)	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 373.00)	AG/CW	PC/SC		SS
Shoshone Falls Reservoir	AG/CW/PC/SC			SS
Twin Falls Reservoir	AG	PC/SC/CW/SS		
Murtaugh Lake	AG		PC/SC/CW/SS	
Pioneer Reservoir	AG	PC/SC/SS	CW	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning.

2.2.2.5 TRIBUTARIES

The results of the Idaho surveyed waters by USEPA for meeting state water quality standards within Upper Snake Rock for the aquatic life beneficial use show that about 1% of the waters are good, about 28% were threatened, about 51% were partially supporting, and about 19% were not supporting this benefical use (*www.epa.gov /surf/IWI/17040212/Drivers-us.html*). Water quality concern sources and the status for these tributaries are summarized in Table 29.

TABLE 29 LITERATURE SOURCES DEFINING WATER QUALITY CONCERNS FOR THE INDICATED WATER BODY

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Alpheus Creek	405.00	X		X		X			X	(X)	X	X	X

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Billingsley Creek	384 00	X	X	X		X	(X)		X	X	X	X	X
Blind Canyon Creek	389 00	X	X	X			(X)		X	(X)	X	X	X
Cedar Draw	397 00	X		X		X	X		X	(X)			X
Clear Springs	395.00	X	X	(X)	X		(X)		X	(X)	X	X	X
Clover Creek	379.00	X	X	X	X	X	X		X	(X)	X	X	X
Cottonwood Creek	403 00	X	X	X	X	X	(X)		X	(X)	X	X	X
Crystal Springs	398.00	X	X	X		X	(X)		X	(X)	X	X	X
Deep Creek	392-93	X		X		X			X	(X)			X
Dry Creek	408.00	X	X	X			(X)		X	(X)	X	X	X
Dry Creek, West Fork	411.00	X		X			(X)		X	(X)	X	X	X
McMullen Creek	404.00	X	X	X			(X)			(X)	X	X	X
Mud Creek	394.00	X		X			X		X	(X)			X
Riley Creek	385.00	X	X	X		X	(X)		X	(X)	X	X	X
Rock Creek	400.00	X	X	X		X	(X)		X	(X)	X	X	X
Sand Springs Creek*	386.00	X	X	X			(X)		X	(X)	X	X	X
Toolbox Creek													X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement*. (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program*. 91 = *1993 Idaho Agricultural Pollution Abatement Plan*. 92 = *1992 Idaho Water Quality Status Report*. 94 = *1994 Idaho Water Quality Status Report*. 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994*. 303(d) Listed Streams: 92 = *1992 §303(d) List*. X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C*. 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D*. 98 = 1998 §303(d) List. Sand Springs Creek is sometimes referred to as Thousand Springs Creek.

Additional sources beyond those identified in the previous table that define the cause of concern and status of the waterbody are referenced as follows:

1. BILLINGSLEY CREEK

In 1991 the IDFG responded to the then proposed reissuance of the NPDES aquaculture permits on seven aquaculture farms (002499-6; 002704-9; 002303-5; 000073-6; 002440-6; 002497-0; and 000086-8) on Billingsley Creek. In general, IDFG was concerned over the number of aquaculture facilities, such that cumulative impacts were being seen on Billingsley Creek. Sampling in Billingsley Creek indicated that a high percentage of fish were wild rainbow trout, wild brown trout, and hatchery rainbow trout (IDFG 1991). The water quality concerns and status of Billingsley Creek are further substantiated in the following reports: *IDHW, WQ Status Report No. WQ-21, Billingsley Creek (Gooding County), Problem Assessment; Billingsley Creek, NPDES Permits, 1991; IDHW, WQStatus Report No. 64, Billingsley Creek, 1984;* and, *IDHW, Upper Snake River Basin Status Report, 1991*. Historically, agricultural nonpoint sources have affected Billingsley Creek slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]).

2. CEDAR DRAW

The water quality concerns and status of Cedar Draw Creek are further substantiated in the following reports: *IDHW. Water Quality Status Report No. 100, 1991* and *IDHW, 1980. Channel Stability Evaluation for Cedar Draw.* It should be noted that IDAPA 16.01.02.280 identifies Cedar Draw as a "spillway. collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. It is not "exempt" from water quality regulations that recognize Cedar Draw as having designated beneficial uses (IDAPA 16.01.02.150[Map Code hh]). Historically, agricultural nonpoint sources affect Cedar Draw (from the source to the mouth) severely from irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 2]).

3. CLOVER CREEK

The water quality concerns and status of Clover Creek are further substantiated in the following field monitoring reports: (1) monitoring conducted by USBLM during 1993-1994 at the sites of Dry Creek, Bell Mare Creek, and Hog Creek indicate "that the water temperature standard established to support cold water biota will not support established beneficial uses, most notably cold water biota and salmonid spawning" because the water temperatures are too high. Macroinvertebrate sampling "...exhibited signs of low to moderate water quality impairment...Impairment appeared to be due to water quality limitations, primarily temperature and fine sediment. An analysis of the macroinvertebrate community...indicates water quality impairment is high. This impairment was due to both water quality limitations and physical habitat conditions. Water quality limitations include high water temperatures, and high levels of fine sediment deposition and nutrients (Lewis 1994);" and, (2) reconnaisance and monitoring in 1997 by IDEQ-TFRO indicated that the confluence was impacted by cattle grazing, irrigated agriculture, roads, and recreational dirt biking. Above the confluence to its headwaters, Clover Creek was principally covered by sagebrush/grassland with moderate to high cattle grazing. Sprinkler irrigated ground used the natural contour slope as drainage access for runoff. In both the USBLM and private ground, minimal fencing-off of cattle from the streams was evident. During the summer months, many filamentuous algae and long strands of macrophytes were evident in the stream. Stream embeddedness appeared to be very high in many stream areas. Headwater areas where seeps come out of the ground are generally trampled by cattle who seek out the more lush grasses for food. Riparian habitat was minimal or not evident, or where it exists it is impaired due to grazing. Embeddedness appears to be much higher in the private ground area and towards the confluence when compared to the headwaters area and the USBLM ground (Buhidar & Sharpnack 1997). Historically, agricultural nonpoint sources affect Clover Creek (from the source to the mouth) slightly for irrigated cropland and slightly for livestock grazing due to channel problems (ISCC 1979 [Table 3]).

4. COTTONWOOD CREEK

The water quality concerns and status of Cottonwood Creek are further substantiated in the 1997 reconnaisance and monitoring by IDEQ-TFRO. It indicated that the stream was still principally impacted by cattle grazing, followed by irrigated agriculture as pastureland and flow alteration/diversion. In many areas of Cottonwood Creek a dense riparian buffer zone prohibited intrusion by man or cattle. However, approximately 40% of the stream itself (beginning from the lower USBLM fenceline to its confluence with Rock Creek) is impaired due to cattle intrusion into the stream. Typically, you will find manure piles along the exposed banks and numerous cow trails leading in-and-out of the stream. Stream banks are uncovered and exposed. Embeddedness in the USBLM area averages less in the stream, while on the private ground (below the USBLM area) averages much more. Flow alteration due to diversion is a major factor and typically occurs

throughout the irrigation season (Buhidar & Sharpnack 1997). Cottonwood Creek does not go beyond the High Line Canal. What water appears below the High Line Canal is from seeps and springs. Also, the Twin Falls Canal Company uses Cottonwood Creek for emergency spills of canal water (USDA/SCS 1998).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of Cottonwood Creek, of which select results are summarized in the following TABLE 30 for samplings done in 1994. Of the three location sites on Cottonwood Creek, two were unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity, with two location sites being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids.

TABLE 30 PROPER FUNCTIONING CONDITION ASSESSMENT OF COTTONWOOD CREEK.

LOCATION ON COTTON WOOD CREEK	*TYPE OF STREAM*	*OVERALL HEALTH RATING*	*LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs*	*CHANNEL BOTTOM*	*STREAM BANK MATERIALS*	*ON-SITE HUMAN ACTIVITIES*
9400305	Intermittent	45.6% (Unhealthy)	0-80-40-10	30% Sand 10% Silt & Clay	40% Sand 20% Silt & Clay	90%/10% Grazing/Roads
9400303	Perennial	68.4% (Healthy w/problems)	0-90-40-40	30% Sand 3% Silt & Clay	60% Sand 20% Silt & Clay	97.5% Grazing
9400302	Perennial	53.3% (Unhealthy)	0.5-90-20-20	20% Sand 10% Clay	30% Sand 40% Silt & Clay	80%/20% Grazing/Roads

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

5. DEEP CREEK

The water quality concerns and status of Deep Creek are further substantiated in the *1983 Idaho Agriculture Pollution Abatement Plan.* It should be noted that IDAPA 16.01.02.280 identifies Deep Creek as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. Historically, agricultural nonpoint sources affect Deep Creek (from the source to the mouth) severely for irrigated cropland sediment and slightly for livestock grazing (ISCC 1979 [Table 3]).

6. DRY CREEK (MURTAUGH LAKE)

The water quality concerns and status of Dry Creek are further substantiated in the *IDHW, Idaho WQ Status Report on Dry Creek, 1979* and the *IDHW, Idaho WQ Status Report on Dry Creek, 1979.* Additionally, complaints in 1996 from various recreationists indicated that Murtaugh Lake was filled with nuisance aquatic plant growths due to impacts from cattle grazing along the shoreline of the lake. Site visitation by IDEQ-TFRO personnel verified that cattle grazing was in fact impacting the lake, eventually contributing to high levels of macrophyte growths throughout the lake. Fecal coliform bacteria samples taken at eight sites on the lake were below the primary contact recreation regulations: 136, <2, 14, <2, <2, 60, 100, and 10 estimated colonies/100 mL (sampled 7-30-1996), thus indicating that nuisance growth was probably due to excess nutrients (Cizmich *et al.* 1998).

USBLM/Burley District, Idaho has various annual reports in the 1980s that describe Dry Creek as to

its aquatic habitat and soil/water status. In 1980, Dry Creek was found to have "excellent" aquatic habitat: excellent streambank vegetation condition, streambank stability, and stream channel stability. The East Fork of Dry Creek was rated as "good" stream habitat with the possibility of improvement by stabilization of its streambanks. "Streambank instability along East Fork of Dry Creek and Middle Fork of Dry Creek primarily results during high streamflow which cuts into steep, exposed banks. These banks are cut in unstable alluvium, are easily undercut, and probably cannot be stabilized completely (USBLM 1980). Additionally, it was noted that portions of the Dry Creek system have a high potential to become unique aquatic habitats since the stream appears "to have good year-round flow for supporting fish." However, it was presently somewhat degraded due to livestock grazing nearby. "Its uniqueness could be improved substantially by preventing access by cattle except to selected areas which may be necessary for livestock watering (USBLM 1980)." In 1985, the monitored stream condition of Dry Creek was divided into the "high in the forks" and "from the forks to private ground." Table 31 summarizes the results.

TABLE 31 1985 DRY CREEK STREAM CONDITION.

STEAM NAME	*AQUATIC QUALITY*	*CHANNEL STABILITY*	*RIPARIAN CONDITION*	*FORAGE UTILIZATION*	*OVERALL STREAM CONDITION*	*WAYS TO IMPROVE CONDITION*
High in Forks	Good	Good	Excellent	40-59% Use	Good	Relieve cattle
Forks to Private	Good	Fair	Fair	40-59% Use	Fair	Plant beaver

Prepared by IDEQ-TFRO. Aquatic, Channel, Riparian, and Forage metrics based on USBLM water quality standards for appropriate fisheries and recreation (USBLM 1985a).

The spring of 1984 had unusual high flows, exceeding 200 cfs, and caused substantial damage to Dry Creek Ranch, destroying the road up the creek on Public land and devasting the bottom mile of BLM administered stream. Dry Creek is one of the few streams in the region supporting a native cutthroat trout fishery. Invertebrate samples collected in 1983 suggested a stream which had an abundant supply of sediment that may have a debilitating long term effect on the fishery if it is affecting the headwaters as it is farther down stream where samples were taken (USBLM 1985a). In 1986, the annual watershed monitoring report revealed that Dry Creek was "holding static and improving in deteriorated spots. The lower stretches of public land blown out so severely in the 1984 flood were stabilizing nicely with shrubs and forbs. The upper reaches, however, appeared to be in motion, indicated by consistent raw cutbanks and fallen undercut trees. This development was not attributed to a cattle-caused trauma (USBLM 1986). In 1987, annual watershed monitoring report revealed that Dry Creek was a "candidate" for most highly impacted stream of the year. It was recovering from the flood impacts of 1984 until it was "double whammied late last summer by heaving grazing and wild fire (USBLM 1987)." Additionally, Dry Creek went intermittant half-way through the canyon and dried up once on private land. Historically, agricultural nonpoint sources affect Dry Creek (from source to the mouth) slightly for irrigated cropland and slightly for livestock grazing (ISCC 1979 [Table 2]).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of Dry Creek of which select results are summarized in Table 32 for samplings done in 1994. Of the five location areas (two or three sites per area), only one site had an average healthy rating (with problems), while the rest were unhealthy: Lower Dry Creek was 65.9% healthy, Upper Cry Creek was 58.3% unhealthy, East Fork was 54.2% unhealthy, Middle Fork was 52.5% unhealthy, and West Fork was 57.2% unhealthy. Grazing was listed as the most predominant on-site human activity, with three location sites being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids, trees, and forbs.

TABLE 32 PROPER FUNCTIONING CONDITION ASSESSMENT OF DRY CREEK.

LOCATION ON DRY & MEDLEY CREEKS	TYPE OF STREAM	OVERALL HEALTH RATING	LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs	CHANNEL BOTTOM	STREAM BANK MATERIALS	ON-SITE HUMAN ACTIVITIES
Upper Dry Ck 9400082	Perennial	71.7% (Healthy w/problems)	30-90-30-10	10% Sand 0.5% Silt&Clay	30% Sand 0.5% Silt&Clay	97.5% Grazing
Upper Dry Ck 9400524	Perennial	53.3% (Unhealthy)	20-40-70-3	20% Sand 10% Silt & Clay	20% Sand 20% Silt & Clay	90%/10% Grazing/Roads
Upper Dry Ck 9400526	Intermittent	50% (Unhealthy)	40-60-60-40	3% Sand 0.5% Silt&Clay	10% Sand 20% Silt & Clay	97.5% Grazing
Lower Dry Ck 9400231	Perennial	65% (Healthy w/problems)	3-80-40-40	3% Sand 0.5% Silt & Clay	30% Sand 10% Silt & Clay	97.5% Grazing
Lower Dry Ck 9400145	Perennial	66.7% (Healthy w/problems)	60-60-50-0.5	10% Sand 3% Silt & Clay	10% Sand 20% Silt & Clay	80%/20% Grazing/Roads
East Fork 9400135	Perennial	41.7% (Unhealthy)	70-30-80-3	10% Sand 0.5% Silt & Clay	10% Sand 20% Silt & Clay	97.5% Grazing
East Fork 9400528	Perennial	66.7% (Healthy w/problems)	30-80-50-30	10% Sand 3% Silt & Clay	20% Sand 20% Silt & Clay	97.5% Grazing
Middle Fork 9400517	Perennial	58.3% (Unhealthy)	0.5-60-60-10	20% Sand 3% Silt & Clay	20% Sand 30% Silt & Clay	97.5% Grazing
Middle Fork 9400523	Perennial	46.7% (Unhealthy)	30-70-60-30	10% Sand 3% Silt & Clay	40% Sand 3% Silt & Clay	97.5% Grazing
West Fork 9400481	Intermittent	54.4% (Unhealthy)	0-40-50-10	20% Sand 10% Silt & Clay	20% Sand 20% Silt & Clay	97.5% Grazing
West Fork 9400516	Intermittent	60% (Healthy w/problems)	3-80-40-20	10% Sand 3% Silt & Clay	20% Sand 20% Silt & Clay	50%/50% Grazing/Roads

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor. Medley Creek has data with proper functioning condition ratings but is not included in this assessment.

7. MCMULLEN CREEK

In 1985, USBLM indicated that McMullen Creek's aquatic habitat was excellent, its channel stability was good, its reparian condition was good, its forage utilization was 40-59% use, and its overall stream condition was good. Suggestions indicated that opportunities to improve the existing situation included planting beavers to increase the water supply (USBLM 1985a). In 1986, the USBLM indicated that McMullen Creek was "improving via the dominance of woody riparian vegetation growing in otherwise absent sites, with beaver having a difficult time being established due to trappers. Livestock utilization at the Forest line on the creek can best be described as devastating. Stream stability starts on the BLM. This situation likely accounts for some of the high coliform counts sampled in years past when the livestock have been off BLM lands and 3 miles up stream on the

Forest (USBLM 1986)." In 1987, USBLM indicated that the stream was "continually improving due to changes in livestock management and diverse and vigorous woody vegetation with abundant regeneration." Beavers were still considered necessary for a "natural equilibrium" in the system, but persistent trappers kept erradicating them and high flows would eliminate their dams. The beaver were considered "the missing link in the recovery phase of McMullen Creek so as to store water to supplement late summer flows, encourage riparian shrubs to invade the dry perched flood plain, and develop a good sport fishery (USBLM 1987)."

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of McMullen Creek, of which select results are summarized in Table 33 for samplings done in 1994. Of the seven location sites on "Lower" McMullen Creek, six were unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity, with one location site being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids.

TABLE 33 PROPER FUNCTIONING CONDITION ASSESSMENT OF MCMULLEN CREEK.

LOCATION ON MCMULLEN CREEK	*TYPE OF STREAM*	*OVERALL HEALTH RATING*	*LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs*	*CHANNEL BOTTOM*	*STREAM BANK MATERIALS*	*ON-SITE HUMAN ACTIVITIES*
Lower 9400319	Intermittent	53.5% (Unhealthy)	3-90-30-10	20% Sand 10% Silt & Clay	60% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400318	Perennial	57.9% (Unhealthy)	0-90-10-10	30% Sand 3% Silt & Clay	50% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400315	Perennial	52.6% (Unhealthy)	0-90-40-20	30% Sand 3% Silt & Clay	50% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400314	Perennial	45.6% (Unhealthy)	0-80-3-3	10% Sand 3% Silt & Clay	40% Sand 10% Silt & Clay	97.5% Grazing
Lower 9400312	Intermittent	56.1% (Unhealthy)	0-97.5-20-10	20% Sand 3% Silt & Clay	50% Sand 20% Silt & Clay	80%/20% Grazing/Roads
Lower 9400310	Perennial	61.4% (Healthy w/problems)	0-80-30-20	10% Sand 0.5% Silt &Clay	30% Sand 20% Silt & Clay	97.5% Grazing
Lower 9400309	Intermittent	57.9% (Unhealthy)	0-97.5-30-20	20% Sand 10% Silt & Clay	40% Sand 20% Silt & Clay	97.5% Grazing

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

8. RILEY CREEK

The water quality concerns and status of Riley Creek are further substantiated in the *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*. Historically, agricultural nonpoint sources affect Riley Creek (from the source to the mouth) slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]). Traditionally, the creek meets all water quality standards except those for total and fecal coliform bacteria (IDHW 1977b [p 1]).

9. ROCK CREEK

The water quality concerns and status of Rock Creek are further substantiated in the 1997 reconnaisance and monitoring by IDEQ-TFRO. Monitoring done indicates that the major cause of sediment runoff into the stream is bank instability, particularly in areas where grazing and irrigated agriculture function to the edge of the creek without any buffer strips. IDAPA 16.01.02.280 identifies Rock Creek as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. Historically, agricultural nonpoint sources affect Rock Creek under two segments or waterbodies: from the source to Rock Creek Town, slightly for livestock grazing only; and, from Rock Creek Town to the mouth, severely for irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 2]).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of the Fifth Fork of Rock Creek, of which select results are summarized in Table 34 for samplings done in 1994. Of the two location sites on the Fifth Fork of Rock Creek, one was unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity. Lifeform canopy covers were predominantly shrubs followed by graminoids, and then forbs.

TABLE 34 PROPER FUNCTIONING CONDITION ASSESSMENT OF FIFTH FORK OF ROCK CREEK.

LOCATION ON ROCK CREEK	*TYPE OF STREAM*	*OVERALL HEALTH RATING*	*LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs*	*CHANNEL BOTTOM*	*STREAM BANK MATERIALS*	*ON-SITE HUMAN ACTIVITIES*
Fifth Fork 9400323	Perennial	73.7% (Healthy w/problems)	0-80-50-60	10% Sand 10% Silt & Clay	20% Sand 30% Silt & Clay	97.5% Grazing
Fifth Fork 9400326	Perennial	57.9% (Unhealthy)	0-70-50-40	0.5% Sand 3% Silt & Clay	10% Sand 0.5% Silt &Clay	97.% Grazing

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

More recently, Rock Creek has had "bacteria contamination" postings from District Health at the Rock Creek Park in Twin Falls, Idaho due to elevated levels of fecal coliform above the primary and secondary recreational water quality standards. These elevated levels have been investigated by IDEQ-TFRO, and it has been found that the major sources include: (1) runoff from fields where manure has been applied; (2) grazing, where animals are allowed to urinate or defecate in the stream or associated streams; (3) septic systems that are unmaintained and which have direct or indirect discharge as sewage and otherwise; and, (4) runaway sewage from the City of Twn Falls municipality due to operational or maintenance problems. These are not the only sources, but they are the most visible. Other sources (and not as visible) may include: unmaintained septic systems in the rural areas wthat have a linkage to a canal drain or stream; over application of manure in land areas affected readily by stgorm events outside the imediate boundary of the suspected zone-of-impact, but which have a linkage via a canal or ag drain to Rock Creek; and, Mother Nature's animals-in-the-wild which are known to urinate and defecate in streams or near streams. This problem as shown by the bacteria data collected by IDEQ-TFRO since 1990 (and before) has been more prevalent during the irrigation season. As a consequence of the public concerns the IDEQ-TFRO, the Mid-Snake WAG, and the Mid-Snake TAC has formed a task force with other local groups that will be providing technical assistance to the private land owners through education and an understanding of the application of voluntary best management practices.

10. BOX CANYON CREEK AND BLUE HEART SPRINGS

The Box Canyon Area of Critical Environmental Concern (as previously discussed in §2.1.3.6) is a nesting ground for the following endangered or threatened species. The Box Canyon Creek is habitat for the Shoshone Sculpin (*Cottus greenii*). The stable aquatic temperatures and chemistry support the largest known population of Shoshone Sculpin on public lands, and the third largest known population in the world. Few are known to exist upstream on private land. Box Canyon Creek also contains populations of three endangered molluscs: the Bliss Rapids snail, the giant Columbia River limpet, and the Utah valvata. Additionally, Box Canyon Creek provides feeding areas for furbearers and game fish. The riparian areas are important for non-game birds particularly during the winter months (USBLM 1985b [p 1-2]).

Blue Heart Springs is a large, aqua blue, cold, clear water spring emerging from the Snake River Canyon. It supports the fourth largest known population of Shoshone sculpin. It is surrounded by riparian vegetation and talus rock which makes physical access difficult, thus protecting the area from heavy disturbance. Blue Heart Springs is "protected" because the Idaho Department of Parks and Recreation holds a water right of 100 cfs for the people of Idaho (USBLM 1985b [p 3-4]). About 26.2 acres of public (federal) land is managed by the U.S. Bureau of Land Management as an Area of Critical Environmental Concern for four threatened or endangered species (Bliss Rapids snail, Utah Valvata snail, Banbury Springs lanx, Snake River physa), and a species-of-special-concern (Shoshone sculpin), and the scenic and unique natural qualities of the area. The area provides recreation, hunting, fishing, and aesthetics for human visitors plus an array of habitats for resident and migrating wildlife species. The land includes a portion of Box Canyon Creek, the entire Blue Heart Springs and its riparian habitat along the Middle Snake River, and 87.1 acres of land above the canyon rim (USBLM 1985b). Approximately 300 cfs of Box Canyon Creek are diverted and piped under the Middle Snake River to a fish propagation facility (Clear Springs Foods, Inc.) located on the south side of the river. The same 300 cfs serves as a small hydro project (Mantech Inc./B.C. Hydro Ltd.) at the outflow of the hatchery.

A study conducted by D.W. Taylor in 1985 as a survey of Box Canyon Creek for molluscs indicated that several populations of living Bliss Rapids snails and Utah Valvata snails along with shell deposits containing numerous specimens of the Bliss Rapids snail and several shells of the Giant Columbia River Limpet were found. Many of the shells were heavily eroded, indicating that these animals had once experienced heavy sediment load exposure, an unusual occurrence in this canyon-enclosed, spring-fed watershed with virtually no turbidity or suspended solids and little naturla sediment load. The surveys showed that a recent extensive deposit area in a natural pool on public land supported a healthy population of Utah Valvata snail, while causing a severely adverse impact to the Bliss Rapids snail by reducing its habitat and also probably that of the Giant Columbia River Limpet (Lanagenstein *et al.* 1989 [p 4]).

11. CRYSTAL SPRINGS LAKE

Nutrients in the ground water, hatchery wastewater discharges, and from the deposited organic sediments promote extensive growths of aquatic plants and algae. Aesthetics, recreational uses, and salmonid spawning are impaired by the organic deposits (USBLM 1985b [p. 1-2]) A 1990 restoration study indicated that Crystal Springs Lake "should be considered an endangered resource as it represents one fo the few remaining spring areas in the Thousand Springs reach of the Snake River that is in the public domain and available for public use and enjoyment (IDHW 1990 [p 1])." Data collected by IDHW-IDEQ in its restoration study showed: (1) nitrate-nitrogen levels exceeded the 0.3 mg/L criterion and ranged from 2.28 to 2.40 mg/L, and reflected elevated nitrate-nitrogen levels in the groundwater feeding the lake; (2) total phosphorus levels generally exceeded the 0.100 mg/L criterion

and ranged from 0.160 to 0.250 mg/L with a groundwater background level of <0.050 mg/L. (3) fecal coliform densities were quite variable, but geometric means were all below the 50/100 mL standard with exceedences only occuring in the hatchery effluent as *Streptococcus faecalis*. Coliform bacteria in the hatchery effluent likely arose from contamination of the spring source or fish feed, since fish do not have a permanent coliform flora in their intestinal tracts; and, (4) solids/sediment organic loadings ranged from 4 to 8 mg/L with an average loading of 2200 lbs/day (flow being 73.6 cfs) (IDHW 1990 [pp 8-19]).

Recreational use of the lake is confined to bank fishermen who fish from the hatchery outfall structure or lake outlet bridge area. Individuals attempt to access the lake to fish along the south shore between these two locations. The IDPR has received complaints from individuals regarding sludge accumulations and macrophyte growths along this side of the lake. These solids release offensive odors when disturbed, and they physically threaten the elderly or children who attempt to wade out into the lake to enjoy this resource. The sediments of the lake contain a mean TKN level of about 930 mg/L. Highest sediment TKN (like TP) levels were measured in sediments collected near the hatchery outfall and on the south side of the lake. Methane and hydrogen sulfide production, in addition to a black color, indicate lake sediments to be decomposing anaerobically (IDHW 1990 [p 26, 35]).

12. BLIND CANYON

The water is largely diverted to commercial fish-rearing ponds. Most of the inner canyon has been developed for fish propagation. Much of the original spring ecosystem has been altered by water diversion for fish production and establishment of fish hatcheries in the canyon. Associated unique wildlife probably has disappeared (IPC 1998).

13. BRIGGS SPRINGS CREEK

The property adjacent to Briggs Springs is mainly used for livestock grazing. Briggs Springs itself is severely impacted by small hydro-development and fish hatchery operations. The undeveloped portions of the property are grazed by livestock, causing local impacts to the vegetation, particularly wetlands. Nearly one-third of the spring flow is diverted to a small fish farm. After passing through this facility, water is returned to one of the original lower elevation stream channels. About two-thirds (70 to 120 cfs) of the spring water is diverted to a private small hydro plant (Briggs Creek Project, FERC No. 4360-001) which began operation in 1989. Water diversion destroyed riparian habitats associated with the springs. As a result of complete dewatering, the *Forested Wetland* vegetation was ultimately destroyed. From the point where hatchery water reenters the stream bed, vegetation remains viable. At the point of entry, there is a 30 cfs minimum stream flow held of the State of Idaho (IPC 1998).

14. PERRINE COULEE SYSTEM

Water quality in the Perrine Coulee System is impacted by irrigated agriculture, livestock operations, aquaculture, wastewater discharges, hydropower development, urban development, and recreation. Water from the Perrine Coulee System enters the Middle Snake River at five main branches and contributes to water quality problems within the river. Primary pollutants of concern are sediment, nutrients, pathogens, and pesticides. The majority of sediment within the Perrine Coulee System and potentially being delivered to the Middle Snake River originates on the surface (furrow) irrigated cropland. Sheet and rill erosion do not contribute significantly, making irrigation-induced erosion on surface (furrow) irrgated clean tilled cropland the significant contributor. Excess tillage, lack of adequate surface residue (from growing low residue crops), soil compaction, and poor irrigation water

management practices all contribute to the resource problems. Overall, sediment loading is greatest from the East Perrine Coulee, although there appears to be some indication that this load has been reduced since 1985. Total phosphorus (predominantly as a sediment-bound species) were frequently above the concentration recommended for water quality protection. Nitrogen, although it does not appear to present a serious water quality problem within the Perrine Coulee System, does deliver relatively high loads to the Middle Snake River. Pathogens pose a potential health risk to humans recreating in and around the Perrine Coulee "tributaries" (SRSCD 1998).

15. VINYARD CREEK

As previously described, there is a channel carrying irrigation return water that enters Vinyard Creek approximately midway between the waterfall and the confluence with Twin Falls Reservoir. IDEQ-TFRO has reported that a peak discharge for the irrigation return channel of 14.8 cfs in 1986, and an annual deposition of approximately 707 metric tons of sediment into the Twin Falls Reservoir (IDHW 1989a). This cannel was re-routed in 1996 by constructing a rock and earthen embankment at the inflow of the pipe in order to pool the irrigation return water for re-route into the pipe (IPC 1997b [p 4]). At the point where the historical creek channel and the irrigation return joined has been re-routed so that Vinyard Creek discharges water from Vinyard Lake only. And the irrigation return discharges only irrigation return water to Twin Falls Reservoir just downstream from when Vinyard Creek discharges accordingly. Fish species collected by IPC biologists in 1996 included: cutthroat trout, rainbow trout, rainbow-cutthroat trout hybrid, speckled dace, reside shiner, Utah sucker, and mottled sculpin (IPC 1997b [p 4]). Vinyard Creek has historically supported a unique population of cutthroat trout. Additionally, the stream has likely provided a spawning, rearing, and adult habitat for cutthroat trout, rainbow trout, and rainbow-cutthroat trout hybrids (IPC 1997b [p 4]).

Finally, the 1994 and 1996 §303(d) lists identified the level of benefical support status for various tributaries in HUC 17040212. These are identified in Table 35.

TABLE 35 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR TRIBUTARIES.

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING	NOT ASSESSED
DEEP CREEK					
Deep Ck (Low Line Canal to SR)	AG	PC/SC	CW/SS		
Deep Ck (HW to LowLineCanal)	AG	PC/SC	CW/SS		
MUD CREEK					
Mud Ck (T09SR14ES33 to SR)	AG	PC/SC	CS/SS		
Mud Ck (HW to T09SR14ES33)	AG	PC/SC	CW/SS		
ROCK CREEK					
Rock Ck (Cottonwood Ck to SR)	AG	PC/SC	CW/SS		
Rock Ck (5th Fork to McMullen Ck)	AG		CW/SS/PC/SC		
MCMULLEN CREEK					
Cottonwood Ck to Rock Ck	AG	PC/SC/CW/SS			
Donahue Ck to N. Cottonwood Ck	AG	PC/SC/CW		SS	
HW to Donahue Ck	AG	PC/SC/CW	SS		

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING	NOT ASSESSED
COTTONWOOD CREEK & NORTH COTTONWOOD CREEK					
McMullen Ck to N Cottonwood Ck	AG	PC/SC	CW	SS	
HW to Dry Cottonwood Ck	AG	PC/SC	CW	SS	
DRY CREEK					
Murtaugh Lake to SR	AG	PC/SC/CW/SS			
EF Dry Creek to Murtaugh Lake	AG	PC/SC	CW/SS		
NF Dry Creek to EF Dry Creek	AG	PC/SC	CW/SS		
HW to WF Dry Creek	AG	PC/SC	CW/SS		
HW to Dry Creek	AG	PC/SC	CW/SS		
HW to MF Dry Creek	AG	PC/SC	CW/SS		
CLOVER CREEK					
Dry Creek to SR	AG	PC/SC/CW/SS			
Pioneer Reservoir to Dry Creek	AG	PC/SC/CW/SS			
Calf Creek to Pioneer Reservoir	AG	PC/SC/CW/SS			
T4SR13ES31 to Calf Creek	AG	PC/SC/CW/SS			
Cottonwood Ck to T4SR13ES31	AG	PC/SC/CW/SS			
Squaw Creek to Catchall Creek	AG	PC/SC/CW/SS			
Deer Creek to Squaw Creek	AG	PC/SC/CW/SS			
HW to Deer Creek	AG	PC/SC/CW/SS			
Catchall Ck to Cottonwood Creek	AG	PC/SC/CW/SS			
OTHER TRIBUTARIES					
Niagara Springs (T9SR15ES11)	DW		PC/SC/CW/SS		
Crystal Springs (T9SR15ES12)			AG/PC/SC/CW /SS		
Cedar Draw (HW to SR)	AG	PC/SC/CW/SS			
Billingsley Creek (HW to SR)	AG/DW	PC/SC/CW/SS			
Cedar Draw Ck (HW to SR)	AG				CW/SS/PC/ SC
Perrine Coulee (Low Line Canal to SR)	AG	PC/SC/CW		SS	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. SR = Snake River. HW = Headwaters. Ck = Creek. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning. EF = East Fork. WF = West Fork. NF = North Fork. Lk = Lake.

2.2.2.6 BENEFICIAL USE RECONNAISSANCE PROJECT DATA

In addition to the data previously described in §2.2.1.1 through §2.2.1.4, information was collated from the Beneficial Use Reconnaissance Project (BURP) in the Twin Falls Regional Office of IDEQ for the streams on the §303(d) list. TABLES 37 and 38 provide an indication of why these streams are not fully supporting their beneficial uses. Dry streams are not included. Also, the ecoregional geographic area is the Snake River Basin/High Desert. Although traditional water quality monitoring for chemical parameters has its benefits, biomonitoring (as BURP) goes beyond the chemistry and centers on the ecological status of the beneficial use (IDEQ 1998). The process used to assess the beneficial use support encompasses both a chemical and a biological process known as IDEQ's Bioassessment Process. BURP by itself is the monitoring protocol. The interpretation of the BURP data for determination of beneficial support status is known as the Waterbody Assessment process. TABLE 36 describes the BURP location sites.

TABLE 36 SITE NUMBER, LATITUDE AND LOGITUDE FOR EACH OF THE BURP SITES.

TRIBUTARY	*SITE No.*	*LATITUDE*	*LONGITUDE*	*TOWNSHIP/RANGE/SECTION*
Billingsley Creek	9423	42°48'1.79"	114°52'8.42"	T 075 R 13E S 19
	9424	42°47'15.09"	114°51'54.74"	T 07S R 13E S 11
	9441	42°47'14.72"	114°51'55.36"	T 07S R 13E S 30
Clover Creek	9510	43°0'3.70"	115°9'13.75"	T 05S R 11E S 09
	9511	42°59'55.00"	115°3'0.00"	T 05S R12E S 08
Cottonwood Creek	9661	42°26'3.41"	114°23'26.73"	T 11S R 18E S 30
Cottonwood Creek, North	9409	42°18'46.46"	114°25'36.42"	T 13S R 17E S 11
	9603	42°19'52.03"	114°25'34.81"	T 13S R 17E S 02
Deep Creek	9647	42°37'51.72"	114°50'35.14"	T 09S R 13E S 20
Dry Creek	9512	42°22'4.63"	114°11'18.05"	T 12S R 19E S 24
	9513	42°28'30.00"	114°8'40.00"	T 11S R 20E S 07
Dry Creek, East Fork	9630	42°20'53.29"	114°12'7.93"	T 12S R 19E S 26
	9647	42°17'54.62"	114°9'9.88"	T 13S R 20E S 18
McMullen Creek	9532	42°14'37.87"	114°25'15.57"	T 13S R 17E S 36
Riley Creek	9503	42°45'34.49"	114°51'26.14"	T 08S R 13E S 01
	9539	42°45'49.17"	114°51'50.59"	T 08S R 13E S 06
Rock Creek, Above (Headwaters to Rock Creek Town)	9439	42°23'91.60"	114°18'32.20"	T 12S R 18E S 13
	9531	42°18'1.85"	113°15'17.88"	T 13S R 19E S 17
	9543	42°22'1.18"	114°18'16.05"	T 12S R 18E S 13
Rock Creek, Below (Rock Creek Town to Confluence with Snake River)	9558	42°35'38.90"	114°31'48.11"	T 09S R 16E S 36
	9559	42°34'2.87"	114°30'15.78"	T 10S R 17E S 08
	9560	42°27'15.35"	114°21'45.94"	T 11S R 18E S 21
	9561	42°33'40.67"	114°29'22.28"	T 10S R 17E S 17

TRIBUTARY	SITE No.	LATITUDE	LONGITUDE	TOWNSHIP/RANGE/SECTION
Tool Box Creek	9557	43°13'49.78"	114°19'3.72"	T 14S R 18E S 11
Prepared by IDEQ-TFRO				

Table 37 describes portions of the BURP data for the indicated waterbody.

TABLE 37 SELECTED STREAM CHARACTERISITICS FROM DEQ-TFRO METHODOLOGY.

WATERBODY NAME	SITE IDENTIFICATION	FLOW cfs	VALLEY TYPE	SINUOSITY	FINES	EMBEDDEDNESS	BANK VEGETATION	LOWER BANK STABILITY	ROSGEN STREAM TYPE
Alpheus Creek	No BURP data available.								
Billingsley Creek	9424	46.50	TL	Moderate	23	9	10	10	-
	9441	6.40	TL	Moderate	90	15	10	9	-
	9423	30.40	TL	Moderate	62	8	10	9	-
Blind Canyon Creek	No BURP data available.								
Cedar Draw Creek	No BURP data available.								
Clear Springs	No BURP data available.								
Clover Creek	9510	20.20	US	Low	64	4	8	8	C
	9511	1.05	TL	Braided	42	11	8	9	C
Cottonwood Creek	9661	4.36	FB	High	80	0	10	10	G
Cottonwood Creek, North	9409	0.40	TL	Moderate	47	10	9	9	-
	9603	4.00	VS	Moderate	32	7	4	1	B
Crystal Springs	No BURP data available.								
Deep Creek	9647	75.32	FB	Moderate	32	0	9	10	C
Dry Creek	9513	3.90	US	Moderate	61	7	9	2	C
	9512	16.20	VS	Braided	41	10	7	9	B

WATERBODY NAME	SITE IDENTIFICATION	FLOW cfs	VALLEY TYPE	SINUOSITY	FINES	EMBEDDEDNESS	BANK VEGETATION	LOWER BANK STABILITY	ROSGEN STREAM TYPE
Dry Creek, East Fork	9630	2.50	VS	Moderate	9	18	7	9	B
Dry Creek, West Fork	9647	0.50	VS	Moderate	6	13	2	3	A
McMullen Creek	9532	7.80	TL	Moderate	100	0	9	9	C
Mud Creek	No BURP data available.								
Riley Creek	9503	1.40	FB	Low	91	2	10	9	A
	9539	58.01	TL	Moderate	70	11	10	10	C
Rock Creek, Above (Headwaters to Rock Creek Town)	9439	5.22	FB	High	53	13	8	6	-
	9543	13.60	FB	High	20	5	8	5	B
	9531	24.00	YS	Moderate	34	15	8	10	B
Rock Creek, Below (Rock Creek Town to Confluence with Snake River)	9560	16.70	BC	Moderate	46	16	6	6	C
	9559	193.0	BC	Moderate	44	6	6	8	C
	9558	>200	BC	Low	43	7	8	10	-
	9561	138.8	BC	Moderate	49	6	10	9	C
Tool Box Creek	9557	0.50	TL	Moderate	50	10	8	9	A

Prepared by IDEQ-TFRO: Site Id. = BURP Site Identification for the specific year; Valley Types: FB = Flat Bottomed, TL = Trough Like, YS = Y-Shaped, US = U-Shaped, VS = V-Shaped,BC = Box Canyon; F = % Fines (<6 mm diameter): Optimal = <10, Suboptimal = 10-30, Marginal = 30-50, Poor = >50; E = Embeddedness Score: Optimal = 16-20, Suboptimal = 11-15, Marginal = 6-10, Poor = 0-5; BVP = Bank Vegetation Protection Score: Optimal = 9-10, Suboptimal = 6-8, Marginal = 3-5, Poor = 0-2; LBS = Lower Bank Stability Score: Optimal = 9-10, Suboptimal = 6-8, Marginal = 3-5, Poor = 0-2; R = Rosgen Stream Type. The flow parameter is noted as one of the prinicple abiotic factors shaping stream ecosystems (Minshall 1993). The Valley Type parameter is a characterization of the dominant shape of the "valley" in which the stream is located. Sinuosity is a parameter measure of the straightness of the channel. Fines is a fraction of the substrate less than 6.00 mm in diameter as an ocular estimate of the percentage of bottom substrate that is fine material. Embeddedness is the degree to which boulders, rubble, or gravel are surrounded by fine sediment and indicates the suitability of the stream substrate as habitat for benthic macroinvertebrates and fish spawning and egg incubation. Bank vegetation protection is an estimate of bank vegetation covering the bank and provides an indication of bank stability and potential instream sedimentation. Lower bank stability is rated by observing existing or potential detachment of soil from the lower streambank and its potential movement into the stream (IDEQ 1996 [pp 55-58]).

Rosgen stream type deal with the broad-level description of a major stream type. These are labeled A through G and have the following Level 1 descriptions, as show in Table 38.

TABLE 38 MODIFIED ROSGEN GEOMORPHIC CHARACTERIZATION OF STREAM TYPES (LEVEL 1).

STREAM TYPE	DESCRIPTION	ENTRENCHMENT RATIO	W/D RATIO	SINUOSITY	SLOPE
A	Steep and entrenched	<1.4	<12	1.0 - 1.2	0.04 - 0.10
B	Moderately entrenched	1.4 - 2.2	>12	>1.2	0.02 - 0.039
C	Low gradient	>2.2	>12	>1.4	<0.02
G	Entrenched "gully"	<1.4	<12	>1.2	0.02 - 0.039
Prepared by DEQ-TFRO after Table 4-1, p. 4-5, of *Applied River Morphology* by Dave Rosgen					

The bioassessment process of these streams considers major numeric standard exceedence (such as temperature) if data is present, Macroinvertebrate Biotic Index, Reconnaissance Index of Biotic Integrity, Algal Biotic Index, and Habitat Index in hierarchical sequence. IDEQ uses the Macroinvertebrate Biotic Index (MBI) as a normalized multimetric index (made up of seven metrics) which include: Hilsenhoff Biotic Index (HBI); Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); Percent Ephemeroptera, Plecoptera, and Trichoptera (%E); Taxa Richness (TAX); % Scrapers (%SC); % Dominance (%D); and, Shannon's H'Diversity Index (SHW). See the IDEQ1996 reference for more detailed information.

For a site support status (SiteSupStat) for a specific site, an MBI score of < 2.50 indicates the water body is Not Fully Supporting (NFS) its beneficial uses. An MBI score in range 2.50 to 3.50 indicates the water body Needs Verification (NV) on its beneficial uses, and results in the waterbody assessment process looking at other indicators (like RIBI or HI) to determine the status of site support. An MBI score > 3.50 indicates the water body is Fully Supporting (FS) its beneficial uses. The lowest MBI score would be NFS, followed by NV, and then FS. An additional metric used by IDEQ is the Habitat Index (HI) to assess cold and warm water biota beneficial uses for wadable streams for the Snake River Basin/High Desert. In the Snake River Basis ecoregion, an HI score of < 34 indicates the habitat is impaired. An HI score in the range from 34 to 66 indicates the habitat needs verification. An HI score > 66 indicates the habitat is not impaired. For the overall support status (OverSupStat) for the entire segment or water body, the lowest SiteSupStat in a group becomes the OverSupStat for the stream. For example, Billingsley Creek has three SiteSupStat on three segments: NFS, NV, and NV. The OverSupStat would be the lowest SiteSupStat of the three, which would be NFS.

TABLE 39 BIOASSESSMENT OF BURP DATA OF 303(d) LISTED WATER BODIES.

NAME	SITE	IDEQ MULTIMETRIC INDICES HBI	EPT	%E	TAX	%SC	%D	SHW	MBI	HI	Site Sup Stat	Over Sup Stat
Billingsley Creek	9441	0.41	0	0	0.24	0.79	0.45	0.45	2.39	54	NFS	NFS
	9424	0.48	0.09	0.09	0.24	1.00	0.31	0.33	2.56	97	FS	
	9423	0.55	0.03	0.05	0.29	0.55	0.74	0.57	2.85	82	NV	
Clover Creek	9511	0.39	0.06	0.03	0.45	0.37	0.87	0.71	2.88	73	NV	NV
	9510	0.61	0.12	0.49	0.38	0.01	0.79	0.63	3.03	70	NV	
Cottonwood Creek	9661	0.61	0.15	0.14	0.36	0.01	0.30	0.36	1.83	54	NFS	NFS
Cottonwood Creek North	9409	0.83	0.38	0.64	0.67	0.24	1.00	0.97	4.73	92	FS	FS
	9603	0.88	0.35	0.92	0.50	0.47	0.70	0.59	4.41	65	FS	

NAME	SITE	IDEQ MULTIMETRIC INDICES HBI	EPT	%E	TAX	%SC	%D	SHW	MBI	HI	Site Sup Stat	Over Sup Stat
Deep Creek	9647	0.63	0 09	0.02	0.21	0	0 05	0 08	1.08	63	NFS	NFS
Dry Creek	9512	0.74	0.29	0.76	0.45	0.21	0.54	0 60	3.59	98	FS	NFS
	9513	0.59	0.12	0.05	0.29	0.01	0.70	0.50	2.26	66	NFS	
Dry Creek East Fork	9630	0.86	0.82	0.64	0.98	0.62	0.93	0 91	5.76	133	FS	FS
Dry Creek WestFork	9647	0.79	0.56	0.53	0.64	0.32	0.98	0.87	4.69	110	FS	FS
McMullen Creek	9532	0.50	0.09	0.07	0.55	0.01	0.57	0.50	2.29	45	NFS	NFS
Riley Creek	9539	0.33	0.12	0.01	0.36	0.79	0.48	0.42	2.83	85	FS	NFS
	9503	0.50	0.06	0.03	0.31	0.04	0.18	0.26	1.23	95	NFS	
Rock Creek (Headwaters to Rock Creek Town)	9439	0.09	0.38	0.69	0.76	0.36	0.87	0.74	4.78	98	FS	FS
	9531	0.92	0.53	0.72	0.76	0.62	0.98	0.86	5.39	103	FS	
	9543	0.84	0.41	0.70	0.60	0.35	0.96	0.88	4.94	95	FS	
Rock Creek (Rock Creek Town to Confluence with Snake River)	9561	0.92	0.12	0.07	0.21	1.14	0.15	0.20	2.81	85	NV	NFS
	9560	0.66	0.18	0.33	0.33	0.69	0.60	0.53	3.32	96	FS	
	9559	0.83	0.18	0.08	0.29	1.19	0.12	0.19	2.88	67	NFS	
	9558	0.58	0.21	0.15	0.40	1.01	0.26	0.33	4.69	91	NFS	
Toolbox Creek	9557	0.58	0.24	0.12	0.33	0	0.26	0.30	1.83	77	NFS	NFS

Prepared by IDEQ-TFRO. SITE = Site Identification by Year and Segment Number (YYNN). SiteSupStat = Site Support Status (for a specific site). OverSupStat = Overall Support Status (for the entire segment or water body).

As of this writing, the protocols for large rivers (Middle Snake River), lakes and reservoirs had not been completed. They are still under development and will be included at a later time.

2.2.3 APPLICABLE BENEFICIAL USES AND WATER QUALITY STANDARDS

Designated beneficial use(s) or designated use(s) are defined by IDAPA 16.01.02.003 (24) as "those beneficial uses assigned to identified waters in Idaho Department of Health and Welfare Rules, Title 01, Chapter 02, 'Water Quality Standards and Wastewater Treatment Requirements,' Sections 110 through 160 and 299, whether or not the uses are being attained." Those designated uses include: domestic water supply, agricultural water supply, cold water biota, warm water biota, salmonid spawning, primary contact recreation, secondary contact recreation, and special resource water. Existing beneficial use(s) or existing use(s) are defined by IDAPA 16.01.02.003 (35) as "those beneficial uses actually attained in waters on or after November 28, 1975, whether or not they are designated for those waters in Idaho Department of Health and Welfare Rules, Title 01, Chapter 02, 'Water Quality Standards and Wastewater Treatment Requirements.'" As part of their statutory defined duties, the basin advisory group shall make "revisions in the beneficial uses designated for each stream and the status and attainability of designated or existing beneficial uses for the water bodies within the basin (Idaho Code 39-3614)." "In determining whether a water body fully supports designated and existing beneficial uses," the IDEQ "shall determine whether all of the applicable water quality standards are being achieved, including any criteria developed pursuant to IDAPA rules, and whether a healthy, balanced biological community is present (IDAPA 16.01.02.053)." "Beneficial uses impaired by

nonpoint source pollution include cold water biota (trout, salmon, and other aquatic organisms), salmonid (trout and salmon) spawning and primary (swimming) and secondary (wading) contact recreation (IDHW 1991b)."

2.2.3.1 APPLICABLE DESIGNATED BENEFICIAL USES

Applicable designated beneficial uses (as designated by the State Legislature through negotiated rulemaking based on recommendations provided by IDEQ via the Board of IDHW) are described in Table 40. Undesignated surface waters are protected under IDAPA 16.01.02.101(01).

TABLE 40 DESIGNATED BENEFICIAL USES OF WATERBODIES IN UPPER SNAKE ROCK

STREAM NAME	BOUNDARIES	BENEFICIAL USES							
		Ag	D	CW	WW	SS	PC	SC	RW
TRIBUTARIES									
Alpheus Creek	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Billingsley Creek	From headwaters to the Snake River	X	X	X		X	X	X	X
Blind Canyon Creek	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Cedar Draw	From headwaters to the Snake River	X		X		X		X	
Clear Springs	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Clover Creek	From headwaters to the Snake River	X		X		X	X	X	
Cottonwood Creek	From headwaters to Rock Creek	*IDAPA 16.01.02.101.01*							
Crystal Springs	From headwaters to Snake River	*IDAPA 16.01.02.101.01*							
Deep Creek	From headwaters to Snake River	X		X		X		X	
Dry Creek	From Medley Creek to Snake River	X		X		X		X	
Dry Creek	From headwaters to Medley Creek	X		X		X		X	
Dry Creek, West Fork	From headwaters to Dry Creek	X		X		X		X	
McMullen Creek	From headwaters to Cottonwood Creek	*IDAPA 16.01.02.101.01*							
Mud Creek	From Deep Creek road to Snake River	X		X		X		X	
Riley Creek	From headwaters to Snake River	X	X	X		X	X	X	X
Rock Creek	From headwaters to Rock Creek Town	X	X	X		X	X	X	X
Rock Creek	From Rock Creek Town to Snake River	X		X		X	*	X	
Sand Springs Creek	From headwaters to Snake River	*IDAPA 16.01.02.101.01*							
Tool Box Creek	From headwaters to Fifth Fk Rock Creek	*IDAPA 16.01.02.101.01*							
RESERVOIRS									
Bliss Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							
Lower Salmon Falls Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							

STREAM NAME	BOUNDARIES	BENEFICIAL USES Ag	D	CW	WW	SS	PC	SC	RW
Pioneer Reservoir	The entire reservoir	*IDAPA 16 01 02 101 01*							
Shoshone Falls Reservoir	The entire reservoir	*IDAPA 16 01 02 101 01*							
Upper Salmon Falls Reservoir	The entire reservoir	*IDAPA 16 01 02 101 01*							
ON THE MIDDLE SNAKE RIVER: *(1) Snake River - Milner Dam to Buhl (IDAPA 16.01.02.150.01)* *(2) Snake River - Buhl to King Hill (IDAPA 16.01 02.150.01).*									
Middle Snake River	From Milner Dam to Murtaugh *(1)*	X		X		X	X	X	
Middle Snake River	From Cedar Draw to Rock Creek *(1)*	X		X		X	X	X	
Middle Snake River	From Clear Lakes Bridge to Cedar Draw *(1)*	X		X		X	X	X	
Middle Snake River	From Deep Creek to Mud Creek *(1)*	X		X		X	X	X	
Middle Snake River	From King Hill to Big Pilgrim Gulch *(2)*	X		X		X	X	X	
Middle Snake River	From Mud Creek to Clear Lakes Bridge *(1)*	X		X		X	X	X	
Middle Snake River	From Rock Creek to Shoshone Falls *(1)*	X		X		X	X	X	
Middle Snake River	From Cassia Gulch to Big Pilgrim Gulch *(2)*	X		X		X	X	X	
Middle Snake River	From Bliss Bridge to King Hill Diversion *(2)*	X		X		X	X	X	
Middle Snake River	From Murtaugh to Twin Falls Reservoir *(1)*	X		X		X	X	X	

Prepared by IDEQ-TFRO: Ag = Agricultural water supply; D = Domestic water supply; CW = Cold water biota; WW = Warm water biota; SS = Salmonid spawning; PC = Primary contact recreation; SC = Secondary contact recreation; RW = Special Resource Water. *IDAPA 16.01.02.101.01* in the Beneficial Uses columnes references Undesignated Surface Waters: "Surface waters not designated in Sections 110 through 160 shall be designated according to Section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Prior to designation, undesignated waters shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, whereever attainable." * = Protected for future use. All surface waters are designated for industrial water supply, wildlife habitats, and aesthetics (IDAPA 16.01.02.100(01c) & (04) & (05).

Existing beneficial uses are summarized in Table 41 for select streams as observed by the waterbody assessment process through BURP.

TABLE 41 EXISTING BENEFICIAL USES OF THE §303(d) LISTED STREAMS

STREAM NAME	BOUNDARIES	BENEFICIAL USES Ag	D	I	CW	WW	SS	PC	SC	W	A
Billingsley Creek	From headwaters to the Snake River	X			X		X		X		
Clover Creek	From Pioneer Reservoir to the Snake River	X									
Cottonwood Creek	From headwaters to Rock Creek	X			X		X				
Deep Creek	From headwaters to Snake River	X			X						
Dry Creek	From West Fork Dry Ck to Murtaugh Lake	X			X		X				
Dry Creek, West Fork	From headwaters to Dry Creek				X				X		
McMullen Creek	From headwaters to Cottonwood Creek	X			X						

STREAM NAME	BOUNDARIES	BENEFICIAL USES									
		Ag	D	I	CW	WW	SS	PC	SC	W	A
Riley Creek	From headwaters to Snake River	X			X		X				
Rock Creek	From Rock Creek Town to Snake River	X			X		X	X			
Tool Box Creek	From headwaters to Fifth Fk Rock Creek	X			X				X		

Prepared by IDEQ-TFRO. Ag = Agricultural water supply; D = Domestic water supply; I = Industrial water supply; CW = Cold water biota; WW = Warm water biota; SS = Salmonid spawning; PC = Primary contact recreation; SC = Secondary contact recreation; W = Wildlife habitats; A = Aesthetics
Information collated from BURP

2.2.3.2 PROTECTION OF BENEFICIAL USES AND THE TMDL PROCESS

Under Idaho Code (IDAPA 16.01.02.003.57) man-made waterways are defined as canals, flumes, ditches, and similar features, constructed for the purpose of water conveyance. Waters of the State (IDAPA 16.01.02.003.116) are defined as all the accumulations of water (surface and underground, natural and artificial, public and private, or parts thereof which are wholly or partially within) which flow through or border upon the state.

According to IDAPA 16.01.02.050(02)(a), "Wherever attainable, surface waters of the state shall be protected for beneficial uses which includes all recreational use in and on the water surface" (for primary and secondary contact recreation) "and the preservation and propagation of desirable species of aquatic biota" (for salmonid spawning, cold or warm water biota, aquatic habitats). Although certain waters of the State may be protected for agricultural conveyence, that protection does not preceed the protections of other beneficial uses. It is recognized by the scientific community that waters of the state which are used for water conveyance may find it difficult to meet their beneficial uses (USDA/SCS 1998). However, the administrative policy (IDAPA 16.01.02.050 (02)(c)) stipulates that "in all cases, existing beneficial uses of the waters of the state will be protected." As part of IDAPA, the Antidegradation Policy allows for maintenance of existing uses for all waters, such that "the existing in-stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected (IDAPA 16.01.02.051(01))."

Beneficial use support status is determined by IDEQ (IDAPA 16.01.02.053) through its *Water Body Assessment Guidance*, but parameters (e.g., aquatic habitat parameters and biological parameters) defined in this document are not considered or treated as individual water quality criteria or otherwise interpreted or applied as water quality standards. After determining that a water body does not fully support designated or existing beneficial uses (as determined through the *Water Body Assessment Guidance* document), the DEQ in consultation with the applicable Basin Advisory Group (i.e, Upper Snake BAG) and Watershed Advisory Group (i.e., Mid-Snake WAG) shall evaluate whether the application of required pollution controls to sources of pollution affecting the impaired water body would restore the water body to full support status (IDAPA 16.01.02.054.01).

2.2.3.3 APPLICABLE WATER QUALITY STANDARDS

Violations of narrative and numeric water quality standards include the following on the Middle Snake River and its tributaries:

1. DELETERIOUS MATERIALS

"Surface waters of the state shall be free from deleterious materials in concentrations that impair designated or protected beneficial uses (See IDAPA §16.01.02.200.03)." Deleterious materials are

defined as 'any nontoxic substance which may cause the tainting of edible species of fish, taste and odors in drinking water supplies, or the reduction of the usability of water without causing physical injury to water users or aquatic and terrestrial organisms (See IDAPA §16.01.02.003.20)." "These materials do not include suspended sediment produced as a result of nonpoint source activities (See IDAPA §16.01.02.200.03)" but do include aquatic plant growths. Like the Middle Snake River, the tributaries have widespread aquatic plant growths, including rooted and non-rooted macrophytes, epiphytic algae, filamentous algae, which may cause the reduction of the usability of the waters without causing physical injury to water users. These aquatic plants are deleterious materials which appear in concentrations which impair designated beneficial uses of the particular waterbody, particularly primary and secondary contact recreation, cold water biota, salmonid spawning, aesthetics, and wildlife habitats.

Mud Creek and Deep Creek in particular, followed by Rock Creek, Cedar Draw, and East Perrine Coulee, and then followed by Salmon Falls Creek and Clover Creek had organic black deposits which when exposed to the atmosphere gave off offensive odors. Local fishermen and fowl hunters were interviewed and they claim that these organic deposits (particularly on Mud Creek and Deep Creek) are so offensive that the fish have been reduced in population numbers and the ducks "avoid the stench" areas when the deposits are exposed (Buhidar & Sharpnack 1997).

2. FLOATING, SUSPENDED, OR SUBMERGED MATTER

"Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities (See IDAPA §16.01.02.200.05)." Nuisance is defined as "anything which is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state (See IDAPA §16.01.02.003.65)."

AQUATIC MACROPHYTES

In addition to the Middle Snake River, the tributaries have concentrations of macrophytes, algae, and organic solids (where point source industries are localized) which are discharged at concentrations which may be defined as floating, suspended, or submerged matter, and which cause definable nuisance and objectionable conditions which adversely effect their beneficial uses. IDEQ-TFRO (Buhidar & Sharpnack 1997) during the 1996-1997 monitoring seasons identified high levels of macrophytes and epiphytic algae in certain sections of East Perrine Coulee, Rock Creek, Cedar Draw, Mud Creek, Deep Creek, Salmon Falls Creek, and Clover Creek that gave the streams the appearance of green-brown discoloration. By definition, these high levels of macrophytes could easily be construed as "nuisance," since they could readily "obstruct" the free use of the waters at certain times during the irrigation season when temperatures are warm and the majority of the discharged water is coming from agricultural drains and runoff. Those designated beneficial uses affected include primary and secondary contact recreation, cold water biota, salmonid spawning, aesthetics, and wildlife habitats.

ORGANIC DEPOSITS

More especially on Mud Creek and Deep Creek were organic black deposits found at locations close-to but downstream from localized point sources as compared to upstream transects where no organic deposits were found mixed with nonpoint source sediments. This organic material, particularly on Deep Creek, was offensive in odor, viscous, and slick in appearance, and from various discussions with local citizens provided a negative aesthetic appearance to the bedrock (where bedrock was

exposed) as well as the cobble and sediment. Salmon Falls Creek and Clover Creek are of particular interest because no point sources are found here, no black organic deposits were noted, but nuisance aquatic plants were found at specific locations where the streams were slow moving and less than 3 meters (Buhidar & Sharpnack 1997).

ALGAL BIOMASS

Additionally, algal biomass may be considered "nuisance floating, suspended, or submerged matter." "Chlorophyll *a* is used as a versatile measure of algal biomass or productivity. The ranges presented for mean summer chlorophyll *a* concentration determined in epilimnetic water supplies collected at least biweekly and analyzed according to *Standard Methods* are indices of the trophic stage of a lake: oligotrophic, 0-4 mg chlorophyll *a*/m^3 ; mesotrophic, 4-10 mg chlorophyll *a*/m^3 ; and, eutrophic, 10-100 mg chlorophyll *a*/m^3 (USEPA 1972 [p 21])." Because the Middle Snake River has a modified flow regime with reservoir-lake-type portions, these values may be used as preliminary indicators of a mesotrophic/eutrophic system. Biomass, as a standing crop, is different than algal biomass, and is a quantitative estimate of the total mass of living plant organisms within a given area or volume after drying (APHA 1995 [p 10-25]). IDEQ-TFRO contracted in 1992-1994 with the University of Idaho/Idaho Water Resources Research Institute to study the primary productivity of the Middle Snake River. The study focused on the highly productive shallow reach rich in aquatic macrophyte development throughout the Crystal Springs Reach (RM 599.5-601.3). The Crystal Springs Reach was determined to be the most productive reach in the water quality limited section due to dense aquatic macrophyte community dominated by *Potamogeton pectinatus, Potamogeton crispus,* and *Ceratophyllum demersum*. Associated with these rooted macrophytes were luxuriant growths of the attached filamentuous green algae *Hydrodictyon* and *Cladophora* that formed dense mats on the water surface. Table 42 shows the results of the 3-year study on the Crystal Springs Reach, which indicate:

1. This reach is on the average eutrophic (>10 mg chlorophyll *a*/m^3).

2. The chlorophyll *a* versus the month is negatively linear correlated (r^2=0.359, *F*-ratio=15.3, p=0.000), decreasing from April to November.

3. The biomass versus the rivermile (RM) is negatively linear correlated (r^2=0.309, *F*-ratio=10.9, p=0.001), decreasing from downstream (RM 600.0) to upstream (RM 600.6), or increasing from upstream to downstream.

4. A negative power regression relationship exists between the mean dry biomass (Y-axis) and the mean chlorophyll *a* (X-axis). As the mean chlorophyll *a* increases the mean biomass decreases.

TABLE 42 1992-1994 FALTER STUDIES ON THE CRYSTAL SPRINGS REACH

YEARS OF STUDY	*DRY BIOMASS g/m²*	*CHLOROPHYLL-a mg/m²*	*N*
1992 MEAN	1052.367	8.922	66
1993 MEAN	422.698	26.787	199
1994 MEAN	390.525	13.291	105
1992-1994 MEAN	525.887	19.770	370

Prepared by IDEQ-TFRO. Falter et al. 1994 (for the year 1992); Falter et al. 1995 (for the year 1993); and, Falter et al. 1996 (for the year 1994).

3. EXCESS NUTRIENTS

"The two nutrients of greatest potential concern in aquatic systems are nitrate and phosphate. These nutrients are the two most related to the eutrophication of surface waters, the assocated nuisance growths of algae, and the development of other noxious conditions (USDA FS 1990b [p 11])." In the State of Idaho, "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (See IDAPA §16.01.02.200.06)." Nutrients are defined as "the major substances necessary for the growth and reproduction of aquatic plant life, consisting of nitrogen, phosphorus, and carbon compounds (See §IDAPA 16.01.02.003.66)." "An excess supply of nutrients may cause an over-abundance of plant and animal biomass, especially of undesirable species or communities (IDHW 1991a)." For the Upper Snake Rock subbasin the excess nutrients include nitrogen and phosphorus, at a minimum.

These excess nutrients may also exist as limiting nutrients. Of the two, phosphorus is considered the limiting nutrient in waters of Upper Snake Rock. A limiting nutrient is a chemical (or physical) condition that determines the growth potential of an organism, and can result in less than maximum or complete inhibition of growth, but typically results in less than maximum growth rates. Because phosphorus is often in short supply relative to biological needs, this element limits plant growth in aquatic systems. Ecologically, when additional phosphorus is added to the system, excess aquatic plant growths are noted (IDEQ 1997b [p 44]). It is possible that nitrogen may be a limiting nutrient at certain times if there is substantial depletion of nitrogen in sediments due to uptake by rooted macrophyte beds.

Dissolved nutrients, especially orthophosphate, are rapidly taken up by aquatic plants. If sufficient nutrients are available in either the sediments or the water column, aquatic plants will take up and store an abundance of such nutrients in excess of the plant's actual need through a chemical phenomenon known as *luxury consumption or luxury uptake*. Phosphorus is the primary limiting nutrient in the Upper Snake Rock subbasin. During the life of the aquatic plant, whether macrophyte or algae, it will continue to store phosphorus in its tissue in quantities far in excess of the plant's immediate need. At the death of the plant, the tissue will decay in the water column and its stored nutrients within the plant biomass will be either returned to the water column or become incorporated into the river sediment. Thus, the submersed macrophytes are unique among rooted aquatic vegetation because they link the sediment with the overlying water. This linkage is responsible for great complexities in nutrition, and has important implications for nutrient cycling. Based on a variety of scientific sources, Table 43 describes the primary sources of nutrient uptake by submersed aquatic macrophytes for various nutrients-of-concern.

TABLE 43 PRIMARY SOURCES OF NUTRIENT UPTAKE BY SUBMERSED AQUATIC MACROPHYTES

NUTRIENTS	SOURCE	COMMENTS
Nitrogen	Sediment	Sediment is primary source for uptake
Phosphorus	Sediment	Sediment is primary source for uptake
Iron	Sediment	Sediment is primary source for uptake
Manganese	Sediment	Sediment is primary source for uptake
Micronutrients	Sediment	Sediment is primary source for uptake
Trace metals	Sediment	Sediment is primary source for uptake
Calcium	Open Water	Component of carbonate system & photosynthetic bicarbonate utilization; uptake from open water

NUTRIENTS	SOURCE	COMMENTS
Magnesium	Open Water	Component of carbonate system & chlorophyll component
Sodium	Open Water	May be exchanged for potassium in sediment
Potassium	Open Water	May be exchanged for NH_4 ions in sediment; uptake also from open water
Sulfate	Open Water	May be exchanged for potassium in sediment or be a component with calcium
Chloride	Open Water	May be exchanged for sulfate in sediment

Prepared by IDEQ-TFRO. Sources include the following: Sculthorpe 1967; Denny 1980; Smart & Barko 1985, 1986; Agami & Waisel 1986; Barko et al. 1982, 1986, 1988; Golterman 1975; Huebert & Gorham 1983; Lowenhaupt 1956; Jackson et al. 1994a,b; and, Barko & James 1998. Rooted submerged macrophytes even with relatively diminutive root systems are capable of significantly depleting pools of nitrogen and phosphorus in sediments (Barko & James 1998). For algae, "since algae on an average contain nitrogen and phosphorus in ratio of 16:1, this ratio in natural waters is commonly cited as an important indicator of relative nutrient limitations by these two nutrients (Stumm & Morgan 1970)." "Higher ratios indicate possible phosphorus limitation, while lower ratios indicate possible nitrogen limitation (USDA FS 1990b [p 11])."

An additional study conducted by Idaho State University on decomposition rates (the process by which nutrients are recycled through ecosystems) for two aquatic macrophyte species, *Ceratophyllum demersum* and *Potamogeton pectinatus*, which are common as dense populations in large, eutrophic rivers, were determined at the beginning and end of the growing season during 1994. The decomposition rate of a highly recalcitrant plant material, leaves of *Populus tremuloides*, also was determined. All three species decomposed at rates much faster than any previously reported values. Furthermore, the decay of the macrophytes was best described by a linear, rather than exponential, model. The decomposition of *P. tremuloides* leaves was best described by an exponential model with a decay constant of 0.002 (standardized for water temperature). The accelerated rates of decomposition are likely a result of the eutrophic condition of the Middle Snake River. An analysis of the carbon and nitrogen concentrations in the plant material suggested that the microbial decomposers in the Middle Snake River are limited by labile organic carbon. Microbial respiration rates were quite high for the macrophytes (*C. demersum* had a daytime of 18 and a nighttime of 4 mg O_2/hr/g dry weight; *P. pectinatus* had daytime of 12 and a nighttime of 3 mg O_2/hr/g dry weight) indicating that potentially large amounts of organic nitrogen, and lesser amounts of phosphorus, can be leached during the early stages of decomposition, thus suggesting that macrophytes play a major role in the nutrient dynamics of the Middle Snake River through the storage and release of carbon, nitrogen, and phosphorus (Royer 1995 [pp iii-iv]).

The following nutrients are described more fully relative to their effect on fisheries and aquatic macrophytes.

a. INORGANIC NITROGEN (NITRITE + NITRATE)

A concentration of total inorganic nitrogen (nitrite+nitrate as N + ammonia-N) of 0.3 mg/L is considered the limit for preventing the development of biological nuisances and the acceleration of cultural eutrophication (IDHW 1980a; USDA FS 1990b [p 11]). Agricultural return flows in Upper Snake Rock often exceed the 0.3 mg/L criterion (IDHW 1991a). The USEPA concluded in 1986 that "nitrate-nitrogen concentrations at or below 90 mg/L should be protective for warmwater fishes, while concentrations at or below 0.06 mg/L should be protective for salmonid fish (USDA FS 1990b [p 11]; USEPA 1986)."

"Nitrate concentrations in ground water from wells that are unaffected by cattle manure, fertilizer, legume crops, or domestic spetic system sources are typically less than 1 mg/L as nitrogen. It is suggested that nitrite plus nitrate as nitrogen concentration in ground water exceeding 2 mg/L probably indicate degradation of water quality from land use activities (USGS 1996a [p 4]). A study conducted by ERI of the major springs discharging to the Middle Snake River indicate nitrite+nitrate levels of 1.611 mg/L in the fall versus 1.688 mg/L in the spring. The % difference of 4.8 is not

statistically different (ERI 1997).

One of the major sources of nitrate is from the production (and eventual plowout) of alfalfa-hay (*Medicago sativa* L.) in southern Idaho. About 50% of the nitrate present in ground water has been determined to be the result of plowout of alfalfa (Robbins & Carter 1980)." In fact, alfalfa-hay dried and ground to pass a 1 mm sieve, then combined with a silt loam soil (at a rate of 1 gram to 500 grams, respectively) showed an average increase in nitrate from 15 mg/L to 85 mg/L (Buhidar 1990).

b. AMMONIA

"Ammonia can enter natural water systems from several sources, including industrial wastes, sewage effluents, alternative fuel conversion processes, and agricultural discharges. It is a natural biological degradation product of nitrogenous organic matter (Rand GM & Petrocelli SR circa 1981 [pp 456]). Ammonia is toxic to fisheries in aqueous media due to its characteristic chemical equilibrium in water as two chemical species: ionized or the ammonium form (NH_4^+) as a dissociated form, and un-ionized or the ammonia form (NH_3) as the undissociated, uncharged form. Total ammonia is the sum of NH_3 and NH_4^+, and the undissociated but combined form NH_4OH. In aqueous solutions ammonia assumes two chemical forms:

$$NH_3 + nH_2O \leftrightharpoons NH_3 \cdot nH_2O \leftrightharpoons NH_4^+ + OH^- + (n-1)H_2O$$

These species are NH_3, NH_4^+, and the hydrogen-bonded to at least three ($n \geq 3$) water molecules. The relative concentrations of ionized and unionized ammonia in a given ammonia solution are principally a function of the pH, temperature, and ionic strength of the aqueous solution. If pH increases, the equilibrium is shifted toward the unionized species, and the concentration of NH_3 increases while that of NH_4^+ decreases. Temperature increases also favor the NH_3 species but to a lesser extent. And, an ionic strength increase (increase in total salt content) at low concentrations favors the NH_4^+ species.

"Ammonia is clearly toxic to fish and has many effects. Fish mortality caused by ammonia may be due to different effects in different cases, and it is likely that ammonia has a different mode of action at high than at low concentrations (Rand GM & Petrocelli SR circa 1981 [pp 456-457])." Table 44 gives some typical examples of the acute toxicity (48- or 96-hour LC50) of un-ionized ammonia. "There is some evidence that salmonid fish species are more susceptible to ammonia than are nonsalmonid species, at least on an acute toxicity basis. Although, in general, nonsalmonids are less sensitive to NH_3 than salmonids, the lower values for nonsalmonids are only slightly higher than the lowest value for salmonids, suggesting that sensitivity differences between these groups are not large (Rand GM & Petrocelli SR circa 1981 [pp 457])."

TABLE 44 REPRESENTATIVE ACUTE TOXICITY VALUES FOR UN-IONIZED AMMONIA ON SELECT FISHERIES

SPECIES	*48- or 96- hour LC50 mg/L NH_3*	*REFERENCE*
Pink salmon	0.08 - 0.10	Rice and Bailey (1980)
	0.030 (simulates early emergence of immature fry)	Rice and Bailey (1980)
Chinook salmon	0.015 (Effluent maximum allowable concentration)	Westers (1981)
	0.006 (gill hyperplasia, 6 wks)	Burrows (1964)
	0.004 (gill hyperplasia)	Emerson et al. (1975)

SPECIES	48- or 96- hour LC50 mg/L NH_3	REFERENCE
	0.025 (adverse affects, prolonged exposure)	EIFAC (1970), Smith and Piper (1975)
	0.097 (12 hr/day exposure)	Burrows (1964)
	0.704 (1 hr/day exposure)	Burrows (1964)
Atlantic salmon	0.38	Herbert and Shurben (1965)
Salmonid Hatchery Fish	0.0125 (Upper limit for continous exposure)	IDEQ, Idaho Waste Management Guidelines for Aquaculture Operations (1997)
	0.012 (Maximum level)	SECL (1983)
Rainbow trout	0.20 - 1.10; 0.39; 0.41; 0.42 - 0.89; 0.88	Calamari et al. (1977); Broderius and Smith (1979); DeGraeve et al. (1980); Thurston et al. (1981); Lloyd and Orr (1969); Ball (1967); Lloyd and Herbert (1960); Herbert and Shurben (1965)
	0.015 (mild gill & liver pathology, 6 month exposure)	Smith and Piper (1975); Piper et al. (1982); Soderbert et al. (1983)
	0.020 (protection of aquatic life in 30-day old fish); 6 month exposure results in gill and liver pathology)	USEPA (1975) ± 0.1 safety factor; Smith and Piper (1975)
	0.328 (acute effluent level)	Willingham et al. (1979)
	0.389-3.764 (96-hr LC50)	Ruffier et al. (1981)
	0.182(temporary growth effect)	Willingham et al. (1979); Wiehenbrauck (1976); Smart (1981)
	0.158 (harmless to growth and food conversion)	Smart (1981); Willingham et al. (1979); Wiehenbrauck (1976)
	0.304-0.364 (gill changes, 36 day exposure)	Mitchell and Cech (1983)
	0.049 (reasonably safe max.)	Mead (1985)
	0.012 - 0.085 (sublethal hyper trophy gill effects)	Thurston et al. (1984)
Steelhead trout	0.005(gill changes to juveniles)	Bradley and Rourke (1985)
Lake trout	0.0012 - 0.004 (Hyperplasia of gills when reared in ammonia)	Mead (1985)
Perch	0.29	Ball (1967)
Bluegill	0.49 - 4.60	Emery and Welch (1969); Roseboom and Richey (1977)
	1.093 (96-hr LC50)	Ruffier et al. (1981)
	0.911 (96-hr LC50)	Roseboom and Richey (1977)
Red shiner	2.80	Hazel et al. (1979)
Channel catfish	1.80 - 3.80	Colt and Tchobanoglous (1976); Roseboom and Richey (1977)
	0.389-3.764 (96-hr LC50)	Ruffier et al. (1981)

SPECIES	48- or 96- hour LC50 mg/L NH_3	REFERENCE
	0.146(gill hyperplasia, 27days)	Robinette (1970)
	0.219 (no hyperplasia, 83days)	Mitchell and Cech (1983)
Striped bass	1.90 - 2.80	Hazel et al. (1971)
Largemouth bass	0.90 - 1.40	Roseboom and Richey (1977)
Carp	0.11 - 0.34	Flis (1968)
Most fish and shellfish	0.121 (max. tolerable conc.)	Wickins (1981)
Most cultured animals	0.06 - 0.24	Colt and Armstrong (1981)

Prepared by IDEQ-TFRO. References listed in the table are not found in §2.60, Sources and References since they are referenced in USEPA 1972 and Rand & Petrocellia 1981. For a test duration of 96 hours, LC50 values reported for two salmonid species fall in the range 0.08 - 1.10 mg/L NH_3, although salmonid hatchery fish have an upper limit for continuous exposure at 0.0125 mg/L NH_3. LC50 values for nonsalmonids species fall in the range 0.50 - 4.60 mg/L NH_3. The most sensitive freshwater fish is the rainbow trout (*Onchorynchus mykiss*) with a 96-hour LC50 of 0.072 mg/L. The most sensitive freshwater invertebrate is the worm *Lumbriculus variegatus* with a 10-day LC50 of 0.455 mg/L. The most sensitive freshwater alga is *Ochromonas sociabilis* with an LC50 of 0.6 mg/L. See www2 internet sources. It should also be noted that the Mitchell and Cech (1983) study (1) debased proposals by Smith and Piper (1975) that gill hyperplasia is a common sign of chronic ammonia poisoning, and (2) that macroscopic/microscopic changes in gills are not necessarily hyperplastic gill damage.

The intent of the previous table was not to provide an exhaustive review of all research on un-ionized ammonia and its effect on fisheries at various concentrations. In order to develop a more holoistic understanding of un-ionized ammonia and its effects on fisheries, one must consider it in conjunction with other parameters. It should be noted that until 1962 only un-ionized ammonia was considered toxic (Mead 1985 [p 138]). Synergistic effects must be considered also in order to establish safe levels of combined toxicants (Mead 1985 [p 137]) for such things as ammonium, dissolved oxygen, carbon dioxide, pH, temperature, and ionic gradients. In fact, sublethal effects of un-ionized ammonia may be related to ammonium and ambient sodium concentrations (Mead 1985 [p 139]). Until such synergistic effects are researched in greater detail, the preliminary use of maximum concentration limits will have to suffice, based on appropriate fisheries research. Therefore, USEPA recommends no concentration greater than 0.020 mg/L of unionized ammonia as a toxic substance for fisheries at any time or place (USEPA 1972 [p 187]). Idaho state water quality standards (IDAPA 16.01.02.250(02)(c)(iii)) specify an un-ionized ammonia (NH_3°) or a total ammonia (NH_3 + NH_4 ⁺) criteria at selected water temperatures and pH values for protection of cold water biota. On the Middle Snake River and its tributaries, un-ionized ammonia can be and has been a problem. See §2.2.3 of this subbasin assessment.

c. TOTAL PHOSPHORUS

To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphorus (as P) should not exceed 0.05 mg/L in streams where it enters a lake or reservoir (USEPA 1977, 1988). A desired goal for the prevention of plant nuisances in flowing waters not discharging directly to lakes or impoundments is 0.10 mg/L total phosphorus (MacKenthun 1973). "The USEPA suggests as a guideline to prevent nuisance algal growths and limit cultural eutrophication that total phosphates as phosphorus should not exceed 0.1 mg/L in any stream or other flowing water, exceed 0.05 mg/L in any stream at the point where it enters a lake or reservoir, or exceed 0.025 mg/L in any lake or reservoir (USDA FS 1990b [p 11]; USEPA 1986)." Therefore, a reasonable criteria for total phosphorus per tributary is in the range of 0.05 - 0.10 mg/L, depending on the location of the tributary and its confluence with or not with the free-flowing stretches of the Middle Snake River (IDHW 1991a). Bear in mind that phosphorus levels below 0.05 mg/L are

desirable when waters flow into any impoundment (USEPA 1988, USDA NRCS & IDEQ 1991 [p 123]). The Mid-Snake TMDL uses a water quality target of 0.075 mg/L total phosphorus at Gridley Bridge, Hagerman, Idaho because of the Middle Snake River's modified flow regime with run-of-the-river impoundments (IDEQ 1997b [p. 53]). This water quality target is proposed as a representative average of the whole river system, assuming that the water pollution targets by the various water user industries are implemented over a 10-year period. It is not a target that is assumed to be completely protective of the resource or the designated beneficial uses, or the final target in total phosphorus reductions. But it is a target that industries and agencies agreed would be a starting point for targeting of phosphorus reductions to reduce nuisance aquatic plant growth at select portions of the river where most nuisance plant growths are known to exist, and where the swimmability and boatability of the river could be restored.

In combination with nitrate, total phosphorus ratios of 16:1 (N:TP) in natural waters is used as the same ratio found in algae on an average. This ratio is commonly used as an important indicator of relative nutrient limitations by these two nutrients: (1) higher ratios indicate possible phosphorus limitation, and (2) lower ratios indicate possible nitrogen limitation (USDA FS 1990b [p 11]).

4. OXYGEN-DEMANDING MATERIALS

"Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition (See IDAPA §16.01.02.200.07)." A measure of oxygen-demanding materials is BOD (biochemical oxygen demand) which is the rate at which organisms use the oxygen in the water (or wastewater) while stabilizing decomposable organic matter under aerobic conditions. Anaerobic is defined as a condition in which life or acitivity occurs in the absence of free oxygen (IDEQ 1997).

Those dark, organic sediments of the Middle Snake River and tributaries of Upper Snake Rock subbasin associated with facilities' discharge outfall have dissolved oxygen concentrations that are by definition zero (see next few sentences for explanation) and remain below the State established minimum standards in the water column for some distance off the stream bottom. Sediments discharged from aquaculture facilities are considered anaerobic, because in general their discharge occurs after the mineralization process has occured (aerobic decomposition) and the anaerobic bacteria continue the decomposition process to produce hydrogen sulfide (instead of sulfate), ammonia, nitrogen gas, methane, and soluble ferrous iron. Under these conditions the organic sediment (which is typically at the bottom of the aquaculture pond, tributary, or river) is "dead," as is the deoygenated water close to it. When disturbed, the dark, organic sediments produce foul and offensive odors due to released hydrogen sulfide and methane (Avault 1996 [pp 370-376]). Phosphorus is also released directly back into the water column to become available for increased algal and macrophyte production in the immediate area and downstream of such anaerobic conditions.

It is possible that a mixing zone at the outfall of these facilities could be issued under §401 water quality certification. IDEQ authorizes mixing zones for meeting Idaho water quality standards (IDAPA 16.01.02.060) for dissolved oxygen in flowing receiving waters limited to the following:

> 1. The cumulative width of the adjacent mixing zones when measured across the receiving water is not to exceed fifty percent (50%) of the total width of the receiving water at that point (IDAPA 16.01.02.060(01)(e)(i)).
>
> 2. The width of the mixing zone is not to exceed twenty-five percent (25%) of the stream width or three hundred (300) meters plus the horizontal length of the diffuser

as measured perpendicularly to the stream flow, whichever is less (IDAPA 16.01.02.060(01)(e)(ii)).

3. The mixing zone is to be no closer to the ten (10) year, seven (7) day low-flow (7Q10) shoreline than fifteen percent (15%) of the stream width (IDAPA 16.01.02.060(01)(e)(iii)).

4. The mixing zone is not to include more than twenty-five percent (25%) of the volume of the stream flow (IDAPA 16.01.02.060(01)(e)(iv)).

5. SEDIMENT AND "SETTABLE SUBSTANCES"

"Sheet and rill, gully, and ephemeral gully erosion from hillslopes are the major source of most sediment introduced into stream channels. Exceptions to this are where sediment is substantially produced by landslides, debris, flows, streambanks, irrigation, and roadsides. The hillslopes are the portions of the landscape that are zones of sediment production. The most effective way to deal with the accumulation of fine sediment in aquatic habitats is to stop the excess at its source. This is only feasible for the sediment derived from accelerated erosion. If the degree of erosion has progressed too far (like gully headcuts), then accelerated erosion requires stabilization and revegetation of slopes and possibly other measures. Fine bed streams have silt or clay bottoms and are unusual in western mountainous watersheds except in estuaries (Castro & Reckendorf 1995 [pp 3-4, 20-29])."

In general, fine suspended sediment affects the aquatic fauna as follows:

1. The highest diversity of benthic macroinvertebrates occurs in gravel-bed streams, not in silt or clay bottom streams. Gravel-bed streams have larger, more diverse macroinvertebrate populations when compared to silt or clay bottom streams, and are extremely important spawning areas for anadromous fish. An average of 70% of freshwater fish species depend on insects as a food source, thus indicating that the macroinvertebrate population controls the fish population because it is the primary food source.

2. Aquatic plants are affected by both increased bedload and suspended load. An increase in bedload may bury an area in which a plant species is growing. Subaqueous plants will be significantly affected by increased suspended sediment loads because primary plant production is reduced with increases in turbidity. This results in a decrease in benthic organism diversity and density because of a limited food supply, thus forcing the fish to migrate to other reaches of the stream.

Additionally, "the European Inland Fisheries Advisory Commission concluded that suspended sediment can affect aquatic organisms by killing them directly, by reducing growth rates and resistance to disease, by preventing successful development of eggs and larvae, by modifying natural movement or migration patterns, or by reducing the natural availabilities of food (USDA FS 1990b [p 10]; USEPA 1986)." "A review completed by the National Academy of Sciences suggested that a limit of 25 mg/L of suspended sediment would provide high, 80 mg/L moderate, 400 mg/L low, and over 400 mg/L very low levels of protection for aquatic organisms ((USDA FS 1990b [p 10]; Thurston *et al.* 1979)." The USEPA and IDEQ have historically used a maximum of 25-80 mg/L of TSS as a guideline for concentrations which may be harmful to aquatic life (IDHW 1983b [p 7]).

"Sediment is the most common nonpoint source pollutant in Idaho affecting the beneficial uses of salmonid spawning and cold water biota (IDHW 1989b)." "In southern Idaho suspended sediment

is the dominant portion of the total sediment load of streams in the Upper Snake Rock subbasin (IDHW 1988)." In fact, all streams on the 1996 §303(d) list have sediment listed as one of the pollutants. "Sediment impacts salmonid spawning and cold water biota beneficial uses by smothering fish spawning and rearing habitats, by smothering fish-food organisms (benthic macroinvertebrates), and by increasing turbidity which can affect light penetration and impair fish feeding behavior (IDHW 1991a)."

A study of particle size composition of the sediment on the Middle Snake River was conducted by the University of Idaho from 1992 to 1994 (See Falter et al. 1993, 1994, and 1995). In 1992 five depositional sites limited to weedbed sites and deep pools on the Middle Snake River were monitored. Overall the average of all sites indicated that one silt size dominated the fines: <0.075 mm. Considering site specific locations:

1. At the Auger Falls site (RM606.3) two silt sizes dominated the fines: between 1.18 mm and 2.36 mm.

2. At the Crystal Springs site (RM599.9) one silt size dominated the fines: <0.075 mm.

3. At the Box Canyon site (RM588.3) one silt size dominated the fines: <0.075 mm.

4. At the Thousand Springs Site (RM535.1) one silt size dominated the fines: <0.300 mm.

5. The site at Blue Heart Springs (RM588.0) was used as a comparison site because it was in a predominant spring fed area. Four silt sizes dominated the fines: at the 5.0-6.0 m depth the sizes were 1.18 mm and 2.36 mm; and, at the 13.0 m depth the sizes were 0.150 mm and 0.300 mm.

In general, the Crystal Springs and Box Canyon sites were dominated by silts <0.075 mm, whereas the most upstream (Auger Falls) and most downstream (Thousand Springs) were dominated by silts >0.075 mm (Falter et al. 1994). In 1993 and 1994 monitoring of the Crystal Springs sites for particle size analysis/texture indicated the following:

1. 1993 monitoring showed an overall average of 56.7% sand, 40.0% silt, and 3.3% clay, with a range for all transects (7) of 53.6-61.4% sand, 36.5-43.6% silt, and 2.1-4.5% clay. In relationship to river mile stretch, sand and clay are statistically significant: sand decreasing from upstream (RM601.0) to downstream (RM600.0), and clay increasing from upstream to downstream. Other parameters studied in the sediment in relationship to river mile stretch showed a statistically significant correlation in organic carbon (an increase from upstream to downstream), organic matter (an increase), carbon (an increase), hydrogen (an increase), and nitrogen (an increase) (Falter et al. 1995).

2. 1994 monitoring showed an overall average of 53.6% sand, 5.5% clay, and 39.8% silt, with a range for all transects (4) of 51.2-72.1% sand, 2.7-6.2% clay, and 25.2-41.2% silt. In relationship to river mile stretch, none of the particle size classes are statistically significant. Other parameters studied in the sediment in relationship to river mile stretch showed a statistically significant correlation in organic carbon (an increase from upstream to downstream), organic matter (an increase), carbon (an increase), nitrogen (an increase), and hydrogen (an increase) (Falter et al. 1996).

3 Comparison of 1993 to 1994 sediment data showed little difference in the particle size analysis: sand was on average a little more in 1993 than 1994 56.7% to 53.6%, respectively; silt was on average about the same from 1993 to 1994, 40.0% to 39.8%, respectively; and, clay was a little less in 1993 than 1994, 3.3% to 5.5%, respectively. The patterns of sand, silt, and clay from month-to-month were similar between 1993 and 1994: mean sand content of sediments was greater at higher velocity, open-channel sites than under aquatic macrophyte beds, since open water channels have greater velocity; mean silt content of sediments was always higher in the aquatic macrophyte beds than in the open water areas, meaning the aquatic macrophyte beds were functioning as traps for fine particulate matter; and, mean clay content of sediments was always higher in the aquatic macrophyte beds than in the open water areas, and increased steadily from April through July.

Idaho water quality standards for sediment have a narrative criteria but no fixed numeric value at which the standard can be met: "Sediment shall not exceed quantities specified in" IDAPA §16.01.02.250, "or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses (See IDAPA §16.01.02.200.08)." Suspended sediment is legally defined as "organic and inorganic particulate matter which has been removed from its site of origin while suspended in surface water (See IDAPA §16.01.02.003.101)." The NRCS defines suspended sediment as solid material (mineral or organic) that is in suspension and is being transported 3 inches above the stream bottom to the top of the water column (IDHW 1986 [p 25]). USEPA defines sediment in conjunction with "settlable substances" for the protection of wildlife. As such, accumulations of "settable substances," like silt deposits, are destructive to aquatic plants due especially to the creation of a soft, semi-liquid substratum inadequate for the anchoring of roots. Thus, "settable substances" can destroy the usefulness of aquatic bottoms to waterfowl, and for that reason, settable substances should be minimized in areas expected to support waterfowl. Additionally, clear waters are normally preferred for recreation as well as the aesthetic value of the water. Because sediment-laden water reduces water clarity, inhibits the growth of plants, displaces water volume as sediments settle, and contributes to the fouling of the bottom, prevention of unnatural quantities of suspended sediments or deposit of sediments is desirable. Individual waters vary in the natural amounts of suspended sediments they carry; therefore, no fixed recommendation can be made. Management decisions should be developed with reference to historical base line data concerning the individual body of water (USEPA 1972 [pp 195,16-17]).

In order to quantify numerically the sediment narrative standard, the IDEQ-TFRO proposes a preliminary interim target of total suspended solids not to exceed a monthly average of 52 mg/L with a daily maximum of 83 mg/L (52 mg/L x 1.6 = 83 mg/L) to allow for natural spikes during flood events over a ten (10) year period. The average monthly of 52 mg/L is identified by the scientific community as "supporting a good fishery (EIFAC 1964; NAS/NAE 1973)." This target is also well in line with the Nevada Division of Environmental Protection's standard, the Washington Department of Ecology's target within the Yakima River subbasin, and the Utah Department of Environmental Quality's targets in the Lower Bear River basin. It also, for a regional comparison in southern Idaho, is close to the proposed 50 mg/L criteria for suspended sediment which provides a "high level of protection for cold water biota (IDHW 1991a)." It is, however, below Lloyd's recommended level of 100 mg/L for a "moderate level of protection of cold water habitat which has been suggested for various tributaries in Upper Snake Rock (USDA NRCS & IDEQ 1991 [pp 120-123).

Narrative criteria applicable to the Middle Snake River and its tributaries include: deleterious materials; floating, suspended, or submerged matter; excess nutrients; and, oxygen-demanding materials. Streams in which sediment is listed as a pollutant exceed these narrative criteria as a result of existing point and/or nonpoint activities. Table 45 summarizes those narrative standards violated.

TABLE 45 WATER QUALITY NARRATIVE VIOLATIONS OF WATERBODIES IN UPPER SNAKE ROCK

STREAM NAME	BOUNDARIES	NARRATIVE WQ STANDARDS DM	FSS	EN	ODM	S
TRIBUTARIES						
Alpheus Creek	From headwaters to the Snake River	None listed on §303(d) list				
Billingsley Creek	From headwaters to the Snake River	X	X	X	X	X
Blind Canyon Creek	From headwaters to the Snake River	X	X	X		X
Cedar Draw	From headwaters to the Snake River	X	X	X	X	X
Clear Springs	From headwaters to the Snake River	X	X	X	X	X
Clover Creek	From Pioneer Reservoir to the Snake River	X	X	X	X	X
Cottonwood Creek	From headwaters to Rock Creek	X	X	X	X	X
Crystal Springs	From headwaters to Snake River	X	X	X	X	X
Deep Creek	From headwaters to Snake River	X	X	X	X	X
Dry Creek	From West Fork Dry Ck to Murtaugh Lake	X	X	X		X
Dry Creek, West Fork	From headwaters to Dry Creek	X	X	X		X
McMullen Creek	From headwaters to Cottonwood Creek	X	X	X	X	X
Mud Creek	From headwaters to Snake River	X	X	X	X	X
Riley Creek	From headwaters to Snake River	X	X	X	X	X
Rock Creek	From Rock Creek Town to Snake River	X	X	X	X	X
Sand Springs Creek	From headwaters to Snake River	X	X	X		X
Tool Box Creek	From headwaters to Fifth Fork Rock Creek	None listed on §303(d) list.				
RESERVOIRS						
Bliss Reservoir	The entire reservoir	X	X	X	X	X
Lower Salmon Falls Reservoir	The entire reservoir	X	X	X	X	X
Pioneer Reservoir	The entire reservoir	X	X	X	X	X
Shoshone Falls Reservoir	The entire reservoir	X	X	X	X	X
Upper Salmon Falls Reservoir	The entire reservoir	X	X	X	X	X
ON THE MIDDLE SNAKE RIVER						
Middle Snake River	From Milner Dam to Murtaugh *(1)*	X	X	X	X	X
Middle Snake River	From Cedar Draw to Rock Creek *(1)*	X	X	X	X	X
Middle Snake River	From Clear Lakes Bridge to Cedar Draw *(1)*	X	X	X	X	X
Middle Snake River	From Deep Creek to Mud Creek *(1)*	X	X	X	X	X
Middle Snake River	From King Hill to Big Pilgrim Gulch *(2)*	X	X	X	X	X

STREAM NAME	BOUNDARIES	NARRATIVE WQ STANDARDS DM	FSS	EN	ODM	S
Middle Snake River	From Mud Creek to Clear Lakes Bridge *(1)*	X	X	X	X	X
Middle Snake River	From Rock Creek to Shoshone Falls *(1)*	X	X	X	X	X
Middle Snake River	From Cassia Gulch to Big Pilgrim Gulch *(2)*	X	X	X	X	X
Middle Snake River	From Bliss Bridge to King Hill Diversion *(2)*	X	X	X	X	X
Middle Snake River	From Murtaugh to Twin Falls Reservoir *(1)*	X	X	X	X	X

Prepared by IDEQ-TFRO. DM = Deleterious materials; FSS = Floating, suspended, submerged materials; EN = Excess nutrients; ODM = Oxygen demanding materials; S = Sediments. Information taken from 1994 & 1996 303(d) lists and various reference materials already cited in the subbasin assessment from IDEQ, NRCS, USEPA, USGS, and IDFG.

6. TURBIDITY

"Turbidity has been described as a major water quality characteristic affecting freshwater fish communities (Lloyd 1987 [p 34])." The justification and implementation of appropriate statndards are important to protect fish resources from habitat degradation caused by this common form of pollution. As an optical property of water, it describes suspended and some dissolved materials such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms which cause light to be scattered and absorbed rather than transmitted in straight lines (APHA 1995). "Measurements of turbidity have been developed to quickly estimate the amount of sediment within a sample of water, and they are also used to describe the effect of suspended sediment in blocking the transmission of light through a body of water (Lloyd 1987 [p 34])." By definition, turbidity and suspended sediment concentrations are closely intertwined. A turbidity standard can be used to address the effects of turbidity as an optical property of water and as an indicator of suspended sediment concentrations (Lloyd 1987 [p 38]. Both parameters are most often used as indicators in nonpoint source monitoring programs. Increases in both these parameters have been associated with reduced light penetration, decreased production and abundance of plant production, decreased fish food organisms, aesthetics, and decreased fish production and abundance (Lloyd *et al.* 1987; USDSA NRCS 1991 [p 120]).

IDAPA 16.01.02.250.02.c.iv for cold water biota states that "turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days." IDAPA 16.01.02.003.07 defines background as "the biological, chemical, or physical condition of waters measured at a point immediately upstream (up-gradient) of the influence of an individual point or nonpoint source discharge." For point source treatment requirements, IDAPA 16.01.02.401.03.b. states that "the wastewater must not increase the turbidity of the receiving water outside the mixing zone by (i) more than five (5) NTU over background turbidity, when background turbidity is fifty (50) or less; or, (ii) more than ten percent (10%) increase in turbidity when background turbidity is more than fifty (50) NTU, not to exceed a maximum increase of twenty-five (25) NTU."

6. TEMPERATURE

"Most biological and chemical processes in aquatic environments ultimately are regulated by water temperature. In fact, temperature has been described as a catalyst, a depressant, an activator, a restrictor, a stimulator, a controller, a killer, one of the most important and influential water quality characteristics to life in water (USDA FS 1990b [p 10-11]; USEPA 1986)." "Temperature exerts an important influence on the chemical and biological processes in a water body. It determines the

distribution of aquatic species; controls spawning and hatching; regulates activity; and, stimulates or suppresses growth and development. The two most important causes of temperature change in a water body are process and cooling water dischcarges, and solar radiation (USEPA 1983c [p II-5-1]). Stream temperatures have been described by USFWS as being influenced directly by air temperature, relative humidity, percent shade, and stream flow and can be readily modeled to predict mean daily water temperature (Barthalow 1989 [p 139]; IDEQ 1998c [p 2]).

COLD WATER BIOTA

Temperature or temperature modification is listed on various streams of Upper Snake Rock as a pollutant/stressor. IDAPA §16.01.02.250(02)(c)(ii) states that waters designated for cold water biota are to exhibit water temperatures of 22°C or less (daily maximum) with a maximum daily average of no greater than 19°C.

On the Middle Snake River and its tributaries, for cold water biota field monitoring data collected by IDEQ-TFRO, shows exceedences in temperature above 22°C as follows in Table 46:

Table 46 Cold water biota temperature exceedences (> 22.00 °C) in Upper Snake Rock

Stream Segment Name	*Temperature Exceedence*	*Date of Exceedence*
Middle Snake River	22.28°C at Twin Falls Reservoir	July 1, 1996 (ERI)
	22.16°C at Twin Falls Reservoir	July 29, 1996
	22.65°C at Twin Falls Reservoir	July 29, 1996
	25.30°C at Shoshone Falls Dam	July 2, 1996 (ERI)
	22.02°C at Below Pillar Falls	July 29, 1996
	22.38°C at Upper Salmon Falls Dam	July 17, 1996 (ERI)
East Perrine Coulee	23.46°C	June 4, 1996 (ERI)
	26.29°C	July 1, 1996 (ERI)
	24.50°C	July 15, 1996 (ERI)
Cedar Draw	22.50°C	June 22, 1990
Salmon Falls Creek	23.50°C	August 18, 1992
Mud Creek	22.60°C	July 27, 1994
Deep Creek	22.40°C	July 29, 1991
Clover Creek	24.66°C	May 28, 1997
	22.40 & 27.70°C	June 9, 1997
	23.98 & 27.66°C	July 22, 1997
	23.64°C	August 5, 1997

Prepared by IDEQ-TFRO. ERI = Ecosystems Research Institute study of 1996. Other monitoring done by IDEQ-TFRO for 1995-1997 seasons.

IDEQ-TFRO proposes that these exceedences per indicated water body for cold water biota are minor excursions (with the exception of Clover Creek) and do not necessarily constitute violations of the temperature water quality standard, especially when compared to the overall length of time in

which IDEQ-TFRO did the monitoring. Clover Creek exceedences are the result of joint geothermal well inputs and complete diversion appropriations of irrigation water. IDEQ-TFRO proposes that water flow regulation constitutes a greater threat to water temperature violations especially in low flow or drought years because impounded reservoir water and agricultural return flow water exceeds temperature criteria for cold water biota.

As presently constituted, the Middle Snake River (as part of the larger "middle Snake River" as defined by USBOR) has been transformed in recent times from a free-flowing, coldwater system to a slow-moving, warmwater system because of hydroelectric impoundment (USBOR 1998). IDAPA 16.01.02.260.01.b. allows for variances from the state water quality standards, provided:

1. "ii. Natural, ephemeral, intermittent, or low flow conditions or water levels prevent the attainment of the standard." As described in §2.1.1.2, the average annual precipitation may vary from 5 to 15 inches which affects not only the rainfall, but also the potential for high snowpack levels in the mountains. Because Upper Snake Rock is a semiarid region, a characteristic is its low annual rainfall with moderately hot,dry summers. Low precipitation indicates low water inputs into the tributaries and streams that feed directly into the Middle Snake River and tributaries of Upper Snake Rock. This causes low flow conditions at Milner Dam, which in turn allows for very low volumes of water, if any, to be discharged directly to the Middle Snake River past Milner Dam. Such low flow conditions create low water levels and low velocity flows in the Middle Snake River, thus enhancing the tendency for higher temperatures that exceed water quality standards, particularly during the summer irrigation months. Under low flow conditions water quality standards and designated beneficial uses are not attained until conditions are changed that allow more water into the system. Therefore, low flow conditions or low water levels prevent the attainment of the standard.

2. "iii. Human caused conditions or sources of pollution prevent the attainment of the standard and cannot be remedied or would cause more environmental damage to correct than to leave in place."

3. "iv. Dams, diversions or other types of hydrologic modifications preclude the attainment of the standard, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in attainment of the standard." As described in §2.1.3, the Middle Snake River is a flow regulated system from American Falls, Lake Walcott, Milner Lake, and other reservoirs. Irrigation return flows constitute a large part of the re-entry water to the Middle Snake River between Milner Dam and King Hill. From 1909 to 1926 the flow (as regulated at gage 13088000) has averaged 5206 cfs (USGS 1997 [WY1997]). Then, from 1926 to 1996 the flow (as regulated at gage 13088000) has averaged 5384 cfs (USGS 1997 [WY1997]). This represents how fairly uniform the average annual flow has been since 1906. However, on a monthly basis, the monthly flow from WY1990 to WY1997 averaged less than 5000 cfs past Milner Dam 85.4% of the time (or a range of 2 to 4449 cfs). It wasn't until WY1995 that flows increased past 5000 cfs due to increased rains; first, for two months in WY1995; then, five months in WY1996; and then, seven months in WY1997. In fact, temperature exceedences during the WY's 1995-1997 occured only in those months when flows were less than 5000 cfs, especially during the summer months. Additionally, there are six (6) major impoundments on the Middle Snake River which greatly affect the water temperature of the system, particularly when only 25.7% of the river system is reservoir-like. See §2.1.3.2 of the subbasin assessment.

4. "v. Physical conditions related to the natural features of the water body, unrelated to water quality, preclude attainment of the standard." These physical conditions have to do with the

six (6) major impoundments and how they make 25.7% of the Middle Snake River system reservoir-like. Additionally, the Middle Snake River s water quality degradation due to high rates of primary productivity and decomposition of aquatic vegetation which cause fluctuations in dissolved oxygen have resulted in the loss of native cold-water species such as trout and white sturgeon, and have favored exotic and pollutant tolerant species. "The hydropower projects on the Middle Snake River alter the physical characteristics of the river, which in turn affect water quality and biotic communities. The reservoirs in particular have altered the river's capacity to process the nutrients that encourage excessive plant growth and create large shallows and areas of sediment deposition that are ideal for the aquatic weeds. Riverine characteristics affected by the dams include water velocity, discharge, water depth, and water retention times. Potential water quality changes associated with the construction and operation of the hydropower projects include dissolved oxygen and temperature modifications, gas supersaturation, sedimentation, and local nutrient processing. White the hydropower projects do not add nutrients to the river, the impoundments behind the dams affect the ability of the river to process sediment and nutrients (FERC 1997b [p 10-11])." "Prior to construction of hydropower dams, the Middle Snake River supported a diverse and rich aquatic community. Salmon, steelhead, white sturgeon, rainbow trout, lamprey, and a host of other aquatic species inhabited the river and could freely range throughout the river. Construction of hydro projects on the Middle Snake River eliminated anadromous species, severely reduced native rainbow trout, contributed to the depletion of white sturgeon, and reduced the diversity of both aquatic species and their habitats. The conversion of a free-flowing river into a slack water environment eliminates important habitat for many native species and does not provide adequate habitat for desirable non-native species. These physical changes to the river envirnoment mean that insects and other invertebrates that once provided an ample food source for rainbow trout, mountain whitefish, and white sturgeon have been replaced by an insect community that is less available as a food source. Existing sport fisheries in the area include a limited population of naturally produced rainbow trout, catch and release fishing for white sturgeon, and hatchery produced rainbow trout (FERC 1997b [p 12-13])."

5. "vi. Controls more stringent than technology-based effluent limitations would result in substantial and widespread economic and social impact." Nonpoint source influence on certain tributaries may be greater since no point sources are present. Under these conditions to attempt to get pollution control mechanisms that are more stringent than technology-based effluent limitations (for point sources) would result in serious economic and social upheaval for industries and citizens of the watershed.

Additionally, as cited in §2.1.4.1, because the Middle Snake River has eutrophic conditions that directly affect water quality standards and designated beneficial uses, IDFG has managed the river system according to the average temperature (as "water types"): from Milner Dam to Twin Falls Reservoir as cold water (about 21.7 miles); from Twin Falls Reservoir to Lower Salmon Falls as mixed water (about 44.4 miles); and, from Lower Salmon Falls to Bliss Dam as warm water (about 12.7 miles). Thus, 16% of the river is stocked for warm water fishes, 56% for mixed water fishes, and 28% for cold water fishes (or 72% of the river is stocked for mixed or warm water fishes).

SALMONID SPAWNING

For salmonid spawning, IDAPA §16.01.02.250(02)(d)(ii) states that waters so designated are to exhibit water temperatures of 13°C or less (daily maximum) with a maximum daily average of no greater than 9°C. A daily average based on diel work is preferred, but minimum standard requirements allow for only two samples since IDAPA §16.01.02.003(19)) states that a daily mean

is the average of at least two appropriately spaced measurements acceptable to IDEQ, calculated over a period of one day. Additionally, "The National Academy of Sciences has listed the following temperatures, for rainbow trout and brook trout adults and juveniles, the maximum weekly average temperature for growth during the summer is listed as 19°C, and the short-term maximum temperature limit for survival during summer is 24°C. The average weekly maximum temperature is reported as 9°C, and 13°C as the short-term maximum reported for survival of their embryos (USDA FS 1990b [p 11]; USEPA 1986)."

On the Middle Snake River and its tributaries, salmonid spawning was assessed for temperature exceedences greater than 13°C during the spawning period or season-of-concern. Table 47 summarizes the number of (and percent of) exceedences for the particular fisheries for the season-of-concern. Only the native species were assessed.

Table 47 Number of temperature exceedences (> 13 °C) based on IDEQ-TFRO data for 1995-1997 for native fisheries

Fisheries' Species	*Spawning Season*	*Number of Exceedences*	*% Exceedences*
Chinook salmon (spring)	August 1st to April 1st	214 out of 539	39.7
Chinook salmon (summer)	August 15th to June 15th	275 out of 720	38.2
Steelhead trout	February 1st to July 15th	204 out of 470	43.4
Redband trout	March 1st to July 15th	201 out of 423	47.5
Cutthroat trout	April 1st to August 1st	250 out of 376	66.5
Rainbow trout	January 15th to July 15th	207 out of 487	42.5
Mountain whitefish	October 15th to March 15th	21 out of 276	7.6

Prepared by IDEQ-TFRO. Number of exceedences and total number of samples were taken from only within the season-of-concern. The % Exceedences represents the percent of the number of samples that exceeded the temperature criteria. Introduced species were not considered in this assessment.

Present Idaho water quality standards contain surface water temperature criteria which do not appear to conform to conditions in the Middle Snake River that have been unchanged since before the inception of the Clean Water Act in 1972. In fact, the dilemma of applying uniform temperature criteria in a diverse environment affected by spatial variation, temporal variation, and the relation of climate to stream temperature is something that needs to be resolved as fisheries data from various agencies indicate that affected fisheries are more tolerant to thermograph exceedances than previously thought. These data indicate that more than 50% of the time where Idaho temperature criteria exceedances occur, the affected age classes of fish are present. Salmonid spawning and incubation have occured coincidentally with measured temperature criteria exceedances (IDEQ 1998c [p 21]). Therefore, IDEQ-TFRO proposes to defer 24 months from the time of TMDL acceptance for a more complete study to resolve some of these issues, and to allow the Idaho State Legislature to make the necessary changes in the regulations that reflect a more realistic picture of the Middle Snake River and its tributaries. At that point, IDEQ-TFRO, USEPA, and the Mid-Snake WAG and TAC will have a better perspective of the temperature dilemma based on data assessed or accumulated by a more intense study.

2.2.3.4 HABITAT MODIFICATION AND FLOW ALTERATION

It is Idaho DEQ's position that habitat modification and flow alteration, while they may adversely affect beneficial uses, are not pollutants per §303(d) of the Clean Water Act. There are no Idaho water quality standards for habitat or flow, nor are they suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed at this time to address habitat modification or flow

alteration per se. For many of the water quality limited waters on Idaho s §303(d) list this will have little effect on implementation plans. This is because concerns which resulted in a listing for habitat modification or flow alteration are often reflected in listed pollutants---sediment or temperature, for example. In such cases actions taken to address these related pollutants will likely address habitat or flow as well. In other cases alternate control strategies would be applied outside the TMDL process.

While USEPA has not reached a resolution regarding IDEQ's position whether habitat modification and/or flow alteration are pollutants under §303(d) of the Clean Water Act, it has taken the following position: If and when USEPA determines that they are considered pollutants under §303(d), USEPA would then require that a TMDL be developed to cover these parameters (USEPA 1998b).

Because sediment is defined as a pollutant in all the streams listed on the §303(d) list for Upper Snake Rock; and because sediment is linked to the degradation of snail habitat of the endangered snails on the Middle Snake River and its associated tributaries; and because IDFG stipulates that sediment is a detriment to fisheries and fisheries habitat over the long term; the TMDL portion for sediment asserts that those reductions to be implemented by point and nonpoint sources in the Upper Snake Rock watershed will yield a less adverse effect on the snail and fish habitats. As a result sediment allocations, over the long term it is expected to see some recovery of habitat and species specific to their known location. High or scouring flows may have a direct impact on the recovery of the habitat as well as the species if flows are available above those allocated for storage and irrigation diversion.

2.2.3.5 EFFECT OF EUTROPHIC WATER ON ENDANGERED AND THREATENED SPECIES

As discussed in §2.1.4.4 various species in Upper Snake Rock are listed as Endangered or Threatened. And as discussed in §2.4.3 the point sources (food processors, municipalities, and aquaculture) are undergoing reissuance or modification of their existing NPDES permits. Also, the major impoundments on the Middle Snake River (Bliss, Upper Salmon Falls, Lower Salmon Falls, Shoshone Falls, and previously Twin Falls Dams) are undergoing FERC relicensing. Because these are major federal permitted activities, the USEPA is required, under the consultation process in Section 7 of the Endangered Species Act, to conduct a biological evaluation with the USFWS and NMFS to identify impacts on endangered or threatened species that may result from the discharges covered by the NPDES and FERC permits. In §2.4.3.3 a description of these species (Endangered and Threatened) is listed. Table 48 describes the effect of eutrophic waters from the Middle Snake River and Billingsley Creek on these species.

TABLE 48 EFFECT OF EUTROPHIC SURFACE WATERS ON ENDANGERED AND THREATENED SPECIES

SPECIES NAME	HABITAT PREFERENCE	REASONS FOR DECLINE
	ENDANGERED SPECIES	
Utah valvata snail	Prefers well-oxygenated areas of limestone mud or mud-sand substrate among beds of submergent aquatic vegetation.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species.
Snake River physa snail	Prefers the undersides of gravel to boulder substrate in swift current in the mainstem.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Banbury Springs limpet	Prefers well-oxygenated, spring-run habitats, with clear waters between 15-16°C, on cobble to boulder substrate.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Idaho springsnail	Prefers permanent flowing waters of the mainstem, not in tributaries or marginal cold-water springs.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species

SPECIES NAME	HABITAT PREFERENCE	REASONS FOR DECLINE
	THREATENED SPECIES	
Bald eagle	No critical habitat is determined.	Habitat loss and food sources due to human intervention.
Bliss Rapids snail	Prefers stable, cobble-boulder size substrate in flowing waters of the unimpounded reaches of mainstem and a few spring habitats requiring cold, clean, well-oxygenated flowing water of low turbidity.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Ute ladies' tresses	May survive in areas where streams remain in a somewhat natural condition, or where conditions mimic naturally created habitat.	Loss of habitat especially riparian and wetland habitats lost to economic development, stream channelization, water diversions.
Prepared by IDEQ-TFRO		

The USFWS listed five species of freshwater snails of the Snake River as threatened or endangered under the Endangered Species Act, effective January 13, 1993. All five species are charactered as geographically limited and generally intolerant of pollution. The USFWS related that the free-flowing, cool water environments required by these species had been impacted by and were vulnerable to continued adverse habitat modification and deteriorating water quality from one or more of the following: hydroelectric development, peak loading effects from existing hydroelectric project operations, water withdrawal and diversions, water pollution, and inadequate government regulatory mechanisms (USBOR 1998). This deterioration, which has accelerated in the last decade because of an extended drought, is the result of water withdrawal for irrigation, agricultural return flows laden with nutrients, runoff from dairies and feedlots, effluent from aquaculture, industrial, and municipal facilities, and storm water. Increased nutrient loads from these sources have contributed to dense blooms of free-living and attached filamentous algae which cannot be utilized by the listed mollusc species. Algal blooms can cause dissolved oxygen depressions, leading to anoxic conditions in sediments and the water column following seasonal algal die-off. In fact, declines in snail populations are attributed to fragmentation of remaining free-flowing habitats in the Snake River as well as deteriorating water quality (USEPA 1997a).

Finally, the New Zealand mudsnail (*Potamopygus antipodarum*) is an exotic species that is experiencing 211explosive population growth in the Middle Snake River. "Its rapid population rise was paralleled by a corresponding precipitous decline in populations of indigenous mollusks. [It] shows a wide range of tolerance for temperature, turbidity, and water velocity fluctuations. The mudsnail appears to prefer warmer, polluted waters over pristine spring environments. It competes directly for habitats of the Snake River physa and Bliss Rapids snails (USEPA 1997a)."

RECENT DATA ON ENDANGERED SNAILS

Recently, data from Idaho Power Company indicate that the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata are found in a wide variety of habitats descriptively contrary to those habitat requirements recounted by Falter (1992), Frest *et al.* (undated), Hershler *et al.* (1994), and USFWS (1992 and 1995). These three snails appear to be not tolerant of only a narrow range of environmental factors (stenotopic), nor does it appear that the requirements of historic description apply to these organisms. The data appear to indicate that the three molluscs are well adapted to and maintain healthy colonies in various habitats. It is suspected that earlier findings were the result of a prolonged drought period (12 years). Thus, the periods of extremely low flows brought a progressive deterioration of Snake River aquatic habitat (accumulation of sediments, macrophyte production, anoxic sediments). A major faunal turnover had begun as several coldwater biota were replaced with more tolerant species. Detrimental conditions most likely continued until

the drought cycle reversed. The synoptic surveys performed by Idaho Power Company suggest an aquatic invertebrate community, including the endangered and threatened river snails, with a high tolerance to nonpoint source pollution (organic effluent and sediment). At present, the Idaho Power Company data suggest that colonies of the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata have met the recovery criteria of increasing, self-producing colonies dwelling in non-threatened habitats for two years (since higher flows have prevailed since the spring of 1995). Idaho Power Company reports that declines in snail population density and distribution and impaired reproduction has not been observed or documented as a trend and the habitat is not currently threatened. Idaho Power Company has recommended that a status review of the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata be done by the USFWS (USBOR 1998).

This recommendation does not include the Snake River physa, since it is not known whether this mollusc persists or not. In 1994, two populations (or colonies) were believed to remain in the Hagerman and King Hill reaches, with possibly a third area of concentration immediately downstream of Minidoka Dam. Live specimens of this species have not beem found even during USBOR's intensive instream, near shoreline sampling efforts in the free-flowing river sections below Minidoka and American Falls Dam, or within reservoir waters at Lake Walcott. At this time, it appears that the Snake River physa has not adapted to a changing river environment and, thus, may be a relic of a former, more suitable ecosystem (USBOR 1998).

RECENT DATA ON THE NORTHERN LEOPARD FROM (RANA PIPIENS)

Recently, a survey of the northern leopard frog (*Rana pipiens*) in Southcentral Idaho by the U.S. Department of Interior Bureau of Land Management (Burley, Idaho) was documented as a springboard to further surveys and monitoring efforts due to the widespread concern in North America over the population status and trend of this species. A statewide survey of natural resource personnel, academmicians and others indicated at least anecdotal evidence for declines in northern leopard frogs. The distribution and relative abundance of northern leopard frogs appears to have decreased considerably in southern Idaho, as well as the Greater Yellowstone Ecosystem. Presently, the species is designated as "sensitive" by the USBLM, and a "priority species of special concern" by the IDFG. The survey study area in Southcentral Idaho encompassed public (BLM), USBOR, USFS, Minidoka National Wildlife Refuge (USFWS), and selected private lands within the perimeter of the USBLM's Snake River Resource Area. Idaho counties represented in the survey included portions of Bannock, Blaine, Cassia, Jerome, Minidoka, Oneida, Power, and Twin Falls. Although the survey is still infant, one of the conclusions drawn from conversations with several long-time residents, was that chemicals (such as xylene and acrolein) used routinely to control aquatic vegetation in irrigation waterways, have allegedly resulted in local frog mortalities in the past. In conjunction with copper sulfate, the use of these chemicals is "a likely factor in limiting the distribution of frogs in these water systems today (USBLM 1998a)."

2.2.3.6 FISHERIES CONCERNS ON 303(d) LISTED WATER BODIES

In 1994, recreational fishing opportunities were surmised by IDFG to have been negatively impacted by poor water quality in the Middle Snake River. Native coldwater fish species, such as cutthroat trout, bull trout, and rainbow trout along with sturgeon, had experienced dramatic population decreases due to a variety of water quality related factors. Those factors included:

1. In response to increased nutrient loading and other impacts, massive macrophyte beds have developed throughout the Middle Snake River. Sediments provide a suitable foot-hold for rooted macrophytes to develope. Macrophytes have physically limited available coldwater fish habitat by reducing the useable area in pools, riffles, and runs, and conversely decreased river habitat diversity. Aquatic vegetation has also slowed river flow velocities and caused strong diel oxygen fluctuations beyond the tolerance levels of most coldwater fish species.

2. Increased sediment loading coupled with modification of the natural hydrograph has also adversely impacted coldwater fish populations. Sediment has choked most spawning gravels both in tributaries and main river channels. This has led to a decrease in population recruitment for salmonids which require well oxygenated gravel areas for reproduction. Also, sediment has filled interstitial spaces within the river substrate which has reduced juvenile rearing habitat and over wintering habitat which can sometimes be a limiting factor for fish populations.

3. Summertime water temperatures have increased due to a variety of complex interrelated reasons. Decreases in water clarity from an increase in nutrients, suspended sediments, plant growth, and decreased river flow velocity appear to increase solar radiation absorption. The result has been an increase in water temperatures to the threshold or above tolerance levels for most coldwater fish species in traditional use areas for the Middle Snake River.

Overall, environmental condition changes associated with a decrease in water quality, impacts of drought and flow, have given the competition edge to more tolerant warmwater and non-game fish species. Historically, fishing pressure focused on the coldwater salmonids and sturgeon in the Middle Snake River due to their abundance and recreational qualities. Today, depressed coldwater fish populations and limited available fishing areas make recreational fishing opportunities minimal throughout the reach (IDFG 1994, Memo to IDEQ).

In 1998, IDFG, in response to IDEQ-TFRO's request for information on the various §303(d) listed waterbodies in the Upper Snake Rock subbasin, noted, "It's also important to note when reviewing data collected by our agency that our funding source is from the sale of fishing and hunting licenses, therefore, our sampling concentrates on gamefish populations which provide a recreational fishery; not entire fish communities (IDFG 1998c)." Using their best professional judgement and experience the following conclusions may be drawn on the §303(d) listed waterbodies:

1. "A massive amount of literature documents the decline in water quality, modification of river hydrology, and alteration of the natural hydrograph in the Snake River Basin. This information can be used to support the deduction that all native fish communities along the Middle Snake River reach and tributaries, from American Falls Dam to King Hill/Glenns Ferry, are depressed over historical levels and in some instances, facing extinction." "Historically, Yellowstone cutthroat and Mountain whitefish were the primary salmonid in the reach from American Falls to Shoshone Falls. Now, whitefish are sampled in the remaining free-flowing riverine environment, both main river and tributaries, with Yellowstone cutthroat only occasionally appearing in the scientific sampling of headwater tributaries. Strongest known remaining remanent populations of Yellowstone cutthroat can be found in perennial South Hill's tributaries to the Snake River, but, it is safe to deduce range and populations are only a fraction of what historically existed in this reach of the Snake River drainange (IDFG 1998c)."

2. "Native fish communities were adapted to riverine type conditions and habitats. Habitat modification due to impoundment, increased sedimentation resulting from conversion of native vegetation to agricultural uses, river and stream diversion for irrigation and hydropower, and the introduction of exotic fish species more tolerant of warmer water temperatures, stagnant flows, and lower dissolved oxygen levels have all, individually, proven to cause coldwater fish population declines. Every HUC and tributary listed [*on the §303(d) list*] has been impacted by one or more of these habitat modifiers. It would, therefore, be logical to assume present fisheries status is diminished when compared to historic range and actual numbers (IDFG 1998c)."

3 "Historical native fish communities in the Snake River and tributaries from Shoshone Falls downstream to King Hill predominantly focused on anadromous fish along with other prominent species such as bull trout, white sturgeon, mountain whitefish, and the resident Redband trout. Several varieties of nongame fish including sculpin, suckers, and a host of native cyprinids provided forage for piscivorous fish and wildlife. Spring areas and tributaries were the primary spawning and juvenile rearing habitats for both native and anadromous fish species. Today, several of these species are no longer sampled within the reach, either because of degradation of water quality or construction of dams which acted as fish migration barriers. The reach is dominated by exotic fishes which are more tolerant of warmer tempeatures, lower dissolved oxygen levels, and a river system with a streambed predominantly of fine sediments and macrophytes rather than gravels, rubble, and boulders. Spring areas and tributaries which were the primary spawning and juvenile rearing habitats for both native and anadromous fish species, now are captured for aquaculture, hydropower, agricultural irrigation, or municipal use prior to being returned to the Snake River in a degraded condition (IDFG 1998c)."

4. "Although comprehensive fisheries information hasn't been collected in every HUC, it's reasonable to conclude, all native fish species within this reach of the Snake River and tributaries are at depressed levels compared to their historic levels. Not enough information exists to evaluate changes between 1975 and the present, but, information we have collected coupled with literature reviewed from your agency and others regarding water quality and habitat modification would indicate conditions have not improved sufficiently to cause a rebound in individual populations or inhabited range (IDFG 1998c)."

Therefore, fish populations are depressed at the present time over historical numbers based on some native species of fish which are no longer sampled at sites which once were inhabited. Also, there is a general lack of age class diversity in wild fish populations sampled. Creek information indicates it takes longer time periods to collect fish compared to previously collected data. The proposed TMDL for Upper Snake Rock does not propose to restore fisheries to historical levels (as were known prior to the Clean Water Act or November 28, 1975), but rather to restore water quality standards and its designated beneficial uses to "full support" which allow for recovery of the species (either from themselves or by stocking regimes by the IDFG) within what the particular tributary or stream can attain based on pollutant reductions agreed to by industries. "Full support" is a broad category of water quality status such that a water body is in compliance with those levels of water quality criteria listed in Idaho's *Water Quality Standards and Wastewater Treatment Requirements*, or with reference conditions approved by the IDEQ Administrator in consultation with the appropriate Basin Advisory Group (IDEQ 1996a [p 48]). Other categories include: "Not full support," "Needs verification," or "Not assessed."

In the case of White sturgeon who do not migrate above Shoshone Falls, but inhabit the Snake River from Shoshone Falls downstream to the confluence of the Columbia River. It is a recent introduced native fish above Shoshone Falls. It is unique as a fish species because the construction and operation of the Middle Snake River impoundment projects, C.J. Strike, Swan Falls, and the Hells Canyon Complex all affect the viability of the white sturgeon. These projects have a wide range of impacts on white sturgeon, including: inundation of important sturgeon habitat, fragmentation and genetic isolation of populations due to inadequate project passage, entrainment, impacts to sturgeon food base due to water quality degradation and physical changes in the river environment, entrainment, and interference with spawning and rearing due to flow fluctuations. As a result of these and other impacts, none of the remaining populations of white sturgeon are strong, and some (such as the population between Shoshone Falls and Upper Salmon Falls Dam) are severely depleted. The Idaho Power Company dams below Shoshone Falls have additive effects on white sturgeon (FERC 1997b [p 4-5]). The Upper Snake Rock TMDL proposes to have pollutant reduction measures in place for the Middle Snake River and its water quality limited stream segments and reservoirs

that will allow for attainment of IDEQ's "full support" status.

2.2.3.7 SEPTIC TANK SYSTEMS

South Central District Health Department (Health District V) responsibilities on spetic tank systems is summarized in Table 49 based on information provided by Health District V personnel. The impact of any septic tank system on water quality is dependent on its upkeep and maintenance, and its location to canals, drains, and tributaries.

Table 49 Septic tank system estimates on a per county basis in Upper Snake Rock

County	*Rural Residences (Individual Households)*	*Number of People/Household*	*Number of Gallons/ Day/Household*
Twin Falls	6206	16,756.2	1,551,500.0
Jerome	6076	16,405.2	1,519,000.0
Gooding	4700	12,690.0	1,175,000.0
Total for 17040212	16982	45,851.4	4,245,500.0

Prepared by IDEQ-TFRO. Rural residences based on Twin Falls, Jerome, and Gooding counties' assessors' office. Health District V estimates 2.7 people per household and 250 gallons/day/household of sewage effluent. Values provided by Dan Kriz of Health District V.

Table 49 figures are more likely over estimates. Based on data provided by the Association of Idaho Cities (AIC 1997 directory), Twin Falls, Jerome, and Gooding counties have a total estimate population of 88,477. A summary of city estimate population for the same counties is 58,612. The city estimate makes up the urban population for Upper Snake Rock (which is 66.2% of the total population). The variance between the total county estimate population (88,477) and the city estimate population (58,612) is 29,865, or the rural population estimate (33.8%). Therefore, the 45,851.4 population estimated in Table 49 for Upper Snake Rock is an over estimate of the rural population estimate of 29,865 (according to AIC). This is critical to TMDL development since these estimates will help to determine the allocation percentages for the loadings to the various nonpoint sources. At 29,865 population, it is estimated that there exists 11,061.1 households (29,865/2.7=11,061.1) which provide 2,765,275.0 gallons/day/household (11,061.1x250=2,765,275.0) of sewage effluent.

2.2.3.8 RECREATIONAL USES AND ITS IMPACTS

"Generally, nonconsumptive recreation has not been directly linked with reductions in salmonid populations, but it has been coupled with water quality changes. Often, campgrounds or water-based recreation do not significantly lower water quality. Nonetheless, campgrounds accessible to automobiles increase bacterial water pollution more than do backpack campgrounds. Recreationist may also concentrate use in riparian zones and thus increase soil compaction and vegetation damage. Ski areas may significantly contribute amounts of sediment to streams, and could desynchronize snowmelt and lead to unusually high peak flows. Snow making at ski areas also can reduce streamflows. Due to poor sewage disposal, homes located in forested watersheds may elevate concentrations of coliform bacteria and nutrients in streams (USDA FS 1990b [p 23])."

"Under some circumstances, anglers possess the ability to alter the size, structure, and distribution of fish populations. Not all trout species are equally susceptible to angling. Data from various sources indicate that anglers more readily caught rainbow trout than brown trout, but both brown and rainbow trout greater than 30 cm were more susceptible to angling than were smaller fish. Based on available data, vulnerability to angling appears to be greatest for cutthroat trout, then brook trout, then rainbow trout, with brown trout seeming to be the least vulnerable. Also, susceptibility to capture by anglers apparently increaes with trout size (*USDA FS 1990b [p 23]*)."

"The Middle Snake River dams have affected recreation by inundating or dewatering unique features such as cascades and rapids and by leaving only two reaches for riverine recreation in project area. The projects have also made access to certain areas of the river more difficult and decreased the diversity of recreational opportunities in the area. In an important sense, recreational impacts are not distinct from other categories of impacts because good water quality as well as fishing, hunting, and wildlife viewing opportunities are all essential components of recreation. The population of the Magic Valley has grown significantly in the last ten years and recreational demands are increasing even more rapidly. The huge growth in whitewater boating on the Middle Snake River in recent years is an example of this trend (FERC 1997b [p 18])." A key component challenge facing the recreation industry is to provide reasonable access to the Middle Snake River for a growing population and to protect the area's special attractions, including the remaning springs and waterfalls and the Middle Snake River itself.

2.2.4 SUMMARY AND ANALYSIS OF EXISTING WATER QUALITY DATA

In addition, the DEQ reviewed its existing monitoring database on the Middle Snake River and its tributaries and statistically analyzed it on sediment and excess nutrients.

2.2.4.1 MIDDLE SNAKE RIVER

Data analysis of 986 samples of the Middle Snake River (1990-1997 monitoring seasons) is described in Table 50. Total nitrogen (TKN + NO2+NO3) had a median value of 1.353 mg/L. Total inorganic nitrogen (NO2+NO3 + NH3) had a median value of 0.955 mg/L. And, total organic nitrogen (TKN - NH3) had a median value of 0.398. SRP generally represented 28.7% of the median total phosphorus. See Appendix D for the various databases.

TABLE 50 WATER QUALITY PARAMETERS ON THE MIDDLE SNAKE RIVER (1990-1997)

PARAMETER	8-YEAR MINIMUM	8-YEAR AVERAGE	8-YEAR MAXIMUM	8-YEAR MEDIAN
TSS, mg/L	0.5	22.3	305.0	17.0
TP, mg/L	0.008	0.104	0.471	0.101
SRP, mg/L	0.002	0.040	0.268	0.029
TKN, mg/L	0.010	0.431	1.430	0.430
NH3-N, mg/L	0.003	0.045	0.503	0.032
(NO2+NO3)-N, mg/L	0.020	0.991	2.840	0.923
Turbidity, NTU	0.1	15.1	107.0	14.2
Flow (Q), cfs	1.7	8729.4	57355.0	5038.5

Prepared by IDEQ-TFRO. Data from the 1995-1997 monitoring seasons is summarized for all samples taken in the three year period. TSS = total suspended solids; TP = total phosphorus; SRP = soluble reactive phosphate; TKN =total Kjeldahl nitrogen; NH3-N = ammonia as nitrogen; (NO2+NO3)-N = nitrite + nitrate as N.

Additionally, a subset (1995-1997; N = 908) was selected that belonged exclusively to IDEQ-TFRO. The following percentages represent the number of samples that were found to be above (as an exceedence) or below the indicated water quality target.

1. INORGANIC NITROGEN (NITRITE + NITRATE or NOX)

Out of IDEQ-TFRO's 884 samples, 4 samples (or 0.50% of the samples) were below the

protective level (<0.06 mg/L NOX) for salmonid fish, and 89 samples (or 10.1% of the samples) were below the suggested prevention level (<0.3 mg/L NOX) for the development of biological nuisances and the acceleration of cultural eutrophication. Thus, 99.5% of the samples were well above the protective level for salmonid fish, and 89.9% of samples were well above the suggested prevention level for nuisance eutrophication. There is no statistical correlation in the mean NOX value per river mile location from upstream to downstream, although the NOX value averages had higher values downstream from Milner Dam: 0.276 mg/L NOX at Milner Dam, 1.067 mg/L NOX at Gridley Bridge, and 0.866 mg/L NOX at King Hill.

2. AMMONIA

Out of IDEQ-TFRO's 884 samples, 5 samples (or 0.57% of the samples) exceeded the protective level (<0.02 mg/L NH_3^0 as a toxic substance) for fisheries. Thus, 99.43% of the samples were below the protective level for fisheries. Those samples which were exceedences are summarized in Table 51.

TABLE 51 UN-IONIZED AMMONIA EXCEEDENCES (>0.020 mg/L) ON THE MIDDLE SNAKE RIVER

RIVERMILE SEGMENT	*NH_3^0, mg/L*	*DATE*
617.3, Twin Falls Reservoir	0.032	23 Apr 1991
617.3, Twin Falls Reservoir	0.026	21 May 1991
600.9, Crystal Springs	0.022	31 Mar 1995
599.4, Niagara Springs	0.022	08 Aug 1995
588.0, Below Box Canyon	0.021	08 Aug 1995

Prepared by IDEQ-TFRO. The un-ionized fraction of total ammonia may be calculated from the equilibrium stoichiometric relationship NH3 + nH20 = NH3:nH2O = NH4 + OH + (n-1)H2O. Most water quality models predict the concentration of measured ammonia in units of weight/volume as a resultant of processes of nitrification, ammonification, respiration, and assimilation. Therefore, Un-ionized NH3, mg/L = (1.4 * X)/(1 + R), where X = total ammonia, mg/L; R = 10^Exponent; Exponent = (0.09018)+(2729.92/C+273.15)-(pH); C = degrees Centigrade (USEPA 1985 [pp 261-264].

3. TOTAL PHOSPHORUS (TP)

Out of IDEQ-TFRO's 884 samples, 130 samples (or 14.7% of the samples) were below the water quality target (<0.075 mg/L TP) for the suggested preliminary prevention level for the development of biological nuisances and the acceleration of cultural eutrophication. Thus, 85.3% of the samples were well above the suggested prevention level for nuisance eutrophication. There is no statistical correlation in the mean TP value per river mile location from upstream to downstream, although the TP value averages had higher values downstream from Milner Dam: 0.089 mg/L TP at Milner Dam, 0.101 mg/L TP at Gridley Bridge, and 0.113 mg/L TP at King Hill.

In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-1999), irrigation season (April 15 to October 15) versus nonirrigation season (October 16 to April 14) were reviewed preliminarily for seasonality issues. TP in the larger dataset (N=986) had a mean of 0.104 mg/L, with an irrigation season mean (N=542) of 0.099 mg/L and a nonirrigation season mean (N=420) of 0.109 mg/L. Additionally, the SRP to TP percentage was 38.5% in the larger dataset, but averaged 34.3% in the irrigation season and 43.1% in the nonirrigation season.

4. TOTAL SUSPENDED SOLIDS (TSS)

Out of IDEQ-TFRO's 908 samples, 48 samples (or 5.3% of the samples) were above the suggested monthly average (52 mg/L TSS) target. Thus, 94.7% of the samples were well below the suggested monthly target. In general, there is a statistical correlation (r^2 = 0.729, F-ratio = 19.3, p = 0.000) in the mean TSS value per river mile location increasing from upstream to downstream: from 7.8 - 19.7 mg/L TSS at RM613.4 - 638.7 (Pillar Falls to Milner Dam), to 21.8 - 28.0 mg/L TSS at RM579.5 - 603.6 (Upper Salmon Falls Dam to Pigeon Cove), to 38.1 - 43.8 mg/L TSS at RM545.0 - 565.7 (Below King Hill Bridge to Shoestring Bridge near Bliss).

In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-1999), irrigation season (April 15 to October 15) versus nonirrigation season (October 16 to April 14) were reviewed preliminarily for seasonality issues. TSS in the larger dataset (N=986) had a mean of 22.3 mg/L, with an irrigation season mean (N=555) of 24.7 mg/L and a nonirrigation season mean (N=431) of 19.1 mg/L.

5. TURBIDITY (NTU) AND TOTAL SUSPENDED SOLIDS (TSS)

Of IDEQ-TFRO's 908 samples, there is a linear correlation between NTU versus TSS over the range 0.5 to 240.6 mg/L TSS, such that r^2 = 0.765, F-ratio = 1281.9, and p = 0.000. The linear regression equation states: NTU = (0.418 x TSS) + 6.423. Thus, at a monthly average of 52 mg/L TSS target, it is expected that the turbidity would be about 28.2 NTU (or 28.2 = (0.418 x 52)+6.423). At a daily maximum of 83 mg/L to allow for spikes during flood events, the turbidity is expected to be about 41.1 NTU (or 41.1 = (0.418 x 83)+6.423). Only 8 samples exceeded the 83 mg/L daily maximum, or 0.9% of the samples were greater than 83 mg/L. The mean value for the 908 samples is 16.0 NTU; the median is 15.4 NTU; the minimum value is 0.1 NTU; and, the maximum value is 107.0 NTU. Approximately, 10.2% (or 93 out of 908 samples) of the samples showed turbidity levels greater than 28.2 NTU (or the equivalent 52 mg/L TSS target).

Additionally, in IDEQ-TFRO's 908 samples, there is a statistical correlation (r^2 = 0.555, F-ratio = 7.6, p = 0.014) in the mean NTU value per river mile location increasing from upstream to downstream: from 8.9 - 12.8 NTU at RM613.4 - 638.7; to 15.2 - 18.6 NTU at RM579.5 - 603.6; to 19.8 - 25.2 NTU at RM545.0 - 565.7. In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-199), the overall mean for turbidity was 15.1 NTU, the irrigation mean was 16.3 NTU, and the nonirrigation mean was 13.5. The larger dataset (N=986) also showed a statistical correlation (r^2=0.284, F-ratio=86.0, p=0.000) in the mean NTU value per river mile location increasing also from upstream to downstream: from 8.4 - 12.6 NTU at RM 613.4 - 638.7; to 14.3 - 18.4 NTU at RM 579.4 - 603.6; to 20.7 - 24.2 NTU at RM 545.0 to 565.7.

ERI, in their short term study, developed similar linear relationships but over the range 5 to 30 mg/L TSS in various locations (Twin Falls, Shoshone Falls, Upper & Lower Salmon Falls reservoirs) on the Middle Snake River (ERI 1997 [pp 67-70]). The following compares ERI's dataset to IDEQ-TFRO's datasets in the NTU versus TSS relationship:

a. ERI 1997 Reservoir Study on the Middle Snake River:
   NTU=(0.7098 x TSS) - 2.4826, r^2=0.497 (Four Reservoirs together)
   NTU=(0.7825 x TSS) - 3.2142, r^2=0.622 (Twin Falls & Shoshone Falls Reservoirs)
   NTU=(0.6547 x TSS) - 2.3017, r^2=0.409 (Upper Salmon Falls Reservoir)

NTU=(1 0933 x TSS) - 7 3718, r^2=0.760 (Middle Snake River)

b IDEQ-TFRO's Dataset(s) on the Middle Snake River:
NTU=(0 4180 x TSS) + 6.423, r^2=0.765 (1995-1997 Dataset; N=908)
NTU=(0.4070 x TSS) + 6.032, r^2=0 749 (1990-1997 Dataset; N=986)
NTU=(0.3880 x TSS) + 6.710, r^2=0.734 (Irrigation Season; N=555)
NTU=(0.4560 x TSS) + 4.836, r^2=0.776 (Nonirrigation Season; N=431)

2.2.4.2 MAJOR TRIBUTARY FLOWS AND WATER QUALITY PARAMETER COMPARISONS

Table 52 describes the average eight (8) year flow, the minimum and maximum flows from the monitoring data on the major tributaries of the Upper Snake Rock subbasin from 1990 through 1997. See Appendix D.

TABLE 52 MINIMUM, MEAN, AND MAXIMUM FLOWS PER MAJOR TRIBUTARY

TRIBUTARY	*MINIMUM FLOW, cfs*	*MEAN FLOW, cfs*	*MAXIMUM FLOW, cfs*
East Perrine Coulee	2.80	29.27	91.15
Rock Creek	68.71	219.91	480.93
Cedar Draw	2.91	130.44	505.38
Mud Creek	29.55	102.09	295.60
Deep Creek	14.78	92.38	314.78
Salmon Falls Creek	35.00	146.22	363.00
Billingsley Creek	39.94	120.78	189.28
Malad River	1.30	306.42	2790.00
Clover Creek	2.30	30.39	300.00
TOTAL FLOW	197.29	1177.90	5330.12
Prepared by IDEQ-TFRO. It is highly unlikely that all maximum flows coincide in time.			

Implications and characteristics from these loading tables per parameter per tributary are summarized in Table 53. TP/TSS and SRP/TP ratios are converted to percentages (multiplying by 100) and are based on the overall mean of Years 1990 through 1997 per parameter. Total inorganic nitrogen (TIN) and total organic nitrogen (TON) are also described.

TABLE 53 SELECT CHARACTERISTICS PER INDICATED STREAM

TRIBUTARY	*PERCENT as TP/TSS x 100*	*PERCENT as SRP/TP x 100*	*TIN in tons/yr (% of TN)*	*TON in tons/yr (% of TN)*	*TN tons/year*
East Perrine Coulee	0.21	32.4	69.3 (78.8)	18.7 (21.2)	88.0
Rock Creek	0.26	46.1	448.7 (78.7)	121.4 (21.3)	570.1
Cedar Draw	0.25	33.6	228.8 (75.7)	73.6 (24.3)	302.4
Mud Creek	0.44	50.6	258.0 (83.8)	49.8 (16.2)	307.8
Deep Creek	0.29	34.7	208.6 (78.5)	57.1 (21.5)	265.7
Salmon Falls Creek	0.27	44.6	392.1 (86.6)	60.6 (13.4)	452.7

TRIBUTARY	PERCENT as TP/TSS x 100	PERCENT as SRP/TP x 100	TIN in tons/yr (% of TN)	TON in tons/yr (% of TN)	TN tons/year
Billingsley Creek	1.48	59.3	138.0 (88.7)	17.6 (11.3)	155.6
Malad River	0.20	33.2	64.3 (28.0)	165.4 (72.0)	229.7
Clover Creek	0.39	46.7	1.45 (24.6)	4.45 (75.4)	5.9

Prepared by IDEQ-TFRO. TIN=Total Inorganic Nitrogen = NOX + NH3; TON = Total Organic Nitrogen = TKN - NH3; TN = Total Nitrogen = TON + TIN. Billingsley Creek based on 1990 to 1996 values. TP/TSS and SRP/TP ratio based on 8 year mean.

The TP/TSS percentage ranking indicates that Billingsley Creek was greatest (1.48%), followed by Mud Creek (0.44%), Clover Creek (0.39%), Deep Creek (0.29%), Salmon Falls Creek (0.27%), Rock Creek (0.26%), Cedar Draw (0.25%), East Perrine Coulee (0.21%), and Malad River (0.20%). The SRP/TP percentage indicates that Billingsley Creek was greatest (59.3%), followed by Mud Creek (50.6%), Clover Creek (46.7%), Rock Creek (46.1%), Salmon Falls Creek (44.6%), Deep Creek (34.7%), Cedar Draw (33.6%), Malad River (33.2%), and East Perrine Coulee (32.4%). With the exception of the Malad River and Clover Creek, all tributaries had TIN values (75.7 - 88.7%) that were much greater than the TON values. The ranking of the tributaries with the most total nitrogen was Rock Creek (570.1 tons/year), followed by Salmon Falls Creek (452.7 tons/year), Mud Creek (307.8 tons/year), Cedar Draw (302.4 tons/year), Deep Creek (265.7 tons/year), Malad River (229.7 tons/year), Billingsley Creek (155.6 tons/year), East Perrine Coulee (88.0 tons/year), and Clover Creek (5.9 tons/year).

1. INORGANIC NITROGEN (NITRITE + NITRATE as NOX)

Samples which were at a protective level for salmonid fish (<0.06 mg/L NOX) and below the suggested prevention level (<0.3 mg/L NOX) for the development of biological nuisances and the acceleration of cultural eutrophication are summarized in Table 54.

Table 54 Inorganic nitrogen (NOX) for protection of salmonid fish and prevention of biological nuisances

Tributaries	Salmonid Fish Protection #<0.06 mg NOX/L per N	% Protected	Biological Nuisance Prevention #<0.30 mg NOX/L per N	% Prevention
East Perrine Coulee	0 out of 225	0.0	0 out of 225	0.0
Rock Creek	0 out of 288	0.0	1 out of 288	0.3
Cedar Draw	1 out of 277	0.4	2 out of 277	0.7
Mud Creek	0 out of 277	0.0	0 out of 277	0.0
Deep Creek	0 out of 275	0.0	1 out of 275	0.4
Salmon Falls Creek	0 out of 270	0.0	0 out of 270	0.0
Billingsley Creek	0 out of 387	0.0	1 out of 387	0.3
Malad River	23 out of 80	28.8	39 out of 80	48.9
Clover Creek	4 out of 17	23.5	17 out of 17	100.0

Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.

2. UNIONIZED AMMONIA

A summary of unionized ammonia ($NH_3°$) exceedences is detailed in Table 55 for the tributaries listed.

Toxic exceedences were considered as values ≥ 0.020 mg NH_3/L which are not protective for fisheries.

Table 55 Unionized ammonia exceedences in tributaries of Upper Snake Rock from 1990 through 1997

Tributaries	*% Unionized of Total Ammonia*	*Number of Unionized Samples per N*	*Specific Dates and Concentrations*
East Perrine Coulee	0.0	0 out of 285	None found
Rock Creek	1.0	3 out of 288	03-18-91 = 0.035 07-01-91 = 0.058 03-07-97 = 0.044
Cedar Draw	3.6	10 out of 277	07-11-90 = 0.026 07-24-90 = 0.038 09-03-90 = 0.042 12-11-90 = 0.023 12-15-90 = 0.021 03-19-91 = 0.031 04-16-91 = 0.020 05-30-91 = 0.021 07-22-97 = 0.031 08-04-97 = 0.041
Mud Creek	5.4	15 out of 277	07-10-90 = 0.042 11-28-90 = 0.020 12-29-90 = 0.020 01-09-91 = 0.027 02-06-91 = 0.034 02-20-91 = 0.098 03-06-91 = 0.032 03-20-91 = 0.022 07-01-91 = 0.098 07-08-91 = 0.061 07-22-91 = 0.023 08-12-91 = 0.032 12-09-91 = 0.027 12-30-91 = 0.023 06-26-95 = 0.025
Deep Creek	2.5	7 out of 275	03-20-91 = 0.039 05-29-91 = 0.020 06-12-91 = 0.032 07-01-91 = 0.054 07-08-91 = 0.029 07-10-91 = 0.034 04-11-94 = 0.027
Salmon Falls Creek	0.5	2 out of 378	04-24-91 = 0.025 08-18-92 = 0.020
Billingsley Creek	8.4	35 out of 417	03/92 = 0.020 03/92 = 0.037 04/92 = 0.027 04/92 = 0.021 04/92 = 0.025 04/92 = 0.021 05/92 = 0.032 06/92 = 0.028 07/92 = 0.024 07/92 = 0.030 09/92 = 0.020 08/93 = 0.021 03/94 = 0.022 03/94 = 0.023 03/94 = 0.027 03/94 = 0.021 04/94 = 0.020 05/94 = 0.033 06/94 = 0.025 06/94 = 0.028 06/94 = 0.020 10/94 = 0.020 08/95 = 0.031 08/95 = 0.023 08/95 = 0.021 04/96 = 0.025 04/96 = 0.063 04/96 = 0.023 04/96 = 0.035 04/96 = 0.023 04/96 = 0.021 04/96 = 0.032 04/96 = 0.025 04/96 = 0.041 04/96 = 0.022
Malad River	0.0	0 out of 88	None found
Clover Creek	23.5	4 out of 17	01-15-97 = 0.020 02-12-97 = 0.043 05-28-97 = 0.021 06-09-97 = 0.025

Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring. The unionized fraction of total ammonia was calculated from the equilibrium stoichiometric relationship NH3 + nH2O = NH3:nH2O = NH4 + OH + (n-1)H2O. Most water quality models predict the concentration of measured ammonia in units of weight/volume as a resultant of processes of nitrification, ammonification, respiration, and assimilation. Therefore, unionized NH3, mg/L = (1.4*X)/(1+R), where X = total ammonia, mg/L; R = 10^Exponent; Exponent = (0.09018)+(2729.92/C+273.15)-(pH); C = degrees Centrigrade (USEPA 1985 [pp 261-264].

3. TOTAL PHOSPHORUS (TP)

Samples at or below the water quality target of 0.075 mg/L TP for the suggested preliminary prevention level for the development of biological nuisances and the acceleration of cultural eutrophication are listed in Table 56.

Table 56 Total phosphorus in tributaries of Upper Snake Rock

Tributaries	*#≤0.075 mg/L TP*	*% Prevention*
East Perrine Coulee	14 out of 225	6.2

Tributaries	# ≤ 0.075 mg/L TP	% Prevention
Rock Creek	20 out of 288	6.9
Cedar Draw	12 out of 277	4.3
Mud Creek	11 out of 277	4.0
Deep Creek	71 out of 275	25.8
Salmon Falls Creek	120 out of 270	44.4
Billingsley Creek	135 out of 387	34.9
Malad River	51 out of 80	63.8
Clover Creek	9 out of 17	52.9
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.		

4. TOTAL SUSPENDED SOILDS (TSS)

Table 57 summarizes on a per tributary basis the number of samples that exceed the preliminary 52 mg/L TSS instream target, and 83 mg/L daily maximum. Additionally, the percentage of samples that are above the proposed instream target is also calculated and summarized.

Table 57 Total suspended solids (TSS) that exceed the proposed instream target of 52 mg/L

Tributary	Number of TSS values > 52 mg/L	Number of TSS values > 83 mg/L	Percent of TSS values > 52 mg/L	Percent of TSS values > 83 mg/L
East Perrine Coulee	152 out of 225	111 out of 225	70.7	49.3
Rock Creek	125 out of 288	72 out of 288	43.4	25.0
Cedar Draw	152 out of 277	111 out of 277	54.9	40.1
Mud Creek	55 out of 277	21 out of 277	19.9	7.6
Deep Creek	81 out of 275	43 out of 275	29.5	15.6
Salmon Falls Creek	60 out of 270	16 out of 270	22.2	5.9
Billingsley Creek	0 out of 417	0 out of 417	0.0	0.0
Malad River	8 out of 79	2 out of 80	10.1	2.5
Clover Creek	0 out of 17	0 out of 17	0.0	0.0
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.				

5. TURBIDITY (NTU) AND TOTAL SUSPENDED SOLIDS (TSS)

Table 58 summarizes on a per tributary basis relationship/correlation between turbidity (as NTU) versus TSS. Their statistical significance is provided as well as what the estimated turbidity reading would be given 52 mg/L TSS.

Table 58 NTU versus TSS on a tributary basis and its significance

Tributary	NTU versus TSS equation	Parameters of Significance r^2	F-ratio	p	Equivalent NTU at 52 mg/L TSS
East Perrine Coulee	NTU=0.547TSS + 13.235	0.847	568.2	0.000	41.7
Rock Creek	NTU=0.530TSS + 3.535	0.893	1124.3	0.000	31.1
Cedar Draw	NTU=0.387TSS + 19.738	0.722	300.0	0.000	39.9
Mud Creek	NTU=0.219TSS + 23.685	0.267	21.1	0.000	35.1
Deep Creek	NTU=0.392TSS + 10.839	0.821	562.6	0.000	31.2
Salmon Falls Creek	NTU=0.881TSS - 4.471	0.770	388.6	0.000	41.3
Billingsley Creek	NTU=1.237TSS + 1.401	0.758	560.7	0.000	54.6
Malad River	NTU=0.075TSS + 0.579	0.332	9.6	0.003	4.5
Clover Creek	NTU=0.862TSS + 4.534	0.647	10.8	0.005	49.4
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.					

Temporal variation by Julian Day per NTU or TSS was also examined in order to account for the varying time periods from year-to-year from 1990 to 1997. Since NTU is correlated to TSS (as demonstrated in Table 58), it was necessary to know if NTU and/or TSS are increasing or decreasing from year-to-year. These are summarized as follows:

1. East Perrine Coulee has a weak increasing trend for NTU (NTU = 0.015 JULIAN + 51.147, r^2 = 0.159, *F*-ratio = 5.8, p = 0.017) while TSS appears to be stationary (r^2= 0.058, *F*-ratio = 0.7, p = 0.390).

2. Rock Creek has a weak increasing trend for both NTU (NTU = 0.010 JULIAN + 23.718, r^2 = 0.189, *F*-ratio = 10.6, p = 0.001) and TSS (TSS = 0.011JULIAN + 49.962, r^2 0.123, *F*-ratio = 4.4, p = 0.038).

3. Cedar Draw has an increasing trend in NTU (NTU = 0.017JULIAN + 26.344, r^2 = 0.297, *F*-ratio = 26.6, p = 0.000) and a TSS that appears stationary (r^2 = 0.034, *F*-ratio = 0.3, p = 0.568).

4. Mud Creek has a stationary NTU (r^2 = 0.042, *F*-ratio = 0.5, p = 0.482) but a weak decreasing TSS trend (TSS = -0.005JULIAN + 47.339, r^2 = 0.143, *F*-ratio = 5.8, p = 0.017).

5. Deep Creek has an increasing trend for NTU (NTU = 0.017JULIAN + 5.010, r^2 = 0.338, *F*-ratio = 35.2, p = 0.000) but a weak stationary trend for TSS (r^2 = 0.105, *F*-ratio = 3.1, p = 0.081).

6. Salmon Falls Creek has both a weak increasing trend for NTU (NTU = 0.008JULIAN + 14.264, r^2 = 0.152, *F*-ratio = 6.3, p = 0.012) and TSS (TSS = 0.007JULIAN + 25.207, r^2 = 0.148, *F*-ratio = 6.0, p = 0.015).

7. Billingsley Creek has a decreasing NTU trend (NTU = -0.004JULIAN + 13.075, r^2 = 0.161, *F*-ratio = 11.0, p = 0.001) but a stationary TSS trend (r^2 = 0.010, *F*-ratio = 0.04, p = 0.842).

8. Malad River has both an increasing trend for NTU (NTU = 0.002JULIAN - 0.037, r^2 = 0.321, *F*-ratio = 8.8, p = 0.004) and for TSS (TSS = 0.012JULIAN + 7.141, r^2 = 0.464, *F* = 21.1, p = 0.000).

9. Clover Creek has a decreasing NTU trend (NTU = -0.089JULIAN + 260.858, r^2 = 0.626, *F*-ratio = 9.7, p = 0.007) and a stationary TSS trend (r^2 = 0.374, *F*-ratio = 2.4, p = 0.139).

2.2.4.4 TRIBUTARY FECAL BACTERIA DATA ASSESSMENT

Table 59 describes per indicated tributary the bacteria assessment based on bacteria monitoring from 1990 through 1997. Assessment is based on the number of instantaneous samples that had exceedences greater than 500 colonies/100 mL of water for primary contact recreation (PCR), and the number of instantaneous samples that had exceedences greater than 800 colonies/100 mL of water for secondary contact recreation (SCR) from 1990 through 1997. See IDAPA §16.01.02.100.03.a and 16.01.02.250.01.a for primary contact recreation, and IDAPA §16.01.02.100.03.b and 16.01.02.250.01.b for secondary contact recreation. A weighted means analysis was also conducted between the fecal value for PCR and the fecal value for SCR to arrive at a weighted means value for ranking of the tributaries according to both criteria. Finally, a comparison of the geometric mean and the arithmetic mean of the fecal data was conducted as irrigation season versus nonirrigation season versus overall year.

Table 59 Bacteria assessment summary of primary and secondary contact recreation (1990-1997) on tributaries

Tributaries	*Primary Contact Recreation % Samples > 500 Fecal Colonies*	*Secondary Contact Recreation % Samles > 800 Fecal Colonies*	*% Weighted Means Assessment Analysis (PCR+SCR)*	*Means Comparisons Geomean (Arithmetic Mean)*		
				Overall Means	*Irrigation Means*	*Non Irrigation*
East Perrine Coulee	66/225 = 29.3%	30/225 = 13.3%	24.3% (N=96)	270(731)	410(970)	96(143)
Rock Creek	69/246 = 28.0%	42/246 = 17.1%	23.9% (N=111)	214(467)	398(583)	58(223)
Cedar Draw	80/225 = 35.6%	35/225 = 15.6%	29.5% (N=115)	233(664)	541(937)	36(58)
Mud Creek	111/227 = 48.9%	77/227 = 33.9%	42.8% (N=188)	413(750)	725(1006)	123(198)
Deep Creek	36/224 = 16.1%	13/224 = 5.8%	13.4% (N=49)	146(305)	289(396)	30(97)
Salmon Falls Creek	17/270 = 6.3%	11/270 = 4.1%	5.4% (N=28)	96(867)	127(184)	54(2278)
Billingsley Creek	44/421 = 10.5%	27/421 = 6.4%	8.9% (N=71)	81(437)	77(511)	87(351)
Malad River	5/23 = 21.7%	5/23 = 21.7%	21.7% (N=10)	45(3571)	63(4913)	26(1382)
Clover Creek	2/17 = 11.8%	0/17 = 0%	11.8% (N=2)	48(95)	41(79)	156(213)

Prepared by IDEQ-TFRO. FECAL COLI. = FECAL COLIFORM. Weighted means assessment analysis = [(N1 x %1) + (N2 x %2)] / NT; where, N1 = population of Primary Contact Recreation (PCR) sample, N2 = population of Secondary Contact Recreation (SCR) Sample.

Ranking the fecal coli. samples in the primary and secondary contact recreation areas according to % exceedence provides the following assessment:

1. For primary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (48.9%), Cedar Draw (35.6%), East Perrine Coulee (29.3%), Rock Creek (28.0%), Malad River (21.7%), Deep Creek (16.1%), Clover Creek (11.8%), Billingsley Creek (10.5%), and Salmon Falls Creek (6.3%).

2. For secondary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (33.9%), Malad River (21.7%), Rock Creek (17.1%), Cedar Draw (15.6%), East Perrine Coulee (13.3%), Billingsley Creek (6.4%), Deep Creek (5.8%), Salmon Falls Creek (4.1%), and Clover Creek (0%).

3. For a weighted means analysis of primary and secondary contact recreation values to rank the tributaries from the most-to-least exceedences are: Mud Creek (42.8%), Cedar Draw (29.5%), East Perrine Coulee (24.3%), Rock Creek (23.9%), Malad River (21.7%), Deep Creek (13.4%), Clover Creek (11.8%), Billingsley Creek (8.9%), and Salmon Falls Creek (5.4%).

4. The means comparison of the geometric mean to the arithmetic mean indicates that in most cases, the irrigation season had fecal coliform levels much greater than the nonirrigation season. Exceptions to this are Salmon Falls Creek which increases when comparing its arithmetic mean and Clover Creek which increases in both geometric and arithmetic means.

2.2.5 IDENTIFICATION OF ANY DATA GAPS

"Generally, monitoring programs are financially constrained to a limited number of sampling days. It is difficult to make inferences about a monthly or biweekly monitoring program from these types of results (ERI 1997)." Therefore, data gaps still deemed necessary and essential to better describe and understand the Middle Snake River system may include the following:

1. "The most serious data gap in the water quality data of Upper Snake Rock is diel pattern studies for continuous number of days and months (ERI 1997)."

2. Trend monitoring over a 12-month period when compared to a fraction of the year is more descriptive of the system, particularly when attempting to make inferences about the water quality and its seasonality. Sufficient data should be collected to allow for this type of analysis.

3. Twelve (12) month surveys should be reviewed from the standpoint of irrigation (April 15 to October 15) versus non-irrigation (October 16 to April 14) seasons. Sufficient data should be collected to allow for this type of comparison.

4. Macrophyte biomass data should be collected so as to correlate samples taken in low flow years versus samples taken in better or high flow years.

5. "The determination of the reference condition primarily from reference sites is based on the premise that streams minimally affected by human activity will exhibit biological conditions most natural and attainable for streams in the region (USEPA 1996c [pp 29-30])." In practise, most reference sites will have some impacts, but not substantial enough for the stream to not meet its beneficial uses. Reference sits should be considered more seriously in developing any monitoring plan.

6. A coordinated monitoring program between agencies, organizations, and industries, should be maintained and reviewed again and more definitively used to bring all stakeholders into the monitoring realm for total phosphorus, sediment, and other essential water quality parameters.

7. "It is important to note that listing impaired waters by State standards, segments, or

PNWRS may in some cases, significantly overstate the spatial extent of the water quality problem. It should be understood that the listing of a specific segment does not necessarily imply that the entire length or area of that segment is affected (Biswas H and Mabbitt ML 1988 [p 1-2])." Over a period of monitoring years, an effort should be made to specifically characterize the listed stream segment so that what is affected is inventoried against what is not affected.

8. In order to develop a more holoistic understanding of un-ionized ammonia and its effects on fisheries, one must consider it in conjunction with other parameters. It should be noted that until 1962 only un-ionized ammonia was considered toxic (Mead 1985 [p 138]). Synergistic effects must be considered also in order to establish safe levels of combined toxicants (Mead 1985 [p 137]) for such things as ammonium, dissolved oxygen, carbon dioxide, pH, temperature, and ionic gradients. In fact, sublethal effects of un-ionized ammonia may be related to ammonium and ambient sodium concentrations (Mead 1985 [p 139]). Until such synergistic effects are researched in greater detail, the preliminary use of maximum concentration limits will have to suffice, based on appropriate fisheries research.

9. "There is no doubt that sediment is the primary pollutant which impacts fish habitat more than any other. Literature has long documented the roll of sediment in substrate compaction and cementing as it relates to spawning gravels and loss of interstitial wintering habitats, loss of pool habitats, reduction in insect diversity, providing a nutrient rich growing media for macrophytes which can contribute to diel oxygen fluctuations, etc. It's safe to say that every stream listed [*on the §303(d) list*] has suffered from sediment inputs greater than what can be hydrologically transported under the current modified hydrographs. Even spring-fed streams such as Billingsley Creek and Crystal Springs have experienced sediment deposition from agricultural run-off and aquaculture which has caused major modifications to streambed substrate resulting in a reduction in carrying capacity of the streams to support native fish populations (IDFG 1998c)." Any monitoring plan should include at a bare minimum total suspended solids analysis.

10. "There is no doubt, from a fisheries perspective, eliminating excessive sediment from a riverine system will result in improved habitat conditions for native fish populations. What is a reasonable time-frame for recovery of a fishery? The science does not exist to answer this question. It is our opinion, however, any action taken which results in an upward trend in native fish populations should be considered reasonable. It's recognized by all agencies that fish and wildlife habitats and populations were not destroyed over-night by degraded water quality and they will not recover immediately once the stressor or pollutant is removed from the system. Don't confuse this statement with a lack of urgency for action to reduce sediment and nutrient inputs! Native fish and other freshwater based biological populations are continuing their spiral towards the point of no recovery as evident by the number of aquatic species listed or proposed for listing within the last 10 years under the federal Endangered Species Act. Actions taken to improve water quality will undoubtedly have a positive impact on all native species within the Snake River drainage (IDFG 1998c)." Where applicable, efforts should be made to include bedload sediment analysis as part of the monitoring regime or plan.

11. "Aquatic biological populations, like all biological populations, are constantly in a state of flux. Due to sampling limitations there is no way to accurately estimate population numbers of any one species for the Middle Snake River. What we can do is look at general trends in populations, over time, at limited locations. Using this information to make specific population projections for Mid-Snake fish populations is risky at best. Some drawbacks to

keep in mind are: sampling was done just along the shoreline using electrofishing equipment (areas and shocking depth are variable and equipment is biased towards larger fish); there is seasonal variations isn use of shallow water habitats by the difference fish species; the areas selected for sampling may not have been representative habitats for the Mid-Snake Reach (described as "general sample areas" in the text); and, the stated purpose of the study was to look at the general species composition of the fish community in short reaches of the Mid-Snake (See also IDFG 1998b)." Any biological monitoring plan should take into account these drawbacks and attempt to get above and beyond them.

2.3 POLLUTANT SOURCE INVENTORY

Table 60 summarizes the pollutant sources within the Upper Snake Rock subbasin for specific streams listed on the 303(d) list or which are known to be impaired (like East Perrine Coulee). For point sources, the number of aquaculture, POTW, and food processing facilities are identified. For nonpoint sources, a simple YES or NO tells if the stream is affected by the particular nonpoint source activity based on known historical information. Nonpoint sources include grazing, agriculture, forestry, CFOs, recreation, and FERC licensed facilities. During TMDL development the IDEQ-TFRO and the Mid-Snake WAG/TAC will determine the extent to which these sources affect the various water bodies.

TABLE 60 GENERAL INVENTORY OF POINT AND NONPOINT SOURCES

WATERBODY IDENTIFICATION	INVENTORY OF POINT AND NONPOINT SOURCES									
	POINT SOURCES				NONPOINT SOURCES					
	A/Q	POTW	FOOD	INDUS	FERC	GRAZE	AG	FOREST	CFOs	REC
Alpheus Creek	0	0	0	0	0	0	0	0	0	Yes
Billingsley Creek	8	0	0	0	2	Yes	Yes	0	Yes	Yes
Blind Canyon Creek	1	0	0	0	1	Yes	Yes	0	Yes	0
Cedar Draw	9	1	0	0	2	Yes	Yes	0	Yes	Yes
Clear Springs	5	0	0	0	1	0	Yes	0	Yes	Yes
Clover Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Cottonwood Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Crystal Springs	1	0	0	0	0	0	Yes	0	Yes	Yes
Deep Creek	6	0	0	0	1	Yes	Yes	0	Yes	Yes
Dry Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Dry Creek, West Fork	0	0	0	0	0	Yes	Yes	0	Yes	Yes
McMullen Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Mud Creek	10	1	0	0	2	Yes	Yes	0	Yes	Yes
East Perrine Coulee	0	0	0	0	1	Yes	Yes	0	Yes	Yes
Riley Creek	2	0	0	0	0	0	Yes	0	0	Yes
Rock Creek	8	0	1	2	2	Yes	Yes	0	Yes	Yes
Sand Springs Creek	1	0	0	0	1	0	Yes	0	0	Yes
Middle Snake River	37	4	2	0	18	Yes	Yes	0	Yes	Yes
Tool Box Creek	0	0	0	0	0	Yes	0	0	0	Yes
Total No. Facilities	88	6	3	2	31	?	?	?	?	?
% Streams Affected	50%	14%	9%	5%	45%	77%	95%	0%	86%	91%

Prepared by IDEQ-TFRO: A/Q = Aquaculture; POTWs = Privately owned treatment works or sewage treatment plants; FOOD = Food processors; FERC = FERC-type facilities for power generation and/or damming; INDUS = Industrial-type facilities; GRAZE = Grazing; AG = both irrigated and nonirrigated agriculture; FOREST = Forestry; CFOs = Confined Feeding Operations; REC = Recreation.

From this table several conclusions may be drawn. First, point sources affect the listed waterbodies in the following amounts: aquaculture affects 50% of the streams, POTWs affect 14% of the streams, food processors affect 9% of the streams, and industrials affect 5% of the streams. Second, although no specific numbers of farms or operations are determined at this time for nonpoint sources, the affect of nonpoint sources for the listed waterbodies may be characterized by the following relative amounts: agriculture affects 95% of streams, recreation affects 91% of the streams, CFOs affect 86% of the streams, grazing affects 77% of the streams, forestry affects none of the streams (0%), and FERC facilities affect 45% of the streams. It should be noted that these effects, whether from point or nonpoint sources, are not necessarily negative on water quality if the overall impact to tributaries and the Middle Snake River is below the assimilative capacity of the particular tributary or river system.

2.3.1 IDENTIFICATION OF POINT AND NONPOINT SOURCES

Specific point sources and general nonpoint sources for the table in §2.3 are identified in the following subsections per listed waterbody. For nonpoint sources, the IDEQ-TFRO has identified overall an inventory of 779 major CFOs (dairies, feedlots, cow-calf operations) in the same area: 309 in Twin Falls County, 258 in Gooding County, and 212 in Jerome County although their effect on specific streams is unknown at this time. Of these, 122 dairies are in Twin Falls County, 126 dairies in Gooding County, and 92 dairies in Jerome County, or a total of 340 dairies in Upper Snake Rock (Cizmich & McMasters 1998). In general, the Upper Snake Rock subbasin has nonpoint source land uses that are estimated to be: 2.36% dryland agriculture, 1.98% forest, 16.63% irrigated agriculture—gravity flow, 5.23% irrigated agriculture—sprinkler, 50.58% rangeland, 20.75% riparian vegetation, 1.2% urban, and 1.3% water (Archview 1996).

For FERC licensed hydroelectric facilities, these are exempt from NPDES permit requirements on the grounds that the change in water condition following its discharge over or through the dam does not constitute a "discharge of pollutants" within the meaning of the Clean Water Act. This was based on a U.S. Court of Appeals, District of Columbia Circuit, dated September 13, 1982. As of May 1, 1998, the NPDES permits for the facilities on the Middle Snake River (namely, Bliss Power Plant, NPDES 00257-8; Lower Malad Power Plant, NPDES 002258-6; Upper Malad Power Plant, NPDES 002259-4; Lower Salmon Power Plant, NPDES 002260-8; Upper Slamon Plant "A," NPDES 002261-6; Upper Salmon Plant "B," NPDES 002262-4; Thousand Spirings Power Plant, NPDES 002263-2; Clear Lakes Power Plant, NPDES 002264-1; Shoshone Falls Power Plant, NPDES 002265-9; Twin Falls Power Plant, NPDES 002266-7) have been terminated.

As of this writing, the aquaculture industry in Idaho is undergoing NPDES permitting requirements on a General Permit for total suspended solids and total phosphorus, and other pollutants where applicable. For the Middle Snake River facilities an interim effluent limit will be used for a period of three years. Data collected during that period will be used to develop a wasteload allocation so that the industry as a whole does not exceed 970.2 lbs/day. Food processors and municipalites are also undergoing NPDES permitting requirements, but on individual permits. These already have pre-assigned wasteload allocations which are being translated into effluent limits in their permits.

Of major concern in identification of point and nonpoint sources is the effect from sediment, and particularly from nonpoint sources that contribute to it. This pollutant is identified in all the water quality limited stream segments as a source of impairment to the designated and existing beneficial uses. As described in §2.1.2.3, Upper Snake Rock has 54% desert shrubland grazing land. "Available data indicates sediment yields from rangelands are less than one (1) ton per acre (range of ½ to ¾ ton). Much of this appears to come from steep and eroding channel banks and during high water runoff periods. Erosion from seriously overgrazed or burned ranges will occur if heavy rain should fall before vegetation regrowth or re-establishment occurs. The most serious potential erosion of rangeland occurs on slopes greater than 30% (ISCC 1979)." Additionally, agriculture represents 41% of the land use in Upper Snake Rock. Sediment contributions more notably may come from irrigation runoff or from tailwater in fields that has collected sediment loads which eventually works

itself into canal systems which eventually end up in associated tributaries and the Middle Snake River

2.3.1.1 ALPHEUS CREEK (SPRINGS)

Blue Lakes Spring is typical of many large springs issuing from the Eastern Snake Plain Aquifer System. It issues from a major interbed, although the specific interbed is covered with talus and windblown sand and is not visible. The orifice of the spring is adequately defined and flows out over a wide area and flows into Upper Blue Lake (water surface elevation 3294.0 feet). The flows into Upper Blue Lake range from 165 cfs to 235 cfs. It is estimated that since 1950 the flow has decreased by 21% (based on USGS gaging station at the mouth of Upper Blue Lake). From Upper Blue Lake, the water flows into Lower Blue Lake (water surface elevation 3288.1 feet). A large volume of the flow disappears through the porous formation in the bottom of Lower Blue Lake. Only 5 cfs to 7 cfs flows out of the Lower Blue Lake. The rest of the water travels through the porous rock formations to again resurface in Alpheus Spring near the Blue Lakes Country Club with a flow of approximately 200 cfs (JUB 1993). From here to where it hits the first main diversion at Blue Lakes Trout Farm main headquarters, this is known as Alpheus Creek. After this diversion there is no longer a true Alpheus Creek. Instead, the creek has been channelized and diverted into what is locally called Perrine Ditch (or Alpheus Ditch) which feeds two aquaculture facilities (Blue Lakes Trout Farm and Pristine Springs) on the north side of the Middle Snake River. At the main diversion, water is diverted across the Middle Snake River to the south side of the Middle Snake River to the Canyon Springs aquaculture facility.

Therefore, Alpheus Creek has three aquaculture facilities that divert water from it: Blue Lakes Trout Farm (with processing plant, NPDES 000095-7) and Pristine Springs/Sunnybrook Warm Water facility (NPDES 002501-1) which divert water in series on the north side of the Snake River Canyon from Alpheus Ditch; and, Canyon Springs (NPDES 002731-6) which diverts water across the river to south side of the Snake River Canyon from the main diversion above Alpheus Ditch. Each of these aquaculture facilities discharges back to the Middle Snake River.

Additionally, the City of Twin Falls diverts water for its domestic supply and irrigation water for its residents, industry, and commerical users at the head of Upper Blue Lake Springs via four large pumps. The water is diverted from the north side of the Snake River Canyon (or North Rim) across the river through a 36" concrete cylinder pipe to the south side of the Snake River Canyon (or South Rim). Then, it is pumped into the Harrison Street tank (after chlorine disinfection), and finally pumped into the City distribution system.

There are no food processors, municipalities, or hydroelectric projects on Alpheus Creek, so it is prinicipally affected by nonpoint sources of pollution. Alpheus Creek is affected occasionally by nonpoint source storm water. As shown in §2.20, Alpheus Creek is listed for sediment, nutrients, and violations of the dissolved oxygen standard.

The Blue Lakes aquaculture facility has fresh spring water from Alpheus Ditch and two discharge points: one which functions as reuse effluent water for the Pristine Springs facility; and, the second which discharges to the Middle Snake River. The Pristine Springs aquaculture facility has input water from two sources: first, from the tail raceway water from the Blue Lakes facility which functions as reuse water; and then from fresh spring water from Alpheus Ditch. Pristine Springs has two discharge points: one discharge point goes directly to the Middle Snake River as discharge from the second set of raceways which are at a higher elevation; and, the other discharge point goes through the Whiskey Slew which has two additional spring sources that mingle at the hatchery house which then discharges to the Middle Snake River at a lower elevation (McMasters 1998b).

2.3.1.2 BILLINGSLEY CREEK

Billingsley Creek has eight aquaculture facilities that discharge to it. They take water from adjacent springs along the stream course or from Billingsley Creek itself. These facilities include: Rangen's Inc. (NPDES

002303-5), Schrank (Spring Creek Springs) Farm Ponds (NPDES _____), Charlie Johnson Farm Ponds (NPDES _____), Bill Jones Raceways (NPDES 000086-8), McFadden Farm Ponds (NPDES 002612-3), Idaho Springs/Gold Springs Ponds (NPDES 000073-6), Hidden Springs (NPDES 002440-6), Fisheries Development (NPDES 002499-6) and Tupper Ponds (not permitted). There are no city sewage treatment plants or food processing facilities discharging to the stream. There two hydroelectric facility, Billingsley Creek Plant (FERC 06208-01) and Fisheries Development Project (FERC 07885-06). Nonpoint sources include grazing operations permitting direct access to the stream for water and agricultural irrigation return flow to the stream. In 1991 Billingsley Creek was assessed by DEQ-TFRO to have water quality impairment: 75% from point sources (specifically, aquaculture) and 25% from nonpoint source pollution based on best professional judgement that nonpoint source pollution was fairly well contained (USEPA 1991). This assessment was challenged by the aquaculture industry, but no specific data was provided to defend the challenge. Nonpoint source land uses are estimated to be: 5.07% irrigated agriculture—gravity flow, 24.54% irrigated agriculture—sprinkler, 19.52% rangeland, and 50.88% riparian vegetation (Archview 1996).

2.3.1.3 BLIND CANYON

Blind Canyon has one aquaculture facility, Blind Canyon Hatchery (NPDES 002599-2), and one hydroelectric project, Blind Canyon Project (FERC 08375-04). No food processors or sewage treatment plants are located on the stream. Nonpoint source land uses for Blind Canyon are estimated to be 100% rangeland. Blind Canyon Springs nonpoint source land uses are estimated to be: 20.38% irrigated agriculture—sprinkler, 29.15% rangeland, and 50.59% riparian vegetation(s) (Archview 1996).

