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MICHAEL DONEEN
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Chief Executive Officer/Manager:
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Public Utility District No.1 of Douglas County

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April 27, 1999

Mr. David P. Boergers
Federal Energy Regulatory Commission
888 1st Street N.E.
Washington, D. C. 20426

Subject: Wells Hydroelectric Project - FERC No. 2149 WA
Annual Report - Fish Settlement Agreement
Docket No.'s P-2149-002 and E-9569-002

Dear Mr. Boergers:

In accordance with paragraph E of the order approving the Settlement Agreement issued January 24, 1991, we submit the enclosed annual report of activities related to this Settlement Agreement. A copy of the January 24, 1991 order is enclosed for your reference.

As directed by the order, the annual report addresses activities during the previous year. This annual report covers activities performed in 1998 and those planned for 1999.

Very truly yours,

Robert W. Clubb, Ph.D.
Chief of Environmental & Regulatory Services

nvh

Enclosures

c: (with report, but not appendices)
Mr. Harry T. Hall
Mr. Ron Wright
Mr. James Hastreiter
Mr. Ron Boyce
Mr. Brian Cates
Mr. Mike Erho
Mr. Cary Feldmann
Mr. Stuart Hammond
Mr. Robert Heinith
Mr. Bob Dach
Mr. Jerry Marco
Mr. Mark Quehrn
Mr. Bill Frymire
Mr. Niel Moeller
Mr. Alan Stay
Mr. Tim Brewer
Mr. Garfield Jeffers
Mr. Richard Nason
Mr. Steve Parker
Mr. Rod Woodin

bc: Mr. William Dobbins
Mr. Rick Klinge

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UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Martin L. Allday, Chairman;
Charles A. Trabandt, Elizabeth Anne Moler,
Jerry J. Langdon and Branko Terzic.

Public Utility District No. 1 of Douglas County, Washington	))	Project No. 2149-002 Docket No. E-9569-002

ORDER APPROVING SETTLEMENT AGREEMENT

(Issued January 24, 1991)

This is the most recent of a series of settlement agreements that have emerged from our consolidated proceeding on anadromous fish issues on the mid-Columbia River in Washington State. Before us today is a comprehensive, uncontested, long-term settlement of such issues arising out of the operation of Wells Project No. 2149, located in Douglas and Okanogan Counties, Washington. We will approve the settlement, with clarifications and conditions that are consistent with our approval of related recent settlements.

BACKGROUND

In 1979, the Commission consolidated and set for hearing in Docket No. E-9569 a set of related petitions seeking modification of the operation of five licensed projects on the mid-Columbia River to protect and enhance salmon and steelhead trout. 1/ The petitions were filed by various state and federal fishery agencies and Indian tribes, and sought to protect anadromous fish migration downstream through project facilities. Wells Project No. 2149 was one of the five projects. The proceeding has generated a series of interim and long-term settlements. Most recently, the Commission approved long-term settlements resolving the Vernita Bar Phase (Priest Rapids Dam) of the proceeding, 2/ and issues involving Rock Island Project No. 943-002 (Chelan County). 3/ We also have had occasion to approve a settlement of fishery issues in Project No. 2149-017, a related proceeding

1/ 6 FERC ¶ 61,210 (1979).

2/ 45 FERC ¶ 61,401 (1988).

3/ 46 FERC ¶ 61,033 (1989).

involving the raising of the surface elevation of the reservoir. 4/

On October 30, 1990, the parties in the above-captioned proceeding filed an offer of settlement with the presiding administrative law judge. On November 19, 1990, the Commission's trial staff filed comments in support of the settlement. On December 4, 1990, the presiding administrative law judge certified the settlement and the staff's comments to the Commission for decision.

The parties to the settlement are Public Utility District No. 1 of Douglas County, Washington (the PUD); Puget Sound Power & Light Company, Pacific Power and Light Company, the Washington Water Power Company, and Portland General Electric Company (collectively, the Power Purchasers); and the Washington Department of Fisheries, the Washington Department of Wildlife, the Oregon Department of Fish and Wildlife, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Colville Reservation (collectively, the Joint Fishery Parties).

As summarized by the trial staff in its comments, the settlement agreement provides for the following.

The agreement has a term from its execution date to the expiration of the license (2012) plus any annual licenses. During that time, the agreement is intended to satisfy the PUD's obligations under Article 41 of the license. The agreement is not subject to modification prior to March 1, 2004. There are procedures (discussed, in part, below) for the resolution of disputes.

The PUD has agreed to provide juvenile and adult fish passage and a hatchery program. The juvenile fish passage system will be a program of controlled spills using five bypass baffles. The agreement specifies criteria for the operation, timing, and performance of the bypass system. The adult passage system will use the existing fish ladder. Criteria are established for water depth over the weirs, entrance gate settings, and jet and trashrack operations.

The PUD's hatchery program is designed to mitigate fish passage losses at the Wells Project. The physical structures include adult collection sites, a central hatchery facility and acclimation facilities. The amount of compensation is to be

4/ 30 FERC ¶ 61,285 (1985).

determined by a formula using a five-year running average of adult runs by species. In 1991, the PUD will produce spring chinook yearlings, sockeye juveniles, and steelhead smolts. The production will then be evaluated and, based on those results, the PUD will either increase sockeye production or eliminate sockeye production and add production of summer chinook juveniles.

At completion of a project juvenile mortality/survival study, adjustment will be made to production levels, except for steelhead, to reflect the differences between the mortality rate developed in the study and the mortality rate assumed in developing the original production amounts. Adjustments will also be made to compensate for any unavoidable and unmitigated adult losses.

Once the five-year rolling average estimate of the juvenile run size reaches 110 percent of the estimated juvenile production used to establish the original production, the Joint Fisheries Parties can request a compensation increase in juvenile run size, except for steelhead.

The settlement also provides for continued studies and evaluations of the program. Studies will also be conducted on the potential unutilized habitat and on establishing sockeye in new habitat. The studies will be conducted under the direction of the Wells Project Coordinating Committee, which will be composed of one technical representative of each signatory to the agreement.

The Joint Fisheries Parties agree with the PUD that the Wells Project portion of the proceeding in Docket No. E-9569 should be terminated. These parties also agree to support the PUD when it requests relicensing of the project. The Joint Fisheries Parties further are of the view that the PUD's performance of its responsibilities under the agreement satisfies the PUD's fish protection and compensation obligations under the Federal Power Act and all other applicable laws and regulations.

In their offer of settlement, the parties indicate that it represents the culmination of two years of intensive negotiation, and that it "is intended to resolve, at least until March 1, 2004, the anadromous fish issues" pending in the proceeding.

The trial staff, in its comments supporting the settlement, requests that the Commission "make clear that the Commission's authority to require changes in structures and operations, should the need arise, is preserved" during the period when the settlement is not subject to modification. The trial staff also suggests adding certain reporting requirements to enable the

Commission to monitor compliance with the settlement. The trial staff does not propose modification of any of the substantive terms of the settlement, and no party opposes the settlement.

DISCUSSION

As we noted in approving an earlier settlement in this proceeding, 5/ the issues have been thoroughly ventilated and debated, and the settlement agreement is the result of a concerted effort to resolve these important matters in a way that is acceptable to all of the participants. We commend the participants for their efforts. We believe the settlement agreement is in the public interest, and we will adopt it. The agreement balances the continued operation of the project with an effective, long-term program for protection, mitigation, and enhancement of the fishery resources affected by the project.

We will clarify the dispute resolution provisions of the settlement agreement in the same manner as we did in our above-cited 1988 and 1989 orders approving related settlements. 6/ Section I.D. of the settlement agreement provides that, if the Wells Project Coordinating Committee cannot resolve a dispute among the signatories and if the amount in controversy is less than $325,000, then any party may request the Commission to refer the dispute to (1) the presiding judge in the mid-Columbia Proceeding, Docket No. E-9569, (2) the Commission's Chief Administrative Law Judge, or (3) the Division of Project Compliance and Administration, Office of Hydropower Licensing, "in the order listed," for expedited review. For the reasons stated in our prior orders, the Commission will in most cases refer such disputes to the Division of Project Compliance and Administration, and will use its best efforts to resolve such disputes within the time frames set forth in the agreement. In appropriate circumstances, such as when there are material facts in dispute, we may refer a matter to an administrative law judge. In either event, the initial staff decision will be subject to de novo review by the Commission. And, as we emphasized in our 1989 order, any resolution by the Coordinating Committee, or a third party, pursuant to Section I.D. that contemplates a change in the license or in the operation of the project thereunder shall result in the filing of an appropriate application therefor by the licensee as soon as practicable after the dispute is resolved.

5/ See 45 FERC at p. 62,259.

6/ See 45 FERC at pp. 62,259-60 and 46 FERC at p. 61,197.

As we noted in our prior orders with respect to the settlements approved therein, 7/ approval of the settlement agreement does not affect the Commission's authority, as reserved in the license, to require, after notice and opportunity for hearing, alterations to project facilities or operations that may be warranted by changed circumstances. We intend that any such reserved authority would be exercised only after full consideration of the benefit sought to be achieved thereby, balanced against the possibility that as a consequence the settlement could be voided, thereby eliminating the benefits obtained thereunder. If any party voids the agreement, the licensee shall, within 30 days, so inform the Commission in writing.

Finally, we will adopt the reporting provisions proposed by the trial staff in its comments.

The Commission orders:

(A) The settlement agreement filed in this proceeding on December 4, 1990, is approved and made a part of the license for Wells Project No. 2149.

(B) The Wells Project No. 2149 portion of the proceeding in Docket No. E-9569 is terminated.

(C) The Commission's approval of the settlement agreement shall not constitute approval of, or precedent regarding, any principle or issue in these or any other proceedings.

(D)(1) Whenever a violation of the settlement agreement occurs, the licensee shall, within 30 days of the occurrence, file with the Commission, and send a copy to the Regional Office, a report containing an explanation of the circumstances surrounding the violation and the licensee's plan to avoid any repetition thereof.

(2) Whenever a dispute arises under Section I.D. of the settlement agreement that is resolved without referral to the Commission, the licensee shall, within 30 days, file with the Commission, and send a copy to the Regional Office, a report containing an explanation of the dispute and the nature of the resolution.

7/ See 45 FERC at p. 62,260 and 46 FERC at p. 61,198.

(E) The licensee: (a) shall notify the Commission and the Commission's Portland Regional Office of all meetings of the Coordinating Committee; (b) shall file functional design drawings, including all information required by 18 C.F.R. § 380.3, at least 90 days prior to construction of any facilities under the agreement; (c) shall file for approval all changes in monitoring, evaluation, study and production plans, not specified in the agreement; and (d) shall file an annual report. The annual report shall be filed on April 30 of each year and shall include:

(1) A description of plans developed during the previous year for any studies, evaluations, monitoring programs, production programs, system operations, or fish passage efforts;

(2) The results of all studies, evaluations and monitoring of the previous year;

(3) An outline of all actions taken towards fulfillment of the terms of the agreement;

(4) An explanation of the reasons for exercising specific alternatives stipulated in the agreement;

(5) A chronology of compliance for the previous year, outlining schedule changes, the reasons for the changes, and documentation that the Joint Agencies were consulted prior to implementation of the changes;

(6) A schedule of activities for the next year; and,

(7) Summaries or meeting minutes from each of the meetings of the Coordinating Committee for the previous year.

(F) This order is final unless a request for rehearing is filed within 30 days from the date of its issuance, as provided in Section 313(a) of the Federal Power Act. The filing of a request for rehearing does not operate as a stay of the effective

date of this order or of any other date specified in this order, except as specifically ordered by the Commission. The licensee's failure to file a request for rehearing shall constitute acceptance of the order.

By the Commission.

(S E A L)

Lois D. Cashell,
Secretary.

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Report to
the Federal Energy Regulatory Commission
of activities under the Long-Term Settlement Agreement
between Fisheries Agencies and Tribes
and Public Utility District No. 1
of Douglas County
for the 1998 calendar year

Wells Hydroelectric Project

F.E.R.C. Project No. 2149

Public Utility District No. 1
of Douglas County, Washington
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497

April 1999

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Foreword

On January 24, 1991, the Federal Energy Regulatory Commission approved a Settlement Agreement to resolve anadromous fish issues for the Wells Hydroelectric Project on the Columbia River in Washington State. The Agreement was a product of negotiations with state and federal fisheries agencies and tribes on the operations of the Wells Project (No. 2149). The F.E.R.C. directed that the licensee of the Wells Project has certain reporting responsibilities. This document is intended to fulfill portion (E)(d) of the Order requiring an annual report to be filed by April 30. This is the ninth annual report under the Agreement and will cover the period between January 1 to December 31, 1998.

Report to
the Federal Energy Regulatory Commission
of activities under the Long-Term Settlement Agreement
between Fisheries Agencies and Tribes
and Public Utility District No. 1
of Douglas County
for the 1998 calendar year

(1) Development of Studies, Plans and Evaluations

The Public Utility District No. 1 of Douglas County (District) worked closely with fisheries agencies and tribes to carry out various studies and obligations specified in the Settlement Agreement. These included various monitoring studies and operation plans.

1.1 Annual Bypass System Operations Plan for 1998

The Settlement Agreement calls for the District to provide an Annual Bypass System Operational Plan to members of the Wells Coordinating Committee (WCC) by December each year. The District submitted this plan for 1998 to the WCC for review. The spring and summer migrations of juvenile salmonids in the Columbia River are monitored by hydroacoustics along with in-turbine fyke netting at Wells Dam. Because of the listing of steelhead, all fyke net activity needed to be authorized by a Section 10 Permit (98-1[1]). The level of hydroacoustic detections is typically in direct proportion to the magnitude of the salmonid migration (98-3; Appendix A).

The Bypass Team decides on bypass operations at Wells during both spring and summer migration periods. Representatives from the agencies, tribes and District make up the team (Agreement II.F.3). Brian Cates (US Fish and Wildlife Service; USFWS), Jerry Marco (Colville Confederated Tribes; CCT) and Rick Klinge for the District (98-1) were the 1998 Bypass Team members.

1.2 Radio Telemetry Study for 1998

The Corps of Engineers was planning to release radio tagged spring and fall chinook below Bonneville Dam and monitor the movement of these fish through lower Columbia River dams (98-4). Many of these fish would also be available for assessment at mid-Columbia dams. The District circulated a study plan to the WCC to assess radio tagged chinook in the ladders at Wells. The plan called for testing passage times while side gates at both ladders were closed and attraction flows were reduced from 1.5 feet at the ladder entrances to 1.0 foot (98-5). The ladders were designed to operate with a 1.0 foot head differential. The District was concerned that the 1.5 foot of head may actually cause a delay of adult salmon passing the dam (98-4). Also, there was interest to see if the operating of the broodstock traps affected passage times (98-1). The WCC agreed to support the proposal once the District dropped the testing of the 1.0 foot head differential settings in the ladder.

1.3 Steelhead Broodstock Spawning Protocol

The Wells Hatchery has the largest summer steelhead production in the mid-Columbia. The Washington Department of Fish and Wildlife (WDFW) implemented a broodstock protocol that explained mating strategies for 1998 brood (98-1). This was done, in part, because once the National Marine

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[1] 98-1 Refers to the first meeting in 1998 of the WCC.

Fisheries Service listed summer steelhead as "Endangered" under the Endangered Species Act, and included the hatchery population as part of the evolutionary significant unit (ESU) for recovery

1.4 Okanogan Sockeye Pilot Program

The District proposed that with the run forecast of 4,000 adult sockeye to Wells Dam in 1998 that brood collection for the Cassimer Bar Hatchery should be reduced from the 250 adults taken the past several years (98-1). Rod Woodin, representing WDFW, suggested that the District and the Colville Tribe develop alternative supplementation strategies for the Cassimer Bar facility (98-1). The District felt that the facility had space and water to rear 200,000 sockeye to 15 fish per pound, though there had not been a review of multiple brood years on station simultaneously (98-2).

Dawn Machin, Biologist with the Okanagan Fisheries Commission in Westbank BC, stated the Canadian first nations were concerned with the removal of adult sockeye from the natural spawning population. The Canadian Supreme Court has reaffirmed aboriginal rights of first nations. Machin suggested that a technical committee be established outside the Pacific Salmon Commission venue to deal with Okanagan issues (98-1).

The District stated it's concern with the continuation of the sockeye pilot effort, as the recruitment of adult to adult has remained low for both hatchery and wild fish from the Okanogan population. The Settlement Agreement allows the WCC the option to switch production from sockeye to summer chinook (98-5). The District's concern is that the existing program will not contribute to the rebuilding of this stock. Rod Woodin feels it is a higher priority to explore sockeye supplementation rather than summer chinook at this time (98-5). Others expressed concern over broodstock collection on low run years. Jerry Marco, CCT representative, said he wants to see the pilot program attempt yearling production before any changes are made (98-5). The District reiterated its position that a program in Canada holds a higher likelihood of success (98-7). The District proposed to initiate discussions with Canadian parties to help this stock. The WCC would support this investigation as long as the District continued the current program (98-8). The District entered into a contract with British Columbia Conservation Foundation to review measures in Canada that would benefit this stock as well as find the support by Canadian agencies. After initial contact with the Canadian fisheries parties, there was consensus in working on some form of habitat restoration (98-11).

1.6 Spring Chinook Broodstock Collection Protocol

The WCC received a plan from WDFW to collect all spring chinook broodstock at Wells Dam in 1998 (98-2,4). Because of the forecast of only 330 adults, it was recommended that the entire adult run be collected at Wells Dam (98-8). In 1996, it had been agreed by most of the joint fisheries parties that when the spring chinook return at Wells Dam was under 500 adults, the entire run would be intercepted. These fish would be held for broodstock at the Methow Hatchery and the Winthrop National Hatchery.

1.7 Dissolved Gas Monitoring

The District improved the monitoring of dissolved gas at the Wells forebay and tailrace by adding an automated system that reports conditions on the hour. TDG values are being monitored from May through mid-September.

1.8 Okanogan Sockeye Spawning Surveys

Radio telemetry studies in 1997 showed that up to 61% of the Okanogan Sockeye spawning activity occurs outside the historical index section of the river. Most spawning took place at the base of vertical drop structures above Osoyoos Lake at a depth where it was impossible to see the fish. This information showed that the assumption of a high pre-spawn loss of sockeye may be wrong and fish do successfully spawn in the river below Oliver, BC, though undetected by visual observations. The District proposed another telemetry study in 1998 to follow adult sockeye that pass Wells Dam to the spawning ground (98-1). Plans submitted were modified to include 50 radio tags and approved by the WCC (98-2). The study would also allow for inspection of spawned carcasses for fin clips (98-6).

1.9 Project Survival Study

The Settlement Agreement specified that the District, in consultation with the JFP, will develop a study of juvenile mortality associated with Wells Dam by 1990 (Agreement IV,C,5). Results from this work would adjust compensation levels of the hatchery programs. The WCC has opted not to pursue this study every year since 1990.

Based upon discussions in 1997, a survival study was agreed to and was conducted in 1998. This study was to test the single release methodology in the mid-Columbia and verify assumptions on recovery rates at Rocky Reach, McNary and John Day dams. Also, it was of importance to understand how fish directly from the hatchery performed next to in-river migrating fish.

Based on information from the 1998 survival study, the District proposed an additional study in 1999. There was discussion about the possibility of using hatchery summer chinook, stray spring chinook (out of basin origin stock returning to mid-Columbia hatcheries) or steelhead for the 1999 study (98-6). A proposal was circulated to the WCC in July (98-7) for review and comments. There was interest in having some level of coordinating between the three mid-Columbia PUDs' as they were all proposing juvenile survival studies in 1999. One of the big concerns was handling stress and the need to duplicate handling exposures for the various release points. The Douglas proposal initially called for 90,000 PIT tagged steelhead to be released in three locations; the Wells tailrace, mouth of the Methow River and in the Okanogan River at Crazy Rapids (98-8,9). It was felt 1999 may be the last year to do a steelhead study because of the listing of these fish as endangered. The number of tags was later revised to 60,000 fish (98-9). It was suggested that radio tags might be considered for these evaluations since the number of test animals required is dramatically less that with PIT tags. By October, the WCC had a chance to review the proposed 1999 study and needed to give the District a final approval. In order to firm up contracts for the magnitude of this project, a decision was needed. There was hesitance to agree next years study prior to review and approval of the 1998 pilot report (98-10). The tribes agreed to provide conditional support based upon review of the incomplete information available (98-10). The proposal for 1999 received the support of the WCC in November (98-11). The support allowed the District to order equipment and enter into contracts for the work.

1.10 Adult Steelhead Radio Telemetry Study in 1999

A passage study was proposed for 1999 where radio transmitters would be placed on adult steelhead at Priest Rapids (98-8). This study was requested by NMFS as part of the Interim Protection Plan for steelhead. The proposal involved tagging 400 adult steelhead at Priest Rapids Dam with monitoring at Wanapum, Rock Island, Rocky Reach and Wells to collect passage information (98-9). NMFS had requested that adult steelhead be tracked beyond the passage at the dams and out to the spawning grounds (98-11). Resolution on this issue was not reached at the end of the calendar year.

1.11 Quantitative Analytical Reports for mid-Columbia Projects

NMFS requested the participation of the mid-Columbia PUD's in a qualitative analytical report (QAR) to aid in the long-term assessment of the Habitat Conservation Plan (98-10). There was some concerns among the mid-Columbia PUD's as far as how this exercise fit into the recently negotiated Habitat Conservation Plan (98-11).

1.12 1999 Bypass Operational Plan

The District submitted to the WCC a Bypass Operational Plan for 1999, as per Section II.F.1 of the Settlement Agreement. The plan outlined scheduled hatchery releases above Wells Dam and anticipated the starting and completion date of bypass operation (Appendix B).

(2) Results of Studies, Evaluations and Monitoring Efforts

2.1 Operation of the Juvenile Bypass

Hydroacoustic sampling was started in mid-March of 1998 to help collect background index levels of activity prior to the spring migration. The juvenile bypass was initiated on April 15 in anticipation of the arrival of released hatchery fish from both the Methow and Winthrop Hatcheries (98-4). The juvenile bypass was operated for 56 days for the spring migration and 56 days for the summer migration (98-6,8). A total of 2.31 million acre feet (MAF) of water was used for operation of the bypass (Appendix C). There was discussion about the accuracy of hydroacoustics as a tool to gauge the spring migration (98-5).

2.2 Sockeye Pilot Program

Sockeye production from 1997 broodstock was split into two groups based upon the ELISA enzyme, a test for the propensity for bacterial kidney disease. Those with a high ELISA level were scheduled to be released after six months of rearing while those with a low level were to be held for fifteen months with final rearing in net pens in Lake Rufus Woods (98-4). There were 82,000 young of the year sockeye released at 60 to 105 fish per pound (fpp). The remaining 57,000 sockeye were to be held until the spring of 1999 (98-5).

Plans to transfer the sockeye to net pens in Rufus Woods Lake were halted as the commercial fish grower received a notice from WDFW about potential fish health issues (98-6). The options for the low ELISA group of sockeye would either be immediate released at the mouth of the Okanogan River or to be held at Cassimer Bar until the following spring (98-6). The District requested that the fish be immediately released to the Okanogan River because of the projected large release size. The District and the Colville Tribe discussed the existing rearing resources. The tribe felt existing facilities could rear 40,000 yearlings and with two additional raceways could bring capacity to 80,000. In July, WDFW circulated a memo that requested the fish be released in the Lower Okanagan instead of holding and release at a very large size (98-7; Appendix D). The Colville Tribe stated they could hold the fish back from the projected size of 3 fpp to 15 fpp.

Collection of 1998 brood sockeye started on July 8 at Wells Dam. There was a temporary interruption in collection as the members of the WCC considered the low run size. The District opposed brood collection because the progeny from this effort would not contribute to the natural population. The

WCC approved the continuation of brood collection, up to 101 adults, given the collection was coordinated with the existing summer chinook brood collection (98-8).

2.3 Dissolved Gas Monitoring

Flows in the Columbia River in the spring and summer of 1998 were at 93% of average at Grand Coulee Dam. Forced spill up stream of Wells Dam was kept to a minimum. Monitoring at Wells showed a range of hourly total dissolved gas of 103% to 115% in the forebay and 104% to 134% in the tailrace (Appendix E). The operation of the bypass had little to no effect on TDG build, even though approximately 9% of the river was being dedicated to bypass flow. However, spill beyond bypass flow showed that there was approximately a 1% increase in tailwater TDG with every 4% of river that was spilled.

2.4 Spring Chinook Salmon Hatchery

As part of the evaluation of the Spring Chinook Program, an annual review of the culture at the Methow Salmon Hatchery was completed. Fish released from the Methow and Winthrop Hatcheries in the spring of 1998 (96 brood) represented the entire run. There was no natural escapement of spring chinook above Wells Dam in 1996. From this brood year, the Methow Hatchery released 460,000 smolts (Appendix F).