2.3.1.4 CEDAR DRAW

Cedar Draw has seven aquaculture facilities that discharge directly to it and two aquaculture facilities which indirectly discharge to it via a tributary, Tunnel Creek. The direct dischargers are: Rainbow Trout Farm Inc./Filer Hatchery (NPDES 000102-3), Yoder Farm Ponds with SEAPAC Processing Plant (NPDES 002423-6), Cedar Draw Hatchery (NPDES 002503-8), Olson Ponds (NPDES 002592-5, via "F"Coulee), Stutzman Farm Ponds (NPDES 002730-8), Rainbow Trout Farm Inc./Filer Processing (NPDES 000102-3), and SEAPAC (as previously identified). The indirect dischargers (via Tunnel Creek) are: Tunnel Creek Fish Farm (NPDES 002292-6) and Leo Martins Fish Farm (NPDES 002775-8). Additionally, the City of Filer Wastewater Treatment Plant discharges to Cedar Draw Creek. Two hydroelectric projects are also located on the stream: Cedar Draw Creek Project (FERC 08278-04) and Little Mac (FERC 06443-00). No food processors are located on the stream. Nonpoint source land uses are estimated to be: 99.43% irrigated agriculture—gravity flow and 0.57% riparian vegetation (Archview 1996).

2.3.1.5 CLEAR SPRINGS CREEK

Five aquaculture facilities discharge to Clear Springs Creek and Clear Springs Lake: Clear Lakes Trout Co./Processing Plant (NPDES 000101-5, via Clear Lakes), Middle Hatchery/Clear Springs Clear Lakes (NPDES 000093-1, via Clear Lakes), Snake River Hatchery/Clear Springs (NPDES 000075-2, via Clear Lakes), Clear Springs Processing Plant (NPDES 002688-3, via Clear Lakes), and Clear Lakes Trout Co./Processing Plant (NPDES 000101-5, via Clear Lakes). Additionally, there is a hydroelectric project that discharges to Clear Lakes Creek: IPC/Clear Lake Power Plant (NPDES 002264-1). No food processors or city sewage treatment plants discharge to the creek. Clear Lakes nonpoint source land uses are estimated to be: 99.43% irrigated agriculture—gravity flow and 0.57% riparian vegetation (Archview 1996).

2.3.1.6 CLOVER CREEK

There are no point sources discharging to Clover Creek from its headwaters to where it discharges into the Middle Snake River. It is affected 100% by nonpoint sources including grazing, agriculture, and confined

feeding operations (including feedlots, dairies, cow-calf operations, and cattle ranches). Nonpoint source land uses are estimated to be: 3.34% dryland agriculture, 14.50% irrigated agriculture---gravity feed, 5.01% irrigated agriculture---sprinkler, 48.58% rangeland, and 28.57% riparian vegetation (Archview 1996).

2.3.1.7 COTTONWOOD CREEK

There are no point sources discharging to Cottonwood Creek from its headwaters to where it discharges to Rock Creek. It is affected 100% by nonpoint sources including grazing, agriculture, and confined feeding operations (including feedlots, dairies, cow-calf operations, and cattle ranches). Nonpoint source land uses are estimated to be: 15.35% dryland agriculture, 10.58% irrigated agriculture---gravity flow, 71.22% rangeland, and 2.86% riparian vegetation (Archview 1996).

2.3.1.8 CRYSTAL SPRINGS

There is one aquaculture facility that discharges to Crystal Springs Creek and Crystal Springs Lake: Crystal Springs Trout Farm/Clear Springs (NPDES 000089-2). Magic Valley Steelhead Hatchery uses this spring for source water, but discharges to the Middle Snake River. No food processors or city sewage treatment plant discharge to the creek or lake. Nonpoint source land uses are estimated to be 100% riparian vegetation (Archview 1996).

2.3.1.9 DEEP CREEK

There are six aquaculture facilities that directly discharge to Deep Creek. These are: Deep Creek Trout Farm/Boswell Trout (NPDES 002515-1), Deep Creek Trout Farm (NPDES 002670-1), Peter's Farm Ponds/Kaufman Farm Ponds (NPDES 002424-4), Harder Livestock Partnership/Cox Farm Ponds (NPDES 002533-0), Dolana Farm Ponds (NPDES 002615-8), and Howell Farm Ponds (NPDES 002763-4, via irrigation canal). There are no city sewage treatment plants or food processors that discharge to the stream. But there is one hydroelectric power plant: Cox's Project (FERC 06850-00). Nonpoint source land uses are estimated to be: 21.39% dryland agriculture, 48.32% irrigated agriculture---gravity flow, 27.97% rangeland, and 2.32% riparian vegetation (Archview 1996).

2.3.1.10 DRY CREEK (MURTAUGH LAKE)

There are no point sources discharging to Dry Creek (Murtaugh Lake area) from its headwaters to where it discharges to Murtaugh Lake and afterwards to the Middle Snake River. It is affected 100% by nonpoint sources including grazing, agriculture, and forestry. Nonpoint source land uses are estimated to be: 18.12% irrigated agriculture---gravity flow, 13.55% irrigated agriculture—sprinklers, 36.11% rangeland, and 32.42% riparian vegetation. For the West Fork of Dry Creek, land use estimates are 100% rangeland (Archview 1996). USBLM states that the West Fork of Dry Creek is not affected by agriculture (irrigated or nonirrigated), but is strictly rangeland (USBLM 1998b).

2.3.1.11 MCMULLEN CREEK

McMullen creek is affected by nonpoint sources. No point sources are known to discharge to it. Nonpoint source land use estimates are estimated to be: 2.33% irrigated agriculture—gravity flow, and 97.67% rangeland (Archview 1996).

2.3.1.12 MUD CREEK

There are eight aquaculture facilities that directly discharge to Mud Creek. These are: Rainbow Trout Farm Inc./Buhl Hatchery (NPDES 000103-1), W & W Trout Farm (NPDES 002606-9), White's Trout Farm (NPDES

002604-2) Buhl Trout Rearing Facility/Bill Fulmer Trout Farm (NPDES 002674-3), Buhl Trout Farm/Blau Farm Ponds (NPDES 002673-5, via unnamed stream), First Ascent Fish Farm (NPDES 002777-4), Rocky Ridge Ranch (NPDES 002729-4), and Mi Vida Loca/Larry Compton (NPDES 002788-0). There are two aquaculture facilities that indirectly discharge to Mud Creek via Silo Creek: Juker Farm Ponds (NPDES 002618-2) and RCP (NPDES 002752-9). The City of Buhl Wastewater Treatment Plant discharges to the east fork of Mud Creek. No food processors discharge to Mud Creek. But there are two hydrolelectric projects on Mud Creek: Mud Creek Project (FERC 04769A02) and White Ranch Project (FERC 04115-06). Nonpoint source land uses are estimated to be 100% riparian vegetation (Archview 1996).

2.3.1.13 EAST PERRINE COULEE

East Perrine Coulee is not listed on the §303(d) list, but it is a major pollutant source. Perrine Coulee has no food processors, industrials, or municipalities that discharge to it. One aquaculture facility, Green's Trout Farm (NPDES 000096-5), discharges to East Perrine Coulee. There is one hydroelectric power generation project: K.W. Inc. (Kasel-Witherspoon (FERC 06410A01). Nonpoint source land use are estimated to be: 18.86% irrigated agriculture—gravity flow, 18.40% rangeland, 18.63% riparian vegetation, and 44.10% urban (Archview 1996). USDA/SCS suggests that the 18.40% rangeland is really "other land or recreational land," since in a strict sense it is not used as rangeland (USDA/SCS 1998).

"Additionally, Perrine Coulee does not contain any perennial streams. Several drainage branches carry excess rainfall and irrigation return flows to the Snake River Canyon. Rapid snowmelt may also add some winter and early spring flows to several branches of this natural drainage system. During the irrigation season all the drainages carry primary irrigation water or return flows. In some cases, the drainages terminate at topographical depressions and disappear into the underlying lava rock. This ground water feeds such small lakes as Dierkes Lake or appears as springs flows in the Snake River Canyon wall (SRSCD 1998)."

2.3.1.14 RILEY CREEK

There are two fish rearing aquaculture facilities that discharge untreated and treated wastewater directly to Riley Creek. These are: USFWS/Hagerman National (NPDES 000082-5) and IDFG/Hagerman State (NPDES 000080-9). The USFWS facility uses about 55 cfs of water collected from 12 springs, while the IDFG uses about 50-90 cfs of water diverted through the hatchery from Riley Creek and 40 cfs from springs (IDHW 1977b). No food processors or city wastewater treatment plants discharge to Riley Creek. And no hydroelectric projects are located on the creek as well. All domestic sanitary wastes in the area are treated by subsurface waste disposal system with the exception of the Idaho State Fish and Fame Wildlife Management Area which has a collection system for all private and public facilities which discharge to a total containment lagoon (IDHW 1977b).

2.3.1.15 ROCK CREEK

There are seven aquaculture facilities that discharge directly to Rock Creek. These are: Canyon Trout Farm (NPDES 002191-1), Daydream Ranch (NPDES 002680-8), Deadman Hatchery (NPDES 002689-1, via Deadman Gulch seep stream), CSI Fish Hatchery (NPDES 002630-1), Aquaculture Industries/Frame Hatchery (NPDES 002703-1), Coats Farm Ponds (NPDES 002761-8), and Canyon Trout Farm/Processing Plant (NPDES 002191-1). There is no city sewage treatment plant that discharges to the creek; however, there are City of Twin Falls sewage lines and pumps in Rock Creek Canyon which have in the past occasionally malfunctioned or overflowed into Rock Creek. There are two hydroelectric projects: Rock Creek Project (FERC 06450-00) and Rock Creek No. 2 Project (FERC 06015-42); one food processor: Independent Meat Co. (NPDES 000038-8); and, two industrials: Monroc, Inc./Magic Valley Division (NPDES 000033-7) and Amalgamated Sugar Company (NPDES 000023-0) that discharge to Rock Creek. Nonpoint source land uses are estimated to be: 61.99% irrigated agriculture—gravity flow, 26.55% rangeland, 2.17% riparian vegetation,

and 9.29% urban (Archview 1996).

2.3.1.16 SAND SPRINGS CREEK (or Thousand Springs Creek)

This creek is affected by discharge from one aquaculture facility: Ten Springs Facility/Blind Canyon Aqua Ranch (NPDES 002600-0). There are no food processors or city sewage treatment plants that discharge. But there is one hydroelectric project that discharges to Sand Springs Creek: IPC/Thousand Springs Project (NPDES 002263-2). Nonpoint source land uses are estimated to be: 42.68% irrigated agriculture---gravity flow, 18.73% irrigated agriculture---sprinkler, 19.30% rangeland, and similarly 19.30% riparian vegetation (Archview 1996).

2.3.1.17 VINYARD CREEK

As previously cited and described, the re-route irrigation canal to Vinyard Creek has been reported (prior to the re-route) to have a peak discharge for the irrigation return channel of 14.8 cfs in 1986, and an annual deposition of approximately 707 metric tons of sediment into the Twin Falls Reservoir (IDHW 1989a). As a result of the pvc pipe re-route approximately 20.1 cfs of irrigation return water can be accomodated for an estimate of 960 metric tons of annual sediment.

2.3.1.18 MIDDLE SNAKE RIVER

The Middle Snake River has point sources that discharge directy and indirectly to it. Those that discharge directly include: 20 aquaculture facilities and 2 wastewater treatment plants. Nonpoint sources include 6 hydroelectric impoundments and 7 hydroelectric generation projects. Indirect dischargers include: 15 aquaculture facilities, 2 wastewater treatment plants, 5 hydroelectric projects, and 2 food processors. These are listed in Table 61.

TABLE 61 DIRECT & INDIRECT AQUACULTURE FACILITIES DISCHARGING TO THE MIDDLE SNAKE RIVER

DISHCHARGE TYPE	AQUACULTURE FACILITIES NAME OF FACILITY	PERMIT No.
Direct Discharger	1. Barret Farm Pond	NPDES 002718-9
	2. Birch Creek Trout Inc.	NPDES 002601-8
	3. Blue Lakes Trout Farm	NPDES 000095-7
	4. Box Canyon Trout Farm/Clear Springs	NPDES 002290-0
	5. Buckeye Farm Ponds	NPDES 002611-5
	6. Canyon Springs	NPDES 002731-6
	7. Catfish Farm	NPDES 002295-1
	8. Flemming Farm Ponds	NPDES 002732-4
	9. Flemming Ponds	NPDES 002780-4
	10. Kaster Trout Farm/Sheldon Ponds	NPDES 002517-8
	11. Magic Valley Steelhead Hatchery/IDFG	NPDES 002304-3
	12. Pisces Investment Inc./Magic Springs	NPDES 000097-3
	13. Pristine Springs/Sunnybrook Cold Water Hatchery	NPDES 002501-1
	14. Rim View Trout Co. Inc./Wendell Hatchery	NPDES 000099-0
	15. Slane Ponds	NPDES 002779-1
	16. Smith Farm Ponds	NPDES 002687-5
	17. Stevenson Ponds	NPDES 002781-2
	18. White Springs Trout Farm	NPDES 002580-1
	19. Woods Farm Ponds/Rangen Inc.	NPDES 002733-2
	20. Wright Farm Ponds	NPDES 002725-1
Indirect Discharger	1. Bell Fish Ponds (via unnamed tributary to Stoddard Creek)	NPDES 002491-1
	2. Briggs Creek Fish Hatchery (via Briggs Creek)	NPDES 002684-1
	3. C.J. Simms Ponds (via Birch Creek)	NPDES 002683-2
	4. Decker Springs Farm Pond (via Decker Springs Creek)	NPDES 002734-1
	5. Lemmon Ponds (via Curren Ditch)	NPDES 002668-9
	6. Niagara Springs Hatchery/IDFG & IPC (via Niagara Springs Creek)	NPDES 002238-1
	7. Rand Trout Farm (via LQ/LS Drains)	NPDES 002583-6
	8. Standal Ponds (via Stoddard Creek)	NPDES 002778-2
	9. White Water Ranch/Bliss Hatchery (via Stoddard Creek)	NPDES 000091-4
	10. Boyer Farm Ponds (Billingsley Creek)	NPDES 002704-9
	11. Big Bend Trout Inc. (via irrigation ditch)	NPDES 002532-1
	12. Eckles Fish Farm (Billingsley Creek)	NPDES 002676-0
	13. Henslee Hatchery (via irrigation ditch)	NPDES 002762-6
	14. Rainbow Falls Fish Ponds /Dunn (Billingsley Creek)	NPDES 002675-1
	15. Talbot Trout Ponds (Billingsley Creek)	NPDES 002677-8

Direct dischargers to the Middle Snake River include the following point sources: 2 wastewater treatment plants—City of Hagerman (NPDES 002594-1) and City of Twin Falls (NPDES 002127-0). Nonpoint sources include 6 hydroelectric impoundments—Milner Dam (FERC 2899), Twin Falls Dam (FERC 0018), Shoshone Falls Dam (FERC 2778), Upper Salmon Falls Dam (FERC 2777), Lower Salmon Falls Dam (FERC 2601), and Bliss Dam (FERC 1975); and, 7 hydroelectric generation projects which discharge to the Middle Snake River—IPC/Bliss Power Plant (NPDES 002257-8, near Bliss), IPC/Lower Malad Power Plant (NPDES 002258-6, near Hagerman), IPC/Lower Salmon Power Plant (NPDES 002260-8, near Hagerman), IPC/Upper Salmon Plant "A" (NPDES 002261-6, near Hagerman), IPC/Upper Salmon Power Plant "B" (NPDES 002262-4, near Hagerman), IPC/Shoshone Falls Power Plant (NPDES 002265-9, near Twin Falls), and IPC/Twin Falls Power Plant (NPDES 002266-7, near Twin Falls).

Indirect point source dischargers may be summarized as follows: 2 wastewater treatment plants—City of Hansen (NPDES 002244-6, via an agricultural ditch) and City of Jerome (NPDES 002016-8, via "J" canal); and 2 food processors above Milner Dam—J.R. Simplot Co. (NPDES 000066-3, at RM 652.2 in Burley, Idaho) and McCain Foodservice Inc. (NPDES 000061-2, at RM 648.8 in Burley, Idaho). Nonpoint sources include 5 hydroelectric projects—Birch Creek Project (FERC 06458B03, via Birch Creek), White Water Ranch Project (FERCs 06271C00, 06271B00, & 06271A00, via Stoddard Creek), Rim View Project (FERC 09543-04, via trout pond), Briggs Creek Project (FERC 04360-02, via Briggs Creek), and IPC/Upper Malad Power Plant

(NPDES 002259-4, via Malad River).

Reservoirs have nonpoint source land uses that affect them directly and which can be estimated as as shown in Table 62.

TABLE 62 NONPOINT SOURCES LAND USES AFFECTING RESERVOIRS ON THE MIDDLE SNAKE RIVER

RESERVOIR	RANGELAND %	IRRIGATED AGRICULTURE %	RIPARIAN VEGETATION %	WATER %	WATERBODY SIZE acres
Bliss	38.70	0	22.46	38.84	254.00
Lower Salmon Falls	66.37	0	33.63	0	168.00
Pioneer	100.00	0	0	0	220.00
Shoshone Falls	0	0	100.00	0	60.00
Twin Falls	0	39.97	60.03	0	85.00
Upper Salmon Falls	3.14	7.75	89.11	0	810.00
Mean (weighted)	28.51	6.06	59.26	6.18	Total = 1597.00
Non-reservoir areas	20.89	22.11	55.50	0.71	

Prepared by IDEQ-TFRO. Percentage land uses from *ArchView GIS 1996*. Waterbody size from *IDEQ & USEPA 1994*. Weighted means based on waterbody size and a total of 1597.00 acres. Water in this table is defined as that water within the reservoir that is affected by nonpoint sources. Non-reservoir areas is a specific land use on the Middle Snake River.

2.3.1.18 ADDITIONAL NONPOINT SOURCES

Additional nonpoint sources that indirectly affect the Middle Snake River or any of its tributaries may be found with FERC-type generation facilities either on canal systems or non-listed tributaries. These facilities will not be listed at this time as their place of discharge is to waterbodies that are not water quality limited or man-made conveyances.

2.3.2 CHARACTERIZATION OF SPECIFIC POLLUTANTS PER POINT SOURCE INDUSTRY

As of this writing, the USEPA was in the process of modifying and reissuing the NPDES permits for food processors, municipalities, and aquaculture in order to incorporate the wasteload allocations of the Mid-Snake TMDL. Effluent characterization of specific pollutants are summarized in Table 63.

TABLE 63 POINT SOURCES AND THEIR POLLUTANT CONTRIBUTIONS IN UPPER SNAKE ROCK

POINT SOURCE INDUSTRIES	TSS	BOD 5	NH3	TEMPERATURE	PH	PATHOGENS	NUTRIENTS	CHLORINE	DO	CHEMICALS	OIL & GREASE
Aquaculture Facilities Effluent Discharge	X	Y		X	X		X	Y	X	X	Y

POINT SOURCE INDUSTRIES	TSS	BOD5	NH3	TEMPERATURE	PH	PATHOGENS	NUTRIENTS	CHLORINE	DO	CHEMICALS	OIL & GREASE
Municipalities (POTW) Effluent Discharge	X	X	X	X	X	X	X	X	X		X
Food Processors Effluent Discharge	X	X	X	X	X	X	X				X
Prepared by IDEQ-TFRO Y = Fish Processors.											

2.3.2.1 FOOD PROCESSORS

Under the conditions of their NPDES permits, food processors are allowed discharges of the following pollutants: BOD_5, total suspended solids, ammonia (as N), temperature, pH, fecal coliform, total phosphorus (as P), dissolved orthophosphate (as P), nitrite+nitrate (as N), and total Kjeldahl nitrogen (as N). A compliance schedule is based on the Mid-Snake TMDL for total phosphorus and requires the food processing industry to meet the final wasteload allocation for total phosphorus over the next five years. In accordance with IDAPA §16.01.02400.03, discharge permits can incorporate compliance schedules which allow a discharger to phase-in compliance with water quality-based effluent limits when new limits are in the permit for the first time. Consistent with *40 CFR 127.47*, the permittee will be required to submit annual reports which document progress towards reaching the final compliance level. IDEQ-TFRO believes that issuance of this permit for allowable discharge of the effluent parameters (at the levels prescribed in the permit) will not adversely effect the bald eagle, the Bliss Rapids snail, or the Ute ladies' tresses. (See the Fact Sheet and NPDES Permit for permittees 000066-3 and 000061-2.)

2.3.2.2 MUNICIPALITIES

Under the conditions of their NPDES permits, municipalities are allowed discharges of the following pollutants: BOD_5, total suspended solids, fecal coliform, total residual chlorine, pH, total phosphorus, ammonia (as N), temperature, dissolved oxygen (where applicable), total Kjeldahl nitrogen, and nitrite+nitrate (as N). Like food processors, a compliance schedule is based on the Mid-Snake TMDL for total phosphorus and requires the municipality industry to submit an annual report of progress which outlines the progress made toward reaching the compliance date for total phosphorus effluent limitations, an assessment of the previous year of phosphorus data, and a comparison to final effluent limitations and milestones targeted for the upcoming year. Consistent with *40 CFR 127.47*, the permittee will be required to submit annual reports which document progress towards reaching the final compliance level.

2.3.2.3 AQUACULTURE

Under the conditions of their NPDES permits, aquaculture facilities are allowed discharges of the following pollutants: BOD_5 (applicable to processors only), total phosphorus, pH, temperature, total suspended solids, settable solids, nutrients, dissolved oxygen, oil and grease (applicable to processors only), and total residual chlorine (applicable to processors only). The Mid-Snake TMDL requires that the final wasteload allocation for total phosphorus be met over the next five years. In accordance with IDAPA §16.01.02.400.03 a compliance schedule is incorporated which allows a discharger to phase-in compliance with water quality-

based effluent limits when new limits are in the permit for the first time. Consistent with *40 CFR 122.47*, the permittee is required to submit annual reports which document progress toward reaching the final compliance level. Compliance with total phosphorus concentration limits must be met in the interim. The proposed permit will improve water quality by significantly reducing total phosphorus loads to the Middle Snake River which will reduce eutrophication.

However, USEPA and USFWS have determined that sediment discharges (either as settable solids or total suspended solids) from aquaculture facilities, which become anoxic or hypoxic below hatchery outfalls, may adversely affect listed snails. To determine the effects of sediment on aquatic life, USEPA will conduct a study below the larget aquaculture facilities in receiving waters. Chemicals in discharges from aquaculture facilities may include disease control chemicals, drugs, or disinfectants. Examples include: antibiotics (Romet-30 and terramycin); algicide (copper sulfate); FDA approved drugs (Parasite-S or formalin, potassium permanganate); disinfectants (chlorine, PVP iodine, Hyamine-3500); FDA unapproved drugs (hydrogen peroxide, salt). These compounds are approved by FDA or USEPA or both depending upon the compound for use in aquaculture, and are used in waters containing trout (except chlorine and Hyamine-3500 which are used on equipment and raceways) which is a sensitive aquatic animal. Chemical pollutants could cause acute or chronic toxicity to aquatic life in the receiving stream depending on the load being delivered. Because no data exist to determine the toxicity of these chemicals to aquatic life, including the endangered snails, USEPA and USFWS have determined that for the present time the discharge of chemicals by the aquaculture facilities may adversely affect the listed snails. Data submitted the first year of the permit by facilities should answer questions about toxicity to aquatic life.

2.3.2.4 HYDROELECTRIC IMPOUNDMENTS AND GENERATION

Hydroelectric projects, whether as impoundments or strict generation without impounding the water, do not supply pollutants to the Middle Snake River or its tributaries. By legal definition, they are defined as nonpoint sources. However, as previously discussed in §2.2.1.5 they have added to the water quality problems of the river in two ways: (1) the river's capacity to process nutrients has been altered to encourage plant growth through nutrient spiraling, and (2) the reservoirs have created large shallows and areas of sediment deposition that are ideal for aquatic weeds. Additionally, diversion for irrigation reduces the amount of flow at Milner Dam and exacerbates the degraded condition in low flow years through agricultural return flows and tributaries which carry much of the nonpoint source pollutants to the Middle Snake River and to tributaries and reservoirs.

Some hydroelectric industrial power generation projects in Upper Snake Rock have NPDES permits that allow discharges with the following effluent characteristics: temperature, and pH. These type of generation projects normally do not impound water, but rather use the resource and discharge for cooling water concerns. As of this writing, a review of these facilities in Upper Snake Rock (at IDEQ-TFRO) indicates that they are complying with their NPDES permits and, thus, discharging in a non-adverse manner.

Hydroelectric industrial power generation impoundment projects in Upper Snake Rock, on the other hand, have FERC permits that allow discharges with the following effient characteristics: pH, temperature, and dissolved oxygen. As of this writing, the Middle Snake River projects (see §2.2.1.5) were undergoing relicensing. A review of these facilities indicates that as "run-of-the-river" systems, they are complying with their FERC permits and, thus, discharging in a non-adverse manner. However, under drought or low flow conditions (due to diversion as irrigation), the potential for low dissolved oxygen and high water temperature is possible.

2.3.2.5 NONPOINT SOURCES

Nonpoint source pollutants are more difficult to control because they don't come from clearly identifiable sources such as a pipe. As described in the table in §2.3, grazing, agriculture, CFOs, and recreation, as nonpoint sources, have some level of effect on the various waterbodies listed. The primary pollutants or stressors for nonpoint sources are: sediment, nutrients, bacteria, organic enrichment, ammonia, oil and grease and other chemicals (pesticides), thermal modification, salt, and flow alteration. Table 64 provides a breakdown of pollutants per nonpoint source activity.

TABLE 64 NONPOINT SOURCES AND THEIR POLLUTANT CONTRIBUTIONS IN UPPER SNAKE ROCK

NONPOINT SOURCES	SEDIMENT	NUTRIENTS	PATHOGENS	BOD5	AMMONIA	OIL & GREASE	PESTICIDES	SALT	THERMAL	FLOW
FERC-type operations									X	X
Agriculture (Irrigated, Dryland)	X	X	X	X	X	X	X	X		X
Confined Feeding Operations	X	X	X	X	X	X	X			
Grazing on private ground, USBLM ground, or USFS ground	X	X	X	X	X				X	X
Forestry-type operations	X	X	X	X	X		X		X	X
Recreation	X	X	X	X	X	X				
Urban Areas	X	X	X	X	X	X	X			
Construction Activities	X	X				X			X	X
Nonpoint Source Industrials (such as fresh pack processors)	X	X	X	X	X	X	X	X		
Suburban "non-farms"	X	X	X	X	X		X	X		

Prepared by IDEQ-TFRO. THERMAL = Thermal Modification; FLOW = Flow Alteration, Diversion. The definition of a "farm" is taken from the USDA, Idaho Agricultural Statistics Service: a farm is any operation that produces an agricultural product in a given year of $1000 or more. IDEQ-TFRO chose this definition over that of the census bureau, the Internal Revenue Service, or the Farm Bureau since the dictionary definition stipulates that a farm is a tract of land used under one management for cultivating crops or rearing livestock. Grazing and forestry have the potential for thermal modification and flow alteration as a result of destroyed riparian canopy over a waterbody causing the stream to lose its capacity to ground water recharge, eventually modifying the stream from perrenial to intermittant. Construction has the potential for thermal modification and flow alteration as a result of stream bank alteration and stream diversion activities. Agriculture has the potential for flow alteration as a consequence of canal or ditch diversions.

Soil science indicates that if sediment is reduced substantially, nutrients, bacteria, and pesticides will likewise be reduced so that their effect is reduced to the water quality, the fauna, and the habitat. "Through the development of best management practices and the enforcement of water quality standards, nonpoint sources of pollution are to be maintained at a minimum, as close as possible to background levels (IDHW 1998a)." Nonpoint source pollution management in Idaho is a process for protecting designated beneficial uses and ambient water quality through the implementation of best management practices, which should be designed, implemented, and maintained to provide full protection or maintenance of beneficial uses. As part of this process, the Idaho Nonpoint Source Management Program and the Coordinated Nonpoint Source Water

Quality Monitoring Program for Idaho were developed under the requirements of Section 319 of the Clean Water Act. The Nonpoint Source Management Program is based on the concept of a feedback loop where best management practices are identified through a planning process and applied by land managers to site-specific conditions. The effectiveness of the best management practices in protecting water quality is evaluated through instream water quality monitoring and best management practices monitoring. Ineffective best management practices are required to be replaced.

CATTLE AND CALVES

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of cattle and calves and their manure output is summarized in Table 65 for 1990 through 1998 for total number of 1000 lb live animals, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen the number of dairy animals has increased by 2.6 times (162,000/62,000=2.6) for the period described. Beef animals have decreased by 0.8 times (50,500/62,000=0.8). And, "other" animals (cow-calf operations) have increased by 1.4 times (185,000/137,000=1.4). As a whole, the total number of cattle increased by 1.5 times (397500/261000 = 1.5). Although the number of animals along with their generated manure may be estimated on an annual basis, an estimate of the amount that is discharged to rivers and streams is unknown since it is assumed that all manure is land applied at proper agronomic rates. The CFO industry is committed to "zero discharge" for nutrients and sediment.

TABLE 65 TRI-COUNTY AREA CATTLE AND CALVES: GOODING, JEROME, AND TWIN FALLS

YEAR	BEEF	DAIRY	OTHER	TOTAL
		TOTAL NUMBER OF 1000 lb LIVE ANIMALS		
1990	62000	62000	137000	261000
1991	58800	72000	146200	277000
1992	60600	75000	162400	298000
1993	53000	85000	164000	302000
1994	50500	92500	173500	316500
1995	51000	115000	189000	355000
1996	52500	133500	190000	376000
1997	50500	149000	182500	382000
1998	50500	162000	185000	397500
		MANURE OUTPUT (tons/day)		
1990	1992.0	2635.0	3842.9	8399.9
1991	1822.8	3060.0	4100.9	8983.7
1992	1878.6	3187.5	4555.3	9621.4
1993	1643.0	3612.5	4600.2	9855.7
1994	1565.5	3931.3	4866.7	10363.4
1995	1581.0	4887.5	5301.5	11770.0

YEAR	BEEF	DAIRY	OTHER	TOTAL
1996	1627.5	5673.8	5329.5	12630.8
1997	1565.5	6332.5	5119.1	13017.1
1998	1565.5	6885.0	5189.3	13639.8
TOTAL SOLIDS OUTPUT (tons/day)				
1990	275.9	288.3	417.9	982.1
1991	261.7	334.8	445.9	1042.4
1992	269.7	348.8	495.3	1113.7
1993	235.9	395.3	500.2	1131.3
1994	224.7	430.1	529.2	1184.0
1995	227.0	534.8	576.5	1338.2
1996	233.6	620.8	579.5	1433.9
1997	224.7	692.9	556.6	1474.2
1998	224.7	753.3	564.3	1542.3
TOTAL NITROGEN OUTPUT (tons/day)				
1990	13.3	11.5	16.4	41.2
1991	12.6	13.3	17.5	43.5
1992	13.0	13.9	19.5	46.4
1993	11.4	15.7	19.7	46.8
1994	10.9	17.1	20.8	48.8
1995	11.0	21.3	22.7	54.9
1996	11.3	24.7	22.8	58.8
1997	10.9	27.6	21.9	60.3
1998	10.9	30.0	22.2	63.0
TOTAL PHOSPHORUS OUTPUT (tons/day)				
1990	2.8	2.1	3.2	8.1
1991	2.6	2.5	3.4	8.5
1992	2.7	2.6	3.7	9.0
1993	2.4	2.9	3.8	9.1
1994	2.3	3.2	4.0	9.5
1995	2.3	4.0	4.3	10.6
1996	2.4	4.6	4.4	11.3

YEAR	BEEF	DAIRY	OTHER	TOTAL
1997	2.3	5.1	4.2	11.6
1998	2.3	5.6	4.3	12.1

Prepared by IDEQ-TFRO. Number of animals derived from the Idaho Agricultural Statistics Service. Output values for manure, total solids, total nitrogen and total phosphorus from the *Idaho Waste Management Guidelines for Confined Feeding Operations* and *Livestock Waste Facilities Handbook*. "Other" animals represents cow-calf operations and is a conservative estimate.

As previously referenced in §2.3.1, IDEQ-TFRO has inventoried 779 CFOs (dairies, feedlots, cow-calf operations) in the tri-county are: 309 in Twin Falls County, 258 in Gooding County, and 212 in Jerome County. Of these, 122 dairies are in Twin Falls County, 126 dairies are in Gooding County, and 92 dairies are in Jerome County, or a total of 340 dairies in Upper Snake Rock. Because no factual information is available to describe the percent of CFO discharge to rivers and/or streams, and because the CFO industry claims "zero discharge," it is assumed at this time that the majority of generated manure is contained and does not discharge to receiving streams or rivers. However, it should be stated that a major portion of this generated manure is land applied throughout Upper Snake Rock at supposed proper agronomic rates. Where those agronomic rates have been exceeded, and where the potential for erosion and water runoff is great, discharge to rivers and streams is very possible. Thus, agricultural runoff, including nutrients from animal waste, may be a large contributor to pollution of the rivers and streams that are identified as "impaired" (Harkin 1998).

SHEEP AND LAMBS

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of sheep and lambs (head) and their manure output is summarized in Table 66 for 1990 through 1998 for total number of 100 lb live animals, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen, the total number of live animals has increased and decreased dramatically such that a comparison of 1998 to 1990 indicates that the total number has stayed about the same.

TABLE 66 TRI-COUNTY AREA SHEEP AND LAMBS (HEAD): GOODING, JEROME, AND TWIN FALLS

YEAR	GOODING	JEROME	TWIN FALLS	TOTAL	MANURE OUTPUT	TOTAL SOLIDS	TOTAL N	TOTAL P
1990	19000	14000	16000	49000	882.0	232.8	9.8	1.8
1991	16500	11000	15500	43000	774.0	204.3	8.6	1.6
1992	27500	11000	15500	54000	972.0	256.5	10.8	2.0
1993	20500	10500	11000	42000	756.0	199.5	8.4	1.6
1994	18500	8000	10500	37000	666.0	175.8	7.4	1.4
1995	19000	8700	10500	38200	687.6	181.5	7.6	1.4
1996	20000	10900	12900	43800	788.4	208.1	8.8	1.6
1997	25000	8000	14800	47800	860.4	227.1	9.6	1.8
1998	27000	8000	14800	49800	896.4	236.6	10.0	1.9
			MEAN =	44956	809.2	213.5	9.0	1.7

Prepared by IDEQ-TFRO. Number of animals derived from the Idaho Agricultural Statistics Service. Output values for manure, total solids, total nitrogen, and total phosphorus from the *Idaho Waste Management Guidelines for Confined Feeding Operations* and *Livestock Waste Facilities Handbook*.

WATERFOWL

As previously noted in §2.1.4.3, as many as half million ducks migrate through the Snake River Canyon each winter, primarily between the Hagerman Wildlife Management Area and the Minidoka National Wildlife Refuge (*FERC, 1997*). Mid-winter waterfowl counts done by IDFG are summarized in Table 67 for the Hagerman Wildlife Management Area (WMA) and the Middle Snake River from 1990 to 1998. Additional information going back to 1954 is available for the Middle Snake River, and to 1971 for the Hagerman Wildlife Management Area. These represent the best available information on waterfowl counts in the Upper Snake Rock for effects on the Middle Snake River. Affects to tributaries is unknown at this time due to lack of information. Overall, it may be concluded that ducks account for the greatest source of waterfowl pollutants to the Middle Snake River, when compared to geese and swans.

TABLE 67 MID-WINTER WATERFOWL COUNT SUMMARY FOR 1990-1998

YEAR	HAGERMAN WMA				MIDDLE SNAKE RIVER				TOTAL			
	Ducks	Geese	Swans	Total	Ducks	Geese	Swans	Total	Ducks	Geese	Swans	TOTAL
1990	46731	3427	0	50158	24610	3208	0	27818	71341	6635	0	77976
1991	19280	1138	0	20418	20390	2096	153	22639	39670	3234	153	43057
1992	13758	4117	0	17875	54509	8526	43	63078	68267	12697	43	81007
1993	19703	298	0	20001	45456	5917	32	51405	65159	6215	32	71406
1994	55652	1686	3	57341	41170	12957	15	54142	96822	14643	18	111483
1995	58993	2794	0	61787	27007	5088	17	32112	86000	7882	17	93899
1996	7545	98	0	7643	16452	8976	21	25449	23997	9074	21	33092
1997	12344	4014	2	16360	9662	8064	3	17729	22006	12078	5	34089
1998	35614	3861	0	39475	19853	10111	6	29970	55467	13972	6	69445
MEAN	29958	2381	1	32340	28790	7216	32	36038	58748	9603	33	68384

Prepared by IDEQ-TFRO. Values provided by IDFG-Jerome. Mean values calculated by IDEQ for 1990-1998 as a 9 year mean.

The data indicate that ducks represent 92.6% of the total waterfowl counted in the Hagerman WMA and 79.9% of the total waterfowl counted in the Middle Snake River, or 85.9% overall of the total waterfowl counted as a 9-year average. Table 68 shows the pollutant loadings (in lbs/day) for total solids output, N, and P.

TABLE 68 ESTIMATED WATERFOWL TOTAL LOADINGS TO THE MIDDLE SNAKE RIVER SYSTEM

YEAR	TOTAL NUMBERS, count				TOTAL GENERATED OUTPUT FOR ALL WATERFOWL, lbs/day			
	Ducks	Geese	Swans	TOTAL	Total Solids*	Total Volatile Solids	Total N as N	Total P as P
1990	71341	6635	0	77976	1176.1	1226.9	120.1	52.5
1991	39670	3234	153	43057	645.6	673.4	66.0	28.8
1992	68267	12697	43	81007	1303.1	1359.3	133.1	58.1
1993	65159	6215	32	71406	1079.4	1126.0	110.3	48.1
1994	96822	14643	18	111483	1753.4	1829.1	179.1	78.2

YEAR	TOTAL NUMBERS, count				TOTAL GENERATED OUTPUT FOR ALL WATERFOWL, lbs/day			
	Ducks	Geese	Swans	TOTAL	Total Solids*	Total Volatile Solids	Total N as N	Total P as P
1995	86000	7882	17	93899	1415.0	1476.1	144.6	63.1
1996	23997	9074	21	33092	586.4	611.7	59.9	26.2
1997	22006	12078	5	34089	641.8	669.5	65.6	28.6
1998	55467	13972	6	69445	1159.8	1209.6	118.5	51.7
MEAN	58748	9603	33	68384	1084.5	1131.3	110.8	48.4

Prepared by IDEQ-TFRO. Ducks based on production figures per 1000 ducks and assuming an average weight of 4 pounds per duck on swim water. The ducks Total Solids based on total suspended solids as 13.9 lb/day/1000 ducks; 14.5 lb volatile solids/day/1000 ducks; 1.42 lb nitrogen/day/1000 ducks; and, 0.62 lb phosphorus/day/1000 ducks (*IDEQ, Idaho Waste Management Guidlines for Confined Feeding Operations, p. 71*). Geese and swans were estimated at twice the rate as ducks, since little research has been done in this area. Therefore: total solids = 27.8 lb/day/1000 geese or swan; volatile solids = 29.0 lb volatile solids/day/1000 geese and swan; nitrogen = 2.84 lb/day/1000 geese and swan; and, phosphorus = 1.24 lb/day/1000 geese and swan. Total Generated Output for all waterfowl was determined by summing the output values for ducks, geese, and swan.

HUMAN POPULATION

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of human population and their manure output is summarized in Table 69 for 1990 through 2010 for total number of people, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen, the total number of human population is expected to increase from 1990 to 2010 by 1.1 times (89574/80351=1.1). These loads are generally accounted for by the various municipalities as urban loadings with the exception of those rural and localized urban areas that are not hooked up to a sewage system, but rather to independent septic systems. See §2.2.3.7 for septic tank system estimates on a per county basis.

TABLE 69 TRI-COUNTY HUMAN POPULATION: GOODING, JEROME, AND TWIN FALLS

YEAR	POPULATION	MANURE OUTPUT	TOTAL SOLIDS OUTPUT	TOTAL N OUTPUT	TOTAL P OUTPUT
1990	80351	1253.5	136.6	8.0	1.0
1991	80812	1260.7	137.4	8.1	1.0
1992	81273	1267.9	138.2	8.1	1.0
1993	81734	1275.1	138.9	8.2	1.0
1994	82195	1282.2	139.7	8.2	1.0
1995	82656	1289.4	140.5	8.3	1.0
1996	83117	1296.6	141.3	8.3	1.0
1997	83578	1303.8	142.1	8.4	1.0
1998	84039	1311.0	142.9	8.4	1.0
2010	89574	1397.4	152.3	9.0	1.1
1990-1998 MEAN	82281	1282.3	139.7	8.2	1.0

Prepared by IDEQ-TFRO. Population estimates based on Idaho Department of Commerce 1993 report as land use values in number of persons. Manure and pollutant estimates based on *Idaho Waste Management Guidelines for Confined Feeding Operations*. Manure output estimates based on interpolation of yearly estimates over a 20-year period from 1990 to 2010.

Comparison analysis of manure output of the human population versus cattle and calves, and sheep and lambs, is shown in Table 70. As can be seen, waterfowl provide the least (although most direct because their discharge is directly into the stream) "pollutant outputs," followed by human, sheep and lambs, and finally cattle and calves (which indirectly discharge).

TABLE 70 COMPARISON OF 9-YEAR MEANS PER SPECIES OF ANIMAL OR HUMAN

ANIMAL SPECIES	*TOTAL SOLIDS tons/day*	*TOTAL N tons/day*	*TOTAL P tons/day*
Cattle and Calves	1249.1	51.5	10.0
Sheep and Lambs	213.5	9.0	1.7
Ducks, Geese, and Swans	0.5423	0.0554	0.0242
Human	139.7	8.2	1.0
Prepared by IDEQ-TFRO.			

One particular item that has given the public a misunderstanding of the effects from water fowl, is their Total P Output and its effect on the concentration of TP in a stream. Based on Table 67 and 68, the Total P as P Output (in tons/day) is 0.0242 (see Table 70) or 48.4 lbs/day (0.0242 tons/day x 2000 lbs/ton = 48.4 lbs/day). If this load were completely watersoluble; and, if it was being discharged directly to streams and tributaries at any one time; then, TABLE 71 shows what the concentration levels would be like in the stream with proper mixing at various stream flows (without taking into account disturbances in the streamload by the animal). Table 71 shows that on an average basis waterfowl provide "background" (0.0051 mg/L or less) since they are at the method detection limit (MDL) of 0.0050 mg/L total phosphorus for USEPA test method 365.4 (Storet No. 00665) when compared to other animal inputs for the specified assumptions.

TABLE 71 ESTIMATED TOTAL P CONCENTRATIONS AT VARIOUS FLOWS FROM VARIOUS DIRECT ANIMAL INPUTS

FLOW cfs	*WATERFOWL*
500	0.0179
1000	0.0090
5000	0.0018
10000	0.0009
15000	0.0006
20000	0.0004
MEAN =	0.0051
Prepared by IDEQ-TFRO. Concentration (mg/L) = Load (lbs/day) / [(Flow, cfs) x (5.393776)]. Loads for the individual animals are: 48.4 lbs/day for waterfowl.	

2.3.3 GROUND WATER CONCERNS

"A combination of natural and man-made factors determine the potential for ground water contamination within a given area. Natural factors, attributable to climate and geologic history, include the thickness and nature of the unsaturated zone, depth to ground water, and ground water movement. Qualitative measures of some

combination of natural factors is often called "hydrogeologic susceptibility." Man-induced factors include water withdrawal, wastewater disposal, hazardous material handling and disposal practices, and other land use practices. Qualitative evaluation of man-induced factors combined with hydrogeologic susceptibility is often termed "ground water vulnerability" or "potential for contamination" (USEPA 1990)." Within the Eastern Snake River Plain, the aquifer supplies 100% of the drinking water consumed. Further, no alternative source or combination of sources can economically supply all those who obtain drinking water from the Eastern Snake River Aquifer. Therefore, the Eastern Snake River Plain Aquifer has the potential for contamination based on the following:

1. Hydrogeologic susceptibility varies considerably within the Eastern Snake River Plain. Significant differences in the thickness and nature of the unsaturated root zone accounts for much of the variation. Areas where fractured basalt crops out at the land surface are more susceptible to ground water contamination than areas where thick deposits of clay rich soil provide a degree of natural protection.

2. Some practices, such as the use of injection wells or inadvertent use of leaking underground storage tanks, partly or entirely override whatever degree of natural protection is afforded by the unsaturated zone. This is of particular concern in the Eastern Snake River Plain because of the widespread use of drain wells (Class V injection wells) to dispose of excess irrigation water, urban storm runoff, and onsite sewage system effluent. In the Upper Snake Rock subbasin Table 72 summarizes the underground storage tanks in the tri-county area (Gooding, Jerome, Twin Falls counties) and the leaking underground storage tanks. Most of the tanks have the ability to impact groundwater.

TABLE 72 SUMMARY OF UNDERGROUND AND LEAKING STORAGE TANKS IN HUC 17040212

CITY	TOTAL	CLOSED	ACTIVE	LEAKING
		GOODING COUNTY		
Bliss	10	9	1	3
Gooding	27	15	12	9
Hagerman	16	10	6	3
Wendell	13	7	6	5
			ACTIVE + LEAKING TANKS =	45
		JEROME COUNTY		
Eden	10	7	3	1
Hazelton	16	9	7	3
Jerome	56	35	21	21
			ACTIVE + LEAKING TANKS =	56
		TWIN FALLS COUNTY		
Buhl	29	18	11	7
Castleford	2	2	0	0
Filer	17	11	6	2

CITY	TOTAL	CLOSED	ACTIVE	LEAKING
Hansen	13	9	4	1
Hollister	1	1	0	1
Kimberly	22	17	5	3
Murtaugh	17	10	7	4
Rogerson	3	1	2	0
Twin Falls	210	147	63	49
			ACTIVE + LEAKING TANKS =	165
			TRI-COUNTY GRAND TOTAL =	266

Prepare by IDEQ-TFRO. Data compiled annually as of February 1998 by IDEQ-Central Office. It should be noted that the table reflects only the regulated underground storage tanks. Heating oil tanks, farm or residential tanks less than 1100 gallons are not UST regulated.

As of this writing, the IDWR estimates that in the tri-county area there are approximately 215 injection wells: 57 in Jerome County, 107 in Gooding County, and 51 in Twin Falls County. These represent the active wells only and not the ones that have been capped.

3. Plumes of dissolved contaminants within the basalt tend to spread laterally, in the direction of ground water flow, within zones of high hydraulic conductivity. Interflow zones of fine grained sediment may almost entirely prevent vertical migration on a local scale.

4. Open-hole well construction is a common practice in the Eastern Snake River Plain which may have ground water quality impacts. When much of the borehole is uncased, water can mingle freely between producing zones. This could be a significant concern wherever hydraulic head relationships are such that a stratigraphic interval of poor quality water could contaminate zones of high quality water.

5. IDEQ has ranked most known and potential sources of ground water contamination (statewide) on the basis of human health risk. From greatest risk to least risk, the ranking is as follows: petroleum handling and storage; feedlots and dairies; landfills and hazardous waste sites; land application of wastewater hazardous material handling; pesticide handling and use; land spreading of sludge and solid or liquid septic tank pumpage; surface runoff; pits, ponds and lagoons; radioactive substances; fertilizer application; septic tank systems; mining, including oil and gas drilling; wells (injection, geothermal, and domestic); and forestry practices.

3.0 TMDL DEVELOPMENT: STREAM CORRIDOR, SYNERGISMS, EVALUATON & ASSESSMENT

As previously discussed, 31 water quality limited stream segments have been identified in the Upper Snake Rock subbasin. In the 1996 303(d) list, these are listed for a variety of pollutants, inclusive of sediment, nutrients (phosphorus and nitrogen), dissolved oxygen, ammonia, pathogens, pesticides, temperature, oil and grease, and flow alteration. Individually, a stream segment may be listed for at least one of these pollutants or a combination of them. Although 303(d) listed streams have high priority in pollution reduction management strategies, all waterbodies (tributaries and irrigation return flows) were identified and considered in the overall TMDL as a consequence of accumulative effect. Where streams or waterbodies are meeting the proposed targets, "the existing instream beneficial uses of each waterbody and the level of water quality necessary to protect those uses shall be maintained and protected (Idaho Code 39-3603)." Once the Upper Snake Rock TMDL is approved and accepted by USEPA, the TMDL will be adopted as part of the State's water quality management plan such that the provisions of the TMDL shall be enforced through normal enforcement practices of IDEQ and other designated agencies (for BMPs) as set forth in the State's water quality management plan (Idaho Code 39-3612).

3.01 ORGANIZATION OF STREAMS INTO WATERSHEDS, COMPLEXES, AND STREAM CORRIDORS

Allocation of loadings was considered on a 5th field HUC (watershed) basis for each water quality limited stream segment. Where one watershed was involved, the HUC was called a watershed. Where more than one watershed was involved, the HUC was called a complex. This process allows for responsible land managing agencies to readily assist in resolving pollution problems on a watershed/complex basis, particularly in defining critical acres that directly impact the waterbody. Accordingly,

Table 76 Organization of 1996 water quality stream segments of Upper Snake Rock

Watershed/Complex	*5th Field Watersheds Involved*	*Stream Segments Involved*
Shoshone Falls Watershed	Shoshone Falls	Alpheus Creek
Billingsley Creek Watershed	Hagerman	Billingsley Creek, Riley Creek
Box Canyon Complex	Wendell,Wendell South,Jerome	Blind Canyon Creek, Clear Springs, Thousand Springs Creek
Clover Creek Complex	Lower Clover Creek, Dry Creek, Upper Clover Creek, Calf-Clover	Clover Creek
Dry Creek Complex	Lake Murtaugh, Lower Dry Creek, Dry Creek	Dry Creek (three segments)
Rock Creek Complex	Upper Rock Creek, Rock Creek, North Cottonwood-McMullen, Hub Butte, Lower Rock Creek	Rock Creek, Cottonwood Creek, McMullen Creek
Cedar Draw Complex	Canyon, Hollister, Filer	Crystal Springs
Middle Snake River Corridor	5th Field HUCs boundarying the Middle Snake River and reservoirs	Middle Snake River & associated reservoirs

Prepared by IDEQ-TFRO. Reservoirs were grouped with Middle Snake River System segments as part of the river system. 5th Field HUC names based on 1998 USGS-GIS coverages.

Recognizing that stream ecosystems may be disrupted by a variety of processes, such as water diversion, impoundment and flow regulation, channel alteration, destruction of riparian habitat, soil erosion (especially from outside the stream/riparian corridor), and cumulative impacts; and, recognizing that within any subbasin or watershed the effect on any water quality limited stream segment is dependent on soil, slope, topography, rainfall, etc.; each stream was reviewed for the development of a stream corridor that focused on the stream channel, the flood plain, and a portion of the transitional upland fringe. Stream corridors are complex ecosystems that perform a number of ecological functions amongst which is removing harmful materials from the water and supporting a higher level of species diversity, species density, and rates of biological productivity than most other landscape elements. "Over the years, human acitvities have contributed to changes in the dynamic equilibrium of stream corridors. These activities center on manipulating stream corridor systems for a wide variety of purposes, including domestic and industrial water supplies, irrigation, transportation, hydropower, waste disposal, mining, flood control, timber management, recreation, aesthetics, and fish and wildlife. Increases in human population and industrial, commercial, and residential development place heavy demands on stream corridors (USDA, USEPA, USBLM, *et al.* 1998 [p 1-2])." "The cumulative effects of these activities result in significant changes, not only to stream corridors, but also to the ecosystems of which they are a part. These changes include degradation of water quality, decreased water storage and conveyance capacity, loss of habitat for recreational and aesthetics value (National Research Council 1992)."

For purposes of allocating loads to nonpoint sources, and taking into account that upland disturbances may not necessarily directly affect the delivery of pollution to a stream, a "stream corridor" of 2 miles wide was used as a reasonable preliminary approach such that the greatest impact to any stream would be coming from this 2 mile transect (1 mile per side of stream). Various sources indicate that riparian areas which are found within the stream corridor and are beneficial for wildlife and domesticated animals are usually too small and narrow, but should have a range greater than 0.5 miles but less than 5.0 miles (Platts 1990; Kindschy et al. 1982; Van Dyke et al. 1983; USDA, USEPA, USBLM, *et al.* 1998). A one-mile per side of stream seemed a reasonable preliminary approach to use.

For purposes of focusing on the water quality limited stream segments, the stream corridor model was used in a phased-approach for preliminary identification of critical acres in water quality limited streams for pursuit of logistic funding by land management agencies for implementation of best management practices. Land management agencies include: Idaho Soil Conservation Commission for grazing and crop production from irrigated and nonirrigated lands, the Idaho Department of Lands and the Board of Land Commissioners for silviculture and mining, Idaho Department of Transportation for construction sites, Idaho Department of Health and Welfare—District Health for septic tank disposal fields, and the Idaho Department of Agriculture for "other NPDES activities" (Idaho Code §39-3602; IDAPA 16.01.02.350.03). For grazing, Executive Order §98-09 (Allotment Management Plan on Public Lands) allows the Idaho Department of Agriculture through a memorandum of understanding with USFS, USBLM, and University of Idaho to develop, implement, and revise allotment management plans. Additionally, the USFS and the USBLM in conjunction with the USEPA have developed protocols for addressing water quality limited stream segments "to protect and restore the quality of public waters under their jurisdiction (USFS, USBLM, and USEPA 1999 [p 1])."

An additional criteria that was considered in the stream corridor model/approach is slope. Slope and/or slope factors define the transport portion of the erosion process. Slope gradient and slope length influence the flow and velocity of runoff. Soil loss is affected by both length and steepness of slope. These factors affect the capability of runoff to detach and transport soil material. For purposes of the stream corridor model/approach, it was determined from professional conversations with the Idaho Soil Conservation Commission and the Twin Falls NRCS group, that slopes from 0 to 10% were more easily adaptable to the stream corridor model/approach. This slope range supports Austrialian research that 7° slope is the minimum level at which

erosion occurs (See www bhp.com.au/scienceawards/sawards97/ atwhat.htm). A review of the slopes of the water quality limited stream segments under the stream corridor model/approach indicates that the model could be used since a major portion (about 81.7%) of the slopes fall in the range of 0-10%.

Table 77 % Slope of water quality limited stream segments in Upper Snake Rock

Watershed/Complex	Total Area acres	% Slope 0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	> 50
Shoshone Falls (Alpheus Creek)	2395.59	75.61	8.65	5.78	5.44	3.74	0.65
Rock Creek Complex	29917.82	95.57	2.70	0.75	0.55	0.39	0.05
Cottonwood Creek	9728.14	97.43	2.52	0.04	0	0	0
McMullen Creek	20940.52	65.71	24.28	8.97	1.04	0	0
Billingsley Creek	10104.19	89.76	8.51	1.38	0.07	0	0
Clear Springs	2938.29	87.24	11.05	1.66	0.04	0	0
Blind Canyon Creek	2811.72	83.12	11.68	4.63	0.49	0.05	0.02
Thousand Springs Creek	2331.47	85.59	7.99	5.11	1.19	0.11	0
Cedar Draw (Crystal Springs)	2191.73	81.15	6.19	6.16	5.75	0.72	0
Clover Creek	11060.21	83.89	12.12	8.26	1.86	0.02	0
Dry Creek: Medley Creek	17933.70	77.73	12.12	8.26	1.86	0.02	0
Dry Creek: West Fork	9589.34	55.60	26.09	15.53	2.75	0	0
Middle Snake River Corridor	113888.91	83.12	9.73	4.32	1.80	0.78	0.23
Upper Snake Rock: water quality limited stream segments (mean)		81.66	11.05	5.45	1.76	0.45	0.07

Prepared by IDEQ-TFRO. % Slope should not be construed as indicating identification of critical acres. Rather, the use of % Slope was to demonstrate the useability of the stream corridor model/approach to land that covered slopes of 0 to 10%. Identification of critical acres will be decided by the land management agency during the implementation phase of the TMDL. Mean base on N=13 water quality limited stream watersheds/complexes.

3.03 EVALUATION AND ASSESSMENT OF 303(D) STREAMS AND POLLUTANTS

This section provides an evaluation and assessment of those streams in the Upper Snake Rock subbasin and their pollutants which should be "de-listed" from the 303(d) list as a steam or pollutant. Two approaches are used: (1) the BURP assessment process which identifies the stream as meeting its beneficial uses, or (2) best professional judgement using water quality data that describes the listed pollutants as meeting water quality standards for a specific beneficial use.

A. EVALUATION OF STREAMS BASED ON BURP ASSESSMENT

Two streams are proposed for "de-listing" based on BURP: Ellison Creek (approximately 0.27 stream miles) and Vinyard Creek (approximately 0.44 stream miles). These are water bodies that BURP has determined meet their beneficial uses and as such should be removed from the 303(d) list. The following tables summarize the BURP analysis that supports de-listing of these streams.

Table 78 BURP site locations of Ellison and Vinyard Creeks

Tributary	Site No.	Latitude	Longitude	Township/Range/Section
Ellison Creek	95A02	42°38'10.00"	114°33'20.00"	T 09S R 16E S 15
Vinyard Creek	93021	-	-	-
Vinyard Creek	1991-1992	-	-	-
Prepared by IDEQ-TFRO				

Table 79 Selected stream characteristics from IDEQ-TFRO methodology

WATEBODY NAME	SITE IDENTI	FLOW cfs	VALLEY TYPE	SINUOSITY	% FINES	EMBEDDEDNESS	BANK VEGETA	LOWER BANK	ROSGEN TYPE
Ellison Creek	95A02	2.63	VS	Low	31	17	10	10	A
Vinyard Creek	93021	16.30	-	-	11	0-5	10	14	-
Vinyard Creek	1991-92	-	-	-	-	-	-	-	-
Prepared by IDEQ-TFRO. See Table 37 for explanations on ranges.									

Table 80 Bioassessment of BURP data of Ellison and Vinyard Creeks

NAME	SITE	IDEQ MULTIMETRIC INDICES							MBI	HI	SITE SUP STAT	OVER SUP STAT
		HBI	EPT	%E	TAX	%SC	%D	SHW				
Ellison Creek	95A02	0.73	0.47	0.38	0.74	0.47	0.93	0.87	4.578	119	FS	FS
Vinyard Creek	93021	-	-	-	-	-	-	-	-	-	Optimal	FS
Vinyard Creek	91-92	-	-	-	-	-	-	-	3.241	-	FS	
Prepared by IDEQ-TFRO. See Table 38 for abbreviations.												

3.03.01 ELLISON CREEK

Table 85 indicates % Fines are 31 which is in the marginal range. However, since this level of % fines is in a spring-fed creek, the % fines are within acceptable levels. Embeddedness is 17 which is in the optimal range. It has a bank vegetation protection score of 10 which is optimal. And, it has a lower bank stability score of 10 which is optimal. Table 86 shows a Macroinvertebrate Biotic Index (MBI) score > 3.50, which indicates the water body is Fully Supporting (FS) its beneficial uses. Its Habitat Index (HI) score > 66 which indicates the habitat is not impaired. The site and overall support status is Full Support (FS) and should be de-listed from the 303(d) list as a stream.

3.03.02 VINYARD CREEK

Table 79 shows BURP data of 93021 indicating that Vinyard Creek has suboptimal levels of % Fines, poor levels of embeddedness (poor = 0 - 5), an optimal score (10) on bank vegetation protection, and an optimal score (14) on lower bank stability. However, since this level of % fines and embeddedness in in a spring-fed creek, the % fines and embeddedness are within acceptable levels. The site support status at the time was defined as "optimal" based the 1993 Habitat Assessment Field Data Sheet Riffle/Run Prevalence (which scored 77 optimal, 11 sub-optimal, 5 marginal, and 6 poor). Fish data collected from IDFG from 1991 and 1992 indicated an average MBI of 3.241 (the average of four values: 3.229, 3.417, 3.181, 3.135). IDEQ assessed the stream as Full Support in 1998.

According to IDEQ-TFRO BURP assessment in 1998, "Vinyard Creek beneficial uses have been determined to be Not Full Support for primary and secondary contact recreation primarily because of fecal coliform contamination. The data for this assessment was collected in 1993 data. The aquatic life uses, however, were Full Support. The primary source of pollutants to Vinyard Creek was an agricultural return canal. Idaho Power Company, in compliance with FERC relicensing, has removed this source of pollution from Vinyard Creek. Data from studies conducted by Idaho Power Company 1995-1997, and reported in 1998 (Twin Falls Project fisheries report 1996)" was in compliance with Articles 404 and 405 of the Twin Falls project license (FERC No. 0018) and "indicate increasing trends in the aquatic communities in response to the removal of the canal (Lay C. 1998. Vinyard Creek Beneficial Uses Memo, dated March 3, 1998)." Additionally, data collected above the return flows indicate "Full Support of beneficial usess. Bacteria data collected from this reach of Vinyard Creek did not indiciate exceedance of water quality standards. As a result of the removal of the return canal, bacteria contamination in the lower reach is no longer a problem. The supporting data from the Idaho Power Company studies of the aquatic communities indicate the recovery of the lower reach. As a result, the primary and secondary contact recreation beneficial uses are assessed as Full Support. Vinyard Creek should be de-listed from the 303(d) list as a stream.

B. EVALUATION OF STREAMS BASED ON NARRATIVE CRITERIA

Streams considered in this section include Alpheus Creek, Clear Springs, Crystal Springs, and Thousand Springs. These spring sources were originally included in the 303(d) list since 1986 (see §2.2.2.5, Table 29) to protect for endangered snail populations which were presumed to exist in these spring-fed "creeks." Therefore, no BURP data is available (see §2.2.2.6, Table 37) because of endangered species concerns. Legal opinion suggests that sampling in spring-fed areas should be avoided in order to diminish the potential for possible take violations with USFWS. Blind Canyon Creek was once a true spring-fed creek, but this is no longer the situation due to impacts from aquaculture and irrigated agriculture.

3.03.03 ALPHEUS CREEK

See §2.3.1.1. This creek is listed for sediment, nutrients, and dissolved oxygen. As previously described Alpheus Creek runs from its spring source headwaters until it reaches the Main Diversion. At the Main Diversion Alpheus Creek ends. Historically (pre-1920), Alpheus Creek discharged directly to the Middle Snake River just downstream of the Main Diversion, but no longer does so because all water is diverted at the Main Diversion. Perrine Ditch, which runs west from the Main Diversion until it discharges to the Middle Snake River, was built as a canal by "Old Man Perrine" (one of the early pioneers to Southern Idaho), and feeds Alpheus Creek water to the Blue Lakes fish farm and the Pristine Springs (Sunnybrook) fish hatchery. Perrine Ditch is currently owned and maintained by Blue Lakes and Pristine Springs fish hatcheries. An exhaustive review of any and all data available on Alpheus Creek within the repository of IDEQ-TFRO and other agencies was conducted. Information collected was divided into six areas: trihelomethanes, volatile organic compounds, soluble organic compounds, turbidity, primary and secondary nutrients, and bacteriology.

Data was mostly from the City of Twin Falls who has been monitoring Alpheus Creek since 1986 for the Drinking Water Information Management System (DWIMS) of IDEQ. Monitoring results indicate:

1. TRIHELOMETHANES

Data collected from 1989 through 1997 shows that Total Trihelomethanes are less than the method detection limit (MDL) and the maximum contaminant level (MCL). No exceedences were noted.

2. VOLATILE ORGANIC COMPOUNDS (VOCs)

Data collected from 1989 through 1997 shows that VOCs are less than the MDL and the MCL. No exceedences were noted.

3. SOLUBLE ORGANIC COMPOUNDS (SOCs)

Data collected from 1990 through 1994 shows that SOCs are less than the MDL and the MCL. No exceedences were noted.

4. TURBIDITY AND SEDIMENT

Data collected from 1986 through 1992 shows that turbidity (in NTU) met the criteria to avoid filtration (< 5 NTU) according to 40 CFR 141.71. From 1986 through 1987 the values were all less than 0.40 NTU. From 1988 through 1992 the values were all less than 0.10 NTU. Such low values indicates that "turbidity disturbances" are highly uncommnon on Alpheus Creek. Since measurements of turbidity have been developed to quickly estimate the amount of sediment within a sample of water (see §2.2.3.3, subsection 6), it can be logically argued chemically that turbidity and suspended sediment concentrations are closely related statistically (see §2.2.4.1, subsection 5, and §2.2.4.2, subsection 5). A review of influent water (Alpheus Creek; see §3.3.01) from the Blue Lakes Fish Farm (NPDES 000095-7) indicates that total suspended solids from 1991 to 1997 had a mean of 1.2 mg/L (standard deviation = 0.5; CV = 0.38); and, a flow from 1991 to 1997 had a mean of 143.7 cfs (standard deviation = 20.1 cfs; CV = 0.14). From these values a calculated load of 31.3 tons/year (mean from 1991 to 1997; standard deviation = 12.3 tons/year; CV = 0.39) may be used to represent natural background on Alpheus Creek for TSS.

5. PRIMARY AND SECONDARY NUTRIENTS

Data collected from 1975 through 1998 indicate that heavy metals are less than the MDL; total ammonia ranges from <0.010 to 0.070 mg/L; NOX from 1975 to 1978 ranges from 1.590 to 9.800 mg/L; and, NOX from 1979 to 1998 ranges from 0.810 to 3.780 mg/L. Surfactants were < 0.08 mg/L, and color was < 5 CU. No point sources discharge to the creek. Nonpoint source effects are minimal. Aquatic plant growths are minimal, and no algal blooms have ever been noted by the local population. Since Alpheus Creek is spring fed; since minimal plant growths as macrophytes do not exist; since no algal blooms have ever been noted; and, since TSS, primary, and secondary nutrients are low, it may be inferred that total phosphorus is probably low and reflects the average known spring concentration as other similar springs in the watershed at < 0.020 mg/L TP.

6. BACTERIOLOGY

Data collected in 1989 through 1991 showed that giardia was not a problem. No exceedences were noted. Additional analysis for cysts, nematoda, rotifers, insects, algae, and diatoms indicates the following: none for cysts; yes for nematoda; small, rare, and yes for insects; yes for green and blue-green algae; and, yes, rare, and none for diatoms. Data collected in 1991-1992 showed total coliform levels from 0 to 200 cfu/100 mL, and fecal coliform levels from 0 to 36 cfu/100 mL. Thus, primary and secondary contact recreational standards are being met.

7. DISSOLVED OXYGEN

Data collected by IDEQ-TFRO in 1997 and 1998 indicates that dissolved oxygen is not a problem. 1997 levels ranged from 8.90 to 9.95 mg/L; 1998 levels ranged from 8.95 to 9.95 mg/L. Data was collected at mid-stream just upstream from the main diversion.

Field assessment by IDEQ-TFRO indicates that there are no impacts from point sources and minimal impacts from nonpoint sources. Possibly during storm events it could be shown that elevated levels of TSS might exist due to stormwater runoff, but this is highly unlikely. Also, recreational impacts are minimal from joggers or the on-site golf course. But daily monitoring data from 1986 to 1992 (as previously discussed) shows that exceedences never occured above the 5.0 mg/L TSS criteria, thus meeting drinking water filtration standards. Thus, recreation and storm water runoff are not a problem. Exploration of the localized stream bed in the spring, summer, and fall of 1997 and 1998 showed that occlusion of the stream by macrophytes was not existent, and substrate was clean of sedimentation and siltation at all sites visited. Therefore, IDEQ-TFRO concludes that the noted pollutants of sediment, nutrients, and dissolved oxygen are not a hinderance or a problem within Alpheus Creek. IDEQ-TFRO supports the "de-listing" of the pollutants, and consequently that Alpheus Creek should be "de-listed" altogether as a water quality limited stream segment from the 303(d) list.

However, in the event that USEPA rejects the proposed "de-listing," then a proposed antidegradation TMDL will be considered. However, because of funding and available resources, IDEQ-TFRO will not do an antidegradation TMDL at this time.

3.03.04 CLEAR SPRINGS "CREEK" AND CLEAR SPRINGS LAKE

See §2.3.1.5. As a consequence of manmade diversions, the TMDL for Clear Springs will run from the headwaters to where it discharges into the Middle Snake River, but it will only be for those segments that are in the natural stream channel: CLS-Headwaters, CLS-Lake, and CLS-Confluence. Due to these numerous diversions there is no true Clear Springs "Creek" that runs from the headwaters of Clear Springs to where it discharges into the Middle Snake River. That portion between the headwater and the lake, and the lake and the confluence, are manmade diversions and not subject to the provisions of this TMDL. The "creek" and lake are listed for sediment, nutrients, dissolved oxygen, and ammonia. The "creek" should be listed only for the CLS-Lake and CLS-Confluence segments. The CLS-Headwaters segment should not be included in the listing. Little water quality information is available to characterize the "creek" and lake.

CLS-HEADWATERS SEGMENT

As previously described Clear Springs runs from its spring source headwaters (literally discharging out of the north Snake River canyon wall), under the concrete road, and collects in man-made collection ditches

(constructed prior to 1974). Therefore, the natural "creek" exists only from the headwaters until it is collected in the ditches. This will be referenced in this document as CLS-Headwaters and may be considered natural background for Clear Springs "Creek" and Clear Springs Lake. CLS-Headwaters provides influent water to various aquaculture facilities. A visit of the site indicates that this portion is unaffected from point sources. Nonpoint source effects may occur under stormwater conditions but very minimally. A review of several inspection reports from 1983 through 1998 by USEPA and IDEQ on the Middle Hatchery of Clear Springs Foods, Inc., indicates that TSS was < 4.0 mg/L and settable solids was < 0.1 mL/L. A review of influent water (Clear Springs; see §3.3.03) from the Clear Springs Foods—Middle Hatchery (NPDES 000101-5) discharge monitoring reports indicates that total suspended solids from 1991 to 1997 had an estimated mean of 0.7 mg/L; and, a flow from 1991 to 1997 had a mean of 191.05 cfs. From these values a calculated mean load of 131.6 tons/year may be used to represent natural background for TSS.

Because of minimal point and nonpoint source inpacts to this segment, it is highly unlikely that the water quality is degraded. Rather, the water quality is similar to other spring fed sources and meeting its beneficial uses for the localized area. However, in the event that USEPA rejects the proposed "de-listing," then a proposed antidegradation TMDL will be considered. However, because of funding and available resources, IDEQ-TFRO will not do an antidegradation TMDL at this time.

CLS-LAKE SEGMENT

From the collection ditches the water is diverted through a series of head gates via manmade canals and raceways to various aquaculture facilities and farms. Effluent discharge from these facilities is to an enhanced lake (constructed prior to 1974) called Clear Lakes. Clear Lakes was previously a swampy area (riparian zone) and has been enhanced (developed) by man for various purposes over the last 50 years. This lake is included as part of the natural system for Clear Springs. This will be referenced in this document as CLS-Lake. CLS-Lake is a private lake used primarily for recreational fishing. The Clear Lake Country Club operates a fee-fishing program and stocks it with catchable rainbow trout. Since 1929, there have been no reports of fish kills or fish distress that would suggest existent toxicity or low dissolved oxygen problems. Sediment accumulation in the lake is attributable to a variety of natural and manmade conditions, including modification of the depth and structure of the lake, construction activity (fish farms, processing plants, golf course, residential home development), aquaculture effluent, and historic grazing and mining practices. Additionally, water fowl maintain a year round population. Historic accumulations of sediment are probably the most significant source of phosphorus. The TMDL for this segment will be summarized in §3.5 for Load Allocation.

CLS-CONFLUENCE SEGMENT

Clear Lakes discharges to a man-made channel, which in turn discharges to the Middle Snake River over the "old stream bed." From the man-made channel a hydropower pipeline transfers water to the Clear Springs H.E. Hydropower facility (owned by Idaho Power Company). The "old stream bed" is located from the penstock of the hydropower facility to where it discharges to the Middle Snake River. This will be referenced in this document as CLS-Confluence. Above the penstock, it is uncertain where the old stream channel exited since it has been displaced by manmade enhancements to the lake. Water quality in this segment is more probably similar and directly affected by the CLS-Lake segment. Therefore, improvements in the CLS-Lake will have an effect on the CLS-Confluence segment. The TMDL for this segment will be summarized in §3.5 for Load Allocation.

3.03.05 CRYSTAL SPRINGS "CREEK" AND CRYSTAL LAKE

See §2.1.3.6, §2.2.2.5, and §2.3.1.8. The TMDL for Crystal Springs will run from the headwaters to where it discharges into the Middle Snake River, but as a consequence of manmade diversions the TMDL will only be for those segments that are in the natural stream channel: CRS-Headwaters and CRS-Lake. Due to a single diversion there is no true Crystal Springs "Creek" that runs from the headwaters of Crystal Springs through Crystal Lake, and then to where it discharges into the Middle Snake River. That portion between the headwater and the lake has a manmade diversion and is not subject to the provisions of this TMDL. The "creek" and lake are listed for sediment, nutrients, dissolved oxygen, flow alteration, and ammonia. The "creek" should be listed only for the CRS-Lake segment. The CRS-Headwaters segment should not be included in the listing.

CRS-HEADWATERS SEGMENT

As previously described, Crystal Springs runs from its spring source headwaters (much like Clear Springs, literally discharging out of the north Snake River canyon wall) to where it is captured in a large collection ditch. This portion will be referenced in this document as CRS-Headwaters and may be considered natural background for Crystal Springs "Creek" and Crystal Springs Lake. From the collection ditch it is either (1) pumped across the Middle Snake River to the Magic Valley Steelhead Hatchery degassing tower, or else (2) sent along the collection ditch to a head gate which delivers the flow to Crystal Springs Hatchery. CRS-Headwaters provides influent water to an aquaculture facility. A visit to the site indicates that CRS-Headwaters is unaffected from point sources. Nonpoint source effects may occur under stormwater conditions but very minimally. A review of Crystal Springs Fish Hatchery inspection reports by USEPA and IDEQ from 1992 to 1997 for the influent spring water used in the hatchery, indicates that ammonia averaged 0.014 mg/L , NOX averaged 3.094 mg/L, TKN averaged 0.09 mg/L, TP averaged 0.035 mg/L, TSS averaged 0.7 mg/L, and settable solids averaged 0.05 mL/L (estimated from ½ MDL). Additionally, a review of influent water (Crystal Springs; see §3.3.04) from the Crystal Springs Fish Hatchery (NPDES Permit No. 000089-2) discharge monitoring reports indicates that TSS from 1991 to 1997 had a mean of 0.6 mg/L; and, a flow from 1991 to 1997 had a mean of 207.56 cfs. From these values a calculated load of 122.5 tons/year may be used to represent natural background for TSS.

Because of minimal point and nonpoint source inpacts to this segment, and based on monitoring information, it can be shown that the water quality is not degraded for NH3, NOX, TP, and TSS. Like other spring fed sources, the water quality is meeting its beneficial uses for the localized area. Therefore, this segment should be "delisted" from the 303(d) list. However, in the event that USEPA rejects the proposed "de-listing," then a proposed antidegradation TMDL will be considered. However, because of funding and available resources, IDEQ-TFRO will not do an antidegradation TMDL at this time.

CRS-LAKE SEGMENT

Crystal Springs Hatchery currently discharges about 10 cfs into Crystal Lake when compared to the 150 cfs of water discharged to it during 1940-1950s. The 10 cfs from the fish hatchery is maintained to facilitate recreational fishing. The remainder is discharged to the Middle Snake River. Crystal Lake, like Clear Lake, is an enhanced lake due to man's intervention for hatchery development. From Crystal Lake the water discharges under the road into the Middle Snake River. No fish kills have been observed since 1940 indicating a low probability of unionized ammonia problems. In essence the lake is essentially composed of effluent discharge from the aquaculture facility, plus any additional unseen underground seeps that may be entering the lake. The TMDL for this segment will be summarized in §3.5 for Load Allocation.

3.03.06 THOUSAND SPRINGS "CREEK" / SAND SPRINGS CREEK

IDEQ-TFRO proposes that the historical record and the limited water quality data support the de-listing of sediment and nutrients as pollutants, and consequently that Thousand Springs Creek should be de-listed as a water quality limited stream segment from the 303(d) list. The listing of flow alteration as a pollutant is beyond the scope of this TMDL at this time.

BACKGROUND AND CURRENT STATUS

It is the professional opinion of IDEQ-TFRO, IDWR-Twin Falls, and USGS-Twin Falls that there is no Thousand Springs "Creek." There are, however, a thousand springs (more or less) that gush out of the Snake River canyon wall from the Snake River Plain Aquifer and eventually discharge to the Middle Snake River. According to IDWR-Twin Falls, prior to man's intervention with flow regulation of the Thousand Springs area, the collection of all the spring sources into one creek was probably more of an estuary area than a creek discharging to the Middle Snake River. In 1986, as part of the Pacific Northwest River Study (PNRS, also known as the Idaho Rivers Study), an assessment of "Thousand Springs Creek" was conducted for a variety of environmental values that might have a bearing on hydropower development in the northwest. Thousand Springs "Creek" was listed as segment 386.00 in HUC 17040212 with an upper boundary as the headwaters and a lower boundary as the Snake River. It was assumed that everything in-between these boundaries was Thousand Springs "Creek." Then, in 1989 a Chairman's Report of the Basin Area Meetings was published and included a more defined description of Thousand Springs "Creek." Thousand Springs "Creek" was defined as PNRS 386.00 and included: Minnie Miller Springs Creek and all the Thousand Springs source water. The primary objective for its inclusion in the Chairman's Report was to maintain water quality (for Minnie Miller Srings Creek) and restore water quality (for Thousand Springs due to flow alteration). At the same time the report stated, "... we are confident the integrity of the Minnie Miller Springs and their creek will be protected by the Nature Conservancy.." However, "... these springs are the ONLY such springs visible from Highway 30 that have not been tampered with by man in some way. Accordingly, we believe it is crucial to afford these springs and their outflow all protection possible". Additionally, Minnie Miller Springs Creek (defined as Thousand Springs "Creek" in the report) has "... a minimum streamflow for the entire discharge ... This spring is a landmark of state and national signficance and its high water quality should be maintained" ("Chairman's Report" 1989 [pp 59-60]. Therefore, the "Thousand Springs Creek" included the Minnie Miller Springs and the Thousand Springs source water. As a result, the eventual listing of the "Thousand Springs Creek" stream in USEPA's 1994 303(d) list (it was not listed in 1992) was not because the water was degraded or of a eutrophic condition (even though it is listed for sediment, nutrients, and flow alteration), but rather because there was public outcry to afford "all protection possible" for a springs source that had not been "tampered with by man," although as will be demonstrated in the following paragraphs flow alteration is the main concern. How do you restore beneficial uses and water quality standards on any stream that already is not "tampered with by man" and has "high water quality?"

Additionally, Sand Springs Creek has been erroneously interpreted as being Thousand Springs "Creek" by various sources. Several agency and industry documents appear to support this, but this is clearly erroneous in interpretation. Sand Springs Creek which is upstream of Thousand Springs (via the Middle Snake River), has a wooden flume diversion pipe that sends a major portion of the water from Sand Springs Creek to the Thousand Springs hydropower facility. Because both waters are combined, it is not unusual to think that Thousand Springs "Creek" and Sand Spirngs Creek are one in the same creek or "one in the same water." But clearly they are two distinct and separate creeks that have the same aquifer as their source water. Water from Sand Springs Creek provides habitat for the largest population of Shoshone sculpin to be found on private property.

See §2.3.1.16. Thousand Springs "Creek" is listed for sediment, nutrients, and flow alteration. The majority

of the spring water is used for hydropower and is unaffected by sediment or the addition of nutrients. In fact, flow alteration due to hydropower generation, constructed before 1974, has altered the nature of this stream. The Idaho Power Company Thousand Springs hydropower facility is located between the Minnie Miller Falls and the man-made Lemmon Falls of the Thousand Springs area. Between these two falls a collection ditch was constructed to collect the outflow from 28 spring sources of Thousand Springs from the tailus walls of the Snake River canyon. Construction of the hydropower facility also included increasing the discharge diameter of the spring sources by boring out a larger hole for the spring water to evacuate into the collection ditch. The collection ditch runs from northwest to southeast towards the powerhouse, and from southeast to northwest towards the powerhouse, and brings all the spring source water to the powerhouse. Discharge from the Thousand Springs hydropower facility is into Ritter Creek. Ritter Creek makes up a portion of the Nature Conservancy Preserve and discharges into the Middle Snake River at approximately RM584.5. The discharge into Ritter Creek is made up of water from the Thousand Springs and from Sand Springs Creek. A review of the influent water (see §3.3.03) from the Blind Canyon Aqua Ranch (or Ten Springs Trout Farm, NPDES No. 002600-0), which is the source water to Thousand Springs, indicates that total suspended solids from 1991 to 1997 had a mean of 0.5 mg/L; and, a flow from 1991 to 1997 had a mean of 28.45 cfs. From these values a calculated load of 14.0 tons/year and may be used to represent natural background for TSS. Additionally, a USEPA Inspection Report of August 18, 1998 indicates that DO = 9.09 mg/L, temperature = 14.2°C, TP = 0.01 mg/L, NOX = 1.07 mg/L, TKN and NH3 were below MDL of 0.4 and 0.1 mg/L, respectively. In IDEQ-TFRO's profession opinion, Ritter Creek is not adversely affected by sediment or nutrients, nor by point sources, and minimally by nonpoint sources of pollution. In NPDES Permit No. 002600-0 it states that the effluent discharge is into Thousand Springs "Creek." This is incorrect as well. A visit to the site by IDEQ-TFRO on May 2, 1999 showed that the discharge is to a man-made channel which goes over a cliff into what is called Lemmon Falls (which is also manmade) which in turn discharges into the Nature Conservancy's Ritter Creek, which then discharges into the Middle Snake River (at RM584.6). Local owners do not consider the discharge from the fish hatchery in combination with spring water as Thousand Springs "Creek." In fact, Lemmon Falls was constructed to collect a number of spring sources and eventually run the spring water through an additional hydropower facility. This hydropower facility was never constructed.

The water as it exists today is affected by flow alteration. It is not affected from point sources and minimally affected from nonpoint sources. As a result, it is highly unlikely that the water quality is degraded for TSS and nutrients. Certainly the USEPA Inspection Report of August 18, 1998 supports this argument. Rather, the water quality is similar to other spring fed sources in the area and in all likelihood is meeting its beneficial uses. IDEQ-TFRO proposes that this "creek" be "de-listed from the 303(d) list since it is not "tampered with by man" and has "high water quality." However, in the event that USEPA rejects the proposed "de-listing," then a proposed antidegradation TMDL will be considered. However, because of funding and available resources, IDEQ-TFRO will not do an antidegradation TMDL at this time.

3.03.07 BLIND CANYON CREEK

Blind Canyon Creek is listed on the 303(d) list from the headwaters to where it discharges into the Middle Snake River. This listing supposes that the headwaters of Blind Canyon Creek is the beginning of Blind Canyon Creek. This is incorrect. Aquifer discharge into Blind Canyon is downstream (about 0.5 - 1.0 miles) from the discharge waterfall spill of the North Side Canal Company's S-19 and S Coulee drains when diverted into the Blind Canyon area. Normally, the S-19 and S Coulee drains are used as input source water for the Lemmon Hydropower Facility which discharges to the Middle Snake River just upstream of the confluence of Blind Canyon Creel IDEQ-TFRO proposes that the listing be changed to incompass the waterfall spill so that the entire canyon is included in the listing. As the listing stands currently, the listing only encompasses about 60% of Blind Canyon Creek since headwaters supposes the spring sources only.

BACKGROUND

See §2.1.3.6. §2.2.2.5. and §2.3.1.3. This creek is listed for sediment, nutrients, dissolved oxygen, flow alteration, ammonia, and pathogens. Flow alteration due to the construction of a fish hatchery, constructed before 1974, has altered the nature of this stream. At one time, prior to population, it is evident from a visit to the site that Blind Canyon Creek was a spring fed creek, and probably provided minimal impact to the Middle Snake River, except during stormwater runoff events. But since development by man, both as irrigation canal water and aquaculture facility discharge, Blind Canyon Creek no longer flows as a natural creek. Rather, it flows as an extension of the irrigation canalway for the North Side Canal Company on occasion when meeting water right diversion needs. Canal company ownership of the canalway ends at the discharge waterfall spill above the channel of Blind Canyon Creek. But from this point to where it discharges into the Middle Snake River the water is still irrigation water with inputs from fish hatchery effluent. The use of irrigation water for the fish hatchery may occur only if the spring source water drops in flow. Otherwise, for the most part the fish hatchery utilizes all of the spring source water for its facility operations.

CURRENT STATUS

A field visit by IDEQ-TFRO on May 7, 1999 indicated that the tallus slope walls of the canyon had two spring outlets that discharged directly out of the canyon wall into a manmade collection ditch which was piped upstream through a water line to the upper raceway of the Blind Canyon Aqua Ranch (NPDES No. 002599-2 or Domsea Farms Inc.). The spring-fed water runs downstream through a number of raceways into a tail settling pond which then discharges into the Blind Canyon Creek channel. The channel follows the natural contour of Blind Canyon through the old stream bed, but the water is now a combination of aquaculture effluent and irrigation water from the North Side Canal Company's S-19 (which comes from the north side) and S Coulee (which comes from the east side) when irrigation water right diversion needs occur. The irrigation water spills (or creates a waterfall) over the crest of the canyon just upstream of the aquaculture facility (about 0.5-1.0 miles) and follows the natural stream channel as an irrigation return flow until it discharges downstream into the Middle Snake River. Besides the spring sources that are collected for Blind Canyon Aqua Ranch, no other spring sources exist above or below these springs. Some underground seeps do occur upstream of the fish hatchery just below the spillway for irrigation water. In essence, the "headwaters" of Blind Canyon Creek begin at the irrigation waterfall spill. It's not till you are about 1 mile from the waterfall spill that you encompass the two springs that discharge into the manmade collection ditch. A review of the influent water (see §3.3.03) from the Blind Canyon Aqua Hatchery (or Domsea Farms Inc., NPDES No. 002599-2), which is the source water to Blind Canyon Creek, indicates that total suspended solids from 1991 to 1997 had a mean of 0.8 mg/L; and, a flow from 1991 to 1997 had a mean of 7.4 cfs. From these values a calculated load of 5.8 tons/year and may be used to represent natural background for TSS.

It is proposed that the listing of this creek be modified from its headwaters (which is within the creek itself) to where the outfall discharge of S-19/S Coulee occurs, thus taking in all of the canyon of Blind Canyon Creek. The TMDL for this segment will be summarized in §3.5 for Load Allocation.

3.04 NONPOINT SOURCE DRIVEN STREAMS

As previously noted the following 12 segments are strictly nonpoint source driven: Alpheus Creek, Clover Creek, Cottonwood Creek (as part of the Rock Creek Complex), Dry Creek (all three segments: Medley Creek to the Snake River, Headwaters to Medley Creek, and Headwaters to Dry Creek), and McMullen Creek (as part of the Rock Creek Complex). The allocation of loadings for these streams will be based on the stream corridor approach model.

3.05 POINT AND NONPOINT SOURCE DRIVEN STREAMS

The remainder of the water quality limited stream segments are affected by both point and nonpoint sources. These streams include: Billingsley Creek, Blind Canyon Creek, Clear Springs, Crystal Springs, Riley Creek, Rock Creek, and Thousand Springs Creek. The Middle Snake River and the five reservoirs are affected by both point and nonpoint sources.

3.1 INSTREAM WATER QUALITY TARGET(S)

Instream water quality targets were identified for the pollutants of concern and are defined in the following sections. Pursuant to IDAPA 16.01.02.400(01)(b) for point sources, failure to meet general or specific water quality criteria is a violation of the water quality standards except in an area defined as a mixing zone (IDAPA 16.01.02.003(59): "a defined area ... of the receiving water surrounding or adjacent to a wastewater discharge where the receiving water, as a result of the discharge, may not meet all applicable water quality criteria or standards. It is considered a place where wastewater mixes with receiving water and not as a place where effluents are treated." (See IDAPA 16.01.02.060 for Mixing Zone Policy.) For site-specific surface water quality criteria, IDAPA 16.01.02.275(a)(iv) allows for water quality criteria to be "derived to protect and maintain existing ambient water quality." Surface water quality within any stream segment that can be demonstrated to be below the instream water quality target will be considered for site-specific criteria development after Year 5 of plan implementation. Site-specific criteria "shall not impair designated or existing beneficial uses year-round (or seasonally for seasonal dependent criteria) and shall prevent acute and chronic toxicity outdside of approved mixing zones (IDAPA 16.01.02.275(c)."

3.1.01 SUSPENDED SEDIMENTS, LOAD CAPACITY, AND SUBSTRATE SEDIMENTS

SUSPENDED SEDIMENTS AND LOAD CAPACITY

See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan* for discussion on instream targets. As discussed in the subbasin assessment (§2.2.3.3, item 5, Sediment and "Settable Substances") sediment is the most common nonpoint source pollutant in the Upper Snake Rock subbasin affecting beneficial uses of salmonid spawning and cold water biota. However, sediment is a narrative standard in the State water quality standards, thus no numeric criteria is cited. Therefore, IDEQ researched and selected an instream water quality target of 52 mg/L for use on both tributaries and the Middle Snake River. This is based on the severity of effects and its relationship to the duration of exposure of TSS to fisheries and the amount of protection they are afforded with this concentration. A TSS concentration of < 80 mg/L TSS affords a moderate-to-high protection level with a none-to-slightly reduced fisheries. Target concentrations at 80 mg/L TSS sustained for 30 or more days consecutively may result in lethal or paralethal effects on fisheries. Therefore, a 52 mg/L TSS instream target will serve as a monthly average, and an 80 mg/L TSS instream target will serve as a daily maximum (see CH2MHILL 1998 for additional information). The 52 mg/L is the load capacity for any stream in the Upper Snake Rock subbasin. The 52 mg/L TSS instream target is an appropriate preliminary target for protecting fisheries from excessive sediments > 80 mg/L. The 52 mg/L TSS instream target is a preliminary target that will be used to bring all industries into compliance within 5 years of plan effectiveness, and held for an additional 5 years to determine the effects of such reductions. Therefore, IDEQ-TFRO has determined the quantification of the narrative standard by proposing a preliminary instream water quality target of 52 mg/L TSS as a monthly average concentration with a maximum daily concentration of 80 mg/L TSS. This target supports a "good fishery (EIFAC 1964; NAS/NAE 1973)," and a "regional comparison for a high level of protection for cold water biota (IDHW 1991a [p 13])," thus meeting a quantity for supporting designated beneficial uses and State water quality standards for excess

sediment. IDEQ-TFRO considers the 52 mg/L monthly average and the 80 mg/L maximum daily concentrations as a valid interpretation of Idaho's narrative sediment criteria for the Middle Snake River and its surface waterbodies (tributaries and irrigation return flows), and thus meets the requirements of the Clean Water Act.

Application of the load capacity (52 mg/L TSS), the instream target (52 mg/L TSS), and existing conditions to various flow scenarios is summarized as follows for the various Middle Snake River segments based on the *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section II)* and from the *Design Flows for the Middle Snake River and Its Tributaries*. Additionally, it was assessed from statistical analysis of existing data, that unlike total phosphorus which dilutes more readily under high flow conditions, TSS appears to proliferate.

Segment Site	Minimum Load (based on Low Q)	Mean Load (based on Mean Q)	Maximum Load (based on High Q)
	≤ 52 mg/L TSS as the Instream Target and Load Capacity		
Milner Dam	18,721.3 tons/year	197,443.2 tons/year	482,457.2 tons/year
Pillar Falls	58,619.2	242,302.8	544,452.3
Crystal Spgs	94,731.8	281,228.7	583,327.1
Box Canyon	182,762.9	368,901.7	668,749.5
Gridley Bridge	277,699.3	466,140.0	773,609.2
Shoestring	341,382.4	568,186.4	900,157.1
King Hill	377,699.7	583,020.2	924,249.2
	Estimate Existing TSS Conditions Based on Existing Data & Sediment Rating Curves		
Milner Dam	5,261.1 tons/year	62,491.0 tons/year	179,994.4 tons/year
Pillar Falls	13,487.9	71,497.9	218,853.9
Crystal Spgs	24,422.0	102,768.9	314,861.7
Box Canyon	65,133.5	183,773.4	485,883.9
Gridley Bridge	63,620.2	186,809.1	526,709.5
Shoestring	28,297.9	196,950.4	659,509.1
King Hill	110,104.6	300,426.8	819,996.0

In comparing existing versus load capacity targets at Milner Dam there is a 71.9% TSS reduction for low flow years, a 68.3% TSS reduction for mean flow years, and a 62.7% TSS reduction in high flow years. Under low flow conditions it is obvious that the least amount of TSS loads occur in the river system because the TSS concentration stays relatively the same with a range from 4.3 mg/L to 18.5 mg/L (with a mean of 12.8 mg/L and a variance of 14.2 mg/L). Under high flow conditions a worse-case scenario occurs for TSS loads because TSS concentrations increase from upstream to downstream with a range of 19.4 mg/L to 46.1 mg/L (with a mean of 32.3 mg/L and a variance of 26.7 mg/L). This increase in TSS concentration under high flow conditions creates extreme TSS load conditions for the river system. In essence, the condition reflects a saturation of TSS creating high turbidity in the clarity of the water. Therefore, reductions in TSS inputs to levels below 52 mg/L TSS will lead to significant reductions in the instream TSS concentration which in turn will greatly reduce the buildup potential for washload in the substrate. If those reductions are reasonably maintained during mean and high flow conditions, then conditions in the river system will improve dramatically, thus leading to attainment of beneficial uses and State water quality standards. However, one cannot dismiss the impacts from TSS under high flow conditions. In a managed system, such as is the case with the Middle Snake River, high flows can be somewhat of a paradox. On the one hand they are necessary to scour and

clean up the system of TSS buildup. On the other hand, they can be potentially detrimental to water quality due to apparent TSS proliferation.

Therefore, IDEQ-TFRO will continue to assess the impacts of TSS under various flow regimes, and will investigate what options may be available in the management of excessive high flows such that TSS does not continue to be an accumulative impactor to the system as evidenced in the data already collected. This does not mean that high flows are the main source of higher TSS values in the downstream reaches of the Middle Snake River. Rather, it indicates that managed high flows could potentially aid in retarding some of the excessive sediments that appear to accumulate in the downstream segments. Reductions from nonpoint source inputs are still a serious consideration and are addressed in the 52 mg/L TSS average monthly limit and the 80 mg/L TSS maximum daily limit.

SUBSTRATE SEDIMENTS

There is no question that fine sediment and its accumulation is detrimental to salmonid spawning since it limits the quality and quantity of the inter-gravel spaces that are critical for egg incubation. Fine sediment and availability of living space have direct affects on both fisheries and macroinvertebrates (IDEQ 1999 [p 3]). In the Upper Snake Rock subbasin, as previously discussed, the principal source of total suspended sediment load to the Middle Snake River are surface waterbodies (tributaries and irrigation return drains). IDEQ-TFRO has discussed substrate sediment targets for the Middle Snake River with USEPA to aid with recovery of the endangered mollusc species. Unfortunately, USEPA and USFWS are ill prepared at this time to provide technical guidance relative to the development of these targets, particularly targets that are reasonable and achieveable with linkage to the instream targets.

It seems reasonable and prudent that as a consequence of the imposed NPDES permit limits for TSS on aquaculture facilities, municipalities, and food processors, that a regular review of the effectiveness of TSS concentration reductions (and consequently TSS load reductions) under the more stringent TSS limits would provide a pathway for which USEPA and USFWS should pursue initially to determine if the implementation of BMPs by point sources will lead to the success of BMP practices for the reduction of TSS loadings to the Middle Snake River and its tributaries. IDEQ-TFRO is prepared to do something similar for all nonpoint source industries and possibly for point source industries, if needed, in the event that USEPA and USFWS are not prepared to do this. There is no question that TSS can impact aquatic environments and species by physically covering their habitat, adding nutrient loading, and by potentially creating hypoxic or anoxic conditions. But there is no current or historical information that can provide direction as to what level or levels of TSS are permissible for the viability of aquatic species and their related environments.

Substrate sediment targets are inappropriate in the Middle Snake River or its tributaries because fine bedload materials (sands, small gravel, silt, and clay fractions) are derived from largely the same sources as the measured suspended sediment materials. Using TSS is a sufficient "surrogate" for the total sediment load because its true substrate sediment comprises a smaller percentage when compared to TSS. TSS comprises a much larger percentage of the total sediment load. Thus, actions taken to reduce suspended sediment load (as TSS) will also reduce the fine bed material load (or more appropriately the "washload") that is commensurate to or greater than TSS reductions. In the Middle Snake River system there is minimal bedload substrate. It is predominantly washload. Thus, such smaller sediment sizes require less energy to be dislodged and transported and are thus less easily trapped or kept in place under average to high flow conditions. In effect, BMPs will need to be developed (on site specific areas within each surface waterbody) that address surface erosion (comprised mostly of silts and clay) which eventually are transported into the river system.

As previously described in the subbasin assessment (§2.2.3.3, item 5, Sediment and "Settable Substances"), the Falter Study (Falter *et al.* 1995, Falter *et al.* 1996) indicated that in the Crystal Springs and Box Canyon sites (limited to depositional sites with weedbeds and deep pools) were dominated by fines (< 0.075 mm). This study as compared to GeoSea® Consulting's Study (McLaren 1998) indicates that in 1997 the sediment particle size was mostly sand and gravel (due to high flushing flows in 1996 and 1997), whereas in 1993-1994 it was mostly silt and clay or muddy sediment (due to low flow conditions). Compare this to USGS's substrate study in 1993-1995 on substrate size, embeddedness, and substrate fines (< 6 mm) (USGS 1997a) which shows the similarity between Rock Creek and the Middle Snake River thus indicating that the substrate character of sediment inputs is similar to the substrate character of the river. A decrease in the suspended sediment (as TSS) in the surface waterbody inputs will result in a decrease in the fines and embeddedness of such waterbodies. This in turn will also help to reduce the fines and embeddedness of the Middle Snake River.

1993-1994 FALTER STUDY

YEAR	LOCATION	SAND	SILT	CLAY
1993	Crystal Springs & Box Canyon	56.7%	40.0%	3.3%
1993	Crystal Springs & Box Canyon	53.6-61.4%	36.5-43.6%	2.1-4.5%
1994	Crystal Springs & Box Canyon	53.6%	39.8%	5.5%
1994	Crystal Springs & Box Canyon	51.2-72.1%	25.2-41.2%	2.7-6.2%

1993-1995 USGS STUDY

YEAR	LOCATION	SUBSTRATE	EMBEDD	FINES
1993	Snake River near Buhl	3.1%	80.0%	76.0%
1993	Snake River at King Hill	2.1%	47.0%	38.0%
1994	Snake River at King Hill	2.1%	47.0%	38.0%
1995	Snake River at King Hill	2.1%	47.0%	38.0%
1993	Rock Creek at Twin Falls	3.5%	74.0%	35.0%
1994	Rock Creek at Twin Falls	2.2%	74.3%	29.0%
1995	Rock Creek at Twin Falls	3.3%	90.0%	29.0%

1997 GeoSea® STUDY

YEAR	LOCATION	SAND/GRAVEL	SANDY MUD	MUD
1997	Middle Snake River	45%	47%	8%

These studies were the only studies that could be found that describe sediment conditions on the Middle Snake River for the period 1990-1998. In effect, macrophyte habitat buildup in the Middle Snake River will increase as flows decrease and fine deposits from tributaries and irrigation returns maintain dominance over the traction transport of the river bed. In conjunction with GeoSea® Consulting's Study, IDEQ-TFRO has also determined the growth of macrophyte habitat can be controlled by periodic flushing of the river. The erosion of the macrophyte habitat appears to be in the range of 1000-1300 cfs in order to start the erosion process, which is typical of river systems that have silt and clay deposits comprising the major sediment fraction. At 10,000 cfs significant movement of fine grained material (sand, silt, clay fractions) is eroded and then added to the river as suspended load.

In addition to these studies, IDEQ-TFRO also confirms GeoSea® Consulting's Study that muddy sediments are most frequently found along the shallow sides of the river. Muddy sediments also tend to increase from upstream to downstream as confirmed in §3.5.07, Table 105, since the TSS increases accordingly. Muddy

sediment is carried mostly in suspension and is deposited along the upper levels of the river sides where friction reduces flow velocities. Sandy sediments, on the other hand, appear to be carried by traction along the river bottom in deeper water. Prior to the flushing flows of 1996-1997, the main channel in depths below a few feet was comprised of higher levels of silt and clay. USBLM considers channel bottom silt and clay fractions of wadable streams as < 10% optimal, 10-30% to be suboptimal, 30-50% marginal, and > 50% poor (Proper Functioning Condition). Discussions with USBLM and USFS suggest that application of this caracterization to managed large rivers has some merit. Thus, the Middle Snake River from 1993-1994 had silt and clay fractions that totaled 40-43%. In 1997 the fines were 8% which includes silt and clay.

Because IDEQ-TFRO does not agree that substrate targets are appropriate for this particular river system because of the managed condition, the nature of the input sediments, and the lack of appropriate substrate sediment research information; and, because IDEQ-TFRO strongly believes that suspended sediment (as TSS) reduction will result in significant reductions to washload sediments; IDEQ-TFRO is not prepared at this time to propose substrate targets for the Middle Snake River or its tributaries. However, IDEQ-TFRO will continue to actively assess and evaluate current and any additional data that defines substrate sediments and will consider a joint-study between USEPA, USFWS, and IDEQ-TFRO so that resolution may be arrived at in the next 3 to 5 years.

3.1.02 TOTAL PHOSPHORUS

See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan* for discussion on instream targets. "In streams, phosphorus occurs primarily as phosphate and can be either dissolved, incorporated in organisms, or attached to particles in the water or in bottom sediments (USGS 1994 [chapter 4])." As described in §2.2.3.3, total phosphorus should not exceed 0.05 mg/L TP in streams where it enters a lake or reservoir to prevent the development of biological nuisances and to control accelarated or cultural eutrophication. To prevent plant nuisances in flowing waters not discharging directly to lakes or impoundments, a desired goal of 0.100 mg/L TP is suggested ("Gold Book" and "Blue Book" value). For a lake or a reservoir, the suggested goal is 0.025 mg/L TP. Because of the modified flow regime with run-of-the-river impoundments, the Mid-Snake TMDL uses a water quality target of 0.075 mg/L TP at the Gridley Bridge, Hagerman, Idaho site. This represents a value between 0.050 and 0.100 mg/L TP. Since excess nutrients is a narrative standard in the State Water Quality Standards, no numeric criteria is cited. Therefore, IDEQ selected for TP an instream water quality target of 0.100 mg/L on tributaries and 0.075 mg/L on the Middle Snake River. SRP is not being considered as a separate TMDL since TP accounts for all the phosphorus in the system, implying that reductions in TP will also produce reductions in SRP. *This water quality target (0.075 mg/L TP) is now proposed as a representative average of the whole Middle Snake River system, assuming that the water quality pollution targets by the various water user industries are implemented over a 10-year period*. A water quality target of 0.100 mg/L or less is proposed for all other tributaries throughout their entire length, from their source water (if applicable) to their discharge with the Middle Snake River. Thus, tributaries or streams discharging to the Middle Snake River are to discharge at TP concentrations not exceeding 0.100 mg/L. From upstream to downstream the overall target of the Middle Snake River is 0.075 mg/L. These criteria are preliminary targets that will be used to bring all industries into compliance within 5 years of plan effectiveness, and held for an additional 5 years to determine the effects of such reductions.

Total phosphorus allocations defined in the Mid-Snake TMDL shall continue to be enforced for those industries that have wasteload or load allocations. For point source industries, such as aquaculture, which have a portion of the facilities defined as TBD (or To Be Determined), these wasteload allocations won't be defined till after 3 years of monitoring. Effective date of all permits for point source industries is described in the

following table for TP

Table 81 Permitted industries permit signing, effectiveness, and expiration under the Mid-Snake TMDL

Industry or Facility	*Permit Signed*	*Permit Effectiveness*	*Permit Expiration*
Aquaculture Industry	August 19, 1999	September 10, 1999	September 10, 2004
City of Buhl	July 29, 1999	August 31, 1999	August 31, 2004
City of Filer	July 29, 1999	August 31, 1999	August 31, 2004
City of Hagerman	July 29, 1999	August 31, 1999	August 31, 2004
City of Hansen	July 29, 1999	August 31, 1999	August 31, 2004
City of Jerome	July 29, 1999	August 31, 1999	August 31, 2004
City of Twin Falls	July 29, 1999	August 31, 1999	August 31, 2004
J.R. Simplot-Burley	July 29, 1999	August 31, 1999	August 31, 2004
McCains-Burley	July 29, 1999	August 31, 1999	August 31, 2004
Prepared by IDEQ-TFRO.			

For nonpoint source industries, like irrigated agriculture, load allocations defined in the Mid-Snake TMDL will continue to be enforced with the provision that if any of the 18 named agricultural drains meets its defined goals for TP reductions but is still above the level imposed by the Upper Snake Rock TMDL, then they will have to reduce additionally to the level defined in the Upper Snake Rock TMDL.

3.1.03 PATHOGENS

For pathogens the development of specific BMPs by the land management agencies during the implementation phase of the TMDL process for Upper Snake Rock will be used to demonstrate reductions towards State Water Quality Standards. Instantaneous limits in the Idaho Rules and Regulations of 500 and 800 colonies/100 mL (primary and secondary contact recreation) will continue to be used, unless changes in the regulations allow for *E. Coli* to be used instead of fecal coliform. Additionally, reductions in TSS will also show reductions in fecal coliform bacteria levels. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan*. See also §2.2.4.3 of sub basin assessment. Therefore, a TMDL for the Middle Snake River on pathogens will not be proposed at this time since it can be demonstrated that the river is meeting State Water Quality Standards for primary and secondary contact recreation. For tributaries, primary contact recreation exceedences are 430 out of 1878 total samples (or 22.9%), and for secondary contact recreation are 240 out of 1878 total samples (or 12.8%). Therefore, a TMDL is proposed that brings the percent of samples with fecal coliform bacteria exceedences down to a level that is less than 5.0% of the samples for a particular stream for both primary and secondary contact recreation. This will require the development of a monitoring plan for the tributaries which the Mid-Snake WAG, the Mid-Snake TAC, and IDEQ-TFRO will develop during the implementation phase of the TMDL process. Based on the subbasin assessment §2.2.4.3, Tributary Fecal Bacteria Data and Assessment:

Surface Waterbody	***Listed for Bacteria?***	***Designation***	***Recommendation***
	303(d) LISTED STREAMS		
Alpheus Creek	No	DW	No action required

Billingsley Creek	No	DW, PCR, SCR	TMDL Required
Blind Canyon Creek	Yes	SCR	Monitoring required
Clear Springs	No	SCR	Monitoring required
Clover Creek	No	PCR, SCR	TMDL Required
Cottonwood Creek	Yes	SCR	No action required
Crystal Springs	No	SCR	Monitoring required
Dry Creek, Medley to SR	Yes	SCR	Monitoring required
Dry Creek, HW to Medley	Yes	SCR	Monitoring required
Dry Creek, West Fork	Yes	SCR	Monitoring required
Ellison Creek	Yes	SCR	Monitoring required
McMullen Creek	Yes	SCR	Monitoring required
Riley Creek	Yes	DW, PCR, SCR	Monitoring required
Rock Creek	Yes	SCR	TMDL Required
Thousand Springs	No	SCR	Monitoring required
Vinyard Creek	Yes	SCR	No action required
Bliss Reservoir	No	PCR, SCR	No action required
Lower Salmon Falls Reservoir	No	PCR, SCR	No action required
Pioneer Reservoir	Yes	PCR, SCR	Monitoring required
Shoshone Falls Reservoir	No	PCR, SCR	No action required
Upper Salmon Falls Reservoir	No	PCR, SCR	No action required
Middle Snake River,			
Milner to Murtaugh	Yes	PCR, SCR	No action required
Murtaugh to King Hill	No	PCR, SCR	No action required

ADDITIONAL SURFACE WATERBODIES NOT ON 303(d) LIST

Natural Streams:			
Cedar Draw	No	SCR	TMDL required
Mud Creek	No	SCR	TMDL required
Deep Creek	No	SCR	TMDL required
Salmon Falls Creek	No	PCR, SCR	No action required
Malad River	No	PCR, SCR	TMDL required
North Side Canal Company Drains (Phase 1 Study):			
C55 Drain	No	Manmade Waterway	Action required
N42 Drain	No	Manmade Waterway	Action required
N42 Drain (Rim)	No	Manmade Waterway	Action required
J8 Drain	No	Manmade Waterway	Action required
S29 Drain	No	Manmade Waterway	Action required
S19/S Drains	No	Manmade Waterway	Action required
W26 Drain	No	Manmade Waterway	Action required
Twin Falls Canal Company Drains (Phase 1 Study):			
A10 Drain	No	Manmade Waterway	Action required
Twin Falls Coulee	No	Manmade Waterway	Action required
East Perrine Coulee	No	Manmade Waterway	Action required
Main Perrine Coulee	No	Manmade Waterway	Action required
West Perrine Coulee	No	Manmade Waterway	Action required
43 Drain	No	Manmade Waterway	Action Required

30 Drain	No	Manmade Waterway	Action Required
LQ/LS Drains	No	Manmade Waterway	Action Required
LS2/39A Drain	No	Manmade Waterway	Action Required
39 Drain	No	Manmade Waterway	Action Required
I Drain	No	Manmade Waterway	Action Required
N Drain	No	Manmade Waterway	No action required

DW = Drinking Water. PCR = Primary contact recreation. SCR = Secondary contact recreation.

The *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan* provides additional technical information on the linkage between bacteria and TSS. As a consequence of TSS reductions, it is anticipated that fecal coliform will likely be reduced as well. However, BMPs that specifically look at minimizing fecal coliform impacts due to land use will be assessed by the land management agencies during the implementation phase of the TMDL. These BMPs will be used to help develop specific farm plans that have in them a pathogen management component that addresses specific actions for pathogen reduction in conjunction with other nonpoint source reductions. These plans will be developed during the implementation phase of the TMDL. Where land management falls under the authority of the USFS or USBLM, it is expected that appropriate measures will be conducted by those agencies "to protect and maintain water quality where standards are met or surpassed, and restore water quality limited water bodies within their jurisdiction to conditions that meet or surpass standards for designated beneficial uses (USFS & USBLM & USEPA 1999 [p 1]l)." Where the land management falls under the authority of the Idaho Bureau of Lands, IDEQ will cooperate with that agency to develop a land management plan that will restore or help to bring restoration to a water quality limited stream. If the land management falls under the authority of private ownership, then IDEQ will cooperate with NRCS, the Idaho Soil Conservation Commission, and the local soil conservation districts, as well as property owners to develop specific BMPs that will remediate the water quality limited stream.

3.1.04 UNIONIZED AMMONIA

See the *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan* for additional information. In terms of assessing unionized NH3, IDEQ-TFRO took the total number of samples collected and categorized unionized ammonia as follows: (1) if the percent unionized ammonia of the total number of samples was zero, then this was reported as *No Exceedences Found*; (2) if the percent unionized ammonia of the total number of samples was < 10.0, then this was reported as *Minor Exceedences Found*; and, if the percent unionized ammonia of the total number of samples was 10.0 or more, then this was reported as *Major Exceedences Found*. Only stream segments with *Major Exceedences Found* will be considered for a TMDL.

For unionized NH3 no instream target is proposed at this time on the Middle Snake River. In § 2.2.4.1 (2) of the subbasin assessment, it was demonstrated that 99.43% of the samples collected (N = 884), only 5 samples exceeded the protective level (based on State water quality standards) for fisheries. These exceedences occured in 1991 and 1995. IDEQ-TFRO proposes that these are minor excursions of the standard (0.57%). Therefore, no instream target is proposed at this time. However, this parameter will continue to be reviewed based on monitoring information and a TMDL may be developed in the future if significant excursions result.

For the tributaries, a summary of unionized ammonia exceedences is detailed in §2.2.4.2 (2). These exceedences represent a fraction of all the tributaries (only 9). Some of the data is not reflective of 9 years, while some is reflective of a smaller portion of a single year. As a whole, the range of exceedences is from

0.0% to 23.5% of unionized ammonia. Therefore in 2302 total samples (for all 9 tributaries) there were 76 unionized ammonia exceedences, or 3.3% of the total sample population. Individually and as summarized in §2.2.4.2 (item 2) of the subbasin assessment (see Table 55), individual tributary streams have the following unionized ammonia exceedences (as a percent of the total number of samples collected) as follows. Major exceedence tributaries are bolded in black. N_{TOTAL} is the total number of samples in the population. $N_{UNIONIZED}$ is the total number of samples where unionized NH3 >= 0.020 mg/L.

DATA AS COLLECTED BY IDEQ-TFRO FROM 1990-1998:

Tributary	N_{TOTAL}	$N_{UNIONIZED}$	% of Total	IDEQ-TFRO Assessment
East Perrine Coulee	285	0	0.0	No exeedences found
Rock Creek	288	3	1.0	Minor exceedences found
Cedar Draw	277	10	3.6	Minor exceedences found
Mud Creek	277	15	5.4	Minor exceedences found
Deep Creek	275	7	2.5	Minor exceedences found
Salmon Falls Creek	378	2	0.5	Minor exceedences found
Billingsley Creek	417	35	8.4	Minor exceedences found
Malad River	88	0	0.0	Minor exceedences found
Clover Creek	17	4	23.5	Major exceedences found
Overall Total	2302	76	3.3	Minor exceedences found

Clover Creek will have ammonia added as a pollutant parameter in the 303(d) list and will develop a TMDL for unionized ammonia. As a consequence of TSS reductions it is expected that unionized ammonia levels will be reduced as well due to the following:

1. Reduction in TSS levels aids in reduction runoff of associated particulates such as total ammonia nitrogen. Reduction in total ammonia nitrogen will also reduce unionized ammonia levels as a consequence. In the Middle Snake River system, a synergistic relationship exists between total ammonia load (in tons/year) and TSS load (in tons/year). That relationship is best described statistically per river segment as follows:

Segment Site	Equation	N	r^2	F-ratio	p value
Milner Dam	TSS=(640.021085xNH3)+17671.5	217	0.662	191.1	0.000000
Pillar Falls	TSS=(83.181116xNH3)+4.9074.1	208	0.325	24.3	0.000002
Crystal Springs	TSS=(682.779413xNH3)-58590.5	300	0.511	105.5	0.000000
Box Canyon	TSS=(834.483746xNH3)-252767.0	176	0.723	190.3	0.000000
Gridley Bridge	TSS=(870.638625xNH3)-172144.0	205	0.762	282.0	0.000000
Shoestring	TSS=(1934.794139xNH3)-301854.0	143	0.884	506.2	0.000000
King Hill	TSS=(754.697364xNH3)+11039.8	161	0.724	175.3	0.000000

TSS = TSSLOAD (tons/year); NH3=NH3LOAD (tons/year)

Since a 33.6% average annual reduction in TSS would be expected in the Middle Snake River system from land use management stgrategies (see §3.5.07 for TSS Loading Analysis Summary), a comparable 10.1% reduction in total ammonia nitrogen would be expected in the Pillar Falls to King Hill area. The Milner Dam to Pillar Falls segment does not have problems with unionized ammonia.

2. Typical organic nitrogen content in sediment is about 1.2 mg/g of associated sediment (Calow & Petts 1992 [p 92, Table 92]). Since organic nitrogen content (as total organic

nitrogen or TON) is the difference between total Kjeldahl nitrogen and total ammonia nitrogen, and since total ammonia will be reduced synergistically as TSS is reduced in the system, it is anticipated that values < 1.2 mg/g organic nitrogen content of associated sediment will be found. Unionized values < 0.020 mg/L would be expected to be found at levels < minor-to-none exceedences.

Additonal to tributaries are irrigation canal drains. These were monitored in the Phase 1 Study (1990-1991) and are described as follows. Major exceedence waterbodies are bolded in black.

IRRIGATION CANAL DRAINS FROM PHASE 1 STUDY:

Tributary	N_{TOTAL}	$N_{UNIONIZED}$	% of Total	IDEQ-TFRO Assessment
	NORTHSIDE CANAL COMPANY DRAINS			
A Drain	18	0	0.0	No exceedences found
C55 Drain	18	0	0.0	No exceedences found
S29 Drain	17	2	11.8	Major exceedences found
N42 Drain	11	1	9.1	Minor exceedences found
N42 Drain (Canyon)	18	3	16.7	Major exceedences found
J8 Drain	16	0	0.0	No exceedences found
S19 & S Drains	19	2	10.5	Major exceedences found
W26 Drain	18	0	0.0	No exceedences found
Overall Total	135	8	5.9	Minor exceedences found
	TWIN FALLS CANAL COMPANY DRAINS			
A10 Drain	17	1	5.9	Minor exceedences found
T.F. Coulee	18	0	0.0	No exceedences found
Main Perrine Coulee	26	1	3.8	Minor exceedences found
West Perrine Coulee	18	1	5.6	Minor exceedences found
43 Drainage	14	2	14.3	Major exceedences found
30 Drain	18	1	5.6	Minor exceedences found
LQ and LS Drains	29	11	37.9	Major exceedences found
LS2/39A Drain	27	0	0.0	No exceedences found
39 Drain	29	4	13.8	Major exceedences found
I Drain	29	6	20.7	Major exceedences found
N Drain	28	3	10.7	Major exceedences found
Overall Total	253	30	11.9	Major exceedences found

A TMDL for waterbodies where unionized ammonia has been found as a major exceedence will be done. Such waterbodies will have to reduce to a level that will be in the minor or no exceedence category. It is understood that reductions in TSS will produced reductions in total ammonia nitrogen which translates to reductions in unionized ammonia.

3.1.05 NOX

Nitrogen as Nitrite+Nitrate (NOX) can be a key eutrophication pollutant in lakes because NOX that enters the water body tends to be recycled within the lake and builds up over a period of time. By contrast, the Middle Snake River and its tributaries are flowing systems in which nutrients are always entering or leaving at any given section. Accumulations tend to occur only in sediment or in slack water, and the effects of these

accumulations are normally moderated by the periodic flushing action of high flow events (USEPA 1993 [p 13]). In the State of Idaho there is no water quality standard for NOX. Thus, the State can only control it as it relates to nuisance aquatic vegetation as a limiting nutrient. Since NOX is not a limiting nutrient in either the Middle Snake Rive or its tributaries, and since there is no nuisance aquatic vegetation because of NOX, there is no proposed instream target at this time. However, this parameter will continue to be reviewed based on monitoring information and a TMDL may be developed in the future if mean loads within the river and its tributaries increase significantly above where the current 1990-1998 mean load exists. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan*. See also § 2.2.4.1 (1) of the sub basin assessment. Additionally, NOX is not considered a toxic pollutant on fisheries at current levels.

3.1.06 PESTICIDES

The only water quality limited stream segment listed for pesticide pollutants is Cottonwood Creek, from its headwaters to where it discharges to Rock Creek. A literature survey of work done by various agencies and organizations was conducted, and no anecdotal evidence of pesticides being discharged to the Cottonwood Creek was found. IDEQ-TFRO sampled in 1999 (June, July, and August) when the potential for pesticide impact to Cottonwood Creek was greatest. Two sampling sites were selected: above the area of impact (to serve as background), and immediately below the area of impact (to demonstrate response). Based on the type of pesticides used for land use in the North Cottonwood-McMullen 5th Field HUC (17040212-23), and consulting with the IDHW-Lab in Boise, Idaho, it was determined that three pesticide groups be tested in the receiving water: organochlorine insecticides (USEPA 508/8080), herbicides (USEPA 505.1/8150), and organophosphates (USEPA 507/8140). Laboratory results are noted in the following table:

Table 82 Pesticide results on Cottonwood Creek instream water

Sites on Cottonwood Creek	*June 1999*	*July 1999*	*August 1999*
Upstream	None Detected	None Detected	None Detected
Downstream	None Detected	None Detected	None Detected

Methods 515.1 (herbicides), 525.2 (Phthalates, PAH), PAH (550.1), 507 (organophosphates) and 508 (organochlorine insecticides) total up to 140 compounds. Site inspection of the zone of impact indicatres that the potential for pesticide entry into Cottonwood Creek is minimal. Diverted stream within the zone of impact is used for irrigation and grazing purposes. Cottonwood Creek at the end of zone of impact is plumbed through a riparian area that is filled with a myriad of wildlife.

Instream water quality analysis for pesticides indicates that no pesticides (as herbicides, organophosphates, or organochlorine insecticides) were detected. Therefore, it is recommended that pesticides, as a parameter, be removed as a pollutant from the 303(d) list for Cottonwood Creek.

3.1.07 OIL AND GREASE

For oil and grease, only one stream segment is listed: Rock Creek. This listing was done as a result of previous historical practices that allowed the discharge of the Twin Falls POTW and various other point sources into Rock Creek. This no longer is the case since these no longer discharge to Rock Creek. Monitoring conducted by IDEQ-TFRO demonstrates that oil and grease is no longer a contaminant of Rock Creek. Therefore, IDEQ-TFRO proposes that oil and grease be "de-listed" from the 303(d) list as a pollutant of Rock Creek. No TMDL for oil and grease will be proposed. See §3.02.03, item 3, Facilities that Discharge, Oil and Grease for more information.

3.1.08 TEMPERATURE

There are definite inconsistencies between water temperatures that exceed criteria in the Idaho water quality standards and fish data that indicate viable, self-sustaining assemblages exist. These inconsistencies or variations as related to stream temperature include a number of physical factors, regional/climatic/species divesity, and temporal air temperature variations which deter the usage of one single temperature value for usage on a larger regional area. The National Academy of Sciences (1973) has concluded that "no single temperature requirement can be applied to ... large regional areas; the requirements must be closely related to each body of water and to its particular community of organisms." Because of these inconsistencies or variations, an aquatic life, salmonid spawning, and temperature regime study is to be developed and conducted by IDEQ statewide so as to comprehensively document the uniform criteria issue, and support development of water quality criteria to protect salmonid spawning which takes into account natural environmental diversity. This issue is complex but a protocol for measuring, reporting, and evaluating stream temperature will be developed to establish a temperature record acceptable for comparison to criteria. The study will be aimed at producing new temperature criteria for proposal in year 2000. Thus, all streams which would be listed for temperature on the 1998 303(d) list, both carryover's from 1996, and additions, will be placed on a separate list. Therefore, TMDLs will be postponed for streams on this list for 18 to 24 months, to allow for a study and new water quality standards to take effect.

3.1.09 DISSOLVED OXYGEN

See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan*. Violations in temperature criteria on the Middle Snake River or its tributaries are not necessarily linked to violations in DO. Additionally, under the terms specified in IDAPA 16.01.02.276, waters discharged from dams, reservoirs, and hydropower facilities are not subject to the provisions of subsection 250.02.c.i (DO standard of 6.00 at all times for lakes and reservoirs for cold water biota) or subsection 250.02.d.i (intergravel DO at 5.00 mg/L one day minimum and water column DO at 6.00 mg/L at one day minimum for salmonid spawning). Subsection 276.02 (from June 15 to Oct 15 a 30-day mean of 6.00 mg/L, a 7-day mean minimum of 4.70 mg/L, and an instantaneous minimum of 3.50 mg/L), subsection 276.03 (modified DO periods for certain fisheries), and subsection 276.04 (DO below American Falls Dam) shall apply to all waters below dams, reservoirs, and hydroelectric facilities as far downstream as the point of measurement as defined in subsection 276.05 (a representative, thoroughly mixed area downstream of the discharge but as close to the facility as practical). Downstream of the point of measurement, all discharges to the waters shall be subject to the provisions of subsections 250.02.c.i and subsection 250.02.d.i (as previously cited).

A contract study conducted by ERI in 1996 at three locations on the Middle Snake River demonstrated that within and outside the macrophyte beds there were no violations of the DO standard as had been demonstrated previously by Falter (Falter 1994; Falter 1995; Falter 1996). Falter's work was done during the lowest flow years and within the most dense macrophyte beds, whereas the ERI study was conducted during a high flow event. IDEQ-TFRO personnel indicate that during the 1990-1993 time period, approximately 75% of the localized nuisance areas in the Middle Snake River (not of the entire river system) were covered with heavy dense macrophytes, 20% were least dense, and about 5% had no macrophytes (McMasters 1999). Falter's work showed only two years where the violations occured: (1) 1992 values showed diel DO within heavily weeded areas to fall below 6.00 mg/L in 5 transects, especially in late summer as the weeds became senescent, although some of the areas demonstrated DO levels > 6.00; (2) 1993 July mean DO values declined to less than 6.30 mg/L with a minimum single value of 5.70 mg/L in one transect; (3) 1994 July mean DO values declined to 8.40 mg/L with a minimum single value of 7.50 mg/L in one transect; and, (4) the lower profile in the water column shower lower DO values than at the surface, indicating that the DO level

approximates the level of water DO that is in contact with the atmosphere. The main reason for lower DO levels in the weedbeds versus outside the weedbeds is the decomposition of senescent vegetation and respiration of the plant biomass.

USGS and IDEQ-TFRO non-diehl monitoring studies indicate no violations of the instantaneous water quality standard. Even when the data is statistically segregated for low- versus high-flow years, violations of the DO standard never occured. It is evident that in the Middle Snake River, and to some extent its tributaries, in the absence of substances that cause the depletion of DO, the DO concentration in stream water approximates the saturation level for oxygen in water in contact with the atmosphere and decreases with increasing water temperature. But these decreases are from about 14 mg/L at freezing to about 7 mg/L at 30°C. This is substantiated to some extent by correlation equations developed from monitoring data from USGS and IDEQ-TFRO. DO estimates at 25°C range from 6.72 - 7.45 mg/L which corresponds closely to the 7mg/L DO level at 30°C.

Thus, it may be concluded that a DO sag < 6.00 mg/L occurs only in the most heavily dense macrophyte beds. These same beds occur in localized areas within the Middle Snake River where the water is most shallow, where the water has minimal velocity, and where the water year is under low flow conditions. 1992 was the most heavily impacted macrophyte year and was also the lowest flow year of record from 1988 to 1995. Thus, macrophyte density and DO sags < 6.00 mg/L may be correlated to flow, implying that under extremely low flow conditions the worst case scenario for DO may potentially occur. A water year of record similar to 1992 may occur once-in-16 years (1983 - 1998) or a 6.3% chance that it would occur within a 16 year period. Since the Middle Snake River was modeled under RBM10 for the worse case scenario, the model predicts that with TP reductions approximating an instream value of 0.075 mg/L TP would result in a DO value of about 8.56 mg/L (See Chapter 4, Table 36, p. 91 of the Mid-Snake TMDL) well above the State's water quality standard. It is estimated that imposed TP reductions under the Mid-Snake TMDL will cause plant biomass to decrease between 20-60%, thus leading to levels below those considered to be "nuisance" and will likely restore beneficial uses. Therefore, no TMDL is proposed for DO on the Middle Snake River or its tributaries at this time.

3.2 SUMMARY OF NPDES PERMIT LIMITS ON POINT SOURCES

This section describes the pollutant NPDES permit limits for aquaculture, food processors, and municipalities. The State of Idaho under its Administrative Procedures Act has designated uses for a number of waterbodies that the State determines can be attained in the future. "Attainable uses" are those uses (based on the State's system of water use classification) that can be achieved when effluent limits for point sources under the Clean Water Act's Section 301(b)(1)A) and (B) and Section 306 are implemented for point source discharges and when cost-effective and reasonable best management practices are implemented for nonpoint sources (USEPA 1991c [p 29]). Therefore, effluent permit limits are so written to meet designated beneficial uses and/or to meet State water quality standards.

3.2.01 AQUACULTURE

Aquaculture wastes consist of uneaten fish feed, fecal material, and other excretory wastes. The characteristics and impacts of wastes from aquaculture operations vary according to the type and siting of the aquaculture system. Aquaculture systems that are relatively open to natural waters have the greatest potential to cause environmental degradation from waste discharges (Goldburg & Triplett 1997 [p 35-36]).

TOTAL SUSPENDED SOLIDS

Data collected and reported in USEPA's Discharge Monitoring Reports (DMRs) from aquaculture facilities in Upper Snake Rock beginning in 1990 through 1998, indicate that sediment as TSS represents a small portion of the gross total TSS when considering all industries together. In general and depending on the tributary (based on flow), the percent TSS attributable to aquaculture when compared to all other input sources is minor (< 10.0%). Exceedences beyond the NPDES permitted 5 mg/L TSS were few (less that 1% of the total number of samples collected from 1990 through 1998, based on a visual review of 65 facilities' DMRs). According to the aquaculture general permit, net TSS shall have interim effluent limits such that the aquaculture discharge from raceways, and from ponds during non-harvest periods, prior to mixing with any other flows, shall be limited as follows:

Table 83 Aquaculture general permit TSS effluent limits

Net Total Suspended Solids Limits for Aquaculture Rearing and Holding Facilities during Non-harvest Periods				
Facility Type	**Units**	**Average Monthly**	**Maximum Daily**	**Instantaneous Maximum**
Cold Water	mg/L	5	10	15
Warm Water	mg/L	15	25	29
For Off-line Settling Basins or Earthen-bottomed Ponds during a Harvest Period				
Facility Type	**Units**	**Average Monthly**	**Maximum Daily**	**% Removal**
All Facilities	mg/L	67	100	≥ 90
Prepared by IDEQ-TFRO.				

NITROGEN

The proposed final General Aquaculture NPDES Permit (ID-G13-0000) provides that total ammonia (net NH_3), total nitrate plus nitrite (net NO_3 + NO_2), and total Kjeldahl nitrogen (net TKN) be monitored as part of an effluent characterization study during the first eighteen (18) months after receiving authorization to discharge under the permit during a twelve (12) month consecutive period both for raceways and ponds, and for offline settling basins. The study will assess the concentrations and loads during the 12 month period. Based on this characterization study, nitrogen loads may become a part of the permit at the end of year 3 in conjunction with other loadings that may be imposed as a result of the reopening of the permit for this specific purpose. In particular is the concern over unionized NH3. This parameter is highly toxic to fisheries at concentrations equal to or greater than 0.020 mg/L. An assessment of the Phase 1 Study aquaculture facilities' gross effluent indicates the following (see *Technical Support Document for Development of Upper Snake Rock Watershed Management Plan*):

AQUACULTURE FISH HATCHERIES FROM PHASE 1 STUDY:				
Aquaculture Facility	***N_{TOTAL}***	***$N_{UNIONIZED}$***	***% of Total***	***IDEQ-TFRO Assessment***
		FISH PROCESSING PLANTS		
Blue Lakes Process	51	51	100.0	Major exceedences found
		REARING AND HOLDING FACILITIES		
Blue Lakes Trout	52	35	67.3	Major exceedences found
Crystal Springs	54	52	96.3	Major exceedences found
Magic Valley Fish	54	16	29.6	Major exceedences found

Rim View	54	52	96.3	Major exceedences found
Idaho Fish Breeders	52	52	100.0	Major exceedences found
Box Canyon	54	54	100.0	Major exceedences found
Buckeye Farm	50	11	22.0	Major exceedences found
White Springs	54	54	100.0	Major exceedences found
Birch Creek	54	52	96.3	Major exceedences found
Overall Total	529	429	81.1	Major exceedences found

If these values are correct, and if the impact from this effluent discharge is significant to the receiving stream, then a TMDL will have to be developed. However, the Phase 1 Study looked only at the effluent discharge and did not account for influent effect, thus indicating that a net for the potential exceedence could not be determined. Also, the receiving stream above and below the discharge point was not monitored so as to ascertain the unionized ammonia effect in the stream column. Additionally, section 3.1.04 indicates that Rock Creek, Cedar Draw, Mud Creek, Deep Creek, Billingsley Creek, and the Middle Snake River had none-to-minor exceedences of unionized NH3. These tributaries and river contain the greatest concentration of fish hatcheries that discharge to them. The data appears to indicate that even though the effluent has higher levels of unionized ammonia, its affect on the tributary water is none-to-minimal.

PHOSPHORUS

Total phosphorus will have load limits imposed after three years of monitoring as a result of the Mid-Snake TMDL. According to the proposed final General Aquaculture NPDES Permit, phosphorus effluent limitations shall not exceed 970.2 lbs/day for those facilities listed in Appendix A. A permittee shall achieve compliance with the TMDL-based phosphorus effluent limitations within five (5) years from the effective date of permit issuance. Sampling frequency will be dependent on facilitiy classification. Net total phosphorus shall have interim effluent limits such that the combined discharges from raceways, ponds, offline settling basins, and all other discharges, prior to mixing with any receiving water flows, shall be limited as follows:

Table 84 Net TP limits for aquaculture rearing and holding facilities

Net Total Phosphorus Limits for Aquaculture Rearing and Holding Facilities				
Facility Type	**Units**	**Average Monthly**	**Maximum Daily**	**Instantaneous Maximum**
Cold Water	mg/L	0.100	0.160	0.180
Warm Water	mg/L	0.200	0.320	0.360
Prepared by IDEQ-TFRO.				

TEMPERATURE

There are no interim limits imposed for temperature, but facilities must comply with instream standards. Facilities shall sample at a frequency according to their facility classification. Additionally, the effluent characterization study will also include temperature as a parameter for testing. At the end of three years of monitoring, temperature data will be reviewed by both USEPA and IDEQ-TFRO, and a determination will be made at that time (based on the monitoring data) if limits will be required in the form of a TMDL. If a TMDL is required for temperature, then a permittee shall achieve compliance with the TMDL-based temperature effluent limitations within five (5) years from the permit effective date after reopening, but not before the stream temperature study proposed for protocol development in the subbasin.

DISSOLVED OXYGEN

There are no interim limits imposed for dissolved oxygen, but facilities must comply with instream standards. Facilities shall monitor for dissolved oxygen as part of an effluent characterization study. Based on this study, at the end of three years dissolved oxygen limits will be reviewed by both USEPA and IDEQ-TFRO, and a determination will be made at that time (based on the data collected from the study) if limits will be required in the form of a TMDL. As previously noted Idaho State Water Quality Standards allow for mixing zones. Unless otherwise noted, for DO and in accordance with Idaho Code § 16.01.02.060, the IDEQ may authorize mixing zones those facilities requesting it so as to ensure compliance with Idaho Water Quality Standards and Wastewater Treatment Requirements, or any TMDL developed that incorporates such water quality parameters. A facility that currently has DO information may apply currently for a mixing zone to IDEQ-TFRO. If a TMDL is required, then a permittee shall achieve compliance with the TMDL-based dissolved oxygen effluent limitations within five (5) years from the effective date of permit issuance.

3.2.02 FOOD PROCESSORS

Two major food processors are located upstream of Milner Dam in HUC 17040209 (Lake Walcott). Their effect on the Middle Snake River is dependent on the amount of water that goes downstream of Milner Dam after all water storage rights have been met. This passage of water downstream of Milner Dam is known as % Passage (or % Pass). Based on USGS flow information from WY1990 through WY1997, an annual average (as a percent) was determined for each year based on a comparison of gages 13087900 (Milner Lake at Milner Dam) against 13090000 (Snake River at Kimberly, ID). Gage 13090000 was selected since gage 13088000 (Snake River at Milner Dam) does not take into account all of the bypass flows that are returned to the system until downstream from this site (Buhidar 1999). The following table shows the annual estimates of downstream flows from Milner Dam, and indicates that in low flow years (WY1990 through WY 1995) the amount of water that actually went past Milner Dam averaged less than 4.56%, where as in high flow years (WY1996 and WY1997) the amount of water averaged 19.40%.

Table 85 Annual flow estimates (in cfs) downstream past Milner Dam

Gage	*WY1990*	*WY1991*	*WY1992*	*WY1993*	*WY1994*	*WY1995*	*WY1996*	*WY1997*	*WY1998*
13087900	26842	26804	25958	35375	35700	35250	37017	38908	37300
13090000	833	716	647	1387	1867	2142	5863	9597	6625
% Pass	3.10	2.67	2.49	3.92	5.23	6.00	15.84	24.67	17.76

Prepared by IDEQ-TFRO. % Pass = percent of flows that pass Milner Dam = (13090000 / 13087900) x 100%. WY s 1990-1995, or the low flow years, averaged 3.90 % Pass, whereas WY s 1996-1998, high flow years, averaged 19.42% Pass. The Overall Average = 9.08%.

The two major food processors are J.R. Simplot Company (located in Heyburn and Burley, and discharging to the Snake River at RM652.2) and McCain Food Service, Inc. (formerly Ore-Ida Foods, Inc., located in Burley and discharging to the Snake River at RM 648.8 and 649.2). The following tables summarize the % Passage of TSS, N series, and TP that affects the Middle Snake River.

Table 86 TSS % pass for food processors above Milner Dam

Facility Name NPDES No.	*1990-1997 TSS Mean mg/L*	*1990-1997 Flow cfs Outfall*	*Mean TSS Load lbs/day Above Milner*	*% Passage, lbs/day Hi-Flow = 19.4% Lo-Flow = 3.9%*	*% Pass tons/year*

J.R. Simplot 000066-3	76.58	3.29	1358.00	Hi-Flow = 263.45	48.08
				Lo-Flow = 52.96	9.67
McCains 000061-2	60.05	5.68	1838.44	Hi-Flow = 356.66	65.09
				Lo-Flow = 71.70	13.09
Prepared by IDEQ-TFRO. Mean TSS Load, lbs/day = TSS Mean, mg/L x Flow, cfs x 5.39. % Passage, lbs/day, Hi-Flow = Mean TSS Load, lbs/day x 0.1940. % Passage, lbs/day, Lo-Flow = Mean TSS Load, lbs/day x 0.0456. % Pass, tons/year = % Passage, lbs/day x 0.1825					

Table 87 N-Series (TKN, NOX, NH3) % pass for food processors above Milner Dam

Facility Name NPDES No.	*1990-1997 N Seires Mean mg/L* TKN NOX NH3	*1990-1997 Flow cfs Outfall*	*Mean N Load lbs/day Above Milner Dam* TKN NOX NH3	*%Passage,lbs/da Hi-Flow = 19.4% Lo-Flow = 3.9%* TKN NOX NH3	*% Pass tons/year* TKN NOX NH3
J.R. Simplot 000066-3	7.74 105.45 4.67	3.29	137.25 1869.96 82.81	Hi-Flow: 26.6 362.8 16.1	4.6 66.2 2.9
McCains 000061-2	2.02 62.53 8.68	5.68	61.84 1914.37 265.74	Hi-Flow: 12.00 371.39 51.55	2.2 67.8 9.4
Prepared by IDEQ-TFRO. Mean TSS Load, lbs/day = TSS Mean, mg/L x Flow, cfs x 5.39. % Passage, lbs/day, Hi-Flow = Mean TSS Load, lbs/day x 0.1940. % Passage, lbs/day. Lo-Flow = Mean TSS Load, lbs/day x 0.0456. % Pass, tons/year = % Passage, lbs/day x 0.1825. Hi-Flow conditions were preferred because they gave the higher load values when comprared to Lo-Flow conditions.					

Table 88 TP % pass for food processors above Milner Dam

Facility Name NPDES No.	*1990-1997 TP Mean mg/L*	*1990-1997 Flow cfs Outfall*	*Mean TP Load lbs/day Above Milner*	*% Passage, lbs/day Hi-Flow = 19.4% Lo-Flow =3.9%*	*% Pass tons/year*
J.R. Simplot 000066-3	25.80	3.29	457.51	Hi-Flow = 88.76	16.20
McCains 000061-2	28.99	5.68	887.53	Hi-Flow = 172.18	31.42
Prepared by IDEQ-TFRO. Mean TSS Load, lbs/day = TSS Mean, mg/L x Flow, cfs x 5.39. % Passage, lbs/day, Hi-Flow = Mean TSS Load, lbs/day x 0.1940. % Passage, lbs/day, Lo-Flow = Mean TSS Load, lbs/day x 0.0456. % Pass, tons/year = % Passage, lbs/day x 0.1825. Hi-Flow conditions were preferred because they gave the higher load values when comprared to Lo-Flow conditions.					

On an average basis, the high flow % passage will be used to describe the background to the Middle Snake River since it would describe the worst-case scenario relative to loadings entering the system. Therefore, TSS has a total load of 113.2 (48.1 + 65.1) tons/year, TKN is 6.8 (4.6 + 2.2) tons/year, NOX is 134.0 (66.2 + 67.8) tons/year, NH_3 is 12.4 (2.9 + 9.4) tons/year, and TP is 47.6 (16.2 + 31.4) tons/year. This is absorbed into the background loading of TSS coming into the Middle Snake River at Milner Dam.

3.2.03 MUNICIPALITIES

Two major municipalities are also located upstream of Milner Dam and are also affected by the % Pass of water that discharges past Milner Dam into the Middle Snake River. These municipalities are listed in the following table, and indicate that in high flow years they contribute 7.0 (5.9 + 1.1) tons TSS/year.

Table 89 TSS % pass for municipalities above Milner Dam

Facility Name NPDES No.	1990-1997 TSS Mean mg/L	1990-1997 Flow cfs Outfall	Mean TSS Load lbs/day Above Milner	% Passage, lbs/day Hi-Flow = 19.4% Lo-Flow = 3.9%	% Pass tons/year
Burley 002009-5	16.2	2.2	166.3	Hi-Flow = 32.26	5.9
Heyburn 002094-0	14.1	0.4	31.0	Hi-Flow = 6.01	1.1

Prepared by IDEQ-TFRO. Mean TSS Load, lbs/day = TSS Mean, mg/L x Flow, cfs x 5.39. % Passage, lbs/day, Hi-Flow = Mean TSS Load, lbs/day x 0.1940. % Passage, lbs/day, Lo-Flow = Mean TSS Load, lbs/day x 0.0456. % Pass, tons/year = % Passage, lbs/day x 0.1825. Hi-Flow conditions were preferred because they gave the higher load values when comprared to Lo-Flow conditions.

Based on the type of discharge, municipalities in the Upper Snake Rock subbasin may be categorized in one of four areas: (1) total containment/non-discharging (TC/ND), (2) land application/discharging to a land site (LA), (3) pre-treatment agreement with another municipality that treats their sewage (PTA), and (4) NPDES permitted facilities that discharge to surface waters. Within the Upper Snake Rock subbasin, municipalities may be classified according to their mode of discharge. These are:

1. FACILITIES THAT DO NOT DISCHARGE

These facilities are covered by land application permits, pre-treatment agreements, or total containment. They include: Hazelton (LA-000023), Kimberly (PTA with Cith of Twn Falls), Eden (TC/ND), Castleford (TC/ND), Wendell (LA-000076), Murtaugh (LA-000147), and Crossroads of Idaho (LA-000096). As part of the Mid-Snake TMDL, total phosphorus loadings (or other parmater loadings) are zero since they do not discharge to waters of the United States or waters of the State of Idaho.

Table 90 Description of facilities that do not discharge in Upper Snake Rock

Name of City / County	NPDES Permit No.	Land Application Permit No.	Type of Discharge
Hazelton / Jerome	None	LA-000023	Total containment/non-discharge
Kimberly / Twin Falls	002037-1	None	Pre-treatment agreement
Eden / Jerome	None	None	Total containment/non-discharge
Castleford / Twin Falls	None	None	Total containment/non-discharge
Wendell / Gooding	None	LA-000076	TC in winter; sprinkler disposal in summer on land
Murtaugh / Twin Falls	None	LA-000147	Land application for rapid infiltration basin
Crossroads of Idaho / Jerome	None	LA-000096	TC in winter; summer LA to cropland

Prepared by IDEQ-TFRO. Hazelton previously had an NPDES Permit No. 002118-1. It no longer discharges to an irrigation canal to Wilson Lake Reservoir. City of Kimberly has a pre-treatment agreement with the Cith of Twin Falls. TC/ND = Total Containment/Non-Discharge. PTA = Pre-treatment Agreement.

2. FACILITIES THAT SEASONALLY DISCHARGE

These facilities discharge seasonally, but not to the Middle Snake River. Only one is

included. Filer (002006 + LA-000079). As part of the Mid-Snake TMDL, a TP allocation of 16.4 lbs/day is estimated at the end of five years following plan implementation. In their new 1998-1999 NPDES permit, a number of changes were incorporated such that the following parameters have effluent limits.

Table 91 Description of facilities that seasonally discharge in Upper Snake Rock

BOD5 mg/L	BOD5 lb/day	TSS mg/L	TSS lb/day	Fecal Coliform per 100 mL	Fecal Coliform Per 100 mL	TRC mg/L	TP lbs/day
AML	AWL	AML	AWL	AML	AWL	AML	AML
30 58	45 87	30 58	45 87	100	200	0.3	17.0

Prepared by IDEQ-TFRO. Monitoring for NH3, TKN, NOX, and temperature have no limits imposed at this time. AML = Average Monthly Limit. AWL = Average Weekly Limit. TRC - Total Residual Chlorine.

3. FACILITIES THAT DISCHARGE

These facilities discharge indirectly or directly to the Middle Snake River. Three facilities discharge indirectly to the Middle Snake River: Buhl (002066-4), Hansen (002244-6), and Jerome (020168 + LA-000149). Two facilities discharge directly to the Middle Snake River: Twin Falls (0021270 + pre-treatment agreements) and Hagerman (0025941 + total containment with evaporation ponds). As part of the Mid-Snake TMDL, a TP allocation of 17.4, 3.3, 204.7, 707.0, and 5.7 lbs/day, respectively, is estimated at the end of five years following plan implementation. The Twin Falls municipality has pre-treatment agreements with the following point sources: Lamb Weston (previously Universal Frozen Foods), Independent Meat, Silver Creek Aquaculture Farm, Avonmore West, City of Kimberly POTW, and Gem Linen Supply. In their new 1998-1999 NPDES permit, a number of changes were incorporated such that the following parameters have effluent limits.

Table 92 Description of facilities that discharge in Upper Snake Rock

City of	BOD5 mg/L	BOD5 lb/day	BOD5 mg/L	BOD5 lb/day	TSS mg/L	TSS lb/day	TSS mg/L	TSS lb/day	Fecal Coliform per 100 mL	Fecal Coliform Per 100 mL	TRC mg/L	TP lbs/day
	AML		AWL		AML		AWL		AML	AWL	AML	AML
Buhl	45	390	65	585	70	-	105	-	100	200	0.5	17.4
Jerome	30	375	30	560	30	375	45	560	50	100	0.5	205.0
Hansen	30	40	45	60	30	40	45	60	100	200	0.5	3.3
Hagerman	45	63	65	95	70	-	105	-	100	200	-	5.7
Twin Falls	30	1952	45	2928	30	1952	45	2928	100	200	0.012	710.0

Prepared by IDEQ-TFRO. The average monthly fecal coliform count must not exceed a geometric mean of 200/100 mL based on a minimum of five (5) samples taken over a 30-day period. The weekly fecal coliform count must not exceed a geometric mean of 200/100 mL based on no more than 1 week's data and a minimum of 5 samples. City of Twin Falls has limits for Total Ammonia as N: May 1 to September 30 at 3.8 mg/L and 247 lbs/day; October 1 to April 30 at 5.2 mg/L and 338 lbs/day. AML = Average Monthly Limit. AWL = Average Weekly Limit.

Loadings for discharging facilities (whether direct or indirect) are summrized in the following tables according to the parameter of concern. The six facilities (1 seasonal and 5 discharge) have their discharges to the outfalls as listed in the following table:

Table 93 Municipalities that discharge seasonally or year-round to the Middle Snake River

City of	NPDES Permit No.	Type of Facility & Discharge
Filer	002006-1	Lagoon facility discharging to Cedar Draw
Buhl	002066-4	Lagoon facility discharging to East Fork of Mud Creek
Hansen	002244-6	Treated domestic wastewater discharging to ag drain to Snake River
Jerome	002016-8	Treatment and disinfection discharging to "J" canal to Snake River
Hagerman	002594-1	Lagoon facility discharging to Snake River
Twin Falls	002127-0	Treatment and disinfection discharging to Snake River

Prepared by IDEQ-TFRO. Cedar Draw and Mud Creek are not listed in the 1996 303(d) list and therefore are not a water quality limited stream segment that is considered in the Upper Snake Rock Subbasin Assessment for TMDLing at this time. The 1998 303(d) list will have these two additional streams listed.

TOTAL SUSPENDED SOLIDS

The mean annual loads for TSS (in lbs/day and tons/year) are summarized in the following table from 1991 through 1997 for each discharging facility. For each year summarized, a yearly concentration was derived (taking the average of 12 months in a year) and a mean flow (with conversion of mgd designation to cfs). A mean annual load (lbs/day) was derived as follows: Mean TSS x Mean Flow x 5.39 = Mean Annual Load (lbs/day). The mean annual load (tons/year) was derived as follows: Mean Annual Load (lbs/day) x 0.1825 = Mean Annual Load (tons/year).

Table 94 TSS Loadings for various municipalities

City of	1991-1997 Mean TSS mg/L	1991-1997 Mean Flow cfs	Daily Load lbs/day	Mean Annual Load tons/year
Filer	9.06	0.24	11.74	2.14
Buhl	48.38	0.61	157.65	28.77
Jerome	17.47	0.91	87.25	15.92
Hegerman	12.71	0.18	12.66	2.31
Hansen	14.32	0.09	7.02	1.28
Twin Falls	23.65	6.28	805.04	146.92

Prepared by IDEQ-TFRO. cfs = mgd x 1.548. CV = Coefficient of Variation.

NITROGEN

Only three city/municipalities had information on nitrogen forms (either as ammonia, NOX, or total Kjeldahl nitrogen). The City of Buhl began monitoring for all three forms beginning in December 1995. Only two full years (1995-1996) are available for review. The City of Filer began monitoring all three forms in January 1996, but sporadically in 1996 and 1997 since they are a seasonal discharger. Additional information is required. And, the City of Twin Falls began monitoring in November 1994 but only for ammonia and NOX. Additional information is required. The other cities did not have any monitoring, and thus require it for determination of loadings.

Table 95 Preliminary nitrogen loadings for various municipalities

Year	Mean Nitrogen, mg/L NH3	NOX	TKN	Mean Flow cfs	Mean Daily Load, lbs/day NH3	NOX	TKN	Mean Annual Load, tns/yr NH3	NOX	TKN
City of Buhl										
1996	17 9	0.12	30.3	0.862	82.54	0.57	140.88	15.06	0.10	25.71
1997	18.3	2.00	30.3	0.749	72.38	6.28	120.77	13.21	1 15	22.04
City of Buhl will continue to collect data under their new permit. Under the Mid-Snake TMDL it was agreed that collecting three years of data would be sufficient to determine if allocations for nitrogen were needed. Therefore, under their new permit, at the end of Year 3 once implementation of the Upper Snake Rock TMDL has occured, a re-evaluation of the entire wasteload allocation in conjunction with other industries will be done.										
City of Filer (seasonal facility)										
1996	14.4	0.69	20.9	0.135	10.72	0.53	15.08	1.96	0.10	2.75
1997	14.9	0.74	19.5	0.297	9.89	0.47	13.03	1 80	0.09	2.38
City of Filer will continue to collect data under their new permit. Under the Mid-Snake TMDL it was agreed that collecting three years of data would be sufficient to determine if allocations for nitrogen were needed. Therefore, under their new permit, at the end of Year 3 once implementation of the Upper Snake Rock TMDL has occured, a re-evaluation of the entire wasteload allocation in conjunction with other industries will be done.										
City of Twin Falls										
1995	2.1	13.0	-	9.771	111.92	695.57	-	20.43	126.94	-
1996	4.0	9.98	-	10.793	236.60	579.07	-	43.18	105.68	-
1997	4.8	5.73	-	11.146	292.48	337.85	-	53.38	61.66	-
City of Twin Falls will continue to collect data under their new permit. Under the Mid-Snake TMDL it was agreed that collecting three years of data would be sufficient to determine if allocations for nitrogen were needed. However, other facilities impacting the Middle Snake River have to be considered as well. Therefore, under their new permit, at the end of Year 3 once implementation of the Upper Snake Rock TMDL has occured, a re-evaluation of the entire wasteload allocation in conjunction with other industries will be done.										
Prepared by IDEQ-TFRO										

PHOSPHORUS

Total phosphorus as a limiting nutrient will have imposed limits based on the Mid-Snake TMDL and the permits for point sources that reflect those limits.

TEMPERATURE

See §3.1.07 for temperature considerations. There are no temperature requirements in the permit for effluent monitoring since there is no reasonable potential that an excursion will occur above water quality standards. However, the City of Twin Falls will conduct a receiving water monitoring plan during low flow periods, as established by historical and current data obtained from the USGS gaging station near Kimberly, Idaho (RM 617.5). Monitoring stations shall be established both upstream and downstream of the discharge and sampled concurrently with the effluent for analysis of the listed parameters.

DISSOLVED OXYGEN

A TMDL may be required based on monitoring data that will be collected over the next 36 months. For all industries, DO is linked to TP limits, such that decreases in TP will result in increases in the DO and

decreases in aquatic macrophyte growth on tributaries and the Middle Snake River.

OIL AND GREASE

The only tributary that is listed for oil and grease is Rock Creek, from Rock Creek Town to its confluence with the Middle Snake River. The historical perspective on why oil and grease is listed for Rock Creek is that at one time the City of Twin Falls municipality discharged directly to Rock Creek. Historical information from local citizens indicates that raw sewage, slime growths, and oil or grease streaks would float in Rock Creek as a common occurrence prior to 1974. Since 1974, the City of Twin Falls municipality, food processors, and industrials have not discharged to Rock Creek. In 1997, the IDEQ-TFRO monitored Rock Creek over a period of several months and determined that oil and grease were not present in Rock Creek water. The City of Twin Falls Stormwater Management Plan calls for stormwater concerns that might carry oil and grease if proper stormwater management practices are not used in the larger areas of industrial and commerical developments. Those areas of concern that may pose a threat to Rock Creek are defined in the following table. IDEQ-TFRO is not pursuing a TMDL for oil and grease on Rock Creek. Impacts to Rock Creek from stormwater sources (that contain oil and grease components) are minimal (0.009%) when compared to TSS discharges from point and additional nonpoint sources. The recommendations listed in the following table should be sufficient to minimize impacts to Rock Creek.

Table 96 Sub basin areas of Rock Creek that pose an oil & grease threat from the City of Twin Falls

Sub Basin	*Land Area*	*Receiving Water (Total Pollutant Load, tons/year)*	*Recommendations to Minimize Impact*
RC-1	945 acres	City storm drain to Orchalara Tunnel to Rock Creek **(0.458 tons/year)**	Increased frequency of maintenance practices for unclogging catch basins and inlets. The City will review its policy for street cleaning and gutter maintenance to improve storm drain inlets.
RC-2	280 acres	Rock Creek **(0.095 tons/year)**	No flooding issues. Maintain proper frequency of street cleaning for sediment removal.
RC-3	245 acres	Rock Creek **(0.239 tons/year)**	No flooding issues. Maintain proper frequency of street cleaning for sediment removal.
RC-4	285 acres	Rock Creek **(0.117 tons/year)**	Historical flooding problems. A new storm drain is proposed with maintenance of proper frequency of street cleaning for sediment removal.
RC-5	100 acres	TFCC Lateral 18 & overland flow to Rock Creek **(0.070 tons/year)**	A sub basin plan is being developed. Current maintenance of borrow ditches is being done.
RC-6	830 acres	TFCC Lateral 18 & overland flow to Rock Creek **(0.299 tons/year)**	A sub basin plan is being developed. Current maintenance via street cleaning policy is being addressed.
TOTAL	**2685 acres**	**(1.278 tons/year)**	**Pollutant Load includes all stormwater pollutants**

Prepared by IDEQ-TFRO. TFCC = Twin Falls Canal Company. Total Pollutant Load, tons/year calculated from (lbs/year)/2000. Data compiled by IDEQ-TFRO suggests that from 1990-1997, sediment loadings discharging to the Middle Snake River from Rock Creek averaged 15,036.7 tons/year. If stormwater accounts for 1.278 tons/year as drainage to Rock Creek, and major fraction of this is sediment, the amount of impact to Rock Creek is minimal (0.0085%) when compared to Rock Creek impacting the Middle Snake River.

PATHOGENS

Municipalities have imposed permit limits for fecal coliform bacteria as previously cited. Their discharge of fecal coliform is summarized in the following table and indicates that from 1990-1997

1. City of Filer exceeded their seasonal permit in three months over a 96 month period (1990-1997): January 1990, March 1991, and January 1993. No exceedences occured from 1994 through 1997. (% Exceedences = 3/96x100% = 3.1%)

2. City of Buhl exceeded their permit limit four times in 96 months for the 30-day geometric mean, and nine times for the 7-day geometric mean. These exceedences were found in 1990, 1991, 1993, and 1997. (% Exceedences = 9/96x100% = 9.4%)

3. City of Hansen and City of Hagerman never exceeded their permit limit in 96 months. (% Exceedences = 0/96x100% = 0.0%)

4. City of Jerome exceeced their permit four times in 96 months: April 1993, May 195, February 1996, and January 1997. (% Exceedences = 4/96x100 = 4.2%)

5. City of Twin Falls exceeded their permit seven times in 96 months: October 1993, June 1994, July and August 1996, and January and February 1997. (% Exceedences = 7/96x100 = 7.3%)

Table 97 30-day geometric mean (on a yearly basis) on municipalities that affect the Upper Snake Rock subbasin

Year (Limit)	*Filer (100)*	*Buhl (100)*	*Hansen (100)*	*Jerome (50)*	*Hagerman (100)*	*Twin Falls (100)*	*Total for Year (550 Limit)*
1990	87	237	11	10	3	14	362
1991	505	37	15	10	0.4	16	583
1992	5	4	23	4	0.8	4	41
1993	159	4	22	22	2	1	210
1994	16	9	25	20	7	1	78
1995	11	4	32	28	4	4	83
1996	8	13	48	16	2	33	120
1997	4	7	33	21	6	70	141
MEAN	**99**	**39**	**26**	**16**	**3**	**18**	**202**
STDs	**173**	**81**	**11**	**8**	**2**	**24**	**184**
CV	**1.74**	**2.05**	**0.44**	**0.48**	**0.75**	**1.34**	**0.91**

Prepared by IDEQ-TFRO.

The table indicates that in 1991 the maximum total exceedence level (550 limit) was exceeded. All other years were well below the exceedence level.

3.2.04 INDUSTRIALS / LAND APPLICATION FACILITIES

Industrial-type facilities that are in Upper Snake Rock include seven (7) non-dischargers and nine (9) who

discharge to land application sites. These include:

Non-discharge Facilities	Discharge to Land Application Sites
Roast Potato Company (Eden)	TASCO (Twin Falls, LA-000049; NPDES 000023-0)
IDA-Pride Potatoes (Hazelton)	Avonmore West (Twin Falls; LA-000022; NPDES 002741-1)
Schutte Potatoes (Hazelton)	Seneca Foods Corporation (Buhl; LA-000016)
Eagle Snacks, Inc. (Twin Falls)	Independent Meat (Twin Falls; NPDES 000038-8; LA-000046)
A.C. Enterprises (Hazelton)	Jerome Cheese (Jerome; NPDES 002760-0)
Heitzman Product Co. (Jerome)	Western Idaho Potato (Jerome; NPDES 002679-4; LA-000038)
J. R. Simplot (Jerome)	Russet Valley Marketing (Kimberly; LA-000041; total containment)
	Keegan Incorporated (Twin Falls; LA-000044)
	A.E. Staley Manufacturing Company (Murtaugh; LA-000045)

These type of NPDES facilities have non-contact cooling water permits which are used for cool refrigeration equipment and generally do not come in contact with processed wastewater. Any loads coming from these NPDES-type facilities are extremely low and therefore negligible to the TMDL process at this time. Therefore, the load allocation to these facilities is zero at this time.

3.3 STREAM CORRIDOR MODEL ON NONPOINT SOURCE STREAMS

USEPA considers that the narrative criteria apply to all designated uses at all flows unless specified otherwise in the State's water quality standards. USEPA also believes that no acutely toxic condition may exist in any State waters regardless of designated use (USEPA 1991c [p 31]; 54 FR 23875). To ensure that narrative criteria for toxicants are attained, the water quality standards regulation requires States to develop implementation procedures (40 CFR 131.11(a)(2)) which address all mechanisms used by the State to ensure that narrative criteria are attained (USEPA 1991c [p 31]). Where insufficient data was available for nonpoint source streams, estimates of existing pollutant loads were based on land use percentages defined by IDWR GIS coverages for ArcView using the stream corridor approach model. Tributaries were classified as previously defined under the 5th field HUCs catergorization: Shoshone Falls Watershed (for Alpheus Creek); Billingsley Creek Watershed (for Billinsley Creek, Riley Creek); Box Canyon Complex (for Blind Canyon Creek, Clear Springs, Thousand Springs Creek); Clover Creek Complex (for Clover Creek); Dry Creek Complex (for the three segments on Dry Creek); Rock Creek Complex (for the Rock Creek, Cottonwood Creek, McMullen Creek); and, Cedar Draw Complex (for Crystal Springs). Reservoirs were combined with Middle Snake River System segments.

It is recognized that riparian zones and wetlands are two distinct vegetative communities. However, riparian zones and wetlands as natural or constructed, if managed properly, have a tremendous impact on reduction of sediment (as TSS) before their discharge enters a stream. Filter or buffer strips are commonly grouped with riparian zones and may also provide a reduction impact on TSS. Literature sites a number of reduction percentages dependent on the type of wetland used on nonpoint source and point source areas:

Table 98 Natural and constructed riparian zones and wetlands

Type or Location	*%TSS Removal*	*Source*
Contructed Wetlands		
Swine Lagoon Treatment	97.4% (annual)	Moshiri 1993 [p 345]
Summer Wetland-Pond	99.8% (seasonal)	Moshiri 1993 [p 363]

Fall Wetland-Pond	96.1% (seasonal)	Moshiri 1993 [p 363]
Marsh System	81.4% (annual)	Moshiri 1993 [p 439]
Constructed Variable Filter Strips		
University of Kentucky, Design 1	87-99% (mean = 93%)	Haan *et al.* 1994
University of Kentucky, Design 2	70-90% (mean = 80%)	Haan *et al.* 1994
Mississippi State University	> 90%	Haan *et al.* 1994
Virginia Poly Tech, Design 1	81-91% (mean = 86%)	Haan *et al.* 1994
Virginia Poly Tech, Design 2	70-84% (mean = 77%)	Haan *et al.* 1994
North Carolina State	70%	Haan *et al.* 1994
Maryland KY 31 Fescue	66%	Haan *et al.* 1994
Buffer Strip Restoration	75%	Williams *et al.* 1997
Natural Ecosystems		
Natural Wetlands	67.9%	Moshiri 1993
NCSU Natural Wetlands	> 50.0%	Haan *et al.* 1994
West Jackson County Wetlands	76.7	USEPA 1993b
Natural grass buffer strips	57%	Williams *et al.* 1997
Prepared by IDEQ-TFRO. Bearing in mind that there is a lot of variability within constructed versus natural wetlands/riparian areas/ buffer strips, on an average basis constructed ecosystems have an average TSS reduction of 90.6% whereas natural ecosystems have an average TSS reduction off 62.9%.		

In general, natural ecosystems can have a 62.9% TSS reduction potential versus contructed ecosystems which average about 90.6% TSS reduction potential. These studies were done in select riparian areas where the percent efficiency was high. In the Middle Snake River the riparian areas do not retard 62.9% of the TSS that comes through their system. Degradation of riparian areas due to human encroachment have reduced the natural ability for these ecosystems to decrease sediment loads in streams by reducing bank erosion and by trapping sediment eroding from hillslopes. Due to population growth and land development, flood plains once normally filled with abundant vegetation are now degraded to the point that hillslopes within the flood plains are encised and cut, thus aiding to the sediment pollution problem. In conversations with USBLM, USFS, and USBOR personnel, it was assessed that an average TSS reduction potential from existing riparian areas was more like 30% (a high average). More seriously degraded riparian areas in agricultural zones may have a TSS reduction potential of 10% or less, depending on the stability of banks and the type of vegetation growing in the riparian area. Areas where only willows are growing may retard TSS in an amount less than those areas with willows and grasses. In this TMDL, riparian areas are grouped with stream erosion as background stream erosion. An assessment of the effect by riparian areas will be done by IDEQ-TFRO, USBLM, USFS, and NRCS as TSS reductions occur within the subbasin. It is expected that as TSS reductions occur, riparian areas will increase by as much as 50%, thus leading to increased TSS reduction from natural ecosystems.

3.3.01 SHOSHONE FALLS WATERSHED (ALPHEUS CREEK)

The Shoshone Falls Watershed has Alpheus Spring and Creek which makes up a small fraction of the entire watershed. Using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses: 36.35% irrigated agriculture (26.73% irrigated-gravity flow and 9.62% irrigated-sprinkler), 36.63% rangeland, and 27.00% riparian zone. Therefore, the nonpoint source allocation for irrigated agriculture and rangeland (grazing) is 36.35% and 36.63%%, respectively. Although several aquaculture facilities divert water from Alpheus Creek none discharge back to Alpheus Creek. Rather, they discharge to the Middle Snake River.

3.3.02 BILLINGSLEY CREEK WATERSHED

The Billingsley Creek Watershed (or the Hagerman Watershed) has Billingsley Creek and Riley Creek. Total land use in the Hagerman watershed is made up of 65.73% irrigated agriculture (27.43% irrigated-gravity flow and 28.30% irrigated-sprinkler), 31.76% rangeland, 12.33% riparian, and 0.16% open water. Total acreage is 31961.6 acres or 49.94 square miles. Looking at Billingsley Creek using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses: 10118.4 acres (or 15.81 square miles) for 23.08% riparian area, 14.67% rangeland, and 62.23% irrigated agriculture (24.54% irrigated-gravity flow and 37.69% irrigated-sprinkler). Therefore, the nonpoint source allocation will be for irrigated agriculture and rangeland (grazing) in the amounts of 62.23% and 14.67%, respectively.

3.3.03 BOX CANYON COMPLEX

The Box Canyon Complex is made up of 136236.8 acres or 212.87 square miles. Total land use is made up of 68.95% irrigated agriculture (26.99% irrigated-gravity flow, 41.96% irrigated-sprinkler), 25.48% rangeland, 3.30% riparian, and 2.25% urban. Looking at the Box Canyon Creek using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses:

1. Clear Springs has a total area of 2937.6 acres (4.59 square miles) with land use being made up of 61.21% irrigated agriculture (30.93% irrigated-gravity flow and 30.28% irrigated-sprinkler), 4.79% rangeland, and 33.98% riparian zone.

2. Blind Canyon Creek has a total area of 2816.0 acres (4.4 square miles) with land use being made up of 73.40% irrigated agriculture (16.18% irrigated-gravity flow and 57.27% irrigated-sprinkler), 9.54% rangeland, and 17.04% riparian zone.

3. Thousand Springs Creek has a total area of 2323.2 acres (3.63 square miles) with land use being made up of 52.60% irrigated agriculture (19.00% irrigated-gravity flow and 33.60% irrigated-sprinkler), 16.25% rangeland, and 31.12% riparian zone.

3.3.04 CEDAR DRAW COMPLEX

The Cedar Draw Complex has Crystal Springs and Lake which up a small fraction of the entire complex, and more specifically a small fraction of the Canyon Watershed (which is one of three watersheds in the Cedar Draw Complex). Crystal Lake is a small 8 acre shallow lake. Looking at Crystal Springs and Crystal Lake using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses: 2188.8 acres (3.42 square miles) is 81.28% irrigated agriculture (38.01% irrigated-gravity flow and 43.27% irrigated-sprinkler), 1.16% rangeland, and 17.54% riparian zone.

3.3.05 CLOVER CREEK COMPLEX

Four 5th field HUCs (or watersheds) make up the Clover Creek Complex: watershed Lower Clover Creek (1704021201), watershed Dry Creek (1704021202), watershed Upper Clover Creek (1704021203), and Calf-Clover (1704021204). Total area of the four watersheds is 280.79 square miles (or 185932.8 acres). Of this, total rangeland makes up 91.99%; total irrigated-gravity flow makes up 0.34%; total irrigated-sprinkler makes up 3.51%; total dryland agriculture makes up 0.68%; and, total riparian area makes up 3.46%. Looking at Clover Creek (from Pioneer Reservoir to where it discharges into the Middle Snake River) using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses: 12211.2 acres (or 19.08 square miles) for 82.18% rangeland, and 17.81% irrigated agriculture (0.26% irrigated-gravity flow and 17.55% irrigated-sprinkler). Therefore, the nonpoint source allocation will be for irrigated agriculture and rangeland (grazing) in the amounts of 17.81% and 82.18%, respectively.

3.3.06 DRY CREEK COMPLEX

Three 5th field HUCs (or watersheds) make up the Dry Creek Complex: watershed Dry Creek (1704021220), watershed Lower Dry Creek (1704021219), and watershed Lake Murtaugh (1704021218). Total area of the three watersheds is 151.04 square miles (or 96,665.6 acres). Of this, total rangeland makes up 43.14%; total irrigated-gravity flow makes up 53.35%; and, total irrigated-sprinkler makes up 3.49%. Looking at Dry Creek using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses:

1. For the West Fork of Dry Creek: 9590.17 acres (14.98 square miles) is 100.00% Rangeland.

2. For the Dry Creek headwaters to Medley Creek, and Medley Creek to the Snake River: 17939.2 acres (28.03 square miles) is 56.40% irrigated agriculture (53.69% irrigated-gravity flow and 2.71% irrigated-sprinkler), 40.49% rangeland, and 3.10% riparian.

3.3.07 ROCK CREEK COMPLEX

The Rock Creek Complex is comprised of five 5th field HUCs. These are: Upper Rock Creek (17040212021), Rock Creek (17040212022), Hub Butte (17040212029), Lower Rock Creek (17040212030), and North Cottonwood-McMullen (17040212023). Watershed "021" drains into Watershed "022," which drains into Watershed "029," and finally into Watershed "030" which discharges to the Middle Snake River. Watershed "023" drains into Watershed "029." Total land use of the Rock Creek Complex is: 5.09% forest, 34.60% irrigated-gravity flow, 0.51% irrigated-sprinkler, 52.24% rangeland, and 7.53% urban. The total area is 308.61 square miles or 197510.4 acres. Looking at Rock Creek using the stream corridor model (2 mile transect, 1 mile from the stream both ways) gives the following land uses for the water quality limited stream segments of the complex:

1. Rock Creek (Rock Creek Town to Middle Snake River): 29926.4 acres (46.76 square miles) is 84.45% irrigated-gravity flow, 1.75% rangeland, 11.44% urban, and 2.35% riparian. As recognized in §2.2.2.5 Rock Creek is a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth.

2. McMullen Creek (Headwaters to Cottonwood Creek): 21420.8 acres (33.47 square miles) is 19.59% irrigated agriculture (18.46% irrigated-gravity flow and 1.13% irrigated-sprinkler) and 80.40% rangeland. McMullen Creek discharges to the High Line Canal of the Twin Falls Canal Company.

3 Cottonwood Creek (Headwaters to Rock Creek): 9734.4 acres (15.21 square miles) is 57.19% irrigated agriculture (56.73% irrigated-gravity flow and 0.46% irrigated-sprinkler), 33.33% rangeland, and 9.46% urban. It discharges to the High Line Canal of the Twin Falls Canal Company. Whatever water appears below the High Line Canal is from seeps and springs.

3.3.08 MIDDLE SNAKE RIVER SEGMENTS AND RESERVOIRS

Pioneer Reservoir is included in the Clover Creek Complex. Applying the 2-mile stream corridor to the Middle Snake River segments and reservoirs: 117273.6 acres (183.24 square miles) is 49.54% irrigated agriculture (33.56% irrigated-gravity flow and 15.98% irrigated-sprinkler), 31.32% rangeland, 18.05% riparian, 0.22% urban, 0.03% forest, and 0.80 water alone.

3.4 MARGIN OF SAFETY (MOS), THE LOAD CAPACITY, & FUTURE GROWTH

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that the Upper Snake Rock TMDL incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. The MOS may be implicit, as in conservative assumptions used in calculating the loading capacity, wasteload allocations, and load allocations. The MOS is not meant to compensate for a failure to consider known sources.

It is apparent that past and, to some extent, current levels of sediment production in the Middle Snake River and its tributaries are "excessive" based on the lack of support status of the lower reaches. However, the degree of excess sediment is difficult to quantify or define. In order to establish a MOS it was necessary, then, to use implicit characteristics that get at conservative estimates that use background estimates which include surface erosion (due to agricultural and grazing production) and minimal mass wasting (because the annual rainfall does not provide a significant basis for mass wasting) characteristics that are characteristic of the sub basin, while at the same time linking sediment reductions to beneficial use and water quality standard attainment. Therefore, instream targets are fairly conservative due to use of background that includes surface erosion. These targets will require that the land management agencies within the subbasin (and on a watershed basis) meet an annual load (tons/year) that reflects surface erosion specific to the particular watershed.

The implicit conservative assumptions include the following:

1. Flow design analysis was based on a low flow year. WY1992 was selected as the lowest WY period of record for WY1983-1998. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan.* The baseline years are still 1990-1991. And the highest flow year of record for the period is 1984. As more data is collected over the next 3-5 years, a better understanding of the impact under high flow conditions will be assessed, thus providing a better direction at determining the upper limits of excess TSS levels.

2. Since excess sediment is a narrative water quality standard, TSS instream concentration targets were based on protection of salmonids, other fish, and aquatic communities as suggested by the European Inland Fisheries Advisory Commission (EIFAC 1965) and the Committee on Water Quality Criteria from the Environmental Studies Board of the National Academy of Science (CWQC 1973) for meeting of designated beneficial uses for cold water biota and salmonid spawning. Designated beneficial uses support the

"fishable/swimmable" goal of Section 101(a)(2) of the Clean Water Act where such uses are attainable. Their recommendations included the following:

TSS Range, mg/L	EIFAC Fisheries Effect	CWQC Protection Level	Beneficial Use Effect
> 400	Poor	Very low	Bad
80 - 400	Significantly Reduced	Low	Poor
< 80	None to Slight	Moderate to High	Good

Thus, 52 mg/L is the load capacity (dependent on the flow) for any stream in the Upper Snake Rock subbasin. This instream target of 52 mg/L TSS has in it an implicit margin of safety. It was selected as a preliminary water quality target as a monthly average. It is 35% below the lower 80 mg/L level and 87% below the upper 400 mg/L level for low protection of the fisheries. A daily maximum value of 80 mg/L will be used to account for seasonality spikes. The 52 mg/L TSS is a preliminary conservative water quality instream target that has an implicit margin of safety. At 52 mg/L there is a none-to-slight effect on the fisheries, which provides a moderate-to-high protection level of the fisheries, and a good restoration effect on the designated beneficial uses.

3. For permitted industries in the Upper Snake Rock subbasin the following describes the targets used based on permit requirements. An Average Monthly Limit was selected over the Average Weekly Limit because it was lower.

Permitted Industry/Facility	Target	Interpretation
Aquaculture General Permit	5 mg/L TSS	Average Monthly Limit
Twin Falls POTW	30 mg/L TSS	Average Monthly Limit
Hagerman POTW	70 mg/L TSS	Average Monthly Limit

4. Where no information was available for TSS on a water quality limited stream segment, the stream corridor approach model was used as the method of allocation. Various sources indicate that stream corridors are protective of beneficial uses for wildlife and should have a range greater than 0.5 miles but less than 5.0 miles (Platts 1990; Kindschy et al. 1982; Van Dyke et al. 1983; USDA, USEPA, USBLM, *et al.* 1998). A one-mile per side of stream seemed reasonable to use with an implicit margin of safety within the recommended range of 0.5 to 5.0 miles.

Therefore, within each load allocation there is an implicit MOS that is understood based on the above conservative assumptions. The load capacity was previously discussed in §3.1.01 for instream targets.

States must include an allowance for future loading in their TMDL that accounts for reasonably foreseeable increases in pollutant loads with careful documentation of the decision-making process. This allowance is based on existing and readily available data at the time the TMDL is established. "Smart Growth" policies and requirements are encouraged if USEPA and IDEQ agree that their adoption and implementation will reduce future loadings in an appropriate amount that equates to the estimate allowance for future growth. However, under the current database for TSS and the other pollutants, and after some discussion with the water user industries, it was decided that an allowance for future growth was not recommended until such time as reductions indicated that beneficial uses or State water quality standards had been restored. Therefore, an allowance for growth at this time is zero, such that any growth is permitted under the following auspices: (1) pollutant trading set to the instream target parameters, (2) not net increase set to the instream target parameters; and, (3) no discharge where land application is the preferred option.

3.5 TSS LOAD ALLOCATION AND ASSESSMENT

The basic model used in the loading analysis was a mass balance spreadsheet such that four general components were summarized for each Middle Snake River segment: point sources directly discharging to the Middle Snake River, spring sources (which might also have point source influence as indirect dischargers to the Middle Snake River), surface waterbodies (which includes tributaries and irrigation canal drains), and the instream segment on the Middle Snake River. These are labeled as A, B, C, and D, respectively. The approach was to consider all streams on a segment by segment basis as they discharged into the Middle Snake River. Those segments are more fully described in the *Technical Support Document (TSD) for the Development of the Upper Snake Rock Watershed Management Plan*. As described in the TSD, six major segments were selected based on where the most water quality information was available. The segments cover the entire length of the Middle Snake River and include their respective reservoirs. The seven location sites from Milner Dam to King Hill include Milner Dam (MD), Pillar Falls (PF), Crystal Springs (CS), Box Canyon (BC), Gridley Bridge (GB), Shoestring Bridge (SB), and King Hill (KH). The six segments derived from these seven sites and their respective land use according to the stream corridor approach model is summarized as follows:

		% Land Use by Stream Corridor Approach Model				
Segment	Name	Agriculture	Rangeland	Forest	Riparian	Other
1	MD to PF	64.2%	11.4%	0.0%	24.3%	0.1%
2	PF to CS	66.7%	13.1%	0.0%	18.6%	1.6%
3	CS to BC	67.1%	11.6%	0.0%	21.2%	0.1%
4	BC to GB	49.3%	29.2%	0.0%	20.8%	0.7%
5	GB to SB	30.3%	55.4%	0.0%	14.1%	0.2%
6	SB to KH	21.9%	65.3%	0.1%	9.4%	3.3%
	Mean	49.9%	31.0%	0.0%	18.1%	1.0%

Background is attributed to riparian areas, forest, and water and includes erosional sediment from the stream corridor. In order to achieve the instream water quality target of < 52.0 mg/L TSS, as well as achieve restoration of beneficial uses and State water quality standards, it is necessary to apply TSS load reductions to the following TSS input sources:

1. SPRING SOURCES

Spring sources as will be demonstrated in §3.5.07 provide a small amount of TSS to any of the segments on the Middle Snake River and its tributaries. Their contribution to TSS pollution is based on the mean value of 1.3 mg/L TSS based on known TSS data from USGS, IDEQ-TFRO, and ERI. This information was tabulated and averaged to arrive at a mean value of 1.3 mg/L TSS for spring sources. It is recognized that the value of 1.3 mg/L may represent a high TSS value particularly since the values reported as < MDL were divided by 2 to arrive at an estimate value for the individual facility or waterbody. Additionally, the spring sources may be coupled with fish hatchery effluent and dependent on the particulary waterbody may have the effluent combined with the overall TSS estimate for the particular spring source. Each section is self-contained and has its own explanation as to how the derivation of the TSS load was achieved. As a whole, known spring sources were included in the calculation for derivation of unkown spring sources. No reductions are proposed for spring sources at this time since their contribution is so small when compared to other sources.