2.5 Pilot Survival Study

There were 20,000 hatchery chinook and 6,000 in-river chinook that were marked and released back into the Columbia as part of the 1998 survival study at Wells. These fish were released both in the tailrace and in the Columbia off the mouth of the Methow River on 5 occasions. Subsequent PIT tag detections were seen at Rocky Reach, McNary, John Day, Bonneville and in the estuary (98-4,5, 6, 8). Travel time of in-river fish was much faster than hatchery chinook initially (98-4) but later the hatchery fish were shown to be faster. The assumptions built into the study were all shown to be feasible and a full study was possible (98-8) and received the support of the WCC (98-9).

2.6 1998 Ladder Passage Study

In 1998, the Corps of Engineers tagged and released 279 summer chinook below Bonneville Dam. Of those fish released, 81 reached Wells of which 39 successfully passed the dam and 42 stayed in the tailrace. The tailrace fish were divided between those who migrated to the Wells Hatchery (12), fish that were removed from the broodstock trap on the east ladder (8) and those that remained in the tailrace (22). The full details of this study are still being prepared.

2.7 1998 Pike Minnow removal program

Douglas PUD contracted to have pike minnow (*Ptychochelius oregonesis),* formerly know as Northern Squawfish, removed from the Wells tailrace and reservoir in 1998. Both long-line and sport gear were used. Between June 17 and September 1, there were 7,194 pike minnows over ten inches removed and 153 under ten inches removed (Appendix G). The tailrace area had twice the catch per unit of effort (CPUE 2.52), than the reservoir (1.22), and Okanogan River (0.88). Catches were initially high and dropped with the season. The catch was comprised of 62% females. A total of 8,229 pounds of pike minnows were removed in 1998.

2.8 Okanogan Sockeye Spawning Ground Surveys

The District using radio telemetry conducted sockeye spawning surveys in 1998. There were 4,135 sockeye that crossed Wells Dam. Of the forty nine sockeye that were tagged and released in the Wells forebay, only eight (16%) successfully reached the spawning areas above Osoyoos Lake. It was anticipated that pre-spawn loss would be high because of warmer than normal temperatures in central Washington and south central British Columbia. After the study was underway, it was discovered that the tags had been fitted with a bad batch of batteries that were failing within weeks of activation. Consequently, it is uncertain how many fish with failed tags reached the spawning area. Of the fifty two carcasses inspected, none had failed tags, nor adipose nor ventral fins clipped.

(3) Outline of Action Taken Toward Fulfillment of the Settlement Agreement

3.1 Methow River Spring Chinook Facility

The Settlement Agreement calls for a hatchery based compensation program for spring chinook composed of adult collection sites; a central hatchery facility for incubation, early rearing, and adult holding and acclimation facilities for final rearing (Agreement IV). Hatchery personnel reared and released progeny from 1996 and 1997 broodstock in the facility during 1998.

The Methow Hatchery was designed to have 4,500 gallons per minute (gpm) of well water that was delivered from four wells. Water production has been dropping off to about 3,600 gpm after six years of use by the facility. This lower capacity of well water has affected how the facility operates. At the end of the calendar year, the District was working to better understand the reasons for the decrease in water delivery at the hatchery.

The Settlement Agreement also calls for evaluation of the hatchery program. Several aspects of the hatchery were evaluated. A final report was received for the 1996 evaluation (Appendix F).

3.2 Cassimer Bar Sockeye Hatchery

The Settlement Agreement calls for a pilot effort to culture Okanogan sockeye for three years at 8,000 pounds of production (IV.A.3.(a)(2)) with an evaluation to gauge the success of the program. Brood have been collected since 1993 at Wells Dam. Information on culture of sockeye at the Cassimer Bar facility was collected by the CCT.

3.3 Contract for Professional Services in Implementing the Settlement Agreement.

During 1998, the District contracted with Mike Erho to serve as Studies Coordinator for the Wells Coordinating Committee. Mr. Erho also serves as coordinator for the Mid-Columbia Coordinating Committee and Rock Island Coordinating Committee. The District also contracted with Dr. Skalski to provide statistical evaluation of methods and studies.

3.4 Juvenile and Adult Fish Passage Operations at Wells Dam

During 1998, the juvenile bypass system operated as per conditions outlined in the Settlement Agreement (II,C,D,F). The bypass team recommended operations based upon information from hydroacoustics and fyke net samples at Wells.

The ladders operated during the year at the criteria established by the fisheries agencies and tribes (Agreement III. B; C; D; E; F). Annual maintenance was performed to both ladders outside of the fish passage times.

3.5 Steelhead Production at Wells Hatchery

The Settlement Agreement specified that the District will fund additional steelhead compensation of 30,000 pounds at 6 fish per pound after 1991 (IV.3.a), bringing the total obligation to 80,000 pounds. Records from the Wells Hatchery show that 493,026 steelhead or 74,908 pounds were liberated in 1998. In previous years, it is felt there were high losses from piciverous birds. Measures were taken in 1998 to reduce predation by hazing as well as exclusionary wires across the ponds. Losses to bird were believed to be relatively minor. Hatchery personnel observed a barrier screen that was not seated properly and possibly allowed small steelhead to exit the pond into the river.

3.6 Other Actions Toward Fulfillment of the Settlement Agreement

The District funded evaluations and studies that are part of the District's responsibility in the Settlement Agreement. These were described in Sections 2 and 3.

(4) Explanation of Alternatives Chosen

4.1 Sockeye Pilot Program

In August, the District approached the WCC proposing that discussions be initiated with the Canadian agencies and first nations about Okanogan sockeye. The District believes that the highest probability of success to mitigate for unavoidable sockeye losses at Wells Dam lay with measures as close to the spawning area as possible. A letter was sent to the WCC outlining the District's interest to seek common ground with the Canadians (98-8). The WCC gave support for the District to pursue discussions with the Canadians as long as there was continued funding of the Cassimer Bar pilot program (98-8).

(5) Chronology of compliance for 1998

Items (3) and (4) above contain chronology of compliance in 1998. Documentation that the Joint Fisheries Parties were consulted prior to implementation of changes is provided in the minutes of the Wells Coordinating Committee. These records are included as Appendix H .

(6) Schedule of Activities for 1999

The following schedule of activities is planned for 1999

Dec. (98)	Develop Annual Bypass System Operation Plan between District, Agencies and Tribes
January	Meeting with District, Agencies and Tribes on adult passage concerns
March 1	Annual Bypass System Operation Plan finalized
March 1	Determine Bypass Team members for bypass season
March 1	Develop Annual Passage Monitoring Plan between District, Agencies and Tribes
March 15	Begin monitoring juvenile migration via hydroacoustics
April 1	Bypass barriers in place
April 10	Start of Project Survival Study
April 15	Anticipated start of the juvenile migration
May 1	Start collecting spring chinook broodstock at Wells Dam
July 1	Start collecting sockeye broodstock at Wells Dam
July 1	Collect and tag adult steelhead for mid-Columbia radio telemetry study
October	Production Plan annual review between District, Agencies and Tribes
November	Pre-draft Results from 1999 survival study
November	Planning for 2000 survival study
on going	Planning sockeye mitigative strategies
on going	Planning for operations and protocols of the Methow River Spring Chinook Facilities

(7) Minutes of Meetings

7.1 Minutes of the Wells Coordinating Committee for 1998

The Wells Project was removed from the mid-Columbia proceedings on January 24, 1991 as the Settlement Agreement between the fisheries agencies and tribes was approved by F.E.R.C. Minutes from the meetings of the WCC for 1998 are attached as Appendix H.

Table of Appendices

Appendix A
Annual Bypass Operation Plan for Wells Dam, 1998

Appendix B
Draft Annual Bypass Operation Plan for Wells Dam, 1999

Appendix C
Memo from L. Brown on Cassimer Bar sockeye, dated July 7, 1998

Appendix D
Memorandum on Summary of Wells Bypass Operations in 1998

Appendix E
Dissolved Gas Monitoring at Wells Dam Forebay and Tailrace, 1998

Appendix F
Summary Report; Methow Basin Spring Chinook Salmon Hatchery; 1996 Brood Year

Appendix G
Draft Copy 1998 Public Utility District No. 1 of Douglas County Northern Pike Minnow removal and research Program.

Appendix H
Minutes of the Wells Coordinating Committee for 1998

Appendix I
1998 Membership list of the Wells Coordinating Committee

Appendix J
The Long Term Settlement Agreement for the Wells Hydroelectric Project.

ANNUAL BYPASS OPERATION PLAN
FOR
WELLS DAM, 1998

APPENDIX A

WELLS HYDROELECTRIC PROJECT
JUVENILE BYPASS SYSTEM OPERATIONS PLAN
for the 1998 Bypass Season

The Wells Long Term Settlement Agreement (II.F.1) specifies that Douglas PUD will submit an Annual Operations Plan for the bypass to the Wells Coordinating Committee by December prior to the spring migration. This plan will be reviewed and approved by the Committee by March 1.

The Bypass System
The PUD will install five bypass barriers in spill gates of the Wells Project. The bypass will operate per criteria in the Settlement Agreement (II.C, E).

Operation Criteria
The operation criteria includes operation of the bypass in partnership with adjacent turbine units, the amount of water required for bypass operation and criteria for full bypass system operation.

Bypass Operations Timing Criteria
The bypass will be in place from two weeks before predicted start of the migration until two weeks after the migration is complete.

Projected Hatchery Releases above Wells Dam
Hatchery releases for 1998 above Wells Dam are as follows:

Facility	Species	No. in thousands	Dates
Winthrop (USFWS)	Spr. Chinook	315	4/15
Methow (WDFW)	Spr. Chinook	380	4/15
Carlton (WDFW)	Sum. Chinook	350	4/15
Similkameen (WDFW)	Sum. Chinook	500	4/15
Wells (WDFW)	Sum Steelhead	420	4/20
Cassimer Bar (CCT)	Sockeye	110	5/15

Starting Dates and Ending Dates
Bypass barriers will be in place between March 15 and September 15. Hydroacoustic and fyke net sampling will start on March 27 and be collected until August 29.

The bypass team will decided the start and end of bypass operation. Hydroacoustics and fyke net information at Wells will be used to show the start and completion of the spring and summer migrations. Preseason dates for bypass operation for spring and summer migration are April 10 through May 30 and July 1 through August 15.

(03/01/98)

c :\Data Files\bypass\bypass98

DRAFT

ANNUAL BYPASS OPERATION PLAN FOR WELLS DAM, 1999

APPENDIX B

WELLS HYDROELECTRIC PROJECT
JUVENILE BYPASS SYSTEM OPERATIONS PLAN
for the 1999 Bypass Season

The Wells Long Term Settlement Agreement (II.F.1) specifies that Douglas PUD will submit an Annual Operations Plan for the bypass to the Wells Coordinating Committee by December prior to the spring migration. This plan will be reviewed and approved by the Committee by March 1.

The Bypass System
The PUD will install five bypass barriers in spill gates of the Wells Project. The bypass will operate per criteria in the Settlement Agreement (II.C, E).

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The operation criteria includes operation of the bypass in partnership with adjacent turbine units, the amount of water required for bypass operation and criteria for full bypass system operation.

Bypass Operations Timing Criteria
The bypass will be in place from two weeks before predicted start of the migration until two weeks after the migration is complete.

Projected Hatchery Releases above Wells Dam
Hatchery releases for 1999 above Wells Dam are as follows:

Facility	Species	No. in thousands	Dates
Winthrop (USFWS)	Spr. Chinook	545	4/15
Methow (WDFW)	Spr. Chinook	480	4/15
Carlton (WDFW)	Sum. Chinook	390	4/15
Similkameen (WDFW)	Sum. Chinook	590	4/15
Wells (WDFW)	Sum. Steelhead	840	4/20
Winthrop (USFWS)	Sum. Steelhead	110	5/01
Cassimer Bar (CCT)	Sockeye	60	4/15

Starting Dates and Ending Dates
Bypass barriers will be in place between March 15 and September 15. Hydroacoustic sampling will start on March 15 and be collected until August 29. Fyke netting will be done between March 15 to either April 10 or the start of the Bypass, which ever occurs first and again from August 15 through 31.

The bypass team will decided the start and end of bypass operation. Hydroacoustics and fyke net information at Wells will be used to show the start and completion of the spring and summer migrations. Preseason dates for bypass operation for spring and summer migration are April 10 through May 30 and July 1 through August 15.

(12/1/98)

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MEMORANDUM FROM LARRY BROWN ON CASSIMER BAR SOCKEYE, DATED JULY 7, 1998

APPENDIX C

Post-it® Fax Note 7671	Date 7/7/98 # of pages ▶ 1
To MIKE ERHO	From LARRY BROWN
Co./Dept.	Co.
Phone #	Phone # in case e-mail
Fax # 886-0872	Fax # fails

From: Larry Brown
To: smtp: "merho@televar.com"
Date: 7/7/98 3:18PM
Subject: Cassimer Bar sockeye program

Mike Erho, Committee Chair
Mid Columbia, Wells, and Rock Island Coordinating Committees

I apologize for not being able to make the 8 July Mid Columbia Coordinating Committee meeting at SeaTac. I promised Rod Woodin that I would represent WDFW in the Cassimer Bar sockeye discussions, but an emergent family medical emergency precludes my attendance. The major issue requiring WDFW input involves the Cassimer Bar sockeye program, or lack of same.

BY97 fingerlings on-hand:
I understand that the growth projections for brood year 97 sub yearlings (approx 58,000) indicate the spring yearlings will be about 3 fpp. That is unreasonably large for sockeye yearlings, and in Rod's and my opinion will promote more kokanee or jacked-out sockeye than provide any real anadromous benefit. We recommend releasing the sub yearlings in or near the lower Okanogan as soon as possible to allow those which may desire to migrate seaward the benefit of summer spill designed to assist chinook salmon sub yearlings.

BY98 brood stock collection:
Although I have not discussed this with Rod, it seems fruitless to continue collecting Okanogan sockeye broodstock in the absence of a realistic supplementation or augmentation program which will benefit the stock. Our only ace in the hole for BY97 was the possible net pen rearing project at Rufus Woods. Since this appears to be an option no longer, and since there is no other viable supplementation or recovery option yet on the table, I question the advisability of collecting adults this year. The 1998 run is expected to be very small and the planned 200-300 fish brood stock collection could have a significant impact on natural escapement. I recommend shelving the Okanogan sockeye program until a viable rearing and supplementation strategy, along with adequate facilities, has been fully thought out, coordinated with BC, fully funded, and ready for implementation. The few adults already collected from Wells can be released into or near the mouth of the Okanogan River. Recent tagging studies show that the survival of such released adults is good.

Again, my sincere apologies for missing the meeting.
Larry Brown
WDFW

CC: Rod Woodin, Ross Fuller

MEMORANDUM ON SUMMARY OF WELLS BYPASS OPERATIONS IN 1998

APPENDIX D

Memorandum

TO: Brian Cates, USFWS
Jerry Marco, Colville Confederated Tribes
FROM: Rick Klinge, Douglas PUD
DATE: September 11, 1997
SUBJECT: Summary of Bypass Operations at Wells Dam, 1998

==========

Flows in the river were average for the Columbia in 1998. Wells Dam had all ten units available during the most of the bypass operations. The highest hourly discharge occurred on June 1 at 1800 hours with 278.6 kcfs. At very high flows bypass barriers are removed to maintain the emergency spill capacity of the dam. Barriers were removed from spillway 6 on June 3 through 8 as daily average flows exceeded 200 kcfs. Barriers were returned on July 17 when daily average flows dropped below 200 kcfs.

The spring outmigration, based upon brood (BY96) contribution of spring chinook and sockeye, should have been large. Sockeye return at Wells in 1996 was over 17,000 adults. The progeny from these fish never caused the large rise in the spring index. This was of particular note by the Bypass Team members. The summer outmigration based upon brood (BY97) contribution of summer / fall chinook was lower than average.

The bypass team used a ten-year average from fyke net samples for percent salmonids to adjust the hydroacoustic index. This reduced the need to fyke net to adjust the raw index. The ten-year average was applied to the raw index values from the end of the spring migration through the end of the summer migration.

Hydroacoustic sampling started at Wells on March 18 to collect background data prior to the start of the spring migration. Initial levels were low and remained low through the time the bypass was initiated on April 15 in anticipation of the arrival of fish from the Methow and Winthrop Hatcheries. The spring bypass operated until June 10 for a total of 56 days and used 1.15 MAF or 7.1% project inflow.

There were six days between spring and summer migration where bypass operations were suspended. During this period there was no forced spill nor nitrogen replacement spill

Summer bypass operations started on June 16 and ran until August 11, for a total of 56 days. Summer operations used 1.16 MAF, or 8.0% project inflow.

There was only one occasion for fyke netting this year to aid in adjustment of the raw index. Fyke netting was done on August 17. The ratio of salmonids from the sample was 1.5%, compared to the average for this date of 30%. The Section 10 permit would not allow fyke netting prior to August 15. Much warmer river temperatures were felt to have pushed the migration a few weeks earlier than seen in the past.

DISSOLVED GAS MONITORING AT WELLS DAM FOREBAY AND TAILRACE 1998

APPENDIX E

Dissolved Gas Monitoring at Wells Dam Forebay and Tailrace, 1998

Rick Klinge, Fisheries Biologist

Douglas County Public Utility District No. 1

1151 Valley Mall Parkway

East Wenatchee, WA 98802

April 1999

Dissolved Gas Monitoring at Wells Dam Forebay and Tailrace, 1998

Introduction

Total dissolved gas (TDG) levels at mid-Columbia dams have been monitored during the spring and summer months since the early 1980's. These data provide information on how projects either contribute or reduce TDG in the Columbia River. Spill at hydroelectric dams can increase TDG during months when adult and juvenile salmonids are migrating in the river. It has been well documented that fish can be injured or die from sustained exposure to elevated dissolved gas. Today, TDG in the Columbia River is monitored at the forebay of all hydroprojects and at least one point in the vicinity of the tailrace.

Initial review of TDG generation at Wells Dam showed a reduction of gas levels to Rocky Reach Dam. In 1997, the third highest flow year on record, tailrace measurements at Wells were collected from a boat at least once a week. Readings over eight weeks showed an increase in forebay to tailrace TDG (Klinge, 1998).

Wells Dam was built as a hydrocombine; that is the spillway is situated directly above the powerhouse. The eleven spill gates at Wells have vertical lift gates with bottom discharge. The water level of the tailrace is within ten feet of the spill ogee elevation under most spring flow conditions. Thus there is little or no vertical plunge of spill. The juvenile bypass system modified five spillway entrances to improve attraction velocity for guidance of salmon and steelhead smolts. Those gates dedicated for bypass operation are gates 2, 4, 6, 8, and 10.

Two of the five modified spillways have top spill trash sluice ways. Bypass flow through top gates (less than 2,000 cfs) drops approximately 70 feet. Additional spill, forced spill and nitrogen replacement spill, is passed through gates (1,3,5,7,9 and 11) not dedicated to the bypass system.

In 1998, TDG was recorded on the hour from the forebay and tailrace at Wells. This report describes methods and results of TDG data collection along with river discharge and spillway volumes.

Methods

Two Hydrolab MiniSonde sensors equipped with a dissolved gas and temperature probe collected data on the hour from April 8 to August 23. The forebay sensor was located midway across the face of the dam at Unit 5 and the tailrace sensor was located on the left bank approximately 2 miles below the dam (Figure 2). Both sensors were located at 15 feet of depth from normal forebay and tailwater levels. Data from both stations were automatically transmitted by radio and stored as a computer file on a personal computer. Hourly data were sent via the Internet to the Army Corps of Engineers for posting at various Web pages. The manufacturer calibrated the sensors at the beginning of the season. Service to each probe during the season was limited to an inspected of the probe membrane and removal of silt and algae, which was done on May 13 and July 28.

Operators at Wells recorded barometric data daily from an Aberbach mercury column barometer between April 8 through May 22. After May 22, a

Figure 1. Location of Wells Dam on the Columbia River.

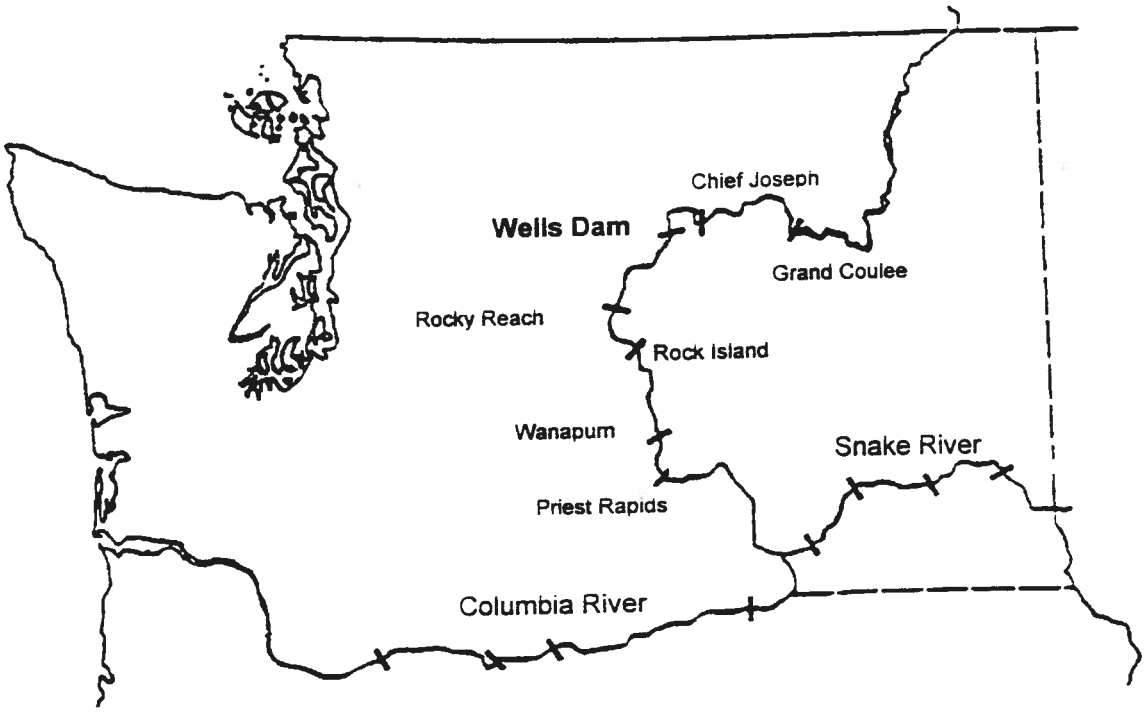
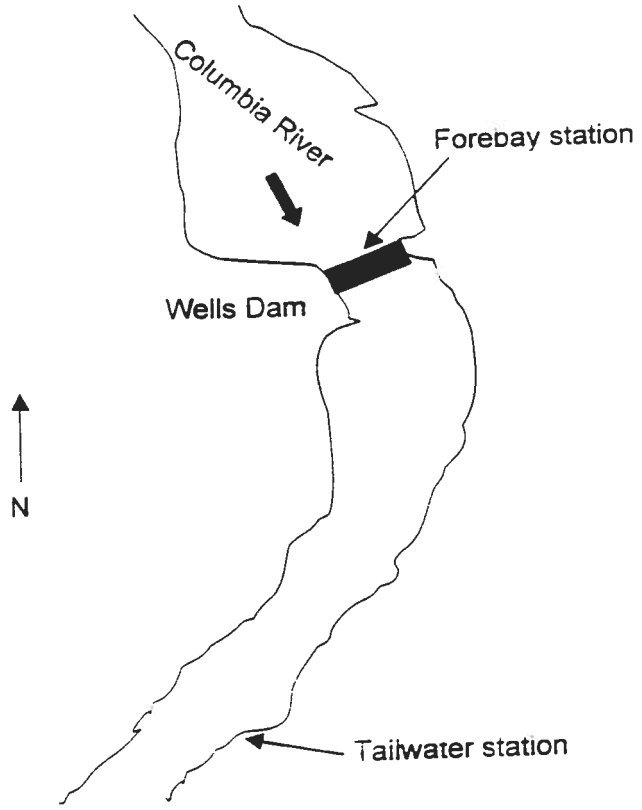


Figure 2. Wells Dam and the TDG sampling locations.



Capricorn 2000 weather station with an electronic barometer provided hourly barometric levels. On June 4, a comparison with the Aberbach barometer indicated the electronic barometer was recording 10 mb high. An adjustment to the Capricorn 2000 instrument was made on June 8 and again on June 9. Afterwards, hourly data from the electronic barometer were comparable to the Aberbach barometer. The Douglas PUD Power Operations provided hydraulic data for discharge and spill.

Results

Data were collected between April 8 and August 23. The system for transmitting information initially had several problems moving data from the two probes to a personal computer for storage. In April and May, there were 101 hours (8% of the hours) of missing information. After May 20, the problems with communication were resolved. There were also problems with the real time barometric data between May 22 and June 9. Barometric data were as much as 10mb too high. This would have biased the TDG estimate as much as 1.5% lower. Data for that period were not adjusted because the relative percent change between forebay and tailrace would not be affected. After June 9, barometric data were reliable. On August 24, at 1700, the tail water sensor recorded elevated levels of TDG when there was no spill. It was assumed that the sensor membrane ruptured, causing spurious readings. The sensor was taken out of service on September 1. Tailrace data after 2300 hours on August 23 were removed from this report.

Forebay TDG

3,161 hours of data between April 8 and August 23 are shown in Figure 3 (also Appendix A). Hourly values of forebay TDG ranged from a low of 102.9% on May 28 at 0800 hours to a high of 114.6% on July 26 at 1500 hours. The Washington Department of Ecology during typical TDG assessment will often use the average from the 12 highest readings from each day. The daily 12 hour average from the forebay at Wells exceeded 110% between June 29 until August 9. The highest 12 hour average for the forebay was 113.7% on July 29 (Figure 3). High flows did not necessarily reflect the time of the highest receiving TDG. High flows occurred in the last week of May and the first week of June when daily average discharge exceeded 200 kcfs.

Tailrace TDG

Tailrace TDG hourly values ranged between 104.3% on April 26 at 0600 to 133.8% on June 2 at 0100 hours (Appendix B). The 12 hour average exceeded 110% from May 29 to June 10 and again from June 18 to August 16. The 12 hour average exceeded 115% for nine days, from May 31 to June 8 and exceeded 120% on four days; June 1, 2, 5, and 7 (see Figure 3). The peak 12 hour average TDG from the tailrace was 122% on June 2.

River Flows and Spill

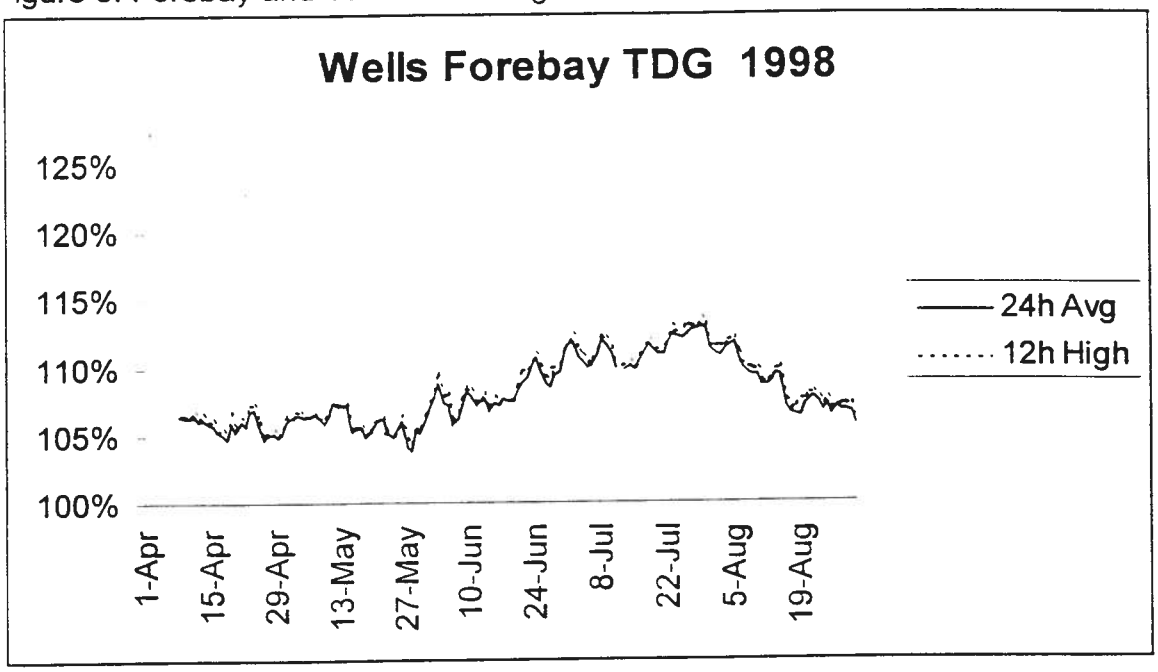
Flows at Wells Dam were considered average during the spring and summer of 1998. The flow at Grand Coulee between January and July was 59

million acre feet or 93% normal (Corps of Engineers, 1998). Daily average discharge and all spills are shown in Figure 4. Total hourly flow peaked on June 1 at 1800 hours at 279 thousand cubic feet per second (kcfs). Daily average flow (24 hour average) between April 1 and August 31 ranged from 42 to 240 kcfs.

Spill at Wells was a combination of juvenile bypass flow, forced spill and nitrogen replacement spill (Appendix C). There was no spill until the bypass system was operated to protect migrating juvenile salmon and steelhead. The bypass operated for the spring migration from April 15 to June 10 and for the summer migration from June 16 to August 11. Bypass operation used approximately 6% to 10% of the project flow. Forced spill occurred on several occasions between May 28 and June 7 and again between August 10 through 14. Replacement spill was received from May 29 to June 3. The amount of replacement spill varied between 30 to 50 kcfs. Combined spill was analyzed as to how it changed TDG between forebay to tailrace sensors. Percent spill verses the change in forebay to tailrace TDG suggests that every 4% of river spilled, TDG would increase by 1% ($R^2 = 0.66$; $p < 0.01$; Figure 5).

Of the 3,161 readings collected in 1998, 595 hours or 19% of the records occurred with no spill. On the average, there was no difference in TDG from forebay to tailrace for non-spill hours.

Figure 3. Forebay and Tailrace average values for 24 hour and 12 high hours.



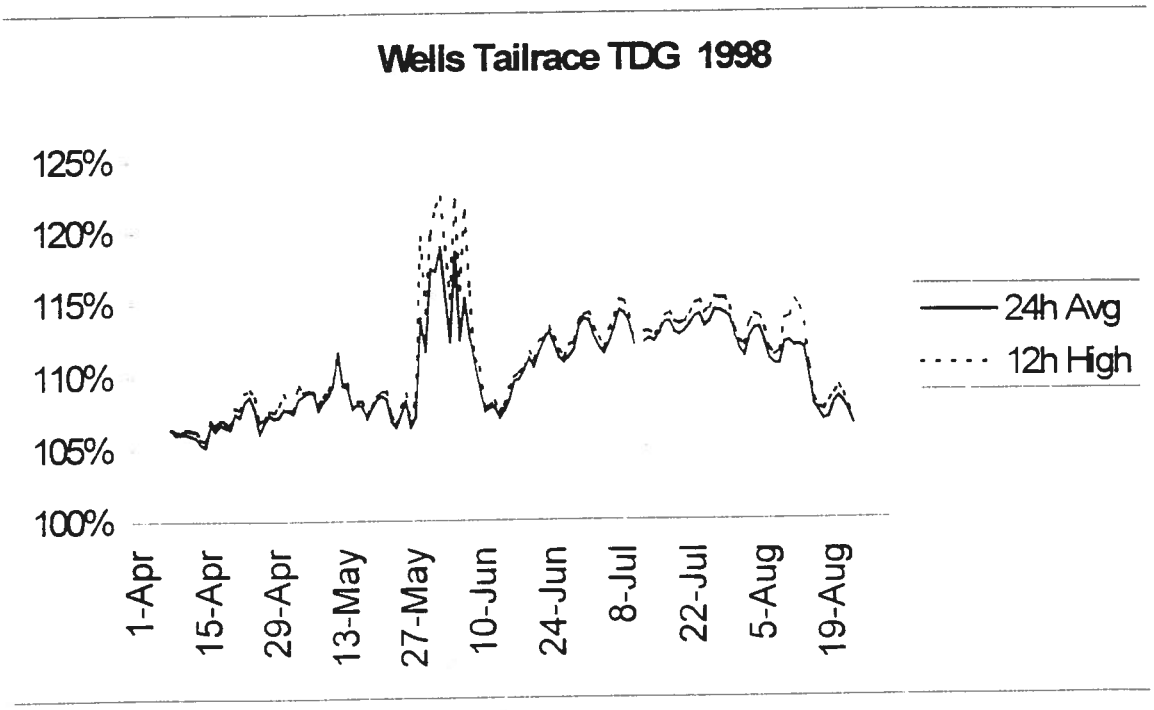


Figure 4. Daily average total discharge and spill at Wells Dam, 1998.

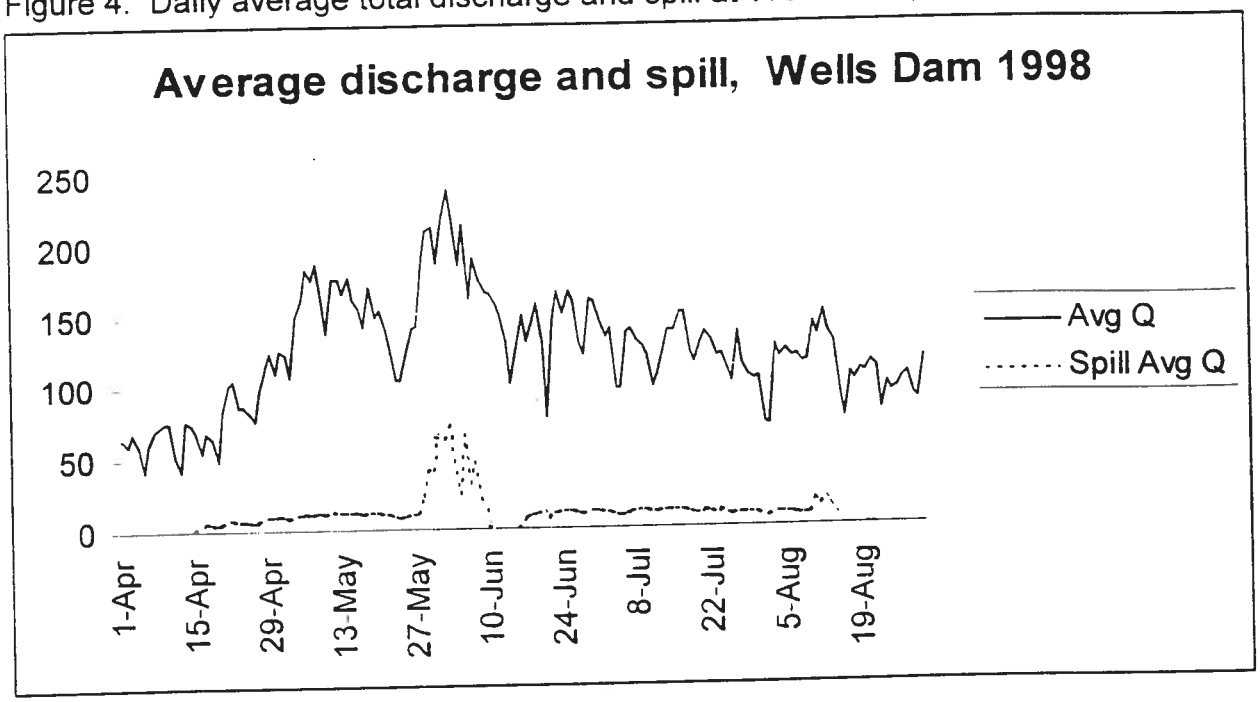
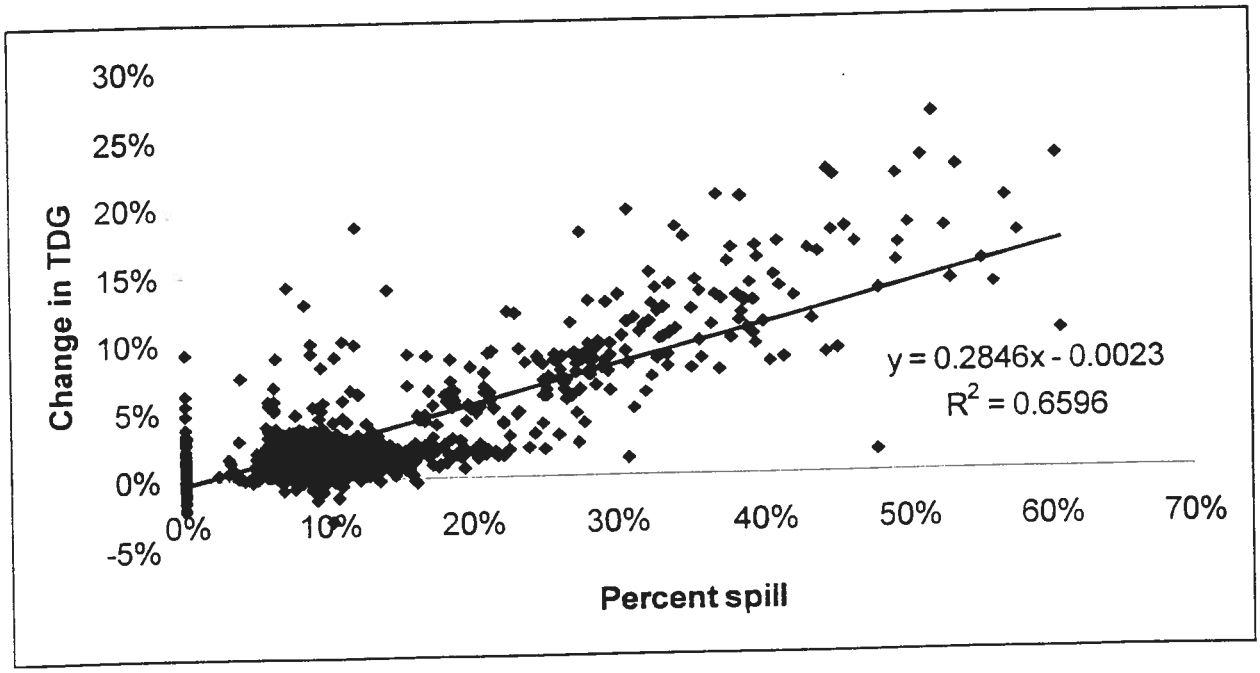


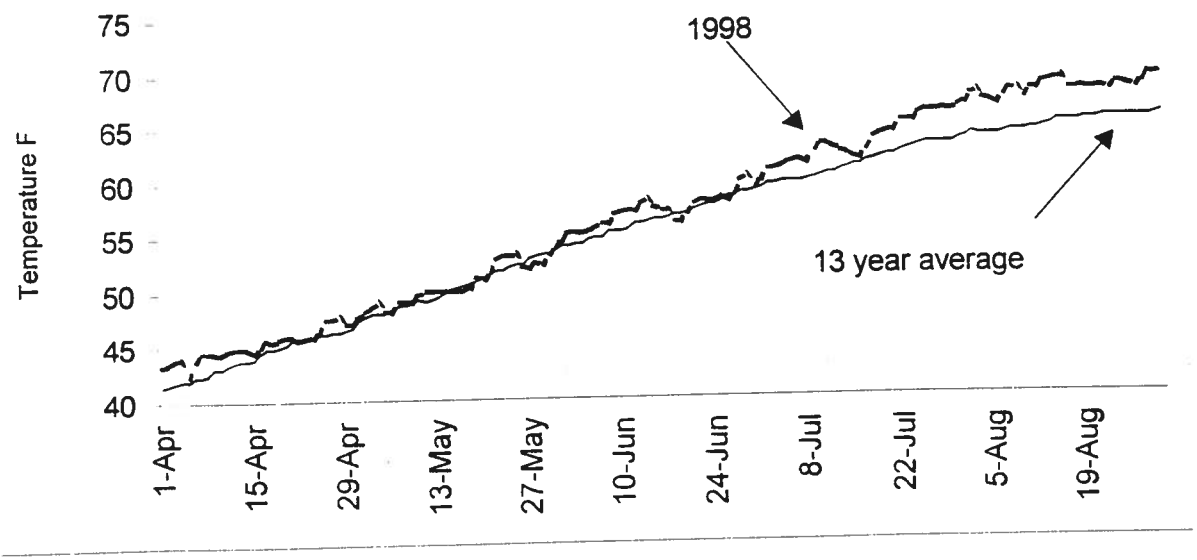
Figure 5. Relation of percent spill to percent change in TDG between tailrace and forebay TDG, Wells Dam, 1998.



Other hydraulic conditions

The summer in 1998 produced record breaking temperatures in Washington State, especially the second half of July. Water temperatures in the Columbia River were well above average. Figure 6 shows the Columbia River temperatures and compares them to the 13 year average at Wells Dam.

Figure 6. Columbia River temperatures, 1998 and 13 year average, Wells Dam.



Discussion

Forebay TDG levels at Wells appear to be driven by operations upstream, namely from Chief Joseph Dam, Grand Coulee Dam or projects in Canada. Figure 7 shows records of receiving TDG for 1998 as posted on the DART Page[1] as water reached the Boundary station (RM 745), Grand Coulee Dam (RM 597) Chief Joseph Dam (RM 545), Wells Dam (RM 515) and Rocky Reach Dam (RM 474). Data generally shows a drop in TDG levels from stations to station moving

[1]University of Washington DART page (**http://www.cqs.washington.edu/dart/river.html**).

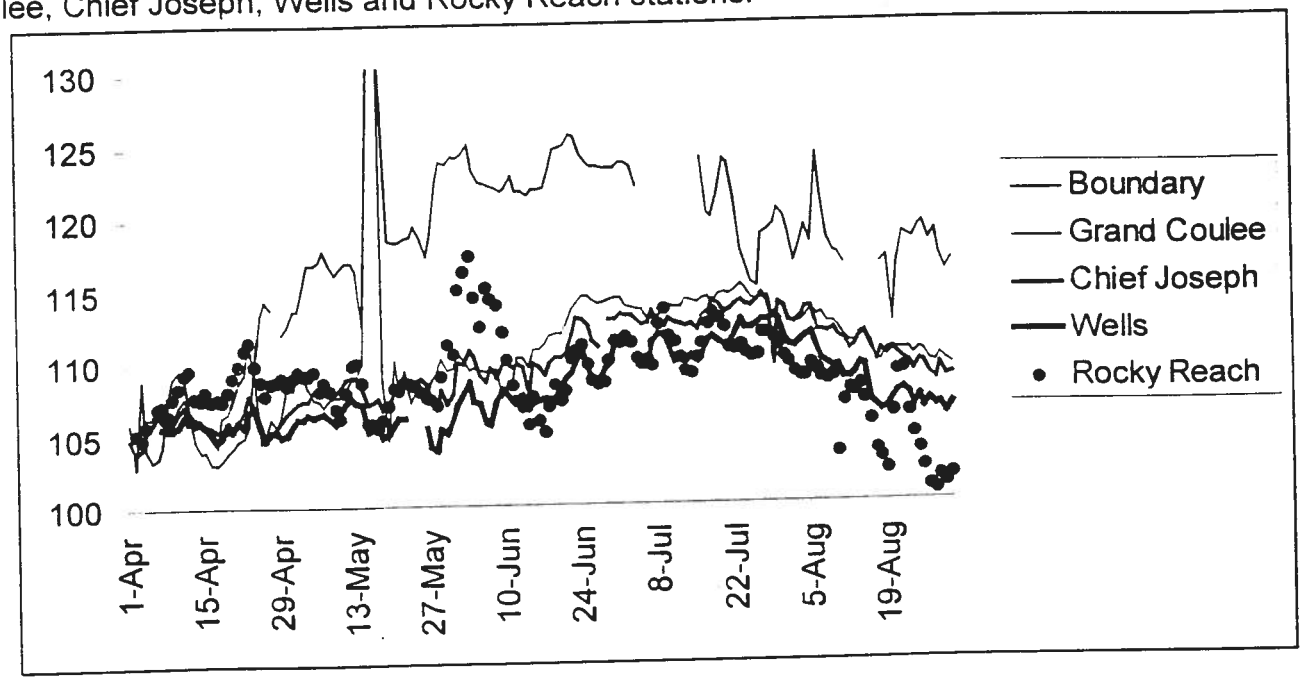
down stream (Figure 7; Appendix D). The operators at both Grand Coulee and Chief Joseph have been addressing this to minimize addition of TDG to the river.

Power peaking and load following cause changes in hourly discharge volumes. This change in volume affects the travel time of water from the dam to the tailwater sensor. The arrival of water at the tailwater sensor from a 30% spill event will be slower with flows at 80 kcfs compared to 240 kcfs. This makes the development of a cause – effect model of spill to changes in TDG difficult and is largely responsible for a modest regression coefficient of percent spill to percent change in tailwater to forebay TDG (see Figure 5). There was no attempt to model response time under a range of flows. Difference in TDG between forebay to tailrace during non-spill hours ranged from -2.1% to +9.4% with an average of 0%. The +9.4% difference of TDG for a non-spill hour was recorded on August 11 at 2100h. There was spill shown the hour before (2000 hours) of 25% and the hour after (2200 hours) of 15% (see Appendix C).

Operations at Wells in mid-April through late May appeared to add 2% TDG to the receiving levels at Rocky Reach Dam. Between May 29 and June 5, high spill (> 30%) was seen during the late night and early morning hours at Wells. This caused elevated TDG at the Rocky Reach forebay monitor. A comparison of 12 hour forebay TDG levels between Wells and Rocky Reach for the same dates shows a build of around 8% (Koehler and McDonald, 1998). This is consistent to the response seen at the Wells tailrace sensor of a build of 1% to every 4% spilt. Though from early July to late August this relationship disap-

pears since there was no change in TDG recorded at the forebays of Wells and Rocky Reach as Wells was dedicating 9% of the river to bypass flow.

Figure 7. 1998 Columbia River TDG daily averages for Boundary, Grand Coulee, Chief Joseph, Wells and Rocky Reach stations.



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Corps of Engineers, NW Division Headquarters. 1998. 1998 Total Dissolved Gas Monitoring Post-Season review; Meeting minutes. Portland, OR, October 14, 1998.

Koehler, Valerie A., Robert D. McDonald. 1998. DRAFT REPORT Total Dissolved Gas Monitoring at rocky Reach and Rock Island Hydroelectric Projects in 1998. Fish and Wildlife Operations, Chelan Public Utility District No. 1; Wenatchee, WA , October 14, 1998.