2. POINT SOURCES

Point sources as will be demonstrated in §3.5.07 provide a small amount of TSS to any of the the segments on the Middle Snake River. Tributaries and associated waterbodies are a different story altogether. In general most tributaries provide a smaller fraction of TSS pollution from point sources. However, some tributaries provide a major portion of their TSS pollution from point sources. These are addressed according to individual streams and define as such in the load analysis. No additional reductions are proposed for any of the point sources discharging directly or indirectly to the Middle Snake River at this time since these have undergone a permit change this year which addresses TSS. As more TSS information is provided by the point sources over the next 3-5 years a re-evaluation of TSS loads may be necessary if exceedences occur beyond the current level of practice.

3. SURFACE WATERBODIES

Surface waterbodies (which means tributaries and irrigation return drains) as will be demonstrated in §3.5.07 provide a major portion of the TSS pollution. Based on known data, TSS reductions to < 52.0 mg/L are so described on a per waterbody basis. Based on this data, an average TSS value for these waterbodies was derived as 35.7 mg/L for natural tributaries and 102.0 mg/L TSS for seasonal irrigation return drains. When further information is obtained that can better define these estimates, more up-to-date data will be used to replace these estimates. When that occurs load estimates will approximate better the influence of TSS on the specific waterbody.

4. MID-SNAKE STREAM SEGMENTS

The TSS instream load was estimated within each of the six segments of the Middle Snake River based on the estimate net load between its upstream and downstream segment sites. It is possible that some accounting of TSS coming from surface waterbodies may be included in this segment. However, this was the best value that could be derived for estimating the instream load of the Middle Snake River segments. It is not possible at this time to derive a truer value of the TSS load.

3.5.01 MILNER DAM TO PILLAR FALLS SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 99 TSS load allocation for Segment 1

TSS Pollutant Sources	*WY1990-1991 Baseline Mean Load, tons/year*	*WY2004 Mean LA, tons/year*	*WY2009 Mean LA, tons/year*
Point Sources Discharging Directly to the Middle Snake River			
Hansen POTW[1]	1.3	1.3	1.3
Sub Total A	**1.3**	**1.3**	**1.3**
Spring Sources			
Vinyard Creek	17.1	17.1	17.1
Devil's Corral Spring	54.0	54.0	54.0
Unaccounted Springs	652.7	652.7	652.7
Sub Total B	**723.8**	**723.8**	**723.8**

Surface Waterbodies			
Dry Creek (main stem)	56.4% Ag = 1,089.3 40.5% Graze = 782.2 3.1% Background = 59.8 Sub Total 1,931.3	Agriculture = 195.0 Grazing = 128.5 Background = 22.2 Year 5 Target = 345.7	Agriculture = 195.0 Grazing = 128.5 Background = 22.2 Year 10 = 345.7
West Fork of Dry Creek	100.0% Graze = 921.4	100.0% Graze = 164.7	Grazing = 164.7
Sub Total	2,852.7	510.6	510.6
A Drain	1,427.8	451.2	451.2
A-10 Drain	209.7	209.7	209.7
C 55 Drain	342.9	342.9	342.9
Twin Falls Coulee	1,038.1	444.3	444.3
Unaccounted Surface	9,523.8	6,785.7	6,785.7
Sub Total C	**15,395.0**	**8,744.4**	**8,744.4**
Segment 1: MD to PF			
Milner Dam to Pillar Falls	64.2% Ag = 5,100.9 11.4% Graze = 905.8 Background = 1,938.7 Sub Total = 7,945.4	Agriculture = 3,402.3 Grazing = 604.2 Background = 1,293.1 Year 5 Target = 5,299.6	Agriculture = 3,402.3 Grazing = 604.2 Background = 1,293.1 Year 10 = 5,299.6
Sub Total D	**7,945.4**	**5,299.6**	**5,299.6**
TOTAL (A+B+C+D)	**24,065.5**	**14,769.0**	**14,769.0**

Prepared by IDEQ-TFRO. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII, Segment 1)* for details of derivation and calculations. TSS reductions are: 0.0% for Point Sources, 0.0% for Spring Sources, 43.2% for Surface Waterbodies, and 41.6% for Segment 1, or an Overall TSS reduction of 41.4%. Dry Creek Complex in the ArcView GIS Hydro100 coverage divides the watershed into 10 segments and includes canalways and unnamed streams. Of the overall total length provided in the coverage of all of the stream segments, 24.7% is attributed to Dry Creek main stem and accounts for Dry Creek from headwaters to Medley Creek and from Medley Creek to the Middle Snake River; 11.8% isattributed to the West Fork of Dry Creek from the headwaters to Dry Creek; and, 63.5% is attributed to Medley Creek, Cold Spring Creek, East Fork of Dry Creek, Middle Fork of Dry Creek, Coyote Creek, Pit Creek, Stump Hollow, and unnamed streams. Only the WQLSs of the Dry Creek Complex are included in the above table. Dry Creek main stem and the West Fork of Dry Creek were prorated to 100% of the total load provided as 87.7% and 32.3%, respectively. LA = Load Allocation.
1. Hansen POTW discharges to an irrigation ditch. Assuming the irrigation ditch discharge reaches the Middle Snake River through its myriad winding turns, it would discharge at approximately RM617.9 on the southside. It is uncertain if this ever really occurs.

The antidegradation policy for the State of Idaho (IDAPA 16.01.02.051(01) indicates that "the existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." The river segment from Milner Dam to Pillar Falls appears to be meeting its narrative standard for sediment although it is listed for sediments in the 1996 303(d) list. Monitoring data confirms that during 1990-1998 of 455 samples taken (247 for Milner Dam and 208 for Pillar Falls) only two samples were > 52 mg/L TSS instream target: 63 mg/L on 6/26/97 and 77 mg/L on 3/25/97. These were found during high flow years in two separate months. Thus, there is a 1.9% chance (2 months in 108 months) that such an event will occur, indicating that even under high flow conditions the water quality entering this segment is well below the instream target for meeting beneficial uses for salmonid spawning and cold water biota. TSS values > 25 mg/L but < 52 mg/L were accounted for in 16.2% of 469 samples taken in the same time period. Thus, 83.8%

of 469 samples were < 25 mg/L TSS. Because of this higher water quality for sediment, this segment will be considered as background for the entire Middle Snake River and will be protected at current existing conditions. Current existing conditions are defined in this TMDL as meaning that: (1) Point and nonpoint source inputs need to reduce to levels < 52 mg/L TSS before discharging into this segment of the Middle Snake River; (2) Instream TSS concentrations < 25 mg/L are to be maintained in the Milner Dam to Pillar Falls stretch during all months of the year, accept that values >= 25 mg/L TSS but < 52 mg/L TSS shall have an occurrence rate of no more than 52% during March, April, and May; no more than 33% during June, July, and August; and, no more than 15% during September, October, and November. These occurrence rates are based on the historical conditions (n=455 samples) from 1990 through 1998 for the total of all samples in any water year. TSS values < 52 mg/L does not imply that degradation by TSS may occur up to 52 mg/L. Rather, TSS values should be < 25 mg/L except during those seasonal quarters where allowance is made (based on historical TSS conditions) to not exceed 52 mg/L under any and all conditions that may affect water quality. Degradation of the water quality beyond these conditions shall not occur but shall be maintained at or below these perscribed levels through Year 10 of plan implementation.

3.5.02 PILLAR FALLS TO CRYSTAL SPRINGS SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 100 TSS load allocation for Segment 2

TSS Pollutant Sources	*WY1990-1991 Baseline Mean Load, tons/year*	*WY2004 Mean LA, tons/year*	*WY2009 Mean LA, tons/year*
Point Sources Discharging Directly to the Middle Snake River			
Canyon Springs FH	31.3	31.3	31.3
Blue Lakes Processing FH	5.6	5.6	5.6
Blue Lakes FH	1,177.1	1,177.1	1,177.1
Pristine Springs (+WW)	125.3	125.3	125.3
City of Twin Falls POTW	146.4	146.4	146.4
Crystal Springs FH	942.5	942.5	942.5
Sub Total A	**2,428.2**	**2,428.2**	**2,428.2**
Spring Sources			
Ellison Springs	1.6	1.6	1.6
Crystal Springs[1] and Lake[4]	63.9	63.9	63.9
Unseen Underground Seeps	165.2	165.2	165.2
Unaccounted Springs[2]	(191.7)	(191.7)	(191.7)
Sub Total B	**39.0**	**39.0**	**39.0**
Surface Waterbodies			

East Perrine Coulee	3,353.8	1,482.3	1,482.3
Green s Trout FH	12.0	12.0	12.0
Sub Total	3,365.8	1,494.3	1,494.3
Main Perrine Coulee	1,262.7	559.0	559.0
West Perrine Coulee	555.5	129.2	129.2
43 Drain	56.6	16.3	16.3
Warm Creek	341.1	341.1	341.1
Jerome Golf Course Drain	780.6	397.2	397.2
Rock Creek Complex:			
Rock Creek main stem	84.5% Ag = 11,979.1 1.8% Graze = 255.2 Background = 1,942.1 Sub Total = 14,176.4	Ag = 9,328.6 Grazing = 198.7 Background = 1,512.5 Sub Total = 11,039.8	Ag = 9,328.6 Grazing = 198.7 Background = 1,512.5 Sub Total = 11,039.8
McMullen Creek[3]	See §2.5.03 Deep Draw	0.0	0.0
Cottonwood Creek[3]	See §2.5.03 Deep Draw	0.0	0.0
Canyon Trout FH	21.1	21.1	21.1
Canyon Trout Processing	Total Containment	0.0	0.0
C&M Farm FH	28.1	28.1	28.1
Daydream Ranch FH	25.9	25.9	25.9
Deadman FH	27.5	27.5	27.5
CSI FH	9.7	9.7	9.7
Frame FH	35.6	35.6	35.6
Coats FH	39.3	39.3	39.3
Sub Total	14,363.6	11,227.0	11,227.0
30 Drain	2,228.0	311.4	311.4
LQ/LS Drain	6,379.8	1,500.4	1,500.4
Rand FH	47.5	47.5	47.5
Sub Total	6,427.3	1,547.9	1,547.9
LS2/39 A Drain	1,111.0	269.6	269.6
N42-N Drain	147.8	147.8	147.8
N42-NT Drain	321.2	321.2	321.2
39 Drain	1,997.4	243.5	243.5
Unaccounted Surface	(2,798.8)	(2,076.4)	(2,076.4)
Sub Total C	**30,159.8**	**14,929.1**	**14,929.1**
Segment 2: PF to CS			
Pillar Falls to Crystal Springs	66.7% Ag = 5,085.0 13.1% Graze = 998.7 Background = 1,540.0 Sub Total = 7,623.7	Agriculture = 3,391.7 Grazing = 666.1 Background = 1,027.2 Sub Total = 5,085.0	Agriculture = 3,391.7 Grazing = 666.1 Background = 1,027.2 Sub Total = 5,085.0
Sub Total D	**7,623.7**	**5,085.0**	**5,085.0**

TOTAL (A+B+C+D)	40,250.7	22,481.3	22,481.3

Prepared by IDEQ-TFRO. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII. Segment 2 and Section X. Segment 2)* for details of derivation and calculations. WW = Warmwater. FH = Fish Hatchery. TSS reductions are 0.0% for point sources, 0.0% for spring sources, 50.5% for surface waterbodies, 33.3% for the instream segment of the Middle Snake River, or an overall 44.1% reduction.

1. Based on 50 cfs that bubbles underneath the lake. 199.6 cfs is accounted for by the Crystal Springs FH.
2. Unaccounted Springs = 153.9 cfs.
3. McMullen Creek and Cottonwood Creek are portions of the Rock Creek Complex and are included in this table as additional streams to Rock Creek. Historically, their discharge was to Rock Creek, but that is no longer the case. Currently, both creeks discharge to the High Line Canal which eventually discharges to Deep Creek.
4. A Crystal Lake remediation plan is proposed by Clear Springs Foods, Inc. In 1991 considerable sediments were removed from Crystal Lake as a result of a dredging effort. Because of lake bottom irregularities not all of the sediments could be removed. It is possible that the remaining sediments are providing sufficient nutrients to support abundant aquatic plant growth. Sufficient time would be needed to diminish these nutrients through natural biological processes. IDEQ-TFRO proposes to do an assessment of the lake within 5 years of plan implementation, and in conjunction with Clear Springs Foods, Inc. to determine the best course to follow to reduce these historical sediments.

3.5.03 CRYSTAL SPRINGS TO BOX CANYON SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 101 TSS load allocation for Segment 3

TSS Pollutant Sources	*WY1990-1991 Baseline Mean Load, tons/year*	*WY2004 Mean LA, tons/year*	*WY2009 Mean LA, tons/year*
Point Sources Discharging Directly to the Middle Snake River			
Magic Valley FH	813.2	813.2	813.2
Rim View FH	606.7	606.7	606.7
IPC/Niagara Springs FH	108.6	108.6	108.6
Gary Wright FH	10.8	10.8	10.8
Catfish FH/FBI	200.8	200.8	200.8
Kaster Trout FH	96.6	96.6	96.6
Box Canyon FH	1,712.3	1,712.3	1,712.3
Briggs Creek FH	47.5	47.5	47.5
Sub Total A	**3,596.5**	**3,596.5**	**3,596.5**
Spring Sources			
Unseen Underground Seeps	141.7	141.7	141.7
Niagara Springs	38.9	38.9	38.9
Clear Springs & Lake[1]	180.1	180.1	180.1
Clear Lakes Trout FH	349.0	349.0	349.0
Middle Hatchery FH	358.2	358.2	358.2
Snake River FH	195.8	195.8	195.8
Clear Springs Processing	4.5	4.5	4.5
Sub Total	1,087.6	1,087.6	1,087.6
Banbury Springs	154.3	154.3	154.3

Briggs Creek Springs	106.6	106.6	106.6
Box Canyon Springs	83.1	83.1	83.1
Unaccounted Springs	(236.7)	(236.7)	(236.7)
Sub Total B	1,375.3	1,375.3	1,375.3
Surface Waterbodies			
Cedar Draw	12,066.3	5,721.0	5,721.0
Filer POTW	2.1	2.1	2.1
Rainbow (Filer) FH	25.3	25.3	25.3
Rainbow Processing	0.04	0.04	0.04
Yoder FH	17.5	17.5	17.5
SEAPAC Processing	Land Application	0.0	0.0
Cedar Draw FH	39.6	39.6	39.6
Olson FH	7.6	7.6	7.6
Stutzman FH	2.4	2.4	2.4
Tunnel Creek FH	35.8	35.8	35.8
Leo Martins FH	29.5	29.5	29.5
Sub Total	12,226.1	5,880.8	5,880.8
Mud Creek	5,809.5	5,809.5	5,809.5
Buhl POTW	28.8	28.8	28.8
Rainbow (Buhl) FH	16.3	16.3	16.3
W&W FH	20.0	20.0	20.0
White's FH	7.9	7.9	7.9
Buhl Trout Rearing FH	6.7	6.7	6.7
Buhl Trout FH	9.9	9.9	9.9
Jukers FH	10.6	10.6	10.6
RCP FH	3.5	3.5	3.5
First Ascent FH	35.3	35.3	35.3
Rock Ridge FH	4.0	4.0	4.0
Mi Vida Loca VH	7.9	7.9	7.9
Sub Total	5,960.4	4,965.4	4,965.4
Deep Creek	5,646.4	4,480.0	4,480.0
McMullen Creek[3]	Est = 257.9	33.3% R = 172.0	172.0
Cottonwood Creek[3]	Est = 148.3	33.3% R = 98.9	98.9
Deep Creek Trout FH	31.1	31.1	31.1
Boswell Trout FH	33.2	33.2	33.2
Peter's FH	20.3	20.3	20.3
Cox FH	30.7	30.7	30.7
Dolana FH	10.2	10.2	10.2
Howell FH	19.0	19.0	19.0
Sub Total	6,197.1	4,895.4	4,895.4
Blind Canyon Creek	73.4% Agriculture = 910.8 9.5% Grazing = 117.9 Background = 198.5 Blind Canyon FH = 13.7 Sub Total = 1,240.9	32.8% Reduction = 611.7 32.6% Reduction = 79.5 Background = 73.6 Blind Canyon FH = 13.7 Sub Total = 778.5	32.8% Reduction = 611.7 32.6% Reduction = 79.5 Background = 73.6 Blind Canyon FH = 13.7 Sub Total = 778.5
S19/S Drain	2,262.2	2,262.2	2,262.2
Sub Total	3,503.1	3,040.7	3,040.7

I Drain	1 257 0	1 257 0	1 257 0
J8 Drain Jerome POTW	349 2 15 9	349 2 15 9	349 2 15 9
Sub Total	365.1	365.1	365.1
N Drain[2]	157.8	157 8	157 8
S29 Drain	30.9	30.9	30 9
Unaccounted Surface	(3,452.0)	534.6	534 6
Sub Total C	**26,245.6**	**21,127.7**	**21,127.7**
Segment 3: CS to BC			
Crystal Springs to Box Canyon	67.1% Ag = 32,458.1 11.6% Graze = 5,611.2 Backgrund = 10,303.4 Sub Total = 48,372.7	Agriculture =21,649.5 Grazing = 3,742.7 Background = 6,872.4 Sub Total = 32,264.6	Agriculture =21,649.5 Grazing = 3,742.7 Background = 6,872.4 Sub Total = 32,264.6
Sub Total D	**48,372.7**	**32,264.6**	**32,264.6**
TOTAL (A+B+C+D)	**79,590.1**	**58,364.1**	**58,364.1**

Prepared by IDEQ-TFRO. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII, Segment 3)* for details of derivation and calculations. R = Reduction. TSS reduction 0.0% for point sources, 0.0% for spring sources, 19.5% for surface waterbodies, 33.3% for the instream portion in the river, or a 26.7% overall reduction.

1. A Clear Lakes Remediation Plan is proposed by Clear Springs Foods, Inc. in collaboration with Idaho Trout Processors, Clear Lakes Trout Company, the Clear Lake Homeowners Association, and the Clear Lake Country Club. A one-time sediment removal effort over a period of several years will be developed and implemented. Based on the NPDES permit requirements for the five aquaculture facilities that discharge to Clear Lakes, there should be no additional need to remove sediments once this project is completed. Once the project is completed, and with the implementation of the Mid-Snake TMDL and the Upper Snake Rock TMDL, re-evaluation of this lake will be done on a regular basis as a component of short-term and long-term goals of the Upper Snake Rock TMDL. An assessment of TSS and TP build up in the lake will be conducted by IDEQ-TFRO within five years of plan implmentation to ascertain if current discharges are contributing to such buildup.

2. Disputed as discharging to Mud Creek rather than the Middle Snake River. It is maintained as a separate discharge to the Middle Snake River to keep continuity with Phase 1 Study.

3. McMullen Creek and Cottonwood Creek have minimal water quality data. Ascertaining the effects from TSS will need to be addressed with a specific monitoring program during the implementation phase of the TMDL. Historically McMullen Creek and Cottonwood Creek discharged to Rock Creek, but have since been diverted to the High Line Canal for irrigation purposes. Both creeks historically have stream water from mid-January to the end of June. After June both creeks are pretty much dry (or intermittent). Based on information provided by the Twin Falls Canal Company, flow from McMullen Creek provides an average of 4.0 cfs to the High Line Canal; flow from Cottonwood Creek provides an average of 2.3 cfs to the High Line Canal. Since both waterbodies orginally belonged to Rock Creek Complex, ascertaining an approximate load to the High Line Canal was based on known load analysis for Rock Creek. Since Rock Creek averages 219.9 cfs (with a TSS load of 14,176.4 tons/year), the following calculations were used to derive the loads for McMullen Creek and Cottonwood Creek: (1) McMullen Creek = (4.0 cfs/219.9 cfs) x 14,176.4 tons/year = 257.9 tons/year; and, (2) Cottonwood Creek = (2.3 cfs/219.9 cfs) x 14,176.4 tons/year = 148.3 tons/year. Until more current TSS information is obtained, these estimate loads will be used in the Deep Creek calculations.

3.5.04 BOX CANYON TO GRIDLEY BRIDGE SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 102 TSS load allocation for Segment 4

TSS Pollutant Sources	*WY1990-1991 Baseline Mean Load, tons/year*	*WY2004 Mean LA, tons/year*	*WY2009 Mean LA, tons/year*
Point Sources Discharging Directly to the Middle Snake River			

Blind Canyon Aqua FH	27.9	27.9	27.9
Pisces Magic Springs FH	83.3	83.3	83.3
Sub Total A	111.2	111.2	111.2
Spring Sources			
Unseen Underground Seeps	92.1	92.1	92.1
Thousand Springs	1,575.2	1,575.2	1,575.2
Ten Springs FH	51.4	51.4	51.4
Sub Total	1,626.6	1,626.6	1,626.6
Riley Creek	734.1	734.1	734.1
USFSW-FH	95.9	95.9	95.9
IDFG-FH	142.2	142.2	142.2
Sub Total	972.2	972.2	972.2
Sand Springs Creek	117.2	117.2	117.2
Unaccounted Springs	(92.8)	(92.8)	(92.8)
Sub Total B	**2,715.3**	**2,715.3**	**2,715.3**
Surface Waterbodies			
Salmon Falls Creek	5,966.6	5,966.6	5,966.6
W26 Drain	1,093.3	927.1	927.1
Unaccounted Surface	(1,355.5)	(2,461.4)	(2,461.4)
Sub Total C	**5,704.4**	**4,432.2**	**4,432.2**
Segment 4: BC to GB			
Box Canyon to Gridley Bridge	49.3% Agriculture = 15,696.7 29.2% Grazing = 9,297.0 Background = 6,845.4 Sub Total = 31,839.1	Agriculture = 9,258.4 Grazing = 5,483.7 Background = 6,494.6 Sub Total = 21,236.7	Agriculture = 9,258.4 Grazing = 5,483.7 Background = 6,494.6 Sub Total = 21,236.7
Sub Total[1] D	**31,839.1**	**21,236.7**	**21,236.7**
TOTAL (A+B+C+D)	**40,389.9**	**28,495.4**	**28,495.4**

Prepared by IDEQ-TFRO. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII, Segment 4)* for details of derivation and calculations. TSS reductions are 0.0% for point sources, 0.0% for springs, 22.3% for surface waterbodies, 33.3% for the instream segment of the river, or an overall 29.4%.

1. Sub Total values taken as worst case scenario such that the absolute value of the load is used instead of the negative value. See Section X, Segment 4 of *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan.*

3.5.05 GRIDLEY BRIDGE TO SHOESTRING BRIDGE SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 103 TSS load allocation for Segment 5

TSS Pollutant Sources	WY1990-1991 Baseline Mean Load, tons/year	WY2004 Mean LA, tons/year	WY2009 Mean LA, tons/year
Point Sources Discharging to the Middle Snake River			
Henslee FH (Irrigation Ditch)	16.7	16.7	16.7
Buckeye FH	446.8	446.8	446.8
Big Bend FH(Big Bend Ditch)	8.5	8.5	8.5
Lemmon FH (Buckeye Ditch)	7.9	7.9	7.9
Eckles FH (Billingsley Creek)	36.5	36.5	36.5
Dunn FH (Billingsley Creek)	71.2	71.2	71.2
Barret FH	19.8	19.8	19.8
White Springs FH	118.0	118.0	118.0
Mike Flemming FH	11.2	11.2	11.2
Smith FH	17.9	17.9	17.9
Woods FH	24.4	24.4	24.4
Slane FH	8.2	8.2	8.2
John Flemming FH	17.7	17.7	17.7
Stevenson FH	15.8	15.8	15.8
City of Hagerman POTW	1.4	1.4	1.4
Sub Total A	**822.0**	**822.0**	**822.0**
Spring Sources			
Birch Creek[1]	1.3	1.3	1.3
Birch Creek FH	87.4	87.4	87.4
C.J. Simms FH	10.4	10.4	10.4
Sub Total	99.1	99.1	99.1
Stoddard Creek	Utilized by FHs	0.0	0.0
Bell FH	7.4	7.4	7.4
Standal FH	9.7	9.7	9.7
White Water FH	22.0	22.0	22.0
Sub Total	39.1	39.1	39.1
Decker Springs Creek	Utilized by FH	0.0	0.0
Decker Springs FH	24.4	24.4	24.4
Sub Total	24.4	24.4	24.4
Unaccounted Springs	208.6	208.6	208.6
Sub Total B	**371.2**	**371.2**	**371.2**
Surface Waterbodies			
Malad River	3,753.7	3,753.7	3,753.7

Malad River Power Flume	23,606.6	23,606.6	23,606.6
Billingsley Creek	181.5	181.5	181.5
Rangen's FH	38.3	38.3	38.3
Jones FH	59.5	59.5	59.5
McFadden FH	13.7	13.7	13.7
Idaho Springs FH	106.2	106.2	106.2
Hidden Springs FH	22.8	22.8	22.8
Schrank Springs Creek FH	6.2	6.2	6.2
Fisheries Development FH	001A + 003A = 190.3	190.3	190.3
2 Non-permitted FH (T & J)	No permit = 9.8	9.8	9.8
Boyer FH (Billingsley Creek)	22.8	22.8	22.8
Talbot FH (Billingsley Creek)	22.2	22.2	22.2
Sub Total	673.3	673.3	673.3
Unaccounted Surface	3,044.7	(156.4)	(156.4)
Sub Total C:	**31,078.3**	**27,877.2**	**27,877.2**
Segment 5: GB to SB			
Gridley Bridge to Shoestring Bridge	30.3% Agriculture = 3,326.1 55.4% Grazing = 6,081.4 Background = 1,569.7 Sub Total = 10,977.2	Agriculture = 2,218.5 Grazing = 4,056.3 Background = 1,047.0 Sub Total = 7,321.8	Agriculture = 2,218.5 Grazing = 4,056.3 Background = 1,047.0 Sub Total = 7,321.8
Sub Total D:	**10,977.2**	**7,321.8**	**7,321.8**
TOTAL (A+B+C+D)	**43,248.7**	**36,392.3**	**36,392.3**

Prepared by IDEQ-TFRO. S & J = Tupper Ponds & Johnson Farm Ponds. FH = Fish Hatcheries. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII, Segment 5)* for details of derivation and calculations. TSS reductions are 0.0% for point sources, 0.0% for spring sources, 0.0% for surface waterbodies since the data indicates they are well below the 52.0 mg/L TSS instream standard, 33.3% for the instream portion of the Middle Snake River, or an overall 8.5% TSS reduction.
1. Birch Creek is listed as two separate entries in the *Technical Support Document (Section VII, Segment 5)*: one with an aquaculture facility and without an aquaculture facility. Total Q is estimated at 11.03 cfs. Q running thru the FH is estimated at 9.98 cfs. The remainder (11.03 cfs - 9.98 cfs) represents what is contributed by the spring source only (or 1.05 cfs).
2. Billingsley Creek: 73% of TSS is attributed to the fish hatcheries. The remaining 27% is attributed to nonpoint sources. The average flow is still 39.3 cfs because fish hatcheries re-use the same water from the headwaters to where it discharges to the Middle Snake River.

3.5.06 SHOESTRING BRIDGE TO KING HILL SEGMENT AND CONNECTING WATERBODIES

All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 104 TSS load allocation for Segment 6

TSS Pollutant Sources	*WY1990-1991 Baseline Mean Load, tons/year*	*WY2004 Mean LA, tons/year*	*WY2009 Mean LA, tons/year*
Point Sources Discharging Directly to the Middle Snake River			
None	0.0	0.0	0.0
Sub Total A:	**0.0**	**0.0**	**0.0**
Spring Sources			

Unaccounted Springs	317.5	317.5	317.5
Sub Total B	317.5	317.5	317.5
Surface Waterbodies			
Clover Creek (+ Pioneer Reservoir)	17.8% Agriculture = 69.2 82.2% Grazing = 319.6 Sub Total = 388.8	Agriculture = 69.2 Grazing = 319.6 Sub Total = 388.8	Agriculture = 69.2 Grazing = 319.6 Sub Total = 388.8
Unaccounted Surface	4,632.0	3,336.0	3,336.0
Sub Total C	5,020.8	3,725.4	3,725.4
Segment 6: SB to KH			
Shoestring Bridge to King Hill	21.9% Agriculture = 19,312.9 65.3% Grazing = 57,585.8 Background = 11,287.8 Sub Total = 88,186.6	Agriculture = 12,881.7 Grazing = 38,409.8 Background = 7,529.0 Sub Total = 58,820.5	Agriculture = 12,881.7 Grazing = 38,409.8 Background = 7,529.0 Sub Total = 58,820.5
Sub Total D	88,186.6	58,820.5	58,820.5
TOTAL (A+B+C+D)	93,524.9	62,863.4	62,863.4

Prepared by IDEQ-TFRO. TOTAL = Summation of all Sub Totals in the Table. See *Technical Support Document for the Development of the Upper Snake Rock Watershed Management Plan (Section VII, Segment 6)* for details of derivation and calculations. TSS reductions are 0.0% for point sources, 0.0% for spring sources, 25.8% for surface waterbodies, 33.3% for the instream portion of the Middle Snake River, or an overall 32.8% TSS reduction.

3.5.07 TSS LOADING ANALYSIS SUMMARY AND ASSESSMENT

The following table summarizes the loading analysis per segment input into the Middle Snake River system. The summary is based on gross totals for the specific input sources defined. All surface waterbodies shall reduce to reach the instream target of < 52.0 mg/L TSS (or 51.9 mg/L).

Table 105 TSS loading analysis summary for the Middle Snake River system

Segment	*Point Sources (A)*	*Spring Sources (B)*	*Surface Waterbodies (C)*	*Snake River Segment (D)*	*TOTAL (A+B+C+D)*
WY1990-1991 BASELINE MEAN LOAD, tons/year					
1: MD to PF	1.3	723.8	15,395.0	7,945.4	24,065.5
2: PF to CS	2,428.2	39.0	30,159.8	7,623.7	40,250.7
3: CS to BC	3,596.5	1,375.3	26,245.6	48,372.7	79,590.1
4: BC to GB	111.2	2,715.3	5,704.4	31,839.1	40,369.9
5: GB to SB	822.0	371.2	31,078.3	10,977.2	43,248.8
6: SB to KH	0.0	317.5	5,020.8	88,186.6	93,524.9
Total	6,959.2	5,542.1	113,603.9	194,944.7	321,049.9

WY2004 & WY2009 MEAN LOAD ALLOCATION, tons/year					
1. MD to PF	1.3	723.8	8,744.4	5,299.6	14,769.0
2. PF to CS	2,428.2	39.0	14,929.1	5,085.0	22,481.3
3. CS to BC	3,596.5	1,375.3	21,127.7	32,264.6	58,364.1
4. BC to GB	111.2	2,715.3	4,432.3	21,236.7	28,495.4
5. GB to SB	822.0	371.2	27,877.2	7,321.8	36,392.3
6. SB to KH	0.0	317.5	3,725.4	58,820.5	62,863.4
Total	6,959.2	5,542.1	80,836.1	130,028.1	223,385.6
% Reduction	0.0%	0.0%	28.8%	33.3%	30.4%

Prepared by IDEQ-TFRO. TSS source contributions may be categorized as follows: Before Reduction---2.2% point sources, 1.7% spring sources, 35.4% surface waterbodies, and 60.7% Middle Snake River instream segment; After Reduction---3.1% point sources, 2.5% spring sources, 36.2% surface waterbodies, and 58.2% Middle Snake River instream segment. The overall categorization of each segment in the Middle Snake River for TSS is: Before Reduction---7.5% MD to PF, 12.5% PF to CS, 24.8% CS to BC, 12.6% BC to GB, 13.5% GB to SB, 29.1% SB to KH; After Reduction---6.6% MD to PF, 10.1% PF to CS, 26.1% CS to BC, 12.8% BC to GB, 16.3% GB to SB, and 28.1% SB to KH.

The Upper Snake Rock Watershed Management Plan's TSS loading analysis accounts for point sources, spring sources, surface waterbodies (tributaries and irrigation return flows), and the Middle Snake River segment that receives these various inputs. Point sources (which account for 2.2% before reduction and 3.1% after reduction of the total mean load) already have imposed NPDES imposed permit limits which will be reviewed at the end of Year 5 of plan implementation. Spring sources (which account for 1.7% before reduction and 2.5% after reduction of the total mean load) are probably at the highest level of TSS based on the mean value taken for various known springs (or 1.3 mg/L TSS) for estimated TSS values. The values are probably less than what is indicated because a greater portion of the values were much less than 1.3 mg/L TSS. Surface waterbodies (which account for 35.4% before reduction and 36.2% after reduction of the total mean load) include tributaries and irrigation return flows and will reduce to instream target values < 52.0 mg/L TSS. These reductions will meet beneficial uses and State water quality standards for sediment. The Middle Snake River segments (which account for 60.7% before reduction and 58.2% after reduction of the total mean load) will also have reductions based on land use estimation from the stream corridor approach model for nonpoint sources. These reductions will meet beneficial uses and State water quality standards for sediment.

An assessment of Table 105 indicates that the overall TSS from the various sources ranks as follows:

	TSS Reductions		
Waterbody	Before	After	Mean
Snake River Segment	60.7%	58.2%	59.5%
Surface Waterbodies	35.4%	36.2%	35.8%
Point Sources	2.2%	3.1%	2.7%
Spring Sources	1.7%	2.5%	2.1%

Point Sources = Fish Hatcheries and Municipalities
Spring Sources may include some fish hatcheries not directly discharging to the river.

If we consider each segment within the Middle Snake River , the categorization and ranking of TSS is as follows:

Segment Rank Order	TSS % of Total Before	After	Mean
SB to KH	29.1%	28.1%	28.6%
CS to BC	24.8%	26.1%	25.5%
GB to SB	13.5%	16.3%	14.9%
BC to GB	12.6%	12.8%	12.7%
PF to CS	12.5%	10.1%	11.3%
MD to PF	7.5%	6.6%	7.1%

CS to BC is known to have the greatest macrophyte nuisance vegetation growing under low flow conditions. SB to KH is known to have the greatest level of TSS under high flow conditions.

The greatest impact from TSS to the Middle Snake River appears to come from the Middle Snake River corridor, followed by surface waterbodies. Point sources and spring sources appear to be the lowest impactor to the system. This does not necessarily hold true for smaller waterbodies when comparing point versus nonpoint sources as is described as follows:

Waterbody	TSS Impact Estimates Point Sources	Nonpoint Sources
Rock Creek	1.3%	98.7%
Clear Springs and Lake	83.4%	16.6%
Cedar Draw	1.3%	98.7%
Mud Creek	2.5%	97.5%
Deep Creek	2.3%	97.7%
Blind Canyon Creek	0.4%	99.6%
J8 Drain	4.4%	95.6%
East Perrine Coulee	0.4%	99.6%
Thousand Springs	3.2%	96.8%
Riley Creek	24.5%	75.5%
Birch Creek	98.7%	1.3%
Stoddard Creek	100.0%	0.0%
Decker Springs Creek	100.0%	0.0%
Billingsley Creek	73.0%	27.0%

Based on the loading analysis in §3.5.01 and §3.5.06.

From this assessment it can be surmised that any cleanup plan will necessitate addressing the specific sources of pollution. For the Middle Snake River the nonpoint sources for both land uses affecting the corridor and for surface waterbodies transporting TSS to the river appear to be the greatest source of TSS pollution. On the other hand, for each surface waterbody (other than the Middle Snake River itself) it may be that nonpoint sources may not necessarily be the major source of TSS. Depending on the stream, point sources may comprise a greater vantage point than nonpoint sources.

Therefore, the development of implementation plans that are specifically designed for the particular waterbody is critical to the success of the Upper Snake Rock TMDL. In the case of some waterbodies, an implementation plan may already be developed but not yet fully applied. For example, Billingsley Creek had a preliminary nonpoint source and point source implementation plan developed by a steering committee for the reduction of pollutants that could easily be adapted to current needs. It may necessitate updating best management practices, but it could readily be applied with some minor updating. Others are already in

progress with the intercession of a land management agency as in the case of Rock Creek, Mud Creek, and Deep Creek. Still others, such as Clear Springs and Lake, are in the development phase and involve particular facilities that already have permit restrictions imposed. Still others have some work already done, as in the case of East Perrine Coulee, but necessitate further development and a more holistic approach to include urban concerns from stormwater impacts. And then there are those that will require new work because little work has been done to curb pollution concerns. Above and beyond this, the division of a waterbody into various segments so as to target various types of BMPs may be necessary for success on some streams.

As a consequence of all these variables, IDEQ-TFRO will review and assess all implementation plans in a coordinated effort with the appropriate land management agency and provide necessary updates to the Mid-Snake WAG and USEPA on a regular basis. See §3.6.01 and §3.6.02.

3.6 REASONABLE ASSURANCES AND IMPLEMENTATION SCHEDULE

The objective of the Upper Snake Rock TMDL is to allocate allowable loads among different pollutant sources so that the appropriate control actions can be taken and water quality standards achieved. The total pollutant load to a waterbody is derived from point, nonpoint, and background sources. The Upper Snake Rock TMDL has attempted to consider the effect of all activities or processes that cause or contribute to the water quality limited conditions of not just the 31 waterbodies listed on the 1996 303(d) list, but rather all potential sources. Control measures to implement this TMDL are not limited to NPDES authorities, but are based on the reasonable assurance that State and local authorities and actions to reduce nonpoint source pollution will also occur. "There must be assurances that nonpoint source control measures will achieve expected load reductions in order to allocate a wasteload to a point source with a TMDL that also allocates expected nonpoint source load reductions (USEPA 1991a [p 22])." The Upper Snake Rock TMDL has load allocations and wasteload allocations calculated with margins of safety to meet water quality standards. However, the allocations are based on estimates which have used available data and information. Therefore, monitoring for the collection of new data is necessary and required. For the Upper Snake Rock TMDL the reasonable assurance that it will meet its goal of water quality standards is based on three components: (1) point source NPDES permits that will require monitoring for the generation of new data that will be used for wasteload allocation concerns; (2) nonpoint source implementation of best management practices based on land management agency's assurance that reductions will occur; and, (3) a trend monitoring plan that will be used to document relative changes in various aquatic organism populations, and in physical and chemical water quality parameters over a 10-year period in conjunction with data from various agencies, organizations, and water user industries that will asssess overall progress towards attainment of water quality standards and its related beneficial uses. These components are further defined as follows.

3.6.01 POINT SOURCE

"Both technology-based and water quality-based controls are implemented through the NPDES permitting process. Permit limits based on TMDLs are called water quality-based limits. Wasteload allocations establish the level of effluent quality necessary to protect water quality in the receiving water and ensure attainment of water quality standards. Once allowable loadings have been developed through wasteload allocations for specific pollution sources, limits are incorporated into NPDES permits (USEPA 1991a [p 23])."

In the Upper Snake Rock TMDL a description of actions (control actions and/or management measures) that will be implemented to achieve the TMDL for point sources was previously summarized in §3.2 for aquaculture, food processors, municipalities, and industrials. For the Upper Snake Rock subbasin the

following table describes the short-term and long-term goals that are prescribed for point source industries and IDEQ-TFRO that will insure reasonable assurance that point sources will comply with their reduction plans per pollutant.

Table 106 Short- and long-term goals for point sources and IDEQ-TFRO on a pollutant basis

Pollutant	*Industry*	*Year 1 (2000)*	*Year 3 (2002)*	*Year 5 (2004)*	*Year 8 (2007)*	*Year 10 (2009)*
TP	Aquaculture	Permit Issued	Re-allocation of TP loads per industry per facility	Meet target reductions & maintain for additional 5 years	Maintainpermit	Possible re-allocation of TP loads per industry based on new data
	Food Processors	Permit Issued			Maintainpermit	
	Municipalities	Permit Issued			Maintainpermit	
	Industrials	LA & NPDES Permits maintained & reviewed by IDEQ				
	IDEQ	Maintain data base; review LA and NPDES permits	Re-allocates TP loads to industry	Reviews all reductions & determines if on target	Commences intensive study for possible re-allocation	Re-allocates TP loads to industry based on new data
TSS Pathogens	Aquaculture	Permit Issued	TMDL will be based on maintaining permit effluent limits			
	Food Processors	Permit Issued	TMDL will be based on maintaining permit effluent limits			
	Municipalities	Permit Issued	TMDL will be based on maintaining permit effluent limits			
	Industrials	LA & NPDES Permits maintained & reviewed by IDEQ				
	IDEQ	Maintain data base; review LA and NPDES permits				
TKN Pesticides Oil & Grease	A TMDL is not anticipated for any of the nonpoint source industries. Pesticide sampling on Cottonwood Creek will occur in 1999 to ascertain removal of pesticide as pollutant. City of Twin Falls & IDEQ-TFRO will jointly support removal of Oil & Grease as pollutant.					
NOX NH_3	Aquaculture	No TMDL anticipated. Monitoring being done.		Re-evaluation of TMDL potential. If needed, it will startup in Year 5.		
	Food Processors	Uncertain about a TMDL. Monitoring being done.		Re-evaluation of TMDL potential. If needed, it will startup in Year 5.		
	Municipalities	Uncertain about a TMDL. Monitoring being done.		Re-evaluation of TMDL potential. If needed, it will startup in Year 5.		
	Industrials	No TMDL is anticipated for the industry				
	IDEQ	Maintain data base	Evaluate TMDL potential	IDEQ will re-evaluation the potential for a TMDL based on industry monitoring		
DO	Aquaculture	DO linked to TP Permit limits		Maintain TP Permit limits		Re-evaluation
	Food Processors	DO linked to TP Permit limits		Maintain TP Permit limits		Re-evaluation
	Municipalities	DO linked to TP Permit limits		Maintain TP Permit limits		Re-evaluation
	Industrials	No TMDL is anticipated for the industry				

	IDEQ	Maintain data base and provide technical assistance to industries on meeting permit limits to cause DO levels to respond appropriately	Meet target reductions & maintain for additional 5 years	Re-evaluation process by IDEQ. begin to make recommendations on beneficial uses and water quality standards recovering
Temperature	Re-evaluation of temperature criteria via project study by IDEQ-State Office			
Flow	No Flow TMDL; Conservation flows encouraged			
Industry Plans	Each industry will be responsible for the development of an annual summary review of assessment of water quality goals and targets for the Upper Snake Rock sub basin. Plans developed under the Mid-Snake TMDL will be revised and applied on the Upper Snake Rock TMDL specific for the water quality limited streams.			
A data base of each industry will be maintained by IDEQ-TFRO. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen, NOX = nitrate+nitrite, NH_3 = ammonia, DO = dissolved oxygen, LA = Land Applicaiton. The feedback loop is an important component in all short-term and long-term goals.				

3.6.02 NONPOINT SOURCE

"When establishing permits for point sources in the watershed, the record should show that in the case of any credit for future nonpoint source reductions, (1) there is reasonable assurance that nonpoint source controls will be implemented and maintained or (2) that nonpoint source reductions are demonstrated through an effective monitoring program (USEPA 1991a [p 24])." Essentially, reasonable assurance for nonpoint sources means that nonenforceable actions will result in the load allocations for nonpoint sources required by the Upper Snake Rock TMDL. At a minimum, this includes:

1. "Demonstration of the availability of funds to implement the nonenforceable actions (USEPA 1998d [p 39])." Funding sources currently available include: §319, SAWQP, EQIP (USDA-NRCS), and CRP (USDA-NRCS-Farm Service Agency). §319 funding as a consequence of the 303(d) list process has taken on a more focused approach in screening TMDL implementation. For example, it is quite possible that linkage to a TMDL within a project area would carry a more favorable view particularly if it was linked to its TMDL implementation activity. The implementation of best management practices from a holistic resource management system approach that addressed all pollutant sources could be considered important as well. And, the support from an existing watershed advisory group could carry some weight in the project being considered. SAWQP, on the other hand, is currently undergoing revision via Senate Bill 1135 that considers "Program Neutral Planning" or implementation planning. A 3-tier approach, much like the stream corridor model, is used to consider the riparian corridor, the adjacent lands, and the uplands. 1996 USDA Farm Bill Conservation Provisions, EQIP (or Environmental Quality Incentives Program) became promulgated as a final rule on May 22, 1997. The purposes of the program are achieved through the implementation of a conservation plan which includes structural, vegetative, and land management practices on eligible land on 5- to 10-year contracts. Finally, the Conservation Reserve Program, or CRP, is aimed at reducing soil erosion, reducing sedimentation into streams and lakes, and protecting food and fiber, and thus improves water quality through establishment of wildlife habitat and enhancing forest and wetland resources. Through cost sharing, farmers are encouraged to convert highly errodible cropland or other environmentally sensitive acreage to vegetative cover, wildlife plantings, trees, filterstrips, or riparian buffers. According to NRCS, each acre under CRP contract reduces erosion by an average of 19 tons of top soil per year. Additional funding sources are available. Therefore,

the Mid-Snake WAG will upon acceptance of the Upper Snake Rock TMDL or Watershed Management Plan, form a Funding Committee that will evaluate and seek after such available funds with the express purpose of funding implementation projects that strive to clean up the 31 water quality listed streams.

2. "Description of the process for entering into any necessary agreements (such as with various federal, State, and local agencies/entities, private landowners, others) to carry out such nonenforceable actions and the probability of success in achieving such agreements (USEPA 1998d [p 39])." IDEQ-TFRO is prepared to discuss with any federal, State, or local agency/entity, private landowners, the possibility of carrying out such nonenforceable actions through the signing of necessary agreements to achieve success on the 31 water quality limited water bodies. Such agreements will be pertinent to the restoration of beneficial uses and water quality standards and may include water quality monitoring. Additionally, IDEQ-TFRO supports the *Forest Service and Bureau of Land Management Protocol for Addressing Clean Water Act Section 303(d) Listed Waters* (USFS & USBLM & USEPA 1999) which is to "protect and maintain water quality where standards are met or surpassed, and restore water-quality-limited waterbodies within their jurisdiction to conditions that meet or surpass standards for designated beneficial uses."

3. "An assessment of the likelihood of continuation of governmental programs (e.g., Conservation Reserve Program) that are planned to assist in implementation (USEPA 1998d [p 40])." According to the most recent survey by the U.S. Department of Commerce on the availability of funds over the next 15-20 years that consider environmental issues, it is estimated that 10-15% of the national budget will be increased from the current 5-10%. State funding in Idaho is already ongoing due to Idaho Code §39-3601 *et seq.* and all that relates to this for point and nonpoint source industries. Current programs, like CRP, EQIP, will continue to be funded so longs as they meet the full purposes for which they were funded. However, no funding program is long-lived and is highly dependent on changes in administrative opinion.

4. "An analysis of the anticipated effectiveness of the management measures (a demonstration of how, if implemented, they will actually lead to desired reductions; an evaluation of the success of existing/prior programs calling for similar controls in the watershed or a similar watershed may be used in this analysis) (USEPA 1998d [p 40])." CRP is not a new program, and as previously noted, has an erosion reduction potential of 19 tons/year/acre. Its viability is dependent on the number of new highly erodible acres that are available in the area of concern. EQIP, on the other hand, is a new program and is evolving yearly to include new acreages that are directed at water quality limited stream segments. Currently, the SCC, NRCS, in conjunction with local SCDs are looking at funding sources for BMP development on several water quality limited stream segments. Each segment will be assessed more fully after implementation of the TMDL with the express purpose of ascertaining if proposed instream targets are stringent enough to meet beneficial uses and State water quality standards. This assessment will occur over the next 5-10 years as part of implementation.

5. "An estimate of the time required to attain applicable water quality standards and a demonstration that the standards will be met as expeditiously as practicable (USEPA 1998d [p 40])." It is expected that management actions and control actions called for to implement

the Upper Snake Rock TMDL will begin immediately after approval of the TMDL submittal to USEPA. However, some industries have taken a more proactive approach by already beginning their management actions and control actions as part of the Mid-Snake TMDL and the Billingsley Creek TMDL. The Upper Snake Rock TMDL is designed with the goal of expeditiously attaining compliance with water quality standards, particularly in defining and repairing water quality impairments through the stream corridor approach. It is the belief of IDEQ-TFRO that attainment of water quality standards and beneficial uses will be met as expeditiously as practicable within the 10-year alloted time frame with implementation of management and control actions. However, in the event that beneficial uses are not attained, then the feedback loop as a component of adaptive management in conjunction with monitoring will be used for re-evaluation for implementation of more stringent measures if needed. The following describes the proposed phased-approach at achieving beneficial uses and State water quality standards:

PHASE 1

Year 1-5

In the first phase, the stream corridor (within the 2 miles) would be reviewed over a 5 year period for the development of critical acres that directly impact the stream. These critical acres would be defined by the land management agency during the implementation phase of the TMDL. Critical acres could include acreages outside the stream corridor if a portion of the area included the stream corridor. Within the first 5 years, all 31 water quality limited stream segments would have land management plans developed that specifically targeted the reduction of listed pollutants. These land management plans become the critical focus of the implementation plan for nonpoint sources. Monitoring would be specifically defined to determine if best management practices were functional and the overall goals of the Upper Snake Rock TMDL were met.

Year 3

In year 3, a preliminary evaluation of the 31 water quality limited stream segments for best management practice implementation via funding will be conducted by the land management agencies and IDEQ so that the goals of the Upper Snake Rock TMDL are being met.

Year 5

In year 5, a re-evaluation of the land management plans and their funding will be conducted by the land management agencies and IDEQ, so that goals of the Upper Snake Rock TMDL are in compliance and being met.

PHASE 2

Years 5-10

In the second phase, or in years 5-10, critical acres would be defined for acres outside the stream corridor but within the 5th field watersheds-of-concern that affect the 31 water quality limited stream segments. These critical acres would be defined similarly as in the first phase and according to the engineering design(s) of the land management agencies. Critical acres could include acreages within the stream corridor if a portion of the acres were included outside the stream corridor. Land management plans would also be developed and included as addendums to the particular water quality limited stream segment.

stop or prevent that danger as provided in §39-108 Idaho Code" (IDAPA §16.01.02.350.02.a). Other pertinent nonpoint source restrictions may be found in IDAPA §16.01.02.350.02 & 03.

3.6.05 CONNECTIVITY EFFECT

Pollution reduction management actions and control actions that occur in the Upper Snake Rock subbasin over the next 10 years will have a direct effect on subbasins downstream of King Hill. In like fashion, subbasins upstream of Milner Dam will have a direct effect on the Upper Snake Rock subbasin. This connectivity effect of a subbasin upon its downstream neighbor subbasins, as well as from its upstream neighbors, is a hydrological linkage that TMDLs do not normally address.

The Upper Snake Rock subbasin instream targets for the Middle Snake River will have a direct effect on subbasins draining into the Middle Snake River; namely, the Salmon Falls Creek subbasin and the subbasins draining into the Malad River. These drainages will not be addressed for TMDLs until the year 2005 (Salmon Falls Creek), 2003 (Camas Creek & Little Wood River), and 2001 (Big Wood River). Also, the Upper Snake Rock subbasin will also have an effect on its downstream neighbor, the Bruneau subbasin (which has a TMDL slated for the year 2000).

Connectivity is an issue that has been discussed by the Mid-Snake Technical Advisory Committee, particularly as to what effects loadings on the Middle Snake River will have on downstream subbasins. One of those concerns deals with algal growth between King Hill and Brownley Reservoir and its linkage to instream total phosphorus concentrations. Implications are that instream total phosphorus concentrations at King Hill are not stringent enough to effectively reduce excess algal growth that appears downstream of King Hill. On February 17, 1999, the Mid-Snake TAC recommended that a letter be drafted to the Upper Snake BAG that would address the concerns of the Mid-Snake WAG on this issue, but in particular as it affected the most immediate subbasins both upstream and downstream of the Upper Snake Rock subbasin. During public comment of the subbasin assessment and the TMDL development section, various members of the Mid-Snake WAG specifically suggested that the assessment and TMDL development section address this concern. Therefore, on or about the date of implementation of the Upper Snake Rock TMDL, the Mid-Snake TAC will continue to have discussions that address the issue of connectivity. Where management actions have been demonstrated through monitoring to not assist the stream in meeting its designated beneficial ues or water quality standards, then more stringent loadings will be imposed until uses and standards are met.

3.6.06 FEEDBACK LOOP AND ADAPTIVE MANAGEMENT

The feedback loop is a component of the Upper Snake Rock TMDL strategy that provides for accountability of plan goals for various pollutants. As part of the TMDL process, the Upper Snake Rock TMDL will use adaptive management as a style and process whereby management of the watershed is initiated by the State, federal agencies, and the water user industries; then, an evaluation process will ascertain the direction in which the reductions are progressing; and, based on monitoring information collected from various agencies, organizations, and water users refine the goals, targets, and BMPs based on short-term and long-term objectives for ecosystem management of the Upper Snake Rock watershed. Past management experiences may be used to evaluate both success and failure and to explore new management options where necessary. By learning from both successes and failures, the Upper Snake Rock TMDL will be iterative to allow implementation of those techniques which may be most useful and helpful, as well as gain insights into which practices best promote recovery for restoration of beneficial uses and State water quality standards (Williams et al. 1997).

For the Upper Snake Rock subbasin the main goal is to reach the preliminary instream water quality target of 52 mg/L TSS for all tributary and irrigation return flows and to maintain the <52.0 mg/L TSS annual mean value already existing in the Middle Snake River. Additonally, for the Upper Snake Rock an additional main goal is to reach the preliminary instream water quality target of 0.100 mg/L TP for tributary and irrigation return flows. The Middle Snake River also has a preliminary instream water quality target of 0.075 mg/L TP. These preliminary targets are set up in this way to allow for modifications in the targets over the next 10-15 years to attain beneficial uses and State water quality standards. This is the purpose for the goals.

In order for the feedback loop to be successful in the Upper Snake Rock TMDL, a concrete mechanism has been designed with short-term and long-term goals for the IDEQ-TFRO, industries, and the Middle Snake River WAG to regularly review progress on implementation, with regular review of monitoring results, regular evaluation of plan effectiveness, and sufficient flexibility in management plans to allow for corrections in management strategies that may not be effective in achieving beneficial uses or State Water Quality Standards. Both point and nonpoint source industries will follow the feedback loop under the following provisions: (1) identification of critical water quality parameter(s), (2) development of site-specific BMPs, (3) application and monitoring of BMPs, and (4) effectiveness evaluations of BMPs by comparing established water quality standards and then modifying the BMPs where needed to achieve water quality goals.

The IDEQ-TFRO will review all monitoring results for point and nonpoint sources, and will provide an opportunity for the Mid-Snake WAG and USEPA to review and comment on an annual basis. Each industry will provide an annual summary review/report to the IDEQ-TFRO on its monitoring efforts, strategies, and on-going reduction mechanisms. Each industry will provide its own data in their annual report. Based on these reports and other data, the Upper Snake Rock TMDL will be revised accordingly as an iterative plan. All industry plans will also be iterative and further developed through adaptive management as new knowledge and technology is discovered for pollution reduction efforts.

Additonally, because of the diverse nature of the partnerships and commitments within the Middle Snake River Watershed Advisory Group from various agencies, organizations, and water users; and, because adaptive management is inherently a characteristic of the Upper Snake Rock TMDL, both restoration and education efforts will be guided by IDEQ-TFRO via the WAG through technical and education committees. These committees will take advantage of partner technical knowledge, experience, existing management plans, and resources in determining which types of activities are appropriate for continued implementation of the Upper Snake Rock TMDL. The Mid-Snake WAG will continue to meet as perscribed in their bylaws and ensure good communication with its partners though monthly newsletters and or minutes of their meetings. Through its technical advisory committee (TAC), the WAG will have available to it the technical expertise of biologists, hydrologists, range conservationists, foresters, and other water quality and watershed specialists. Monitoring done by the various agencies, organizations, and water users will be evaluated by IDEQ-TFRO and provided to the TAC and WAG as a feedback mechanism that is science based; and, through adaptive management allow such scientific knowledge to be adapted to the task of watershed restoration almost immediately.

4.0 SUMMARY OF PAST/PRESENT POLLUTION CONTROL EFFORTS

Current and past pollution control efforts in Upper Snake Rock have included a number of projects on various tributaries. The follow pollution control efforts/projects are described as point and nonpoint source efforts.

4.1 NONPOINT SOURCE PAST/PRESENT POLLUTION CONTROL EFFORTS

In 1979 as a part of a 208 Study conducted by IDEQ on the Snake River from the Idaho-Wyoming border to Weiser, it was stated that a "general increase in nutrient concentrations from upstream to downstream stations exceeded the recommended criteria over most of the river a majority of the time (IDHW 1979a). It was stated that "in most Snake River segments and major tributaries, point sources are not major contributors of nutrients." In fact, "the major reduction in nutrient loadings will come from nonpoint source controls (IDHW 1979a). It was recommended at that time that the nutrient control plan for the Snake River should be implemented in two phases: Phase I would concentrate on control of phosphorus sources, and Phase II would focus on nitrogen sources. As part of the study, the Middle Snake River (from Milner Dam to King Hill) was defined as the segment most affected by upstream segments and upstream controls. "In addition, the springs entering this portion of the river and nonpoint sources on the three major tributaries also contribute a major portion of the phosphorus load. The nonpoint sources on both sides of the Snake River should be reduced by implementation of the Agriculture Pollution Abatement Plan (IDHW 1979a)." The Rock Creek drainage was defined as one of the major tributaries and was being considered for a special Rural Clean Water Program project (which later occured in the 1980s). Since that time, the Idaho Agriculture Pollution Abatement Plan has been referenced in Idaho Code §39-3601 *et seq.* as the source of best management practices for agricultural sources. IDEQ anticipates that agriculture as part of the nonpoint source portion of the TMDL will adopt and implement those best management practices (where applicable) as defined in the Pollution Abatement Plan and that the feedback loop will be used to identify non-functioning best management practices and these will be modified so functional best management practices will be applied for the reduction of sediment and nutrients, as well as other parameters linked to the sediment. Precedence for this has been set by the Mid-Snake TMDL (1997b) in which a portion of irrigated agriculture selected site-specific canal drains to apply best management practices for specific total phosphorus reductions. Still to be defined are: (1) tributary reduciton efforts from various nonpoint sources, (2) grazing reduction efforts that need to be defined for public and private lands, and (3) additional agricultural drains that may have significant impact to receiving streams.

4.1.1 WATER QUALITY PROJECTS

The Idaho State Agricultural Water Quality Plan (or SAWQP) has undergone major revisions in its funding since it was developed as a partnership between the "participant", the technical agency, the soil conservation district, and the IDEQ. SAWQP conducted in Upper Snake Rock has included some of the following projects as described in Table 73. Additionally, the federal Rural Clean Water Program has been used on one water quality project and is so described in TABLE 42.

TABLE 109 SAWQP PROJECTS OF IDEQ-TFRO

NAME OF PROJECT	*ACREAGE AFFECTED*	*WATER QUALITY PROJECT TYPE & PROBLEM ASSESSMENT*
Vinyard Creek	9,890	A SAWQP Project. Vinyard Creek watershed has a serious erosion problem on irrigated cropland, especially during spring runoff of winter snows and furrow irrigation of row crops.

NAME OF PROJECT	ACREAGE AFFECTED	WATER QUALITY PROJECT TYPE & PROBLEM ASSESSMENT
East Upper Deep Creek	5,079	A SAWQP Project. The land is primarily agricultural in nature, intensively farmed, and severely impacted by livestock operations thus contributing to inefficient water management and soil erosion via sediment and associated nutrients and pathogens. The two critical water quality problems are erosion from irrigated cropland and inadequate animal wate management handling systems. Riparian areas are primarily pastures along canals and irrigation waterways.
West Upper Deep Creek	4,079	
Scotts Pond	58,674	A SAWQP Project. Surface water pollution includes sediment erosion from irrigated cropland and from winter/spring runoff as the greatest source of sediment, and numerous dairies and feedlots which contribute organic and inorganic pollutants. Ground water pollution is possibly due to CFO concentration of animal wastes in improperly engineered containment facilities.
Rock Creek	202,000	A Rural Clean Water Program (RCWP). Water quality problems from both point (sugar company, concrete mining, processed foods, aquaculture) and nonpoint source (forestry, road construction, urban runoff, grazing, pasture, irrigated cropland) industries. The creek is used as well for recreation and industrial water supply. Unstable streambanks are a major problem on Rock Creek.
Cedar Draw	15,665	Water quality problems primarily from critical erosion sites and irrigated cropland.
Mud Creek		Similar to Deep Creek. A SAWQP planning project.
Perrine Coulee	27,552	The major water quality problems include excessive sediment loads, excessive nutrient levels, and excessive bacteria levels which are largely from agricultural sources (irrigated cropland, occasional animal feeding operations, pastures draining directly into drainage channels). Urban runoff is also a priority. A SAWQP planning project.

Although, in general the SAWQP and RCWP projects were successful, sediment still continues to be a major problem year-after-year in the Upper Snake Rock subbasin. Sediment is a complex problem requiring a complex solution. Yet, the key to reducing sediment on the Middle Snake River is to reduce the sediment in the individual tributaries and agricultural returns through reductions in sediment at individual farm sites. When this is accomplished, the overall water quality on the Middle Snake River and its associated tributaries and agricultural returns will greatly improve. It is anticipated that with decreases in sediment (as total suspended solids) over a ten year period, baterial contamination, excess nutrients, and excessive macrophytes will be substantially reduced. Public education; application of functional, voluntary, and cost-effective BMPs; effectiveness monitoring for the short- and long-term; and, constant vigilance of the applied BMPs through the feedback loop are key considerations in developing a functional and workable sediment reduction strategy for the Upper Snake Rock subbasin.

4.1.2 FERC RELICENSING PROCESS

One of the issues for relicensing of the Idaho Power Company (IPC) Mid-Snake hydropower facilities (Bliss Dam, FERC No. 1975; Lower Salmon Falls Dam, FERC No. 2061; Upper Salmon Falls Dam, FERC No. 2777; Shoshone Falls, FERC No. 2778) is §401 Water Quality Certification by IDEQ. IDEQ is the designated water quality agency for the State of Idaho and administratively issues §401 Water Quality Certification for FERC projects to meet state water quality standards. In December 1995, IPC submitted to FERC applications for relicensing for three (Bliss, Lower Salmon Falls, Upper Salmon Falls) hydropower facilities located near Hagerman and Bliss. The IPC also submitted a request for federal Clean Water Act §401 Water Quality Certification. Then, in May 1997, IPC filed an application with FERC to relicense its Shoshone Falls hydropower facility (near Twin Falls) and applied for a request with IDEQ for §401 Water Quality Certification for this facility.

The IDEQ has conducted settlement discussions and negotiations with IPC concerning protection, mitigation,

and enhancement (PM&E) measures and actions that address water quality in the Middle Snake River. A formal and legally enforceable Consent Order (dated May 22, 1998) was entered into with IPC with terms and conditions that address water quality issues, concerns, measures, and actions to be taken by IPC to protect, mitigate, and enhance water quality in the Middle Snake River. PM&E measures to address the effects of the four hydropower facilities on water quality in the Middle Snake River were proposed by IPC in their license applications to FERC. These PM&Es were evaluated by IDEQ and are included as specific actions or activities by IPC and considered as mitigation for water quality impacts. The physical characteristics (such as dam design and impoundments), as well as the operations of the individual hydropower facility, make it very difficult to protect, mitigate, or enhance water quality short of removal of the dams and returning the river to its natural free-flowing state. The ability of IPC to incorporate operational changes is limited and IDEQ included specific activities which would result in improving water quality and enhancing the beneficial uses of the Middle Snake River.

IDEQ PM&E measures and actions include: protection of spring habitats; off-site measures to limit sediment and nutrient pollution loadings; and, water quality monitoring. IPC PM&E measures and actions include: continued active participation in the Middle Snake River Watershed Management Plan; aquatic macrophyte harvest; minimum flow in the north channel at Upper Salmon Falls; and, temperature and dissolved oxygen monitoring. The IDEQ entered into a consent order agreement with IPC to the §401 Water Quality Certification that addresses terms and conditions agreed to by both IDEQ and IPC relative to activities or actions to meet water quality standards. The goal of the §401 Water Quality Certification action is to ensure that water quality values affected by the four hydropower facilities' operations result in appropriate PM&Es for the benefits of the State of Idaho as well as maintaining the facilities as cost-effective power generators and electric suppliers for the State.

VINYARD CREEK

One particular FERC environmental project that has been used to assist in the recovering of certain trout species is the Vinyard Creek Diversion Project (NPW No. 963200350) as part of the Twin Falls Project (FERC No. 0018). License Article 405 required IPC to implement aquatic habitat enhancement. For the Vinyard Creek Diversion Project, the primary purpose was to divert agricultural drain return water out of Vinyard Creek and into the Twin Falls Reservoir so as to improve the aquatic habitat of lower Vinyard Creek to improve fisheries in the Twin Falls Reservoir. The specific fisheries are cutthroat trout and rainbow/cutthroat trout hybrids in the Twin Falls Reservoir. The irrigation return drain conveys irrigation waste water and suspended sediments into Vinyard Creek. The diversion project (dike, pipeline, and outfall) would intercept this waste water flow and sediment before it entered the lower portion of Vinyard Creek. The diverted flow would be discharged into the Twin Falls Reservoir below the outlet of Vinyard Creek. (See IDEQ 1996b, DOA-COE 1996, and IPC 1997b for additional information.)

4.1.3 IDAHO DEPARTMENT OF LANDS (IDL)

On April 17, 1998 a memorandum was jointly signed by IDEQ and IDL whick attempted to clarify roles and ensure coordination of efforts in development of TMDLs for forested portions of TMDLs. As previously described, only 3% of the land use in Upper Snake Rock is forested making the overall effects from forested ground minimal. (See §2.1.2.3) At this time, forestry is not included as a major component of the TMDL process for Upper Snake Rock since its land use comprises a smaller fraction when compared to rangeland and agriculture. At a future date, forestry will be addressed if necessary.

4.1.4 IRRIGATION COMPANY POLLUTION CONTROL EFFORTS

In addition to water quality monitoring being contracted by The North Side and Twin Falls Canal Companies, both have constructed sediment retention ponds at selected sites on their canal systems. A summary of these

retention ponds is found in Appendix B (§2.80). As part of their industry plan, the irrigation agricultural community will continue to monitor as described in their industry plan on selected agricultural return drains.

The Twin Falls and Northside Canal Companies, as part of the Irrigators Water Quality Committee, have set a goal of reducing sediment by 27% and phosphorus by 10% by the Year 2000. These goals are part of irrigated agriculture industry s nutrient management plan submitted to IDEQ in the Mid-Snake TMDL (1997b). Baseline loads were determined to be the 1990-91 load base. As part of their management actions and their specific watershed reduction plan, the canal companies jointly contracted with the University of Idaho for an initial two-year period (beginning July 1, 1992) of which a water quality monitoring network was developed on the return flows in order to determine the 1995 irrigation season loads. Significant amounts of sediment are removed from the drains resulting in expensive cleaning costs. Although irrigation diversions benefit the Middle Snake River as far as their water quantity is concerned, their pollutant concentrations result in elevated concentrations of pollutants in the Middle Snake River. However, the 1995 suspended solids and total phosphorus loading results showed a general decreasing trend from the 1990-91 loading results and indicate that the proposed goals of the Mid-Snake TMDL (1997b) can be achieved (Barry 1996).

4.1.5 319 PROJECTS

Only one project was funded through the 319 Program in Upper Snake Rock. It was the CFO position at IDEQ-TFRO. The project was funded in 1993, 1995, and 1996, and was instrumental in developing a database that located dairies and feedlots in the region. Additionally, it was beneficial for inspection of CFOs, prevention of discharges, and providing technical assistance to operators.

4.1.6 104(b) PROJECTS

One 104(b) project was funded by USEPA at the IDEQ-TFRO as an aquaculture basic research study on offline settling ponds for the development of best management practices in 1995-1998.

4.1.7 WATER QUALITY 106

One water quality 106 project funded by USEPA for monitoring on Billingsley Creek commenced in the late 1980s and is still on-going for monitoring of various water quality parameters.

4.1.8 GROUND WATER

The eastern Snake River Plain is underlain predominantly by a series of vesicular and broken basalt flows that has regional water flows that in the aquifer that move from northeast to southwest. Ground water is discharged from the eastern Snake River Plain aquifer as spring flow and seepage to the Snake River between Milner Dam and King Hill. Discharge to the entire reach was about 6000 cfs in 1980 (USGS 1997c). As previously stated in §2.1.3.4, the average discharge specifically at Thousands Springs was about 4000 cfs in the early 1900s and increased to almost 7000 cfs in the 1950s. It has since decreased to about 5000 cfs (USBOR 1996-1997).

NO2+NO3 as N (or NOX) in ground water is a result of nitrogen input from many difference sources. The proportions of nitrogen supplied by the various sources depend on land use practices. For instance, most nitrogen in the A&B area of Burley-Rupert is from inorganic fertilizer and legume crops. In the Jerome-Gooding study area, a greater percentage of nitrogen is from cattle manure because of the large number of dairies, particularly in Gooding county (USGS 1997c). USGS estimated the amount of nitrogen supplied by cattle manure, domestic septic systems, inorganic fertilizer, legume crops (alfalfa and beans), and precipitation for each countin in the Upper Snake River Basin. They concluded that domestic septic systems provided minimal amounts of nitrogen input (less than 1 percent) and that precipitation provided only 6 percent

of the nitrogen input to the basin as a whole. The remaining 93% was provided by cattle manure (29%), fertilizer (45%), and legume crops (19%). Additionally, the greatest amount of mean residual total nitrogen input of all 24 counties in the basin occurs in Cassia, Gooding, and Twin Falls counties. Gooding and Twin Falls are in Upper Snake Rock (USGS 1996b).

As previously noted in §2.1, excessive aquatic plant growth in surface water is a major concern in the Middle Snake River, particularly during low flow/drought years. Ground water adds nitrogen and phosphorus to surface water where ground water discharges to the Middle Snake River. Water from more than 78% of the regional wells contained NOX concentrations higher than 0.3 mg/L, which is the critical limit for stimulation of aquatic plant growth in surface water in the presence of adequate phosphorus. According to USGS, this suggests that nitrogen is not a limiting factor for aquatic plant growth in most streams that receive ground water (USGS 1997c).

4.2 POINT SOURCE POLLUTION CONTROL EFFORTS

At the time of this writing, the food processors, municipalities, and aquaculture permits were undergoing public comment for reissuance or modification of their individual permits.

4.2.1 AQUACULTURE GENERAL PERMIT

Aquaculture facilities and associated, on-site fish processors had their public comment period from April 10, 1998 to June 9, 1998 on a proposed general NPDES permit (No. ID-G13-0000). The general NPDES permit contains technology-based limitations for sediment based upon the same effluent guidelines as previous NPDES permits for Idaho's aquaculture industry. The general NPDES permit contains technology-based limitations for BOD_5, oil and grease, based upon the same effluent guidelines as previous NPDES permits for Idaho's fish processors.

The aquaculture facilities authorized to discharge under this general permit raise fish: rainbow trout, steelhead trout, chinook salmon, catfish, tilapia, and other fish. These fish are produced for market as food products or for the enhancement of salmonid populations. They discharge rearing wastewater containing fish excreta, excess fish feed, dissolved and suspended soild biological pollutants, oxygen demanding materials, nutrients, and residual disease control chemicals or therapeutics. The aquaculture facilities are required to develop best management practices plans supported by mass balance assessments of their operations and to restrict their discharges below specific technology-based limitations on total suspended solids and settable solids and specific water quality-based limitations on total phosphorus, dissolved oxygen, and pH.

The fish processors authorized to discharge under this general permit butcher fish: rainbow trout, steelhead trout, chinook salmon, catfish, tilapia, and other fish. These are butchered for food products, thus discharging processing wastewater containing dissolved and suspended solid biological pollutants, oxygen demanding materials, nutrients, and residual disinfectants. The fish processors are required to develop best management practices plans supported by mass balance assessments of their operations and to restrict their discharges below specific technology-based limitations on total suspended solids, biochemical oxygen demand, oil and grease, and pH and specific water quality-based limitations on total residual chlorine and pH.

4.2.2 FOOD PROCESSORS INDIVIDUAL PERMITS

The food processors have individual NPDES permits which had their public comment period from September 24, 1997 to November 10, 1997. These permits reflect J.R. Simplot Company (which is a permit modification) and McCain Foodservice, Inc. (which is a permit modification) to incorporate the conditions of total phosphorus limits established by the Mid-Snake TMDL (1997b).

The J R Simplot Company processes raw potatoes into frozen potato products (french fries) and dehydrofrozen potato products. Final effluent is discharged into the Snake River at RM 652.2. The proposed permit modification will retain the 1994 permit conditions and further improve water quality by reducing total phosphorus loads to the Middle Snake River (which is downstream of HUC 17040209), which will in turn reduce eutrophication. The 1994 permit established both ambient and effluent monitoring of nutrients including total phosphorus and dissolved ortho-phosphate (USEPA 1997c).

The McCain Foodservice, Inc. food processor processes raw potatoes, manufacturing frozen potato products. Process wastewater is treated prior to discharge into the Snake River (mid-channel) at RM 648.8. The proposed permit modification will retain the 1994 permit conditions and further improve water quality by reducing total phosphorus loads to the Middle Snake River (which is downstream of HUC 17040209), which will in turn reduce eutrophication. Effluent monitoring is done at a weekly frequency while ambient monitoring is required twice per year (USEPA 1997b).

4.3.3 MUNICIPALITY INDIVIDUAL PERMITS

The municipalities have individual NPDES permits which had their public comment period from September 24, 1997 to November 10, 1997. These permits are for the cities of Buhl (permit reiissuance, USEPA 1997e), Filer (permit reiissuance, USEPA 1997f), Hagerman (permit reiissuance, USEPA 1997d), Hansen (permit reiissuance, USEPA 1997h), Jerome (permit reiissuance, USEPA 1997g), and Twin Falls (permit modification, 1997i). The USEPA is reiissuing and modifying the existing permits in order to incorporate the wasteload allocations of the Mid-Snake TMDL (1997b). Only the cities of Jerome and Buhl are allowed for alternatives from their current practice of the handling of treated sewage sludge (biosolids). Under the proposed permit, treated sewage sludge from the City of Jerome may be distributed and spread on the land as a fertilizer in western Jerome county. Under the proposed permit, the City of Buhl is allowed to spread small amounts of treated sewage sludge on agricultural test plots of up to 2 acres, encouraging the City to consider beneficial use in the future.

The proposed permit will improve water quality by significantly reducing phosphorus loads to the Middle Snake River, which in turn will reduce eutrophication. In addition, the permit includes water quality-based limits on residual chlorine and ammonia. These limits will ensure that water quality standards are met at the edge of the mixing zone (USEPA 1997i).

4.3 MID-SNAKE TMDL

The Mid-Snake TMDL (1997b) was accepted by the EPA on April 25, 1997 as a TMDL for total phosphorus for both point and nonpoint sources in the Upper Snake Rock watershed. Although the TMDL does not bring new enforcement authority, it does provide wasteload allocations for total phosphorus limits for point source permits for food processors, municipalities, and aquaculture. Specific commitments have been entered into by nonpoint source industries relative to best managment practices. Violation of state water quality standards and best management practices by any industry on the Middle Snake River (to which all tributaries in Upper Snake Rock discharge) would be inconsistent with the Mid-Snake TMDL and therefore could result in statutory enforcement by the IDEQ, specifically IDAPA §16.01.02.080, where "no pollutant shall be discharged from a single source or in combination with pollutants discharged from other sources in concentrations or in a manner that will or can be expected to result in violation of water quality standards applicable to the receiving water body or downstream waters; or will injure designated or existing beneficial uses; or is not authorized by the appropriate authorizing agency for those discharges that require authorization;" and, Idaho Code §39-3603, where "the existing instream beneficial uses of each water body and the level of water quality necessary to protect those uses shall be maintained and protected." See also the Mid-Snake TMDL (1997b) for a summary of industry reduction goals, management actions, compliance actions, and implementation.

4.3.1 MONITORING IN UPPER SNAKE ROCK

Monitoring of Upper Snake Rock tributaries and the Middle Snake River will continue to occur with the resources from various agencies, organizations, and groups. As of this writing, a trend monitoring plan was being reviewed by the Mid-Snake TAC for purposes of documenting relative changes in various aquatic organism populations, and in physical and chemical water quality parameters over a ten year period during the implementation of the Mid-Snake TMDL (or Middle Snake River Watershed Management Plan). Monitoring by IDEQ-TFRO on the various tributaries and additional sites on the Middle Snake River will be incorporated as funds become more available. A draft copy of the *Trend Monitoring Plan* is found in Appendix A (§2.7).

4.3.2 BURP MONITORING

BURP monitoring will continue annually within the subbasin to verify if beneficial use support status has been changed or achieved as necessary. For wadable streams, large rivers, lakes and reservoirs, the following parameters in Table 74 may be used to decide assessment of their beneficial uses. These reflect the minimum number of parameters needed to adequately surmise the level of beneficial use support status (either as full support or not full support). It is highly unlikely that any one parameter will have sufficient sensitivity to be useful in all circumstances.

TABLE 110 BURP MONITORING PROTOCOLS

PARAMETER	*WADABLE STREAMS*	*LARGE RIVERS*	*LAKES & RESERVOIRS*
	PHYSICAL/CHEMICAL PARAMETES		
Bathymetry or Depth			X
Canopy Closure (Shade)	X		
Channel Alterations		X	
Conductivity		X	X
Discharge	X	X	
Dissolved Oxygen		X	X
Floodplain Disturbance		X	
Habitat Distribution	X	X	
pH		X	X
Large Organic Debris	X		
Nutrients			X
Photo Documentation & Diagrammatic Mapping	X	X	X
Pool Quality	X		
Riparian Vegetation		X	
Stream-Channel Classification	X		
Streambank Condition & Material Types	X	X	
Substrate and Embeddedness	X	X	X

PARAMETER	WADABLE STREAMS	LARGE RIVERS	LAKES & RESERVOIRS
Temperature	X	X	X
Water Clarity		X	X
Width and Depth	X	X	
BIOLOGICAL PARAMETERS			
Aquatic Macrophytes		X	X
Fecal Coliform		X	X
Fish	X	X	X
Macroinvertebrates	X	X	X
Periphyton		X	X
Phytoplankton/Chlorophyll *a*		X	
Prepared by IDEQ-TFRO.			

4.4 NO-NET INCREASE POLICY ON TMDLs

On May 7, 1998, a No-Net Increase (NNI) Policy was made effective by IDEQ. When a stream is designated as not fully meeting its designated or existing beneficial uses, an interim of time exits until the stream has a TMDL developed or the stream is delisted because its beneficial uses have returned to full support. During that interim of time, the NNI Policy (IDEQ Policy Memorandum, *PM98-2*, May 7, 1998), the provisions of IDAPA §16.01.02.054.04 (High Priority Provision) and IDAPA §16.02.02.054.05 (Medium and Low Priority Provisions) are to be utilized. The NNI Policy may not be interpreted as requiring best management practices for nonpoint source operations unless they are voluntary or unless they are outlined in applicable federal or state statute or IDAPA 16 Tital 01 Chapter 02. For agriculture, the *Idaho Agriculture Pollution Abatement Plan* has been referenced (IDAPA §16.01.02.054.07) as "the source for best management practices for the control of nonpoint sources of pollution for agriculture." Although the policy does not generally pertain to accidental spills or unauthorized releases that may occur on listed waters, IDEQ must ensure that human health along with the appropriate beneficial uses are protected in the case of accidental spills or unauthorized releases, and could, depending on the spill or release, require clean up. Provisions of the NNI Policy include nonpoint source, point source, and general provisons.

4.4.1 NONPOINT SOURCE PROVISION OF NNI POLICY

It is the responsibility of the designated agency to ensure that cost effective best management practices or knowledgeable and reasonable control measures, including pollution trading, have been or are properly implemented for all nonpoint source activities on federal, state, or private lands.

1. Where approved best management practices do not exist, the landowner should be assisted by the designated agency in using knowledgeable and reasonable control measures to ensure no further impairments of beneficial uses on low and medium priority waters, and that the load remains constant or decreases on high priority waters.

2. IDEQ recommends monitoring as a component of application of best management practices or other control measures.

3. If monitoring indicates that approved best management practices or other control measures are not maintaining or protecting beneficial uses, then additional restrictions or modified control measures may be imposed.

4.4.2 POINT SOURCE (NPDES PERMIT) PROVISION OF NNI POLICY

The Clean Water Act requires all point source dischargers to have an NPDES permit. In the event that USEPA cannot or does not issue a permit on a §303(d) listed water body, IDEQ will notify the discharger of the applicable provisions specified in the High Priority Provision (IDAPA §16.01.02.054.04), the Medium and Low Priority Provision (IDAPA §16.01.02.054.05), and the Violation of Water Quality Standards (IDAPA §16.01.02.080). Additionally,

1. A facility will be allowed to discharge to its existing maximum NPDES permit limit without being considered in violation of the High Priority and the Medium and Low Priority Provisions. However, dischargers of listed pollutants to §303(d) waters should be aware that interim increases in existing loads may result in the need for greater load reduction once a TMDL is developed and implemented.

2. A facility operating within its permitted discharge limits will not have to change its discharge limit while the TMDL is being developed. The NPDES permit and associated discharge limit will be examined and modified, if necessary, by USEPA at the time of permit reissuance.

3. When reviewing and approving plans under IC §39-118 including facility plans and specifications, written or verbal communication to the facility should emphasize that additional load reductions from the facility may be likely or required once the TMDL has been developed.

4. When meeting the provisions of the NNI policy, an NPDES permittee should address new or increased discharge of listed pollutants in terms of mass per unit time, toxicity, or other appropriate measures. However, IDAPA §16.01.02.054.04 specifies that for high priority waters, the total load must remain constant or decrease within the watershed.

5. To write a TMDL, IDEQ will establish loads based upon available information. However, where information is lacking, facilities will be allowed to establish baseline data for the listed pollutants using standard analytical methods. IDEQ regions shall issue a letter to each facility detailing that if baseline information is not established by the discharger by a certain date, IDEQ will proceed to establish baseline information necessary for the development of a TMDL.

6. In situations where dischargers apply to exceed their maximum permit limits, provisions of IDAPA §16.01.02.054 shall apply. For high priority waters, new or increased discharge of pollutants of concern above permitted limits may be allowed if the total load to the watershed remains constant or decreases. For medium and low priority waters, IDEQ may require changes in loads and/or concentrations of pollutants of concern that prevent further impairment of beneficial uses. In either case, it is incumbent on the facility to provide loading calculations based on sound and accepted engineering practices which demonstrate the applicable provisions of IDAPA §16.01.02.054. However, dischargers of listed pollutants to §303(d) waters should be aware that interim increases in existing loads may result in the need for greater load reduction once a TMDL is developed and implemented.

7. Unpermitted facilities wishing to expand their facility operations will be required to acquire an NPDES permit from USEPA and meet all applicable provisions of IDAPA §16.01.02.054.04 or IDAPA §16.01.02.054.05.

4.4.3 GENERAL PROVISION OF NNI POLICY

The following general provisions apply on the NNI Policy:

1. If IDEQ determines, based on reliable and verifiable water quality information, that a specific listed pollutant is not impairing the §303(d) water body, then delisting will be recommended and a TMDL will not be developed for that pollutant and water body.

2. Any facility or operation implementing control measures after the WAG (if applicable) or BAG (in the absence of a WAG) review of the subbasin assessment, and before USEPA's approval of the the TMDL that results in a verifiable reduction of listed pollutant(s) to a §303(d) water quality limited water body, will be credited with the appropriate load reduction during the allocation phase of the TMDL. However, this does not guarantee that additional load reductions by the facility will not be required in order to meet water quality goals necessary to obtain beneficial uses.

3. All activities related to stream channel alteration permit applications must comply with IDWR's Rules and Minimum Standards for Stream Channels Alteration. IDEQ shall give IDWR written notice if a §303(d) stream will be impacted, and caution that additional measures may need to be taken to later address water quality once the immediate threat has passed. In any situation, stream alteration activities shall not violate Idaho Water Quality Standards except as outlined in IDAPA §167.01.02.080.02 (Short Term Activity Exemptions).

In order to ensure that water quality is protected, the following conditions may be included by IDEQ in the final stream channel alteration permit:

a. Construction shall be conducted in such a manner so as to minimize turbidity and comply with the Idaho Water Quality Standards and Wastewater Treatment Requirements.

b. Work shall be conducted during low flows and heavy equipment shall operate from the bank.

c. All fuel, oil and other hazardous materials, shall be stored and equipment refueled and serviced away from the stream to ensure that a spill cannot enter the waterway.

d. All areas subject to erosion as a result of the construction shall be protected with rock riprap or other suitable methods of erosion protection meeting IDWR minimum standards.

e. Disturbed areas shall be revegetated and/or seeded with perennial vegetation.

f. All temporary structures, excavated material or construction debris resulting from the construction shall be disposed of out of the stream channel so it cannot reenter at high flows.

g. Materials excavated from the construction site shall be discharged in an upland area so it cannot reenter the stream channel at high flows.

h. Sand bags or other methods of coffer damming shall be utilized to minimize working in the flowing water.

Provided that these inclusions and IDWR minimum construction standards are included in the final permit, water quality impacts should be minimal.

Additionally, for suction dredging operations in Idaho, USEPA has provided the following guidelines (USEPA 1998c) if an NPDES permit strategy was developed:

a. For new large-scale commercial operations, individual NPDES permits would be required prior to beginning operations.

b. For moderately sized operations (with intakes greater than 5 inches and over 15 horse power), consideration would be given to issuing a general NPDES permit. The state of Idaho would have the flexibility, through their 401 certification program, to determine which stream segments would be off limits to dredging due to water quality concerns (such as segments on the 303(d) list).

c. For small-scale, recreational dredging operations which are adequately regulated under state programs (such as the "one stop" permit), or other federal programs (by the Corps of Engineers CWA 404 program), the USEPA could consider either a general permit or, with respect to unpermitted discharges, enforcement discretion if the discharges did not result in violations of state water quality standards.

4. All NEPA related activities are subject to compliance with all applicable rules and regulations. During the formal NEPA public comment period, IDEQ shall notify the designated agency when activities may impact a listed water. It is incumbent on the designated agency to demonstrate that the activity under consideration will result in no further impairments of the beneficial uses on low and medium priority waters, and that the total load of listed pollutants remains constant or decreases on high priority waters.

5. IDEQ has the authority to review storm water pollution prevention plans for adequacy and compliance with the provisions of IDAPA §16.01.02.054. Should these plans be deemed inadequate, IDEQ will notify USEPA who is responsible for enforcement and/or corrective actions.

6. Pollution trading to reduce the effects of increasing the load to a high priority water will be allowed as long as the total load remains constant or decreases within the watershed. Pollution trading will be permitted in accordance with the provisions of the Mid-Snake TMDL, §3.02 (Wasteload and Load Allocation Tables) and §3.04 (Enforcement Mechanisms). Any facility desiring a modification in their wasteload allocation through effluent trading must receive approval from IDEQ and USEPA. Facilities that were not currently in production (since April 25, 1997 when the Mid-Snake TMDL was approved) but have current NPDES permits will receive an allocation in Year 3 provided they are in production and have monitoring data sufficient to demonstrate their phosphorus contribution to the Middle Snake River.

4.5 POLLUTION PREVENTION

The U.S. Pollution Prevention Act of 1990 defines source reduction as any practice that reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment prior to recycle, treatment or disposal. Pollution prevention includes reduction of pollution at the source (source reduction), and increased efficiency in the use of raw materials and natural resources, such that the emphasis on end-of-pipe control (for point sources) as a continuing exclusive reliance by regulatory agencies for realizing environmental goals is deemphasized by augmenting attention to reducing the sources of environmental pollution through changes in processes, operations and the use of materials;

placing the focus for identifying opportunities for such changes on the owners and managers of commercial, transportation, agricultural and industrial operations who best know and understand them; and, encouraging an emphasis not just on achieving regulatory compliance, but on achieving the best possible environmental results which will often substantially surpass compliance requirements and generally yield economic benefits. IDEQ and USEPA promote and support this change of emphasis and are working with other stakeholder state and federal agencies to develop a range of incentives and recognition programs for companies, farmers, or other entities to improve their environmental performance by focusing generally on environmental improvements or targeting on particular environmental problems (IDEQ 1998a). At the present time, IDEQ is in the process of building a framework for an Idaho Pollution Prevention Incentive program. When this program is in place, IDEQ will promote and support it by encouraging superior environmental management and beyond-compliance environmental performance with appropriate stakeholders.

5.0 PUBLIC PARTICIPATION

Part of the process in the development of the Upper Snake Rock subbasin assessment was the use of public participation through the Middle Snake River Watershed Advisory Group (Mid-Snake WAG). Key to this was the use of the Middle Snake River Technical Advisory Committee (Mid-Snake TAC), which represented various scientists and technical specialists from the water user industries and from various governmental agencies and organizations. Their review of the subbasin assessment, along with their technical comments, provided a vehicle for IDEQ-TFRO to develop a document which provided the necessary information from which to eventually derive a TMDL for the water quality limited waterbodies in the Upper Snake Rock subbasin.

5.1 UPPER SNAKE BASIN ADVISORY GROUP

The Upper Snake Basin Advisory Group (or Upper Snake BAG) as part of their statutory stewardship under §39-3601 *et seq.* provided guidance and advise to the Mid-Snake WAG, the Mid-Snake TAC, and IDEQ in the final development of the subbasin assessment. Part of that stewardship was to review the document after formal presentation and provide their comments and assessment. The subbasin assessment was presented by IDEQ-TFRO to the Upper Snake BAG on September 2, 1998 with comments being solicited. The TMDL Development (Section 3.0) section was presented by IDEQ-TFRO to the BAG on October 6, 1999.

5.2 MIDDLE SNAKE RIVER WATERSHED ADVISORY GROUP

The Mid-Snake WAG as part of their statutory stewardshsip under §39-3601 *et seq.* provided necessary and valuble comments and assessment of the subbasin assessment. As part of their comments each representative industry provided additional insight and comments that went a long ways to making the final version of the document more scientific of the subbasin. The assessment was presented by IDEQ-TFRO to the Mid-Snake WAG on July 15, 1998 with comments being solicited.

On November 17, 1998, the Mid-Snake WAG was presented with a draft Fact Sheet on Fecal Coliform Bacteria for their review and comment. IDEQ-TFRO had researched and prepared the fact sheet to incorporate it as an education tool on pathogen concerns on the various tributaries. The comment period lasted through March 2, 1999.

From March through October 1999, various portions of the subbasin assessment and the TMDL development section were presented to the WAG and solicited for comment. Comments provided were incorporated into the body of this document prior to the official public comment period.

5.3 MIDDLE SNAKE RIVER TECHNICAL ADIVSORY COMMITTEE

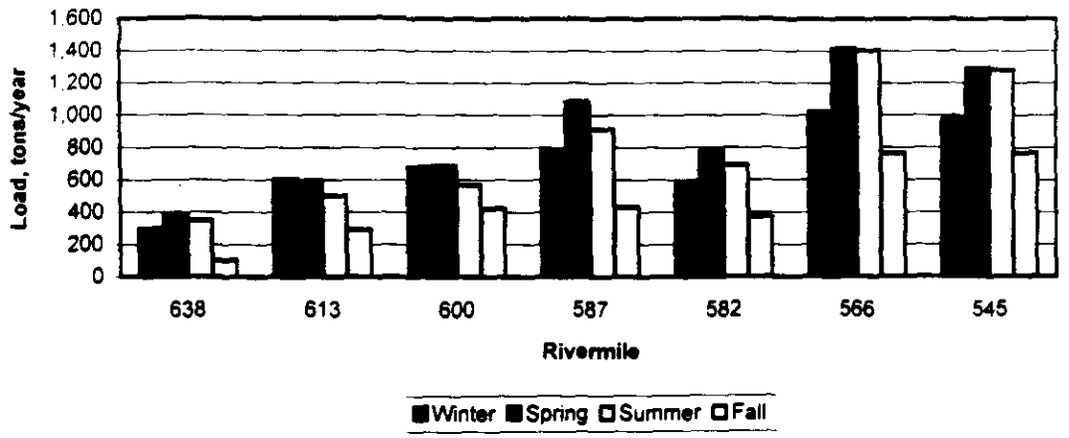
The Mid-Snake TAC was the scientific arm of the Mid-Snake WAG and provided technical assistance to IDEQ in the development of the final version of the subbasin assessment and the TMDL development section. They helped to review all technical databases, sources, and references and provided guidance on the technical aspects of the assessment. Various governmental agencies, organizations, and industry representatives (previously defined in §2.0 of this assessment) provided their expertise in the final version of the document. The Mid-Snake TAC commenced review of the subbasin assessment on June 17, 1998.

Beginning January 1, 1999, the technical specialists for the various industries were contacted so they would be prepared to review and make comments on the TMDL development section 3.0 of the TMDL. IDEQ-TFRO met individually with each industry initially and provided the necessary data that had been collected that would be used in the TMDL development. On March 17, 1999, the Mid-Snake TAC was provided a general overview of the TMDL development phase and what each of the industries was reviewing. TAC meetings following the

VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

TP tons/year (WY1990-1991)

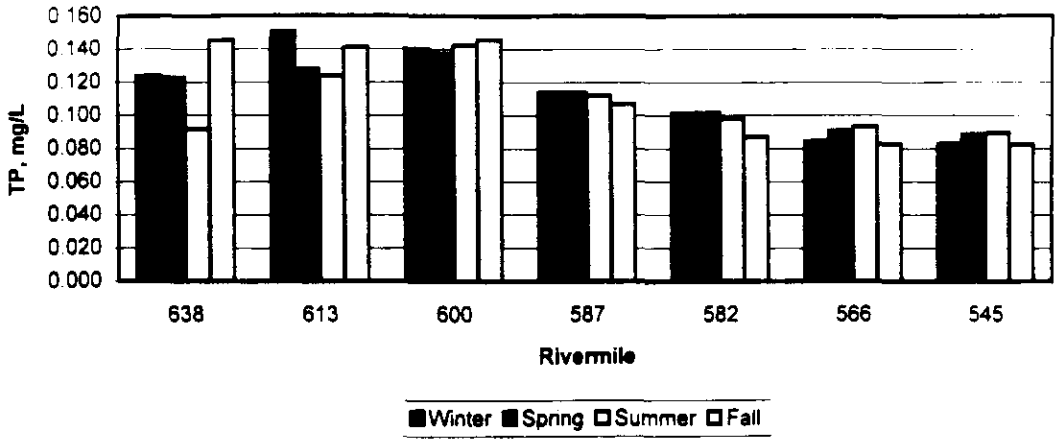
Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	301.7	605.1	680.5	789.4	589.6	1021.9	975.6
SPRG (3,4,5)	386.4	593.9	687.5	1083.1	776.7	1415.9	1291.3
SUMM (6,7,8)	347.7	501.7	568.1	913.1	691.6	1403.5	1279.2
FALL (9,10,11)	103.0	291.5	423.7	432.8	371.4	761.9	768.8
SPRG/SUMM	367.1	547.8	627.8	998.1	734.2	1409.7	1285.3
FALL/WINT	202.3	448.3	552.1	611.1	480.5	891.9	872.2



VI. SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

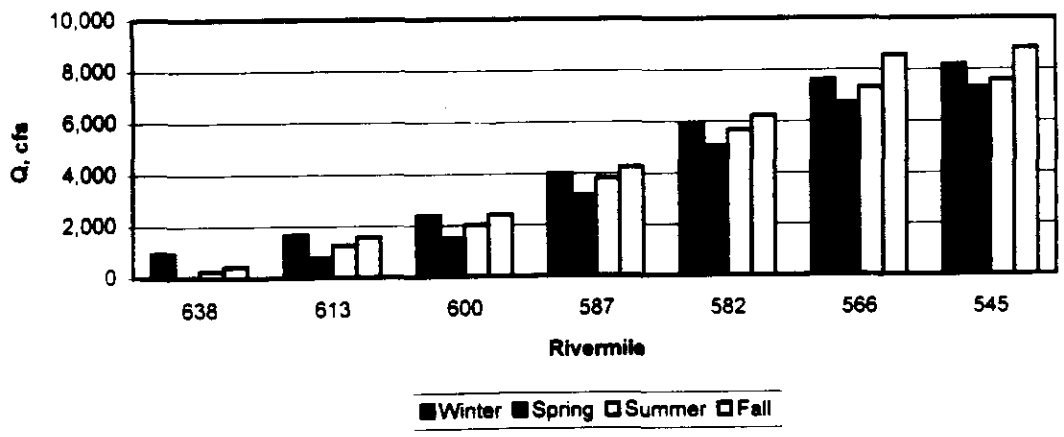
TP (mg/L) (WY1990-1998):

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	0.124	0.151	0.140	0.114	0.101	0.084	0.083
SPRG (3,4,5)	0.123	0.128	0.137	0.114	0.102	0.091	0.089
SUMM (6,7,8)	0.092	0.124	0.142	0.112	0.098	0.093	0.089
FALL (9,10,11)	0.145	0.141	0.146	0.107	0.087	0.083	0.082
SPRG/SUMM	0.107	0.126	0.140	0.113	0.100	0.092	0.089
FALL/WINT	0.135	0.146	0.143	0.111	0.094	0.084	0.083



TP, Q (WY1990-1991):

Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503

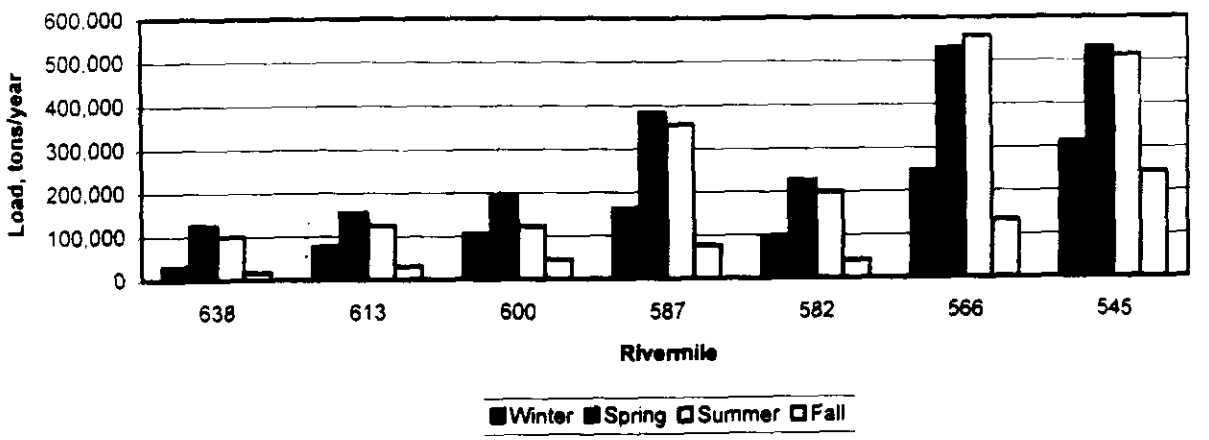


VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT

Concentration (mg/L), Q, Load (tons/year)

TSS (tons/year) (WY1990-1991)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	30,961.9	77,435.3	106,379.0	163,070.1	97,998.1	246,528.2	312,123.7
SPRG (3,4,5)	125,574.5	154,805.1	191,188.6	382,954.8	227,262.3	530,201.5	529,736.2
SUMM (6,7,8)	100,076.0	125,208.6	123,461.9	355,850.9	199,277.0	557,407.1	511,650.4
FALL (9,10,11)	17,957.5	30,982.1	45,975.5	77,251.9	41,541.3	132,884.1	242,634.9
SPRG/SUMM	112,825.3	140,006.9	157,325.3	369,402.9	213,269.7	543,804.3	520,693.3
FALL/WINT	24,459.7	54,208.7	76,177.3	120,161.0	69,769.7	189,706.1	277,379.3

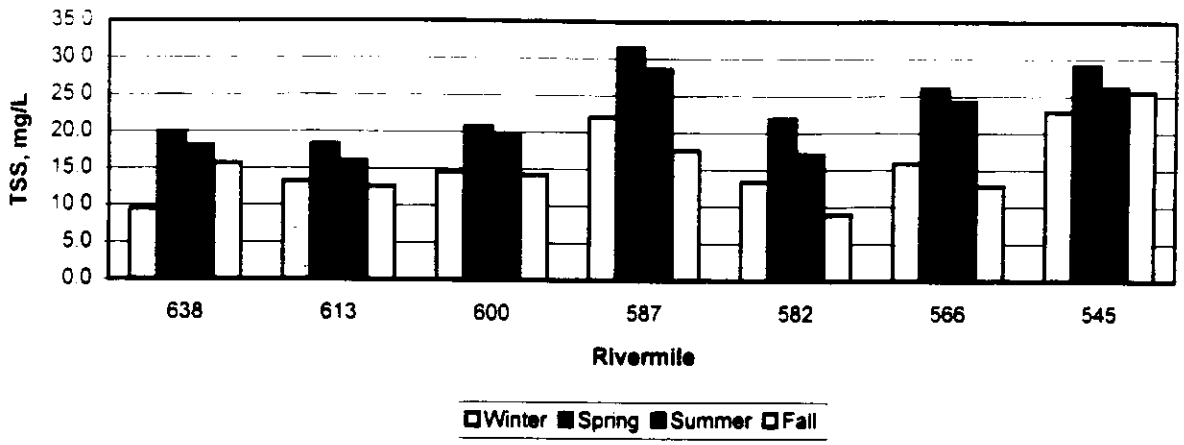


SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT

Concentration (mg/L), Q, Load (tons/year)

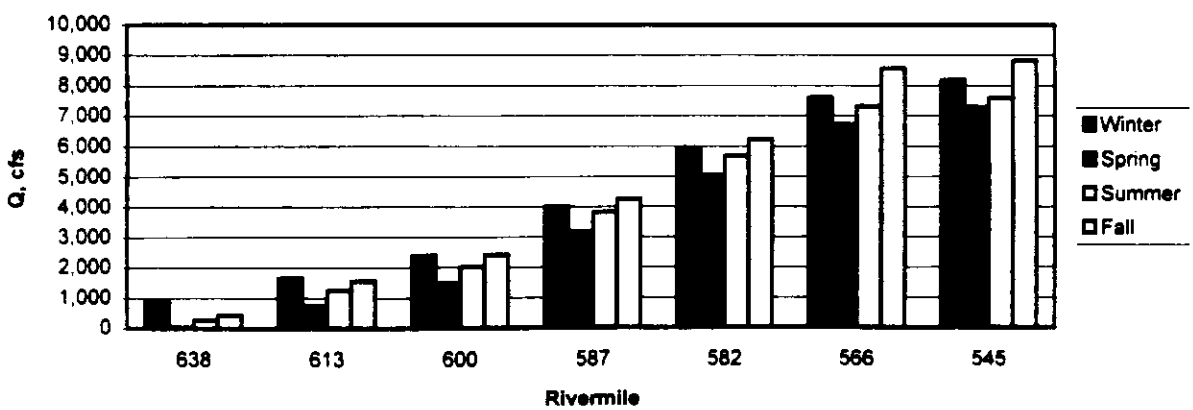
TSS (mg/L) (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	9.5	13.2	14.6	22.0	13.3	15.8	22.9
SPRG (3,4,5)	19.8	18.3	20.7	31.5	21.9	26.1	29.2
SUMM (6,7,8)	18.1	16.0	19.6	28.6	17.1	24.3	26.1
FALL (9,10,11)	15.6	12.6	14.2	17.6	8.9	12.8	25.5
SPRG/SUMM	19.0	17.1	20.2	30.1	19.5	25.2	27.7
FALL/WINT	12.6	12.9	14.4	19.8	11.1	14.3	24.2



TSS, Q (WY1990-1991):

Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503



V N VALUES

WY-to-WY, Month-to-month, Season-to-season

3 SEASONAL QUARTERS ANALYSIS

WINT (MONTHS 1, 2, 12)

	MD	PF	CS	BC	GB	SB	KH
NH3	51	42	48	37	43	19	37
NOX	51	42	48	37	43	19	37
TKN	51	42	48	37	43	19	37
TP	51	42	48	37	43	19	37
SRP	51	42	48	37	43	19	37
TSS	51	42	48	37	43	19	37
Q	51	42	48	37	43	19	37

SPRG (MONTHS 3, 4, 5):

	MD	PF	CS	BC	GB	SB	KH
NH3	74	60	71	48	54	18	43
NOX	74	60	71	48	54	18	43
TKN	74	60	71	48	54	18	43
TP	74	60	71	48	54	18	43
SRP	74	60	71	48	54	18	43
TSS	74	60	71	48	54	18	43
Q	74	60	71	48	54	18	43

SUMM (MONTHS 6, 7, 8):

	MD	PF	CS	BC	GB	SB	KH
NH3	64	56	100	47	59	18	43
NOX	64	56	100	47	59	18	43
TKN	64	56	100	47	59	18	43
TP	64	56	100	47	59	18	43
SRP	64	56	100	47	59	18	43
TSS	64	56	100	47	59	18	43
Q	64	56	100	47	59	18	43

FALL (MONTHS 9, 10, 11):

	MD	PF	CS	BC	GB	SB	KH
NH3	58	50	81	44	49	20	38
NOX	58	50	81	44	49	20	38
TKN	58	50	81	44	49	20	38
TP	58	50	81	44	49	20	38
SRP	58	50	81	44	49	20	38
TSS	58	50	81	44	49	20	38
Q	58	50	81	44	49	20	38

V N VALUES

WY-to-WY Month-to-month Season-to-season

NOV		MD	PF	CS	BC	GB	SB	KH
	NH3	17	16	28	14	15	7	12
	NOX	17	16	28	14	15	7	12
	TKN	17	16	28	14	15	7	12
	TP	17	16	28	14	15	7	12
	SRP	17	16	28	14	15	7	12
	TSS	17	16	28	14	15	7	12
	Q	17	16	28	14	15	7	12

DEC		MD	PF	CS	BC	GB	SB	KH
	NH3	15	15	18	14	16	7	12
	NOX	15	15	18	14	16	7	12
	TKN	15	15	18	14	16	7	12
	TP	15	15	18	14	16	7	12
	SRP	15	15	18	14	16	7	12
	TSS	15	15	18	14	16	7	12
	Q	15	15	18	14	16	7	12

V N VALUES

WY-to-WY, Month-to-month, Season-to-season

2 AVERAGE FOR LO-FLOW & HI-FLOW YEARS COMBINED

JAN	MD	PF	CS	BC	GB	SB	KH
NH3	18	13	15	11	13	6	12
NOX	18	13	15	11	13	6	12
TKN	18	13	15	11	13	6	12
TP	18	13	15	11	13	6	12
SRP	18	13	15	11	13	6	12
TSS	18	13	15	11	13	6	12
Q	18	13	15	11	13	6	12

JUN	MD	PF	CS	BC	GB	SB	KH
NH3	21	17	34	15	17	6	13
NOX	21	17	34	15	17	6	13
TKN	21	17	34	15	17	6	13
TP	21	17	34	15	17	6	13
SRP	21	17	34	15	17	6	13
TSS	21	17	34	15	17	6	13
Q	21	17	34	15	17	6	13

FEB	MD	PF	CS	BC	GB	SB	KH
NH3	18	14	15	12	14	6	13
NOX	18	14	15	12	14	6	13
TKN	18	14	15	12	14	6	13
TP	18	14	15	12	14	6	13
SRP	18	14	15	12	14	6	13
TSS	18	14	15	12	14	6	13
Q	18	14	15	12	14	6	13

JUL	MD	PF	CS	BC	GB	SB	KH
NH3	23	22	32	17	21	6	16
NOX	23	22	32	17	21	6	16
TKN	23	22	32	17	21	6	16
TP	23	22	32	17	21	6	16
SRP	23	22	32	17	21	6	16
TSS	23	22	32	17	21	6	16
Q	23	22	32	17	21	6	16

MAR	MD	PF	CS	BC	GB	SB	KH
NH3	29	18	26	16	18	6	15
NOX	29	18	26	16	18	6	15
TKN	29	18	26	16	18	6	15
TP	29	18	26	16	18	6	15
SRP	29	18	26	16	18	6	15
TSS	29	18	26	16	18	6	15
Q	29	18	26	16	18	6	15

AUG	MD	PF	CS	BC	GB	SB	KH
NH3	20	17	34	15	21	6	14
NOX	20	17	34	15	21	6	14
TKN	20	17	34	15	21	6	14
TP	20	17	34	15	21	6	14
SRP	20	17	34	15	21	6	14
TSS	20	17	34	15	21	6	14
Q	20	17	34	15	21	6	14

APR	MD	PF	CS	BC	GB	SB	KH
NH3	21	24	24	16	18	6	14
NOX	21	24	24	16	18	6	14
TKN	21	24	24	16	18	6	14
TP	21	24	24	16	18	6	14
SRP	21	24	24	16	18	6	14
TSS	21	24	24	16	18	6	14
Q	21	24	24	16	18	6	14

SEP	MD	PF	CS	BC	GB	SB	KH
NH3	22	17	19	15	17	6	14
NOX	22	17	19	15	17	6	14
TKN	22	17	19	15	17	6	14
TP	22	17	19	15	17	6	14
SRP	22	17	19	15	17	6	14
TSS	22	17	19	15	17	6	14
Q	22	17	19	15	17	6	14

MAY	MD	PF	CS	BC	GB	SB	KH
NH3	24	18	21	16	18	6	14
NOX	24	18	21	16	18	6	14
TKN	24	18	21	16	18	6	14
TP	24	18	21	16	18	6	14
SRP	24	18	21	16	18	6	14
TSS	24	18	21	16	18	6	14
Q	24	18	21	16	18	6	14

OCT	MD	PF	CS	BC	GB	SB	KH
NH3	19	17	34	15	17	7	12
NOX	19	17	34	15	17	7	12
TKN	19	17	34	15	17	7	12
TP	19	17	34	15	17	7	12
SRP	19	17	34	15	17	7	12
TSS	19	17	34	15	17	7	12
Q	19	17	34	15	17	7	12

V N VALUES

WY-to-WY Month-to-month Season-to-season

1 WY-TO-WY ANALYSIS

1990	MD	PF	CS	BC	GB	SB	KH
NH3	14	24	12	12	27	12	27
NOX	14	24	12	12	27	12	27
TKN	14	24	12	12	27	12	27
TP	14	24	12	12	27	12	27
SRP	14	24	12	12	27	12	27
TSS	14	24	12	12	27	12	27
Q	14	24	12	12	27	12	27

1991	MD	PF	CS	BC	GB	SB	KH
NH3	17	26	64	12	26	12	30
NOX	17	26	64	12	26	12	30
TKN	17	26	64	12	26	12	30
TP	17	26	64	12	26	12	30
SRP	17	26	64	12	26	12	30
TSS	17	26	64	12	26	12	30
Q	17	26	64	12	26	12	30

1992	MD	PF	CS	BC	GB	SB	KH
NH3	21	12	24	12	12	12	12
NOX	21	12	24	12	12	12	12
TKN	21	12	24	12	12	12	12
TP	21	12	24	12	12	12	12
SRP	21	12	24	12	12	12	12
TSS	21	12	24	12	12	12	12
Q	21	12	24	12	12	12	12

1993	MD	PF	CS	BC	GB	SB	KH
NH3	28	12	47	12	12	12	12
NOX	28	12	47	12	12	12	12
TKN	28	12	47	12	12	12	12
TP	28	12	47	12	12	12	12
SRP	28	12	47	12	12	12	12
TSS	28	12	47	12	12	12	12
Q	28	12	47	12	12	12	12

1994	MD	PF	CS	BC	GB	SB	KH
NH3	26	12	31	12	12	12	12
NOX	26	12	31	12	12	12	12
TKN	26	12	31	12	12	12	12
TP	26	12	31	12	12	12	12
SRP	26	12	31	12	12	12	12
TSS	26	12	31	12	12	12	12
Q	26	12	31	12	12	12	12

1995	MD	PF	CS	BC	GB	SB	KH
NH3	37	39	39	33	33	12	12
NOX	37	39	39	33	33	12	12
TKN	37	39	39	33	33	12	12
TP	37	39	39	33	33	12	12
SRP	37	39	39	33	33	12	12
TSS	37	39	39	33	33	12	12
Q	37	39	39	33	33	12	12

1996	MD	PF	CS	BC	GB	SB	KH
NH3	23	36	36	36	36	12	12
NOX	23	36	36	36	36	12	12
TKN	23	36	36	36	36	12	12
TP	23	36	36	36	36	12	12
SRP	23	36	36	36	36	12	12
TSS	23	36	36	36	36	12	12
Q	23	36	36	36	36	12	12

1997	MD	PF	CS	BC	GB	SB	KH
NH3	60	35	35	35	35	38	35
NOX	60	35	35	35	35	38	35
TKN	60	35	35	35	35	38	35
TP	60	35	35	35	35	38	35
SRP	60	35	35	35	35	38	35
TSS	60	35	35	35	35	38	35
Q	60	35	35	35	35	38	35

1998	MD	PF	CS	BC	GB	SB	KH
NH3	21	12	12	12	12	18	9
NOX	21	12	12	12	12	18	9
TKN	21	12	12	12	12	18	9
TP	21	12	12	12	12	18	9
SRP	21	12	12	12	12	18	9
TSS	21	12	12	12	12	18	9
Q	21	12	12	12	12	18	9

IV TN TP RATIOS AND LIMITING NUTRIENTS
TN TP Ratios mg/L mg/L

CONCLUSIONS ON TN TP RATIOS

1 Month-to-month analysis indicates that ratios increase from upstream to downstream. Box Canyon area appears to have ratios > 16, whereas Pillar Falls and Crystal Springs areas have ratios > 10.

2 Seasonal Quarters Analysis indicates that ratios increase from upstream to downstream. Box Canyon area appears to have ratios > 16, whereas Pillar Falls and Crystal Springs areas have ratios > 10.

3. Year-to-year analysis indicates that ratios increase from upstream to downstream. Box Canyon area appears to have ratios > 16, whereas Pillar Falls and Crystal Springs areas have ratios > 10.

4. TP as a limiting nutrient appaears to increase from upstream to downstream.

MEAN	MD	PF	CS	BC	GB	SB	KH
Month-to-Month	7	11	13	17	17	16	19
Seasonal Quarters	7	11	13	17	17	16	19
WY-to-WY:							
WY1990-WY1991	4	14	14	21	20	19	17
WY1990-WY1995	5	11	13	20	19	18	22
WY1996-WY1998	8	10	11	14	13	14	17
Mean of All Values	6	11	13	18	17	17	19
TN:TP Range	4 to 8	10 to 14		13 to 22			
Mean of Range	6	$\bar{x}$ = 13		$\bar{x}$ = 18			

MD discharge has TP:TN ratios < 10, indicating that TN may be limiting other than TP. This discharge is affected by input sources coming from American Falls Reservoir and the Lake Walcott sub basin. It is highly unlikely that the Upper Snake Rock sub basin reduction goals will have any effect on MD unless the Lake Walcott sub basin reduction goals are developed and applied to the Milner Pool, which feeds the MD discharge into the Middle Snake River.

Growth-limiting Concentrations and Ratios of N and P

Many studies have identified N and P as the nutrients in short supply for benthic algal communities. Fewer studies have quantified the N and P concentrations that are growth-limiting. In studies of benthic algae, a range of ambient or cellular N:P ratios has been used as the transition between N and P limitation. Ambient N:P ratios > 20:1 are considered P-limited, < 10:1 N-limited, and between 10:1 and 20:1 the distinction is equivocal. Nutrient enrichment studies have corroborated that in broad terms these ratios represent transitions between N and P limitation. Nutrient ratios are useful for assessing limitation insofar as ambient concentrations are near growth-limiting levels. When nutrients are in excess, the supply ratio becomes irrelevant. Moreover, because the uptake rates of two nutrients may differ, the ambient ratio may not reflect the cellular ratio relevant to the physiological processes of growth. Hence, cellular ratios should be used when feasible. (Stevenson RJ 1996 [p 206]).

IV TN:TP RATIOS AND LIMITING NUTRIENTS

TN:TP Ratios, mg/L:mg/L

TP, mg/L

WY	MD	PF	CS	BC	GB	SB	KH
1990	0.190	0.132	0.145	0.107	0.086	0.074	0.073
1991	0.184	0.133	0.137	0.107	0.095	0.074	0.097
1992	0.264	0.191	0.147	0.107	0.086	0.070	0.064
1993	0.122	0.183	0.181	0.109	0.089	0.078	0.074
1994	0.129	0.182	0.133	0.109	0.089	0.074	0.067
1995	0.169	0.131	0.143	0.109	0.093	0.081	0.074
1996	0.080	0.113	0.130	0.113	0.102	0.093	0.081
1997	0.078	0.105	0.117	0.117	0.106	0.110	0.110
1998	0.100	0.152	0.136	0.119	0.102	0.090	0.088
1990-1991	0.187	0.133	0.141	0.107	0.091	0.074	0.085
1990-1995	0.176	0.159	0.148	0.108	0.090	0.075	0.075
1996-1998	0.086	0.123	0.128	0.116	0.103	0.098	0.093

TN:TP Ratio:

WY	MD	PF	CS	BC	GB	SB	KH
1990	4	14	12	21	22	19	18
1991	5	14	17	21	19	19	16
1992	4	9	15	21	20	20	27
1993	7	9	9	20	19	18	23
1994	7	9	15	20	19	19	26
1995	7	12	13	17	18	17	23
1996	7	11	11	15	15	14	21
1997	9	10	10	12	12	12	13
1998	7	10	11	16	13	15	19
1990-1991	4	14	14	21	20	19	17
1990-1995	5	11	13	20	19	18	22
1996-1998	8	10	11	14	13	14	17

IV TN:TP RATIOS AND LIMITING NUTRIENTS

TN:TP Ratios, mg/L:mg/L

3 WY-TO-WY ANALYSIS

TKN, mg/L:

WY	MD	PF	CS	BC	GB	SB	KH
1990	0.27	0.22	0.12	0.40	0.44	0.35	0.27
1991	0.36	0.19	0.33	0.40	0.47	0.35	0.27
1992	0.51	0.11	0.29	0.39	0.41	0.34	0.29
1993	0.45	0.12	0.28	0.41	0.42	0.36	0.32
1994	0.33	0.12	0.23	0.40	0.42	0.35	0.30
1995	0.69	0.39	0.43	0.41	0.39	0.37	0.32
1996	0.33	0.34	0.40	0.45	0.42	0.41	0.34
1997	0.41	0.38	0.42	0.47	0.46	0.44	0.43
1998	0.29	0.20	0.22	0.45	0.44	0.40	0.36
1990-1991	0.32	0.21	0.22	0.40	0.46	0.35	0.27
1990-1995	0.44	0.19	0.28	0.40	0.43	0.35	0.30
1996-1998	0.34	0.31	0.35	0.46	0.44	0.42	0.38

NOX, mg/L:

WY	MD	PF	CS	BC	GB	SB	KH
1990	0.517	1.642	1.64	1.81	1.431	1.043	1.046
1991	0.535	1.660	1.990	1.807	1.344	1.045	1.289
1992	0.420	1.572	1.868	1.829	1.336	1.065	1.427
1993	0.432	1.511	1.439	1.747	1.250	1.018	1.379
1994	0.600	1.515	1.728	1.755	1.258	1.039	1.411
1995	0.413	1.230	1.500	1.471	1.239	1.002	1.371
1996	0.250	0.858	1.006	1.238	1.088	0.930	1.324
1997	0.269	0.685	0.728	0.984	0.813	0.859	0.969
1998	0.391	1.278	1.254	1.428	0.915	0.929	1.271
1990-1991	0.526	1.651	1.815	1.809	1.388	1.044	1.168
1990-1995	0.486	1.522	1.694	1.737	1.310	1.035	1.321
1996-1998	0.303	0.940	0.996	1.217	0.939	0.906	1.188

TN, mg/L:

WY	MD	PF	CS	BC	GB	SB	KH
1990	0.787	1.862	1.757	2.210	1.871	1.393	1.316
1991	0.895	1.850	2.321	2.207	1.814	1.395	1.559
1992	0.930	1.682	2.162	2.219	1.746	1.405	1.717
1993	0.882	1.631	1.717	2.157	1.670	1.378	1.699
1994	0.930	1.635	1.960	2.155	1.678	1.389	1.711
1995	1.103	1.620	1.926	1.881	1.629	1.372	1.691
1996	0.580	1.198	1.403	1.688	1.508	1.340	1.664
1997	0.679	1.065	1.147	1.454	1.273	1.299	1.399
1998	0.681	1.478	1.477	1.878	1.355	1.329	1.631
1990-1991	0.841	1.856	2.039	2.209	1.843	1.394	1.438
1990-1995	0.921	1.713	1.974	2.138	1.735	1.389	1.616
1996-1998	0.647	1.247	1.342	1.673	1.379	1.323	1.565

IV TN TP RATIOS AND LIMITING NUTRIENTS

TN TP Ratios, mg/L mg/L

2 SEASONAL QUARTERS ANALYSIS

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT	8	10	13	17	16	16	20
SPRG	7	12	13	15	14	14	17
SUMM	6	11	12	16	17	15	19
FALL	6	12	14	19	20	17	21
MEAN	7	11	13	17	17	16	19
SD-s	1.1	0.9	1.0	1.8	2.3	1.2	1.8
CV	0.16	0.08	0.08	0.11	0.14	0.08	0.10

IV TN:TP RATIOS AND LIMITING NUTRIENTS

TN TP Ratios: mg/L mg/L

TP mg/L:

MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.126	0.155	0.141	0.112	0.097	0.086	0.082
2	0.109	0.148	0.140	0.113	0.101	0.089	0.088
3	0.184	0.129	0.148	0.115	0.105	0.090	0.090
4	0.113	0.132	0.135	0.110	0.099	0.094	0.091
5	0.071	0.122	0.129	0.116	0.101	0.088	0.085
6	0.080	0.111	0.148	0.123	0.128	0.118	0.122
7	0.086	0.120	0.137	0.105	0.083	0.080	0.074
8	0.109	0.140	0.142	0.108	0.083	0.082	0.072
9	0.135	0.137	0.136	0.110	0.091	0.085	0.100
10	0.132	0.137	0.142	0.102	0.083	0.083	0.074
11	0.169	0.149	0.159	0.109	0.087	0.080	0.073
12	0.136	0.149	0.140	0.117	0.106	0.078	0.079

TN:TP Ratio:

MONTH	MD	PF	CS	BC	GB	SB	KH
1	9	10	13	18	17	16	21
2	9	10	12	16	16	15	19
3	7	12	14	15	15	15	17
4	7	13	12	15	15	13	16
5	7	11	12	14	14	15	17
6	7	10	11	12	10	11	12
7	7	11	11	18	19	17	21
8	6	10	13	18	21	17	23
9	5	11	14	18	18	16	16
10	6	13	16	21	22	17	23
11	7	11	13	19	20	18	24
12	8	10	13	17	16	18	22
MEAN	7	11	13	17	17	16	19
SD-s	1.1	1.1	1.3	2.2	3.3	2.1	3.6
CV	0.17	0.10	0.10	0.13	0.20	0.13	0.19

IV TN:TP RATIOS AND LIMITING NUTRIENTS

TN TP Ratios mg/L mg/L

TN TP Ratio Analysis

TN TP >= 16 P is considered limiting to algal growth

TN TP < 10 N is considered limiting to algal growth

1 MONTH-TO-MONTH ANALYSIS

TKN mg/L

MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.27	0.18	0.26	0.41	0.43	0.37	0.31
2	0.34	0.18	0.25	0.41	0.41	0.38	0.31
3	0.69	0.31	0.45	0.43	0.46	0.40	0.31
4	0.49	0.40	0.33	0.43	0.44	0.41	0.35
5	0.34	0.29	0.36	0.45	0.46	0.40	0.32
6	0.34	0.30	0.38	0.50	0.52	0.47	0.42
7	0.36	0.26	0.30	0.40	0.40	0.36	0.30
8	0.48	0.26	0.31	0.41	0.45	0.38	0.32
9	0.44	0.27	0.33	0.40	0.37	0.39	0.36
10	0.43	0.25	0.29	0.40	0.39	0.39	0.32
11	0.46	0.31	0.34	0.45	0.42	0.38	0.29
12	0.37	0.24	0.26	0.43	0.42	0.35	0.31

NOX, mg/L:

MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.844	1.325	1.529	1.598	1.248	1.026	1.389
2	0.615	1.333	1.444	1.439	1.173	0.970	1.321
3	0.589	1.268	1.643	1.299	1.088	0.905	1.188
4	0.266	1.289	1.314	1.255	1.007	0.856	1.144
5	0.168	1.038	1.151	1.213	0.954	0.899	1.156
6	0.182	0.845	1.238	1.027	0.775	0.802	1.032
7	0.209	1.108	1.277	1.455	1.207	1.032	1.286
8	0.151	1.161	1.501	1.547	1.260	1.041	1.333
9	0.209	1.244	1.511	1.550	1.284	1.009	1.276
10	0.373	1.57	1.919	1.698	1.420	1.007	1.377
11	0.701	1.304	1.755	1.613	1.333	1.021	1.428
12	0.669	1.298	1.569	1.593	1.295	1.053	1.410

TN = TKN + NOX

MONTH	MD	PF	CS	BC	GB	SB	KH
1	1.114	1.507	1.784	2.008	1.678	1.396	1.699
2	0.955	1.509	1.695	1.849	1.583	1.350	1.631
3	1.279	1.576	2.095	1.729	1.548	1.305	1.498
4	0.756	1.691	1.643	1.685	1.447	1.266	1.494
5	0.508	1.332	1.511	1.663	1.414	1.299	1.476
6	0.522	1.149	1.619	1.527	1.295	1.272	1.452
7	0.569	1.366	1.575	1.855	1.607	1.392	1.586
8	0.631	1.416	1.810	1.957	1.710	1.421	1.653
9	0.649	1.513	1.837	1.950	1.654	1.399	1.636
10	0.803	1.815	2.212	2.098	1.810	1.397	1.697
11	1.161	1.617	2.090	2.063	1.753	1.401	1.718
12	1.039	1.541	1.833	2.023	1.715	1.403	1.720

III ANALYSIS OF FLOWS
Q, mean flow in cfs

1. MONTH-TO-MONTH ANALYSIS (WY1990-1991)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
10	182	1,352	2,252	4,173	6,158	9,056	8,959
11	994	1,896	2,696	4,406	6,334	8,314	8,638
12	1,016	1,749	2,506	4,142	6,044	7,851	8,286
1	1,111	1,854	2,588	4,202	6,085	7,756	8,441
2	711	1,366	2,075	3,696	5,576	7,182	7,799
3	89	703	1,417	3,029	4,887	6,452	7,121
4	7	667	1,393	3,041	4,935	6,633	7,237
5	6	869	1,626	3,396	5,300	7,015	7,464
6	7	992	1,767	3,607	5,490	7,255	7,392
7	414	1,314	2,071	3,845	5,642	7,068	7,348
8	412	1,427	2,209	4,036	5,868	7,606	8,010
9	159	1,431	2,290	4,226	6,175	8,331	8,894
MEAN	426	1,302	2,074	3,817	5,708	7,543	7,966
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503

2. SEASONAL QUARTERS ANALYSIS (WY1990-1991)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
MEAN	426	1,302	2,074	3,817	5,708	7,543	7,966
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1983	7,988	8,666	9,403	11,097	12,982	15,713	15,850	
1984	9,432	10,644	11,404	13,074	15,124	17,598	18,069	(High Q)
1985	6,470	7,519	8,339	10,082	11,989	14,186	14,207	
1986	6,925	7,900	8,759	10,522	12,440	15,041	15,464	
1987	3,439	4,431	5,309	7,058	8,949	10,793	11,023	
1988	528	1,385	2,230	3,952	5,832	7,521	7,680	
1989	498	1,363	2,116	3,861	5,743	7,525	7,875	
1990	462	1,338	2,111	3,837	5,730	7,724	8,004	
1991	388	1,265	2,038	3,798	5,687	7,366	7,929	
1992	366	1,146	1,852	3,573	5,429	6,674	7,384	(Low Q)
1993	1,017	1,842	2,524	4,209	6,083	7,590	8,299	
1994	1,508	2,329	2,997	4,689	6,558	7,970	8,149	
1995	1,740	2,628	3,329	5,036	6,917	8,547	8,906	
1996	5,360	6,247	6,950	8,593	10,483	12,467	12,625	
1997	9,296	10,011	10,789	12,517	14,444	17,203	16,922	
1998	6,325	7,069	7,816	9,494	11,416	13,826	13,989	
1990-1991	425	1,302	2,075	3,818	5,709	7,545	7,967	
Low Q Mean	813	1,662	2,400	4,119	5,997	7,615	8,028	
High Q Mean	6,904	7,811	8,596	10,305	12,228	14,603	14,769	

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

SELECTION OF A SEDIMENT INSTREAM TARGET

Existing conditions are estimated based on sediment rating curves derived for each segment site based on actual water quality data collected over a 9 year period of record (1990-1998). These rating curves are summarized as follows:

Segment Site	TSS.Q Rating Equation	r^2	F-ratio	p value
Milner Dam	TSS = (0.000528 x Q) + 14.419982	0.334	30.8	0.000000
Pillar Falls	TSS = (0.000941 x Q) + 10.886472	0.726	229.6	0.000000
Crystal Springs	TSS = (0.001535 x Q) + 10.562829	0.637	203.6	0.000000
Box Canyon	TSS = (0.002026 x Q) + 11.292988	0.767	249.2	0.000000
Gridley Bridge	TSS = (0.002423 x Q) - 1.241410	0.871	639.3	0.000000
Shoestring	TSS = (0.003093 x Q) - 16.332292	0.916	739.5	0.000000
King Hill	TSS = (0.002899 x Q) - 6.247515	0.614	96.4	0.000000

The estimate existing condition for TSS concentration on a per segment site basis is summarized as follows:

Segment Site	Lo-Q TSS mg/L	Mean Q TSS mg/L	Hi-Q TSS mg/L
Milner Dam	14.6	16.5	19.4
Pillar Falls	12.0	15.3	20.9
Crystal Springs	13.4	19.0	28.1
Box Canyon	18.5	25.9	37.8
Gridley Bridge	11.9	20.8	35.4
Shoestring	4.3	18.0	38.1
King Hill	15.2	26.8	46.1

The estimate existing condition for TSS loads on a per segment site basis is summarized as follows:

Segment Site	Lo-Q TSS mg/L	Mean Q TSS mg/L	Hi-Q TSS mg/L
Milner Dam	5,261.1	62,491.0	179,994.4
Pillar Falls	13,487.9	71,497.9	218,853.9
Crystal Springs	24,422.0	102,768.9	314,861.7
Box Canyon	65,133.5	183,773.4	485,883.9
Gridley Bridge	63,620.2	186,809.1	526,709.5
Shoestring	28,297.9	196,950.4	659,509.1
King Hill	110,104.6	300,426.8	819,996.0

Estimate % Load Reduction as compared to Expected Load as a result of Instream Target:

Segment Site	Lo-Q % Reduction	Mean Q % Reduction	Hi-Q % Reduction
Milner Dam	71.9	68.3	62.7
Pillar Falls	77.0	70.5	59.8
Crystal Springs	74.2	63.5	46.0
Box Canyon	64.4	50.2	27.3
Gridley Bridge	77.1	59.9	31.9
Shoestring	91.7	65.3	26.7
King Hill	70.8	48.5	11.3
OVERALL MEAN	75.3	60.9	38.0

I ANALYSIS OF PARAMETER LOADS
mean loads in annual tons or tons/year

SELECTION OF A SEDIMENT INSTREAM TARGET

Applying the 80 mg/L load capacity and the 52 mg/L instream target to various flow scenarios on the Middle Snake River is summarized as follows.

Flow data per stream segment from design flow study on the Middle Snake River:

Segment Site	Lo-Q cfs	Mean Q cfs	Hi-Q cfs
Milner Dam	366.0	3,860.0	9,432.0
Pillar Falls	1,146.0	4,737.0	10,644.0
Crystal Springs	1,852.0	5,498.0	11,404.0
Box Canyon	3,573.0	7,212.0	13,074.0
Gridley Bridge	5,429.0	9,113.0	15,124.0
Shoestring	6,674.0	11,108.0	17,598.0
King Hill	7,384.0	11,398.0	18,069.0

Expected load at Load Capacity (80 mg/L):

Segment Site	Lo-Q tons/year	Mean Q tons/year	Hi-Q tons/year
Milner Dam	28,802.0	303,758.8	742,241.8
Pillar Falls	90,183.3	372,773.5	837,618.9
Crystal Springs	145,741.3	432,659.6	897,426.4
Box Canyon	281,173.7	567,541.1	1,028,845.4
Gridley Bridge	427,229.7	717,138.4	1,190,168.1
Shoestring	525,203.8	874,133.0	1,384,857.0
King Hill	581,076.5	896,954.2	1,421,921.9

Expected load at Instream Target (52 mg/L):

Segment Site	Lo-Q tons/year	Mean Q tons/year	Hi-Q tons/year
Milner Dam	18,721.3	197,443.2	482,457.2
Pillar Falls	58,619.2	242,302.8	544,452.3
Crystal Springs	94,731.8	281,228.7	583,327.1
Box Canyon	182,762.9	368,901.7	668,749.5
Gridley Bridge	277,699.3	466,140.0	773,609.2
Shoestring	341,382.4	568,186.4	900,157.1
King Hill	377,699.7	583,020.2	924,249.2

Estimated Margin of Safety due to Instream Target below Load Capacity:

Segment Site	Lo-Q % Reduction	Mean Q % Reduction	Hi-Q % Reduction
Milner Dam	35.0	35.0	35.0
Pillar Falls	35.0	35.0	35.0
Crystal Springs	35.0	35.0	35.0
Box Canyon	35.0	35.0	35.0
Gridley Bridge	35.0	35.0	35.0
Shoestring	35.0	35.0	35.0
King Hill	35.0	35.0	35.0

SELECTION OF A SEDIMENT INSTREAM TARGET
(continued)

EIFAC (1965) has suggested that 80.0 mg/L was the upper limit associated with a "slight effect on production" and the lower limit associated with a "significant reduction in fisheries."

CWQC (1973) recommended 80.0 mg/L as the maximum concentration of TSS for moderate protection of aquatic communities.

Therefore, based on these two suggested recommendations, 80.0 mg/L will be used as the maximum concentration not to be exceeded for protection of the aquatic community.

Relative to duration of exposure, the life stage of the aquatic organism needs to be considered. For example,

At 35.0 mg/L for 7 days duration the severity-of-ill-effect is 0 to 20% mortality of eggs and larvae of salmonids and nonsalmonids.

At 35.0 mg/L for 7 days duration the survival rates for larval smallmouth bass is less than 50% under laboratory conditions.

At 76.0 mg/L for 14 days duration the percent mortality is 20 to 40% for larval bluegill.

At 76.0 mg/L for 14 days duration the survival rates for larval bluegill is < 50%.

The selection of a duration target is based on the premise that the target would need to be protective over a duration equal to the maximum probable length of time for which an elevated TSS concentration would be sustained. This would rely on seasonal variation in flow regimes and land use practices to avoid having to select a duration that continues indefinitely, or even annually. Yet, it would be protective for a duration equal to the maximum probable length of time for which elevated TSS concentrations would be sustained.

In the Upper Snake Rock sub basin, and at Milner Dam, high flow conditions (as evaluated for the WY1984 such that Q > 7629 cfs, or the maximum value of MEAN Q) occur seasonally at two distinct times of the water year: (1) the first one begins at Day 13, or October 13, and runs through Day 131, or February 8, for a total of 118 days; and, (2) the second one begins Day 180, or March 28, and runs through Day 283, or July 9, or a total of 103 days. The TSS concentration on this days when compared to MEAN Q and Low Q is summarized in the following table.

	Fall/Winter Range of TSS Days 13 - 131	Spring/Summer Range of TSS Days 180 - 283
High Q, WY1984	16.5 - 22.2 = 19.4 mg/L	18.2 - 25.3 = 21.8 mg/L
MEAN Q	16.1 - 17.1 = 16.6 mg/L	15.2 - 18.4 = 16.8 mg/L
Low Q, WY1992	14.6 - 15.1 = 14.9 mg/L	14.4 - 14.5 = 14.5 mg/L

As can be seen, all instream values are < 52.0 mg/L TSS. Therefore, a protective but not overly conservative duration would be a third of each of the two hydrologic seasons: 118 days/3 = 39.3 days, and 103 days/3 = 34.3 days. Or, (118 + 103 days)/(3 + 3) = 36.8 days, or a little over a month. Thus, a month seems appropriate for maximum duration, or 30 days.

Therefore, 52.0 mg/L TSS is the instream target for a duration of 30 days (1 month).

Maximum daily value will be 80 mg/L TSS for protection of egg and larvae of salmonids and nonsalmonids.

II ANALYSIS OF PARAMETER LOADS
mean loads in annual tons or tons/year

SELECTION OF A SEDIMENT INSTREAM TARGET

The effects of suspended sediment (as TSS) on fisheries vary with life stage, species, concentration of TSS, duration of exposure, particle size, and angularity. Most published studies have only reported concentration without consideration of the severity of effects as related to duration of exposure. Duration of exporsure plays a more dominant role than concentration (CH2MHILL 1998 [p 1])

Idaho State Water Quality Standards (IDAPA 16.01.02.200.08) state that sediment shall not exceed quantities specified in Section 250, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. No specific criteria are specified for sediment. Therefore, IDEQ-TFRO conducted a literature survey to determine if any specific criteria had been determined that was specifically applicable to the Upper Snake Rock sub basin streams. It was determined that no assessment had been done to determine specific criteria. Therefore, as a result of the Idaho State Water Quality Standards (IDAPA 16.01.02.200.08, sentence 2), IDEQ-TFRO determined impairment based on water quality monitoring and surveillance information they and others had collected on the Middle Snake River and other tributaries. This is summarized in the Upper Snake Rock subbasin assessment. Additionally, IDEQ-TFRO researched other State TMDLs where sediment criteria was a necessary constituent in order to ascertain short-term and long-term goals for agencies. Existing or suggested mass-based TSS criteria for protection of salmonids, other fish, and aquatic communities are based on the European Inland Fisheries Advisory Commission (EIFAC 1965) and the Committee on Water Quality Criteria from the Environmental Studies Board of the National Academy of Sciences (CWQC 1973), and their recommendations are as follows:

TSS Range		EIFAC	CWQC
mg/L	mg/L	1965	1973
> 400	> 400.1	Poor fisheries	Very low protection level
80 - 400	80.1-400.0	Significant reduced fisheries	Low protection level
25 - 80	25.1-80.0	Slightly reduced fisheries	Moderate protection level
< 25	<= 25.0	No effect on fisheries	High protection level

Only four states have a numeric criteria for TSS in the water column:

State	TSS mg/L
Nevada	25 & 80, for Upper and Lower reaches
New Jersey	25 - 40, for specific streams
South Dakota	30, maximum limit for cold water biota
West Virginia	30, maximum limit for receiving waters
Overall Conclusions	25, 25, 30, 30 = 27.5 mg/L mean for Upper Reaches 40, 80 = 60 mg/L mean for Lower Reaches & Receiving Streams

The practical range of protection for the Middle Snake River and its tributaries and irrigation return flows is somewhere between 25.0 and 80.0 mg/L TSS. A low level of 25.0 mg/L affords a high protection level, whereas a high level of 80.0 mg/L TSS affords the high range of moderate protection. The midrange "mean" is approximately 52.5 mg/L, or 52.0 mg/L as the midrange instream target. The criteria 52.0 mg/L TSS is midrange for moderate protection of fisheries with only slight reduced fisheries, and below the 60.0 mg/L for lower reaches and receiving streams when compared to other states.

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

COMPARISON OF USGS VERSUS IDEQ-TFRO TSS DATA

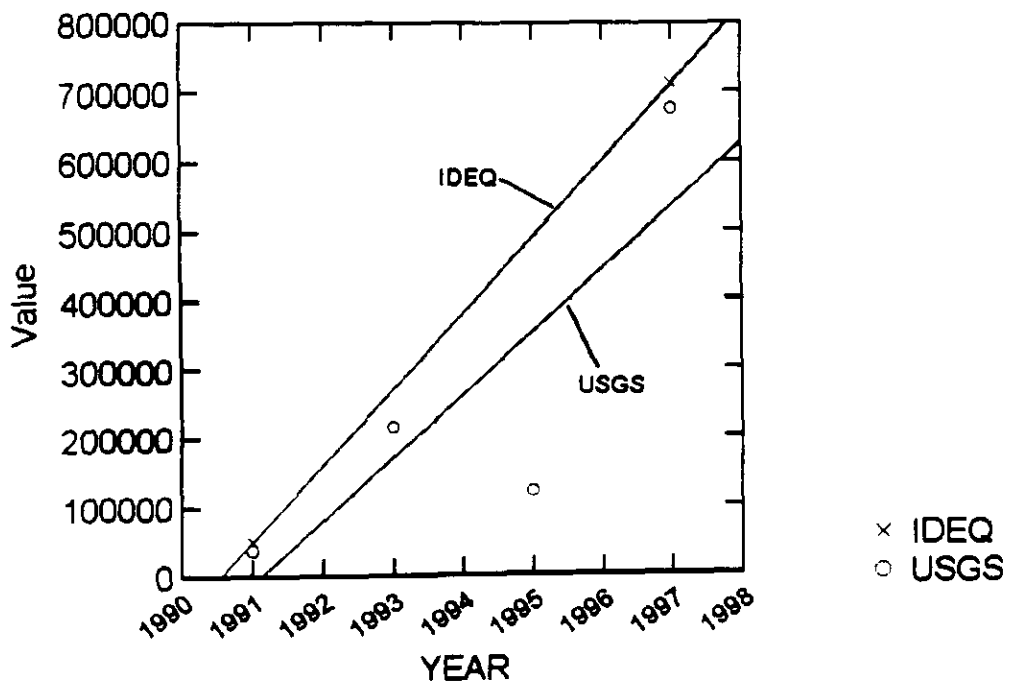
TSS data comparison of USGS and IDEQ data (1991, 1993, 1995, and 1997) provides a reputable estimate of TSS loading variations between Milner Dam and King Hill, as an estimate of the TSS loading being delivered to the entire Middle Snake River system. A comparison of both data sets indicates that IDEQ data is higher than USGS, but within comparable limits for TSS (allowing for natural variability).

Year	*USGS TSS Load tons/year*	*IDEQ TSS Load tons/year*
1991	37,470.90	49,797.48
1993	215,623.75	234,551.73*
1995	121,132.55	136,564.36*
1997	675,547.31	711,316.71
Mean	262,443.63	283,057.57
STDs	284,855.70	295,312.96
CV	1.09	1.04

*Based on comparison estimates of USGS versus IDEQ TSS loads.
IDEQ=(1.037xUSGS)+10949.905.

One of the main reasons why WY1991 was lowest in TSS loads is because it was the lowest year for flow past Milner Dam. Conservation flows were practiced more readily by all interested parties. In fact, average flows past Milner Dam for 1991, 1993, 1995, and 1997 were 388, 400, 754, and 5384 cfs, respectively. Average flows past King Hill were 7929, 8299, 8906, and 16,920, respectively; or a variance of 7541, 7899, 8152, and 11,536 cfs for the same years. Thus, the higher TSS loads occured in 1997 when compared to 1991, but with an overall average of 262,443.63 - 283,057.57 tons/year TSS.

1991-1997 IDEQ versus USGS TSS data.



II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

SUMMARY OF ESTIMATED TOTAL MONITORED LOADS

1. MONTH-TO-MONTH ANALYSIS NET ACCUMULATIVE LOADS = KH - MD

MONTH	TSS	TP	SRP	NH3	NOX	TKN
1	267,240.1	617.1	313.2	412.3	12,272.8	2,729.4
2	406,152.1	818.2	311.2	430.9	11,509.8	2,927.0
3	541,148.6	974.8	361.2	615.3	11,245.8	2,876.9
4	398,771.8	926.7	359.0	539.1	12,106.9	2,524.9
5	272,564.9	813.2	391.0	478.2	11,655.0	2,972.0
6	936,898.3	1,729.7	406.9	1,024.0	12,024.3	4,985.5
7	157,128.0	551.8	253.8	191.3	9,588.7	2,114.8
8	140,696.7	513.1	278.5	292.5	11,016.7	2,361.7
9	349,257.6	874.1	491.0	254.7	12,100.5	3,018.3
10	180,414.7	607.5	344.6	325.0	12,150.1	2,589.1
11	144,360.0	515.8	273.3	281.2	11,942.4	2,066.2
12	170,093.3	586.5	272.8	355.3	12,015.0	2,409.6
MEAN	330,393.8	794.0	338.0	433.3	11,635.7	2,798.0
SPRG/SUMM	407,868.1	918.2	341.7	523.4	11,272.9	2,972.6
FALL/WINT	252,919.6	669.9	334.4	343.2	11,998.4	2,623.3

2. SEASONAL QUARTERS ANALYSIS: NET ACCUMULATIVE LOADS = KH - MD

SEASON	TSS	TP	SRP	NH3	NOX	TKN
WINT (12,1,2)	281,161.8	673.9	299.1	399.5	11,932.5	2,688.7
SPRG (3,4,5)	404,161.8	904.9	370.4	544.2	11,669.2	2,791.3
SUMM (6,7,8)	411,574.3	931.5	313.1	502.6	10,876.6	3,154.0
FALL (9,10,11)	224,677.4	665.8	369.6	287.0	12,064.3	2,557.9
MEAN	330,393.8	794.0	338.0	433.3	11,635.7	2,798.0
SPRG/SUMM	407,868.1	918.2	341.7	523.4	11,272.9	2,972.6
FALL/WINT	252,919.6	669.9	334.4	343.2	11,998.4	2,623.3

3. WY-TO-WY ANALYSIS: TOTAL ACCUMULATIVE LOADS = MD+PF+CS+BC+GB+SB+KH

WY	TSS	TP	SRP	NH3	NOX	TKN
1990	290,430.5	2,383.1	1,553.4	1,835.0	36,466.4	8,576.6
1991	355,906.2	2,541.1	1,689.2	2,062.3	34,957.2	8,927.6
1992	241,320.1	2,052.4	1,342.9	1,739.0	31,897.9	7,524.0
1993	614,111.4	3,247.9	1,910.9	2,425.7	38,357.5	11,463.9
1994	384,983.1	2,719.9	1,767.6	2,347.1	38,443.2	9,283.0
1995	829,234.3	3,401.2	1,569.1	1,917.5	37,567.4	13,368.3
1996	1,857,683.0	5,847.9	1,875.7	3,064.5	49,587.9	23,244.2
1997	3,897,845.0	10,479.1	3,199.7	4,199.1	63,696.3	41,277.1
1998	1,802,617.5	6,491.8	3,077.4	5,062.4	62,820.9	21,626.8
1990-1991	323,168.4	2,462.1	1,621.3	1,948.7	35,711.8	8,752.1
1990-1995	452,664.3	2,724.3	1,638.9	2,054.4	36,281.6	9,857.2
1996-1998	2,519,381.8	7,606.3	2,717.6	4,108.7	58,701.7	28,716.0

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

SRP LOADS

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	156.3	468.3	337.0	457.5	296.4	294.2	469.5
2	190.0	481.9	375.8	496.2	333.9	365.0	501.2
3	135.5	341.3	252.1	430.9	254.1	375.6	496.7
4	83.9	248.6	240.1	397.3	212.0	354.3	442.9
5	58.3	304.9	253.4	394.5	220.6	300.7	449.3
6	570.5	421.2	300.0	622.0	334.5	642.2	977.4
7	79.5	177.0	215.8	291.0	238.0	227.1	333.3
8	41.7	216.8	220.8	298.4	246.7	211.7	320.2
9	36.6	225.6	234.9	334.0	223.6	258.1	527.6
10	28.5	168.8	226.5	273.7	197.3	216.6	373.1
11	46.8	227.5	253.4	293.6	191.0	201.2	320.1
12	80.7	366.5	311.7	415.4	271.9	269.6	353.5
MEAN	125.7	304.0	268.5	392.0	251.7	309.7	463.7
SPRG/SUMM	161.6	285.0	247.0	405.7	251.0	351.9	503.3
FALL/WINT	89.8	323.1	289.9	378.4	252.4	267.5	424.2

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	142.3	438.9	341.5	456.4	300.7	309.6	441.4
SPRG (3,4,5)	92.6	298.3	248.5	407.6	228.9	343.5	463.0
SUMM (6,7,8)	230.6	271.7	245.5	403.8	273.1	360.3	543.6
FALL (9,10,11)	37.3	207.3	238.3	300.4	204.0	225.3	406.9
MEAN	125.7	304.0	268.5	392.0	251.7	309.7	463.7
SPRG/SUMM	161.6	285.0	247.0	405.7	251.0	351.9	503.3
FALL/WINT	89.8	323.1	289.9	378.4	252.4	267.5	424.2

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	37.2	128.2	193.4	289.8	327.3	171.9	405.6
1991	29.9	138.9	220.8	294.3	331.1	170.2	504.0
1992	19.1	207.3	202.6	263.6	191.8	146.6	311.9
1993	62.4	338.2	258.0	352.4	183.4	205.8	510.7
1994	58.0	372.6	247.4	368.0	184.1	176.4	361.1
1995	63.9	158.7	188.1	279.3	197.4	224.0	457.7
1996	115.1	293.2	261.4	367.2	201.8	323.9	313.1
1997	314.6	463.3	394.8	530.5	325.2	549.1	622.2
1998	130.5	862.2	511.6	710.3	150.4	350.6	361.8
1990-1991	33.6	133.6	207.1	292.1	329.2	171.1	454.8
1990-1995	45.1	224.0	218.4	307.9	235.9	182.5	425.2
1996-1998	186.7	539.6	389.3	536.0	225.8	407.9	432.4

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

TKN LOADS

1 MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	906.6	1,095.5	1,388.9	2,573.9	2,309.8	4,128.8	3,636.0
2	1,598.5	1,832.5	2,204.7	3,716.2	2,675.6	5,276.5	4,525.5
3	2,108.3	3,058.4	2,735.2	4,893.0	4,002.1	6,276.8	4,985.2
4	2,873.7	2,098.2	2,557.6	4,348.3	3,387.1	6,549.9	5,398.6
5	864.6	1,552.6	2,005.4	3,352.2	2,701.6	5,187.1	3,836.6
6	3,169.2	3,808.9	2,930.6	7,310.1	5,003.3	9,785.7	8,154.7
7	693.0	714.9	1,089.5	1,888.4	1,989.7	3,294.3	2,807.8
8	422.6	599.5	838.1	1,693.4	2,134.4	3,253.5	2,784.3
9	580.6	807.4	1,213.7	1,906.0	1,796.0	3,980.1	3,598.9
10	344.5	299.2	665.9	1,366.8	1,498.4	3,411.0	2,933.6
11	514.7	768.5	965.1	1,822.5	1,775.5	3,137.4	2,580.9
12	520.2	861.5	1,030.2	2,158.9	1,952.8	3,339.9	2,929.8
MEAN	1,216.4	1,458.1	1,635.4	3,085.8	2,602.2	4,801.8	4,014.3
SPRG/SUMM	1,688.6	1,972.1	2,026.1	3,914.2	3,203.0	5,724.6	4,661.2
FALL/WINT	744.2	944.1	1,244.8	2,257.4	2,001.4	3,879.0	3,367.5

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	1,008.4	1,263.2	1,541.3	2,816.3	2,312.7	4,248.4	3,697.1
SPRG (3,4,5)	1,948.9	2,236.4	2,432.7	4,197.8	3,363.6	6,004.6	4,740.1
SUMM (6,7,8)	1,428.3	1,707.8	1,619.4	3,630.6	3,042.5	5,444.5	4,582.3
FALL (9,10,11)	479.9	625.0	948.2	1,698.4	1,690.0	3,509.5	3,037.8
MEAN	1,216.4	1,458.1	1,635.4	3,085.8	2,602.2	4,801.8	4,014.3
SPRG/SUMM	1,688.6	1,972.1	2,026.1	3,914.2	3,203.0	5,724.6	4,661.2
FALL/WINT	744.2	944.1	1,244.8	2,257.4	2,001.4	3,879.0	3,367.5

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	128.1	169.4	276.0	1,103.0	2,188.0	2,559.8	2,152.3
1991	125.6	148.9	773.4	1,122.0	2,182.0	2,533.4	2,042.3
1992	106.4	135.6	576.0	989.0	1,509.1	2,148.7	2,059.2
1993	785.4	443.5	850.5	1,587.7	1,528.9	3,184.0	3,083.9
1994	359.2	303.6	652.2	1,459.4	1,527.1	2,635.1	2,346.4
1995	628.6	866.2	1,138.2	2,094.4	1,931.9	3,480.5	3,228.5
1996	1,581.0	2,264.8	2,734.9	3,644.0	2,919.7	5,362.2	4,737.6
1997	3,088.0	4,436.0	5,392.0	6,407.3	5,026.7	8,524.4	8,402.7
1998	1,512.4	1,570.7	2,032.3	3,892.3	1,606.8	5,542.8	5,469.5
1990-1991	126.9	159.2	524.7	1,112.5	2,185.0	2,546.6	2,097.3
1990-1995	355.6	344.5	711.1	1,392.6	1,811.2	2,756.9	2,485.4
1996-1998	2,060.5	2,757.2	3,386.4	4,647.9	3,184.4	6,476.5	6,203.3

II ANALYSIS OF PARAMETER LOADS
mean loads in annual tons or tons/year

NH3 LOADS

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	86.3	973.0	343.9	697.4	409.6	302.8	498.6
2	210.1	938.4	376.9	844.6	489.3	482.9	641.0
3	100.8	695.9	372.3	667.9	473.9	384.3	716.1
4	124.7	521.4	273.3	663.1	365.6	429.0	663.8
5	56.5	642.5	289.9	604.5	363.6	329.7	534.7
6	262.2	885.6	279.2	998.8	524.9	718.1	1,286.2
7	70.8	334.6	247.4	452.4	278.5	257.5	262.1
8	13.5	421.6	197.9	427.9	302.1	197.1	306.0
9	20.5	443.6	208.4	475.5	244.6	261.6	275.2
10	13.7	365.3	166.9	414.2	268.0	225.9	338.7
11	23.0	481.2	190.0	456.7	284.9	215.9	304.2
12	54.8	680.3	243.3	597.1	370.8	320.5	410.1
MEAN	86.4	615.3	265.8	608.3	364.7	343.8	519.7
SPRG/SUMM	104.8	583.6	276.7	635.8	384.8	386.0	628.2
FALL/WINT	68.1	647.0	254.9	580.9	344.5	301.6	411.3

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	117.1	863.9	321.4	713.0	423.2	368.7	516.6
SPRG (3,4,5)	94.0	619.9	311.8	645.2	401.0	381.0	638.2
SUMM (6,7,8)	115.5	547.3	241.5	626.4	368.5	390.9	618.1
FALL (9,10,11)	19.1	430.0	188.4	448.8	265.8	234.5	306.0
MEAN	86.4	615.3	265.8	608.3	364.7	343.8	519.7
SPRG/SUMM	104.8	583.6	276.7	635.8	384.8	386.0	628.2
FALL/WINT	68.1	647.0	254.9	580.9	344.5	301.6	411.3

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	15.7	250.7	196.4	453.3	401.0	186.4	331.5
1991	21.0	294.7	254.7	460.3	497.6	184.6	349.4
1992	11.6	458.9	212.9	412.7	278.0	159.2	205.7
1993	51.2	749.9	171.5	544.9	262.1	222.5	423.6
1994	21.6	826.7	218.4	574.1	263.5	191.3	251.5
1995	34.7	301.8	209.9	417.4	291.9	242.1	419.7
1996	113.5	608.8	304.5	617.8	339.2	348.2	732.5
1997	213.0	827.8	373.3	789.8	463.5	630.3	901.4
1998	98.4	1,905.7	483.5	1,080.7	199.5	389.3	905.3
1990-1991	18.4	272.7	225.6	456.8	449.3	185.5	340.5
1990-1995	26.0	480.5	210.6	477.1	332.4	197.7	330.2
1996-1998	141.6	1,114.1	387.1	829.4	334.1	455.9	846.4

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

NOX LOADS

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	2,006.7	5,023.9	6,529.2	9,002.6	6,861.6	11,051.0	14,279.5
2	3,189.6	5,707.2	6,542.5	9,367.3	7,401.4	11,981.8	14,699.4
3	2,636.7	5,045.2	5,219.4	8,924.0	7,238.8	11,666.1	13,882.5
4	1,387.3	3,020.2	4,451.7	7,565.6	5,665.2	11,112.2	13,494.2
5	353.5	3,154.7	4,317.8	6,866.5	4,783.2	9,850.9	12,008.5
6	1,540.0	3,936.1	4,409.5	8,511.9	5,147.0	11,507.5	13,564.3
7	687.7	2,012.0	3,942.3	5,772.0	5,486.2	8,523.9	10,276.4
8	82.2	2,214.4	3,899.3	5,916.7	5,739.5	8,627.3	11,098.9
9	95.9	2,407.4	4,614.4	6,486.3	5,953.4	9,807.9	12,196.4
10	163.6	2,045.3	4,730.0	5,619.2	5,525.7	8,617.2	12,313.7
11	425.6	2,679.2	4,861.3	6,308.6	5,728.9	8,400.2	12,368.0
12	910.1	3,994.5	5,532.5	7,491.7	6,055.9	10,240.1	12,925.1
MEAN	1,123.2	3,436.7	4,920.8	7,319.4	5,965.6	10,115.5	12,758.9
SPRG/SUMM	1,114.6	3,230.4	4,373.3	7,259.5	5,676.7	10,214.7	12,387.5
FALL/WINT	1,131.9	3,642.9	5,468.3	7,379.3	6,254.5	10,016.4	13,130.4

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	2,035.5	4,908.5	6,201.4	8,620.5	6,773.0	11,091.0	13,968.0
SPRG (3,4,5)	1,459.2	3,740.0	4,663.0	7,785.4	5,895.7	10,876.4	13,128.4
SUMM (6,7,8)	770.0	2,720.8	4,083.7	6,733.5	5,457.6	9,552.9	11,646.5
FALL (9,10,11)	228.4	2,377.3	4,735.2	6,138.0	5,736.0	8,941.8	12,292.7
MEAN	1,123.2	3,436.7	4,920.8	7,319.4	5,965.6	10,115.5	12,758.9
SPRG/SUMM	1,114.6	3,230.4	4,373.3	7,259.5	5,676.7	10,214.7	12,387.5
FALL/WINT	1,131.9	3,642.9	5,468.3	7,379.3	6,254.5	10,016.4	13,130.4

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	252.2	1,535.7	3,760.3	4,990.6	7,281.2	7,556.0	11,090.4
1991	202.9	1,583.3	4,671.7	5,067.0	6,224.5	7,498.8	9,709.0
1992	128.6	1,965.1	3,679.6	4,551.7	4,878.4	6,686.8	10,007.7
1993	459.0	3,231.6	4,121.3	5,855.7	4,566.0	8,230.5	11,893.4
1994	592.5	3,565.0	4,751.7	6,286.1	4,594.6	7,707.8	10,945.5
1995	328.7	1,878.6	3,346.6	5,532.1	4,772.7	8,852.6	12,856.1
1996	1,618.8	3,784.6	4,909.8	7,528.3	5,911.5	10,534.9	15,300.0
1997	2,716.3	5,701.8	6,613.0	10,439.8	7,860.4	14,123.1	16,241.9
1998	1,581.5	8,363.3	9,166.0	11,207.3	3,339.5	11,975.6	17,187.7
1990-1991	227.6	1,559.5	4,216.0	5,028.8	6,752.9	7,527.4	10,399.7
1990-1995	327.3	2,293.2	4,055.2	5,380.5	5,386.2	7,755.4	11,083.7
1996-1998	1,972.2	5,949.9	6,896.3	9,725.1	5,703.8	12,211.2	16,243.2

II ANALYSIS OF PARAMETER LOADS

mean loads in annual tons or tons/year

TP LOADS

1 MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	300.2	654.5	670.7	721.6	571.1	975.0	917.3
2	450.7	687.2	850.3	1,057.8	738.3	1,321.6	1,268.9
3	459.3	751.0	732.8	1,332.6	975.0	1,490.2	1,434.1
4	500.0	523.7	717.5	1,075.3	783.1	1,578.3	1,426.7
5	200.0	506.9	612.3	841.3	572.0	1,179.2	1,013.2
6	749.0	892.6	823.7	1,801.5	1,248.6	2,702.9	2,478.7
7	184.6	304.3	483.6	503.5	443.7	791.6	736.4
8	109.5	308.2	397.0	434.4	382.6	716.1	622.6
9	115.6	330.8	461.6	509.8	432.4	884.8	989.7
10	73.0	214.4	351.4	354.8	317.6	731.9	680.5
11	120.3	329.2	458.0	433.9	364.1	668.9	636.1
12	154.2	473.7	520.6	588.8	459.3	769.0	740.7
MEAN	284.7	498.0	590.0	804.6	607.3	1,150.8	1,078.7
SPRG/SUMM	367.1	547.8	627.8	998.1	734.2	1,409.7	1,285.3
FALL/WINT	202.3	448.3	552.1	611.1	480.5	891.9	872.2

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	301.7	605.1	680.5	789.4	589.6	1,021.9	975.6
SPRG (3,4,5)	386.4	593.9	687.5	1,083.1	776.7	1,415.9	1,291.3
SUMM (6,7,8)	347.7	501.7	568.1	913.1	691.6	1,403.5	1,279.2
FALL (9,10,11)	103.0	291.5	423.7	432.8	371.4	761.9	768.8
MEAN	284.7	498.0	590.0	804.6	607.3	1,150.8	1,078.7
SPRG/SUMM	367.1	547.8	627.8	998.1	734.2	1,409.7	1,285.3
FALL/WINT	202.3	448.3	552.1	611.1	480.5	891.9	872.2

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	63.7	149.5	333.6	297.6	424.8	536.6	577.3
1991	50.5	161.0	316.4	302.7	446.6	530.6	733.3
1992	44.9	237.3	293.8	267.0	314.8	441.8	452.8
1993	134.2	391.4	532.4	425.5	326.2	696.6	741.6
1994	117.3	427.4	378.5	393.0	325.2	554.2	524.3
1995	150.9	296.3	408.2	544.1	472.6	765.1	764.0
1996	372.2	599.0	796.3	919.3	725.5	1,256.3	1,179.3
1997	686.1	1,042.4	1,325.7	1,665.5	1,228.6	2,226.7	2,304.1
1998	373.5	1,002.9	1,065.9	1,036.0	371.1	1,279.6	1,362.8
1990-1991	57.1	155.3	325.0	300.2	435.7	533.6	655.3
1990-1995	93.6	277.2	377.2	371.7	385.0	587.5	632.2
1996-1998	477.3	881.4	1,062.6	1,206.9	775.1	1,587.5	1,615.4

II ANALYSIS OF PARAMETER LOADS

Mean loads in annual tons or tons/year

TSS LOADS

1 MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	32,150.7	75,725.7	94,700.1	130,869.2	78,487.4	210,300.2	299,390.8
2	50,795.6	116,835.7	171,690.4	252,850.1	165,308.1	415,397.2	456,947.7
3	153,997.4	220,853.9	223,262.4	474,931.9	293,061.3	566,666.5	695,146.0
4	169,219.0	132,706.2	204,274.6	398,568.3	229,935.1	628,503.5	567,990.8
5	53,507.0	110,855.3	146,028.9	275,364.1	158,790.5	395,434.4	326,071.9
6	247,691.3	304,696.5	244,262.5	881,860.4	494,573.1	1,379,222.9	1,184,589.6
7	31,148.0	36,755.7	69,433.6	94,696.2	59,004.9	160,475.0	188,276.0
8	21,388.8	34,173.5	56,689.7	90,996.2	44,253.1	132,523.5	162,085.5
9	30,355.0	43,814.0	62,474.2	96,197.0	53,644.7	178,540.6	379,612.6
10	11,470.8	18,916.5	28,025.1	64,184.0	30,061.1	136,637.9	191,885.5
11	12,046.6	30,215.7	47,427.3	71,374.6	40,918.2	83,473.8	156,406.6
12	9,939.3	39,744.5	52,746.4	105,490.9	50,198.8	113,887.1	180,032.6
MEAN	68,642.5	97,107.8	116,751.3	244,781.9	141,519.7	366,755.2	399,036.3
SPRG/SUMM	112,825.3	140,006.9	157,325.3	369,402.9	213,269.7	543,804.3	520,693.3
FALL/WINT	24,459.7	54,208.7	76,177.3	120,161.0	69,769.7	189,706.1	277,379.3

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	30,961.9	77,435.3	106,379.0	163,070.1	97,998.1	246,528.2	312,123.7
SPRG (3,4,5)	125,574.5	154,805.1	191,188.6	382,954.8	227,262.3	530,201.5	529,736.2
SUMM (6,7,8)	100,076.0	125,208.6	123,461.9	355,850.9	199,277.0	557,407.1	511,650.4
FALL (9,10,11)	17,957.5	30,982.1	45,975.5	77,251.9	41,541.3	132,884.1	242,634.9
MEAN	68,642.5	97,107.8	116,751.3	244,781.9	141,519.7	366,755.2	399,036.3
SPRG/SUMM	112,825.3	140,006.9	157,325.3	369,402.9	213,269.7	543,804.3	520,693.3
FALL/WINT	24,459.7	54,208.7	76,177.3	120,161.0	69,769.7	189,706.1	277,379.3

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH
1990	6,526.1	10,899.2	33,112.9	52,614.9	32,060.5	50,763.2	104,453.7
1991	6,087.4	12,045.6	16,884.9	53,748.6	35,961.9	48,932.8	182,245.0
1992	3,675.1	15,371.7	33,021.5	45,364.4	19,018.9	20,804.8	104,063.7
1993	26,534.5	41,432.0	53,323.1	107,108.0	30,444.4	137,092.9	218,176.5
1994	13,915.4	31,720.3	42,906.5	77,101.4	29,395.9	56,719.8	133,223.8
1995	26,412.8	52,451.8	87,216.1	146,188.8	117,537.6	158,994.8	240,432.4
1996	90,638.4	146,022.5	218,739.6	286,968.1	200,887.9	441,462.9	472,963.6
1997	208,887.1	283,212.2	423,316.2	591,736.8	407,503.8	916,944.5	1,066,244.4
1998	56,670.5	136,616.1	203,539.4	336,916.0	75,286.8	417,993.6	575,595.1
1990-1991	6,306.8	11,472.4	24,998.9	53,181.8	34,011.2	49,848.0	143,349.4
1990-1995	13,858.6	27,320.1	44,410.8	80,354.4	44,069.9	78,884.7	163,765.9
1996-1998	118,732.0	188,616.9	281,865.1	405,207.0	227,892.8	592,133.7	704,934.4

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

TP BACKGROUND CONSIDERATIONS

Although it can be shown that % Pass from Milner Dam may impact the Middle Snake River minimally, background levels of total phosphorus (TP) appear to have a significant effect on the water quality of the system. Similar sites and data sources used for TSS were used for TP. The following table shows the average values (on a yearly basis) for background from 1990 to 1997 on the Middle Snake River.

Upstream/background levels on TP in the Middle Snake River

Year	*IDEQ-TFRO Data TP, mg/L*	*USGS Data TP, mg/L*	*Comments*
1990	0.114	-	Lo-Flow Years: 1990-1995 — Range: IDEQ-TFRO = 0.120 mg/L TP — 0.110 - 0.137 USGS = 0.131 mg/L TP — 0.050 - 0.203 $\bar{x}$ = 0.126 mg/L TP — 0.050 - 0.203
1991	0.137	0.203	
1992	-	-	
1993	-	0.138	
1994	-	0.050	
1995	0.110	0.134	
1996	0.087	0.067	Hi-Flow Years: 1996-1997 — Range: IDEQ-TFRO = 0.087 mg/L TP — 0.087 - 0.087 USGS = 0.063 mg/L TP — 0.058 - 0.067 $\bar{x}$ = 0.075 mg/L TP — 0.058 - 0.087
1997	0.087	0.058	
MEAN	0.107	0.108	OVERALL MEAN IDEQ + USGS DATA = 0.108 mg/L

The data indicates that the overall mean TP value is 0.108 mg/L as background (taking into account both USGS and IDEQ-TFRO data). For IDEQ-TFRO data the value is 0.107 mg/L TP. For USGS data alone the value is 0.108 mg/L TP. Water years 1996-1997 have lesser values for USGS when compared to the previous six years (1990-1995) thus indicating a reduction in TP since 1990-1991. IDEQ-TFRO data indicates the same. Therefore, the overall mean TP value was used as a reasonable background value.

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

TSS BACKGROUND CONSIDERATIONS

Background levels of TSS were investigated. IDAPA §16.01.02.003.07 defines background as "the biological, chemical, or physical condition of waters measured at a point immediately upstream (up-gradient) of the influence of an individual point or nonpoint source discharge." On the Middle Snake River background was defined as the Milner Dam site (RM638.7) since it is the "water source" that is "immediately upstream of the influence of any individual point or nonpoint source discharge." or any upstream site close to it that did not carry with it point or nonpoint sources of pollution coming from within the watershed. Two data sources were used for comparison purposes to determine a reasonable value for background on TSS: USGS data and IDEQ-TFRO data. The following table shows the average values (on a yearly basis) from 1990 to 1997.

Upstream/background TSS values on the Middle Snake River

Year	*IDEQ-TFRO Data TSS, mg/L*	*USGS Data TSS, mg/L*	*Comments*
1990	23.0	-	Lo-Flow Years: 1990-1995 — Range: IDEQ-TFRO = 16.5 mg/L TSS — 11.7 - 23.0 USGS = 17.2 mg/L TSS — 11.5 - 21.2 $\bar{x}$ = 16.9 mg/L TSS — 11.5 - 23.0
1991	11.7	18.0	
1992	-	-	
1993	-	11.5	
1994	-	18.0	
1995	14.8	21.2	
1996	17.1	29.6	Hi-Flow Years: 1996-1997 — Range: IDEQ-TFRO = 19.1 mg/L TSS — 17.1 - 21.1 USGS = 30.4 mg/L TSS — 29.6 - 31.2 $\bar{x}$ = 24.8 mg/L TSS — 17.1 - 31.2
1997	21.1	31.2	
MEAN	17.5	21.6	OVERALL MEAN IDEQ + USGS DATA = 19.7 mg/L

Prepared by IDEQ-TFRO. IDEQ data from monitoring conducted in 1990, 1995-1997. USGS data from WY1991, 1993-1997. USGS WY1996-1997 looked at gage 13087995. Other years were gage 13088000. TSS values for IDEQ-TFRO based on surface grab samples. TSS (suspended sediment) values for USGS based on integrated depth sampling. IDEQ-TFRO values increased by 15.8% from Lo-Flow Years to Hi-Flow Years, whereas USGS values increased by 76.7%, or an overall average of 46.8% increase in TSS. The t-ttest (paired samples on IDEQ versus USGS) indicates the samle populasons are from different populations (Ho: $\mu 1 = \mu 2$) and may be considered distinct and seperate.

The data indicates that the overall mean TSS value is 19.7 mg/L as background (taking into account both USGS and IDEQ-TFRO data) based on data from 1990-1997. Additional data may indicate otherwise. For IDEQ-TFRO data the value is 17.5 mg/L TSS. For USGS data the value is 21.6 mg/L. Water years 1996-1997 have greater values for USGS when compared to the previous six years (1990-1995). IDEQ-TFRO indicates the opposite.

The data used in this document indicates that the TSS background average is 15.5 mg/L based on data from 1990-1998. Additional information will always change the overall average for the total years of data used.