Wells Dam TDG data 1998

DATE Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
1-Apr FB TDG																									
2-Apr FB TDG																									
3-Apr FB TDG																									
4-Apr FB TDG																									
5-Apr FB TDG																									
6-Apr FB TDG																									
7-Apr FB TDG														107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%
8-Apr FB TDG														107%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%
9-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	106%	107%	106%	106%	106%	106%	106%	106%	106%
10-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	106%					107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%
11-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
12-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	106%	106%	106%	107%	108%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%
13-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	105%	105%	106%	106%	106%	106%	106%	106%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%
14-Apr FB TDG	106%	106%	106%	105%	105%	105%	105%	105%		105%	106%	106%	106%	107%	107%	107%	106%	106%	106%	106%	105%	105%	105%	105%	106%
15-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	105%	105%	106%	105%	106%	106%	105%	105%	105%	105%	105%	105%	105%	105%
16-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	104%	104%	104%	104%	104%	104%	105%	106%	105%	106%	108%	106%	105%	105%	105%	105%	105%
17-Apr FB TDG	104%	104%	104%	104%	104%	104%	104%	104%	104%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
18-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	105%	105%	106%			106%	107%	108%	107%	106%	106%	106%	106%
19-Apr FB TDG	106%	106%	105%	105%	105%	105%	105%	105%		105%	105%	105%	105%	105%	105%	105%	105%	106%	105%	106%	106%	106%	105%	105%	105%
20-Apr FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	106%	106%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%
21-Apr FB TDG	106%	106%	105%	105%	105%	105%	105%	105%		105%	106%	106%	106%	106%	107%	106%	106%	106%	106%	106%	105%	105%	105%	105%	106%
22-Apr FB TDG	105%	105%	105%	105%	105%	105%	107%	107%	107%	107%	107%	107%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
23-Apr FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	109%	107%	107%	107%	106%	107%	106%	106%	106%	106%	106%	106%	107%
24-Apr FB TDG	106%	106%	106%	106%	106%	106%	105%	106%	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	104%	105%	105%	105%	106%
25-Apr FB TDG	105%	105%	105%	105%	105%	104%	104%	104%	104%	104%	104%	105%	105%	105%	105%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%
26-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%				105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
27-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%
28-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
29-Apr FB TDG	105%	105%	104%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%
30-Apr FB TDG	105%	105%	105%	105%	105%	105%	105%	105%		106%	106%	106%	106%	107%	107%	107%	107%	107%	106%	106%	106%				106%
1-May FB TDG													107%	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
2-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%
3-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%		106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%
4-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	106%	106%
5-May FB TDG	107%	106%	107%	107%	107%	107%	107%	106%	106%	106%	106%			106%	107%	106%									106%
6-May FB TDG								107%	107%	107%	106%	106%	106%	106%	106%	106%	106%								107%
7-May FB TDG									107%	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
8-May FB TDG	106%	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%
9-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	106%	107%	107%	107%	107%	106%
10-May FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%		107%	107%	107%	107%	107%	107%	107%	107%	108%	107%	107%
11-May FB TDG	107%	107%	107%	107%	107%	108%	107%	107%	107%	107%															107%
12-May FB TDG									107%	107%	107%	107%	107%			107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
13-May FB TDG	107%	108%	108%	107%	107%	107%	107%	107%		107%	107%	107%	107%	107%	107%		106%	106%							107%
14-May FB TDG								105%	105%		105%	105%							105%	105%	105%	105%	105%	105%	105%
15-May FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	105%	105%	105%	105%	106%	106%	105%
16-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%
17-May FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
18-May FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%			105%	105%	105%	105%	105%	105%
19-May FB TDG	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	106%	106%		106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
20-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
21-May FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
22-May FB TDG																									

Wells Dam TDG data 1998																										
DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
23-May	FB TDG	106%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
24 May	FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	104%	104%	104%	104%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
25 May	FB TDG	105%	105%	106%	106%	106%	106%	106%	106%	106%	105%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	106%	105%
26 May	FB TDG	106%	106%	106%	106%	107%	106%	107%	106%	106%	107%	106%	107%	107%	107%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	106%
27 May	FB TDG	105%	105%	105%	105%	105%	105%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	103%	103%	103%	103%	104%
28 May	FB TDG	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	104%	104%	104%	104%	104%	104%	104%	105%	105%	106%	105%	105%	104%
29 May	FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
30 May	FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	104%	104%	104%	104%	104%	104%	104%	105%	106%	106%	106%	106%	106%	106%	106%	105%
31 May	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	106%
1-Jun	FB TDG	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	107%
2 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	109%	109%	109%	109%	109%	108%	108%	108%	108%
3 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	110%	110%	110%	110%	110%	110%	109%	109%	109%
4 Jun	FB TDG	109%	109%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	106%	107%	106%	106%	106%	107%	107%	108%	108%	107%	107%	107%
5 Jun	FB TDG	107%	107%	107%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	108%	109%	109%	109%	109%	108%	108%	107%	107%	107%	107%
6 Jun	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	105%	106%	106%	105%	105%	105%	105%	106%	106%
7 Jun	FB TDG	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%	105%	106%	106%	106%	107%	107%	107%	108%	108%	108%	107%	106%
8 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%
9 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	108%	108%	108%	108%	108%	109%	108%
10 Jun	FB TDG	108%	109%	109%	109%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%
11 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	107%	108%	107%	108%	108%	107%
12 Jun	FB TDG	108%	108%	108%	107%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	107%	107%	107%	108%	107%	107%
13 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	106%	106%	106%	108%	108%
14 Jun	FB TDG	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
15 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	108%	108%	107%
16 Jun	FB TDG	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
17 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
18 Jun	FB TDG	108%	108%	108%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%
19 Jun	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	107%
20 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	110%	109%	109%	109%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
21 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	110%	110%	110%	110%	110%	111%	110%	110%	109%	109%	109%	109%	109%	109%
22 Jun	FB TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	109%
23 Jun	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	110%
24 Jun	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	110%	110%	111%	111%
25 Jun	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%
26 Jun	FB TDG	110%	110%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%
27 Jun	FB TDG	109%	109%	109%	108%	108%	108%	108%	108%	108%	109%	108%	108%	108%	108%	108%	109%	109%	108%	108%	108%	108%	108%	108%	108%	108%
28 Jun	FB TDG	108%	108%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%
29 Jun	FB TDG	109%	109%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%		110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	110%
30 Jun	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	111%	111%	111%	111%	111%	112%	112%	111%
1 Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	112%	112%	112%
2 Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	112%	112%	112%	112%	111%	111%	110%	110%	110%	110%	111%	112%
3 Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%	110%	109%	109%	109%	110%	110%	111%
4 Jul	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%
5 Jul	FB TDG	110%	110%	110%	110%	110%	110%	109%	110%	110%	110%	110%	110%	110%	111%	111%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
6 Jul	FB TDG	110%	110%	110%	110%	110%	110%	109%	109%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	110%
7 Jul	FB TDG	111%	110%	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%
8 Jul	FB TDG	111%	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	112%	112%	112%	113%	112%	113%	112%	112%	112%	112%	111%	111%	111%	112%
9 Jul	FB TDG	111%	112%	112%	111%	111%	112%	112%	112%	112%	112%	112%	113%	113%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	112%
10 Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	111%	112%	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	111%
11 Jul	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
12 Jul	FB TDG																									
13 Jul	FB TDG	110%	109%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%

Wells Dam TDG data 1998																										
DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
14-Jul	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	110%
15 Jul	FB TDG	110%	110%	110%	110%	110%	110%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
16 Jul	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%
17-Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	111%	112%	111%	111%	111%	111%	111%	111%	111%	112%	112%	111%
18-Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	112%
19-Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	111%
20-Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	111%	111%	112%	112%	112%	111%	111%	110%	110%	110%	110%	111%
21-Jul	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	112%	111%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%
22-Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	113%	113%	113%	113%	112%	112%	112%	112%	112%	112%	111%	112%	112%	112%
23-Jul	FB TDG	112%	112%	112%	111%	112%	112%	112%	112%	112%	112%	113%	113%	113%	114%	113%	113%	113%	113%	113%	113%	112%	112%	112%	112%	112%
24-Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	112%	112%	112%	111%	111%	112%
25-Jul	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	113%	112%	113%	114%	113%	114%	114%	113%	113%	112%	112%	112%	112%	112%	112%
26-Jul	FB TDG	112%	112%	112%	111%	112%	111%	111%	111%	112%	112%	112%	112%	114%	114%	115%	114%	114%	113%	113%	113%	113%	112%	112%	112%	112%
27-Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%
28-Jul	FB TDG	113%	113%	113%	113%	113%	113%	113%		113%	113%	113%		113%	113%	114%	114%	113%	113%	113%	113%	113%	113%	113%	112%	113%
29-Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%
30-Jul	FB TDG	113%	113%	113%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	114%	113%	113%	113%	113%	112%	112%	112%	113%
31-Jul	FB TDG	112%	112%	112%	112%	112%	112%	112%	111%	111%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%
1-Aug	FB TDG	111%	111%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	112%	112%	112%	112%	112%	112%	111%	111%	111%	110%	110%	111%
2-Aug	FB TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	112%	113%	113%	113%	112%	112%	111%	111%	111%	111%	111%	111%
3-Aug	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%
4-Aug	FB TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	112%	112%
5-Aug	FB TDG	112%	111%	111%	111%	111%	111%	111%	111%	112%	112%	113%	112%	113%	113%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%
6-Aug	FB TDG	111%	111%	111%	111%	111%	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	110%	111%
7-Aug	FB TDG	110%	110%	110%	109%	109%	109%	109%	109%	110%	110%	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%	109%	109%	109%	110%
8-Aug	FB TDG	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	111%	111%	111%	111%	110%	110%	109%	109%	109%	109%	109%	110%
9-Aug	FB TDG	109%	109%	108%	108%	108%	108%	108%	108%	109%	109%	109%	110%	110%	111%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	109%
10-Aug	FB TDG	109%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%	109%	109%	109%
11-Aug	FB TDG	109%	109%	109%	109%	109%	108%	108%	108%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%
12-Aug	FB TDG	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	109%
13-Aug	FB TDG	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	109%
14-Aug	FB TDG	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%	109%	109%
15-Aug	FB TDG	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	111%	111%	110%	110%	110%	110%	108%	108%	107%	107%	107%	107%	107%	107%
16-Aug	FB TDG	108%	108%	108%	107%	107%	107%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	107%
17-Aug	FB TDG	106%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	108%	107%	107%	106%	106%	106%	106%	106%
18-Aug	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	106%
19-Aug	FB TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	107%	108%	107%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%
20-Aug	FB TDG	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
21-Aug	FB TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
22-Aug	FB TDG	108%	108%	108%	108%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	106%	107%
23-Aug	FB TDG	108%	108%	108%	108%	108%	108%	107%	107%	107%	108%	108%	107%	107%	107%	107%	107%	107%	108%	107%	107%	107%	107%	107%	107%	107%
24-Aug	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	108%	108%	108%	108%	108%	107%	107%	107%	106%	106%	106%
25-Aug	FB TDG	107%	107%	107%	107%	107%	107%	107%	106%	107%	107%	107%	107%	107%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%
26-Aug	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	108%	108%	108%	108%	107%	107%	107%	107%	106%	107%
27-Aug	FB TDG	106%	106%	106%														107%	107%	107%	107%	107%	107%	106%	106%	107%
28-Aug	FB TDG	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	108%	108%	108%	107%	107%	107%	106%	106%	107%
29-Aug	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%
30-Aug	FB TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	106%
31-Aug	FB TDG	106%	106%	106%	105%	105%	106%	106%	106%	106%	106%															

Appendix B 1998 Wells Dam Tailwater TDG by hour

Wells Dam TDG data 1998

DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
1-Apr	TW TDG																									#####
2-Apr	TW TDG																									#####
3-Apr	TW TDG																									#####
4-Apr	TW TDG																									#####
5-Apr	TW TDG																									#####
6-Apr	TW TDG																									#####
7-Apr	TW TDG														106%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%	106%
8-Apr	TW TDG														106%	106%	106%	106%	107%	106%	106%	106%	106%	106%	106%	106%
9-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	105%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%
10-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%					106%	106%	106%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%
11-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	106%	106%	106%	106%	106%	106%	106%
12-Apr	TW TDG	106%	106%	106%	106%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	106%	106%	107%	108%	107%	106%	106%	105%	105%	106%
13-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	105%	105%	105%	105%	105%
14-Apr	TW TDG	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	106%	106%	106%	106%	106%	106%	106%	106%	105%	105%	105%	106%	107%	105%
15-Apr	TW TDG	105%	105%	105%	105%	105%	105%	105%	105%		105%	105%	105%	105%	105%	105%	105%	105%	107%	107%	107%	106%	106%	106%	106%	107%
16-Apr	TW TDG	107%	107%	107%	106%	106%	106%	107%	107%	107%	107%	107%	106%	106%	107%	107%	107%	107%	107%	106%	106%	106%	105%	106%	107%	106%
17-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	108%	107%	107%	107%	106%	106%	107%
18-Apr	TW TDG	107%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%
19-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%
20-Apr	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%		107%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	108%	107%	107%	107%	107%
21-Apr	TW TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	107%	108%	108%	108%	109%	108%	108%	108%	107%	107%	107%	107%	107%
22-Apr	TW TDG	108%	109%	109%	108%	108%	108%	107%	107%		106%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%
23-Apr	TW TDG	107%	107%	107%	107%	107%	107%	109%	109%	109%	109%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	109%
24-Apr	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	110%	110%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	108%
25-Apr	TW TDG	109%	109%	109%	108%	109%	108%	107%	107%	107%	108%	108%	108%	109%	109%	109%	109%	107%	107%	107%	107%	106%	106%	106%	106%	106%
26-Apr	TW TDG	106%	106%	105%	105%	105%	104%	104%	105%	105%	105%	106%	106%	107%	107%	107%	107%	107%	107%	107%	107%	106%	106%	106%	106%	106%
27-Apr	TW TDG	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%				107%	107%	107%	107%	107%	107%	107%	108%	108%	107%
28-Apr	TW TDG	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%
29-Apr	TW TDG	107%	107%	107%	107%	106%	106%	106%	107%	107%	107%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%
30-Apr	TW TDG	107%	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	108%	108%	107%
1-May	TW TDG	107%	107%	107%	106%	106%	106%	106%	106%		107%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%				108%
2-May	TW TDG													108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	108%
3-May	TW TDG	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	107%	108%	108%	107%	107%	107%	107%
4-May	TW TDG	107%	107%	107%	107%	107%	107%	107%	107%	108%		108%	108%	109%	109%	110%	110%	110%	110%	109%	110%	109%	109%	109%	109%	108%
5-May	TW TDG	109%	109%	109%	109%	109%	109%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	109%	109%
6-May	TW TDG	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%			109%	109%	109%									109%
7-May	TW TDG								109%	109%	109%	109%	109%	109%	109%	109%	109%	109%								109%
8-May	TW TDG									109%	109%	109%	109%	108%	108%	108%	107%	107%	107%	106%	106%	106%	107%	107%	108%	108%
9-May	TW TDG	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	108%
10-May	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%
11-May	TW TDG	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%		110%	110%	109%	109%	109%	109%	109%	109%	109%	109%	109%
12-May	TW TDG	117%	116%	112%	111%	111%	111%	110%	110%	110%	110%															112%
13-May	TW TDG									110%	110%	110%	109%	109%			109%	109%	109%	109%	109%	109%	109%	109%	110%	109%
14-May	TW TDG	110%	110%	110%	110%	110%	110%	110%	110%		109%	109%	109%	109%	109%	109%		108%	108%							109%
15-May	TW TDG								108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	108%	108%
16-May	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
17-May	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	108%
18-May	TW TDG	107%	107%	107%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
19-May	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%			108%	108%	108%	107%	108%	108%
20-May	TW TDG	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	108%	108%	108%	109%		109%	109%	109%	108%	108%	108%	108%	108%	108%	108%
21-May	TW TDG	109%	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	109%
22-May	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	108%	109%	109%	108%	108%	108%	107%	107%	108%

Wells Dam TDG data 1998

DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
23-May	TW TDG	107%	107%	107%	107%	107%	106%	107%	107%	107%	107%	107%	107%	107%	108%	107%	107%	107%	106%	106%	107%	106%	106%	107%	107%	107%
24-May	TW TDG	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	107%	107%	107%	106%	107%	106%	106%	107%	107%	107%	106%
25-May	TW TDG	107%	107%	107%	107%	107%	106%	106%	106%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%
26-May	TW TDG	108%	108%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%	107%	107%	107%	107%	108%
27-May	TW TDG	107%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	106%	106%	106%	106%	107%	107%	107%	107%	107%	106%	106%	106%	106%
28-May	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	106%	106%	106%	107%	107%	110%	113%	119%	107%
29-May	TW TDG	129%	126%	122%	121%	122%	122%	120%	111%	109%	108%	107%	107%	107%	107%	107%	108%	108%	110%	110%	114%	115%	114%	110%	111%	114%
30-May	TW TDG	110%	115%	115%	115%	116%	116%	114%	108%	107%	108%	107%	107%	108%	109%	112%	114%	114%	114%	112%	111%	110%	110%	109%	112%	111%
31-May	TW TDG	114%	114%	115%	116%	115%	116%	116%	116%	115%	115%	115%	115%	115%	115%	115%	115%	115%	118%	122%	123%	124%	124%	122%	123%	117%
1-Jun	TW TDG	124%	121%	120%	120%	119%	119%	119%	112%	110%	109%	109%	108%	108%	109%	115%	116%	116%	116%	119%	120%	122%	122%	122%	131%	117%
2-Jun	TW TDG	134%	129%	126%	121%	119%	119%	119%	117%	115%	116%	115%	113%	113%	113%	113%	117%	119%	117%	117%	118%	117%	117%	117%	126%	119%
3-Jun	TW TDG	129%	121%	117%	115%	114%	114%	113%	112%	110%	110%	110%	110%	110%	113%	113%	115%	116%	116%	116%	117%	118%	118%	118%	123%	116%
4-Jun	TW TDG	123%	118%	113%	112%	111%	111%	111%	110%	110%	110%	110%	110%	110%	110%	109%	109%	109%	109%	109%	109%	115%	119%	116%	121%	112%
5-Jun	TW TDG	120%	117%	118%	118%	118%	124%	128%	126%	116%	111%	113%	111%	116%	114%	114%	116%	117%	117%	120%	122%	126%	125%	117%	113%	118%
6-Jun	TW TDG	117%	119%	120%	119%	116%	113%	110%	109%	109%	109%	109%	109%	109%	109%	109%	111%	111%	111%	109%	109%	113%	114%	117%	116%	112%
7-Jun	TW TDG	119%	121%	118%	117%	117%	121%	126%	128%	128%	124%	112%	108%	107%	107%	108%	109%	109%	109%	109%	109%	109%	111%	115%	118%	115%
8-Jun	TW TDG	125%	126%	123%	119%	116%	112%	110%	110%	110%	109%	109%	108%	108%	110%	110%	110%	110%	111%	111%	110%	110%	110%	110%	110%	112%
9-Jun	TW TDG	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	111%	110%	111%	111%	110%	110%	111%	111%
10-Jun	TW TDG	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	109%	109%	109%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	109%
11-Jun	TW TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
12-Jun	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	108%
13-Jun	TW TDG	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	109%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	108%
14-Jun	TW TDG	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%
15-Jun	TW TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
16-Jun	TW TDG	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%	107%	108%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	109%	108%
17-Jun	TW TDG	109%	109%	109%	110%	110%	110%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%	110%
18-Jun	TW TDG	109%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	110%	110%	110%	110%	110%	110%	110%
19-Jun	TW TDG	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	110%	110%	111%	110%
20-Jun	TW TDG	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	111%	111%	111%
21-Jun	TW TDG	110%	110%	110%	110%	110%	110%	109%	109%	110%	110%	110%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%
22-Jun	TW TDG	111%	110%	110%	111%	111%	110%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	112%	112%	112%	112%	112%	112%
23-Jun	TW TDG	112%	112%	112%	113%	112%	112%	112%	112%	112%	113%	113%	113%	112%	112%	112%	113%	113%	113%	113%	113%	112%	112%	112%	112%	112%
24-Jun	TW TDG	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	112%	112%	112%	113%	113%	113%
25-Jun	TW TDG	113%	113%	113%	113%	113%	112%	112%	112%	113%	113%	113%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	112%	112%
26-Jun	TW TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	110%	111%	110%	111%	111%	111%
27-Jun	TW TDG	111%	111%	111%	111%	111%	110%	110%	110%	110%	110%	111%	111%	111%	112%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%	111%
28-Jun	TW TDG	111%	111%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	112%	113%	113%	113%	112%	112%	112%	112%	112%	111%	111%	111%
29-Jun	TW TDG	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	113%	113%		113%	112%	112%	112%	112%	112%	111%	112%	112%	112%	112%
30-Jun	TW TDG	112%	113%	113%	113%	113%	113%	113%	113%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%	113%	113%
1-Jul	TW TDG	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	114%
2-Jul	TW TDG	114%	113%	113%	113%	113%	113%	113%	113%	113%	113%	114%	115%	115%	115%	115%	115%	115%	114%	114%	113%	113%	113%	113%	113%	114%
3-Jul	TW TDG	113%	113%	113%	113%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	114%	114%	113%	113%	112%	112%	112%	112%	112%	113%
4-Jul	TW TDG	112%	112%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	113%	113%	113%	112%	113%	113%	113%	112%	112%	112%	112%
5-Jul	TW TDG	112%	111%	111%	111%	111%	111%	110%	110%	111%	111%	111%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%
6-Jul	TW TDG	112%	112%	111%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	113%	113%	113%	113%	113%	113%	112%	112%	112%	113%	113%	112%
7-Jul	TW TDG	113%	113%	112%	112%	112%	112%	112%	112%	112%	112%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%
8-Jul	TW TDG	114%	114%	114%	114%	114%	113%	113%	113%	113%	114%	114%	115%	115%	115%	116%	115%	115%	115%	115%	115%	115%	114%	114%	114%	114%
9-Jul	TW TDG	114%	114%	113%	113%	113%	113%	113%	113%	113%	114%	114%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	114%	114%	114%	114%
10-Jul	TW TDG	114%	113%	113%	113%	113%	112%	113%	113%	113%	113%	114%	114%	114%	114%	115%	115%	114%	114%	114%	114%	113%	114%	113%	113%	113%
11-Jul	TW TDG	113%	112%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%
12-Jul	TW TDG																									#####
13-Jul	TW TDG	112%	112%	112%	111%	111%	111%	111%	111%	111%	111%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	112%	112%

Appendix B 1998 Wells Dam Tailwater TDG by hour

Wells Dam TDG data 1998

DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
14-Jul	TW TDG	112%	112%	112%	112%	112%	111%	111%	112%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	112%	112%	112%	112%	112%
15 Jul	TW TDG	112%	112%	112%	112%	112%	112%	112%	112%	111%	112%	112%	113%	113%	113%	113%	113%	113%	113%	112%	112%	112%	112%	112%	112%	112%
16 Jul	TW TDG	112%	112%	112%	112%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%	113%
17-Jul	TW TDG	113%	113%	113%	113%	113%	113%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	114%
18-Jul	TW TDG	113%	113%	113%	113%	113%	113%	112%	113%	113%	113%	114%	114%	114%	115%	115%	115%	115%	114%	114%	114%	114%	113%	113%	113%	114%
19-Jul	TW TDG	113%	113%	113%	112%	112%	112%	111%	111%	111%	112%	112%	112%	113%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%	113%
20-Jul	TW TDG	113%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%	113%
21 Jul	TW TDG	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	115%	115%	115%	114%	114%	114%	114%	114%	114%	113%
22-Jul	TW TDG	113%	113%	113%	113%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	115%	115%	115%	115%	115%	115%	115%	115%	114%	114%	114%
23 Jul	TW TDG	113%	113%	113%	113%	113%	112%	112%	113%	113%	113%	114%	114%	114%	114%	115%	115%	115%	115%	114%	114%	114%	114%	113%	113%	114%
24 Jul	TW TDG	114%	113%	117%	118%	115%	114%	113%	113%	113%	113%	114%	114%	114%	114%	115%	115%	115%	115%	115%	115%	114%	114%	114%	114%	113%
25-Jul	TW TDG	113%	112%	112%	112%	112%	112%	112%	112%	112%	113%	113%	113%	114%	114%	115%	115%	115%	115%	115%	115%	115%	114%	114%	114%	114%
26-Jul	TW TDG	113%	113%	113%	112%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	114%
27-Jul	TW TDG	114%	114%	113%	113%	113%	113%	113%	113%	113%	114%	114%	114%	115%	115%	116%	116%	116%	116%	116%	115%	115%	115%	115%	115%	114%
28-Jul	TW TDG	114%	114%	114%	113%	113%	113%	113%		113%	113%	114%		115%	115%	115%	116%	116%	116%	116%	116%	115%	115%	115%	115%	114%
29-Jul	TW TDG	114%	114%	113%	113%	113%	112%	112%	112%	113%	113%	114%	114%	114%	115%	115%	115%	116%	116%	116%	116%	115%	115%	115%	115%	114%
30-Jul	TW TDG	114%	114%	114%	113%	113%	113%	113%	113%	113%	113%	113%	114%	114%	115%	115%	115%	115%	115%	115%	115%	114%	114%	114%	114%	114%
31-Jul	TW TDG	113%	113%	113%	113%	112%	112%	112%	112%	112%	112%	113%	113%	113%	113%	113%	113%	113%	113%	112%	112%	112%	112%	112%	112%	113%
1-Aug	TW TDG	112%	112%	112%	111%	111%	111%	111%	111%	110%	111%	111%	112%	112%	112%	113%	113%	113%	113%	113%	112%	112%	112%	112%	111%	112%
2 Aug	TW TDG	111%	111%	111%	111%	111%	110%	110%	110%	109%	110%	110%	111%	111%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	112%	111%
3 Aug	TW TDG	112%	111%	111%	111%	111%	111%	111%	111%	111%	112%	112%	113%	113%	113%	113%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%
4 Aug	TW TDG	113%	112%	112%	112%	112%	111%	111%	111%	112%	112%	112%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%
5 Aug	TW TDG	113%	113%	112%	112%	112%	112%	112%	112%	112%	113%	113%	114%	114%	114%	114%	114%	114%	114%	114%	114%	114%	113%	113%	113%	113%
6 Aug	TW TDG	112%	112%	112%	112%	112%	111%	111%	111%	111%	112%	113%	113%	114%	114%	114%	114%	114%	113%	112%	112%	112%	111%	111%	111%	112%
7 Aug	TW TDG	111%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%	111%	111%	111%
8 Aug	TW TDG	111%	110%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	112%	112%	112%	111%	111%	111%	111%	111%	110%	111%
9 Aug	TW TDG	110%	110%	110%	110%	109%	109%	109%	109%	109%	110%	110%	111%	111%	111%	111%	112%	112%	112%	112%	112%	112%	112%	111%	111%	111%
10 Aug	TW TDG	111%	110%	110%	110%	110%	110%	110%	110%	110%	111%	111%	112%	112%	112%	112%	112%	114%	114%	114%	114%	115%	115%	115%	114%	112%
11 Aug	TW TDG	112%	112%	111%	111%	111%	110%	110%	110%	111%	111%	111%	111%	112%	111%	110%	110%	110%	111%	114%	117%	118%	117%	115%	113%	112%
12 Aug	TW TDG	112%	110%	109%	109%	109%	108%	108%	109%	109%	109%	109%	110%	110%	110%	113%	116%	117%	117%	117%	115%	115%	114%	115%	115%	112%
13 Aug	TW TDG	115%	115%	112%	110%	109%	109%	109%	109%	109%	109%	109%	110%	110%	110%	110%	110%	110%	110%	113%	116%	117%	117%	117%	117%	112%
14 Aug	TW TDG	116%	115%	112%	111%	110%	110%	110%	110%	110%	110%	110%	111%	111%	111%	111%	111%	111%	111%	111%	114%	116%	117%	114%	111%	112%
15 Aug	TW TDG	110%	110%	110%	109%	109%	109%	109%	109%	109%	110%	110%	110%	111%	111%	111%	111%	111%	111%	110%	110%	109%	109%	109%	108%	110%
16 Aug	TW TDG	108%	108%	108%	108%	107%	106%	108%	107%	107%	107%	108%	108%	108%	108%	109%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%
17-Aug	TW TDG	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%
18-Aug	TW TDG	106%	106%	106%	106%	105%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	107%	107%	107%	106%	107%
19-Aug	TW TDG	106%	106%	106%	106%	106%	105%	105%	105%	105%	106%	106%	107%	107%	108%	108%	108%	109%	109%	109%	108%	108%	108%	108%	108%	107%
20-Aug	TW TDG	107%	107%	107%	107%	107%	106%	107%	107%	107%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%
21-Aug	TW TDG	108%	108%	108%	108%	108%	107%	108%	108%	108%	108%	108%	108%	109%	109%	108%	108%	108%	109%	110%	110%	110%	110%	108%	108%	108%
22-Aug	TW TDG	108%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	109%	109%	109%	109%	109%	109%	109%	108%	108%	108%	108%	108%
23 Aug	TW TDG	108%	108%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	108%	108%	108%	108%	108%	108%	107%	107%	107%	107%	107%	107%
24-Aug	TW TDG	107%	106%	106%	106%	106%	106%	106%	106%	106%	106%	106%	107%	107%	107%	107%	108%	108%								107%
25 Aug	TW TDG																									
26-Aug	TW TDG																									
27-Aug	TW TDG																									
28-Aug	TW TDG																									
29 Aug	TW TDG																									
30-Aug	TW TDG																									
31-Aug	TW TDG																									