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

SRP

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.090	0.131	0.080	0.088	0.055	0.027	0.049
2	0.073	0.122	0.079	0.081	0.051	0.026	0.045
3	0.075	0.089	0.085	0.067	0.042	0.024	0.040
4	0.036	0.075	0.062	0.066	0.041	0.024	0.037
5	0.024	0.080	0.062	0.069	0.044	0.024	0.044
6	0.049	0.076	0.076	0.064	0.041	0.030	0.054
7	0.041	0.081	0.067	0.073	0.049	0.024	0.040
8	0.050	0.105	0.083	0.080	0.053	0.025	0.039
9	0.051	0.101	0.075	0.082	0.049	0.026	0.058
10	0.060	0.097	0.090	0.080	0.049	0.025	0.042
11	0.098	0.109	0.091	0.078	0.046	0.024	0.038
12	0.072	0.119	0.088	0.088	0.057	0.027	0.041
MEAN	0.060	0.099	0.078	0.076	0.048	0.026	0.044
SPRG/SUMM	0.046	0.084	0.073	0.070	0.045	0.025	0.042
FALL/WINT	0.074	0.113	0.084	0.083	0.051	0.026	0.046

2. SEASONAL QUARTES ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	0.078	0.124	0.082	0.086	0.054	0.027	0.045
SPRG (3,4,5)	0.045	0.081	0.070	0.067	0.042	0.024	0.040
SUMM (6,7,8)	0.047	0.087	0.075	0.072	0.048	0.026	0.044
FALL (9,10,11)	0.070	0.102	0.085	0.080	0.048	0.025	0.046
MEAN	0.060	0.099	0.078	0.076	0.048	0.026	0.044
SPRG/SUMM	0.046	0.084	0.073	0.070	0.045	0.025	0.042
FALL/WINT	0.074	0.113	0.084	0.083	0.051	0.026	0.046

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	0.077	0.111	0.084	0.105	0.063	0.024	0.051	
1991	0.080	0.110	0.094	0.105	0.068	0.024	0.066	
1992	0.070	0.167	0.105	0.106	0.052	0.023	0.044	
1993	0.077	0.160	0.090	0.102	0.050	0.024	0.051	
1994	0.074	0.159	0.088	0.102	0.051	0.024	0.046	
1995	0.078	0.075	0.075	0.070	0.047	0.024	0.044	
1996	0.031	0.062	0.054	0.058	0.039	0.026	0.021	
1997	0.032	0.055	0.039	0.046	0.030	0.029	0.029	
1998	0.043	0.131	0.068	0.088	0.041	0.026	0.023	
1990-1991	0.079	0.111	0.089	0.105	0.066	0.024	0.059	Baseline Years
1990-1995	0.076	0.130	0.089	0.098	0.055	0.024	0.050	Lo-Flow Years
1996-1998	0.035	0.083	0.054	0.064	0.037	0.027	0.024	Hi-Flow Years
1990-1998	0.062	0.114	0.077	0.087	0.049	0.025	0.042	Overall Mean

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

TKN

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.27	0.18	0.26	0.41	0.43	0.37	0.31
2	0.34	0.18	0.25	0.41	0.41	0.38	0.31
3	0.69	0.31	0.45	0.43	0.46	0.40	0.31
4	0.49	0.40	0.33	0.43	0.44	0.41	0.35
5	0.34	0.29	0.36	0.45	0.46	0.40	0.32
6	0.34	0.30	0.38	0.50	0.52	0.47	0.42
7	0.36	0.26	0.30	0.40	0.40	0.36	0.30
8	0.48	0.26	0.31	0.41	0.45	0.38	0.32
9	0.44	0.27	0.33	0.40	0.37	0.39	0.36
10	0.43	0.25	0.29	0.40	0.39	0.39	0.32
11	0.46	0.31	0.34	0.45	0.42	0.38	0.29
12	0.37	0.24	0.26	0.43	0.42	0.35	0.31
MEAN	0.42	0.27	0.32	0.43	0.43	0.39	0.33
SPRG/SUMM	0.45	0.30	0.35	0.44	0.46	0.40	0.34
FALL/WINT	0.39	0.24	0.29	0.42	0.41	0.38	0.32

2. SEASONAL QUARTES ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	0.33	0.20	0.26	0.42	0.42	0.37	0.31
SPRG (3,4,5)	0.51	0.33	0.38	0.44	0.45	0.40	0.33
SUMM (6,7,8)	0.39	0.27	0.33	0.44	0.46	0.40	0.35
FALL (9,10,11)	0.44	0.28	0.32	0.42	0.39	0.39	0.32
MEAN	0.42	0.27	0.32	0.43	0.43	0.39	0.33
SPRG/SUMM	0.45	0.30	0.35	0.44	0.46	0.40	0.34
FALL/WINT	0.39	0.24	0.29	0.42	0.41	0.38	0.32

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	0.27	0.22	0.12	0.40	0.44	0.35	0.27	
1991	0.36	0.19	0.33	0.40	0.47	0.35	0.27	
1992	0.51	0.11	0.29	0.39	0.41	0.34	0.29	
1993	0.45	0.12	0.28	0.41	0.42	0.36	0.32	
1994	0.33	0.12	0.23	0.40	0.42	0.35	0.30	
1995	0.69	0.39	0.43	0.41	0.39	0.37	0.32	
1996	0.33	0.34	0.40	0.45	0.42	0.41	0.34	
1997	0.41	0.38	0.42	0.47	0.46	0.44	0.43	
1998	0.29	0.20	0.22	0.45	0.44	0.40	0.36	
1990-1991	0.32	0.21	0.22	0.40	0.46	0.35	0.27	Baseline Years
1990-1995	0.44	0.19	0.28	0.40	0.43	0.35	0.30	Lo-Flow Years
1996-1998	0.34	0.31	0.35	0.46	0.44	0.42	0.38	Hi-Flow Years
1990-1998	0.40	0.23	0.30	0.42	0.43	0.37	0.32	Overall Mean

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

NH3

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

River mile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.044	0.291	0.084	0.138	0.078	0.027	0.049
2	0.030	0.240	0.077	0.133	0.073	0.032	0.044
3	0.039	0.183	0.140	0.109	0.078	0.026	0.051
4	0.030	0.143	0.071	0.105	0.063	0.028	0.042
5	0.026	0.174	0.079	0.104	0.069	0.027	0.043
6	0.024	0.167	0.075	0.100	0.057	0.033	0.057
7	0.027	0.160	0.080	0.112	0.060	0.028	0.030
8	0.021	0.199	0.075	0.116	0.066	0.024	0.038
9	0.023	0.198	0.067	0.119	0.059	0.026	0.028
10	0.024	0.200	0.063	0.120	0.068	0.026	0.036
11	0.023	0.216	0.067	0.121	0.067	0.026	0.035
12	0.038	0.216	0.068	0.129	0.078	0.032	0.044
MEAN	0.029	0.199	0.079	0.117	0.068	0.028	0.041
SPRG/SUMM	0.028	0.171	0.087	0.108	0.066	0.028	0.044
FALL/WINT	0.030	0.227	0.071	0.127	0.071	0.028	0.039

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	0.037	0.249	0.076	0.133	0.076	0.030	0.046
SPRG (3,4,5)	0.032	0.167	0.097	0.106	0.070	0.027	0.045
SUMM (6,7,8)	0.024	0.175	0.077	0.109	0.061	0.028	0.042
FALL (9,10,11)	0.023	0.205	0.066	0.120	0.065	0.026	0.033
MEAN	0.029	0.199	0.079	0.117	0.068	0.028	0.041
SPRG/SUMM	0.028	0.171	0.087	0.108	0.066	0.028	0.044
FALL/WINT	0.030	0.227	0.071	0.127	0.071	0.028	0.039

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	0.037	0.205	0.086	0.164	0.079	0.026	0.042	
1991	0.043	0.225	0.112	0.164	0.103	0.026	0.046	
1992	0.042	0.368	0.111	0.166	0.076	0.025	0.029	
1993	0.031	0.354	0.058	0.160	0.072	0.026	0.039	
1994	0.020	0.353	0.076	0.160	0.072	0.026	0.032	
1995	0.035	0.132	0.097	0.103	0.067	0.026	0.038	
1996	0.020	0.120	0.051	0.091	0.058	0.028	0.045	
1997	0.023	0.104	0.036	0.068	0.041	0.032	0.040	
1998	0.023	0.290	0.066	0.136	0.055	0.028	0.056	
1990-1991	0.040	0.215	0.099	0.164	0.091	0.026	0.044	Baseline Years
1990-1995	0.035	0.273	0.090	0.153	0.078	0.026	0.038	Lo-Flow Years
1996-1998	0.022	0.171	0.051	0.098	0.051	0.029	0.047	Hi-Flow Years
1990-1998	0.030	0.239	0.077	0.135	0.069	0.027	0.041	Overall Mean

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

NOX

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

R vermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.844	1.325	1.529	1.598	1.248	1.026	1.389
2	0.615	1.333	1.444	1.439	1.173	0.970	1.321
3	0.589	1.258	1.643	1.299	1.088	0.905	1.188
4	0.266	1.289	1.314	1.255	1.007	0.856	1.144
5	0.168	1.038	1.151	1.213	0.954	0.899	1.156
6	0.182	0.845	1.238	1.027	0.775	0.802	1.032
7	0.209	1.108	1.277	1.455	1.207	1.032	1.286
8	0.151	1.161	1.501	1.547	1.260	1.041	1.333
9	0.209	1.244	1.511	1.550	1.284	1.009	1.276
10	0.373	1.570	1.919	1.698	1.420	1.007	1.377
11	0.701	1.304	1.755	1.613	1.333	1.021	1.428
12	0.669	1.298	1.569	1.593	1.295	1.053	1.410
MEAN	0.415	1.232	1.488	1.441	1.170	0.968	1.278
SPRG/SUMM	0.261	1.118	1.354	1.299	1.049	0.923	1.190
FALL/WINT	0.569	1.346	1.621	1.582	1.292	1.014	1.367

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	0.709	1.319	1.514	1.543	1.239	1.016	1.373
SPRG (3,4,5)	0.341	1.198	1.369	1.256	1.016	0.887	1.163
SUMM (6,7,8)	0.181	1.038	1.339	1.343	1.081	0.958	1.217
FALL (9,10,11)	0.428	1.373	1.728	1.620	1.346	1.012	1.360
MEAN	0.415	1.232	1.488	1.441	1.170	0.968	1.278
SPRG/SUMM	0.261	1.118	1.354	1.299	1.049	0.923	1.190
FALL/WINT	0.569	1.346	1.621	1.582	1.292	1.014	1.367

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	0.517	1.642	1.640	1.810	1.431	1.043	1.046	
1991	0.535	1.660	1.990	1.807	1.344	1.045	1.289	
1992	0.420	1.572	1.868	1.829	1.336	1.065	1.427	
1993	0.432	1.511	1.439	1.747	1.250	1.018	1.379	
1994	0.600	1.515	1.728	1.755	1.258	1.039	1.411	
1995	0.413	1.230	1.500	1.471	1.239	1.002	1.371	
1996	0.250	0.858	1.006	1.238	1.088	0.930	1.324	
1997	0.269	0.685	0.728	0.984	0.813	0.859	0.969	
1998	0.391	1.278	1.254	1.428	0.915	0.929	1.271	
1990-1991	0.526	1.651	1.815	1.809	1.388	1.044	1.168	Baseline Years
1990-1995	0.486	1.522	1.694	1.737	1.310	1.035	1.321	Lo-Flow Years
1996-1998	0.303	0.940	0.996	1.217	0.939	0.906	1.188	Hi-Flow Years
1990-1998	0.425	1.328	1.461	1.563	1.186	0.992	1.276	Overall Mean

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

TP

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

R.vermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	0.126	0.155	0.141	0.112	0.097	0.086	0.082
2	0.109	0.148	0.140	0.113	0.101	0.089	0.088
3	0.184	0.129	0.148	0.115	0.105	0.090	0.090
4	0.113	0.132	0.135	0.110	0.099	0.094	0.091
5	0.071	0.122	0.129	0.116	0.101	0.088	0.085
6	0.080	0.111	0.148	0.123	0.128	0.118	0.122
7	0.086	0.120	0.137	0.105	0.083	0.080	0.074
8	0.109	0.140	0.142	0.108	0.083	0.082	0.072
9	0.135	0.137	0.136	0.110	0.091	0.085	0.100
10	0.132	0.137	0.142	0.102	0.083	0.083	0.074
11	0.169	0.149	0.159	0.109	0.087	0.080	0.073
12	0.136	0.149	0.140	0.117	0.106	0.078	0.079
MEAN	0.121	0.136	0.141	0.112	0.097	0.088	0.086
SPRG/SUMM	0.107	0.126	0.140	0.113	0.100	0.092	0.089
FALL/WINT	0.135	0.146	0.143	0.111	0.094	0.084	0.083

2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	0.124	0.151	0.140	0.114	0.101	0.084	0.083
SPRG (3,4,5)	0.123	0.128	0.137	0.114	0.102	0.091	0.089
SUMM (6,7,8)	0.092	0.124	0.142	0.112	0.098	0.093	0.089
FALL (9,10,11)	0.145	0.141	0.146	0.107	0.087	0.083	0.082
MEAN	0.121	0.136	0.141	0.112	0.097	0.088	0.086
SPRG/SUMM	0.107	0.126	0.140	0.113	0.100	0.092	0.089
FALL/WINT	0.135	0.146	0.143	0.111	0.094	0.084	0.083

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	0.190	0.132	0.145	0.107	0.086	0.074	0.073	
1991	0.184	0.133	0.137	0.107	0.095	0.074	0.097	
1992	0.264	0.191	0.147	0.107	0.086	0.070	0.064	
1993	0.122	0.183	0.181	0.109	0.089	0.078	0.074	
1994	0.129	0.182	0.133	0.109	0.089	0.074	0.067	
1995	0.169	0.131	0.143	0.109	0.093	0.081	0.074	
1996	0.080	0.113	0.130	0.113	0.102	0.093	0.081	
1997	0.078	0.105	0.117	0.117	0.106	0.110	0.110	
1998	0.100	0.152	0.136	0.119	0.102	0.090	0.088	
1990-1991	0.187	0.133	0.141	0.107	0.091	0.074	0.085	Baseline Years
1990-1995	0.176	0.159	0.148	0.108	0.090	0.075	0.075	Lo-Flow Years
1996-1998	0.086	0.123	0.128	0.116	0.103	0.098	0.093	Hi-Flow Years
1990-1998	0.146	0.147	0.141	0.111	0.094	0.083	0.081	Overall Mean

ANALYSIS OF PARAMETER CONCENTRATIONS
mean concentration in mg/L

TSS

1. MONTH-TO-MONTH ANALYSIS (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
MONTH	MD	PF	CS	BC	GB	SB	KH
1	9.5	14.0	14.6	22.1	12.3	15.8	23.9
2	10.3	14.4	17.1	24.0	17.0	21.0	26.8
3	22.2	18.1	19.5	31.1	22.6	25.9	33.5
4	21.4	16.7	20.3	30.8	20.7	29.7	30.2
5	15.9	20.1	22.4	32.6	22.4	22.6	23.8
6	19.8	22.5	24.6	47.2	33.6	47.4	43.6
7	14.4	11.7	15.8	17.8	8.7	12.1	16.7
8	20.0	13.7	18.5	20.8	8.9	13.3	18.1
9	18.6	14.3	15.7	18.6	9.6	15.1	39.0
10	14.1	10.6	11.0	16.1	7.7	13.7	20.0
11	14.2	12.9	15.9	18.0	9.5	9.7	17.6
12	8.7	11.2	12.1	20.0	10.7	10.7	18.0
MEAN	15.8	15.0	17.3	24.9	15.3	19.8	25.9
SPRG/SUMM	19.0	17.1	20.2	30.1	19.5	25.2	27.7
FALL/WINT	12.6	12.9	14.4	19.8	11.1	14.3	24.2

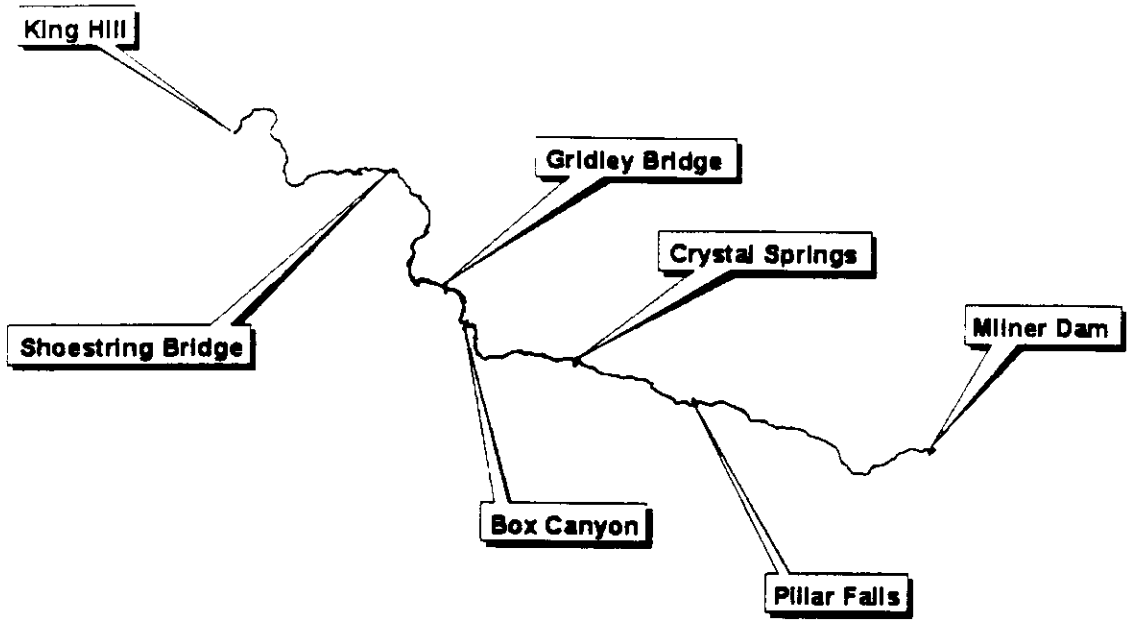
2. SEASONAL QUARTERS ANALYSIS (WY1990-1998)

SEASON	MD	PF	CS	BC	GB	SB	KH
WINT (12,1,2)	9.5	13.2	14.6	22.0	13.3	15.8	22.9
SPRG (3,4,5)	19.8	18.3	20.7	31.5	21.9	26.1	29.2
SUMM (6,7,8)	18.1	16.0	19.6	28.6	17.1	24.3	26.1
FALL (9,10,11)	15.6	12.6	14.2	17.6	8.9	12.8	25.5
MEAN	15.8	15.0	17.3	24.9	15.3	19.8	25.9
SPRG/SUMM	19.0	17.1	20.2	30.1	19.5	25.2	27.7
FALL/WINT	12.6	12.9	14.4	19.8	11.1	14.3	24.2

3. WY-TO-WY ANALYSIS

WY	MD	PF	CS	BC	GB	SB	KH	
1990	14.2	10.5	14.2	18.7	6.3	6.8	13.1	
1991	15.7	11.6	7.1	18.8	7.5	6.5	22.1	
1992	17.1	12.1	17.4	17.8	5.2	3.1	14.7	
1993	14.6	13.2	16.4	21.5	8.3	11.0	20.4	
1994	12.8	13.2	14.8	21.1	8.1	7.4	17.0	
1995	17.8	14.2	18.9	20.1	14.5	13.7	22.4	
1996	14.5	17.2	26.6	27.0	20.9	25.6	30.8	
1997	19.8	21.1	28.7	33.7	29.3	38.7	45.3	
1998	13.4	17.6	23.0	35.5	20.6	26.0	36.2	
1990-1991	15.0	11.1	10.7	18.8	6.9	6.7	17.6	Baseline Years
1990-1995	15.4	12.5	14.8	19.7	8.3	8.1	18.3	Lo-Flow Years
1996-1998	15.9	18.6	26.1	32.1	23.6	30.1	37.4	Hi-Flow Years
1990-1998	15.5	14.5	18.6	23.8	13.4	15.4	24.7	Overall Mean

Segments of the Middle Snake River



	Segment Length
Segment 1 = MD to PF (Milner Dam to Pillar Falls)	25.61 miles (27.3%)
Segment 2 = PF to CS (Pillar Falls to Crystal Springs)	12.69 miles (13.5%)
Segment 3 = CS to BC (Crystal Springs to Box Canyon)	13.40 miles (14.3%)
Segment 4 = BC to GB (Box Canyon to Gridley Bridge)	05.00 miles (5.3%)
Segment 5 = GB to SB (Gridley Bridge to Shoestring Bridge)	16.25 miles (17.3%)
Segment 6 = SB to KH (Shoestring Bridge to King Hill)	20.75 miles (22.1%)
	Total = 93.70 miles

% LAND USE BY STREAM CORRIDOR APPROACH MODEL

Segment	AG	RANGE	FOREST	RIPARIAN	OTHER
1	64.2	11.4	0.0	24.3	0.1
2	66.7	13.1	0.0	18.6	1.6
3	67.1	11.6	0.0	21.2	0.1
4	49.3	29.2	0.0	20.8	0.7
5	30.3	55.4	0.0	14.1	0.2
6	21.9	65.3	0.1	9.4	3.3
MEAN	49.9	31.0	0.0	18.1	1.0

APPENDIX D

Data used in this TSD was averaged under a variety of methods

1. Month-to-Month Analysis: All data was summarized for a particular location site on a per month basis.

2. Seasonal Quarters Analysis: All data was summarized for a particular location site on a seasonal quarters basis.

3. Year-to-Year Analysis (Water Years): All data was summarized for a particular location site on a water year basis.

Total Sediment Load: This is all of the sediment that is in the stream transport system. It includes that part that is moving as suspended load plus that part that is moving as bedload. The sediment material may be natural or the result of man's activities.

Washload: That portion of the total stream sediment load composed of particles (< 0.062 mm in diameter) which are found only in relatively small quantities in the bed. The material can be natural or the result from man's activities.

Suspended Load: That portion of the total sediment load which is suspended sediment. It usually is from 0.062 to 0.5 mm in diameter. The material can be natural or the result from man's activities.

Bedload: That material that is moving on or near the stream bed by rolling, sliding, or skipping. It usually is > 0.5 mm in diameter. The material can be natural or the result from man's activites.

Depositional Load: That load that is made up of suspended load and washload that builds up. The Middle Snake River as a sediment-driven system is considered by IDEQ and USGS to be a depositional loading system. It does not have a true bedload partly because it is a managed water system affected by reservoir water and impounded water.

t-Test: The t-Test is a statistical test used to establish the likelihood that a given sample could be a member of a population with specified characteristics about the equivalency of two samples. The two sample t-Test assumes that both samples come at random from normal populations with equal variances. Numerous studies have shown that the t-Test is robust enough to stand considerable departures from its theoretical assumptions, especially if the sample sizes are equal (or nearly equal), and especially when two-tailed hypothesis are considered. If the underlying populations are markedly skewed, then be wary of one-tail testing. If there is considerable nonnormality in the population, then very small significance levels (alpha < 0.01) should not be depended upon.

APPENDIX D

Baseline Lo-Flow and Hi-Flow Years

WY1990-1991 = These are considered the Baseline Years. This is a carry-over from the Mid-Snake TMDL and will be used in the Upper Snake Rock TMDL

WY1990-1995 = These are considered the Lo-Flow Years as far as the period of record for water quality data. As far as Q is concerned, the period of record will be for WY1988-WY1995.

WY1996-1998 = These are considered the Hi-Flow Years as far as the period of record for water quality data. As far as Q is concernred, the period of record will be for WY1983-WY1987 and WY1996-WY1998.

Standard, Hydrologic, and Seasonal Quarters:

The determination of quarters is based on one of three systems available to the analyst. In this TSD seasonal quarters were used in preference to hydrologic or standard quarters.

Standard Quarters: Yearly quarters defined as four 3-month intervals per year and are listed as 1st Quarter (Jan, Feb, Mar), 2nd Quarter (Apr, May, Jun), 3rd Quarter (Jul, Aug, Sep), and 4th Quarter (Oct, Nov, Dec). They are based on the subdivision of a calendar year.

Hydrologic Quarters: These are offset yearly quarters that are established by the USGS water year definition. The quarters are listed as 1st Quarter (Oct, Nov, Dec of the previous year), 2nd Quarter (Jan, Feb, Mar of the current year), 3rd Quarter (Apr, May, Jun of the current year), and 4th Quarter (Jul, Aug, Sep of the current year).

Seasonal Quarters: These are four 3-month intervals that follow the common seasonal calendar: Winter or WINT (Dec of the previous year, Jan, Feb), Spring or SPRG (Mar, Apr, May), Summer or SUMM (June, July, August), and Fall or FALL (September, October, November).

N: This represents the number of samples or observations in a population. The population may be a large population or a small population. Depending on the school of thought (statisticians, mathematicians, chemists versus biologists, physicists, geologists) a small population may be < 30 samples (BPG) or < 50 samples (SMC). In general, two types of Ns are recognized, or two types of populations: small populations (with the symbol n) and large populations (with the symbol N). Another way of labeling a small population is to call it the sample population. Large populations are sometimes called universal populations or just simply populations.

Estimator: This is a mathematical expression that indicates how to calculate an estimate of a parameter from the sample population or sample data. Estimators are necessary because we almost never know the value of the population parameter.

Parameter: A parameter is the true population value of interest, expressed as a number.

Mean: This is also known as the arithmetic mean or average. It is calculated by summing all the individual observations in a small population and dividing it by the total number of observations. For example, a small population of 10 observations which when summed gives a total value of 488, has an average value of 488/10 or 48.8 or 49.

APPENDIX D

Abbreviations, Calculations, & Explanations

This section is provided at the request of the Mid-Snake WAG to more fully explain details relative to abbreviations, calculations, and definitions used throughout this document. Statistical definitions used in this section were abbreviated and may require further explanation in statistical books by the reader.

ABBREVIATIONS

TSS = Total Suspended Solids, mg/L
TP = Total Phosphorus, mg/L
SRP = Soluble Reactive Phosphate, mg/L
NH3 = Ammonia-N, mg/L
NOX = Nitrite+Nitrate as N, mg/L
TKN = Total Kjeldahl Nitrogen, mg/L
Q = Flow, cfs

TSSLOAD = TSS, tons/year
TPLOAD = TP, tons/year
SRPLOAD = SRP, tons/year
NH3LOAD = NH3, tons/year
NOXLOAD = NOX, tons/year
TKNLOAD = TKN, tons/year
TSD = Technical Support Document

Middle Snake River Segments

MD = Milner Dam (Influent Background)
PF = Pillar Falls
CS = Crystal Springs
BC = Box Canyon
GB = Gridley Bridge
SB = Shoestring Bridge
KH = King Hill Area (Effluent Background)

Segment 1 = MD to PF
Segment 2 = PF to CS
Segment 3 = CS to BC
Segment 4 = BC to GB
Segment 5 = GB to SB
Segment 6 = SB to KH

CALCULATIONS

Total Nitrogen = TN = TKN + NOX

LOAD = (parameter, mg/L) x (Q, cfs) x (5.39) x (0.1825) = tons/year

5.39 = the factor used to convert concentration & Q to pounds/day load

0.1825 = the factor used to convert pounds/day to tons/year load

Total Accumulative Loadings = MD + PF + CS + BC + GB + SB + KH

Used for Year-to-Year analysis.

Net Accumulative Loadings = KH - MD

Used for Month-to-Month and Seasonal Quarters analysis.

EXPLANATIONS & DEFINITIONS

Database: All data was collected and segregated into 7 SYSTAT (TM) files: MILNER.SYS, PILLAR.SYS, CRYSTAL.SYS, BOXCANYN.SYS, GRIDLEY.SYS, SHOSTRNG.SYS, and KINGHILL.SYS. Each file represents the specific location site where 9 years of water quality data (TSS, TP, SRP, NH3, NOX, and TKN) were present. On the basis of a 9 year period of water quality data, 6 river segments were established. Since the entire stretch of the Middle Snake River is listed in the 1996 & 1998 303(d) list, the 14 303(d) listed segments are blended into the 6 nine year period-of-record segments. Also, because of the enormous amount of data collected for these 7 sites, it was assumed that the database was normally distributed. The 9 year period was from 1990 to 1998.

Year-to-Year: This means Water Year-to-Water Year as defined by USGS.

APPENDIX D

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4. NH3: Concentration, Q, & Load	
5. TKN: Concentration, Q, & Load	
6. SRP: Concentration, Q, & Load	

Technical Support Document (TSD) for the Development of the Upper Snake Rock Watershed Management Plan

(Upper Snake Rock WMP = Upper Snake Rock TMDL)

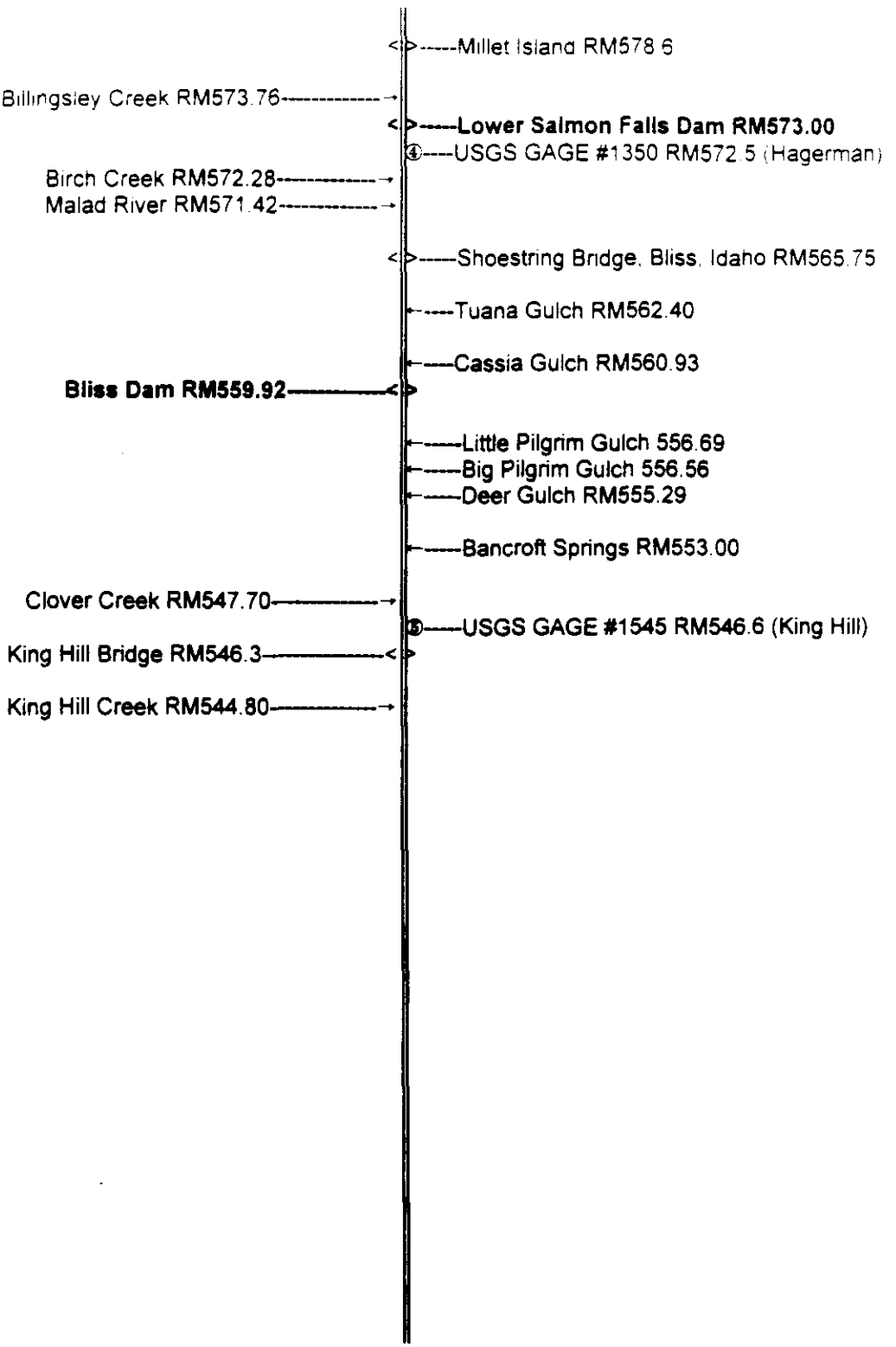
Database: 1990 - 1998

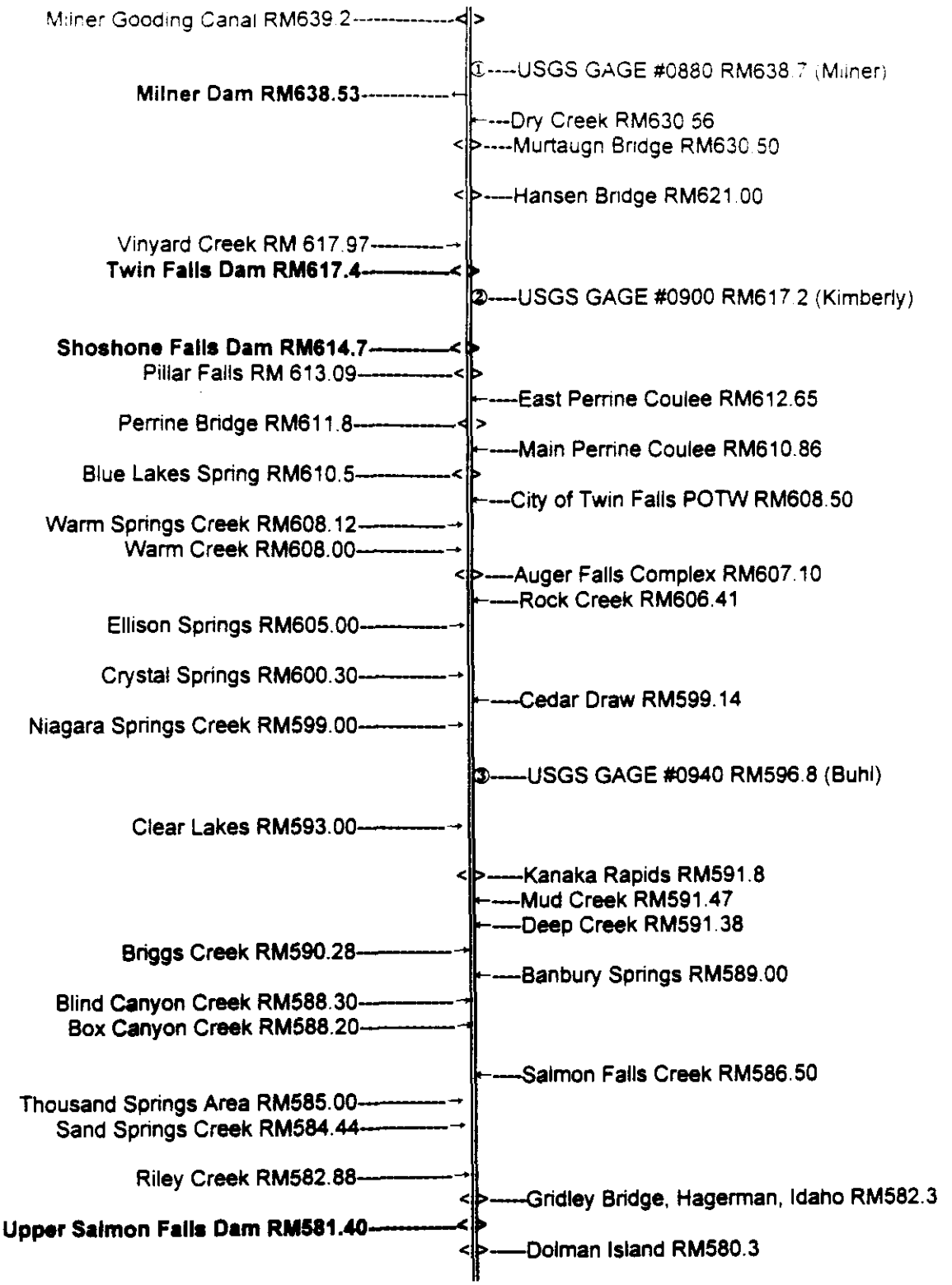
analyzed by
Dr. Balthasar B. Buhidar, Ph.D.
Senior Water Quality Analyst
Idaho Division of Environmental Quality
Twin Falls Regional Office

analysis suggestions and support from
IDEQ-TFRO (Darren Brandt, Clyde Lay, Rob Sharpnack)
University of Idaho-USDA/ARS (Clarence Robison, Rick Allen)
Clear Springs Foods Inc. (Randy MacMillan)
Aquaculture Industry (Gary Fornshell, Mark Daily)
Idaho Power Company (Paul Schinke)
Food Processors Industry (Mike Gann)
USEPA (Carla Fromm)
Idaho Conservation League (Larry Pennington)
Idaho Rivers United (Robert Lunte)

Data Sources:
Idaho Division of Environmental Quality-Twin Falls Regional Office
University of Idaho-USDA/ARS Kimberly Station
Clear Springs Foods Inc.
United States Geological Survey-Twin Falls Regional Office
Idaho Power Company
Aquaculture Industry
Municipality Industry: City of Twin Falls POTW
Food Processors Industry
United State Environmental Protection Agency

October 25, 1999
Idaho Division of Environmental Quality-Twin Falls Regional Office
Middle Snake River Technical Advisory Committee
Middle Snake River Watershed Advisory Group


Millet Island RM578.6
Billingsley Creek RM573.76
Lower Salmon Falls Dam RM573.00
④----USGS GAGE #1350 RM572.5 (Hagerman)
Birch Creek RM572.28
Malad River RM571.42
Shoestring Bridge, Bliss, Idaho RM565.75
Tuana Gulch RM562.40
Cassia Gulch RM560.93
Bliss Dam RM559.92
Little Pilgrim Gulch 556.69
Big Pilgrim Gulch 556.56
Deer Gulch RM555.29
Bancroft Springs RM553.00
Clover Creek RM547.70
⑤----USGS GAGE #1545 RM546.6 (King Hill)
King Hill Bridge RM546.3
King Hill Creek RM544.80


Milner Gooding Canal RM639.2
①----USGS GAGE #0880 RM638.7 (Milner)
Milner Dam RM638.53
Dry Creek RM630.56
Murtaugh Bridge RM630.50
Hansen Bridge RM621.00
Vinyard Creek RM 617.97
Twin Falls Dam RM617.4
②----USGS GAGE #0900 RM617.2 (Kimberly)
Shoshone Falls Dam RM614.7
Pillar Falls RM 613.09
East Perrine Coulee RM612.65
Perrine Bridge RM611.8
Main Perrine Coulee RM610.86
Blue Lakes Spring RM610.5
City of Twin Falls POTW RM608.50
Warm Springs Creek RM608.12
Warm Creek RM608.00
Auger Falls Complex RM607.10
Rock Creek RM606.41
Ellison Springs RM605.00
Crystal Springs RM600.30
Cedar Draw RM599.14
Niagara Springs Creek RM599.00
③----USGS GAGE #0940 RM596.8 (Buhl)
Clear Lakes RM593.00
Kanaka Rapids RM591.8
Mud Creek RM591.47
Deep Creek RM591.38
Briggs Creek RM590.28
Banbury Springs RM589.00
Blind Canyon Creek RM588.30
Box Canyon Creek RM588.20
Salmon Falls Creek RM586.50
Thousand Springs Area RM585.00
Sand Springs Creek RM584.44
Riley Creek RM582.88
Gridley Bridge, Hagerman, Idaho RM582.3
Upper Salmon Falls Dam RM581.40
Dolman Island RM580.3

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
636.00			3935	
637.00			3940	
638.00			4080	
638.53	Milner Dam		4134	
638.70		USGS 13088000	4135	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
622.10	Spring (1 spg)		3616	
622.15		Spring (1 spg)	3622	
623.00			3630	
623.05	Unnamed stream		3642	
623.12	Spring (1 spg)		3654	
623.39	Spring (1 spg)		3666	
623.75	Spring (1 spg)		3678	
624.00			3690	
624.45	Unnamed stream		3700	
625.00			3710	
626.00			3720	
627.00			3780	
627.30		Unnamed stream (U)	3785	Eden, Idaho
627.65		Unnamed stream (U)	3790	
627.89	Springs (2 spg)		3795	
628.00			3800	
628.29	Unnamed stream (U)		3820	
629.00			3840	
630.00			3840	
630.49	Spring (1 spg)		3850	
630.50	Murtaugh Bridge		3855	Murtaugh, Idaho
630.56	Dry Creek (C)		3860	
631.00			3870	
632.00			3900	Milner Butte, Idaho
632.75	Unnamed stream	Unnamed stream	3905	
633.00			3910	
634.00			3920	
635.00			3930	
635.67		Unnamed stream	3933	Milner, Idaho

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
613.09	Pillar Falls		3137	
613.37	Springs (4 spg)		3144	
613.67	Springs (4 spg)		3151	
614.00	Springs (3 spg)		3160	
614.70	Shoshone Falls Dam		3204	
614.87		Springs (2 spg)	3248	
615.00			3355	
615.66	Springs (2 spg)		3358	
616.00		Unnamed stream (2 spg)	3360	
616.78		Unnamed stream (5 spg)	3363	
616.90	Spring (1 spg)		3367	
617.00			3370	
617.12	Unnamed stream		3395	
617.20	USGS 13090900		3408	
617.37	Unnamed stream (braided)		3420	
617.50	Twin Falls Dam Spillway		3433	
617.54	Springs (6 spg)		3445	Kimberly, Idaho
617.86	Springs (4 spg)		3470	
617.97		Vinyard Lake Creek	3495	
618.00			3520	
619.00			3520	
619.21	Springs (3 spg)		3527	
619.53	Unnamed stream	Springs (3 spg)	3534	
620.00			3540	
620.17	Springs (3 spg)		3552	
620.75	Springs (3 spg)		3564	
620.88	Spring (1 spg)		3576	
621.00	Hanson Bridge		3590	
622.00			3610	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
605.30	Unnamed stream	Spring (1 spg)	2990	
605.43		Unnamed stream	2990	
605.49	Unnamed stream (3 spg)		2990	
605.90		Springs (5 spg)	2990	
606.00			2990	
606.09		Springs (4 spg)	2990	
606.41	Rock Creek (C)		2990	
607.00			3000	
607.15	Auger Falls		3026	
607.54		Unnamed stream	3052	
608.00		Warm Creek	3080	
608.12		Warm Spring Creek (U)	3100	
608.50	City of Twin Falls POTW		3115	Filer, Idaho
609.00			3120	
609.42	Springs (11 spg)		3125	Twin Falls, Idaho
610.00			3130	
610.50		Blue Lakes Spring (1 spg)	3130	
610.86	Main Perrine Coulee (C)		3130	
611.00			3130	
611.10	Springs (11 spg)		3130	
611.53		Unnamed stream (from Bass Lake)	3130	
611.57	Springs (6 spg)		3130	
611.80	Perrine Bridge		3130	
612.00	Springs (5 spg)		3130	
612.50	Springs (1 spg)		3130	
612.60	Unnamed stream		3130	
612.63	Springs (1 spg)		3130	
612.65	East Perrine Coulee (C)		3130	
613.00			3130	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
595.00			2950	
595.04	Unnamed stream		2955	
596.00			2960	
596.43	Unnamed stream (U)		2965	
596.80	USGS 13094000		2968	
597.00			2970	
597.66	Spring (1 spg)		2975	
598.00			2980	Niagara Springs, Idaho
598.09	Unnamed stream		2980	
598.30	Spring (1 spg)		2980	
599.00		Niagara Sps Ck (C; 5 spg)	2980	
599.12		Spring (1 spg)	2980	
599.14	Cedar Draw (C)		2980	
599.50	Crystal Springs Reach (Downstream Portion)		2980	
600.00			2980	
600.40	CRYSTAL SPRINGS AREA	Crystal Springs (14 spg)	2980	
600.92	Unnamed stream		2980	
601.00			2980	
601.30	Crystal Springs Reach (Upstream Portion)		2985	
602.00			2990	
602.15	Unnamed stream		2990	
603.00			2990	
603.17	Springs (8 spg)		2990	
603.39	Unnamed stream		2990	
604.00			2990	
604.07	Unnamed stream		2990	
604.42	Springs (3 spg)		2990	
604.62	Springs (4 spg)		2990	Jerome, Idaho
605.00	Ellison Springs		2990	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
586.12	Unnamed stream (U)		2956	
586.50	Salmon Falls Creek (C)		2923	
587.00	BELOW BOX CANYON CREEK		2890	
587.21		Unnamed stream	2890	
587.50		Blue "Heart" Sps (3 spg)	2890	
587.76		Box Canyon Creek (C: 3)	2890	
588.00			2890	
588.06		Blind Canyon Creek (C: 2)	2890	
588.48		Unnamed stream (2 spg)	2890	
588.85		Banbury Springs (19 spg)	2890	
589.00			2890	
589.48	Unnamed stream		2895	
590.00			2900	
590.28		Briggs Creek (C; 5 spg)	2900	
590.33	Unnamed stream		2900	
590.82	Unnamed stream		2900	
591.00			2900	
591.38	Deep Creek (C)		2900	
591.47	Mud Creek (C)		2900	
591.80	Kanaka Rapids		2925	
592.00			2950	
593.00		Clear Lakes (24 spg)	2970	
594.00			2970	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
578.60	Millet Island		2800	
578.99	Unnamed stream		2800	
579.00			2800	
579.52	Upper Salmon Falls Power Plant		2813	
580.00			2825	
580.12		Buckeye Ditch	2837	
580.30	Dolman Island		2844	
581.00			2850	
581.40	Upper Salmon Falls Dam		2888	
581.72	Owsley Bridge		2890	
582.00	GRIDLEY BRIDGE AREA		2890	
582.30	Gridley Bridge		2890	
582.48	Unnamed stream	Spring (1)	2916	
582.88		Riley Creek (C)	2942	
583.00			2970	Tuttle, Idaho
583.71		Unnamed stream	2942	
583.85		Thousand Springs (12 spg)	2916	
584.00			2890	
584.09	Unnamed stream (U)	Thousand Springs (1 spg)	2906	
584.20	Sliggers Hot Springs	1000 Springs Hydropower	2917	
584.38		Thousand Springs (15 spg)	2926	
584.44		Sand Springs Crk (7 spg)	2944	
584.82		Unnamed stream	2962	
584.87		Unnamed stream (6 spg)	2980	
585.00	Thousand Springs Area		3000	Thousand Springs, Idaho
585.30	Unnamed stream (U)		2998	
585.58	Unnamed stream (U)		2995	
585.90		Unnamed stream (1 spg)	2992	
586.00			2990	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
570.71		Unnamed stream	2766	
571.00			2770	
571.19	Unnamed stream	Power Plant Bypass	2773	
571.42		Malad River Gorge (C)	2776	
572.00			2780	
572.28		Birch Creek (C)	2787	
572.41		Unnamed stream	2794	
572.50	USGS 13135000		2798	
572.96	Lower Salmon Falls Power Plant		2801	
573.00			2806	
573.34	Unnamed stream	Unnamed stream	2805	
573.76		Billingsley Creek (C)	2803	
573.97		Unnamed stream	2802	
574.00			2800	
574.27		Unnamed stream (ditch?)	2800	
574.53	Unnamed stream		2800	
575.00			2800	
575.16	Aqueduct	Sands Ditch	2800	
575.41	Fossil Gulch (C)		2800	
575.57	Unnamed stream		2800	
575.83	Unnamed stream	Unnamed stream (ditch?)	2800	
576.00	City of Hagerman POTW		2800	
576.39	Unnamed stream		2800	
576.72		Unnamed stream (ditch?)	2800	
577.00			2800	
577.16	Unnamed stream	Bell Ditch	2800	
577.97	Unnamed stream		2800	
578.00			2800	
578.03	Unnamed stream (Peters Gulch)		2800	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
561.11			2675	
562.00			2675	
562.08	Tuana Gulch (C)		2675	
563.00			2675	
564.00	Unaccounted River Mile: mislabeled on map		2675	
564.00	Unaccounted River Mile: mislabeled on map		2675	
565.00	Aqueduct King Hill Canal		2675	
565.75	Shoestring Road Bridge ("Bliss Grade")		2675	
565.85		Spring (1)	2675	
566.00			2675	
566.33		Unnamed stream (1 Spg)	2675	
567.00			2675	
567.25		Unnamed stream (1 Spg)	2680	Bliss, Idaho
567.73		Unnamed stream (1 Spg)	2690	
568.00			2700	
568.05		Unnamed stream (1 Spg)	2707	
568.51	Unnamed stream		2714	
568.58		Unnamed stream	2421	
568.72	Unnamed stream		2728	
569.00			2735	
569.80		Unnamed stream (1 Spg)	2742	
570.00			2749	
570.04		Unnamed stream (1 Spg)	2756	
570.46	Unnamed stream (U)		2763	Hagerman, Idaho

RIVER MILE INDEX OF THE MIDDLE SNAKE RIVER.

RIGHT BANK IS THE BANK ON THE RIGHT LOOKING UPSTREAM. WHEREAS TH E LEFT BANK IS THE BANK ON THE LEFT LOCKING UPSTREAM PREPARED BY BALTHASAR B. BUHIDAR. IDEQ-TFRO

U = Unconnected stream to the Middle Snake River. C = Confluance to the Middle Snake River

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
544.80		King Hill Creek (C)	2517	Pasadena Valley. Idaho
545.00	KING HILL AREA		2475	
546.00		King Hill, Idaho	2500	King Hill, Idaho
546.30	King Hill Bridge		2500	
546.60		USGS 13154500	2500	
547.00			2500	
547.70		Clover Creek (C)	2533	Pasadena Valley. Idaho
548.00			2525	
549.00			2525	
550.00			2525	
551.00			2525	
552.00			2525	
553.00		Bancroft Springs (3)	2525	
554.00			2550	
554.85	Unnamed stream		2550	
555.00			2550	
555.29	Deer Gulch (C)		2550	
556.00			2550	
556.56	Big Pilgrim Gulch (C)		2575	
556.69	Little Pilgrim Gulch (C)		2575	
557.00			2575	Ticeska, Idaho
558.00			2575	
559.00			2615	
559.92	Bliss Dam		2655	
560.93	Cassia Gulch (C)		2665	
560.00			2675	

LATERAL	FACILITY	SIZE
N-34	1 pond	0 5 acres
-8	Wetland	40 acres total (under construction)
S-42	1 pond	2 acres
S-Coulee	1 pond	2 acres
S-19	1 pond	4 acres
W-28	Wetland	Nature Conservancy
W-26	Pond-wetland	20 acres estimated (under construction)
W-46	1 pond	3 acres
W	2 ponds	2 acres each
X-15	1 pond	3 acres

NUMBER	NAME	YEAR	ACRES INVOLVED
17	Steward's	1996	
18	Smutny	1996	Took over Lateral 4. E Coulee
19	Norris Pond 2	1996	TFC 3 + PR1
20	Ballard Pond 2	1993	TFC
21	K-2 Ponds	1996	1 5, K-2
22	Cedar Draw	1995	5.5
23	Sharp Ponds	1994	0.25, Laterals 30A & Q-2
24	McDonards Ponds	1994	0.5
25	Armatage	1995	0.25, Lateral 30
26	Fleming	1994	I 10
27	Van Winkle	1996	1.5, K-2
28	Kincade	1996	0.25, Next to Salmon Falls
29	N-Coulee	1996	0.25
30	Lateral 78	1996	0.16
31	I 3 Coulee	1996	0.25
32	Blass/Holms Drain	1996	0.25
33	N Coulee	1996	
34	Kueny	1996	3.0
35	T Coulee		
36	Summer Camp Ponds	1997	5.0
37	Dickerson	97	1.2

NORTH SIDE CANAL COMPANY BEST MANAGEMENT PRACTICES (1982-1997).
[Source: Dennis Heaps, Assistant Manager, North Side Canal Company Ltd., 921 North Lincoln, Jerome, Idaho 83338]

LATERAL	FACILITY	SIZE
A Drain	*2 ponds*	*1 acre/3 acres*
C-50	*2 ponds*	*1 acre each*
C-55	*1 pond*	*2 acres*
C-33	*3 ponds*	*1 acre each*
K-Coulee	*4 ponds*	*1-3 acres in size*

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Lateral 1		*Dissipates over pasture ground at 3700N 600E. Any return flows would enter Salmon Falls Creek.*
Lateral 3		*From Lateral 2 being fed by High Line Canal. It enters Salmon Falls Creek.*
Lateral 4	*690E 3950N*	*Some live water with lots of waste water.*
Lateral 5	*850E 4080N*	*This is a mix of live water and waste water.*
Lateral 7 becomes Lateral 7A and then becomes Lateral 6	*3900N 1060E Deep Creek* *840E 4080N Salmon Falls*	*Lateral 7 located at 1090E 3680N. Is mostly supplied by upper waste water returns. Enters Deep Creek as Lateral 7A and continues as Lateral 6 towards Salmon Falls Creek where it finally discharges.. Made up of waste water returns.*
Lateral 9		*Rarely enters Salmon Falls Creek since all the water is dispersed across pasture ground.*
Lateral 10	*4600N 790E*	*Mostly live water when a spill is present.*

TWIN FALLS CANAL COMPANY WATER QUALITY PONDS.
[Source: Stan Haye III, Field Supervisor, Twin Falls Canal Company, P.O. Box 326, Twin Falls, Idaho 83303]

NUMBER	NAME	YEAR	ACRES INVOLVED
1	Oregon Trail	1993	0.5, Lateral 31
2	Ballard	1993	0.25, Lateral 33
3	Norris #1 Pond	1993	1.50, Laterals 35/34 TFC
4	Summer Camp	1995	0.25, Perrine
5	Summer Camp	1995	0.25, Perrine
6	Spear Ponds	1994	0.5, Main
7	Spear Ponds	1994	0.5, Main
8	KIEM Ponds	1994	0.5, Perrine 3, Lateral 49
9	KIEM Ponds	1995	0.75, Perrine 3, Lateral 49
10	College of Southern Idaho Ponds	1993	1.0, Main Perrine
11	University of Idaho	1993	0.5, TFC
12	Walt Jones	1995	1.0, 2LL/Lateral 8
13		1995	0.15
14	Filer Polnds	1995	S Coulee
15	Blass	1995	S-2 Coulee
16	Steward's	1996	

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Lateral 53	3800N 1090E	Made up of some waste water returns and little live water
"Hp" Coulee	3850N 1080E	Mostly made up of seep water exiting some fish ponds & waste water returns.
"Lp" Coulee	3925N 1060E	This is the tail end of the Low Line Canal. Primarily made up of live water to make delivenes to Laterals 9 and 10.
Lateral 9A	4050N 1030E	
Lateral 57 A1	1030E 4050N	Some waste water and little live water.
Lateral 9C	4280N 1030E	Runs mainly over pasture ground on the tail end.
Lateral 60A	4200N 1020E	Some waste water and little live water.
Lateral 10B	4410N 1040E	Mostly waste water and some live water.
"N2" Coulee		This is the lower half of 44A. Water sometimes enters Deep Creek when not used up by pasture ground.

4. MUD CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
"N" Coulee	1350E 4040N	Made up of mostly waste water. Can supplement from Low Line Canal.
Lateral 41	4040N 1350E	Mostly waste water with a little live water.
"O" Coulee	4110N 1240E	Made up mostly of seep flows and some waste returns.
Lateral 44	1110E 4460N	Turns into "N1" Coulee. Mostly waste water with little live water.
Lateral 40B	4190N 1105E	Runs mainly over pastum ground then into Mud Creek.
Lateral 40A	4205N 1105E	Runs mainly over pastum ground before entering Mud Creek.
"L" Coulee		Becomes Laterals 40, 40A, 40B.
"K" Coulee	4330N 1240E	Made up of seep flow and waste water.
"J" Coulee	1300E 4425N	Made up of seep flows and waste water.
"I 1" Coulee	4330N 1310E	Made mostly of seep water, some live water, & waste water returns.
"N 1" Coulee		This is the lower half of Mud Creek. This catches a lot of waste water drainages.

5. SALMON FALLS CREEK TAIL SPILLS

2. CEDAR DRAW TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Cedar Draw	1920E 4550N	Cedar Draw spills into the Middle Snake River. Its return spill is from farmland.
Lateral 42	2120E 4010N	Waste water with some live water returns.
"E" Coulee	4200N 2050E	Seep water and waste water returns.
Lateral 11A	4275N 2030E	Mostly waste water. A little live water.
"F" Coulee	4360N 1960E	Mostly waste water returns with some live water.
"I 10" Coulee	1950E 4460N	Majority is waste water returns with some live water.

3. DEEP CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
High Line Canal	3150N 960E	High Line Canal spills into the upper end of Deep Creek, south of Castleford. Live water flows and numerous waste water returns. It feeds Laterals 1, 2, 4, 5, 7, 9, and 10.
Low Line Canal	3920N 1070E	Low Line Canal spills into Deep Creek. Waste water is from farmland.
Lateral 1		Dissipates over pastum ground at 3700N 600E.
Lateral 2		Becomes Lateral 3 west of Castleford. Enters Salmon Falls Creek.
Lateral 76	3300N 975E	Some live water, little waste water.
Lateral 75	3340N 950E	Made up of little live water, some waste water.
Lateral 73	3500N 940E	Some live water and some waste water.
"I" Coulee	940E 3540N	This is primarily a waste water return from farm ground. Farmers use up most of returns.
Lateral 69C	1000E 3620N	Some live water with little waste water.
Lateral 69 becomes "S 1" Coulee	1050E 3610N	"S 1" enters Deep Creek. Mostly waste water and some live water returns.
Laterals 65 & 65B, "R" and "S" Coulees	1090E 3680N	Enter Deep Creek above the head of Lateral 7. Mostly waste water returns.
Lateral 7 becomes Lateral 7A	3900N 1060E	Lateral 7 located at 1090E 3680N. Is mostly supplied by upper waste water returns. Enters Deep Creek as Lateral 7A and continues as Lateral 6 towards Salmon Falls Creek.
Lateral 61	3700N 1090E	Made up of some waste water returns with little live water.

TAIL SPILLS, WATER QUALITY PONDS, AND BEST MANAGEMENT PRACTICES OF THE TWIN FALLS AND NORTH SIDE CANAL COMPANIES

TWIN FALLS CANAL COMPANY TAIL SPILLS.

[Source: Stan Haye III, Field Supervisor, Twin Falls Canal Company, P O. Box 326, Twin Falls, Idaho 83303]

1. ROCK CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Rock Creek	4450N 2600E Twin Falls	Rock Creek spills into the Middle Snake River.
High Line Canal	3010N 3825E Hansen	High Line Canal goes over Rock Creek.
McMullen Creek	2950N 3460E Kimberly	McMullen Creek spills into both the High Line Canal and Rock Creek. This water enters the High Line Canal, flows downstream to 3350E 2975N Twin Falls, where it is diverted into Cottonwood Creek. This water is also supplemented from seeps and water from Coyote Creek that drains to the north into Rock Creek.
Cottonwood Creek	3320E 3310N Twin Falls	Cottonwood Creek drains under the High Line Canal which flows northeast into Rock Creek at 3110N 3450E Kimberly.
Low Line Canal siphon	3360E 3310N Twin Falls	The Low Line Canal crosses Rock Creek through a siphon.
Lateral 30	3310E 3400N Twin Falls	Lateral 30 spills to Rock Creek.
Lateral 31	3550N 3220E Twin Falls	Lateral 31 spills to Rock Creek.
Lateral 7A	3650N 3165E Twin Falls	Lateral 7A spills to Rock Creek.
Lateral 32		This lateral does not spill into Rock Creek.
Lateral 7	3670N 3130E	Spills into Rock Creek.
Lateral 12	3680N 3050E	This also collects water from Laterals 14, 9, Coulees "H", "I."
Lateral 36EXT	3730N 3030E	Spills into Rock Creek.
Lateral 36B	3010E 3760N Twin Falls	Spills into Rock Creek.
"K" Coulee	3880N 2820E Twin Falls	There are a number of seeps that supplement this coulee.
"L" Coulee	3910N 2780E	There are many seeps along this drain.
"OI" Coulee	3925N 2765E Twin Falls	Seep streams are the main source on this drain.
"PI" Coulee	4020N 2660E	This return flow is a natural draw.
"P" Coulee	4030N 2640E	Flows both return and seep & spills to Rock Creek.
Lateral 38	4070N 2650E	Lateral 38 is a waste water return & spills to Rock Creek.
"P2" Coulee	4080N 2630E	A seep flow with some return flows discharges to Rock Creek.
"Q2" Coulee	4270N 2600E	A return flow with Lateral 30 meeting on Rock Creek.
Lateral 30	4270N 2600E	A return flow with "Q2" Coulee meeting on Rock Creek.

b. STANDARD SOURCES AND PREPARATION
This will include procedures used to prepare working standards and the internal documentation that traces internal working standards to primary standards or purchased stocks. Additionally this will also include standard sources and preparation protocols including instrument group, source of primary standards and traceability of sources, frequency of standard preparation, and how the primary and working standards are stored.

c. STANDARD OPERATING PROCEDURES FOR EQUIPMENT CALIBRATION
This will include the specific calibration procedures for each instrument group with a list of the minimum or routine calibration procedures. This includes: instrument group or analysis type; initial calibration requirements such as the number of standards used for calibration, the frequency of initial calibration, how a calibration curve is generated (linear or logarithmic), and what criteria is used for acceptance or rejection; QC checks standards used for initial calibration and acceptance or rejection criteria; continuing calibration standards such as the number of standards used, the frequency of use, the concentration range, and the criteria for acceptance and rejection; and, equipment monitoring/calibration activities such as balances for accuracy checks, ovens for temperature monitoring, refrigerators for temperature monitoring, and incubators for temperature monitoring.

d. STANDARDIZATION OF TITRATION SOLUTION
This will include the information pertaining to standardization of titrating solutions, including solution(s) that require standardization, the source of the primary standards used for standardization, and the frequency of standardization.

5. LABORATORY QUALITY CONTROL CHECKS
The testing laboratory will follow the minimum quality control specified by each method. If no quality control requirements are listed in the method, the laboratory will follow its internal requirements with a description of the details of those internal requirements. Additional QC checks will be included, if specified by the approved method, and may be reagent purity checks, internal standards, and surrogate spikes.

6. DATA PROCEDURES AND RESULT REPORTING
The laboratory will list its method detection limits, accuracy, precision targets for different equipment and analytical procedures. Additionally, there will be a description of how to assess precision and accuracy within the laboratory, how data integrity can be assured, how raw data are reduced to reportable values (including notebook, worksheet or spreadsheet used to calculate values and the formulas), the types of forms and records that are routinely printed for verification and signatures, how data entry into computer and paper records (by identified person), and how data are transferred.

DOCUMENT SOURCE: Principle writer Dr. Balthasar B. Buhidar, Ph.D., DEQ-TFRO, October 15, 1997. Additional comments incorporated from the Mid-Snake TAC representing water user industries, organizations, and agencies, and the Mid-Snake WAG through public comment from October 15, 1997 to November 15, 1997. Previous to October 15, the TAC had met and preliminarily began developing a plan for the Mid-Snake River. The plan was incorporated into the Upper Snake Rock Subbasin Assessment. Final plan was presented to Mid-Snake WAG on _____ for approval.

of submitted specimen/sample, requisition form, fixation, promptness of delivery to the laboratory, and specimen/sample preservation; and, complete specimen/sample documentation and identification.

b. SPECIMEN/SAMPLE LOG IN
This describes how specimens/samples are logged, the information that is entered in a specimen/sample log book, and how samples are identified. At a minimum, specimen/sample logs must include the following: date of receipt in lab, specimen/sample collection date, lab identification number, field identification number, requested analyses, and initials of logger.

c. SPECIMEN/SAMPLE STORAGE AND SECURITY
This describes specimen/sample storage, accessibility, and supporting documentation. It should include discussions of security for sample digestates and extracts.

d. SPECIMEN/SAMPLE DISTRIBUTION AND TRACKING
This describes the procedures used to identify incoming samples, work assignments, and how the samples are tracked through sample preparation and sample analysis.

e. SPECIMEN/SAMPLE DISPOSITION
This describes how specimen/sample disposition is documented.

f. OTHER LABORATORIES
This describes the procedures used to transport samples and/or sample extracts to another laboratory. It includes a discussion of documentation, and the information that is transmitted with the sample(s).

3. ANALYTICAL PROCEDURES
The testing laboratory will be an EPA certified laboratory with approved EPA procedures that are documented in the Code of Federal Regulations (CFR). Not all procedures, however, are EPA certified, but may be adopted by EPA as "alternative methods." Therefore, as a minimum, the following requirements should embrace all analytical procedures by the testing laboratory:

a. All procedures should be based on EPA approved procedures. The procedures should be identified by component name, EPA method number, and source.

b. Where a procedure is not found in an EPA approved procedures source but may be considered as an alternative method, or where an EPA procedure is modified, documentation of the alternative method or of the modified EPA procedure will be referenced accordingly.

c. Laboratory glassware including cleaning procedures (appropriate detergents, rinses with tap water and lab grade water, and acid or solvent rinses/soaks) and storage operating procedures will be referenced accordingly.

d. Reagent storage (for all reagents and chemicals other than standards) and their documentation will be referenced accordingly.

4. MAINTENANCE LOG OF PRINCIPAL EQUIPMENT
The testing laboratory will maintain a list of principal equipment and instrument (including manufacturer's name and model number) and the name of the person designated to maintain them. As part of this maintenance log, the following will be included:

a. STANDARD RECEIPT
This will include the standard operating procedures on how the standards are received, stored, logged, and documented for the internal laboratory use, and how records of manufacturer's certification and traceability statements are maintained.

COROLLARY 1. QUALITY CONTROL AND QUALITY ASSURANCE

As part of a QA/QC system, quality improvement objectives may include the following:

- To demonstrate that the quality control operations are, in fact, being carried out both in the field and in the laboratory, and maintain a continuing assessment of the accuracy and precision of data generated by analysts within the laboratory group.
- To assure the accountability and traceability of field samples, their transport to the laboratory, their testing and reporting within the laboratory, and to help ensure that the analytical work will withstand legal security.
- To identify any weakness and problems in the field and in the laboratory and provide immediate preventive and corrective actions.
- To detect training needs and concerns within the whole system when they are warranted.

The *Idaho Bureau of Laboratories'* Policy Statement Number 1-91 (Appendix A) states: "there shall be sufficient QA activities conducted to ensure that all data generated and processed will be scientifically valid." As part of this policy, it is assumed that QA will include a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and defensible quality. Thus, as a consequence of this QA the accuracy of the analytical result can be stated with a high level of confidence. Included in QA are two critical components: QC (or internal QC) and quality assessment (or external QC).

The testing laboratory shall have a QC program which shall include at a minimum the following: certification of operator/analyst competence, recovery of known additions, analysis of externally supplied standards, analysis of reagent blanks, calibration with standards, analysis of duplicates, and control charts. *Standard Methods*, 19th Edition 1995, §1020 B is referenced for further consideration.

The testing laboratory will have a quality assessment program which will use external and internal quality control measures to determine the quality of the data produced by the laboratory. It will include at a minimum the following: performance evaluation samples, performance audits, and laboratory intercomparison samples. *Standard Methods*, 19th Edition 1995, §1020 C is referenced for further consideration.

The following specifies the minimum criteria for sampling and laboratory analysis within the confines of this trend monitoring plan:

1. SPECIMEN/SAMPLE CUSTODY

The testing laboratory will have a specimen/sample custody process that will provide a clear description of specimen/sample (and container) traceability from the point of origin through final specimen/sample disposition. It will also identify all responsible persons involved in the laboratory procedures and a brief description of their duties with respect to specimen/sample custody. Documentation will be provided and maintained by the laboratory to establish legal chain of custody and will include: specimen/sample transmittal/submission forms, laboratory specimen/sample logs, specimen/sample preparation and analysis logs, specimen/sample storage logs, and specimen/sample disposition logs.

2. LABORATORY CUSTODY

The testing laboratory will provide laboratory custody and will include the following:

a. SPECIMEN/SAMPLE RECEIPT

This describes the activities involved with initial specimen/sample receipt and includes: specimen/sample acceptability; verification of specimen/sample integrity through correct identification

Species composition and functional attributes will be summarized and comparisons made to expected conditions or upstream reference site(s). Salmonids size classes and biomass will be evaluated to determine attainment of salmonid spawning and to assess the quality of the sport-fishery at each site

All data will be considered for STORET databasing by the TAC, or an appropriate database system that allows for retrieval of the data for future use. Initially, the reporting laboratory will provide the preliminary electronic database for readily available access.

An annual progress review will be instituted and prepared by the TAC. As part of that review, the TAC will review other monitoring that supports the trend monitoring plan but is independent of the plan. Other monitoring may include data from point source industries, nonpoint source industries, agencies, and organizations that specifically monitor the Middle Snake River.

As part of the statistical analysis, the TAC will provide some direction on conclusions to be drawn from the trend monitoring. Such interpretive analysis shall be based on relative changes that may occur in the river system from year-to-year. The trend monitoring plan does not proport to demonstrate cause and effect relationships. Rather, it is designed to quantitatively measure changes over time.

V. CONCLUSION

The proposed trend monitoring plan for the Middle Snake River is but one component in assessing if its beneficial uses have attained state water quality standards. It is important to understand that this plan has its limits. Although some parameters (such as total phosphorus and total suspended solids) have extensive databases since 1990, other parameters (such as plant species composition, macroinvertebrates) have received less attention and thus are less definable. Additonally, normal variation within any parameter is difficult to estimate unless extensive data is collected. Thus, the plan calls for minimal trend monitoring (on a monthly basis) of three selected sites for water chemistry parameters, and a special, more intensive survey (every three years) of the three near-the-selected sites for biological species (inclusive of habitat, fisheries, macrophytes, macroinvertebrates, and phytoplankton). Additional monitoring being done by various agencies and organizations on the Middle Snake River, as well as point source effluent monitoring, will be used to assess the river for a fuller understanding of its nutrient processing, ecosystem metabolism, organic carbon dynamics, and other processes to determine if its beneficial uses have been met. And, if resources become available to IDEQ-TFRO additional sites (inclusive of the tributaries) will be considered.

VI. SOURCES

All sources and references are included in §2.60 of the Upper Snake Rock Subbasin Assessment.

PARAMETER	RECOMMENDED MDL
TOP, mg/L	0.01 mg/L
TKN, mg/L	0.10 mg/L
NH3, mg/L	0.01 mg/L
NO2+NO3, mg/L	0.01 mg/L
Suspended Sediment, mg/L	1.0 mg/L

Water quality sampling will follow standard protocols and methods as defined by the TAC for the Middle Snake River. Appendix 1 is included as a basis from which the TAC may wish to resolve technical issues.

C. EQUIPMENT AND MATERIALS

All equipment and materials used for field and laboratory preparatory procedures will be reviewed by the TAC relative to sampling of water chemistry, macroinvertebrates, fisheries, macrophytes, and phytoplankton. The TAC will determine if the equipment and materials for sampling and preparation of field parameters for testing is appropriate.

A modified slack sampler (425 micron) will be used in riffle habitats for semi-quantitative collections and multiple gear (Ponar dredge, d-frame net, hand-picking, etc. used to collect qualitative samples within each reach). Samples would be composited to represent the overall reach conditions and to reduce costs.

All fish would be sampled using standard electrofishing techniques (developed by either the Idaho Fish and Game, the Division of Environmental Quality, or NAWQA protocols) including both boat and backpack equipment. All habitats and species would be sampled within each reach and standard units of effort recorded. Multiple gear would be used if conditions warranted their use. All species would be enumerated and game species would be measured for weight and length. Composite weights would be taken for biomass estimates for all nongame species. Each fish would be checked for external anomalies.

Periphyton samples will be taken from natural substrate in the same area where macroinvertebrate samples are taken in riffle habitat. Collections would be made with a standard collection device used in the NAWQA program of a known area and samples composited for an overall reach condition.

D. STATISTICAL ANALYSIS OF DATA

Statistical analysis of data will be based on a seasonal Kendall-tau test that is detrended for flow to analyze the water quality data for monotonic trends. This nonparametric procedure is suitable for application to water quality data which are often skewed, serially correlated, and seasonality affected. Additionally, missing values, or values defined as "less than" the laboratory detection limit present no problems. The test also provides a "slope estimator" for the average rate of change over the whole test period. Examples of the application of the seasonal Kendall test include analyses of U.S. nationwide stream-sampling data, Swedish and Latvian river water quality data, estuarine data sets, and long-term trends in Pamlico River estuary nutrients for watershed nutrient production.

If *a post hoc* or *ad hoc* test is warranted, then it will be done based on current accepted *post hoc* statistical test procedures. Nonparametric summaries will be performed on all metrics. The IDEQ and the TAC will review and make suggestions on all statistical analysis of the data.

METRIC COMPONENT	DESCRIPTION
EPT Index	A measure of a groups sensitive to pollution by measuring the taxa richness for the three major groups
Taxa Richness	A measure of the health of the community through a measure of the variety of taxa present.
Shannon s H Diversity Index	A measure of species diversity or the evenness of the distribution of individuals in a community and their response to pollution.

d. MACROPHYTES

Macrophyte mapping will be done annually on the Middle Snake River with a minimal evaluation of habitat for flow, velocities, and specific macrophytes and/or algae. Additionally, macropohytes (including filamentous algae) will be assessed annually within each reach at each site. Species composition and biomass will be determined for primary species and major groups (i.e., rooted vascular, filamentous algae, and floating). Fly-over mapping of macrophytes will also be made to supplement reach data and to characterize the areal extent of plant growth. Ground truthing would be used to confirm habitat conditions and species composition.

e. ALGAE

Algae samples will be collected from natural substrate (periphyton) and from water column (phytoplankton) samples. Samples will be analyzed for chlorophyll and pheophytin, and taxonomic composition and densities per unit area and/or volume determined. Biomass estimates will be determined for periphyton.

IV. MATERIALS AND METHODS

In general, the trend monitoring plan will use those protocols for materials and methods as defined by the IDEQ and USGS/NAWQA and will follow the standard USEPA protocols for QA/QC and sampling and parameter testing.

A. QUALITY ASSURANCE AND QUALITY CONTROL

The primary objective of the trend monitoimg plan's quality assurance and quality control (QA/QC) is to generate high quality data in an efficient and cost effective manner under a planned and documented quality system. Corollary 1 describes some of the more pertinent considerations for QA/QC. The TAC will review and make suggestions on all QA/QC procedures relevant to the testing laboratory. At least 10% of all samples taken during each sampling event will have QA/QC checks for blanks, spikes, and duplicates where appropriate.

B. PARAMETERS-OF-CONCERN

The testing laboratory will provide to the TAC the method detection limit (MDL) for each parameter so the TAC can make suggestions on the applicability of the appropriate MDL. As part of the overall effort and purpose of the trend monitoring plan, the TAC will provide scientific recommendations to the laboratory on the MDL for each parameter to be tested. Those recommendations may include the following MDL levels for selected parameters:

RECOMMENDED METHOD DETECTION LIMITS FOR SELECTED PARAMETERS TO BE TESTED.

PARAMETER	RECOMMENDED MDL
TP, mg/L	0.01 mg/L

PARAMETER	MONITORING FREQUENCY	COMMENTS
Number of species	Annual	
Number of native species	Annual	
Percent anomalies	Annual	
Percent introduced species	Annual	
Percent common carp	Annual	
Percent cottids	Annual	
Percent salmonids	Annual	
Percent juvenile salmonids	Annual	< 4 inches length
Percent adult salmonids	Annual	> 8 inches length
Number of intolerant species	Annual	
Percent omnivores	Annual	
Percent coldwater adapted	Annual	

The Reconnaissance Index of Biotic Integrity (RIBI), as developed by the Idaho Division of Environmental Quality, will be used as an analytical tool for assessing the aquatic life beneficial use status determinations for the wadable stream portions of the Middle Snake River. The minimum collection effort must include the core methods defined in the Idaho Division of Environmental Quality's Water Body Assessment Guidance.

c. MACROINVERTEBRATES

Macroinvertebrates will be collected from both natural riffle substrate (semi-quantitative) and from all habitats (qualitative) found within each reach. Microhabitat measures of depth, velocity, and substrate quality would be made for each riffle collection.

The Macroinvertebrate Biotic Index (MBI), as developed by the Idaho Division of Environmental Quality, will be used as an analytical tool for assessing cold or warm water biota in wadable stream portions of the Middle Snake River. The MBI consists of seven (7) metrics which are described in the following table:

THE METRICS OF THE MACROINVERTEBRATE BIOTIC INDEX.

METRIC COMPONENT	DESCRIPTION
EPT%	A measure of the proportion of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) to the rest of the macroinvertebrates in the sample.
HBI	A measure of organic pollution and its effect on the macroinvertebrates.
Scrapers %	A measure of a functional feeding group as an indicator of the riffle community food base based on their relative abundance.
Dominance %	A measure of the contribution of the numerically dominant taxon to the total number of individuals in the community.

The following physical, hydrologic, and physicochemical habitat characteristics will be monitored: reach length, width, depth, width/depth ratio, velocity, discharge, discharge as percent coefficient of variation (CV), specific conductivity, water temperature, pH, dissolved oxygen, percent dissolved oxygen saturation, substrate size, percent embeddedness, percent substrate fines, percent cover, and percent open canopy.

HABITAT CHARACTERISTIC PARAMETERS-OF-CONCERN

PARAMETERS	MONITORING FREQUENCY	COMMENTS
Reach length, ft	Annual	Physical characteristic
Width, ft	Annual	Phisical characteristic
Depth, ft	Annual	Physical characteristic
Width/Depth Ratio	Annual	Physical characteristic
Velocity, ft/s	Annual	Hydrologic characteristic
Discharge, cfs	Annual	Hydrologic characteristic
Discharge, % CV	Annual	Hydrologic characteristic
SC	Annual	Physicochemical characteristic
Temperature, °C	Annual	Physicochemical characteristic
pH	Annual	Physicochemical characteristic
DO, mg/L	Annual	Physicochemical characteristic
% DO Saturation	Annual	Physicochemical characteristic
Substrate size, inches	Annual	Physical characteristic
Percent Embeddedness	Annual	Physical characteristic
Percent substrate fines	Annual	Physical characteristic
Percent cover	Annual	Physical characteristic
Percent open canopy	Annual	Physical characteristic

b. FISH METRICS

Fish metrics will be determined for: number of fish collected, number of fish per minute of electrofishing, number of species, number of native species, percent anomalies, percent introduced species, percent common carp, percent cottids, percent salmonids, percent juvenile salmonids (less than 4 inches in length), percent adult salmonids (greater than 8 inches in length), number of intolerant species, percent omnivores, and percent coldwater adapted.

BIOLOGICAL PARAMEERS-OF-CONCERN FOR FISHERIES

PARAMETER	MONITORING FREQUENCY	COMMENTS
Number of fish collected	Annual	
Number of fish/min. Electrofishing	Annual	In an upstream direction

I. LITERATURE SURVEY

A literature survey of sampling procedures, analytical procedures, and quality control/quality assurance protocols was previously conducted by the Idaho Division of Environmental Quality (IDEQ) for the express purpose of formulating "minimal requirements" for a variety of trend monitoring plans. The results of that survey are included in this document as sited references. Those references are cited in §VII, Sources.

III. DESCRIPTION OF LOCATION AND SAMPLING SITES

The objective of the trend monitoring plan is to assess and report the existing condition of the Middle Snake River, to determine the long term trends, and to evaluate compliance with the state's water quality standards. Trend monitoring requires repeated sampling at a few key locations for a number of years. A monthly sampling frequency at these stations is the minimum frequency needed to adequately assess long term trends in water quality. Special and more intensive surveys may be performed to provide the more detailed data needed for determination of changes throughout a stream (or stream segment) in a short period of time (for cause and effect studies) or a study designed to determine the water quality at a series of closely related points in conjunction with a later survey to determine changes in water quality related to time. Ideally, all major surface waters (like the Middle Snake River) should undergo special or intensive water quality surveys on a periodic basis (such as three or four years).

The TAC determined that a less aggressive but overall comprehensive trend monitoring plan that incorporates monthly trend monitoring (for water chemistry parameters) and annual monitoring of aquatic biota would be suitable for defining a "skeletal framework" that could be built upon over the next ten years by the various agencies and organizations. The trend monitoring will also survey loads, concentrations, and changes in flow. Biological and habitat assessments will be conducted during summer low flow conditions (July-August) annually. This comprehensive approach of collecting multiple lines of evidence including chemical, physical, and biological parameters will provide a more robust trend monitoring approach which can accurately assess beneficial use attainment resulting from long-term management activities.

Therefore, the following describes the location and the sites to be considered for the trend monitoring of the Middle Snake River over the next ten years.

1. Three monitoring sites on the Middle Snake River have been selected. These sites are in the Milner area, the Buhl area, and the King Hill area. Their selection is due primarily to already existing USGS gaging stations for flow determination and ongoing National Water Quality Assessment (NAWQA) activities at selected sites. Additional sites (inclusive of tributaries) may be considered by IDEQ-TFRO if resources become available and allow for such.

2. At each site, water chemistry parameters will be monitored on a monthly basis. In conjuntion with this, flows will be determined as well. Water chemistry parameters will include total phosphorus (TP), dissolved ortho-phosphate (DOP), total Kjeldahl nitrogen (TKN), ammonia (NH3), nitrite+nitrate (NO2+NO3), sediment (as suspended sediment), dissolved oxygen (DO), turbidity (NTU), pH, specific conductance (SC). Continuous summer water temperature will be monitored at each site. Additionally, chlorophyll *a* and pheophytin will be collected as part of the water chemistry parameters.

3. Within the vecinity of the three selected sites, biological species will be monitored annually for richness, diversity, and their functional attributes. These sites will be selected based on areas that are conducive to macrophyte growths. The biologicals will include fish, macroinvertebrates, macrophytes, algae (periphyton and phytoplankton) and will be monitored annually. Associated instream and riparian habitat reach characteristics will be assessed annually at each site. In order to maintain consistency and comparability with ongoing programs, NAWQA protocols will be used when possible for aquatic life and habitat assessments.

a. HABITAT CHARACTERISTICS

A TREND MONITORING PLAN FOR THE MIDDLE SNAKE RIVER TO DEFINE RELATIVE CHANGES IN VARIOUS AQUATIC LIFE: CHEMICAL, PHYSICAL, AND WATER QUALITY PARAMETERS OVER A TEN YEAR PERIOD

by the

Technical Advisory Committee of the
Middle Snake River Watershed Advisory Group
June 2, 1998

I. INTRODUCTION

The purpose of this trend monitoring plan for the Middle Snake River is to help document relative changes in various aquatic organism populations, and in physical and chemical water quality parameters over a ten year period during the implementation of the Middle Snake River Watershed Management Plan. The river system-of-interest is the Middle Snake River. Tributaries to the Middle Snake River will be considered at a later time. The parameters defined in this plan summarize the minimal number of parameters that should be considered when developing other monitoring plans in the Middle Snake River by various agencies and organizations. Additionally, the data collected in this trend monitoring plan will be used in conjunction with other data from various agencies, organizations, and water user industries to assess if progress is being made on the Middle Snake River towards attainment of state water quality standards and its beneficial uses.

Various agencies and organizations have been involved in the collection of aquatic organisms and of physical and chemical water quality data over a number of years. In addition, point source industries have been involved in effluent monitoring of which their effluent either directly or indirectly discharges to the Middle Snake River. Collectively, this information will provide a substantial database from which to assess the overall condition of the Middle Snake River. The proposed trend monitoring plan is but one component in the overall database for assessment of the Middle Snake River. As of this writing, the IDEQ-TFRO has developed and will continue to develop a multi-agency/multi-organization monitoring database on the Middle Snake River as resources permit. All data collected through monitoring by IDEQ-TFRO will be made available on its www/Internet site as it becomes available.

On April 25, 1997 the Middle Snake River Watershed Management Plan containing the Mid-Snake TMDL for total phosphorus was approved by the U.S. Environmental Protection Agency (EPA). Implementation of this plan with its point and nonpoint source pollutant limitations is likely to bring the Middle Snake River into compliance with state water quality standards and allow the water body to meet its beneficial use requirements. Refining initial control strategies, additions and refinements to allocations and use of the feedback loop to identify if other adjustments to the plan are necessary and are dependent on effective monitoring. The trend monitoring described below is an integral part of this effort.

On September 4, 1997 the Middle Snake River Technical Advisory Committee (TAC), representing various scientists from agencies and water user industries agreed that the following parameters be included as "minimal water quality parameters" for the initial water quality testing in the trend monitoring plan: total phosphorus (TP), dissolved ortho-phosphate (DOP), total Kjeldahl nitrogen (TKN), ammonia (NH3), nitrite+nitrate (NO2+NO3), sediment (as suspended sediment), dissolved oxygen (DO), temperature, turbidity (NTU), pH, specific conductance (SC), and water velocity (as a subcomponent of flow). Minimal parameters that will be used in mass balance determinations include: TP, DOP, TKN, NH3, NO2+NO3, and sediment. -Additionally, the TAC considered various aquatic organisms and physical parameters, and these will be monitored as well.

One additional consideration was the need to use the same laboratory for the trend monitoring over the ten year period. This was agreed to by the TAC so as to reduce the variability that exists if various laboratories are used within the scope of the time frame. Therefore, the TAC strongly suggests that one laboratory be used throughout the life of the monitoring plan.

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6.0 SOURCES AND REFERENCES

A conscientious effort was made to maintain a list of all references used in the development of the subbasin assessment and the TMDL. Every document reviewed, whether identified in the document or not, was included in this list of sources and references. Additionally, the bibliography noted in the *Trend Monitoring Plan* is included in this list of sources and references. The format used is that of the Name-Year System as described in the CBE Manual (6th edition) and is a system widely known as the "Harvard system." The listing is alphabetical by author surname, organization/agency name, or computer program name. Sources and references may be located at IDEQ-TFRO, IDEQ-State Office, Boise State University library, Idaho State University library, or as a download of information from the internet website where available, or from the specific agency or organization that publishes the document.

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Land Use Anderson Level 2. Basins, EPA.
Land Ownership, IDWR.
USGS Gaging Stations. Basins, EPA.
Hydrography (1:100k and 1:250k), IDWR.
Geology (1:100k topographic images (DRGs) for Idaho, USGS.
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meeting in March were for continue discussion and receipt of comments from the TAC on the TMDL development section.

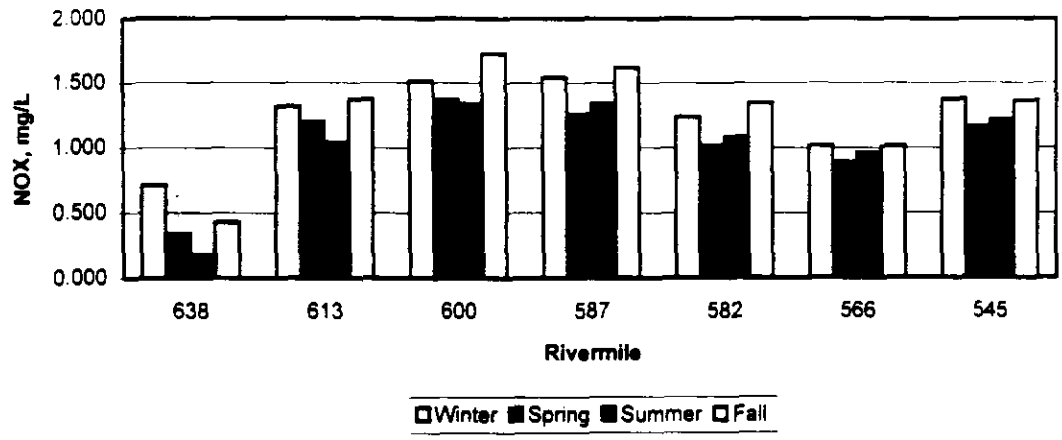
5.4 PUBLIC NOTICE ON THE SUBBASIN ASSESSMENT

Although no office public notice was advertised for the Upper Snake Rock Subbasin Assessment, public review of the document commenced on June 17, 1998 and ended on September 17, 1998. Additional comments that came in during this period were also incorporated into the document. After a second review by IDEQ-Central Office, the document was proposed as a final draft on December 31,1998. TMDL development commenced January 1, 1998. A final proposed TMDL development draft was finalized on October 4, 1999. The WAG received this copy of October 20, 1999 at their regularly scheduled WAG meeting. Official public notice commenced on November 1, 1999 and lasted 30 days. Comments received were incorporated into the body of document where appropriate. The final Upper Snake Rock Watershed Management Plan was submitted to USEPA-Boise on December 20, 1999.

VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q Load (tons/year)

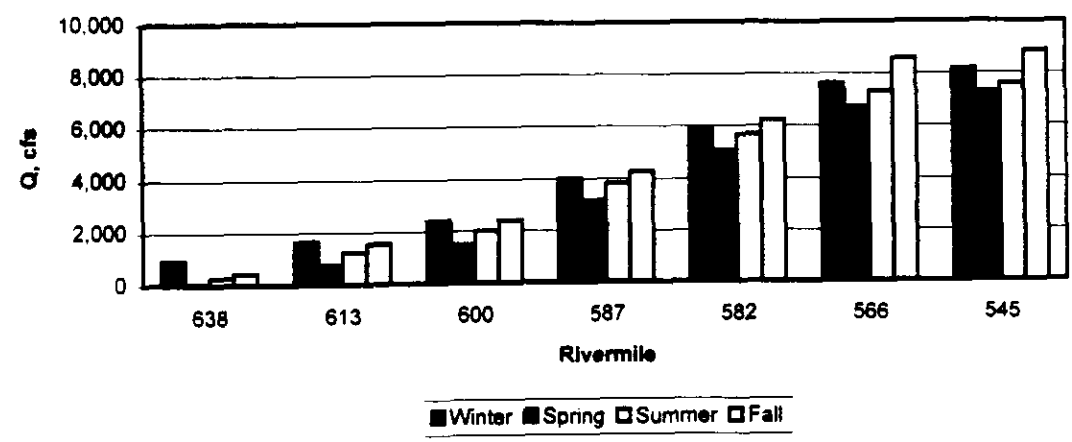
NOX, mg/L (WY1990-1998):

Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	0.709	1.319	1.514	1.543	1.239	1.016	1.373
SPRG (3,4,5)	0.341	1.198	1.369	1.256	1.016	0.887	1.163
SUMM (6,7,8)	0.181	1.038	1.339	1.343	1.081	0.958	1.217
FALL (9,10,11)	0.428	1.373	1.728	1.620	1.346	1.012	1.360
SPRG/SUMM	0.261	1.118	1.354	1.299	1.049	0.923	1.190
FALL/WINT	0.569	1.346	1.621	1.582	1.292	1.014	1.367



NOX, Q:

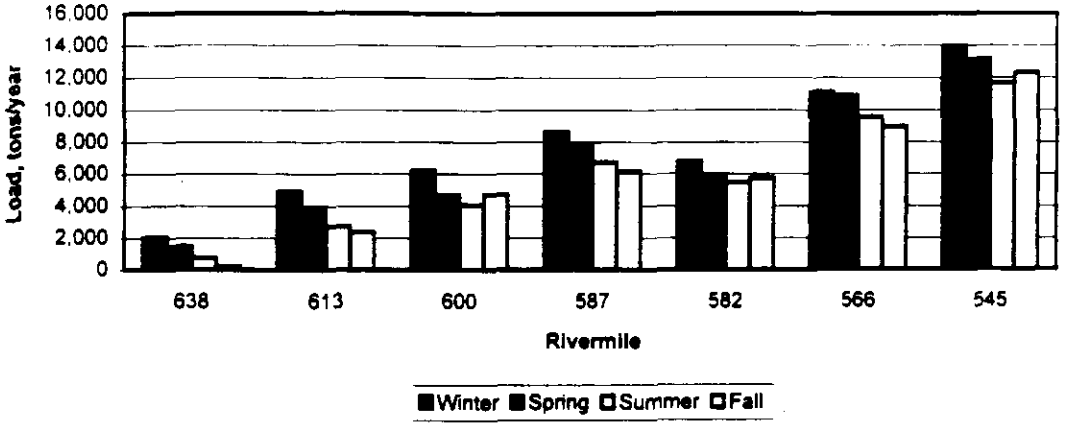
Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503



VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L); Q. Load (tons/year)

NOX: tons/year

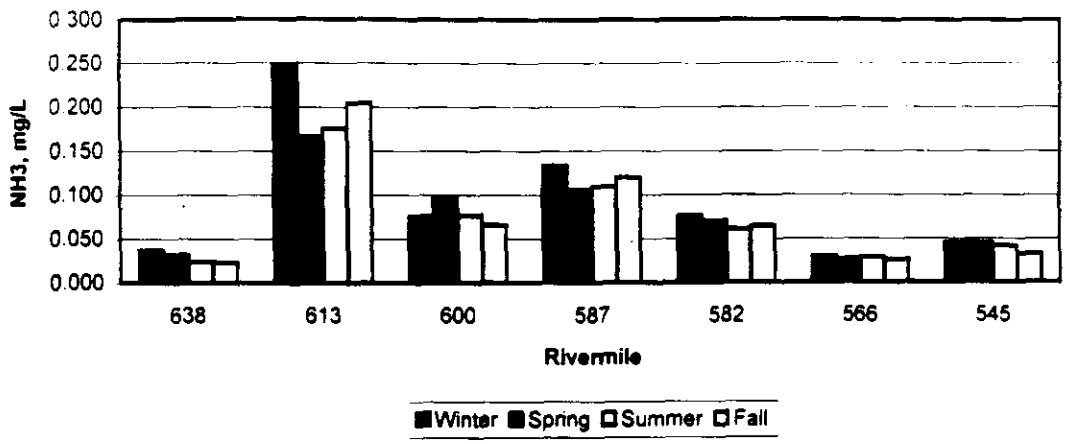
Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12.1.2)	2,035.5	4,908.5	6,201.4	8,620.5	6,773.0	11,091.0	13,968.0
SPRG (3.4.5)	1,459.2	3,740.0	4,663.0	7,785.4	5,895.7	10,876.4	13,128.4
SUMM (6.7.8)	770.0	2,720.8	4,083.7	6,733.5	5,457.6	9,552.9	11,646.5
FALL (9.10.11)	228.4	2,377.3	4,735.2	6,138.0	5,736.0	8,941.8	12,292.7
SPRG/SUMM	1,114.6	3,230.4	4,373.3	7,259.5	5,676.7	10,214.7	12,387.5
FALL/WINT	1,131.9	3,642.9	5,468.3	7,379.3	6,254.5	10,016.4	13,130.4



VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

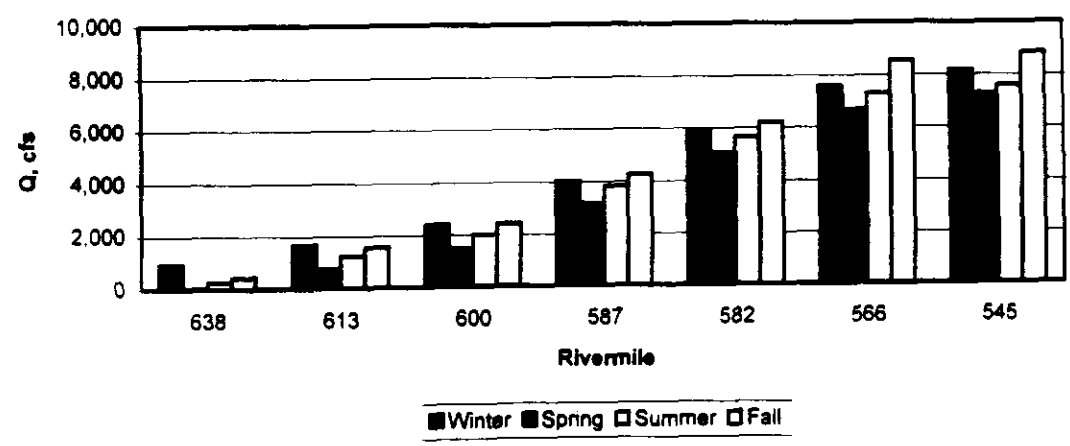
NH3 mg/L WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	0.037	0.249	0.076	0.133	0.076	0.030	0.046
SPRG (3,4,5)	0.032	0.167	0.097	0.106	0.070	0.027	0.045
SUMM (6,7,8)	0.024	0.175	0.077	0.109	0.061	0.028	0.042
FALL (9,10,11)	0.023	0.205	0.066	0.120	0.065	0.026	0.033
SPRG/SUMM	0.028	0.171	0.087	0.108	0.066	0.028	0.044
FALL/WINT	0.030	0.227	0.071	0.127	0.071	0.028	0.039



NH3, Q:

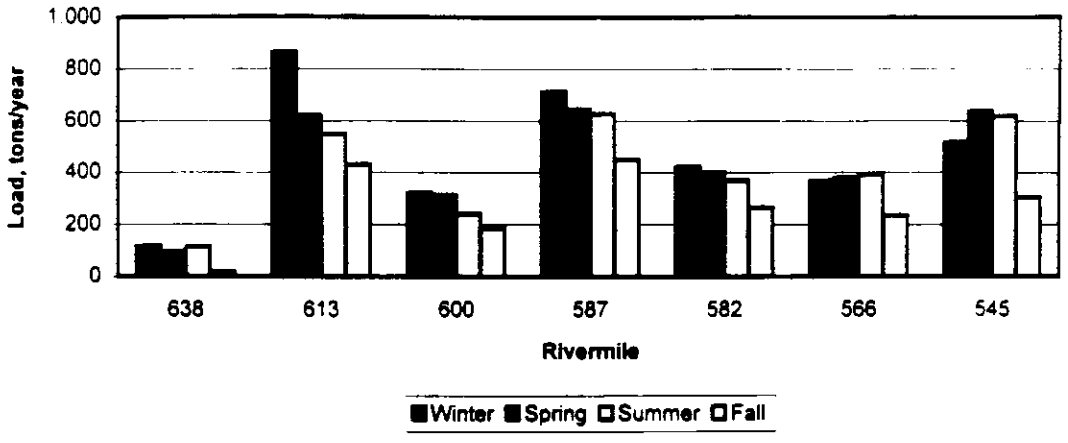
Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503



VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

NH3 tons/year

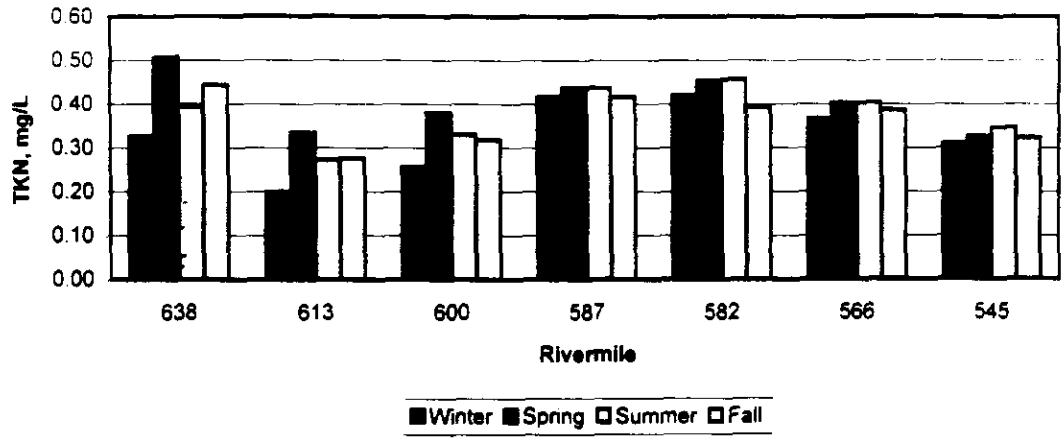
Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12.1.2)	117.1	863.9	321.4	713.0	423.2	368.7	516.6
SPRG (3.4.5)	94.0	619.9	311.8	645.2	401.0	381.0	638.2
SUMM (6.7.8)	115.5	547.3	241.5	626.4	368.5	390.9	618.1
FALL (9.10.11)	19.1	430.0	188.4	448.8	265.8	234.5	306.0
SPRG/SUMM	104.8	583.6	276.7	635.8	384.8	386.0	628.2
FALL/WINT	68.1	647.0	254.9	580.9	344.5	301.6	411.3



VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q. Load (tons/year)

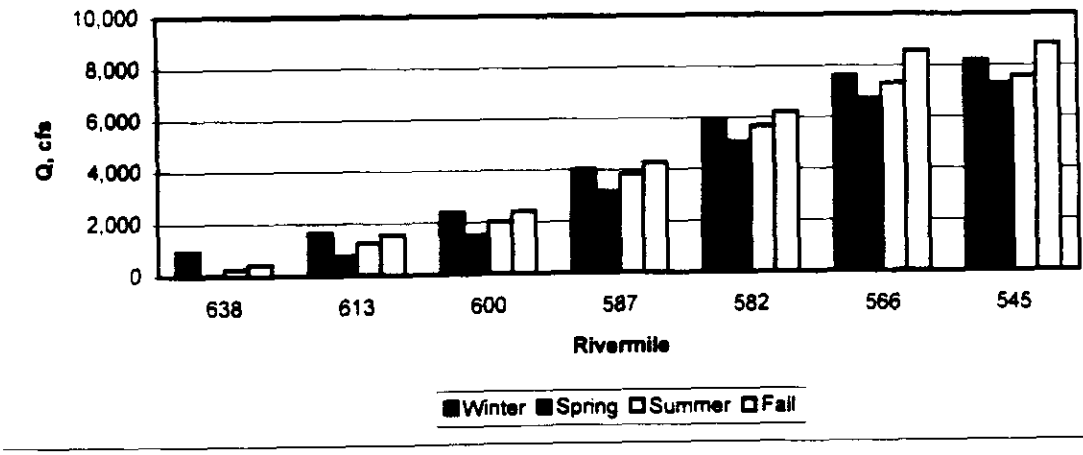
TKN (mg/L) (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	0.33	0.20	0.26	0.42	0.42	0.37	0.31
SPRG (3,4,5)	0.51	0.33	0.38	0.44	0.45	0.40	0.33
SUMM (6,7,8)	0.39	0.27	0.33	0.44	0.46	0.40	0.35
FALL (9,10,11)	0.44	0.28	0.32	0.42	0.39	0.39	0.32
SPRG/SUMM	0.45	0.30	0.35	0.44	0.46	0.40	0.34
FALL/WINT	0.39	0.24	0.29	0.42	0.41	0.38	0.32



TKN, Q:

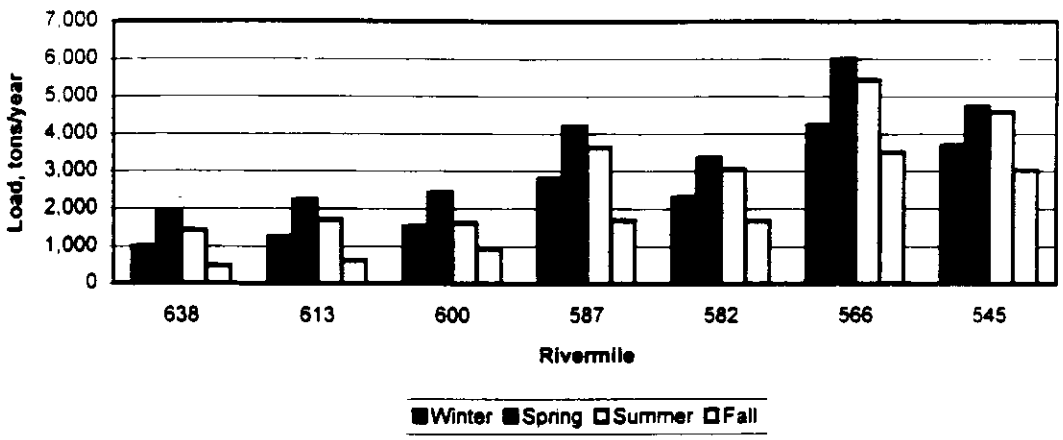
Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503



VI SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L) Q Load (tons/year)

TKN tons/year

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	1,008.4	1,263.2	1,541.3	2,816.3	2,312.7	4,248.4	3,697.1
SPRG (3,4,5)	1,948.9	2,236.4	2,432.7	4,197.8	3,363.6	6,004.6	4,740.1
SUMM (6,7,8)	1,428.3	1,707.8	1,619.4	3,630.6	3,042.5	5,444.5	4,582.3
FALL (9,10,11)	479.9	625.0	948.2	1,698.4	1,690.0	3,509.5	3,037.8
SPRG/SUMM	1,688.6	1,972.1	2,026.1	3,914.2	3,203.0	5,724.6	4,661.2
FALL/WINT	744.2	944.1	1,244.8	2,257.4	2,001.4	3,879.0	3,367.5

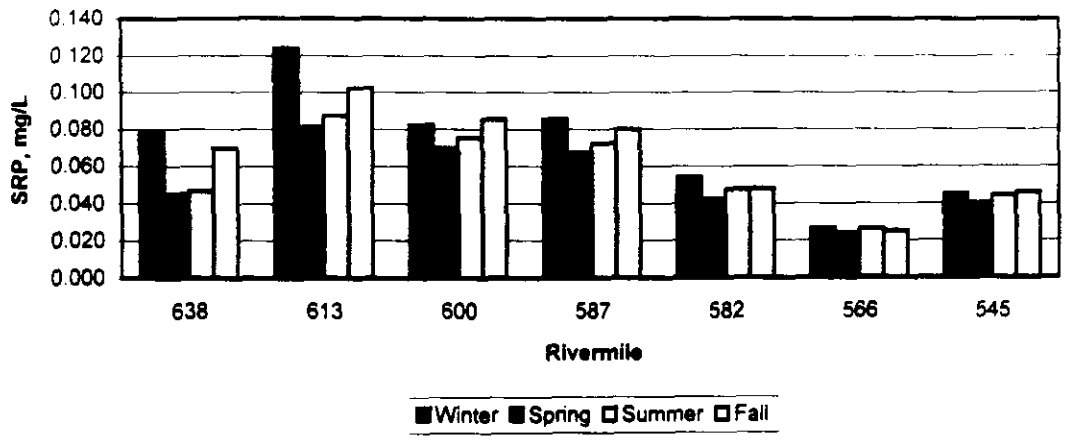


SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT

Concentration (mg/L) Q, Load (tons/year)

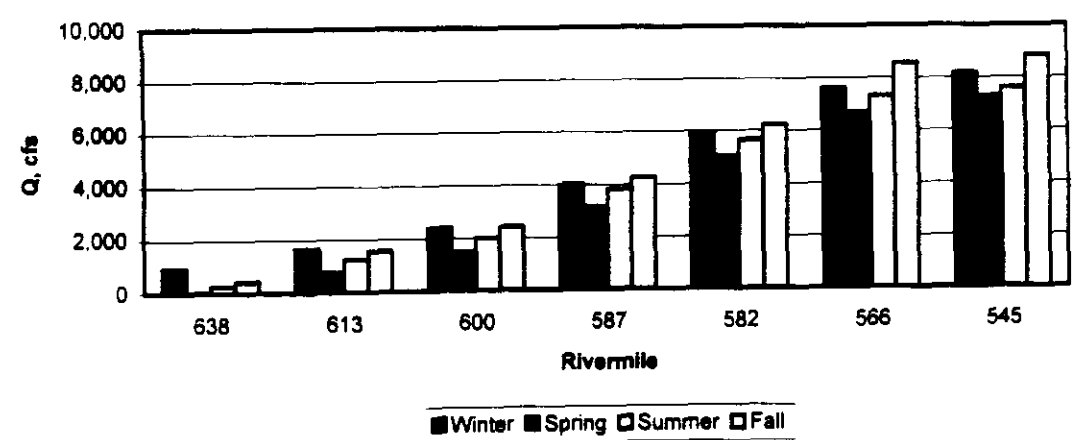
SRP, mg/L (WY1990-1998)

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	0.078	0.124	0.082	0.086	0.054	0.027	0.045
SPRG (3,4,5)	0.045	0.081	0.070	0.067	0.042	0.024	0.040
SUMM (6,7,8)	0.047	0.087	0.075	0.072	0.048	0.026	0.044
FALL (9,10,11)	0.070	0.102	0.085	0.080	0.048	0.025	0.046
SPRG/SUMM	0.046	0.084	0.073	0.070	0.045	0.025	0.042
FALL/WINT	0.074	0.113	0.084	0.083	0.051	0.026	0.046



SRP, Q:

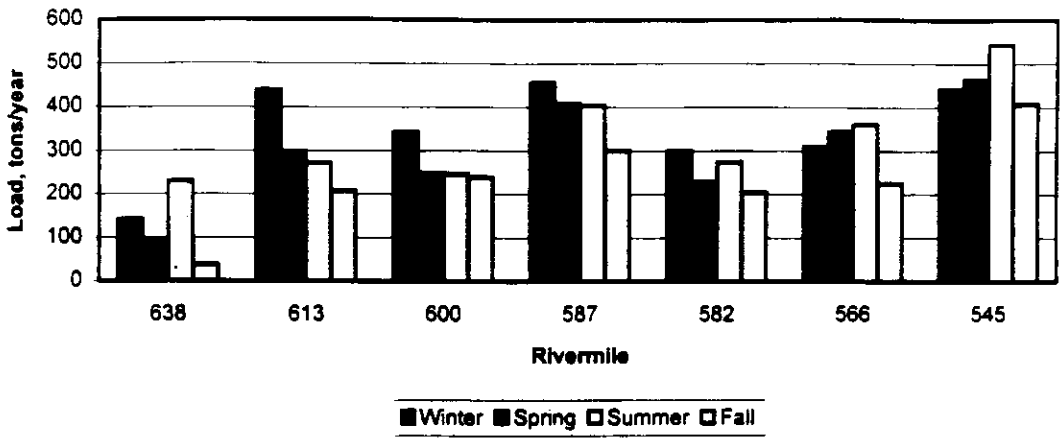
Rivermile:	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830
SPRG/SUMM	156	995	1,747	3,492	5,354	7,005	7,429
FALL/WINT	696	1,608	2,401	4,141	6,062	8,082	8,503



SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

SRP tons/year

Rivermile	638.00	613.09	600.40	587.00	582.00	565.75	545.00
WINT (12.1.2)	142.3	438.9	341.5	456.4	300.7	309.6	441.4
SPRG (3.4.5)	92.6	298.3	248.5	407.6	228.9	343.5	463.0
SUMM (6.7.8)	230.6	271.7	245.5	403.8	273.1	360.3	543.6
FALL (9.10.11)	37.3	207.3	238.3	300.4	204.0	225.3	406.9
SPRG/SUMM	161.6	285.0	247.0	405.7	251.0	351.9	503.3
FALL/WINT	89.8	323.1	289.9	378.4	252.4	267.5	424.2



VI. SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q, Load (tons/year)

SUMMARY ANALYSIS: PAIRED t-TEST TO ASCERTAIN DIFFERENCES BETWEEN SEASONS WITHIN EACH LOCATION SITE

(1) Q, cfs (for all parameters)

Rivermile	638	613	600	587	582	566	545
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	ac	a	a	a	a	a	a
SPRG (3,4,5)	b	b	ab	ab	b	ab	ab
SUMM (6,7,8)	bc	ac	c	ac	ac	ab	ac
FALL (9,10,11)	d	d	cd	cd	ad	d	cd

(2A) TSS, mg/L:

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	9.5	13.2	14.6	22.0	13.3	15.8	22.9
SPRG (3,4,5)	19.8	18.3	20.7	31.5	21.9	26.1	29.2
SUMM (6,7,8)	18.1	16.0	19.6	28.6	17.1	24.3	26.1
FALL (9,10,11)	15.6	12.6	14.2	17.6	8.9	12.8	25.5

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	a	a	a	a	a	a
SPRG (3,4,5)	b	b	ab	b	b	b	abd
SUMM (6,7,8)	b	ab	ab	ab	b	ab	abc
FALL (9,10,11)	ad	ad	d	ad	abd	abd	acd

(2B) TSS Load, tons/year:

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	30,961.9	77,435.3	106,379.0	163,070.1	97,998.1	246,528.2	312,123.7
SPRG (3,4,5)	125,574.5	154,805.1	191,188.6	382,954.8	227,262.3	530,201.5	529,736.1
SUMM (6,7,8)	100,076.0	125,208.6	123,461.9	355,850.9	199,277.0	557,407.1	511,650.4
FALL (9,10,11)	17,957.5	30,982.1	45,975.5	77,251.9	41,541.3	132,884.1	242,634.9

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	a	a	a	a	ad	ac
SPRG (3,4,5)	b	b	ab	b	b	b	abd
SUMM (6,7,8)	b	ab	ab	ab	bc	abd	bc
FALL (9,10,11)	ad	ad	d	ad	acd	d	cd

V' SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q Load (tons/year)

3A. TP mg/L

Rivermile	638	613	600	587	582	566	545
WINT (12,1,2)	0.124	0.151	0.140	0.114	0.101	0.084	0.083
SPRG (3,4,5)	0.123	0.128	0.137	0.114	0.102	0.091	0.089
SUMM (6,7,8)	0.092	0.124	0.142	0.112	0.098	0.093	0.089
FALL (9,10,11)	0.145	0.141	0.146	0.107	0.087	0.083	0.082

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	ac	a	a	a	b	a
SPRG (3,4,5)	ab	abd	bd	b	b	b	ab
SUMM (6,7,8)	bc	bc	bc	b	b	b	bd
FALL (9,10,11)	abc	cd	cd	ad	ad	b	ad

(3B) TP, tons/year:

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	301.7	605.1	680.5	789.4	589.6	1,021.9	975.6
SPRG (3,4,5)	386.4	593.9	687.5	1,083.1	776.7	1,415.9	1,291.3
SUMM (6,7,8)	347.7	501.7	568.1	913.1	691.6	1,403.5	1,279.2
FALL (9,10,11)	103.0	291.5	423.7	432.8	371.4	761.9	768.8

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	a	a	a	a	a	a
SPRG (3,4,5)	ab	ab	ab	ab	b	ab	ab
SUMM (6,7,8)	ab	ab	bd	ab	ab	ab	ab
FALL (9,10,11)	d	d	d	d	ad	d	d

VI. SEASONALITY GRAPH OF INDICATED PARAMETERS PER SEGMENT
Concentration (mg/L), Q. Load (tons/year)

SUMMARY ANALYSIS: PAIRED t-TEST TO ASCERTAIN DIFFERENCES BETWEEN SEASONS WITHIN EACH LOCATION SITE

(1) Q. cfs (for all parameters)

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	946	1,656	2,390	4,013	5,902	7,596	8,175
SPRG (3,4,5)	34	746	1,479	3,155	5,041	6,700	7,274
SUMM (6,7,8)	278	1,244	2,016	3,829	5,667	7,310	7,583
FALL (9,10,11)	445	1,560	2,413	4,268	6,222	8,567	8,830

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	ac	a	a	a	a	a	a
SPRG (3,4,5)	b	b	ab	ab	b	ab	ab
SUMM (6,7,8)	bc	ac	c	ac	ac	ab	ac
FALL (9,10,11)	d	d	cd	cd	ad	d	cd

(2A) TSS, mg/L:

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	9.5	13.2	14.6	22.0	13.3	15.8	22.9
SPRG (3,4,5)	19.8	18.3	20.7	31.5	21.9	26.1	29.2
SUMM (6,7,8)	18.1	16.0	19.6	28.6	17.1	24.3	26.1
FALL (9,10,11)	15.6	12.6	14.2	17.6	8.9	12.8	25.5

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	a	a	a	a	a	a
SPRG (3,4,5)	b	b	ab	b	b	b	abd
SUMM (6,7,8)	b	ab	ab	ab	b	ab	abc
FALL (9,10,11)	ad	ad	d	ad	abd	abd	acd

(2B) TSS Load, tons/year:

Rivermile:	638	613	600	587	582	566	545
WINT (12,1,2)	30,961.9	77,435.3	106,379.0	163,070.1	97,998.1	246,528.2	312,123.7
SPRG (3,4,5)	125,574.5	154,805.1	191,188.6	382,954.8	227,262.3	530,201.5	529,736.1
SUMM (6,7,8)	100,076.0	125,208.6	123,461.9	355,850.9	199,277.0	557,407.1	511,650.4
FALL (9,10,11)	17,957.5	30,982.1	45,975.5	77,251.9	41,541.3	132,884.1	242,634.9

t-Test Results:	638	613	600	587	582	566	545
WINT (12,1,2)	a	a	a	a	a	ad	ac
SPRG (3,4,5)	b	b	ab	b	b	b	abd
SUMM (6,7,8)	b	ab	ab	ab	bc	abd	bc
FALL (9,10,11)	ad	ad	d	ad	acd	d	cd

613 09	Pillar Falls	USGS Twin Falls, ID Quadrangle Map + IDEQ Data
612 65	***East Perrine Coulee (IR11S)***	Phase 1 Study 1992, Upper Snake Rock SBA
612 63	1 Spring	USGS Twin Falls, ID Quadrangle Map + Assumption 2
612 60	1 Unnamed Stream	USGS Twin Falls, ID Quadrangle Map + Assumption 3
612 60	***Green's Trout Farm FH***	USEPA DMRs, Phase 1 Study 1992
612 50	1 Spring	USGS Twin Falls, ID Quadrangle Map + Assumption 2
612 00	5 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2
611 80	Perrine Bridge	USGS Twin Falls, ID Quadrangle Map
611 57	6 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2
611 53	1 Unnamed Stream	USGS Twin Falls, ID Quadrangle Map + Assumption 3
611 10	11 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2
610 86	***Main Perrine Coulee (IR12S)***	Phase 1 Study 1992
610 50	**Blue Lakes Spring**	USGS 13091000
610 10	***Canyon Springs FH***	USEPA DMRs, Phase 1 Study 1992
610 00	***Blue Lakes Processing FH***	USEPA DMRs, Phase 1 Study 1992
609 90	***Blue Lakes FH***	USEPA DMRs, Phase 1 Study 1992
609 42	11 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2
609 10	***Southside West Perrine Coulee (IR16S)***	Phase 1 Study 1992
608 90	***Pristine Springs FH (+WW)***	USEPA DMRs, Phase 1 Study 1992
608 50	***City of Twin Falls***	USEPA DMRs, Phase 1 Study, SBA
608 30	***Southside 43 Drainage (IR17S)***	Phase 1 Study 1992
608 00	**Warm Creek (TS18N)**	Phase 1 Study 1992, USGS 13091700
607 54	**Jerome Golf Course Drain**	USGS Jerome, ID Quadrangle Map + Assumption 3
607 15	Auger Falls	USGS Jerome, ID Quadrangle Map
606 41	**Rock Creek**	Phase 1 Study 1992, Upper Snake Rock SBA
606 09	4 Springs	USGS Jerome, ID Quadrangle Map + Assumption 2
605 90	5 Springs	USGS Jerome, ID Quadrangle Map + Assumption 2
605 49	3 Springs	USGS Jerome, ID Quadrangle Map + Assumption 2
605 43	1 Unnamed Stream	USGS Jerome, ID Quadrangle Map + Assumption 2
605 30	***Southside 30 Drain (IR20S)***	Phase 1 Study 1992
605 30	1 Spring	USGS Jerome, ID Quadrangle Map + Assumption 2
605 00 or 604 62	Eilson Springs (3 Springs)	USGS Jerome, ID Quadrangle Map + Assumption 2
604 42	4 Springs	USGS Jerome, ID Quadrangle Map + Assumption 2
604 07	1 Unnamed Stream	USGS Jerome, ID Quadrangle Map + Assumption 3
603 39 or 603 60	***Pigeon Cove: LQ/LS Drains (IR21S)***	Phase 1 Study 1992
603 17	8 Springs	USGS Jerome, ID Quadrangle Map + Assmpton 2
602 15 or 602 20	***Southside LS2/39A Drain (IR22S)***	Phase 1 Study 1992
600 92 or 601 40	***Northside N42 Drain (IR23N)***	Phase 1 Study 1992
601 40	***Northside N42 Drain (IR23NT)***	Phase 1 Study 1992
600 90	***Southside 39 Drain (IR24S)***	Phase 1 Study 1992
600 50	***Crystal Springs FH***	USEPA DMRs, Phase 1 Study 1992
600 40	Crystal Springs (14 Springs)	USGS 13093400
600 40	Crystal Springs Area	

Note RM603 60 for LQ/LS Drain has Rand FH included in its discharge

Note RM606 41 for Rock Creek also has the following fish hatcheries that are included in the TSS load Canyon Trout FH, Canyon Trout Processing, C&M Farm FH, Daydream Ranch FH, Deadmen FH, CSI FH, Frame FH, & Coats FH It does not include the discharges from McMullen Creek and Cottonwood Creek because they discharge to the High Line Canal which eventually discharges to Deep Creek Canyon Trout FH (21 1 tons/year), Canyon Trout Processing + Total Containment C&M FH (28 1 tons/year), Daydream Ranch FH (25 9 tons/year), Deadmen FH (27 5 tons/year) CSI FH (9 7 tons/year), Frame FH (35 8 tons/year), and Coats FH (36 3 tons/year)

Note Green's Trout FH (12 0 tons/year) is accounted for in the East Perrine Coulee drain

Instream Load for 1990-1991 (Baseline Years)		Load tons/year	Q cfs
Accounted Q CS (1990-1991) = 2075 cfs			
PF (1990-1991) = 1302 cfs			
Difference = 773 cfs Net Q in Segment 2	Accounted	7 623 7	773 0
Accounted TSS PF (1990-1991) = 11 1 mg/L Mean 1302 cfs x 11 1 mg/L x 5 39 x 0 1825 = 14 216 3 tons/year			
CS (1990-1991) = 10 7 mg/L Mean 2075 cfs x 10 7 mg/L x 5 39 x 0 1825 = 21 840 0 tons/year			
Difference = CS PF = 21 840 0 14 216 3 = 7 623 7 tons/year			
	OVERALL TOTAL (Sub Total D) =	(7 623 7)	773 0
Unaccounted Q = 773 0 cfs (Known Springs + Known Surface + Point Sources)			
Unaccounted Q = 773 0 cfs (180 5 cfs + 357 8 cfs + 464 2 cfs) = (229 6 cfs)			
Unaccounted Springs = 65 3% (229 6 cfs) x 0 653 = (149 9 cfs)			
Unaccounted Surface = 34 7% (229 6 cfs) x 0 347 = (79 7 cfs)			
Springs for 1990-1991			
Unseen Underground Seeps	129 2 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	165 2	129 2
Eilson Springs	1 25 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	1 6	1 3
Crystal Springs FH	50 cfs bubbles underneath the lake The rest used by FH		
	50 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	63 9	50 0
		(230 7)	(180 5)
Unaccounted Springs	(149 9) cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	191 7	149 9
	Springs (Sub Total B) =	(39 0)	(30 6)
Point Sources for 1990-1991 Directly Discharging to the Mid-Snake River			
Canyon Springs FH	15 93 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	31 3	15 9
Blue Lakes Processing FH	0 097 cfs x 58 9 mg/L x 5 39 x 0 1825 =	5 6	0 1
Blue Lakes FH	178 60 cfs x 6 7 mg/L TSS x 5 39 x 0 1825 =	1 177 1	178 6
Pristine Springs FH (+WW)	63 70 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	125 3	63 7
City of Twin Falls POTW	6 28 cfs x 23 7 mg/L TSS x 5 39 x 0 1825 =	146 4	6 3
Crystal Springs FH	199 61 cfs x 4 8 mg/L TSS x 5 39 x 0 1825 =	942 5	199 6
	Point Sources (Sub Total A) =	(2 428 2)	(464 2)
Surface Waters for 1990-1991			
East Perrine Coulee	29 27 cfs x 116 9 mg/L TSS x 5 39 x 0 1825 =	3 365 8	29 3
Main Perrine Coulee	10 95 cfs x 117 2 mg/L TSS x 5 39 x 0 1825 =	1 262 7	11 0
West Perrine Coulee	2 53 cfs x 223 2 mg/L TSS x 5 39 x 0 1825 =	555 5	2 5
43 Drainage	0 32 cfs x 179 7 mg/L TSS x 5 39 x 0 1825 =	56 6	0 3
Warm Creek	21 67 cfs x 16 0 mg/L TSS x 5 39 x 0 1825 =	341 1	21 7
Jerome Golf Course Drain	7 78 cfs x 102 0 mg/L TSS x 5 39 x 0 1825 =	780 6	7 8
Rock Creek	219 91 cfs x 66 4 mg/L TSS x 5 39 x 0 1825 =	14 163 6	219 9
30 Drain	6 10 cfs x 371 3 mg/L TSS x 5 39 x 0 1825 =	2 228 0	6 1
LQ/LS Drains	30 32 cfs x 215 5 mg/L TSS x 5 39 x 0 1825 =	6 427 3	30 3
LS2/39A Drain	5 28 cfs x 213 9 mg/L TSS x 5 39 x 0 1825 =	1 111 0	5 3
N42 Drain (IR23N)	8 84 cfs x 17 0 mg/L TSS x 5 39 x 0 1825 =	147 8	8 8
N42 Drain (IR23NT)	10 14 cfs x 32 2 mg/L TSS x 5 39 x 0 1825 =	321 2	10 1
39 Drain	4 77 cfs x 425 7 mg/L TSS x 5 39 x 0 1825 =	1 997 4	4 8
		(32 958 6)	(1357 9)
Unaccounted Surface	(79 7) cfs x **36.7 mg/L TSS** x 5 39 x 0 1825 =	2 798 8	79 7
	Surface (Sub Total C) =	(30 159 8)	(1278 2)
	WITHOUT MID SNAKE RIVER TOTAL (A+B+C) =	(32 627 0)	(772 0)
	ACCOUNTING FOR FLOW (A+B+C) (D) =	0 0	0 0%
	WITH MID SNAKE RIVER TOTAL (A+B+C+D) =	(40 250 7)	

638 70	USGS 13088000	USGS 13088000	Instream Load for 1990-1991(Baseline Years) Load, tons/year Q, cfs
638 53	Milner Dam	IDEQ-TFRO Monitoring Data	Accounted Q PF (1990-1991) = 1302 cfs
635 67	1 Unnamed Stream	USGS Milner, ID Quadrangle Map + Assumption 3	MD (1990-1991) = 425 cfs
632 75	2 Unnamed Streams	USGS Milner, ID Quadrangle Map + Assumption 3	Difference = 877 cfs Net Q in Segment 1 Accounted 7 945 4 877 0
630 56	**Dry Creek**	Schaeffer & Bauer Report 1979	Accounted TSS PF (1990-1991) = 11 1 mg/L Mean (1302 cfs x 11 1 mg/L x 5 39 x 0 1825 = 14,216 3 tons/year
630 50	Murtaugh Bridge	USGS Murtaugh, ID Quadrangle Map	MD (1990-1991) = 15 0 mg/L Mean 425 cfs x 15 0 mg/L x 5 39 x 0 1825 = 6 270 9 tons/year
630 49	1 Spring	USGS Murtaugh, ID Quadrangle Map + Assumption 2	Difference = PF - MD = 14,216 3 6,270 9 = 7 945 4 tons/year Net Load in Segment 1
627 89	2 Springs	USGS Eden, ID Quadrangle Map + Assumption 2	OVERALL TOTAL (Sub Total D) = (7 945 4) 877 0
627 60	***Northside A Drain (IR02N)***	Phase 1 Study 1992	
624 45	1 Unnamed Stream	USGS Eden, ID Quadrangle Map + Assumption 3	Unaccounted Q = 877 0 cfs (Known Springs + Known Surface + Point Sources)
623 75	1 Spring	USGS Eden, ID Quadrangle Map + Assumption 2	Unaccounted Q = 877 0 cfs (55 6 cfs + 39 7 cfs + 0 1 cfs) = 781 6 cfs
623 39	1 Spring	USGS Kimberly, ID Quadrangle Map + Asumption 2	Unaccounted Springs = 65 3% 781 6 cfs x 0 653 = 510 4 cfs
623 12	1 Spring	USGS Kimberly, ID Quadrangle Map + Assumption 2	Unaccounted Surface = 34 7% 781 6 cfs x 0 347 = 271 2 cfs
623 05	1 Unnamed Stream	USGS Kimberly, ID Quadrangle Map + Assumption 3	
622 15	1 Spring	USGS Kimberly, ID Quadrangle Map + Assumption 2	
622 10	1 Spring	USGS Kimberly, ID Quadrangle Map + Assumption 2	Springs for 1990-1991
621 00	Hansen Bridge	USGS Kimberly, ID Quadrangle Map	Vinyard Creek 13 38 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 = 1/ 1 13 4
620 88	1 Spring	USGS Kimberly, ID Quadrangle Map + Assumption 2	Devils Corral Spring 42 23 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 = 54 0 42 2
620 75	3 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	(71 1) (55 6)
620 17	3 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	
619 53	***Southside A10 Drain (IR03S)***	Phase 1 Study 1992	Unaccounted Springs 510 4 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 = 652 7 510 4
619 53	3 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	
619 21	3 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	All Springs (Sub Total B) = (723 8) (566 0)
619 00	***Northside C55 Drain (IR04N)***	Phase 1 Study 1992	
618 00	***Southside Twin Falls Coulee (IR07S)***	Phase 1 Study 1992	Surface Waters for 1990-1991
617 97	**Vinyard Creek (Devils Washbowl Spring)**	USGS 13089500 + Assumption 2	Dry Creek 10 0 cfs x 290 0 mg/L x 5 39 x 0 1825 = 2 852 7 10 0
617 90	***Hansen POTW***	Assuming it reaches the Snake River	Northside A Drain (IR02N) 8 8 cfs x 164 2 mg/L x 5 39 x 0 1825 = 1 427 8 8 8
617 86	4 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	Southside A10 Drain (IR03S) 4 8 cfs x 44 5 mg/L x 5 39 x 0 1825 = 209 7 4 8
617 54	6 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	Northside C55 Drain (IR04N) 7 4 cfs x 47 3 mg/L x 5 39 x 0 1825 = 342 9 7 4
617 50	Twin Falls Dam Spillway	USGS Kimberly, ID Quadrangle Map	Southside TF Coulee (IR07S) 8 7 cfs x 121 3 mg/L x 5 39 x 0 1825 = 1 038 3 8 7
617 37	1 Unnamed Stream	USGS Kimberly, ID Quadrangle Map + Assumption 3	(5 871 2) (39 7)
617 20	USGS 13090000, Kimberly	USGS 13090900	
617 12	**Devils Corral Spring**	USGS 13090100 + Assumption 2	Unaccounted Surface 271 2 cfs x **38.7 mg/L TSS** x 5 39 x 0 1825 = 9 523 8 271 2
616 90	1 Spring	USGS Kimberly, ID Quadrangle Map + Assumption 2	
616 78	5 Springs	USGS Kimberly, ID Quadrangle Map + Assumption 2	All Surface (Sub Total C) = (15 395 0) (310 9)
616 00	2 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	
615 66	2 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	Point Sources for 1990-1991 Directly Discharging to Mid-Snake
614 87	2 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	Hansen POTW 0 09 cfs x 14 3 mg/L TSS x 5 39 x 0 1825 = 1 3 0 1
614 70	Shoshone Falls Dam	USGS Twin Falls, ID Quadrangle Map	Point Sources (Sub Total A) = (1 3) (0 1)
614 00	3 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	
613 67	4 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	
613 37	4 Springs	USGS Twin Falls, ID Quadrangle Map + Assumption 2	WITHOUT MID-SNAKE RIVER TOTAL (A+B+C) = (16 120 1) (877 0)
613 09	Pillar Falls	USGS Twin Falls, ID Quadrangle Map + IDEQ Data	ACCOUNTING FOR FLOW (A+B+C) - (D) 0 0 0 0%
			WITH MID-SNAKE RIVER TOTAL (A+B+C+D) = (24,065 5) (1 754 0)

			Instream Load for 1990-1991 (Baseline Years)			Load, tons/year	Q, cfs
			Accounted Q: GB (1990-1991) = 5709 cfs				
			BC (1990-1991) = 3817 cfs				
			Difference = 1892 cfs in Segment 4		Accounted	31 839 1	1 705 5
			Accounted TSS: GB (1990-1991) = 6 9 mg/L Mean 5709 cfs x 6 9 mg/L x 5 39 x 0 1825 = 38 749 0 tons/year				
			BC (1990-1991) = 18 8 mg/L Mean 3817 cfs x 18 8 mg/L x 5 39 x 0 1825 = 70 588 1 tons/year				
			Difference = BC GB = 70 588 1 38 749 0 = 31 839 1 tons/year				
					OVERALL TOTAL (Sub Total D) =	(31 839 1)	1 705 5
			Unaccounted Q = 1705 5 cfs - (Known Springs + Known Surface + Point Sources)				
			Unaccounted Q = 1705 5 cfs - (1502 4 cfs + 187 6 cfs + 148 7 cfs) = (111 2 cfs)				
			Unaccounted Springs = 65 3% (111 2 cfs) x 0 653 = (72 6 cfs)				
			Unaccounted Surface = 34 7% (111 2 cfs) x 0 347 = (38 6 cfs)				
587 00	Below Box Canyon Creek Area	Thousand Springs Quadrangle Map	Point Sources	Blind Canyon Aqua Ranch FH	25 74 cfs x 1 1 mg/L TSS x 5 39 x 0 1825 =	27 9	25 7
586 50	Salmon Falls Creek (USGS 13108150)	ERI Study, USGS, Phase 1 Study 1992		Pisces Magic Springs FH	120 99 cfs x 0 7 mg/L TSS x 5 39 x 0 1825 =	83 3	121 0
585 90	1 Spring	Thousand Springs Quadrangle Map + Assumption 2			Point Sources (Sub Total A) =	(111 2)	(146 7)
585 50	1000 Springs USGS 13132800	USGS	Spring Sources				
585 00	Thousand Springs Area Upper End	Thousand Springs Quadrangle Map		Unseen Underground Springs	72 0 cfs x 1.3 mg/L TSS x 5 39 x 0 1825 =	92 1	72 0
584 87	6 Springs	Thousand Springs Quadrangle Map + Assumption 2		Thousand Springs	1272 0 cfs x 1.3 mg/L TSS x 5 39 x 0 1825 =	1 626 6	1 272 0
584 82	1 Unnamed	Thousand Springs Quadrangle Map + Assumption 3		Riley Creek	66 78 cfs x 14 8 mg/L TSS x 5 39 x 0 1825 =	972 2	66 8
584 50	*Blind Canyon Aqua Ranch FH*	IDEQ-TFRO, USEPA DMRs		Sand Springs Creek	91 65 cfs x 1.3 mg/L TSS x 5 39 x 0 1825 =	117 2	91 7
584 44	Sand Springs Creek (7 springs, USGS 13132800	USGS				(2 808 1)	(1 502 4)
584 38	Thousand Springs (15 springs) Lower End	USGS		Unaccounted Springs	(72 6 cfs) x 1.3 mg/L TSS x 5 39 x 0 1825 =	92 8	72 6
584 20	Sliggers & 1000 Springs Hydropower Facility	Thousand Springs Quadrangle Map			Spring Sources (Sub Total B) =	(2 715 3)	(1 429 8)
584 09 or 584 30	*Northside W26 Drain (IR42N)*	Phase 1 Study 1992	Surface Stream Sources				
584 09	Bickel Springs (1 spring)	USGS		Salmon Falls Creek	149 40 cfs x 40 6 mg/L TSS x 5 39 x 0 1825 =	5 966 6	149 4
583 85	Mini-Miller (12 springs)	ERI Study		Northside W26 Drain (IR42N)	18 16 cfs x 61 2 mg/L TSS x 5 39 x 0 1825 =	1 093 3	18 2
583 80	*Pisces Magic Springs FH*	IDEQ-TFRO, USEPA DMRs, Consent Order data				(7 059 9)	(167 6)
583 71	1 Unnamed	Thousand Springs Quadrangle Map + Assumption 3		Unaccounted Surface	(38 6 cfs) x 38.7 mg/L TSS x 5 39 x 0 1825 =	1 355 5	38 6
582 88	Riley Creek (USGS 13133800)	USGS			Surface Streams (Sub Total C) =	(5 704 4)	(129 0)
582 48	1 Unnamed	Thousand Springs Quadrangle Map + Assumpson 3			WITHOUT MID-SNAKE RIVER TOTAL (A+B+C) =	(8 530 8)	(1 705 5)
582 48	Magic Springs (1 Spring)	Covington & Weaver			ACCOUNTING FOR FLOW (A+B+C) (D) =	0 0	0 0%
582 30	Gridley Bridge	Hagerman Quadrangle Map			WITH MID-SNAKE RIVER TOTAL (A+B+C+D) =	(40 369 9)	
582 00	Gridley Bridge Area	Hagerman Quadrangle Map					

Note: Thousand Springs "watershed" includes the following inputs: Ten Springs FH (51 4 tons/year), Thousand Springs watershed inputs (1,676 2 tons/year), for a total of 1,828 6 tons/year

Note: Riley Creek "watershed" includes the following inputs: USFWS-FH (66 8 tons/year), IDFG-FH (142 2 tons/year), Riley Creek watershed inputs (734 1 tons/year), for a total of 872 2 tons/year

600 40	Crystal Springs Area	Niagara Springs Quadrangle Map
600 00	***Magic Valley FH***	Phase 1 Study 1992, USEPA DMR Sheets
599 50	Crystal Springs downstream portion	Niagara Springs Quadrangle Map
599 14	**Cedar Draw**	Upper Snake Rock SBA, Phase 1 Study 1992
599 12	1 Spring	Niagara Springs Quadrangle Map + Assumption 2
599 00	**Niagara Springs (5 springs)**	ERI Study, USGS 13083700
599 00	***Niagara Springs FH***	IDEQ-TFRO; USEPA DMR Sheets
598 70	***Rim View FH***	Phase 1 Study 1992; USEPA DMR Sheets
598 30	1 Spring	Niagara Springs Quadrangle Map + Assumption 2
598 09 or 598 00	***Southside I Drain (IR29S)***	Phase 1 Study 1992
597 66	1 Spring	Niagara Springs Quadrangle Map + Assumption 2
596 80	USGS 13094000	Niagara Springs Quadrangle Map, USGS
595 04 or 595 10	***Northside J8 Drain (IR30N)***	Phase 1 Study 1992
593 00	**Clear Lakes (24 springs)**	USGS 13094500; Phase 1 Study 1992
592 50	***Gary Wright FH***	IDEQ-TFRO; USEPA DMR Sheets
591 80	Kanaka Rapids	Niagara Springs Quadrangle Map
591 50	***Southside N Drain (IR35S)***	Phase 1 Study 1992
591 50	***Catfish FH/FBI***	Phase 1 Study 1992; USEPA DMR Sheets
591 47	**Mud Creek**	Upper Snake Rock SBA, Phase 1 Study 1992
591 38	**Deep Creek**	Upper Snake Rock SBA, Phase 1 Study 1992
590 82	1 Unnamed Stream	Thousand Springs Quadrangle Map + Assumption 3
590 33	1 Unnamed Stream	Thousand Springs Quadrangle Map + Assumption 3
590 28	**Briggs Creek (6 springs)**	Covington & Weaver
590 28	***Briggs Creek FH***	IDEQ-TFRO; USEPA DMR Sheets
589 48 or 589 50	***Northside S29 Drain (IR36N)***	Phase 1 Study 1992
588 85	**Banbury Springs (19 springs)**	USGS 13095300
589 80	***Kaster Trout FH***	IDEQ-TFRO; USEPA DMR Sheets
588 48	2 Springs	Thousand Springs Quadrangle Map + Assumption 2
588 40	***Northside S19/S Drains (IR39N)***	Phase 1 Study 1992
588 40	***Box Canyon FH***	Phase 1 Study 1992; USEPA DMR Sheets
588 06	**Blind Canyon Creek (2 springs)**	USGS
588 06	***Blind Canyon FH (within the canyon)***	IDEQ-TFRO; USEPA DMR Sheets
587 76	**Box Canyon Creek (3 springs)**	Covington & Weaver
587 50	Blue Heart Springs (3 springs)	Thousand Springs Quadrangle Map + Assumption 2
587 21	1 Unnamed Stream	Thousand Springs Quadrangle Map + Assumption 3
587 00	Below Box Canyon Ck	Thousand Springs Quadrangle Map
587 00	Below Box Canyon Ck Area	

Note Niagara Springs inputs are categorized as follows impacts from the Niagara Springs FH and impacts from the Niagara Springs "creek" area Both are 108 6 and 38 9 tons/year, respectively, or a total of 147 5 tons/year

Note Clear Springs & Lake inputs are categorized as follows impacts from Clear Lakes Trout FH (349 0 tons/year), Middle Hatchery FH (353 2 tons/year), Snake River FH (195 8 tons/year), Clear Springs Processing (4 5 tons/year), and impacts from the Clear Springs & Lake "area" (180 1 tons/year), or a total of 1,087 6 tons/year

Note Blind Canyon Creek inputs are categorized as follows impacts from the Blind Canyon FH (13 7 tons/year) with impacts from agriculture, grazing, and riparian areas S19/S Drain traditionally discharged to the Blind Canyon Creek canyon but is now diverted to the Lenmon Hy dropower Facility which discharges just upstream of the Blind Canyon Creek confluence with the Middle Snake River Occasionally, the owner may discharge to Blind Canyon Creek to meet water right needs for irrigation and possibly fish propagation

Note Cedar Draw inputs are categorized as follows impacts from the Filer POTW (2 1 tons/year), Rainbow (Filer) FH (25 3 tons/year), Rainbow Processing (0 04 tons/year), Yoder FH (17 5 tons/year), SEAPAC Processing (Land Application), Cedar Draw FH (39 6 tons/year), Olson FH (7 8 tons/year), Stutzman FH (2 4 tons/year), Tunnel Creek FH (35 8 tons/year), Lee Martins FH (29 5 tons/year), and from the Cedar Draw watershed (12,086 3 tons/year), or a total of 12,226 1 tons/year

Note Mud Creek inputs are categorized as follows impacts from the Buhl POTW (28 6 tons/year), Rainbow (Buhl) FH (16 3 tons/year) W&W FH (29 0 tons/year), White's FH (7 9 tons/year), Buhl Trout Rearing FH (5 7 tons/year), Buhl Trout FH (9 9 tons/year), Jukars FH (10 8 tons/year), RCP FH (3 5 tons/year), First Ascent FH (35 3 tons/year), Rock Ridge FH (4 0 tons/year), Mi Vida Loca FH (7 9 tons/year), and from the Mud Creek watershed (5,809 5 tons/year), or a total of 5,960 4 tons/year

Note Deep Creek inputs are categorized as follows McMullen Creek and Cottonwood Creek which discharge into the High Line Canal which discharges to Deep Creek, Deep Creek Trout FH (31 1 tons/year), Boswell Trout FH (33 2 tons/year), Peter's FH (20 3 tons/year), Cox FH (30 7 tons/year), Dolana FH (10 2 tons/year), Howell FH (19 0 tons/year), and, from the Deep Creek watershed, for a total of 6,197 1 tons/year

Note Jerome POTW includes the Jerome POTW

Note Blind Canyon Creek includes Blind Canyon FH

ACCOUNTING OF INPUT SOURCES

Instream Load for 1990-1991 (Baseline Years) — Load, tons/year — Q, cfs

Accounted Q BC (1990-1991) = 3817 cfs
CS (1990-1991) = 2075 cfs
Difference = 1742 cfs Net Q in Segment 3 — Accounted — 48 372 7 — 1 742 0

Accounted TSS BC (1990-1991) = 18 8 mg/L Mean 3817 cfs x 18 7 mg/L x 5 39 x 0 1825 = 70 588 1 tons/year
CS (1990-1992) = 10 7 mg/L Mean 2075 cfs x 10 7 mg/L x 5 39 x 0 1825 = 21,840 0 tons/year
Difference = BC - CS = 70 212 7 - 21 840 0 = 48 372 7 tons/year

OVERALL TOTAL (Sub Total D) = 48 372 7 — 1 742 0

Unaccounted Q = 1 742 0 cfs - (Known Springs + Known Surface + Point Sources)
Unaccounted Q = 1 742 0 cfs (805 4 + 432 3 + 687 7) = (283 4)
Unaccounted Springs = 65 3% (283 4 cfs) x 0 653 = (185 1 cfs)
Unaccounted Surface = 34 7% (283 4 cfs) x 0 347 = (98 3 cfs)

Point Sources			
Magic Valley FH	111 72 cfs x 7 4 mg/L TSS x 5 39 x 0 1825 =	813 2	111 7
Rim View FH	134 07 cfs x 4 6 mg/L TSS x 5 39 x 0 1825 =	606 7	134 1
IPC/Niagara Springs FH	55 19 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	108 6	55 2
Gary Wright FH	5 50 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	10 8	5 5
Catfish FH/FBI	12 92 cfs x 15 8 mg/L TSS x 5 39 x 0 1825 =	200 8	12 9
Kaster Trout FH	49 12 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	96 6	49 1
Box Canyon FH	295 03 cfs x 5 9 mg/L TSS x 5 39 x 0 1825 =	1 712 3	295 0
Briggs Creek FH	24 15 cfs x **2.0 mg/L TSS** x 5 39 x 0 1825 =	47 5	24 2
	Point Sources (Sub Total A) =	(3,596 5)	(687 7)
Spring Sources			
Unseen Underground Seeps	110 8 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	141 7	110 8
Niagara Springs	30 4 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	38 9	30 4
Clear Lakes Springs (TS32N)	52 31 cfs x 3 5 mg/L TSS x 5 39 x 0 1825 =	180 1	52 3
Snake River FH	99 5 cfs x 2 0 mg/L TSS x 5 39 x 0 1825 =	195 8	99 5
Clear Springs Processing	0 05 cfs x 90 9 mg/L TSS x 5 39 x 0 1825 =	4 5	0 1
Middle FH	182 06 cfs x 2 0 mg/L TSS x 5 39 x 0 1825 =	358 2	182 1
Clear Lakes Trout FH	161 25 cfs x 2 2 mg/L TSS x 5 39 x 0 1825 =	349 0	161 3
TSS from Clear Lakes FHs are based on 1991 DMR gross effluent			
Banbury Springs	120 67 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	154 3	120 7
Briggs Creek Springs	83 35 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	106 6	83 4
Box Canyon Springs	64 97 cfs x **1.3 mg/L TSS** x 5 39 x 0 1825 =	83 1	65 0
		(1 612 0)	(905 4)
Unaccounted Springs	(185 1 cfs) x **1.3 mg/L TSS** x 5 39 x 0 1825 =	236 7	185 1
	Spring Sources (Sub Total B) =	(1 375 3)	(720 3)
Surface Stream Sources			
Cedar Draw (TS27S)	115 19 cfs x 107 9 mg/L TSS x 5 39 x 0 1825 =	12 226 1	115 2
Mud Creek (TS33S)	97 26 cfs x 62 3 mg/L TSS x 5 39 x 0 1825 =	5 960 4	97 3
Deep Creek (TS34S)	95 89 cfs x 65 7 mg/L TSS x 5 39 x 0 1825 =	6 197 1	95 9
Blind Canyon Creek (TS40N)	43 50 cfs x 29 0 mg/L TSS x 5 39 x 0 1825 =	1 240 9	43 5
Southside I Drain (IR29S)	11 42 cfs x 111 9 mg/L TSS x 5 39 x 0 1825 =	1 257 0	11 4
Northside J8 Drain (IR30N)	9 03 cfs x 41 1 mg/L TSS x 5 39 x 0 1825 =	365 1	9 0
Southside N Drain (IR35S)	4 36 cfs x 36 8 mg/L TSS x 5 39 x 0 1825 =	157 8	4 4
Northside S29 Drain (IR36N)	2 64 cfs x 11 9 mg/L TSS x 5 39 x 0 1825 =	30 9	2 6
Northside S19/S Drain (IR39N)	52 99 cfs x 43 4 mg/L TSS x 5 39 x 0 1825 =	2 262 2	531 0
		(29 697 6)	(432 3)
Unaccounted Surface	(98 3 cfs) x **35.7 mg/L** TSS x 5 39 x 0 1825 =	3 452 0	98 3
	Surface Sources (Sub Total C) =	(26 245 6)	(334 0)
	WITHOUT MID-SNAKE RIVER TOTAL (A+B+C) =	(31 217 4)	(1 741 9)
	ACCOUNTING FOR FLOW (A+B+C) (D) =	0 1	0 0%
	WITH MID-SNAKE RIVER TOTAL (A+B+C+D) =	(79 590 1)	

566 33	1 Spring	Bliss Quadrangle Map + Assumption 2	All Surface (Sub Total C) -	(31 078 3) (1 498 0)
565 85	1 Spring	Bliss Quadrangle Map + Assumption 2		
565 75	Shoestring Bridge	Bliss Quadrangle Map	WITHOUT MID-SNAKE RIVER TOTAL (A+B+C) -	(32 271 6) (1 556 0)
			ACCOUNTING FOR FLOW (A+B+C) (D) -	0 0 0 0%
			WITH MID-SNAKE RIVER TOTAL (A+B+C+D) -	(41 248 8)
			DIVERSIONS Bell Rapids (USGS 13134570) 104 77 cfs x 17 2 mg/L TSS x 5 39 x 0 1825 -	1 772 6 104 8
			(17 2 mg/L TSS is instream value at GB to SB) All Diversions -	(1 772 6) (104 8)
			Instream Effect	(41 476 2) 1 771 2

COMMENTS ON SEGMENT 5:

Note Bell Ditch and Buckeye Ditch begin at Billingsley Creek about 0 8 miles upstream from the confluence with the Snake River
Big Bend Ditch starts at Tucker Springs and at the Idaho State Fish Hatchery and Game Preserve
Bell Ditch, Buckeye Ditch, and Big Bend Ditch are integrated west of the Hagerman POTW Sewage Disposal Ponds

Note The Lemmon FH discharges to Curren Ditch which eventually winds up in Buckeye Ditch and then discharges to the Snake River

Note Stoddard Creek discharges to the Snake River at RM570 1 (or RM570 04) The following FHs discharge to Stoddard Creek
Bell FH (7 4 tons/year), Standal FH (9 7 tons/year), and White Water FH (22 0 tons/year) for a total of 39 1 tons/year
It appears that Stoddard Creek Spring(s) are completely utilized by the FHs

Note Birch Creek discharges to the Snake River at RM572 28 The following FHs discharge to Birch Creek Birch Creek FH (87 4 tons/year), C J Simms FH (10 4 tons/year), the Birch Creek "watershed" contributes about 1 3 tons/year, for a total of 99 1 tons/year

Note Billingsley Creek discharges to the Snake River at RM573 78 The following FHs discharge to Billingsley Creek Rangen's FH (38 3 tons/year), Jones FH (59 5 tons/year), McFadden FH (13 7 tons/year), Idaho Springs FH (106 2 tons/year), Hidden Springs (22 8 tons/year), Schrank Springs Creek FH (6 2 tons/year), Fisheries Development FH (190 3 tons/year for the two discharge points), two non-permitted FH (9 8 tons/year), Boyer FH (22 8 tons/year), Talbot FH (22 2 tons/year), the Billingsley Creek "watershed" contributes about 181 5 tons/year; for a total of 673 3 tons/year Unlike other tributaries, Billingsley Creek is a sediment loader within the creek itself Data obtained from the Idaho Springs FH showed that an accumulation of very fine instream sediment (appears to be Yahoo Clay) filled in the upper part of the raceways to an approximate loading of 167 truckloads in one "season " Inspection of the stream bed in Billingsley Creek noted that a washload is created from these suspended particulates and appears to settle on the bedload (made up of cobbles and some fine grains) and is very slow moving from upstream to downstream Billingsley Creek does not have flushing flows and is highly influenced by flow diversions, so it is quite possible that any movement of the washload occurs very slowly from upstream to downstream The macrophytes also form a tight cover of the washload and bedload so upstream to downstream movement of the washload and bedload is retarded For this reason, a true indication of the sediment loading in Billingsley Creek is best summarized by combining the approximate loads from all the FHs with the discharge value obtained from Billingsley Creek as it discharges to the Middle Snake River However, the FHs utilize and re-utilized the same water throughout the creek such that the average discharge to the Middle Snake River best describes Billingsley Creek Thus, the flow from the FHs is not included in the total flow from Billingsley Creek

	DESCRIPTION	LOCATION	UTILIZATION AND ACCOUNTING OF INPUT SOURCES		
			Instream Load for 1990-1991 (Baseline Years)		
			Accounted Q SB (1990-1991) = 7545 cfs		
			GB (1990-1991) = 5709 cfs		
			Difference = 1836 cfs in Segment 5	Accounted	10,977.2	1,896.0
			Accounted TSS SB (1990-1991) = 6.7 mg/L Mean 7545 cfs x 6.7 mg/L x 5.39 x 0.1825 = 49,726.2 tons/year			
			GB (1990-1991) = 6.9 mg/L Mean 5709 cfs x 6.9 mg/L x 5.39 x 0.1825 = 38,749.0 tons/year			
			Difference = SB GB = 49,726.2 38,749.0 = 10,977.2 tons/year			
			OVERALL TOTAL (Sub Total D) =		10,977.2	1,896.0
			Unaccounted Q = 1836.0 cfs (Known Springs + Known Surfaces + Point Sources)			
			Unaccounted Q = 1836.0 cfs (48.7 cfs + 1,351.3 cfs + 186.1 cfs) = 249.9 cfs			
			Unaccounted Springs = 65.3% 249.9 cfs x 0.653 = 163.2 cfs			
			Unaccounted Surface = 34.7% 249.9 cfs x 0.347 = 86.7 cfs			
			Point Sources for 1990-1991 Directly Discharging to the Mid-Snake			
			Buckeye FH (FH46N)	25.81 cfs x 17.6 mg/L TSS x 5.39 x 0.1825 =	446.8	25.8
			Barret FH	10.06 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	19.8	10.1
			White Springs (FH48N)	30.0 cfs x 4.0 mg/L TSS x 5.39 x 0.1825 =	118.0	30.0
			Mike Flemming FH	5.71 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	11.2	5.7
			Smith FH	9.11 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	17.9	9.1
			Woods FH	12.38 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	24.4	12.4
			Slane FH	4.18 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	8.2	4.2
			John Flemming FH	8.97 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	17.7	9.0
			Stevenson FH	8.04 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	15.8	8.0
			City of Hagerman POTW	0.27 cfs x 5.1 mg/L TSS x 5.39 x 0.1825 =	1.4	0.3
			Henslee FH (Irrigation Ditch)	8.51 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	16.7	8.5
			Big Bend FH (Big Bend Ditch)	4.34 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	8.5	4.3
			Lemmon FH (Buckeye Ditch)	4.03 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	7.9	4.0
			Eckles FH (Billingsley Creek)	18.56 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	36.5	18.6
			Dunn FH (Billingsley Creek)	36.20 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	71.2	36.2
			Point Sources (Sub Total A) =		(822.0)	(186.1)
			Springs for 1990-1991 (+ FHs which utilize and discharge indirectly to the Mid-Snake			
			Birch Creek (excluding FH)	1.05 cfs x **1.3 mg/L TSS** x 5.39 x 0.1825 =	1.3	1.1
			Birch Creek FH	9.98 cfs x 8.9 mg/L TSS x 5.39 x 0.1825 =	87.4	10.0
			C J Simms FH	5.3 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	10.4	5.3
			Stoddard Creek (excluding FH)	Utilized completely by FHs = 0.0 cfs	0.0	0.0
			Bell FH	3.8 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	7.4	3.8
			Standal FH	5.0 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	9.7	5.0
			White Water FH	11.2 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	22.0	11.2
			Decker Springs Creek (-FH)	Utilized completely by FHs = 0.0 cfs	0.0	0.0
			Decker Springs FH	12.4 cfs x **2.0 mg/L TSS** x 5.39 x 0.1825 =	24.4	12.4
					(162.6)	(48.7)
			Unaccounted Springs	163.2 cfs x **1.3 mg/L TSS** x 5.39 x 0.1825 =	208.7	163.2
			All Springs (Sub Total B) =		(371.3)	(211.9)
			Surface Streams for 1990-1991			
			Malad River	180.0 cfs x 21.2 mg/L TSS x 5.39 x 0.1825 =	3,753.7	180.0
			Malad River Power Flume	1132.0 cfs x 21.2 mg/L TSS x 5.39 x 0.1825 =	23,606.6	1,132.0
			Billingsley Creek	39.25 cfs x 4.7 mg/L TSS x 5.39 x 0.1825 =	181.5	39.3
			FHs that Discharge to Billingsley Creek: Rangen's FH 19.5 cfs		38.3	
			FHs that Discharge to Billingsley Creek: Jones FH 30.3 cfs		59.5	
			FHs that Discharge to Billingsley Creek: McFadden FH 7.0 cfs		13.7	
			FHs that Discharge to Billingsley Creek: Idaho Springs 54.0 cfs		106.2	
			FHs that Discharge to Billingsley Creek: Hidden Springs 11.6 cfs		22.8	
			FHs that Discharge to Billingsley Creek: Schrank FH 3.2 cfs		6.2	
			FHs that Discharge to Billingsley Creek: Fisheries Development 96.7 cfs		190.3	
			FHs that Discharge to Billingsley Creek: 2-non permitted facilities 5.0 cfs		9.8	
			FHs that Discharge to Billingsley Creek: Boyer FH 11.6 cfs		22.8	
			FHs that Discharge to Billingsley Creek: Talbot FH 11.3 cfs		22.2	
					(28,033.6)	(1,351.9)
			Unaccounted Surface	86.7 cfs x **35.7 mg/L TSS** x 5.39 x 0.1825 =	3,044.7	86.7

ASSUMPTIONS & DEFINITIONS

Note Some rivermiles are repeated to separate out a stream source from a spring source
Calculation Load, tons/year = Concentration (mg/L) x Flow (cfs) x 5 39 x 0 1825

Assumption 1. Not all Q is accounted for because not all springs and surface streams were monitored According to USGS-Boise & USGS-Twin Falls, it is not possible to account for all input and output flows because of unknown seeps & underground springs However, a reasonable estimate can be derived that accounts for at least 90% or more of the instream Q by making several assumptions

1 Accounted Q can be estimated within a stream reach based on USGS flow information
2 Unaccounted Q can be subtracting the known Point Source Q, the known Surface Q, and the known Spring Q, from the Accounted Q
3 Total Q = Accounted Q + Unaccounted Q

4 Spring discharges from the Eastern Snake Plain Aquifer from Milner Dam to King Hill increased from 4200 cfs in the early 1900s to more than 6500 cfs in the mid-1950s, after which declines began to occur (Kjelstrom 1986 IDWR 1997) Early 1990s data indicate Milner Dam to King Hill spring discharges in the range of 5200 cfs (IDWR 1997) In this inventory of sources, the following summarizes the estimated Q on a per segment basis

Segment Reach	USGS Mapped Springs	% of Total	Estimated Q, cfs	Accumulative Q, cfs
Segment 1 MD to PF	57	22 5%	1,170 0	1,170 0
Segment 2 PF to CS	77	30 4%	1,580 8	2,750 8
Segment 3 CS to BC	66	26 1%	1,357 2	4,108 0
Segment 4 BC to GB	43	17 0%	884 0	4,992 0
Segment 5 GB to SB	7	2 8%	145 6	5,137 6
Segment 6 SB to KH	3	1 2%	62 4	5,200 0
	253	100 0%	5,200 0	5,200 0

5 5200 cfs represents a gross total of the springs from Milner Dam to King Hill The gross average flow at King Hill from WY1990-1991 = 7966 cfs Approximately 6% of the gross flow is attributable to seeps and unseen underground springs (or 5200 cfs x 0 06 = 312 cfs) (IDWR 1997; IDWR Personal Communication), and most of this comes in from Pilar Falls to Gridley Bridge Therefore

% Spring Q (Milner Dam to King Hill) = (5200 cfs x 100%) / 7966 cfs = 65 3%, which is attributed to all springs in the Middle Snake River
% Surface Q (Milner Dam to King Hill) = 7966 cfs - 5200 cfs = 2766 cfs = (2766 cfs x 100%) / 7966 cfs = 34 7%, attributed to surface Q

312 cfs of seeps and unseen underground springs
Segment 2 = 77 known springs = (77 x 100%) / 186 = 41 4% = 312 cfs x 0 414 = 129 2 cfs
Segment 3 = 66 known springs = (66 x 100%) / 186 = 35 5% = 312 cfs x 0 355 = 110 8 cfs
Segment 4 = 43 known springs = (43 x 100%) / 186 = 23 1% = 312 cfs x 0 231 = 72 0 cfs
Total Springs in Segments 2 - 4 = 186 springs
≈ 312 cfs

Note also that springs are either utilized by fish hatcheries or not utilized whatsoever Based on the information in this section

Segment	Known Springs +	Utilized by FH +	Unseen Underground Seeps +	Unaccounted Springs Q	=	Total Q, cfs
Segment 1 MD to PF	55 6	0 0	0 0	510 5		566 1
Segment 2 PF to CS	51 3	463 9	129 2	153 9 *		798 3
Segment 3 CS to BC	351 7	871 8	110 8	185 0 *		1,519 3
Segment 4 BC to GB	1,430 5	146 7	72 0	72 6 *		1,721 8
Segment 5 GB to SB	1 1	82 7	0 0	231 0		314 8
Segment 6 SB to KH	0 0	0 0	0 0	248 3		248 3
Total	1,890 2	1,565 1	312 0	1,401 3		5,168 6

* These values are calculated as negative values within the TSD It is evidence that more data is required in knowing the true Q values of springs within the Middle Snake River corridor
** Total Q as calculated within the segments is much lower than here because of the accounting for Unaccounted Springs, Unseen Seeps, Springs Utilized by Fish Hatcheries, and Known Springs Thus

Total Spring Q = Unaccounted Springs + Unseen Seeps + Fish Hatchery Utilization + Known Springs

It can be stated that overall when comparing the Estimated Total Q (5200 0 cfs) to the Total Q (5168 6) there is confidence that these gross estimates are fairly close to each other However within each specific segment much research still needs to be done to better define the flow estimates (as evidenced by the wide standard deviation and the coefficient of variation

	Estimated Q, cfs	Total Q, cfs	Standard Deviation	Mean	Coefficient of Variation
	1,170 0	566 1	427 0	1,375 4	0 310
	1,580 8	798 3	553 3	1,469 0	0 377
	1 357 2	1,519 3	114 6	1 120 6	0 102
	884 0	1,721 8	592 4	514 8	1 151
	145 6	314 8	119 6	104 0	1 150
	62 4	248 3	131 5	2 631 2	0 050
Overall Estimates	5,200 0	5,168 6	22 2	#REF!	#REF!

			Instream Load for 1990-1991 (Baseline Years)		
			Accounted Q KH (1990-1991) = 7986 cfs		
			SB (1990-1991) = 7545 cfs		
			Difference = 421 cfs	Accounted	88,186.6	421.0
			Accounted TSS KH (1990-1991) = 17.6 mg/L Mean 7986 cfs x 17.6 mg/L x 5.39 x 0.1825 = 137,912.8 tons/year		
			SB (1990-1991) = 6.7 mg/L Mean 7545 cfs x 6.7 mg/L x 5.39 x 0.1825 = 49,726.2 tons/year		
			Difference = KH - SB = 137,912.8 - 49,726.2 = 88,186.6 tons/year		
			OVERALL TOTAL (Sub Total D) =	88,186.6	421.0
			Unaccounted Q = 421.0 cfs - (Known Springs + Known Surface + Point Sources)		
			Unaccounted Q = 421.0 cfs (0.0 cfs + 40.8 cfs + 0.0 cfs) = 380.2 cfs		
			Unaccounted Springs = 65.3% 380.2 cfs x 0.653 = 248.3 cfs		
			Unaccounted Surface = 34.7% 380.2 cfs x 0.347 = 131.9 cfs		
565.75	Shoestring Bridge	Bliss Quadrangle Map	Point Sources for 1990-1991 Discharging Directly to the Mid-Snake River		
565.00	Aqueduct Wiley Pumps = USGS 1315377299	Bliss Quadrangle Map + Assumption 3	None	0.0	0.0
562.03	Tuana Gulch	Ticeska Quadrangle Map + Assumption 3	Point Sources (Sub Total A) =	0.0	0.0
560.93	Cassia Gulch	Ticeska Quadrangle Map + Assumption 3			
559.92	Bliss Dam	Ticeska Quadrangle Map			
556.69	Little Pilgrim Gulch	Pasadena Valley Quadrangle Map + Assumption 3			
556.56	Big Pilgrim Gulch	Pasadena Valley Quadrangle Map + Assumption 3			
555.29	Deer Gulch	Pasadena Valley Quadrangle Map + Assumption 3			
554.85	1 Unnamed Stream	Pasadena Valley Quadrangle Map + Assumption 3			
553.00	Bancroft Springs (3 springs)	Pasadena Valley Quadrangle Map + Assumption 2			
552.50	Black Mesa Pumps (USGS 13153778)	USGS			
547.70	Clover Creek (USGS 13154400)	Upper Snake Rock SBA, USGS			
546.60	USGS 13154500	King Hill Quadrangle Map, USGS			
546.30	King Hill Bridge	King Hill Quadrangle Map			
546.00	King Hill town site	King Hill Quadrangle Map			
545.00	King Hill Area	King Hill Quadrangle Map			
			Springs for 1990-1991		
			Unaccounted Springs 248.3 cfs x **1.3 mg/L TSS** x 5.39 x 0.1825 =	317.5	248.3
			All Springs (Sub Total B) =	(317.5)	(248.3)
			Surface Waters for 1990-1991		
			Clover Creek 40.75 cfs x 9.7 mg/L TSS x 5.39 x 0.1825 =	388.8	40.8
				(388.8)	(40.8)
			Unaccounted Surface: 131.9 cfs x **36.7 mg/L TSS** x 5.39 x 0.1825 =	4,632.0	131.9
			All Surface (Sub Total C) =	(5,020.8)	(172.7)
			WITHOUT MID-SNAKE RIVER TOTAL (A+B+C) =	(5,338.3)	(421.0)
			ACCOUNTING FOR FLOW (A+B+C) - (D) =	0.0	0.0%
			WITH MID-SNAKE RIVER TOTAL (A+B+C+D) =	(93,524.9)	
			DIVERSIONS: Black Mesa Pumps (diversion) 63.59 cfs x 23.2 mg/L TSS x 5.39 x 0.1825 =	1,451.2	63.6
			Wiley Pumps (diversion) 19.29 cfs x 23.2 mg/L TSS x 5.39 x 0.1825 =	440.2	19.3
			(23.2 mg/L TSS = instream value at SB to KH) All Diversions =	(1,891.4)	(82.9)
			Instream Effect	95,416.3	338.1

VIII DESIGN FLOW ANALYSIS AND LOGIC

Design flow analysis based on USGS data for known sites on the Middle Snake River

1. Baseline Years = WY1990-WY1991, which was also within a low flow period

2. IDEQ-TFRO included the low flow years most recent to WY1990-WY1991 Baseline since the Baseline fell in the middle of the low flow period.

   Therefore, low flow years ranged from WY1988-WY1995, or 8 years.

3. Recent high flow years since Baseline are WY1996-WY1998, or 3 years. IDEQ-TFRO expanded high flow year coverage to include most recent high flow years prior to Baseline.

Therefore, high flow years ranged from WY1983-WY1987 to WY1996-WY1998, or 8 years.

Therefore, High Flow Years = WY1983-WY1987, WY1996-1998 = 8 years
MEAN Flow Years = WY1983-WY1998 = 16 years total
Low Flow Years = WY1988-WY1995 = 8 years

4. Within the WY1983-WY1998, it was determined that the highest flow WY was WY1984. This was used as the high flow water year or High Q.

   At Milner Dam the Mean Q of WY1984 = 9432 cfs +/- 604 cfs (95% CL)

5. Within the WY1983-WY1998, it was determined that the lowest flow WY was WY1992. This was used as the low flow water year or Low Q.

   At Milner Dam the Mean Q of WY1992 = 366 cfs +/- 45 cfs (95% CL)

6. Within the WY1983-WY1998, it was determined that the daily average of all flows for any specific USGS site would be the MEAN Q.

   At Milner Dam, MEAN Q of WY1983-WY1998 = 3860 cfs +/- 183 cfs (95% CL)

7. So,

Highest Q Year =	WY1984 =	9432 +/- 604 cfs
MEAN Q =	WY1983-WY1998 =	3860 +/- 183 cfs
Lowest Q Year =	WY1992 =	366 +/- 45 cfs

ASSUMPTIONS & DEFINITIONS (continued)

Assumption 2. Unnamed Spring is estimated on a river gain bases per USGS data TSS is estimated 1 3 mg/L TSS (USGS, ERI, IDEQ) Spring sources identified on USGS topographic maps

Assumption 3. Unknown streams are estimated at 35 7 mg/L TSS This is based on natural streams only When irrigation ditches are combined with natural streams, TSS = 107 3 mg/L mean Flow is estimated on a per reach basis Unknown streams are identified from USGS topographic maps TSS load gains per segment are summarized as follows

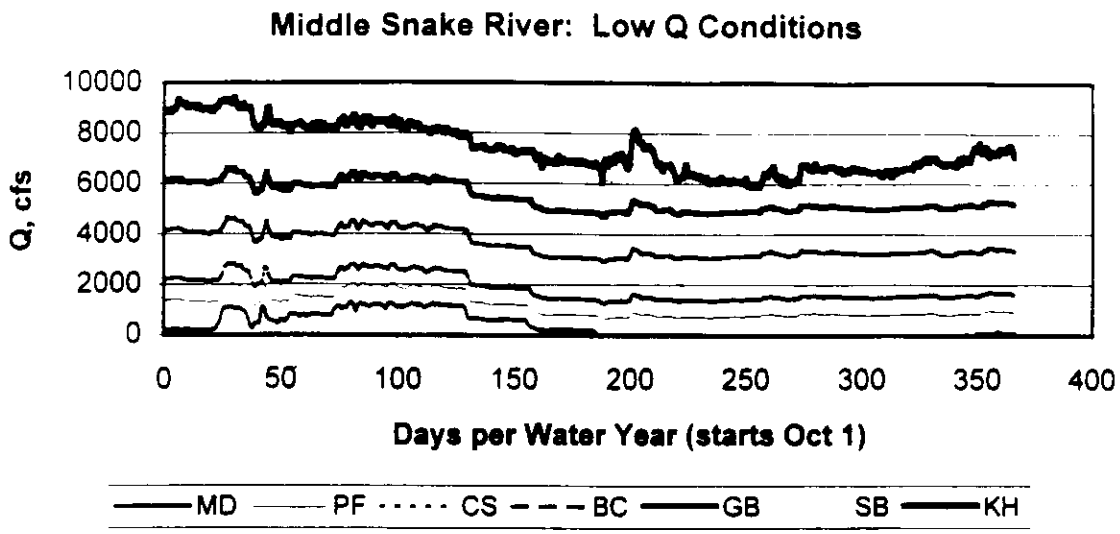
Segment Reach	TSS Load, tons/year (Input Unaccountability)	Possible Segment Action
Segment 1 MD to PF	(8,173 5)	Passes Thru
Segment 2 PF to CS	(24,936 4)	Passes Thru
Segment 3 CS to BC	17,155 2	Depositional
Segment 4 BC to GB	(40,369 9)	Passes Thru
Segment 5 GB to SB	(20,172 6)	Passes Thru
Segment 6 SB to KH	82,848 3	Depositional
	6,351 1	

Passes Thru =	(93,652 4) tons/year	48 4%
Depositional =	100 003 5 tons/year	51 6%
Gross Total TSS =	193,655 9 tons/year	

Assumption 4. For fish hatcheries (FH) without monitoring data, it is estimated that the effluent TSS concentration is 1/2 MDL = 1/2 (4 mg/L) = 2 0 mg/L TSS

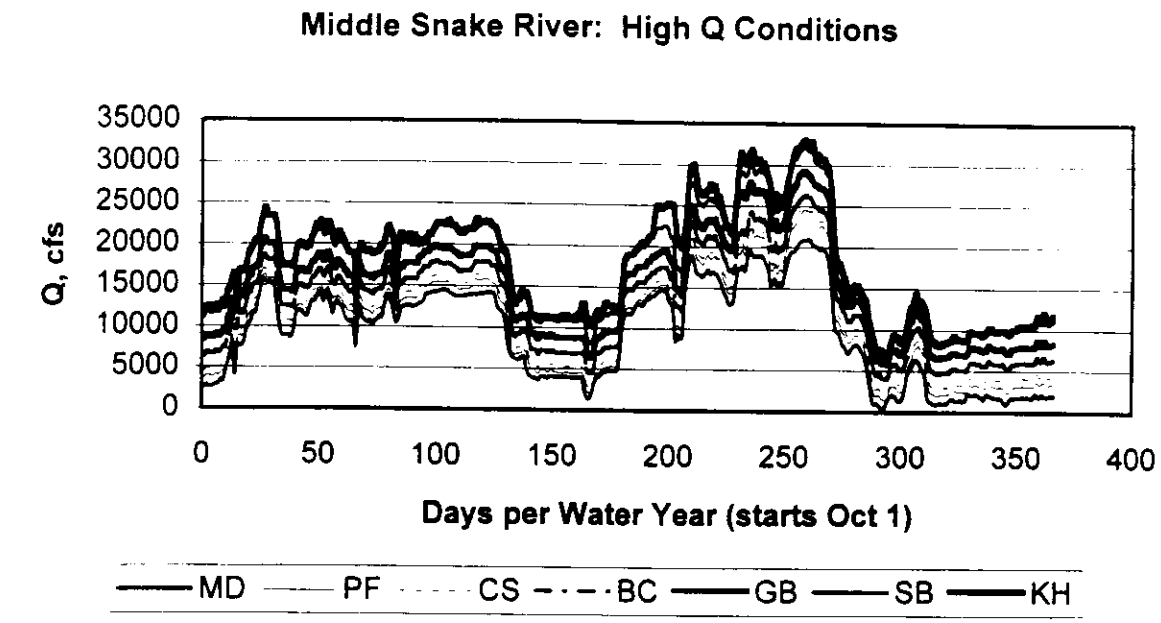
Middle Snake River Flows

3 WY 1992 = Low Q Conditions

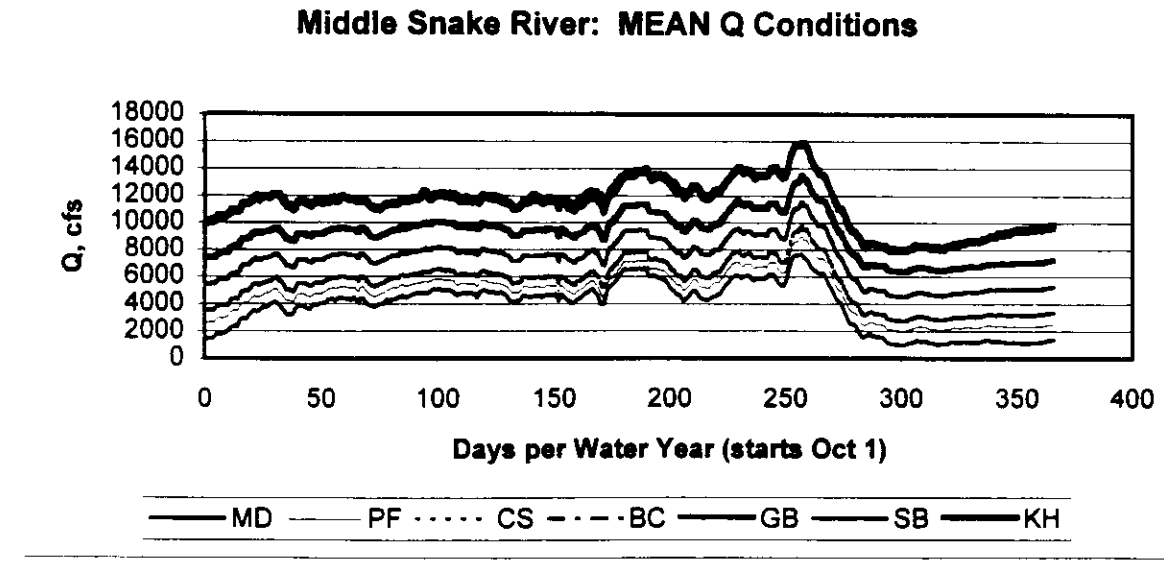


Middle Snake River Flows

1 WY1984 High Q Conditions



2. WY1983-WY1998 = MEAN Q Conditions:



X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

A KNOWN SURFACE SOURCES TARGET = 52.0 mg/L TSS or less = 51.9 mg/L

Segment Name	Surface Stream	Q, cfs	Mean TSS mg/L	Reduce to < 52.0 mg/L	% Reduction
1. MD to PF	Dry Creek	10.0	290.0	51.9	82.1
	A Drain	8.8	164.2	51.9	68.4
	A10 Drain	4.8	44.5	44.5	0
	C55 Drain	7.4	47.3	47.3	0
	TF Coulee	8.7	121.3	51.9	57.2
	Sub Total/Mean =	39.7			
2. PF to CS	East Perrine Coulee	29.3	116.9	51.9	55.6
	Main Perrine Coulee	11.0	117.2	51.9	55.7
	West Perrine Coulee	2.5	223.2	51.9	76.7
	43 Drain	0.3	179.7	51.9	71.1
	Warm Creek	21.7	16.0	16.0	0.0
	Jerome Golf Course	7.8	35.7	35.7	0.0
	Rock Creek	219.9	66.4	51.9	21.8
	30 Drain	6.1	371.3	51.9	86.0
	LQ/LS Drains	30.3	215.5	51.9	75.9
	LS2/39A Drains	5.3	213.9	51.9	75.7
	N42 Drain (N)	8.8	17.0	17.0	0.0
	N42 Drain (NT)	10.1	32.2	32.2	0.0
	39 Drain	4.8	425.7	51.9	87.8
	Sub Total/Mean =	357.9			
3. CS to BC	Cedar Draw	115.2	107.9	51.9	51.9
	Mud Creek	97.3	62.3	51.9	16.7
	Deep Creek	95.9	65.7	51.9	21.0
	Blind Canyon Creek	43.5	29.0	29.0	0.0
	I Drain	11.4	111.9	51.9	53.6
	J8 Drain	9.0	41.1	41.1	0.0
	N Drain	4.4	36.8	36.8	0.0
	S29 Drain	2.6	11.9	11.9	0.0
	S19/S Drain	53.0	43.4	43.4	0.0
	Sub Total/Mean =	432.3			
4. BC to GB	Salmon Falls Creek	149.4	40.6	40.6	0
	W26 Drain	18.2	61.2	51.9	15.2
	Sub Total/Mean =	167.6			
5. GB to SB	Malad River	180.0	21.2	21.2	0.0
	Malad Power Flume	1132.0	21.2	21.2	0.0
	Billingsley Creek	39.3	4.7	4.7	0.0
	Birch Creek	11.0	1.3	1.3	0.0
	Sub Total/Mean =	1312.0	21.2	21.2	0.0
6. SB to KH	Clover Creek	40.8	9.7	9.7 0	0.0
	Sub Total/Mean =	40.8			0.0
Segs 1 to 7	Overall Total/Mean =	2350.2	96.8	38.8	27.0

IX. TSS MID-SNAKE INSTREAM LOADING ANALYSIS

SEGMENT	RM	WY1984 High Flow Conditions Q cfs	TSS mg/L	TSS Load tons/year	MEAN Flow Conditions Q cfs	TSS mg/L	TSS Load tons/year	WY1992 Low Flow Conditions Q cfs	TSS mg/L	TSS Load tons/year
Milner Dam	638.43	9,432	19.4	197,999.1	3,860	16.5	64,131.7	366	14.6	5,364.7
Pillar Falls	613.09	10,644	20.9	254,219.9	4,737	15.3	74,130.1	1,146	12.0	13,668.7
Crystal Springs	600.40	11,404	28.1	371,618.9	5,498	19.0	106,909.1	1,852	13.4	24,748.1
Box Canyon	587.00	13,074	37.8	558,102.0	7,212	25.9	188,852.8	3,573	18.5	65,586.9
Gridley Bridge	582.00	15,124	35.4	620,382.7	9,113	20.8	193,004.5	5,429	11.9	64,306.7
Shoestring Bridge	565.75	17,598	38.1	789,778.7	11,108	18.0	206,695.4	6,674	4.3	30,590.4
King Hill	545.00	18,069	46.1	953,355.6	11,398	26.8	309,662.6	7,384	15.2	112,646.4

NET TSS LOADING ANALYSIS:		Range			Range			Range	
MD to PF (PF - MD)	1,212	19.4 - 20.9	56,220.8	877	15.3 - 16.5	9,998.4	780	12.0 - 14.6	8,304.0
PF to CS (CS - PF)	760	20.9 - 28.1	117,399.0	761	15.3 - 19.0	32,779.0	706	12.0 - 13.4	11,079.4
CS to BC (BC - CS)	1,670	28.1 - 37.8	186,483.1	1,714	19.0 - 25.9	81,943.7	1,721	13.4 - 18.5	40,838.8
BC to GB (GB - BC)	2,050	35.4 - 37.8	62,280.7	1,901	20.8 - 25.9	4,151.7	1,856	11.9 - 18.5	-1,280.2
GB to SB (SB - GB)	2,474	35.4 - 38.1	169,396.0	1,995	18.0 - 20.8	13,690.9	1,245	4.3 - 11.9	-33,716.3
SB to KH (KH - SB)	471	38.1 - 46.1	163,576.9	290	18.0 - 26.8	102,967.2	710	4.3 - 15.2	82,056.0
TOTAL	8,637		755,356.5	7,538		245,530.9	7,018		107,281.7

% VALUES >= 52 mg/L:			
MD	0.00%	0.00%	0.00%
PF	0.00%	0.00%	0.00%
CS	0.00%	0.00%	0.00%
BC	13.90%	0.00%	0.00%
GB	15.30%	0.00%	0.00%
SB	25.40%	0.00%	0.00%
KH	42.30%	0.00%	0.00%

TSS information based on rating curved established between known Q and known TSS at each location site
Q information based on USGS sites.

X. TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 1: MD to PF (RM638.53 to RM613.09)

(1) Determine % Reduction of Surface Source Inputs

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent Load	Load After Reduction	
Point Sources (A)	1.3	0.0%	0.0	1.3	
All Springs (B)	723.8	0.0%	0.0	723.8	
All Surface (C)	15,395.0	43.2%	6,650.6	8,744.4	
Total Load (A+B+C)	16,120.1		6,650.6	9,469.5	= Inputs %R 41.3

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segment 1

	Net Q, cfs	Net Load	% Red	Net Load	
Instream Net (D)	877.0	7,945.4	33.3%	5,299.6	= Instream %R 33.3%
Segment 1:		**Before**		**After**	
Point Sources (A)	0.1	1.3	0.0%	1.3	
All Springs (B)	566.0	723.8	0.0%	723.8	
All Surface (C)	310.9	15,395.0	43.2%	8,744.4	
Total Inputs (A+B+C)	877.0	16,120.1	41.3	9,469.5	
TOTAL (A+B+C+D)	1,754.0	24,065.5		14,769.0	= Instream %R 38.6
TSS, mg/L		13.9		8.6	= 38.6

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 1.
2. Instream Net Load from Section VII, Segment I, Oveall Total.
3. 43.2% All Surface Reduction obtained from Section X. B. Segment 1 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

B ACCOUNTING FOR UNKNOWN SOURCES

Segment Name	Surface Stream	Q, cfs	Mean TSS mg/L	Reduce to < 52.0 mg/L	% Reduction
1 MD to PF	Dry Creek	10.00	290.0	51.9	82.1
	A Drain	8.80	164.2	51.9	68.4
	A10 Drain	4.80	44.5	44.5	0.0
	C55 Drain	7.40	47.3	47.3	0.0
	TF Coulee	8.70	121.3	51.9	57.2
	Unknown Surface	271.20	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
2. PF to CS	East Perrine Coulee	29.3	116.9	51.9	55.6
	Main Perrine Coulee	11.0	117.2	51.9	55.7
	West Perrine Coulee	2.5	223.2	51.9	76.7
	43 Drain	0.3	179.7	51.9	71.1
	Warm Creek	21.7	16.0	16.0	0.0
	Jerome Golf Course	7.8	102.0	51.9	49.1
	Rock Creek	219.9	66.4	51.9	21.8
	30 Drain	6.1	371.3	51.9	86
	LQ/LS Drains	30.3	215.5	51.9	75.9
	LS2/39A Drains	5.3	213.9	51.9	75.7
	N42 Drain (N)	8.8	17.0	17.0	0.0
	N42 Drain (NT)	10.1	32.2	32.2	0.0
	39 Drain	4.8	425.7	51.9	87.8
	Unknown Surface	-81.8	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
3. CS to BC	Cedar Draw	115.2	107.9	51.9	51.9
	Mud Creek	97.3	62.3	51.9	16.7
	Deep Creek	95.9	65.7	51.9	21.0
	Blind Canyon Creek	43.5	29.0	29.0	0.0
	I Drain	11.4	111.9	51.9	53.6
	J8 Drain	9.0	41.1	41.1	0.0
	N Drain	4.4	36.8	36.8	0.0
	S29 Drain	2.6	11.9	11.9	0.0
	S19/S Drain	53.0	43.4	43.4	0.0
	Unknown Surface	-98.3	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
4. BC to GB	Salmon Falls Creek	149.4	40.6	40.6	0.0
	W26 Drain	18.2	61.2	51.9	15.2
	Unknown Surface	-38.6	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
5. GB to SB	Malad River	180.0	21.2	21.2	0.0
	Malad Power Flume	1132.0	21.2	21.2	0.0
	Billingsley Creek	39.3	4.7	4.7	0.0
	Birch Creek	11.0	1.3	1.3	0.0
	Unknown Surface	122.8	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
6. SB to KH	Clover Creek	40.8	9.7	9.7	0.0
	Unknown Surface	131.9	107.3	51.9	51.6
	Sub Total/Mean =	[redacted]		[redacted]	[redacted]
Segs 1 to 7	Overall Total/Mean =	2707.7	102.0	41.6	33.3

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 3 CS to BC (RM600 40 to RM587 00)

(1) Determine % Reduction of Surface Sources

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent % Load	Load After Reduction	
Point Sources (A)	3,596.5	0.0%	0 0	3,596 5	
All Springs (B)	1,375.3	0.0%	0 0	1,375.3	
All Surface (C)	26,245.6	19.5%	5,117 9	21,127 7	
Total Load (A+B+C)	31,217.4		5,117.9	26,099.5	= Inputs %R 16.4

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segment 3

	Net Q, cfs	Before Net Load	% Red	After Net Load	
Instream Seg 3 (D)	1,742.0	48,372.7	33.3%	32,264.6	
Total Segs 3	1,742.0	48,372.7		32,264.6	Instream %R 33.3
Segment 3:		Before		After	
Point Sources (A)	687.7	3,596.5	0.0%	3,596.5	
All Springs (B)	720.3	1,375.3	0.0%	1,375.3	
All Surface (C)	334.0	26,245.6	19.5%	21,127.7	
Total Inputs (A+B+C)	1,742.0	31,217.4		26,099.5	
TOTAL (A+B+C+D)	3,484.0	79,590.1		58,364.1	Instream %R 26.7
TSS, mg/L		22.5		16.5	26.7

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 3.
2. Instream Net Load from Section VII, Segment 3, Oveall Total.
3. 19.5% All Surface Reduction obtained from Section X. B. Segment 3 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X. TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 2: PF to CS (RM613.09 to RM600.40)

(1) Determine % Reduction of Surface Sources

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent % Load	Load After Reduction
Point Sources (A)	2,428.2	0.0%	0.0	2,428.2
All Springs (B)	39.0	0.0%	0.0	39.0
All Surface (C)	30,159.8	50.5%	15,230.7	14,929.1
Total Load (A+B+C)	32,627.0		15,230.7	17,396.3 =

Inputs %R
46.7

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segments 2

	Before Reduction Net Q, cfs	Net Load	% Red	After Reduction Net Load
Instream Seg 2 (D)	773.0	7,623.7	33.3%	5,085.0
Total Segs 2	773.0	7,623.7		5,085.0

Instream %R
33.3

Segment 2:		Before		After
Point Sources (A)	464.2	2,428.2	0.0%	2,428.2
All Springs (B)	30.6	39.0	0.0%	39.0
All Surface (C)	278.2	30,159.8	50.5%	14,929.1
Total Inputs (A+B+C)	773.0	32,627.0		17,396.3
TOTAL (A+B+C+D)	1,546.0	40,250.7		22,481.3
TSS, mg/L		26.5		14.8

Instream %R
44.1
44.1

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 2.
2. Instream Net Load from Section VII, Segment 2, Oveall Total.
3. 50.5% All Surface Reduction obtained from Section X. B. Segment 2 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 5 GB to SB (RM582.00 to RM565.75)

(1) Determine % Reduction of Surface Sources

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent % Load	Load After Reduction
Point Sources (A)	822.0	0.0%	0.0	822.0
All Springs (B)	371.3	0.0%	0.0	371.3
All Surface (C)	31,078.3	10.3%	3,201.1	27,877.2
Total Load (A+B+C)	32,271.6		3,201.1	29,070.5 =

Inputs %R
9.9

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segment 5

	Net Q, cfs	Before Net Load	% Red	After Net Load
Instream Seg 5 (D)	1,836.0	10,977.2	33.3%	7,321.8
Instream Net	1,836.0	10,977.2		7,321.8

Instream %R
33.3

Segment 5:		Before		After
Point Sources (A)	186.1	822.0	0.0%	822.0
All Springs (B)	211.9	371.3	0.0%	371.3
All Surface (C)	1,438.0	31,078.3	10.3%	27,877.2
Total Inputs (A+B+C)	1,836.0	32,271.6		29,070.5
TOTAL (A+B+C+D)	3,672.0	43,248.8		36,392.3
TSS, mg/L		11.6		9.7

% Red
15.9
15.9

(3) Diversions

Bell Rapids	-104.8	-1772.6		-1772.6
Total Diversion	(104.80)	(1772.6)		(1772.6)
Instream Effect	3,567.2	41,476.2		34,619.7
TSS mg/L		11.4		9.5

% Red
16.5
16.5

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 5.
2. Instream Net Load from Section VII, Segment 5, Oveall Total.
3. 10.3% All Surface Reduction obtained from Section X. B. Segment 5 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 4 BC to GB (RM587.00 to RM582.00)

(1) Determine % Reduction of Surface Sources

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent % Load	Load After Reduction	
Point Sources (A)	111.2	0.0%	0.0	111.2	
All Springs (B)	2,715.3	0.0%	0.0	2,715.3	
All Surface (C)	5,704.3	22.3%	1,272.1	4,432.2	
Total Load (A+B+C)	8,530.8		1,272.1	7,258.7	= Inputs %R 14.9

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segment 4

	Net Q, cfs	Before Net Load	% Red	After Net Load	
Instream Seg 4 (D)	1,705.5	31,839.1	33.3%	21,236.7	Instream %R 33.3
Instream Net	1,705.5	31,839.1		21,236.7	
Segment 4:		**Before**		**After**	
Point Sources (A)	146.7	111.2	0.0%	111.2	
All Springs (B)	1,429.8	2,715.3	0.0%	2,715.3	
All Surface (C)	129.0	5,704.3	22.3%	4,432.2	
Total Inputs (A+B+C)	1,705.5	8,530.8		7,258.7	
TOTAL (A+B+C+D)	3,411.0	40,369.9		28,495.4	% Red 29.4
TSS, mg/L		11.6		8.2	29.4

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 4.
2. Instream Net Load from Section VII, Segment 4, Oveall Total.
3. 22.3% All Surface Reduction obtained from Section X. B. Segment 4 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SUMMARY REVIEW OF SEGMENTS RESPONDING TO TSS REDUCTIONS IN SURFACE SOURCES
BASED ON BASELINE FLOW CONDITIONS

BEFORE TSS LOAD REDUCTIONS:

	Segment	Total Inputs tons/year	Insteam Net Load tons/year	Instream Total Load tons/year	Total Inputs Q, cfs	Insteam Net Load Q, cfs	Instream Total Load Q, cfs
1	MD to PF	16,120.1	7,945.4	24,065.5	877.0	877.0	1,754.0
2	PF to CS	32,627.0	7,623.7	40,250.7	773.0	773.0	1,546.0
3	CS to BC	31,217.4	48,372.7	79,590.1	1742.0	1742.0	3,484.0
4	BC to GB	8,530.8	31,839.1	40,369.9	1705.5	1705.5	3,411.0
5	GB to SB	32,271.6	10,977.2	43,248.8	1836.0	1836.0	3,672.0
6	SB to KH	5,338.3	88,186.6	93,524.9	421.0	421.0	842.0
	Total	126,105.2	194,944.7	321,049.9	7,354.5	7,354.5	14,709.0
	% of Total	39.3	60.7		50.0	50.0	

AFTER TSS LOAD REDUCTIONS:

	Segment	Total Inputs tons/year	Insteam Net Load tons/year	Instream Total Load tons/year	Total Inputs Q, cfs	Insteam Net Load Q, cfs	Instream Total Load Q, cfs
1	MD to PF	9,469.5	5,299.6	14,769.0	877.0	877.0	1,754.0
2	PF to CS	17,396.3	5,085.0	22,481.3	773.0	773.0	1,546.0
3	CS to BC	26,099.5	32,264.6	58,364.1	1742.0	1742.0	3,484.0
4	BC to GB	7,258.7	21,236.7	28,495.4	1705.5	1705.5	3,411.0
5	GB to SB	29,070.5	7,321.8	36,392.3	1836.0	1836.0	3,672.0
6	SB to KH	4,042.9	58,820.5	62,863.4	421.0	421.0	842.0
	Total	93,337.5	130,028.1	223,365.6	7,354.5	7,354.5	14,709.0
	% of Total	41.8	58.2		50.0	50.0	

OVERALL % REDUCTION:

	Segment	Total Inputs %R	Insteam Net Load %R	Instream Total Load %R
1	MD to PF	41.3	33.3	38.6
2	PF to CS	46.7	33.3	44.1
3	CS to BC	16.4	33.3	26.7
4	BC to GB	14.9	33.3	29.4
5	GB to SB	9.9	33.3	15.9
6	SB to KH	24.3	33.3	32.8
	% of Total	26.0	33.3	30.4

X TSS REDUCTION TARGETS ON THE MID-SNAKE RIVER SURFACE WATERBODIES
YEAR 2004 YEAR 2009 TARGETS

SEGMENT 6. SB to KH (RM565.75 to RM545.00)

(1) Determine % Reduction of Surface Sources

TSS Sources	TSS Load, tons/year	% Reduction	Equivalent % Load	Load After Reduction	
Point Sources (A)	0.0	0.0%	0.0	0.0	
All Springs (B)	317.5	0.0%	0.0	317.5	
All Surface (C)	5,020.8	25.8%	1,295.4	3,725.4	
Total Load (A+B+C)	5,338.3		1,295.4	4,042.9	= Inputs %R 24.3

(2) Surface Stream TSS Reduction Effect on Mid-Snake River Segment 1

	Net Q, cfs	Before Net Load	% Red	After Net Load	
Instream Seg 6 (D)	421.0	88,186.6	33.3%	58,820.5	Instream %R 33.3
Instream Net	421.0	88,186.6		58,820.5	
Segment 6:		Before		After	
Point Sources (A)	0.0	0.0	0.0%	0.0	
All Springs (B)	248.3	317.5	0.0%	317.5	
All Surface (C)	172.7	5,020.8	25.8%	3,725.4	
Total Inputs (A+B+C)	421.0	5,338.3		4,042.9	
TOTAL (A+B+C+D)	842.0	93,524.9		62,863.4	Instream %R 32.8
TSS, mg/L		109.3		73.4	32.8

(3) Diversions

Black Mesa	-63.6	-1,451.2		-1,451.2
Wiley Pumps	-19.3	-440.2		-440.2
Total Diversion	(82.9)	(1,891.4)		(1,891.4)
Instream Effect	759.1	91,633.5		60,972.0
TSS, mg/L		118.7		79.0

% Red: 33.5 / 33.5

NOTES:

1. TSS Load for Point Sources, All Springs, and All Surface from Section VII, Segment 6.
2. Instream Net Load from Section VII, Segment 6, Oveall Total.
3. 25.8% All Surface Reduction obtained from Section X. B. Segment 6 % Reduction.
4. 33.3% Instream Reduction obtained from Section X. B. Overall Total/Mean to reduce to < 52.0

X. THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

1. Ascertaining the Normality of Raw Data versus Log Transformed Data (Trans Data)

Parameter Format	Q cfs	TSS mg/L	TP mg/L	SRP mg/L	NH3 mg/L	NOX mg/L	TKN mg/L	DO mg/L
1. N	1440	1440	1440	1440	1440	1440	1440	1463
2. CV								
Raw Data	1.02	0.92	0.44	0.74	1.10	0.51	0.49	0.17
Log Data	0.17	0.31	0.18	0.26	0.32	7.67	0.48	-
3. Curve Shape Skewness								
Raw Data	Right	Right	Right	Right	Right	Normal	Normal	Normal
Log Data	Binomial	Normal	Normal	Normal	Normal	Left	Normal	-
4. Mean/Median								
Raw Data	6412/3819	18.6/14.8	0.115/0.108	0.064/0.051	0.080/0.050	1.136/1.237	0.37/0.37	10.0/9.9
Log Data	3.54/3.58	1.14/1.27	-0.97/-0.97	-1.31/-1.29	-1.30/-1.30	-0.05/-0.09	-0.49/-0.43	-
5. Skewness Value								
Raw Data	1.88	5.29	2.27	1.76	2.11	-0.07	1.80	0.35
Log Data	-1.85	-0.87	-0.23	-0.56	0.18	-2.02	-0.82	-
6. Kurtosis Value								
Raw Data	4.05	59.58	11.45	6.76	3.90	-0.51	8.10	-0.14
Log Data	6.52	2.91	2.58	0.49	-0.21	4.90	1.10	-
Conclusion: Which database has a normal distribution?								
Raw Data						X	X	X
Log Data	X	X	X	X	X		X	

Fecal Coliform Bacteria reductions will be assessed separately in item 9, BACTERIA:TSS SYNERGISTIC RELATIONSHIP.

2. Synergistic Relationships Summary Statistics:

	N	r^2	F-ratio	p-value	Equation
TSS:Q	1440	0.252	97.1	0.000000	logTSS=(0.147313 logQ)+0.622362
TP:TSS	1440	0.223	75.3	0.000000	logTP=(0.110944logTSS)-1.101016
SRP:TSS	1440	0.133	26.0	0.000000	logSRP=(-0.127320logTSS)-1.167700
NH3:TSS	1440	0.045	2.9	0.086422	logNH3=(-0.052298logTSS)-1.235676
NOX:TSS	1440	0.315	158.4	0.000000	NOX=(-0.010577TSS)+1.334458
TKN:TSS	1440	0.316	159.2	0.000000	TKN=(0.003342TSS)+0.307932
DO:TSS	1463	0.973	-	-	*Quadratic Equation

NOTE: Biological data cannot always have r^2 values > 0.950. In fact, scientific literature indicates that if a p-value is < 0.050, the relationship is significant no matter how low the r^2 value or the F-ratio are. Transformation of data to arrive at a higher r^2 value will not always provide results with r^2 values > 0.950.

*Quadratic Equation: DO=(logTSS^2x(-0.296809))+(logTSSx0.566078)+9.829993

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS.
Prediction Estimates on Parameter Responses

N^ WATER QUALITY SYNERGISMS

)nitoring data collected by IDEQ-TFRO, other agencies, and organizations, statistical
or total suspended solids were explored for the Middle Snake River and its tributaries.
:h water quality parameters to describe sediment (as TSS) have been described by
arcners and is the basis for water quality reduction estimates when TSS is reduced on
basis (Lloyd 1987; Lloyd 1987; Truhlar 1976; Schroeder et al. 1981; Earhart 1984).
f. 2.2.4.2, §2.2.4.3, and Appendix D.) It was determined that there existed various
elationships that could be correlated statistically to TSS. These are defined in the
es according to the particular stream segment and followed by an explanation.

\K_ RIVER SYNERGISMS

rg ns between TSS and selected water quality parameters

'm..t	*TSS Synergistic Equation*	*Criteria Determining Significance* r^2	*F-ratio*	*p*	*Equivalency at 52 mg/L TSS*
	Middle Snake River				
?iver	TP = (0.001 x TSS) + 0.083	0.450	243.4	0.000	TP = 0.135 mg/L
?i\	NTU = (0.407 x TSS) + 6.032	0.749	1256.2	0.000	NTU = 27.2 NTU
?iver	SRP = (-0.0001 x TSS) + 0.358	0.114	12.6	0.000	SRP = 0.049 mg/L
?i\	TKN = (0.003 x TSS) + 0.358	0.389	171.3	0.000	TKN = 0.514 mg/L
?iver	NOX = (-0.011 x TSS) + 1.247	0.413	197.1	0.000	NOX = 0.675 mg/L
?i\	Q = (226.518 x TSS) + 3688.583	0.538	401.1	0.000	Q = 15467.5 cfs
?iver	DO = (0.0001 x Q) + 9.486	0.331	121.5	0.000	DO = 11.03 mg/L

1-T^O p values < 0.050 were considered significant

s^ergisms in the Middle Snake River for TSS include TP, NTU, TKN, NOX, and Q
f ii Table 77), such that as TSS is decreased so is the synergistic water quality
r vice versi). On the other hand, SRP and NOX have an inverse relationship. DO does
well with TSS (r2 = 0.062, F-ratio = 3.8, p = 0.051). However, DO does have a
re tion to flow (Q), such that as Q increases so does the DO. Higher flows appear to
em to aerate better than lower flows.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS
Prediction Estimates on Parameter Responses

ROCK CREEK SYNERGISMS

Statistical synergisms between TSS and selected water quality parameters on Rock Creek

Stream Segment	TSS Synergistic Equation	Criteria Determining Significance r^2	F-ratio	p	Equivalency at 52 mg/L TSS
Rock Creek (from Rock Creek Town to confluence with Middle Snake River)					
Rock Creek	TP = (0.001 x TSS) + 0.129	0.420	61.3	0.000	TP = 0.181 mg/L
Rock Creek	NTU = (0.530 x TSS) + 3.535	0.893	1124.3	0.000	NTU = 31.1 NTU
Rock Creek	TKN = (0.0001 x TSS) + 0.561	0.124	4.5	0.035	TKN = 0.566 mg/L
Rock Creek	Q = (0.201 x TSS) + 206.577	0.220	14.5	0.000	Q = 217.0 cfs

Prepared by IDEQ-TFRO. Water quality surrogates that are inversely related to TSS include NOX and DO. The NOX equation includes NOX = (-0.005 x TSS) + 2.448, with a statistical relationship of r^2=0.537, F-ratio=116.0, p = 0.000. The DO equation includes DO = (-0.003 x TSS) + 9.744, with a statistical relationship, r^2=0.210, F-ratio=13.1, p=0.000. The equivalency at 52 mg/L TSS is 2.188 mg/L NOX and 9.59 mg/L DO, respectively.

Water quality synergisms in Rock Creek for TSS include TP, NTU, TKN, and Q (as described in Table 78), such that as the TSS is decreased so is the synergistic water quality parameter. On the other hand, NOX and DO have an inverse correlation to TSS, such that as TSS is increased the corresponding water quality synergism is decreased. DO also correlates statistically to Q but as an inverse relationship: DO = (-0.006 x Q) + 10.768 (r2=0.346, F-ratio=38.9, p=0.000). The DO equivalency at 52 mg/L TSS is 9.46 mg/L DO.

A sediment (TSS) rating curve was established for Rock Creek. A high level of variability was noted in the data population, although the log transformation gave a higher correlation value (as expected): logTSS = (1.065 x logQ) - 0.832 (r2 = 0.403, F-ratio = 55.3, p = 0.000).

BILLINGSLEY CREEK SYNERGISMS

Statistical synergisms between TSS and selected water quality parameters on Billingsley Creek

Stream Segment	TSS Synergistic Equation	Parameters of Significance r^2	F-ratio	p	Equivalency at 52 mg/L TSS
Billingsley Creek					
Billingsley Creek	Q = (1.088 x TSS) + 52.507	0.158	10.5	0.001	109.08 cfs
Billingsley Creek	NTU = (1.031 x TSS) + 1.524	0.746	520.2	0.000	55.1 NTU
Billingsley Creek	NH3 = (0.003 x TSS) + 0.144	0.156	10.3	0.001	0.30 mg/L
Billingsley Creek	NOX = (0.006 x TSS) + 1.047	0.141	8.4	0.004	1.359 mg/L
Billingsley Creek	TKN = (0.013 x TSS) + 0.300	0.385	72.0	0.000	0.976 mg/L
Billingsley Creek	TP = (0.003 x TSS) + 0.098	0.229	22.9	0.000	0.254 mg/L

Prepared by IDEQ-TFRO. Two synergisms were not positively correlated: TEM and RM. Temperature had an equation of TEM = (-0.160 x TSS) + 15.459, with significance at r^2=484, F-ratio=126.6, p = 0.000; River mile had an equation of RM = (-0.054 x TSS) + 4.695, with significance at r^2=0.166, F-ratio=11.8, and p=0.001. The equivalency of 52 mg/L TSS is 7.14 °C and 1.887 mg/L TP, respectively.

XI. THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS
Prediction Estimates on Parameter Responses

Water quality synergisms in Billingsley Creek for TSS include Q, NTU, NH3, NOX, TKN, and TP (as described in Table 80), such that as TSS is reduced so is the Q, NTU, NH3, NOX, TKN, and TP

A sediment (TSS) rating curve was established for Billingsley Creek. A high level of variability was noted in the data population. The log transformation did not give a higher correlation value as anticipated: logTSS = (0.150 x logQ) + 0.212 (r2 = 0.147, F-ratio = 5.1, p = 0.025).

CLOVER CREEK SYNERGISMS

Statistical synergisms between TSS and selected water quality parameters on Clover Creek

Stream Segment	***TSS Synergistic Equation***	***Parameters of Significance***			***Equivalency at 52 mg/L TSS***
		r	***F-ratio***	***p***	
Billinsley Creek					
Clover Creek	Q = (2.664 x TSS) - 6.521	0.587	21.0	0.000	132.0 mg/L
Clover Creek	DO = (0.083 x TSS) + 8.148	0.407	8.0	0.007	12.5 mg/L
Clover Creek	NTU = (0.663 x TSS) + 6.593	0.408	8.0	0.007	41.1 mg/L
Clover Creek	NH3 = (0.001 x TSS) + 0.011	0.584	20.7	0.000	0.063 mg/L
Clover Creek	NOX = (0.005 x TSS) + 0.015	0.412	8.2	0.007	0.275 mg/L
Prepared by IDEQ-TFRO					

Water quality synergisms in Clover Creek for TSS include Q, DO, NTU, NH3, and NOX (as described in Table 82), such that as TSS is reduced so is the Q, DO, NTU, NH3, and NOX. Other parameters are not statistically signficant for determination of synergisms.

A sediment (TSS) rating curve was established for Clover. A high level of variability was noted in the data population. The log transformation did not give a higher correlation value as anticipated: logTSS = (0.157 x logQ) + 0.698 (r2 = 0.309, F-ratio = 4.2, p = 0.047).

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

3 TP TSS SYNERGISTIC RELATIONSHIP logTP=(0.110944xlogTSS)-1.101016

R = Reduction		Before R	After R	log TSS		TP mg/L	
Segment	Surface Name	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R
1 - 1	Dry Creek	290.0	51.9	2.462	1.715	0.149	0.123
1 - 2	A Drain	164.2	51.9	2.215	1.715	0.140	0.123
1 - 3	A10 Drain	44.5	44.5	1.648	1.648	0.121	0.121
1 - 4	C55 Drain	47.3	47.3	1.675	1.675	0.122	0.122
1 - 5	TF Coulee	121.3	51.9	2.084	1.715	0.135	0.123
1 - 6	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
2 - 1	East Perrine Coulee	116.9	51.9	2.068	1.715	0.134	0.123
2 - 2	Main Perrine Coulee	117.2	51.9	2.069	1.715	0.134	0.123
2 - 3	West Perrine Coulee	223.2	51.9	2.349	1.715	0.144	0.123
2 - 4	43 Drain	179.7	51.9	2.255	1.715	0.141	0.123
2 - 5	Warm Creek	16.0	16	1.204	1.204	0.108	0.108
2 - 6	Rock Creek	66.4	51.9	1.822	1.715	0.126	0.123
2 - 7	30 Drain	371.3	51.9	2.570	1.715	0.153	0.123
2 - 8	LQ/LS Drains	215.5	51.9	2.333	1.715	0.144	0.123
2 - 9	LS2/39A Drains	213.9	51.9	2.330	1.715	0.144	0.123
2 - 10	N42 Drain (N)	17.0	17	1.230	1.230	0.109	0.109
2 - 11	N42 Drain (NT)	32.2	32.2	1.508	1.508	0.116	0.116
2 - 12	39 Drain	425.7	51.9	2.629	1.715	0.155	0.123
2 - 13	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
3 - 1	Cedar Draw	107.9	51.9	2.033	1.715	0.133	0.123
3 - 2	Mud Creek	62.3	51.9	1.794	1.715	0.125	0.123
3 - 3	Deep Creek	65.7	51.9	1.818	1.715	0.126	0.123
3 - 4	Blind Canyon Creek	29.0	29.0	1.462	1.462	0.115	0.115
3 - 5	I Drain	111.9	51.9	2.049	1.715	0.134	0.123
3 - 6	J8 Drain	41.1	41.1	1.614	1.614	0.120	0.120
3 - 7	N Drain	36.8	36.8	1.566	1.566	0.118	0.118
3 - 8	S29 Drain	11.9	11.9	1.076	1.076	0.104	0.104
3 - 9	S19/S Drain	43.4	43.4	1.637	1.637	0.120	0.120
3 - 20	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
4 - 1	Salmon Falls Creek	40.6	40.6	1.609	1.609	0.120	0.120
4 - 2	W26 Drain	61.2	51.9	1.787	1.715	0.125	0.123
4 - 3	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
5 - 1	Malad River	21.2	21.2	1.326	1.326	0.111	0.111
5 - 2	Malad River Power Flu	21.2	21.2	1.326	1.326	0.111	0.111
5 - 3	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
6 - 1	Clover Creek	9.7	9.7	0.987	0.987	0.102	0.102
6 - 2	Unknown Surface	107.3	51.9	2.031	1.715	0.133	0.123
(n = 37)	MEAN	107.3	43.4	1.857	1.603	0.128	0.120
	% REDUCTION		59.6		13.7		6.7
	t-test (Before versus After): p =		0.000134		0.000002		0.000004
	t-test Bonferroni p =		0.003760		0.000052		0.000102
	Are paired data sets different?		YES		YES		YES

Prediction: A 59.6% TSS reduction will produce a significant decrease in TP by 6.7%.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

4 SRP:TSS SYNERGISTIC RELATIONSHIP: logSRP=(-0.127320xlogTSS)-1.167700

	Before R	After R	log TSS		log SRP		SRP mg/L	
Segment	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R	Before R	After R
1 - 1	290.0	51.9	2.462	1.715	-1.481	-1.386	0.033	0.041
1 - 2	164.2	51.9	2.215	1.715	-1.450	-1.386	0.036	0.041
1 - 3	44.5	44.5	1.648	1.648	-1.378	-1.378	0.042	0.042
1 - 4	47.3	47.3	1.675	1.675	-1.381	-1.381	0.042	0.042
1 - 5	121.3	51.9	2.084	1.715	-1.433	-1.386	0.037	0.041
1 - 6	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
2 - 1	116.9	51.9	2.068	1.715	-1.431	-1.386	0.037	0.041
2 - 2	117.2	51.9	2.069	1.715	-1.431	-1.386	0.037	0.041
2 - 3	223.2	51.9	2.349	1.715	-1.467	-1.386	0.034	0.041
2 - 4	179.7	51.9	2.255	1.715	-1.455	-1.386	0.035	0.041
2 - 5	16.0	16	1.204	1.204	-1.321	-1.321	0.048	0.048
2 - 6	66.4	51.9	1.822	1.715	-1.400	-1.386	0.040	0.041
2 - 7	371.3	51.9	2.570	1.715	-1.495	-1.386	0.032	0.041
2 - 8	215.5	51.9	2.333	1.715	-1.465	-1.386	0.034	0.041
2 - 9	213.9	51.9	2.330	1.715	-1.464	-1.386	0.034	0.041
2 - 10	17.0	17	1.230	1.230	-1.324	-1.324	0.047	0.047
2 - 11	32.2	32.2	1.508	1.508	-1.360	-1.360	0.044	0.044
2 - 12	425.7	51.9	2.629	1.715	-1.502	-1.386	0.031	0.041
2 - 13	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
3 - 1	107.9	51.9	2.033	1.715	-1.427	-1.386	0.037	0.041
3 - 2	62.3	51.9	1.794	1.715	-1.396	-1.386	0.040	0.041
3 - 3	65.7	51.9	1.818	1.715	-1.399	-1.386	0.040	0.041
3 - 4	29.0	29.0	1.462	1.462	-1.354	-1.354	0.044	0.044
3 - 5	111.9	51.9	2.049	1.715	-1.429	-1.386	0.037	0.041
3 - 6	41.1	41.1	1.614	1.614	-1.373	-1.373	0.042	0.042
3 - 7	36.8	36.8	1.566	1.566	-1.367	-1.367	0.043	0.043
3 - 8	11.9	11.9	1.076	1.076	-1.305	-1.305	0.050	0.050
3 - 9	43.4	43.4	1.637	1.637	-1.376	-1.376	0.042	0.042
3 - 20	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
4 - 1	40.6	40.6	1.609	1.609	-1.372	-1.372	0.042	0.042
4 - 2	61.2	51.9	1.787	1.715	-1.395	-1.386	0.040	0.041
4 - 3	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
5 - 1	21.2	21.2	1.326	1.326	-1.337	-1.337	0.046	0.046
5 - 2	21.2	21.2	1.326	1.326	-1.337	-1.337	0.046	0.046
5 - 3	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
6 - 1	9.7	9.7	0.987	0.987	-1.293	-1.293	0.051	0.051
6 - 2	107.3	51.9	2.031	1.715	-1.426	-1.386	0.037	0.041
(n = 37)								
MEAN	107.3	43.4	1.857	1.603	-1.404	-1.372	0.040	0.043
% REDUCTION		59.6		13.7		2.3		-7.1

t-test (Before versus After): p = 0.000001

t-test Bonferroni p = 0.000029

Are paired data sets different? YES

Prediction: A 59.6% TSS reduction will produce a signficant increase in SRP by 7.1%.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

5 NH3 TSS SYNERGISTIC RELATIONSHIP logNH3=(-0 052298 x logTSS) - 1 235676

	Before R	After R	log TSS		log NH3		NH3 mg/L	
Segment	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R	Before R	After R
1 - 1	290 0	51 9	2.462	1 715	-1 364	-1 325	0 043	0 047
1 - 2	164 2	51.9	2 215	1.715	-1 352	-1 325	0 045	0 047
1 - 3	44 5	44 5	1 648	1 648	-1 322	-1 322	0 048	0 048
1 - 4	47 3	47 3	1 675	1 675	-1 323	-1 323	0 048	0 048
1 - 5	121.3	51.9	2.084	1.715	-1.345	-1 325	0 045	0 047
1 - 6	107.3	51.9	2.031	1.715	-1.342	-1 325	0.046	0.047
2 - 1	116.9	51.9	2.068	1.715	-1.344	-1.325	0 045	0 047
2 - 2	117.2	51.9	2.069	1.715	-1.344	-1.325	0 045	0.047
2 - 3	223.2	51.9	2.349	1.715	-1.359	-1.325	0.044	0.047
2 - 4	179.7	51.9	2.255	1.715	-1.354	-1 325	0.044	0.047
2 - 5	16.0	16	1.204	1.204	-1.299	-1.299	0 050	0 050
2 - 6	66.4	51.9	1.822	1.715	-1.331	-1.325	0.047	0.047
2 - 7	371.3	51.9	2.570	1.715	-1.370	-1.325	0.043	0.047
2 - 8	215.5	51.9	2.333	1.715	-1.358	-1.325	0.044	0.047
2 - 9	213.9	51.9	2.330	1.715	-1.358	-1.325	0.044	0.047
2 - 10	17.0	17	1.230	1.230	-1.300	-1.300	0.050	0.050
2 - 11	32.2	32.2	1.508	1.508	-1.315	-1.315	0.048	0.048
2 - 12	425.7	51.9	2.629	1.715	-1.373	-1.325	0 042	0.047
2 - 13	107.3	51.9	2.031	1.715	-1.342	-1.325	0.046	0.047
3 - 1	107.9	51.9	2.033	1.715	-1.342	-1.325	0.045	0.047
3 - 2	62.3	51.9	1.794	1.715	-1.330	-1.325	0.047	0.047
3 - 3	65.7	51.9	1.818	1.715	-1.331	-1.325	0.047	0.047
3 - 4	29.0	29.0	1.462	1.462	-1.312	-1.312	0.049	0.049
3 - 5	111.9	51.9	2.049	1.715	-1.343	-1.325	0.045	0.047
3 - 6	41.1	41.1	1.614	1.614	-1.320	-1.320	0.048	0.048
3 - 7	36.8	36.8	1.566	1.566	-1.318	-1.318	0.048	0.048
3 - 8	11.9	11.9	1.076	1.076	-1.292	-1.292	0.051	0.051
3 - 9	43.4	43.4	1.637	1.637	-1.321	-1.321	0.048	0.048
3 - 20	107.3	51.9	2.031	1.715	-1.342	-1.325	0.046	0.047
4 - 1	40.6	40.6	1.609	1.609	-1.320	-1.320	0.048	0.048
4 - 2	61.2	51.9	1.787	1.715	-1.329	-1.325	0.047	0.047
4 - 3	107.3	51.9	2.031	1.715	-1.342	-1.325	0.046	0.047
5 - 1	21.2	21.2	1.326	1.326	-1.305	-1.305	0.050	0.050
5 - 2	21.2	21.2	1.326	1.326	-1.305	-1.305	0.050	0.050
5 - 3	107.3	51.9	2.031	1.715	-1.342	-1.325	0.046	0.047
6 - 1	9.7	9.7	0.987	0.987	-1.287	-1.287	0.052	0.052
6 - 2	107.3	51.9	2.031	1.715	-1.342	-1.325	0.046	0.047
(n = 37)								
MEAN	107.3	43.4	1.857	1.603	-1.333	-1.320	0.047	0.048
% REDUCTION		59.6		13.7		1.0		-3.0

t-test (Before versus After): p = 0.000017

t-test Bonferroni p = 0.000017

Are paired data sets different? YES

Prediction: A 59.6% TSS reduction will produce a signficant increase in NH3 by 3.0%.

5 NH3:TSS SYNERGISTIC RELATIONSHIP (Continued):

Ammonia is the principle nitrogenous by-product of fish metabolism and is of importance in fish culture because it is toxic to fish in its un-ionized form. Aqueous ammonia occurs in two molecular forms and the equilibrium between them is determined by pH, and to a lesser extent, temperature: NH3 = NH4+ , and NH3-N + NH4+ -N = Total Ammonia N (TAN). The un-ionized form, NH3, is a gas and can freely pass the gill membrane. Un-ionized ammonia is toxic to fish while ammonium is relatively non-toxic (Sodereberg 1995 [pp 97-98]). Additionally, un-ionized ammonia is toxic to nitrification bacteria and may inhibit the nitrification process (Soderberg 1995 [p 114]). Water recirculation in fish production calls for reuse of the water so that maintenance of dissolved oxygen is suitable for efficient respiration, maintenance of safe levels of un-ionized ammonia, and maintenance of water reasonably clear of solid waste. Biological filtration of the recycled water depends upon nitrification, a microbiological process by which autotrophic bacteria oxidize ammonium (NH4+) to nitrite (N02-) and then to nitrate (NO3-). Ammonium, although relatively nontoxic to fish, when removed from culture water reduces the levels of its equilibrium product, ammonia (NH3). The intermediate product, NO2-, is quite toxic to fish and is an important concern in recirculating aquaculture. Nitrate is essentially nontoxic to fish and is allowed to accumulate in recirculating systems (Soderberg 1995 [pp 113-114]).

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

NOX:TSS SYNERGISTIC RELATIONSHIP NOX = (-0.010577 x TSS) + 1.334458

	Before R	After R	log TSS		NOX mg/L		Increase by 3.219	
Segment	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R	Before R	After R
1 - 1	290.0	51.9	2.462	1.715	-1.733	0.786	1.486	4.005
1 - 2	164.2	51.9	2.215	1.715	-0.402	0.786	2.817	4.005
1 - 3	44.5	44.5	1.648	1.648	0.864	0.864	4.083	4.083
1 - 4	47.3	47.3	1.675	1.675	0.834	0.834	4.053	4.053
1 - 5	121.3	51.9	2.084	1.715	0.051	0.786	3.270	4.005
1 - 6	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
2 - 1	116.9	51.9	2.068	1.715	0.098	0.786	3.317	4.005
2 - 2	117.2	51.9	2.069	1.715	0.095	0.786	3.314	4.005
2 - 3	223.2	51.9	2.349	1.715	-1.026	0.786	2.193	4.005
2 - 4	179.7	51.9	2.255	1.715	-0.566	0.786	2.653	4.005
2 - 5	16.0	16	1.204	1.204	1.165	1.165	4.384	4.384
2 - 6	66.4	51.9	1.822	1.715	0.632	0.786	3.851	4.005
2 - 7	371.3	51.9	2.570	1.715	-2.593	0.786	0.626	4.005
2 - 8	215.5	51.9	2.333	1.715	-0.945	0.786	2.274	4.005
2 - 9	213.9	51.9	2.330	1.715	-0.928	0.786	2.291	4.005
2 - 10	17.0	17	1.230	1.230	1.155	1.155	4.374	4.374
2 - 11	32.2	32.2	1.508	1.508	0.994	0.994	4.213	4.213
2 - 12	425.7	51.9	2.629	1.715	-3.168	0.786	0.051	4.005
2 - 13	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
3 - 1	107.9	51.9	2.033	1.715	0.193	0.786	3.412	4.005
3 - 2	62.3	51.9	1.794	1.715	0.676	0.786	3.895	4.005
3 - 3	65.7	51.9	1.818	1.715	0.640	0.786	3.859	4.005
3 - 4	29.0	29.0	1.462	1.462	1.028	1.028	4.247	4.247
3 - 5	111.9	51.9	2.049	1.715	0.151	0.786	3.370	4.005
3 - 6	41.1	41.1	1.614	1.614	0.900	0.900	4.119	4.119
3 - 7	36.8	36.8	1.566	1.566	0.945	0.945	4.164	4.164
3 - 8	11.9	11.9	1.076	1.076	1.209	1.209	4.428	4.428
3 - 9	43.4	43.4	1.637	1.637	0.875	0.875	4.094	4.094
3 - 20	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
4 - 1	40.6	40.6	1.609	1.609	0.905	0.905	4.124	4.124
4 - 2	61.2	51.9	1.787	1.715	0.687	0.786	3.906	4.005
4 - 3	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
5 - 1	21.2	21.2	1.326	1.326	1.110	1.110	4.329	4.329
5 - 2	21.2	21.2	1.326	1.326	1.110	1.110	4.329	4.329
5 - 3	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
6 - 1	9.7	9.7	0.987	0.987	1.232	1.232	4.451	4.451
6 - 2	107.3	51.9	2.031	1.715	0.200	0.786	3.419	4.005
(n = 37)								
MEAN	107.3	43.4	1.857	1.603			3.419	4.094
% REDUCTION		59.6		13.7				-19.8

t-test (Before versus After): p =	0.000134
t-test Bonferroni p =	0.000134
Are paired data sets different?	YES

Prediction: A 59.6% TSS reduction will produce a significant increase in NOX by 19.8%.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS
Prediction Estimates on Parameter Responses

NOX:TSS SYNERGISTIC RELATIONSHIP: UNDERSTANDING NOX IN ECOLOGICAL SYSTEMS

"Ecological concern about high concentrations of nitrate in streams stems from its potential for contributing to eutrophication, which is the excessive growth of aquatic plants that can impart unpleasant odors and tastes to water and reduce its clarity, and upon dying, can lower the DO concentrations (USGS 1994 [Chapter 4])." It has not been possible to establish an applicable threshold concentration for nitrate to protect against eutrophication because the effects of nitrate concentration are highly variable from place to place, and are greatest in coastal waters that are far removed from inland nitrate sources. Historically, government standards and eutrophication-control strategies for inland waters have focused on phosphorus concentration rather than on nitrate concentration, because phosphorus usually is depleted more rapidly by the growth of aquatic plants than is nitrate, and, therefore, frequently is the limiting factor in eutrophication. Yet, a water quality concentration target of 0.300 mg/L NOX is considered the limit for preventing the development of biological nuisances and the acceleration of cultural eutrophication. Agricultural return flows as well as samples from the Milner Pool often exceed the 0.300 mg/L criterion. NOX concentrations at or below 90 mg/L should be protective of warmwater fishes, while concentrations at or below 0.060 mg/L should be protective for salmonid fish. However, NOX concentrations as found in the Middle Snake River and its tributaries does no toxic harm to fisheries.

Although it can be shown that % Pass from Milner Dam may impact the Middle Snake River minimally, background levels of nitrate+nitrite (NOX) appear to have a significant effect on the water quality of the system. Similar sites and data sources used for TSS were used for NOX. The following table shows the average values (on a yearly basis) for background from 1990 to 1997 on the Middle Snake River.

Table 89 Upstream/background NOX values in the Middle Snake River

Year	*IDEQ-TFRO Data NOX, mg/L*	*USGS Data NOX, mg/L*	*Comments*
1990	1.377	-	Lo-Flow Years: 1990-1995 — Range: IDEQ-TFRO = 1.201 mg/L NOX — 0.806 - 1.420 USGS = 0.500 mg/L NOX — 0.025 - 0.883 $\bar{x}$ = 0.851 mg/L NOX — 0.025 - 1.420
1991	1.420	0.883	
1992	-	-	
1993	-	0.640	
1994	-	0.025	
1995	0.806	0.451	
1996	0.527	0.148	Hi-Flow Years: 1996-1997 — Range: IDEQ-TFRO = 0.449 mg/L NOX — 0.370 - 0.527 USGS = 0.137 mg/L NOX — 0.126 - 0.148 $\bar{x}$ = 0.293 mg/L NOX — 0.126 - 0.527
1997	0.370	0.126	
MEAN	0.900	0.385	OVERALL MEAN IDEQ + USGS DATA = 0.617 mg/L

Prepared by IDEQ-TFRO. IDEQ data from monitoring conducted in 1990, 1995-1997. USGS data from WY1991, 1993-1997. USGS WY1996-1997 looked at gage 13087995. Other years were gage 13088000. TSS values for IDEQ-TFRO based on surface grab samples. IDEQ-TFRO values decreased by 62.6% from Lo-Flow Years to Hi-Flow Years, whereas USGS values decreased by 72.6%, or an overall average of 65.5% decrease in NOX. The t-test (paired samples on IDEQ versus USGS) indicates that the sample populations are from different populations (Ho: $\mu 1 = \mu 2$) and may be considered distinct and separate.

The data indicates that the overall mean NOX value is 0.617 mg/L as background (taking into account both USGS and IDEQ-TFRO data). For IDEQ-TFRO data alone the value is 0.900 mg/L TP. For USGS data alone the value is 0.385 mg/L NOX. Water years 1996-1997 have lesser values for USGS when compared to the previous six years (1990-1995) thus indicating a reduction in NOX since 1990-1991. IDEQ-TFRO data indicates the same. Therefore, the overall mean NOX value was used as a reasonable background value, although within a specific year this value could reasonably be less. This background value (0.617 mg/L NOX) is two times greater than the recommended value of 0.300 mg/L NOX which is the limit for preventing the development of biological nuisances and the acceleration of cultural eutrophication. Additionally, some influent sources (such as tributaries or canals) exceed the average 0.617 mg/L NOX at Milner Dam. The following tables show the average values for NOX for various

tributaries and the Middle Snake River in Upper Snake Rock. None of the NOX values cause toxicity to fisheries

Mean NOX values as annual, irrigation, and non-irrigation seasons per tributary, mg/L

Tributary	Annual Value	Irrigation Season Value	Non-Irrigation Season Value
East Perrine Coulee	2.466	1.743	4.245
Rock Creek	2.144	1.808	2.755
Cedar Draw	2.299	1.584	3.668
Mud Creek	2.787	2.228	3.857
Deep Creek	2.747	2.169	3.895
Salmon Falls Creek	2.597	2.161	3.500
Billingsley Creek	1.084	1.080	1.088
Malad River	0.603	0.395	0.930
Clover Creek	0.059	0.056	0.087
Mean	1.865	1.469	2.669

Prepared by IDEQ-TFRO. See Appendix D for the other parameters. Irrigation seasonalities appear less than non-irrigation season due to increased flows during irrigation which appear to dilute NOX.

Mean NOX as annual, irrigation, and non-irrigation seasons on the Middle Snake River

Middle Snake River Location	Annual Value	Irrigation Season Value	Non-Irrigation Season Value
Milner Dam "Pass"	0.367	0.140	0.651
Murtaugh Area	1.085	0.765	1.485
Hansen Area	0.592	0.468	0.759
Crystal Springs Area	0.881	0.717	0.940
Box Canyon Area	1.003	0.914	1.113
Gridley Bridge Area	1.067	0.974	1.193
King Hill Area	1.123	1.027	1.251
Mean	0.874	0.715	1.056

Prepared by IDEQ-TFRO. See Appendix D for other parameters.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

7 TKN TSS SYNERGISTIC RELATIONSHIP TKN = (0.003342 x TSS) + 0.307932

	Before R	After R	log TSS		TKN mg/L		Increase by 1.201	
Segment	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R	Before R	After R
1 - 1	290.0	51.9	2.462	1.715	-0.661	0.481	0.540	1.682
1 - 2	164.2	51.9	2.215	1.715	-0.241	0.481	0.960	1.682
1 - 3	44.5	44.5	1.648	1.648	0.159	0.457	1.360	1.658
1 - 4	47.3	47.3	1.675	1.675	0.150	0.466	1.351	1.667
1 - 5	121.3	51.9	2.084	1.715	-0.097	0.481	1.104	1.682
1 - 6	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
2 - 1	116.9	51.9	2.068	1.715	-0.083	0.481	1.118	1.682
2 - 2	117.2	51.9	2.069	1.715	-0.084	0.481	1.117	1.682
2 - 3	223.2	51.9	2.349	1.715	-0.438	0.481	0.763	1.682
2 - 4	179.7	51.9	2.255	1.715	-0.293	0.481	0.908	1.682
2 - 5	16.0	16	1.204	1.204	0.254	0.361	1.455	1.562
2 - 6	66.4	51.9	1.822	1.715	0.086	0.481	1.287	1.682
2 - 7	371.3	51.9	2.570	1.715	-0.933	0.481	0.268	1.682
2 - 8	215.5	51.9	2.333	1.715	-0.412	0.481	0.789	1.682
2 - 9	213.9	51.9	2.330	1.715	-0.407	0.481	0.794	1.682
2 - 10	17.0	17	1.230	1.230	0.251	0.365	1.452	1.566
2 - 11	32.2	32.2	1.508	1.508	0.200	0.416	1.401	1.617
2 - 12	425.7	51.9	2.629	1.715	-1.115	0.481	0.086	1.682
2 - 13	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
3 - 1	107.9	51.9	2.033	1.715	-0.053	0.481	1.148	1.682
3 - 2	62.3	51.9	1.794	1.715	0.100	0.481	1.301	1.682
3 - 3	65.7	51.9	1.818	1.715	0.088	0.481	1.289	1.682
3 - 4	29.0	29.0	1.462	1.462	0.211	0.405	1.412	1.606
3 - 5	111.9	51.9	2.049	1.715	-0.066	0.481	1.135	1.682
3 - 6	41.1	41.1	1.614	1.614	0.171	0.445	1.372	1.646
3 - 7	36.8	36.8	1.566	1.566	0.185	0.431	1.386	1.632
3 - 8	11.9	11.9	1.076	1.076	0.268	0.348	1.469	1.549
3 - 9	43.4	43.4	1.637	1.637	0.163	0.453	1.364	1.654
3 - 20	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
4 - 1	40.6	40.6	1.609	1.609	0.172	0.444	1.373	1.645
4 - 2	61.2	51.9	1.787	1.715	0.103	0.481	1.304	1.682
4 - 3	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
5 - 1	21.2	21.2	1.326	1.326	0.237	0.379	1.438	1.580
5 - 2	21.2	21.2	1.326	1.326	0.237	0.379	1.438	1.580
5 - 3	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
6 - 1	9.7	9.7	0.987	0.987	0.276	0.340	1.477	1.541
6 - 2	107.3	51.9	2.031	1.715	-0.051	0.481	1.150	1.682
(n = 37)								
MEAN	107.3	43.4	1.857	1.603			1.150	1.654
% REDUCTION		59.6		13.7				-43.8

t-test (Before versus After): p = 0.000000

t-test Bonferroni p = 0.000000

Are paired data sets different? YES

Prediction: A 59.6% TSS reduction will produce a significant increase in TKN by 43.8%.

XI. THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

8. DO TSS SYNERGISTIC RELATIONSHIP DO=(logTSS^2 x (-0.296809))+(logTSS x 0.566078)+9.829993

	Before R	After R	log TSS		DO mg/L	
Segment	TSS mg/L	TSS mg/L	Before R	After R	Before R	After R
1 - 1	290.0	51.9	2.462	1.715	9.42	9.93
1 - 2	164.2	51.9	2.215	1.715	9.63	9.93
1 - 3	44.5	44.5	1.648	1.648	9.96	9.96
1 - 4	47.3	47.3	1.675	1.675	9.95	9.95
1 - 5	121.3	51.9	2.084	1.715	9.72	9.93
1 - 6	107.3	51.9	2.031	1.715	9.76	9.93
2 - 1	116.9	51.9	2.068	1.715	9.73	9.93
2 - 2	117.2	51.9	2.069	1.715	9.73	9.93
2 - 3	223.2	51.9	2.349	1.715	9.52	9.93
2 - 4	179.7	51.9	2.255	1.715	9.60	9.93
2 - 5	16.0	16	1.204	1.204	10.08	10.08
2 - 6	66.4	51.9	1.822	1.715	9.88	9.93
2 - 7	371.3	51.9	2.570	1.715	9.32	9.93
2 - 8	215.5	51.9	2.333	1.715	9.53	9.93
2 - 9	213.9	51.9	2.330	1.715	9.54	9.93
2 - 10	17.0	17	1.230	1.230	10.08	10.08
2 - 11	32.2	32.2	1.508	1.508	10.01	10.01
2 - 12	425.7	51.9	2.629	1.715	9.27	9.93
2 - 13	107.3	51.9	2.031	1.715	9.76	9.93
3 - 1	107.9	51.9	2.033	1.715	9.75	9.93
3 - 2	62.3	51.9	1.794	1.715	9.89	9.93
3 - 3	65.7	51.9	1.818	1.715	9.88	9.93
3 - 4	29.0	29.0	1.462	1.462	10.02	10.02
3 - 5	111.9	51.9	2.049	1.715	9.74	9.93
3 - 6	41.1	41.1	1.614	1.614	9.97	9.97
3 - 7	36.8	36.8	1.566	1.566	9.99	9.99
3 - 8	11.9	11.9	1.076	1.076	10.10	10.10
3 - 9	43.4	43.4	1.637	1.637	9.96	9.96
3 - 20	107.3	51.9	2.031	1.715	9.76	9.93
4 - 1	40.6	40.6	1.609	1.609	9.97	9.97
4 - 2	61.2	51.9	1.787	1.715	9.89	9.93
4 - 3	107.3	51.9	2.031	1.715	9.76	9.93
5 - 1	21.2	21.2	1.326	1.326	10.06	10.06
5 - 2	21.2	21.2	1.326	1.326	10.06	10.06
5 - 3	107.3	51.9	2.031	1.715	9.76	9.93
6 - 1	9.7	9.7	0.987	0.987	10.10	10.10
6 - 2	107.3	51.9	2.031	1.715	9.76	9.93
(n = 37)						
MEAN	107.3	43.4	1.857	1.603	9.81	9.96
% REDUCTION		59.6		13.7		-1.6

t-test (Before versus After): p =	0.000009
t-test Bonferroni p =	0.000009
Are paired data sets different?	YES

Prediction: A 59.6% TSS reduction will produce a significant increase in DO by 1.6%.

8. DO:TSS SYNERGISTIC RELATIONSHIP (Continued):

It's highly unlikely that a synergistic relationship exists biologically between DO and TSS, unless the organic matter portion of the TSS is significantly high to cause elevated levels of BOD5 in the water column. IDEQ-TFRO in their water quality monitoring determined that the organic matter portion of TSS and the BOD5 concentration in the water column were both very low.

Therefore, a stepwise linear regression was perfomed to determine which additional parameters were significant in their relationship to DO.

N = 1464
Dependent Variable = DO
Independent Variables = LOGTSS, TEMP, YEAR, MONTH, LOGQ

Results indicate that:	r	r^2	p-value
62.2% of the variability is attributed to TEMP	0.789	0.622	0.00000
0.6% of the variability is attributed to LOGQ	0.793	0.628	0.01501
0.3% of the variability is attributed to LOGTSS	0.794	0.631	0.02761
0.1% of the variability is attributed to MONTH	0.795	0.632	0.01191
0.2% of the variability is attributed to YEAR	0.796	0.634	0.02096

Therefore, Multiple r = 0.796
Adjusted r^2 = 0.634
F-ratio = 504.7
p-value = 0.000000

Therefore, the following polynomial linear regression equation describes the relationship:
DO=(0.115732LOGQ)+(-0.022829MONTH)+(0.031099YEAR)+(-0.219196TEMP)+(0.130662LOGTSS)-49.655385

From the above results it can be seen that TEMP has the greatest impact on DO than LOGQ, LOGTSS, MONTH, or YEAR, though all of these parameters were significant.

A more logical biological scenario for the above relationships may be summarized as follows:

1..... DO and TEMP are greatly correlated. DO has a characteristic sag that may be seen during the late spring and summer months when compared to fall and winter. TEMP is greatest during the late spring and summer months and lowest during the fall and winter.
2..... TSS or LOGTSS has the greatest loads (tons/year) during the spring and summer when compared to fall and winter. This characteristic is seen in all the river sites.
3..... If TSS loads are reduced we know that TP (as a limiting nutrient) will be reduced as well. Additionally, TP reductions will be occuring in point source facilities.
4..... A reduction in TP will in turn cause a reduction in primary productivity in the river system.
5..... A reduction in primary productivity will cause the DO sag to not be as great during the evening hours. However, it will take a certain period of time for the river to respond.
6..... Because TSS, TP, and primary productivity are reduced, it should be expected that some level of macrophyte and algae reduction will occur. However, TSS reductions will incur better clarity of the stream column allowing for light to penetrate deeper. When light begins to penetrate deeper into the water column, macrophyte growth will be increase for a period of time, thus making light limiting "nutrient." To reduce this effect, sediment reductions need to be revisited and revised to allow the river system to recover and restore beneficial uses.

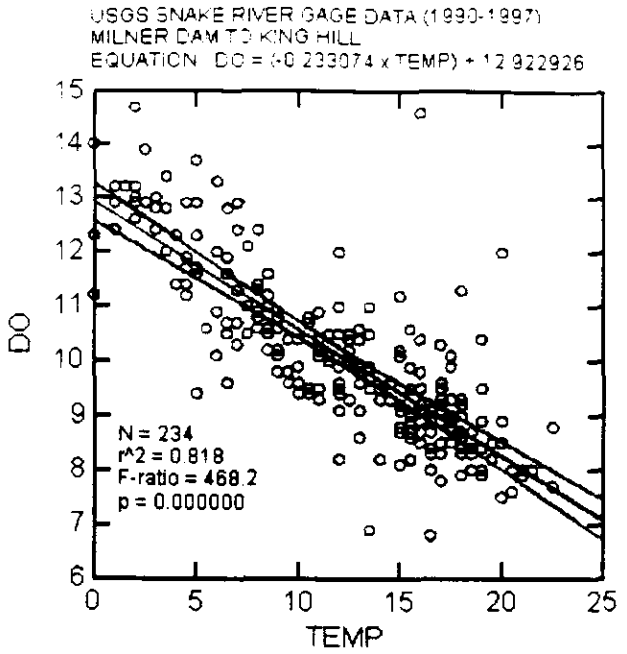
8 DISSOLVED OXYGEN SYNERGISTIC RELATIONSHIP (Continued)

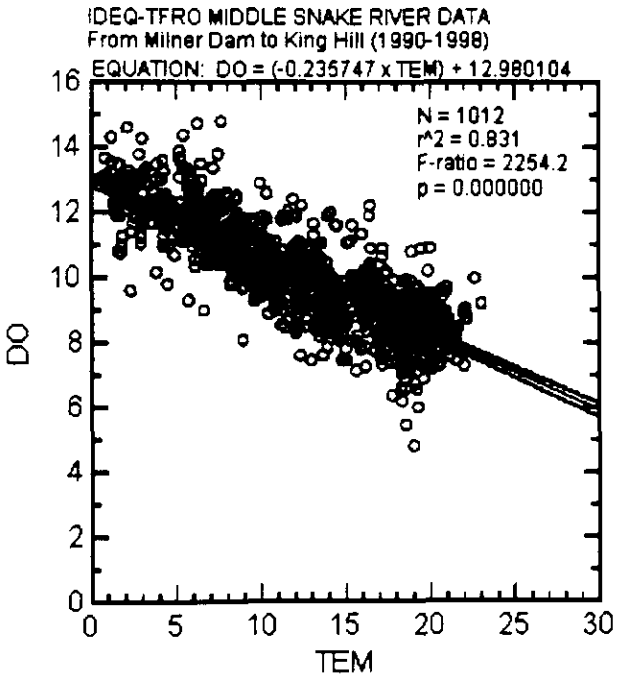
Dissolved oxygen is listed for 18 of the 31 water quality limited stream segments in Upper Snake Rock. The listing is based on the DO sag that occurs pushing the DO below state water quality standards during summer months as a result of nuisance aquatic plant growth as a result of eutrophication. Violations in temperature criteria are intimately linked to violations in DO.

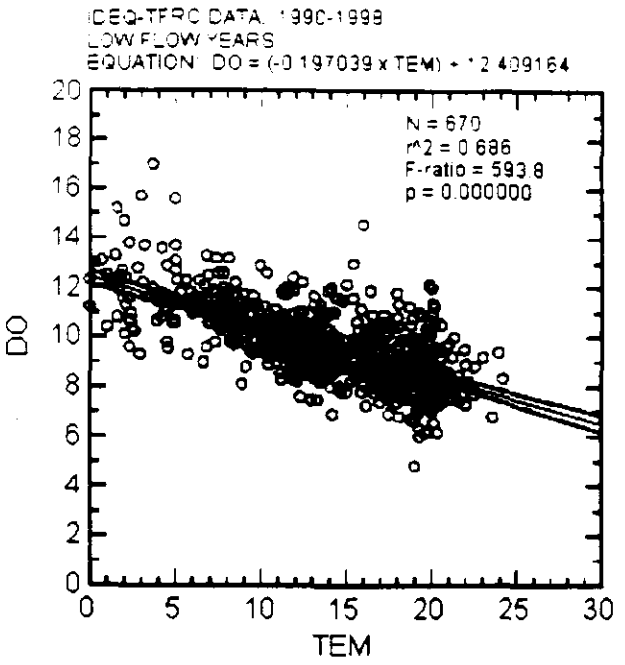
In 1996, IDEQ contracted with ERI to do a productivity and respiration of macrophytes analysis utilizing *in situ* instrumentation at three locations on the Middle Snake River. Instantaneous diehl data for temperature, pH, and DO, as well as macrophyte productivity and respiration was measured. Results were collected in August and September within the macrophyte bed and outside the macrophyte bed. Within the macrophyte beds, there was never an exceedence (< 6.0 mg/L) for DO, although levels < 7.00 were not uncommon (and did approach 6.00 mg/L). Outside the macrophyte beds, there was never an exceedence for DO below state water quality standards (< 6.00 mg/L), and generally followed a trend similar to the same trend within the macrophytes but above the lowest values (*ERI 1997* [pp 73-83]). Previous non-diehl productivity work done by Falter (*Falter 1994; Falter 1995; Falter 1996*) confirms that within the macrophytes bed DO levels below 6.00 mg/L occured only once in three years (during the hottest part of the summer, the lowest flow year, and the slowest moving water).

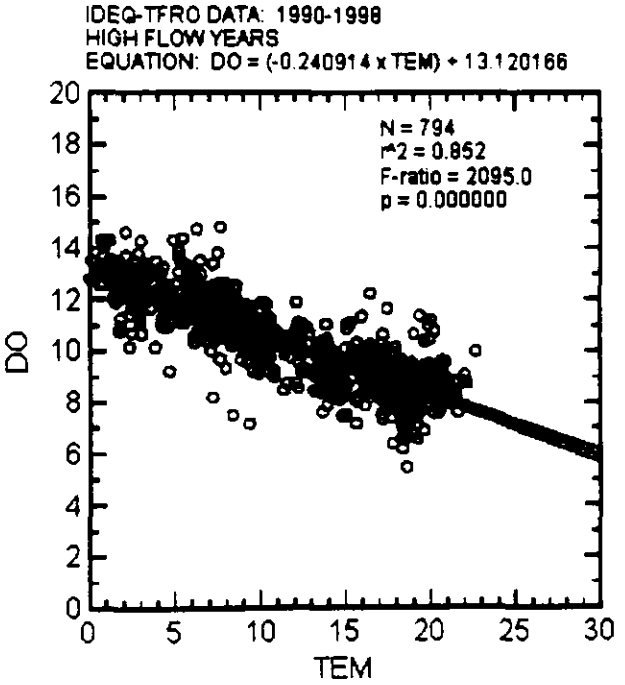
USGS studies for WY s 1990 through 1997 indicate that the non-diehl DO concentrations never fell below 6.0 mg/L. In fact, a statistically significant relationship exists between DO and temperature that can be segregated for low-flow and high-flow years. In each instance, as the temperature increases the DO correspondingly decreases. Data on the Middle Snake River from IDEQ-TFRO from 1990 to 1997 indicates a similar relationship between DO and temperature, and supports the USGS data conclusions. This is shown in the following graphs.

Prediction Estimates on Parameter Responses






IDEQ-TFRO DATA: 1990-1998
LOW FLOW YEARS
EQUATION: DO = (-0.197039 x TEM) + 12.409164
N = 670
r^2 = 0.686
F-ratio = 593.8
p = 0.000000
DO
TEM
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30


IDEQ-TFRO DATA: 1990-1998
HIGH FLOW YEARS
EQUATION: DO = (-0.240914 x TEM) + 13.120166
N = 794
r^2 = 0.852
F-ratio = 2095.0
p = 0.000000
DO
TEM
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30

8 DO TSS SYNERGISTIC RELATIONSHIP (Continued):

The statistical equations for each graph indicate that as the temperature increases, the DO decreases correspondingly but never below the state water quality standards. Based on these statistical equations, the following DO values correspond to the expected concentration based on the temperature violation for the specific water quality criteria. See §2.2.3.3. Even under low-flow or high-flow years, the DO is never violated regardless of the temperature.

Table 93 Expected DO concentrations based on temperature violations from statistical analysis of DO and temperature

Water Quality Criteria	*Middle Snake River & Tributaries*	
USGS Overall Graph:	DO = (-0.233 x TEMP) + 12.923	
Cold water biota (22°C/25°C)	22°C = 7.80 mg/L DO	25°C = 7.10 mg/L DO
Salmonid spawning (13°C/16°C)	13°C = 9.89 mg/L DO	16°C = 9.20 mg/L DO
USGS Low-Flow Years (1990-1995):	DO = (-0.197 x TEMP) + 12.371	
Cold water biota (22°C/25°C)	22°C = 8.04 mg/L DO	25°C = 7.45 mg/L DO
Salmonid spawning (13°C/16°C)	13°C = 10.36 mg/L DO	16°C = 9.22 mg/L DO
USGS High-Flow Years (1996-1997):	DO = (-0.269 x TEMP) + 13.444	
Cold water biota (22°C/25°C)	22°C = 7.53 mg/L DO	25°C = 6.72 mg/L DO
Salmonid spawning (13°C/16°C)	13°C = 9.95 mg/L DO	16°C = 9.14 mg/L DO
IDEQ-TFRO Overall Graph:	DO = (-0.236 x TEMP) + 12.980	
Cold water biota (22°C/25°C)	22°C = 7.77 mg/L DO	25°C = 7.08 mg/L DO
Salmonid spawning (13°C/16°C)	13°C = 9.91 mg/L DO	16°C = 9.20 mg/L DO

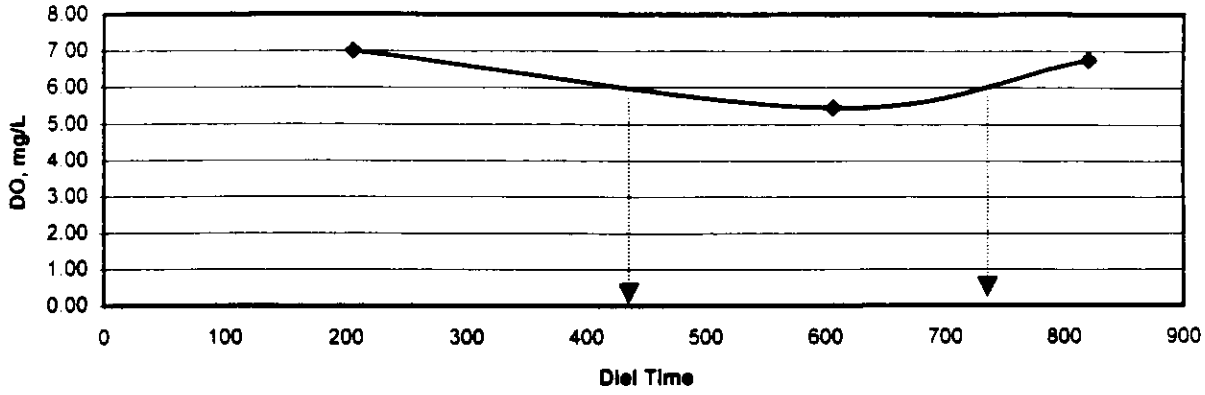
Prepared by IDEQ-TFRO. Cold water biota has a daily maximum of 22°C and a daily average of 19°C. Salmonid spawning has a daily maximum of 13°C and a daily average of 9°C. Temperatures for cold water biota were taken at 22°C and 25°C based on the monitoring data for both the tributaries and the Middle Snake River. Temperatures for salmonid spawning were taken at 13°C and 16°C based on the monitoring data for both the tributaries and the Middle Snake River.

Therefore, it may be concluded that DO values less than 6.00 mg/L are few and seldom discovered. Their appearance only indicates that a minor perturbation of the standard has been violated. Additionally, modeling via USEPA's RBM10 indicates that nutrient reductions of the Mid-Snake TMDL will tentatively reach a mean DO value of 8.56 mg/L over a 10-year period at the Gridley Bridge, Hagerman site (IDEQ 1997b [p 91]). Since the modeling effort was based on a worst-case scenario during low-flow years, it is quite possible that in high flow years attainment of this goal is highly possible. In low flow years, continued nutrient reductions will help a long ways to remediation of the Middle Snake River. Additionally, "in the abscence of substances that cause its depletion, the DO concentration in stream water approximates the saturation level for oxygen in water in contact with the atmosphere and decreases with increasing water temperature from about 14 mg/L at freezing to about 7 mg/L at 30°C. For this reason, in ecologically healthy streams, the DO concentration depends primarily on temperature, which varies with season and climate (USGS 1994 [Chapter 4])."

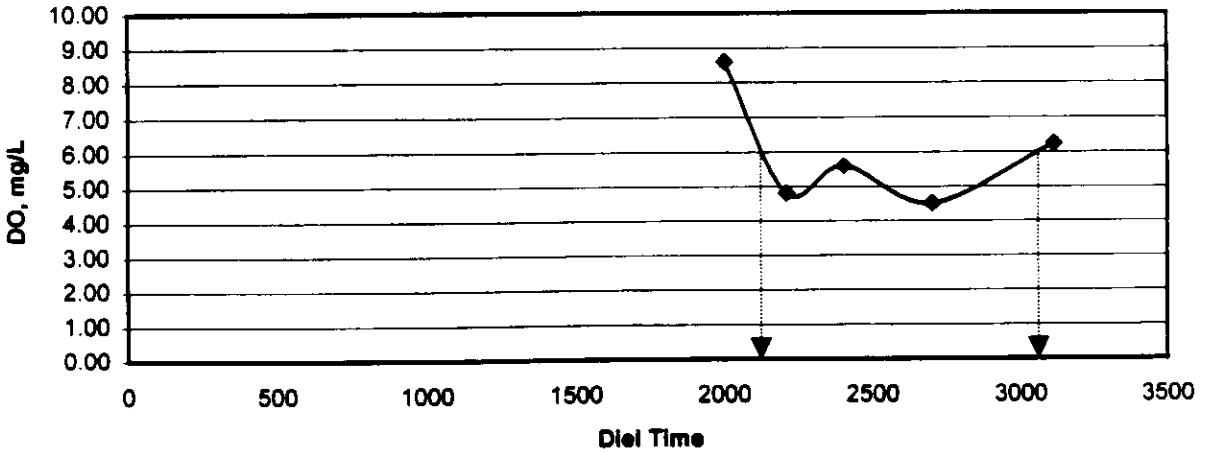
DO in tributaries is also affected by a similar scenario as on the Middle Snake River. However, only Rock Creek has shown violations of the water quality standard in 1986: August 4, 5.80 mg/L; August 12, 4.80 mg/L; and, September 3, 6.00 mg/L. At no other times have there been any reported violations. Data collected by USGS at Daydream Ranch, at Poleline Road Crossing, and at the confluence with the Middle Snake River does not indicate that any violations have occurred since WY1990. No data exists that would indicate violations of this standard for any of the other tributaries, whether the data was collected by IDEQ, USGS, or any other agency or organization. If such violations do occur, it may be concluded that these too are minor perturbations of the standard and do not constitute a common problem to any tributary that is water quality limited, *unless serious nuisance aquatic plant growth exist compounded by heavy sediment-laden deposits*. No modeling efforts were attempted on any tributary, but like the Middle Snake River under the worst case scenario (low flow years), violations of the DO standard may possibly occur due to lack of sufficient running water within the tributary systems, which promotes high temperatures of the water, which in turn promotes low concentrations of the DO. High flow years will help promote attainment of the standard if sufficient water exists in the system. Furthermore, "studies cited by the USEPA (USEPA 1986) of the dependence of fresh water biota on DO suggest that streams in which the

the concentration is less than 6.50 mg/L for more than about 20% of the time generally are not capable of supporting trout or other cold-water fish, and such concentrations could impair population growth among some water game fish, such as large mouth bass (USGS 1994 [Chapter 4])." Falter's work for 1992 in very heavy mats of weeds in the Middle Snake River indicates that on an average bases, about 28% of the time the diel DO sags below 6.00 mg/L. This sag has a range from 13.9% to 40.6% depending on the location, the depth of the weed mat in the water column, the velocity of the stream immediately adjacent to the weedbed, and the water temperature in the weed mat. Falter's work is summarized as follows:

RM588.7	Time	DO	DO Sag Time:
	206	7.00	Start Time 4:30
	606	5.45	End Time 7:30
	820	6.75	Difference = 3:30 Time = 3 hr 20 minutes = 200 min
			200 min / 1440 min = 13.9% of diel time



RM599.9	Time	DO	DO Sag Time:
	2004	8.60	Start Time 21:25
	2212	4.80	End Time 31:00
	2405	5.60	Difference = 9.75 Time = 9 hr 45 min = 585 min
	2702	4.50	585 min / 1440 min = 40.6% of diel time
	3115	6.25	



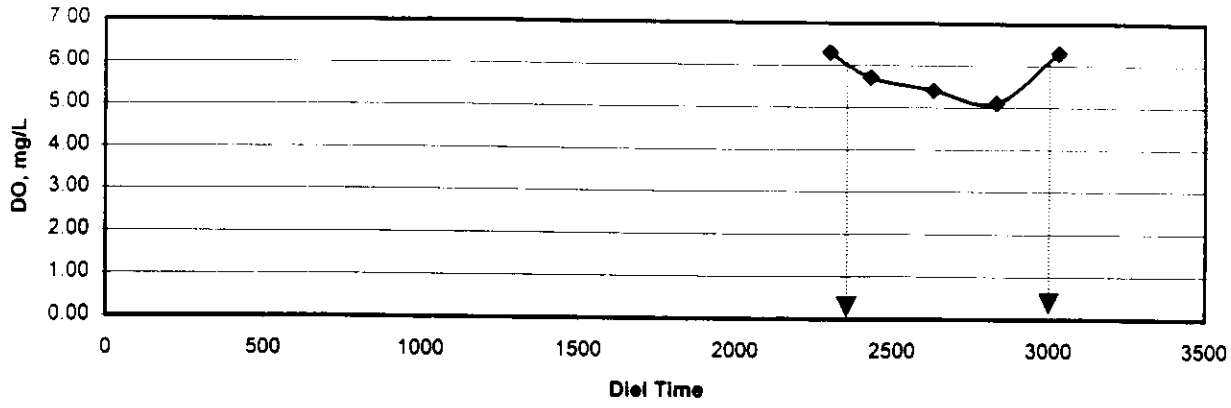
XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS.

Prediction Estimates on Parameter Responses

RM599.9

Time	DO
2300	6.30
2430	5.70
2630	5.40
2830	5.10
3030	6.30

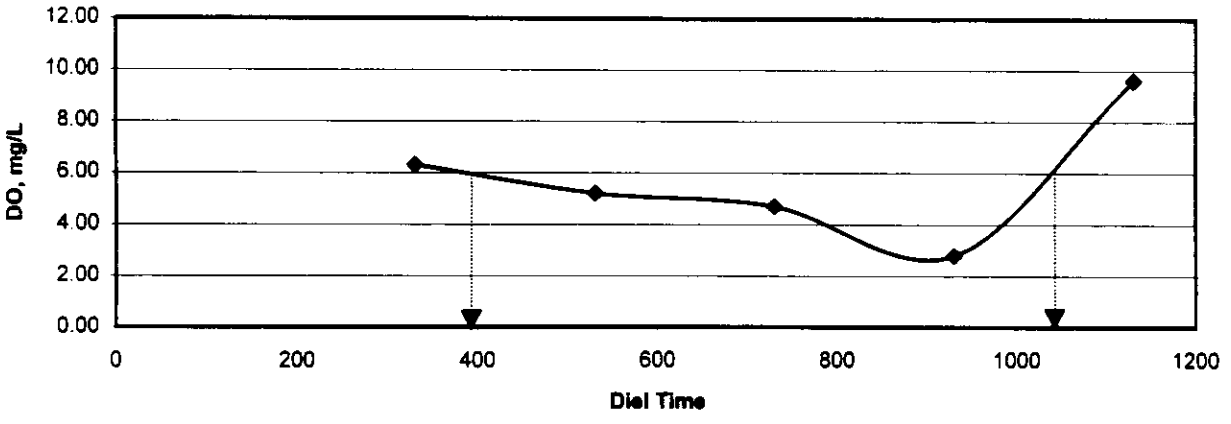
DO Sag Time:
Start Time 23:50
End Time 30:00
Difference = 6:50 Time = 6 hr 30 min = 390 min
390 min / 1440 min = 27.1% of diel time



RM585.2

Time	DO
330	6.30
530	5.20
730	4.70
930	2.80
1130	9.60

DO Sag Time:
Start Time 3:90
End Time: 10:40
Diffence = 6:50 Time = 6 hr 30 min = 390 min
390 min / 1440 min = 27.1% of diel time

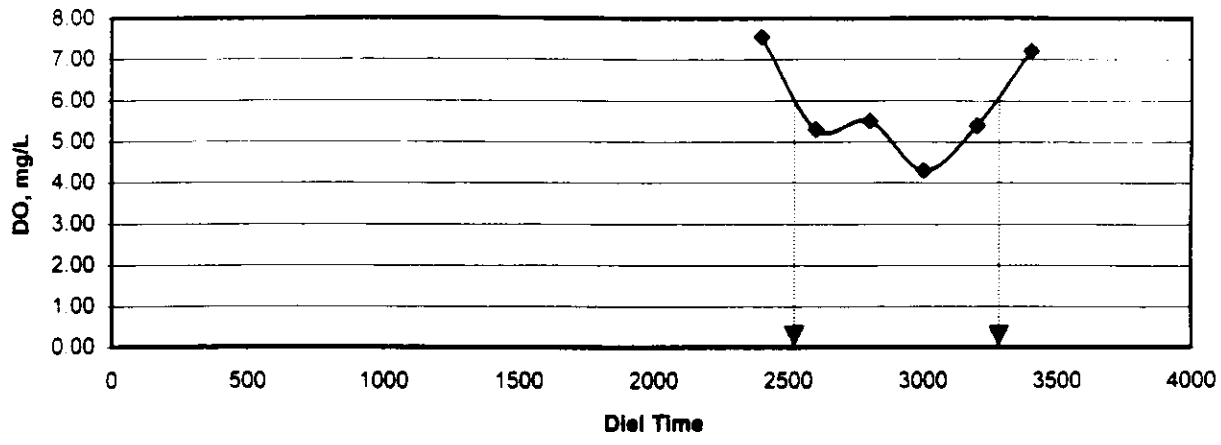


XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

RM585 2	Time	DO
	2400	7 55
	2600	5 30
	2800	5 50
	3000	4 30
	3200	5 40
	3400	7 20

DO Sag Time
Start Time 25 25
End Time 32 75
Difference = 7 50 Time = 7 hr 30 min = 450 min
450 min / 1440 min = 31 3% of diel time



DO Sag Summary Within Macrophyte Mats (Falter 1992 Study):

RM	% of Diel Time
588.7	13.9
599.9	40.6
599.9	27.1
585.2	27.1
585.2	31.3
Mean	**28.0**
St Dev	**9.6**
Confidence	**8.4**
Upper CL	**36.4**
Lower CL	**19.6**

Note: Not all macrophyte mats had DO sags that were < 6.00 mg/L. Some ranged between 6.00 and 6.50 mg/L. Others maintained a sag between 6.50 and 7.00 mg/L. It is uncertain what percentage of all the macrophytes within any localized area in the Middle Snake River can be attributed to DO sags that were < 6.00 mg/L. All that can be said at this time is that a small percentage of all the macrophytes within a localized area have DO sags that are < 6.00 mg/L and the sag existed for 28% of the diel time.

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS
Prediction Estimates on Parameter Responses

9. BACTERIA SYNERGISTIC RELATIONSHIP

BACKGROUND

Fecal coliform is an indicator of fecal contamination by warmblooded animals and can indicate the presence of pathogenic micro-organisms. In 1986 the USEPA revised the bacterial criteria for recreationa waters recommending the use of *Eschenchia coli* (*E. coli*) and *Enterococci*. These recommendations were based on an association established between levels of *E. coli* and *Enterococci* and illness rates in swimmers exposed to these bacteria. 1998 the USEPA requested the Idaho Department of Health and Welfare/Bureau of Laboratories consider modifying its water quality testing for fecal contamination by providing testing for *E. coli*. The laboratory responded by commencing a comparative study to determine the relative statistical association of fecal coliform to *E. coli*. Although the use of total and fecal coliform organisms as indicators of water-borne fecal contamination has served well for protecting public health, watershed-based decision making will require information that is risk-based and can be applied with some consistency for various water uses. And *E. coli* and *Enterococci* are more appropriate bacterial indicators for future use. Therefore, until the Idaho State Water Quality Standards indicate the appropriate levels of *E. coli* and *Enterococci*, based on a comparison study being conducted by the IDHW-Bureau of Laboratories, use of total and fecal coliform as a surrogate indicator for fecal contamination will be continued.

A literature survey was conducted to assess if a linkage between sediment and pathogens (fecal coliform bacteria) had been established or investigated. Several scientific articles suggest that such a linkage does exist (or should exist). For example,

(1) "high concentrations of suspended sediment in streams diminish the recreational use of streams because *pathogens and toxic substances commonly associated with suspended sediment* are threats to public health (USGS 1994 [Chapter 4]);"

(2) fecal coliform bacteria "in aquatic environments *are deposited into the sediment* from surface waters (Tiedemann *et al.* 1987);"

(3) sediment or total suspended solids have a significant effect in pollutant mass loading *"by transporting pollutants such as bacteria* ... to receiving waters," and "... *microorganisms are predominantly sediment-bound pollutants* existing in a chemical equilibrium with their dissolved phase (http://ate.cc.vt.edu/eng/bse/dillaha/bse4324/water_quality.html);"

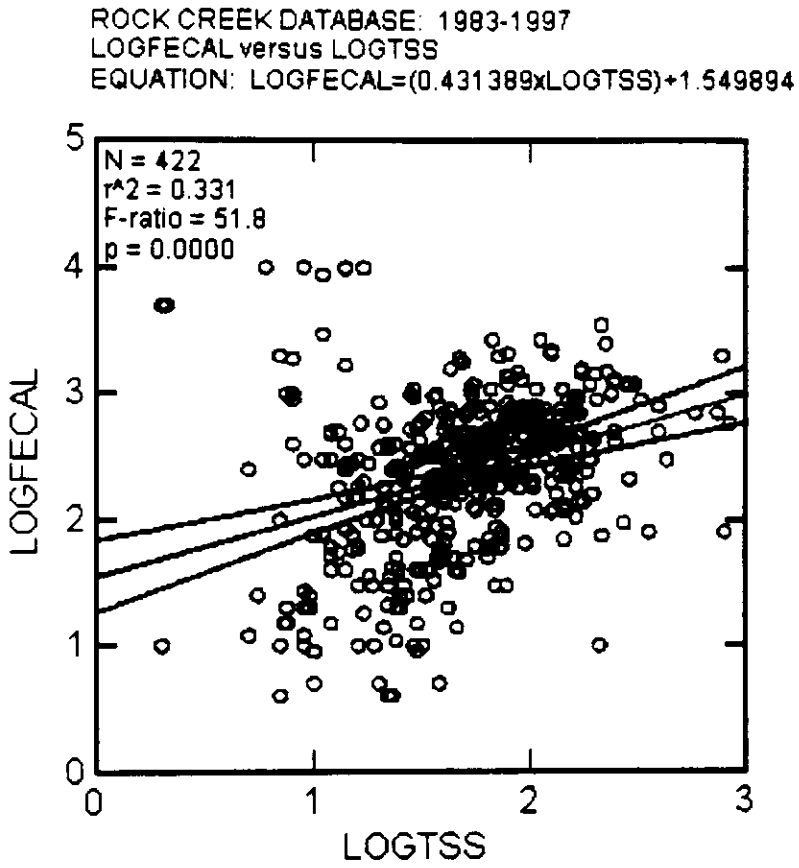
(4) "as much as 95% of deposited *manure will settle to the bottom of the stream* within the first 50 meters (Biskie *et al.* 1988);"

(5) "*the bacteria in the sediment* may remain alive for several weeks (Sherer *et al.* 1992);" and,

(6) "Heavy livestock trampling of streambanks will reduce water information resulting in *greater sediment production* and lower herbage yield and cover. The effects to water chemistry are *increases in fecal coliform* (Shovlin 1984)."

9 BACTERIA SYNERGISTIC RELATIONSHIP (Continued).

Based on this Rock Creek data from the Rural Clean Water Project (1981-1991) and additional monitoring data from IDEQ-TFRO (1983-1997), a synergistic linkage was developed between fecal coliform and TSS. Fecal coliform levels on the Middle Snake River were also tested for the TSS statistical relationship. IDEQ-TFRO data (1990-1997), USGS data (1990-1997), and RCWP data (1981-1991) indicate that a relationship exists, as shown by the following graph. Variability in the database is principally due to the various sources used (combined as an accumulation of field and lab errors) and the natural variability inherent in bacteriological data in natural streams. A 21.8% TSS reduction in Rock Creek (to achieve 51.9 mg/L TSS) is equivalent to a 10.1% reduction in fecal coliform.



Additionally, bacteria data from Rock Creek indicates that although at times the primary and secondary contact recreational standards are violated, as a general rule there has been a great reduction in fecal coliform since 1971. On or about 1974 the major point sources no longer discharged to Rock Creek. The following table summarizes this data:

YEARS	MEAN	GEOMEAN	N	COMMENTS
1971-1974	48,788,502	328,442	25	Point Sources + Nonpoint Sources
1975-1989	721	222	86	Point sources no longer discharging to RC.
1990-1998	359	44	97	Nonpoint Source industries increase

9. BACTERIA SYNERGISTIC RELATIONSHIP (Continued):
Sources of fecal coliform in streams are diffuse and varied. The most common is from warm-blooded animals that defecate directly into the stream. Another source is the movement of fecal materials into the stream due to runoff after a heavy rain or over-irrigation. Other sources could include sewage system discharge or septic system failure. The following scenario describes the generic process by which fecal coliforms may enter surface waters and is compiled from a number of scientific sources:

1. A warm-blooded animal defecates on the soil or stream. If the defecation is in the stream, then the water's carrying capacity for fecal coliforms from the manure is immediate and direct. If the defecation is on the soil or land, then water's carrying capacity for fecal coliforms is diminished until some event occurs that will flush or move the manure (or residue) into the stream.

2. A storm event occurs or improper irrigation of the land creates runoff that carries the manure (or residue) into a receiving stream.

3. The receiving stream becomes the carrier or conduit through which the fecal coliform bacteria are moved. The stream on receiving the fecal coliform bacteria shows an elevated level potentially exceeding primary or secondary contact recreation standards. Fecal coliform bacteria once in the surface water have been shown to survive at least two weeks (or 14 days).

4. Various scientific studies have shown that fecal coliform bacteria in aquatic environments have a tendency to be deposited into the sediment from surface waters. In combination with sediment the fecal coliform bacteria create a sediment bed inoculating reservoir. In this inoculating reservoir, the viability of fecal coliforms could be from 14 days to as much as several months.

5. When the sediment bed inoculating reservoir is disrupted the enoculated coliform mix water body's overlying water and quite possibly increase the fecal coliform levels. Several scientific studies have shown that fecal coliform bacteria levels almost double after disruption of a creek's sediment bed

In the Upper Snake Rock sub basin, pathogens (or fecal coliform bacteria) are listed in 14 of the 31 water quality limited stream segments. As previously mentioned in §2.2.4.4, fecal coliform bacteria in the tributaries indicates that, in general, the irrigation season had higher bacteria counts when compared to the non-irrigation season. Those counts exceeded primary and secondary contact recreational standards. A similar relationship may be seen for TSS (see §2.2.4.1 (4)). Bacteria data collected on the Middle Snake River indicates that fecal coliform exceedences are rarely a problem unless a storm event occurs, or discharge from tributaries during the irrigation season produces sediment deltas and/or alluvial fans and plumes downstream of the discharge confluence. As an example, during the 1996 IDEQ-TFRO monitoring season, one storm event caused fecal coliform levels at the Kanaka Rapids area to exceed primary and secondary contact recreation (2900 colonies/100 mL on September 24, 1996). However, in general, the mean/geomean values for fecal coliform in the Middle Snake River are 40/13 colonies/100 mL. There were no exceedences noted in Bliss Reservoir or in the reach from Milner Dam to Twin Falls Reservoir.

As a threat to human health, fecal levels exceeding primary and/or secondary contact recreation standards could potentially threaten human health. But it is highly unlikely that they pose any threat to endangered snails. There is no information to suggest otherwise on the Middle Snake River. USFWS, in their biological opinion on the reissuance of NPDES permits for six municipal sewage treatment plants, two food processors, and the issuance of a General Permit for 80 aquaculture facilities, says that the "propsed action is not likely

9 BACTERIA SYNERGISTIC RELATIONSHIP (Continued).

to jeopardize the continued existence of the Idaho springsnail, the Snake River physa, the Utahl valvata, and the Bliss Rapids snail. No critical habitat has been designated for these species, therefore, none will be affected (USFWS 1999)." The following table describes the effluent limits for municipalities, food processros and aquaculture.

Effluent permit limitations for point sources in Upper Snake Rock

City/Company	***NPDES No.***	***Effluent Limitations, colonies/100 ml***		
		Average Monthly Limit (Geometric Mean)	***Average Weekly Limit (Geometric Mean)***	***Daily Maximum Limit***
Municipalities				
Filer	002006-1	200	200	800
Buhl	002066-4	200	200	800
Twin Falls	002127-0	100	200	-
Jerome	002016-8	200	200	800
Hansen May 1 - Sep 30 Oct 1 - Apr 30	002244-8	50 200	100 200	500 800
Hagerman May 1 - Sep 30 Oct 1 - Apr 30	002594-1	50 200	200 200	500 800
Food Processors				
J.R. Simplot	000066-3	No effluent limits. Ambient water quality monitoring during Aug and Nov at 4 river stations. Will conduct a fecal coliform bacteria study within 6 months of permit issuance date on outfall 003.		
McCain Food Service	000061-2	No effluent limits. Ambient water quality monitoring during Aug and Nov at 4 river stations.		
Aquaculture Facilities				
~80 fish hatcheries	NPDES Permitted	The permit authorizes the discharge of fecal coliform and other bacteria suject to the limitations and conditions of effluent limits. Discharges from aquaculture facilities or associated, on-site fish processors shall not violate Idaho State Water Quality Standards for fecal coliform bacteria.		

Prepared by IDEQ-TFRO

XI THE EFFECT OF TSS REDUCTION ON OTHER PARAMETERS

Prediction Estimates on Parameter Responses

10 SUMMARY CONCLUSIONS

RELATION	% REDUCE	SYNERGISTIC PREDICTION FROM TSS REDUCTIONS
TP:TSS	6.7	TP will decrease by 6.7%.
SRP:TSS	(7.1)	SRP will increase by 7.1%.
NH3:TSS	(3.00)	NH3 will increase by 3.0%
NOX:TSS	(19.3)	NOX will increase by 19.3%
TKN:TSS	(43.8)	TKN will increase by 43.8%
DO:TSS	(1.6)	DO will increase by 1.6%
Bacteria:TSS	10.1	Bacteria will decrease by 10.1%

TP and Bacteria will most likely be reduced with reductions in TSS.
SRP, NH3, NOX, TKN, and DO will most likely increase with reductions in TSS.

XII AQUACULTURE WASTELOAD ALLOCATIONS AS DEFINED BY TSS MDL

TOTAL SUSPENDED SOLIDS

Data collected and reported in USEPA's Discharge Monitoring Reports (DMRs) from aquaculture facilities in Upper Snake Rock beginning in 1990 through 1998, indicate that sediment as TSS represents a small portion of the gross total TSS when considering all of the industries together Exceedences beyond the permitted 5 mg/L TSS were few (less that 1% of the total number of samples collected from 1990 through 1998, based on a visual review of 65 facilities' DMRs). The method detection level (MDL) used in the majority of these facilities was <4 mg/L. (Some facilities reported <5 mg/L or <2 mg/L.) Since the appropriate TSS value at that time was <4 mg/L, a best professional judgement TSS concentration of 2 mg/L (or ½ MDL) was used to estimate the amount of TSS potentially being discharged by any one aquaculture facility regardless of size or flow discharge. IDEQ-TFRO consulted with various fish farmers and fish specialists within the aquaculture industry, and the overall consensus of best professional opinion was that a TSS concentration range of 1.5 to 2.0 mg/L should come fairly close to estimating the amount of TSS discharge occuring on any aquaculture facility. Therefore, 2 mg/L TSS was used as an estimate TSS concentration value for effluent discharge, recognizing that it is probably a high estimate of TSS. The following table shows the estimated TSS discharge on a per watershed complex basis.

Estimated TSS loads for aquaculture facilities in Upper Snake Rock

Facility Name	***NPDES No.***	***Average Annual Flow, cfs***	***TSS, mg/L Estimated ½ MDL***	***Estimated Mean Daily Load lbs/day***	***Estimated Mean Yearly Load ton s/year***
Rock Creek Complex (includes Cottonwood Creek, McMullen Creek)					
Canyon Trout Farm	002191-1	10.74	2.0	115.78	21.13
Canyon Trout Farm/Processing Plant	002191-1	Total Containment Fish Processor			
C&M Fish Farm	002714-6	14.26	2.0	153.72	28.05
Daydream Ranch	002680-8	13.18	2.0	142.08	25.93
Deadman Hatchery	002689-1	13.98	2.0	150.70	27.50
CSI Fish Hatchery	002630-1	4.95	2.0	53.36	9.74
Aquaculture Industries/Frame Hatchery	002703-1	18.10	2.0	195.12	35.61
Coats Farm Ponds	002761-8	19.96	2.0	215.17	39.27
			Sub Total =	1025.93	187.23
Billingsley Creek Complex (includes Riley Creek)					
Rangen's Inc.	002303-5	19.45	2.0	209.67	38.27
Jones Fish Hatchery	000086-8	30.25	2.0	326.10	59.51
Donny McFadden Farm Ponds	002612-3	6.96	2.0	75.03	13.69
Idaho Springs/Gold Springs Ponds	000073-6	53.97	2.0	581.80	106.18
Hidden Springs	002440-6	11.57	2.0	124.72	22.76
Springs Creek Springs Hatchery (Shrank)	002497-0	3.16	2.0	34.06	6.22
Fisheries Development	002499-6	001A= 11.05 003A= 85.69	2.0 2.0	119.12 923.74	21.74 168.58
Two Non-permitted Facilities	No Permit	<5.00>	2.0	53.9	9.84
Sub Total for Permitted Facilities Discharging Directly to Billingsley Creek =				2448.14	446.79

Sub Total for Permitted Facilities Discharging Directly to Billingsley Creek =				2448.14	446.79
USFWS/Hagerman National	000082-5	48.72	2.0	525.20	95.85
IDFG/Hagerman State	000080-9	72.28	2.0	779.18	142.20
Sub Total for Permitted Facilities Discharging Directly to Riley Creek =				1304.38	238.05
Sub Total for All Permitted Facilities Discharging into the Billingsley Creek Complex =				3752.52	684.84
Box Canyon Complex (includes Blind Canyon Creek, Clear Springs Creek & Lake, and Sand Springs Creek)					
Blind Canyon Hatchery	002599-2	6.97	2.0	75.14	13.71
Clear Lakes Trout Co.	000101-5	161.25	2.0	1738.28	317.24
Clear Springs Clear Lakes/Middle Hatchry	000093-1	182.06	2.0	1962.61	358.18
Clear Springs/Snake River Hatchery	000075-2	99.50	2.0	1072.61	195.75
Clear Springs Processing Plant	002688-3	0.05	118.33	31.89	5.82
Clear Lakes Trout Co./ID Trout Processor	000101-5	0.02	49.26	5.31	0.97
Ten Springs/Blind Canyon Aqua Ranch	002600-0	26.10	2.0	281.36	51.35
Blind Canyon Creek = 13.71 tons/year Clear Springs & Clear Lakes = 877.96 tons/year Thousand Springs Creek = 51.35 tons/year			Sub Total =	5167.20	943.02
Crystal Springs (part of the Cedar Draw Complex)					
Crystal Springs Trout Farm	000089-2	205.47	2.0	2214.97	404.23
			Sub Total =	2214.97	404.23
Middle Snake River Hatcheries					
Direct Dischargers to the Middle Snake River:					
Barret Farm Pond/Fish Breeders of ID	002718-9	10.06	2.0	108.45	19.79
Birch Creek Trout Inc.	002601-8	9.08	2.0	97.88	17.86
Blue Lakes Trout Farm	000095-7	150.90	2.0	1626.70	296.87
Blue Lakes Processing Plant		0.31	2.0	3.34	0.61
Box Canyon Trout Farm/Clear Springs	002290-0	297.09	2.0	3202.63	584.48
Buckeye Farm Ponds	002611-5	20.42	2.0	220.13	40.17
Canyon Springs (WW)	002731-6	15.93	2.0	171.73	31.34
Catfish Farm (WW)/Fish Breeders of ID	002295-1	17.95	2.0	193.50	35.31
Green's Trout Farm	000096-5	6.10	2.0	65.76	12.00
Mike Flemming Farm Ponds	002732-4	5.71	2.0	61.55	11.23
John Flemming Ponds	002780-4	8.97	2.0	96.70	17.65
Kaster Trout Farm/Sheldon Ponds	002517-8	49.12	2.0	529.51	96.64
Magic Valley Steelhead Hatchery/IDFG	002304-3	73.25	2.0	789.64	144.11
Pisces Investment Inc./Magic Springs	000097-3	120.99	2.0	1304.27	238.03

XII AQUACULTURE WASTELOAD ALLOCATIONS AS DEFINED BY TSS MDL

[illegible] Investment Inc. Magic Springs	[illegible]	[illegible]	2.0	1304.27	[illegible]
[illegible] Springs Subsystem Hatchery	[illegible]	47.80	2.0	515.28	92.74
[illegible] Springs Farm Annex		15.90	2.0	171.41	31.24
Rim View Trout Inc. Wendell Hatchery	000090-3	135.67	2.0	1462.52	266.94
Slane Ponds	002779-1	4.18	2.0	45.06	8.22
Smith Farm Ponds	002687-5	9.11	2.0	98.21	17.92
Stevenson Ponds	002781-2	8.04	2.0	86.67	15.82
White Springs Trout Farm	002580-1	31.34	2.0	337.85	61.66
Woods Farm Ponds, Rangen Inc.	002733-2	12.38	2.0	133.46	24.36
Gary Wright Farm Ponds	002725-1	5.50	2.0	59.29	10.82
			Sub Total of Direct Dischargers =	11381.53	2077.12
Indirect Dischargers to the Middle Snake River:					
Bell Fish Ponds (Stoddard Creek)	002491-1	3.77	2.0	40.64	7.42
Briggs Creek Hatchery (Briggs Creek)	002684-1	22.84	2.0	246.22	44.93
CJ Simms Ponds (Birch Creek)	002683-2	5.28	2.0	56.92	10.39
Decker Springs Farm (Decker SpringsCk)	002734-1	12.38	2.0	133.46	24.36
Lemmon Ponds (Curren Ditch)	002668-9	4.03	2.0	43.44	7.93
Niagara Springs Hatchery (Niagara SpCk)	002238-1	55.19	2.0	594.95	108.58
Rand Trout Farm (LQ/LS Drains)	002583-6	24.13	2.0	260.12	47.47
Standal Ponds (Stoddard Creek)	002778-2	4.95	2.0	53.36	9.74
White Water Ranch (Stoddard Creek)	000091-4	11.18	2.0	120.52	22.00
Bover Farm Ponds (Billingsley Creek)	002704-9	11.60	2.0	125.05	22.82
Big Bend Trout Inc. (Irrigation Ditch)	002532-1	4.34	2.0	46.79	8.54
Eckles Fish Farm (Billingsley Creek)	002676-0	18.56	2.0	200.08	36.51
Henslee Hatchery (Irrigation Ditch)	002762-6	8.51	2.0	91.74	16.74
Rainbow Falls/Dunn (Billingsley Creek)	002675-1	36.20	2.0	390.24	71.22
Talbot Trout Ponds (Billingsley Creek)	002677-8	11.30	2.0	121.81	22.23
			Sub Total of Indirect Dischargers =	2525.34	460.88
			Sub Total of Direct Dischargers + Indirect Dischargers =	13906.87	2538.00



XII AQUACULTURE WASTELOAD ALLOCATIONS AS DEFINED BY TSS MDL

Crystal Springs Sup Tota (Cedar Draw Complex)		2214.97	404.23
Middle Snake River	38	13906.81	2538.00
	TOTAL	26067.89	4757.32
Other Watersheds/Co			

Prepared by IDEQ-TFRO. Numbers after location sites represent number of aquaculture facilities. cfs = 1.548 x mgd. Estimated Daily Load: lbs/day = Flow (cfs) x Concentration (2.0 mg/L TSS) x 5.39. Estimated Yearly Load: tons/year = lbs/day x 365 days/year x 1 ton/2000 lbs = lbs/day x 0.1825 = tons/year. Average annual flow = Operational Average flow. Operational historical mode = 1991 through 1995. Aquaculture facilities located on streams introduced in the 1998 303(d) list are not included in this table. Those streams would include Cedar Draw, Mud Creek, and Deep Creek. Flow information derived from USEPA Permit Compliance System (1996).

TOTAL SUSPENDED SOLIDS (continued)

Other aquaculture facilities that discharge to other streams in the Upper Snake Rock subbasin, but which have direct impact on the water quality conditions of the Middle Snake River include the following: Deep Creek, Mud Creek, Cedar Draw, and Tunnel Creek. These facilities are included in the Mid-Snake TMDL as facilities discharging to "other" streams that are not listed on the 1996 303(d) list. They include:

"Other" aquaculture facilities discharging in the Upper Snake Rock subbasin (1998 303(d) Listed Streams)					
Facility Name	***NPDES No.***	***Average Annual Flow, cfs***	***TSS, mg/L Estimated % MDL***	***Estimated Daily Load lbs/day***	***Estimated Yearly Load tons/year***
Deep Creek					
Deep Creek Trout Farm	002515-1	15.83	2.0	170.65	31.14
Boswell Trout Farm	002670-1	16.89	2.0	182.07	33.23
Peter's Farm Pond	002424-4	10.33	2.0	111.36	20.32
Cox Farm Ponds/Harder Livestock	002533-0	15.58	2.0	167.95	30.65
Dolana Farm Ponds	002615-8	5.17	2.0	55.73	10.17
Howell Farm Ponds	002763-4	9.65	2.0	104.03	18.98
Sub Total of Dischargers to Deep Creek =				791.79	144.49
Mud Creek					
Rainbow Trout Farm (Buhl)	000103-1	8.26	2.0	89.04	16.25
W&W Trout Farm	002606-9	10.17	2.0	109.63	20.01
White's Trout Farm	002604-2	3.99	2.0	43.01	7.85
Buhl Trout Rearing Facility	002674-3	3.40	2.0	36.65	6.69
Buhl Trout Farm Pond (Blau)	002673-5	5.01	2.0	54.01	9.86
Jukers Ponds (via Silo Creek)	002618-2	5.41	2.0	58.32	10.64
RCP (via Silo Creek)	002752-9	1.78	2.0	19.19	3.50
First Ascent Fish Farm	002777-4	17.95	2.0	193.50	35.31
Rocky Ridge Ranch	002780-4	2.01	2.0	21.67	3.95
Mi Vida Loca (Compton)	002788-0	4.02	2.0	43.34	7.91
Sub Total of Dischargers to Mud Creek =				668.36	121.97
Cedar Draw					
Rainbow Trout Farm (Filer)	000102-3	12.85	2.0	138.52	25.28
Yoder's Farm Pond	002423-6	8.90	2.0	95.94	17.51
Cedar Draw Hatchery	002503-8	20.15	2.0	217.22	39.64
Olson Ponds	002592-5	3.87	2.0	41.72	7.61
Stutzman Fish Farm	002730-8	1.24	2.0	13.37	2.44
Rainbow Trout Farm Processing	( )	0.02	2.0	0.22	0.04
SEAPAC	( )	0.00	2.0	0.00	0.00

XII AQUACULTURE WASTELOAD ALLOCATIONS AS DEFINED BY TSS MDL

SEAPAC	[illegible]	0.00	2.0	0.00	0.00
Tunnel Creek Hatchery (Tunnel)	002292-6	18.22	2.0	196.41	35.85
Leo Martin Fish Hatchery (Tunnel)	002775-8	15.01	2.0	161.81	29.53
Sub Total of Dischargers to Cedar Creek =				865.21	157.90
Total of Deep Creek, Mud Creek, & Cedar Draw Dischargers =				2325.36	424.36

NORTHSIDE = NORTHSIDE CANAL COMPANY
SOUTHSIDE = TWIN FALLS CANAL COMPANY

NORTHSIDE A DRAIN:

	NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L	
	0.017	8.30	23.80	0.002	0	
	0.032	8.50	25.90	0.004	0	
	0.037	8.20	23.80	0.005	0	
	0.058	8.30	26.20	0.008	0	
	0.107	8.50	19.50	0.014	0	
	0.080	8.50	19.50	0.011	0	
	0.062	8.70	16.80	0.008	0	
	0.140	8.40	19.10	0.018	0	
	0.037	8.00	11.40	0.005	0	
	0.027	8.30	10.40	0.003	0	
	0.095	8.90	5.70	0.012	0	
	0.081	8.40	11.80	0.010	0	
	0.059	8.60	10.80	0.008	0	
	0.033	8.40	12.80	0.004	0	
	0.110	8.60	13.30	0.014	0	
	0.047	8.50	16.70	0.006	0	
	0.003	8.70	17.60	0.000	0	Exceedences
	0.023	8.40	21.00	0.003	0	Number Percent
Total	18			18	0	1:18 0.00%

SOUTHSIDE A10 DRAIN:

	NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L	
	0.021	7.60	19.40	0.003	0	
	0.022	7.50	21.00	0.003	0	
	0.160	7.30	22.60	0.021	1	
	0.048	7.90	22.80	0.006	0	
	0.050	8.10	18.00	0.007	0	
	0.058	8.50	19.00	0.008	0	
	0.082	8.40	18.00	0.011	0	
	0.020	7.80	18.40	0.003	0	
	0.030	7.70	10.90	0.004	0	
	0.050	8.20	6.00	0.006	0	
	0.003	8.20	9.40	0.000	0	
	0.003	8.10	10.50	0.000	0	
	0.144	8.10	14.00	0.019	0	
	0.113	7.80	11.90	0.015	0	
	0.042	7.60	16.40	0.006	0	
	0.020	7.70	16.90	0.003	0	Exceedences
	0.030	7.70	19.80	0.004	0	Number Percent
Total	17			17	1	1:17 5.90%

NORTHSIDE C55 DRAIN:

	NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
	0.012	7.80	22.50	0.002	0
	0.011	8.00	23.20	0.001	0

	0.037	8.00	23.30	0.005	0	
	0.055	7.70	27.20	0.007	0	
	0.101	8.40	20.00	0.013	0	
	0.032	8.40	19.00	0.004	0	
	0.070	8.40	16.50	0.009	0	
	0.046	8.00	16.30	0.006	0	
	0.042	7.90	10.70	0.005	0	
	0.029	7.90	10.00	0.004	0	
	0.070	9.00	6.80	0.009	0	
	0.003	8.80	8.90	0.000	0	
	0.089	8.80	10.80	0.011	0	
	0.137	8.70	14.60	0.018	0	
	0.144	8.40	13.40	0.019	0	
	0.029	8.60	17.40	0.004	0	
	0.003	8.60	18.10	0.000	0	Exceedences
	0.003	8.40	22.00	0.000	0	Number Percent
Total	18			18	0	1:18 0.00%

SOUTHSIDE TWIN FALLS COULEE:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L	
0.015	8.80	19.10	0.002	0	
0.021	8.80	24.00	0.003	0	
0.035	7.90	24.00	0.005	0	
0.037	8.70	19.00	0.005	0	
0.033	8.00	21.00	0.004	0	
0.089	8.20	21.00	0.012	0	
0.086	8.70	18.90	0.011	0	
0.026	8.20	19.70	0.003	0	
0.032	8.70	12.70	0.004	0	
0.003	9.50	10.60	0.000	0	
0.129	8.70	8.30	0.016	0	
0.003	8.70	8.40	0.000	0	
0.003	8.70	11.30	0.000	0	
0.006	8.60	15.40	0.001	0	
0.003	8.40	16.90	0.000	0	
0.036	8.70	23.60	0.005	0	
0.003	8.80	24.20	0.000	0	Exceedences
0.025	8.20	21.20	0.003	0	Number Percent
Total 18			18	0	1:18 0.00%

SOUTHSIDE MAIN PERRINE COULEE:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.042	8.80	21.70	0.006	0
0.064	8.60	19.70	0.008	0
0.046	8.10	19.50	0.006	0
0.047	8.50	17.00	0.006	0
0.086	8.20	17.00	0.011	0
0.030	8.40	17.50	0.004	0
0.240	8.70	15.10	0.031	1

	0.050	8.60	17.30	0.007	0		
	0.033	8.50	13.00	0.004	0		
	0.032	8.70	11.80	0.004	0		
	0.003	7.90	2.90	0.000	0		
	0.097	7.80	9.60	0.012	0		
	0.078	8.80	7.60	0.010	0		
	0.037	8.80	4.40	0.005	0		
	0.044	8.90	7.70	0.006	0		
	0.029	8.60	11.00	0.004	0		
	0.151	8.90	9.80	0.019	0		
	0.019	9.00	10.70	0.002	0		
	0.112	8.80	9.50	0.014	0		
	0.100	8.60	6.80	0.013	0		
	0.031	8.50	11.40	0.004	0		
	0.006	8.50	14.80	0.001	0		
	0.044	8.70	12.50	0.006	0		
	0.068	8.50	16.10	0.009	0		
	0.003	8.90	18.00	0.000	0	Exceedences	
	0.008	8.70	21.40	0.001	0	Number	Percent
Total	26			26	1	1:26	3.80%

SOUTHSIDE WEST PERRINE COULEE:

	NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
	0.017	8.60	19.70	0.002	0		
	0.040	8.70	18.00	0.005	0		
	0.027	7.90	18.00	0.004	0		
	0.043	8.40	16.50	0.006	0		
	0.046	8.20	17.00	0.006	0		
	0.076	8.40	15.50	0.010	0		
	0.054	8.70	12.60	0.007	0		
	0.034	8.60	13.10	0.004	0		
	0.038	8.60	8.80	0.005	0		
	0.104	8.60	8.00	0.013	0		
	0.087	8.60	4.90	0.011	0		
	0.104	8.10	12.50	0.013	0		
	0.003	8.60	13.90	0.000	0		
	0.300	8.50	13.50	0.039	1		
	0.133	8.70	12.80	0.017	0		
	0.066	8.50	15.80	0.009	0		
	0.003	8.60	15.40	0.000	0	Exceedences	
	0.086	8.30	19.50	0.011	0	Number	Percent
Total	18			18	1	1:18	5.60%

SOUTHSIDE 43 DRAINAGE:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.193	8.50	18.80	0.025	1
0.034	8.90	17.00	0.004	0
0.020	8.20	18.00	0.003	0

	0.040	8.70	16.00	0.005	0		
	0.059	8.20	16.50	0.008	0		
	0.088	8.60	15.50	0.011	0		
	0.062	8.60	13.00	0.008	0		
	0.087	8.60	13.10	0.011	0		
	0.040	8.50	9.10	0.005	0		
	0.100	8.60	8.40	0.013	0		
	0.069	8.50	6.00	0.009	0		
	0.072	8.10	10.70	0.009	0		
	0.008	8.50	11.80	0.001	0	Exceedences	
	0.164	8.50	11.60	0.021	1	Number	Percent
Total	14			14	2	2:14	14.30%

SOUTHSIDE 30 DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
0.122	8.10	20.00	0.016	0		
0.018	8.00	20.10	0.002	0		
0.049	7.80	20.10	0.006	0		
0.054	8.40	20.10	0.007	0		
0.123	8.50	16.50	0.016	0		
0.106	8.50	19.50	0.014	0		
0.022	8.50	15.80	0.003	0		
0.031	8.10	12.90	0.004	0		
0.051	8.00	8.90	0.007	0		
0.032	8.00	7.70	0.004	0		
0.172	8.70	4.90	0.022	1		
0.003	8.60	8.30	0.000	0		
0.019	8.60	9.90	0.002	0		
0.006	8.40	12.20	0.001	0		
0.021	8.40	11.40	0.003	0		
0.117	8.40	16.90	0.015	0		
0.019	8.30	14.60	0.002	0	Exceedences	
0.129	8.10	18.80	0.017	0	Number	Percent
Total 18			18	1	1:18	5.60%

NORTHSIDE S29 DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.034	8.90	25.70	0.005	0
0.131	8.10	27.40	0.018	0
0.058	8.20	23.80	0.008	0
0.061	8.90	22.00	0.008	0
0.140	8.40	17.50	0.018	0
0.026	8.20	19.00	0.003	0
0.025	8.40	16.60	0.003	0
0.162	8.40	13.60	0.021	1
0.119	8.10	7.00	0.015	0
0.177	8.70	11.50	0.023	1
0.034	8.50	13.10	0.004	0
0.020	8.70	12.30	0.003	0

	0.051	8.60	16.50	0.007	0		
	0.087	8.60	16.10	0.011	0		
	0.062	8.30	17.60	0.008	0		
	0.009	8.50	17.40	0.001	0	Exceedences	
	0.104	8.40	20.50	0.014	0	Number	Percent
Total	17			17	2	2:17	11.80%

SOUTHSIDE PIGEON COVE HYDRO PLANT: LQ AND LS DRAINS:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
0.037	7.90	18.90	0.005	0		
0.041	7.80	19.50	0.005	0		
0.119	7.50	18.40	0.016	0		
0.043	8.10	17.20	0.006	0		
0.056	8.20	15.50	0.007	0		
0.060	8.20	18.00	0.008	0		
0.046	8.20	14.60	0.006	0		
0.029	8.10	12.10	0.004	0		
0.065	7.90	10.80	0.008	0		
0.233	7.70	13.20	0.030	1		
0.243	8.20	12.00	0.031	1		
0.195	7.80	10.30	0.025	1		
0.591	7.80	11.20	0.076	1		
0.440	8.10	10.90	0.057	1		
0.316	8.40	10.10	0.040	1		
0.308	8.20	11.10	0.040	1		
0.462	8.30	11.20	0.059	1		
0.283	8.20	9.20	0.036	1		
0.423	8.10	10.90	0.054	1		
0.333	8.00	11.30	0.043	1		
0.102	8.50	9.00	0.013	0		
0.067	8.40	7.00	0.008	0		
0.012	8.40	12.70	0.002	0		
0.084	8.30	10.50	0.011	0		
0.127	8.20	12.60	0.016	0		
0.117	8.30	12.00	0.015	0		
0.067	8.30	16.40	0.009	0		
0.015	8.30	15.00	0.002	0	Exceedences	
0.104	8.10	18.60	0.014	0	Number	Percent
Total 29			29	11	11:29	37.90%

NORTHSIDE N42 DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.051	8.30	19.50	0.007	0
0.030	8.20	17.00	0.004	0
0.079	8.20	15.50	0.010	0
0.035	7.90	20.00	0.005	0
0.021	8.50	15.60	0.003	0
0.033	8.40	13.10	0.004	0
0.030	8.30	10.70	0.004	0

	0.037	8.10	13.60	0.005	0		
	0.078	6.60	11.90	0.010	0		
	0.031	7.70	7.60	0.004	0	Exceedences	
	0.215	8.60	7.90	0.027	1	Number	Percent
Total	11			11	1	1:11	9.10%

SOUTHSIDE LS2/39A DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
0.032	8.00	19.50	0.004	0		
0.049	7.80	21.30	0.007	0		
0.068	7.70	19.10	0.009	0		
0.064	8.00	21.20	0.009	0		
0.065	8.40	17.00	0.009	0		
0.129	8.40	20.00	0.017	0		
0.049	7.80	12.80	0.006	0		
0.019	7.90	10.70	0.002	0		
0.028	7.90	10.50	0.004	0		
0.028	8.40	9.80	0.004	0		
0.003	8.30	4.90	0.000	0		
0.113	8.30	6.60	0.014	0		
0.035	8.80	3.40	0.004	0		
0.026	8.60	5.80	0.003	0		
0.031	8.60	7.10	0.004	0		
0.041	8.50	6.30	0.005	0		
0.152	8.40	7.10	0.019	0		
0.056	8.40	10.40	0.007	0		
0.042	8.40	9.10	0.005	0		
0.096	8.50	7.60	0.012	0		
0.057	8.60	12.60	0.007	0		
0.053	8.50	10.60	0.007	0		
0.101	8.30	12.50	0.013	0		
0.003	8.40	10.70	0.000	0		
0.064	8.40	15.80	0.008	0		
0.020	8.40	15.30	0.003	0	Exceedences	
0.143	8.20	18.10	0.019	0	Number	Percent
Total 27			27	0	0:27	0.00%

NORTHSIDE N42 DRAIN ON CANYON RIM:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.035	8.50	19.20	0.005	0
0.044	8.60	18.50	0.006	0
0.078	8.60	19.00	0.010	0
0.085	8.30	21.00	0.011	0
0.069	8.60	15.50	0.009	0
0.195	8.00	19.50	0.026	1
0.022	8.50	15.60	0.003	0
0.094	8.80	11.90	0.012	0
0.043	8.40	10.20	0.006	0
0.317	8.60	9.40	0.040	1

	0.120	8.40	6.50	0.015	0		
	0.045	8.60	12.60	0.006	0		
	0.277	8.50	11.40	0.036	1		
	0.039	8.40	12.30	0.005	0		
	0.026	8.40	13.20	0.003	0		
	0.100	8.30	19.30	0.013	0		
	0.050	8.40	16.90	0.007	0	Exceedences	
	0.112	8.40	21.70	0.015	0	Number	Percent
Total	18			18	3	3:18	16.70%

NORTHSIDE J8 DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
0.037	8.70	28.10	0.005	0		
0.069	10.40	23.50	0.009	0		
0.029	8.60	21.00	0.004	0		
0.055	8.30	23.00	0.007	0		
0.054	7.90	17.00	0.007	0		
0.089	8.10	22.00	0.012	0		
0.022	8.80	17.10	0.003	0		
0.021	10.20	14.40	0.003	0		
0.030	8.50	10.00	0.004	0		
0.109	8.50	10.30	0.014	0		
0.024	8.50	13.30	0.003	0		
0.055	8.60	13.00	0.007	0		
0.035	8.60	14.80	0.005	0		
0.003	8.50	16.70	0.000	0		
0.114	8.60	22.50	0.015	0	Exceedences	
0.043	8.50	23.90	0.006	0	Number	Percent
Total 16			16	0	0:16	0.00%

SOUTHSIDE 39 DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.041	8.10	22.30	0.005	0
0.078	8.00	22.40	0.010	0
0.045	8.00	20.50	0.006	0
0.058	8.40	18.70	0.008	0
0.051	8.50	18.00	0.007	0
0.104	8.50	21.00	0.014	0
0.028	8.40	15.70	0.004	0
0.034	7.90	13.10	0.004	0
0.104	7.80	9.70	0.013	0
0.170	7.50	12.90	0.022	1
0.011	8.50	12.10	0.001	0
0.003	8.20	7.70	0.000	0
0.127	8.20	8.90	0.016	0
0.158	8.70	5.80	0.020	0
0.040	8.80	5.00	0.005	0
0.042	8.70	7.40	0.005	0
0.030	8.60	8.10	0.004	0

	0.036	8.70	6.10	0.005	0		
	0.292	8.50	7.50	0.037	1		
	0.044	8.50	10.50	0.006	0		
	0.003	8.60	9.50	0.000	0		
	0.150	8.70	8.90	0.019	0		
	0.003	8.70	12.30	0.000	0		
	0.082	8.60	10.90	0.011	0		
	0.240	8.50	13.30	0.031	1		
	0.430	8.50	13.30	0.056	1		
	0.051	8.30	18.40	0.007	0		
	0.101	8.60	16.60	0.013	0	Exceedences	
	0.151	8.30	20.20	0.020	0	Number	Percent
Total	29			29	4	4:29	13.80%

SOUTHSIDE I DRAIN:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
0.039	8.70	19.70	0.005	0		
0.033	8.80	20.50	0.004	0		
0.040	8.60	18.00	0.005	0		
0.058	8.50	18.90	0.008	0		
0.044	8.20	15.50	0.006	0		
0.013	7.90	20.00	0.002	0		
0.022	8.60	16.50	0.003	0		
0.283	9.90	12.70	0.036	1		
0.029	8.40	11.40	0.004	0		
0.144	8.60	13.60	0.019	0		
0.045	6.90	12.20	0.006	0		
0.003	8.20	7.20	0.000	0		
0.219	9.40	8.10	0.028	1		
0.137	8.10	7.00	0.017	0		
0.292	8.80	6.90	0.037	1		
0.222	8.80	9.10	0.028	1		
0.098	8.60	12.20	0.013	0		
0.337	8.80	7.30	0.043	1		
0.236	8.60	9.70	0.030	1		
0.062	8.80	12.50	0.008	0		
0.036	8.70	11.20	0.005	0		
0.141	8.60	12.50	0.018	0		
0.025	8.60	8.00	0.003	0		
0.023	8.70	13.20	0.003	0		
0.092	8.50	11.60	0.012	0		
0.105	8.60	17.20	0.014	0		
0.058	8.60	19.90	0.008	0		
0.014	6.80	17.80	0.002	0	Exceedences	
0.021	8.70	20.00	0.003	0	Number	Percent
Total 29			29	6	6:29	20.70%

SOUTHSIDE N DRAIN PRIOR TO IDAHO FISH BREEDERS:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L

	0.034	7.90	16.60	0.004	0		
	0.069	7.80	17.50	0.009	0		
	0.033	8.10	15.30	0.004	0		
	0.087	8.50	18.20	0.011	0		
	0.059	8.20	17.80	0.008	0		
	0.014	8.10	17.00	0.002	0		
	0.029	8.10	14.50	0.004	0		
	0.017	8.00	11.80	0.002	0		
	0.031	7.90	12.00	0.004	0		
	0.042	8.00	11.80	0.005	0		
	0.090	8.30	11.50	0.012	0		
	0.032	8.50	8.20	0.004	0		
	0.026	8.60	6.40	0.003	0		
	0.066	8.50	6.30	0.008	0		
	0.087	8.60	7.50	0.011	0		
	0.090	8.50	10.00	0.012	0		
	0.180	8.40	8.80	0.023	1		
	0.115	8.40	11.30	0.015	0		
	0.040	8.20	14.40	0.005	0		
	0.090	8.40	13.00	0.012	0		
	0.049	8.50	15.30	0.006	0		
	0.064	8.40	13.60	0.008	0		
	0.026	8.40	15.70	0.003	0		
	0.155	8.40	15.40	0.020	1		
	0.035	8.40	15.20	0.005	0		
	0.056	8.30	14.30	0.007	0		
	0.155	8.30	15.40	0.020	1	Exceedences	
	0.048	8.10	16.80	0.006	0	Number	Percent
Total	28			28	3	3:28	10.7%

NORTHSIDE S19/S DRAINS:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.044	8.90	24.30	0.006	0
0.054	8.70	24.50	0.007	0
0.028	8.40	22.50	0.004	0
0.047	8.40	22.00	0.006	0
0.050	8.10	17.50	0.007	0
0.158	7.80	20.50	0.021	1
0.025	8.70	16.00	0.003	0
0.035	8.50	9.50	0.004	0
0.051	8.50	5.90	0.006	0
0.061	8.40	8.80	0.008	0
0.224	8.70	8.10	0.028	1
0.152	8.60	9.70	0.019	0
0.003	8.30	9.70	0.000	0
0.040	8.50	12.10	0.005	0
0.076	8.30	17.20	0.010	0
0.031	8.50	14.30	0.004	0
0.081	8.80	21.30	0.011	0

	0.018	8.70	17.70	0.002	0	Exceedences	
	0.056	8.70	20.60	0.007	0	Number	Percent
Total	19			19	2	2:19	10.50%

NORTHSIDE W26 DRAIN:

	NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L		
	0.03	9.20	25.00	0.004	0		
	0.02	8.70	25.50	0.003	0		
	0.02	8.50	23.00	0.003	0		
	0.05	8.40	23.00	0.007	0		
	0.05	8.20	9.50	0.007	0		
	0.10	8.20	19.00	0.013	0		
	0.02	8.60	15.30	0.002	0		
	0.06	8.40	11.60	0.007	0		
	0.07	8.60	8.50	0.009	0		
	0.11	8.70	9.30	0.014	0		
	0.10	8.70	15.10	0.013	0		
	0.00	8.40	13.00	0.000	0		
	0.06	8.50	9.60	0.008	0		
	0.10	8.50	18.10	0.013	0		
	0.15	8.60	14.20	0.019	0		
	0.04	8.70	21.80	0.006	0		
	0.00	8.60	16.20	0.000	0	Exceedences	
	0.05	6.80	19.90	0.006	0	Number	Percent
Total	18			18	0	0:18	0.00%

END OF IRRIGATION RETURN DRAINS

AQUACULTURE FISH HATCHERIES

BLUE LAKES TROUT FARM FISH PROCESSING PLANT

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
35.1	6.70	20.60	4.674	1
27.2	6.60	19.80	3.614	1
33.9	6.30	19.60	4.505	1
31.7	6.30	19.90	4.217	1
42.0	6.60	20.90	5.599	1
44.1	6.50	20.20	5.868	1
42.5	6.80	19.20	5.632	1
16.8	6.80	19.00	2.225	1
13.8	6.90	17.00	1.815	1
24.9	6.90	16.50	3.270	1
23.4	6.70	18.50	3.095	1
27.8	6.70	20.00	3.695	1
21.5	7.10	17.50	2.831	1
44.3	6.60	17.60	5.845	1
35.8	7.50	16.40	4.691	1
43.6	6.70	13.00	5.666	1
46.8	6.70	12.30	6.068	1
38.7	7.80	12.20	4.998	1
30.2	7.10	8.10	3.857	1
29.4	7.40	7.40	3.742	1
18.4	7.40	6.20	2.333	1
11.6	7.50	4.00	1.459	1
1.3	7.40	4.10	0.169	1
9.8	7.50	2.90	1.233	1
5.0	8.00	4.60	0.629	1
12.6	7.50	8.00	1.606	1
14.1	7.60	5.30	1.781	1
9.14	8.10	5.10	1.152	1
10.90	7.80	8.10	1.389	1
9.68	7.50	8.60	1.237	1
14.90	7.30	8.80	1.906	1
10.60	7.50	9.90	1.360	1
15.40	7.40	8.60	1.968	1
9.90	7.50	9.90	1.270	1
11.40	7.40	9.60	1.462	1
13.90	7.40	11.90	1.796	1
13.10	7.40	10.30	1.684	1
11.80	7.50	11.70	1.523	1
14.40	7.50	13.60	1.870	1
1.48	7.70	10.50	0.190	1
18.90	7.40	14.90	2.466	1
19.00	7.50	14.90	2.478	1
10.90	7.30	14.30	1.420	1
15.90	7.30	16.80	2.088	1
11.70	7.20	18.90	1.547	1

	17.50	7.30	20.50	2.325	1		
	12.20	7.10	17.90	1.609	1		
	18.90	7.10	20.00	2.509	1		
	22.40	7.10	18.60	2.960	1		
	23.60	7.20	22.90	3.160	1	Exceedences	
	23.10	7.00	23.30	3.099	1	Number	Percent
Total	51			51	51	51.51	100.0%

BLUE LAKES TROUT FARM HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.013	7.90	18.70	0.002	0
0.161	7.80	17.00	0.021	1
0.150	7.40	16.20	0.020	0
0.154	7.30	16.80	0.020	1
0.117	7.30	17.10	0.015	0
0.288	7.40	18.80	0.038	1
0.208	7.90	16.90	0.027	1
0.133	8.10	16.50	0.017	0
0.143	8.00	16.00	0.019	0
0.276	8.10	16.00	0.036	1
0.205	8.10	17.00	0.027	1
0.287	8.00	18.00	0.038	1
0.298	8.00	15.90	0.039	1
0.175	8.00	17.10	0.023	1
0.217	7.90	15.70	0.028	1
0.240	7.80	14.20	0.031	1
0.219	7.80	14.80	0.029	1
0.140	7.70	14.80	0.018	0
0.263	7.80	15.30	0.034	1
0.189	5.80	13.60	0.025	1
0.164	7.80	14.10	0.021	1
0.205	7.80	12.60	0.027	1
0.279	7.70	13.30	0.036	1
0.376	7.60	13.60	0.049	1
0.271	7.60	13.20	0.035	1
0.121	8.10	14.00	0.016	0
0.246	8.10	13.80	0.032	1
0.295	8.10	14.10	0.038	1
0.243	8.20	13.20	0.031	1
0.282	8.10	14.30	0.037	1
0.160	8.10	14.20	0.021	1
0.395	8.00	14.50	0.051	1
0.455	8.00	14.50	0.059	1
0.396	7.80	13.30	0.051	1
0.410	7.90	14.20	0.053	1
0.240	7.90	14.10	0.031	1
0.147	8.10	14.70	0.019	0
0.113	8.00	14.00	0.015	0
0.270	8.00	14.70	0.035	1

	0.129	8.00	15.30	0.017	0		
	0.126	8.20	14.10	0.016	0		
	0.119	7.90	14.80	0.015	0		
	0.133	8.10	16.40	0.017	0		
	0.145	7.90	15.20	0.019	0		
	0.385	8.00	15.70	0.050	1		
	0.221	7.90	16.20	0.029	1		
	0.242	7.90	17.70	0.032	1		
	0.115	8.00	15.70	0.015	0		
	0.125	7.90	15.80	0.016	0		
	0.196	7.90	16.10	0.026	1		
	0.070	8.00	16.80	0.009	0	Exceedences	
	0.182	7.90	16.30	0.024	1	Number	Percent
Total	52			52	35	35:52	67.3%

CRYSTAL SPRINGS FISH HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.329	8.10	16.20	0.043	1
0.416	8.30	15.50	0.054	1
0.332	8.30	15.00	0.043	1
0.305	6.60	15.00	0.040	1
0.303	7.70	15.00	0.040	1
0.332	8.20	16.00	0.043	1
0.287	8.10	15.50	0.037	1
0.276	8.20	15.50	0.036	1
0.885	7.30	14.50	0.115	1
0.418	8.10	16.50	0.055	1
0.403	7.40	17.50	0.053	1
0.342	8.00	16.50	0.045	1
0.362	8.10	15.70	0.047	1
0.228	7.90	16.60	0.030	1
0.324	8.10	14.30	0.042	1
0.354	7.80	13.90	0.046	1
0.378	8.10	13.80	0.049	1
0.357	7.70	13.70	0.046	1
0.313	8.00	15.20	0.041	1
0.331	7.80	13.10	0.043	1
0.338	6.60	14.80	0.044	1
0.377	7.90	13.60	0.049	1
0.284	7.80	12.20	0.037	1
0.452	7.90	13.10	0.059	1
0.475	8.60	12.10	0.061	1
0.454	7.70	12.40	0.059	1
0.325	7.10	13.80	0.042	1
0.328	8.20	13.70	0.043	1
0.319	8.30	13.00	0.041	1
0.284	8.20	12.70	0.037	1
0.344	8.00	13.50	0.045	1
0.180	8.10	14.00	0.023	1

	0.142	8.20	13.80	0.018	0		
	0.421	8.00	14.40	0.055	1		
	0.388	8.80	13.10	0.050	1		
	0.505	8.00	12.90	0.065	1		
	0.329	7.90	13.00	0.043	1		
	0.210	7.90	13.50	0.027	1		
	0.271	8.10	15.10	0.035	1		
	0.267	8.00	14.00	0.035	1		
	0.260	8.00	14.20	0.034	1		
	0.423	8.10	15.10	0.055	1		
	0.239	7.60	15.20	0.031	1		
	0.322	8.00	14.30	0.042	1		
	0.100	8.10	14.00	0.013	0		
	0.390	7.90	15.50	0.051	1		
	0.559	8.00	16.00	0.073	1		
	0.310	8.00	16.30	0.041	1		
	0.276	8.00	17.70	0.036	1		
	0.328	8.00	16.00	0.043	1		
	0.308	7.90	16.50	0.040	1		
	0.304	8.00	16.40	0.040	1		
	0.369	7.90	17.60	0.048	1	Exceedences	
	0.346	7.90	16.80	0.045	1	Number	Percent
Total	54			54	52	52:54	96.3%

MAGIC VALLEY FISH HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.135	7.90	17.80	0.018	0
0.093	7.80	16.60	0.012	0
0.065	7.70	16.90	0.009	0
0.062	7.80	16.80	0.008	0
0.040	7.80	16.40	0.005	0
0.074	7.80	15.80	0.010	0
0.090	7.80	16.80	0.012	0
0.033	8.30	15.50	0.004	0
0.098	8.10	15.50	0.013	0
0.142	8.20	16.50	0.019	0
0.106	8.10	15.50	0.014	0
0.134	8.10	16.00	0.018	0
0.106	8.10	15.10	0.014	0
0.064	7.40	15.20	0.008	0
0.117	8.10	14.10	0.015	0
0.063	8.00	14.10	0.008	0
0.082	7.90	14.30	0.011	0
0.123	7.70	14.40	0.016	0
0.203	7.80	14.60	0.026	1
0.144	7.90	13.50	0.019	0
0.097	8.10	14.50	0.013	0
0.126	7.80	14.00	0.016	0
0.151	7.80	13.40	0.020	0

	0.247	7.60	14.30	0.032	1		
	0.260	7.80	13.80	0.034	1		
	0.182	7.60	13.60	0.024	1		
	0.122	8.10	13.90	0.016	0		
	0.182	8.10	14.00	0.024	1		
	0.164	8.20	13.80	0.021	1		
	0.182	8.10	13.20	0.024	1		
	0.241	8.00	14.10	0.031	1		
	0.268	8.00	14.40	0.035	1		
	0.250	8.10	14.40	0.032	1		
	0.321	7.70	14.20	0.042	1		
	0.193	8.10	13.10	0.025	1		
	0.214	8.00	13.60	0.028	1		
	0.283	7.90	14.20	0.037	1		
	0.401	7.90	13.90	0.052	1		
	0.090	8.00	14.70	0.012	0		
	0.131	8.10	14.50	0.017	0		
	0.020	8.10	14.40	0.003	0		
	0.142	8.10	15.20	0.019	0		
	0.100	8.40	15.60	0.013	0		
	0.112	8.10	14.20	0.015	0		
	0.125	8.50	14.10	0.016	0		
	0.221	8.00	14.40	0.029	1		
	0.135	8.60	15.90	0.018	0		
	0.139	8.40	16.50	0.018	0		
	0.102	8.20	17.10	0.013	0		
	0.138	8.40	15.30	0.018	0		
	0.057	8.30	16.00	0.007	0		
	0.054	8.20	15.40	0.007	0		
	0.106	8.00	16.60	0.014	0	Exceedences	
	0.086	8.10	15.50	0.011	0	Number	Percent
Total	54			54	16	16:54	29.6%

RIM VIEW HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.374	8.30	14.90	0.049	1
0.326	8.30	15.20	0.042	1
0.341	10.10	14.50	0.044	1
0.330	7.70	15.00	0.043	1
0.360	7.80	15.00	0.047	1
0.283	8.10	16.00	0.037	1
0.344	8.00	15.50	0.045	1
0.286	8.30	14.70	0.037	1
0.381	7.50	14.50	0.050	1
0.406	8.00	15.50	0.053	1
0.295	7.30	17.00	0.039	1
0.271	7.90	16.00	0.035	1
0.508	7.90	15.50	0.066	1
0.338	7.80	15.90	0.044	1

	0.334	8.00	14.60	0.043	1	
	0.313	7.70	14.00	0.041	1	
	0.389	7.90	14.10	0.051	1	
	0.266	7.60	13.80	0.035	1	
	0.529	7.90	14.50	0.069	1	
	0.528	7.90	13.40	0.068	1	
	0.396	6.50	14.70	0.052	1	
	0.300	7.80	13.60	0.039	1	
	0.378	7.90	9.60	0.048	1	
	0.288	7.60	13.60	0.037	1	
	0.494	8.00	12.80	0.064	1	
	0.313	7.60	13.30	0.041	1	
	0.277	7.10	13.20	0.036	1	
	0.260	8.00	13.70	0.034	1	
	0.338	8.10	12.50	0.044	1	
	0.299	8.00	12.70	0.039	1	
	0.328	6.70	14.00	0.043	1	
	0.180	8.00	14.20	0.023	1	
	0.368	7.90	14.00	0.048	1	
	0.451	7.90	14.30	0.059	1	
	0.370	8.10	12.10	0.048	1	
	0.367	7.80	13.20	0.048	1	
	0.496	7.90	13.40	0.064	1	
	0.286	7.70	13.30	0.037	1	
	0.325	7.90	14.90	0.042	1	
	0.148	7.90	13.70	0.019	0	
	0.277	7.50	14.50	0.036	1	
	0.369	8.00	14.90	0.048	1	
	0.242	7.80	15.00	0.032	1	
	0.265	7.90	14.30	0.034	1	
	0.337	7.90	14.20	0.044	1	
	0.409	7.80	15.20	0.053	1	
	0.315	7.90	15.60	0.041	1	
	0.276	7.90	15.90	0.036	1	
	0.386	7.70	16.00	0.050	1	
	0.153	7.80	15.30	0.020	0	
	0.377	7.40	15.30	0.049	1	
	0.356	7.80	15.30	0.046	1	
	0.513	7.70	16.00	0.067	1	Exceedences
	0.295	7.70	15.20	0.038	1	Number Percent
Total	54			54	52	52:54 96.3%

IDAHO FISH BREEDERS (N DRAIN WITH GEOTHERMAL WATER):

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.700	7.60	27.60	0.095	1
0.747	7.50	27.50	0.101	1
0.853	7.40	27.20	0.116	1
0.764	7.60	25.60	0.103	1
0.844	7.90	25.80	0.114	1

	0.787	8.10	29.40	0.107	1	
	0.626	8.00	27.00	0.085	1	
	0.602	8.10	27.20	0.081	1	
	0.686	8.00	27.00	0.093	1	
	0.732	7.90	26.50	0.099	1	
	0.594	8.00	25.50	0.080	1	
	0.778	8.10	24.80	0.105	1	
	0.735	7.90	26.70	0.099	1	
	0.522	7.80	22.60	0.070	1	
	0.668	8.00	22.80	0.089	1	
	0.685	7.80	22.10	0.091	1	
	0.675	7.70	23.00	0.090	1	
	0.560	7.90	23.20	0.075	1	
	0.558	7.70	20.60	0.074	1	
	0.900	7.70	22.40	0.120	1	
	0.947	7.50	22.60	0.127	1	
	0.966	7.90	21.10	0.128	1	
	1.060	7.50	21.10	0.141	1	
	0.975	7.30	21.50	0.130	1	
	0.617	8.00	20.30	0.082	1	
	0.680	7.90	22.50	0.091	1	
	0.731	7.90	20.20	0.097	1	
	0.727	7.90	18.00	0.096	1	
	0.821	7.80	21.90	0.109	1	
	0.622	7.70	24.70	0.084	1	
	1.080	7.70	23.70	0.145	1	
	1.080	7.70	25.00	0.145	1	
	1.260	7.70	22.30	0.168	1	
	1.210	7.80	22.70	0.162	1	
	0.937	7.60	25.10	0.126	1	
	0.665	7.80	23.60	0.089	1	
	0.794	8.00	25.60	0.107	1	
	0.857	7.70	25.40	0.115	1	
	0.570	7.80	25.90	0.077	1	
	0.662	7.80	27.70	0.090	1	
	0.534	8.00	24.20	0.072	1	
	0.419	7.90	24.40	0.056	1	
	0.539	7.90	24.90	0.072	1	
	1.150	7.80	26.30	0.155	1	
	0.615	7.80	26.70	0.083	1	
	0.735	7.70	27.90	0.100	1	
	0.895	7.70	25.80	0.121	1	
	0.437	7.80	25.00	0.059	1	
	1.110	7.70	27.10	0.150	1	
	0.425	7.80	26.40	0.057	1	
	0.724	7.90	26.80	0.098	1	Exceedences
	0.679	7.70	27.20	0.092	1	Number Percent
Total	52			52	52	52:52 100.0%

BOX CANYON FISH HATCHERY

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.552	7.00	16.00	0.072	1
0.498	7.40	17.10	0.065	1
0.537	7.10	16.00	0.070	1
0.540	6.90	17.00	0.071	1
0.566	7.20	16.20	0.074	1
0.485	7.20	15.70	0.063	1
0.581	7.80	17.20	0.076	1
0.535	7.80	16.50	0.070	1
0.544	7.90	16.30	0.071	1
0.695	7.80	16.00	0.091	1
0.585	7.70	16.10	0.077	1
0.482	7.90	16.00	0.063	1
0.700	7.80	15.90	0.091	1
0.536	7.70	16.50	0.070	1
0.652	7.50	14.50	0.085	1
0.553	7.50	14.90	0.072	1
0.540	7.50	14.00	0.070	1
0.664	7.40	14.70	0.087	1
0.569	7.60	14.50	0.074	1
0.529	7.50	13.40	0.069	1
0.667	7.90	14.10	0.087	1
0.665	7.70	13.90	0.086	1
0.735	7.70	11.70	0.095	1
0.652	7.50	13.20	0.085	1
0.452	7.80	9.90	0.058	1
0.601	7.40	13.40	0.078	1
0.518	7.40	9.70	0.066	1
0.524	7.90	13.80	0.068	1
0.478	7.90	11.70	0.062	1
0.443	8.00	12.10	0.057	1
0.424	7.80	12.50	0.055	1
0.301	7.80	14.50	0.039	1
0.494	7.80	15.00	0.064	1
0.620	7.70	14.50	0.081	1
0.745	6.70	12.60	0.097	1
0.684	7.90	13.30	0.089	1
0.477	7.80	13.90	0.062	1
0.565	7.70	13.50	0.073	1
0.537	7.50	15.10	0.070	1
0.475	7.80	14.80	0.062	1
0.481	7.70	14.90	0.063	1
0.692	7.80	16.30	0.091	1
0.487	7.80	15.30	0.064	1
0.478	7.80	14.20	0.062	1
0.443	7.70	16.30	0.058	1
0.714	7.70	15.30	0.093	1

	0.532	7.80	16.20	0.070	1		
	0.535	7.70	16.10	0.070	1		
	0.541	7.80	16.80	0.071	1		
	0.481	7.80	15.40	0.063	1		
	0.502	7.80	14.40	0.065	1		
	0.409	7.70	15.80	0.053	1		
	0.572	7.90	17.30	0.075	1	Exceedences	
	0.547	7.70	17.70	0.072	1	Number	Percent
Total	54			54	54	54.54	100.0%

BUCKEYE FARM FISH HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.103	8.90	24.30	0.014	0
0.013	8.90	25.70	0.002	0
0.003	8.20	26.00	0.000	0
0.022	7.20	22.00	0.003	0
0.014	8.50	23.00	0.002	0
0.023	8.90	25.00	0.003	0
0.035	8.90	21.00	0.005	0
0.033	8.20	19.50	0.004	0
0.108	8.90	22.00	0.014	0
0.098	8.50	24.50	0.013	0
0.039	9.00	21.00	0.005	0
0.130	9.00	16.70	0.017	0
0.017	8.90	21.60	0.002	0
0.040	8.80	13.60	0.005	0
0.034	8.10	10.00	0.004	0
0.031	8.70	11.80	0.004	0
0.010	8.70	9.70	0.001	0
0.062	8.80	11.90	0.008	0
0.137	8.40	7.90	0.017	0
0.104	6.30	9.20	0.013	0
0.125	8.50	8.60	0.016	0
0.205	8.00	2.70	0.026	1
0.199	8.30	5.20	0.025	1
0.445	8.70	5.80	0.056	1
0.217	8.40	2.80	0.027	1
0.243	6.80	2.10	0.030	1
0.278	8.50	3.60	0.035	1
0.176	8.80	3.40	0.022	1
0.231	8.40	8.60	0.029	1
0.068	8.70	9.90	0.009	0
0.099	8.60	8.40	0.013	0
0.053	8.70	10.10	0.007	0
0.281	8.60	6.30	0.035	1
0.091	8.80	8.60	0.012	0
0.072	8.90	10.70	0.009	0
0.076	8.90	9.80	0.010	0
0.114	8.10	12.50	0.015	0

	0.090	9.10	10.30	0.012	0		
	0.074	9.40	13.80	0.010	0		
	0.065	9.10	16.10	0.008	0		
	0.537	8.70	13.70	0.069	1		
	0.061	9.00	16.60	0.008	0		
	0.046	9.20	14.30	0.006	0		
	0.029	9.20	16.80	0.004	0		
	0.003	9.00	16.20	0.000	0		
	0.036	9.20	21.10	0.005	0		
	0.067	6.90	20.40	0.009	0		
	0.034	9.00	17.30	0.004	0		
	0.153	6.70	19.40	0.020	1	Exceedences	
	0.049	6.70	27.90	0.007	0	Number	Percent
Total	50			50	11	11:50	22.0%

WHITE SPRINGS FISH HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.419	8.30	15.60	0.055	1
0.267	8.40	15.80	0.035	1
0.201	7.90	15.00	0.026	1
0.258	7.20	15.00	0.034	1
0.394	7.60	15.00	0.051	1
0.237	7.80	15.50	0.031	1
0.447	7.70	16.90	0.059	1
0.283	7.90	16.00	0.037	1
0.411	7.10	16.30	0.054	1
0.436	7.70	16.50	0.057	1
0.439	7.30	17.00	0.058	1
0.182	7.90	16.00	0.024	1
0.376	7.80	16.00	0.049	1
0.207	7.70	17.10	0.027	1
0.367	7.70	15.90	0.048	1
0.301	7.70	14.50	0.039	1
0.372	7.50	15.30	0.049	1
0.196	7.50	15.20	0.026	1
0.239	7.70	15.20	0.031	1
0.217	7.60	15.00	0.028	1
0.514	7.60	15.00	0.067	1
0.380	7.60	15.20	0.050	1
0.585	7.70	14.30	0.076	1
0.349	7.30	15.10	0.046	1
0.332	7.70	13.30	0.043	1
0.296	7.40	14.40	0.039	1
0.269	7.70	13.10	0.035	1
0.162	8.00	15.10	0.021	1
0.398	7.70	13.30	0.052	1
0.343	8.00	14.10	0.045	1
0.539	7.60	14.90	0.070	1
0.170	7.70	15.40	0.022	1

	0.670	7.60	14.90	0.087	1		
	0.318	7.70	15.60	0.042	1		
	0.813	7.70	13.90	0.106	1		
	0.392	7.80	14.60	0.051	1		
	0.156	7.70	15.20	0.020	1		
	0.384	7.50	14.70	0.050	1		
	0.485	7.40	16.00	0.063	1		
	0.176	7.80	15.30	0.023	1		
	0.421	7.70	15.70	0.055	1		
	0.333	7.70	16.20	0.044	1		
	0.544	7.60	16.30	0.071	1		
	0.350	7.60	15.40	0.046	1		
	0.563	7.60	16.40	0.074	1		
	0.467	7.80	16.30	0.061	1		
	0.777	7.70	16.10	0.102	1		
	0.355	7.70	17.30	0.047	1		
	0.600	7.70	16.00	0.078	1		
	0.321	7.80	16.80	0.042	1		
	0.400	7.70	15.20	0.052	1		
	0.292	7.70	16.70	0.038	1		
	0.617	7.60	17.00	0.081	1	Exceedences	
	0.318	7.70	17.30	0.042	1	Number	Percent
Total	54			54	54	54:54	100.0%

BIRCH CREEK FISH HATCHERY:

NH3	pH	TEM	NH3o	NH3o>=0.020 mg/L
0.329	8.60	15.80	0.043	1
0.311	8.50	16.60	0.041	1
0.387	8.00	15.50	0.050	1
0.484	7.70	18.20	0.064	1
0.412	7.90	16.00	0.054	1
0.316	8.10	16.50	0.041	1
0.325	8.00	18.10	0.043	1
0.387	8.00	17.00	0.051	1
0.407	7.60	18.50	0.054	1
0.302	8.20	17.50	0.040	1
0.517	7.50	19.00	0.068	1
0.386	8.20	15.00	0.050	1
0.446	8.20	16.60	0.058	1
0.317	8.00	18.50	0.042	1
0.137	8.10	14.90	0.018	0
0.321	7.90	13.60	0.042	1
0.343	8.00	3.40	0.043	1
0.365	7.80	13.60	0.047	1
0.152	8.10	13.90	0.020	0
0.396	7.90	12.20	0.051	1
0.268	7.80	13.10	0.035	1
0.262	8.00	12.20	0.034	1
0.371	7.80	11.00	0.048	1

	0.211	7.80	11.10	0.027	1		
	0.264	8.10	8.80	0.034	1		
	0.418	7.90	9.90	0.054	1		
	0.215	7.60	8.00	0.027	1		
	0.324	8.20	12.00	0.042	1		
	0.354	8.20	9.50	0.045	1		
	0.329	8.40	9.50	0.042	1		
	0.422	6.70	12.90	0.055	1		
	0.256	8.30	12.30	0.033	1		
	0.475	8.10	11.40	0.061	1		
	0.604	8.20	13.40	0.078	1		
	0.614	6.70	10.00	0.079	1		
	0.485	8.10	11.50	0.062	1		
	0.424	8.10	15.10	0.055	1		
	0.337	7.70	11.80	0.043	1		
	0.384	7.80	16.90	0.050	1		
	0.263	8.20	13.10	0.034	1		
	0.586	8.00	17.00	0.077	1		
	0.408	8.20	15.60	0.053	1		
	0.484	8.00	16.70	0.063	1		
	0.367	8.00	16.70	0.048	1		
	0.807	8.00	18.90	0.106	1		
	0.771	8.00	19.50	0.102	1		
	0.819	8.00	16.70	0.107	1		
	0.757	8.10	18.60	0.100	1		
	0.659	8.10	15.90	0.086	1		
	0.433	8.10	18.20	0.057	1		
	0.765	8.00	18.20	0.101	1		
	0.541	8.00	18.20	0.071	1		
	0.708	8.00	19.80	0.094	1	Exceedences	
	0.542	6.70	20.20	0.072	1	Number	Percent
Total	54			54	52	52:54	96.3%

END OF FISH HATCHERIES

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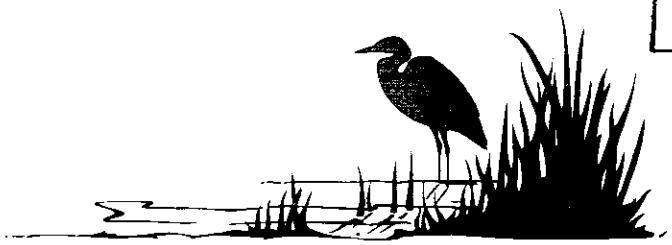
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Department of Water Resources
PROTESTANT'S
Exhibit B
Date Admitted 11/9/99



The Upper Snake Rock Subbasin Assessment

(or Upper Snake/Rock Creek Subbasin Assessment)

Prepared by:

Dr. Balthasar B. Buhidar, Ph.D.
and the Water Quality Protection Staff of
Idaho Division of Environmental Quality-Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

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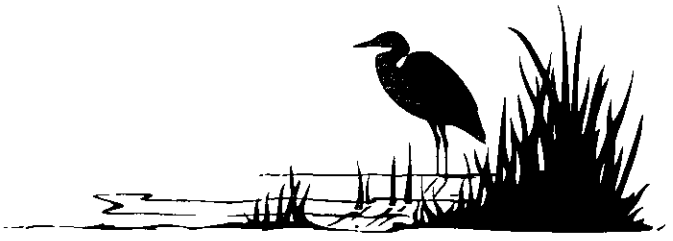
Idaho Division of Environmental Quality- "Central Office"
Water Quality & Remediation Division
Watershed & Aquifer Protection Bureau
1410 North Hilton
Boise, Idaho 83706

&

The Middle Snake Technical Advisory Committee
of
The Middle Snake River Watershed Advisory Group
c/o Idaho Division of Environmental Quality
Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

December 31, 1998
Proposed Final Draft

Insert Table of Contents Only



The Upper Snake Rock Subbasin Assessment

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Prepared by:

Dr. Balthasar B. Buhidar, Ph.D.
and the Water Quality Protection Staff of
Idaho Division of Environmental Quality-Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

&

Idaho Division of Environmental Quality- "Central Office"
Water Quality & Remediation Division
Watershed & Aquifer Protection Bureau
1410 North Hilton
Boise, Idaho 83706

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Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, Idaho 83301-3035

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December 31, 1998
Proposed Final Draft

PREPARERS AND CONTRIBUTORS

The Middle Snake River Technical Advisory Committee of the Middle Snake River Watershed Advisory Group was instrumental in the preparation of the Upper Snake Rock Subbasin Assessment (or SBA). The SBA was prepared by the principle writer, Dr. Balthasar B. Buhidar, Ph.D., who wrote it to satisfy the Idaho Division of Environmental Quality's Suggested TMDL Outline. Maps and figures were prepared by Rob Sharpnack, IDEQ-TFRO.

A Preliminary Draft No. 1 was prepared for internal IDEQ-Twin Falls Regional Office and IDEQ-Central Office Boise beginning April 30, 1998. Those involved included: Darren Brandt, Mike McMasters, Clyde Lay, Tom Miller, Rob Sharpnack, Mike Etcheverry, Greg Misbach, Nick Cizmich, Steve Van Zandt, Tom Askew, Dave Anderson, Pat O'Rorke, and Doug Howard. Central Office IDEQ-Boise comments came from Gary Dailey and Don Essig. From comments received with additonal extensive research, a Public Review Draft No. 1 was prepared on June 17, 1998 and presented to the TAC. TAC members solicited included the following: Carla Fromm, USEPA-Boise; Randy MacMillan, Clear Springs Foods & Upper Snake Basin Advisory Group Chairman; Gary Fornshell, University of Idaho Extension Service; Rich Yankey, Natural Resources Conservation Service-Twin Falls & Grazing Industry; Mike Gann, Food Processors Industry & Simplot Soil Builders; Travis Parsons, Idaho Soil Conservation Commission-Twin Falls; Clarence Robison, University of Idaho/IWWRI; Dave Parrish, IDFG-Jerome; Susan Birch, USFWS-Boise; Susan Martin, USFWS-Boise; Bob Luntey, Idaho Rivers United; Dave Zimmer, USBOR-Boise; Jennifer Smout, USBOR-Boise; Ralph Myers, Idaho Power Company-Boise; Mike Trabert, Municipality Industry, Mid-Snake WAG Chairman; Judy Brossy, Recreation Industry; Biff Burley, Idaho Soil Conservation Commission-Boise; Gary Bahn, Idaho Soil Conservation Commission-Boise; Greg Clark, USGS-Boise; Larry Pennington, Idaho Conservation League & Mid-Snake WAG Vice-Chairman; Leigh Woodruff, USEPA-Boise; John Yearsley, USEPA-Seattle; Rick Allen, Mid-Snake Water Resource Commission-Jerome; Steve Thompson, Natural Resources Conservation Service-Gooding; Tom Burnum, Natural Resources Conservation Service-Jerome; Joe Russell, USBLM-Shoshone; Tom Dyer, USBLM-Burley; Dale Westermann, USDA/ARS-Kimberly Research Station; Bill Graham, IDWR-Boise; Rich Prang, USBOR-Boise; and, Don Zuck, Recreation Industry.

Preliminary comments from the TAC were solicited and due by July 2, 1998, with additional comments by July 15, 1998. A presentation was made to the WAG on July 15, 1998 with a solicitation of comments from the group. A presentation was also made to the Upper Snake Basin Advisory Group on August 5, 1998 with a solicitation of comments from the group. These comments were incorporated into Public Review Draft No. 2 on September 1, 1998. With additional comments coming in from the TAC, the WAG, the BAG, and additional research being conducted a preliminary final Public Review Draft No. 3 was prepared on September 18, 1998. This draft was forwarded one more time to IDEQ-Central Office Boise for a second final review. Their review was finished by Don Essig on December 18, 1998. All comments where appropriate were incorporated into a Proposed Final Draft, dated December 31, 1998. The final proposed draft was presented to the TAC and the WAG on February 17, 1999.

The subbasin assessment was intended to be iterative during the TMDL development phase, so that the assessment and the final TMDL would complement each other in content when final submittal to USEPA-Boise/Seattle occurs on-or-before December 31, 1999. Preliminary final TMDL development was intended to be finished by August 31, 1999, allowing four additional months for legal review and biopolitical assessment.

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ACRONYMS AND GLOSSARY

The acronyms and glossary used in this document are summarized in the following list. The list is only inclusive for those terms used in this subbasin assessment.

TERM	*DEFINITION*
Acute toxicity	The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose.
ArcView™	ArcView is a computer Windows based program made by Environmental Systems Research Institute, Inc. (ESRI) for the creation of GIS-type maps.
Biopolitics	The integral relationship between the human institution of politics and the natural elements of the environment, such that no matter how scientific of technically correct certain processes or guidelines may seem, they are without foundation until accepted and established through the existing political system.
BSU	Boise State University (Boise, Idaho)
BURP	Beneficial Use Reconnaissance Project of IDEQ.
Ephemeral Stream	A stream which functions as a drainage channel which is normally dry but carries water in response to storms or annual snowmelt. There is no IDAPA definition. USBLM describes ephemeral streams as streams which last for brief periods of time. Many ephemeral streams do not appear on USGS maps as blue lines.
Epiphyte	Plants living on another plant or partly within the plant but nonparasitically, deriving its nutrients from the air, water, or debris accumulating around it.
GIS™	Geographic Information System (by ArchView)
HUC	Hydrologic Unit Code (USGS designation)
HUC 17040212	Upper Snake Rock Subbasin
HUC 4th Field	Subbasin hydrologic unit
HUC 5th Field	Watershed hydrologic unit (a sub component of 4th Field HUCs)
IDA	Idaho Department of Agriculture
IDL	Idaho Department of Lands
IDEQ	Idaho Division of Environmental Quality
IDFG	Idaho Department of Fish and Game
ISCC	Idaho Soil Conservation Commission
ISU	Idaho State University (Pocatello, Idaho)
IDWR	Idaho Department of Water Resources

TERM	DEFINITION
Intermittent Stream	IDAPA 16.01.02.003.50 defines intermittent stream(s) as "a stream which has a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 hydrologically-based design flow of less than one-tenth (0.1) cfs is considered intermittent. Streams with perennial pools which create significant aquatic life uses are not intermittent." USBLM describes intermittent streams as streams which have periodic interruptions in a normal pattern or process. USDA FS describes intermittent streams as streams in contact with the ground water table that flow only certain times of the year, such as, when the ground water table is high or when it receives water from springs or from some surface source such as melting snow in mountainous areas. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available streamflow (USDA FS 1997d).
LA	Load allocations for nonpoint source industries.
LC	Load Capacity = TMDL = Assimilative Capacity = WLA + LA + MOS
Man-made water body	IDAPA 16.01.02.003.57 defines man-made waterways as "canals, flumes, ditches, and similar features, constructed for the purpose of water conveyance." In Upper Snake Rock there are many natural stream drainage channels which have been converted into man-made waterways.
Mid-Snake TAC	Middle Snake River Technical Advisory Committee
Mid-Snake WAG	Middle Snake River Watershed Advisory Group
MOS	Margin of Safety in a TMDL
Nonpoint Source	Any unconfined and diffuse source of contamination, such as stormwater or snowmelt runoff, or atmospheric pollution. Legally, a nonpoint source of water pollution is any source of water pollution that does not meet the definition of "point source" in section 502(14) of the Clean Water Act. (USEPA 1997k [p. xii])
NRCS	Natural Resources Conservaton Service
Perennial Stream	A stream which flows year-round in most years. There is no IDAPA definition. USBLM describes perennial streams as streams which have uninterrupted flow from year to year. USDA FS describes perennial streams as streams that flow continuously throughout the year (permanently) (USDA FS 1997d).
Point Source	Any discernable, confined or discrete conveyence (pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation (CAFO), or vessel or other floating craft from which pollutants are or may be discharged. (USEPA 1997k)
QA/QC	Quality Assurance/Quality Control
SBA	Subbasin Assessment
SCC	Soil Conservation Commission (the equivalent of ISCC)

TERM	DEFINITION
SCD	Soil Conservation District
TFRO	Twin Falls Regional Office
TMDL	Total maximum daily load. The standard formula for a TMDL is: TMDL = Loading Capacity = Assimilative Capacity = Point Source Wasteloads + Nonpoint Source Loads + Margin of Safety.
UI or U of I	University of Idaho (Moscow, Idaho)
Upper Snake BAG	Upper Snake Basin Advisory Group
USBLM	United States Bureau of Land Management
USDA/ARS	United States Department of Agriculture/Agriculture Research Service
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WLA	Wasteload allocations for point source facilities.

THE UPPER SNAKE ROCK SUBBASIN ASSESSMENT for SURFACE WATERS of HYDROLOGIC UNIT CODE 17040212

EXECUTIVE SUMMARY

UPPER SNAKE ROCK SUBBASIN AT A GLANCE

Hydrologic Unit Code:	*17040212*
1996 Water Quality Limited Segments:	*16 tributaries, 5 reservoirs, 10 segments on the Middle Snake River*
Beneficial Uses Affected:	*Cold water biota, salmonid spawning, primary contact recreation, secondary contact recreation*
Pollutants of Concern:	*Sediment, nutrients, ammonia, pathogens, pesticides, oil & grease*
Stressors of Concern:	*Dissolved oxygen, flow alteration, thermal modification, temperature*
Major Land Uses:	*54% Rangeland & 41% Agriculture*
Area:	*2438 square miles or 1,536,880 acres*
Population (Year 2000):	*About 85,000*

1.0 EXECUTIVE SUMMARY

The *Upper Snake Rock Subbasin Assessment (SBA) for Surface Waters of Hydrologic Unit Code (HUC) 17040212* describes those waterbodies that are listed on the 1996 §303(d) list of the federal Clean Water Act that are not meeting their beneficial uses or State water quality standards within HUC 17040212. The SBA is not a total maximum daily load (TMDL), but rather provides information that may be used in the development of TMDLs for these water quality limited water bodies based on pollutants described in the §303(d) list. It describes the affected subbasin (as a 4th field HUC), the water quality concerns and status of beneficial uses of individual waterbodies, the nature and location of pollution sources, and a summary of past and ongoing pollution control activities (IDHW 1998). The development of a typical "subbasin TMDL" is idealized as a 22-month process: the first ten months focusing on preparing the SBA and the following year spent on developing the TMDL itself (IDEQ 1998).

This assessment was prepared as a collaborative effort between Idaho Division of Environmental Quality (IDEQ)-Twin Falls Regional Office (TFRO, who prepared the document), IDEQ-Central Office (who reviewed the document for statewide consistency and legal review), and the Middle Snake River Technical Advisory Committee (Mid-Snake TAC, who provided technical review comments). Additionally, the Middle Snake River Watershed Advisory Group (WAG) and the Upper Snake Basin Advisory Group (BAG) provided comments.

Over 95% of Upper Snake Rock is a Snake River Basin/High Desert ecoregion such that: (1) Its topography consists of tablelands with medium to high relief; (2) Its vegetation is made up predominantly of a sagebrush-grass zone with minimal riparian vegetation in the Middle Snake River or its tributaries; (3) Its land use is 54% desert shrublands (of which grazing is a major activity) and 41% agricultural land (both irrigated and dryland); (4) Its soils are 87% Aridisols and 13% Mollisols, of which 37% are from loess while 63% contain residium, colluvium, and alluvium. The loessal portion is a type of soil structure more susceptible to water and wind erosion, particularly when vegetation cover is removed. Less than 5% of Upper Snake Rock is a Northern Basin and Range ecosystem (predominantley in the forested areas of the Mount Bennett Hills and the Sawtooth National Forest) such that: (1) Its land form is that of plains with low to high mountains which have open high mountains; (2) Its vegetation is a great basin sagebrush saltbush and greasewood; and, (3) Its land

use is a desert shrubland which is grazed and comprises 3% of the total land use.

The SBA describes Upper Snake Rock as having 16 tributaries, 5 reservoirs, and 10 Middle Snake River segments (or a total of 31 waterbody segments) which are water quality limited (based on the 1996 303(d) list), thus requiring the development of a TMDL. Previous to this, the Billingsley Creek TMDL (in 1992) for total phosphorus from aquaculture facilities, and the Mid-Snake TMDL (in 1997) for total phosphorus for point and nonpoint source industries were drafted and approved by the USEPA. This SBA is but a continuation of the TMDL process in Upper Snake Rock so that all water quality limited streams and their associated pollutants are brought into the TMDL development process. The point sources include the NPDES permitted facilities: aquaculture, food processors, municipalities, and industrials. The nonpoint source industries include: FERC permitted hydroelectric impoundments and generation; confined feeding operations and confined animal feeding operations; agriculture; grazing; forestry; recreation; urban runoff/storm sewers; construction; and hydrologic modification.

The SBA attempts to describe the most current conditions of the water quality limited waterbodies in the subbasin, as well as provide supporting documentation for the various loading elements per tributary at their confluence with the Middle Snake River. Additionally, a summary of past/present pollution control efforts are presented, including the current NPDES permits being developed for point sources in the subbasin. FERC permits for Bliss, Shoshone Falls, Upper Salmon Falls, and Lower Salmon Falls dams are also discussed.

A *Trend Monitoring Plan* has been developed by IDEQ-TFRO and the Middle Snake River Technical Advisory Committee to determine water quality trends in Upper Snake Rock. This is included as an appendix to the SBA. Additional monitoring by point source industries as required by their NPDES permits is also discussed. Nonpoint sources will monitor as defined in their industry plans and the Mid-Snake TMDL (IDEQ 1997b).

In general, the Middle Snake River and all its tributaries are impacted by runoff from irrigated crop production, rangeland, pastureland, animal holding areas, feedlots, dredging, hydro-modification (as defined in *40 CFR 131.10(g)*), and urban runoff. Natural springs (such as Crystal Springs, Clear Springs, Niagara Springs) have exhibited hydro-modification and streambank modification from activities relating to sedimentation and siltation, aquaculture, hydropower, irrigated crop production, and land development. The Middle Snake River is a managed water system where *normal* flow regimes (such as spring flush) are no longer present. As a consequence, the absence of the *normal* flow regimes allows for sediment to accumulate which in turn exacerbates the growth of aquatic macrophytes during low flow years.

Applicable designated beneficial uses include agricultural water supply, domestic water supply, industrial water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, wildlife habitats, and aesthetics. At present, those designated beneficial uses not being met include cold water biota, salmonid spawning, primary and secondary contact recreation on the Middle Snake River and the tributaries. Applicable state water quality standards to support these beneficial uses include waters being free of deleterious materials; floating, suspended, or submerged matter; excess nutrients; oxygen-demanding materials; and, sediment. At present, these standards are not being met.

Finally, endangered and threatened species affected by degraded water quality are listed and described. Hydroelectric development throughout the Middle Snake River, as well as hydrologic modification in Upper Snake Rock, have to some extent impacted snail species through inundation of lotic habitats, isolating segmented populations, and reducing suitable shallow water shoreline. Declines in snail populations have been attributed, in part, to water quality degradation due to tributary and agricultural return flows laden with sediment, nutrients, runoff from dairies and feedlots, effluent from aquaculture, industrial and municipal facilities, and storm water runoff.

THE UPPER SNAKE ROCK SUBBASIN ASSESSMENT for SURFACE WATERS of HYDROLOGIC UNIT CODE 17040212

2.0 INTRODUCTION

The Upper Snake Rock Subbasin Assessment describes Hydrologic Unit Code (HUC) 17040212 for those water bodies that are water quality limited and listed on the 1996 §303(d) list of the Clean Water Act. Included in those water quality limited streams (or stream segments) are the fourteen (14) stream segments of the Middle Snake River (already addressed by the Mid-Snake TMDL for total phosphorus) and Billingsley Creek (already addressed by the Billingsley Creek TMDL for total phosphorus). Important to the Middle Snake River system is its managed flow. Although the IDEQ does not consider flow to be a pollutant for TMDL development, it nevertheless affects how the river functions. Reduced flows reduces loading capacity and intensifies the effects of pollutant loading, particularly under seasonal low flow conditions.

2.0.1 IDENTIFICATION SYSTEM

The identification system used in this subbasin assessment follows the Hydrologic Unit Codes (HUCs) used by the U.S. Geological Survey (USGS). The Upper Snake Rock subbasin (or HUC 17040212) is a 4th field hydrologic unit that represents a geographic area in the Upper Snake Basin such that "it is a distinct hydrologic feature (Gregory and Walling 1973)." Figure 1 shows HUC 17040212 in relationship to other adjacent HUCs in southern Idaho. Figure 2 shows the 38 watersheds (or 5th field HUCs) in HUC 17040212. Figure 3 shows the overall Upper Snake Basin and where HUC 17040212 is located in relation to it. Figures 1, 2, 3 are located at the end of this section of the subbasin.

2.0.2 COMPILATION OF DATABASES

The IDEQ-TFRO, reviewed a substantial amount of information from GIS coverages, databases from various internet sources, published water quality reports and maps, and data information requests from such sources as the U.S. Bureau of Land Management (USBLM), U.S. Forest Service (USFS), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), U.S. Department of Agriculture/Agricultural Research Service (USDA/ARS), Natural Resources Conservation Service (NRCS), Idaho Department of Fish and Game (IDFG), Idaho Department of Lands (IDL), Idaho Department of Water Resources (IDWR), Idaho Department of Agriculture (IDA), Soil Conservation Commission (SCC), various Soil Conservation Districts (SCDs), University of Idaho (U of I), Idaho State University (ISU), Boise State University (BSU), and various industries and organizations from the Upper Snake Rock subbasin.

As a primary concern, compilation and review of existing data (either as historical or recent) centered on the characterization of pollutant loads from all sources within Upper Snake Rock, so that the development of the "Upper Snake Rock TMDL" could readily be obtained from the loading descriptions provided in this subbasin assessment. Where technology-based controls are inadequate to achieve water quality standards, it is expected that the eventual TMDL will provide more stringent water quality-based controls in order to meet state water quality standards. Post-SBA includes the development of the Upper Snake Rock "TMDL," which will be structured on wasteload allocations (WLAs) for point sources, load allocations (LA s) for nonpoint sources, and a margin of safety (MOS): TMDL = WLA + LA + MOS. The MOS will account for scientific uncertainty in establishing the TMDL due to insufficient or poor-quality data, or a lack of knowledge about the relation between the receiving water quality and the effects of pollutant loading rates. It is expected that when the TMDL is developed, the loading capacity (LC) or assimilative capacity of all water quality limited

waterbodies will be identified as *the greatest amount of pollutant loading that a water body can receive without violating water quality standards* (USEPA 1997k).

Sediment will be shown to be the prinicipal pollutant in Upper Snake Rock. It is a highly complex pollutant to assess, particularly for more than one affected water body. The model used in this assessment for the eventual development of a TMDL was a simple mass balance using average annual loadings. No attempt was made at this time to view the Upper Snake Rock "TMDL" as a complex water quality model, so as to simulate rainfall events, cumulative chemical fate, or transport (USEPA 1996k). Perhaps at some point in the future, consideration for such complex modeling may be realized, but at this point it is not an effort that IDEQ or the Mid-Snake Technical Advisory Committee considered feasible under current time and financial constraints. Additionally, information on river flow as it relates to sediment transport dynamics and nutrient assimilation is also included. Flow, both as quantity and velocity, is a key component in the overall river system and is vital to the biological community, not only from a water quality perspective, but also for biological transport as it relates to the genetic interchange between aquatic animal populations and their reproductive needs.

2.0.3 QUALITY ASSURANCE/QUALITY CONTROL OF DATA

The data information sources provided to IDEQ-TFRO and used in this subbasin assessment were scrutinized for quality assurance/quality control (QA/QC). As the majority of the data were collected under field conditions and transported for analysis to a laboratory, the following protocols were used to ascertain a minimum level of compliance for QA/QC field and laboratory considerations: (1) The data were reviewed for use of blanks, spikes, and duplicates as a minimum protocol; (2) Under QA all data had to be ensured to be scientifically valid, defensible, and of known precision and accuracy both in the field and in the laboratory so as to withstand scientific and legal challenges; (3) QC samples were introduced into the process to monitor performance of the system from the field collection to the final laboratory analysis; and, (4) In all databases reviewed, it had to be demonstrated that a QA/QC plan was enforced throughout the life of the project. As a consequence, a preliminary database was developed for the Middle Snake River and for the other water quality limited water bodies by IDEQ-TFRO, which will be incorporated over the next ten (10) years for use by the Mid-Snake Technical Advisory Committee's *Trend Monitoring Plan*.

2.0.4 PUBLIC ADVISORY COMMITTEE INVOLVEMENT

As part of the public's involvement in the development of this subbasin assessment, the Middle Snake River Watershed Advisory Group's (Mid-Snake WAG) Technical Advisory Committee (TAC) was instrumental in the review of the document. The document was prepared by the IDEQ-TFRO, with supplemental comments and review by IDEQ-Central Office, and the Mid-Snake WAG's TAC. The subbasin assessment was provided to the Mid-Snake WAG (as the general membership) and the Upper Snake Basin Advisory Group (Upper Snake BAG) for their review and comments before submission to the USEPA.

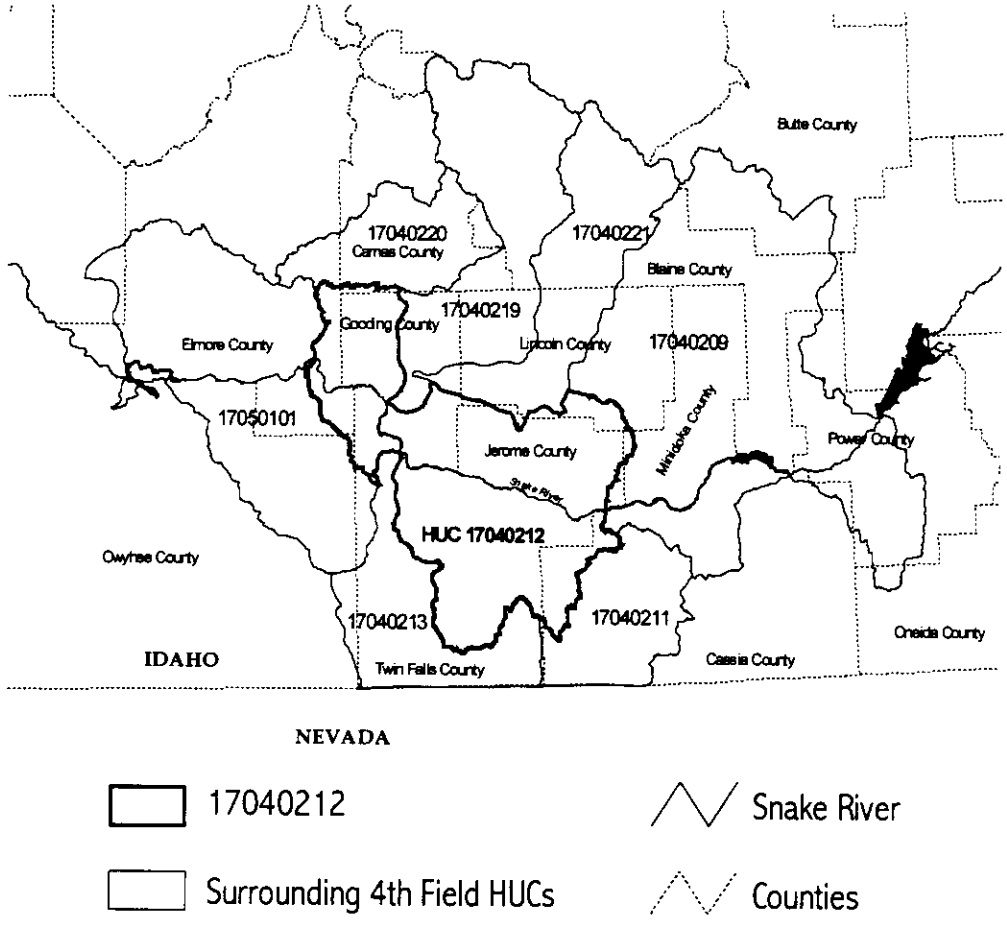
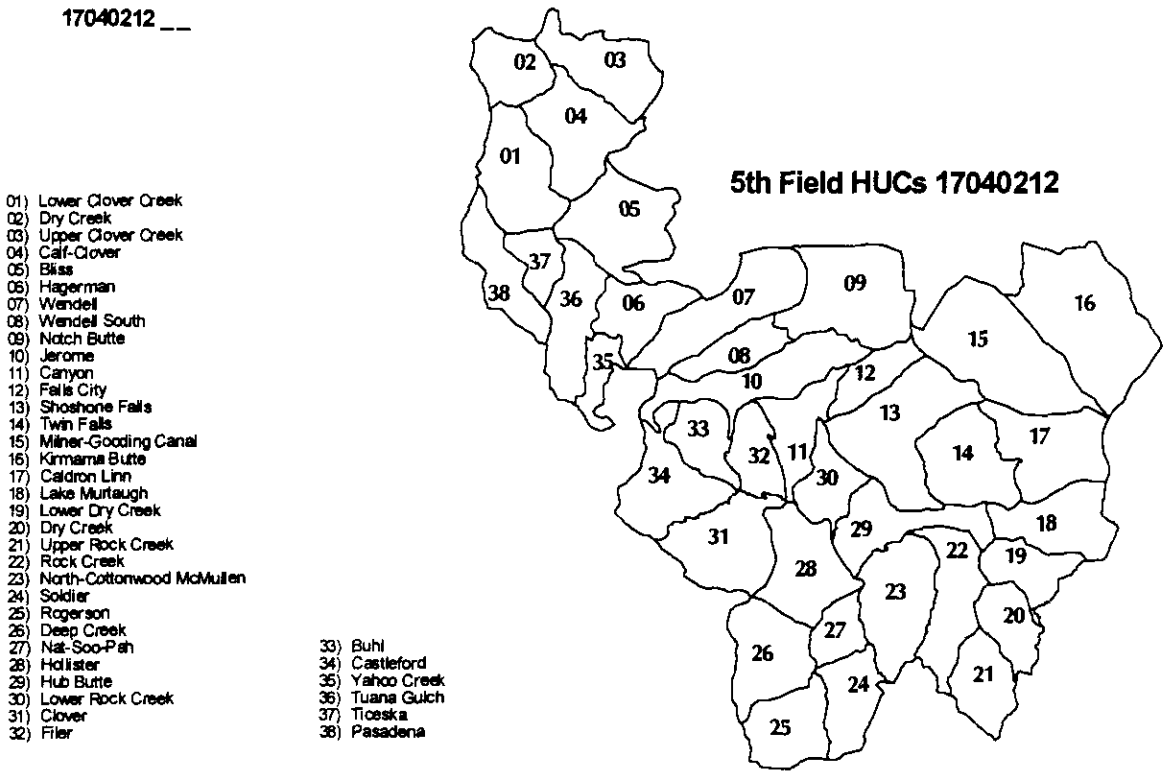
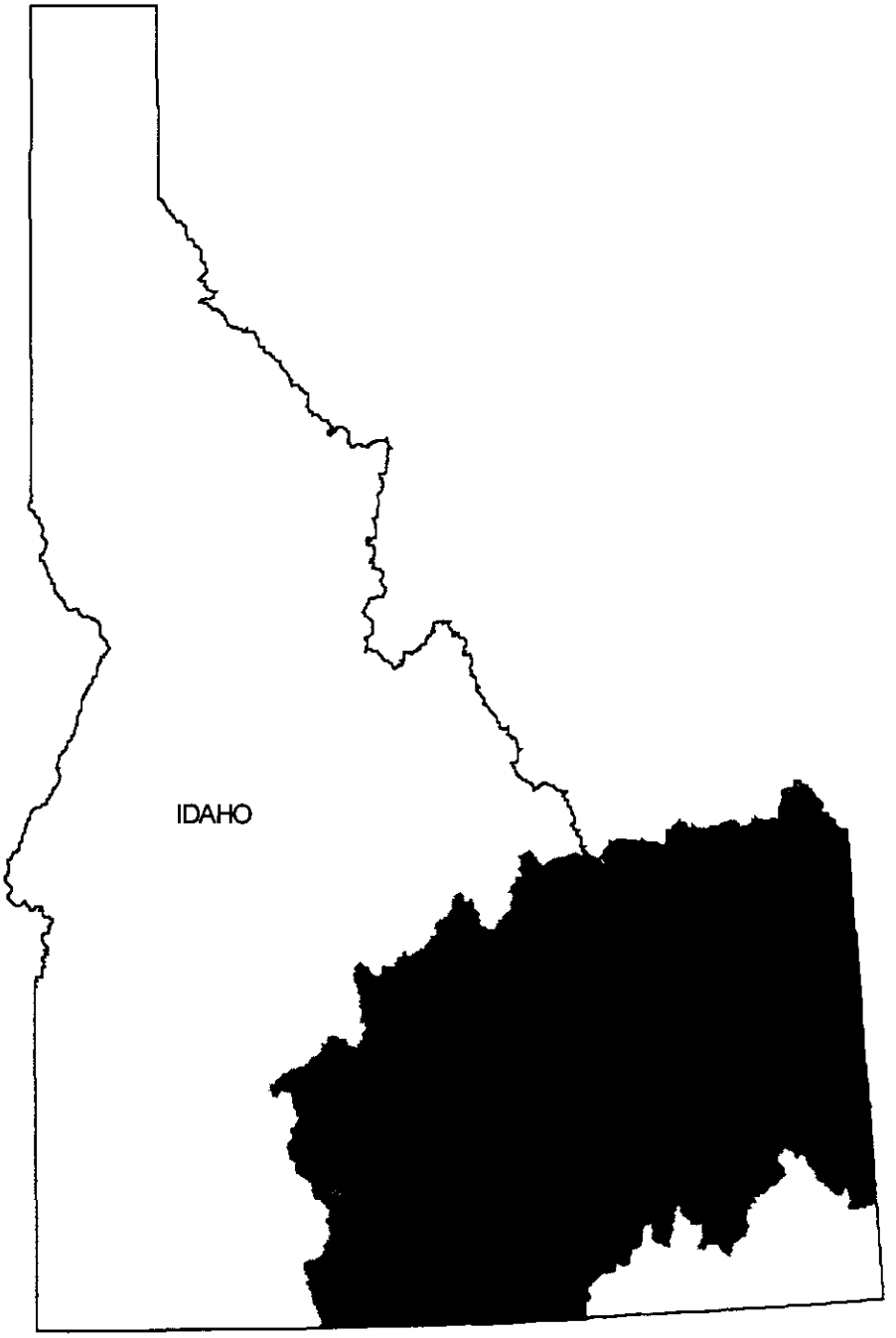


Figure 1 Hydrologic Unit Code (HUC) 17040212

17040212 __



1 Figure 2 Fifth Field HUCS in 17040212



1 Figure 3 HUC 17040212 in the Upper Snake Basin

2.1 CHARACTERIZATION OF THE WATERSHED

The characterization of the Upper Snake Rock subbasin (or Upper Snake/Rock Creek subbasin) will be based on its physical and biological characteristics and how these characteristics interplay with ecoregional and hydrological traits. The Upper Snake Rock subbasin is complex in its ecoregional and hydrological traits principally due to its continual evolving physical and highly varied biological characteristics. Part of that complexity is the issue of sediment pollution in the waterbodies which is affected by soil characteristics, climate, vegetation, topography, and human activities (Sing *et al.* 1988 [p 260]). This complexity is described and discussed in the following subsections relative to sediment yield sources: natural sources (erosion, sheet erosion, rill erosion, gully erosion, massive runoff), artificial sources (human activities such as agricultural tillage, domestic animal grazing, highway construction and maintenance, timber cutting, mining, urbanization, and recreational land development), channel sources (stream bed, stream banks, hydraulic structure construction, channelization, dredging, dam breaches, mining of gravels), and disaster sources (natural disasters, extra-large storms creating excessive floods, earthquakes causing slides and mudflows, fires, and droughts) (Sing *et al.* 1988 [p 260]).