Appendix C 1998 Wells Dam Percent spill by hour

Wells Dam TDG data 1998																									
DATE : Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
1-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	#####
5-Apr % spill	0%	0%	#####	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	8%	8%	7%	1%
15-Apr % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	7%	7%	8%	9%	9%
16-Apr % spill	8%	9%	12%	14%	10%	7%	7%	7%	8%	8%	11%	11%	10%	10%	10%	10%	9%	7%	8%	8%	7%	8%	9%	9%	10%
17-Apr % spill	13%	15%	15%	15%	9%	7%	6%	9%	9%	9%	9%	11%	11%	12%	11%	9%	10%	12%	11%	8%	10%	10%	9%	11%	10%
18-Apr % spill	10%	11%	12%	14%	8%	9%	10%	8%	9%	8%	9%	10%	10%	10%	10%	9%	9%	10%	9%	9%	5%	7%	8%	7%	9%
19-Apr % spill	22%	9%	7%	9%	10%	9%	12%	13%	8%	8%	8%	10%	8%	9%	11%	10%	9%	9%	11%	7%	7%	8%	8%	9%	8%
20-Apr % spill	7%	7%	8%	8%	6%	6%	5%	6%	6%	8%	7%	9%	9%	9%	7%	8%	9%	9%	10%	8%	6%	8%	8%	17%	8%
21-Apr % spill	11%	10%	9%	9%	8%	9%	8%	9%	8%	8%	7%	9%	8%	9%	8%	7%	7%	7%	7%	7%	6%	7%	8%	9%	8%
22-Apr % spill	14%	8%	9%	11%	10%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	6%	8%	9%	7%	9%
23-Apr % spill	9%	10%	11%	12%	11%	10%	9%	9%	8%	7%	9%	8%	8%	8%	10%	9%	10%	9%	9%	10%	8%	8%	12%	13%	9%
24-Apr % spill	11%	12%	18%	11%	8%	8%	9%	9%	10%	7%	8%	9%	8%	7%	8%	9%	10%	9%	8%	8%	6%	8%	12%	13%	9%
25-Apr % spill	10%	9%	10%	11%	7%	7%	8%	10%	8%	8%	9%	9%	9%	11%	10%	9%	10%	10%	9%	7%	5%	6%	8%	11%	9%
26-Apr % spill	3%	3%	3%	4%	4%	4%	5%	5%	6%	8%	9%	9%	10%	11%	11%	11%	9%	9%	8%	7%	5%	6%	10%	6%	7%
27-Apr % spill	6%	3%	4%	4%	3%	9%	8%	7%	8%	9%	8%	8%	8%	8%	7%	8%	8%	9%	9%	9%	8%	9%	11%	10%	7%
28-Apr % spill	10%	10%	8%	9%	10%	10%	10%	10%	10%	8%	8%	8%	8%	9%	10%	8%	8%	8%	7%	7%	7%	7%	10%	11%	9%
29-Apr % spill	11%	10%	11%	11%	10%	9%	9%	8%	9%	9%	9%	9%	8%	8%	8%	9%	10%	7%	8%	7%	6%	8%	8%	11%	9%
30-Apr % spill	9%	10%	15%	13%	9%	12%	9%	9%	9%	9%	8%	8%	9%	8%	9%	9%	9%	8%	7%	7%	6%	8%	10%	11%	9%
1-May % spill	10%	12%	11%	12%	10%	11%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	7%	7%	7%	9%	10%
2-May % spill	10%	11%	9%	9%	9%	9%	9%	9%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	8%	7%	8%	9%	9%	8%
3-May % spill	11%	10%	9%	9%	9%	9%	9%	9%	9%	8%	8%	8%	8%	8%	8%	8%	8%	8%	9%	8%	7%	7%	10%	9%	9%
4-May % spill	10%	12%	11%	9%	11%	9%	8%	7%	6%	6%	6%	7%	7%	7%	7%	7%	7%	6%	7%	6%	7%	7%	7%	7%	8%
5-May % spill	6%	7%	9%	11%	12%	9%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	6%	6%	6%	6%	8%	9%	7%
6-May % spill	10%	10%	10%	10%	9%	8%	7%	6%	6%	6%	6%	6%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%
7-May % spill	7%	8%	9%	8%	8%	8%	7%	7%	7%	7%	6%	7%	7%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%
8-May % spill	8%	9%	7%	9%	9%	8%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%
9-May % spill	7%	7%	7%	8%	8%	9%	9%	8%	7%	7%	6%	7%	7%	8%	8%	8%	8%	8%	8%	7%	7%	7%	8%	9%	8%
10-May % spill	10%	9%	9%	10%	11%	10%	9%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%	8%	7%	6%	6%	7%	9%	9%
11-May % spill	10%	10%	10%	10%	10%	9%	8%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	48%	9%
12-May % spill	15%	9%	11%	13%	13%	9%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%	8%	8%
13-May % spill	9%	11%	12%	13%	12%	10%	7%	6%	6%	6%	6%	6%	6%	6%	7%	7%	7%	6%	6%	6%	6%	7%	8%	9%	8%
14-May % spill	10%	11%	12%	11%	10%	9%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%	7%	6%	6%	6%	6%	6%	6%	7%
15-May % spill	8%	8%	9%	10%	9%	9%	8%	7%	6%	6%	6%	7%	7%	7%	7%	8%	8%	8%	8%	8%	7%	7%	7%	8%	8%
16-May % spill	10%	10%	10%	9%	9%	9%	9%	7%	8%	7%	7%	7%	7%	8%	7%	9%	7%	7%	7%	7%	7%	7%	7%	8%	8%
17-May % spill	9%	9%	9%	8%	8%	9%	9%	8%	8%	8%	7%	8%	8%	9%	9%	9%	9%	9%	7%	7%	7%	7%	8%	8%	8%
18-May % spill	11%	13%	13%	12%	12%	9%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%	11%	8%
19-May % spill	11%	11%	13%	13%	12%	11%	8%	7%	7%	7%	7%	7%	7%	7%	8%	8%	8%	7%	7%	7%	6%	6%	9%	13%	9%
20-May % spill	12%	10%	11%	13%	14%	12%	9%	7%	7%	6%	6%	6%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%	10%	11%	8%
21-May % spill	8%	10%	11%	11%	9%	8%	7%	7%	8%	8%	7%	7%	7%	7%	8%	8%	9%	8%	7%	7%	7%	8%	10%	10%	8%
22-May % spill	9%	12%	12%	11%	10%	8%	8%	7%	7%	7%	7%	7%	8%	9%	9%	8%	9%	10%	9%	8%	8%	8%	8%	8%	9%

Appendix C 1998 Wells Dam Percent spill by hour

Wells Dam TDG data 1998																									
DATE Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
23-May % spill	12%	10%	10%	9%	10%	10%	11%	9%	7%	7%	7%	8%	9%	9%	8%	8%	8%	8%	9%	8%	8%	8%	9%	11%	9%
24 May % spill	13%	11%	9%	10%	11%	11%	9%	8%	8%	9%	9%	9%	9%	9%	9%	9%	8%	8%	7%	7%	7%	8%	9%	8%	9%
25 May % spill	9%	9%	11%	8%	9%	8%	11%	9%	8%	7%	6%	7%	8%	9%	9%	9%	8%	7%	8%	8%	8%	7%	9%	9%	8%
26 May % spill	10%	8%	8%	8%	10%	8%	7%	6%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	8%
27 May % spill	10%	10%	10%	10%	10%	9%	7%	7%	7%	7%	7%	6%	7%	7%	7%	7%	8%	8%	9%	8%	7%	7%	9%	10%	8%
28 May % spill	10%	10%	9%	9%	9%	8%	6%	6%	6%	7%	7%	6%	6%	6%	6%	6%	6%	6%	11%	11%	17%	23%	28%	56%	12%
29 May % spill	51%	39%	46%	55%	49%	39%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	19%	19%	21%	28%	29%	21%	20%	18%	21%
30 May % spill	31%	28%	33%	34%	32%	27%	6%	6%	7%	6%	6%	17%	17%	20%	27%	27%	26%	24%	18%	17%	16%	11%	24%	28%	20%
31 May % spill	34%	40%	45%	36%	40%	38%	33%	30%	29%	29%	28%	28%	28%	28%	28%	27%	33%	39%	40%	43%	41%	38%	41%	44%	35%
1-Jun % spill	35%	35%	37%	39%	39%	39%	8%	6%	6%	6%	6%	6%	6%	25%	28%	27%	26%	31%	34%	39%	39%	34%	53%	60%	28%
2 Jun % spill	52%	45%	34%	33%	33%	35%	22%	23%	28%	28%	21%	20%	20%	20%	27%	31%	29%	27%	29%	30%	29%	28%	41%	45%	30%
3 Jun % spill	37%	29%	21%	21%	21%	21%	6%	6%	6%	6%	6%	6%	19%	20%	22%	25%	25%	25%	27%	30%	29%	29%	44%	41%	22%
4 Jun % spill	14%	9%	8%	7%	8%	8%	7%	7%	7%	8%	8%	9%	7%	7%	7%	7%	7%	7%	8%	13%	37%	32%	36%	37%	13%
5 Jun % spill	30%	32%	31%	31%	43%	53%	49%	31%	9%	13%	12%	28%	26%	26%	26%	29%	27%	35%	38%	48%	46%	28%	11%	32%	30%
6 Jun % spill	36%	38%	36%	28%	12%	11%	10%	9%	8%	8%	8%	8%	8%	8%	19%	19%	17%	9%	10%	23%	25%	33%	33%	39%	19%
7 Jun % spill	42%	32%	32%	31%	40%	49%	57%	54%	44%	12%	6%	6%	6%	7%	8%	7%	7%	6%	6%	7%	8%	26%	32%	61%	25%
8-Jun % spill	58%	50%	38%	23%	10%	9%	9%	8%	6%	7%	6%	6%	6%	6%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	13%
9-Jun % spill	10%	11%	11%	12%	11%	10%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	8%	6%	6%	9%	8%	8%
10-Jun % spill	9%	8%	9%	10%	9%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
11 Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12-Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13-Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14-Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15-Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16-Jun % spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17-Jun % spill	12%	8%	8%	8%	8%	7%	7%	5%	5%	5%	6%	7%	7%	6%	7%	6%	6%	6%	6%	6%	6%	5%	5%	7%	4%
18-Jun % spill	9%	7%	8%	7%	7%	7%	7%	8%	7%	6%	6%	5%	6%	6%	6%	6%	6%	7%	7%	7%	6%	6%	8%	9%	7%
19-Jun % spill	9%	9%	10%	10%	10%	9%	7%	7%	7%	7%	7%	6%	6%	6%	6%	7%	7%	7%	7%	7%	7%	7%	7%	9%	7%
20-Jun % spill	8%	9%	9%	10%	10%	11%	10%	9%	8%	7%	7%	8%	8%	8%	8%	8%	6%	6%	6%	7%	7%	7%	7%	8%	7%
21-Jun % spill	13%	10%	14%	13%	11%	12%	10%	11%	8%	9%	11%	10%	10%	10%	10%	10%	8%	8%	9%	9%	9%	8%	9%	9%	9%
22-Jun % spill	11%	10%	10%	10%	10%	13%	11%	9%	9%	8%	7%	7%	6%	6%	6%	6%	10%	10%	9%	9%	7%	9%	8%	10%	10%
23-Jun % spill	9%	10%	10%	9%	10%	11%	9%	7%	7%	6%	6%	6%	6%	6%	6%	6%	6%	7%	9%	9%	9%	7%	7%	9%	8%
24-Jun % spill	9%	10%	11%	12%	13%	14%	12%	9%	8%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%	7%	7%	7%	7%	9%	7%
25-Jun % spill	10%	13%	14%	14%	14%	13%	10%	8%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	7%	8%	8%
26-Jun % spill	8%	10%	11%	12%	12%	12%	10%	8%	7%	7%	7%	6%	6%	6%	6%	7%	7%	7%	7%	7%	6%	6%	7%	8%	8%
27-Jun % spill	9%	10%	11%	10%	9%	9%	8%	8%	8%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	9%	8%	8%	8%	10%	9%
28-Jun % spill	10%	11%	11%	11%	11%	12%	12%	9%	7%	6%	6%	7%	8%	8%	9%	9%	9%	8%	8%	7%	7%	7%	7%	10%	9%
29-Jun % spill	12%	14%	14%	15%	16%	16%	12%	9%	8%	7%	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	9%
30-Jun % spill	9%	10%	12%	13%	13%	13%	10%	9%	7%	7%	6%	6%	7%	7%	7%	6%	6%	6%	6%	6%	6%	6%	7%	10%	8%
1-Jul % spill	10%	10%	9%	10%	10%	11%	11%	11%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	7%	7%	7%	7%	7%	8%	9%
2-Jul % spill	9%	10%	11%	11%	9%	10%	10%	8%	7%	7%	8%	8%	8%	8%	8%	8%	7%	7%	7%	7%	8%	8%	8%	9%	8%
3 Jul % spill	11%	13%	9%	10%	10%	10%	9%	8%	8%	8%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%	8%	8%	9%	8%	8%
4-Jul % spill	10%	13%	15%	16%	15%	14%	14%	12%	9%	8%	9%	9%	9%	9%	9%	8%	8%	9%	9%	10%	10%	10%	8%	9%	10%
5-Jul % spill	12%	14%	13%	12%	13%	14%	15%	15%	12%	10%	9%	9%	9%	8%	8%	8%	8%	7%	7%	6%	7%	7%	9%	9%	10%
6-Jul % spill	8%	9%	10%	10%	10%	12%	11%	9%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	6%	7%	8%	8%
7-Jul % spill	10%	11%	10%	9%	9%	10%	9%	8%	8%	7%	8%	8%	8%	7%	7%	8%	7%	7%	7%	7%	7%	7%	8%	10%	8%
8 Jul % spill	10%	12%	13%	12%	15%	16%	13%	11%	10%	10%	9%	9%	8%	8%	7%	8%	7%	7%	7%	8%	8%	9%	9%	9%	9%
9-Jul % spill	11%	12%	15%	19%	19%	16%	12%	11%	10%	9%	9%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	8%
10-Jul % spill	11%	12%	15%	18%	20%	18%	14%	11%	9%	10%	9%	9%	9%	9%	9%	10%	9%	9%	7%	7%	7%	11%	12%	12%	14%
11-Jul % spill	15%	18%	20%	21%	22%	19%	14%	13%	14%	11%	9%	10%	10%	10%	10%	10%	10%	9%	12%	11%	10%	10%	10%	8%	9%
12-Jul % spill	12%	11%	12%	12%	13%	11%	14%	20%	20%	14%	10%	9%	9%	9%	9%	9%	9%	9%	9%	9%	8%	8%	8%	10%	14%
13-Jul % spill	14%	18%	21%	20%	21%	19%	22%	14%	10%	9%	9%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	9%	12%

Appendix C 1998 Wells Dam Percent spill by hour

Wells Dam TDG data 1998																										
DATE	Name	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10	Hour 11	Hour 12	Hour 13	Hour 14	Hour 15	Hour 16	Hour 17	Hour 18	Hour 19	Hour 20	Hour 21	Hour 22	Hour 23	Hour 24	Avg Q
14-Jul	% spill	13%	12%	14%	15%	15%	15%	13%	10%	10%	9%	9%	9%	9%	8%	7%	7%	7%	7%	7%	7%	7%	8%	9%	11%	10%
15 Jul	% spill	13%	17%	20%	24%	22%	17%	16%	10%	9%	8%	8%	8%	7%	8%	7%	7%	7%	7%	6%	6%	6%	7%	7%	10%	11%
16 Jul	% spill	11%	12%	13%	17%	18%	17%	14%	10%	8%	7%	7%	6%	6%	6%	6%	7%	7%	7%	7%	7%	7%	7%	7%	7%	9%
17 Jul	% spill	8%	10%	13%	16%	17%	17%	11%	9%	8%	8%	7%	7%	7%	7%	6%	6%	6%	7%	7%	6%	6%	7%	7%	8%	9%
18 Jul	% spill	10%	9%	10%	11%	12%	12%	11%	12%	8%	9%	8%	7%	8%	8%	8%	8%	7%	8%	8%	8%	8%	9%	10%	10%	9%
19 Jul	% spill	11%	11%	12%	13%	10%	11%	12%	12%	10%	10%	8%	8%	8%	8%	8%	8%	7%	7%	7%	7%	7%	7%	9%	10%	9%
20 Jul	% spill	10%	10%	10%	10%	10%	10%	9%	8%	7%	6%	8%	8%	8%	8%	8%	8%	7%	7%	7%	7%	7%	8%	9%	10%	8%
21 Jul	% spill	14%	15%	19%	21%	22%	20%	14%	10%	9%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	9%	10%
22 Jul	% spill	11%	10%	10%	12%	13%	11%	10%	8%	8%	7%	9%	9%	8%	8%	7%	7%	7%	7%	7%	7%	8%	8%	7%	8%	9%
23 Jul	% spill	11%	10%	11%	11%	10%	10%	9%	8%	8%	8%	7%	7%	8%	7%	7%	7%	7%	8%	8%	9%	9%	8%	8%	10%	9%
24 Jul	% spill	48%	31%	9%	10%	9%	9%	11%	10%	9%	8%	7%	7%	7%	8%	8%	8%	8%	9%	9%	8%	8%	7%	7%	8%	11%
25 Jul	% spill	9%	9%	10%	11%	11%	11%	11%	10%	11%	9%	8%	8%	8%	8%	7%	8%	8%	8%	9%	9%	8%	8%	8%	9%	9%
26 Jul	% spill	9%	10%	11%	11%	12%	10%	11%	10%	9%	10%	8%	8%	8%	8%	8%	8%	8%	8%	7%	7%	8%	9%	8%	9%	9%
27 Jul	% spill	8%	9%	9%	9%	9%	9%	9%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	8%	8%	7%	7%	7%	8%	9%	8%
28 Jul	% spill	9%	9%	10%	11%	10%	10%	10%	9%	8%	8%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	10%	11%	9%
29 Jul	% spill	10%	10%	10%	11%	15%	12%	9%	9%	9%	9%	8%	7%	7%	7%	7%	8%	9%	9%	10%	9%	9%	9%	10%	10%	9%
30 Jul	% spill	10%	12%	12%	13%	12%	9%	11%	8%	8%	8%	8%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	9%	9%	11%	10%
31 Jul	% spill	11%	13%	14%	14%	13%	11%	9%	9%	8%	8%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	9%	11%	9%
1-Aug	% spill	11%	11%	13%	12%	10%	12%	13%	13%	11%	10%	11%	9%	9%	9%	9%	9%	9%	9%	9%	10%	10%	9%	9%	11%	10%
2 Aug	% spill	9%	10%	11%	12%	12%	14%	16%	16%	16%	14%	11%	10%	10%	11%	10%	9%	9%	8%	8%	9%	9%	9%	9%	9%	11%
3 Aug	% spill	11%	12%	10%	10%	11%	11%	10%	8%	9%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	8%	9%	10%	8%
4 Aug	% spill	9%	11%	13%	14%	16%	14%	11%	9%	8%	7%	7%	8%	6%	7%	7%	8%	8%	7%	7%	8%	8%	8%	8%	10%	9%
5 Aug	% spill	9%	11%	12%	14%	12%	10%	10%	9%	8%	8%	8%	7%	7%	6%	7%	7%	7%	7%	7%	7%	8%	8%	8%	10%	9%
6 Aug	% spill	10%	11%	11%	13%	13%	11%	9%	10%	10%	8%	8%	8%	7%	7%	8%	8%	7%	7%	6%	7%	7%	6%	7%	7%	9%
7 Aug	% spill	8%	9%	10%	10%	11%	10%	9%	8%	7%	8%	7%	6%	6%	7%	7%	7%	6%	6%	6%	6%	6%	7%	7%	7%	8%
8 Aug	% spill	9%	9%	9%	9%	8%	9%	8%	7%	7%	7%	7%	6%	6%	6%	6%	6%	6%	7%	8%	8%	9%	9%	6%	8%	8%
9 Aug	% spill	8%	7%	8%	9%	9%	11%	13%	11%	9%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	6%	7%	9%	8%
10 Aug	% spill	14%	9%	9%	9%	9%	7%	8%	6%	5%	5%	5%	5%	5%	5%	5%	16%	16%	17%	16%	20%	21%	21%	19%	6%	11%
11 Aug	% spill	6%	8%	8%	10%	10%	9%	8%	8%	7%	7%	6%	6%	0%	0%	0%	0%	14%	27%	27%	26%	0%	17%	17%	6%	9%
12 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%	22%	25%	25%	24%	18%	19%	19%	19%	19%	21%	9%
13 Aug	% spill	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	25%	25%	25%	26%	28%	20%	7%
14 Aug	% spill	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	20%	23%	26%	4%	0%	0%	4%
15 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
21 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	8%	8%	8%	4%	0%	0%	0%	1%
22 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%
23 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
24 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
25 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
26 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
27 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
28 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
29 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
31 Aug	% spill	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Appendix D. Forebay daily average TDG levels at Boundary (RM 745), Grand Coulee (RM 597), Chief Joseph (RM 545), Wells (RM 515) and Rocky Reach (RM 474).