2.1.1 SUBBASIN OVERALL GENERAL CHARACTERISTICS

The Middle Snake River traverses the Upper Snake Rock subbasin from Milner Dam (RM 638.5) to the town of King Hill, Idaho (RM 546.0). It extends 92.5 miles dropping from an elevation of 4135 feet at Milner Dam to 2498 feet at King Hill. Those Idaho counties making up HUC 17040212 are listed in Table 1.

Table 1 Estimated breakdown of HUC 17040212 in the indicated county

County	*% in HUC 17040212*	*County*	*% in HUC 17040212*
Jerome (M)	90%	Elmore (E)	3%
Twin Falls (UH)	60%	Owyhee (E)	1%
Gooding (W & SE)	60%	Minidoka (NW)	1%
Cassia (NW)	5%	Lincoln (SW & S)	1%
Camas (S)	3%		

Prepared by IDEQ-TFRO. NW = Northwestern portion; E = Eastern portion; S = Southern portion; SE = South eastern portion; SW = South western portion; W = Western portion; UH = Upper Half; M = Majority of county.

It is an unusually geographically structured drainage. Although Salmon Falls Creek and the Big Wood River (Malad River) drain into the Middle Snake River, they are not included in the drainage of Upper Snake Rock because they are considered separate and distinct subbasins. As defined in the Mid-Snake TMDL (IDEQ 1997b), the Upper Snake Rock subbasin describes 53.5% of the Middle Snake River Watershed Management Area (or 2438 square miles). The other portion of the management area (46.5%), or the Salmon Falls Creek drainage (2120 square miles), will be covered in a separate TMDL. Assigned water quality parameter loadings may occur for the mouth of the tributaries discharging to the Middle Snake River in Upper Snake Rock.

The Interior Columbia Basin Ecosystem Management Project has distinguished the Upper Snake Rock subbasin as a Category 3 Subbasin, such that it may be described by the following general characteristics:

1. "This subbasin may support populations of key salmonids or have other important aquatic values, such as threatened and endangered species, narrow endemics, and introduced or hatchery supported sport fisheries (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

2. "In general this subbasin is strongly fragmented by extensive habitat loss or disruption throughout the component watersheds, and most notably through disruption of the mainstream corridor (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

3. "Major portions of this subbasin are often associated with private and agricultural lands not managed by the Forest Service or USBLM (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

4. "Although important and unique aquatic resources exist, they are usually localized (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

5. "Opportunities for restoring connectivity among watersheds, full expression of life histories, or other large-scale characteristics of fully functioning and resilient aquatic ecosystems are limited or nonexistent in the near future (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

6. "Opportunities for management of aquatic resources in this subbasin is primarily in conserving remaining habitats in specific locations, rather than restoration of a more functional mosaic (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

7. "Although there may be greater flexibility in land-use management for subbasin areas outside of critical watersheds, some management conflicts may arise (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

8. "Because the remaining aquatic resources are often strongly isolated, risks of local extinction may be high (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

9. "Land-use activities within this subbasin may call for extreme caution to not aggravate present conditions (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

10. "Conservation of the remaining productive areas may require a disproportionate contribution from Federal management agencies, because these subbasins often include large areas of non-Federal land (USDA/USBLM 1997a [Vol 1, Chpt 2, p 158])."

Additionally, those lands administered by the Forest Service and Bureau of Land Management in Upper Snake Rock may be categorized according to integrated ecological measures. These measures are summarized as follows:

1. Low Composite Ecological Integrity: Ecological integrity describes the wholeness and resiliency of an ecological system (such as the Upper Snake Rock subbasin). An ecological system with a low integrity functions poorly because it does not have all its parts and processes intact. Such a system does not readily rebound quickly after wildfires, floods, road building, and other disturbances. In general, the more the ecological system has been altered, the lower its integrity. A low-integrity area may not be highly degraded, but may be filling societal needs including agricultural lands and roads related to recreational areas (USDA FS & USDI/BLM 1997b [p 8]).

2. Low Aquatic Integrity: An ecological system with low aquatic integrity does not possess a full complement of native fishes and other aquatic species that are well distributed in high-quality, well-connected habitats (USDA FS & USDI/BLM 1997b [pp 10-11]).

3. High Rangeland Hydrologic Integrity: An ecological system with high rangeland hydrologic integrity has a network of streams where upland, flood-plain, and riparian areas have resilient vegetation. These networks support diverse and productive aquatic and terrestrial environments (USDA FS & USDI/BLM 1997b [p 11]).

4. Low Rangeland Integrity: An ecological system with low rangeland integrity does not have a mosaic of plant and animal communities that are well-connect. The habitat is not high quality because of poor diverse assemblages of native and desired nonnative species (USDA FS & USDI/BLM 1997b [p 11]).

5. Forest Integrity & Forest Hydrologic Integrity: Because of the low percentage of forest habitat (in terms of land use), no forest integrity ratings are assigned to the Upper Snake Rock subbasin (USDA FS & USDI/BLM 1997b [pp 10-11]).

2.1.1.1 5TH FIELD HUC CHARACTERISTICS

The Upper Snake Rock subbasin is cartographically subdivided into 38 watersheds (or 5th order HUCs). These are described in Table 2 with their appropriate name and 5th order HUC number. Figure 2 illustrates the 38 watersheds in Upper Snake Rock subbasin. See §2.0, Figure 2.

Table 2 5th order HUCs of Upper Snake Rock 17040212

5th Order Number	*Watershed Name*	*Total Acres*	*5th Order Number*	*Watershed Name*	*Total Acres*
1704021201	Lower Clover Creek	50758	1704021220	Dry Creek	25698
... 02	Dry Creek	30286	... 21	Upper Rock Creek	31935
... 03	Upper Clover Creek	44761	... 22	Rock Creek	43737
... 04	Calf-Clover	53750	... 23	North Cottonwood-McMullen	54547
... 05	Bliss	56284	... 24	Soldier	32066
... 06	Hagerman	31927	... 25	Rogerson	37558
... 07	Wendell	58719	... 26	Deep Creek	46341
... 08	Wendell South	24319	... 27	Nat-Soo-Pah	18628
... 09	Notch Butte	68825	... 28	Hollister	49067
... 10	Jerome	53027	... 29	Hub Butte	41009
... 11	Canyon	30939	... 30	Lower Rock Creek	25957
... 12	Falls City	21880	... 31	Clover	54088
... 13	Shoshone Falls	73777	... 32	Filer	24572
... 14	Twin Falls	48758	... 33	Buhl	25958

5th Order Number	Watershed Name	Total Acres	5th Order Number	Watershed Name	Total Acres
... 15	Milner-Gooding Canal	87798	... 34	Castleford	47756
... 16	Kimama Butte	95944	... 35	Yahoo Creek	16059
... 17	Caldron Linn	53225	... 36	Tuana Gulch	41865
... 18	Lake Murtaugh	43181	... 37	Ticeska	18588
... 19	Lower Dry Creek	27620	... 38	Pasadena	35387

Prepared by IDEQ-TFRO from USGS GIS maps. There are two Dry Creek watersheds in the Upper Snake Rock subbasin: 17040212-02 and 17040212-20, which are indicated in gray in the table.

2.1.1.2 CLIMATOLOGY: PRECIPITATION, HUMIDITY, TEMPERATURE

The climate of Upper Snake Rock is semiarid with low annual rainfall, moderately hot, dry summers, moderate to cold winters, and relatively windy springs.

Average annual precipitation is 10.5 inches and may vary from 50 to 150% of the mean. See Figure 4 at the end of §2.1. The figure illustrates that over 95% of the subbasin is in the 10.5 inches as average annual precipitation, while higher precipitation may be found in the uppermost northern boundary (Mount Bennett Hills) and the lowermost southern boundary (Sawtooth National Forest). In general, precipitation is fairly consistent throughout the year, except July through September, when the total for the three months may be less than 1 inch. More recently, from 1991 to 1996 the higher precipitation quarters were winter and spring, with values of 3.35" and 3.82", respectively (or a total of 7.17"). The lower precipitation quarters were summer and fall at 1.92" and 2.11", respectively (or a total of 4.03"). The higher average annual precipitation (11.20") when compared to the historical normal (10.5") was due to the above normal rains and snows of winter and spring (AgriMet 1994).

Relative humidity from 1991 to 1996 averaged 62.4%. Winter and spring for the same time period averaged 73.4% and 60.7%, respectively (or 67.0% average). Summer and fall averaged 53.8% and 61.8%, respectively (or 57.8% average)(AgriMet 1994).

Average annual air temperature ranges from 40 to 51°F. January and July are typically the coldest and warmest months with average temperatures of 29.4°F and 72.7°F, respectively. During the summer, temperatures in excess of 100°F are common. More recently, from 1991 to 1996 the higher annual air temperatures in the spring were principally due to higher than normal temperatures in 1992 and 1994 when compared to those year's mean air temperature (AgriMet 1994).

2.1.1.3 POPULATION AND RECREATION

Much growth has occured in the population of Upper Snake Rock since 1990. Table 3 summarizes the projected estimates through the year 2010 for the three largest counties in the Upper Snake Rock subbasin as compared to the more expansive South Central Region (which includes eight counties).

Table 3 Major counties in Upper Snake Rock subbasin and their actual and projected populations

County	1970 (census)	1980 (census)	1990 (census)	2010 (projected)
Gooding	8645	11874	11633	12512
Incorporated	4271	5215	5568	5726
Unincorporated	4374	6659	6065	6786
Jerome	10253	14840	15138	17095
Incorporated	4922	6616	7237	7986
Unincorporated	5331	8224	7901	9109
Twin Falls	41807	52927	53580	59967
Incorporated	28389	32340	36290	40641
Unincorporated	13418	20587	17290	19326
SC Region vs Tricounty Area	102987 vs 60705	135367 vs 79641	136831 vs 80351	155901 vs 89574
Incorporated	60081 vs 37582	69673 vs 43339	79265 vs 49095	89021 vs 54353
Unincorporated	42906 vs 23123	65694 vs 36302	57566 vs 31256	66880 vs 35221

Prepared by DEQ-TFRO. Land use values for incorporated versus unincorporated is based on the number of persons living in these areas of the county, tricounty, or region. SC = South Central and includes Blaine, Camas, Cassia, Gooding, Jerome, Lincoln, Minidoka, and Twin Falls counties. The Tricounty Area includes only Gooding, Jerome, and Twin Falls counties (IDC 1993).

From these figures it is estimated that in the 40 years up to year 2010, the tricounties will experience a 47.6% population increase as the South Central Region increases by 51.4%, with the tricounties making up 57.5% of the region's total. Incorporated portions of the tricounties will increase by 44.6% as the region increases by 48.2%, and the tricounties will make up 61.1% of the region's total. Unincorporated portions of the tricounties will increase by 52.3% as the region increases by 55.9%, and the tricounties will make up 52.7% of the region's total. See Figure 5 at the end of §2.1 for an illustration of the human population according to the major towns and cities.

"The population of a community and rate of change of that population are often used as indicators of economic diversity, economic resiliency, community vitality, and whether the community is prospering or in decline. Economists use population growth as a proxy for economic growth (USDA/USBLM 1997a [Vol 1, p 196]; Haynes & Horne 1996). Communities with larger populations lead to more businesses such that many industries are represented with many firms in each industry. Population growth is usually associated with economic growth and vice versa. As a measure of economic diversity, the statistical Shannon-Weaver Diversity Index is used to characterize the economic resiliency as low, moderate, or high rating (USDA/USBLM 1997a [Vol 1, p 196]; Alward 1996). Table 4 describes the index per indicated county in the Upper Snake Rock subbasin.

Table 4 Economic resiliency ratings of the Upper Snake Rock tri-county area

County	Economic Resiliency Rating
Jerome	Moderate
Gooding	Moderate
Twin Falls	High

Prepared by IDEQ-TFRO from the *Interior Columbia Basin Ecosystem Management Project*. This index was also used to score timber/forage importance, such that the % Timber from National Forests in the three counties was not applicable (or zero), and the % Forage from Federal Land was 1, 1, and 8 for Jerome, Gooding, and Twin Falls counties, respectively (USDA/USBLM 1997a [Vol 1, pp 183-184]).

Because of population growth, recreational areas in Upper Snake Rock have become more prominent in the last few years due to their accessibility, commercial advertisement, and development. As the population experiences the more unaccessible water areas of Upper Snake Rock, and as commercial development grows into those areas, water quality concerns will need to be addressed as well. Even now, many recreational areas are having an effect on water quality due to degradation of their stream banks. Storm water runoff in the City of Twin Falls and in agricultural rural areas is becoming more of a public concern because of erosion and its contribution to sediment pollution.

2.1.2 ECOREGION CONSIDERATION

Over 95% of Upper Snake Rock comprises an ecoregional area known as the Snake River Basin/High Desert, as defined by Omernik (Omernik 1986). Less than 5% of Upper Snake Rock is considered a Northern Basin and Range ecoregion; specifically for the higher elevation headwater sources for Clover Creek (in the Mount Bennett Hills) and the Rock Creek Complex (in the Sawtooth National Forest). According to Omernik's ecoregional descriptors three general characteristics predominate as to land form, vegetation, and land use. These will be discussed in the following sub-sections.

2.1.2.1 TOPOGRAPHY

In general, Upper Snake Rock has a land-surface form or topography that consists of tablelands with medium to high relief. Its plains have hills or low mountains. The Snake River Canyon is a steep-sided trench, cut into the relatively flat, surrounding plain. Table 5 summarizes the width of the main channel, its slope (feet/River Mile), elevations, and elevation drop of the Middle Snake River at various river mile locations or reaches. The Middle Snake River may be segregated into three "reaches" or segments according to slope: an "upper reach" (from river miles 619 to 638); a "middle reach" (from river miles 559 to 618); and, a "lower reach" (from river miles 545 to 558). The smallest width is estimated at 50 feet, and the widest width is estimated at 1500 feet.

Table 5 Width of the Middle Snake River (channel) at various "reaches"

River Miles	*River width, feet*			*"Reach" Miles*	*Slope ft/RM*	*Elevation feet*	*Elevation Drop feet*
	Mean	*Max*	*Min*				
638-619	103	225	50	20	29.5	4135-3380	755
618-559	441	1500	100	60	15.2	3380-2580	800
558-545	254	600	150	14	7.7	2580-2497	83
Prepared by IDEQ-TFRO.							

Shoshone Falls stands as a 212-foot-tall natural waterfall located about 2.7 miles downstream of Twin Falls Dam. It is recognized as a natural barrier to upstream migration of native species of fish (FERC 1997a).

The elevation within Upper Snake Rock also describes the varying topography of the subbasin. In the northwestern portion of the subbasin the Clover Creek drainage begins at 6400 feet in the Mount Bennett Hills and drains southwestward to the Middle Snake River at about 3000 feet. In the southeastern portion of the subbasin the Rock Creek drainage begins at 7700 feet in the Sawtooth National Forest and drains northward to the Middle Snake River at about 3500 feet. Generally speaking the topography of the subbasin is such that drainage moves towards the Middle Snake River, whether it be from natural drainage or the myriad of constructed canals, drains, and laterals. It is for this reason that the Upper Snake Rock subbasin is

sometimes called the "Mid-Snake subbasin." See Figure 6 at the end of §2.1 for a view of the topography of Upper Snake Rock.

2.1.2.2 POTENTIAL NATURAL VEGETATION

In general, there are two types of natural vegetation in Upper Snake Rock: sagebrush-grass vegetation that predominates the entire subbasin and riparian vegetation in the tributaries and Snake River Canyon. The advent of irrigation canals changed some of the sagebrush-grass vegetation to agricultural crops and pastureland, and in some locations has provided a means by which some riparian and grassland plants have established due to incidental leekage.

SAGEBRUSH-GRASS VEGETATION ZONE

Upper Snake Rock is a sagebrush steppe (made up of sagebrush and wheatgrass) with salt bush /greasewood. The HUC is 54% rangeland. The HUC is part of the Snake River Plain which occupies approximately 22500 square miles and supports a sagebrush or a *SAGEBRUSH-GRASS VEGETATION ZONE*. Big sagebrush (*Artemisia tridentata*) and bluebunch wheatgrass (*Agropyron spicatum*) are the dominant shrub and grass species in this zone. Most of the "sagebrush" zone is found at elevations from 2000 to 7000 feet. Where sagebrush dominates below 7000 feet, annual precipitation characteristically varies between 8 and 20 inches (Wright 1979; Cronquist 1972; West 1983). Currently, large tracts of native rangelands have been converted to non-native crested wheatgrass monocultures in response to fire restoration by the USBLM and private land-owners. Sagebrush directly influences the soil microclimate by accumulating litter (litter, moss lichen) to a much greater depth when compared to adjacent grass or sparse vegetation; by insulating through its plant canopy and affecting the amount of radiant energy that reaches the surface of the soil or understory vegetation; and, by having a significant effect on the soil-water potential due both to the shading effects of the canopy and insulating effects of the litter (Wight *et al.* 1991).

RIPARIAN VEGETATION IN THE TRIBUTARIES AND SNAKE RIVER CANYON

Since forests are minimal in Upper Snake Rock subbasin (comprising less than 5%), riparian areas and wetlands become most critical and important plant communities because of their vegetative diversity and value to wildlife. These communities vary from emergent herbaceous wetlands, associated with springs and seeps, to forest-scrub areas, containing small trees and understories of shrubs (FERC 1997a). In river and tributary canyons, little vegetation occurs on the basalt cliffs and talus slopes because of the steep walls and the lack of soil and organic material which limits the establishment of vegetation (Smithman 1983; Brinson *et al.* 1981). Where they do occur in the Middle Snake River and the tributaries, they occur primarily as a narrow fringe along the flood zone, near springs, and in low areas near the river (such as between Milner Dam and Auger Falls) (FERC 1987). Agricultural land use, commercial land development, and more diversified year-round recreational use have drastically changed many riparian "buffer zones" in Upper Snake Rock over the last twenty years by drawing the population closer to the edges of streams and tributaries. Because of this, sediment trapping has been minimized, nutrient retention and removal through filtering has been minimized, wildlife habitat in areas with woody vegetation have been reduced (FERC 1990). With regard to the irrigation canal system, some irrigation return flows have increased the riparian area and vegetation by providing a water source via a sediment delta (Robison 1998).

2.1.2.3 LAND USE AND OWNERSHIP

In general, Upper Snake Rock has 54% shrubland grazing land and 41% of agricultural land (both irrigated and dryland) (ArchView 1996). These are the principle cultural land use types which affect water quality.

Other land use types include forestry, urbanization, construction and development, but as a total represent less than 5%. Urban areas, in particular, should not be discounted as potent pollution sources. As much as 75% of the economy of southern Idaho is driven by agriculture (Hazen 1997a). Current land use for Upper Snake Rock in comparison to adjacent HUCs are described in Table 6. See also Figure 7 at the end of §2.1 for a description of land use and ownership in Upper Snake Rock. It shows the concentration of agriculture (dryland and irrigated) close to the Middle Snake River and rangeland further away from the Middle Snake River.

Table 6. Land use estimates for the IDEQ-TFRO

HUC	NAME	LANDUSE TYPE	FOREST	RANGE	AG	URBAN	OTHER	TOTAL
17040209	Lake Walcott	% Sq.Miles Acres	4 151 96100	54 1982 1260000	25 919 584000	1 24 15300	16 593 377000	100 3669 2332400
17040210	Raft River	% Sq.Miles Acre	24 350 225000	50 741 476000	25 371 238000	0 7 4220	0 1 470	99 1470 943690
17040211	Goose Creek	% Sq.Miles Acres	38 440 284000	44 500 323000	18 208 134000	0 2 1140	0 1 357	100 1150 742497
17040212	Upper Snake Rock	% Sq.Miles Acres	3 73 46300	54 1322 833000	41 1006 634000	1 31 19700	0 6 3880	99 2438 1536880
17040213	Salmon Falls	% Sq.Miles Acres	8 178 115000	85 1808 1170000	6 130 84000	0 1 616	0 3 1970	99 2120 1371586
17040219	Malad River	% Sq.Miles Acres	24 353 218000	63 917 567000	10 148 91600	1 10 6270	2 30 18500	100 1458 901370
17040220	Camas Creek	% Sq.Miles Acres	6 38 23900	70 468 298000	25 165 105000	0 1 432	0 0 100	101 672 427432
17040221	Little Wood River	% Sq.Miles Acres	5 56 35700	67 753 482000	17 189 121000	0 4 2390	11 118 75400	100 1120 716490

Prepared by DEQ-TFRO. HUC 17040212 is generally reported to have an area of 2440 square miles according to USGS.

Idaho's Magic Valley economy remains very dependent on natural resources. Because the area has an overall elevation of 4000 feet, a moderate-to-long growing season (April to September) when compared to other parts of Idaho, and an average of 9-10 inches of average annual precipitation, it is very dependent on irrigation diversions from surface and ground water. The primary irrigation companies for the area have a major portion of their water rights as "natural flow" with supplemental storage rights (Robison 1998).

2.1.2.4 SOILS AND GEOLOGY

"Soils certainly owe more to climate and vegetation than to bedrock (Lambert 1998)." In Upper Snake Rock alkalization of the area lets the soil water bring salts and alkalis to the surface, then evaporating to leave a

whitish crush. This alkalization and evaportation has produced salty desert soils (or Aridisols) in many areas of Upper Snake Rock. In general, Upper Snake Rock has soils that are 87% Aridisols and 13% Mollisols. Aridisols are mineral soils that have developed in dry regions, are light colored, low in organic matter, and may have accumulations of soluble salts and lime. The lower the precipitation, the more likely these accumulations are to be near the surface. The vegetation found on aridisols are important contributors to the western livestock industry (USBLM 1991). Of the Aridisols and Mollisols in Upper Snake Rock, about 35% are loess (or buff-colored calcareous silt transported as wind deposits), while the remaining 63% contains residium (or residual soil that is developed from the weathering of rock directly beneath it), colluvium (loose and incoherent deposits at the foot of a slope or cliff brought there by gravity), and alluvium (deposits of silt or silty clay laid down during times of flooding). The loessal soils are composed of wind-blown particles from a variety of sources, and have a type of structure highly susceptible to water and wind erosion, particularly when vegetation cover is removed (Malde 1965; Alt & Hyndman 1989; Fenneman 1931; Freeman *et al.* 1945; Cronquist *et al.* 1972; Myers 1996; FERC 1990). See Figure 8 and Figure 9 for the soils and geology of Upper Snake Rock, respectively.

A summary of the more prominent soil characteristics and the properties of the more prominant soil series are described in Table 7. The topography of Upper Snake Rock is correlated to the particular soil series. The majority of the soils may be classified as a Portneuf silt-loam loessal aridisols which are characteristically highly erodible soils.

Table 7. Summary of soil characteristics and properties in HUC 17040212

SOIL SERIES	MEAN SOIL DEPTH inches	PARENT MATERIAL	Ppt as AMP	ELEVATION (Average) feet	SAGEBRUSH	WHEATGRASS	BLUEGRASS	RABBITBRUSH	NEEDLEGRASS	JUNEGRASS	BALSAM ROOT	HAWKS BEARD	FESCUE	WINTER FAT	SHADESCALE	RICEGRASS	SQUIRRELTAIL	LAND USE R	LAND USE IC
Gooding	50"	A over L over B	9 "	3500'	X	X	X											X	X
Portneuf	50"	L	9 "	3600'	X	X	X	X	X	X								X	X
Trevino	15"	L over B	9 "	3500'	X	X	X		X		X	X						X	X
Garbutt	60 "	A	8 "	3700'			X		X					X	X	X	X	X	X
Duric C.	30"	A over R	16 "	6300'	X	X	X						X					X	
MEAN	41"	A & L	10.2"	4120'	X	X	X		X										

Prepared by DEQ-TFRO. Duric C. = Duric Cryoborolis; Ppt = Annual Mean Precipitation (AMP); Land Use: R = Rangeland; IC = Irrigated Cropland. Of the ten soil orders which have worldwide distribution (USDA/SCS 1984), three are found in the Upper Snake Rock subbasin: aridisols (light-colored soils of dry regions), mollisols (dark-surfaced soils formed under grass), and vertisols (soils dominated by swelling clays). On a tri-county basis, the following is their distribution: (1) Twin Falls County: Mesic Aridisols (Map Units 38, 46, and 54), Xeric Frigid Mollisols (Map Unit 59), and Udic Cryic Mollisol (Map Unit 22); (2) Jerome County: Mesic Aridisols (Map Units 38, 42, 44, and 46); and, (3) Gooding County: Mesic Aridisols (Map Units 42 and 54) and Xeric Mesic Vertisols (Map Unit 47; General Soil Map Idaho, 1984).

In Upper Snake Rock soil and soil productivity contribute to water quality problems in a number of ways: (1) Soil productivity is generally stable to declining due to greater intensities of vegetation management, roading, and grazing; (2) Woody material greater than 3 inches has been lost or has decreased in streams as a result of displacement and removal of soils, whole trees, and branches; (3) There is loss of soil material due to direct displacement of soils, surface and mass erosion yielding increased bare soils exposure, compaction, and concentration of water from roads; (4) Changes in the physical properties of soils have occurred in conjunction with activities that increase bulk density through compaction thus increasing surface erosion; (5) Sustainability of soil ecosystem function and process is at risk due to the redistribution of nutrients in terrestrial ecosystems due to changes in vegetation composition and pattern, removal of the larger size component of wood, and risk of uncharacteristic fire; and, (6) Floodplain and riparian area soils have reduced their ability to store and regulate chemicals and water, in areas where riparian vegetation has been reduced or removed or where soil loss associated with roading in riparian areas has occurred (USDA & USDI/BLM 1997a [Chpt 2, p 9]).

2.1.3 SUBBASIN HYDROLOGY

In general, "streams or water bodies" within Upper Snake Rock may be divided into perennial and intermittant waterbodies. Each of these may be further subdivided into springs, streams, aqueducts, and lakes/reservoirs or canals. These are described in Table 8 and are further defined in §2.2.1 of this assessment.

Table 8. Perrenial and Intermittant waterbodies of UPPER SNAKE ROCK

WATERBODY	*METERS*	*MILES*	*% OF GRAND TOTAL*
	PERENNIAL WATERBODIES		
SPRINGS	10297.30	6.40	0.20
STREAMS	797277.50	495.41	15.18
AQUEDUCTS	1226.60	0.76	0.02
LAKES, RESERVOIRS	143486.07	89.16	2.73
SUBTOTAL	952287.47	591.73	18.13
	INTERMITTANT WATERBODIES		
SPRINGS	5168.34	3.21	0.10
STREAMS	2435981.54	1513.65	46.37
AQUEDUCTS	1514.23	0.94	0.03
CANALS	1857934.29	1154.47	35.37
SUBTOTAL	4300598.40	2672.27	81.87
GRAND TOTAL	5252885.87	3264.00	100.00

Prepared by IDEQ-TFRO from USGS GIS Maps via ArchView 1996. A "canal" is a man-made conveyance structure used to carry irrigation water from a recognized point of diversion. Natural streams which may at times convey irrigation water are not considered "canals" under the present legal definition. Aqueducts are defined as conduits or artificial channels which convey water above the surface across a river or hollow.

From this table three functional groups emerge: intermittant streams (which comprise 46.4% of the total stream miles), canals (which make up 35.4% of the total stream miles), and perennial streams (which make up 15.2% of the total stream miles). All streams, whether intermittant or perrenial, if they are listed as water

quality limited stream segments on the 1996 303(d) list will undergo the TMDL process is defined in the Clean Water Act and Idaho Code §39-3601 *et seq.* Other streams may serve as sources of pollution.

2.1.3.1 THE MIDDLE SNAKE RIVER

The Snake River traverses southern Idaho from east to west, originating at elevations above 9500 feet (USBOR 1996-1997) along the Continental Divide in Wyoming and flowing 1038 miles to the confluence of the Snake River with the Columbia River at Pasco, Washington. It is an nth-order stream at the 1:100,000 map scale since it is greater than a 5th order level by definition. The discharge into the Middle Snake River is highly dependent upon upstream storage, irrigation diversion rights in the Upper Snake River, and spring water discharge from the Snake River Plain aquifer. Discharge is highly variable and is managed by the USBOR and Water District No. 1. The major canal companies divert water from the Snake River at Milner Dam through traditional gravity diversion systems that flow in open channels along contours (Barry 1996). See *The Middle Snake River Watershed Management Plan, Phase 1 TMDL Total Phosphorus, January 29, 1998 Update* for further infomation. See Figure 10 for an illustrative summary of stream inputs into the Middle Snake River in Upper Snake Rock.

2.1.3.2 IMPOUNDMENTS

Generally speaking, about 25.7% of the Middle Snake River is reservoir-like (from RM 639.1 to RM 565.7). American Falls Reservoir, 75 miles upstream from Milner Dam, is a large storage reservoir which directly affects the discharge into the Middle Snake River. Consumptive use of the Snake River is primarily for agriculture (USBOR 1996-1997).

The six major impoundments that regulate the water velocities of the Middle Snake River are described in Table 9. Water volume and discharges are regulated by American Falls Reservoir, Lake Walcott, Milner Lake, and other reservoirs. See Figure 11 at end of §2.1 for summary of major impoundments in Upper Snake Rock.

Table 9. Description of impoundments affecting water velocities on the Middle Snake River

PROJECT NAME and FERC No.	*RIVER MILE*	*RESERVOIR DESCRIPTION*			*OWNER*
		Distance, RM	*Capacity, acre-feet*	*Elevation, feet msl*	
Bliss Dam (FERC 1975)	560.3	560.0-565.7	11,100	2654.0	IPC
Lower Salmon Falls Dam (FERC 2061)	573.0	573.0-579.6	10,900	2798.0	IPC
Upper Salmon Falls Dam (FERC 2777)	581.4	581.4-585.4	600	2878.2	IPC
Shoshone Falls Dam (FERC 2778)	614.7	614.7-616.5	1500	3354.5	IPC
Twin Falls Dam (FERC 0018)	617.4	617.4-618.2	1000	3511.4	IPC
Milner Dam (FERC 2899)	639.1	639.1-674.5	26,000	4130.5	TFCC NSCC

PROJECT NAME and FERC No.	RIVER MILE	RESERVOIR DESCRIPTION Distance, RM	Capacity, acre-feet	Elevation, feet msl	OWNER

Prepared by DEQ-TFRO. Based on FERC 1997a, and the individual FERC or NPDES license applications. IPC = Idaho Power Company; TFCC = Twin Falls Canal Company; NSCC = North Side Canal Company. msl = mean sea level. Twin Falls Dam, Shoshone Falls Dam, and Upper Salmon Falls Dam do not store water nor load follow, meaning they have no effect on discharge in the Middle Snake River on either a diel or seasonal basis. Lower Salmon Falls Dam and Bliss Dam load follow but do not alter their flows outside of a diel timeframe.

In the Middle Snake River the flow is principally influenced by snowmelt, springs, and seeps discharging from the Snake River Plain Aquifer, irrigation diversion, irrigation returns, and reservoir storage management by the USBOR above Milner Dam. Overall, the principal source of streamflow is snowmelt, which occurs primarily during the spring and early summer months. The aquifer is recharged by streamflow, by precipitation directly onto the plain, and by the percolation of irrigation water. Most of the groundwater discharged from the aquifer occurs in the 92-mile reach of the Middle Snake River between Milner reservoir and King Hill, Idaho. Most of the spring water enters the river through numerous large springs where the aquifer discharges through seams or cracks in the basalt layers of the canyon walls (FERC 1990).

Historic annual mean discharge volumes of the Middle Snake River at various sites from water year 1990 through water year 1997 are summarized in Table 10 with a comparison to water year 1990. The years 1991 and 1992 are considered "baseline" for the Mid-Snake TMDL and are so used in this assessment.

Table 10 Middle Snake River annual mean flow (Q) as affected by irrigation return flows and spring sources (WYs 1990 - 1997)

SNAKE RIVER USGS GAGE	RIVER MILE LOCATION	WATER YEAR ANNUAL MEAN Q cfs 1990	1991	1992	1993	1994	1995	1996	1997	DIVERSION IRRIGATION ACREAGES
Milner 13088000	638.7	2743	2707	2671	2647	2630	2617	2656	2750	A: 1,990,000 GW: 504,000 B: 436,000
Kimberly 13090000	617.2	3136	3100	3065	3041	3025	3013	3051	3139	A: 2,020,000 GW: 537,000 B: 364,000
Buhl 13094000	596.8	5306	5238	5169	5117	5077	5045	5088	5208	A: 2,030,000 GW: 542,000 B: 230,000
Hagerman 13135000	572.5	9207	9148	9079	9027	8984	8949	8979	9079	A: 2,330,000 GW: 665,000 B: 83,000
Bliss 13153776	559.0	8774*	8717*	7377	7861	8093	8381	9378	10460	A: NMIR GW: NMIR B: NMIR
King Hill 13154500	546.6	10890	10860	10810	10780	10750	10730	10750	10820	A: 2,450,000 GW: 675,000 B: NMIR
NET DIFFERENCE FROM MILNER TO KING HILL IN 92.1 MILES		8147	8153	8139	8133	8120	8113	8094	8070	

SNAKE RIVER USGS GAGE	RIVER MILE LOCATION	WATER YEAR ANNUAL MEAN Q cfs 1990	1991	1992	1993	1994	1995	1996	1997	DIVERSION IRRIGATION ACREAGES
Prepared by DEQ-TFRO. American Falls Reservoir was unregulated from 1909-1926 and had a historic annual mean Q of 5206 cfs. After construction of the dam the historic annual mean Q was 2656 cfs. All sites are regulated by American Falls Reservoir, Lake Walcott, and Milner "Lake." A = diversions above the gage station for irrigation; GW = a portion of the diversions above the gage station which use withdrawals from groundwater for irrigation; B = diversions below the gage station for irrigation; NMIR = Not Mentioned In USGS Record. * = This value was calculated by taking the average value for Hagerman (1992-1997), which is 9016.2, and Bliss (1992-1997), which is 8591.7 cfs. A ratio is developed, such that 9016.2/8591.7=1.0494; thus, Hagerman values in 1990 & 1991 are divided by 1.0494 to give 8774 and 8717 cfs, respectively. Average WY based on the following USGS protocols: 13088000 = from WY1927; 13090000 = from WY1924; 1309400 = from WY1947; 13135000 = from WY1938; 13153776 = from WY1992; and, 13154500 = from WY1909. There is no statistical difference within the values of each gaging station based on a t-test. Additionally, the net difference versus the Bliss gaging station, and Bliss versus Hagerman, are not significantly different according to a t-test. All other possibilities are significant.										

Statistically speaking, the values in Table 9 indicate that the net difference from Milner to King Hill or any of the individual USGS Gage location stations from WY1990 to WY1997 are not increasing or decreasing in their flow values from year to year. It should be noted that from 1987 through 1993, drought conditions caused flows to reach values below 2500 cfs below Milner Dam to the Buhl area during the irrigation season. Previous drought conditions occured in the 1930s and the 1960s.

The impact of the water management above Milner Dam on the water quality in the Middle Snake River may be summarized as follows:

1. During low flow years in the Middle Snake River, sediment has a tendency to fall out and accumulate in pooled stream areas. Because of low flows, very little processing of waste in the water column occurs. Additonally, low flows result in low velocity thus potentially producing increased temperatures in the water column in conjunction with already elevated water temperatures in agricultural return flows.

2. During high flow years in the Middle Snake River, sediment has a tendency to move more readily from upstream to downstream, thus reducing the amount of accumulation that may occur in pooled stream areas. In fact, Table 11 shows the results of a bathymetric study conducted on the Middle Snake River before-and-after a period of high flows (1996) at three separate reaches: Thousand Springs, Niagara Springs, and Pigeon Cove. The results indicate that high flows in the spring and summer (of 1996) resulted in the moving of a fair amount of sediment out of these reaches, particularly the Niagara Springs and Pigeon Cove areas.

Table 11 1996 Bathymetric study of the Middle Snake River

RIVER REACH	SEGMENT LENGTH feet	VOLUME BEFORE 1996 yds	VOLUME AFTER 1996 yds	NET CHANGE yds	RIVER MILE
Thousand Springs	500	2462.2	866.6	1598.6	584.3
Niagara Springs	600	7183.5	205.7	6977.8	598.8
Pigeon Cove	600	4093.5	70.4	4028.1	602.8
Prepared by IDEQ-TFRO. Volume Below and Volume Above is the calculated volume below and above the river bottom as it was surveyed in September 1996 in each of the three areas. Volume Below represents material lost or scoured since the 1996 survey. Volume Above represents material deposited above the 1996 level. To determine the actual amount of sediment that is present in the system, you would need a sub bottom profiler that would penetrate the depth-to-bedrock level so as to calculate the amount of sediment (Ralston and Associates 1996). Reference line = 1996 survey.					

3. Because of higher and possible scouring flows (particularly at flows > 20,000 cfs), processing of waste throughout the water column is potentially increased. This is especially true during the off-irrigation winter season when diversions for irrigation are minimal to none. Relatively speaking, higher flows provide higher velocities which in turn provide decreased temperatures in the water column. Table 12 compares the non-irrigation season (October 16 to April 14) against the irrigation season (April 15 to October 15) from 1990 to 1997, and shows that during the drought years (1990-1995) the net difference (highest flow - lowest flow) in the off-season (October 16 to April 14) flows were relatively low when compared to 1996-1997 which had relatively higher scouring flows. Average flows (1990-1997, 1990-1995, 1996-1997) show that irrigation season flows were greater than non-irrigation season flows. 1996-1997 had an unusually higher level of precipitation when compared to 1990-1995.

Table 12 Seasonal flows past Milner Dam (USGS 13088000)

WATER YEAR	OCT 16 to APR 14 RANGE of Q, cfs	NET DIFFERENCE (HIGH - LOW)	APR 15 to OCT 15 RANGE of Q, cfs	NET DIFFERENCE (HIGH - LOW)
1990	2.7 - 2060	2057.3	0.85 - 612	611.2
1991	1.4 - 1590	1588.6	2.70 - 827	824.3
1992	17 - 1300	1283.0	1.10 - 209	207.9
1993	80 - 998	918.0	12 - 8460	8448.0
1994	213 - 291	78.0	221 - 246	25.0
1995	225 - 237	12.0	220 - 12,400	12180.0
1996	230 - 20,000	19770.0	220 - 17,200	16980.0
1997	239 - 20,600	20361.0	236 - 31,200	30964.0
1990-1995 Avg Drought Years	989.5		3,716.1	
1996-1997 Avg High Flow Years	20,065.5		23,972.0	
1990-1997 Overall Average	5758.5 Non-irrigation Season		8780.1 Irrigation Season	

Prepared by IDEQ-TFRO. Net Difference = Highest Flow - Lowest Flow = Range.

4. Table 13 compares the main portions of the seasonal irrigation/non-irrigation period between the major months of irrigation (May through September) versus non-irrigation (November through March). This comparison indicates that with the exception of 1993-1995, the average flows during the non-irrigation period were relatively greater than the average flows during the irrigation period. The years 1993-1995 indicate that the average flows during the non-irrigation period were relatively less or the same as the average flows during the irrigation period.

Table 13 Seasonal flows past Milner Dam (USGS 13088000): mean monthly flows (Q, cfs)

WY	NON-IRRIGATION PERIOD MONTHS Nov	Dec	Jan	Feb	Mar	NonIrrg Mean	IRRIGATION PERIOD MONTHS May	June	July	Aug	Sept	Irrg Mean
1990	1335	1388	889	743	91.5	889.3	2.81	2.27	345	283	109	148.4
1991	653	643	1333	678	87.4	678.9	10.4	13.0	484	542	210	251.9
1992	692	1025	1173	729	263	776.4	7.28	1.65	1.52	2.03	56.2	13.7
1993	306	220	222	223	224	239.0	217	2402	228	224	221	658.4
1994	224	225	225	235	232	228.2	230	228	226	228	225	227.4
1995	229	230	228	228	228	228.6	3560	3265	228	227	242	1504.4
1996	2316	3136	4449	7380	16650	6786.2	5488	7058	2031	1541	515	3326.6
1997	2181	3503	8968	18740	19930	10664.4	8405	23580	3182	3899	6778	9168.8
90-95 MEAN						506.7						467.4
96-97 MEAN						8725.3						6247.7
90-97 MEAN						2561.4						1912.5

Prepared by IDEQ-TFRO. WY = USGS Water Year (October 1 to September 30). Irrg Mean = Irrigation period mean. NonIrrg Mean = Non-irrigation period mean.

5. Tributaries in Upper Snake Rock are affected by irrigation return flows, particularly if the irrigation return drains discharge directly to the tributary. During high flow years, the amount of waste appears to be relatively greater than low flow years. Some evidence exists that indicates that during low flow years water quality improvements may be demonstrated due to better water management by the water users. But in general, irrigation return flows with poor water quality degrade the water quality in tributaries and the Middle Snake River.

2.1.3.3 WATER RIGHTS, MANAGEMENT, AND STORAGE

The State of Idaho has statutory authority in administering water rights within its boundaries. Under the prior appropriation doctrine, natural flow rights in Idaho are satisfied in order of priority based on date ("first in time is first in right"). When the water supply is limited, a water right holder with an earlier natural flow right (or "senior" water right) may receive full supply, whereas a water right holder with a later or more recent date (or "junior" water right) may not receive full supply. Diversion rights for irrigation are appurtenant to the lands (belong to those lands), whereas diversion rights for other purposes (such as power, municipal, and industrial water supply) are not. Thus, storage reservoirs (like American Falls, Jackson Lake, Palisades) are constructed and operated to change the flow regime for irrigation purposes (USBOR 1996-1997) to provide for the water rights. Table 14 describes the spaceholder contracts (through November 1995) in the American Falls, Jackson Lake, and Palisades storage facilities for the specific canal companies in Upper Snake Rock subbasin. The two primary canal companies in Upper Snake Rock have their water rights based on primarily natural flow with supplemental storage rights (Robison 1998).

Table 14 Current spaceholder contracts (November 1995, acre-feet)

SPACEHOLDER	AMERICAN FALLS	JACKSON LAKE	PALISADES	TOTAL
American Falls Reservoir District	274,338 (NSCC) 148,747 (TFCC)	0 0	0 0	423,085
MID	44,951	0	44,500	89,451
NSCC	116,471	312,007	116,600	545,078
TFCC	0	97,183	0	97,183
TOTAL (and %)	584,507 (50.6%)	409,190 (35.4%)	161,100 (14.0%)	1,154,797

NSCC = North Side Canal Company; TFCC = Twin Falls Canal Company. MID = Milner Irrigation District. A spaceholder contract is defined as a type of repayment contract in which storage space is purchased in contrast to purchasing a specific amount of water. The amount of water that accumulates in that storage space belongs to the purchaser. Storage season is normally defined as beginning October 1 and extending to the date that no more water is available for storage. The irrigation season is defined in spaceholder contracts as April 1 to October 31, although the actual water may not be used till April 15 to October 15. A water year (or WY) begins on October 1 and extends to September 30 the following year (USBOR 1996-1997).

2.1.3.4 SPRINGS, SEEPS, AND GROUND WATER

In addition to tributary streams, springs and seeps provide a significant contribution to the flow of the Middle Snake River. Numerous springs and seeps emerge from the Snake River canyon walls from Milner Dam to King Hill. The greatest number of springs are located in the Thousand Springs area of the Hagerman valley and run year-round. On an annual basis, over 60% of the total streamflow measured at King Hill is from groundwater discharge or irrigation returns (IDHW 1983). Additionally, USGS has allocated spring discharges into the Middle Snake River to north and south side sources: 90% of the spring discharges come from springs north of the river; and, 10% of the spring discharges come from springs south of the river (Robison 1998). Because spring water comprises such a large amount of the total streamflow in the Middle Snake River, it has an obvious beneficial effect on water quality. Additionally, the decline in average spring flows (since the 1950s) is credited to increased groundwater pumping, change from furrow to sprinkler irrigation, changes in water management, and traditional drought conditions. Average discharge at Thousand Springs was around 4000 cfs in the early 1900s and increased to almost 7000 cfs in the 1950s. It has since decreased to about 5000 cfs (USBOR 1996-1997). See Figure 12 at the end of §2.1 for a view of the Snake River Plain Aquifer in relationship to Upper Snake Rock.

Ecosystems Research Institute in a short-term study of twelve springs in the Hagerman area concluded that in general there is little variability from fall to spring in the overall aquifer discharge flow and water quality characteristics within a single year, although individual springs may show some significant differences. Twelve (12) springs were sampled in September 1996 and in March 1997. The sites ranged from Blue Lakes Spring, which enters the Middle Snake River near the town of Twin Falls (RM 610.5) to the Malad springs complex, which enters the Middle Snake River below Lower Salmon Falls Reservoir (RM 571.5). Discharge from the springs ranged from about 100 cfs at Banbury and Box Springs to over 1400 cfs at the Malad River. Table 15 illustrates the various springs, their discharge, their various water quality parameters, and the statistics demonstrating the level of variability from the springs.

Table 15. DISCHARGE AND WATER QUALITY PARAMETERS OF SPRING SOURCES IN THE MID-SNAKE.

NAME	RM	DISCHARGE, cfs		TSS, mg/L		TP, mg/L		NOX, mg/L		NH3, mg/L	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
BLSp	610.5	172	159	2	<3	0.015	0.018	2.13	2.07	0.028	<0.025

NAME	RM	DISCHARGE, cfs		TSS, mg/L		TP, mg/L		NOX, mg/L		NH3, mg/L	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
CrSp	600.5	452	432	2	<3	0.017	0.021	3.09	2.85	0.036	<0.025
NSp	599.0	287	234	<3	<3	0.014	0.021	2.52	2.81	0.035	<0.025
ClrSp	593.0	528	456	<2	<3	0.016	0.018	1.80	1.68	0.028	<0.025
BgSp	590.3	110	101	-	<3	0.066	0.057	1.42	2.08	0.041	0.075
BbSp	589.0	108	108	2	<3	0.014	0.017	1.43	1.58	0.037	0.059
BoxSp	587.7	357	328	<2	<3	0.013	0.019	1.02	1.24	0.034	0.028
BHSp	587.5	UTA	UTA	<2	<3	0.015	0.018	1.30	1.23	0.031	<0.025
ThSp	584.2	659	632	2	<3	0.016	0.019	1.60	1.58	0.030	<0.025
MMSp	583.6	145	139	<2	<3	0.013	0.017	1.05	1.09	0.031	0.026
MgSp	582.7	UTA	UTA	<2	<3	0.015	0.017	0.847	0.758	0.033	0.052
MldSp	571.5	1419	1580	-	-	0.030	0.043	1.12	1.29	0.030	0.026
TOTAL		4237	4169								
OVERALL MEAN		423.7	416.9	1.45	1.50	0.020	0.024	1.611	1.688	0.033	0.028
% DIFFERENCE		1.6 %		3.3 %		20.0 %		4.8 %		17.9 %	
t-Test (*p* value) Significance		0.741 Not Significant		0.758 Not Significant		0.036 Not Significant		0.288 Not Significant		0.441 Not Significant	

Prepared by IDEQ-TFRO. BLSp = Blue Lakes Spring; CrSp = Crystal Spring; Nsp = Niagara Spring; ClrSp = Clear Spring; BgSp = Briggs Spring; BbSp = Banbury Spring; BoxSp = Box Spring; BHSp = Blue Heart Spring; ThSp = Thousand Springs; MMSp = Mini Miller Spring; MgSp = Magic Springs; MldSp = Malad Springs. UTA = Unable to Access. A *t*-Test (with a Bonferroni adjustment) was calculated showing, with the exception of TP, that there was no significant difference between the fall and spring databases (*p>0.010*). "-" excluded from data set due to field sampling contamination.

2.1.3.5 CANAL SYSTEMS

In Upper Snake Rock, there are two major canal companies that irrigate tracts on the south and north sides of the Middle Snake River: Twin Falls Canal Company (TFCC) and North Side Canal Company (NSCC), respectively.

The Twin Falls area (or Twin Falls tract) is predominantly irrigated by the Twin Falls Canal Company (TFCC), the largest irrigation company in the state of Idaho. The TFCC diverts an average of 1.1 million acre-feet/year from the Middle Snake River. The irrigation water is delivered to the area by gravity feed via the High Line and Low Line canals. Approximately 202,000 acres are serviced by the TFCC. It is estimated that about 85-90% of irrigation in the Twin Falls tract is surface irrigated (primarily furrow irrigation) with sprinkler irrigation making up the balance (Cosgrove *et al.* 1997; Haye 1998; Barry 1996 [pp 5,7]).

The Hazelton-Jerome-Wendell-Gooding area (or Northside tract) is predominantly irrigated by the North Side Canal Company (NSCC). The NSCC diverts an average of 1.2 million acre-feet/year from the Middle Snake River. The irrigation water is delivered to the area by gravity feed via the Main Canal. Approximately 160,000 acres are serviced by the NSCC. It is estimated that about 80% of irrigation is primarily sprinkler irrigation (Heaps 1998; Barry 1996 [pp 5,7]).

Approximately 6000 farms within the Twin Falls and Northside Tracts have a discharge to one or more points in a return flow channel. It should be noted that at Milner Dam there are ten (10) different Loads "leaks" or discharges: (1) Middle Snake River, (2) Milner Hydro Plant, (3) North Side Canal Company, (4) Twin Falls Canal Company, (5) Milner-Gooding Canal, (6) "Cross-cut" canal, (7) A-Lateral, (8) PA-Lateral, (9) Milner Irrigation Pumping Plant, and (10) A & B Irrigation Pumping Plant. See Figure 13 illustrates the canal system in Upper Snake Rock.

2.1.3.6 TRIBUTARIES

Because of the hydrologic and geomorphic structure of Upper Snake Rock, in general all perennial tributaries eventually discharge to the Middle Snake River, whether directly or indirectly. The major tributaries to the Middle Snake River (from upstream to downstream) in Upper Snake Rock include:

Dry Creek (Murtaugh)	Salmon Falls Creek
Vinyard Creek	Sand (Thousand) Springs Creek
Perrine Coulee System (East and Main)	Riley Creek
Warm Springs Creek	Fossil Gulch
Rock Creek	Peters Gulch
Crystal Springs (Lake)	Billingsley Creek
Cedar Draw	Birch Creek
Niagara Springs Creek	Malad River
Clear Lakes	Tuana Gulch
Mud Creek	Cassia Gulch
Deep Creek	Little Pilgrim Gulch
Briggs Creek	Big Pilgrim Gulch
Blind Canyon Creek	Deer Gulch
Box Canyon Creek	Clover Creek

Included in this "other" category are an additional 54 unnamed streams (which are intermittent) and over 200 spring sources which eventually drain into the Middle Snake River. See Figure 10 and Appendix C for an illustration of the major tributaries to the Middle Snake River. See also Figure 14 for a summary list of the water quality limited stream segments in Upper Snake Rock. "Some of the perennial tributaries are simply depressions or at best ephemeral streams prior to the development of irrigation in the subbasin. There is some evidence to suggest that irrigation development in the subbasin increased aquifer recharge above the natural amount. Some of the south side perennial streams fed by springs or seeps would be be perennial without surface irrigation. As irrigation methods change, the flows from these springs or seeps will change and most likely decrease (Robison 1998)."

DRY CREEK (MURTAUGH)

The portion of Dry Creek that discharges Murtaugh Lake to the Middle Snake River (at RM 630.6) is no longer an intermittant small stream, because enough seepage from Murtaugh Lake enters the stream below the dam to maintain water in Dry Creek on a year-round basis. From Murtaugh Lake to the Milner Low Lift Main Canal, Dry Creek has been completely altered into an agricultural return drain, completely changing the natural contour of the stream. From Murtaugh Lake to between 2800 North and 2900 North, Dry Creek has been completely altered into an irrigation delivery system and drain. The portion of Dry Creek above the Milner Low Lift Main Canal to its headwaters is considered a major tributary. This portion has its headwaters in the Dry Creek watershed, crosses the Lower Dry Creek watershed, and ends in the Lake Murtaugh watershed. Associated tributaries include: (1) West

Fork of Dry Creek; (2) Middle Fork of Dry Creek (with its associated tributary Coyote Creek); (3) East Fork of Dry Creek (with its associated tributary Coal Pit Creek); (4) Medley Creek; (5) Cold Spring Creek; and (6) Dry Creek main stem. It drains approximately 79,496 acres of predominantly rangeland and some irrigated-gravity flow agricultural fields. It should also be noted that presently a significant amount of spring runoff water from Dry Creek is diverted for ground water recharge via the South West Irrigation District. See Figure 15 for an illustration of the Dry Creek (Murtaugh Lake) Complex in Upper Snake Rock.

VINYARD CREEK

Vinyard Creek is also known as the Devil's Washbowl Spring and is located 0.5 miles upstream from the Twin Falls of the Snake River (USGS WY1997 [p 164]). It is located on the north side of the Middle Snake River in Jerome County. The source of the stream is a large spring which feeds a small lake that overflows (via a waterfall) to form Vinyard Creek. The creek flows for approximately 570 meters through a canyon (called Box Canyon) before it discharges to the Twin Falls Reservoir at Rivermile 618.0. The creek drains a 4004 hectare watershed that is totally irrigated from groundwater sources and the Middle Snake River (IPC 1997b [p 3]). The maximum daily discharge (1950-1959) is 27.5 cfs during the month of October. This has changed to 19 cfs (1986-1997) for the month of September. The average annual discharge is 22.3 cfs (1950-1959) which has now changed to 14.7 cfs (1986-1997). According to IPC, peak discharge in 1996 was 14.8 cfs (range 9.9 - 14.8 cfs) which is less than the average reported by USGS (IPC 1997b [p 3]). There is a channel carrying irrigation return water that used to enter Vinyard Creek approximately midway between the waterfall and the confluence with the Twin Falls Reservoir. This has since been re-routed so that the irrigation canal discharges directly to the Middle Snake River at Rivermile 617.9.

PERRINE COULEE SYSTEM

The Perrine Coulee System encompasses a natural drainage (Perrine Creek) interconnected with an irrigation canal system (Twin Falls Canal Company) and a storm drainage (City of Twin Falls). It drains into the Middle Snake River at two locations: East Perrine Coulee at RM 612.7 (elevation 3130 feet) and Perrine Coulee Falls at RM 610.9 (elevation 3130 feet). The Perrine Coulee System does not have associated tributaries. It drains approximately 22,400 acres of irrigated-gravity flow agricultural land and urban land.

Aside from the main drainage (known as the Perrine Coulee), three drainages of importance exist: (1) Perrine #1, (2) Perrine #2, and (3) Perrine #3. Perrine #s 1 and 2 are located parallel and east of the main Perrine Coulee. Perrine #3 lies parallel and west of the main coulee. All drainages drain to the north-northwest. According to the Twin Falls Canal Company, there are 19 linear miles of riparian areas in the Perrine Coulee "watershed," of which 3 miles are considered urban and 16 miles non-urban. The Twin Falls Canal Company diverts 125 cfs into the Perrine system, but calculates 176.8 cfs as actual use throughout the system. Additionally, TFC-1, TFC-2, and TFC-3 are natural drainages (termed coulees or laterals) fed by field runoff following natural land slopes but adjusted to follow farm and field boundaries. These natural drainages are significant because they accumulate in the large southwest areas of the Perrine Coulee System, which enters the Perrine Coulee drainage downstream (SRSCD 1998). See Figure 16 for an illustration of the Perrine Coulee System.

ROCK CREEK COMPLEX

The Rock Creek Complex is made up of the main Rock Creek System, McMullen Creek, and North Cottonwood Creek. The main Rock Creek System has its headwaters in the Upper Rock Creek and the Rock Creek 5th Field HUC watersheds. After being joined by McMullen Creek and North Cottonwood Creek, it traverses the Hub Butte 5th Field HUC watershed and then follows the eastern portion of Lower Rock Creek 5th Field HUC watershed until it drains into the Middle Snake River at RM 606.4 (elevation 2990 feet). It drains approximately 197,185 acres rangeland, irrigated-gravity flow, and forested ground. Rock Creek has the following associated tributaries from the headwaters to Rock Creek town:

(1) Rock Creek main stem, Wooden Shoe Creek, Deer Creek, and Little Creek (with associated Bluff Creek and Niles Gulch);

(2) Harrington Fork main stem, Dry Fork, and East Line;

(3) Fourth Fork main stem, Narrow Creek (with associated North Fork and South Fork), Mountain View Creek, Thompson Creek, Elk Butte Creek, and Pike Mountain Creek;

(4) Third Fork main stem, Cotton Creek, AH Creek, Martindale Fork, Little Fork (with associated Trail Canyon, Middle Fork, Little Fork Spring Creek, and Telephone Canyon), Second Fork main stem, and First Fork main stem (with associated Bear Gulch);

(5) Fifth Fork main stem, Dooddlelink Creek, Lucky Gulch, Trail Gulch, Crockett Spring Creek, Secret Creek, Indian Spring Creek, Jones Fork Creek (with associated Joes Spring Creek), and Toolbox Creek;

(6) Cottonwood Creek main stem, McMullen Creek (with associated Donahue Creek), North Cottonwood Creek, Dry Cottonwood Creek (with associated Burnt Creek). These streams are used for irrigation and then are intercepted by the High Line Canal. McMullen Creek in particular is a seasonal stream. It discharges directly into the High Line Canal. There is a diversion to Cottonwood Creek via the Twin Falls Canal Company flume. The closer McMullen Creek gets to Rock Creek, little bits of seep water discharge into McMullen Creek, thus making the lowest portion of McMullen Creek, near Rock Creek, perennial. The typical historical trend for McMullen Creek below the canyon is:

Spring: high flows due to snow pack from February till June 15th.
Low Flow: from June 15th till about July 15th.
After July 15th: its pretty much dried out.

In the canyon to the headwaters area, five miles upstream in the canyon McMullen Creek dissipates back into the ground. There are small springs that feed out from the headwaters area (known as McMullen Narrows). Access is very limited in the canyon portion of the stream.

Cottonwood Creek is similar to McMullen Creek in that it is intermittant. It has some artesian sources and is very swampy ground. North Cottonwood Creek is strictly reservoir water after June 15th.

Rock Creek has two small tributaries: Deadman Gulch, between Rock Creek town and the confluence with the Middle Snake River; and, Silo Creek which emanates from Slaughterhouse Gulch. Of note, Rock Creek has numerous irrigation return flows and several outlets to seepage tunnels between Rock Creek town and its confluence. Above Rock Creek town most of the stream flow is diverted for irrigation. See Figure 17 for an illustration of the Rock Creek Complex.

CEDAR DRAW

Cedar Draw has its headwaters in the upper portion of the Hollister watershed and traverses the eastern portion of the Filer watershed until it drains into the Middle Snake River at RM 599.1 (elevation 2980 feet). It drains approximately 73,639 acres of irrigated-gravity flow and urban ground. Cedar Draw has Desert Creek as an associated tributary that connects to the Main Canal. The High Line Canal blocks flow in Cedar Draw above the High Line Canal. Flow in Cedar Draw below the High Line Canal is blocked by the Low Line Canal, which forms Cedar Draw Lake. The portion of Cedar Draw below the Low Line Canal to the Middle Snake River is fed by seepage tunnels and is the only portion with year-round flow. See Figure 18 for an illustration of the Cedar Draw tributary.

MUD CREEK

Mud Creek has its "headwaters" in the Low Line Canal (of the Twin Falls Canal Company) in the Buhl watershed and traverses the western portion of the watershed till it drains into the Middle Snake River at RM 591.5 (elevation 2900 feet). It drains approximately 25,958 acres of irrigated-gravity flow agricultural land. Mud Creek has the following associated tributaries: Clear Creek, Silver Creek, Silo Creek, and other minor tributaries (seeps, seep tunnels, and springs) in Melon Valley. Because the Low Line Canal functions as the "headwaters," during the irrigation season (April to September) the majority of the flow may be attributed to irrigation return flows. Off-season flows are attitributed to spring seeps and rainfall/snow. See Figure 18 for an illustration of the Mud Creek tributary.

DEEP CREEK

Deep Creek is divided into two portions: an Upper Deep Creek and a Lower Deep Creek. The irrigation canal system of Twin Falls Canal Company keeps these two portions segregated throughout much of the year. Upper Deep Creek has its headwaters in the Clover watershed and traverses the western portion of the watershed, draining approximately 54,088 acres of rangeland. Upper Deep Creek has associated tributaries: (1) South Fork of Deep Creek; (2) North Fork of Deep Creek; (3) Emerson Spring Creek; (4) Soldier Creek; (5) Green Creek; and (6) Cottonwood Creek. Upper Deep Creek is used for irrigation and if there is any irrigation left, it flows into the Salmon River Canal Company canal. Lower Deep Creek has its "headwaters" in the Castleford watershed. The portion of Deep Creek above the High Line Canal is blocked by the High Line Canal. Flow above the High Line Canal seldom occurs and is only due to extreme snowmelt conditions that last occurred in 1984. Therefore, the High Line Canal acts as "headwaters" into Deep Creek which eventually drains into the Middle Snake River at RM 591.4 (elevation 2900 feet). Excess flow from the Low Line Canal spills into Deep Creek. Flow in Deep Creek between the High Line and the Middle Snake River is partially diverated at several locations by the Twin Falls Canal Company. Deep Creek drains approximately 47,756 acres of irrigated-gravity flow agricultural land. See Figure 18 for an illustration of the Deep Creek tributary.

SALMON FALLS CREEK

Salmon Falls Creek drains from the Salmon Falls subbasin (HUC 17040213) into the Middle Snake River at RM 586.2 (elevation 2923 feet). It drains for the most part approximately 1,371,586 acres of rangeland and irrigated agriculture from both Nevada and Idaho. Salmon Dam separates the watershed on Salmon Falls Creek. On only three occasions since the dam was built in 1911 has any water been released by Salmon Dam down the canyon to the Middle Snake River.

BILLINGSLEY CREEK

Billingsley Creek has its headwaters in the Hagerman watershed and drains into the Middle Snake River at RM 573.8 (elevation 2804 feet). It drains approximately 31,927 acres of irrigated-sprinkler ground and rangeland. Billingsley Creek does not have any associated tributaries and is largely a spring fed stream. See Figure 19 for an illustration of the Billingsley Creek tributary.

MALAD RIVER

Malad River drains from the Camas Creek HUC (17040220), the Big Wood River subbasin (HUC 17040219), and the Little Wood River subbasin (HUC 17040221) into the Middle Snake River at RM 571.4 (elevation 2776 feet). It drains for the most part approximately 427,432 acres of the Camas Creek HUC, 901,370 acres of the Big Wood River HUC, and 716,490 acres of the Little Wood River HUC, or a total of 2,045,292 acres.

CLOVER CREEK

Clover Creek has its headwaters in the Upper Clover Creek watershed, traverses through the lower portion of Calf-Clover watershed, and then drains into the Middle Snake River via the Lower Clover Creek watershed at RM 547.6 (elevation 2533 feet). Including its tributaries, it drains approximately 179,555 acres of prinicipally rangeland, with minor irrigated-gravity flow and irrigated-sprinkler agricultural land. Clover Creek has the following associated tributaries: (1) Hog Creek; (2) Dry Creek (with associated Thorn Creek, East Dempsey Creek, and West Dempsey Creek); (3) Calf Creek; (4) Cottonwood Creek; (5) East Fork of Clover Creek; (6) Squaw Creek; and (7) Deer Creek. See Figure 20 for an illustration of the Clover Creek Complex.

CRYSTAL SPRINGS LAKE

Crystal Springs Lake is a natural spring fed lake with an outfall that discharges to the Middle Snake River at RM600.4. It is a small (8 acre) shallow lake (existing mean depth of less than 3 m) that historically has received effluent discharges from a private commerical fish hatchery (USBLM 1985b). Historically, the lake received about 450-525 cfs of spring flows from the Snake Plain Aquifer. Flow from the springs averages (from 1950 to 1982) 450 to 550 cfs with maximum flows in September, October, and November, and barely enough flows to cover water rights during March, April, and May. The lake is located along the sourthwestern edge of the Snake Plain in the Thousand Springs area of the Snake River canyon. Soils in the vicinity of the lake and along the western edge of the Snake Plain may be characterized as predominantly fine sandy loams and silty clay loams with moderate to high erosion potentials. Land use is diverse and includes irrigated agriculture, grazing, fish propagation, and some residential development. No surface runoff or irrigation return flows from agricultural lands reach the lake. Historically, some soil erosion occurred near the lake as a result of hatchery construction activities with some sediment reaching the lake. These areas have since been stabilized and the sediment has been eliminated. Most recreational use of the lake at present is for fishing by bank fishermen who fish from the hatchery outfall structure or lake outlet bridge area.

The hydraulic characteristics of the lake include: 7.8 acres of surface area; 16.0 feet maximum depth; 5.8 feet average depth; 45.20 acre feet volume; 1475 feet maximum length; 350 feet maximum width; 175 feet minimum width; and, 6.8 hours/0.3 days as hydraulic retention time at 80 cfs inflow (IDHW 1990 [p 3]). With a hydraulic retention time of 6.8 hours/0.3 days at 80 cfs inflow, there is little opportunity for a phytoplankton community to develop. Even with with total phosphorus which would promote eutrophic conditions, the rapid flushing rate precludes phytoplankton blooms in the lake (IDHW 1990 [p 30]).

Historically, the lake was entirely spring fed with virtually no definitive watershed. Spring flows entered the lake directly on the north side, with water flowing through the lake to the Middle Snake River. At present, most of these flows are diverted away from the lake with a portion of the flow (0-80 cfs) returning to the lake after use in a nearby fish hatchery. No other surface water flows enter the lake.

BOX CANYON

The upper two-thirds of Box Canyon (or 117.5 acres) including the existing diversion structure) is privately owned, as is the mouth of Box Canyon Creek. The remainder (or 26.2 acres) is public (federal) land managed by the U.S. Bureau of Land Management. Box Canyon Creek discharges to the Middle Snake River at RM587.8 (although USGS records the mouth at RM588.8 in their water year resource books). It is the 11th largest spring in the United States. Numerous springs emerge from the creek bed throughout the 1.4 mile water course. The average discharge of Box Canyon (measured at the mouth) is 852 cfs (USGS WY1968). In the 1950s the creek flowed at 850 cfs at its confluence with the Middle Snake River. In the 1980s there was one diversion (300 cfs) from the creek and extensive deep well pumping of the Snake River Plain Aquifer for agricultural irrigation, stream flow at the mouth is approximately 400 cfs, which has reduced the natural dilution and instream flow values of the lower stream as well as the adjacent habitat in the Middle Snake River (Langenstein & Bowler 1989). More current USGS gage readings indicate that for the water years 1995-1997, the average discharge to the Middle Snake River is 329, 336, and 347 cfs, respectively (USGS WY1995, WY1996, WY1997). The main spring emerges at the foot of a cliff at the head of a deep, narrow alcove canyon. Many other springs and seeps enter the outflow channel above and below the USGS gage. The head of Box Canyon contains a large alcove pool (about 0.5 hectare) where the initial springs emerge. Below this pool, the creek rapidly descends approximately 804.6 m (about 0.5 miles) to a large waterfall approximately 12.2 m (or 40 ft) across and 3.7 m (or 12 ft) high. This waterfall is sufficiently high to be a barrier to some fish species, but it is estimated that salmon and steelhead from the Middle Snake River could have historically passed this mark (IPC 1998). The waterfall is sufficiently high to also be a barrier to at least one endemic species, the Shoshone sculpin (*Cottus greenei*) which occurs in the lower canyon, while its congener, the Mottled sculpin (*Cottus bairdi*) is found both above and below the waterfall. Other species of endangered or threatened species include: the Bliss Rapids Snail, the Utah or Desert Valvata Snail, the Giant Columbia River Limpet, Shoshone sculpin, and an undescribed Lanx species. These species are not uniformly distributed throughout the canyon, and each occupy unique habitats and may be affected by the barrier presented by the falls (Langenstein & Bowler 1989). See Figure 21 for an illustration of the Box Canyon tributary.

BLIND CANYON

Blind Canyon is entirely in private ownership (54.3 acres). It is situated immediately upstream of Box Canyon. The average discharge is 12.8 cfs (USGS WY1968) and it discharges to the Middle Snake River at RM588.1. Blind Canyon is fed by numerous springs originating throughout the canyon. The topography of Blind Canyon is similar to Box Canyon. See Figure 21 for an illustration of the Blind Canyon tributary.

BRIGGS SPRINGS CREEK

Briggs Springs Creek is entirely in private ownership. The average disharge measured at Briggs Creek was 109.7 cfs (USGS WY1968) and discharges to the Middle Snake River at RM590.3).

RILEY CREEK

Riley Creek was classified as a Class A stream in southwestern Gooding County in 1977 (IDHW 1977b). It is entirely spring fed during the non-irrigation season. More than 20 springs discharge from the Snake Plain Aquifer to the creek. The creek discharges to the Middle Snake River at RM582.9. More than 20 springs discharge from the Snake Plain Aquifer to the creek. The creek's discharge increases to about 300 cfs in the less than two miles distance to its mouth (IDHW 1977b).

2.1.4 BIOLOGICAL CONSIDERATIONS

This section covers fisheries, macroinvertebrates, aquatic fowl, aquatic endangered species, and aquatic macrophytes.

2.1.4.1 FISHERIES

The fish fauna in the Upper Snake Basin, and specifically the Middle Snake River, consists primarily of native coldwater species in the families *Salmonidae* (trout), *Acipenseridae* (sturgeon), *Cottidae* (sculpins), *Cyprinidae* (minnows), and *Catostomidae* (suckers) (USGS 1997a), although other families are noted: *Petromyzontidae* and *Percopsidae*. Indigenous fishes are represented by 26 species in five families. Thirteen additional species have been introduced, primarily to enhance sport-fishing opportunities (Maret *et al.* 1995). Following the construction of large hydroelectric facilities on the main-stem of the Middle Snake River (i.e., Bliss Dam, Lower Salmon Falls Dam, Upper Salmon Falls Dam, Shoshone Falls Dam), salmon, steelhead, and Pacific lamprey were extirpated from the region between King Hill and Shoshone Falls (USGS 1997a).

Until the twentieth century, three anadromous species frequented the Middle Snake River and its tributaries as far upstream as Shoshone Falls. These include: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Onchorhynchus mykiss*), and the lamprey (*Lampetra tridentata*) (Myers 1996; FERC 1990; Everman 1896). All three runs of Chinook salmon (spring, summer, and fall) were at one time found in the Middle Snake River system. Spring and summer runs were the most prevalent with little historical information regarding use of the system by fall chinook salmon, although some references cite this run as occuring in the Middle Snake River (see *Fishes of Idaho* by James Simpson and Richard Wallace, p. 67).

Although sockeye salmon (*Oncorhynchus nerka*) are occasionally mentioned in various sources (Myers 1996; FERC 1990; Everman 1896) as existing in the Middle Snake River system, sockeye historically resided only in the Payette River system and the Salmon River system, in Idaho. Sockeye have specific habitat requirements which include a lake or other "impoundment" immediately below their spawning streams (for example Redfish Lake, Alturas Lake, Yellow Belly Lake, Pettit Lake, Payette Lake, Little Payette Lake). No spawning streams with an associated lake exist within the Middle Snake River system.

Native non-anadromous species include: white sturgeon (*Acipenser transmontanus*), rainbow trout as steelhead (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), mountain whitefish (*Prosopium williamsoni*), northern squawfish (*Prychocheilus oregonensis*), suckers (*Catostomus* spp.), shiner (*Richardsonius* spp.), dace (*Rhinichthys* spp.), peamouth (*Mylocheilus* spp.) and bull trout (*Salvelinus confluencus*). There are closely related anadromous species of both white sturgeon and bull trout (see next paragraph). Not a great deal is known about historic existence or movements of these "potentially" anadromous species prior to damming of the Snake and Columbia Rivers. Additionally, some ichthyologists and geneticists believe the native redband trout found downstream of Shoshone Falls are a residualized form of anadromous steelhead (IDFG 1998b). White sturgeon do not migrate above Shoshone Falls, thus inhabiting the Snake River from Shoshone Falls downstream to the confluence of the Columbia River (FERC 1997b [pp 2, 4]).

IDFG notes that bull trout have been documented within the Rock Creek and Salmon Falls Creek drainages. It is possible that remnant, isolated populations still exist within the Rock Creek drainage. Bull trout distribution in the Middle Snake River system, like other areas of Idaho, paralleled distribution of anadromous fish species. Any of the perennial tributaries below Shoshone Falls, containing anadromous fish, probably also contained bull trout. Within the Rock Creek drainage, due to water quality degradation and migration barriers, bull trout could only exist in headwater areas as isolated remnant populations (IDFG 1998b).

Other species (of which their reproductive and population status in the Middle Snake River is unknown at this time) includes the following native and non-native fish species of the Middle Snake River:

1. Native Fish Species: Leatherside chub (*Gila copei*), Utah chub (*Gila atraria*), Chiselmouth (*Arocheilus alutaceus*), Mottled sculpin (*Cottus bairdi*), Shoshone sculpin (*Cottus greenei*), and Mountain whitefish (*Prosopium williamsoni*).

2. Non-native Fish Species: Brown bullhead (*Ictalurus nebulosus*), Black bullhead (*Ictalurus melas*), Channel catfish (*Ictalurus punctatus*), Smallmouth bass (*Micropterus dolomieui*), Yellow perch (*Perca flavescens*), and Carp (*Cyprinus carpio*).

Mountain whitefish, as a native fish species of the Middle Snake River, are probably the most widely distributed native fish species of the family *Salmonidae* found in Idaho. They have persisted, without population augmentation or special management, in the Middle Snake River drainage. Little is known about local population other than they are widely distributed with the Middle Snake River reach, and they are commonly sampled near flowing riverine habitats (IDFG 1998b).

Table 16 describes the fish species occuring in the Middle Snake River reach by drainage, as the Snake River below Shoshone Falls (Sb) and the Snake River above Shoshone Falls (Sa), and by origin, as native or introduced species.

Table 16 List of fishes in the Middle Snake River drainage

FAMILY TAXONOMY		***SPECIES TAXONOMY***		***Sb***	***Sa***
Common Name	***Scientific Name***	***Common Name***	***Scientific Name***		
NATIVE ORIGIN					
Sturgeon	*Acipenseridae*	White sturgeon	*Acipenser transmontanus*	X	X'

FAMILY TAXONOMY		SPECIES TAXONOMY		Sb	Sa
Common Name	Scientific Name	Common Name	Scientific Name		
Trout	*Salmonidae*	Mountain whitefish	*Prosopium williamsoni*	X	X
		Chinook salmon	*Oncorhynchus tshawytscha*	X	
		Cutthroat trout Yellowstone	*Oncorhynchus clarki bouvieri*	X	X
		Cutthroat trout Finespotted	*Oncorhynchus clarki ssp.*		X
		Rainbow trout	*Oncorhynchus mykiss*	X	X[1]
		Redband trout	*Oncorhynchus mykiss gairdneri*	X	
		Bull trout	*Salvelinus confluentus*	X	
Minnow	*Cyprinidae*	Chiselmouth	*Acrochellus alutaceus*	X	
		Utah chub	*Gila atraria*	X	X
		Leatherside chub	*Gila copei*	X	X
		Peamouth	*Mylocheilus caurinus*	X	
		Northern squawfish*	*Ptychocheilus oregonensis*	X	
		Longnose dace	*Rhinichthys cataractae*	X	X
		Speckled dace	*Rhinichthys osculus*	X	X
		Redside shiner	*Richardsonius balteatus*	X	X
Sucker	*Catostomidae*	Utah sucker	*Catostomus ardens*		X
		Bridgelip sucker	*Catostomus columbianus*	X	
		Largescale sucker	*Catostomus macrocheilus*	X	
		Mountain sucker	*Catostomus platyrhynchus*	X	X
Sculpin	*Cottidae*	Mottled sculpin	*Cottus bairdi*	X	X
		Shorthead sculpin	*Cottus confusus*	X	
		Shoshone sculpin	*Cottus greenei*	X	
		Wood River sculpin	*Cottus leiopomus*	X	
INTRODUCED ORIGIN					
Trout	*Salmonidae*	Coho salmon	*Oncorhynchus kisutch*	X	X
		Golden trout	*Oncorhynchus aguabonita*	X	X
		Brown trout	*Salmo trutta*	X	X
		Atlantic salmon	*Salmo salar*	X	
		Blueback trout	*Salvelinus alpinus oquassa*	X	

FAMILY TAXONOMY		SPECIES TAXONOMY		Sb	Sa
Common Name	Scientific Name	Common Name	Scientific Name		
		Brook trout	*Salvelinus fontinalis*	X	X
		Lake trout	*Salvelinus namaycush*	X	X
		Arctic grayling	*Thymallus arcticus*	X	X
Pike	*Eocidae*	Tiger muskie	*Esox lucius x E. masquinongy*	X	
Minnow	*Cyprinidae*	Goldfish	*Carassius auratus*	X	
		Carp	*Cyprinus carpio*	X	X
		Grass carp	*Ctenopharyngodon idella*	X	X
		Tui chub	*Gila bicolor*	X	
		Spottail shiner	*Notropis hudsonius*	X	X
		Fathead minnow	*Pimephales promelas*	X	X
Catfish	*Ictaluridae*	Black bullhead	*Ameiurus melas*	X	
		Brown bullhead	*Ameiurus nebulosus*	X	X
		Yellow bullhead	*Ameiurus natalis*	X	X
		Blue catfish	*Ictalurus furcatus*	X	X
		Channel catfish	*Ictalurus punctatus*	X	X
		Tadpole madtom	*Noturus gyrinus*	X	
		Flathead catfish	*Pylodictis olivaris*	X	
Livebearer	*Poeciliidae*	Mosquitofish	*Gambusia affinis*		X
Sunfish	*Centrarchidae*	Pumpkinseed	*Lepomis gibbosus*	X	X
		Warmouth	*Lepomis gulosus*	X	
		Bluegill	*Lepomis macrochirus*	X	X
		Smallmouth bass	*Micropterus dolomieu*	X	X
		Largemouth bass	*Micropterus salmoides*	X	X
		Black crappie	*Pomoxis nigromaculatus*	X	X
		White crappie	*Pomoxis annularis*	X	
Perch	*Percidae*	Yellow perch	*Perca flavescens*	X	X
		Walleye	*Stizostedion vitreum*	X	X
Loach	*Cobitidae*	Oriental weatherfish	*Misgurnus anguillicaudatus*	X	
Shad	*Clupeidae*	American shad	*Alosa sapidissima*	X	

FAMILY TAXONOMY		SPECIES TAXONOMY		Sb	Sa
Common Name	Scientific Name	Common Name	Scientific Name		

Prepared by IDEQ-TFRO. Adapted from IDFG 1996. Sb = Below Shoshone Falls. Sa = Above Shoshone Falls. X' = Introduced native fish. In addition to the above introduced species, there are three species of the Cichlid family (*Cichlidae)* which are introduced Sb specifically confined to geothermal waters: Mozambique (Java) talapia (*Talapia mossambica*), Redbelly (Zill's) talapia (*Talapia zilli*), and Convict cichlid (*Cichlasoma nigrofasciatum*). "At the time of this writing, an international committee of fish experts had agreed to change the common name of the "squawfish" to avoid use of a term that many American Indian women find offensive and derogatory. The new name proposed is "pikeminnows," and won't be final until publication in the American Fisheries Society journal. Table verified by IDFG-Jerome for the Upper Snake Rock subbasin.

A knowledge of fisheries management in the Middle Snake River is important to understanding the diversified nature of the native and introduced species of fish. The major responsibility of the IDFG fisheries activities is to provide continued supplies of game fish for sport fishermen. Primary fish species from a management standpoint include: native sport fish, including rainbow trout, cutthroat trout, bull trout, steelhead (rainbow trout), chinook salmon, kokanee salmon, whitefish, and white sturgeon. Two of these, steelhead and chinook salmon, migrate to the ocean to complete a portion of their life cycle (i.e., they are "anadromous" species). Introduced game fish, such as brown trout, lake trout, brook trout, landlocked coho and chinook salmon, bass, sunfish, perch, crappie, catfish, walleye, northern pike, and tiger muskie, provide sport fisheries where habitat conditions are unsuitable for native species and also provide a diversity of angling opportunity. It should be noted that the most preferred species of fish sought by anglers in Idaho, based on a 1994 study, were 67% for coldwater (mostly rainbow trout or any trout) and 33% for warmwater (mostly any bass). Most waters suitable for establishment of a warmwater fishery have received introductions. Regulations were developed to improve the quality of bass and provide some trophy opportunity. Additonal species were introduced to existing warmwater fisheries to diversity opportunity and provide forage. During the next five-year period (1996-2000), the primary emphasis by IDFG will be on management to improve existing warmwater fisheries. Addition of habitat structure and fish concentration devices will be used to improve catch rates for bluegill and crappie. Regulations will be used to provide quality and trophy bass fishing opportunities. Further evaluation of forage needs for bass and other species will be made, and forage introduced where needed. Additional species will be added to diversity fisheries in some cases. Areas with warmwater or mixed water fisheries are fairly numerous in the main Middle Snake River, and are described in Table 17:

Table 17 IDFG water types by river segment

MIDDLE SNAKE RIVER SEGMENT	IDFG MANAGEMENT GOALS
Bliss Reservoir	Warm Water
Bliss Pool to Lower Salmon Falls Dam	Mixed Water
Lower Salmon Falls Reservoir	
Upper Salmon Falls Reservoir	
Upper Salmon Falls Pool to Shoshone Falls	
Shoshone Falls Reservoir	
Shoshone Falls Reservoir to Twin Falls Dam	
Twin Falls Reservoir	Cold Water
Twin Falls Reservoir to Murtaugh Bridge	
Murtaugh Bridge to Milner Dam	

MIDDLE SNAKE RIVER SEGMENT	IDFG MANAGEMENT GOALS
Prepared by IDEQ. These water types are IDFG's fisheries management for the segments on the Middle Snake River. Warm water fisheries are supported by warm water or cool water game fish including bass, crappie, sunfish, catfish, northern pike, tiger muskie, walleye, and yellow perch. Mixed water fisheries are supported by a combination of cold water and warm water fish species. Cold water fisheries are supported by resident populations of salmonid game fish, including trout, char, non-anadromous salmon (kokanee, coho, chinook), and whitefish. Anadromous fisheries are supported by anadromous salmonids (steelhead trout, chinook salmon, and sockeye salmon).	

According to IDFG, a great demand exists for mixed waters in the populated portions of the drainage. The Middle Snake River has the greatest potential for increasing angler opportunity of any major water in the southern portion of Idaho. Lack of flows, especially during irrigation season, apparently deteriorating water quality, and loss of spawning areas appear to be the factors most significantly affecting fish populations in the Middle Snake River. Should water become available, IDFG will make every effort to improve summer flows (IDFG 1996 [pp 2-3, 23-24, 35, 58, 197-198]).

Finally, IDAPA 16.01.02.250(02. Aquatic Life)(c. Cold water biota)(iv.Time periods for salmonid spawning and incubation) defines the time periods for salmonid spawning and incubation for cold water biota stream segments. These are listed in Table 18.

Table 18 Time periods for salmonid spawning and incubation on cold water biota stream segments

FISH SPECIES	J	F	M	A	M	J	J	A	S	O	N	D
Chinook salmon (spring): native species	... April 1st							August 1st to ...				
Chinook salmon (summer): native species	... June 15th							August 15th to ...				
Steelhead trout: native species		February 1st to July 15th										
Redband trout: native species			March 1st to July 15th									
Cutthroat trout: native species				April 1st to August 1st								
Bull trout: native species	... April 1st								September 1st to ...			
Rainbow trout: native species	January 15th to July 15th											
Mountain whitefish: native species	... March 15th									Oct 15th to ...		
Brown trout: introduced species	... April 1st									Oct 1st to ...		
Brook trout: introduced species	... June 1st									Oct 1st to ...		

Prepared by IDEQ-TFRO. Months of the year symbolized by first letter of month's name. Fall Chinook salmon may not occur on the Middle Snake River and is not included in this table. Sockeye salmon, sunapee trout, Golden trout, Kokanee salmon, lake trout, and arctic grayling do not occur on the Middle Snake River and are not included in this table. Contents of table verified by IDFG-Jerome for the Upper Snake Rock subbasin.

2.1.4.2 MACROINVERTEBRATES

The aquatic insect fauna in the Middle Snake River is dominated by two orders, *Diptera* (flies) and *Trichoptera* (caddisflies) (FERC 1990). Caddisflies have been reported as the predominant taxa in benthic invertebrate samples collected at most river sites (Falter *et al.* 1976). A study (1978-1979) conducted on the Middle Snake River area (including some of the tributaries) found the greatest number of macroinvertebrate taxa in the Milner area (30.2%), Rock Creek (20.0%), and the Malad River (25.3%), and that the most common taxa were *Trichoptera* (51.8%), *Amphipoda* (17.4%), *Gastropoda* (15.0%), and *Diptera* (7.6%) (Bauer 1986). The

aquatic insect fauna in the tributaries (excluding the Middle Snake River) of Upper Snake Rock includes *Diptera* (chironomids), *Oligochaeta* (worms), *Amphipoda* (scuds), and molluscs (mud snail).

Additional studies by Idaho Power Company have shown that the reservoirs in the Buhl to King Hill area are characterized by species commonly found in eutrophic waters (Myers *et al.* 1995 [p 17]). Families include *Diptera*, *Ephemenoptera*, *Odonata*, *Crustacea*, *Annelida*, and *Mollusca*. In these studies, the family *Tricoptera* was not found.

2.1.4.3 AQUATIC FOWL

The Middle Snake River is a major wintering area and migration corridor for waterfowl using the Pacific flyway. Mallards (*Anas platyrhynchos*) and Canada geese (*Branta canadensis* or *Anser canadensis*) comprise much of the waterfowl population using the flyway. Waste grain from croplands outside the canyon provides forage for these species. Ducks that commonly feed in the fast-water sections of the Middle Snake River include Common merganser (*Mergus merganser*) and Common goldeneye (*Bucephala clangula*). As many as a half million ducks migrate through the Snake River Canyon each winter, primarily between the Hagerman Wildlife Management Area and the Minidoka National Wildlife Refuge (FERC 1997a).

2.1.4.4 AQUATIC ENDANGERED SPECIES

This section describes those species of fish, aquatic wildlife, and aquatic plants which are in danger of, or threatened with extinction.

RARE AND ENDANGERED AQUATIC SPECIES

Those rare and endangered aquatic species are categorized by county in Table 20. The distributions of the federally listed mollusc species in the Middle Snake River and its tributaries are represented by the counties along the extent of the current known ranges of the species.

Table 20 Rare aquatic wildlife species in the tri-county area: Gooding, Jerome, and Twin Falls

COUNTY	*RARE WILDLIFE SPECIES*
GOODING	Shoshone sculpin, White sturgeon, Inland columbia basin redband trout, Desert valvata, California floater, Columbia pebblesnail, Shortface lanx, Banbury springs limpet, Snake river physa, Bliss rapids snail
JEROME	White sturgeon, California floater, Desert valvata, Snake river physa, Bliss rapids snail
TWIN FALLS	Shoshone sculpin, White sturgeon, Inland columbia basin redband trout,California floater, Banbury springs limpet, Desert valvata, Snake river physa, Columbia pebblesnail, Shortface lanx, Bliss rapids snail
Prepared by DEQ-TFRO.	

2.1.4.5 MACROPHYTES AS ROOTED AND NON-ROOTED SPECIES

The most common macrophytes occuring on the Middle Snake River have been studied from the standpoint of eutrophication since 1974 (Falter et al. 1974). Nuisance plants in the Brownlee to American Falls reservoirs region were studied in 1974 and identified as: *Potomageton pectinatus, Potamogeton crispus, Potamogeton filiformis, Potamogeton pusillus, Chara vulgaris, Brasenia schreberi, Rorippa nasturtium-aquaticum, Myriophyllum spp., Lemna minor, Nasturtium officinale,* and *Zannichellia palustris.* In 1992-1994, the IDEQ-TFRO contracted with the University of Idaho to ascertain biomass and % species composition. TABLE 19 summarizes the results of the 3-year research. In general, *Ceratophyllum demersum*, *Potamogeton*

pectinatus, and *Potamogeton crispus* dominated the species composition of the aquatic plant communities in the Crystal Springs Reach. Sub-dominants were *Potamogeton foliosus, Elodea nuttallii*, and *Elodea canadensis*. The *Ceratophyllum spp.* is a genus of aquatic macrophyte that does not have a well developed root system, thus getting most of its nitrogen and phosphorus from the water column. The *Potamogeton spp.* is a genus of aquatic macrophyte that has a well developed root system and gets most of its nitrogen and phosphorus from the sediment.

The Idaho Power Company also conducted studies from Buhl to King Hill and found extensive areas of submerged vegetation (Myers et al. 1995 [p. 19-20]). Their qualitative survey of Lower and Upper Salmon Falls reservoirs found 13 species: *Elodea nuttallii* and *Elodiea canadensis; Ranunculus aquatilis; Certatophyllum demersum; Potamogeton crispus, Potamogeton pectinatus, Potamogeton filiformes*, and *Potomageton foliosus; Myriophyllum spicatum* and *Myriophyllum sp.; Chara sp.; Zannichellia palustris; Veronica sp.;* and *Lemna minor.*

The primary components of the epiphyton community are the filamentous green algae *Hydrodictyon spp.*, the multi-branching green algae *Cladophora spp.*, and (in 1994) the fresh-water adapted green algae *Enteromorpha*. The *Hydrodictyon spp.* is the familiar "water net" which often grows in such dense mats in lakes, small ponds, or irrigation ditches. The *Cladophora spp.* has the characteristic habitat of flowing water, especially on dams and waterfalls and derives all of its nutrients from the water column. The *Enteromorpha spp.* is primarily a marine alga but becomes adapted rather successfully in fresh-water habitats. *Enteromorpha spp.* is always attached (at least when young) to submersed aquatic plants, sticks and stones, especially in flowing water and nearly always in hard (calcareous) or saline water. Due to the mixed nature of the epiphyton community and the relative difficulty of separating the different algae to genus, the functional group epiphyton was treated in the same fashion as individual species of macrophytes, although in the 1994 study an attempt was made to segregate out the three major epiphyton species. There were several instances where epiphyton was the prinicipal component of the total macrophyte biomass.

The Idaho Power Company also conducted studies on phytoplankton from Buhl to King Hill and found similar species in all three reservoirs from the following families: *Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Euglenophyta,* and *Pyrrophyta.* Zooplankton families included: *Cladocera, Copepoda, Rotifera, Hydracarina,* and *Ostracoda.*

The Crystal Springs Reach was chosen by IDEQ-TFRO and the University of Idaho (Mike Falter) as an area potentially impacted by agricultural, aquaculture, and Twin Falls Sewage Treatment Plant returns. Table 21 indicates that only three species dominated the Crystal Springs Reach: *Ceratophyllum spp., Potamogeton spp.,* and three *Epiphytes*. Although dependent on the individual site location, in general the rooted macrophytes (*Ceratophyllum spp.* and *Potamogeton spp.*) comprised from 38.1% to 79.1% of the total biomass, whereas the non-rooted plants comprised from 20.5% to 61.3% of the total biomass. Other species were found in the mixture of aquatic plants, but their % species compostion (as biomass) was not significant (< 0.4% of the biomass).

It should be noted that *Ceratophyllum spp.* is not a typical rooted macrophyte. It behaves more like an epiphyte. The roots are a modified stem that the plant uses as an anchor rather than a nutrient source. In low phosphorus water *Ceratophyllum spp.* are seldom found. It derives the majority of its nutrients from the water column through its leaves.

Nutrient uptake through the leaves of macrophytes occurs when the water is rich in phosphate. However, lake waters or reservoir-like waters are usually low in available phosphate. Thus, the main method by which rooted macrophytes obtain phosphorus is absorption of phosphate directly from the interstitial soil water. Plant

phosphorus losses are attributed to two reasons: (1) direct excretion by the plants, or (2) eventual loss by death and decomposition. Sediment phosphorus is controlled to a great extent by the amount of dissolved oxygen present. When the sediment-water interface becomes anoxic, phosphate passes rapidly into the water above. Anoxic sediments release phosphate at rates as much as 1000 times faster than releases from oxygenated sediments. This is attibutable to both classical chemical bonding and physiochemical sorptive mechansims (Goldman 1983 [pp 137-140]).

Table 21 Three major species of aquatic plants on the Crystal Springs reach of the Middle Snake River

SITE	NAME	CHARACTERIZATION OF DRY BIOMASS AS % OF TOTAL SPECIES PER INDICATED PLANT SPECIES		
	1992 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	***Ceratophyllum spp.***	***Potamogeton spp.***	***Epiphytes spp.***
1	Above the weedbed areas	25.4	0.8	73.7
2	Right/Left channel around island in weeds	36.9	15.8	47.0
3	Large cross-channel weedbed	28.4	7.1	63.3
	AVERAGE OF 3 SITES:	30.2	7.9	61.3
	1993 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	***Ceratophyllum spp.***	***Potamogeton spp.***	***Epiphytes spp.***
1	Upstream from Crystal Springs Hatchery	11.7	84.1	4.1
2	Across channel from Crystal Springs Hatchery	77.3	2.5	18.4
3	Right side of island 50m into the channel	22.0	53.1	24.9
4	Left channel midway down the island	7.4	83.9	8.7
5	Bottom end of Magic Valley Steelhead	43.3	32.8	23.8
6	100m downstream from Site 5	29.3	42.2	27.8
7	200m downstream from Site 5	46.7	17.3	35.8
	AVERAGE OF 7 SITES:	34.0	45.1	20.5
	1994 AQUATIC ROOTED MACROPHYTES AND EPIPHYTES:	***Ceratophyllum spp.***	***Potamogeton spp.***	***Epiphytes spp.***
2	Across channel from Crystal Springs Hatchery	50.8	15.4	31.2
5	Downstream from Magic Valley Steelhead	78.6	21.5	0.0
7	200m downstream from Site 5	27.6	28.3	43.9
R	Between Sites 2 and 7	17.0	51.4	31.5
	AVEAGE OF 4 SITES:	43.5	29.2	26.7

Prepared by IDEQ-TFRO. *Falter et al., 1994; Falter et al., 1995; Falter et al., 1996.*

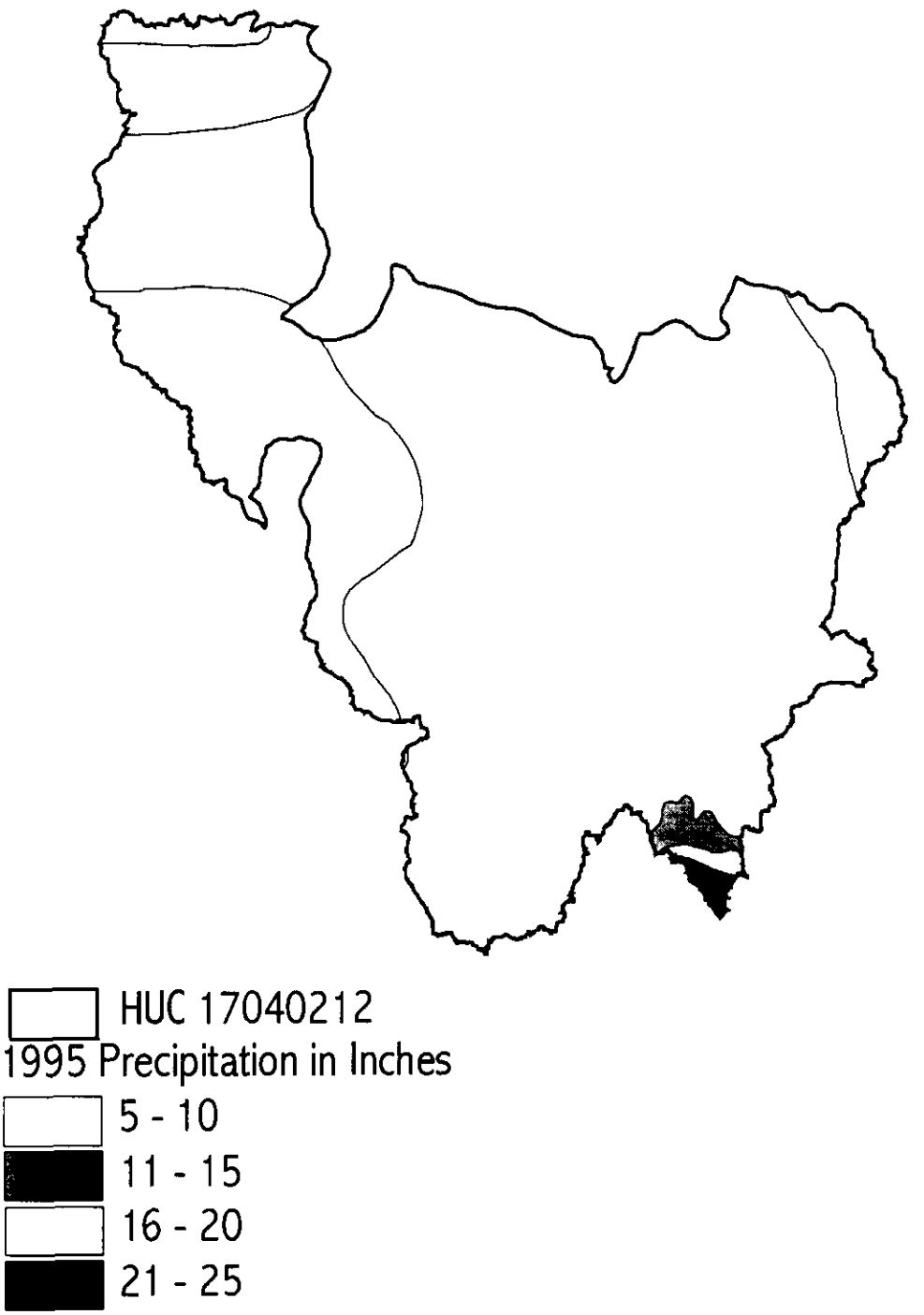


Figure 4 Precipitation in Upper Snake Rock

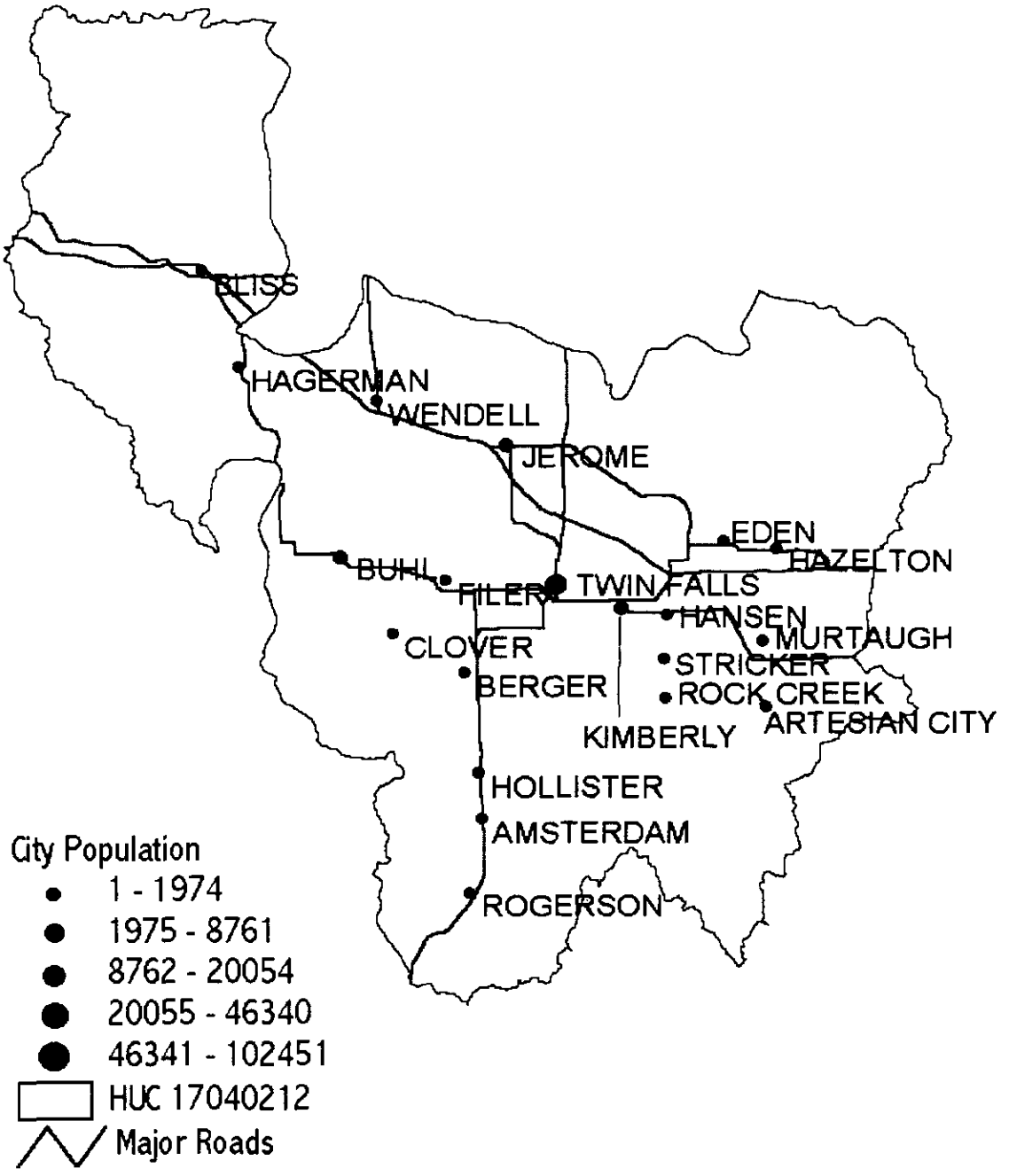


Figure 5 Human population centers in Upper Snake Rock



Figure 6 Topography of Upper Snake Rock

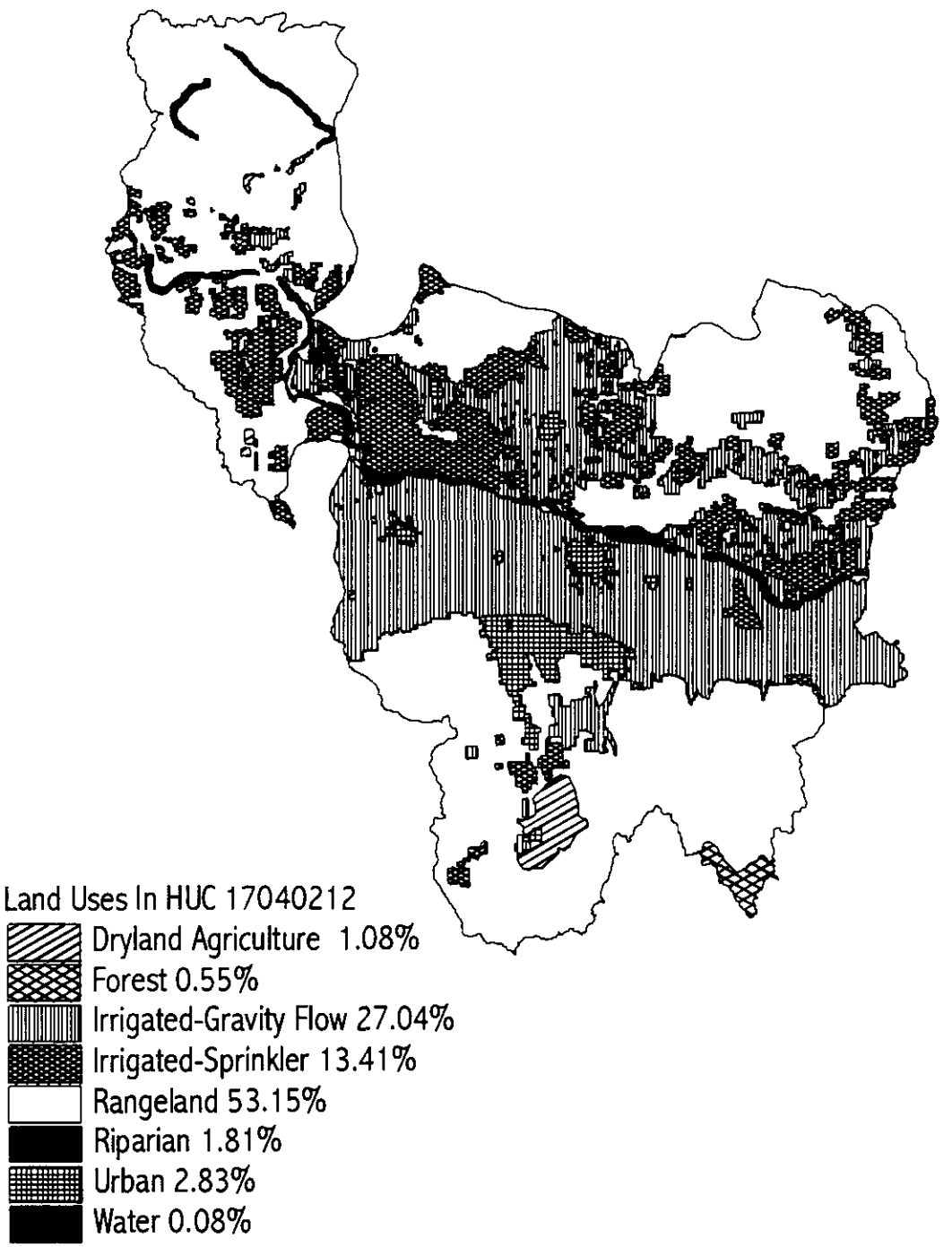


Figure 7 Landuse and ownership in Upper Snake Rock

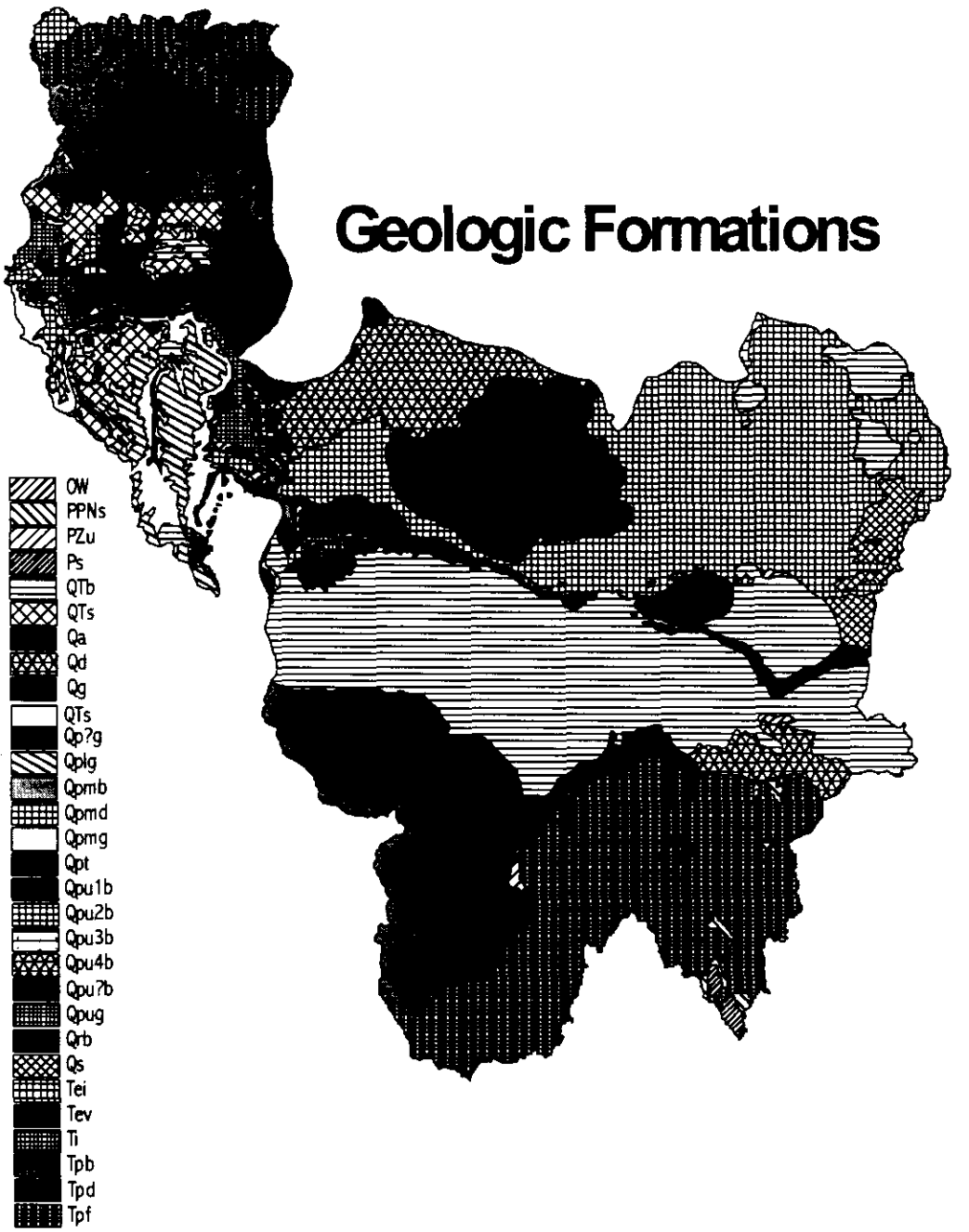


Figure 8 Soils of Upper Snake Rock



Figure 9. General geology of Upper Snake Rock

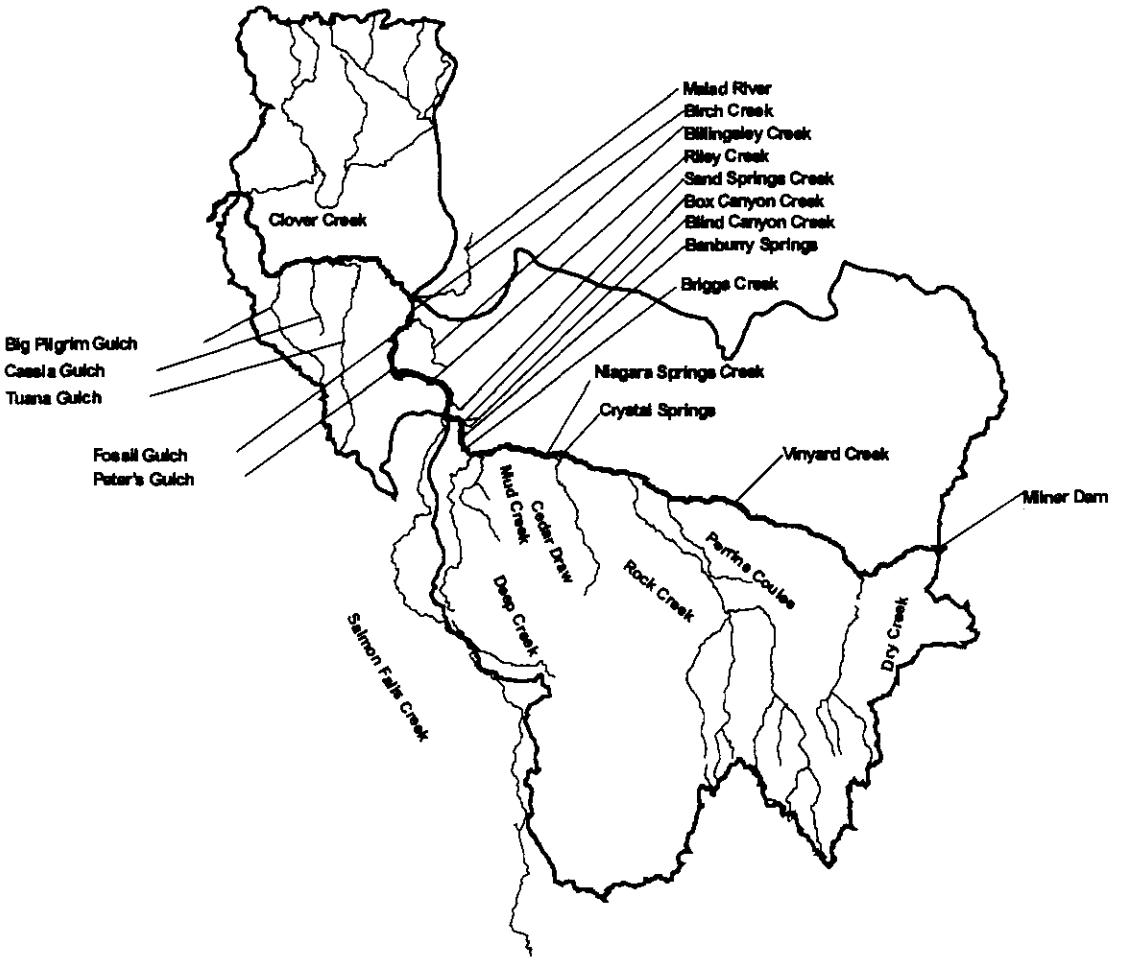


Figure 10 Summary of various tributary inputs into the Middle Snake River

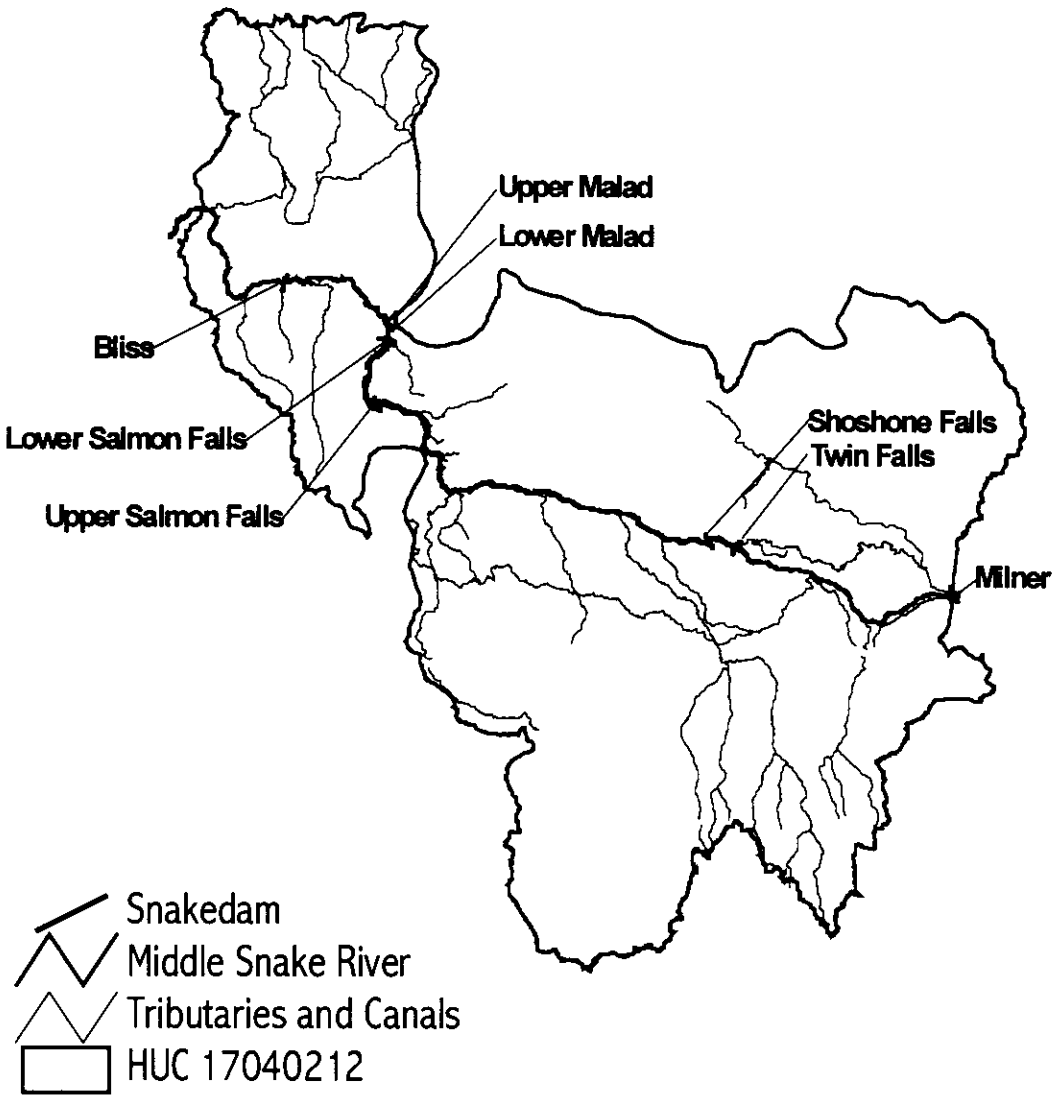
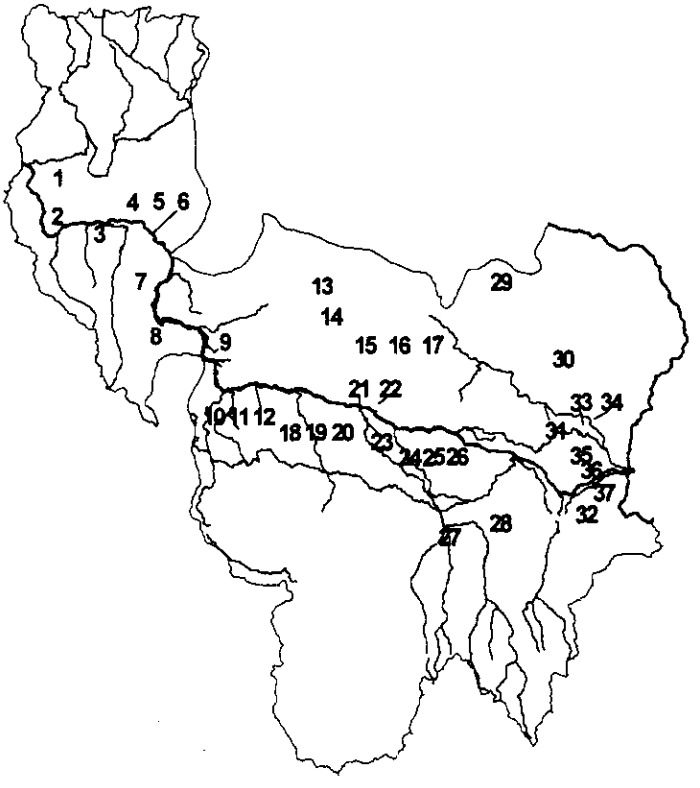


Figure 11a Major impoundments on the Middle Snake River



1. Freeway Drop
2. Dike
3. Bliss
4. A. J. Wiley
5. Stevenson No. 2
6. Stevenson No. 1
7. Lower Salmon
8. Upper Salmon Falls
9. Blind Canyon
10. Kanaka Rapids
11. Empire
12. Boulder Rapids
13. North Side Jerome
14. North Side Jerome
15. North Side Jerome
16. North Side Jerome
17. North Side Jerome
18. Cedar Draw Creek
19. Sahko
20. LQ-LS Drains
21. Rock Creek
22. Auger Falls*
23. Rock Creek No. 2
24. Kasel-Witherspoon
25. Shoshone Falls
26. Twin Falls
27. Lower Low Line
28. Low Line Canal Drop
29. Dietrich Drop
30. Mile-28 Water Power
31. Wilson Lake
32. Star Falls*
33. Hazelton A
34. Hazelton B
35. Bypass
36. Milner
37. Milner

* Proposed Projects

Figure 11b Additional power generation projects near the Middle Snake River



Figure 12 The Eastern Snake River Plain Aquifer in Upper Snake Rock

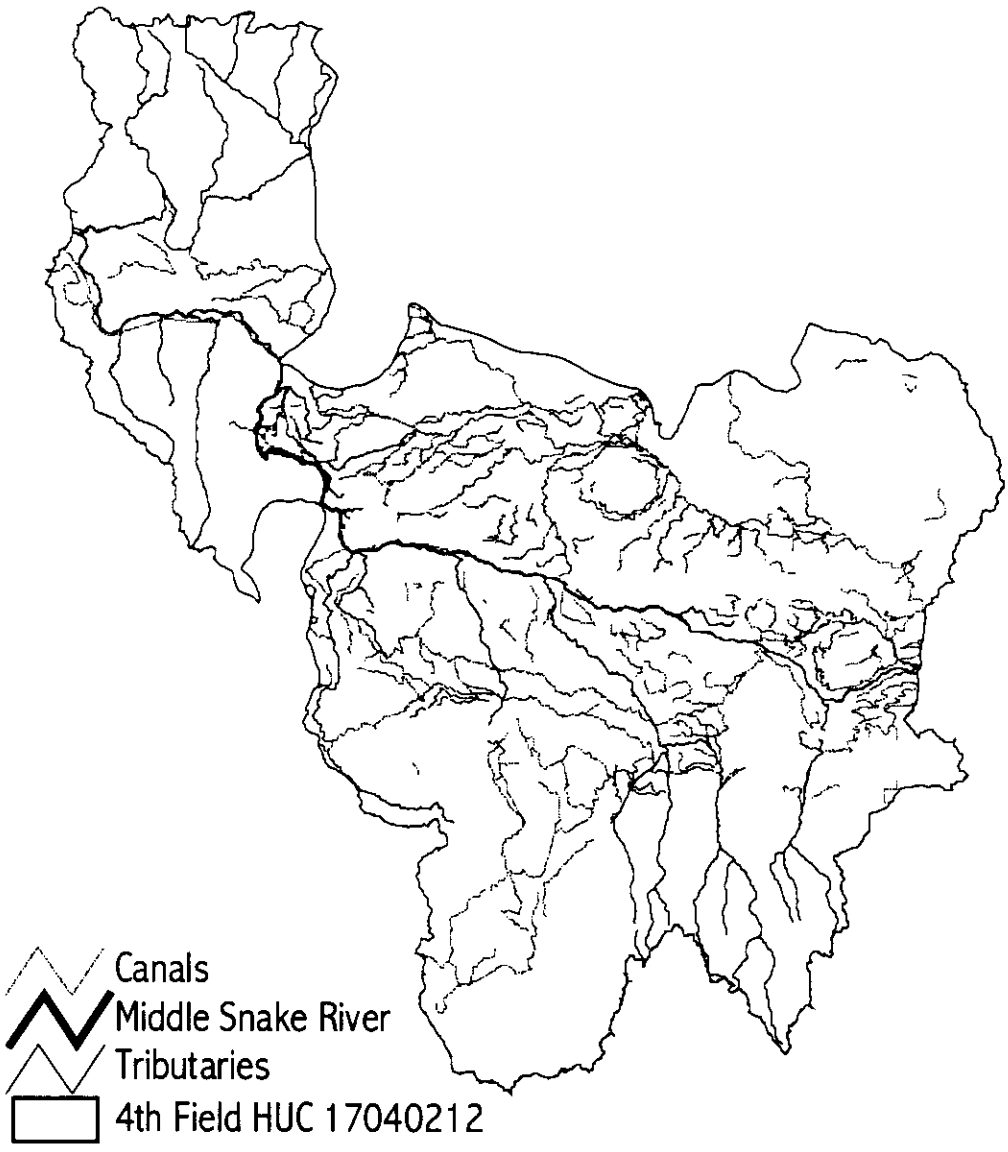
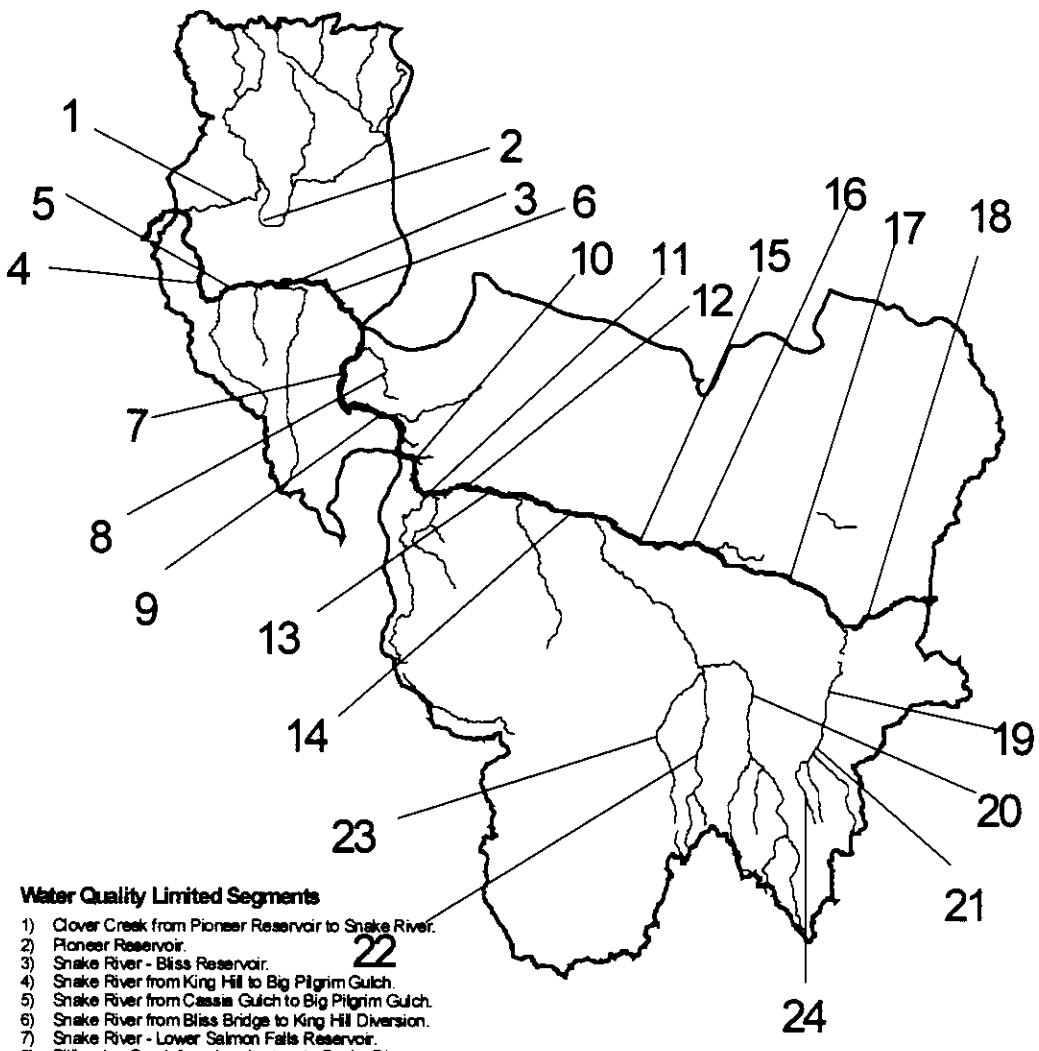


Figure 13 Canal system integration with tributaries and the Middle Snake River



Water Quality Limited Segments

1) Clover Creek from Pioneer Reservoir to Snake River.
2) Pioneer Reservoir.
3) Snake River - Bliss Reservoir.
4) Snake River from King Hill to Big Pilgrim Gulch.
5) Snake River from Cassia Gulch to Big Pilgrim Gulch.
6) Snake River from Bliss Bridge to King Hill Diversion.
7) Snake River - Lower Salmon Falls Reservoir.
8) Billingsley Creek from headwaters to Snake River.
9) Snake River - Upper Salmon Falls Reservoir.
10) Blind Canyon Creek from headwaters to Snake River.
11) Snake River from Deep Creek to Mud Creek.
12) Snake River from Mud Creek to Clear Lakes Bridge.
13) Snake River from Clear Lakes Bridge to Cedar Draw.
14) Snake River fromn Cedar Draw to Rock Creek.
15) Snake River from Rock Creek to Shoshone Falls.
16) Snake River - Shoshone Falls Reservoir.
17) Snake River from Twin Falls Reservoir to Murtaugh.
18) Snake River from Murtaugh to Milner Dam.
19) Dry Creek from Medley Creek to Snake River.
20) Rock Creek from Rock Creek Town to Snake River.
21) Dry Creek from headwaters to Medley Creek.
22) McMullen Creek from headwaters to Cottonwood Creek.
23) Cottonwood Creek from headwaters to Rock Creek.
24) West Fork of Dry Creek from headwaters to Dry Creek.

Water Quality Limited Segments Not Shown

25) Alpheus Creek from headwaters to Snake River.
26) Clear Springs from headwaters to Snake River.
27) Crystal Springs from headwaters to Snake River.
28) Ellison Creek from headwaters to Snake River.
29) Riley Creek from headwaters to Snake River.
30) Thousand Springs Creek from headwaters to Snake River.
31) Vinyard Creek from headwaters to Snake River.

Figure 14 Water quality limited stream segments of Upper Snake Rock

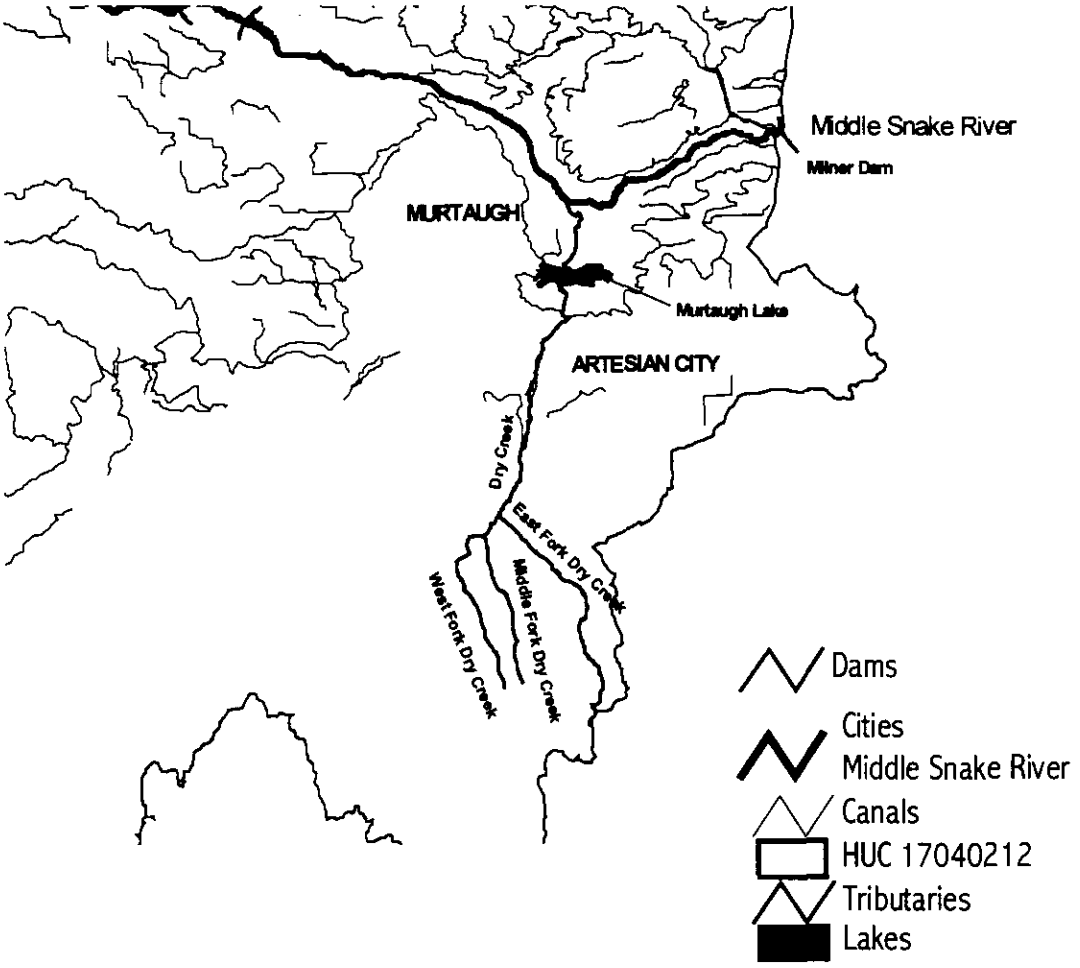


Figure 15 Dry Creek (Murtaugh) Complex of Upper Snake Rock

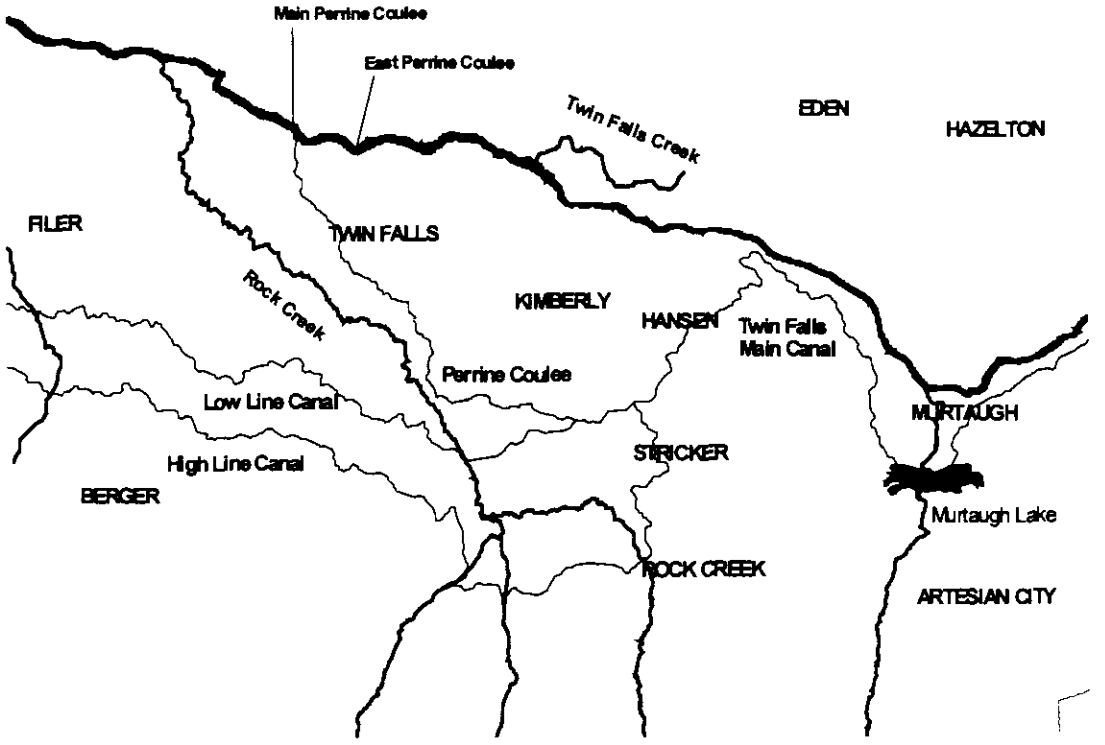


Figure 16 The Perrine Coulee System of Upper Snake Rock

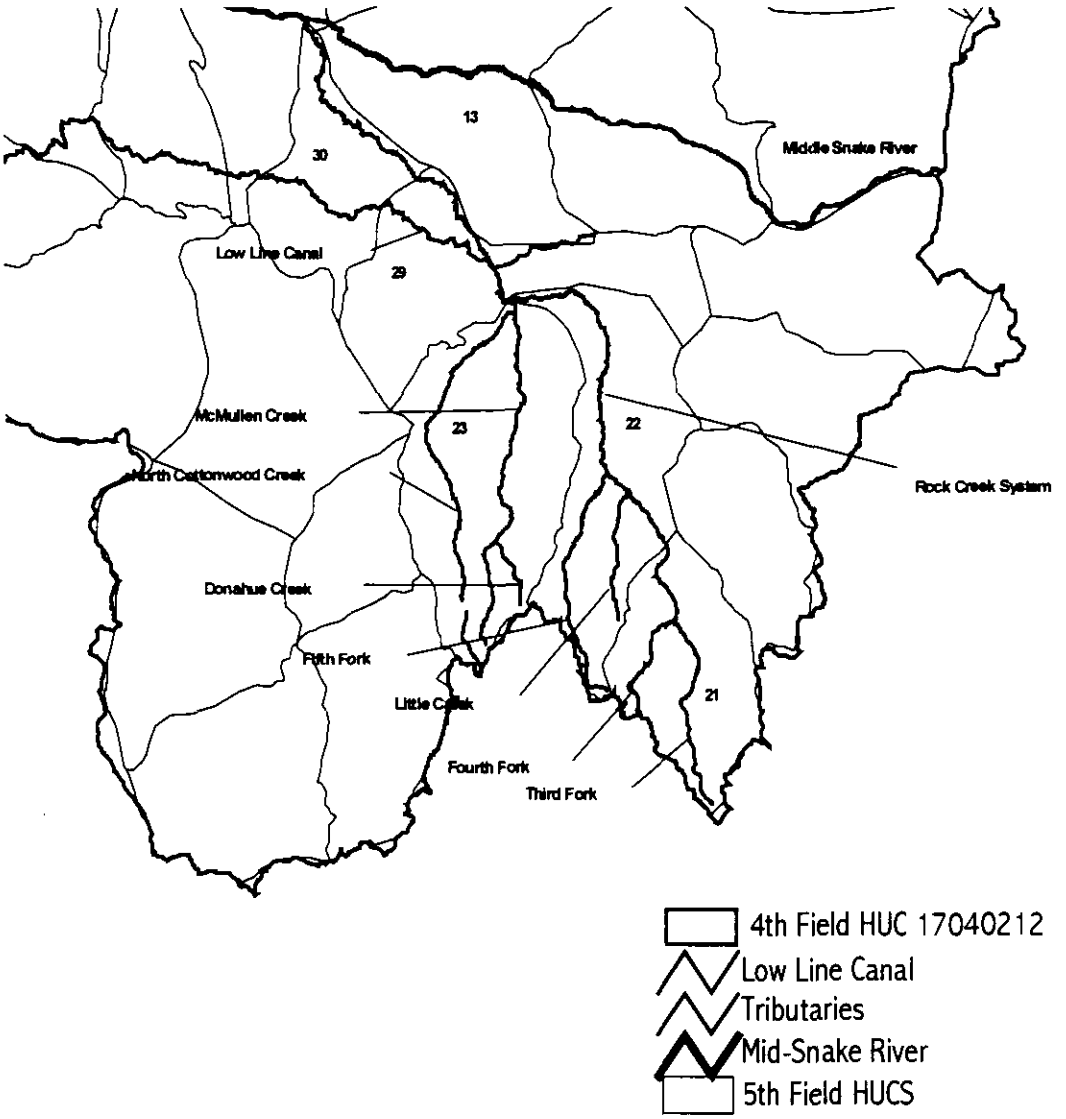


Figure 17 The Rock Creek Complex of Upper Snake Rock

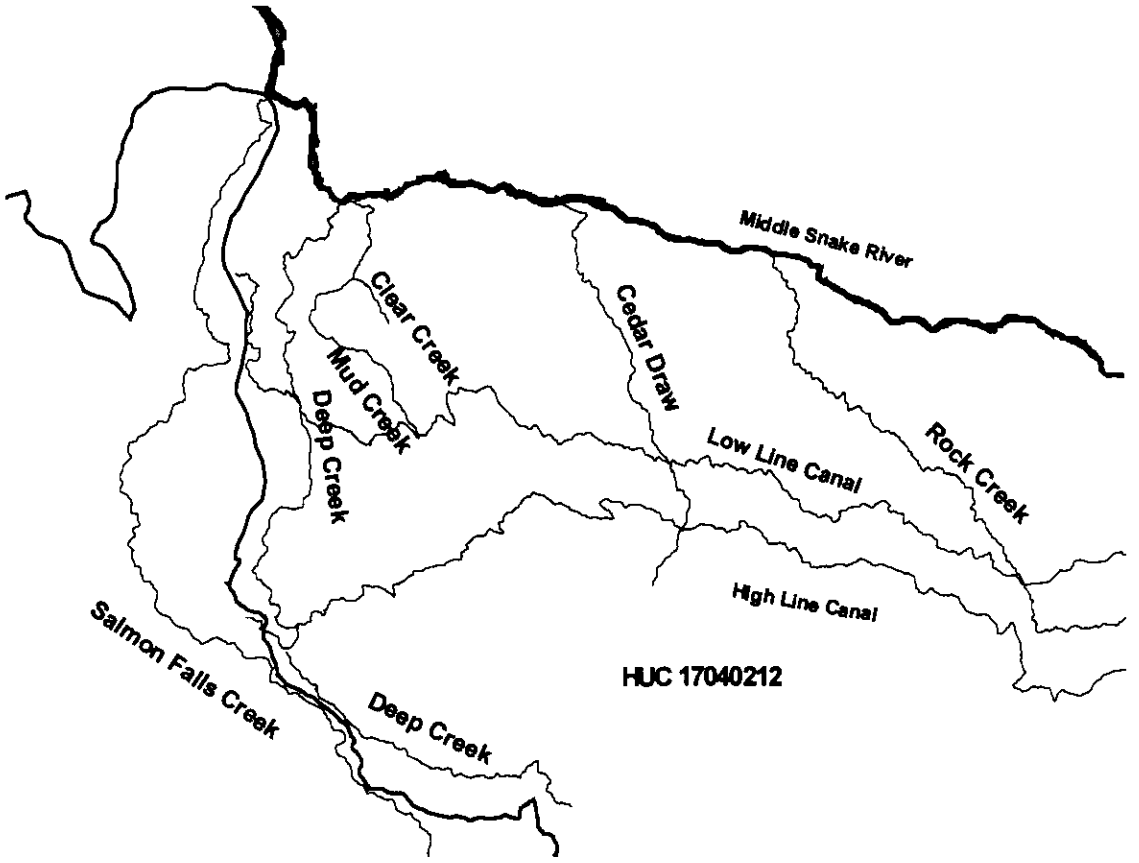


Figure 18 Cedar Draw, Mud Creek, and Deep Creek in Upper Snake Rock

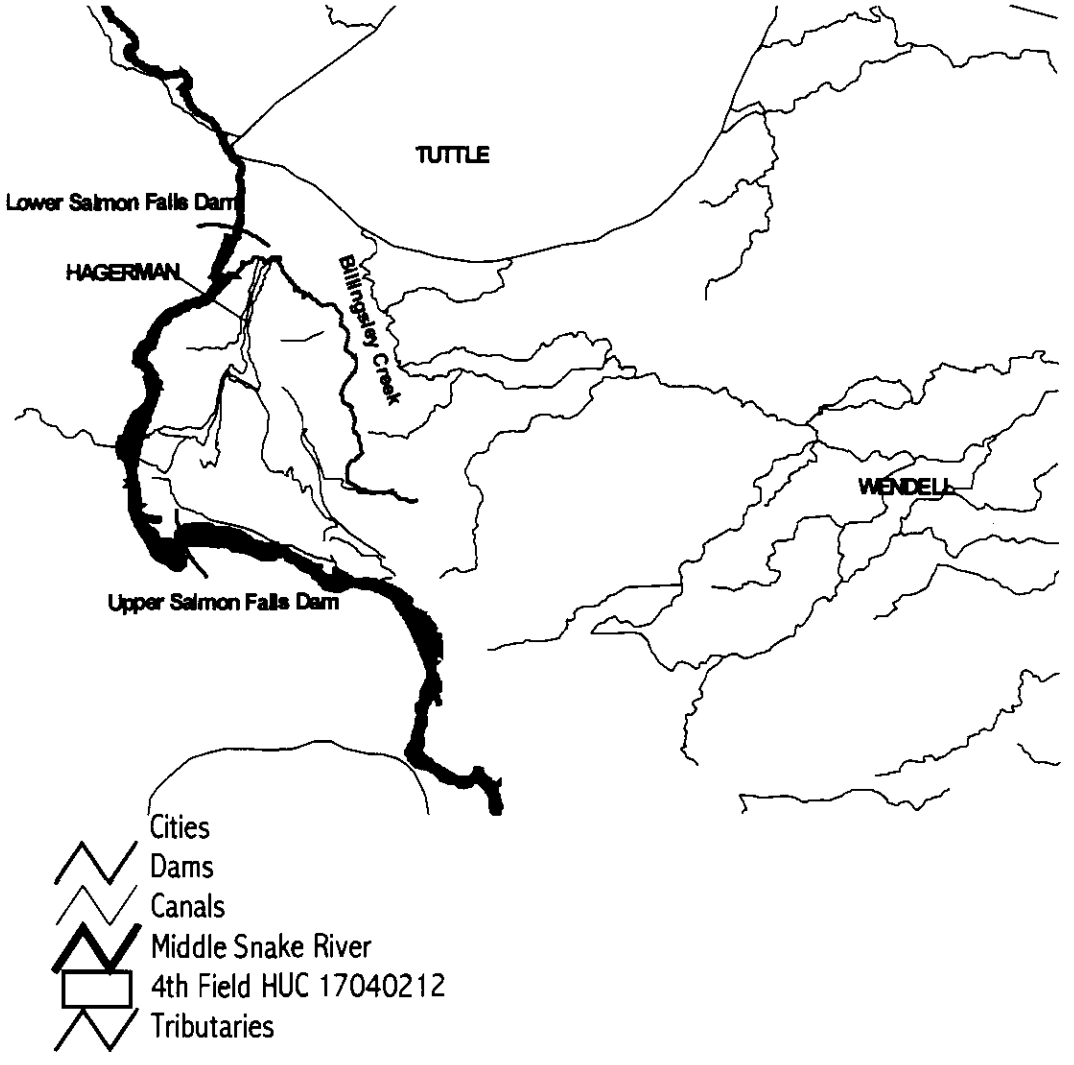


Figure 19 Billingsley Creek in Upper Snake Rock

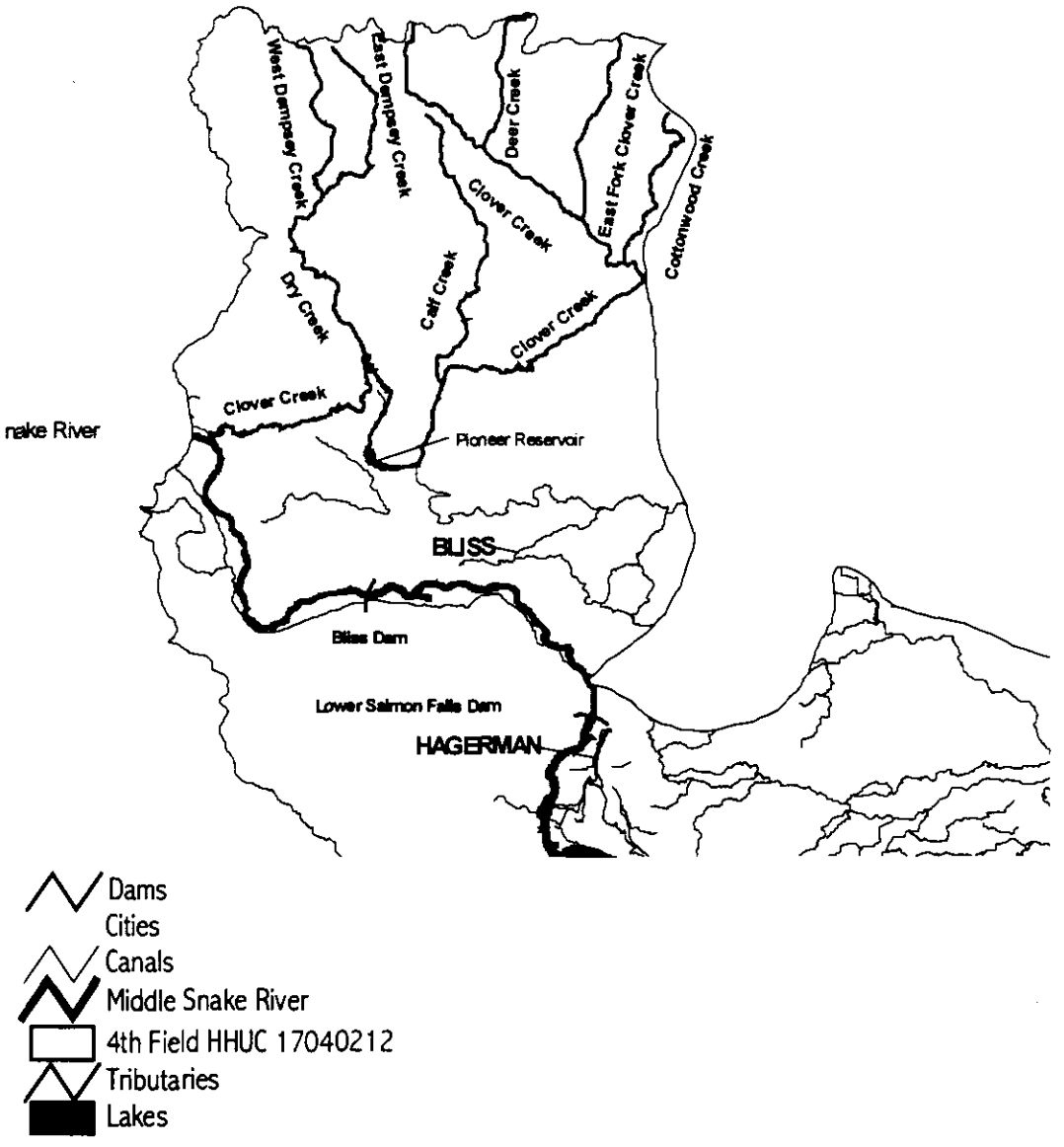


Figure 20 The Clover Creek Complex of Upper Snake Rock

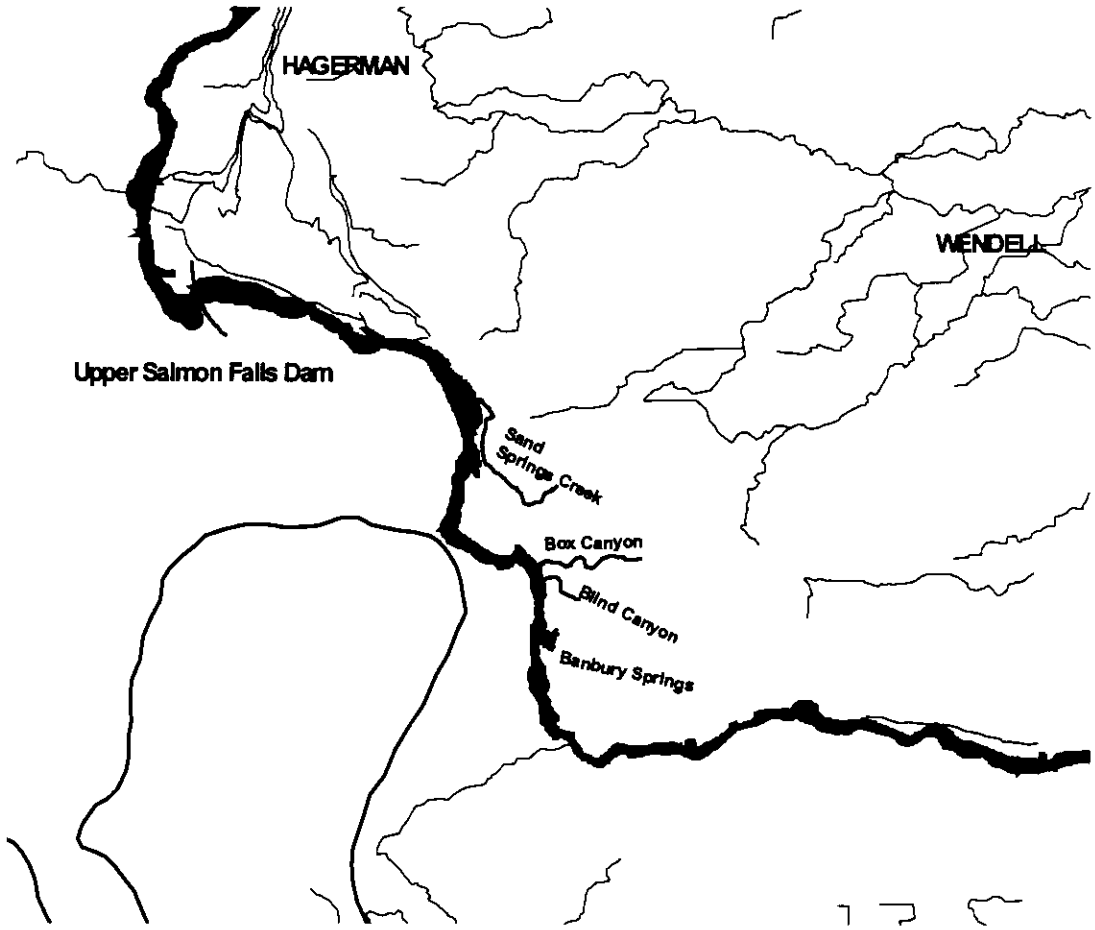


Figure 21 Box Canyon, Blind Canyon, and Sand Springs Creek.

2.2 WATER QUALITY CONCERNS AND STATUS

Sixteen (16) tributaries, five (5) reservoirs, and ten (10) river segments on the Middle Snake River from the Upper Snake Rock subbasin are listed in TABLE 22 (for a total of 31 waterbodies). The table reflects the 1996 303(d) list (which was a continuation of the 1994 list. The overall basis on which these streams were selected as water quality limited stream segments was based on best professional judgment (BPJ). BPJ assessment included evaluating the designated beneficial uses on a hydrologic unit basis (HUC) as being full support, threatened, partially supporting, not supporting, not being attained, or not assessed.

TABLE 22. 1996 POLLUTANTS/STRESSORS OF WATER QUALITY IMPAIRED STREAMS IN UPPER SNAKE ROCK.

STREAM NAME (STREAM MILES)	BOUNDARIES	POLLUTANTS/STRESSORS S	N	DO	NH3	FA	T	TM	PG	PC	O
TRIBUTARIES											
Alpheus Creek	From headwaters to the Snake River	X	X	X							
Billingsley Creek	From headwaters to the Snake River	X		X	X	X					
Blind Canyon Creek	From headwaters to the Snake River	X	X	X	X	X			X		
Clear Springs	From headwaters to the Snake River	X	X	X	X						
Clover Creek	From Pioneer Reservoir to the Snake River	X									
Cottonwood Creek	From headwaters to Rock Creek	X	X		X	X			X	X	
Crystal Springs	From headwaters to Snake River	X	X	X	X	X					
Dry Creek	From Medley Creek to Snake River	X				X		X	X		
Dry Creek	From headwaters to Medley Creek	X				X		X	X		
Dry Ck, West Fork	From headwaters to Dry Creek	X	X	X		X			X		
Ellison Creek	From headwaters to Snake River	X	X	X	X	X			X		
McMullen Creek	From headwaters to Cottonwood Creek	X	X	X		X		X	X		
Riley Creek	From headwaters to Snake River	X	X	X	X				X		
Rock Creek	From Rock Creek Town to Snake River	X	X	X	X	X			X		X
Thousand Springs Creek	From headwaters to Snake River	X	X			X					
Vinyard Creek	From headwaters to Snake River	X	X	X	X				X		
RESERVOIRS											
Bliss Reservoir	The entire reservoir	X		X	X	X			X		
Lower Salmon Falls Reservoir	The entire reservoir	X		X		X					
Pioneer Reservoir	The entire reservoir	X	X	X	X	X	X		X		
Shoshone Falls Reservoir	The entire reservoir	X		X		X					
Upper Salmon Falls Reservoir	The entire reservoir	X		X		X					
ON THE MIDDLE SNAKE RIVER = 61.80 miles											

STREAM NAME (STREAM MILES)	BOUNDARIES	POLLUTANTS/STRESSORS S	N	DO	NH3	FA	T	TM	PG	PC	O
Middle Snake River (8.53 miles)	From Milner Dam to Murtaugh	X		X		X		X	X		
Middle Snake River (7.27 miles)	From Cedar Draw to Rock Creek	X					X				
Middle Snake River (6.10 miles)	From Clear Lakes Bridge to Cedar Draw	X					X				
Middle Snake River (0.11 miles)	From Deep Creek to Mud Creek	X					X				
Middle Snake River (9.31 miles)	From King Hill to Big Pilgrim Gulch	X					X				
Middle Snake River (1.33 miles)	From Mud Creek to Clear Lakes Bridge	X					X				
Middle Snake River (8.25 miles)	From Shoshone Falls to Rock Creek	X					X				
Middle Snake River (3.47 miles)	From Cassia Gulch to Big Pilgrim Gulch	X	X				X				
Middle Snake River (5.78 miles)	From Bliss Bridge to King Hill Diversion	X									
Middle Snake River (11.65 miles)	From Murtaugh to Twin Falls Reservoir	X		X	X				X		

S = Sediment; N = Nutrients; DO = Dissolved Oxygen; NH3 = Ammonia; FA = Flow Alteration; T = Temperature; TM = Thermal Modification; PG = Pathogens; PC = Pesticides; O = Oil and Grease. Temperature and Thermal Modification mean essentially one in the same thing and may be combined.

2.2.1 GENERAL INFORMATION ON POINT AND NONPOINT SOURCES

Two major sources of pollutants are identified in Upper Snake Rock: point and nonpoint source. Point sources include: aquaculture, food processors, municipalities, and industrials. Their pollutants as defined in their permits include: ammonia; BOD; biological wastes; deleterious materials; fecal coliform and other bacteria; floating, suspended or submerged matter; nutrients, including phosphorus and nitrogen compounds; oil and grease; oxygen-demanding materials; residual disinfectants, including total residual chlorine; residual disease control drugs and other chemicals; residual feed and nutritional supplements; sediment; settable solids; temperature and pH; total suspended solids; toxic substances; and turbidity (USEPA 1997b-i).

For Upper Snake Rock, the nonpoint sources include: irrigated and nonirrigated agriculture, grazing, confined feeding operations (CFOs), NPDES permitted CAFOs, urban runoff/storm sewers, and recreation. Their pollutants include: sediment, nutrients, pathogens, salts, toxics substances, petroleum products, and pesticides are the pollutants contributed to surface and ground water (USEPA 1997k [pp xii, 1-4])." "Pollutants-of-concern resulting from these [nonpoint source] activities include sediment, bacteria, nutrients, organic enrichment, and pesticides (IDHW 1991b [p2])." "In 1988 IDEQ conducted an assessment of non-point source pollution in Idaho [*and concluded that*] the primary non-point source activities in the region are agriculture, hydrologic modification, forest practices, and some construction and mining. Agriculture is by far the greatest source of non-point source pollution to...river impoundments (IDHW 1991b [p2])."

In the Mid-Snake TMDL (IDEQ 1997b) irrigated and nonirrigated agriculture, CFOs, NPDES permitted CAFOs, and urban runoff/storm sewers are discussed and defined. Grazing was not defined and was referenced as "to be defined more fully within five years of the final plan (IDEQ 1997b [p 73])." The "final plan" is the Mid-Snake TMDL, but also includes the Upper Snake Rock TMDL. One of the priniciple concerns of over-grazing is the degradation of riparian sites. Livestock grazing in riparian areas is a controversial issue (UI-IFWRPAG 1997 [p 6]). "Grazing by livestock has had the most destructive effect upon riparian vegetation (Platts 1983 [p 83]; Armour *et al.* 1991 [p 7])." Exclusion of grazing animals from the affected areas may not completely allow riparian habitats and revegetation programs to recover. For the grazing industry, the following concerns which ultimately affect water quality need to be considered:

1. VEGETATION FOR STREAMSIDE COVER

Many studies have documented that salmonid abundance declines as stream cover is reduced, and that it increases as stream cover is added. Stream cover is highly significant in determining fish biomass and fish populations. Thus, trees, brush, grasses, and forbs each play an important role in building and maintaining productive streams: trees to provide shade and streambank stability; brush to provide cover for streambank protection and stability; and, grasss and forbs to provide vegetative mats and sod banks that reduce surface erosion and mass wasting of streambanks (Platts 1983 [p 184]).

2. VEGETATION FOR STREAMBANK STABILITY

The elimination of streamside vegetation and the caving in of overhanging streambanks by animals are the principal factors contributing to the decline of native trout populations in western streams (Armour *et al.* 1991 [p 7]). Streambank erosion or collapsing have been going on since banks were first formed by glaciation, floods, drought, debris flows, and ice flows, but this for the most part occured over prolonged time and in equilibrium with bank rebuilding processes so that as banks were naturally being eroded there were just as many banks being built. During the past century this state of equilibrium has been upset by altering the banks much faster then they can be rebuilt (Platts 1983 [p 185]). Several studies have noted that the average stream temperature dropped 12°F in an enclosure that was ungrazed for 10 years (Armour *et al.* 1991 [p 9]).

3. VEGETATION FOR STREAM TEMPERATURE CONTROL

Streamside vegetation shades the stream and reduces water temperatures. Solar radiation accounts for about 95% of the heat input into Intermountain West streams during the midday periods in mid-summer. Because streamside vegetation has been reduced and helped to increase summer stream temperatures, there has been a gradual shift in the management of game fish to less non-game fish tolerant to higher stream temperatures. Streams in the west that have had a change in the riprarian plant forms (from brush to grass), are often too warm in the summer and too cold in the winter (Platts 1983 [pp 186-187]). Additionally, several studies have attributed high *E. coli* counts in streams to livestock. Mortality for rainbow trout can exceed 75% when sediments elevate to 200 mg/L, which is a common occurrence in streams damaged by improperly managed grazing (Armour *et al.* 1991 [p 9]).

4. VEGETATION FOR FISH PRODUCTION

Streamside vegetation provides habitat for terrestrial insects, which are an important part of the fish diet. The vegetation also provides direct organic material to the stream which makes up 50% of the stream's nutrient energy supply for the food chain. Removal of streamside vegetation can affect the diet of fish by reducing both the terrestrial and aquatic insect production (Platts 1983 [p 187]). Additionally, stream-channel sedimentation caused by soil erosion has been recognized as a major watershed-fisheries problem (Armour *et al.* 1991 [p 7]).

5. VEGETATION FOR CHANNEL HYDROLOGY CHANGES

Livestock grazing can affect the riparian environment by changing and reducing vegetation or by actual elimination of riparian areas by channel wideing, channel aggradation, or lowering of the water table. Areas heavily grazed by sheep have been found to be four times as wide when compared to adjacent areas lightly grazed. Studies have shown that livestock grazing on the vegetative cover causes caving in of overhanging streambanks (thus causing the streams to widen), probably affecting

fish populations. Vegetation influences hydrologic conditions within a watershed. Any activity, including grazing, that decreases vegetation can result in adverse hydrological conditions (Armour *et al.* 1991 [p 9-10]).

6. VEGETATION FOR REDUCTION IN NUTRIENT LOSSES

The highest concentration of nutrients in stream water samples is highest when cattle are present in a watershed (Jawson *et al.* 1982 [p 630]). Moderate grazing intensities generally do not increase nutrient concentrations in surface runoff or stream water. In fact, grazing intensity is the most important variable affecting response of upland range to cattle grazing (UI-IFWRPAG 1997 [p 13]).

2.2.2 WATER QUALITY LIMITED SEGMENTS OCCURRING IN THE SUBBASIN

As previously described in §2.1.2.1, "...the topography [*of Upper Snake Rock*] is such that the majority of the subbasin drains into the Middle Snake River, whether it be from natural drainage or the myriad of miles of canal drains and laterals." By definition, all of the waters in the Upper Snake Rock subbasin drain towards the Middle Snake River (with some minor exceptions). See also §2.1.3.6. Therefore, it may be concluded that the water quality of the tributaries or any discharging waterbody to the Middle Snake River will directly effect the water quality of the Middle Snake River.

Initially, the IDEQ-TFRO will do a total maximum daily load (TMDL) on water quality limited streams that are listed on the 1996 303(d) list, whether they be perrenial or intermmitent (or ephemeral). According to §39-3602.27, a TMDL means "a plan for a water body not fully supporting designated beneficial uses and includes the sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources, and natural background levels of the pollutant impacting the water body." And, the definition of water quality limited streams applies only when water is present in the stream. Then, §39-3602.28 defines "waters or water body" as "the accumulations of surface water, natural and artificial, public and private, or parts thereof which are wholly or partially within, flow through or border upon this state...and shall not include municipal or industrial wastewater treatment or storage structures or private reservoirs, the operation of which has no effect on waters of the state." Therefore, man-made waterways will not be considered for TMDL development at this time.

As part of the development of the subbasin assessment, 303(d) listed waterbodies were classified according to USGS hydrological GIS coverages (ArchView 1996). The coverage indicates whether a waterbody is intermittent, perennial, or man-made. Unless the IDEQ had evidence contrary to the USGS data, the USGS designation was used for waterbody typing.

2.2.2.1 THE MIDDLE SNAKE RIVER

The Middle Snake River and its tributaries have altered streamflow dynamics. These have created changes in the balance of erosion/transport and deposition reaches and increased the levels of seasonal suspended sediment. The flows in the Middle Snake River are highly regulated for agricultural irrigation. Under extreme low flow conditions the water quality is adversely impacted (USDA & USDI/BLM 1997a). In fact, where excess irrigation occurs: "erosion washes soil away...and water-borne silt contaminates the rest of the irrigation system, the river, and the groundwater (Palmer 1991)." The published sources for water quality concerns and the status of those segments on the Middle Snake River listed on the §303(d) list are summarized in Table 23. These literature sources are used as the basis for which the segments are listed.

TABLE 23. SOURCES DEFINING WATER QUALITY CONCERNS FOR THE MIDDLE SNAKE RIVER

STREAM SEGMENT	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
MIDDLE SNAKE RIVER													
Milner Dam to Murtaugh	378	X	X	X	X	X	(X)	X	X	(X)	X	X	X
Cedar Drw to Rock Creek	374			X		X	X	X	X	(X)	X	X	X
Clear Lakes Bdg to Cedar Drw	-			X		X	X	X	X	(X)	X	X	X
Deep Creek to Mud Creek	-	X		X		X	X	X	X	(X)	X	X	X
King Hill to Big Pilgrim Gch	371	X		X		X	X	X	X	(X)	X	X	X
Mud Creek to Clear Lakes Bdg	-			X		X	X	X	X	(X)	X	X	X
Rock Creek to Shoshone Falls	374.1	X		X		X	X	X	X	(X)	X	X	X
Cassia Gch to Big Pilgrim Gch	-			X		X	X	X	X	(X)	X	X	X
Bliss Bridge to King Hill Divrs	369	X	X	X	X	X	(X)	X	X	(X)	X	X	X
Murtaugh to Twin Falls Reserv	372	X	X	X		X	(X)	X	X	(X)	X	X	X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement.* (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program.* 91 = *1993 Idaho Agricultural Pollution Abatement Plan* based on the *1979 Appendix of the Idaho Agricultural Pollution Abatement Plan.* 92 = *1992 Idaho Water Quality Status Report.* 94 = *1994 Idaho Water Quality Status Report.* 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994.* 303(d) Listed Streams: 92 = *1992 §303(d) List.* X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C.* 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D.* 98 = 1998 §303(d) List. Reserv = Reservoir. Bdg = Bridge. Drw = Draw. Gch = Gulch. Divrs = Diversion.

The 1994 and 1996 §303(d) lists identified the level of benefical support status for the Middle Snake River according to various segments on the river. These are identified in Table 24.

TABLE 24. 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR THE MIDDLE SNAKE RIVER.

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
King Hill to Pilgrim Gulch	AG	PC/SC	CW/SS	
Cassia Gulch to Big Pilgrim Gulch	AG/PC/SC		CW/SS	
Malad River to Bliss Reservoir	AG	PC/SC	CW/SS	
Lower Salmon Falls to Malad River	AG	PC/SC	CW/SS	
Hwy 30 to Upper Salmon Falls Power Plant	AG		CW	PC/SC/SS
Salmon Falls Creek to Highway 30	AG	PC/SC	CW	SS
Box Canyon to Salmon Falls Creek	AG	PC/SC	CW	SS
Deep Creek to Box Canyon	AG	PC/SC	CW	SS
Deep Creek to Mud Creek	AG	PC/SC	CW	SS
Clear Lakes Bridge to Mud Creek	AG	PC/SC	CW	SS
Cedar Draw to Clear Lakes Bridge	AG	PC/SC	CW	SS

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
Rock Creek to Cedar Draw	AG	PC/SC	CW	SS
Auger Falls to Shoshone Falls Power Plant	AG	PC/SC/CW/SS		
Shoshone Falls PP to Shoshone Falls Rsrvoir	AG	PC/SC/CW/SS		
Twin Falls Creek to Shoshone Falls Reservoir	AG	PC/SC/CW	SS	
Hansen Bridge to Twin Falls Reservoir	AG	PC/SC	CW/SS	
Dry Creek to Hansen Bridge	AG		CW/SS/PC/SC	
Milner Lake to Dry Creek	AG		CW/SS/PC/SC	

Prepared by IDEQ-TFRO. Based on the 1994 and 1996 §303(d) lists. PP = Power Plant. Rsrvoir = Reservoir. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning.

Additionally, agricultural nonpoint sources have historically affected the listed segments of the Middle Snake River as indicated in Table 25.

TABLE 25. AGRICULTURAL NONPOINT SOURCE EFFECTS ON THE MIDDLE SNAKE RIVER.

MIDDLE SNAKE RIVER SEGMENTS	IRRIGATED CROPLAND			LIVESTOCK GRAZING		
	Slight	Moderate	Severe	Slight	Moderate	Severe
Milner Dam to Murtaugh			Sediment	X		
Murtaugh to Twin Falls Reservoir			Sediment	X		
Shoshone Falls to Rock Creek			Sediment	X		
Cedar Draw to Rock Creek			Sediment	X		
Clear Lakes Bridge to Cedar Draw			Sediment	X		
Mud Creek to Cedar Draw			Sediment	X		
Deep creek to Mud Creek			Sediment	X		
Cassia Gulch to big Pilgrim Gulch		Sediment		X		
King Hill to Big Pilgrim Gulch		Sediment		X		
Bliss Bridge to King Hill Diversion		Sediment		X		

Prepared by IDEQ-TFRO. Dryland cropland was shown to not directly affect the Middle Snake River. Descriptors of Irrigated Cropland and Livestock Grazing provided by Soil Conservation Commission and Soil Conservation Districts from *Soil Conservation Commission, 1979, Idaho Agricultural Pollution Abatement Plan, Tables 2 & 3.* An X describes the general effect but not the specific agricultural effect from sediment.

Point source industries (like aquaculture, food processors, municipalities, and industrials) also contribute pollution. In general, "the Middle Snake River exhibits severe eutrophication from nutrient enrichment (www._____ 1997h)" that comes from both point and nonpoint sources. This eutrophication appears to be heightened during low flow/drought years, because during the 1996-1997 water years (years in which high flows were very characteristic) eutrophication and nuisance macrophytes were not as evident in those locations (Crystal Springs, Niagara Springs, Box Canyon) previously known to be severely afflicted by water quality problems.

Thus, the degradation of water quality on the Middle Snake River is caused by flow modifications, agricultural

activities, urbanization, hydroelectric activities, industrial activities, impoundments, municipal waste, flood control, mining, forestry, aquaculture, and habitat conversion. Additionally, whitewater boating opportunities are severely limited by reduced flow effects from hydroelectric and irrigation facilities. Recreational cold-water fishing is reduced as is limited hunting opportunities (USDA & USDI/BLM 1997a). Also, although there has been a loss in natural wetlands, there has been some significant amount of artificial wetlands created by irrigation water and irrigation flows (USDA/SCS 1998). On the other hand, opportunities for warmwater fishing, flatwater recreation, picnicking, and sightseeing improves by creation of reservoirs and developed recreation sites.

2.2.2.2 SALMON FALLS CREEK

As noted in §2.1.3.6, Salmon Falls Creek, although representing a separate and distinct subbasin (HUC 17040213), discharges directly into the Middle Snake River, thus impacting its water quality. "Water quality within the Salmon Falls River watershed is impacted by non-point source pollution. The pollutants of primary concern include sediment, phosphorus, nitrogen, and bacterial contamination. The water quality standards typically violated include low dissolved oxygen, high water temperature, and the presence of coliform bacteria. The prinicipal activities affecting water quality within the watershed include: irrigated agriculture, pasture and rangeland grazing. Water quality above Salmon Falls Reservoir is impacted principally by rangeland grazing. Downstream from Salmon Falls Reservoir the flows are highly regulated and water quality is influenced more by irrigated farmland and pasture grazing. It should be noted that very little water is ever released from Salmon Falls Dam down Salmon Falls Creek to the Middle Snake River. The overall water quality condition of the Salmon Falls River watershed is fair to poor (IDHW 1994)." This is supported by water quality monitoring conducted by IDEQ-TFRO since 1990. Historically, agricultural nonpoint sources have affected the Salmon Falls River slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]).

2.2.2.3 MALAD RIVER DRAINAGE

As noted in §2.1.3.6, the Malad River discharges to the Middle Snake River (at RM571.42) It includes drainage from Camas Creek (HUC 17040220), Big Wood River (HUC 17040219), and Little Wood River (HUC 17040221). Historically, agricultural nonpoint sources have affected the Malad River (from Magic Dam to the mouth with the Middle Snake River) moderately from irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 3]). The Camas Creek subbasin is heavily impacted by non-point source pollution from irrigated agriculture, and pasture and rangeland grazing (IDHW 1994; ISCC 1979 [Table 3]). The Big Wood River subbasin is impacted by point and non-point source pollution from irrigated agriculture, pasture and rangeland grazing, confined animal feeding operations, and municipal wastewater treatment plants (IDHW 1994; ISCC 1979 [Table 3]). The Little Wood River subbasin is impacted by non-point source pollution from irrigated agriculture, pasture and rangeland grazing, and confined animal feeding operations (IDHW 1994; ISCC 1979 [Table 3]).

2.2.2.4 RESERVOIRS AND LAKES

"Artificial river impoundments dominate this region of the state. Many are reservoirs on the main stem of the Snake River created for irrigation water storage and power generation (IDHW 1991b)." The Middle Snake River hydropower projects have significantly changed the river environment and the river's ability to assimilate wastes and have created a range of impacts. The issue of flow modification is one of timing (as seasonal shifts and changes) and volume. Timing is critical because of the hydroelectric development itself, flow augmentation, flood control, dam operations, and irrigation (as diversions, pumping, and return flows). Volume is critical because of the development of the hydroelectric development itself, irrigation, municipal water consumption, agricultural development, aquaculture, mining, and impoundments. Timing and volume affect the fisheries resource in the potential anadromous fish spawning and rearing habitat, native resident

fish, listed snails, riparian vegetation, recreational use, aesthetics, and cultural resources. The effects are on habitat loss, unsuitable water temperature, alteration of sediment transport resulting in the loss of spawning habitat and loss of sand and gravel bar recruitment (USDAFS & USDI/BLM 1997a)." The dams on the Middle Snake River have had the effect of "converting much of the river into lakes. In addition, diversions greatly reduce the flows along the river. These two aspects of development have greatly influenced the quality of the waters (Parametrix 1977)." Table 26 illustrates those sources that define water quality concerns for the reservoirs in Upper Snake Rock.

TABLE 26. LITERATURE SOURCES DEFINING WATER QUALITY CONCERNS FOR THE RESERVOIRS IN UPPER SNAKE ROCK.

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Bliss Reservoir	370.00	X	X	X	X		(X)	X		(X)	X	X	X
Lower Salmon Falls Res.	372.00	X	X	X	X	X	(X)	X	X	X	X	X	X
Pioneer Reservoir	380.00	X	X	X	X		X		X	(X)	X	X	X
Shoshone Falls Reservoir	375.00	X		X	X	X	X	X	X	(X)	X	X	X
Upper Salmon Falls Reser.	373.00	X	X	X	X	X	(X)	X	X	X	X	X	X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement.* (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program.* 91 = *1993 Idaho Agricultural Pollution Abatement Plan.* 92 = *1992 Idaho Water Quality Status Report.* 94 = *1994 Idaho Water Quality Status Report.* 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994.* 303(d) Listed Streams: 92 = *1992 §303(d) List.* X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C.* 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D.* 98 = 1998 §303(d) List.

Additionally, hydroelectric impoundments and their associated reservoirs exacerbate the following problems:

1. "Artificial impoundments alter the natural hydrograph of the Middle Snake River system which in-turn affects the biological communities. A prime example is white sturgeon spawning. White sturgeon is typically key on spring-time changes in flow and temperatures to maximize reproductive success. With dams regulating upstream flow, the hydrograph flattens and changes in peak events no longer occur at the same time as they historically occured. Now, sturgeon spawning is sometimes not cued (or spawning occurs) and then drastic regulated flow changes alter temperatures and wetted channel area which reduces reproductive success (IDFG 1998c)."

2. "The hydropower projects alter the physical characteristics of the river, which in turn affects water quality and habitat conditions. Riverine characteristics affected by the dams include water velocity, discharge, water depth, and water retention times. Water quality changes associated with the operations of the hydropower projects include dissolved oxygen, temperature modification, gas supersaturation, sedimentation, and in-stream nutrient processing. While the hydropower plants do not add nutrients to the river, nutrient processing is increased and flushing of pollutants downstream is reduced. The impoundments behind the dams have impacts on the ability of the river to process sediment and nutrients. The loss of anadromous ecosystem is due to hydroelectric development, irrigation, flood control, and other factors (USDAFS & USDI/BLM 1997a)."

3. The "run-of-the-river" reservoirs have also altered the ability of the Middle Snake River to produce self-sustaining recreational fisheries. Insects and other invertebrates that once provided an ample food source for rainbow trout, mountain whitefish, and white sturgeon have been replaced by an insect community that is less available as a food source. Existing sport fisheries in the area include a limited population of naturally produced rainbow trout, catch and release fishing for white sturgeon,

and hatchery produced rainbow trout (although it could be argued that hatchery reared fish are a good source to supplement the limited resource). The practice of using reservoir storage to follow short-term peaks in power demand (known as "load following") adds further impacts. The resulting changes in river levels degrade downstream riparian areas and adversely affect fish populations. Load following activities create river velocities that may cause undue expenditure of energy during winter months, provide false spawning cues, increase drift of aquatic insects, and deteriorate habitat for macro-invertebrates. "The Lower Salmon Falls and Bliss Projects are operated in load-following manner, and as a result, the impoundments have fluctuated by as much as 6 feet and 5 feet, respectively, over a 24-hour period (FERC 1998 [p 41])."

4. According to USEPA, lakes and reservoirs in Upper Snake Rock when surveyed for meeting state water quality standards indicated that about 11% were threatened, about 60% were partially supporting, and about 28% were not supporting their aquatic life use (www._____ 1997 [/IDlakes-us.html]). The most prevalent causes of pollution of the surveyed acres were: about 100% of the time was siltation and nutrients, about 90% of the time was flow alteration, and about 78% of the time was pathogens and organic enrichment/low dissolved oxygen. The most prevalent sources of pollution of the surveyed acres were: about 100% of the time was agriculture and hydromodification (www._____ 1997 [/Idlakes-cs.html]). See also IDHW 1989b for a review of nonpoint source affects on reservoirs and lakes.

5. "Cold water biota and salmonid spawning have been reported as impaired...Agriculture is the main non-point source activity affecting lakes [and reservoirs] in this region. Pollutants of concern include nutrients, sediment, bacteria, and organic wastes. Water level fluctuations from irrigation water draw-downs have also impacted water quality by increasing temperatures and decreasing dissolved oxygen in some [lakes and] reservoirs (IDHW 1991b)." It should be noted that, according to Idaho Power Company, none of the mainstem Middle Snake River reservoirs drawn down for irrigation. However, "the Lower Salmon Falls and Bliss Projects are operated in load-following manner, and as a result, the impoundments have fluctuated by as much as 6 feet and 5 feet, respectively, over a 24-hour period (FERC 1998 [p 41])."

6. Ecosystems Research Institute studied the primary productivity (PP) and respiration (R) of the Middle Snake River at three reservoirs: Twin Falls, Shoshone Falls, and Upper Salmon Falls reservoirs in 1997. PPR was measured in each reservoir using the light bottle/dark bottle method, so as to use simplified stoichiometric relationships between the carbon fixed and the oxygen produced through photosynthesis, and the carbon and oxygen consumed during respiration. Average extinction coefficients for each reservoir on each date of sampling, and incident light recordings from the continuous light monitoring were used to determine the light intensity at each incubation depth throughout the water column throughout the day. Table 27 shows the average results on a monthly basis for the extinction coefficient and the depth to 1% light within each reservoir.

TABLE 27 MEAN EXTINCTION COEFFICIENTS AND MEAN DEPTH TO 1% LIGHT PER RESERVOIR.

MONTH	TWIN FALLS		SHOSHONE FALLS		UPPER SALMON FALLS	
	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%
May 1996	1.863 ± 0.154	2.5 ± 0.2	1.755 ± 0.264	2.7 ± 0.4	1.942 ± 0.144	2.4 ± 0.2
Jun 1996	1.387 ± 0.039	3.4 ± 0.1	1.366 ± 0.065	3.4 ± 0.2	1.717 ± 0.106	2.8 ± 0.3
Jul 1996	1.024 ± 0.108	4.6 ± 0.4	1.210 ± 0.153	3.8 ± 0.5	1.275 ± 0.128	3.7 ± 0.4
Aug 1996	—	—	—	—	0.978 ± —	4.7 ± —
Sep 1996	1.266 ± 0.248	3.7 ± 0.7	0.982 ± 0.108	4.7 ± 0.5	0.985 ± 0.248	4.9 ± 1.1

MONTH	TWIN FALLS		SHOSHONE FALLS		UPPER SALMON FALLS	
	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%	Ext.Coeff.	Depth to 1%
Oct 1996	1.106 ± 0.281	4.3 ± 1.0	0.869 ± 0.118	5.4 ± 0.7	0.753 ± 0.114	6.2 ± 0.9
Prepared by IDEQ-TFRO. ERI 1997.						

In general, light extinction in the reservoirs were quite high for most of the study period (May through October). For all three reservoirs extinction coefficients averaged 1.755 to 1.942 in May, then declined to averages of 0.753 to 1.106 in October, which translate to a 1% light depth of about 2.4 to 2.7 meters in May to 4.3 to 6.2 meters in October. Net primary productivity peaked at over 400 mg C/m^3/hr in early May and reached a maximum rate of about 250 mg C/m^3/hr for most of the summer. By September, the peak rate had fallen to about 120 C/m^3/hr. Total net primary production in Upper Salmon Falls Reservoir peaked in early May at almost 7000 kg C/day, and declined to a low of 1400 kg C/day by the end of the season. In contrast, both Twin and Shoshone Falls reservoirs varied between 300 and 1000 kg C/day through most of the season, dipping to negative values on one date in mid-July. When averaged over the entire reservoir volume, Upper Salmon Falls had higher rate of carbon fixation than the other two reservoirs. These values indicate that the Middle Snake River is autotrophic during the summer, and marginally heterotrophic during the spring and fall. Spring is the period of highest net primary productivity, with relatively low respiration rates due to low temperatures, but high gross production rates due to increasing light and high nutrients (ERI 1997).

7. Water quality in the Middle Snake River has deteriorated because of point and nonpoint sources, compounded by managed, altered, or reduced flows and velocities, which have yielded extensive growths of nuisance aquatic vegetation, degraded stream habitat, and elevated water temperatures. The high rates of primary productivity (as shown in item 6 above) and decomposition of aquatic vegetation causes fluctuations in dissolved oxygen that often violate Idaho water quality standards. In fact, oxygen deficits occur when "the amount of oxygen lost from the hypolimnion (the deeper, relatively cold, undisturbed region of the water column) during summer stratification not only increases with depth, but becomes increasingly depleted as the summer stratification period progresses (Wetzel 1975 [pp 137-141])." These conditions have resulted in the loss of native cold-water species (such as trout and white sturgeon) and have favored exotic and pollution tolerant species. As previously stated, hydroelectric projects do not add nutrients to the river. Instead nutrient processing is intensified and flushing of pollutants downstream is reduced. The impoundments behind the dams may have significant impacts on the ability of the river to process sediment and nutrients. Thus, the dams on the Middle Snake River (particularly Upper Salmon Falls and Lower Salmon Falls dams) have added to the water quality problems of the river in two ways: (1) the river's capacity to process nutrients has been altered to encourage plant growth, and (2) the reservoirs have created large shallows and areas of sediment deposition that are ideal for aquatic weeds. As part of the §401 Water Quality Certification for hydroelectric impoundments on the Middle Snake River under a consent order, the Idaho Power Company shall take certain specific actions to mitigate water quality impacts and achieve in conjunction with other proposed actions compliance with Idaho water quality standards.

8. The Middle Snake River dams have affected recreation by inundating or dewatering unique features such as cascades and rapids. Access to certain areas of the river have also become more difficult. According to the Idaho Department of Parks and Recreation, recreation impacts are not distinct from other categories of impacts because good water quality as well as fishing, hunting, and wildlife viewing opportunities are all essential components of recreation. Reasonable access to the river for a growing population and protection of the river's special attractions (including the remaining springs and waterfalls and the river itself) are key issues that have been impacted by the degraded water quality.

For the reservoirs the following additional sources provide water quality concerns and status of the indicated water body:

1. BLISS RESERVOIR

The water quality concerns and status of Bliss Reservoir are further substantiated in the *Idaho Power Company, New License Application for Bliss FERC Project No. 1975, 1995, pp. E2-17 to E2-20.* As prevously noted, this reservoir is listed for sediment, nutrients, dissolved oxygen, flow alteration, ammonia, and pathogens as pollutants and/or stressors of concern.

2. LOWER SALMON FALLS RESERVOIR

The water quality concerns and status of Lower Salmon Falls Reservoir are further substantiated in the *Idaho Power Company, New License Application for Lower Salmon Falls FERC Project No. 2061, 1995, pp. E2-17 to E2-20.* This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

3. UPPER SALMON FALLS RESERVOIR

The water quality concerns and status of Upper Salmon Falls Reservoir are further substantiated in the *Idaho Power Company , New License Application for Upper Salmon Falls FERC Project No. 2777, 1995, pp. E2-15 to E2-18.* Additionally, contract studies conducted on Upper Salmon Falls Reservoir indicate it is well mixed, nearly isothermal throughout the water column and along the longitudinal axis. Temperatures seldom vary by more than 1°C (ERI 1997). This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

4. SHOSHONE FALLS RESERVOIR

The water quality concerns and status of Shoshone Falls Reservoir are further substantiated in the *Idaho Power Company, New License Application for Shoshone Falls FERC Project No. 2778, 1997, pp. E2-1 to E2-15*; and, the *1983 Idaho Agriculture Pollution Abatement Plan*. Additionally, contract studies conducted on Shoshone Falls Reservoir indicate it is well mixed, nearly isothermal throughout the water column and along the longitudinal axis. Temperatures seldom vary by more than 1°C (ERI 1997). This reservoir is listed for sediment, nutrients, dissolved oxygen, and flow alteration as pollutants and/or stressors of concern.

5. TWIN FALLS RESERVOIR

The Twin Falls Reservoir is not specifically listed as a reservoir-segment on the 303(d) list, but it is included in the Middle Snake River segment (from Murtaugh to Twin Falls Reservoir). Several agency reports indicate that from Twin Falls Reservoir to Bliss Reservoir, the impoundments are exhibiting nonpoint source impacts from irrigated crop production and animal holding areas. Runoff from irrigated crop production, rangeland, pastureland, animal holding areas, feedlots, dredging, urban runoff from combined sewers and surface runoff, some construction, surface mining, land development, and its flow modification affect the watershed detrimentally. The Snake River between Bliss Reservoir and King Hill Dam is primarily impacted from irrigated crop production, rangeland, flow modification, and streambank modification (IDHW 1989b [p 37]). As a Middle Snake River segment it is listed for sediment, nutrients, dissolved oxygen, ammonia, and pathogens as pollutants and/or stressors of concern.

6. PIONEER RESERVOIR

Pioneer Reservoir is a man-made reservoir that is functions as a nonpoint source sink for the Clover Creek drainage prior to discharge to the Middle Snake River. It is highly affected by nonpoint sources of pollution. This reservoir is listed for sediment, nutrients, dissolved oxygen, flow alteration, ammonia, pathogens, and thermal modification as pollutants and/or stressors.

According to IDFG, "Upper Salmon Falls, Lower Salmon Falls, and Bliss Reservoirs have collectively inundated over 1055 acres of terrestrial and riverine habitat. Combined, the three reservoirs stretch over 12.6 miles of the Middle Snake River, inundating over 25 miles of riparian vegetation and associated uplands, with an estimated loss of 365 riparian species habitat units and 1320 upland species habitat units. In places where riparian vegetation has recolonized areas along reservoirs, it has been predominated by the non-native shrub, Russian Olive. Idaho Power Company has described the existing nongame bird community in detail and points out that bird densities average 22 times higher in riparian habitat than upland habitat, although no information is provided for comparing impounded versus unimpounded areas (FERC 1997b [Appendix A, pp 1, 3])."

Finally, the 1994 and 1996 §303(d) lists identified the level of benefical support status for various reservoirs and lakes in HUC 17040212. These are identified in Table 28.

TABLE 28 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR THE RESERVOIRS AND LAKES.

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING
Bliss Reservoir	AG	CW/SS	PC/SC	
Lower Salmon Falls Reservoir	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 372.00)	AG	PC/SC	CW/SS	
Upper Salmon Falls Reservoir (PNRS 373.00)	AG/CW	PC/SC		SS
Shoshone Falls Reservoir	AG/CW/PC/SC			SS
Twin Falls Reservoir	AG	PC/SC/CW/SS		
Murtaugh Lake	AG		PC/SC/CW/SS	
Pioneer Reservoir	AG	PC/SC/SS	CW	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning.

2.2.2.5 TRIBUTARIES

The results of the Idaho surveyed waters by USEPA for meeting state water quality standards within Upper Snake Rock for the aquatic life beneficial use show that about 1% of the waters are good, about 28% were threatened, about 51% were partially supporting, and about 19% were not supporting this benefical use (*www.epa.gov /surf/lWl/17040212/Drivers-us.html*). Water quality concern sources and the status for these tributaries are summarized in Table 29.

TABLE 29 LITERATURE SOURCES DEFINING WATER QUALITY CONCERNS FOR THE INDICATED WATER BODY

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Alpheus Creek	405.00	X		X		X			X	(X)	X	X	X

STREAM NAME	PNRS No.	86	88	89	89 NP	91	92	94	92-94	303(d) Listed Streams 92	94	96	98
Billingsley Creek	384.00	X	X	X		X	(X)		X	X	X	X	X
Blind Canyon Creek	389.00	X	X	X			(X)		X	(X)	X	X	X
Cedar Draw	397.00	X		X		X	X		X	(X)			X
Clear Springs	395.00	X	X	(X)	X		(X)		X	(X)	X	X	X
Clover Creek	379.00	X	X	X	X	X	X		X	(X)	X	X	X
Cottonwood Creek	403.00	X	X	X	X	X	(X)		X	(X)	X	X	X
Crystal Springs	398.00	X	X	X		X	(X)		X	(X)	X	X	X
Deep Creek	392-93	X		X		X			X	(X)			X
Dry Creek	408.00	X	X	X			(X)		X	(X)	X	X	X
Dry Creek, West Fork	411.00	X		X			(X)		X	(X)	X	X	X
McMullen Creek	404.00	X	X	X			(X)			(X)	X	X	X
Mud Creek	394.00	X		X			X		X	(X)			X
Riley Creek	385.00	X	X	X		X	(X)		X	(X)	X	X	X
Rock Creek	400.00	X	X	X		X	(X)		X	(X)	X	X	X
Sand Springs Creek*	386.00	X	X	X			(X)		X	(X)	X	X	X
Toolbox Creek													X

Prepared by IDEQ-TFRO. References cited which define water quality concerns are: 86 = *Pacific Northwest Rivers Study, Final Report*; 88 = *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*; 89 = *Chairman's Report 1989 Basin Area Meetings State of Idaho Antidegradation Agreement.* (X) in this report defines those waterbodies which are indirectly referenced via the Middle Snake River; 89 NP = *1989 Idaho Nonpoint Source Management Program.* 91 = *1993 Idaho Agricultural Pollution Abatement Plan.* 92 = *1992 Idaho Water Quality Status Report.* 94 = *1994 Idaho Water Quality Status Report.* 92-94 = *Water Quality Working Committee Designated Stream Segments of Concern, 1992-1994.* 303(d) Listed Streams: 92 = *1992 §303(d) List.* X = 1992 Designated Stream Segments of Concern. (X) = 1991 Stream Segments of Concern Nominations. 94 = *1994 §303(d) List, October 7, 1994, Appendix C.* 96 = *1996 §303(d) List, April 2, 1996, plus Attachment D.* 98 = 1998 §303(d) List. Sand Springs Creek is sometimes referred to as Thousand Springs Creek.

Additional sources beyond those identified in the previous table that define the cause of concern and status of the waterbody are referenced as follows:

1. BILLINGSLEY CREEK

In 1991 the IDFG responded to the then proposed reissuance of the NPDES aquaculture permits on seven aquaculture farms (002499-6; 002704-9; 002303-5; 000073-6; 002440-6; 002497-0; and 000086-8) on Billingsley Creek. In general, IDFG was concerned over the number of aquaculture facilities, such that cumulative impacts were being seen on Billingsley Creek. Sampling in Billingsley Creek indicated that a high percentage of fish were wild rainbow trout, wild brown trout, and hatchery rainbow trout (IDFG 1991). The water quality concerns and status of Billingsley Creek are further substantiated in the following reports: *IDHW, WQ Status Report No. WQ-21, Billingsley Creek (Gooding County), Problem Assessment; Billingsley Creek, NPDES Permits, 1991; IDHW, WQStatus Report No. 64, Billingsley Creek, 1984;* and, *IDHW, Upper Snake River Basin Status Report, 1991.* Historically, agricultural nonpoint sources have affected Billingsley Creek slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]).

2. CEDAR DRAW

The water quality concerns and status of Cedar Draw Creek are further substantiated in the following reports: *IDHW, Water Quality Status Report No. 100, 1991* and *IDHW, 1980, Channel Stability Evaluation for Cedar Draw.* It should be noted that IDAPA 16.01.02.280 identifies Cedar Draw as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. It is not "exempt" from water quality regulations that recognize Cedar Draw as having designated beneficial uses (IDAPA 16.01.02.150[Map Code hh]). Historically, agricultural nonpoint sources affect Cedar Draw (from the source to the mouth) severely from irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 2]).

3. CLOVER CREEK

The water quality concerns and status of Clover Creek are further substantiated in the following field monitoring reports: (1) monitoring conducted by USBLM during 1993-1994 at the sites of Dry Creek, Bell Mare Creek, and Hog Creek indicate "that the water temperature standard established to support cold water biota will not support established beneficial uses, most notably cold water biota and salmonid spawning" because the water temperatures are too high. Macroinvertebrate sampling "...exhibited signs of low to moderate water quality impairment...Impairment appeared to be due to water quality limitations, primarily temperature and fine sediment. An analysis of the macroinvertebrate community...indicates water quality impairment is high. This impairment was due to both water quality limitations and physical habitat conditions. Water quality limitations include high water temperatures, and high levels of fine sediment deposition and nutrients (Lewis 1994);" and, (2) reconnaisance and monitoring in 1997 by IDEQ-TFRO indicated that the confluence was impacted by cattle grazing, irrigated agriculture, roads, and recreational dirt biking. Above the confluence to its headwaters, Clover Creek was principally covered by sagebrush/grassland with moderate to high cattle grazing. Sprinkler irrigated ground used the natural contour slope as drainage access for runoff. In both the USBLM and private ground, minimal fencing-off of cattle from the streams was evident. During the summer months, many filamentuous algae and long strands of macrophytes were evident in the stream. Stream embeddedness appeared to be very high in many stream areas. Headwater areas where seeps come out of the ground are generally trampled by cattle who seek out the more lush grasses for food. Riparian habitat was minimal or not evident, or where it exists it is impaired due to grazing. Embeddedness appears to be much higher in the private ground area and towards the confluence when compared to the headwaters area and the USBLM ground (Buhidar & Sharpnack 1997). Historically, agricultural nonpoint sources affect Clover Creek (from the source to the mouth) slightly for irrigated cropland and slightly for livestock grazing due to channel problems (ISCC 1979 [Table 3]).

4. COTTONWOOD CREEK

The water quality concerns and status of Cottonwood Creek are further substantiated in the 1997 reconnaisance and monitoring by IDEQ-TFRO. It indicated that the stream was still principally impacted by cattle grazing, followed by irrigated agriculture as pastureland and flow alteration/diversion. In many areas of Cottonwood Creek a dense riparian buffer zone prohibited intrusion by man or cattle. However, approximately 40% of the stream itself (beginning from the lower USBLM fenceline to its confluence with Rock Creek) is impaired due to cattle intrusion into the stream. Typically, you will find manure piles along the exposed banks and numerous cow trails leading in-and-out of the stream. Stream banks are uncovered and exposed. Embeddedness in the USBLM area averages less in the stream, while on the private ground (below the USBLM area) averages much more. Flow alteration due to diversion is a major factor and typically occurs

throughout the irrigation season (Buhidar & Sharpnack 1997). Cottonwood Creek does not go beyond the High Line Canal. What water appears below the High Line Canal is from seeps and springs. Also, the Twin Falls Canal Company uses Cottonwood Creek for emergency spills of canal water (USDA/SCS 1998).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of Cottonwood Creek, of which select results are summarized in the following TABLE 30 for samplings done in 1994. Of the three location sites on Cottonwood Creek, two were unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity, with two location sites being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids.

TABLE 30 PROPER FUNCTIONING CONDITION ASSESSMENT OF COTTONWOOD CREEK.

LOCATION ON COTTON WOOD CREEK	*TYPE OF STREAM*	*OVERALL HEALTH RATING*	*LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs*	*CHANNEL BOTTOM*	*STREAM BANK MATERIALS*	*ON-SITE HUMAN ACTIVITIES*
9400305	Intermittent	45.6% (Unhealthy)	0-80-40-10	30% Sand 10% Silt & Clay	40% Sand 20% Silt & Clay	90%/10% Grazing/Roads
9400303	Perennial	68.4% (Healthy w/problems)	0-90-40-40	30% Sand 3% Silt & Clay	60% Sand 20% Silt & Clay	97.5% Grazing
9400302	Perennial	53.3% (Unhealthy)	0.5-90-20-20	20% Sand 10% Clay	30% Sand 40% Silt & Clay	80%/20% Grazing/Roads

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

5. DEEP CREEK

The water quality concerns and status of Deep Creek are further substantiated in the *1983 Idaho Agriculture Pollution Abatement Plan.* It should be noted that IDAPA 16.01.02.280 identifies Deep Creek as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. Historically, agricultural nonpoint sources affect Deep Creek (from the source to the mouth) severely for irrigated cropland sediment and slightly for livestock grazing (ISCC 1979 [Table 3]).

6. DRY CREEK (MURTAUGH LAKE)

The water quality concerns and status of Dry Creek are further substantiated in the *IDHW, Idaho WQ Status Report on Dry Creek, 1979* and the *IDHW, Idaho WQ Status Report on Dry Creek, 1979.* Additionally, complaints in 1996 from various recreationists indicated that Murtaugh Lake was filled with nuisance aquatic plant growths due to impacts from cattle grazing along the shoreline of the lake. Site visitation by IDEQ-TFRO personnel verified that cattle grazing was in fact impacting the lake, eventually contributing to high levels of macrophyte growths throughout the lake. Fecal coliform bacteria samples taken at eight sites on the lake were below the primary contact recreation regulations: 136, <2, 14, <2, <2, 60, 100, and 10 estimated colonies/100 mL (sampled 7-30-1996), thus indicating that nuisance growth was probably due to excess nutrients (Cizmich *et al.* 1998).

USBLM/Burley District, Idaho has various annual reports in the 1980s that describe Dry Creek as to

its aquatic habitat and soil/water status. In 1980, Dry Creek was found to have "excellent" aquatic habitat: excellent streambank vegetation condition, streambank stability, and stream channel stability. The East Fork of Dry Creek was rated as "good" stream habitat with the possibility of improvement by stabilization of its streambanks. "Streambank instability along East Fork of Dry Creek and Middle Fork of Dry Creek primarily results during high streamflow which cuts into steep, exposed banks. These banks are cut in unstable alluvium, are easily undercut, and probably cannot be stabilized completely (USBLM 1980). Additionally, it was noted that portions of the Dry Creek system have a high potential to become unique aquatic habitats since the stream appears "to have good year-round flow for supporting fish." However, it was presently somewhat degraded due to livestock grazing nearby. "Its uniqueness could be improved substantially by preventing access by cattle except to selected areas which may be necessary for livestock watering (USBLM 1980)." In 1985, the monitored stream condition of Dry Creek was divided into the "high in the forks" and "from the forks to private ground." Table 31 summarizes the results.

TABLE 31 1985 DRY CREEK STREAM CONDITION.

STEAM NAME	*AQUATIC QUALITY*	*CHANNEL STABILITY*	*RIPARIAN CONDITION*	*FORAGE UTILIZATION*	*OVERALL STREAM CONDITION*	*WAYS TO IMPROVE CONDITION*
High in Forks	Good	Good	Excellent	40-59% Use	Good	Relieve cattle
Forks to Private	Good	Fair	Fair	40-59% Use	Fair	Plant beaver

Prepared by IDEQ-TFRO. Aquatic, Channel, Riparian, and Forage metrics based on USBLM water quality standards for appropriate fisheries and recreation (USBLM 1985a).

The spring of 1984 had unusual high flows, exceeding 200 cfs, and caused substantial damage to Dry Creek Ranch, destroying the road up the creek on Public land and devasting the bottom mile of BLM administered stream. Dry Creek is one of the few streams in the region supporting a native cutthroat trout fishery. Invertebrate samples collected in 1983 suggested a stream which had an abundant supply of sediment that may have a debilitating long term effect on the fishery if it is affecting the headwaters as it is farther down stream where samples were taken (USBLM 1985a). In 1986, the annual watershed monitoring report revealed that Dry Creek was "holding static and improving in deteriorated spots. The lower stretches of public land blown out so severely in the 1984 flood were stabilizing nicely with shrubs and forbs. The upper reaches, however, appeared to be in motion, indicated by consistent raw cutbanks and fallen undercut trees. This development was not attributed to a cattle-caused trauma (USBLM 1986). In 1987, annual watershed monitoring report revealed that Dry Creek was a "candidate" for most highly impacted stream of the year. It was recovering from the flood impacts of 1984 until it was "double whammied late last summer by heaving grazing and wild fire (USBLM 1987)." Additionally, Dry Creek went intermittant half-way through the canyon and dried up once on private land. Historically, agricultural nonpoint sources affect Dry Creek (from source to the mouth) slightly for irrigated cropland and slightly for livestock grazing (ISCC 1979 [Table 2]).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of Dry Creek of which select results are summarized in Table 32 for samplings done in 1994. Of the five location areas (two or three sites per area), only one site had an average healthy rating (with problems), while the rest were unhealthy: Lower Dry Creek was 65.9% healthy, Upper Cry Creek was 58.3% unhealthy, East Fork was 54.2% unhealthy, Middle Fork was 52.5% unhealthy, and West Fork was 57.2% unhealthy. Grazing was listed as the most predominant on-site human activity, with three location sites being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids, trees, and forbs.

TABLE 32 PROPER FUNCTIONING CONDITION ASSESSMENT OF DRY CREEK.

LOCATION ON DRY & MEDLEY CREEKS	TYPE OF STREAM	OVERALL HEALTH RATING	LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs	CHANNEL BOTTOM	STREAM BANK MATERIALS	ON-SITE HUMAN ACTIVITIES
Upper Dry Ck 9400082	Perennial	71.7% (Healthy w/problems)	30-90-30-10	10% Sand 0.5% Silt&Clay	30% Sand 0.5% Silt&Clay	97.5% Grazing
Upper Dry Ck 9400524	Perennial	53.3% (Unhealthy)	20-40-70-3	20% Sand 10% Silt & Clay	20% Sand 20% Silt & Clay	90%/10% Grazing/Roads
Upper Dry Ck 9400526	Intermittent	50% (Unhealthy)	40-60-60-40	3% Sand 0.5% Silt&Clay	10% Sand 20% Silt & Clay	97.5% Grazing
Lower Dry Ck 9400231	Perennial	65% (Healthy w/problems)	3-80-40-40	3% Sand 0.5% Silt & Clay	30% Sand 10% Silt & Clay	97.5% Grazing
Lower Dry Ck 9400145	Perennial	66.7% (Healthy w/problems)	60-60-50-0.5	10% Sand 3% Silt & Clay	10% Sand 20% Silt & Clay	80%/20% Grazing/Roads
East Fork 9400135	Perennial	41.7% (Unhealthy)	70-30-80-3	10% Sand 0.5% Silt & Clay	10% Sand 20% Silt & Clay	97.5% Grazing
East Fork 9400528	Perennial	66.7% (Healthy w/problems)	30-80-50-30	10% Sand 3% Silt & Clay	20% Sand 20% Silt & Clay	97.5% Grazing
Middle Fork 9400517	Perennial	58.3% (Unhealthy)	0.5-60-60-10	20% Sand 3% Silt & Clay	20% Sand 30% Silt & Clay	97.5% Grazing
Middle Fork 9400523	Perennial	46.7% (Unhealthy)	30-70-60-30	10% Sand 3% Silt & Clay	40% Sand 3% Silt & Clay	97.5% Grazing
West Fork 9400481	Intermittent	54.4% (Unhealthy)	0-40-50-10	20% Sand 10% Silt & Clay	20% Sand 20% Silt & Clay	97.5% Grazing
West Fork 9400516	Intermittent	60% (Healthy w/problems)	3-80-40-20	10% Sand 3% Silt & Clay	20% Sand 20% Silt & Clay	50%/50% Grazing/Roads

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor. Medley Creek has data with proper functioning condition ratings but is not included in this assessment.

7. MCMULLEN CREEK

In 1985, USBLM indicated that McMullen Creek's aquatic habitat was excellent, its channel stability was good, its reparian condition was good, its forage utilization was 40-59% use, and its overall stream condition was good. Suggestions indicated that opportunities to improve the existing situation included planting beavers to increase the water supply (USBLM 1985a). In 1986, the USBLM indicated that McMullen Creek was "improving via the dominance of woody riparian vegetation growing in otherwise absent sites, with beaver having a difficult time being established due to trappers. Livestock utilization at the Forest line on the creek can best be described as devastating. Stream stability starts on the BLM. This situation likely accounts for some of the high coliform counts sampled in years past when the livestock have been off BLM lands and 3 miles up stream on the

Forest (USBLM 1986)." In 1987, USBLM indicated that the stream was "continually improving due to changes in livestock management and diverse and vigorous woody vegetation with abundant regeneration." Beavers were still considered necessary for a "natural equilibrium" in the system, but persistent trappers kept erradicating them and high flows would eliminate their dams. The beaver were considered "the missing link in the recovery phase of McMullen Creek so as to store water to supplement late summer flows, encourage riparian shrubs to invade the dry perched flood plain, and develop a good sport fishery (USBLM 1987)."

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of McMullen Creek, of which select results are summarized in Table 33 for samplings done in 1994. Of the seven location sites on "Lower" McMullen Creek, six were unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity, with one location site being also affected by roads. Lifeform canopy covers were predominantly shrubs followed by graminoids.

TABLE 33 PROPER FUNCTIONING CONDITION ASSESSMENT OF MCMULLEN CREEK.

LOCATION ON MCMULLEN CREEK	*TYPE OF STREAM*	*OVERALL HEALTH RATING*	*LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs*	*CHANNEL BOTTOM*	*STREAM BANK MATERIALS*	*ON-SITE HUMAN ACTIVITIES*
Lower 9400319	Intermittent	53.5% (Unhealthy)	3-90-30-10	20% Sand 10% Silt & Clay	60% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400318	Perennial	57.9% (Unhealthy)	0-90-10-10	30% Sand 3% Silt & Clay	50% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400315	Perennial	52.6% (Unhealthy)	0-90-40-20	30% Sand 3% Silt & Clay	50% Sand 30% Silt & Clay	97.5% Grazing
Lower 9400314	Perennial	45.6% (Unhealthy)	0-80-3-3	10% Sand 3% Silt & Clay	40% Sand 10% Silt & Clay	97.5% Grazing
Lower 9400312	Intermittent	56.1% (Unhealthy)	0-97.5-20-10	20% Sand 3% Silt & Clay	50% Sand 20% Silt & Clay	80%/20% Grazing/Roads
Lower 9400310	Perennial	61.4% (Healthy w/problems)	0-80-30-20	10% Sand 0.5% Silt &Clay	30% Sand 20% Silt & Clay	97.5% Grazing
Lower 9400309	Intermittent	57.9% (Unhealthy)	0-97.5-30-20	20% Sand 10% Silt & Clay	40% Sand 20% Silt & Clay	97.5% Grazing

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

8. RILEY CREEK

The water quality concerns and status of Riley Creek are further substantiated in the *1988 Idaho Water Quality Status Report and Nonpoint Source Assessment*. Historically, agricultural nonpoint sources affect Riley Creek (from the source to the mouth) slightly from irrigated cropland and slightly from livestock grazing (ISCC 1979 [Table 3]). Traditionally, the creek meets all water quality standards except those for total and fecal coliform bacteria (IDHW 1977b [p 1]).

9. ROCK CREEK

The water quality concerns and status of Rock Creek are further substantiated in the 1997 reconnaisance and monitoring by IDEQ-TFRO. Monitoring done indicates that the major cause of sediment runoff into the stream is bank instability, particularly in areas where grazing and irrigated agriculture function to the edge of the creek without any buffer strips. IDAPA 16.01.02.280 identifies Rock Creek as a "spillway, collection and conveyance facility" for the Twin Falls Canal Company from the intersection with the High Line Canal to the mouth. Historically, agricultural nonpoint sources affect Rock Creek under two segments or waterbodies: from the source to Rock Creek Town, slightly for livestock grazing only; and, from Rock Creek Town to the mouth, severely for irrigated cropland for sediment and slightly for livestock grazing (ISCC 1979 [Table 2]).

Additionally, the Riparian & Wetland Research Project (RWRP) of the University of Montana administered through the USBLM has done a Proper Functioning Condition (PFC) assessment of the Fifth Fork of Rock Creek, of which select results are summarized in Table 34 for samplings done in 1994. Of the two location sites on the Fifth Fork of Rock Creek, one was unhealthy as to its overall health rating and one was healthy but with problems. Grazing was listed as the most predominant on-site human activity. Lifeform canopy covers were predominantly shrubs followed by graminoids, and then forbs.

TABLE 34 PROPER FUNCTIONING CONDITION ASSESSMENT OF FIFTH FORK OF ROCK CREEK.

LOCATION ON ROCK CREEK	TYPE OF STREAM	OVERALL HEALTH RATING	LIFEFORM CANOPY COVER % Trees/Shrubs/Grams/Forbs	CHANNEL BOTTOM	STREAM BANK MATERIALS	ON-SITE HUMAN ACTIVITIES
Fifth Fork 9400323	Perennial	73.7% (Healthy w/problems)	0-80-50-60	10% Sand 10% Silt & Clay	20% Sand 30% Silt & Clay	97.5% Grazing
Fifth Fork 9400326	Perennial	57.9% (Unhealthy)	0-70-50-40	0.5% Sand 3% Silt & Clay	10% Sand 0.5% Silt &Clay	97.% Grazing

Prepared by IDEQ-TFRO. Based on database at www.rwrp.umt.edu. Lifeforms include trees, shrubs, graminoids, and forbs. Channel bottom silt & clay fractions <10% are considered optimal, 10-30 suboptimal, 30-50 marginal, and >50 poor.

More recently, Rock Creek has had "bacteria contamination" postings from District Health at the Rock Creek Park in Twin Falls, Idaho due to elevated levels of fecal coliform above the primary and secondary recreational water quality standards. These elevated levels have been investigated by IDEQ-TFRO, and it has been found that the major sources include: (1) runoff from fields where manure has been applied; (2) grazing, where animals are allowed to urinate or defecate in the stream or associated streams; (3) septic systems that are unmaintained and which have direct or indirect discharge as sewage and otherwise; and, (4) runaway sewage from the City of Twn Falls municipality due to operational or maintenance problems. These are not the only sources, but they are the most visible. Other sources (and not as visible) may include: unmaintained septic systems in the rural areas wthat have a linkage to a canal drain or stream; over application of manure in land areas affected readily by stgorm events outside the imediate boundary of the suspected zone-of-impact, but which have a linkage via a canal or ag drain to Rock Creek; and, Mother Nature's animals-in-the-wild which are known to urinate and defecate in streams or near streams. This problem as shown by the bacteria data collected by IDEQ-TFRO since 1990 (and before) has been more prevalent during the irrigation season. As a consequence of the public concerns the IDEQ-TFRO, the Mid-Snake WAG, and the Mid-Snake TAC has formed a task force with other local groups that will be providing technical assistance to the private land owners through education and an understanding of the application of voluntary best management practices.

10. BOX CANYON CREEK AND BLUE HEART SPRINGS

The Box Canyon Area of Critical Environmental Concern (as previously discussed in §2.1.3.6) is a nesting ground for the following endangered or threatened species. The Box Canyon Creek is habitat for the Shoshone Sculpin (*Cottus greenii*). The stable aquatic temperatures and chemistry support the largest known population of Shoshone Sculpin on public lands, and the third largest known population in the world. Few are known to exist upstream on private land. Box Canyon Creek also contains populations of three endangered molluscs: the Bliss Rapids snail, the giant Columbia River limpet, and the Utah valvata. Additionally, Box Canyon Creek provides feeding areas for furbearers and game fish. The riparian areas are important for non-game birds particularly during the winter months (USBLM 1985b [p 1-2]).

Blue Heart Springs is a large, aqua blue, cold, clear water spring emerging from the Snake River Canyon. It supports the fourth largest known population of Shoshone sculpin. It is surrounded by riparian vegetation and talus rock which makes physical access difficult, thus protecting the area from heavy disturbance. Blue Heart Springs is "protected" because the Idaho Department of Parks and Recreation holds a water right of 100 cfs for the people of Idaho (USBLM 1985b [p 3-4]). About 26.2 acres of public (federal) land is managed by the U.S. Bureau of Land Management as an Area of Critical Environmental Concern for four threatened or endangered species (Bliss Rapids snail, Utah Valvata snail, Banbury Springs lanx, Snake River physa), and a species-of-special-concern (Shoshone sculpin), and the scenic and unique natural qualities of the area. The area provides recreation, hunting, fishing, and aesthetics for human visitors plus an array of habitats for resident and migrating wildlife species. The land includes a portion of Box Canyon Creek, the entire Blue Heart Springs and its riparian habitat along the Middle Snake River, and 87.1 acres of land above the canyon rim (USBLM 1985b). Approximately 300 cfs of Box Canyon Creek are diverted and piped under the Middle Snake River to a fish propagation facility (Clear Springs Foods, Inc.) located on the south side of the river. The same 300 cfs serves as a small hydro project (Mantech Inc./B.C. Hydro Ltd.) at the outflow of the hatchery.

A study conducted by D.W. Taylor in 1985 as a survey of Box Canyon Creek for molluscs indicated that several populations of living Bliss Rapids snails and Utah Valvata snails along with shell deposits containing numerous specimens of the Bliss Rapids snail and several shells of the Giant Columbia River Limpet were found. Many of the shells were heavily eroded, indicating that these animals had once experienced heavy sediment load exposure, an unusual occurrence in this canyon-enclosed, spring-fed watershed with virtually no turbidity or suspended solids and little naturla sediment load. The surveys showed that a recent extensive deposit area in a natural pool on public land supported a healthy population of Utah Valvata snail, while causing a severely adverse impact to the Bliss Rapids snail by reducing its habitat and also probably that of the Giant Columbia River Limpet (Lanagenstein *et al.* 1989 [p 4]).

11. CRYSTAL SPRINGS LAKE

Nutrients in the ground water, hatchery wastewater discharges, and from the deposited organic sediments promote extensive growths of aquatic plants and algae. Aesthetics, recreational uses, and salmonid spawning are impaired by the organic deposits (USBLM 1985b [p. 1-2]) A 1990 restoration study indicated that Crystal Springs Lake "should be considered an endangered resource as it represents one fo the few remaining spring areas in the Thousand Springs reach of the Snake River that is in the public domain and available for public use and enjoyment (IDHW 1990 [p 1])." Data collected by IDHW-IDEQ in its restoration study showed: (1) nitrate-nitrogen levels exceeded the 0.3 mg/L criterion and ranged from 2.28 to 2.40 mg/L, and reflected elevated nitrate-nitrogen levels in the groundwater feeding the lake; (2) total phosphorus levels generally exceeded the 0.100 mg/L criterion

and ranged from 0.160 to 0.250 mg/L with a groundwater background level of <0.050 mg/L; (3) fecal coliform densities were quite variable, but geometric means were all below the 50/100 mL standard with exceedences only occuring in the hatchery effluent as *Streptococcus faecalis*. Coliform bacteria in the hatchery effluent likely arose from contamination of the spring source or fish feed, since fish do not have a permanent coliform flora in their intestinal tracts; and, (4) solids/sediment organic loadings ranged from 4 to 8 mg/L with an average loading of 2200 lbs/day (flow being 73.6 cfs) (IDHW 1990 [pp 8-19]).

Recreational use of the lake is confined to bank fishermen who fish from the hatchery outfall structure or lake outlet bridge area. Individuals attempt to access the lake to fish along the south shore between these two locations. The IDPR has received complaints from individuals regarding sludge accumulations and macrophyte growths along this side of the lake. These solids release offensive odors when disturbed, and they physically threaten the elderly or children who attempt to wade out into the lake to enjoy this resource. The sediments of the lake contain a mean TKN level of about 930 mg/L. Highest sediment TKN (like TP) levels were measured in sediments collected near the hatchery outfall and on the south side of the lake. Methane and hydrogen sulfide production, in addition to a black color, indicate lake sediments to be decomposing anaerobically (IDHW 1990 [p 26, 35]).

12. BLIND CANYON

The water is largely diverted to commercial fish-rearing ponds. Most of the inner canyon has been developed for fish propagation. Much of the original spring ecosystem has been altered by water diversion for fish production and establishment of fish hatcheries in the canyon. Associated unique wildlife probably has disappeared (IPC 1998).

13. BRIGGS SPRINGS CREEK

The property adjacent to Briggs Springs is mainly used for livestock grazing. Briggs Springs itself is severely impacted by small hydro-development and fish hatchery operations. The undeveloped portions of the property are grazed by livestock, causing local impacts to the vegetation, particularly wetlands. Nearly one-third of the spring flow is diverted to a small fish farm. After passing through this facility, water is returned to one of the original lower elevation stream channels. About two-thirds (70 to 120 cfs) of the spring water is diverted to a private small hydro plant (Briggs Creek Project, FERC No. 4360-001) which began operation in 1989. Water diversion destroyed riparian habitats associated with the springs. As a result of complete dewatering, the *Forested Wetland* vegetation was ultimately destroyed. From the point where hatchery water reenters the stream bed, vegetation remains viable. At the point of entry, there is a 30 cfs minimum stream flow held of the State of Idaho (IPC 1998).

14. PERRINE COULEE SYSTEM

Water quality in the Perrine Coulee System is impacted by irrigated agriculture, livestock operations, aquaculture, wastewater discharges, hydropower development, urban development, and recreation. Water from the Perrine Coulee System enters the Middle Snake River at five main branches and contributes to water quality problems within the river. Primary pollutants of concern are sediment, nutrients, pathogens, and pesticides. The majority of sediment within the Perrine Coulee System and potentially being delivered to the Middle Snake River originates on the surface (furrow) irrigated cropland. Sheet and rill erosion do not contribute significantly, making irrigation-induced erosion on surface (furrow) irrgated clean tilled cropland the significant contributor. Excess tillage, lack of adequate surface residue (from growing low residue crops), soil compaction, and poor irrigation water

management practices all contribute to the resource problems. Overall, sediment loading is greatest from the East Perrine Coulee, although there appears to be some indication that this load has been reduced since 1985. Total phosphorus (predominantly as a sediment-bound species) were frequently above the concentration recommended for water quality protection. Nitrogen, although it does not appear to present a serious water quality problem within the Perrine Coulee System, does deliver relatively high loads to the Middle Snake River. Pathogens pose a potential health risk to humans recreating in and around the Perrine Coulee "tributaries" (SRSCD 1998).

15. VINYARD CREEK

As previously described, there is a channel carrying irrigation return water that enters Vinyard Creek approximately midway between the waterfall and the confluence with Twin Falls Reservoir. IDEQ-TFRO has reported that a peak discharge for the irrigation return channel of 14.8 cfs in 1986, and an annual deposition of approximately 707 metric tons of sediment into the Twin Falls Reservoir (IDHW 1989a). This cannel was re-routed in 1996 by constructing a rock and earthen embankment at the inflow of the pipe in order to pool the irrigation return water for re-route into the pipe (IPC 1997b [p 4]). At the point where the historical creek channel and the irrigation return joined has been re-routed so that Vinyard Creek discharges water from Vinyard Lake only. And the irrigation return discharges only irrigation return water to Twin Falls Reservoir just downstream from when Vinyard Creek discharges accordingly. Fish species collected by IPC biologists in 1996 included: cutthroat trout, rainbow trout, rainbow-cutthroat trout hybrid, speckled dace, reside shiner, Utah sucker, and mottled sculpin (IPC 1997b [p 4]). Vinyard Creek has historically supported a unique population of cutthroat trout. Additionally, the stream has likely provided a spawning, rearing, and adult habitat for cutthroat trout, rainbow trout, and rainbow-cutthroat trout hybrids (IPC 1997b [p 4]).

Finally, the 1994 and 1996 §303(d) lists identified the level of benefical support status for various tributaries in HUC 17040212. These are identified in Table 35.

TABLE 35 1994 & 1996 BENEFICIAL SUPPORT STATUS FOR TRIBUTARIES.

SEGMENT NAME	*FULL SUPPORT*	*THREATENED*	*PARTIAL SUPPORT*	*NOT SUPPORTING*	*NOT ASSESSED*
		DEEP CREEK			
Deep Ck (Low Line Canal to SR)	AG	PC/SC	CW/SS		
Deep Ck (HW to LowLineCanal)	AG	PC/SC	CW/SS		
		MUD CREEK			
Mud Ck (T09SR14ES33 to SR)	AG	PC/SC	CS/SS		
Mud Ck (HW to T09SR14ES33)	AG	PC/SC	CW/SS		
		ROCK CREEK			
Rock Ck (Cottonwood Ck to SR)	AG	PC/SC	CW/SS		
Rock Ck (5th Fork to McMullen Ck)	AG		CW/SS/PC/SC		
		MCMULLEN CREEK			
Cottonwood Ck to Rock Ck	AG	PC/SC/CW/SS			
Donahue Ck to N. Cottonwood Ck	AG	PC/SC/CW		SS	
HW to Donahue Ck	AG	PC/SC/CW	SS		

SEGMENT NAME	FULL SUPPORT	THREATENED	PARTIAL SUPPORT	NOT SUPPORTING	NOT ASSESSED
COTTONWOOD CREEK & NORTH COTTONWOOD CREEK					
McMullen Ck to N. Cottonwood Ck	AG	PC/SC	CW	SS	
HW to Dry Cottonwood Ck	AG	PC/SC	CW	SS	
DRY CREEK					
Murtaugh Lake to SR	AG	PC/SC/CW/SS			
EF Dry Creek to Murtaugh Lake	AG	PC/SC	CW/SS		
NF Dry Creek to EF Dry Creek	AG	PC/SC	CW/SS		
HW to WF Dry Creek	AG	PC/SC	CW/SS		
HW to Dry Creek	AG	PC/SC	CW/SS		
HW to MF Dry Creek	AG	PC/SC	CW/SS		
CLOVER CREEK					
Dry Creek to SR	AG	PC/SC/CW/SS			
Pioneer Reservoir to Dry Creek	AG	PC/SC/CW/SS			
Calf Creek to Pioneer Reservoir	AG	PC/SC/CW/SS			
T4SR13ES31 to Calf Creek	AG	PC/SC/CW/SS			
Cottonwood Ck to T4SR13ES31	AG	PC/SC/CW/SS			
Squaw Creek to Catchall Creek	AG	PC/SC/CW/SS			
Deer Creek to Squaw Creek	AG	PC/SC/CW/SS			
HW to Deer Creek	AG	PC/SC/CW/SS			
Catchall Ck to Cottonwood Creek	AG	PC/SC/CW/SS			
OTHER TRIBUTARIES					
Niagara Springs (T9SR15ES11)	DW		PC/SC/CW/SS		
Crystal Springs (T9SR15ES12)			AG/PC/SC/CW /SS		
Cedar Draw (HW to SR)	AG	PC/SC/CW/SS			
Billingsley Creek (HW to SR)	AG/DW	PC/SC/CW/SS			
Cedar Draw Ck (HW to SR)	AG				CW/SS/PC/ SC
Perrine Coulee (Low Line Canal to SR)	AG	PC/SC/CW		SS	

Prepared by IDEQ-TFRO. Based on the 1994 & 1996 §303(d) lists. SR = Snake River. HW = Headwaters. Ck = Creek. AG = agricultural water supply. PC = primary contact recreation. SC = secondary contact recreation. CW = cold water biota. SS = salmonid spawning. EF = East Fork. WF = West Fork. NF = North Fork. Lk = Lake.

2.2.2.6 BENEFICIAL USE RECONNAISSANCE PROJECT DATA

In addition to the data previously described in §2.2.1.1 through §2.2.1.4, information was collated from the Beneficial Use Reconnaissance Project (BURP) in the Twin Falls Regional Office of IDEQ for the streams on the §303(d) list. TABLES 37 and 38 provide an indication of why these streams are not fully supporting their beneficial uses. Dry streams are not included. Also, the ecoregional geographic area is the Snake River Basin/High Desert. Although traditional water quality monitoring for chemical parameters has its benefits, biomonitoring (as BURP) goes beyond the chemistry and centers on the ecological status of the beneficial use (IDEQ 1998). The process used to assess the beneficial use support encompasses both a chemical and a biological process known as IDEQ's Bioassessment Process. BURP by itself is the monitoring protocol. The interpretation of the BURP data for determination of beneficial support status is known as the Waterbody Assessment process. TABLE 36 describes the BURP location sites.

TABLE 36 SITE NUMBER, LATITUDE AND LOGITUDE FOR EACH OF THE BURP SITES.

TRIBUTARY	*SITE No.*	*LATITUDE*	*LONGITUDE*	*TOWNSHIP/RANGE/SECTION*
Billingsley Creek	9423	42°48'1.79"	114°52'8.42"	T 075 R 13E S 19
	9424	42°47'15.09"	114°51'54.74"	T 07S R 13E S 11
	9441	42°47'14.72"	114°51'55.36"	T 07S R 13E S 30
Clover Creek	9510	43°0'3.70"	115°9'13.75"	T 05S R 11E S 09
	9511	42°59'55.00"	115°3'0.00"	T 05S R12E S 08
Cottonwood Creek	9661	42°26'3.41"	114°23'26.73"	T 11S R 18E S 30
Cottonwood Creek, North	9409	42°18'46.46"	114°25'36.42"	T 13S R 17E S 11
	9603	42°19'52.03"	114°25'34.81"	T 13S R 17E S 02
Deep Creek	9647	42°37'51.72"	114°50'35.14"	T 09S R 13E S 20
Dry Creek	9512	42°22'4.63"	114°11'18.05"	T 12S R 19E S 24
	9513	42°28'30.00"	114°8'40.00"	T 11S R 20E S 07
Dry Creek, East Fork	9630	42°20'53.29"	114°12'7.93"	T 12S R 19E S 26
	9647	42°17'54.62"	114°9'9.88"	T 13S R 20E S 18
McMullen Creek	9532	42°14'37.87"	114°25'15.57"	T 13S R 17E S 36
Riley Creek	9503	42°45'34.49"	114°51'26.14"	T 08S R 13E S 01
	9539	42°45'49.17"	114°51'50.59"	T 08S R 13E S 06
Rock Creek, Above (Headwaters to Rock Creek Town)	9439	42°23'91.60"	114°18'32.20"	T 12S R 18E S 13
	9531	42°18'1.85"	113°15'17.88"	T 13S R 19E S 17
	9543	42°22'1.18"	114°18'16.05"	T 12S R 18E S 13
Rock Creek, Below (Rock Creek Town to Confluence with Snake River)	9558	42°35'38.90"	114°31'48.11"	T 09S R 16E S 36
	9559	42°34'2.87"	114°30'15.78"	T 10S R 17E S 08
	9560	42°27'15.35"	114°21'45.94"	T 11S R 18E S 21
	9561	42°33'40.67"	114°29'22.28"	T 10S R 17E S 17

TRIBUTARY	SITE No.	LATITUDE	LONGITUDE	TOWNSHIP/RANGE/SECTION
Tool Box Creek	9557	43°13'49.78"	114°19'3.72"	T 14S R 18E S 11
Prepared by IDEQ-TFRO.				

Table 37 describes portions of the BURP data for the indicated waterbody.

TABLE 37 SELECTED STREAM CHARACTERISITICS FROM DEQ-TFRO METHODOLOGY.

WATERBODY NAME	SITE IDENTIFICATION	FLOW cfs	VALLEY TYPE	SINUOSITY	FINES	EMBEDDEDNESS	BANK VEGETATION	LOWER BANK STABILITY	ROSGEN STREAM TYPE
Alpheus Creek	No BURP data available.								
Billingsley Creek	9424	46.50	TL	Moderate	23	9	10	10	-
	9441	6.40	TL	Moderate	90	15	10	9	-
	9423	30.40	TL	Moderate	62	8	10	9	-
Blind Canyon Creek	No BURP data available.								
Cedar Draw Creek	No BURP data available.								
Clear Springs	No BURP data available.								
Clover Creek	9510	20.20	US	Low	64	4	8	8	C
	9511	1.05	TL	Braided	42	11	8	9	C
Cottonwood Creek	9661	4.36	FB	High	80	0	10	10	G
Cottonwood Creek, North	9409	0.40	TL	Moderate	47	10	9	9	-
	9603	4.00	VS	Moderate	32	7	4	1	B
Crystal Springs	No BURP data available.								
Deep Creek	9647	75.32	FB	Moderate	32	0	9	10	C
Dry Creek	9513	3.90	US	Moderate	61	7	9	2	C
	9512	16.20	VS	Braided	41	10	7	9	B

WATERBODY NAME	SITE IDENTIFICATION	FLOW cfs	VALLEY TYPE	SINUOSITY	FINES	EMBEDDEDNESS	BANK VEGETATION	LOWER BANK STABILITY	ROSGEN STREAM TYPE
Dry Creek, East Fork	9630	2.50	VS	Moderate	9	18	7	9	B
Dry Creek, West Fork	9647	0.50	VS	Moderate	6	13	2	3	A
McMullen Creek	9532	7.80	TL	Moderate	100	0	9	9	C
Mud Creek	No BURP data available.								
Riley Creek	9503	1.40	FB	Low	91	2	10	9	A
	9539	58.01	TL	Moderate	70	11	10	10	C
Rock Creek, Above (Headwaters to Rock Creek Town)	9439	5.22	FB	High	53	13	8	6	-
	9543	13.60	FB	High	20	5	8	5	B
	9531	24.00	YS	Moderate	34	15	8	10	B
Rock Creek, Below (Rock Creek Town to Confluence with Snake River)	9560	16.70	BC	Moderate	46	16	6	6	C
	9559	193.0	BC	Moderate	44	6	6	8	C
	9558	>200	BC	Low	43	7	8	10	-
	9561	138.8	BC	Moderate	49	6	10	9	C
Tool Box Creek	9557	0.50	TL	Moderate	50	10	8	9	A

Prepared by IDEQ-TFRO: Site Id. = BURP Site Identification for the specific year; Valley Types: FB = Flat Bottomed, TL = Trough Like, YS = Y-Shaped, US = U-Shaped, VS = V-Shaped,BC = Box Canyon; F = % Fines (<6 mm diameter): Optimal = <10, Suboptimal = 10-30, Marginal = 30-50, Poor = >50; E = Embeddedness Score: Optimal = 16-20, Suboptimal = 11-15, Marginal = 6-10, Poor = 0-5; BVP = Bank Vegetation Protection Score: Optimal = 9-10, Suboptimal = 6-8, Marginal = 3-5, Poor = 0-2; LBS = Lower Bank Stability Score: Optimal = 9-10, Suboptimal = 6-8, Marginal = 3-5, Poor = 0-2; R = Rosgen Stream Type. The flow parameter is noted as one of the priniciple abiotic factors shaping stream ecosystems (Minshall 1993). The Valley Type parameter is a characterization of the dominant shape of the "valley" in which the stream is located. Sinuosity is a parameter measure of the straightness of the channel. Fines is a fraction of the substrate less than 6.00 mm in diameter as an ocular estimate of the percentage of bottom substrate that is fine material. Embeddedness is the degree to which boulders, rubble, or gravel are surrounded by fine sediment and indicates the suitability of the stream substrate as habitat for benthic macroinvertebrates and fish spawning and egg incubation. Bank vegetation protection is an estimate of bank vegetation covering the bank and provides an indication of bank stability and potential instream sedimentation. Lower bank stability is rated by observing existing or potential detachment of soil from the lower streambank and its potential movement into the stream (IDEQ 1996 [pp 55-58]).

Rosgen stream type deal with the broad-level description of a major stream type. These are labeled A through G and have the following Level 1 descriptions, as show in Table 38.

TABLE 38 MODIFIED ROSGEN GEOMORPHIC CHARACTERIZATION OF STREAM TYPES (LEVEL 1).

STREAM TYPE	DESCRIPTION	ENTRENCHMENT RATIO	W/D RATIO	SINUOSITY	SLOPE
A	Steep and entrenched	<1.4	<12	1.0 - 1.2	0.04 - 0.10
B	Moderately entrenched	1.4 - 2.2	>12	>1.2	0.02 - 0.039
C	Low gradient	>2.2	>12	>1.4	<0.02
G	Entrenched "gully"	<1.4	<12	>1.2	0.02 - 0.039

Prepared by DEQ-TFRO: after Table 4-1, p. 4-5, of *Applied River Morphology* by Dave Rosgen.

The bioassessment process of these streams considers major numeric standard exceedence (such as temperature) if data is present, Macroinvertebrate Biotic Index, Reconnaissance Index of Biotic Integrity, Algal Biotic Index, and Habitat Index in hierarchical sequence. IDEQ uses the Macroinvertebrate Biotic Index (MBI) as a normalized multimetric index (made up of seven metrics) which include: Hilsenhoff Biotic Index (HBI); Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); Percent Ephemeroptera, Plecoptera, and Trichoptera (%E); Taxa Richness (TAX); % Scrapers (%SC); % Dominance (%D); and, Shannon's H'Diversity Index (SHW). See the IDEQ1996 reference for more detailed information.

For a site support status (SiteSupStat) for a specific site, an MBI score of < 2.50 indicates the water body is Not Fully Supporting (NFS) its beneficial uses. An MBI score in range 2.50 to 3.50 indicates the water body Needs Verification (NV) on its beneficial uses, and results in the waterbody assessment process looking at other indicators (like RIBI or HI) to determine the status of site support. An MBI score > 3.50 indicates the water body is Fully Supporting (FS) its beneficial uses. The lowest MBI score would be NFS, followed by NV, and then FS. An additional metric used by IDEQ is the Habitat Index (HI) to assess cold and warm water biota beneficial uses for wadable streams for the Snake River Basin/High Desert. In the Snake River Basis ecoregion, an HI score of < 34 indicates the habitat is impaired. An HI score in the range from 34 to 66 indicates the habitat needs verification. An HI score > 66 indicates the habitat is not impaired. For the overall support status (OverSupStat) for the entire segment or water body, the lowest SiteSupStat in a group becomes the OverSupStat for the stream. For example, Billingsley Creek has three SiteSupStat on three segments: NFS, NV, and NV. The OverSupStat would be the lowest SiteSupStat of the three, which would be NFS.

TABLE 39 BIOASSESSMENT OF BURP DATA OF 303(d) LISTED WATER BODIES.

NAME	SITE	IDEQ MULTIMETRIC INDICES HBI	EPT	%E	TAX	%SC	%D	SHW	MBI	HI	Site Sup Stat	Over Sup Stat
Billingsley Creek	9441	0.41	0	0	0.24	0.79	0.45	0.45	2.39	54	NFS	NFS
	9424	0.48	0.09	0.09	0.24	1.00	0.31	0.33	2.56	97	FS	
	9423	0.55	0.03	0.05	0.29	0.55	0.74	0.57	2.85	82	NV	
Clover Creek	9511	0.39	0.06	0.03	0.45	0.37	0.87	0.71	2.88	73	NV	NV
	9510	0.61	0.12	0.49	0.38	0.01	0.79	0.63	3.03	70	NV	
Cottonwood Creek	9661	0.61	0.15	0.14	0.36	0.01	0.30	0.36	1.83	54	NFS	NFS
Cottonwood Creek North	9409	0.83	0.38	0.64	0.67	0.24	1.00	0.97	4.73	92	FS	FS
	9603	0.88	0.35	0.92	0.50	0.47	0.70	0.59	4.41	65	FS	

NAME	SITE	IDEQ MULTIMETRIC INDICES HBI	EPT	%E	TAX	%SC	%D	SHW	MBI	HI	Site Sup Stat	Over Sup Stat
Deep Creek	9647	0.63	0.09	0.02	0.21	0	0.05	0.08	1.08	63	NFS	NFS
Dry Creek	9512	0.74	0.29	0.76	0.45	0.21	0.54	0.60	3.59	98	FS	NFS
	9513	0.59	0.12	0.05	0.29	0.01	0.70	0.50	2.26	66	NFS	
Dry Creek East Fork	9630	0.86	0.82	0.64	0.98	0.62	0.93	0.91	5.76	133	FS	FS
Dry Creek WestFork	9647	0.79	0.56	0.53	0.64	0.32	0.98	0.87	4.69	110	FS	FS
McMullen Creek	9532	0.50	0.09	0.07	0.55	0.01	0.57	0.50	2.29	45	NFS	NFS
Riley Creek	9539	0.33	0.12	0.01	0.36	0.79	0.48	0.42	2.83	85	FS	NFS
	9503	0.50	0.06	0.03	0.31	0.04	0.18	0.26	1.23	95	NFS	
Rock Creek (Headwaters to Rock Creek Town)	9439	0.09	0.38	0.69	0.76	0.36	0.87	0.74	4.78	98	FS	FS
	9531	0.92	0.53	0.72	0.76	0.62	0.98	0.86	5.39	103	FS	
	9543	0.84	0.41	0.70	0.60	0.35	0.96	0.88	4.94	95	FS	
Rock Creek (Rock Creek Town to Confluence with Snake River)	9561	0.92	0.12	0.07	0.21	1.14	0.15	0.20	2.81	85	NV	NFS
	9560	0.66	0.18	0.33	0.33	0.69	0.60	0.53	3.32	96	FS	
	9559	0.83	0.18	0.08	0.29	1.19	0.12	0.19	2.88	67	NFS	
	9558	0.58	0.21	0.15	0.40	1.01	0.26	0.33	4.69	91	NFS	
Toolbox Creek	9557	0.58	0.24	0.12	0.33	0	0.26	0.30	1.83	77	NFS	NFS

Prepared by IDEQ-TFRO. SITE = Site Identification by Year and Segment Number (YYNN). SiteSupStat = Site Support Status (for a specific site). OverSupStat = Overall Support Status (for the entire segment or water body).

As of this writing, the protocols for large rivers (Middle Snake River), lakes and reservoirs had not been completed. They are still under development and will be included at a later time.

2.2.3 APPLICABLE BENEFICIAL USES AND WATER QUALITY STANDARDS

Designated beneficial use(s) or designated use(s) are defined by IDAPA 16.01.02.003 (24) as "those beneficial uses assigned to identified waters in Idaho Department of Health and Welfare Rules, Title 01, Chapter 02, 'Water Quality Standards and Wastewater Treatment Requirements,' Sections 110 through 160 and 299, whether or not the uses are being attained." Those designated uses include: domestic water supply, agricultural water supply, cold water biota, warm water biota, salmonid spawning, primary contact recreation, secondary contact recreation, and special resource water. Existing beneficial use(s) or existing use(s) are defined by IDAPA 16.01.02.003 (35) as "those beneficial uses actually attained in waters on or after November 28, 1975, whether or not they are designated for those waters in Idaho Department of Health and Welfare Rules, Title 01, Chapter 02, 'Water Quality Standards and Wastewater Treatment Requirements.'" As part of their statutory defined duties, the basin advisory group shall make "revisions in the beneficial uses designated for each stream and the status and attainability of designated or existing beneficial uses for the water bodies within the basin (Idaho Code 39-3614)." "In determining whether a water body fully supports designated and existing beneficial uses," the IDEQ "shall determine whether all of the applicable water quality standards are being achieved, including any criteria developed pursuant to IDAPA rules, and whether a healthy, balanced biological community is present (IDAPA 16.01.02.053)." "Beneficial uses impaired by

nonpoint source pollution include cold water biota (trout, salmon, and other aquatic organisms), salmonid (trout and salmon) spawning and primary (swimming) and secondary (wading) contact recreation (IDHW 1991b)."

2.2.3.1 APPLICABLE DESIGNATED BENEFICIAL USES

Applicable designated beneficial uses (as designated by the State Legislature through negotiated rulemaking based on recommendations provided by IDEQ via the Board of IDHW) are described in Table 40. Undesignated surface waters are protected under IDAPA 16.01.02.101(01).

TABLE 40 DESIGNATED BENEFICIAL USES OF WATERBODIES IN UPPER SNAKE ROCK

STREAM NAME	BOUNDARIES	BENEFICIAL USES Ag	D	CW	WW	SS	PC	SC	RW
TRIBUTARIES									
Alpheus Creek	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Billingsley Creek	From headwaters to the Snake River	X	X	X		X	X	X	X
Blind Canyon Creek	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Cedar Draw	From headwaters to the Snake River	X		X		X		X	
Clear Springs	From headwaters to the Snake River	*IDAPA 16.01.02.101.01*							
Clover Creek	From headwaters to the Snake River	X		X		X	X	X	
Cottonwood Creek	From headwaters to Rock Creek	*IDAPA 16.01.02.101.01*							
Crystal Springs	From headwaters to Snake River	*IDAPA 16.01.02.101.01*							
Deep Creek	From headwaters to Snake River	X		X		X		X	
Dry Creek	From Medley Creek to Snake River	X		X		X		X	
Dry Creek	From headwaters to Medley Creek	X		X		X		X	
Dry Creek, West Fork	From headwaters to Dry Creek	X		X		X		X	
McMullen Creek	From headwaters to Cottonwood Creek	*IDAPA 16.01.02.101.01*							
Mud Creek	From Deep Creek road to Snake River	X		X		X		X	
Riley Creek	From headwaters to Snake River	X	X	X		X	X	X	X
Rock Creek	From headwaters to Rock Creek Town	X	X	X		X	X	X	X
Rock Creek	From Rock Creek Town to Snake River	X		X		X	*	X	
Sand Springs Creek	From headwaters to Snake River	*IDAPA 16.01.02.101.01*							
Tool Box Creek	From headwaters to Fifth Fk Rock Creek	*IDAPA 16.01.02.101.01*							
RESERVOIRS									
Bliss Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							
Lower Salmon Falls Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							

STREAM NAME	BOUNDARIES	BENEFICIAL USES Ag	D	CW	WW	SS	PC	SC	RW
Pioneer Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							
Shoshone Falls Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							
Upper Salmon Falls Reservoir	The entire reservoir	*IDAPA 16.01.02.101.01*							
ON THE MIDDLE SNAKE RIVER: *(1) Snake River - Milner Dam to Buhl (IDAPA 16.01.02.150.01)* *(2) Snake River - Buhl to King Hill (IDAPA 16.01.02.150.01).*									
Middle Snake River	From Milner Dam to Murtaugh *(1)*	X		X		X	X	X	
Middle Snake River	From Cedar Draw to Rock Creek *(1)*	X		X		X	X	X	
Middle Snake River	From Clear Lakes Bridge to Cedar Draw *(1)*	X		X		X	X	X	
Middle Snake River	From Deep Creek to Mud Creek *(1)*	X		X		X	X	X	
Middle Snake River	From King Hill to Big Pilgrim Gulch *(2)*	X		X		X	X	X	
Middle Snake River	From Mud Creek to Clear Lakes Bridge *(1)*	X		X		X	X	X	
Middle Snake River	From Rock Creek to Shoshone Falls *(1)*	X		X		X	X	X	
Middle Snake River	From Cassia Gulch to Big Pilgrim Gulch *(2)*	X		X		X	X	X	
Middle Snake River	From Bliss Bridge to King Hill Diversion *(2)*	X		X		X	X	X	
Middle Snake River	From Murtaugh to Twin Falls Reservoir *(1)*	X		X		X	X	X	

Prepared by IDEQ-TFRO: Ag = Agricultural water supply; D = Domestic water supply; CW = Cold water biota; WW = Warm water biota; SS = Salmonid spawning; PC = Primary contact recreation; SC = Secondary contact recreation; RW = Special Resource Water. *IDAPA 16.01.02.101.01* in the Beneficial Uses columnes references Undesignated Surface Waters: "Surface waters not designated in Sections 110 through 160 shall be designated according to Section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Prior to designation, undesignated waters shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, whereever attainable." * = Protected for future use. All surface waters are designated for industrial water supply, wildlife habitats, and aesthetics (IDAPA 16.01.02.100(01c) & (04) & (05).

Existing beneficial uses are summarized in Table 41 for select streams as observed by the waterbody assessment process through BURP.

TABLE 41 EXISTING BENEFICIAL USES OF THE §303(d) LISTED STREAMS

STREAM NAME	BOUNDARIES	BENEFICIAL USES Ag	D	I	CW	WW	SS	PC	SC	W	A
Billingsley Creek	From headwaters to the Snake River	X			X		X		X		
Clover Creek	From Pioneer Reservoir to the Snake River	X									
Cottonwood Creek	From headwaters to Rock Creek	X			X		X				
Deep Creek	From headwaters to Snake River	X			X						
Dry Creek	From West Fork Dry Ck to Murtaugh Lake	X			X		X				
Dry Creek, West Fork	From headwaters to Dry Creek				X				X		
McMullen Creek	From headwaters to Cottonwood Creek	X			X						

STREAM NAME	BOUNDARIES	BENEFICIAL USES									
		Ag	D	I	CW	WW	SS	PC	SC	W	A
Riley Creek	From headwaters to Snake River	X			X		X				
Rock Creek	From Rock Creek Town to Snake River	X			X		X	X			
Tool Box Creek	From headwaters to Fifth Fk Rock Creek	X			X				X		

Prepared by IDEQ-TFRO: Ag = Agricultural water supply; D = Domestic water supply; I = Industrial water supply; CW = Cold water biota; WW = Warm water biota; SS = Salmonid spawning; PC = Primary contact recreation; SC = Secondary contact recreation; W = Wildlife habitats; A = Aesthetics. Information collated from BURP.

2.2.3.2 PROTECTION OF BENEFICIAL USES AND THE TMDL PROCESS

Under Idaho Code (IDAPA 16.01.02.003.57) man-made waterways are defined as canals, flumes, ditches, and similar features, constructed for the purpose of water conveyance. Waters of the State (IDAPA 16.01.02.003.116) are defined as all the accumulations of water (surface and underground, natural and artificial, public and private, or parts thereof which are wholly or partially within) which flow through or border upon the state.

According to IDAPA 16.01.02.050(02)(a), "Wherever attainable, surface waters of the state shall be protected for beneficial uses which includes all recreational use in and on the water surface" (for primary and secondary contact recreation) "and the preservation and propagation of desirable species of aquatic biota" (for salmonid spawning, cold or warm water biota, aquatic habitats). Although certain waters of the State may be protected for agricultural conveyence, that protection does not preceed the protections of other beneficial uses. It is recognized by the scientific community that waters of the state which are used for water conveyance may find it difficult to meet their beneficial uses (USDA/SCS 1998). However, the administrative policy (IDAPA 16.01.02.050 (02)(c)) stipulates that "in all cases, existing beneficial uses of the waters of the state will be protected." As part of IDAPA, the Antidegradation Policy allows for maintenance of existing uses for all waters, such that "the existing in-stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected (IDAPA 16.01.02.051(01))."

Beneficial use support status is determined by IDEQ (IDAPA 16.01.02.053) through its *Water Body Assessment Guidance*, but parameters (e.g., aquatic habitat parameters and biological parameters) defined in this document are not considered or treated as individual water quality criteria or otherwise interpreted or applied as water quality standards. After determining that a water body does not fully support designated or existing beneficial uses (as determined through the *Water Body Assessment Guidance* document), the DEQ in consultation with the applicable Basin Advisory Group (i.e, Upper Snake BAG) and Watershed Advisory Group (i.e., Mid-Snake WAG) shall evaluate whether the application of required pollution controls to sources of pollution affecting the impaired water body would restore the water body to full support status (IDAPA 16.01.02.054.01).

2.2.3.3 APPLICABLE WATER QUALITY STANDARDS

Violations of narrative and numeric water quality standards include the following on the Middle Snake River and its tributaries:

1. DELETERIOUS MATERIALS

"Surface waters of the state shall be free from deleterious materials in concentrations that impair designated or protected beneficial uses (See IDAPA §16.01.02.200.03)." Deleterious materials are

defined as "any nontoxic substance which may cause the tainting of edible species of fish, taste and odors in drinking water supplies, or the reduction of the usability of water without causing physical injury to water users or aquatic and terrestrial organisms (See IDAPA §16.01.02.003.20)." "These materials do not include suspended sediment produced as a result of nonpoint source activities (See IDAPA §16.01.02.200.03)" but do include aquatic plant growths. Like the Middle Snake River, the tributaries have widespread aquatic plant growths, including rooted and non-rooted macrophytes, epiphytic algae, filamentous algae, which may cause the reduction of the usability of the waters without causing physical injury to water users. These aquatic plants are deleterious materials which appear in concentrations which impair designated beneficial uses of the particular waterbody, particularly primary and secondary contact recreation, cold water biota, salmonid spawning, aesthetics, and wildlife habitats.

Mud Creek and Deep Creek in particular, followed by Rock Creek, Cedar Draw, and East Perrine Coulee, and then followed by Salmon Falls Creek and Clover Creek had organic black deposits which when exposed to the atmosphere gave off offensive odors. Local fishermen and fowl hunters were interviewed and they claim that these organic deposits (particularly on Mud Creek and Deep Creek) are so offensive that the fish have been reduced in population numbers and the ducks "avoid the stench" areas when the deposits are exposed (Buhidar & Sharpnack 1997).

2. FLOATING, SUSPENDED, OR SUBMERGED MATTER

"Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities (See IDAPA §16.01.02.200.05)." Nuisance is defined as "anything which is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state (See IDAPA §16.01.02.003.65)."

AQUATIC MACROPHYTES

In addition to the Middle Snake River, the tributaries have concentrations of macrophytes, algae, and organic solids (where point source industries are localized) which are discharged at concentrations which may be defined as floating, suspended, or submerged matter, and which cause definable nuisance and objectionable conditions which adversely effect their beneficial uses. IDEQ-TFRO (Buhidar & Sharpnack 1997) during the 1996-1997 monitoring seasons identified high levels of macrophytes and epiphytic algae in certain sections of East Perrine Coulee, Rock Creek, Cedar Draw, Mud Creek, Deep Creek, Salmon Falls Creek, and Clover Creek that gave the streams the appearance of green-brown discoloration. By definition, these high levels of macrophytes could easily be construed as "nuisance," since they could readily "obstruct" the free use of the waters at certain times during the irrigation season when temperatures are warm and the majority of the discharged water is coming from agricultural drains and runoff. Those designated beneficial uses affected include primary and secondary contact recreation, cold water biota, salmonid spawning, aesthetics, and wildlife habitats.

ORGANIC DEPOSITS

More especially on Mud Creek and Deep Creek were organic black deposits found at locations close-to but downstream from localized point sources as compared to upstream transects where no organic deposits were found mixed with nonpoint source sediments. This organic material, particularly on Deep Creek, was offensive in odor, viscous, and slick in appearance, and from various discussions with local citizens provided a negative aesthetic appearance to the bedrock (where bedrock was

exposed) as well as the cobble and sediment. Salmon Falls Creek and Clover Creek are of particular interest because no point sources are found here, no black organic deposits were noted, but nusiance aquatic plants were found at specific locations where the streams were slow moving and less than 3 meters (Buhidar & Sharpnack 1997).

ALGAL BIOMASS

Additionally, algal biomass may be considered "nuisance floating, suspended, or submerged matter." "Chlorophyll *a* is used as a versatile measure of algal biomass or productivity. The ranges presented for mean summer chlorophyll *a* concentration determined in epilimnetic water supplies collected at least biweekly and analyzed according to *Standard Methods* are indices of the trophic stage of a lake: oligotrophic, 0-4 mg chlorophyll *a*/m^3 ; mesotrophic, 4-10 mg chlorophyll *a*/m^3 ; and, eutrophic, 10-100 mg chlorophyll *a*/m^3 (USEPA 1972 [p 21])." Because the Middle Snake River has a modified flow regime with reservoir-lake-type portions, these values may be used as preliminary indicators of a mesotrophic/eutrophic system. Biomass, as a standing crop, is different than algal biomass, and is a quantitative estimate of the total mass of living plant organisms within a given area or volume after drying (APHA 1995 [p 10-25]). IDEQ-TFRO contracted in 1992-1994 with the University of Idaho/Idaho Water Resources Research Institute to study the primary productivity of the Middle Snake River. The study focused on the highly productive shallow reach rich in aquatic macrophyte development throughout the Crystal Springs Reach (RM 599.5-601.3). The Crystal Springs Reach was determined to be the most productive reach in the water quality limited section due to dense aquatic macrophyte community dominated by *Potamogeton pectinatus, Potamogeton crispus,* and *Ceratophyllum demersum*. Associated with these rooted macrophytes were luxuriant growths of the attached filamentuous green algae *Hydrodictyon* and *Cladophora* that formed dense mats on the water surface. Table 42 shows the results of the 3-year study on the Crystal Springs Reach, which indicate:

1. This reach is on the average eutrophic (>10 mg chlorophyll *a*/m^3).

2. The chlorophyll *a* versus the month is negatively linear correlated (r^2=0.359, *F*-ratio=15.3, p=0.000), decreasing from April to November.

3. The biomass versus the rivermile (RM) is negatively linear correlated (r^2=0.309, *F*-ratio=10.9, p=0.001), decreasing from downstream (RM 600.0) to upstream (RM 600.6), or increasing from upstream to downstream.

4. A negative power regression relationship exists between the mean dry biomass (Y-axis) and the mean chlorophyll *a* (X-axis). As the mean chlorophyll *a* increases the mean biomass decreases.

TABLE 42 1992-1994 FALTER STUDIES ON THE CRYSTAL SPRINGS REACH

YEARS OF STUDY	DRY BIOMASS g/m^3	CHLOROPHYLL-a mg/m^3	N
1992 MEAN	1052.367	8.922	66
1993 MEAN	422.698	26.787	199
1994 MEAN	390.525	13.291	105
1992-1994 MEAN	525.887	19.770	370

Prepared by IDEQ-TFRO. Falter et al. 1994 (for the year 1992); Falter et al. 1995 (for the year 1993); and, Falter et al. 1996 (for the year 1994).

3. EXCESS NUTRIENTS

"The two nutrients of greatest potential concern in aquatic systems are nitrate and phosphate. These nutrients are the two most related to the eutrophication of surface waters, the assocated nuisance growths of algae, and the development of other noxious conditions (USDA FS 1990b [p 11])." In the State of Idaho, "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (See IDAPA §16.01.02.200.06)." Nutrients are defined as "the major substances necessary for the growth and reproduction of aquatic plant life, consisting of nitrogen, phosphorus, and carbon compounds (See §IDAPA 16.01.02.003.66)." "An excess supply of nutrients may cause an over-abundance of plant and animal biomass, especially of undesirable species or communities (IDHW 1991a)." For the Upper Snake Rock subbasin the excess nutrients include nitrogen and phosphorus, at a minimum.

These excess nutrients may also exist as limiting nutrients. Of the two, phosphorus is considered the limiting nutrient in waters of Upper Snake Rock. A limiting nutrient is a chemical (or physical) condition that determines the growth potential of an organism, and can result in less than maximum or complete inhibition of growth, but typically results in less than maximum growth rates. Because phosphorus is often in short supply relative to biological needs, this element limits plant growth in aquatic systems. Ecologically, when additional phosphorus is added to the system, excess aquatic plant growths are noted (IDEQ 1997b [p 44]). It is possible that nitrogen may be a limiting nutrient at certain times if there is substantial depletion of nitrogen in sediments due to uptake by rooted macrophyte beds.

Dissolved nutrients, especially orthophosphate, are rapidly taken up by aquatic plants. If sufficient nutrients are available in either the sediments or the water column, aquatic plants will take up and store an abundance of such nutrients in excess of the plant's actual need through a chemical phenomenon known as *luxury consumption or luxury uptake*. Phosphorus is the primary limiting nutrient in the Upper Snake Rock subbasin. During the life of the aquatic plant, whether macrophyte or algae, it will continue to store phosphorus in its tissue in quantities far in excess of the plant's immediate need. At the death of the plant, the tissue will decay in the water column and its stored nutrients within the plant biomass will be either returned to the water column or become incorporated into the river sediment. Thus, the submersed macrophytes are unique among rooted aquatic vegetation because they link the sediment with the overlying water. This linkage is responsible for great complexities in nutrition, and has important implications for nutrient cycling. Based on a variety of scientific sources, Table 43 describes the primary sources of nutrient uptake by submersed aquatic macrophytes for various nutrients-of-concern.

TABLE 43 PRIMARY SOURCES OF NUTRIENT UPTAKE BY SUBMERSED AQUATIC MACROPHYTES

NUTRIENTS	*SOURCE*	*COMMENTS*
Nitrogen	Sediment	Sediment is primary source for uptake
Phosphorus	Sediment	Sediment is primary source for uptake
Iron	Sediment	Sediment is primary source for uptake
Manganese	Sediment	Sediment is primary source for uptake
Micronutrients	Sediment	Sediment is primary source for uptake
Trace metals	Sediment	Sediment is primary source for uptake
Calcium	Open Water	Component of carbonate system & photosynthetic bicarbonate utilization; uptake from open water

NUTRIENTS	SOURCE	COMMENTS
Magnesium	Open Water	Component of carbonate system & chlorophyll component
Sodium	Open Water	May be exchanged for potassium in sediment
Potassium	Open Water	May be exchanged for NH_4 ions in sediment; uptake also from open water
Sulfate	Open Water	May be exchanged for potassium in sediment or be a component with calcium
Chloride	Open Water	May be exchanged for sulfate in sediment

Prepared by IDEQ-TFRO. Sources include the following: Sculthorpe 1967; Denny 1980; Smart & Barko 1985, 1986; Agami & Waisel 1986; Barko et al. 1982, 1986, 1988; Golterman 1975; Huebert & Gorham 1983; Lowenhaupt 1956; Jackson et al. 1994a,b; and, Barko & James 1998. Rooted submerged macrophytes even with relatively diminutive root systems are capable of significantly depleting pools of nitrogen and phosphorus in sediments (Barko & James 1998). For algae, "since algae on an average contain nitrogen and phosphorus in ratio of 16:1, this ratio in natural waters is commonly cited as an important indicator of relative nutrient limitations by these two nutrients (Stumm & Morgan 1970)." "Higher ratios indicate possible phosphorus limitation, while lower ratios indicate possible nitrogen limitation (USDA FS 1990b [p 11])."

An additional study conducted by Idaho State University on decomposition rates (the process by which nutrients are recycled through ecosystems) for two aquatic macrophyte species, *Ceratophyllum demersum* and *Potamogeton pectinatus*, which are common as dense populations in large, eutrophic rivers, were determined at the beginning and end of the growing season during 1994. The decomposition rate of a highly recalcitrant plant material, leaves of *Populus tremuloides*, also was determined. All three species decomposed at rates much faster than any previously reported values. Furthermore, the decay of the macrophytes was best described by a linear, rather than exponential, model. The decomposition of *P. tremuloides* leaves was best described by an exponential model with a decay constant of 0.002 (standardized for water temperature). The accelerated rates of decomposition are likely a result of the eutrophic condition of the Middle Snake River. An analysis of the carbon and nitrogen concentrations in the plant material suggested that the microbial decomposers in the Middle Snake River are limited by labile organic carbon. Microbial respiration rates were quite high for the macrophytes (*C. demersum* had a daytime of 18 and a nighttime of 4 mg O_2/hr/g dry weight; *P. pectinatus* had daytime of 12 and a nighttime of 3 mg O_2/hr/g dry weight) indicating that potentially large amounts of organic nitrogen, and lesser amounts of phosphorus, can be leached during the early stages of decomposition, thus suggesting that macrophytes play a major role in the nutrient dynamics of the Middle Snake River through the storage and release of carbon, nitrogen, and phosphorus (Royer 1995 [pp iii-iv]).

The following nutrients are described more fully relative to their effect on fisheries and aquatic macrophytes.

a. INORGANIC NITROGEN (NITRITE + NITRATE)

A concentration of total inorganic nitrogen (nitrite+nitrate as N + ammonia-N) of 0.3 mg/L is considered the limit for preventing the development of biological nuisances and the acceleration of cultural eutrophication (IDHW 1980a; USDA FS 1990b [p 11]). Agricultural return flows in Upper Snake Rock often exceed the 0.3 mg/L criterion (IDHW 1991a). The USEPA concluded in 1986 that "nitrate-nitrogen concentrations at or below 90 mg/L should be protective for warmwater fishes, while concentrations at or below 0.06 mg/L should be protective for salmonid fish (USDA FS 1990b [p 11]; USEPA 1986)."

"Nitrate concentrations in ground water from wells that are unaffected by cattle manure, fertilizer, legume crops, or domestic spetic system sources are typically less than 1 mg/L as nitrogen. It is suggested that nitrite plus nitrate as nitrogen concentration in ground water exceeding 2 mg/L probably indicate degradation of water quality from land use activities (USGS 1996a [p 4]). A study conducted by ERI of the major springs discharging to the Middle Snake River indicate nitrite+nitrate levels of 1.611 mg/L in the fall versus 1.688 mg/L in the spring. The % difference of 4.8 is not

statistically different (ERI 1997).

One of the major sources "of nitrate is from the production (and eventual plowout) of alfalfa-hay (*Medicago sativa* L.) In southern Idaho. About 50% of the nitrate present in ground water has been determined to be the result of plowout of alfalfa (Robbins & Carter 1980)." In fact, alfalfa-hay dried and ground to pass a 1 mm sieve, then combined with a silt loam soil (at a rate of 1 gram to 500 grams, respectively) showed an average increase in nitrate from 15 mg/L to 85 mg/L (Buhidar 1990).

b. AMMONIA

"Ammonia can enter natural water systems from several sources, including industrial wastes, sewage effluents, alternative fuel conversion processes, and agricultural discharges. It is a natural biological degradation product of nitrogenous organic matter (Rand GM & Petrocelli SR circa 1981 [pp 456]). Ammonia is toxic to fisheries in aqueous media due to its characteristic chemical equilibrium in water as two chemical species: ionized or the ammonium form (NH_4^+) as a dissociated form, and un-ionized or the ammonia form (NH_3) as the undissociated, uncharged form. Total ammonia is the sum of NH_3 and NH_4^+, and the undissociated but combined form NH_4OH. In aqueous solutions ammonia assumes two chemical forms:

$$NH_3 + nH_2O \leftrightharpoons NH_3 \cdot nH_2O \leftrightharpoons NH_4^+ + OH^- + (n - 1)H_2O$$

These species are NH_3, NH_4^+, and the hydrogen-bonded to at least three ($n \geq 3$) water molecules. The relative concentrations of ionized and unionized ammonia in a given ammonia solution are principally a function of the pH, temperature, and ionic strength of the aqueous solution. If pH increases, the equilibrium is shifted toward the unionized species, and the concentration of NH_3 increases while that of NH_4^+ decreases. Temperature increases also favor the NH_3 species but to a lesser extent. And, an ionic strength increase (increase in total salt content) at low concentrations favors the NH_4^+ species.

"Ammonia is clearly toxic to fish and has many effects. Fish mortality caused by ammonia may be due to different effects in different cases, and it is likely that ammonia has a different mode of action at high than at low concentrations (Rand GM & Petrocelli SR circa 1981 [pp 456-457])." Table 44 gives some typical examples of the acute toxicity (48- or 96-hour LC50) of un-ionized ammonia. "There is some evidence that salmonid fish species are more susceptible to ammonia than are nonsalmonid species, at least on an acute toxicity basis. Although, in general, nonsalmonids are less sensitive to NH_3 than salmonids, the lower values for nonsalmonids are only slightly higher than the lowest value for salmonids, suggesting that sensitivity differences between these groups are not large (Rand GM & Petrocelli SR circa 1981 [pp 457])."

TABLE 44 REPRESENTATIVE ACUTE TOXICITY VALUES FOR UN-IONIZED AMMONIA ON SELECT FISHERIES

SPECIES	*48- or 96- hour LC50 mg/L NH_3*	*REFERENCE*
Pink salmon	0.08 - 0.10	Rice and Bailey (1980)
	0.030 (simulates early emergence of immature fry)	Rice and Bailey (1980)
Chinook salmon	0.015 (Effluent maximum allowable concentration)	Westers (1981)
	0.006 (gill hyperplasia, 6 wks)	Burrows (1964)
	0.004 (gill hyperplasia)	Emerson et al. (1975)

SPECIES	48- or 96- hour LC50 mg/L NH_3	REFERENCE
	0.025 (adverse affects, prolonged exposure)	EIFAC (1970); Smith and Piper (1975)
	0.097 (12 hr/day exposure)	Burrows (1964)
	0.704 (1 hr/day exposure)	Burrows (1964)
Atlantic salmon	0.38	Herbert and Shurben (1965)
Salmonid Hatchery Fish	0.0125 (Upper limit for continous exposure)	IDEQ, Idaho Waste Management Guidelines for Aquaculture Operations (1997)
	0.012 (Maximum level)	SECL (1983)
Rainbow trout	0.20 - 1.10; 0.39; 0.41; 0.42 - 0.89; 0.88	Calamari et al. (1977); Broderius and Smith (1979); DeGraeve et al. (1980); Thurston et al. (1981); Lloyd and Orr (1969); Ball (1967); Lloyd and Herbert (1960); Herbert and Shurben (1965)
	0.015 (mild gill & liver pathology, 6 month exposure)	Smith and Piper (1975); Piper et al. (1982); Soderbert et al. (1983)
	0.020 (protection of aquatic life in 30-day old fish); 6 month exposure results in gill and liver pathology)	USEPA (1975) ± 0.1 safety factor; Smith and Piper (1975)
	0.328 (acute effluent level)	Willingham et al. (1979)
	0.389-3.764 (96-hr LC50)	Ruffier et al. (1981)
	0.182(temporary growth effect)	Willingham et al. (1979); Wiehenbrauck (1976); Smart (1981)
	0.158 (harmless to growth and food conversion)	Smart (1981); Willingham et al. (1979); Wiehenbrauck (1976)
	0.304-0.364 (gill changes, 36 day exposure)	Mitchell and Cech (1983)
	0.049 (reasonably safe max.)	Mead (1985)
	0.012 - 0.085 (sublethal hyper trophy gill effects)	Thurston et al. (1984)
Steelhead trout	0.005(gill changes to juveniles)	Bradley and Rourke (1985)
Lake trout	0.0012 - 0.004 (Hyperplasia of gills when reared in ammonia)	Mead (1985)
Perch	0.29	Ball (1967)
Bluegill	0.49 - 4.60	Emery and Welch (1969); Roseboom and Richey (1977)
	1.093 (96-hr LC50)	Ruffier et al. (1981)
	0.911 (96-hr LC50)	Roseboom and Richey (1977)
Red shiner	2.80	Hazel et al. (1979)
Channel catfish	1.80 - 3.80	Colt and Tchobanoglous (1976); Roseboom and Richey (1977)
	0.389-3.764 (96-hr LC50)	Ruffier et al. (1981)

SPECIES	48- or 96- hour LC50 mg/L NH_3	REFERENCE
	0.146(gill hyperplasia, 27days)	Robinette (1970)
	0.219 (no hyperplasia, 83days)	Mitchell and Cech (1983)
Striped bass	1.90 - 2.80	Hazel et al. (1971)
Largemouth bass	0.90 - 1.40	Roseboom and Richey (1977)
Carp	0.11 - 0.34	Flis (1968)
Most fish and shellfish	0.121 (max. tolerable conc.)	Wickins (1981)
Most cultured animals	0.06 - 0.24	Colt and Armstrong (1981)

Prepared by IDEQ-TFRO. References listed in the table are not found in §2.60, Sources and References since they are referenced in USEPA 1972 and Rand & Petrocellia 1981. For a test duration of 96 hours, LC50 values reported for two salmonid species fall in the range 0.08 - 1.10 mg/L NH_3, although salmonid hatchery fish have an upper limit for continuous exposure at 0.0125 mg/L NH_3. LC50 values for nonsalmonids species fall in the range 0.50 - 4.60 mg/L NH_3. The most sensitive freshwater fish is the rainbow trout (*Onchorynchus mykiss*) with a 96-hour LC50 of 0.072 mg/L. The most sensitive freshwater invertebrate is the worm *Lumbriculus variegatus* with a 10-day LC50 of 0.455 mg/L. The most sensitive freshwater alga is *Ochromonas sociabilis* with an LC50 of 0.6 mg/L. See www2 internet sources. It should also be noted that the Mitchell and Cech (1983) study (1) debased proposals by Smith and Piper (1975) that gill hyperplasia is a common sign of chronic ammonia poisoning, and (2) that macroscopic/microscopic changes in gills are not necessarily hyperplastic gill damage.

The intent of the previous table was not to provide an exhaustive review of all research on un-ionized ammonia and its effect on fisheries at various concentrations. In order to develop a more holoistic understanding of un-ionized ammonia and its effects on fisheries, one must consider it in conjunction with other parameters. It should be noted that until 1962 only un-ionized ammonia was considered toxic (Mead 1985 [p 138]). Synergistic effects must be considered also in order to establish safe levels of combined toxicants (Mead 1985 [p 137]) for such things as ammonium, dissolved oxygen, carbon dioxide, pH, temperature, and ionic gradients. In fact, sublethal effects of un-ionized ammonia may be related to ammonium and ambient sodium concentrations (Mead 1985 [p 139]). Until such synergistic effects are researched in greater detail, the preliminary use of maximum concentration limits will have to suffice, based on appropriate fisheries research. Therefore, USEPA recommends no concentration greater than 0.020 mg/L of unionized ammonia as a toxic substance for fisheries at any time or place (USEPA 1972 [p 187]). Idaho state water quality standards (IDAPA 16.01.02.250(02)(c)(iii)) specify an un-ionized ammonia (NH_3°) or a total ammonia ($NH_3 + NH_4^+$) criteria at selected water temperatures and pH values for protection of cold water biota. On the Middle Snake River and its tributaries, un-ionized ammonia can be and has been a problem. See §2.2.3 of this subbasin assessment.

c. TOTAL PHOSPHORUS

To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphorus (as P) should not exceed 0.05 mg/L in streams where it enters a lake or reservoir (USEPA 1977, 1988). A desired goal for the prevention of plant nuisances in flowing waters not discharging directly to lakes or impoundments is 0.10 mg/L total phosphorus (MacKenthun 1973). "The USEPA suggests as a guideline to prevent nuisance algal growths and limit cultural eutrophication that total phosphates as phosphorus should not exceed 0.1 mg/L in any stream or other flowing water, exceed 0.05 mg/L in any stream at the point where it enters a lake or reservoir, or exceed 0.025 mg/L in any lake or reservoir (USDA FS 1990b [p 11]; USEPA 1986)." Therefore, a reasonable criteria for total phosphorus per tributary is in the range of 0.05 - 0.10 mg/L, depending on the location of the tributary and its confluence with or not with the free-flowing stretches of the Middle Snake River (IDHW 1991a). Bear in mind that phosphorus levels below 0.05 mg/L are

desirable when waters flow into any impoundment (USEPA 1988; USDA NRCS & IDEQ 1991 [p 123]). The Mid-Snake TMDL uses a water quality target of 0.075 mg/L total phosphorus at Gridley Bridge, Hagerman, Idaho because of the Middle Snake River's modified flow regime with run-of-the-river impoundments (IDEQ 1997b [p. 53]). This water quality target is proposed as a representative average of the whole river system, assuming that the water pollution targets by the various water user industries are implemented over a 10-year period. It is not a target that is assumed to be completely protective of the resource or the designated beneficial uses, or the final target in total phosphorus reductions. But it is a target that industries and agencies agreed would be a starting point for targeting of phosphorus reductions to reduce nuisance aquatic plant growth at select portions of the river where most nuisance plant growths are known to exist, and where the swimmability and boatability of the river could be restored.

In combination with nitrate, total phosphorus ratios of 16:1 (N:TP) in natural waters is used as the same ratio found in algae on an average. This ratio is commonly used as an important indicator of relative nutrient limitations by these two nutrients: (1) higher ratios indicate possible phosphorus limitation, and (2) lower ratios indicate possible nitrogen limitation (USDA FS 1990b [p 11]).

4. OXYGEN-DEMANDING MATERIALS

"Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition (See IDAPA §16.01.02.200.07)." A measure of oxygen-demanding materials is BOD (biochemical oxygen demand) which is the rate at which organisms use the oxygen in the water (or wastewater) while stabilizing decomposable organic matter under aerobic conditions. Anaerobic is defined as a condition in which life or acitivity occurs in the absence of free oxygen (IDEQ 1997).

Those dark, organic sediments of the Middle Snake River and tributaries of Upper Snake Rock subbasin associated with facilities' discharge outfall have dissolved oxygen concentrations that are by definition zero (see next few sentences for explanation) and remain below the State established minimum standards in the water column for some distance off the stream bottom. Sediments discharged from aquaculture facilities are considered anaerobic, because in general their discharge occurs after the mineralization process has occured (aerobic decomposition) and the anaerobic bacteria continue the decomposition process to produce hydrogen sulfide (instead of sulfate), ammonia, nitrogen gas, methane, and soluble ferrous iron. Under these conditions the organic sediment (which is typically at the bottom of the aquaculture pond, tributary, or river) is "dead," as is the deoygenated water close to it. When disturbed, the dark, organic sediments produce foul and offensive odors due to released hydrogen sulfide and methane (Avault 1996 [pp 370-376]). Phosphorus is also released directly back into the water column to become available for increased algal and macrophyte production in the immediate area and downstream of such anaerobic conditions.

It is possible that a mixing zone at the outfall of these facilities could be issued under §401 water quality certification. IDEQ authorizes mixing zones for meeting Idaho water quality standards (IDAPA 16.01.02.060) for dissolved oxygen in flowing receiving waters limited to the following:

> 1. The cumulative width of the adjacent mixing zones when measured across the receiving water is not to exceed fifty percent (50%) of the total width of the receiving water at that point (IDAPA 16.01.02.060(01)(e)(i)).
>
> 2. The width of the mixing zone is not to exceed twenty-five percent (25%) of the stream width or three hundred (300) meters plus the horizontal length of the diffuser

as measured perpendicularly to the stream flow, whichever is less (IDAPA 16.01.02.060(01)(e)(ii)).

3. The mixing zone is to be no closer to the ten (10) year, seven (7) day low-flow (7Q10) shoreline than fifteen percent (15%) of the stream width (IDAPA 16.01.02.060(01)(e)(iii)).

4. The mixing zone is not to include more than twenty-five percent (25%) of the volume of the stream flow (IDAPA 16.01.02.060(01)(e)(iv)).

5. SEDIMENT AND "SETTABLE SUBSTANCES"

"Sheet and rill, gully, and ephemeral gully erosion from hillslopes are the major source of most sediment introduced into stream channels. Exceptions to this are where sediment is substantially produced by landslides, debris, flows, streambanks, irrigation, and roadsides. The hillslopes are the portions of the landscape that are zones of sediment production. The most effective way to deal with the accumulation of fine sediment in aquatic habitats is to stop the excess at its source. This is only feasible for the sediment derived from accelerated erosion. If the degree of erosion has progressed too far (like gully headcuts), then accelerated erosion requires stabilization and revegetation of slopes and possibly other measures. Fine bed streams have silt or clay bottoms and are unusual in western mountainous watersheds except in estuaries (Castro & Reckendorf 1995 [pp 3-4, 20-29])."

In general, fine suspended sediment affects the aquatic fauna as follows:

1. The highest diversity of benthic macroinvertebrates occurs in gravel-bed streams, not in silt or clay bottom streams. Gravel-bed streams have larger, more diverse macroinvertebrate populations when compared to silt or clay bottom streams, and are extremely important spawning areas for anadromous fish. An average of 70% of freshwater fish species depend on insects as a food source, thus indicating that the macroinvertebrate population controls the fish population because it is the primary food source.

2. Aquatic plants are affected by both increased bedload and suspended load. An increase in bedload may bury an area in which a plant species is growing. Subaqueous plants will be significantly affected by increased suspended sediment loads because primary plant production is reduced with increases in turbidity. This results in a decrease in benthic organism diversity and density because of a limited food supply, thus forcing the fish to migrate to other reaches of the stream.

Additionally, "the European Inland Fisheries Advisory Commission concluded that suspended sediment can affect aquatic organisms by killing them directly, by reducing growth rates and resistance to disease, by preventing successful development of eggs and larvae, by modifying natural movement or migration patterns, or by reducing the natural availabilities of food (USDA FS 1990b [p 10]; USEPA 1986)." "A review completed by the National Academy of Sciences suggested that a limit of 25 mg/L of suspended sediment would provide high, 80 mg/L moderate, 400 mg/L low, and over 400 mg/L very low levels of protection for aquatic organisms ((USDA FS 1990b [p 10]; Thurston *et al.* 1979)."

"Sediment is the most common nonpoint source pollutant in Idaho affecting the beneficial uses of salmonid spawning and cold water biota (IDHW 1989b)." "In southern Idaho suspended sediment is the dominant portion of the total sediment load of streams in the Upper Snake Rock subbasin

(IDHW 1988)." In fact, all streams on the 1996 §303(d) list have sediment listed as one of the pollutants. "Sediment impacts salmonid spawning and cold water biota beneficial uses by smothering fish spawning and rearing habitats, by smothering fish-food organisms (benthic macroinvertebrates), and by increasing turbidity which can affect light penetration and impair fish feeding behavior (IDHW 1991a)."

A study of particle size composition of the sediment on the Middle Snake River was conducted by the University of Idaho from 1992 to 1994 (See Falter et al. 1993, 1994, and 1995). In 1992 five depositional sites limited to weedbed sites and deep pools on the Middle Snake River were monitored. Overall the average of all sites indicated that one silt size dominated the fines: <0.075 mm. Considering site specific locations:

1. At the Auger Falls site (RM606.3) two silt sizes dominated the fines: between 1.18 mm and 2.36 mm.

2. At the Crystal Springs site (RM599.9) one silt size dominated the fines: <0.075 mm.

3. At the Box Canyon site (RM588.3) one silt size dominated the fines: <0.075 mm.

4. At the Thousand Springs Site (RM535.1) one silt size dominated the fines: <0.300 mm.

5. The site at Blue Heart Springs (RM588.0) was used as a comparison site because it was in a predominant spring fed area. Four silt sizes dominated the fines: at the 5.0-6.0 m depth the sizes were 1.18 mm and 2.36 mm; and, at the 13.0 m depth the sizes were 0.150 mm and 0.300 mm.

In general, the Crystal Springs and Box Canyon sites were dominated by silts <0.075 mm, whereas the most upstream (Auger Falls) and most downstream (Thousand Springs) were dominated by silts >0.075 mm (Falter et al. 1994). In 1993 and 1994 monitoring of the Crystal Springs sites for particle size analysis/texture indicated the following:

1. 1993 monitoring showed an overall average of 56.7% sand, 40.0% silt, and 3.3% clay, with a range for all transects (7) of 53.6-61.4% sand, 36.5-43.6% silt, and 2.1-4.5% clay. In relationship to river mile stretch, sand and clay are statistically significant: sand decreasing from upstream (RM601.0) to downstream (RM600.0), and clay increasing from upstream to downstream. Other parameters studied in the sediment in relationship to river mile stretch showed a statistically significant correlation in organic carbon (an increase from upstream to downstream), organic matter (an increase), carbon (an increase), hydrogen (an increase), and nitrogen (an increase) (Falter et al. 1995).

2. 1994 monitoring showed an overall average of 53.6% sand, 5.5% clay, and 39.8% silt, with a range for all transects (4) of 51.2-72.1% sand, 2.7-6.2% clay, and 25.2-41.2% silt. In relationship to river mile stretch, none of the particle size classes are statistically significant. Other parameters studied in the sediment in relationship to river mile stretch showed a statistically significant correlation in organic carbon (an increase from upstream to downstream), organic matter (an increase), carbon (an increase), nitrogen (an increase), and hydrogen (an increase) (Falter et al. 1996).

3. Comparison of 1993 to 1994 sediment data showed little difference in the particle size analysis: sand was on average a little more in 1993 than 1994, 56.7% to 53.6%, respectively; silt was on average about the same from 1993 to 1994, 40.0% to 39.8%, respectively; and, clay was a little less in 1993 than 1994, 3.3% to 5.5%, respectively. The patterns of sand, silt, and clay from month-to-month were similar between 1993 and 1994: mean sand content of sediments was greater at higher velocity, open-channel sites than under aquatic macrophyte beds, since open water channels have greater velocity; mean silt content of sediments was always higher in the aquatic macrophyte beds than in the open water areas, meaning the aquatic macrophyte beds were functioning as traps for fine particulate matter; and, mean clay content of sediments was always higher in the aquatic macrophyte beds than in the open water areas, and increased steadily from April through July.

Idaho water quality standards for sediment have a narrative criteria but no fixed numeric value at which the standard can be met: "Sediment shall not exceed quantities specified in" IDAPA §16.01.02.250, "or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses (See IDAPA §16.01.02.200.08)." Suspended sediment is legally defined as "organic and inorganic particulate matter which has been removed from its site of origin while suspended in surface water (See IDAPA §16.01.02.003.101)." The NRCS defines suspended sediment as solid material (mineral or organic) that is in suspension and is being transported 3 inches above the stream bottom to the top of the water column (IDHW 1986 [p 25]). USEPA defines sediment in conjunction with "settlable substances" for the protection of wildlife. As such, accumulations of "settable substances," like silt deposits, are destructive to aquatic plants due especially to the creation of a soft, semi-liquid substratum inadequate for the anchoring of roots. Thus, "settable substances" can destroy the usefulness of aquatic bottoms to waterfowl, and for that reason, settable substances should be minimized in areas expected to support waterfowl. Additionally, clear waters are normally preferred for recreation as well as the aesthetic value of the water. Because sediment-laden water reduces water clarity, inhibits the growth of plants, displaces water volume as sediments settle, and contributes to the fouling of the bottom, prevention of unnatural quantities of suspended sediments or deposit of sediments is desirable. Individual waters vary in the natural amounts of suspended sediments they carry; therefore, no fixed recommendation can be made. Management decisions should be developed with reference to historical base line data concerning the individual body of water (USEPA 1972 [pp 195,16-17]).

In order to quantify numerically the sediment narrative standard, the IDEQ-TFRO proposes a preliminary interim target of total suspended solids not to exceed a monthly average of 52 mg/L with a daily maximum of 83 mg/L (52 mg/L x 1.6 = 83 mg/L) to allow for natural spikes during flood events over a ten (10) year period. The average monthly of 52 mg/L is identified by the scientific community as "supporting a good fishery (EIFAC 1964; NAS/NAE 1973)." This target is also well in line with the Nevada Division of Environmental Protection's standard, the Washington Department of Ecology's target within the Yakima River subbasin, and the Utah Department of Environmental Quality's targets in the Lower Bear River basin. It also, for a regional comparison in southern Idaho, is close to the proposed 50 mg/L criteria for suspended sediment which provides a "high level of protection for cold water biota (IDHW 1991a)." It is, however, below Lloyd's recommended level of 100 mg/L for a "moderate level of protection of cold water habitat which has been suggested for various tributaries in Upper Snake Rock (USDA NRCS & IDEQ 1991 [pp 120-123).

Narrative criteria applicable to the Middle Snake River and its tributaries include: deleterious materials; floating, suspended, or submerged matter; excess nutrients; and, oxygen-demanding materials. Streams in which sediment is listed as a pollutant exceed these narrative criteria as a result of existing point and/or nonpoint activities. Table 45 summarizes those narrative standards violated.

TABLE 45 WATER QUALITY NARRATIVE VIOLATIONS OF WATERBODIES IN UPPER SNAKE ROCK

STREAM NAME	BOUNDARIES	NARRATIVE WQ STANDARDS DM	FSS	EN	ODM	S
	TRIBUTARIES					
Alpheus Creek	From headwaters to the Snake River	None listed on §303(d) list.				
Billingsley Creek	From headwaters to the Snake River	X	X	X	X	X
Blind Canyon Creek	From headwaters to the Snake River	X	X	X		X
Cedar Draw	From headwaters to the Snake River	X	X	X	X	X
Clear Springs	From headwaters to the Snake River	X	X	X	X	X
Clover Creek	From Pioneer Reservoir to the Snake River	X	X	X	X	X
Cottonwood Creek	From headwaters to Rock Creek	X	X	X	X	X
Crystal Springs	From headwaters to Snake River	X	X	X	X	X
Deep Creek	From headwaters to Snake River	X	X	X	X	X
Dry Creek	From West Fork Dry Ck to Murtaugh Lake	X	X	X		X
Dry Creek, West Fork	From headwaters to Dry Creek	X	X	X		X
McMullen Creek	From headwaters to Cottonwood Creek	X	X	X	X	X
Mud Creek	From headwaters to Snake River	X	X	X	X	X
Riley Creek	From headwaters to Snake River	X	X	X	X	X
Rock Creek	From Rock Creek Town to Snake River	X	X	X	X	X
Sand Springs Creek	From headwaters to Snake River	X	X	X		X
Tool Box Creek	From headwaters to Fifth Fork Rock Creek	None listed on §303(d) list.				
	RESERVOIRS					
Bliss Reservoir	The entire reservoir	X	X	X	X	X
Lower Salmon Falls Reservoir	The entire reservoir	X	X	X	X	X
Pioneer Reservoir	The entire reservoir	X	X	X	X	X
Shoshone Falls Reservoir	The entire reservoir	X	X	X	X	X
Upper Salmon Falls Reservoir	The entire reservoir	X	X	X	X	X
	ON THE MIDDLE SNAKE RIVER					
Middle Snake River	From Milner Dam to Murtaugh *(1)*	X	X	X	X	X
Middle Snake River	From Cedar Draw to Rock Creek *(1)*	X	X	X	X	X
Middle Snake River	From Clear Lakes Bridge to Cedar Draw *(1)*	X	X	X	X	X
Middle Snake River	From Deep Creek to Mud Creek *(1)*	X	X	X	X	X
Middle Snake River	From King Hill to Big Pilgrim Gulch *(2)*	X	X	X	X	X

STREAM NAME	BOUNDARIES	NARRATIVE WQ STANDARDS DM	FSS	EN	ODM	S
Middle Snake River	From Mud Creek to Clear Lakes Bridge *(1)*	X	X	X	X	X
Middle Snake River	From Rock Creek to Shoshone Falls *(1)*	X	X	X	X	X
Middle Snake River	From Cassia Gulch to Big Pilgrim Gulch *(2)*	X	X	X	X	X
Middle Snake River	From Bliss Bridge to King Hill Diversion *(2)*	X	X	X	X	X
Middle Snake River	From Murtaugh to Twin Falls Reservoir *(1)*	X	X	X	X	X

Prepared by IDEQ-TFRO: DM = Deleterious materials; FSS = Floating, suspended, submerged materials; EN = Excess nutrients; ODM = Oxygen demanding materials; S = Sediments. Information taken from 1994 & 1996 303(d) lists and various reference materials already cited in the subbasin assessment from IDEQ, NRCS, USEPA, USGS, and IDFG.

6. TURBIDITY

"Turbidity has been described as a major water quality characteristic affecting freshwater fish communities (Lloyd 1987 [p 34])." The justification and implementation of appropriate statndards are important to protect fish resources from habitat degradation caused by this common form of pollution. As an optical property of water, it describes suspended and some dissolved materials such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms which cause light to be scattered and absorbed rather than transmitted in straight lines (APHA 1995). "Measurements of turbidity have been developed to quickly estimate the amount of sediment within a sample of water, and they are also used to describe the effect of suspended sediment in blocking the transmission of light through a body of water (Lloyd 1987 [p 34])." By definition, turbidity and suspended sediment concentrations are closely intertwined. A turbidity standard can be used to address the effects of turbidity as an optical property of water and as an indicator of suspended sediment concentrations (Lloyd 1987 [p 38]. Both parameters are most often used as indicators in nonpoint source monitoring programs. Increases in both these parameters have been associated with reduced light penetration, decreased production and abundance of plant production, decreased fish food organisms, aesthetics, and decreased fish production and abundance (Lloyd *et al.* 1987; USDSA NRCS 1991 [p 120]).

IDAPA 16.01.02.250.02.c.iv for cold water biota states that "turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days." IDAPA 16.01.02.003.07 defines background as "the biological, chemical, or physical condition of waters measured at a point immediately upstream (up-gradient) of the influence of an individual point or nonpoint source discharge." For point source treatment requirements, IDAPA 16.01.02.401.03.b. states that "the wastewater must not increase the turbidity of the receiving water outside the mixing zone by (i) more than five (5) NTU over background turbidity, when background turbidity is fifty (50) or less; or, (ii) more than ten percent (10%) increase in turbidity when background turbidity is more than fifty (50) NTU, not to exceed a maximum increase of twenty-five (25) NTU."

6. TEMPERATURE

"Most biological and chemical processes in aquatic environments ultimately are regulated by water temperature. In fact, temperature has been described as a catalyst, a depressant, an activator, a restrictor, a stimulator, a controller, a killer, one of the most important and influential water quality characteristics to life in water (USDA FS 1990b [p 10-11]; USEPA 1986)." "Temperature exerts an important influence on the chemical and biological processes in a water body. It determines the

distribution of aquatic species; controls spawning and hatching; regulates activity; and, stimulates or suppresses growth and development. The two most important causes of temperature change in a water body are process and cooling water dishcarges, and solar radiation (USEPA 1983c [p II-5-1])." Stream temperatures have been described by USFWS as being influenced directly by air temperature, relative humidity, percent shade, and stream flow and can be readily modeled to predict mean daily water temperature (Barthalow 1989 [p 139]; IDEQ 1998c [p 2]).

COLD WATER BIOTA

Temperature or temperature modification is listed on various streams of Upper Snake Rock as a pollutant/stressor. IDAPA §16.01.02.250(02)(c)(ii) states that waters designated for cold water biota are to exhibit water temperatures of 22°C or less (daily maximum) with a maximum daily average of no greater than 19°C.

On the Middle Snake River and its tributaries, for cold water biota field monitoring data collected by IDEQ-TFRO, shows exceedences in temperature above 22°C as follows in Table 46:

Table 46 Cold water biota temperature exceedences (> 22.00 °C) in Upper Snake Rock

Stream Segment Name	*Temperature Exceedence*	*Date of Exceedence*
Middle Snake River	22.28°C at Twin Falls Reservoir	July 1, 1996 (ERI)
	22.16°C at Twin Falls Reservoir	July 29, 1996
	22.65°C at Twin Falls Reservoir	July 29, 1996
	25.30°C at Shoshone Falls Dam	July 2, 1996 (ERI)
	22.02°C at Below Pillar Falls	July 29, 1996
	22.38°C at Upper Salmon Falls Dam	July 17, 1996 (ERI)
East Perrine Coulee	23.46°C	June 4, 1996 (ERI)
	26.29°C	July 1, 1996 (ERI)
	24.50°C	July 15, 1996 (ERI)
Cedar Draw	22.50°C	June 22, 1990
Salmon Falls Creek	23.50°C	August 18, 1992
Mud Creek	22.60°C	July 27, 1994
Deep Creek	22.40°C	July 29, 1991
Clover Creek	24.66°C	May 28, 1997
	22.40 & 27.70°C	June 9, 1997
	23.98 & 27.66°C	July 22, 1997
	23.64°C	August 5, 1997

Prepared by IDEQ-TFRO. ERI = Ecosystems Research Institute study of 1996. Other monitoring done by IDEQ-TFRO for 1995-1997 seasons.

IDEQ-TFRO proposes that these exceedences per indicated water body for cold water biota are minor excursions (with the exception of Clover Creek) and do not necessarily constitute violations of the temperature water quality standard, especially when compared to the overall length of time in

which IDEQ-TFRO did the monitoring. Clover Creek exceedences are the result of joint geothermal well inputs and complete diversion appropriations of irrigation water. IDEQ-TFRO proposes that water flow regulation constitutes a greater threat to water temperature violations especially in low flow or drought years because impounded reservoir water and agricultural return flow water exceeds temperature criteria for cold water biota.

As presently constituted, the Middle Snake River (as part of the larger "middle Snake River" as defined by USBOR) has been transformed in recent times from a free-flowing, coldwater system to a slow-moving, warmwater system because of hydroelectric impoundment (USBOR 1998). IDAPA 16.01.02.260.01.b. allows for variances from the state water quality standards, provided:

1. "ii. Natural, ephemeral, intermittent, or low flow conditions or water levels prevent the attainment of the standard." As described in §2.1.1.2, the average annual precipitation may vary from 5 to 15 inches which affects not only the rainfall, but also the potential for high snowpack levels in the mountains. Because Upper Snake Rock is a semiarid region, a characteristic is its low annual rainfall with moderately hot,dry summers. Low precipitation indicates low water inputs into the tributaries and streams that feed directly into the Middle Snake River and tributaries of Upper Snake Rock. This causes low flow conditions at Milner Dam, which in turn allows for very low volumes of water, if any, to be discharged directly to the Middle Snake River past Milner Dam. Such low flow conditions create low water levels and low velocity flows in the Middle Snake River, thus enhancing the tendency for higher temperatures that exceed water quality standards, particularly during the summer irrigation months. Under low flow conditions water quality standards and designated beneficial uses are not attained until conditions are changed that allow more water into the system. Therefore, low flow conditions or low water levels prevent the attainment of the standard.

2. "iii. Human caused conditions or sources of pollution prevent the attainment of the standard and cannot be remedied or would cause more environmental damage to correct than to leave in place."

3. "iv. Dams, diversions or other types of hydrologic modifications preclude the attainment of the standard, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in attainment of the standard." As described in §2.1.3, the Middle Snake River is a flow regulated system from American Falls, Lake Walcott, Milner Lake, and other reservoirs. Irrigation return flows constitute a large part of the re-entry water to the Middle Snake River between Milner Dam and King Hill. From 1909 to 1926 the flow (as regulated at gage 13088000) has averaged 5206 cfs (USGS 1997 [WY1997]). Then, from 1926 to 1996 the flow (as regulated at gage 13088000) has averaged 5384 cfs (USGS 1997 [WY1997]). This represents how fairly uniform the average annual flow has been since 1906. However, on a monthly basis, the monthly flow from WY1990 to WY1997 averaged less than 5000 cfs past Milner Dam 85.4% of the time (or a range of 2 to 4449 cfs). It wasn't until WY1995 that flows increased past 5000 cfs due to increased rains; first, for two months in WY1995; then, five months in WY1996; and then, seven months in WY1997. In fact, temperature exceedences during the WY's 1995-1997 occured only in those months when flows were less than 5000 cfs, especially during the summer months. Additionally, there are six (6) major impoundments on the Middle Snake River which greatly affect the water temperature of the system, particularly when only 25.7% of the river system is reservoir-like. See §2.1.3.2 of the subbasin assessment.

4. "v. Physical conditions related to the natural features of the water body, unrelated to water quality, preclude attainment of the standard." These physical conditions have to do with the

six (6) major impoundments and how they make 25.7% of the Middle Snake River system reservoir-like. Additionally, the Middle Snake River's water quality degradation due to high rates of primary productivity and decomposition of aquatic vegetation which cause fluctuations in dissolved oxygen have resulted in the loss of native cold-water species such as trout and white sturgeon, and have favored exotic and pollutant tolerant species. "The hydropower projects on the Middle Snake River alter the physical characteristics of the river, which in turn affect water quality and biotic communities. The reservoirs in particular have altered the river's capacity to process the nutrients that encourage excessive plant growth and create large shallows and areas of sediment deposition that are ideal for the aquatic weeds. Riverine characteristics affected by the dams include water velocity, discharge, water depth, and water retention times. Potential water quality changes associated with the construction and operation of the hydropower projects include dissolved oxygen and temperature modifications, gas supersaturation, sedimentation, and local nutrient processing. White the hydropower projects do not add nutrients to the river, the impoundments behind the dams affect the ability of the river to process sediment and nutrients (FERC 1997b [p 10-11])." "Prior to construction of hydropower dams, the Middle Snake River supported a diverse and rich aquatic community. Salmon, steelhead, white sturgeon, rainbow trout, lamprey, and a host of other aquatic species inhabited the river and could freely range throughout the river. Construction of hydro projects on the Middle Snake River eliminated anadromous species, severely reduced native rainbow trout, contributed to the depletion of white sturgeon, and reduced the diversity of both aquatic species and their habitats. The conversion of a free-flowing river into a slack water environment eliminates important habitat for many native species and does not provide adequate habitat for desirable non-native species. These physical changes to the river envirnoment mean that insects and other invertebrates that once provided an ample food source for rainbow trout, mountain whitefish, and white sturgeon have been replaced by an insect community that is less available as a food source. Existing sport fisheries in the area include a limited population of naturally produced rainbow trout, catch and release fishing for white sturgeon, and hatchery produced rainbow trout (FERC 1997b [p 12-13])."

5. "vi. Controls more stringent than technology-based effluent limitations would result in substantial and widespread economic and social impact." Nonpoint source influence on certain tributaries may be greater since no point sources are present. Under these conditions to attempt to get pollution control mechanisms that are more stringent than technology-based effluent limitations (for point sources) would result in serious economic and social upheaval for industries and citizens of the watershed.

Additionally, as cited in §2.1.4.1, because the Middle Snake River has eutrophic conditions that directly affect water quality standards and designated beneficial uses, IDFG has managed the river system according to the average temperature (as "water types"): from Milner Dam to Twin Falls Reservoir as cold water (about 21.7 miles); from Twin Falls Reservoir to Lower Salmon Falls as mixed water (about 44.4 miles); and, from Lower Salmon Falls to Bliss Dam as warm water (about 12.7 miles). Thus, 16% of the river is stocked for warm water fishes, 56% for mixed water fishes, and 28% for cold water fishes (or 72% of the river is stocked for mixed or warm water fishes).

SALMONID SPAWNING

For salmonid spawning, IDAPA §16.01.02.250(02)(d)(ii) states that waters so designated are to exhibit water temperatures of 13°C or less (daily maximum) with a maximum daily average of no greater than 9°C. A daily average based on diel work is preferred, but minimum standard requirements allow for only two samples since IDAPA §16.01.02.003(19)) states that a daily mean

is the average of at least two appropriately spaced measurements acceptable to IDEQ, calculated over a period of one day. Additionally, "The National Academy of Sciences has listed the following temperatures: for rainbow trout and brook trout adults and juveniles, the maximum weekly average temperature for growth during the summer is listed as 19°C, and the short-term maximum temperature limit for survival during summer is 24°C. The average weekly maximum temperature is reported as 9°C, and 13°C as the short-term maximum reported for survival of their embryos (USDA FS 1990b [p 11]; USEPA 1986)."

On the Middle Snake River and its tributaries, salmonid spawning was assessed for temperature exceedences greater than 13°C during the spawning period or season-of-concern. Table 47 summarizes the number of (and percent of) exceedences for the particular fisheries for the season-of-concern. Only the native species were assessed.

Table 47 Number of temperature exceedences (> 13 °C) based on IDEQ-TFRO data for 1995-1997 for native fisheries

Fisheries' Species	*Spawning Season*	*Number of Exceedences*	*% Exceedences*
Chinook salmon (spring)	August 1st to April 1st	214 out of 539	39.7
Chinook salmon (summer)	August 15th to June 15th	275 out of 720	38.2
Steelhead trout	February 1st to July 15th	204 out of 470	43.4
Redband trout	March 1st to July 15th	201 out of 423	47.5
Cutthroat trout	April 1st to August 1st	250 out of 376	66.5
Rainbow trout	January 15th to July 15th	207 out of 487	42.5
Mountain whitefish	October 15th to March 15th	21 out of 276	7.6

Prepared by IDEQ-TFRO. Number of exceedences and total number of samples were taken from only within the season-of-concern. The % Exceedences represents the percent of the number of samples that exceeded the temperature criteria. Introduced species were not considered in this assessment.

Present Idaho water quality standards contain surface water temperature criteria which do not appear to conform to conditions in the Middle Snake River that have been unchanged since before the inception of the Clean Water Act in 1972. In fact, the dilemma of applying uniform temperature criteria in a diverse environment affected by spatial variation, temporal variation, and the relation of climate to stream temperature is something that needs to be resolved as fisheries data from various agencies indicate that affected fisheries are more tolerant to thermograph exceedances than previously thought. These data indicate that more than 50% of the time where Idaho temperature criteria exceedances occur, the affected age classes of fish are present. Salmonid spawning and incubation have occured coincidentally with measured temperature criteria exceedances (IDEQ 1998c [p 21]). Therefore, IDEQ-TFRO proposes to defer 24 months from the time of TMDL acceptance for a more complete study to resolve some of these issues, and to allow the Idaho State Legislature to make the necessary changes in the regulations that reflect a more realistic picture of the Middle Snake River and its tributaries. At that point, IDEQ-TFRO, USEPA, and the Mid-Snake WAG and TAC will have a better perspective of the temperature dilemma based on data assessed or accumulated by a more intense study.

2.2.3.4 HABITAT MODIFICATION AND FLOW ALTERATION

It is Idaho DEQ's position that habitat modification and flow alteration, while they may adversely affect beneficial uses, are not pollutants per §303(d) of the Clean Water Act. There are no Idaho water quality standards for habitat or flow, nor are they suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed at this time to address habitat modification or flow

alteration per se. For many of the water quality limited waters on Idaho's §303(d) list this will have little effect on implementation plans. This is because concerns which resulted in a listing for habitat modification or flow alteration are often reflected in listed pollutants---sediment or temperature, for example. In such cases, actions taken to address these related pollutants will likely address habitat or flow as well. In other cases alternate control strategies would be applied outside the TMDL process.

While USEPA has not reached a resolution regarding IDEQ's position whether habitat modification and/or flow alteration are pollutants under §303(d) of the Clean Water Act, it has taken the following position: If and when USEPA determines that they are considered pollutants under §303(d), USEPA would then require that a TMDL be developed to cover these parameters (USEPA 1998b).

Because sediment is defined as a pollutant in all the streams listed on the §303(d) list for Upper Snake Rock; and because sediment is linked to the degradation of snail habitat of the endangered snails on the Middle Snake River and its associated tributaries; and because IDFG stipulates that sediment is a detriment to fisheries and fisheries habitat over the long term; the TMDL portion for sediment asserts that those reductions to be implemented by point and nonpoint sources in the Upper Snake Rock watershed will yield a less adverse effect on the snail and fish habitats. As a result sediment allocations, over the long term it is expected to see some recovery of habitat and species specific to their known location. High or scouring flows may have a direct impact on the recovery of the habitat as well as the species if flows are available above those allocated for storage and irrigation diversion.

2.2.3.5 EFFECT OF EUTROPHIC WATER ON ENDANGERED AND THREATENED SPECIES

As discussed in §2.1.4.4 various species in Upper Snake Rock are listed as Endangered or Threatened. And as discussed in §2.4.3 the point sources (food processors, municipalities, and aquaculture) are undergoing reissuance or modification of their existing NPDES permits. Also, the major impoundments on the Middle Snake River (Bliss, Upper Salmon Falls, Lower Salmon Falls, Shoshone Falls, and previously Twin Falls Dams) are undergoing FERC relicensing. Because these are major federal permitted activities, the USEPA is required, under the consultation process in Section 7 of the Endangered Species Act, to conduct a biological evaluation with the USFWS and NMFS to identify impacts on endangered or threatened species that may result from the discharges covered by the NPDES and FERC permits. In §2.4.3.3 a description of these species (Endangered and Threatened) is listed. Table 48 describes the effect of eutrophic waters from the Middle Snake River and Billingsley Creek on these species.

TABLE 48 EFFECT OF EUTROPHIC SURFACE WATERS ON ENDANGERED AND THREATENED SPECIES

SPECIES NAME	HABITAT PREFERENCE	REASONS FOR DECLINE
	ENDANGERED SPECIES	
Utah valvata snail	Prefers well-oxygenated areas of limestone mud or mud-sand substrate among beds of submergent aquatic vegetation.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species.
Snake River physa snail	Prefers the undersides of gravel to boulder substrate in swift current in the mainstem.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Banbury Springs limpet	Prefers well-oxygenated, spring-run habitats, with clear waters between 15-16°C, on cobble to boulder substrate.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Idaho springsnail	Prefers permanent flowing waters of the mainstem, not in tributaries or marginal cold-water springs.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species

SPECIES NAME	HABITAT PREFERENCE	REASONS FOR DECLINE
	THREATENED SPECIES	
Bald eagle	No critical habitat is determined.	Habitat loss and food sources due to human intervention.
Bliss Rapids snail	Prefers stable, cobble-boulder size substrate in flowing waters of the unimpounded reaches of mainstem and a few spring habitats requiring cold, clean, well-oxygenated flowing water of low turbidity.	Hydroelectric dam development; deterioration of water quality; presence of New Zealand mudsnail, an exotic species
Ute ladies' tresses	May survive in areas where streams remain in a somewhat natural condition, or where conditions mimic naturally created habitat.	Loss of habitat especially riparian and wetland habitats lost to economic development, stream channelization, water diversions.
Prepared by IDEQ-TFRO.		

The USFWS listed five species of freshwater snails of the Snake River as threatened or endangered under the Endangered Species Act, effective January 13, 1993. All five species are charactered as geographically limited and generally intolerant of pollution. The USFWS related that the free-flowing, cool water environments required by these species had been impacted by and were vulnerable to continued adverse habitat modification and deteriorating water quality from one or more of the following: hydroelectric development, peak loading effects from existing hydroelectric project operations, water withdrawal and diversions, water pollution, and inadequate government regulatory mechanisms (USBOR 1998). This deterioration, which has accelerated in the last decade because of an extended drought, is the result of water withdrawal for irrigation, agricultural return flows laden with nutrients, runoff from dairies and feedlots, effluent from aquaculture, industrial, and municipal facilities, and storm water. Increased nutrient loads from these sources have contributed to dense blooms of free-living and attached filamentous algae which cannot be utilized by the listed mollusc species. Algal blooms can cause dissolved oxygen depressions, leading to anoxic conditions in sediments and the water column following seasonal algal die-off. In fact, declines in snail populations are attributed to fragmentation of remaining free-flowing habitats in the Snake River as well as deteriorating water quality (USEPA 1997a).

Finally, the New Zealand mudsnail (*Potamopygus antipodarum*) is an exotic species that is experiencing 211explosive population growth in the Middle Snake River. "Its rapid population rise was paralleled by a corresponding precipitous decline in populations of indigenous mollusks. [It] shows a wide range of tolerance for temperature, turbidity, and water velocity fluctuations. The mudsnail appears to prefer warmer, polluted waters over pristine spring environments. It competes directly for habitats of the Snake River physa and Bliss Rapids snails (USEPA 1997a)."

RECENT DATA ON ENDANGERED SNAILS

Recently, data from Idaho Power Company indicate that the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata are found in a wide variety of habitats descriptively contrary to those habitat requirements recounted by Falter (1992), Frest *et al.* (undated), Hershler *et al.* (1994), and USFWS (1992 and 1995). These three snails appear to be not tolerant of only a narrow range of environmental factors (stenotopic), nor does it appear that the requirements of historic description apply to these organisms. The data appear to indicate that the three molluscs are well adapted to and maintain healthy colonies in various habitats. It is suspected that earlier findings were the result of a prolonged drought period (12 years). Thus, the periods of extremely low flows brought a progressive deterioration of Snake River aquatic habitat (accumulation of sediments, macrophyte production, anoxic sediments). A major faunal turnover had begun as several coldwater biota were replaced with more tolerant species. Detrimental conditions most likely continued until

the drought cycle reversed. The synoptic surveys performed by Idaho Power Company suggest an aquatic invertebrate community, including the endangered and threatened river snails, with a high tolerance to nonpoint source pollution (organic effluent and sediment). At present, the Idaho Power Company data suggest that colonies of the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata have met the recovery criteria of increasing, self-producing colonies dwelling in non-threatened habitats for two years (since higher flows have prevailed since the spring of 1995). Idaho Power Company reports that declines in snail population density and distribution and impaired reproduction has not been observed or documented as a trend and the habitat is not currently threatened. Idaho Power Company has recommended that a status review of the Bliss Rapids snail, the Idaho springsnail, and the Utah valvata be done by the USFWS (USBOR 1998).

This recommendation does not include the Snake River physa, since it is not known whether this mollusc persists or not. In 1994, two populations (or colonies) were believed to remain in the Hagerman and King Hill reaches, with possibly a third area of concentration immediately downstream of Minidoka Dam. Live specimens of this species have not beem found even during USBOR's intensive instream, near shoreline sampling efforts in the free-flowing river sections below Minidoka and American Falls Dam, or within reservoir waters at Lake Walcott. At this time, it appears that the Snake River physa has not adapted to a changing river environment and, thus, may be a relic of a former, more suitable ecosystem (USBOR 1998).

RECENT DATA ON THE NORTHERN LEOPARD FROM (RANA PIPIENS)

Recently, a survey of the northern leopard frog (*Rana pipiens*) in Southcentral Idaho by the U.S. Department of Interior Bureau of Land Management (Burley, Idaho) was documented as a springboard to further surveys and monitoring efforts due to the widespread concern in North America over the population status and trend of this species. A statewide survey of natural resource personnel, academmicians and others indicated at least anecdotal evidence for declines in northern leopard frogs. The distribution and relative abundance of northern leopard frogs appears to have decreased considerably in southern Idaho, as well as the Greater Yellowstone Ecosystem. Presently, the species is designated as "sensitive" by the USBLM, and a "priority species of special concern" by the IDFG. The survey study area in Southcentral Idaho encompassed public (BLM), USBOR, USFS, Minidoka National Wildlife Refuge (USFWS), and selected private lands within the perimeter of the USBLM's Snake River Resource Area. Idaho counties represented in the survey included portions of Bannock, Blaine, Cassia, Jerome, Minidoka, Oneida, Power, and Twin Falls. Although the survey is still infant, one of the conclusions drawn from conversations with several long-time residents, was that chemicals (such as xylene and acrolein) used routinely to control aquatic vegetation in irrigation waterways, have allegedly resulted in local frog mortalities in the past. In conjunction with copper sulfate, the use of these chemicals is "a likely factor in limiting the distribution of frogs in these water systems today (USBLM 1998a)."

2.2.3.6 FISHERIES CONCERNS ON 303(d) LISTED WATER BODIES

In 1994, recreational fishing opportunities were surmised by IDFG to have been negatively impacted by poor water quality in the Middle Snake River. Native coldwater fish species, such as cutthroat trout, bull trout, and rainbow trout along with sturgeon, had experienced dramatic population decreases due to a variety of water quality related factors. Those factors included:

1. In response to increased nutrient loading and other impacts, massive macrophyte beds have developed throughout the Middle Snake River. Sediments provide a suitable foot-hold for rooted macrophytes to develope. Macrophytes have physically limited available coldwater fish habitat by reducing the useable area in pools, riffles, and runs, and conversely decreased river habitat diversity. Aquatic vegetation has also slowed river flow velocities and caused strong diel oxygen fluctuations beyond the tolerance levels of most coldwater fish species.

2. Increased sediment loading coupled with modification of the natural hydrograph has also adversely impacted coldwater fish populations. Sediment has choked most spawning gravels, both in tributaries and main river channels. This has led to a decrease in population recruitment for salmonids which require well oxygenated gravel areas for reproduction. Also, sediment has filled interstitial spaces within the river substrate which has reduced juvenile rearing habitat and over wintering habitat which can sometimes be a limiting factor for fish populations.

3. Summertime water temperatures have increased due to a variety of complex interrelated reasons. Decreases in water clarity from an increase in nutrients, suspended sediments, plant growth, and decreased river flow velocity appear to increase solar radiation absorption. The result has been an increase in water temperatures to the threshold or above tolerance levels for most coldwater fish species in traditional use areas for the Middle Snake River.

Overall, environmental condition changes associated with a decrease in water quality, impacts of drought and flow, have given the competition edge to more tolerant warmwater and non-game fish species. Historically, fishing pressure focused on the coldwater salmonids and sturgeon in the Middle Snake River due to their abundance and recreational qualities. Today, depressed coldwater fish populations and limited available fishing areas make recreational fishing opportunities minimal throughout the reach (IDFG 1994, Memo to IDEQ).

In 1998, IDFG, in response to IDEQ-TFRO's request for information on the various §303(d) listed waterbodies in the Upper Snake Rock subbasin, noted, "It's also important to note when reviewing data collected by our agency that our funding source is from the sale of fishing and hunting licenses, therefore, our sampling concentrates on gamefish populations which provide a recreational fishery; not entire fish communities (IDFG 1998c)." Using their best professional judgement and experience the following conclusions may be drawn on the §303(d) listed waterbodies:

1. "A massive amount of literature documents the decline in water quality, modification of river hydrology, and alteration of the natural hydrograph in the Snake River Basin. This information can be used to support the deduction that all native fish communities along the Middle Snake River reach and tributaries, from American Falls Dam to King Hill/Glenns Ferry, are depressed over historical levels and in some instances, facing extinction." "Historically, Yellowstone cutthroat and Mountain whitefish were the primary salmonid in the reach from American Falls to Shoshone Falls. Now, whitefish are sampled in the remaining free-flowing riverine environment, both main river and tributaries, with Yellowstone cutthroat only occasionally appearing in the scientific sampling of headwater tributaries. Strongest known remaining remanent populations of Yellowstone cutthroat can be found in perennial South Hill's tributaries to the Snake River, but, it is safe to deduce range and populations are only a fraction of what historically existed in this reach of the Snake River drainange (IDFG 1998c)."

2. "Native fish communities were adapted to riverine type conditions and habitats. Habitat modification due to impoundment, increased sedimentation resulting from conversion of native vegetation to agricultural uses, river and stream diversion for irrigation and hydropower, and the introduction of exotic fish species more tolerant of warmer water temperatures, stagnant flows, and lower dissolved oxygen levels have all, individually, proven to cause coldwater fish population declines. Every HUC and tributary listed [*on the §303(d) list*] has been impacted by one or more of these habitat modifiers. It would, therefore, be logical to assume present fisheries status is diminished when compared to historic range and actual numbers (IDFG 1998c)."

3. "Historical native fish communities in the Snake River and tributaries from Shoshone Falls downstream to King Hill predominantly focused on anadromous fish along with other prominent species such as bull trout, white sturgeon, mountain whitefish, and the resident Redband trout. Several varieties of nongame fish including sculpin, suckers, and a host of native cyprinids provided forage for piscivorous fish and wildlife. Spring areas and tributaries were the primary spawning and juvenile rearing habitats for both native and anadromous fish species. Today, several of these species are no longer sampled within the reach, either because of degradation of water quality or construction of dams which acted as fish migration barriers. The reach is dominated by exotic fishes which are more tolerant of warmer tempeatures, lower dissolved oxygen levels, and a river system with a streambed predominantly of fine sediments and macrophytes rather than gravels, rubble, and boulders. Spring areas and tributaries which were the primary spawning and juvenile rearing habitats for both native and anadromous fish species, now are captured for aquaculture, hydropower, agricultural irrigation, or municipal use prior to being returned to the Snake River in a degraded condition (IDFG 1998c)."

4. "Although comprehensive fisheries information hasn't been collected in every HUC, it's reasonable to conclude, all native fish species within this reach of the Snake River and tributaries are at depressed levels compared to their historic levels. Not enough information exists to evaluate changes between 1975 and the present, but, information we have collected coupled with literature reviewed from your agency and others regarding water quality and habitat modification would indicate conditions have not improved sufficiently to cause a rebound in individual populations or inhabited range (IDFG 1998c)."

Therefore, fish populations are depressed at the present time over historical numbers based on some native species of fish which are no longer sampled at sites which once were inhabited. Also, there is a general lack of age class diversity in wild fish populations sampled. Creek information indicates it takes longer time periods to collect fish compared to previously collected data. The proposed TMDL for Upper Snake Rock does not propose to restore fisheries to historical levels (as were known prior to the Clean Water Act or November 28, 1975), but rather to restore water quality standards and its designated beneficial uses to "full support" which allow for recovery of the species (either from themselves or by stocking regimes by the IDFG) within what the particular tributary or stream can attain based on pollutant reductions agreed to by industries. "Full support" is a broad category of water quality status such that a water body is in compliance with those levels of water quality criteria listed in Idaho's *Water Quality Standards and Wastewater Treatment Requirements*, or with reference conditions approved by the IDEQ Administrator in consultation with the appropriate Basin Advisory Group (IDEQ 1996a [p 48]). Other categories include: "Not full support," "Needs verification," or "Not assessed."

In the case of White sturgeon who do not migrate above Shoshone Falls, but inhabit the Snake River from Shoshone Falls downstream to the confluence of the Columbia River. It is a recent introduced native fish above Shoshone Falls. It is unique as a fish species because the construction and operation of the Middle Snake River impoundment projects, C.J. Strike, Swan Falls, and the Hells Canyon Complex all affect the viability of the white sturgeon. These projects have a wide range of impacts on white sturgeon, including: inundation of important sturgeon habitat, fragmentation and genetic isolation of populations due to inadequate project passage, entrainment, impacts to sturgeon food base due to water quality degradation and physical changes in the river environment, entrainment, and interference with spawning and rearing due to flow fluctuations. As a result of these and other impacts, none of the remaining populations of white sturgeon are strong, and some (such as the population between Shoshone Falls and Upper Salmon Falls Dam) are severely depleted. The Idaho Power Company dams below Shoshone Falls have additive effects on white sturgeon (FERC 1997b [p 4-5]). The Upper Snake Rock TMDL proposes to have pollutant reduction measures in place for the Middle Snake River and its water quality limited stream segments and reservoirs

that will allow for attainment of IDEQ's "full support" status.

2.2.3.7 SEPTIC TANK SYSTEMS

South Central District Health Department (Health District V) responsibilities on spetic tank systems is summarized in Table 49 based on information provided by Health District V personnel. The impact of any septic tank system on water quality is dependent on its upkeep and maintenance, and its location to canals, drains, and tributaries.

Table 49 Septic tank system estimates on a per county basis in Upper Snake Rock

County	*Rural Residences (Individual Households)*	*Number of People/Household*	*Number of Gallons/ Day/Household*
Twin Falls	6206	16,756.2	1,551,500.0
Jerome	6076	16,405.2	1,519,000.0
Gooding	4700	12,690.0	1,175,000.0
Total for 17040212	16982	45,851.4	4,245,500.0

Prepared by IDEQ-TFRO. Rural residences based on Twin Falls, Jerome, and Gooding counties' assessors' office. Health District V estimates 2.7 people per household and 250 gallons/day/household of sewage effluent. Values provided by Dan Kriz of Health District V.

Table 49 figures are more likely over estimates. Based on data provided by the Association of Idaho Cities (AIC 1997 directory), Twin Falls, Jerome, and Gooding counties have a total estimate population of 88,477. A summary of city estimate population for the same counties is 58,612. The city estimate makes up the urban population for Upper Snake Rock (which is 66.2% of the total population). The variance between the total county estimate population (88,477) and the city estimate population (58,612) is 29,865, or the rural population estimate (33.8%). Therefore, the 45,851.4 population estimated in Table 49 for Upper Snake Rock is an over estimate of the rural population estimate of 29,865 (according to AIC). This is critical to TMDL development since these estimates will help to determine the allocation percentages for the loadings to the various nonpoint sources. At 29,865 population, it is estimated that there exists 11,061.1 households (29,865/2.7=11,061.1) which provide 2,765,275.0 gallons/day/household (11,061.1x250=2,765,275.0) of sewage effluent.

2.2.3.8 RECREATIONAL USES AND ITS IMPACTS

"Generally, nonconsumptive recreation has not been directly linked with reductions in salmonid populations, but it has been coupled with water quality changes. Often, campgrounds or water-based recreation do not significantly lower water quality. Nonetheless, campgrounds accessible to automobiles increase bacterial water pollution more than do backpack campgrounds. Recreationist may also concentrate use in riparian zones and thus increase soil compaction and vegetation damage. Ski areas may significantly contribute amounts of sediment to streams, and could desynchronize snowmelt and lead to unusually high peak flows. Snow making at ski areas also can reduce streamflows. Due to poor sewage disposal, homes located in forested watersheds may elevate concentrations of coliform bacteria and nutrients in streams (USDA FS 1990b [p 23])."

"Under some circumstances, anglers possess the ability to alter the size, structure, and distribution of fish populations. Not all trout species are equally susceptible to angling. Data from various sources indicate that anglers more readily caught rainbow trout than brown trout, but both brown and rainbow trout greater than 30 cm were more susceptible to angling than were smaller fish. Based on available data, vulnerability to angling appears to be greatest for cutthroat trout, then brook trout, then rainbow trout, with brown trout seeming to be the least vulnerable. Also, susceptibility to capture by anglers apparently increaes with trout size (*USDA FS 1990b [p 23]*)."

"The Middle Snake River dams have affected recreation by inundating or dewatering unique features such as cascades and rapids and by leaving only two reaches for riverine recreation in project area. The projects have also made access to certain areas of the river more difficult and decreased the diversity of recreational opportunities in the area. In an important sense, recreational impacts are not distinct from other categories of impacts because good water quality as well as fishing, hunting, and wildlife viewing opportunities are all essential components of recreation. The population of the Magic Valley has grown significantly in the last ten years and recreational demands are increasing even more rapidly. The huge growth in whitewater boating on the Middle Snake River in recent years is an example of this trend (FERC 1997b [p 18])." A key component challenge facing the recreation industry is to provide reasonable access to the Middle Snake River for a growing population and to protect the area's special attractions, including the remaning springs and waterfalls and the Middle Snake River itself.

2.2.4 SUMMARY AND ANALYSIS OF EXISTING WATER QUALITY DATA

In addition, the DEQ reviewed its existing monitoring database on the Middle Snake River and its tributaries and statistically analyzed it on sediment and excess nutrients.

2.2.4.1 MIDDLE SNAKE RIVER

Data analysis of 986 samples of the Middle Snake River (1990-1997 monitoring seasons) is described in Table 50. Total nitrogen (TKN + NO2+NO3) had a median value of 1.353 mg/L. Total inorganic nitrogen (NO2+NO3 + NH3) had a median value of 0.955 mg/L. And, total organic nitrogen (TKN - NH3) had a median value of 0.398. SRP generally represented 28.7% of the median total phosphorus. See Appendix D for the various databases.

TABLE 50 WATER QUALITY PARAMETERS ON THE MIDDLE SNAKE RIVER (1990-1997)

PARAMETER	8-YEAR MINIMUM	8-YEAR AVERAGE	8-YEAR MAXIMUM	8-YEAR MEDIAN
TSS, mg/L	0.5	22.3	305.0	17.0
TP, mg/L	0.008	0.104	0.471	0.101
SRP, mg/L	0.002	0.040	0.268	0.029
TKN, mg/L	0.010	0.431	1.430	0.430
NH3-N, mg/L	0.003	0.045	0.503	0.032
(NO2+NO3)-N, mg/L	0.020	0.991	2.840	0.923
Turbidity, NTU	0.1	15.1	107.0	14.2
Flow (Q), cfs	1.7	8729.4	57355.0	5038.5

Prepared by IDEQ-TFRO. Data from the 1995-1997 monitoring seasons is summarized for all samples taken in the three year period. TSS = total suspended solids; TP = total phosphorus; SRP = soluble reactive phosphate; TKN =total Kjeldahl nitrogen; NH3-N = ammonia as nitrogen; (NO2+NO3)-N = nitrite + nitrate as N.

Additionally, a subset (1995-1997; N = 908) was selected that belonged exclusively to IDEQ-TFRO. The following percentages represent the number of samples that were found to be above (as an exceedence) or below the indicated water quality target.

1. INORGANIC NITROGEN (NITRITE + NITRATE or NOX)

Out of IDEQ-TFRO's 884 samples, 4 samples (or 0.50% of the samples) were below the

protective level (<0.06 mg/L NOX) for salmonid fish, and 89 samples (or 10.1% of the samples) were below the suggested prevention level (<0.3 mg/L NOX) for the development of biological nuisances and the acceleration of cultural eutrophication. Thus, 99.5% of the samples were well above the protective level for salmonid fish, and 89.9% of samples were well above the suggested prevention level for nuisance eutrophication. There is no statistical correlation in the mean NOX value per river mile location from upstream to downstream, although the NOX value averages had higher values downstream from Milner Dam: 0.276 mg/L NOX at Milner Dam, 1.067 mg/L NOX at Gridley Bridge, and 0.866 mg/L NOX at King Hill.

2. AMMONIA

Out of IDEQ-TFRO's 884 samples, 5 samples (or 0.57% of the samples) exceeded the protective level (<0.02 mg/L NH_3^0 as a toxic substance) for fisheries. Thus, 99.43% of the samples were below the protective level for fisheries. Those samples which were exceedences are summarized in Table 51.

TABLE 51 UN-IONIZED AMMONIA EXCEEDENCES (>0.020 mg/L) ON THE MIDDLE SNAKE RIVER

RIVERMILE SEGMENT	*NH_3^0, mg/L*	*DATE*
617.3, Twin Falls Reservoir	0.032	23 Apr 1991
617.3, Twin Falls Reservoir	0.026	21 May 1991
600.9, Crystal Springs	0.022	31 Mar 1995
599.4, Niagara Springs	0.022	08 Aug 1995
588.0, Below Box Canyon	0.021	08 Aug 1995

Prepared by IDEQ-TFRO. The un-ionized fraction of total ammonia may be calculated from the equilibrium stoichiometric relationship NH3 + nH20 = NH3:nH2O = NH4 + OH + (n-1)H2O. Most water quality models predict the concentration of measured ammonia in units of weight/volume as a resultant of processes of nitrification, ammonification, respiration, and assimilation. Therefore, Un-ionized NH3, mg/L = (1.4 * X)/(1 + R), where X = total ammonia, mg/L; R = 10^Exponent; Exponent = (0.09018)+(2729.92/C+273.15)-(pH); C = degrees Centigrade (USEPA 1985 [pp 261-264].

3. TOTAL PHOSPHORUS (TP)

Out of IDEQ-TFRO's 884 samples, 130 samples (or 14.7% of the samples) were below the water quality target (<0.075 mg/L TP) for the suggested preliminary prevention level for the development of biological nuisances and the acceleration of cultural eutrophication. Thus, 85.3% of the samples were well above the suggested prevention level for nuisance eutrophication. There is no statistical correlation in the mean TP value per river mile location from upstream to downstream, although the TP value averages had higher values downstream from Milner Dam: 0.089 mg/L TP at Milner Dam, 0.101 mg/L TP at Gridley Bridge, and 0.113 mg/L TP at King Hill.

In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-1999), irrigation season (April 15 to October 15) versus nonirrigation season (October 16 to April 14) were reviewed preliminarily for seasonality issues. TP in the larger dataset (N=986) had a mean of 0.104 mg/L, with an irrigation season mean (N=542) of 0.099 mg/L and a nonirrigation season mean (N=420) of 0.109 mg/L. Additionally, the SRP to TP percentage was 38.5% in the larger dataset, but averaged 34.3% in the irrigation season and 43.1% in

the nonirrigation season.

4. TOTAL SUSPENDED SOLIDS (TSS)

Out of IDEQ-TFRO's 908 samples, 48 samples (or 5.3% of the samples) were above the suggested monthly average (52 mg/L TSS) target. Thus, 94.7% of the samples were well below the suggested monthly target. In general, there is a statistical correlation (r^2 = 0.729, *F*-ratio = 19.3, p = 0.000) in the mean TSS value per river mile location increasing from upstream to downstream: from 7.8 - 19.7 mg/L TSS at RM613.4 - 638.7 (Pillar Falls to Milner Dam), to 21.8 - 28.0 mg/L TSS at RM579.5 - 603.6 (Upper Salmon Falls Dam to Pigeon Cove), to 38.1 - 43.8 mg/L TSS at RM545.0 - 565.7 (Below King Hill Bridge to Shoestring Bridge near Bliss).

In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-1999), irrigation season (April 15 to October 15) versus nonirrigation season (October 16 to April 14) were reviewed preliminarily for seasonality issues. TSS in the larger dataset (N=986) had a mean of 22.3 mg/L, with an irrigation season mean (N=555) of 24.7 mg/L and a nonirrigation season mean (N=431) of 19.1 mg/L.

5. TURBIDITY (NTU) AND TOTAL SUSPENDED SOLIDS (TSS)

Of IDEQ-TFRO's 908 samples, there is a linear correlation between NTU versus TSS over the range 0.5 to 240.6 mg/L TSS, such that r^2 = 0.765, *F*-ratio = 1281.9, and p = 0.000. The linear regression equation states: NTU = (0.418 x TSS) + 6.423. Thus, at a monthly average of 52 mg/L TSS target, it is expected that the turbidity would be about 28.2 NTU (or 28.2 = (0.418 x 52)+6.423). At a daily maximum of 83 mg/L to allow for spikes during flood events, the turbidity is expected to be about 41.1 NTU (or 41.1 = (0.418 x 83)+6.423). Only 8 samples exceeded the 83 mg/L daily maximum, or 0.9% of the samples were greater than 83 mg/L. The mean value for the 908 samples is 16.0 NTU; the median is 15.4 NTU; the minimum value is 0.1 NTU; and, the maximum value is 107.0 NTU. Approximately, 10.2% (or 93 out of 908 samples) of the samples showed turbidity levels greater than 28.2 NTU (or the equivalent 52 mg/L TSS target).

Additionally, in IDEQ-TFRO's 908 samples, there is a statistical correlation (r^2 = 0.555, *F*-ratio = 7.6, p = 0.014) in the mean NTU value per river mile location increasing from upstream to downstream: from 8.9 - 12.8 NTU at RM613.4 - 638.7; to 15.2 - 18.6 NTU at RM579.5 - 603.6; to 19.8 - 25.2 NTU at RM545.0 - 565.7. In reviewing the larger dataset (N=986; file = c:\data\snake\1995-97\iversusn.sys, dated 1-20-199), the overall mean for turbidity was 15.1 NTU, the irrigation mean was 16.3 NTU, and the nonirrigation mean was 13.5. The larger dataset (N=986) also showed a statistical correlation (r^2=0.284, *F*-ratio=86.0, p=0.000) in the mean NTU value per river mile location increasing also from upstream to downstream: from 8.4 - 12.6 NTU at RM 613.4 - 638.7; to 14.3 - 18.4 NTU at RM 579.4 - 603.6; to 20.7 - 24.2 NTU at RM 545.0 to 565.7.

ERI, in their short term study, developed similar linear relationships but over the range 5 to 30 mg/L TSS in various locations (Twin Falls, Shoshone Falls, Upper & Lower Salmon Falls reservoirs) on the Middle Snake River (ERI 1997 [pp 67-70]). The following compares ERI's dataset to IDEQ-TFRO's datasets in the NTU versus TSS relationship:

a. ERI 1997 Reservoir Study on the Middle Snake River:
   NTU=(0.7098 x TSS) - 2.4826, r^2=0.497 (Four Reservoirs together)

NTU=(0.7825 x TSS) - 3.2142, r^2=0.622 (Twin Falls & Shoshone Falls Reservoirs)
NTU=(0.6547 x TSS) - 2.3017, r^2=0.409 (Upper Salmon Falls Reservoir)
NTU=(1.0933 x TSS) - 7.3718, r^2=0.760 (Middle Snake River)

b. IDEQ-TFRO's Dataset(s) on the Middle Snake River:
NTU=(0.4180 x TSS) + 6.423, r^2=0.765 (1995-1997 Dataset; N=908)
NTU=(0.4070 x TSS) + 6.032, r^2=0.749 (1990-1997 Dataset; N=986)
NTU=(0.3880 x TSS) + 6.710, r^2=0.734 (Irrigation Season; N=555)
NTU=(0.4560 x TSS) + 4.836, r^2=0.776 (Nonirrigation Season; N=431)

2.2.4.2 MAJOR TRIBUTARY FLOWS AND WATER QUALITY PARAMETER COMPARISONS

Table 52 describes the average eight (8) year flow, the minimum and maximum flows from the monitoring data on the major tributaries of the Upper Snake Rock subbasin from 1990 through 1997. See Appendix D.

TABLE 52 MINIMUM, MEAN, AND MAXIMUM FLOWS PER MAJOR TRIBUTARY

TRIBUTARY	*MINIMUM FLOW, cfs*	*MEAN FLOW, cfs*	*MAXIMUM FLOW, cfs*
East Perrine Coulee	2.80	29.27	91.15
Rock Creek	68.71	219.91	480.93
Cedar Draw	2.91	130.44	505.38
Mud Creek	29.55	102.09	295.60
Deep Creek	14.78	92.38	314.78
Salmon Falls Creek	35.00	146.22	363.00
Billingsley Creek	39.94	120.78	189.28
Malad River	1.30	306.42	2790.00
Clover Creek	2.30	30.39	300.00
TOTAL FLOW	197.29	1177.90	5330.12
Prepared by IDEQ-TFRO. It is highly unlikely that all maximum flows coincide in time.			

Implications and characteristics from these loading tables per parameter per tributary are summarized in Table 53. TP/TSS and SRP/TP ratios are converted to percentages (multiplying by 100) and are based on the overall mean of Years 1990 through 1997 per parameter. Total inorganic nitrogen (TIN) and total organic nitrogen (TON) are also described.

TABLE 53 SELECT CHARACTERISTICS PER INDICATED STREAM

TRIBUTARY	*PERCENT as TP/TSS x 100*	*PERCENT as SRP/TP x 100*	*TIN in tons/yr (% of TN)*	*TON in tons/yr (% of TN)*	*TN tons/year*
East Perrine Coulee	0.21	32.4	69.3 (78.8)	18.7 (21.2)	88.0
Rock Creek	0.26	46.1	448.7 (78.7)	121.4 (21.3)	570.1
Cedar Draw	0.25	33.6	228.8 (75.7)	73.6 (24.3)	302.4
Mud Creek	0.44	50.6	258.0 (83.8)	49.8 (16.2)	307.8
Deep Creek	0.29	34.7	208.6 (78.5)	57.1 (21.5)	265.7

TRIBUTARY	PERCENT as TP/TSS x 100	PERCENT as SRP/TP x 100	TIN in tons/yr (% of TN)	TON in tons/yr (% of TN)	TN tons/year
Salmon Falls Creek	0.27	44.6	392.1 (86.6)	60.6 (13.4)	452.7
Billingsley Creek	1.48	59.3	138.0 (88.7)	17.6 (11.3)	155.6
Malad River	0.20	33.2	64.3 (28.0)	165.4 (72.0)	229.7
Clover Creek	0.39	46.7	1.45 (24.6)	4.45 (75.4)	5.9
Prepared by IDEQ-TFRO. TIN=Total Inorganic Nitrogen = NOX + NH3; TON = Total Organic Nitrogen = TKN - NH3; TN = Total Nitrogen = TON + TIN. Billingsley Creek based on 1990 to 1996 values. TP/TSS and SRP/TP ratio based on 8 year mean.					

The TP/TSS percentage ranking indicates that Billingsley Creek was greatest (1.48%), followed by Mud Creek (0.44%), Clover Creek (0.39%), Deep Creek (0.29%), Salmon Falls Creek (0.27%), Rock Creek (0.26%), Cedar Draw (0.25%), East Perrine Coulee (0.21%), and Malad River (0.20%). The SRP/TP percentage indicates that Billingsley Creek was greatest (59.3%), followed by Mud Creek (50.6%), Clover Creek (46.7%), Rock Creek (46.1%), Salmon Falls Creek (44.6%), Deep Creek (34.7%), Cedar Draw (33.6%), Malad River (33.2%), and East Perrine Coulee (32.4%). With the exception of the Malad River and Clover Creek, all tributaries had TIN values (75.7 - 88.7%) that were much greater than the TON values. The ranking of the tributaries with the most total nitrogen was Rock Creek (570.1 tons/year), followed by Salmon Falls Creek (452.7 tons/year), Mud Creek (307.8 tons/year), Cedar Draw (302.4 tons/year), Deep Creek (265.7 tons/year), Malad River (229.7 tons/year), Billingsley Creek (155.6 tons/year), East Perrine Coulee (88.0 tons/year), and Clover Creek (5.9 tons/year).

1. INORGANIC NITROGEN (NITRITE + NITRATE as NOX)

Samples which were at a protective level for salmonid fish (<0.06 mg/L NOX) and below the suggested prevention level (<0.3 mg/L NOX) for the development of biological nuisances and the acceleration of cultural eutrophication are summarized in Table 54.

Table 54 Inorganic nitrogen (NOX) for protection of salmonid fish and prevention of biological nuisances

Tributaries	Salmonid Fish Protection #<0.06 mg NOX/L per N	% Protected	Biological Nuisance Prevention #<0.30 mg NOX/L per N	% Prevention
East Perrine Coulee	0 out of 225	0.0	0 out of 225	0.0
Rock Creek	0 out of 288	0.0	1 out of 288	0.3
Cedar Draw	1 out of 277	0.4	2 out of 277	0.7
Mud Creek	0 out of 277	0.0	0 out of 277	0.0
Deep Creek	0 out of 275	0.0	1 out of 275	0.4
Salmon Falls Creek	0 out of 270	0.0	0 out of 270	0.0
Billingsley Creek	0 out of 387	0.0	1 out of 387	0.3
Malad River	23 out of 80	28.8	39 out of 80	48.9
Clover Creek	4 out of 17	23.5	17 out of 17	100.0
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.				

2. UNIONIZED AMMONIA

A summary of unionized ammonia ($NH_3°$) exceedences is detailed in Table 55 for the tributaries listed. Toxic exceedences were considered as values ≥ 0.020 mg $NH_3°$/L which are not protective for fisheries.

Table 55 Unionized ammonia exceedences in tributaries of Upper Snake Rock from 1990 through 1997

Tributaries	*% Unionized of Total Ammonia*	*Number of Unionized Samples per N*	*Specific Dates and Concentrations*
East Perrine Coulee	0.0	0 out of 285	None found
Rock Creek	1.0	3 out of 288	03-18-91 = 0.035 07-01-91 = 0.058 03-07-97 = 0.044
Cedar Draw	3.6	10 out of 277	07-11-90 = 0.026 07-24-90 = 0.038 09-03-90 = 0.042 12-11-90 = 0.023 12-15-90 = 0.021 03-19-91 = 0.031 04-16-91 = 0.020 05-30-91 = 0.021 07-22-97 = 0.031 08-04-97 = 0.041
Mud Creek	5.4	15 out of 277	07-10-90 = 0.042 11-28-90 = 0.020 12-29-90 = 0.020 01-09-91 = 0.027 02-06-91 = 0.034 02-20-91 = 0.098 03-06-91 = 0.032 03-20-91 = 0.022 07-01-91 = 0.098 07-08-91 = 0.061 07-22-91 = 0.023 08-12-91 = 0.032 12-09-91 = 0.027 12-30-91 = 0.023 06-26-95 = 0.025
Deep Creek	2.5	7 out of 275	03-20-91 = 0.039 05-29-91 = 0.020 06-12-91 = 0.032 07-01-91 = 0.054 07-08-91 = 0.029 07-10-91 = 0.034 04-11-94 = 0.027
Salmon Falls Creek	0.5	2 out of 378	04-24-91 = 0.025 08-18-92 = 0.020
Billingsley Creek	8.4	35 out of 417	03/92 = 0.020 03/92 = 0.037 04/92 = 0.027 04/92 = 0.021 04/92 = 0.025 04/92 = 0.021 05/92 = 0.032 06/92 = 0.028 07/92 = 0.024 07/92 = 0.030 09/92 = 0.020 08/93 = 0.021 03/94 = 0.022 03/94 = 0.023 03/94 = 0.027 03/94 = 0.021 04/94 = 0.020 05/94 = 0.033 06/94 = 0.025 06/94 = 0.028 06/94 = 0.020 10/94 = 0.020 08/95 = 0.031 08/95 = 0.023 08/95 = 0.021 04/96 = 0.025 04/96 = 0.063 04/96 = 0.023 04/96 = 0.035 04/96 = 0.023 04/96 = 0.021 04/96 = 0.032 04/96 = 0.025 04/96 = 0.041 04/96 = 0.022
Malad River	0.0	0 out of 88	None found
Clover Creek	23.5	4 out of 17	01-15-97 = 0.020 02-12-97 = 0.043 05-28-97 = 0.021 06-09-97 = 0.025

Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring. The unionized fraction of total ammonia was calculated from the equilibrium stoichiometric relationship NH3 + nH2O = NH3:nH2O = NH4 + OH + (n-1)H2O. Most water quality models predict the concentration of measured ammonia in units of weight/volume as a resultant of processes of nitrification, ammonification, respiration, and assimilation. Therefore, unionized NH3, mg/L = (1.4*X)/(1+R), where X = total ammonia, mg/L; R = 10^Exponent; Exponent = (0.09018)+(2729.92/C+273.15)-(pH); C = degrees Centrigrade (USEPA 1985 [pp 261-264].

3. TOTAL PHOSPHORUS (TP)

Samples at or below the water quality target of 0.075 mg/L TP for the suggested preliminary prevention level for the development of biological nuisances and the acceleration of cultural eutrophication are listed in Table 56.

Table 56 Total phosphorus in tributaries of Upper Snake Rock

Tributaries	#≤0.075 mg/L TP	% Prevention
East Perrine Coulee	14 out of 225	6.2
Rock Creek	20 out of 288	6.9
Cedar Draw	12 out of 277	4.3
Mud Creek	11 out of 277	4.0
Deep Creek	71 out of 275	25.8
Salmon Falls Creek	120 out of 270	44.4
Billingsley Creek	135 out of 387	34.9
Malad River	51 out of 80	63.8
Clover Creek	9 out of 17	52.9
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.		

4. TOTAL SUSPENDED SOILDS (TSS)

Table 57 summarizes on a per tributary basis the number of samples that exceed the preliminary 52 mg/L TSS instream target, and 83 mg/L daily maximum. Additionally, the percentage of samples that are above the proposed instream target is also calculated and summarized.

Table 57 Total suspended solids (TSS) that exceed the proposed instream target of 52 mg/L

Tributary	Number of TSS values > 52 mg/L	Number of TSS values > 83 mg/L	Percent of TSS values > 52 mg/L	Percent of TSS values > 83 mg/L
East Perrine Coulee	152 out of 225	111 out of 225	70.7	49.3
Rock Creek	125 out of 288	72 out of 288	43.4	25.0
Cedar Draw	152 out of 277	111 out of 277	54.9	40.1
Mud Creek	55 out of 277	21 out of 277	19.9	7.6
Deep Creek	81 out of 275	43 out of 275	29.5	15.6
Salmon Falls Creek	60 out of 270	16 out of 270	22.2	5.9
Billingsley Creek	0 out of 417	0 out of 417	0.0	0.0
Malad River	8 out of 79	2 out of 80	10.1	2.5
Clover Creek	0 out of 17	0 out of 17	0.0	0.0
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.				

5. TURBIDITY (NTU) AND TOTAL SUSPENDED SOLIDS (TSS)

Table 58 summarizes on a per tributary basis relationship/correlation between turbidity (as NTU) versus TSS. Their statistical significance is provided as well as what the estimated turbidity reading would be given 52 mg/L TSS.

Table 58 NTU versus TSS on a tributary basis and its significance

Tributary	NTU versus TSS equation	Parameters of Significance r^2	F-ratio	p	Equivalent NTU at 52 mg/L TSS
East Perrine Coulee	NTU=0.547TSS + 13.235	0.847	568.2	0.000	41.7
Rock Creek	NTU=0.530TSS + 3.535	0.893	1124.3	0.000	31.1
Cedar Draw	NTU=0.387TSS + 19.738	0.722	300.0	0.000	39.9
Mud Creek	NTU=0.219TSS + 23.685	0.267	21.1	0.000	35.1
Deep Creek	NTU=0.392TSS + 10.839	0.821	562.6	0.000	31.2
Salmon Falls Creek	NTU=0.881TSS - 4.471	0.770	388.6	0.000	41.3
Billingsley Creek	NTU=1.237TSS + 1.401	0.758	560.7	0.000	54.6
Malad River	NTU=0.075TSS + 0.579	0.332	9.6	0.003	4.5
Clover Creek	NTU=0.862TSS + 4.534	0.647	10.8	0.005	49.4
Prepared by IDEQ-TFRO. Dataset from 1990-1997 monitoring.					

Temporal variation by Julian Day per NTU or TSS was also examined in order to account for the varying time periods from year-to-year from 1990 to 1997. Since NTU is correlated to TSS (as demonstrated in Table 58), it was necessary to know if NTU and/or TSS are increasing or decreasing from year-to-year. These are summarized as follows:

1. East Perrine Coulee has a weak increasing trend for NTU (NTU = 0.015 JULIAN + 51.147, r^2 = 0.159, *F*-ratio = 5.8, p = 0.017) while TSS appears to be stationary (r^2= 0.058, *F*-ratio = 0.7, p = 0.390).

2. Rock Creek has a weak increasing trend for both NTU (NTU = 0.010 JULIAN + 23.718, r^2 = 0.189, *F*-ratio = 10.6, p = 0.001) and TSS (TSS = 0.011JULIAN + 49.962, r^2 0.123, *F*-ratio = 4.4, p = 0.038).

3. Cedar Draw has an increasing trend in NTU (NTU = 0.017JULIAN + 26.344, r^2 = 0.297, *F*-ratio = 26.6, p = 0.000) and a TSS that appears stationary (r^2 = 0.034, *F*-ratio = 0.3, p = 0.568).

4. Mud Creek has a stationary NTU (r^2 = 0.042, *F*-ratio = 0.5, p = 0.482) but a weak decreasing TSS trend (TSS = -0.005JULIAN + 47.339, r^2 = 0.143, *F*-ratio = 5.8, p = 0.017).

5. Deep Creek has an increasing trend for NTU (NTU = 0.017JULIAN + 5.010, r^2 = 0.338, *F*-ratio = 35.2, p = 0.000) but a weak stationary trend for TSS (r^2 = 0.105, *F*-ratio = 3.1, p = 0.081).

6. Salmon Falls Creek has both a weak increasing trend for NTU (NTU = 0.008JULIAN + 14.264, r^2 = 0.152, *F*-ratio = 6.3, p = 0.012) and TSS (TSS = 0.007JULIAN + 25.207, r^2 = 0.148, *F*-ratio = 6.0, p = 0.015).

7. Billingsley Creek has a decreasing NTU trend (NTU = -0.004JULIAN + 13.075, r^2 = 0.161, *F*-ratio = 11.0, p = 0.001) but a stationary TSS trend (r^2 = 0.010, *F*-ratio = 0.04, p = 0.842).

8. Malad River has both an increasing trend for NTU (NTU = 0.002JULIAN - 0.037, r^2 = 0.321, *F*-ratio = 8.8, p = 0.004) and for TSS (TSS = 0.012JULIAN + 7.141, r^2 = 0.464, F = 21.1, p = 0.000).

9. Clover Creek has a decreasing NTU trend (NTU = -0.089JULIAN + 260.858, r^2 = 0.626, *F*-ratio = 9.7, p = 0.007) and a stationary TSS trend (r^2 = 0.374, *F*-ratio = 2.4, p = 0.139).

2.2.4.4 TRIBUTARY FECAL BACTERIA DATA ASSESSMENT

Table 59 describes per indicated tributary the bacteria assessment based on bacteria monitoring from 1990 through 1997. Assessment is based on the number of instantaneous samples that had exceedences greater than 500 colonies/100 mL of water for primary contact recreation (PCR), and the number of instantaneous samples that had exceedences greater than 800 colonies/100 mL of water for secondary contact recreation (SCR) from 1990 through 1997. See IDAPA §16.01.02.100.03.a and 16.01.02.250.01.a for primary contact recreation, and IDAPA §16.01.02.100.03.b and 16.01.02.250.01.b for secondary contact recreation. A weighted means analysis was also conducted between the fecal value for PCR and the fecal value for SCR to arrive at a weighted means value for ranking of the tributaries according to both criteria. Finally, a comparison of the geometric mean and the arithmetic mean of the fecal data was conducted as irrigation season versus nonirrigation season versus overall year.

Table 59 Bacteria assessment summary of primary and secondary contact recreation (1990-1997) on tributaries

Tributaries	*Primary Contact Recreation % Samples > 500 Fecal Colonies*	*Secondary Contact Recreation % Samles > 800 Fecal Colonies*	*% Weighted Means Assessment Analysis (PCR+SCR)*	*Means Comparisons Geomean (Arithmetic Mean)*		
				Overall Means	*Irrigation Means*	*Non Irrigation*
East Perrine Coulee	66/225 = 29.3%	30/225 = 13.3%	24.3% (N=96)	270(731)	410(970)	96(143)
Rock Creek	69/246 = 28.0%	42/246 = 17.1%	23.9% (N=111)	214(467)	398(583)	58(223)
Cedar Draw	80/225 = 35.6%	35/225 = 15.6%	29.5% (N=115)	233(664)	541(937)	36(58)
Mud Creek	111/227 = 48.9%	77/227 = 33.9%	42.8% (N=188)	413(750)	725(1006)	123(198)
Deep Creek	36/224 = 16.1%	13/224 = 5.8%	13.4% (N=49)	146(305)	289(396)	30(97)
Salmon Falls Creek	17/270 = 6.3%	11/270 = 4.1%	5.4% (N=28)	96(867)	127(184)	54(2278)
Billingsley Creek	44/421 = 10.5%	27/421 = 6.4%	8.9% (N=71)	81(437)	77(511)	87(351)
Malad River	5/23 = 21.7%	5/23 = 21.7%	21.7% (N=10)	45(3571)	63(4913)	26(1382)
Clover Creek	2/17 = 11.8%	0/17 = 0%	11.8% (N=2)	48(95)	41(79)	156(213)

Prepared by IDEQ-TFRO. FECAL COLI. = FECAL COLIFORM. Weighted means assessment analysis = [(N1 x %1) + (N2 x %2)] / NT; where, N1 = population of Primary Contact Recreation (PCR) sample, N2 = population of Secondary Contact Recreation (SCR) Sample.

Ranking the fecal coli. samples in the primary and secondary contact recreation areas according to % exceedence provides the following assessment:

1. For primary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (48.9%), Cedar Draw (35.6%), East Perrine Coulee (29.3%), Rock Creek (28.0%), Malad River (21.7%), Deep Creek (16.1%), Clover Creek (11.8%), Billingsley Creek (10.5%), and Salmon Falls Creek (6.3%).

2. For secondary contact recreation the ranking of the tributaries of the most-to-least exceedences in fecal coliform are: Mud Creek (33.9%), Malad River (21.7%), Rock Creek (17.1%), Cedar Draw (15.6%), East Perrine Coulee (13.3%), Billingsley Creek (6.4%), Deep Creek (5.8%), Salmon Falls Creek (4.1%), and Clover Creek (0%).

3. For a weighted means analysis of primary and secondary contact recreation values to rank the tributaries from the most-to-least exceedences are: Mud Creek (42.8%), Cedar Draw (29.5%), East Perrine Coulee (24.3%), Rock Creek (23.9%), Malad River (21.7%), Deep Creek (13.4%), Clover Creek (11.8%), Billingsley Creek (8.9%), and Salmon Falls Creek (5.4%).

4. The means comparison of the geometric mean to the arithmetic mean indicates that in most cases, the irrigation season had fecal coliform levels much greater than the nonirrigation season. Exceptions to this are Salmon Falls Creek which increases when comparing its arithmetic mean and Clover Creek which increases in both geometric and arithmetic means.

2.2.5 IDENTIFICATION OF ANY DATA GAPS

"Generally, monitoring programs are financially constrained to a limited number of sampling days. It is difficult to make inferences about a monthly or biweekly monitoring program from these types of results (ERI 1997)." Therefore, data gaps still deemed necessary and essential to better describe and understand the Middle Snake River system may include the following:

1. "The most serious data gap in the water quality data of Upper Snake Rock is diel pattern studies for continuous number of days and months (ERI 1997)."

2. Trend monitoring over a 12-month period when compared to a fraction of the year is more descriptive of the system, particularly when attempting to make inferences about the water quality and its seasonality. Sufficient data should be collected to allow for this type of analysis.

3. Twelve (12) month surveys should be reviewed from the standpoint of irrigation (April 15 to October 15) versus non-irrigation (October 16 to April 14) seasons. Sufficient data should be collected to allow for this type of comparison.

4. Macrophyte biomass data should be collected so as to correlate samples taken in low flow years versus samples taken in better or high flow years.

5. "The determination of the reference condition primarily from reference sites is based on the premise that streams minimally affected by human activity will exhibit biological conditions most natural and attainable for streams in the region (USEPA 1996c [pp 29-30])." In practise, most reference sites will have some impacts, but not substantial enough for the stream to not meet its beneficial uses. Reference sits should be considered more seriously in developing any monitoring plan.

6. A coordinated monitoring program between agencies, organizations, and industries, should be maintained and reviewed again and more definitively used to bring all stakeholders into the monitoring realm for total phosphorus, sediment, and other essential water quality parameters.

7. "It is important to note that listing impaired waters by State standards, segments, or

PNWRS may in some cases, significantly overstate the spatial extent of the water quality problem. It should be understood that the listing of a specific segment does not necessarily imply that the entire length or area of that segment is affected (Biswas H and Mabbitt ML 1988 [p 1-2])." Over a period of monitoring years, an effort should be made to specifically characterize the listed stream segment so that what is affected is inventoried against what is not affected.

8. In order to develop a more holoistic understanding of un-ionized ammonia and its effects on fisheries, one must consider it in conjunction with other parameters. It should be noted that until 1962 only un-ionized ammonia was considered toxic (Mead 1985 [p 138]). Synergistic effects must be considered also in order to establish safe levels of combined toxicants (Mead 1985 [p 137]) for such things as ammonium, dissolved oxygen, carbon dioxide, pH, temperature, and ionic gradients. In fact, sublethal effects of un-ionized ammonia may be related to ammonium and ambient sodium concentrations (Mead 1985 [p 139]). Until such synergistic effects are researched in greater detail, the preliminary use of maximum concentration limits will have to suffice, based on appropriate fisheries research.

9. "There is no doubt that sediment is the primary pollutant which impacts fish habitat more than any other. Literature has long documented the roll of sediment in substrate compaction and cementing as it relates to spawning gravels and loss of interstitial wintering habitats, loss of pool habitats, reduction in insect diversity, providing a nutrient rich growing media for macrophytes which can contribute to diel oxygen fluctuations, etc. It's safe to say that every stream listed [*on the §303(d) list*] has suffered from sediment inputs greater than what can be hydrologically transported under the current modified hydrographs. Even spring-fed streams such as Billingsley Creek and Crystal Springs have experienced sediment deposition from agricultural run-off and aquaculture which has caused major modifications to streambed substrate resulting in a reduction in carrying capacity of the streams to support native fish populations (IDFG 1998c)." Any monitoring plan should include at a bare minimum total suspended solids analysis.