	Apr-98					May-98				
Date	Boundary	G. Coulee	Ch. Joseph	Wells	R. Reach	Boundary	G. Coulee	Ch. Joseph	Wells	R. Reach
1	105.9	104.7	104.8			113.8	108.2	106.9	105.7	109.1
2	102.9	105.3	103.9		105.2	113.6	109.9	107.3	106.2	109.4
3	108.8	105.7	104.3		104.8	115.5	109.4	107.3	106.2	109.2
4	104.2	106.2	105.3		105.8	116.8	108.3	107.4	106.4	109.2
5	103.3	106.4	105.9			116.9	107.6	108.0	106.3	109.4
6	103.6	107.4	106.6		107.0	117.1	107.3	108.4	106.4	108.0
7	104.5	107.4	106.2	105.6	107.1	117.7	107.0	108.2	106.5	108.6
8	107.8	105.7	105.6	105.5	106.5	116.8	107.6	108.4	106.2	108.1
9	109.0	106.1	105.9	105.4	107.6	116.2	107.7	107.9	105.8	106.8
10	109.6	107.2	106.7	105.7	108.4	116.6	107.7	108.2	106.6	106.1
11	108.9	107.7	107.2	106.5	109.3	117.0	108.3	108.9	107.2	108.0
12	107.1	106.9	106.1	106.0	109.6	117.0	108.9	109.0	107.6	109.9
13	104.7	106.3	105.8	106.1	107.7	116.4	108.9	109.0	107.3	110.0
14	103.9	106.2	105.9	105.8	107.6	112.7	110.1	108.2	107.2	108.6
15	104.0	105.5	105.8	105.7	108.1	125.7	126.8	107.1	105.3	105.8
16	103.0	104.8	105.6	105.2	107.4	135.4	138.1	107.2	105.4	105.7
17	103.1	104.3	105.3	104.7	107.6	134.0	142.8	107.6	105.5	105.5
18	103.3	106.2	105.3	104.9	107.4	128.5	108.9	106.8	104.8	106.0
19	103.9	106.5	105.4	105.9	108.1	118.5	104.6	107.1	105.1	107.0
20	104.1	107.4	105.6	105.3	109.0	118.4	110.1	108.0	105.8	108.2
21	104.6	108.7	105.9	106.0	109.9	118.4	108.1	108.4	106.2	108.1
22	104.9	109.3	106.8	105.7	111.0	118.6	109.5	109.1	106.2	108.6
23	105.7	111.6	107.8	106.7	111.5	118.8	107.3	108.5		108.5
24	110.0	109.3	107.0	106.9	109.8	119.4	107.7	108.6		108.4
25	113.4	104.5	105.8	105.5	108.8	118.7	107.5	108.9		108.0
26	114.4	105.0	104.9	104.7	107.8	117.3	107.7	108.5	105.5	107.5
27	113.8	106.1	105.2	105.3	108.6	118.8	108.7	107.4	104.1	107.5
28		105.6	105.6	105.1	108.8	122.4	109.5	106.7	103.8	107.0
29	112.1	106.4	106.1	104.9	109.1	123.9	110.3	108.1	105.3	109.0
30	112.6	108.4	106.6	105.1	108.5	123.7	109.5	107.1	105.1	111.3
31						124.3	109.7	107.8	106.2	110.6

Appendix D. Forebay daily average TDG levels at Boundary (RM 745), Grand Coulee (RM 597), Chief Joseph (RM 545), Wells (RM 515) and Rocky Reach (RM 474).

	Jun-98					Jul-98				
Date	Boundary	G. Coulee	Ch. Joseph	Wells	R. Reach	Boundary	G. Coulee	Ch. Joseph	Wells	R. Reach
1	124.2	110.7	110.0	107.0	115.0	123.8	114.4	113.3	111.7	111.3
2	124.4	110.1	109.8	107.8	116.3	123.7	113.8	113.2	111.8	111.6
3	125.1	109.5	110.9	108.7	117.5	123.4	113.8	113.2	111.0	111.2
4	123.3	109.5	110.4	107.3	114.5	122.0	113.6	112.7		110.1
5	122.4	109.5	109.1	107.2	112.5		113.5	112.5		109.7
6	122.3	109.3	108.6	105.8	115.2		112.9	112.6	109.5	110.0
7	122.2	109.6	109.6	105.6	114.4		112.9	113.5	111.2	109.6
8	122.0	109.5	108.9	107.3	113.9		113.0	112.8	111.8	112.4
9	121.8	107.5	109.9	108.0	112.1		113.6	112.4	111.8	113.6
10	122.0	108.4	109.8	107.8	110.1		113.9	112.8	110.9	111.6
11	122.9	108.7	109.6	107.3	108.4		113.7	112.7	109.9	111.2
12	121.7	110.3	109.8	107.4	107.3		113.7	112.4		110.1
13	121.8	110.3	109.5	107.7	106.9		114.2	112.3	109.8	109.2
14	121.5	109.6	107.9	106.8	105.6		114.2	112.5	110.3	109.0
15	121.9	110.8	109.9	107.2	107.5		114.0	112.0	109.9	110.1
16	121.9	110.9	109.7	107.2	105.9	124.0	114.2	113.0	110.4	111.1
17	122.1	111.3	109.1	107.4	105.0	120.1	114.4	113.4	111.4	112.5
18	123.0	111.7	109.8	107.4	106.9	119.9	113.9	114.1	111.7	113.4
19	124.7	111.9	110.2	107.4	108.3	121.5	114.5	113.9	111.3	112.8
20	124.9	111.9	110.3	108.2	107.3	123.8	114.6	113.3	111.0	112.2
21	124.9	112.5	110.6	108.8	108.0	123.6	114.5	113.4	111.0	110.8
22	125.7	113.6	111.8	109.2	110.1	121.1	114.8	113.9	111.8	110.7
23	125.4	114.0	113.0	109.9	110.6	117.5	115.2	114.2	112.7	110.9
24	124.2	114.6	112.8	110.6	111.1	116.8	114.9	113.8	112.2	110.4
25	123.6	114.6	112.5	109.4	109.7	115.3	114.3	113.8	112.2	110.2
26	123.5	114.2	111.4	108.7	108.7	115.1	114.1	114.1	112.5	110.2
27	123.4	114.0	111.0	108.5	108.4	118.6	114.2	114.5	112.7	111.8
28	123.2	114.1		109.4	108.5	118.9	114.4	114.0	112.7	111.8
29	123.4	114.2	112.9	109.7	110.0	119.4	112.7	109.6	113.0	111.3
30	123.3	114.4	112.9	111.1	111.3	120.4	114.0	113.9	112.8	110.9
31						119.8	113.8	113.6	111.3	110.2

Appendix D. Forebay daily average TDG levels at Boundary (RM 745), Grand Coulee (RM 597), Chief Joseph (RM 545), Wells (RM 515) and Rocky Reach (RM 474).

	Aug-98				
Date	Boundary	G. Coulee	Ch. Joseph	Wells	R. Reach
1	118.8	112.8	112.6	110.9	109.7
2	116.7	112.5	112.5	110.8	109.1
3	118.1	112.6	112.9	111.2	108.8
4	119.1	112.9	113.6	111.5	108.8
5	118.0	113.4	113.6	111.7	109.6
6	124.1	113.0	111.9	110.6	109.2
7	121.2	113.1	111.9	109.9	108.6
8	118.3	112.5	111.7	109.6	108.5
9	117.5	112.5	112.1	109.3	108.7
10	117.3	112.2	111.6	109.4	103.5
11	116.6	111.5	111.2	108.7	107.0
12		111.0	110.6	108.6	107.8
13		111.1	110.8	109.0	107.7
14		111.4	111.7	109.5	108.1
15		111.7	111.8	109.4	107.2
16		111.1	110.6	107.0	105.6
17		109.9	109.8	106.6	103.6
18	116.6	109.7	110.5	106.3	103.1
19	116.9	110.5	110.2	106.4	102.2
20	112.4	110.7	110.5	107.1	106.1
21	116.5	110.6	110.3	107.5	109.1
22	118.6	110.5	109.8	107.8	109.1
23	118.3	110.5	109.6	107.4	106.2
24	118.2	110.1	109.1	106.6	104.7
25	119.0	110.6	109.8	107.2	103.6
26	119.3	110.4	109.6	106.5	102.3
27	118.1	109.8	108.8	107.0	100.9
28	118.8	109.6	108.4	106.5	100.7
29	117.2	110.1	109.5	106.8	101.6
30	116.1	109.7	108.7	106.1	101.3
31	116.7	109.5	108.8	106.7	101.7

SUMMARY REPORT;
METHOW BASIN SPRING CHINOOK SALMON HATCHERY;
1996 BROOD YEAR

APPENDIX F

Summary Report for the 1996 Brood Year Methow Basin Spring Chinook Salmon Hatchery Program

Prepared for
Douglas County Public Utility District

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ABSTRACT

The juvenile migrant bypass system at Wells Dam, Washington, 830.1 km from the mouth of the Columbia River, was completed in 1988, but some juveniles were still killed passing the dam (Skalski et al. 1996). To mitigate for these losses, Douglas County Public Utility District built the Methow Hatchery (MH) on the Methow River, to supplement adult production while minimizing ecological and genetic risks to the natural population. The objective is to release 22,700 kg (50,000 lbs.) of yearling spring chinook salmon at 30 g each year. This requires trapping enough adult broodstock to meet the release numbers. In addition, the MH is directed to maintain the genetic integrity of the Methow, Chewuch, and Twisp river stocks, and to release high quality smolts (Peck 1993).

Washington Department of Fish and Wildlife personnel trapped 464 Methow Basin bound spring chinook salmon at Wells Dam in 1996. The age and origin was determined for each fish using acetate imprint readings and/or elemental scale analysis. One hundred and forty-six hatchery origin fish with adipose fins were transferred to the Winthrop National Fish Hatchery (WNFH) on 18 July 1996. MH retained 318 salmon to spawn, of which 126 were wild. Elemental scale analysis of the first 100 wild fish collected gave a 60% probability that 46 fish originated from the Methow River, 11 from the Chewuch River and 13 from the Twisp River. The remaining 192 fish were either CWT marked or had a hatchery origin scale pattern and arrived after the 18 July transfer to WNFH. Wild fish with known origins provided a base for spawning the three recognized populations. We used 55 females and 59 males for the Methow population, 32 females and 33 males for the Chewuch population and 22 females and 27 males for the Twisp population.

Of the fish trapped at Wells Dam, 93.8% survived to spawn and 95.7% of those transferred to the Methow Hatchery survived to spawning. The egg take for the Methow River program was 219,977. Green egg to fry survival was 97.1%, fry to smolt survival was 95.0%, and green egg to smolt survival was 92.3%. The egg take for the Chewuch River program was 120,402. Green egg to fry survival was 94.3%, while fry to smolt survival was 80.8% and green egg to smolt survival was 76.1%. The egg take for the Twisp River program was 85,843. Green egg to fry survival was 94.0%, fry to smolt survival was 95% and green egg to smolt survival was 89.3%.

INTRODUCTION

Mitigation for the effects of hydroelectric development on out-migrating juvenile salmon and steelhead was not considered in the agreements which guided the original fishery mitigation efforts for Wells Dam. After low flows in the 1970's, fisheries agencies and tribes petitioned the Federal Energy Regulatory Commission to require Douglas County Public Utility District #1 (PUD) to provide a bypass system for out-migrating juvenile salmonids. This reduced the number of juveniles passing through turbines, but some losses still occurred, so the PUD built a hatchery on the Methow River as mitigation for these losses. The Wells Coordinating Committee developed a comprehensive evaluation plan designed to monitor progress towards meeting the hatchery program objectives required under the Wells Project Settlement Agreement. The Wells Coordinating Committee includes representatives of the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife, Columbia River Intertribal Fish Commission, the Yakama Indian Nation (YIN), the Colville Confederated Tribes and Douglas County PUD and its purchasers.

Long-term monitoring of the hatchery performance is based on the following objectives:

1. **Determine whether the MH can meet a negotiated production level for compensation during development of the artificial propagation program facilities as required in the Wells Project Settlement Agreement.**
2. **Determine whether the Methow Phase 1 hatchery program conserves the genetic success, genetic integrity, and long-term fitness of the natural spawning populations of salmon in the Columbia River above Wells Dam.**
3. **Determine whether smolts released from the acclimation facilities disperse and migrate downstream without affecting the natural populations.**

The objectives may be modified annually to better accomplish the goals of the evaluation plan. This report summarizes the 1996 BY evaluation of the MH. The contract period is 1 July 1997 to 30 June 1998 between Douglas County PUD and WDFW.

STUDY SITE

Methow Hatchery

The MH, designed by Fish Pro Inc., consists of a central hatchery, two satellite acclimation ponds, and two satellite adult trapping facilities (Figure 1). It provides separate incubation and rearing for the three Methow Basin spring chinook salmon stocks. It is located in Winthrop WA, along the Methow River 83 km from its confluence with the Columbia River. The hatchery has 3 canopy covered adult salmon holding raceways, 12 canopy covered juvenile raceways, 24 indoor start tanks, 3 separate incubation rooms with 15 single stack vertical incubators and a plastic lined acclimation pond. About 200 m upstream from the MH and the adjacent Foghorn Irrigation Ditch intake, which provides the hatchery with Methow River water, is a small boulder dam and adult collection trap for Methow River spring chinook.

Four ground water wells provide 0.28 m^3/s of water. The well water temperature is a constant 9°C all year. The MH also uses up to 0.31 m^3/s of Methow River water. An additional 0.2 m^3/s is shared with the WNFH during the spring. The WNFH is located 2.4 km downstream from the MH.

The MH program was designed to use only naturally produced spring chinook salmon for broodstock. Actual broodstock composition varies, and is dependent upon the availability of wild and hatchery fish. To better prepare fish for post-release survival, juveniles are reared differently than at conventional hatcheries. For example, the maximum density index the fish are reared under at the MH is 0.125 lbs. of fish/cu. ft. of rearing space/in. of fish, and some raceways have been altered to increase flow. The production goal is 250,000 yearling spring chinook salmon for each of the Methow, Chewuch and Twisp rivers.

Chewuch Acclimation Pond and Adult Trap

Chewuch pond is 9.6 km up the Chewuch River from its confluence with the Methow. It is a large cobble lined pond, with Chewuch River water supplied by gravity from the Chewuch Canal Company's irrigation ditch. Maximum flow is 0.16 m^3/s. Chewuch broodstock are collected at Fulton Dam, rkm 2.4. The Dam is a man-made barrier of boulders directing upstream migrants to a denil (steep-pass) ladder and into a v-trap.

Twisp Acclimation Pond and Adult Trap

Twisp pond is 8 km up the Twisp River from its confluence with the Methow. Like the Chewuch Pond, it is also cobble lined. The pond is gravity fed with Twisp River water from the Twisp Valley Power irrigation canal. The adult trap, located adjacent to the outfall of the acclimation pond, includes a floating picket weir to direct fish into the v-trap.

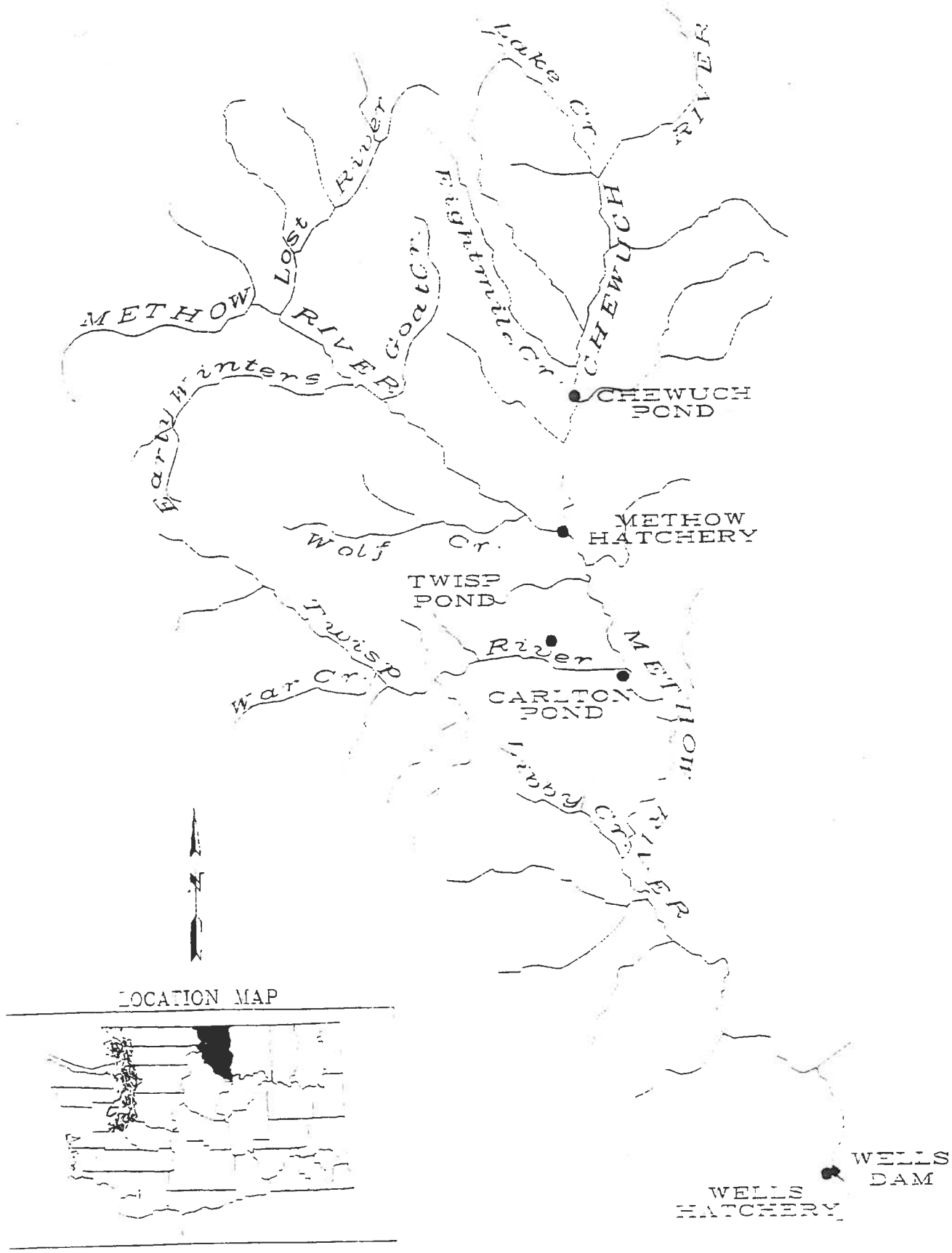
BROODSTOCK MANAGEMENT

Adult Collection

Spawner/recruit ratios indicate the stocks are not replacing themselves (L. LaVoy-WDFW personal communication). Escapements in 1994 and 1995 were the lowest on record and the projected escapement for 1996 was less than 350 fish. Consequently, aggressive intervention was necessary because hatchery broodstock collection and rearing offered a considerable egg to smolt survival advantage over natural production.

All adults used for the MH broodstock were collected from the east or west ladder of Wells Dam in 1996. We began spring chinook collection on 5 May and continued into the first part of August to ensure collection of the entire spring chinook run (Table 1). Spring chinook trapped at Wells Dam were held in the steelhead adult holding pond at Wells Hatchery until identification and transfer to the MH. Five or six non-regenerated scales were taken from each spring chinook.

METHOW RIVER BASIN



In addition, a unique visual implant (VI) tag was placed into the adipose tissue behind both eyes of every sampled fish. Scales were sent to the WDFW- Scale Analysis Lab in Olympia for determination of age and origin (hatchery or wild) using acetate imprints. One scale from each of the first 100 wild fish collected was cleaned and mounted on petrographic slides. Prepared slides were sent to Elemental Research, Inc. of Vancouver B.C. for elemental analysis (C. Knudsen-WDFW Document 1996). Identification and transfer of fish from Wells Dam to Methow Hatchery occurred at least twice a week. We used a rubber sock partially filled with water to transfer the maturing chinook from the trap to the transfer tank. The maximum loading density for the transfer tank was 0.12 kg/L, and transfer took about 75 minutes.

Table 1. Collection and transfer of Methow Basin spring chinook, 1996

Week ending	Adults Collected				Transfers		Estimated adults on hand
	Wild		**Hatchery**				
	Adults	Jacks	Adults	Jacks	Adults	Jacks	
11 May 1996	1		1		2		2
18 May 1996	1		1		2		4
25 May 1996	13		12		25		29
1 June 1996	35		44	4	79	4	112
8 June 1996	16	6	37	12	53	18	183
15 June 1996	21	2	32	7	53	9	245
22 June 1996	13		28	6	41	11	297
29 June 1996	10	1	41	9	51	10	358
6 July 1996	4		31	7	35	7	400
13 July 1996	1		28	5	29	5	434[a]
20 July 1996	2	1	5	1	7	2	297
27 July 1996			9		9		306
3 August 1996			4	1	4	1	311
10 August 1997	1		2	1	3	1	315

[a] On 18 July we transferred 58 males, 78 females, and 10 jacks to WNFH.

The maximum loading density for an adult raceway at the MH is one fish/0.28 m^3 (Wells Settlement Agreement 1990). This density corresponds to about 250 adult salmon per raceway. In 1996, the maximum density was one fish/0.31 m^3 or about 230 fish/raceway. A sprinkler system over the raceways helped calm the fish.

Prophylaxis

Formalin (one part formalin to 6,000 parts water) was used to control fungus during holding. Treatments began with the first arrival, and followed a 3 day/week schedule, unless the fish were handled. If the fish were handled, they were treated for three consecutive days before returning to the standard schedule. On 18 July, all but two females received an injection of 10 mg/kg erythromycin to protect eggs from the vertical transmission of BKD. The two un-injected females had been misidentified as males. Females collected from Wells Dam after 18 July were inoculated before transfer to MH.

Identification and Spawning

Original information received from Curt Knudsen[1] indicated only 39 fish had an 80% or higher probability of being from a determinable population origin. Of these 39 fish, 28 were categorized to the Methow program, 5 to the Chewuch program and 6 to the Twisp program. We felt these numbers were too low to provide adequate broodstock. Therefore, the evaluation staff reduced the probability to ≥60% for the remaining fish. This increased the likelihood of error, but it also increased the effective population size for each program. When a fish did not fit with ≥60% probability into one of the three populations, it was categorized as an unknown wild fish, and spawned with known hatchery or wild fish. We felt increasing the effective population sizes and equalizing the sex ratio outweighed the risks of genetic mixing.

During the 18 July erythromycin injection, the fish were sorted according to their origin, determined by matching the VI tags to the results of the scale analysis. Wild fish were put into one adult holding raceway and coded wire tagged (CWT) hatchery origin fish were held in another adult raceway at MH. Hatchery fish without CWTs were transferred to WNFH, because before the 1994 brood year, only 25% to 33% of the spring chinook yearling production at WNFH was tagged. All fish collected from Wells Dam after 18 July were added to the raceway containing CWT marked fish at MH.

Once trapping was complete, the hatchery origin raceway contained at least eight possible categories of fish: 92 BY MH-Chewuch River spring chinook; 92 BY MH-Twisp River spring chinook; 93 BY MH-Methow River spring chinook; 93 BY MH-Chewuch River spring chinook; 93 BY MH-Twisp River spring chinook; 92 BY CWT WNFH spring chinook; 93 BY CWT WNFH spring chinook; and unmarked WNFH spring chinook. The wild origin raceway contained at least six possible categories of fish: 92 BY Methow River spring chinook; 92 BY Chewuch River spring chinook; 92 BY Twisp River spring chinook; 93 BY Methow River spring chinook; 93 BY Chewuch River spring chinook; and 93 BY Twisp River spring chinook.

During spawning, eggs and milt were collected into zip-loc freezer bags and stored in coolers with burlap covered ice until the origin of each fish was determined from their CWT or scale

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[1]WDFW-Scale Analysis Lab, Olympia WA

analysis. To maximize the gametes for each stock, and to maintain stock integrity, we established priorities for spawning. The priorities were intended to serve as a guide, since actual spawning and fertilization needs were difficult to predict (Table 2).

Table 2. 1996 spring chinook gamete fertilization priorities

Stock	Priority	Fertilization	Age
Methow	1	Methow wild (W) x unknown W	
	2	Methow W x Methow W	92 BY x 93 BY or 92 BY x 92 BY
	3	unknown x unknown	
Chewuch	1	Hatchery (H) x W	
	2	H x H	92 BY x 93 BY
	3	H x H	92 BY x 92 BY different families
	4	H x unknown W	
Twisp	1	H x W	
	2	H x H	92 BY x 93 BY
	3	H x H	92 BY x 92 BY different families
	4	H x unknown W	

Spawning began 6 August and occurred every seventh day until 3 September (Table 3). The Methow population peaked the third week of August, while the Chewuch population peaked the last week in August. The Twisp population remained steady through the last weeks of August and into the first week of September.

Table 3. Spawn time for spring chinook at the MH

		06 Aug 96	13 Aug 96	20 Aug 96	27 Aug 96	03 Sep 96	Total
	female	3	9	20	18	5	55
Methow	male	1	6	19	18	5	49
	jack	2	3	1	0	0	6
	female	0	7	5	12	8	32
Chewuch	male	0	5	3	10	4	22
	jack	0	2	2	2	5	11
	female	0	1	7	8	6	22
Twisp	male	0	1	6	8	3	18
	jack	0	0	1	0	3	4
Total		6	34	64	76	39	219

Methow Spring Chinook

Methow River spring chinook females arrived at Wells Dam between 17 May and 29 July, 1996. Table 4 describes the Methow River spawned females. Females arriving early tended to spawn earlier than their later arriving cohorts $\rho = 0.47$). Most of the Methow River female spawners were wild, so data was insufficient to detect a difference in arrival or spawn time for hatchery versus wild fish.