10. "There is no doubt, from a fisheries perspective, eliminating excessive sediment from a riverine system will result in improved habitat conditions for native fish populations. What is a reasonable time-frame for recovery of a fishery? The science does not exist to answer this question. It is our opinion, however, any action taken which results in an upward trend in native fish populations should be considered reasonable. It's recognized by all agencies that fish and wildlife habitats and populations were not destroyed over-night by degraded water quality and they will not recover immediately once the stressor or pollutant is removed from the system. Don't confuse this statement with a lack of urgency for action to reduce sediment and nutrient inputs! Native fish and other freshwater based biological populations are continuing their spiral towards the point of no recovery as evident by the number of aquatic species listed or proposed for listing within the last 10 years under the federal Endangered Species Act. Actions taken to improve water quality will undoubtedly have a positive impact on all native species within the Snake River drainage (IDFG 1998c)." Where applicable, efforts should be made to include bedload sediment analysis as part of the monitoring regime or plan.

11. "Aquatic biological populations, like all biological populations, are constantly in a state of flux. Due to sampling limitations there is no way to accurately estimate population numbers of any one species for the Middle Snake River. What we can do is look at general trends in populations, over time, at limited locations. Using this information to make specific population projections for Mid-Snake fish populations is risky at best. Some drawbacks to

keep in mind are: sampling was done just along the shoreline using electrofishing equipment (areas and shocking depth are variable and equipment is biased towards larger fish); there is seasonal variations isn use of shallow water habitats by the difference fish species; the areas selected for sampling may not have been representative habitats for the Mid-Snake Reach (described as "general sample areas" in the text); and, the stated purpose of the study was to look at the general species composition of the fish community in short reaches of the Mid-Snake (See also IDFG 1998b)." Any biological monitoring plan should take into account these drawbacks and attempt to get above and beyond them.

2.3 POLLUTANT SOURCE INVENTORY

Table 60 summarizes the pollutant sources within the Upper Snake Rock subbasin for specific streams listed on the 303(d) list or which are known to be impaired (like East Perrine Coulee). For point sources, the number of aquaculture, POTW, and food processing facilities are identified. For nonpoint sources, a simple YES or NO tells if the stream is affected by the particular nonpoint source activity based on known historical information. Nonpoint sources include grazing, agriculture, forestry, CFOs, recreation, and FERC licensed facilities. During TMDL development the IDEQ-TFRO and the Mid-Snake WAG/TAC will determine the extent to which these sources affect the various water bodies.

TABLE 60 GENERAL INVENTORY OF POINT AND NONPOINT SOURCES

WATERBODY IDENTIFICATION	INVENTORY OF POINT AND NONPOINT SOURCES									
	POINT SOURCES				NONPOINT SOURCES					
	A/Q	POTW	FOOD	INDUS	FERC	GRAZE	AG	FOREST	CFOs	REC
Alpheus Creek	0	0	0	0	0	0	0	0	0	Yes
Billingsley Creek	8	0	0	0	2	Yes	Yes	0	Yes	Yes
Blind Canyon Creek	1	0	0	0	1	Yes	Yes	0	Yes	0
Cedar Draw	9	1	0	0	2	Yes	Yes	0	Yes	Yes
Clear Springs	5	0	0	0	1	0	Yes	0	Yes	Yes
Clover Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Cottonwood Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Crystal Springs	1	0	0	0	0	0	Yes	0	Yes	Yes
Deep Creek	6	0	0	0	1	Yes	Yes	0	Yes	Yes
Dry Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Dry Creek, West Fork	0	0	0	0	0	Yes	Yes	0	Yes	Yes
McMullen Creek	0	0	0	0	0	Yes	Yes	0	Yes	Yes
Mud Creek	10	1	0	0	2	Yes	Yes	0	Yes	Yes
East Perrine Coulee	0	0	0	0	1	Yes	Yes	0	Yes	Yes
Riley Creek	2	0	0	0	0	0	Yes	0	0	Yes
Rock Creek	8	0	1	2	2	Yes	Yes	0	Yes	Yes
Sand Springs Creek	1	0	0	0	1	0	Yes	0	0	Yes
Middle Snake River	37	4	2	0	18	Yes	Yes	0	Yes	Yes
Tool Box Creek	0	0	0	0	0	Yes	0	0	0	Yes
Total No. Facilities % Streams Affected	88 50%	6 14%	3 9%	2 5%	31 45%	? 77%	? 95%	? 0%	? 86%	? 91%

Prepared by IDEQ-TFRO: A/Q = Aquaculture; POTWs = Privately owned treatment works or sewage treatment plants; FOOD = Food processors; FERC = FERC-type facilities for power generation and/or damming; INDUS = Industrial-type facilities; GRAZE = Grazing; AG = both irrigated and nonirrigated agriculture; FOREST = Forestry; CFOs = Confined Feeding Operations; REC = Recreation.

From this table several conclusions may be drawn. First, point sources affect the listed waterbodies in the following amounts: aquaculture affects 50% of the streams, POTWs affect 14% of the streams, food processors affect 9% of the streams, and industrials affect 5% of the streams. Second, although no specific numbers of farms or operations are determined at this time for nonpoint sources, the affect of nonpoint sources for the listed waterbodies may be characterized by the following relative amounts: agriculture affects 95% of streams, recreation affects 91% of the streams, CFOs affect 86% of the streams, grazing affects 77% of the streams, forestry affects none of the streams (0%), and FERC facilities affect 45% of the streams. It should be noted that these effects, whether from point or nonpoint sources, are not necessarily negative on water quality if the overall impact to tributaries and the Middle Snake River is below the assimilative capacity of the particular tributary or river system.

2.3.1 IDENTIFICATION OF POINT AND NONPOINT SOURCES

Specific point sources and general nonpoint sources for the table in §2.3 are identified in the following subsections per listed waterbody. For nonpoint sources, the IDEQ-TFRO has identified overall an inventory of 779 major CFOs (dairies, feedlots, cow-calf operations) in the same area: 309 in Twin Falls County, 258 in Gooding County, and 212 in Jerome County although their effect on specific streams is unknown at this time. Of these, 122 dairies are in Twin Falls County, 126 dairies in Gooding County, and 92 dairies in Jerome County, or a total of 340 dairies in Upper Snake Rock (Cizmich & McMasters 1998). In general, the Upper Snake Rock subbasin has nonpoint source land uses that are estimated to be: 2.36% dryland agriculture, 1.98% forest, 16.63% irrigated agriculture—gravity flow, 5.23% irrigated agriculture—sprinkler, 50.58% rangeland, 20.75% riparian vegetation, 1.2% urban, and 1.3% water (Archview 1996).

For FERC licensed hydroelectric facilities, these are exempt from NPDES permit requirements on the grounds that the change in water condition following its discharge over or through the dam does not constitute a "discharge of pollutants" within the meaning of the Clean Water Act. This was based on a U.S. Court of Appeals, District of Columbia Circuit, dated September 13, 1982. As of May 1, 1998, the NPDES permits for the facilities on the Middle Snake River (namely, Bliss Power Plant, NPDES 00257-8; Lower Malad Power Plant, NPDES 002258-6; Upper Malad Power Plant, NPDES 002259-4; Lower Salmon Power Plant, NPDES 002260-8; Upper Slamon Plant "A," NPDES 002261-6; Upper Salmon Plant "B," NPDES 002262-4; Thousand Splrings Power Plant, NPDES 002263-2; Clear Lakes Power Plant, NPDES 002264-1; Shoshone Falls Power Plant, NPDES 002265-9; Twin Falls Power Plant, NPDES 002266-7) have been terminated.

As of this writing, the aquaculture industry in Idaho is undergoing NPDES permitting requirements on a General Permit for total suspended solids and total phosphorus, and other pollutants where applicable. For the Middle Snake River facilities an interim effluent limit will be used for a period of three years. Data collected during that period will be used to develop a wasteload allocation so that the industry as a whole does not exceed 970.2 lbs/day. Food processors and municipalites are also undergoing NPDES permitting requirements, but on individual permits. These already have pre-assigned wasteload allocations which are being translated into effluent limits in their permits.

Of major concern in identification of point and nonpoint sources is the effect from sediment, and particularly from nonpoint sources that contribute to it. This pollutant is identified in all the water quality limited stream segments as a source of impairment to the designated and existing beneficial uses. As described in §2.1.2.3, Upper Snake Rock has 54% desert shrubland grazing land. "Available data indicates sediment yields from rangelands are less than one (1) ton per acre (range of ½ to ¾ ton). Much of this appears to come from steep and eroding channel banks and during high water runoff periods. Erosion from seriously overgrazed or burned ranges will occur if heavy rain should fall before vegetation regrowth or re-establishment occurs. The most serious potential erosion of rangeland occurs on slopes greater than 30% (ISCC 1979)." Additionally, agriculture represents 41% of the land use in Upper Snake Rock. Sediment contributions more notably may come from irrigation runoff or from tailwater in fields that has collected sediment loads which eventually works

itself into canal systems which eventually end up in associated tributaries and the Middle Snake River.

2.3.1.1 ALPHEUS CREEK (SPRINGS)

Blue Lakes Spring is typical of many large springs issuing from the Eastern Snake Plain Aquifer System. It issues from a major interbed, although the specific interbed is covered with talus and windblown sand and is not visible. The orifice of the spring is adequately defined and flows out over a wide area and flows into Upper Blue Lake (water surface elevation 3294.0 feet). The flows into Upper Blue Lake range from 165 cfs to 235 cfs. It is estimated that since 1950 the flow has decreased by 21% (based on USGS gaging station at the mouth of Upper Blue Lake). From Upper Blue Lake, the water flows into Lower Blue Lake (water surface elevation 3288.1 feet). A large volume of the flow disappears through the porous formation in the bottom of Lower Blue Lake. Only 5 cfs to 7 cfs flows out of the Lower Blue Lake. The rest of the water travels through the porous rock formations to again resurface in Alpheus Spring near the Blue Lakes Country Club with a flow of approximately 200 cfs (JUB 1993). From here to where it hits the first main diversion at Blue Lakes Trout Farm main headquarters, this is known as Alpheus Creek. After this diversion there is no longer a true Alpheus Creek. Instead, the creek has been channelized and diverted into what is locally called Perrine Ditch (or Alpheus Ditch) which feeds two aquaculture facilities (Blue Lakes Trout Farm and Pristine Springs) on the north side of the Middle Snake River. At the main diversion, water is diverted across the Middle Snake River to the south side of the Middle Snake River to the Canyon Springs aquaculture facility.

Therefore, Alpheus Creek has three aquaculture facilities that divert water from it: Blue Lakes Trout Farm (with processing plant, NPDES 000095-7) and Pristine Springs/Sunnybrook Warm Water facility (NPDES 002501-1) which divert water in series on the north side of the Snake River Canyon from Alpheus Ditch; and, Canyon Springs (NPDES 002731-6) which diverts water across the river to south side of the Snake River Canyon from the main diversion above Alpheus Ditch. Each of these aquaculture facilities discharges back to the Middle Snake River.

Additionally, the City of Twin Falls diverts water for its domestic supply and irrigation water for its residents, industry, and commerical users at the head of Upper Blue Lake Springs via four large pumps. The water is diverted from the north side of the Snake River Canyon (or North Rim) across the river through a 36" concrete cylinder pipe to the south side of the Snake River Canyon (or South Rim). Then, it is pumped into the Harrison Street tank (after chlorine disinfection), and finally pumped into the City distribution system.

There are no food processors, municipalities, or hydroelectric projects on Alpheus Creek, so it is prinicipally affected by nonpoint sources of pollution. Alpheus Creek is affected occasionally by nonpoint source storm water. As shown in §2.20, Alpheus Creek is listed for sediment, nutrients, and violations of the dissolved oxygen standard.

The Blue Lakes aquaculture facility has fresh spring water from Alpheus Ditch and two discharge points: one which functions as reuse effluent water for the Pristine Springs facility; and, the second which discharges to the Middle Snake River. The Pristine Springs aquaculture facility has input water from two sources: first, from the tail raceway water from the Blue Lakes facility which functions as reuse water; and then from fresh spring water from Alpheus Ditch. Pristine Springs has two discharge points: one discharge point goes directly to the Middle Snake River as discharge from the second set of raceways which are at a higher elevation; and, the other discharge point goes through the Whiskey Slew which has two additional spring sources that mingle at the hatchery house which then discharges to the Middle Snake River at a lower elevation (McMasters 1998b).

2.3.1.2 BILLINGSLEY CREEK

Billingsley Creek has eight aquaculture facilities that discharge to it. They take water from adjacent springs along the stream course or from Billingsley Creek itself. These facilities include: Rangen's Inc. (NPDES

002303-5), Schrank (Spring Creek Springs) Farm Ponds (NPDES _____), Charlie Johnson Farm Ponds (NPDES _____), Bill Jones Raceways (NPDES 000086-8), McFadden Farm Ponds (NPDES 002612-3), Idaho Springs/Gold Springs Ponds (NPDES 000073-6), Hidden Springs (NPDES 002440-6), Fisheries Development (NPDES 002499-6) and Tupper Ponds (not permitted). There are no city sewage treatment plants or food processing facilities discharging to the stream. There two hydroelectric facility, Billingsley Creek Plant (FERC 06208-01) and Fisheries Development Project (FERC 07885-06). Nonpoint sources include grazing operations permitting direct access to the stream for water and agricultural irrigation return flow to the stream. In 1991 Billingsley Creek was assessed by DEQ-TFRO to have water quality impairment: 75% from point sources (specifically, aquaculture) and 25% from nonpoint source pollution based on best professional judgement that nonpoint source pollution was fairly well contained (USEPA 1991). This assessment was challenged by the aquaculture industry, but no specific data was provided to defend the challenge. Nonpoint source land uses are estimated to be: 5.07% irrigated agriculture---gravity flow, 24.54% irrigated agriculture---sprinkler, 19.52% rangeland, and 50.88% riparian vegetation (Archview 1996).

2.3.1.3 BLIND CANYON

Blind Canyon has one aquaculture facility, Blind Canyon Hatchery (NPDES 002599-2), and one hydroelectric project, Blind Canyon Project (FERC 08375-04). No food processors or sewage treatment plants are located on the stream. Nonpoint source land uses for Blind Canyon are estimated to be 100% rangeland. Blind Canyon Springs nonpoint source land uses are estimated to be: 20.38% irrigated agriculture---sprinkler, 29.15% rangeland, and 50.59% riparian vegetation(s) (Archview 1996).

2.3.1.4 CEDAR DRAW

Cedar Draw has seven aquaculture facilities that discharge directly to it and two aquaculture facilities which indirectly discharge to it via a tributary, Tunnel Creek. The direct dischargers are: Rainbow Trout Farm Inc./Filer Hatchery (NPDES 000102-3), Yoder Farm Ponds with SEAPAC Processing Plant (NPDES 002423-6), Cedar Draw Hatchery (NPDES 002503-8), Olson Ponds (NPDES 002592-5, via "F"Coulee), Stutzman Farm Ponds (NPDES 002730-8), Rainbow Trout Farm Inc./Filer Processing (NPDES 000102-3), and SEAPAC (as previously identified). The indirect dischargers (via Tunnel Creek) are: Tunnel Creek Fish Farm (NPDES 002292-6) and Leo Martins Fish Farm (NPDES 002775-8). Additionally, the City of Filer Wastewater Treatment Plant discharges to Cedar Draw Creek. Two hydroelectric projects are also located on the stream: Cedar Draw Creek Project (FERC 08278-04) and Little Mac (FERC 06443-00). No food processors are located on the stream. Nonpoint source land uses are estimated to be: 99.43% irrigated agriculture---gravity flow and 0.57% riparian vegetation (Archview 1996).

2.3.1.5 CLEAR SPRINGS CREEK

Five aquaculture facilities discharge to Clear Springs Creek and Clear Springs Lake: Clear Lakes Trout Co./Processing Plant (NPDES 000101-5, via Clear Lakes), Middle Hatchery/Clear Splrings Clear Lakes (NPDES 000093-1, via Clear Lakes), Snake River Hatchery/Clear Springs (NPDES 000075-2, via Clear Lakes), Clear Springs Processing Plant (NPDES 002688-3, via Clear Lakes), and Clear Lakes Trout Co./Processing Plant (NPDES 000101-5, via Clear Lakes). Additionally, there is a hydroelectric project that discharges to Clear Lakes Creek: IPC/Clear Lake Power Plant (NPDES 002264-1). No food processors or city sewage treatment plants discharge to the creek. Clear Lakes nonpoint source land uses are estimated to be: 99.43% irrigated agriculture---gravity flow and 0.57% riparian vegetation (Archview 1996).

2.3.1.6 CLOVER CREEK

There are no point sources discharging to Clover Creek from its headwaters to where it discharges into the Middle Snake River. It is affected 100% by nonpoint sources including grazing, agriculture, and confined

feeding operations (including feedlots, dairies, cow-calf operations, and cattle ranches). Nonpoint source land uses are estimated to be: 3.34% dryland agriculture, 14.50% irrigated agriculture---gravity feed, 5.01% irrigated agriculture---sprinkler, 48.58% rangeland, and 28.57% riparian vegetation (Archview 1996).

2.3.1.7 COTTONWOOD CREEK

There are no point sources discharging to Cottonwood Creek from its headwaters to where it discharges to Rock Creek. It is affected 100% by nonpoint sources including grazing, agriculture, and confined feeding operations (including feedlots, dairies, cow-calf operations, and cattle ranches). Nonpoint source land uses are estimated to be: 15.35% dryland agriculture, 10.58% irrigated agriculture---gravity flow, 71.22% rangeland, and 2.86% riparian vegetation (Archview 1996).

2.3.1.8 CRYSTAL SPRINGS

There is one aquaculture facility that discharges to Crystal Springs Creek and Crystal Springs Lake: Crystal Springs Trout Farm/Clear Springs (NPDES 000089-2). Magic Valley Steelhead Hatchery uses this spring for source water, but discharges to the Middle Snake River. No food processors or city sewage treatment plant discharge to the creek or lake. Nonpoint source land uses are estimated to be 100% riparian vegetation (Archview 1996).

2.3.1.9 DEEP CREEK

There are six aquaculture facilities that directly discharge to Deep Creek. These are: Deep Creek Trout Farm/Boswell Trout (NPDES 002515-1), Deep Creek Trout Farm (NPDES 002670-1), Peter's Farm Ponds/Kaufman Farm Ponds (NPDES 002424-4), Harder Livestock Partnership/Cox Farm Ponds (NPDES 002533-0), Dolana Farm Ponds (NPDES 002615-8), and Howell Farm Ponds (NPDES 002763-4, via irrigation canal). There are no city sewage treatment plants or food processors that discharge to the stream. But there is one hydroelectric power plant: Cox's Project (FERC 06850-00). Nonpoint source land uses are estimated to be: 21.39% dryland agriculture, 48.32% irrigated agriculture---gravity flow, 27.97% rangeland, and 2.32% riparian vegetation (Archview 1996).

2.3.1.10 DRY CREEK (MURTAUGH LAKE)

There are no point sources discharging to Dry Creek (Murtaugh Lake area) from its headwaters to where it discharges to Murtaugh Lake and afterwards to the Middle Snake River. It is affected 100% by nonpoint sources including grazing, agriculture, and forestry. Nonpoint source land uses are estimated to be: 18.12% irrigated agriculture---gravity flow, 13.55% irrigated agriculture---sprinklers, 36.11% rangeland, and 32.42% riparian vegetation. For the West Fork of Dry Creek, land use estimates are 100% rangeland (Archview 1996). USBLM states that the West Fork of Dry Creek is not affected by agriculture (irrigated or nonirrigated), but is strictly rangeland (USBLM 1998b).

2.3.1.11 MCMULLEN CREEK

McMullen creek is affected by nonpoint sources. No point sources are known to discharge to it. Nonpoint source land use estimates are estimated to be: 2.33% irrigated agriculture---gravity flow, and 97.67% rangeland (Archview 1996).

2.3.1.12 MUD CREEK

There are eight aquaculture facilities that directly discharge to Mud Creek. These are: Rainbow Trout Farm Inc./Buhl Hatchery (NPDES 000103-1), W & W Trout Farm (NPDES 002606-9), White's Trout Farm (NPDES

002604-2), Buhl Trout Rearing Facility/Bill Fulmer Trout Farm (NPDES 002674-3), Buhl Trout Farm/Blau Farm Ponds (NPDES 002673-5, via unnamed stream), First Ascent Fish Farm (NPDES 002777-4), Rocky Ridge Ranch (NPDES 002729-4), and Mi Vida Loca/Larry Compton (NPDES 002788-0). There are two aquaculture facilities that indirectly discharge to Mud Creek via Silo Creek: Juker Farm Ponds (NPDES 002618-2) and RCP (NPDES 002752-9). The City of Buhl Wastewater Treatment Plant discharges to the east fork of Mud Creek. No food processors discharge to Mud Creek. But there are two hydrolelectric projects on Mud Creek: Mud Creek Project (FERC 04769A02) and White Ranch Project (FERC 04115-06). Nonpoint source land uses are estimated to be 100% riparian vegetation (Archview 1996).

2.3.1.13 EAST PERRINE COULEE

East Perrine Coulee is not listed on the §303(d) list, but it is a major pollutant source. Perrine Coulee has no food processors, industrials, or municipalities that discharge to it. One aquaculture facility, Green's Trout Farm (NPDES 000096-5), discharges to East Perrine Coulee. There is one hydroelectric power generation project: K.W. Inc. (Kasel-Witherspoon (FERC 06410A01). Nonpoint source land use are estimated to be: 18.86% irrigated agriculture—gravity flow, 18.40% rangeland, 18.63% riparian vegetation, and 44.10% urban (Archview 1996). USDA/SCS suggests that the 18.40% rangeland is really "other land or recreational land," since in a strict sense it is not used as rangeland (USDA/SCS 1998).

"Additionally, Perrine Coulee does not contain any perennial streams. Several drainage branches carry excess rainfall and irrigation return flows to the Snake River Canyon. Rapid snowmelt may also add some winter and early spring flows to several branches of this natural drainage system. During the irrigation season all the drainages carry primary irrigation water or return flows. In some cases, the drainages terminate at topographical depressions and disappear into the underlying lava rock. This ground water feeds such small lakes as Dierkes Lake or appears as springs flows in the Snake River Canyon wall (SRSCD 1998)."

2.3.1.14 RILEY CREEK

There are two fish rearing aquaculture facilities that discharge untreated and treated wastewater directly to Riley Creek. These are: USFWS/Hagerman National (NPDES 000082-5) and IDFG/Hagerman State (NPDES 000080-9). The USFWS facility uses about 55 cfs of water collected from 12 springs, while the IDFG uses about 50-90 cfs of water diverted through the hatchery from Riley Creek and 40 cfs from springs (IDHW 1977b). No food processors or city wastewater treatment plants discharge to Riley Creek. And no hydroelectric projects are located on the creek as well. All domestic sanitary wastes in the area are treated by subsurface waste disposal system with the exception of the Idaho State Fish and Fame Wildlife Management Area which has a collection system for all private and public facilities which discharge to a total containment lagoon (IDHW 1977b).

2.3.1.15 ROCK CREEK

There are seven aquaculture facilities that discharge directly to Rock Creek. These are: Canyon Trout Farm (NPDES 002191-1), Daydream Ranch (NPDES 002680-8), Deadman Hatchery (NPDES 002689-1, via Deadman Gulch seep stream), CSI Fish Hatchery (NPDES 002630-1), Aquaculture Industries/Frame Hatchery (NPDES 002703-1), Coats Farm Ponds (NPDES 002761-8), and Canyon Trout Farm/Processing Plant (NPDES 002191-1). There is no city sewage treatment plant that discharges to the creek; however, there are City of Twin Falls sewage lines and pumps in Rock Creek Canyon which have in the past occasionally malfunctioned or overflowed into Rock Creek. There are two hydroelectric projects: Rock Creek Project (FERC 06450-00) and Rock Creek No. 2 Project (FERC 06015-42); one food processor: Independent Meat Co. (NPDES 000038-8); and, two industrials: Monroc, Inc./Magic Valley Division (NPDES 000033-7) and Amalgamated Sugar Company (NPDES 000023-0) that discharge to Rock Creek. Nonpoint source land uses are estimated to be: 61.99% irrigated agriculture—gravity flow, 26.55% rangeland, 2.17% riparian vegetation,

and 9.29% urban (Archview 1996).

2.3.1.16 SAND SPRINGS CREEK (or Thousand Springs Creek)

This creek is affected by discharge from one aquaculture facility: Ten Springs Facility/Blind Canyon Aqua Ranch (NPDES 002600-0). There are no food processors or city sewage treatment plants that discharge. But there is one hydroelectric project that discharges to Sand Springs Creek: IPC/Thousand Springs Project (NPDES 002263-2). Nonpoint source land uses are estimated to be: 42.68% irrigated agriculture---gravity flow, 18.73% irrigated agriculture---sprinkler, 19.30% rangeland, and similarly 19.30% riparian vegetation (Archview 1996).

2.3.1.17 VINYARD CREEK

As previously cited and described, the re-route irrigation canal to Vinyard Creek has been reported (prior to the re-route) to have a peak discharge for the irrigation return channel of 14.8 cfs in 1986, and an annual deposition of approximately 707 metric tons of sediment into the Twin Falls Reservoir (IDHW 1989a). As a result of the pvc pipe re-route approximately 20.1 cfs of irrigation return water can be accomodated for an estimate of 960 metric tons of annual sediment.

2.3.1.18 MIDDLE SNAKE RIVER

The Middle Snake River has point sources that discharge directy and indirectly to it. Those that discharge directly include: 26 aquaculture facilities and 2 wastewater treatment plants. Nonpoint sources include 6 hydroelectric impoundments and 7 hydroelectric generation projects. Indirect dischargers include: 9 aquaculture facilities, 2 wastewater treatment plants, 5 hydroelectric projects, and 2 food processors. These are listed in Table 61.

TABLE 61 DIRECT & INDIRECT AQUACULTURE FACILITIES DISCHARGING TO THE MIDDLE SNAKE RIVER

DISHCHARGE TYPE	AQUACULTURE FACILITIES NAME OF FACILITY	PERMIT No.
Direct Discharger	1. Barret Farm Pond	NPDES 002718-9
	2. Big Bend Trout Inc. (via irrigation ditch)	NPDES 002532-1
	3. Birch Creek Trout Inc.	NPDES 002601-8
	4. Blue Lakes Trout Farm	NPDES 000095-7
	5. Boyer Farm Ponds	NPDES 002704-9
	6. Box Canyon Trout Farm/Clear Springs	NPDES 002290-0
	7. Buckeye Farm Ponds	NPDES 002611-5
	8. Canyon Springs	NPDES 002731-6
	9. Catfish Farm	NPDES 002295-1
	10. Eckles Fish Farm	NPDES 002676-0
	11. Flemming Farm Ponds	NPDES 002732-4
	12. Flemming Ponds	NPDES 002780-4
	13. Henslee Hatchery (via irrigation ditch)	NPDES 002762-6
	14. Kaster Trout Farm/Sheldon Ponds	NPDES 002517-8
	15. Magic Valley Steelhead Hatchery/IDFG	NPDES 002304-3
	16. Pisces Investment Inc./Magic Springs	NPDES 000097-3
	17. Pristine Springs/Sunnybrook Cold Water Hatchery	NPDES 002501-1
	18. Rainbow Falls Fish Ponds /Dunn	NPDES 002675-1
	19. Rim View Trout Co. Inc./Wendell Hatchery	NPDES 000099-0
	20. Slane Ponds	NPDES 002779-1
	21. Smith Farm Ponds	NPDES 002687-5
	22. Stevenson Ponds	NPDES 002781-2
	23. Talbot Trout Ponds	NPDES 002677-8
	24. White Springs Trout Farm	NPDES 002580-1
	25. Woods Farm Ponds/Rangen Inc.	NPDES 002733-2
	26. Wright Farm Ponds	NPDES 002725-1
Indirect Discharger	1. Bell Fish Ponds (via unnamed tributary to Stoddard Creek)	NPDES 002491-1
	2. Briggs Creek Fish Hatchery (via Briggs Creek)	NPDES 002684-1
	3. C.J. Simms Ponds (via Birch Creek)	NPDES 002683-2
	4. Decker Springs Farm Pond (via Decker Springs Creek)	NPDES 002734-1
	5. Lemmon Ponds (via Curren Ditch)	NPDES 002668-9
	6. Niagara Springs Hatchery/IDFG & IPC (via Niagara Springs Creek)	NPDES 002238-1
	7. Rand Trout Farm (via LQ/LS Drains)	NPDES 002583-6
	8. Standal Ponds (via Stoddard Creek)	NPDES 002778-2
	9. White Water Ranch/Bliss Hatchery (via Stoddard Creek)	NPDES 000091-4

Direct dischargers to the Middle Snake River include the following point sources: 2 wastewater treatment plants—City of Hagerman (NPDES 002594-1) and City of Twin Falls (NPDES 002127-0). Nonpoint sources include 6 hydroelectric impoundments—Milner Dam (FERC 2899), Twin Falls Dam (FERC 0018), Shoshone Falls Dam (FERC 2778), Upper Salmon Falls Dam (FERC 2777), Lower Salmon Falls Dam (FERC 2601), and Bliss Dam (FERC 1975); and, 7 hydroelectric generation projects which discharge to the Middle Snake River—IPC/Bliss Power Plant (NPDES 002257-8, near Bliss), IPC/Lower Malad Power Plant (NPDES 002258-6, near Hagerman), IPC/Lower Salmon Power Plant (NPDES 002260-8, near Hagerman), IPC/Upper Salmon Plant "A" (NPDES 002261-6, near Hagerman), IPC/Upper Salmon Power Plant "B" (NPDES 002262-4, near Hagerman), IPC/Shoshone Falls Power Plant (NPDES 002265-9, near Twin Falls), and IPC/Twin Falls Power Plant (NPDES 002266-7, near Twin Falls).

Indirect point source dischargers may be summarized as follows: 2 wastewater treatment plants—City of Hansen (NPDES 002244-6, via an agricultural ditch) and City of Jerome (NPDES 002016-8, via "J" canal); and 2 food processors above Milner Dam—J.R. Simplot Co. (NPDES 000066-3, at RM 652.2 in Burley, Idaho) and McCain Foodservice Inc. (NPDES 000061-2, at RM 648.8 in Burley, Idaho). Nonpoint sources include 5 hydroelectric projects—Birch Creek Project (FERC 06458B03, via Birch Creek), White Water Ranch Project (FERCs 06271C00, 06271B00, & 06271A00, via Stoddard Creek), Rim View Project (FERC 09543-04, via trout pond), Briggs Creek Project (FERC 04360-02, via Briggs Creek), and IPC/Upper Malad Power Plant

(NPDES 002259-4, via Malad River).

Reservoirs have nonpoint source land uses that affect them directly and which can be estimated as as shown in Table 62.

TABLE 62 NONPOINT SOURCES LAND USES AFFECTING RESERVOIRS ON THE MIDDLE SNAKE RIVER

RESERVOIR	RANGELAND %	IRRIGATED AGRICULTURE %	RIPARIAN VEGETATION %	WATER %	WATERBODY SIZE acres
Bliss	38.70	0	22.46	38.84	254.00
Lower Salmon Falls	66.37	0	33.63	0	168.00
Pioneer	100.00	0	0	0	220.00
Shoshone Falls	0	0	100.00	0	60.00
Twin Falls	0	39.97	60.03	0	85.00
Upper Salmon Falls	3.14	7.75	89.11	0	810.00
Mean (weighted)	28.51	6.06	59.26	6.18	Total = 1597.00
Non-reservoir areas	20.89	22.11	55.50	0.71	

Prepared by IDEQ-TFRO. Percentage land uses from *ArchView GIS 1996*. Waterbody size from *IDEQ & USEPA 1994*. Weighted means based on waterbody size and a total of 1597.00 acres. Water in this table is defined as that water within the reservoir that is affected by nonpoint sources. Non-reservoir areas is a specific land use on the Middle Snake River.

2.3.1.18 ADDITIONAL NONPOINT SOURCES

Additional nonpoint sources that indirectly affect the Middle Snake River or any of its tributaries may be found with FERC-type generation facilities either on canal systems or non-listed tributaries. These facilities will not be listed at this time as their place of discharge is to waterbodies that are not water quality limited or man-made conveyances.

2.3.2 CHARACTERIZATION OF SPECIFIC POLLUTANTS PER POINT SOURCE INDUSTRY

As of this writing, the USEPA was in the process of modifying and reissuing the NPDES permits for food processors, municipalities, and aquaculture in order to incorporate the wasteload allocations of the Mid-Snake TMDL. Effluent characterization of specific pollutants are summarized in Table 63.

TABLE 63 POINT SOURCES AND THEIR POLLUTANT CONTRIBUTIONS IN UPPER SNAKE ROCK

POINT SOURCE INDUSTRIES	TSS	BOD 5	NH3	TEMPERATURE	PH	PATHOGENS	NUTRIENTS	CHLORINE	DO	CHEMICALS	OIL & GREASE
Aquaculture Facilities Effluent Discharge	X	Y		X	X		X	Y	X	X	Y

POINT SOURCE INDUSTRIES	TSS	BOD5	NH3	TEMPERATURE	pH	PATHOGENS	NUTRIENTS	CHLORINE	DO	CHEMICALS	OIL&GREASE
Municipalities (POTW) Effluent Discharge	X	X	X	X	X	X	X	X	X		X
Food Processors Effluent Discharge	X	X	X	X	X	X	X				X
Prepared by IDEQ-TFRO. Y = Fish Processors.											

2.3.2.1 FOOD PROCESSORS

Under the conditions of their NPDES permits, food processors are allowed discharges of the following pollutants: BOD_5, total suspended solids, ammonia (as N), temperature, pH, fecal coliform, total phosphorus (as P), dissolved orthophosphate (as P), nitrite+nitrate (as N), and total Kjeldahl nitrogen (as N). A compliance schedule is based on the Mid-Snake TMDL for total phosphorus and requires the food processing industry to meet the final wasteload allocation for total phosphorus over the next five years. In accordance with IDAPA §16.01.02400.03, discharge permits can incorporate compliance schedules which allow a discharger to phase-in compliance with water quality-based effluent limits when new limits are in the permit for the first time. Consistent with *40 CFR 127.47*, the permittee will be required to submit annual reports which document progress towards reaching the final compliance level. IDEQ-TFRO believes that issuance of this permit for allowable discharge of the effluent parameters (at the levels prescribed in the permit) will not adversely effect the bald eagle, the Bliss Rapids snail, or the Ute ladies' tresses. (See the Fact Sheet and NPDES Permit for permittees 000066-3 and 000061-2.)

2.3.2.2 MUNICIPALITIES

Under the conditions of their NPDES permits, municipalities are allowed discharges of the following pollutants: BOD_5, total suspended solids, fecal coliform, total residual chlorine, pH, total phosphorus, ammonia (as N), temperature, dissolved oxygen (where applicable), total Kjeldahl nitrogen, and nitrite+nitrate (as N). Like food processors, a compliance schedule is based on the Mid-Snake TMDL for total phosphorus and requires the municipality industry to submit an annual report of progress which outlines the progress made toward reaching the compliance date for total phosphorus effluent limitations, an assessment of the previous year of phosphorus data, and a comparison to final effluent limitations and milestones targeted for the upcoming year. Consistent with *40 CFR 127.47*, the permittee will be required to submit annual reports which document progress towards reaching the final compliance level.

2.3.2.3 AQUACULTURE

Under the conditions of their NPDES permits, aquaculture facilities are allowed discharges of the following pollutants: BOD_5 (applicable to processors only), total phosphorus, pH, temperature, total suspended solids, settable solids, nutrients, dissolved oxygen, oil and grease (applicable to processors only), and total residual chlorine (applicable to processors only). The Mid-Snake TMDL requires that the final wasteload allocation for total phosphorus be met over the next five years. In accordance with IDAPA §16.01.02.400.03 a compliance schedule is incorporated which allows a discharger to phase-in compliance with water quality-

based effluent limits when new limits are in the permit for the first time. Consistent with *40 CFR 122.47*, the permittee is required to submit annual reports which document progress toward reaching the final compliance level. Compliance with total phosphorus concentration limits must be met in the interim. The proposed permit will improve water quality by significantly reducing total phosphorus loads to the Middle Snake River which will reduce eutrophication.

However, USEPA and USFWS have determined that sediment discharges (either as settable solids or total suspended solids) from aquaculture facilities, which become anoxic or hypoxic below hatchery outfalls, may adversely affect listed snails. To determine the effects of sediment on aquatic life, USEPA will conduct a study below the larget aquaculture facilities in receiving waters. Chemicals in discharges from aquaculture facilities may include disease control chemicals, drugs, or disinfectants. Examples include: antibiotics (Romet-30 and terramycin); algicide (copper sulfate); FDA approved drugs (Parasite-S or formalin, potassium permanganate); disinfectants (chlorine, PVP iodine, Hyamine-3500); FDA unapproved drugs (hydrogen peroxide, salt). These compounds are approved by FDA or USEPA or both depending upon the compound for use in aquaculture, and are used in waters containing trout (except chlorine and Hyamine-3500 which are used on equipment and raceways) which is a sensitive aquatic animal. Chemical pollutants could cause acute or chronic toxicity to aquatic life in the receiving stream depending on the load being delivered. Because no data exist to determine the toxicity of these chemicals to aquatic life, including the endangered snails, USEPA and USFWS have determined that for the present time the discharge of chemicals by the aquaculture facilities may adversely affect the listed snails. Data submitted the first year of the permit by facilities should answer questions about toxicity to aquatic life.

2.3.2.4 HYDROELECTRIC IMPOUNDMENTS AND GENERATION

Hydroelectric projects, whether as impoundments or strict generation without impounding the water, do not supply pollutants to the Middle Snake River or its tributaries. By legal definition, they are defined as nonpoint sources. However, as previously discussed in §2.2.1.5 they have added to the water quality problems of the river in two ways: (1) the river's capacity to process nutrients has been altered to encourage plant growth through nutrient spiraling, and (2) the reservoirs have created large shallows and areas of sediment deposition that are ideal for aquatic weeds. Additionally, diversion for irrigation reduces the amount of flow at Milner Dam and exacerbates the degraded condition in low flow years through agricultural return flows and tributaries which carry much of the nonpoint source pollutants to the Middle Snake River and to tributaries and reservoirs.

Some hydroelectric industrial power generation projects in Upper Snake Rock have NPDES permits that allow discharges with the following effluent characteristics: temperature, and pH. These type of generation projects normally do not impound water, but rather use the resource and discharge for cooling water concerns. As of this writing, a review of these facilities in Upper Snake Rock (at IDEQ-TFRO) indicates that they are complying with their NPDES permits and, thus, discharging in a non-adverse manner.

Hydroelectric industrial power generation impoundment projects in Upper Snake Rock, on the other hand, have FERC permits that allow discharges with the following effient characteristics: pH, temperature, and dissolved oxygen. As of this writing, the Middle Snake River projects (see §2.2.1.5) were undergoing relicensing. A review of these facilities indicates that as "run-of-the-river" systems, they are complying with their FERC permits and, thus, discharging in a non-adverse manner. However, under drought or low flow conditions (due to diversion as irrigation), the potential for low dissolved oxygen and high water temperature is possible.

2.3.2.5 NONPOINT SOURCES

Nonpoint source pollutants are more difficult to control because they don't come from clearly identifiable sources such as a pipe. As described in the table in §2.3, grazing, agriculture, CFOs, and recreation, as nonpoint sources, have some level of effect on the various waterbodies listed. The primary pollutants or stressors for nonpoint sources are: sediment, nutrients, bacteria, organic enrichment, ammonia, oil and grease and other chemicals (pesticides), thermal modification, salt, and flow alteration. Table 64 provides a breakdown of pollutants per nonpoint source activity.

TABLE 64 NONPOINT SOURCES AND THEIR POLLUTANT CONTRIBUTIONS IN UPPER SNAKE ROCK

NONPOINT SOURCES	SEDIMENT	NUTRIENTS	PATHOGENS	BOD 5	AMMONIA	OIL & GREASE	PESTICIDES	SALT	THERMAL	FLOW
FERC-type operations									X	X
Agriculture (Irrigated, Dryland)	X	X	X	X	X	X	X	X		X
Confined Feeding Operations	X	X	X	X	X	X	X			
Grazing on private ground, USBLM ground, or USFS ground	X	X	X	X	X				X	X
Forestry-type operations	X	X	X	X	X		X		X	X
Recreation	X	X	X	X	X	X				
Urban Areas	X	X	X	X	X	X	X			
Construction Activities	X	X				X			X	X
Nonpoint Source Industrials (such as fresh pack processors)	X	X	X	X	X	X	X	X		
Suburban "non-farms"	X	X	X	X	X		X	X		

Prepared by IDEQ-TFRO. THERMAL = Thermal Modification; FLOW = Flow Alteration, Diversion. The definition of a "farm" is taken from the USDA, Idaho Agricultural Statistics Service: a farm is any operation that produces an agricultural product in a given year of $1000 or more. IDEQ-TFRO chose this definition over that of the census bureau, the Internal Revenue Service, or the Farm Bureau since the dictionary definition stipulates that a farm is a tract of land used under one management for cultivating crops or rearing livestock. Grazing and forestry have the potential for thermal modification and flow alteration as a result of destroyed riparian canopy over a waterbody causing the stream to lose its capacity to ground water recharge, eventually modifying the stream from perrenial to intermittant. Construction has the potential for thermal modification and flow alteration as a result of stream bank alteration and stream diversion activities. Agriculture has the potential for flow alteration as a consequence of canal or ditch diversions.

Soil science indicates that if sediment is reduced substantially, nutrients, bacteria, and pesticides will likewise be reduced so that their effect is reduced to the water quality, the fauna, and the habitat. "Through the development of best management practices and the enforcement of water quality standards, nonpoint sources of pollution are to be maintained at a minimum, as close as possible to background levels (IDHW 1998a)." Nonpoint source pollution management in Idaho is a process for protecting designated beneficial uses and ambient water quality through the implementation of best management practices, which should be designed, implemented, and maintained to provide full protection or maintenance of beneficial uses. As part of this process, the Idaho Nonpoint Source Management Program and the Coordinated Nonpoint Source Water

Quality Monitoring Program for Idaho were developed under the requirements of Section 319 of the Clean Water Act. The Nonpoint Source Management Program is based on the concept of a feedback loop where best management practices are identified through a planning process and applied by land managers to site-specific conditions. The effectiveness of the best management practices in protecting water quality is evaluated through instream water quality monitoring and best management practices monitoring. Ineffective best management practices are required to be replaced.

CATTLE AND CALVES

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of cattle and calves and their manure output is summarized in Table 65 for 1990 through 1998 for total number of 1000 lb live animals, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen the number of dairy animals has increased by 2.6 times (162,000/62,000=2.6) for the period described. Beef animals have decreased by 0.8 times (50,500/62,000=0.8). And, "other" animals (cow-calf operations) have increased by 1.4 times (185,000/137,000=1.4). As a whole, the total number of cattle increased by 1.5 times (397500/261000 = 1.5). Although the number of animals along with their generated manure may be estimated on an annual basis, an estimate of the amount that is discharged to rivers and streams is unknown since it is assumed that all manure is land applied at proper agronomic rates. The CFO industry is committed to "zero discharge" for nutrients and sediment.

TABLE 65 TRI-COUNTY AREA CATTLE AND CALVES: GOODING, JEROME, AND TWIN FALLS

YEAR	BEEF	DAIRY	OTHER	TOTAL
TOTAL NUMBER OF 1000 lb LIVE ANIMALS				
1990	62000	62000	137000	261000
1991	58800	72000	146200	277000
1992	60600	75000	162400	298000
1993	53000	85000	164000	302000
1994	50500	92500	173500	316500
1995	51000	115000	189000	355000
1996	52500	133500	190000	376000
1997	50500	149000	182500	382000
1998	50500	162000	185000	397500
MANURE OUTPUT (tons/day)				
1990	1992.0	2635.0	3842.9	8399.9
1991	1822.8	3060.0	4100.9	8983.7
1992	1878.6	3187.5	4555.3	9621.4
1993	1643.0	3612.5	4600.2	9855.7
1994	1565.5	3931.3	4866.7	10363.4
1995	1581.0	4887.5	5301.5	11770.0

YEAR	BEEF	DAIRY	OTHER	TOTAL
1996	1627.5	5673.8	5329.5	12630.8
1997	1565.5	6332.5	5119.1	13017.1
1998	1565.5	6885.0	5189.3	13639.8
TOTAL SOLIDS OUTPUT (tons/day)				
1990	275.9	288.3	417.9	982.1
1991	261.7	334.8	445.9	1042.4
1992	269.7	348.8	495.3	1113.7
1993	235.9	395.3	500.2	1131.3
1994	224.7	430.1	529.2	1184.0
1995	227.0	534.8	576.5	1338.2
1996	233.6	620.8	579.5	1433.9
1997	224.7	692.9	556.6	1474.2
1998	224.7	753.3	564.3	1542.3
TOTAL NITROGEN OUTPUT (tons/day)				
1990	13.3	11.5	16.4	41.2
1991	12.6	13.3	17.5	43.5
1992	13.0	13.9	19.5	46.4
1993	11.4	15.7	19.7	46.8
1994	10.9	17.1	20.8	48.8
1995	11.0	21.3	22.7	54.9
1996	11.3	24.7	22.8	58.8
1997	10.9	27.6	21.9	60.3
1998	10.9	30.0	22.2	63.0
TOTAL PHOSPHORUS OUTPUT (tons/day)				
1990	2.8	2.1	3.2	8.1
1991	2.6	2.5	3.4	8.5
1992	2.7	2.6	3.7	9.0
1993	2.4	2.9	3.8	9.1
1994	2.3	3.2	4.0	9.5
1995	2.3	4.0	4.3	10.6
1996	2.4	4.6	4.4	11.3

YEAR	BEEF	DAIRY	OTHER	TOTAL
1997	2.3	5.1	4.2	11.6
1998	2.3	5.6	4.3	12.1

Prepared by IDEQ-TFRO. Number of animals derived from the Idaho Agricultural Statistics Service. Output values for manure, total solids, total nitrogen, and total phosphorus from the *Idaho Waste Management Guidelines for Confined Feeding Operations* and *Livestock Waste Facilities Handbook*. "Other" animals represents cow-calf operations and is a conservative estimate.

As previously referenced in §2.3.1, IDEQ-TFRO has inventoried 779 CFOs (dairies, feedlots, cow-calf operations) in the tri-county are: 309 in Twin Falls County, 258 in Gooding County, and 212 in Jerome County. Of these, 122 dairies are in Twin Falls County, 126 dairies are in Gooding County, and 92 dairies are in Jerome County, or a total of 340 dairies in Upper Snake Rock. Because no factual information is available to describe the percent of CFO discharge to rivers and/or streams, and because the CFO industry claims "zero discharge," it is assumed at this time that the majority of generated manure is contained and does not discharge to receiving streams or rivers. However, it should be stated that a major portion of this generated manure is land applied throughout Upper Snake Rock at supposed proper agronomic rates. Where those agronomic rates have been exceeded, and where the potential for erosion and water runoff is great, discharge to rivers and streams is very possible. Thus, agricultural runoff, including nutrients from animal waste, may be a large contributor to pollution of the rivers and streams that are identified as "impaired" (Harkin 1998).

SHEEP AND LAMBS

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of sheep and lambs (head) and their manure output is summarized in Table 66 for 1990 through 1998 for total number of 100 lb live animals, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen, the total number of live animals has increased and decreased dramatically such that a comparison of 1998 to 1990 indicates that the total number has stayed about the same.

TABLE 66 TRI-COUNTY AREA SHEEP AND LAMBS (HEAD): GOODING, JEROME, AND TWIN FALLS

YEAR	GOODING	JEROME	TWIN FALLS	TOTAL	MANURE OUTPUT	TOTAL SOLIDS	TOTAL N	TOTAL P
1990	19000	14000	16000	49000	882.0	232.8	9.8	1.8
1991	16500	11000	15500	43000	774.0	204.3	8.6	1.6
1992	27500	11000	15500	54000	972.0	256.5	10.8	2.0
1993	20500	10500	11000	42000	756.0	199.5	8.4	1.6
1994	18500	8000	10500	37000	666.0	175.8	7.4	1.4
1995	19000	8700	10500	38200	687.6	181.5	7.6	1.4
1996	20000	10900	12900	43800	788.4	208.1	8.8	1.6
1997	25000	8000	14800	47800	860.4	227.1	9.6	1.8
1998	27000	8000	14800	49800	896.4	236.6	10.0	1.9
			MEAN =	44956	809.2	213.5	9.0	1.7

Prepared by IDEQ-TFRO. Number of animals derived from the Idaho Agricultural Statistics Service. Output values for manure, total solids, total nitrogen, and total phosphorus from the *Idaho Waste Management Guidelines for Confined Feeding Operations* and *Livestock Waste Facilities Handbook*.

WATERFOWL

As previously noted in §2.1.4.3, as many as half million ducks migrate through the Snake River Canyon each winter, primarily between the Hagerman Wildlife Management Area and the Minidoka National Wildlife Refuge (*FERC, 1997*). Mid-winter waterfowl counts done by IDFG are summarized in Table 67 for the Hagerman Wildlife Management Area (WMA) and the Middle Snake River from 1990 to 1998. Additional information going back to 1954 is available for the Middle Snake River, and to 1971 for the Hagerman Wildlife Management Area. These represent the best available information on waterfowl counts in the Upper Snake Rock for effects on the Middle Snake River. Affects to tributaries is unknown at this time due to lack of information. Overall, it may be concluded that ducks account for the greatest source of waterfowl pollutants to the Middle Snake River, when compared to geese and swans.

TABLE 67 MID-WINTER WATERFOWL COUNT SUMMARY FOR 1990-1998

YEAR	HAGERMAN WMA				MIDDLE SNAKE RIVER				TOTAL			
	Ducks	Geese	Swans	Total	Ducks	Geese	Swans	Total	Ducks	Geese	Swans	TOTAL
1990	46731	3427	0	50158	24610	3208	0	27818	71341	6635	0	77976
1991	19280	1138	0	20418	20390	2096	153	22639	39670	3234	153	43057
1992	13758	4117	0	17875	54509	8526	43	63078	68267	12697	43	81007
1993	19703	298	0	20001	45456	5917	32	51405	65159	6215	32	71406
1994	55652	1686	3	57341	41170	12957	15	54142	96822	14643	18	111483
1995	58993	2794	0	61787	27007	5088	17	32112	86000	7882	17	93899
1996	7545	98	0	7643	16452	8976	21	25449	23997	9074	21	33092
1997	12344	4014	2	16360	9662	8064	3	17729	22006	12078	5	34089
1998	35614	3861	0	39475	19853	10111	6	29970	55467	13972	6	69445
MEAN	29958	2381	1	32340	28790	7216	32	36038	58748	9603	33	68384

Prepared by IDEQ-TFRO. Values provided by IDFG-Jerome. Mean values calculated by IDEQ for 1990-1998 as a 9 year mean.

The data indicate that ducks represent 92.6% of the total waterfowl counted in the Hagerman WMA and 79.9% of the total waterfowl counted in the Middle Snake River, or 85.9% overall of the total waterfowl counted as a 9-year average. Table 68 shows the pollutant loadings (in lbs/day) for total solids output, N, and P.

TABLE 68 ESTIMATED WATERFOWL TOTAL LOADINGS TO THE MIDDLE SNAKE RIVER SYSTEM

YEAR	TOTAL NUMBERS, count				TOTAL GENERATED OUTPUT FOR ALL WATERFOWL, lbs/day			
	Ducks	Geese	Swans	TOTAL	Total Solids*	Total Volatile Solids	Total N as N	Total P as P
1990	71341	6635	0	77976	1176.1	1226.9	120.1	52.5
1991	39670	3234	153	43057	645.6	673.4	66.0	28.8
1992	68267	12697	43	81007	1303.1	1359.3	133.1	58.1
1993	65159	6215	32	71406	1079.4	1126.0	110.3	48.1
1994	96822	14643	18	111483	1753.4	1829.1	179.1	78.2

YEAR	TOTAL NUMBERS, count				TOTAL GENERATED OUTPUT FOR ALL WATERFOWL, lbs/day			
	Ducks	Geese	Swans	TOTAL	Total Solids*	Total Volatile Solids	Total N as N	Total P as P
1995	86000	7882	17	93899	1415.0	1476.1	144.6	63.1
1996	23997	9074	21	33092	586.4	611.7	59.9	26.2
1997	22006	12078	5	34089	641.8	669.5	65.6	28.6
1998	55467	13972	6	69445	1159.8	1209.6	118.5	51.7
MEAN	58748	9603	33	68384	1084.5	1131.3	110.8	48.4

Prepared by IDEQ-TFRO. Ducks based on production figures per 1000 ducks and assuming an average weight of 4 pounds per duck on swim water. The ducks Total Solids based on total suspended solids as 13.9 lb/day/1000 ducks; 14.5 lb volatile solids/day/1000 ducks; 1.42 lb nitrogen/day/1000 ducks; and, 0.62 lb phosphorus/day/1000 ducks (*IDEQ, Idaho Waste Management Guidlines for Confined Feeding Operations, p. 71*). Geese and swans were estimated at twice the rate as ducks, since little research has been done in this area. Therefore: total solids = 27.8 lb/day/1000 geese or swan; volatile solids = 29.0 lb volatile solids/day/1000 geese and swan; nitrogen = 2.84 lb/day/1000 geese and swan; and, phosphorus = 1.24 lb/day/1000 geese and swan. Total Generated Output for all waterfowl was determined by summing the output values for ducks, geese, and swan.

HUMAN POPULATION

The tri-county area (Gooding, Jerome, Twin Falls) estimate number of human population and their manure output is summarized in Table 69 for 1990 through 2010 for total number of people, manure output (tons/day), total solids output (tons/day), total nitrogen output (tons/day), and total phosphorus output (tons/day). As can be seen, the total number of human population is expected to increase from 1990 to 2010 by 1.1 times (89574/80351=1.1). These loads are generally accounted for by the various municipalities as urban loadings with the exception of those rural and localized urban areas that are not hooked up to a sewage system, but rather to independent septic systems. See §2.2.3.7 for septic tank system estimates on a per county basis.

TABLE 69 TRI-COUNTY HUMAN POPULATION: GOODING, JEROME, AND TWIN FALLS

YEAR	POPULATION	MANURE OUTPUT	TOTAL SOLIDS OUTPUT	TOTAL N OUTPUT	TOTAL P OUTPUT
1990	80351	1253.5	136.6	8.0	1.0
1991	80812	1260.7	137.4	8.1	1.0
1992	81273	1267.9	138.2	8.1	1.0
1993	81734	1275.1	138.9	8.2	1.0
1994	82195	1282.2	139.7	8.2	1.0
1995	82656	1289.4	140.5	8.3	1.0
1996	83117	1296.6	141.3	8.3	1.0
1997	83578	1303.8	142.1	8.4	1.0
1998	84039	1311.0	142.9	8.4	1.0
2010	89574	1397.4	152.3	9.0	1.1
1990-1998 MEAN	82281	1282.3	139.7	8.2	1.0

Prepared by IDEQ-TFRO. Population estimates based on Idaho Department of Commerce 1993 report as land use values in number of persons. Manure and pollutant estimates based on *Idaho Waste Management Guidelines for Confined Feeding Operations.* Manure output estimates based on interpolation of yearly estimates over a 20-year period from 1990 to 2010.

Comparison analysis of manure output of the human population versus cattle and calves, and sheep and lambs, is shown in Table 70. As can be seen, waterfowl provide the least (although most direct because their discharge is directly into the stream) "pollutant outputs," followed by human, sheep and lambs, and finally cattle and calves (which indirectly discharge).

TABLE 70 COMPARISON OF 9-YEAR MEANS PER SPECIES OF ANIMAL OR HUMAN

ANIMAL SPECIES	TOTAL SOLIDS tons/day	TOTAL N tons/day	TOTAL P tons/day
Cattle and Calves	1249.1	51.5	10.0
Sheep and Lambs	213.5	9.0	1.7
Ducks, Geese, and Swans	0.5423	0.0554	0.0242
Human	139.7	8.2	1.0
Prepared by IDEQ-TFRO.			

One particular item that has given the public a misunderstanding of the effects from water fowl, is their Total P Output and its effect on the concentration of TP in a stream. Based on Table 67 and 68, the Total P as P Output (in tons/day) is 0.0242 (see Table 70) or 48.4 lbs/day (0.0242 tons/day x 2000 lbs/ton = 48.4 lbs/day). If this load were completely watersoluble; and, if it was being discharged directly to streams and tributaries at any one time; then, TABLE 71 shows what the concentration levels would be like in the stream with proper mixing at various stream flows (without taking into account disturbances in the streamload by the animal). Table 71 shows that on an average basis waterfowl provide "background" (0.0051 mg/L or less) since they are at the method detection limit (MDL) of 0.0050 mg/L total phosphorus for USEPA test method 365.4 (Storet No. 00665) when compared to other animal inputs for the specified assumptions.

TABLE 71 ESTIMATED TOTAL P CONCENTRATIONS AT VARIOUS FLOWS FROM VARIOUS DIRECT ANIMAL INPUTS

FLOW cfs	WATERFOWL
500	0.0179
1000	0.0090
5000	0.0018
10000	0.0009
15000	0.0006
20000	0.0004
MEAN =	0.0051
Prepared by IDEQ-TFRO. Concentration (mg/L) = Load (lbs/day) / [(Flow, cfs) x (5.393776)]. Loads for the individual animals are: 48.4 lbs/day for waterfowl.	

2.3.3 GROUND WATER CONCERNS

"A combination of natural and man-made factors determine the potential for ground water contamination within a given area. Natural factors, attributable to climate and geologic history, include the thickness and nature of the unsaturated zone, depth to ground water, and ground water movement. Qualitative measures of some

combination of natural factors is often called "hydrogeologic susceptibility." Man-induced factors include water withdrawal, wastewater disposal, hazardous material handling and disposal practices, and other land use practices. Qualitative evaluation of man-induced factors combined with hydrogeologic susceptibility is often termed "ground water vulnerability" or "potential for contamination" (USEPA 1990)." Within the Eastern Snake River Plain, the aquifer supplies 100% of the drinking water consumed. Further, no alternative source or combination of sources can economically supply all those who obtain drinking water from the Eastern Snake River Aquifer. Therefore, the Eastern Snake River Plain Aquifer has the potential for contamination based on the following:

1. Hydrogeologic susceptibility varies considerably within the Eastern Snake River Plain. Significant differences in the thickness and nature of the unsaturated root zone accounts for much of the variation. Areas where fractured basalt crops out at the land surface are more susceptible to ground water contamination than areas where thick deposits of clay rich soil provide a degree of natural protection.

2. Some practices, such as the use of injection wells or inadvertent use of leaking underground storage tanks, partly or entirely override whatever degree of natural protection is afforded by the unsaturated zone. This is of particular concern in the Eastern Snake River Plain because of the widespread use of drain wells (Class V injection wells) to dispose of excess irrigation water, urban storm runoff, and onsite sewage system effluent. In the Upper Snake Rock subbasin Table 72 summarizes the underground storage tanks in the tri-county area (Gooding, Jerome, Twin Falls counties) and the leaking underground storage tanks. Most of the tanks have the ability to impact groundwater.

TABLE 72 SUMMARY OF UNDERGROUND AND LEAKING STORAGE TANKS IN HUC 17040212

CITY	*TOTAL*	*CLOSED*	*ACTIVE*	*LEAKING*
		GOODING COUNTY		
Bliss	10	9	1	3
Gooding	27	15	12	9
Hagerman	16	10	6	3
Wendell	13	7	6	5
			ACTIVE + LEAKING TANKS =	45
		JEROME COUNTY		
Eden	10	7	3	1
Hazelton	16	9	7	3
Jerome	56	35	21	21
			ACTIVE + LEAKING TANKS =	56
		TWIN FALLS COUNTY		
Buhl	29	18	11	7
Castleford	2	2	0	0
Filer	17	11	6	2

CITY	TOTAL	CLOSED	ACTIVE	LEAKING
Hansen	13	9	4	1
Hollister	1	1	0	1
Kimberly	22	17	5	3
Murtaugh	17	10	7	4
Rogerson	3	1	2	0
Twin Falls	210	147	63	49
			ACTIVE + LEAKING TANKS =	165
			TRI-COUNTY GRAND TOTAL =	266

Prepare by IDEQ-TFRO. Data compiled annually as of February 1998 by IDEQ-Central Office. It should be noted that the table reflects only the regulated underground storage tanks. Heating oil tanks, farm or residential tanks less than 1100 gallons are not UST regulated.

As of this writing, the IDWR estimates that in the tri-county area there are approximately 215 injection wells: 57 in Jerome County, 107 in Gooding County, and 51 in Twin Falls County. These represent the active wells only and not the ones that have been capped.

3. Plumes of dissolved contaminants within the basalt tend to spread laterally, in the direction of ground water flow, within zones of high hydraulic conductivity. Interflow zones of fine grained sediment may almost entirely prevent vertical migration on a local scale.

4. Open-hole well construction is a common practice in the Eastern Snake River Plain which may have ground water quality impacts. When much of the borehole is uncased, water can mingle freely between producing zones. This could be a significant concern wherever hydraulic head relationships are such that a stratigraphic interval of poor quality water could contaminate zones of high quality water.

5. IDEQ has ranked most known and potential sources of ground water contamination (statewide) on the basis of human health risk. From greatest risk to least risk, the ranking is as follows: petroleum handling and storage; feedlots and dairies; landfills and hazardous waste sites; land application of wastewater hazardous material handling; pesticide handling and use; land spreading of sludge and solid or liquid septic tank pumpage; surface runoff; pits, ponds and lagoons; radioactive substances; fertilizer application; septic tank systems; mining, including oil and gas drilling; wells (injection, geothermal, and domestic); and forestry practices.

2.4 SUMMARY OF PAST/PRESENT POLLUTION CONTROL EFFORTS

Current and past pollution control efforts in Upper Snake Rock have included a number of projects on various tributaries. The follow pollution control efforts/projects are described as point and nonpoint source efforts.

2.4.1 NONPOINT SOURCE PAST/PRESENT POLLUTION CONTROL EFFORTS

In 1979 as a part of a 208 Study conducted by IDEQ on the Snake River from the Idaho-Wyoming border to Weiser, it was stated that a "general increase in nutrient concentrations from upstream to downstream stations exceeded the recommended criteria over most of the river a majority of the time (IDHW 1979a). It was stated that "in most Snake River segments and major tributaries, point sources are not major contributors of nutrients." In fact, "the major reduction in nutrient loadings will come from nonpoint source controls (IDHW 1979a). It was recommended at that time that the nutrient control plan for the Snake River should be implemented in two phases: Phase I would concentrate on control of phosphorus sources, and Phase II would focus on nitrogen sources. As part of the study, the Middle Snake River (from Milner Dam to King Hill) was defined as the segment most affected by upstream segments and upstream controls. "In addition, the springs entering this portion of the river and nonpoint sources on the three major tributaries also contribute a major portion of the phosphorus load. The nonpoint sources on both sides of the Snake River should be reduced by implementation of the Agriculture Pollution Abatement Plan (IDHW 1979a)." The Rock Creek drainage was defined as one of the major tributaries and was being considered for a special Rural Clean Water Program project (which later occured in the 1980s). Since that time, the Idaho Agriculture Pollution Abatement Plan has been referenced in Idaho Code §39-3601 *et seq.* as the source of best management practices for agricultural sources. IDEQ anticipates that agriculture as part of the nonpoint source portion of the TMDL will adopt and implement those best management practices (where applicable) as defined in the Pollution Abatement Plan and that the feedback loop will be used to identify non-functioning best management practices and these will be modified so functional best management practices will be applied for the reduction of sediment and nutrients, as well as other parameters linked to the sediment. Precedence for this has been set by the Mid-Snake TMDL (1997b) in which a portion of irrigated agriculture selected site-specific canal drains to apply best management practices for specific total phosphorus reductions. Still to be defined are: (1) tributary reduciton efforts from various nonpoint sources, (2) grazing reduction efforts that need to be defined for public and private lands, and (3) additional agricultural drains that may have significant impact to receiving streams.

2.4.1.1 WATER QUALITY PROJECTS

The Idaho State Agricultural Water Quality Plan (or SAWQP) has undergone major revisions in its funding since it was developed as a partnership between the "participant", the technical agency, the soil conservation district, and the IDEQ. SAWQP conducted in Upper Snake Rock has included some of the following projects as described in Table 73. Additionally, the federal Rural Clean Water Program has been used on one water quality project and is so described in TABLE 42.

TABLE 73 SAWQP PROJECTS OF IDEQ-TFRO

NAME OF PROJECT	*ACREAGE AFFECTED*	*WATER QUALITY PROJECT TYPE & PROBLEM ASSESSMENT*
Vinyard Creek	9,890	A SAWQP Project. Vinyard Creek watershed has a serious erosion problem on irrigated cropland, especially during spring runoff of winter snows and furrow irrigation of row crops.

NAME OF PROJECT	ACREAGE AFFECTED	WATER QUALITY PROJECT TYPE & PROBLEM ASSESSMENT
East Upper Deep Creek	5,079	A SAWQP Project. The land is primarily agricultural in nature, intensively farmed, and severely impacted by livestock operations thus contributing to inefficient water management and soil erosion via sediment and associated nutrients and pathogens. The two critical water quality problems are erosion from irrigated cropland and inadequate animal wate management handling systems. Riparian areas are primarily pastures along canals and irrigation waterways.
West Upper Deep Creek	4,079	
Scotts Pond	58,674	A SAWQP Project. Surface water pollution includes sediment erosion from irrigated cropland and from winter/spring runoff as the greatest source of sediment, and numerous dairies and feedlots which contribute organic and inorganic pollutants. Ground water pollution is possibly due to CFO concentration of animal wastes in improperly engineered containment facilities.
Rock Creek	202,000	A Rural Clean Water Program (RCWP). Water quality problems from both point (sugar company, concrete mining, processed foods, aquaculture) and nonpoint source (forestry, road construction, urban runoff, grazing, pasture, irrigated cropland) industries. The creek is used as well for recreation and industrial water supply. Unstable streambanks are a major problem on Rock Creek.
Cedar Draw	15,665	Water quality problems primarily from critical erosion sites and irrigated cropland.
Mud Creek		Similar to Deep Creek. A SAWQP planning project.
Perrine Coulee	27,552	The major water quality problems include excessive sediment loads, excessive nutrient levels, and excessive bacteria levels which are largely from agricultural sources (irrigated cropland, occasional animal feeding operations, pastures draining directly into drainage channels). Urban runoff is also a priority. A SAWQP planning project.

Although, in general the SAWQP and RCWP projects were successful, sediment still continues to be a major problem year-after-year in the Upper Snake Rock subbasin. Sediment is a complex problem requiring a complex solution. Yet, the key to reducing sediment on the Middle Snake River is to reduce the sediment in the individual tributaries and agricultural returns through reductions in sediment at individual farm sites. When this is accomplished, the overall water quality on the Middle Snake River and its associated tributaries and agricultural returns will greatly improve. It is anticipated that with decreases in sediment (as total suspended solids) over a ten year period, baterial contamination, excess nutrients, and excessive macrophytes will be substantially reduced. Public education; application of functional, voluntary, and cost-effective BMPs; effectiveness monitoring for the short- and long-term; and, constant vigilance of the applied BMPs through the feedback loop are key considerations in developing a functional and workable sediment reduction strategy for the Upper Snake Rock subbasin.

2.4.1.2 FERC RELICENSING PROCESS

One of the issues for relicensing of the Idaho Power Company (IPC) Mid-Snake hydropower facilities (Bliss Dam, FERC No. 1975; Lower Salmon Falls Dam, FERC No. 2061; Upper Salmon Falls Dam, FERC No. 2777; Shoshone Falls, FERC No. 2778) is §401 Water Quality Certification by IDEQ. IDEQ is the designated water quality agency for the State of Idaho and administratively issues §401 Water Quality Certification for FERC projects to meet state water quality standards. In December 1995, IPC submitted to FERC applications for relicensing for three (Bliss, Lower Salmon Falls, Upper Salmon Falls) hydropower facilities located near Hagerman and Bliss. The IPC also submitted a request for federal Clean Water Act §401 Water Quality Certification. Then, in May 1997, IPC filed an application with FERC to relicense its Shoshone Falls hydropower facility (near Twin Falls) and applied for a request with IDEQ for §401 Water Quality Certification for this facility.

The IDEQ has conducted settlement discussions and negotiations with IPC concerning protection, mitigation,

and enhancement (PM&E) measures and actions that address water quality in the Middle Snake River. A formal and legally enforceable Consent Order (dated May 22, 1998) was entered into with IPC with terms and conditions that address water quality issues, concerns, measures, and actions to be taken by IPC to protect, mitigate, and enhance water quality in the Middle Snake River. PM&E measures to address the effects of the four hydropower facilities on water quality in the Middle Snake River were proposed by IPC in their license applications to FERC. These PM&Es were evaluated by IDEQ and are included as specific actions or activities by IPC and considered as mitigation for water quality impacts. The physical characteristics (such as dam design and impoundments), as well as the operations of the individual hydropower facility, make it very difficult to protect, mitigate, or enhance water quality short of removal of the dams and returning the river to its natural free-flowing state. The ability of IPC to incorporate operational changes is limited and IDEQ included specific activities which would result in improving water quality and enhancing the beneficial uses of the Middle Snake River.

IDEQ PM&E measures and actions include: protection of spring habitats; off-site measures to limit sediment and nutrient pollution loadings; and, water quality monitoring. IPC PM&E measures and actions include: continued active participation in the Middle Snake River Watershed Management Plan; aquatic macrophyte harvest; minimum flow in the north channel at Upper Salmon Falls; and, temperature and dissolved oxygen monitoring. The IDEQ entered into a consent order agreement with IPC to the §401 Water Quality Certification that addresses terms and conditions agreed to by both IDEQ and IPC relative to activities or actions to meet water quality standards. The goal of the §401 Water Quality Certification action is to ensure that water quality values affected by the four hydropower facilities' operations result in appropriate PM&Es for the benefits of the State of Idaho as well as maintaining the facilities as cost-effective power generators and electric suppliers for the State.

VINYARD CREEK

One particular FERC environmental project that has been used to assist in the recovering of certain trout species is the Vinyard Creek Diversion Project (NPW No. 963200350) as part of the Twin Falls Project (FERC No. 0018). License Article 405 required IPC to implement aquatic habitat enhancement. For the Vinyard Creek Diversion Project, the primary purpose was to divert agricultural drain return water out of Vinyard Creek and into the Twin Falls Reservoir so as to improve the aquatic habitat of lower Vinyard Creek to improve fisheries in the Twin Falls Reservoir. The specific fisheries are cutthroat trout and rainbow/cutthroat trout hybrids in the Twin Falls Reservoir. The irrigation return drain conveys irrigation waste water and suspended sediments into Vinyard Creek. The diversion project (dike, pipeline, and outfall) would intercept this waste water flow and sediment before it entered the lower portion of Vinyard Creek. The diverted flow would be discharged into the Twin Falls Reservoir below the outlet of Vinyard Creek. (See IDEQ 1996b, DOA-COE 1996, and IPC 1997b for additional information.)

2.4.1.3 IDAHO DEPARTMENT OF LANDS (IDL)

On April 17, 1998 a memorandum was jointly signed by IDEQ and IDL whick attempted to clarify roles and ensure coordination of efforts in development of TMDLs for forested portions of TMDLs. As previously described, only 3% of the land use in Upper Snake Rock is forested making the overall effects from forested ground minimal. (See §2.1.2.3) At this time, forestry is not included as a major component of the TMDL process for Upper Snake Rock since its land use comprises a smaller fraction when compared to rangeland and agriculture. At a future date, forestry will be addressed if necessary.

2.4.1.4 IRRIGATION COMPANY POLLUTION CONTROL EFFORTS

In addition to water quality monitoring being contracted by The North Side and Twin Falls Canal Companies, both have constructed sediment retention ponds at selected sites on their canal systems. A summary of these

retention ponds is found in Appendix B (§2.80). As part of their industry plan, the irrigation agricultural community will continue to monitor as described in their industry plan on selected agricultural return drains.

The Twin Falls and Northside Canal Companies, as part of the Irrigators Water Quality Committee, have set a goal of reducing sediment by 27% and phosphorus by 10% by the Year 2000. These goals are part of irrigated agriculture industry's nutrient management plan submitted to IDEQ in the Mid-Snake TMDL (1997b). Baseline loads were determined to be the 1990-91 load base. As part of their management actions and their specific watershed reduction plan, the canal companies jointly contracted with the University of Idaho for an initial two-year period (beginning July 1, 1992) of which a water quality monitoring network was developed on the return flows in order to determine the 1995 irrigation season loads. Significant amounts of sediment are removed from the drains resulting in expensive cleaning costs. Although irrigation diversions benefit the Middle Snake River as far as their water quantity is concerned, their pollutant concentrations result in elevated concentrations of pollutants in the Middle Snake River. However, the 1995 suspended solids and total phosphorus loading results showed a general decreasing trend from the 1990-91 loading results and indicate that the proposed goals of the Mid-Snake TMDL (1997b) can be achieved (Barry 1996).

2.4.1.5 319 PROJECTS

Only one project was funded through the 319 Program in Upper Snake Rock. It was the CFO position at IDEQ-TFRO. The project was funded in 1993, 1995, and 1996, and was instrumental in developing a database that located dairies and feedlots in the region. Additionally, it was beneficial for inspection of CFOs, prevention of discharges, and providing technical assistance to operators.

2.4.1.5 104(b) PROJECTS

One 104(b) project was funded by USEPA at the IDEQ-TFRO as an aquaculture basic research study on offline settling ponds for the development of best management practices in 1995-1998.

2.4.1.6 WATER QUALITY 106

One water quality 106 project funded by USEPA for monitoring on Billingsley Creek commenced in the late 1980s and is still on-going for monitoring of various water quality parameters.

2.4.1.7 GROUND WATER

The eastern Snake River Plain is underlain predominantly by a series of vesicular and broken basalt flows that has regional water flows that in the aquifer that move from northeast to southwest. Ground water is discharged from the eastern Snake River Plain aquifer as spring flow and seepage to the Snake River between Milner Dam and King Hill. Discharge to the entire reach was about 6000 cfs in 1980 (USGS 1997c). As previously stated in §2.1.3.4, the average discharge specifically at Thousands Springs was about 4000 cfs in the early 1900s and increased to almost 7000 cfs in the 1950s. It has since decreased to about 5000 cfs (USBOR 1996-1997).

NO2+NO3 as N (or NOX) in ground water is a result of nitrogen input from many difference sources. The proportions of nitrogen supplied by the various sources depend on land use practices. For instance, most nitrogen in the A&B area of Burley-Rupert is from inorganic fertilizer and legume crops. In the Jerome-Gooding study area, a greater percentage of nitrogen is from cattle manure because of the large number of dairies, particularly in Gooding county (USGS 1997c). USGS estimated the amount of nitrogen supplied by cattle manure, domestic septic systems, inorganic fertilizer, legume crops (alfalfa and beans), and precipitation for each countin in the Upper Snake River Basin. They concluded that domestic septic systems provided minimal amounts of nitrogen input (less than 1 percent) and that precipitation provided only 6 percent

of the nitrogen input to the basin as a whole. The remaining 93% was provided by cattle manure (29%), fertilizer (45%), and legume crops (19%). Additionally, the greatest amount of mean residual total nitrogen input of all 24 counties in the basin occurs in Cassia, Gooding, and Twin Falls counties. Gooding and Twin Falls are in Upper Snake Rock (USGS 1996b).

As previously noted in §2.1, excessive aquatic plant growth in surface water is a major concern in the Middle Snake River, particularly during low flow/drought years. Ground water adds nitrogen and phosphorus to surface water where ground water discharges to the Middle Snake River. Water from more than 78% of the regional wells contained NOX concentrations higher than 0.3 mg/L, which is the critical limit for stimulation of aquatic plant growth in surface water in the presence of adequate phosphorus. According to USGS, this suggests that nitrogen is not a limiting factor for aquatic plant growth in most streams that receive ground water (USGS 1997c).

2.4.2 POINT SOURCE POLLUTION CONTROL EFFORTS

At the time of this writing, the food processors, municipalities, and aquaculture permits were undergoing public comment for reissuance or modification of their individual permits.

2.4.2.1 AQUACULTURE GENERAL PERMIT

Aquaculture facilities and associated, on-site fish processors had their public comment period from April 10, 1998 to June 9, 1998 on a proposed general NPDES permit (No. ID-G13-0000). The general NPDES permit contains technology-based limitations for sediment based upon the same effluent guidelines as previous NPDES permits for Idaho's aquaculture industry. The general NPDES permit contains technology-based limitations for BOD_5, oil and grease, based upon the same effluent guidelines as previous NPDES permits for Idaho's fish processors.

The aquaculture facilities authorized to discharge under this general permit raise fish: rainbow trout, steelhead trout, chinook salmon, catfish, tilapia, and other fish. These fish are produced for market as food products or for the enhancement of salmonid populations. They discharge rearing wastewater containing fish excreta, excess fish feed, dissolved and suspended soild biological pollutants, oxygen demanding materials, nutrients, and residual disease control chemicals or therapeutics. The aquaculture facilities are required to develop best management practices plans supported by mass balance assessments of their operations and to restrict their discharges below specific technology-based limitations on total suspended solids and settable solids and specific water quality-based limitations on total phosphorus, dissolved oxygen, and pH.

The fish processors authorized to discharge under this general permit butcher fish: rainbow trout, steelhead trout, chinook salmon, catfish, tilapia, and other fish. These are butchered for food products, thus discharging processing wastewater containing dissolved and suspended solid biological pollutants, oxygen demanding materials, nutrients, and residual disinfectants. The fish processors are required to develop best management practices plans supported by mass balance assessments of their operations and to restrict their discharges below specific technology-based limitations on total suspended solids, biochemical oxygen demand, oil and grease, and pH and specific water quality-based limitations on total residual chlorine and pH.

2.4.2.2 FOOD PROCESSORS INDIVIDUAL PERMITS

The food processors have individual NPDES permits which had their public comment period from September 24, 1997 to November 10, 1997. These permits reflect J.R. Simplot Company (which is a permit modification) and McCain Foodservice, Inc. (which is a permit modification) to incorporate the conditions of total phosphorus limits established by the Mid-Snake TMDL (1997b).

The J.R. Simplot Company processes raw potatoes into frozen potato products (french fries) and dehydrofrozen potato products. Final effluent is discharged into the Snake River at RM 652.2. The proposed permit modification will retain the 1994 permit conditions and further improve water quality by reducing total phosphorus loads to the Middle Snake River (which is downstream of HUC 17040209), which will in turn reduce eutrophication. The 1994 permit established both ambient and effluent monitoring of nutrients including total phosphorus and dissolved ortho-phosphate (USEPA 1997c).

The McCain Foodservice, Inc. food processor processes raw potatoes, manufacturing frozen potato products. Process wastewater is treated prior to discharge into the Snake River (mid-channel) at RM 648.8. The proposed permit modification will retain the 1994 permit conditions and further improve water quality by reducing total phosphorus loads to the Middle Snake River (which is downstream of HUC 17040209), which will in turn reduce eutrophication. Effluent monitoring is done at a weekly frequency while ambient monitoring is required twice per year (USEPA 1997b).

2.4.3.3 MUNICIPALITY INDIVIDUAL PERMITS

The municipalities have individual NPDES permits which had their public comment period from September 24, 1997 to November 10, 1997. These permits are for the cities of Buhl (permit reiissuance, USEPA 1997e), Filer (permit reiissuance, USEPA 1997f), Hagerman (permit reiissuance, USEPA 1997d), Hansen (permit reiissuance, USEPA 1997h), Jerome (permit reiissuance, USEPA 1997g), and Twin Falls (permit modification, 1997i). The USEPA is reiissuing and modifying the existing permits in order to incorporate the wasteload allocations of the Mid-Snake TMDL (1997b). Only the cities of Jerome and Buhl are allowed for alternatives from their current practice of the handling of treated sewage sludge (biosolids). Under the proposed permit, treated sewage sludge from the City of Jerome may be distributed and spread on the land as a fertilizer in western Jerome county. Under the proposed permit, the City of Buhl is allowed to spread small amounts of treated sewage sludge on agricultural test plots of up to 2 acres, encouraging the City to consider beneficial use in the future.

The proposed permit will improve water quality by significantly reducing phosphorus loads to the Middle Snake River, which in turn will reduce eutrophication. In addition, the permit includes water quality-based limits on residual chlorine and ammonia. These limits will ensure that water quality standards are met at the edge of the mixing zone (USEPA 1997i).

2.4.3 MID-SNAKE TMDL

The Mid-Snake TMDL (1997b) was accepted by the EPA on April 25, 1997 as a TMDL for total phosphorus for both point and nonpoint sources in the Upper Snake Rock watershed. Although the TMDL does not bring new enforcement authority, it does provide wasteload allocations for total phosphorus limits for point source permits for food processors, municipalities, and aquaculture. Specific commitments have been entered into by nonpoint source industries relative to best managment practices. Violation of state water quality standards and best management practices by any industry on the Middle Snake River (to which all tributaries in Upper Snake Rock discharge) would be inconsistent with the Mid-Snake TMDL and therefore could result in statutory enforcement by the IDEQ, specifically IDAPA §16.01.02.080, where "no pollutant shall be discharged from a single source or in combination with pollutants discharged from other sources in concentrations or in a manner that will or can be expected to result in violation of water quality standards applicable to the receiving water body or downstream waters; or will injure designated or existing beneficial uses; or is not authorized by the appropriate authorizing agency for those discharges that require authorization;" and, Idaho Code §39-3603, where "the existing instream beneficial uses of each water body and the level of water quality necessary to protect those uses shall be maintained and protected." See also the Mid-Snake TMDL (1997b) for a summary of industry reduction goals, management actions, compliance actions, and implementation.

2.4.3.1 MONITORING IN UPPER SNAKE ROCK

Monitoring of Upper Snake Rock tributaries and the Middle Snake River will continue to occur with the resources from various agencies, organizations, and groups. As of this writing, a trend monitoring plan was being reviewed by the Mid-Snake TAC for purposes of documenting relative changes in various aquatic organism populations, and in physical and chemical water quality parameters over a ten year period during the implementation of the Mid-Snake TMDL (or Middle Snake River Watershed Management Plan). Monitoring by IDEQ-TFRO on the various tributaries and additional sites on the Middle Snake River will be incorporated as funds become more available. A draft copy of the *Trend Monitoring Plan* is found in Appendix A (§2.7).

2.4.3.2 BURP MONITORING

BURP monitoring will continue annually within the subbasin to verify if beneficial use support status has been changed or achieved as necessary. For wadable streams, large rivers, lakes and reservoirs, the following parameters in Table 74 may be used to decide assessment of their beneficial uses. These reflect the minimum number of parameters needed to adequately surmise the level of beneficial use support status (either as full support or not full support). It is highly unlikely that any one parameter will have sufficient sensitivity to be useful in all circumstances.

TABLE 74 BURP MONITORING PROTOCOLS

PARAMETER	*WADABLE STREAMS*	*LARGE RIVERS*	*LAKES & RESERVOIRS*
	PHYSICAL/CHEMICAL PARAMETES		
Bathymetry or Depth			X
Canopy Closure (Shade)	X		
Channel Alterations		X	
Conductivity		X	X
Discharge	X	X	
Dissolved Oxygen		X	X
Floodplain Disturbance		X	
Habitat Distribution	X	X	
pH		X	X
Large Organic Debris	X		
Nutrients			X
Photo Documentation & Diagrammatic Mapping	X	X	X
Pool Quality	X		
Riparian Vegetation		X	
Stream-Channel Classification	X		
Streambank Condition & Material Types	X	X	
Substrate and Embeddedness	X	X	X

PARAMETER	WADABLE STREAMS	LARGE RIVERS	LAKES & RESERVOIRS
Temperature	X	X	X
Water Clarity		X	X
Width and Depth	X	X	
BIOLOGICAL PARAMETERS			
Aquatic Macrophytes		X	X
Fecal Coliform		X	X
Fish	X	X	X
Macroinvertebrates	X	X	X
Periphyton		X	X
Phytoplankton/Chlorophyll *a*		X	
Prepared by IDEQ-TFRO.			

2.4.4 NO-NET INCREASE POLICY ON TMDLs

On May 7, 1998, a No-Net Increase (NNI) Policy was made effective by IDEQ. When a stream is designated as not fully meeting its designated or existing beneficial uses, an interim of time exits until the stream has a TMDL developed or the stream is delisted because its beneficial uses have returned to full support. During that interim of time, the NNI Policy (IDEQ Policy Memorandum, *PM98-2*, May 7, 1998), the provisions of IDAPA §16.01.02.054.04 (High Priority Provision) and IDAPA §16.02.02.054.05 (Medium and Low Priority Provisions) are to be utilized. The NNI Policy may not be interpreted as requiring best management practices for nonpoint source operations unless they are voluntary or unless they are outlined in applicable federal or state statute or IDAPA 16 Tital 01 Chapter 02. For agriculture, the *Idaho Agriculture Pollution Abatement Plan* has been referenced (IDAPA §16.01.02.054.07) as "the source for best management practices for the control of nonpoint sources of pollution for agriculture." Although the policy does not generally pertain to accidental spills or unauthorized releases that may occur on listed waters, IDEQ must ensure that human health along with the appropriate beneficial uses are protected in the case of accidental spills or unauthorized releases, and could, depending on the spill or release, require clean up. Provisions of the NNI Policy include nonpoint source, point source, and general provisons.

2.4.4.1 NONPOINT SOURCE PROVISION OF NNI POLICY

It is the responsibility of the designated agency to ensure that cost effective best management practices or knowledgeable and reasonable control measures, including pollution trading, have been or are properly implemented for all nonpoint source activities on federal, state, or private lands.

1. Where approved best management practices do not exist, the landowner should be assisted by the designated agency in using knowledgeable and reasonable control measures to ensure no further impairments of beneficial uses on low and medium priority waters, and that the load remains constant or decreases on high priority waters.

2. IDEQ recommends monitoring as a component of application of best management practices or other control measures.

3. If monitoring indicates that approved best management practices or other control measures are not maintaining or protecting beneficial uses, then additional restrictions or modified control measures may be imposed.

2.4.4.2 POINT SOURCE (NPDES PERMIT) PROVISION OF NNI POLICY

The Clean Water Act requires all point source dischargers to have an NPDES permit. In the event that USEPA cannot or does not issue a permit on a §303(d) listed water body, IDEQ will notify the discharger of the applicable provisions specified in the High Priority Provision (IDAPA §16.01.02.054.04), the Medium and Low Priority Provision (IDAPA §16.01.02.054.05), and the Violation of Water Quality Standards (IDAPA §16.01.02.080). Additionally,

1. A facility will be allowed to discharge to its existing maximum NPDES permit limit without being considered in violation of the High Priority and the Medium and Low Priority Provisions. However, dischargers of listed pollutants to §303(d) waters should be aware that interim increases in existing loads may result in the need for greater load reduction once a TMDL is developed and implemented.

2. A facility operating within its permitted discharge limits will not have to change its discharge limit while the TMDL is being developed. The NPDES permit and associated discharge limit will be examined and modified, if necessary, by USEPA at the time of permit reissuance.

3. When reviewing and approving plans under IC §39-118 including facility plans and specifications, written or verbal communication to the facility should emphasize that additional load reductions from the facility may be likely or required once the TMDL has been developed.

4. When meeting the provisions of the NNI policy, an NPDES permittee should address new or increased discharge of listed pollutants in terms of mass per unit time, toxicity, or other appropriate measures. However, IDAPA §16.01.02.054.04 specifies that for high priority waters, the total load must remain constant or decrease within the watershed.

5. To write a TMDL, IDEQ will establish loads based upon available information. However, where information is lacking, facilities will be allowed to establish baseline data for the listed pollutants using standard analytical methods. IDEQ regions shall issue a letter to each facility detailing that if baseline information is not established by the discharger by a certain date, IDEQ will proceed to establish baseline information necessary for the development of a TMDL.

6. In situations where dischargers apply to exceed their maximum permit limits, provisions of IDAPA §16.01.02.054 shall apply. For high priority waters, new or increased discharge of pollutants of concern above permitted limits may be allowed if the total load to the watershed remains constant or decreases. For medium and low priority waters, IDEQ may require changes in loads and/or concentrations of pollutants of concern that prevent further impairment of beneficial uses. In either case, it is incumbent on the facility to provide loading calculations based on sound and accepted engineering practices which demonstrate the applicable provisions of IDAPA §16.01.02.054. However, dischargers of listed pollutants to §303(d) waters should be aware that interim increases in existing loads may result in the need for greater load reduction once a TMDL is developed and implemented.

7. Unpermitted facilities wishing to expand their facility operations will be required to acquire an NPDES permit from USEPA and meet all applicable provisions of IDAPA §16.01.02.054.04 or IDAPA §16.01.02.054.05.

2.4.4.3 GENERAL PROVISION OF NNI POLICY

The following general provisions apply on the NNI Policy:

1. If IDEQ determines, based on reliable and verifiable water quality information, that a specific listed pollutant is not impairing the §303(d) water body, then delisting will be recommended and a TMDL will not be developed for that pollutant and water body.

2. Any faclility or operation implementing control measures after the WAG (if applicable) or BAG (in the absence of a WAG) review of the subbasin assessment, and before USEPA's approval of the the TMDL that results in a verifiable reduction of listed pollutant(s) to a §303(d) water quality limited water body, will be credited with the appropriate load reduction during the allocation phase of the TMDL. However, this does not guarantee that additional load reductions by the facility will not be required in order to meet water quality goals necessary to obtain beneficial uses.

3. All activities related to stream channel alteration permit applications must comply with IDWR's Rules and Minimum Standards for Stream Channels Alteration. IDEQ shall give IDWR written notice if a §303(d) stream will be impacted, and caution that additional measures may need to be taken to later address water quality once the immediate threat has passed. In any situation, stream alteration activities shall not violate Idaho Water Quality Standards except as outlined in IDAPA §167.01.02.080.02 (Short Term Activity Exemptions).

In order to ensure that water quality is protected, the following conditions may be included by IDEQ in the final stream channel alteration permit:

a. Construction shall be conducted in such a manner so as to minimize turbidity and comply with the Idaho Water Quality Standards and Wastewater Treatment Requirements.

b. Work shall be conducted during low flows and heavy equipment shall operate from the bank.

c. All fuel, oil and other hazardous materials, shall be stored and equipment refueled and serviced away from the stream to ensure that a spill cannot enter the waterway.

d. All areas subject to erosion as a result of the construction shall be protected with rock riprap or other suitable methods of erosion protection meeting IDWR minimum standards.

e. Disturbed areas shall be revegetated and/or seeded with perennial vegetation.

f. All temporary structures, excavated material or construction debris resulting from the construction shall be disposed of out of the stream channel so it cannot reenter at high flows.

g. Materials excavated from the construction site shall be discharged in an upland area so it cannot reenter the stream channel at high flows.

h. Sand bags or other methods of coffer damming shall be utilized to minimize working in the flowing water.

Provided that these inclusions and IDWR minimum construction standards are included in the final permit, water quality impacts should be minimal.

Additionally, for suction dredging operations in Idaho, USEPA has provided the following guidelines (USEPA 1998c) if an NPDES permit strategy was developed:

a. For new large-scale commercial operations, individual NPDES permits would be required prior to beginning operations.

b. For moderately sized operations (with intakes greater than 5 inches and over 15 horse power), consideration would be given to issuing a general NPDES permit. The state of Idaho would have the flexibility, through their 401 certification program, to determine which stream segments would be off limits to dredging due to water quality concerns (such as segments on the 303(d) list).

c. For small-scale, recreational dredging operations which are adequately regulated under state programs (such as the "one stop" permit), or other federal programs (by the Corps of Engineers CWA 404 program), the USEPA could consider either a general permit or, with respect to unpermitted discharges, enforcement discretion if the discharges did not result in violations of state water quality standards.

4. All NEPA related activities are subject to compliance with all applicable rules and regulations. During the formal NEPA public comment period, IDEQ shall notify the designated agency when activities may impact a listed water. It is incumbent on the designated agency to demonstrate that the activity under consideration will result in no further impairments of the beneficial uses on low and medium priority waters, and that the total load of listed pollutants remains constant or decreases on high priority waters.

5. IDEQ has the authority to review storm water pollution prevention plans for adequacy and compliance with the provisions of IDAPA §16.01.02.054. Should these plans be deemed inadequate, IDEQ will notify USEPA who is responsible for enforcement and/or corrective actions.

6. Pollution trading to reduce the effects of increasing the load to a high priority water will be allowed as long as the total load remains constant or decreases within the watershed. Pollution trading will be permitted in accordance with the provisions of the Mid-Snake TMDL, §3.02 (Wasteload and Load Allocation Tables) and §3.04 (Enforcement Mechanisms). Any facility desiring a modification in their wasteload allocation through effluent trading must receive approval from IDEQ and USEPA. Facilities that were not currently in production (since April 25, 1997 when the Mid-Snake TMDL was approved) but have current NPDES permits will receive an allocation in Year 3 provided they are in production and have monitoring data sufficient to demonstrate their phosphorus contribution to the Middle Snake River.

2.4.5 POLLUTION PREVENTION

The U.S. Pollution Prevention Act of 1990 defines source reduction as any practice that reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment prior to recycle, treatment or disposal. Pollution prevention includes reduction of pollution at the source (source reduction), and increased efficiency in the use of raw materials and natural resources, such that the emphasis on end-of-pipe control (for point sources) as a continuing exclusive reliance by regulatory agencies for realizing environmental goals is deemphasized by augmenting attention to reducing the sources of environmental pollution through changes in processes, operations and the use of materials;

placing the focus for identifying opportunities for such changes on the owners and managers of commercial, transportation, agricultural and industrial operations who best know and understand them; and, encouraging an emphasis not just on achieving regulatory compliance, but on achieving the best possible environmental results which will often substantially surpass compliance requirements and generally yield economic benefits. IDEQ and USEPA promote and support this change of emphasis and are working with other stakeholder state and federal agencies to develop a range of incentives and recognition programs for companies, farmers, or other entities to improve their environmental performance by focusing generally on environmental improvements or targeting on particular environmental problems (IDEQ 1998a). At the present time, IDEQ is in the process of building a framework for an Idaho Pollution Prevention Incentive program. When this program is in place, IDEQ will promote and support it by encouraging superior environmental management and beyond-compliance environmental performance with appropriate stakeholders.

2.5 PUBLIC PARTICIPATION

Part of the process in the development of the Upper Snake Rock subbasin assessment was the use of public participation through the Middle Snake River Watershed Advisory Group (Mid-Snake WAG). Key to this was the use of the Middle Snake River Technical Advisory Committee (Mid-Snake TAC), which represented various scientists and technical specialists from the water user industries and from various governmental agencies and organizations. Their review of the subbasin assessment, along with their technical comments, provided a vehicle for IDEQ-TFRO to develop a document which provided the necessary information from which to eventually derive a TMDL for the water quality limited waterbodies in the Upper Snake Rock subbasin.

2.5.1 UPPER SNAKE BASIN ADVISORY GROUP

The Upper Snake Basin Advisory Group (or Upper Snake BAG) as part of their statutory stewardship under §39-3601 *et seq.* provided guidance and advise to the Mid-Snake WAG, the Mid-Snake TAC, and IDEQ in the final development of the subbasin assessment. Part of that stewardship was to review the document after formal presentation and provide their comments and assessment. The subbasin assessment was presented by IDEQ-TFRO to the Upper Snake BAG on September 2, 1998 with comments being solicited.

2.5.2 MIDDLE SNAKE RIVER WATERSHED ADVISORY GROUP

The Mid-Snake WAG as part of their statutory stewardshsip under §39-3601 *et seq.* provided necessary and valuble comments and assessment of the subbasin assessment. As part of their comments each representative industry provided additional insight and comments that went a long ways to making the final version of the document more scientific of the subbasin. The assessment was presented by IDEQ-TFRO to the Mid-Snake WAG on July 15, 1998 with comments being solicited.

2.5.3 MIDDLE SNAKE RIVER TECHNICAL ADIVSORY COMMITTEE

The Mid-Snake TAC was the scientific arm of the Mid-Snake WAG and provided technical assistance to IDEQ in the development of the final version of the subbasin assessment. They helped to review all technical databases, sources, and references and provided guidance on the technical aspects of the assessment. Various governmental agencies, organizations, and industry representatives (previously defined in §2.0 of this assessment) provided their expertise in the final version of the document. The Mid-Snake TAC commenced review of the subbasin assessment on June 17, 1998.

2.5.4 PUBLIC NOTICE ON THE SUBBASIN ASSESSMENT

Although no office public notice was advertised for the Upper Snake Rock Subbasin Assessment, public review of the document commenced on June 17, 1998 and ended on September 17, 1998. Additional comments that came in during this period were also incorporated into the document. After a second review by IDEQ-Central Office, the document was proposed as a final draft on December 31,1998. TMDL development commenced January 1, 1998.

2.6 SOURCES AND REFERENCES

A consciencious effort was made to maintain a list of all references used in the development of the subbasin assessment. Every document reviewed, whether identified in the document or not, was included in this list of sources and references. Additionally, the bibliography noted in the *Trend Monitoring Plan* is included in this list of sources and references. The format used is that of the Name-Year System as described in the CBE Manual (6th edition) and is a system widely known as the "Harvard system." The listing is alphabetical by author surname, organization/agency name, or computer program name.

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Land Ownership, IDWR.
USGS Gaging Stations. Basins, EPA.
Hydrography (1:100k and 1:250k), IDWR.
Geology (1:100k topographic images (DRGs) for Idaho, USGS.
STATSGO, soil coverage, NRCS.
Precip95, areal precipitation for Idaho, Idaho Climate Service, University of Idaho.
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A TREND MONITORING PLAN FOR THE MIDDLE SNAKE RIVER TO DEFINE RELATIVE CHANGES IN VARIOUS AQUATIC LIFE; CHEMICAL, PHYSICAL, AND WATER QUALITY PARAMETERS OVER A TEN YEAR PERIOD

by the

Technical Advisory Committee of the
Middle Snake River Watershed Advisory Group
June 2, 1998

I. INTRODUCTION

The purpose of this trend monitoring plan for the Middle Snake River is to help document relative changes in various aquatic organism populations, and in physical and chemical water quality parameters over a ten year period during the implementation of the Middle Snake River Watershed Management Plan. The river system-of-interest is the Middle Snake River. Tributaries to the Middle Snake River will be considered at a later time. The parameters defined in this plan summarize the minimal number of parameters that should be considered when developing other monitoring plans in the Middle Snake River by various agencies and organizations. Additionally, the data collected in this trend monitoring plan will be used in conjunction with other data from various agencies, organizations, and water user industries to assess if progress is being made on the Middle Snake River towards attainment of state water quality standards and its beneficial uses.

Various agencies and organizations have been involved in the collection of aquatic organisms and of physical and chemical water quality data over a number of years. In addition, point source industries have been involved in effluent monitoring of which their effluent either directly or indirectly discharges to the Middle Snake River. Collectively, this information will provide a substantial database from which to assess the overall condition of the Middle Snake River. The proposed trend monitoring plan is but one component in the overall database for assessment of the Middle Snake River. As of this writing, the IDEQ-TFRO has developed and will continue to develop a multi-agency/multi-organization monitoring database on the Middle Snake River as resources permit. All data collected through monitoring by IDEQ-TFRO will be made available on its www/Internet site as it becomes available.

On April 25, 1997 the Middle Snake River Watershed Management Plan containing the Mid-Snake TMDL for total phosphorus was approved by the U.S. Environmental Protection Agency (EPA). Implementation of this plan with its point and nonpoint source pollutant limitations is likely to bring the Middle Snake River into compliance with state water quality standards and allow the water body to meet its beneficial use requirements. Refining initial control strategies, additions and refinements to allocations and use of the feedback loop to identify if other adjustments to the plan are necessary and are dependent on effective monitoring. The trend monitoring described below is an integral part of this effort.

On September 4, 1997 the Middle Snake River Technical Advisory Committee (TAC), representing various scientists from agencies and water user industries agreed that the following parameters be included as "minimal water quality parameters" for the initial water quality testing in the trend monitoring plan: total phosphorus (TP), dissolved ortho-phosphate (DOP), total Kjeldahl nitrogen (TKN), ammonia (NH3), nitrite+nitrate (NO2+NO3), sediment (as suspended sediment), dissolved oxygen (DO), temperature, turbidity (NTU), pH, specific conductance (SC), and water velocity (as a subcomponent of flow). Minimal parameters that will be used in mass balance determinations include: TP, DOP, TKN, NH3, NO2+NO3, and sediment. -Additionally, the TAC considered various aquatic organisms and physical parameters, and these will be monitored as well.

One additional consideration was the need to use the same laboratory for the trend monitoring over the ten year period. This was agreed to by the TAC so as to reduce the variability that exists if various laboratories are used within the scope of the time frame. Therefore, the TAC strongly suggests that one laboratory be used throughout the life of the monitoring plan.

II. LITERATURE SURVEY

A literature survey of sampling procedures, analytical procedures, and quality control/quality assurance protocols was previously conducted by the Idaho Division of Environmental Quality (IDEQ) for the express purpose of formlating "minimal requirements" for a variety of trend monitoring plans. The results of that survey are included in this document as sited references. Those references are cited in §VII, Sources.

III. DESCRIPTION OF LOCATION AND SAMPLING SITES

The objective of the trend monitoring plan is to assess and report the existing condition of the Middle Snake River, to determine the long term trends, and to evaluate compliance with the state's water quality standards. Trend monitoring requires repeated sampling at a few key locations for a number of years. A monthly sampling frequency at these stations is the minimum frequency needed to adequately assess long term trends in water quality. Special and more intensive surveys may be performed to provide the more detailed data needed for determination of changes throughout a stream (or stream segment) in a short period of time (for cause and effect studies) or a study designed to determine the water quality at a series of closely related points in conjunction with a later survey to determine changes in water quality related to time. Ideally, all major surface waters (like the Middle Snake River) should undergo special or intensive water quality surveys on a periodic basis (such as three or four years).

The TAC determined that a less aggressive but overall comprehensive trend monitoring plan that incorporates monthly trend monitoring (for water chemistry parameters) and annual monitoring of aquatic biota would be suitable for defining a "skeletal framework" that could be built upon over the next ten years by the various agencies and organizations. The trend monitoring will also survey loads, concentrations, and changes in flow. Biological and habitat assessments will be conducted during summer low flow conditions (July-August) annually. This comprehensive approach of collecting multiple lines of evidence including chemical, physical, and biological parameters will provide a more robust trend monitoring approach which can accurately assess beneficial use attainment resulting from long-term management activities.

Therefore, the following describes the location and the sites to be considered for the trend monitoring of the Middle Snake River over the next ten years.

1. Three monitoring sites on the Middle Snake River have been selected. These sites are in the Milner area, the Buhl area, and the King Hill area. Their selection is due primarily to already existing USGS gaging stations for flow determination and ongoing National Water Quality Assessment (NAWQA) activities at selected sites. Additional sites (inclusive of tributaries) may be considered by IDEQ-TFRO if resources become available and allow for such.

2. At each site, water chemistry parameters will be monitored on a monthly basis. In conjuntion with this, flows will be determined as well. Water chemistry parameters will include total phosphorus (TP), dissolved ortho-phosphate (DOP), total Kjeldahl nitrogen (TKN), ammonia (NH3), nitrite+nitrate (NO2+NO3), sediment (as suspended sediment), dissolved oxygen (DO), turbidity (NTU), pH, specific conductance (SC). Continuous summer water temperature will be monitored at each site. Additionally, chlorophyll *a* and pheophytin will be collected as part of the water chemistry parameters.

3. Within the vecinity of the three selected sites, biological species will be monitored annually for richness, diversity, and their functional attributes. These sites will be selected based on areas that are conducive to macrophyte growths. The biologicals will include fish, macroinvertebrates, macrophytes, algae (periphyton and phytoplankton) and will be monitored annually. Associated instream and riparian habitat reach characteristics will be assessed annually at each site. In order to maintain consistency and comparability with ongoing programs, NAWQA protocols will be used when possible for aquatic life and habitat assessments.

a. HABITAT CHARACTERISTICS

The following physical, hydrologic, and physicochemical habitat characteristics will be monitored: reach length, width, depth, width/depth ratio, velocity, discharge, discharge as percent coefficient of variation (CV), specific conductivity, water temperature, pH, dissolved oxygen, percent dissolved oxygen saturation, substrate size, percent embeddedness, percent substrate fines, percent cover, and percent open canopy.

HABITAT CHARACTERISTIC PARAMETERS-OF-CONCERN

PARAMETERS	MONITORING FREQUENCY	COMMENTS
Reach length, ft	Annual	Physical characteristic
Width, ft	Annual	Phisical characteristic
Depth, ft	Annual	Physical characteristic
Width/Depth Ratio	Annual	Physical characteristic
Velocity, ft/s	Annual	Hydrologic characteristic
Discharge, cfs	Annual	Hydrologic characteristic
Discharge, % CV	Annual	Hydrologic characteristic
SC	Annual	Physicochemical characteristic
Temperature, °C	Annual	Physicochemical characteristic
pH	Annual	Physicochemical characteristic
DO, mg/L	Annual	Physicochemical characteristic
% DO Saturation	Annual	Physicochemical characteristic
Substrate size, inches	Annual	Physical characteristic
Percent Embeddedness	Annual	Physical characteristic
Percent substrate fines	Annual	Physical characteristic
Percent cover	Annual	Physical characteristic
Percent open canopy	Annual	Physical characteristic

b. FISH METRICS

Fish metrics will be determined for: number of fish collected, number of fish per minute of electrofishing, number of species, number of native species, percent anomalies, percent introduced species, percent common carp, percent cottids, percent salmonids, percent juvenile salmonids (less than 4 inches in length), percent adult salmonids (greater than 8 inches in length), number of intolerant species, percent omnivores, and percent coldwater adapted.

BIOLOGICAL PARAMEERS-OF-CONCERN FOR FISHERIES

PARAMETER	MONITORING FREQUENCY	COMMENTS
Number of fish collected	Annual	
Number of fish/min. Electrofishing	Annual	In an upstream direction

PARAMETER	MONITORING FREQUENCY	COMMENTS
Number of species	Annual	
Number of native species	Annual	
Percent anomalies	Annual	
Percent introduced species	Annual	
Percent common carp	Annual	
Percent cottids	Annual	
Percent salmonids	Annual	
Percent juvenile salmonids	Annual	< 4 inches length
Percent adult salmonids	Annual	> 8 inches length
Number of intolerant species	Annual	
Percent omnivores	Annual	
Percent coldwater adapted	Annual	

The Reconnaissance Index of Biotic Integrity (RIBI), as developed by the Idaho Division of Environmental Quality, will be used as an analytical tool for assessing the aquatic life beneficial use status determinations for the wadable stream portions of the Middle Snake River. The minimum collection effort must include the core methods defined in the Idaho Division of Environmental Quality's Water Body Assessment Guidance.

c. MACROINVERTEBRATES

Macroinvertebrates will be collected from both natural riffle substrate (semi-quantitative) and from all habitats (qualitative) found within each reach. Microhabitat measures of depth, velocity, and substrate quality would be made for each riffle collection.

The Macroinvertebrate Biotic Index (MBI), as developed by the Idaho Division of Environmental Quality, will be used as an analytical tool for assessing cold or warm water biota in wadable stream portions of the Middle Snake River. The MBI consists of seven (7) metrics which are described in the following table:

THE METRICS OF THE MACROINVERTEBRATE BIOTIC INDEX.

METRIC COMPONENT	DESCRIPTION
EPT%	A measure of the proportion of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) to the rest of the macroinvertebrates in the sample.
HBI	A measure of organic pollution and its effect on the macroinvertebrates.
Scrapers %	A measure of a functional feeding group as an indicator of the riffle community food base based on their relative abundance.
Dominance %	A measure of the contribution of the numerically dominant taxon to the total number of individuals in the community.

METRIC COMPONENT	DESCRIPTION
EPT Index	A measure of a groups sensitive to pollution by measuring the taxa richness for the three major groups.
Taxa Richness	A measure of the health of the community through a measure of the variety of taxa present.
Shannon's H'Diversity Index	A measure of species diversity or the evenness of the distribution of individuals in a community and their response to pollution.

d. MACROPHYTES

Macrophyte mapping will be done annually on the Middle Snake River with a minimal evaluation of habitat for flow, velocities, and specific macrophytes and/or algae. Additionally, macropohytes (including filamentous algae) will be assessed annually within each reach at each site. Species composition and biomass will be determined for primary species and major groups (i.e., rooted vascular, filamentous algae, and floating). Fly-over mapping of macrophytes will also be made to supplement reach data and to characterize the areal extent of plant growth. Ground truthing would be used to confirm habitat conditions and species composition.

e. ALGAE

Algae samples will be collected from natural substrate (periphyton) and from water column (phytoplankton) samples. Samples will be analyzed for chlorophyll and pheophytin, and taxonomic composition and densities per unit area and/or volume determined. Biomass estimates will be determined for periphyton.

IV. MATERIALS AND METHODS

In general, the trend monitoring plan will use those protocols for materials and methods as defined by the IDEQ and USGS/NAWQA and will follow the standard USEPA protocols for QA/QC and sampling and parameter testing.

A. QUALITY ASSURANCE AND QUALITY CONTROL

The primary objective of the trend monitoirng plan's quality assurance and quality control (QA/QC) is to generate high quality data in an efficient and cost effective manner under a planned and documented quality system. Corollary 1 describes some of the more pertinent considerations for QA/QC. The TAC will review and make suggestions on all QA/QC procedures relevant to the testing laboratory. At least 10% of all samples taken during each sampling event will have QA/QC checks for blanks, spikes, and duplicates where appropriate.

B. PARAMETERS-OF-CONCERN

The testing laboratory will provide to the TAC the method detection limit (MDL) for each parameter so the TAC can make suggestions on the applicability of the appropriate MDL. As part of the overall effort and purpose of the trend monitoring plan, the TAC will provide scientific recommendations to the laboratory on the MDL for each parameter to be tested. Those recommendations may include the following MDL levels for selected parameters:

RECOMMENDED METHOD DETECTION LIMITS FOR SELECTED PARAMETERS TO BE TESTED.

PARAMETER	RECOMMENDED MDL
TP, mg/L	0.01 mg/L

PARAMETER	RECOMMENDED MDL
DOP, mg/L	0.01 mg/L
TKN, mg/L	0.10 mg/L
NH3, mg/L	0.01 mg/L
NO2+NO3, mg/L	0.01 mg/L
Suspended Sediment, mg/L	1.0 mg/L

Water quality sampling will follow standard protocols and methods as defined by the TAC for the Middle Snake River. Appendix 1 is included as a basis from which the TAC may wish to resolve technical issues.

C. EQUIPMENT AND MATERIALS

All equipment and materials used for field and laboratory preparatory procedures will be reviewed by the TAC relative to sampling of water chemistry, macroinvertebrates, fisheries, macrophytes, and phytoplankton. The TAC will determine if the equipment and materials for sampling and preparation of field parameters for testing is appropriate.

A modified slack sampler (425 micron) will be used in riffle habitats for semi-quantitative collections and multiple gear (Ponar dredge, d-frame net, hand-picking, etc. used to collect qualitative samples within each reach). Samples would be composited to represent the overall reach conditions and to reduce costs.

All fish would be sampled using standard electrofishing techniques (developed by either the Idaho Fish and Game, the Division of Environmental Quality, or NAWQA protocols) including both boat and backpack equipment. All habitats and species would be sampled within each reach and standard units of effort recorded. Multiple gear would be used if conditions warranted their use. All species would be enumerated and game species would be measured for weight and length. Composite weights would be taken for biomass estimates for all nongame species. Each fish would be checked for external anomalies.

Periphyton samples will be taken from natural substrate in the same area where macroinvertebrate samples are taken in riffle habitat. Collections would be made with a standard collection device used in the NAWQA program of a known area and samples composited for an overall reach condition.

D. STATISTICAL ANALYSIS OF DATA

Statistical analysis of data will be based on a seasonal Kendall-tau test that is detrended for flow to analyze the water quality data for monotonic trends. This nonparametric procedure is suitable for application to water quality data which are often skewed, serially correlated, and seasonality affected. Additionally, missing values, or values defined as "less than" the laboratory detection limit present no problems. The test also provides a "slope estimator" for the average rate of change over the whole test period. Examples of the application of the seasonal Kendall test include analyses of U.S. nationwide stream-sampling data, Swedish and Latvian river water quality data, estuarine data sets, and long-term trends in Pamlico River estuary nutrients for watershed nutrient production.

If a *post hoc* or *ad hoc* test is warranted, then it will be done based on current accepted *post hoc* statistical test procedures. Nonparametric summaries will be performed on all metrics. The IDEQ and the TAC will review and make suggestions on all statistical analysis of the data.

Species composition and functional attributes will be summarized and comparisons made to expected conditions or upstream reference site(s). Salmonids size classes and biomass will be evaluated to determine attainment of salmonid spawning and to assess the quality of the sport-fishery at each site.

All data will be considered for STORET databasing by the TAC, or an appropriate database system that allows for retrieval of the data for future use. Initially, the reporting laboratory will provide the preliminary electronic database for readily available access.

An annual progress review will be instituted and prepared by the TAC. As part of that review, the TAC will review other monitoring that supports the trend monitoring plan but is independent of the plan. Other monitoring may include data from point source industries, nonpoint source industries, agencies, and organizations that specifically monitor the Middle Snake River.

As part of the statistical analysis, the TAC will provide some direction on conclusions to be drawn from the trend monitoring. Such interpretive analysis shall be based on relative changes that may occur in the river system from year-to-year. The trend monitoring plan does not proport to demonstrate cause and effect relationships. Rather, it is designed to quantitatively measure changes over time.

V. CONCLUSION

The proposed trend monitoring plan for the Middle Snake River is but one component in assessing if its beneficial uses have attained state water quality standards. It is important to understand that this plan has its limits. Although some parameters (such as total phosphorus and total suspended solids) have extensive databases since 1990, other parameters (such as plant species composition, macroinvertebrates) have received less attention and thus are less definable. Additonally, normal variation within any parameter is difficult to estimate unless extensive data is collected. Thus, the plan calls for minimal trend monitoring (on a monthly basis) of three selected sites for water chemistry parameters, and a special, more intensive survey (every three years) of the three near-the-selected sites for biological species (inclusive of habitat, fisheries, macrophytes, macroinvertebrates, and phytoplankton). Additional monitoring being done by various agencies and organizations on the Middle Snake River, as well as point source effluent monitoring, will be used to assess the river for a fuller understanding of its nutrient processing, ecosystem metabolism, organic carbon dynamics, and other processes to determine if its beneficial uses have been met. And, if resources become available to IDEQ-TFRO additional sites (inclusive of the tributaries) will be considered.

VI. SOURCES

All sources and references are included in §2.60 of the Upper Snake Rock Subbasin Assessment.

COROLLARY 1. QUALITY CONTROL AND QUALITY ASSURANCE

As part of a QA/QC system, quality improvement objectives may include the following:

- To demonstrate that the quality control operations are, in fact, being carried out both in the field and in the laboratory, and maintain a continuing assessment of the accuracy and precision of data generated by analysts within the laboratory group.
- To assure the accountability and traceability of field samples, their transport to the laboratory, their testing and reporting within the laboratory, and to help ensure that the analytical work will withstand legal security.
- To identify any weakness and problems in the field and in the laboratory and provide immediate preventive and corrective actions.
- To detect training needs and concerns within the whole system when they are warranted.

The *Idaho Bureau of Laboratories'* Policy Statement Number 1-91 (Appendix A) states: "there shall be sufficient QA activities conducted to ensure that all data generated and processed will be scientifically valid." As part of this policy, it is assumed that QA will include a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and defensible quality. Thus, as a consequence of this QA the accuracy of the analytical result can be stated with a high level of confidence. Included in QA are two critical components: QC (or internal QC) and quality assessment (or external QC).

The testing laboratory shall have a QC program which shall include at a minimum the following: certification of operator/analyst competence, recovery of known additions, analysis of externally supplied standards, analysis of reagent blanks, calibration with standards, analysis of duplicates, and control charts. *Standard Methods*, 19th Edition 1995, §1020 B is referenced for further consideration.

The testing laboratory will have a quality assessment program which will use external and internal quality control measures to determine the quality of the data produced by the laboratory. It will include at a minimum the following: performance evaluation samples, performance audits, and laboratory intercomparison samples. *Standard Methods*, 19th Edition 1995, §1020 C is referenced for further consideration.

The following specifies the minimum criteria for sampling and laboratory analysis within the confines of this trend monitoring plan:

1. SPECIMEN/SAMPLE CUSTODY

The testing laboratory will have a specimen/sample custody process that will provide a clear description of specimen/sample (and container) traceability from the point of origin through final specimen/sample disposition. It will also identify all responsible persons involved in the laboratory procedures and a brief description of their duties with respect to specimen/sample custody. Documentation will be provided and maintained by the laboratory to establish legal chain of custody and will include: specimen/sample transmittal/submission forms, laboratory specimen/sample logs, specimen/sample preparation and analysis logs, specimen/sample storage logs, and specimen/sample disposition logs.

2. LABORATORY CUSTODY

The testing laboratory will provide laboratory custody and will include the following:

a. SPECIMEN/SAMPLE RECEIPT

This describes the activities involved with initial specimen/sample receipt and includes: specimen/sample acceptability; verification of specimen/sample integrity through correct identification

of submitted specimen/sample, requisition form, fixation, promptness of delivery to the laboratory, and specimen/sample preservation; and, complete specimen/sample documentation and identification.

b. SPECIMEN/SAMPLE LOG IN
This describes how specimens/samples are logged, the information that is entered in a specimen/sample log book, and how samples are identified. At a minimum, specimen/sample logs must include the following: date of receipt in lab, specimen/sample collection date, lab identification number, field identification number, requested analyses, and initials of logger.

c. SPECIMEN/SAMPLE STORAGE AND SECURITY
This describes specimen/sample storage, accessibility, and supporting documentation. It should include discussions of security for sample digestates and extracts.

d. SPECIMEN/SAMPLE DISTRIBUTION AND TRACKING
This describes the procedures used to identify incoming samples, work assignments, and how the samples are tracked through sample preparation and sample analysis.

e. SPECIMEN/SAMPLE DISPOSITION
This describes how specimen/sample disposition is documented.

f. OTHER LABORATORIES
This describes the procedures used to transport samples and/or sample extracts to another laboratory. It includes a discussion of documentation, and the information that is transmitted with the sample(s).

3. ANALYTICAL PROCEDURES
The testing laboratory will be an EPA certified laboratory with approved EPA procedures that are documented in the Code of Federal Regulations (CFR). Not all procedures, however, are EPA certified, but may be adopted by EPA as "alternative methods." Therefore, as a minimum, the following requirements should embrace all analytical procedures by the testing laboratory:

a. All procedures should be based on EPA approved procedures. The procedures should be identified by component name, EPA method number, and source.

b. Where a procedure is not found in an EPA approved procedures source but may be considered as an alternative method, or where an EPA procedure is modified, documentation of the alternative method or of the modified EPA procedure will be referenced accordingly.

c. Laboratory glassware including cleaning procedures (appropriate detergents, rinses with tap water and lab grade water, and acid or solvent rinses/soaks) and storage operating procedures will be referenced accordingly.

d. Reagent storage (for all reagents and chemicals other than standards) and their documentation will be referenced accordingly.

4. MAINTENANCE LOG OF PRINCIPAL EQUIPMENT
The testing laboratory will maintain a list of principal equipment and instrument (including manufacturer's name and model number) and the name of the person designated to maintain them. As part of this maintenance log, the following will be included:

a. STANDARD RECEIPT
This will include the standard operating procedures on how the standards are received, stored, logged, and documented for the internal laboratory use, and how records of manufacturer's certification and traceability statements are maintained.

b. STANDARD SOURCES AND PREPARATION
This will include procedures used to prepare working standards and the internal documentation that traces internal working standards to primary standards or purchased stocks. Additionally, this will also include standard sources and preparation protocols including instrument group, source of primary standards and traceability of sources, frequency of standard preparation, and how the primary and working standards are stored.

c. STANDARD OPERATING PROCEDURES FOR EQUIPMENT CALIBRATION
This will include the specific calibration procedures for each instrument group with a list of the minimum or routine calibration procedures. This includes: instrument group or analysis type; initial calibration requirements such as the number of standards used for calibration, the frequency of initial calibration, how a calibration curve is generated (linear or logarithmic), and what criteria is used for acceptance or rejection; QC checks standards used for initial calibration and acceptance or rejection criteria; continuing calibration standards such as the number of standards used, the frequency of use, the concentration range, and the criteria for acceptance and rejection; and, equipment monitoring/calibration activities such as balances for accuracy checks, ovens for temperature monitoring, refrigerators for temperature monitoring, and incubators for temperature monitoring.

d. STANDARDIZATION OF TITRATION SOLUTION
This will include the information pertaining to standardization of titrating solutions, including solution(s) that require standardization, the source of the primary standards used for standardization, and the frequency of standardization.

5. LABORATORY QUALITY CONTROL CHECKS
The testing laboratory will follow the minimum quality control specified by each method. If no quality control requirements are listed in the method, the laboratory will follow its internal requirements with a description of the details of those internal requirements. Additional QC checks will be included, if specified by the approved method, and may be reagent purity checks, internal standards, and surrogate spikes.

6. DATA PROCEDURES AND RESULT REPORTING
The laboratory will list its method detection limits, accuracy, precision targets for different equipment and analytical procedures. Additionally, there will be a description of how to assess precision and accuracy within the laboratory, how data integrity can be assured, how raw data are reduced to reportable values (including notebook, worksheet or spreadsheet used to calculate values and the formulas), the types of forms and records that are routinely printed for verification and signatures, how data entry into computer and paper records (by identified person), and how data are transferred.

DOCUMENT SOURCE: Principle writer Dr. Balthasar B. Buhidar, Ph.D., DEQ-TFRO, October 15, 1997. Additional comments incorporated from the Mid-Snake TAC representing water user industries, organizations, and agencies, and the Mid-Snake WAG through public comment from October 15, 1997 to November 15, 1997. Previous to October 15, the TAC had met and preliminarily began developing a plan for the Mid-Snake River. The plan was incorporated into the Upper Snake Rock Subbasin Assessment. Final plan was presented to Mid-Snake WAG on _____ for approval.

TAIL SPILLS, WATER QUALITY PONDS, AND BEST MANAGEMENT PRACTICES OF THE TWIN FALLS AND NORTH SIDE CANAL COMPANIES

TWIN FALLS CANAL COMPANY TAIL SPILLS.

[Source: Stan Haye III, Field Supervisor, Twin Falls Canal Company, P.O. Box 326, Twin Falls, Idaho 83303]

1. ROCK CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Rock Creek	4450N 2600E Twin Falls	Rock Creek spills into the Middle Snake River.
High Line Canal	3010N 3825E Hansen	High Line Canal goes over Rock Creek.
McMullen Creek	2950N 3460E Kimberly	McMullen Creek spills into both the High Line Canal and Rock Creek. This water enters the High Line Canal, flows downstream to 3350E 2975N Twin Falls, where it is diverted into Cottonwood Creek. This water is also supplemented from seeps and water from Coyote Creek that drains to the north into Rock Creek.
Cottonwood Creek	3320E 3310N Twin Falls	Cottonwood Creek drains under the High Line Canal which flows northeast into Rock Creek at 3110N 3450E Kimberly.
Low Line Canal siphon	3360E 3310N Twin Falls	The Low Line Canal crosses Rock Creek through a siphon.
Lateral 30	3310E 3400N Twin Falls	Lateral 30 spills to Rock Creek.
Lateral 31	3550N 3220E Twin Falls	Lateral 31 spills to Rock Creek.
Lateral 7A	3650N 3165E Twin Falls	Lateral 7A spills to Rock Creek.
Lateral 32		This lateral does not spill into Rock Creek.
Lateral 7	3670N 3130E	Spills into Rock Creek.
Lateral 12	3680N 3050E	This also collects water from Laterals 14, 9, Coulees "H", "I."
Lateral 36EXT	3730N 3030E	Spills into Rock Creek.
Lateral 36B	3010E 3760N Twin Falls	Spills into Rock Creek.
"K" Coulee	3880N 2820E Twin Falls	There are a number of seeps that supplement this coulee.
"L" Coulee	3910N 2780E	There are many seeps along this drain.
"OI" Coulee	3925N 2765E Twin Falls	Seep streams are the main source on this drain.
"PI" Coulee	4020N 2660E	This return flow is a natural draw.
"P" Coulee	4030N 2640E	Flows both return and seep & spills to Rock Creek.
Lateral 38	4070N 2650E	Lateral 38 is a waste water return & spills to Rock Creek.
"P2" Coulee	4080N 2630E	A seep flow with some return flows discharges to Rock Creek.
"Q2" Coulee	4270N 2600E	A return flow with Lateral 30 meeting on Rock Creek.
Lateral 30	4270N 2600E	A return flow with "Q2" Coulee meeting on Rock Creek.

2. CEDAR DRAW TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Cedar Draw	1920E 4550N	Cedar Draw spills into the Middle Snake River. Its return spill is from farmland.
Lateral 42	2120E 4010N	Waste water with some live water returns.
"E" Coulee	4200N 2050E	Seep water and waste water returns.
Lateral 11A	4275N 2030E	Mostly waste water. A little live water.
"F" Coulee	4360N 1960E	Mostly waste water returns with some live water.
"I 10" Coulee	1950E 4460N	Majority is waste water returns with some live water.

3. DEEP CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
High Line Canal	3150N 960E	High Line Canal spills into the upper end of Deep Creek, south of Castleford. Live water flows and numerous waste water returns. It feeds Laterals 1, 2, 4, 5, 7, 9, and 10..
Low Line Canal	3920N 1070E	Low Line Canal spills into Deep Creek. Waste water is from farmland.
Lateral 1		Dissipates over pastum ground at 3700N 600E.
Lateral 2		Becomes Lateral 3 west of Castleford. Enters Salmon Falls Creek.
Lateral 76	3300N 975E	Some live water, little waste water.
Lateral 75	3340N 950E	Made up of little live water, some waste water.
Lateral 73	3500N 940E	Some live water and some waste water.
"I" Coulee	940E 3540N	This is primarily a waste water return from farm ground. Farmers use up most of returns.
Lateral 69C	1000E 3620N	Some live water with little waste water.
Lateral 69 becomes "S 1" Coulee	1050E 3610N	"S 1" enters Deep Creek. Mostly waste water and some live water returns.
Laterals 65 & 65B, "R" and "S" Coulees	1090E 3680N	Enter Deep Creek above the head of Lateral 7. Mostly waste water returns.
Lateral 7 becomes Lateral 7A	3900N 1060E	Lateral 7 located at 1090E 3680N. Is mostly supplied by upper waste water returns. Enters Deep Creek as Lateral 7A and continues as Lateral 6 towards Salmon Falls Creek.
Lateral 61	3700N 1090E	Made up of some waste water returns with little live water.

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Lateral 63	3800N 1090E	Made up of some waste water returns and little live water.
"Hp" Coulee	3850N 1080E	Mostly made up of seep water exiting some fish ponds & waste water returns.
"Lp" Coulee	3925N 1060E	This is the tail end of the Low Line Canal. Primarily made up of live water to make deliveries to Laterals 9 and 10.
Lateral 9A	4050N 1030E	
Lateral 57 A1	1030E 4050N	Some waste water and little live water.
Lateral 9C	4280N 1030E	Runs mainly over pasture ground on the tail end.
Lateral 60A	4200N 1020E	Some waste water and little live water.
Lateral 10B	4410N 1040E	Mostly waste water and some live water.
"N2" Coulee		This is the lower half of 44A. Water sometimes enters Deep Creek when not used up by pasture ground.

4. MUD CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
"N" Coulee	1350E 4040N	Made up of mostly waste water. Can supplement from Low Line Canal.
Lateral 41	4040N 1350E	Mostly waste water with a little live water.
"O" Coulee	4110N 1240E	Made up mostly of seep flows and some waste returns.
Lateral 44	1110E 4460N	Turns into "N1" Coulee. Mostly waste water with little live water.
Lateral 40B	4190N 1105E	Runs mainly over pastum ground then into Mud Creek.
Lateral 40A	4205N 1105E	Runs mainly over pastum ground before entering Mud Creek.
"L" Coulee		Becomes Laterals 40, 40A, 40B.
"K" Coulee	4330N 1240E	Made up of seep flow and waste water.
"J" Coulee	1300E 4425N	Made up of seep flows and waste water.
"I 1" Coulee	4330N 1310E	Made mostly of seep water, some live water, & waste water returns.
"N 1" Coulee		This is the lower half of Mud Creek. This catches a lot of waste water drainages.

5. SALMON FALLS CREEK TAIL SPILLS

NAME OF CONVEYANCE	TAIL SPILL LOCATION	COMMENTS
Lateral 1		*Dissipates over pastum ground at 3700N 600E. Any return flows would enter Salmon Falls Creek.*
Lateral 3		*From Lateral 2 being fed by High Line Canal. It enters Salmon Falls Creek.*
Lateral 4	*690E 3950N*	*Some live water with lots of waste water.*
Lateral 5	*850E 4080N*	*This is a mix of live water and waste water.*
Lateral 7 becomes Lateral 7A and then becomes Lateral 6	*3900N 1060E Deep Creek* *840E 4080N Salmon Falls*	*Lateral 7 located at 1090E 3680N. Is mostly supplied by upper waste water returns. Enters Deep Creek as Lateral 7A and continues as Lateral 6 towards Salmon Falls Creek where it finally discharges.. Made up of waste water returns.*
Lateral 9		*Rarely enters Salmon Falls Creek since all the water is dispersed across pasture ground.*
Lateral 10	*4600N 790E*	*Mostly live water when a spill is present.*

TWIN FALLS CANAL COMPANY WATER QUALITY PONDS.
[Source: Stan Haye III, Field Supervisor, Twin Falls Canal Company, P.O. Box 326, Twin Falls, Idaho 83303]

NUMBER	*NAME*	*YEAR*	*ACRES INVOLVED*
1	Oregon Trail	1993	0.5, Lateral 31
2	Ballard	1993	0.25, Lateral 33
3	Norris #1 Pond	1993	1.50, Laterals 35/34 TFC
4	Summer Camp	1995	0.25, Perrine
5	Summer Camp	1995	0.25, Perrine
6	Spear Ponds	1994	0.5, Main
7	Spear Ponds	1994	0.5, Main
8	KIEM Ponds	1994	0.5, Perrine 3, Lateral 49
9	KIEM Ponds	1995	0.75, Perrine 3, Lateral 49
10	College of Southern Idaho Ponds	1993	1.0, Main Perrine
11	University of Idaho	1993	0.5, TFC
12	Walt Jones	1995	1.0, 2LL/Lateral 8
13		1995	0.15
14	Filer Polnds	1995	S Coulee
15	Blass	1995	S-2 Coulee
16	Steward's	1996	

NUMBER	NAME	YEAR	ACRES INVOLVED
17	Steward's	1996	
18	Smutny	1996	Took over Lateral 4, E Coulee
19	Norris Pond 2	1996	TFC 3 + PR1
20	Ballard Pond 2	1993	TFC
21	K-2 Ponds	1996	1.5, K-2
22	Cedar Draw	1995	5.5
23	Sharp Ponds	1994	0.25, Laterals 30A & Q-2
24	McDonards Ponds	1994	0.5
25	Armatage	1995	0.25, Lateral 30
26	Fleming	1994	I 10
27	Van Winkle	1996	1.5, K-2
28	Kincade	1996	0.25, Next to Salmon Falls
29	N-Coulee	1996	0.25
30	Lateral 78	1996	0.16
31	I 3 Coulee	1996	0.25
32	Blass/Holms Drain	1996	0.25
33	N Coulee	1996	
34	Kueny	1996	3.0
35	T Coulee		
36	Summer Camp Ponds	1997	5.0
37	Dickerson	97	1.2

NORTH SIDE CANAL COMPANY BEST MANAGEMENT PRACTICES (1982-1997).
[Source: Dennis Heaps, Assistant Manager, North Side Canal Company Ltd., 921 North Lincoln, Jerome, Idaho 83338]

LATERAL	FACILITY	SIZE
A Drain	*2 ponds*	*1 acre/3 acres*
C-50	*2 ponds*	*1 acre each*
C-55	*1 pond*	*2 acres*
C-33	*3 ponds*	*1 acre each*
K-Coulee	*4 ponds*	*1-3 acres in size*

LATERAL	FACILITY	SIZE
N-34	1 pond	0.5 acres
J-8	Wetland	40 acres total (under construction)
S-42	1 pond	2 acres
S-Coulee	1 pond	2 acres
S-19	1 pond	4 acres
W-28	Wetland	Nature Conservancy
W-26	Pond-wetland	20 acres estimated (under construction)
W-46	1 pond	3 acres
W	2 ponds	2 acres each
X-15	1 pond	3 acres

RIVER MILE INDEX OF THE MIDDLE SNAKE RIVER.

RIGHT BANK IS THE BANK ON THE RIGHT LOOKING UPSTREAM, WHEREAS TH E LEFT BANK IS THE BANK ON THE LEFT LOOKING UPSTREAM. PREPARED BY BALTHASAR B. BUHIDAR, IDEQ-TFRO.

U = Unconnected stream to the Middle Snake River. C = Confluence to the Middle Snake River.

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
544.89		King Hill Creek (C)	2517	Pasadena Valley, Idaho
545.00			2475	
546.00		King Hill, Idaho	2500	King Hill, Idaho
546.60			2500	
547.00			2500	
547.58		Clover Creek (C)	2533	Pasadena Valley, Idaho
548.00			2525	
549.00			2525	
550.00			2525	
551.00			2525	
552.00			2525	
552.82		Bancroft Springs (3)	2525	
553.00			2525	
554.00			2550	
554.85	Unnamed stream		2550	
555.00			2550	
555.29	Deer Gulch (C)		2550	
556.00			2550	
556.56	Big Pilgrim Gulch (C)		2575	
556.69	Little Pilgrim Gulch (C)		2575	
557.00			2575	Ticeska, Idaho
558.00			2575	
559.00			2615	
559.92	Bliss Dam		2655	
560.93	Cassia Gulch (C)		2665	
560.00			2675	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
561.11			2675	
562.00			2675	
562.08	Tuana Gulch (C)		2675	
563.00			2675	
564.00	Unaccounted River Mile on Map		2675	
564.00	Unaccounted River Mile on Map		2675	
565.00	Aqueduct King Hill Canal		2675	
565.75	Shoestring Road Bridge ("Bliss Grade")		2675	
565.85		Spring (1)	2675	
566.00			2675	
566.33		Unnamed stream (1 Spg)	2675	
567.00			2675	
567.25		Unnamed stream (1 Spg)	2680	Bliss, Idaho
567.73		Unnamed stream (1 Spg)	2690	
568.00			2700	
568.05		Unnamed stream (1 Spg)	2707	
568.51	Unnamed stream		2714	
568.58		Unnamed stream	2421	
568.72	Unnamed stream		2728	
569.00			2735	
569.80		Unnamed stream (1 Spg)	2742	
570.00			2749	
570.04		Unnamed stream (1 Spg)	2756	
570.46	Unnamed stream (U)		2763	Hagerman, Idaho

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
570.71		Unnamed stream	2766	
571.00			2770	
571.19	Unnamed stream	Power Plant Bypass	2773	
571.42		Malad River Gorge (C)	2776	
572.00			2780	
572.28		Birch Creek (C)	2787	
572.41		Unnamed stream	2794	
572.96	Lower Salmon Falls Power Plant		2801	
573.00			2806	
573.34	Unnamed stream	Unnamed stream	2805	
573.76		Billingsley Creek (C)	2803	
573.97		Unnamed stream	2802	
574.00			2800	
574.27		Unnamed stream (ditch?)	2800	
574.53	Unnamed stream		2800	
575.00			2800	
575.16	Aqueduct	Sands Ditch	2800	
575.41	Fossil Gulch (C)		2800	
575.57	Unnamed stream		2800	
575.83	Unnamed stream	Unnamed stream (ditch?)	2800	
576.00			2800	
576.39	Unnamed stream		2800	
576.72		Unnamed stream (ditch?)	2800	
577.00			2800	
577.16	Unnamed stream	Bell Ditch	2800	
577.97	Unnamed stream		2800	
578.00			2800	
578.03	Unnamed stream (Peters Gulch)		2800	
578.99	Unnamed stream		2800	

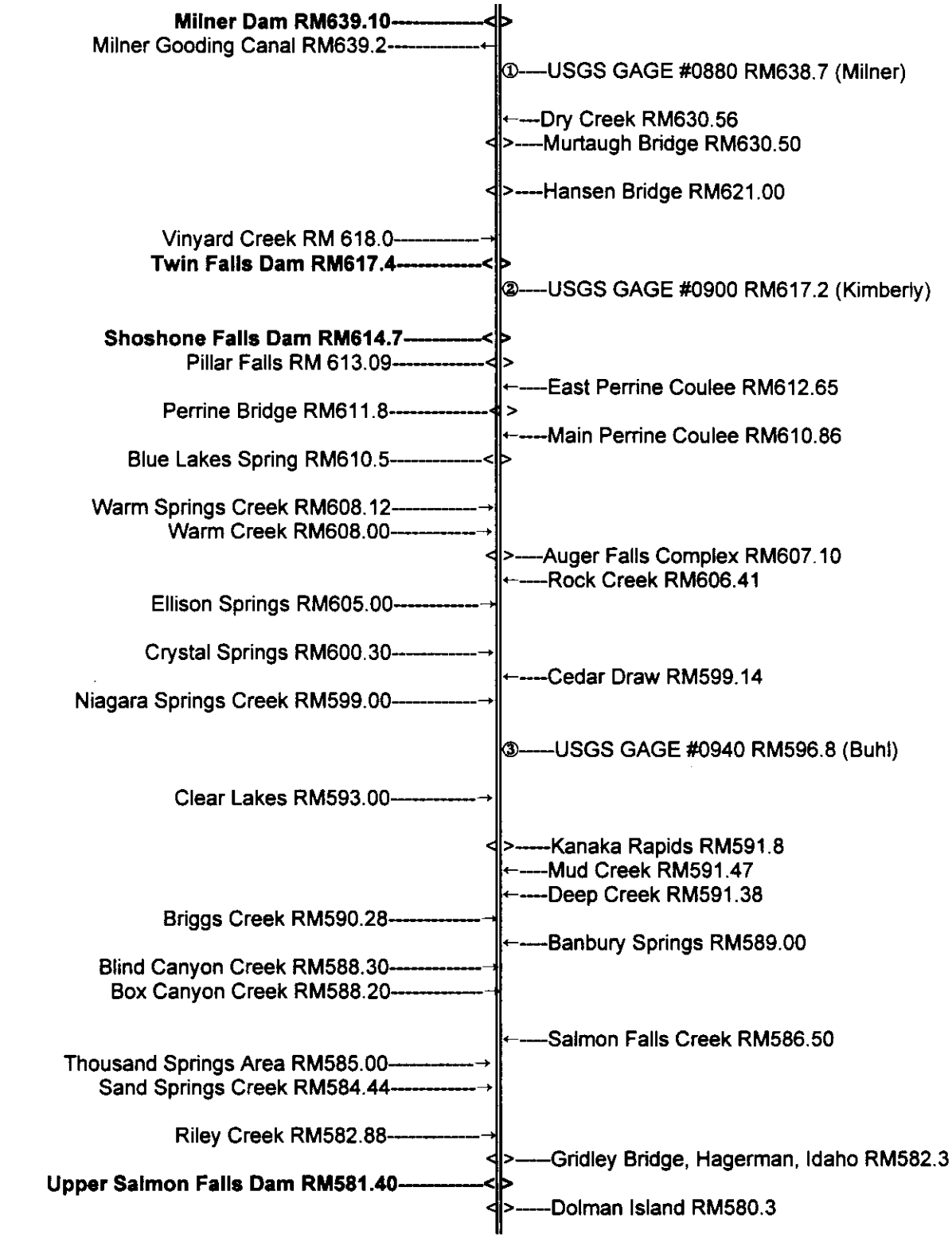
CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
579.00			2800	
579.52	Upper Salmon Falls Power Plant		2813	
580.00			2825	
580.12		Buckeye Ditch	2837	
581.00			2850	
581.40	Upper Salmon Falls Dam		2888	
581.72	Owsley Bridge		2890	
582.00			2890	
582.48	Unnamed stream	Spring (1)	2916	
582.88		Riley Creek (C)	2942	
583.00			2970	Tuttle, Idaho
583.71		Unnamed stream	2942	
583.85		Thousand Springs (12 spg)	2916	
584.00			2890	
584.09	Unnamed stream (U)	Thousand Springs (1 spg)	2908	
584.38		Thousand Springs (15 spg)	2926	
584.44		Sand Springs Crk (7 spg)	2944	
584.82		Unnamed stream	2962	
584.87		Unnamed stream (6 spg)	2980	
585.00			3000	
585.30	Unnamed stream (U)		2998	Thousand Springs, Idaho
585.58	Unnamed stream (U)		2995	
585.90		Unnamed stream (1 spg)	2992	
586.00			2990	
586.12	Unnamed stream (U)		2956	
586.18	Salmon Falls Creek (C)		2923	
587.00			2890	
587.21		Unnamed stream	2890	

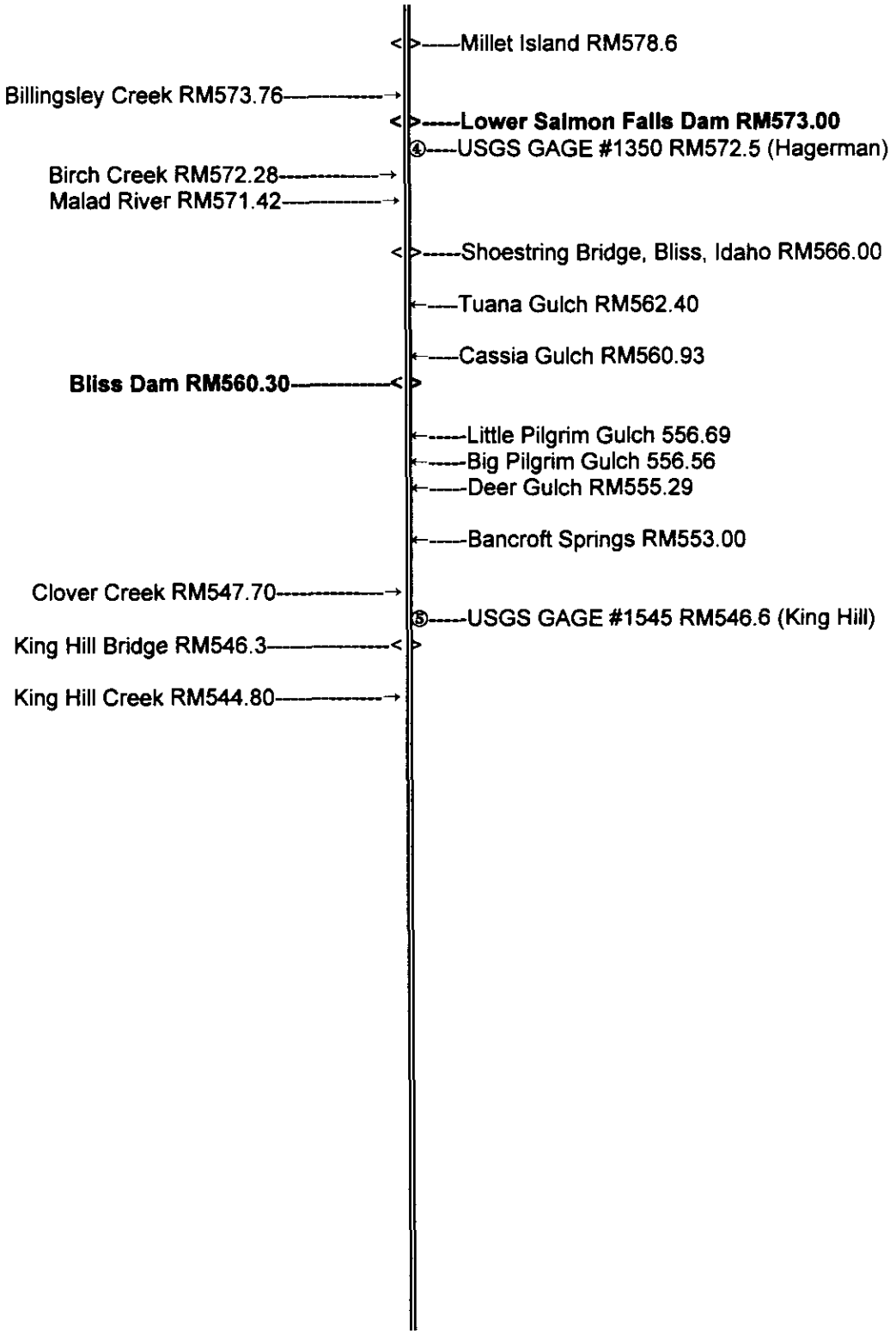
CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
587.50		Blue "Heart" Springs (3 spg)	2890	
587.76		Box Canyon Creek (C)	2890	
588.00			2890	
588.06		Blind Canyon Creek (C)	2890	
588.48		Unnamed stream (2 spg)	2890	
588.85		Banbury Springs (19 spg)	2890	
589.00			2890	
589.48	Unnamed stream		2895	
590.00			2900	
590.28		Briggs Creek (C; 5 spg)	2900	
590.33	Unnamed stream		2900	
590.82	Unnamed stream		2900	
591.00			2900	
591.38	Deep Creek (C)		2900	
591.47	Mud Creek (C)		2900	
592.00			2950	
593.00		Clear Lakes (24 spg)	2970	
594.00			2970	
595.00			2950	
595.04	Unnamed stream		2955	
596.00			2960	
596.43	Unnamed stream (U)		2965	
597.00			2970	
597.66	Spring (1 spg)		2975	
598.00			2980	
598.09	Unnamed stream		2980	Niagara Springs, Idaho
598.30	Spring (1 spg)		2980	
599.00		Niagara Springs Creek (C; 5 spg)	2980	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
609.42	Springs (11 spg)		3125	
610.00			3130	
610.86	Perrine Coulee Falls (C)		3130	
611.00			3130	
611.10	Springs (11 spg)		3130	Twin Falls, Idaho
611.53		Unnamed stream	3130	
611.57	Springs (6 spg)		3130	
612.00	Springs (5 spg)		3130	
612.50	Springs (1 spg)		3130	
612.60	Unnamed stream		3130	
612.63	Springs (1 spg)		3130	
612.65	East Perrine Coulee (C)		3130	
613.00			3130	
613.09	Pillar Falls		3137	
613.37	Springs (4 spg)		3144	
613.67	Springs (4 spg)		3151	
614.00	Springs (3 spg)		3160	
614.87		Springs (2 spg)	3248	
615.00			3355	
615.66	Springs (2 spg)		3358	
616.00		Unnamed stream (2 spg)	3360	
616.78		Unnamed stream (5 spg)	3363	
616.90	Spring (1 spg)		3367	
617.00			3370	
617.12	Unnamed stream		3395	
617.37	Unnamed stream (braided)		3420	
617.54	Springs (6 spg)		3445	
617.86	Springs (4 spg)		3470	
617.97		Unnamed stream	3495	Kimberly, Idaho

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
618.00			3520	
619.00			3520	
619.21	Springs (3 spg)		3527	
619.53	Unnamed stream	Springs (3 spg)	3534	
620.00			3540	
620.17	Springs (3 spg)		3552	
620.75	Springs (3 spg)		3564	
620.88	Spring (1 spg)		3576	
621.00			3590	
622.00			3610	
622.10	Spring (1 spg)		3616	
622.15		Spring (1 spg)	3622	
623.00			3630	
623.05	Unnamed stream		3642	
623.12	Spring (1 spg)		3654	
623.39	Spring (1 spg)		3666	
623.75	Spring (1 spg)		3678	Eden, Idaho
624.00			3690	
624.45	Unnamed stream		3700	
625.00			3710	
626.00			3720	
627.00			3780	
627.30		Unnamed stream (U)	3785	
627.65		Unnamed stream (U)	3790	
627.89	Springs (2 spg)		3795	
628.00			3800	
628.29	Unnamed stream (U)		3820	
629.00			3840	
630.00			3840	

CARTOGRAPHIC RIVER MILE (RM)	RIGHT BANK ("South or West Side")	LEFT BANK ("North or East Side")	ELEVATION feet	QUADRANGLE MAP 1:24,000
630.49	Spring (1 spg)		3850	Murtaugh, Idaho
630.56	Dry Creek (C)		3860	
631.00			3870	
632.00			3900	Milner Butte, Idaho
632.75	Unnamed stream	Unnamed stream	3905	Milner, Idaho
633.00			3910	
634.00			3920	
635.00			3930	
635.67		Unnamed stream	3933	
636.00			3935	
637.00			3940	
638.00			4080	
638.53	Milner Dam		4134	


Milner Dam RM639.10
Milner Gooding Canal RM639.2
①---USGS GAGE #0880 RM638.7 (Milner)
---Dry Creek RM630.56
---Murtaugh Bridge RM630.50
---Hansen Bridge RM621.00
Vinyard Creek RM 618.0
Twin Falls Dam RM617.4
②---USGS GAGE #0900 RM617.2 (Kimberly)
Shoshone Falls Dam RM614.7
Pillar Falls RM 613.09
---East Perrine Coulee RM612.65
Perrine Bridge RM611.8
---Main Perrine Coulee RM610.86
Blue Lakes Spring RM610.5
Warm Springs Creek RM608.12
Warm Creek RM608.00
---Auger Falls Complex RM607.10
---Rock Creek RM606.41
Ellison Springs RM605.00
Crystal Springs RM600.30
---Cedar Draw RM599.14
Niagara Springs Creek RM599.00
③---USGS GAGE #0940 RM596.8 (Buhl)
Clear Lakes RM593.00
---Kanaka Rapids RM591.8
---Mud Creek RM591.47
---Deep Creek RM591.38
Briggs Creek RM590.28
---Banbury Springs RM589.00
Blind Canyon Creek RM588.30
Box Canyon Creek RM588.20
---Salmon Falls Creek RM586.50
Thousand Springs Area RM585.00
Sand Springs Creek RM584.44
Riley Creek RM582.88
---Gridley Bridge, Hagerman, Idaho RM582.3
Upper Salmon Falls Dam RM581.40
---Dolman Island RM580.3


Millet Island RM578.6
Billingsley Creek RM573.76
Lower Salmon Falls Dam RM573.00
④---USGS GAGE #1350 RM572.5 (Hagerman)
Birch Creek RM572.28
Malad River RM571.42
Shoestring Bridge, Bliss, Idaho RM566.00
Tuana Gulch RM562.40
Cassia Gulch RM560.93
Bliss Dam RM560.30
Little Pilgrim Gulch 556.69
Big Pilgrim Gulch 556.56
Deer Gulch RM555.29
Bancroft Springs RM553.00
Clover Creek RM547.70
⑤-----USGS GAGE #1545 RM546.6 (King Hill)
King Hill Bridge RM546.3
King Hill Creek RM544.80

2.10 MIDDLE SNAKE RIVER AND TRIBUTARY DATABASE (APPENDIX D)

A. WATER QUALITY PARAMETERS PER TRIBUTARY

Overall annual water quality parameters per major tributary are summarized in Table 1 for minimum, mean, maximum, and median values. This provides an overall summary of the water quality of the indicated tributary. Additionally, the irrigated season (from April 15 to October 15) versus the non-irrigated season (from October 16 to April 14) is compared as well. As there is an obvious risk that data might not have been following a normal distribution, the median values are reported to reduce the influence of outliers if the data are non-normally distributed (Oberg & Gron 1988).

TABLE 1 MINIMUM, MEAN, MAXIMUM, AND MEDIAN WATER QUALITY VALUES PER INDICATED TRIBUTARY AS A FUNCTION OF THE OVERALL ANNUAL DATASET AND THE IRRIGATED VERSUS THE NON-IRRIGATED SEASON.

PARAMETER	MINIMUM	MEAN	MAXIMUM	MEDIAN	N
EAST PERRINE COULEE: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	2.80/5.30/2.80	29.27/33.88/17.92	91.15/91.15/41.59	28.65/31.80/16.40	225/160/65
Temperature, C	4.50/7.12/4.50	13.29/14.74/9.71	21.50/21.50/13.36	13.10/15.00/9.66	225/160/65
DO, mg/L	5.90/5.90/7.60	8.82/8.71/9.08	12.25/12.25/11.98	8.75/8.66/8.88	225/160/65
pH	6.45/6.84/6.45	7.96/8.01/7.82	8.80/8.80/8.40	7.96/8.01/7.80	225/160/65
Turbidity, NTU	0.1/7.8/0.1	77.2/96.1/30.7	436.9/436.9/106.3	52.8/52.8/28.4	225/160/65
Fecal Coliform	5/5/5	731/970/143	34600/34600/600	300/400/96	225/160/65
Fecal Streptococci	5/10/5	1934/2481/586	31800/31800/5500	900/1350/240	225/160/65
TSS, mg/L	2.0/6.0/2.0	116.9/137.5/66.4	735.0/735.0/260.0	79.0/115.5/46.0	225/160/65
NH3, mg/L	0.003/0.003/0.026	0.076/0.059/0.117	0.384/0.340/0.384	0.060/0.049/0.087	225/160/65
NOX, mg/L	0.453/0.453/1.200	2.466/1.743/4.245	5.470/4.900/5.470	1.950/1.645/4.640	225/160/65
TKN, mg/L	0.20/0.22/0.20	0.71/0.75/0.62	2.38/2.38/1.10	0.66/0.69/0.60	225/160/65
TP, mg/L	0.025/0.059/0.025	0.245/0.288/0.139	1.400/1.400/0.300	0.210/0.240/0.123	225/160/65
SRP, mg/L	0.010/0.013/0.010	0.075/0.084/0.052	0.360/0.360/0.160	0.060/0.065/0.044	225/160/65
ROCK CREEK: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	68.71/75.67/68.71	219.91/244.81/167.71	480.93/480.93/345.74	225.00/246.00/154.91	288/195/93
Temperature, C	3.14/5.93/3.14	12.07/13.85/8.33	18.50/18.50/13.40	12.70/14.00/8.04	288/195/93
DO, mg/L	6.64/6.64/8.51	9.54/9.16/10.33	14.30/14.30/12.42	9.40/9.00/10.30	288/195/93
pH	6.98/6.98/7.77	8.22/8.18/8.29	9.74/8.82/9.74	8.23/8.20/8.28	288/195/93
Turbidity, NTU	1.0/6.0/1.0	38.9/47.6/20.7	412.2/412.0/137.0	26.0/32.0/17.0	288/195/93
Fecal Coliform	5/10/5	495/609/254	9800/8800/9800	295/430/60	246/167/79
Fecal Streptococci	5/30/5	16243/1351/47725	3742300/28600/ 3742300	605/810/220	246/167/79

PARAMETER	MINIMUM	MEAN	MAXIMUM	MEDIAN	N
TSS, mg/L	2.0/7.5/2.p	66.4/83.0/31.6	796.0/796.0/249.0	43.0/62.0/23.0	288/195/93
NH3, mg/L	0.001/0.001/0.009	0.056/0.049/0.071	0.590/0.590/0.326	0.050/0.040/0.060	288/195/93
NOX, mg/L	0.130/0.130/1.030	2.144/1.808/2.755	3.660/2.770/3.660	2.09/1.920/3.050	288/195/93
TKN, mg/L	0.03/0.05/0.03	0.58/0.60/0.55	1.46/1.27/1.46	0.57/0.59/0.52	288/195/93
TP, mg/L	0.020/0.025/0.020	0.176/0.201/0.123	0.980/0.980/0.660	0.140/0.170/0.109	288/195/93
SRP, mg/L	0.009/0.011/0.009	0.081/0.089/0.065	0.510/0.510/0.390	0.060/0.070/0.050	288/195/93
CEDAR DRAW: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	2.91/17.00/2.91	130.44/148.00/96.81	505.38/505.38/468.02	114.50/132.46/58.00	277/182/95
Temperature, C	2.00/5.65/2.00	12.11/14.65/7.30	22.50/22.50/12.50	12.40/14.98/6.90	275/180/95
DO, mg/L	6.50/6.96/6.50	9.61/9.02/10.75	13.40/12.52/13.40	9.43/8.90/10.70	275/180/95
pH	6.69/7.10/6.69	8.36/8.36/8.38	8.94/8.94/8.90	8.40/8.39/8.42	277/182/95
Turbidity, NTU	0.3/1.0/0.3	57.3/71.3/26.2	295.0/295.0/256.0	46.1/60.8/21.1	225/155/70
Fecal Coliform	2/30/2	664/937/58	13800/13800/400	320/520/40	225/155/70
Fecal Streptococci	5/10/5	2323/3184/417	45700/45700/3600	770/1200/166	225/155/70
TSS, mg/L	0.5/0.5/2.0	81.9/110.7/26.9	800.0/800.0/160.0	56.0/93.5/16.0	277/182/95
NH3, mg/L	0.003/0.003/0.003	0.078/0.074/0.087	0.525/0.391/0.525	0.061./0.060/0.065	277/182/95
NOX, mg/L	0.003/0.003/0.564	2.299/1.584/3.668	5.700/4.060/5.700	1.800/1.540/4.350	277/182/95
TKN, mg/L	0.09/0.09/0.15	0.68/0.73/0.57	1.85/1.85/1.34	0.67/0.68/0.58	277/182/95
TP, mg/L	0.025/0.025/0.025	0.220/0.267/0.128	1.140/1.140/0.920	0.172/0.230/0.118	277/182/95
SRP, mg/L	0.006/0.011/0.006	0.080/0.088/0.067	0.071/0.270/0.200	0.071/0.078/0.068	277/182/95
MUD CREEK: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	29.55/34.00/29.55	102.09/106.69/93.27	295.60/295.60/238.20	95.57/102.14/83.53	277/182/95
Temperature, C	3.87/8.90/3.87	13.06/15.04/9.26	22.20/22.20/15.60	13.40/15.22/9.21	277/182/95
DO, mg/L	7.10/7.10/8.30	9.61/9.25/10.30	13.43/12.80/13.43	9.51/9.15/10.20	277/182/95
pH	7.13/7.13/7.73	8.38/8.38/8.38	8.99/8.99/8.80	8.40/8.40/8.38	277/182/95
Turbidity, NTU	0.1/4.9/0.1	28.4/31.8/21.1	257.0/257.0/69.0	24.3/25.6/20.4	277/205/72
Fecal Coliform	10/20/10	750/1006/198	5400/5400/1500	500/790/120	277/205/72
Fecal Streptococci	20/30/20	2223/258/1609	28000/21000/28000	1000/1300/560	277/205/72
TSS, mg/L	1.0/1.0/4.0	39.8/45.6/28.6	208.0/208.0/108.0	32.0/36.0/24.0	277/182/95
NH3, mg/L	0.003/0.003/0.003	0.092/0.063/0.148	1.020/0.900/1.020	0.056/0.049/0.105	277/182/95
NOX, mg/L	1.190/1.190/1.520	2.787/2.228/3.857	4.920/3.870/4.920	2.400/2.230/4.050	277/182/95

PARAMETER	MINIMUM	MEAN	MAXIMUM	MEDIAN	N
TKN, mg/L	0.05/0.05/0.05	0.64/0.65/0.63	1.24/1.24/1.12	0.65/0.66/0.65	277/182/95
TP, mg/L	0.025/0.063/0.025	0.186/0.205/0.149	0.840/0.840/0.350	0.160/0.174/0.130	277/182/95
SRP, mg/L	0.018/0.018/0.025	0.090/0.094/0.082	0.300/0.300/0.245	0.078/0.080/0.070	277/182/95
DEEP CREEK: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	14.78/14.78/21.74	92.38/100.68/75.87	314.78/280/90/314.78	75.89/90.33/51.40	275/183/92
Temperature, C	3.00/7.20/3.00	12.92/15.21/8.38	21.90/21.90/14.06	13.14/15.41/8.18	275/183/92
DO, mg/L	5.21/5.21/8.30	9.60/9.15/10.50	13.95/12.88/13.95	9.43/9.08/10.42	275/183/92
pH	7.04/7.04/7.81	8.47/8.47/8.46	9.19/9.19/8.90	8.48/8.48/8.49	275/183/92
Turbidity, NTU	0.1/1.1/0.1	34.6/34.3/34.1	373.0/158.0/373.0	22.0/25.9/14.6	224/156/68
Fecal Coliform	4/30/4	305/396/97	2300/2300/1480	210/300/32	224/156/68
Fecal Streptococci	10/10/10	609/725/344	6300/6300/2220	390/530/170	224/156/68
TSS, mg/L	0.5/0.5/0.5	49.6/51.4/46.0	776.0/286.0/776.0	24.0/32.0/12.0	275/183/92
NH3, mg/L	0.003/0.003/0.003	0.042/0.036/0.054	0.450/0.450/0.327	0.030/0.026/0.048	275/183/92
NOX, mg/L	0.220/0.220/0.714	2.747/2.169/3.895	5.550/4.130/5.550	2.430/2.160/4.335	275/183/92
TKN, mg/L	0.06/0.06/0.06	0.63/0.65/0.57	2.95/1.79/2.95	0.62/0.64/0.51	275/183/92
TP, mg/L	0.020/0.025/0.020	0.172/0.188/0.141	1.840/0.700/1.840	0.123/0.153/0.084	275/183/92
SRP, mg/L	0.007/0.009/0.007	0.073/0.081/0.057	0.371/0.371/0.362	0.060/0.065/0.050	275/183/92
SALMON FALLS CREEK: ANNUAL/ IRRIGATED/NON-IRRIGATED					
Q, cfs	35.00/35.00/84.00	146.22/136.37/166.6	363.00/363.00/271.00	145.00/127.50/169.0	270/182/88
Temperature, C	3.80/9.78/3.80	13.86/16.27/8.88	23.50/23.50/15.59	14.50/16.38/8.98	270/182/88
DO, mg/L	6.90/6.90/8.90	10.43/10.28/10.73	15.58/15.58/14.02	10.40/10.10/10.63	270/182/88
pH	6.83/6.83/7.63	8.38/8.40/8.35	9.12/9.12/8.78	8.41/8.43/8.39	270/182/88
Turbidity, NTU	0.1/0.1/0.8	28.2/28.2/28.1	584.0/584.0/143.0	19.7/17.5/23.0	270/182/88
Fecal Coliform	1/10/1	867/184/2278	69000/2200/69000	100/130/36	270/182/88
Fecal Streptococci	4/5/4	563/328/1047	30000/2600/30000	170/200/98	270/182/88
TSS, mg/L	0.1/0.1/0.5	37.1/36.2/38.8	277.0/277.0/161.0	30.0/27.5/35.5	270/182/88
NH3, mg/L	0.003/0.005/0.003	0.038/0.033/0.047	0.258/0.202/0.258	0.030/0.030/0.040	270/182/88
NOX, mg/L	0.498/0.498/1.260	2.597/2.161/3.500	4.580/3.500/4.580	2.360/2.200/3.720	270/182/88
TKN, mg/L	0.06/0.06/0.07	0.45/0.44/0.48	1.66/1.66/1.10	0.41/0.40/0.43	270/182/88
TP, mg/L	0.005/0.005/0.005	0.110/0.119/0.092	1.230/1.230/0.700	0.085/0.090/0.070	270/182/88
SRP, mg/L	0.003/0.003/0.005	0.052/0.057/0.041	0.300/0.280/0.300	0.040/0.040/0.034	270/182/88

PARAMETER	MINIMUM	MEAN	MAXIMUM	MEDIAN	N
BILLINGSLEY CREEK: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	1.35/1.35/1.43	46.6/41.0/53.8	176.8/146.2/176.8	38.21/35.00/45.00	322/186/133
Temperature, C	9.00/11.10/9.00	14.68/15.76/13.14	21.80/21.80/18.60	14.60/15.58/13.30	412/238/169
DO, mg/L	6.07/6.07/6.51	9.58/8.89/9.13	18.50/18.50/14.10	9.14/9.14/8.98	402/235/162
pH	7.21/7.21/7.43	8.14/8.23/7.98	9.01/9.01/8.81	8.13/8.24/8.03	340/187/154
Turbidity, NTU	0.1/0.1/0.1	7.2/6.2/8.6	91.0/91.0/52.1	4.0/3.7/5.0	417/242/170
Fecal Coliform	**THIS AREA NEEDS TO BE FINISHED FROM THE BILLINGSLEY CREEK DATABASE.**				
Fecal Streptococci					
TSS, mg/L	0.1/0.1/0.5	4.7/4.0/5.7	46.0/46.0/41.0	2.0/2.0/3.0	417/242/170
NH3, mg/L	0.003/0.003/0.003	0.156/0.131/0.190	0.592/0.496/0.592	0.150/0.113/0.199	387/220/162
NOX, mg/L	0.104/0.645/0.104	1.084/1.080/1.088	2.710/2.710/1.920	1.000/0.967/1.030	387/220/162
TKN, mg/L	0.03/0.03/0.03	0.36/0.33/0.41	1.60/1.36/1.60	0.35/0.32/0.38	387/220/162
TP, mg/L	0.003/0.012/0.003	0.114/0.106/0.126	0.900/0.900/0.750	0.090/0.090/0.105	387/220/162
SRP, mg/L	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-
MALAD RIVER: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	6.30/8.10/6.30	618.01/877.78/523.1	2790.0/2790.0/1320.0	288.50/383.5/232.5	88/54/34
Temperature, C	0.00/9.00/0.00	13.05/16.66/7.35	24.50/24.50/16.40	15.10/16.50/8.00	80/49/31
DO, mg/L	6.30/6.30/9.10	10.02/9.32/11.11	15.90/15.90/15.60	9.55/9.20/10.70	80/49/31
pH	6.40/6.40/6.80	8.38/8.43/8.31	9.10/9.10/9.10	8.50/8.50/8.40	80/49/31
Turbidity, NTU	0.3/0.5/0.3	6.0/5.6/6.6	28.0/18.0/28.0	3.7/4.4/2.7	80/49/31
Fecal Coliform	1/5/1	3571/4913/1382	150000/150000/8000	39/60/10	50/31/19
Fecal Streptococci	10/10/10	2342/2930/1352	90000/90000/23000	93/125/58	51/323/19
TSS, mg/L	1.0/1.0/2.0	21.2/21.0/21.5	85.0/80.0/85.0	13.0/15.0/12.0	80/49/31
NH3, mg/L	0.005/0.005/0.005	0.032/0.024/0.045	0.250/0.112/0.250	0.020/0.020/0.031	80/49/31
NOX, mg/L	0.025/0.025/0.025	0.603/0.395/0.930	2.930/1.900/2.930	0.375/0.090/1.100	80/49/31
TKN, mg/L	0.01/0.02/0.01	0.34/0.36/0.31	1.20/1.00/1.20	0.30/0.38/0.20	80/49/31
TP, mg/L	0.005/0.030/0.005	0.074/0.071/0.079	0.330/0.160/0.330	0.060/0.070/0.050	80/49/31
SRP, mg/L	0.005/0.005/0.005	0.034/0.028/0.045	0.220/0.060/0.220	0.030/0.030/0.040	80/49/31
CLOVER CREEK: ANNUAL/IRRIGATED/NON-IRRIGATED					
Q, cfs	0.05/0.05/5.60	19.34/11.47/77.52	241/145.64/188.75	5.90/3.52/85.65	42/37/5
Temperature, C	5.80/9.66/5.80	17.04/18.21/8.34	27.66/27.66/10.60	17.32/18.79/8.60	42/37/5

PARAMETER	MINIMUM	MEAN	MAXIMUM	MEDIAN	N
DO, mg/L	6.41/6.41/10.86	8.95/8.56/11.85	12.94/12.94/12.88	8.97/8.68/11.68	42/37/5
pH	7.58/7.58/8.40	8.37/8.35/8.50	9.21/9.21/8.60	8.42/8.35/8.50	42/37/5
Turbidity, NTU	0.0/0.0/12.0	13.0/11.2/26.2	64.6/64.6/45.0	10.9/7.3/21.0	42/37/5
Fecal Coliform	8/8/55	95/79/213	525/510/525	45/30/150	42/37/5
Fecal Streptococci	20/20/25	416/436/265	4500/4500/750	165/150/200	42/37/5
TSS, mg/L	0.5/0.5/11.6	9.7/8.1/21.6	41.0/27.0/41.0	7.0/6.0/18.0	42/37/5
NH3, mg/L	0.006/0.006/0.020	0.022/0.018/0.049	0.105/0.047/0.105	0.017/0.016/0.040	42/37/5
NOX, mg/L	0.003/0.003/0.065	0.059/0.056/0.087	0.561/0.561/0.150	0.021/0.011/0.070	42/37/5
TKN, mg/L	0.20/0.20/0.30	0.39/0.39/0.41	0.72/0.72/0.62	0.38/0.38/0.38	42/37/5
TP, mg/L	0.038/0.038/0.045	0.075/0.076/0.068	0.144/0.144/0.112	0.070/0.073/0.065	42/37/5
SRP, mg/L	-/-/-	-/-/-	-/-/-	-/-/-	-/-/-

Prepared by IDEQ-TFRO. Q = Flow in cfs. DO = Dissolved Oxygen. TSS = Total Suspended Solids. NH3 = Ammonia-N. NOX = Nitrite + Nitrate as N. TKN = Total Kjeldahl Nitrogen. TP = Total Phosphorus. SRP = Soluble Reactive Phosphate. Irrigation season = April 15 to October 15. Non-irrigation season = October 16 to April 14.

B. TRIBUTARY PARAMETER LOADING ESTIMATES AND IMPLICATIONS

Tributary loadings data is summarized in the following set of spreadsheets for the indicated waterbody.

TABLE 2 WATER QUALITY PARAMETERS OF EAST PERRINE COULEE FROM 1990 TO 1997.

	EAST PERRINE COULEE (tons/year)						
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	3881.4	4.5	82.6	20.9	6.4	2.5	17
1991	2154.0	1.7	31.2	15.6	4.9	1.0	15
1992	2457.5	3.8	138.3	26.1	7.1	3.9	16
1993	7583.8	1.6	67.9	31.6	15.2	4.3	30
1994	3747.7	1.5	57.3	17.4	7.5	3.6	32
1995	2054.8	1.5	58.7	18.1	5.7	1.7	38
1996	2347.5	1.6	50.7	16.7	4.9	1.1	42
1997	3938.8	1.6	49.7	20.9	7.2	1.2	35
8 Year Mean	3520.7	2.2	67.1	20.9	7.4	2.4	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 3 WATER QUALITY PARAMETERS OF ROCK CREEK FROM 1990 TO 1997.

	ROCK CREEK (tons/year)						
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	11816.3	12.8	423.4	121.7	25.8	15.2	21
1991	9203.8	11.8	397.7	85.9	32.8	13.9	69
1992	1968.6	7.5	449.3	150.7	26.9	16.8	18
1993	26989.9	10.4	406.9	150.0	74.5	33.7	35
1994	13972.4	9.7	445.8	105.2	35.7	28.8	32
1995	18889.0	12.9	424.7	147.1	36.8	11.6	39
1996	15569.6	12.0	457.6	142.0	34.1	10.3	42
1997	21883.7	11.8	495.6	157.3	42.3	12.0	35
8 Year Mean	15036.7	11.1	437.6	132.5	38.6	17.8	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 4 WATER QUALITY PARAMETERS OF CEDAR DRAW FROM 1990 TO 1997.

	CEDAR DRAW (tons/year)						
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	9378.0	14.8	256.3	54.9	18.4	9.4	18
1991	12558.2	10.3	244.5	80.5	28.8	9.9	65
1992	2187.6	3.9	204.0	35.1	9.0	6.3	18
1993	17217.6	6.2	174.9	98.0	58.1	17.3	30
1994	11685.9	6.3	168.0	63.6	26.7	10.1	33
1995	16535.6	9.1	294.7	129.2	35.2	11.4	40
1996	10663.4	6.9	194.4	89.4	24.1	5.8	43
1997	11641.7	9.2	227.2	104.8	25.8	5.8	35
8 Year Mean	11483.5	8.3	220.5	81.9	28.3	9.5	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 5 WATER QUALITY PARAMETERS OF MUD CREEK FROM 1990 TO 1997.

	MUD CREEK (tons/year)						
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	5827.6	18.8	312.5	69.7	17.7	11.4	18
1991	4349.2	15.5	288.1	62.5	20.1	9.6	64
1992	2591.8	5.7	239.6	55.3	11.7	8.0	18
1993	581.8	1.8	87.3	20.4	10.2	3.2	33

MUD CREEK (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1994	4357.0	4.1	244.2	50.8	18.7	10.5	32
1995	2855.6	5.3	273.3	66.4	14.3	6.7	38
1996	3663.6	7.5	287.8	72.2	15.1	6.5	44
1997	3778.6	5.3	267.5	64.7	15.1	6.2	35
8 Year Mean	3500.7	8.0	250.0	57.8	15.4	7.8	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 6 WATER QUALITY PARAMETERS OF DEEP CREEK FROM 1990 TO 1997.

DEEP CREEK (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	6809.8	4.7	249.1	56.7	12.3	6.5	18
1991	5027.5	7.0	217.8	64.2	19.4	7.0	64
1992	537.4	1.9	186.8	33.7	5.6	5.0	18
1993	5613.1	2.1	188.5	70.7	37.2	13.6	30
1994	12490.2	3.7	185.8	48.7	33.7	9.6	33
1995	8241.6	3.3	202.2	74.7	18.3	5.3	38
1996	7343.4	3.0	202.5	66.9	17.8	4.3	43
1997	9620.9	3.0	207.6	70.3	17.5	4.4	36
8 Year Mean	6960.5	3.6	205.0	60.7	20.2	7.0	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 7 WATER QUALITY PARAMETERS OF SALMON FALLS CREEK FROM 1990 TO 1997.

SALMON FALLS CREEK (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	4872.5	7.0	479.4	67.1	9.0	6.5	26
1991	8720.1	9.2	382.9	59.1	12.4	5.6	20
1992	1338.3	4.1	339.8	37.3	5.7	5.5	21
1993	4999.2	4.9	373.9	60.6	29.2	15.7	36
1994	4076.9	3.0	301.0	39.9	12.9	8.3	41
1995	8264.6	5.8	380.4	82.1	19.8	5.8	42
1996	6662.9	6.6	383.1	82.4	20.4	5.4	56
1997	10536.7	6.4	448.8	103.8	23.1	6.7	37

SALMON FALLS CREEK (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
8 Year Mean	6183.9	5.9	386.2	66.5	16.6	7.4	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 8 WATER QUALITY PARAMETERS OF BILLINGSLEY CREEK FROM 1990 TO 1997.

BILLINGSLEY CREEK (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	696.6	13.9	144.9	22.8	11.8	7.6	4
1991	305.6	12.3	182.5	12.3	13.0	8.4	4
1992	194.1	5.4	58.9	23.2	5.9	2.6	7
1993	1794.8	15.4	112.8	36.3	21.6	13.1 e	7
1994	954.9	10.6	86.6	30.2	9.2	5.4 e	10
1995	767.8	19.8	143.8	46.6	10.8	6.3 e	8
1996	853.8	20.2	139.5	49.2	10.0	5.9 e	3
1997	*No monitoring done during the 1997 season.*						
7 Year Mean	795.4	13.9	124.1	31.5	11.8	7.0 e	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples.

TABLE 9 WATER QUALITY PARAMETERS OF MALAD RIVER FROM 1990 TO 1997.

MALAD RIVER (tons/year)							
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	5895.9	29.2	1129.3	104.8	52.6	37.2	19
1991	5044.5	49.8	1376.8	138.8	83.4	41.1	14
1992	3762.3 e	3.5 e	28.8 e	56.2 e	9.0 e	4.3 e	20 e
1993	10407.0	10.2	83.9	120.2	26.6	13.3	14
1994	2933.4	2.8	33.8	58.0	8.3	2.0	12
1995	21586.7	17.2	90.2	261.9	52.1	22.7	8
1996	27112.4	8.7	68.5	281.8	49.0	10.6	6
1997	38932.4	10.8	80.1	430.2	68.3	15.4	6
8 Year Mean	14281.1 e	7.7 e	56.6 e	173.1 e	29.2 e	9.7 e	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples; e = estimated. The estimates on Malad River are based on flow proportion analysis. Flows were determined from the WY1990 through WY1993. Flow estimates were then derived for WY1991 through WY1992 as average annual flows using the WY1990 and WY1993 USGS flows.

TABLE 10 WATER QUALITY PARAMETERS OF CLOVER CREEK FROM 1990 TO 1997.

	CLOVER CREEK (tons/year)						
YEAR	TSS	NH3	NO2+NO3	TKN	TP	SRP	N
1990	57.2 e	0.11 e	0.2 e	1.2 e	0.2 e	0.10 e	17e
1991	20.2 e	0.04 e	0.1 e	0.4 e	0.1 e	0.04 e	17e
1992	13.2 e	0.03 e	0.1 e	0.3 e	0.1 e	0.02 e	17e
1993	151.7 e	0.29 e	0.6 e	3.2 e	0.6 e	0.28 e	17e
1994	47.9 e	0.09 e	0.2 e	1.0 e	0.2 e	0.09 e	17e
1995	179.5 e	0.35 e	0.8 e	3.8 e	0.7 e	0.33 e	17e
1996	492.7 e	0.95 e	2.1 e	10.5 e	1.9 e	0.90 e	17e
1997	877.5	1.7	3.7	18.7	3.4	1.6	17
8 Year Mean	230.0 e	0.45 e	1.0 e	4.9 e	0.9 e	0.42 e	-

TSS = total suspended solids; NH3 = ammonia (as N); NO2+NO3 = nitrite+nitrate (as N); TKN = total Kjeldahl nitrogen; TP = total phosphorus; SRP = soluble reactive phosphate; N = number of annual samples; e = estimated. The estimates on Clover Creek are based flow proportion analysis. Flows were determined from the WY1990 through WY1993. Flow estimates were then derived for WY1994 through WY1997 as average annual flows. WY1993 was a partial year, so flow was averaged for those months (the month of September was provided by USGS) that flow was running. Then, based on the loadings determined by IDEQ-TFRO monitoring during 1997 (which was the 100 year flood event), estimates of loadings for each parameter were back-calculated based on the loadings derived for 1997.