The Methow spring chinook spawned earlier than the Chewuch and Twisp populations. Fifty-five females (50.0%), 44 males (43.5%) and 6 jacks (6.5%) contributed to the 96 BY and we collected and fertilized 219,977 eggs. Five Methow River wild males were each used twice as primary fertilizers. Four females and one male were Locsha River-Idaho Department of Fish and Game releases. One female spawned on 13 August was a 92 BY MH-Chewuch spring chinook, but the only mature male available to fertilize her gametes was a Methow River wild fish. The Methow River population contained most of the unknown origin wild fish and all the unknown hatchery and out-of-basin stray fish, along with the known Methow River chinook. Figure 2 shows the origin breakdown. For clarity, only primary males and jacks are included in the table and figure.

We checked the fecundity from seven wild Methow River females spawned on 27 August. The average fecundity was 4,270 eggs/female, with a range of 3,041 to 5,433 eggs/female. Six of the females were $4/_2$, while one was $5/_2$. The $5/_2$ female had the highest fecundity.

Table 4. Arrival and spawn time for 1996 Methow River chinook (N = 48)

	Mean	Median	Mode
Arrival	6/13/96	6/14/96	6/28/96
Spawn	8/22/96	8/20/96	8/20/96

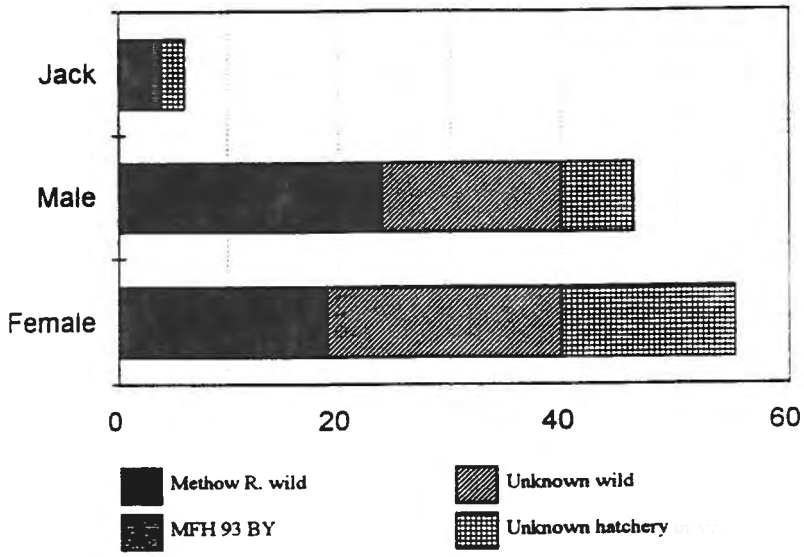

Figure 2. Methow spring chinook salmon spawner origin.

Adult Sampling

We collected scales and tissue for genetic stock identification (GSI), and recorded length and sex from 43 known Methow River chinook salmon. This included three MH 93 BY jacks. Age and origin was determined from scale samples (Table 5).

Table 5. Age composition, sex ratio and post-orbital hypural (POH) length of known Methow River chinook salmon.

SEX		Age 3	Age 4	Age 5	TOTAL
Male	Number	3	20		23
	Mean length (cm)	41	55.6		53.7
Female	Number		19	1	20
	Mean length (cm)		61.6	72	62.1
Total	Number	3	39	1	43
	Mean length (cm)	41	58.5	72	57.6

Pathology

In accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State, we tested ovarian fluid and kidney/spleen tissue from the 55 spawned females for Infectious Hematopoietic Necrosis (IHNv) and Infectious Pancreatic Necrosis (IPNv) viruses. A portion of the male spawning population was also tested for these pathogens. IHNv was isolated from fish spawned within this stock on 27 August and 3 September, 1996. IHNv is endemic to the Columbia River watershed, and has been isolated from other chinook stocks within the watershed, including spring chinook spawned at the WNFH. As suggested in the Salmonid Disease Control Policy, we did not destroy the eggs from IHNv positive females, but as planned no eggs were transferred off station.

Kidney tissue from all females were analyzed for bacterial kidney disease (BKD) using enzyme-linked immunosorbant assay (ELISA). ELISA measures the optical density of a colorimic assay for a targeted protein produced by the bacteria *Renibacterium salmoninarum*, the causative agent of BKD. The assigned labels are used throughout the Northwest, and describe the correlation between the number of bacterial cells and the ELISA readings. Forty-six females had optical densities < 0.100, and were reported as "below low" for the bacterium. Six females, reported as "low", had optical densities between 0.100 - 0.199. The remaining three females were "high" for the bacterium, with optical densities > 0.45. Progeny from high ELISA females are segregated from all other progeny throughout the juvenile rearing period.

Hatchery Return

MH did not rear or release any spring chinook from the 92 BY Methow River stock, so there were no adult returns in 1996. However, we collected three 93 BY Methow River chinook, all progeny of low ELISA females.

Chewuch Spring Chinook

Chewuch River females arrived during the 61 days between 17 May and 17 July, 1996 (Table 6). Unlike the Methow River population, arrival time was not positively correlated with spawn time ($\rho = 0.15$). Peak spawning in the last week of August is similar to previous years (H. Bartlett and R. Bugert 1994, H. Bartlett 1995). Thirty-two females (50.0%), 21 males (32.8%) and 11 jacks (17.2%) made up the 1996 Chewuch stock spawners, and we collected and fertilized 120,402 eggs. Most of the females were 92 BY MH-Chewuch River (Figure 3). No distinct difference in spawn time was observed between the wild and hatchery fish.

We measured the fecundity from 10 MH-Chewuch River females and 4 wild females. Four of the 11 Chewuch River families released from the MH for the 92 BY were represented in the fecundity sample. The mean fecundity of the MH-Chewuch River females (age 4/2) was 3,635 eggs/female, with a range of 3,146 to 4,425 eggs/female, while females from the parental generation (age 5/2) had an average of 5,389 eggs/female (range 4,637 to 5,783 eggs/female). The wild females (two age 4/2 and two probable age 4/2) had a mean fecundity of 3,820 eggs/female (range 3,252 to 4,406 eggs/female).

Table 6. Arrival and spawn time for 1996 Chewuch River females (N = 32)

	Mean	Median	Mode
Arrival	6/12/96	6/14/96	6/17/96
Spawn	8/23/96	8/27/96	8/27/96

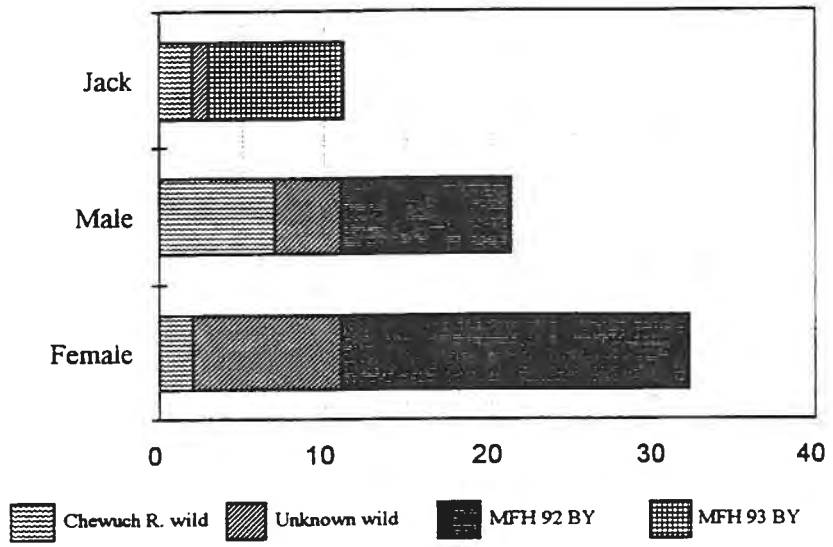

Figure 3. Chewuch spring chinook salmon spawner origin.

Adult Sampling

We collected scales and tissue for GSI, and recorded length and sex of 55 known age $4/_2$ Chewuch River chinook salmon (Table 7). Males were longer than females, and there was no observable difference in length for wild versus hatchery adults of the same sex.

Table 7. Age composition, sex ratio, and POH length of known Chewuch River chinook salmon.

SEX		Age 3	Age 4	TOTAL
Male	Number	18	14	32
	Mean length (cm)	39.4	59.2	48
Female	Number		23	23
	Mean length (cm)		52.5	52.5
Total	Number	18	37	55
	Mean length (cm)	39.4	55	49.9

Pathology

Ovarian fluid and kidney/spleen tissue was collected from all the spawned females and a portion of the spawned males. The tissue was tested for the presence of IHNv and IPNv. IHNv was isolated from a five fish pool sampled on 27 August. Three Chewuch males and two unknown origin females comprised the pool. All the spawned females had additional kidney tissue collected to test for the presence of *R. salmoninarum* using ELISA. Twenty-three females were "below low" for *R. salmoninarum*, five were "low", one "moderate", and three "high". See Methow Spring Chinook pathology (pg. 9) for further explanation of disease history.

Adult Return

We collected 39 adult (92 BY only) Chewuch spring chinook salmon at Wells Dam in 1996. These adults came from a 1994 release of 40,862 juveniles originating from 11 families (known male x known female). Smolt to adult return for the 92 BY Chewuch spring chinook reared at the MH was 0.1%, while green egg to adult return was 0.08%. Because the parent brood was 33.3% age $5/_2$ we anticipated additional adult returns in 1997, increasing overall survival. However, none of the age $5/_2$ adults collected in 1997 were from the MH Chewuch spring chinook program .

Although all 11 families were represented in the returning brood, two families survived at twice the level of the other nine (Table 8). The sex ratio observed within each family was about equal except family 7, from which six of the fish were female (N = 8). We compared the fecundity and POH length of the 92 BY with their parent brood, but found no correlation (Table 9). For most families, the modal spawn date in 1996 was comparable to their parent brood in 1992. Only one family's modal spawn date differed from their parents by more than ten days.

Table 8. 1992 BY Chewuch spring chinook survival.

Family #	Total eggs	Egg survival	Smolt release	Fry-smolt survival	4/2 returns	Smolt-adult return	Green egg-adult return
1	5,783	97.4%	5,218	95.20%	2	0.04%	0.03%
2	5,359	64.0%	3,119	92.10%	4	0.13%	0.07%
3	3,025	86.9%	2,529	96.80%	1	0.04%	0.03%
4	4,515	97.8%	4,165	98.50%	3	0.07%	0.07%
5	3,737	92.4%	3,296	98.30%	2	0.06%	0.05%
6	3,638	98.6%	3,557	98.40%	3	0.08%	0.08%
7	4,637	97.4%	4,449	98.10%	8	0.18%	0.17%
8	5,775	82.5%	4,438	99.30%	8	0.18%	0.14%
9	4,144	99.3%	4,093	99.30%	4	0.10%	0.10%
10	3,839	93.0%	3,435	97.30%	1	0.03%	0.03%
11	4,212	67.8%	2,563	93.50%	3	0.09%	0.07%

Table 9. Comparison of 1992 Chewuch spring chinook adults and their progeny which returned in 1996.

1992 Returning adults (parent)					1996 Returning adults (progeny)			
Family #	Spawn date	Fecundity	♀ POH length (cm)	Age	Modal spawn date	Fecundity	♀ POH length (cm)	# age 4/2 return
1	8/20/92	5,783	64	4/2		3,478	56	2
2	8/20/92	5,359	72	5/2	8/20/96	3,654	61	4
3	8/26/92	3,025	66	5/2			54	1
4	8/26/92	4,515	67	5/2	9/3/96		60	3
5	8/26/92	3,737	58	4/2			72	2
6	8/26/92	3,638	58	4/2	8/27/96		55	3
7	8/31/92	4,637	67	5/2	8/13/96	3,788	61	8
8	8/31/92	5,775	71	5/2	8/27/96	3,345	58	8
9	8/31/92	4,144	60	4/2	8/27/96		60	4
10	9/3/92	3,839	60	4/2			61	1
11	9/17/92	4,212	67	5/2	9/3/96		58	3

Twisp Spring Chinook

Twisp River female chinook arrived at Wells Dam between 24 May and 22 July, 1996. Twisp River females arriving early tended to spawn early ($\rho = 0.40$). Although hatchery females appeared to arrive later than wild females, data was insufficient to determine significance (Table 10). Equal numbers of Twisp spring chinook spawned from the third week of August through the first week of September (Table 3). Twenty-two females (50.0%), 18 males (40.9%) and 4 jacks (9.1%) comprised the 1996 Twisp spawning population and we collected and fertilized 85,847 eggs. The spawned population was evenly split between wild fish and hatchery fish (Figure 4), and both groups spawned simultaneously.

We measured the fecundity of four wild and seven MH-Twisp River females. Mean fecundity for the wild fish was 4,131 eggs/female (range 3,543 to 4,614 eggs/female), and 3,862 eggs/female (range 3,361 to 4,420 eggs/female) for the hatchery fish. All sampled females were age 4/2. The female parents of the hatchery females were also age 4/2 and their mean fecundity was 4,184 eggs/female (range 3,867 to 4,487 eggs/female, N = 3).

Table 10. Arrival and spawn information for 1996 Twisp River females (N = 22)

	Mean	Median	Mode
Arrival	6/13/96	6/8/96	5/24/96
Spawn	8/25/96	8/27/96	8/20/96

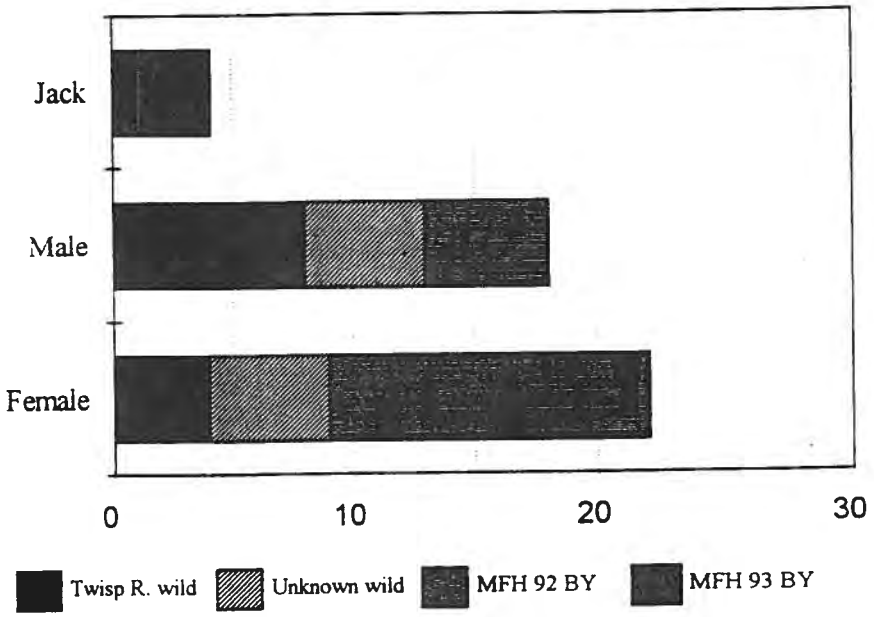

Figure 4. 1996 Twisp spring chinook salmon spawner origin.

Adult Sampling

Scales and tissue for GSI were collected, and length and sex were recorded from 37 known Twisp River chinook salmon (Table 11). Samples included hatchery as well as wild fish.

Table 11. Age composition, sex ratio, and POH length of known Twisp River chinook salmon spawned in 1996.

SEX		Age 3	Age 4	TOTAL
Male	Number	8	11	19
	Mean length (cm)	37.9	55.2	47.9
Female	Number		18	18
	Mean length (cm)		59.4	59.4
Total	Number	8	29	37
	Mean length (cm)	37.9	57.8	53.5

Pathology

Ovarian fluid and kidney/spleen tissue was collected from all the spawned females and a portion of the spawned males. The tissue was tested for the presence of IHNv and IPNv. Neither IHNv nor IPNv were isolated. All the spawned females had additional kidney tissue collected to test for the level of *R. salmoninarum*. Thirteen females had "below low" levels of the bacteria, five had "low" levels, two had "moderate" levels, and two had "high" levels. See Methow Spring Chinook pathology (pg. 9) for further explanation of disease history.

Adult Return

We collected 21 adult (92 BY only) Twisp spring chinook salmon at Wells Dam in 1996. These originated from 35,861 smolts representing nine families released in April 1994. Smolt to adult return for the 92 BY Twisp spring chinook was 0.06%, while green egg to adult return was 0.05%. About 16% of the parent brood was age $5/_2$, so we expected to see some returns in 1997. Only 12 fish sampled in 1997 were age $5/_2$ (2.8%), and none were from the MH Twisp spring chinook program.

Representatives from eight of the nine Twisp families returned to Wells Dam in 1996. The one family not represented in the 1996 escapement were progeny of a "high" ELISA female. The progeny showed no symptoms of the disease during rearing or at smolt release, and had "below low" levels for the bacteria in pre-release ELISA samples. Survival per family was more even than the Chewuch stock (Table 12). Average fecundity in the 1996 brood was smaller for two families, while it was larger in another when compared with their parental counterparts. The 1996 spawners tended to be smaller than the parent brood (Table 13). Modal spawn date was comparable to the parent brood, sometimes peaking on the same day as their parental counterpart.

Table 12. 1992 Twisp spring chinook survival.

Family #	Total eggs	Egg survival	Smolt release	Fry-smolt survival	$4/_2$ returns	Smolt-adult return	Green egg-adult return
1	5,481	98.8%	5,147	94.5%	2	0.04%	0.04%
2	4,703	97.0%	4,485	97.9%	1	0.02%	0.02%
3	4,895	73.7%	3,363	96.0%	2	0.06%	0.04%
4	3,951	98.1%	3,903	98.3%	0		
5	4,487	97.0%	4,288	94.9%	2	0.05%	0.04%
6	4,197	97.1%	4,068	99.0%	5	0.12%	0.12%
7	3,263	99.4%	3,197	97.9%	3	0.09%	0.09%
8	3,867	91.9%	3,398	97.7%	5	0.15%	0.13%
9	4,107	97.2%	4,012	99.3%	1	0.02%	0.02%

Table 13. Comparison of 1992 Twisp spring chinook adults and their progeny which returned in 1996.

1992 Returning adults (parent)					1996 Returning adults (progeny)			
Family #	Spawn date	Fecundity	♀ POH length (cm)	Age	Modal spawn date	Fecundity	♀ POH length (cm)	# age 4/2 return
1	8/13/92	5,481	65	5/2				2
2	8/20/92	4,703	61	4/2			57	1
3	8/20/92	4,895	66	5/2			49	2
4	8/26/92	3,951	62	4/2				
5	8/27/92	4,487	61	4/2	8/20/96	3,813	63	2
6	8/27/92	4,197	63	4/2	8/27/96	3,713	60	5
7	8/27/92	3,263	58	4/2	9/3/96		53	3
8	8/27/92	3,867	58	4/2	8/27/96	3,993	60	5
9	9/3/92	4,107	63	4/2			53	1

JUVENILE REARING

1996 Methow Spring Chinook Salmon

Incubation

The Methow chinook eggs were incubated in 9.5 liter iso-buckets, with one family per bucket. Well water flowed at 0.02 cm^3/s, and each bucket contained a foam float to reduce water disturbance on the developing eggs. A drip system delivered formalin at a concentration of 1:600 three times per week. When the eggs accumulated between 500 and 750 temperature units[2] (TU) the hatchery crew moved the eggs in their family units to vertical stack incubators. This movement turned the unfertilized or dead eggs white for easy counting and removal. A tabletop scale was used to weigh the live eggs and determine female fecundity. Approximately 7 days before hatching, plastic substrate was placed in each tray to mimic natural substrate and reduce movement of the newly hatched fry. The 1996 BY Methow chinook had a green egg to fry survival of 97.1%.

Early Rearing

Methow fry were moved from the incubators to indoor start tanks beginning in December

[2]Temperature unit = one degree above 32°F in a 24 hour period.

1996. Each start tank contained a combination of family units based upon weight of eggs, date of egg take, adult ELISA value and injection history of the female parent. The largest collective group contained families from "low" ELISA injected females. The hatchery crew started this group of fish directly in a juvenile rearing raceway because of limited space within the start tank room. Progeny of "high" ELISA females, progeny of spring chinook released in Idaho, and progeny of non-injected adult females were started in separate tanks indoors. Densities were maintained at or below 0.125 lbs. of fish/cu. ft. rearing space/in. of fish.

Methow spring chinook were 100% coded wire tagged (CWT) and adipose fin clipped during June 1997. Four unique tag codes were assigned to 209,198 fish: 192,076 "low" ELISA progeny received tag code 63-01/03; 9,135 fish from Snake River-Idaho strays received tag code 63-63/15; 3,128 fish from adults not injected with erythromycin received tag code 63-02/46; and 4,859 "high" ELISA progeny received tag code 63-02/48. At CWT marking the low ELISA progeny averaged 4.5 g, while all others averaged 3 g.

Fish Health Monitoring

Fish were routinely examined every four to six weeks, or as needed if fish mortalities increased (Table 14). Diseases in this stock were exacerbated by the extreme water demands on the facility caused by well and/or pump problems and concurrent full brood year production numbers. During the recommended Aquamycin treatments, fish were fed every other day to meet daily drug dosage requirements, because low river water temperatures reduced their appetites. River water temperatures in late summer and early fall likely contributed to the higher incidence of flagtail. The smolting behavior seen in the fall has been documented in previous years (Bartlett 1996 and 1997).

Table 14. 1996 Methow chinook fish health monitoring.

Date	Weight (g)	Mean daily loss	Water temp. °C	Comments
1/9/97	0.65	0.500%	9	Mortalities have been elevated, and fungus found in tissue. Possibly associated with coagulated yolk.
3/20/97	1.6	0.000%	9	Gills and fins good condition. Fish full of feed and fat d its started.
6/18/97	5.3	0.000%	11	CWT marking almost complete. Fish in large acclimation pond originally showing signs of sunburn, but that has subsided. Want one turnover of water/hour.
7/14/97	7.0	0.015%	10 - 14	Elevated mortalities a result of poor fin clips. Smolt like behavior. Overall population looks healthy.
8/12/97	8.7	0.001%	10 - 14	BKD - very low loss rate. Will treat if exceeds 0.02%/day.
9/17/97	11.5	0.005%	10 - 14	Mortalities associated with BKD and flagtail, likely a result of river r. Smolting behavior also noted, with some precocity.
10/20/97	13.8	0.004%	7 -9	Low level loss to flagtail. Recommend formalin treatment. Fat levels at +2.
11/17/97	16.8	0.010%	3	Fish still descaling and smolty in appearance. Flagtail mortalities increasing. Recommend seven treatments given every other day.
12/10/97	18.2	0.020%	4	Gross clinical signs of BKD. Treat 28 d with Aquamycin.
1/9/98	21.6	0.025%	5	Mortalities to flagtail and BKD. Increased water to acclimation pond by reducing flow to raceways.
1/29/98	22.7	0.024%	6	Mink killing fish in pond. Healthy fish look good with +2 fat levels. Mortalities to BKD and flagtail. Recommend treating flagtail.
2/25/98	18.7	0.010%	6	Healthy. Loss down from BKD and flagtail.
3/16/98	22.6	0.002%	6	Low level loss to BKD.
4/8/98	23.9	0.005%	7	Low level loss to BKD and bacterial gill disease. Okay to start volitional release 4/15/98.

Acclimation

Following CWT marking, the progeny were moved into the large Methow River acclimation pond. The Methow River spring chinook reared primarily on Methow River water through the remainder of the hatchery rearing period. Well water was used to temper extremely high or low river temperatures. Flow to the large acclimation pond generally stayed at one complete turnover every hour. Overall, the Methow spring chinook salmon appeared to rear well in the large acclimation pond. They had less fin splits and a better external appearance than the spring chinook reared in raceways. The fish were fed about 0.8% body weight per day.

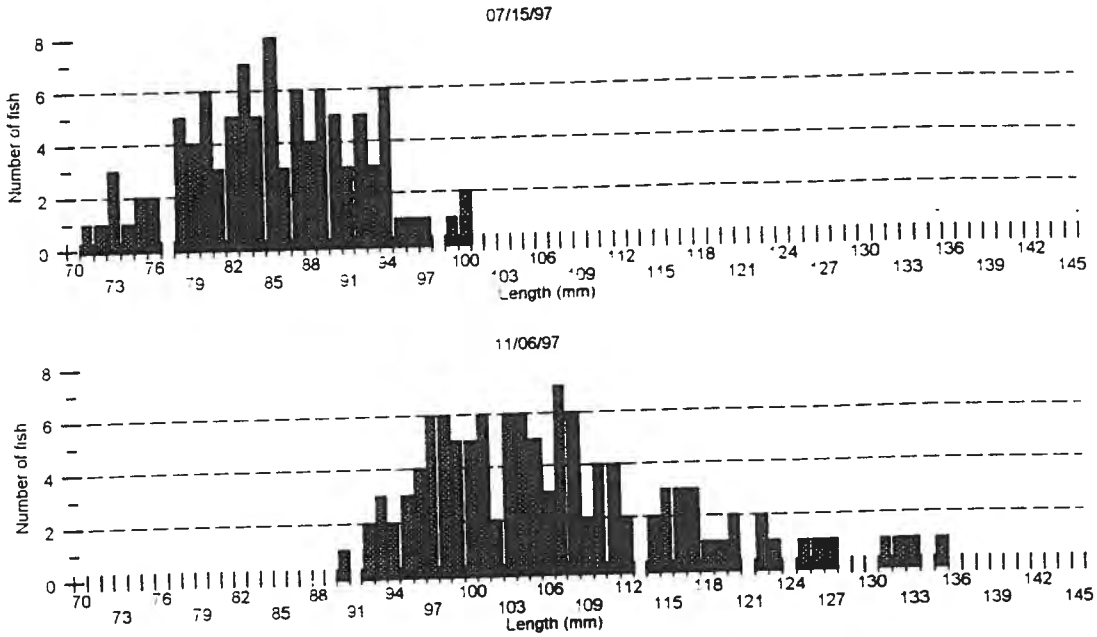

Figure 5. Juvenile length information collected from 96 BY Methow spring chinook.

The hatchery crew intended to take quarterly length and weight samples from the large acclimation pond population, but mortalities from BKD prevented a sample in January 1998 (Figure 5).

Smolt Release

Volitional release began the evening of 15 April 1998 when migration conditions looked suitable. The Methow River doubled in flow during the release and the water was opaque from run-off. Water temperature high-low was 8-4°C. A total of 202,947 Methow River spring chinook salmon (5.065 kg) migrated between 15 and 24 April 1998. Fry to smolt survival for the Methow spring chinook was 95.0%, and green egg to smolt survival was 92.3%. Four CWT groups were released: 63-02/48 (4,668 smolts - progeny of high ELISA females), 63-63/15 (8,930 smolts - progeny of Idaho adult strays), 63-01/03 (186,305 smolts - progeny of low ELISA females), 63-02/46 (3,044 smolts - progeny of adults not injected with erythromycin). At release, the population had a mean length of 128.2 mm, with a coefficient of variation (CV) of 5.7%, a condition factor (k) of 1.2 and an individual mean weight of 25 g (N = 100). The sex ratio was 1:1 with no apparent precocity.

Juvenile Sampling

Before release, we sampled 20 fish for organosomatic indexing (OSI) (Table 15). OSI assesses the general health of the population through the examination of external and internal organs (Goede and Barton 1990).

Table 15. 1996 Methow spring chinook juvenile organosomatic indexing results.

Summary of Normals									
Eyes	Gills	Pseudo-branchs	Thymus	Spleen	Hind gut	Kidney	Liver	Fin	Opercle
100.0%	75.0%	95.0%	95.0%	100.0%	100.0%	90.0%	20.0%	95.0%	100.0%

From the summary of normals the calculated normality index was 87.0%. A value above 90.0% is considered healthy (Goede 1993). The 1996 BY Methow spring chinook salmon included in the sample had extremely fatty livers. I have documented fatty livers in previous years; and although by definition this may not be "healthy", I believe it to be normal for this population and not detrimental to their overall smolt quality. Two fish sampled had gross clinical signs of BKD in their kidneys. Five fish in the sample had pale gills. These abnormalities resulted in the population's below healthy normality index.

1996 Chewuch Spring Chinook Salmon

Incubation

The Chewuch spring chinook were incubated similarly to the Methow spring chinook (pg. 16). The 1996 BY Chewuch spring chinook had a green egg to fry survival of 94.3%.

Start Tank and Early Rearing

Fry were transferred from the incubation room to juvenile rearing vessels starting 21 December 1996. The same criteria was used to combine and start Chewuch spring chinook as that used for the Methow spring chinook. Indoor start tanks held high ELISA and non-injected progeny, while the juvenile raceways held low and moderate ELISA progeny. The hatchery crew split and transferred the populations to keep the density index at or below 0.125 lbs. of fish/cu. ft. of rearing space/in. of fish. After 100% CWT marking of 110,105 fish with tag code 63-02/33, fish were placed into four juvenile raceways. Fish weighed about 4.5 g in June 1997 during CWT marking.

Fish Health Monitoring

BKD developed in the population early and persisted until release. The Chewuch chinook received three 28 day Aquamycin treatments during their hatchery rearing period. During the first two treatments, fish took a long time to respond to the antibiotic, so the pathologist considered the possibility of a drug resistant bacteria, but later decided it was unlikely. BKD was exacerbated by the reduced availability of well water, then the feed supplier ran out of Aquamycin medicated feed in January. The reduced flows to the rearing raceways caused gill hyperplasia in the developing smolts, and the fish caught Costia. Five formalin treatments at varying doses from 1:6,000 to 1:4,000 were required to clear the parasite from the fish.

Table 16. 1996 Chewuch chinook fish health monitoring.

Date	Weight (g)	Mean daily loss	Water temp. C	Comments
1/9/97	0.65	0.300%	9	Mortalities have been elevated, and fungus found in tissue. Possibly associated with coagulated yolk.
3/20/97	1.3	0.002%	9	Healthy. Gills and fins in good condition.
6/18/97	5.0	0.010%	9	CWT marking almost complete. Healthy. Low level loss to BKD. Increase raceway flows when marking complete.
6/30/97	6.1	0.023%	9	Mortalities increasing from BKD. Start Aquamycin treatment as soon as possible.
7/14/97	6.7	0.037%	9	Overall the population looks good, even though clinical signs of BKD can be seen.
8/12/97	8.4	0.027%	9	Population took a long time to respond to Aquamycin treatment. BKD still evident. Recommend another treatment in one month.
9/17/97	11.4	1.000%	9	10/11 fish examined had gross clinical signs of BKD. Treat with 28d Aquamycin treatment as soon as possible.
10/20/97	13.4	0.150%	9	BKD epizootic. Population not responding to Aquamycin treatment. Fish not eating the required 1%bw/day dosage.
12/10/97	15.0			Aquamycin treatment recommended as soon as possible.
1/9/98	16.8	0.130%	4	Healthy fish look good with +2 fat levels. Mortalities to BKD gradually decreasing. Mild gill hyperplasia from cold water temperatures and low turnover.
1/29/98	18.2	0.100%	9	Flow had to be reduced to half of recommendation because not enough well water available. Mortalities from BKD, but fish are responding to treatment. Gills have mild hyperplasia and hypertrophy.
2/19/98	19.7	0.033%	5	BKD and costia. Treat costia with formalin.
2/25/98	21.6	0.040%	6	Costia gone, but some fish still have hyper plastic gills. Okay to transfer to acclimation pond in early March.
3/4/98				Costia still present. Increase formalin level to 1:5,000.
3/9/98	22.0	0.050%	6	Costia and BKD. Treat costia with formalin again.
3/16/98	22.0	0.050%	7	Costia infection still present. Treat again at 1:4,000. This is fifth treatment.
4/8/98			7	Okay to volitionally release 4/15/98.

1996 Twisp Spring Chinook Salmon

Incubation

Twisp spring chinook were incubated similarly to Methow spring chinook (pg. 16). The 1996 BY Twisp spring chinook had a green egg to fry survival of 94.0%.

Start Tank and Early Rearing

Fry were transferred from the incubation room to juvenile rearing vessels in December 1996. All the Twisp fry were started in indoor start tanks, although most of the low and moderate ELISA progeny were soon transferred to a juvenile raceway. The high ELISA and non-injected progeny remained in the indoor start tanks until close to CWT marking.

All Twisp spring chinook were CWT marked and adipose fin clipped during June 1997. Three unique tag codes identified 79,805 fish; 63-61/14 identified 67,663 low ELISA progeny, tag code 63-63/16 identified 7,477 high ELISA progeny, and tag code 63-63/17 identified 4,665 progeny from adults that were not injected with erythromycin. The low ELISA progeny weighed about 4.5 g at CWT marking, and the high ELISA and non-injected progeny weighed about 3 g.

Fish Health Monitoring

The population remained healthy throughout juvenile rearing (Table 18). Shortly before release mortalities showed gross clinical signs of BKD, but the loss rate did n[illegible]nt drug treatment. We would not have expected this raceway to have mortalities from [illegible] but the density in this raceway was the highest of the four raceways containing Twisp spring chinook. reduced flows likely worsened the situation. In January low flows also contr[illegible]ed to gill hyperplasia and hypertrophy.

Table 18. 1996 Twisp chinook fish health monitoring.

Date	Weight (g)	Mean daily loss	Water temp. C	Comments
1/9/97	0.65	0.100%	9	Mortalities have been elevated, and fungus found in tissue. Possibly associated with coagulated yolk.
2/11/97	0.78	0.075%	9	Phoma evident in some of the mortalities.
3/20/97	1.5	0.002%	9	Good fat deposits started. Gills and fins in good condition. Healthy.
4/28/97	2.7	0.000%	9	CWT marking complete, but mortalities increasing and attributed to marking.
6/18/97	5.4	0.000%	9	Healthy. Raceways could benefit from increased flows. Would prefer a turnover every hour.
8/12/97	8.4	0.000%	10	Healthy.
1/9/98	17.5	0.000%	0	Low level loss to BKD, but overall the fish look great.
2/19/98	21.6	0.100%	6	BKD and costia. Treat costia with formalin.
3/9/98	23.9	0.150%	6	Mortalities only in RW4. No costia found, but high loss to BKD.

Juvenile Rearing and Acclimation

This population was reared primarily on Methow River water. During the winter, flow periodically fell below the optimal turnover rate, which may have contributed to disease outbreaks. Overall, the population was healthy and reared well at the Methow Hatchery. The fish were length and weight sampled three times during the juvenile rearing period (Figure 6). Before transfer to the Twisp River acclimation pond, 500 fish from the healthy raceways were retained for the potential captive brood program. The population retained represented a number of families. Three of the four raceway populations were transferred to the Twisp River acclimation pond the week of 23 March 1998, about 22 days before release. The one raceway with mortalities to BKD was released directly into the Twisp River on 17 April without acclimation, to ensure BKD was not transmitted to the healthy fish.

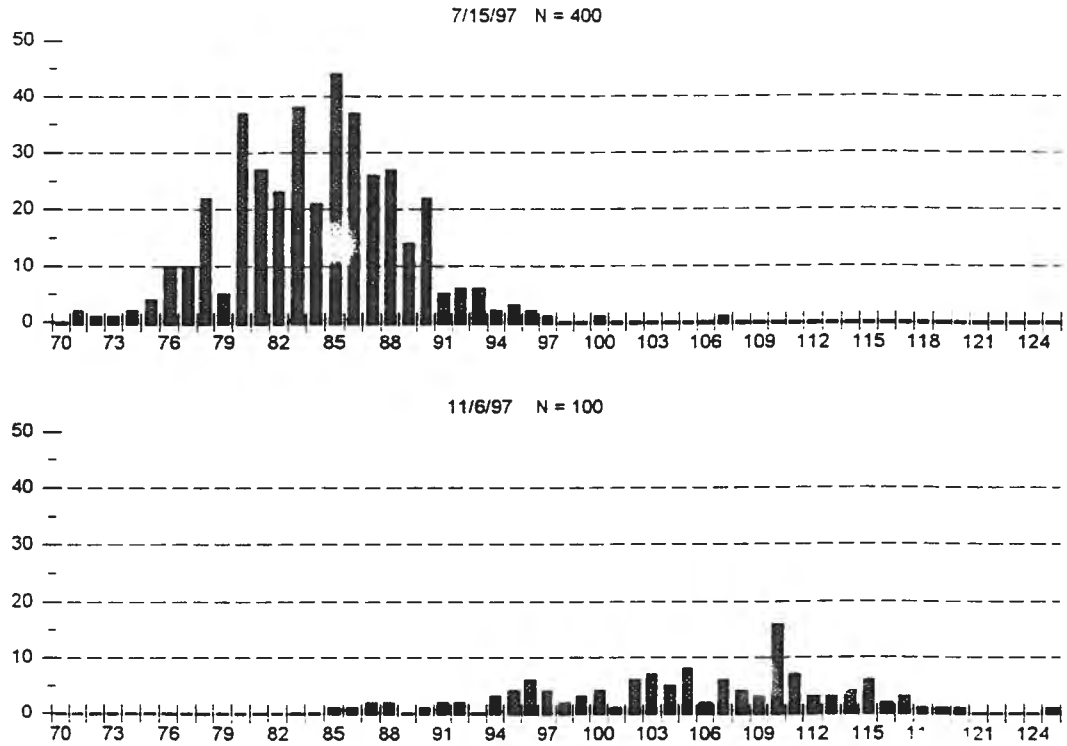

Figure 6. Juvenile length information collected from 96 BY Twisp spring chinook.

Smolt Release

Volitional release began the evening of 15 April 1998, and the pond was virtually empty in 7 days. A total of 57,729 Twisp spring chinook smolts (1,770 kg) migrated from the Twisp River acclimation pond, and 18,958 smolts (582 kg) were direct stream released at the Twisp River acclimation pond outfall. Fry to smolt survival was 95% while green egg to smolt survival was 89.3%. Water temperature high-low was 7-4°C. At release, the population had a mean length of 137.2 mm, (CV = 6.9%, k = 1.2, N = 100). The individual mean weight was 30.7 g.

Juvenile Sampling

Six days before volitional release began, we sampled 20 fish (Table 19).

Table 19. 1996 BY Twisp spring chinook juvenile OSI results.

Summary of Normals									
Eyes	Gills	Pseudo-branchs	Thymus	Spleen	Hind gut	Kidney	Liver	Fin	Opercle
100.0%	100.0%	100.0%	85.0%	100.0%	100.0%	100.0%	70.0%	35.0%	100.0%

The normality index for the population was 89.0%. Minor fin splits and minor hemorrhaging in the thymus reduced the normality index. The one anomaly noted was an unequal sex ratio of 1 female to 10 males. Sampling error was possible since the 20 fish sample was a small proportion

of the population. Most of the males within the 20 fish sample had some gonadal maturation, although they were not precocious.

DISCUSSION

The collapse of the Methow Basin spring chinook run in 1995 prompted significant changes in the Methow Hatchery operation. Instead of collecting predominately wild fish at the three off-site trap facilities, all fish were collected at Wells Dam, with the goal of preventing extinction at the risk of genetic mixing, though significant effort was made to separate the three stocks.

Emphasis moved from innovative rearing practices and production of hatchery fish well suited for natural conditions (Wells Coordinating Committee 1995) to more traditional hatchery practices which encompassed higher densities and limited rearing options. This significant change resulted from pressure to increase production.

Results from the elemental scale analysis were inconclusive. Initial information suggested 80% confidence was an appropriate cut-off point. Unfortunately this provided insufficient adults for the Twisp and Chewuch programs, so hatchery evaluations staff assigned an origin to the fish at a 60% confidence level, and favored fish with about equal probability of coming from the remaining two rivers. An anecdotal observation showed that Twisp and Methow or Methow and Chewuch, were more likely to be confounded as origins than Twisp and Chewuch. Because both the Twisp and Chewuch are tributaries to the Methow River, either wild Methow River fish accumulate minerals released from the tributaries, or some young of the year migrate from the tributaries early and complete freshwater rearing in the Methow River. Elemental scale analysis is a new tool that shows promise, and may become useful for our work if it is refined.

The 1996 BY was characterized by BKD outbreaks exacerbated by water shortages in the winter. All three stocks had an outbreak of BKD, but the Chewuch stock had an early onset of the disease and was more seriously affected. Aquamycin treatments barely kept the disease manageable. Consecutive brood years reaching hatchery program production goals required more well water than was available. Because well water is the only water source for the incubation and start tank rooms, the start tanks were used for disease segregation and initial rearing of extremely small fry (>1450 fpp). Healthy fish were quickly moved to juvenile raceways, which used Methow River water tempered with well water. The river/well water mix was adequate for the yearlings when they were healthy, though sometimes flows were below optimal. When the yearlings were sick with BKD, well water was diverted from young-of-the-year to stimulate the yearlings appetites to induce them to eat the required dosage of drug incorporated into their feed.

Tags recovered from the 1997 Methow Basin spring chinook spawners indicated fish strayed. Five of the 13 CWT marked Chewuch spring chinook were recovered in the Methow River. One of the two CWT marked Twisp spring chinook was recovered in the Chewuch River. Conversely, all 11 CWT marked Methow spring chinook were recovered in the Methow River. This suggested the 3-4 weeks of acclimation provided at the Twisp and Chewuch river ponds was

inadequate. Future survey information should confirm this preliminary assessment. River water provided to the off-site acclimation ponds in the fall and winter would reduce water demands at the central facility, increase acclimation and imprint time, and alleviate the transfer of spring smolts. It would also allow the Methow Hatchery to rear and release 700,000 smolts annually. Juvenile rearing space and water at the central facility limit annual production to about 450,000 to 500,000 smolts.

There was a strong push in 1997 for a composite population between the three Methow Basin stocks at the Methow Hatchery. The hatchery started a captive brood program for the Twisp River stock beginning with the 1996 brood year. Preliminary genetic information suggested this stock exhibited genotypic differences from the Methow and Chewuch stocks, which were more alike. It is likely there will no longer be three distinct stocks at the Methow Hatchery in 1998. Hatchery operation goals and objectives have not been clearly defined for these changes, particularly the captive brood portion. The Evaluation Plan (Wells Coordinating Committee 1995) stated changes were to be made, but the continual decline of the Methow Basin chinook populations has resulted in operational changes, that unfortunately, the Evaluation Plan inadequately addresses. How will a composite population affect the genetic integrity of the Methow Basin populations? Will the off-site adult traps be used in the future, or will collection occur annually at Wells Dam? If a composite population is maintained at Methow Hatchery, collection at Wells Dam seems legitimate. Will wild fish be the predominate hatchery spawners, or will their level of incorporation vary annually? Original broodstock collection goals required the collection of only wild fish. The incorporation of some hatchery produced fish is important to maintain gene flow between the two spawner groups, but continual reliance on hatchery fish for annual production has some drawbacks (Busack and Currens 1995). Are natural rearing programs within the hatchery still important? They should be to help maintain diversity and better prepare fish for the natural environment. Although the overall quality of the fish remains good, I have noticed a decline since the first few years. As production has increased, the water demands, increased densities, inability to split populations or put them in appropriate rearing vessels for the life stage, and disease have all compromised quality. I don't have enough information to determine if higher quality smolts produce more adult returns. The initial Evaluation Plan suggested quality was most important, but quantity seems to have taken precedence.

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Appendix A. Visual implant tag information

Implant tag code	Transfer from Wells Dam to MFH	Spawn date	Stock	Origin
u01	05/17/96	08/13/96	Methow	unknown
u03	05/17/96	09/03/96	Chewuch	hatchery
u09	05/17/96	08/13/96	Chewuch	hatchery
u13	05/24/96	08/27/96	Chewuch	hatchery
u14	05/24/96	08/27/96	Chewuch	wild
u16	05/24/96	08/13/96	Chewuch	wild
u17	05/24/96	08/20/96	Methow	unknown
u20	05/24/96	08/27/96	Twisp	wild
u22	05/24/96	08/13/96	Methow	unknown
u24	05/24/96	08/06/96	Methow	unknown
u25	05/24/96	08/20/96	Twisp	wild
u27	05/24/96	08/13/96	Chewuch	hatchery
u30	05/24/96	08/20/96	Twisp	wild
u31	05/28/96	08/20/96	Twisp	wild
u34	05/28/96	08/20/96	Methow	unknown
u40	05/28/96	08/20/96	Methow	wild
u49	05/28/96	08/13/96	Twisp	wild
u51	05/28/96	08/13/96	Methow	wild
u69	05/28/96	08/20/96	Methow	unknown
u70	05/28/96	09/03/96	Methow	unknown
u75	05/28/96	08/27/96	Methow	wild
u76	05/28/96	09/03/96	Chewuch	hatchery
u86	05/30/96	08/27/96	Methow	wild
u90	05/30/96	08/20/96	Twisp	unknown
u92	05/30/96	08/20/96	Methow	wild
u97	05/31/96	08/13/96	Chewuch	hatchery
u98	05/31/96	08/20/96	Methow	wild
v01	05/31/96	08/20/96	Methow	wild
v06	05/31/96	09/03/96	Chewuch	unknown
v07	05/31/96	08/27/96	Methow	wild
v11	05/31/96	09/03/96	Twisp	unknown
v18	06/05/96	08/27/96	Methow	wild
v22	06/05/96	08/20/96	Methow	wild
v24	06/05/96	08/06/96	Methow	unknown
v25	06/05/96	08/20/96	Chewuch	hatchery
v28	06/05/96	08/27/96	Chewuch	hatchery
v29	06/05/96	08/20/96	Twisp	hatchery
v30	06/05/96	08/20/96	Methow	wild
v37	06/05/96	08/27/96	Methow	wild
v40	06/05/96	08/27/96	Chewuch	unknown
v43	06/05/96	08/20/96	Twisp	hatchery
v55	06/05/96	08/13/96	Methow	unknown
v61	06/05/96	08/27/96	Chewuch	unknown
v64	06/07/96	08/27/96	Twisp	hatchery
v65	06/07/96	08/27/96	Chewuch	unknown
v68	06/07/96	09/03/96	Twisp	hatchery
v93	06/10/96	08/20/96	Methow	unknown
v95	06/10/96	08/27/96	Twisp	hatchery
w00	06/10/96	09/03/96	Twisp	unknown
w01	06/10/96	08/13/96	Chewuch	hatchery
w02	06/10/96	08/27/96	Methow	unknown

Implant tag code	Transfer from Wells Dam to MFH	Spawn date	Stock	Origin
w17	06/14/96	08/13/96	Chewuch	hatchery
w18	06/14/96	08/20/96	Methow	wild
w19	06/14/96	08/27/96	Methow	wild
w23	06/14/96	08/27/96	Twisp	hatchery
w24	06/14/96	08/13/96	Methow	wild
w25	06/14/96	08/27/96	Chewuch	hatchery
w27	06/14/96	08/27/96	Methow	wild
w30	06/14/96	08/13/96	Chewuch	hatchery
w39	06/14/96	08/20/96	Methow	wild
w47	06/17/96	08/27/96	Chewuch	hatchery
w48	06/17/96	08/20/96	Methow	unknown
w51	06/17/96	08/27/96	Chewuch	hatchery
w52	06/17/96	09/03/96	Chewuch	wild
w54	06/17/96	08/20/96	Methow	unknown
w57	06/17/96	08/20/96	Chewuch	hatchery
w58	06/17/96	08/27/96	Methow	unknown
w59	06/17/96	09/03/96	Methow	unknown
w60	06/17/96	08/20/96	Methow	unknown
w61	06/17/96	08/20/96	Chewuch	hatchery
w64	06/17/96	08/13/96	Methow	unknown
w68	06/17/96	08/27/96	Chewuch	unknown
w70	06/17/96	08/20/96	Twisp	hatchery
w76	06/21/96	08/27/96	Methow	unknown
w99	06/24/96	08/20/96	Methow	wild
y08	06/24/96	08/27/96	Methow	unknown
y09	06/24/96	08/27/96	Twisp	hatchery
y27	06/24/96	08/13/96	Methow	unknown
y35	06/24/96	08/27/96	Chewuch	unknown
y37	06/28/96	09/03/96	Twisp	hatchery
y38	06/28/96	08/20/96	Methow	unknown
y39	06/28/96	09/03/96	Methow	unknown
y44	06/28/96	09/03/96	Chewuch	hatchery
y45	06/28/96	09/03/96	Chewuch	hatchery
y53	06/28/96	08/20/96	Chewuch	hatchery
y67	07/01/96	08/27/96	Twisp	hatchery
y68	07/01/96	08/27/96	Twisp	hatchery
y82	07/01/96	08/13/96	Chewuch	hatchery
y85	07/05/96	08/20/96	Twisp	unknown
y93	07/05/96	08/27/96	Methow	unknown
y94	07/05/96	08/20/96	Methow	unknown
y96	07/05/96	08/27/96	Chewuch	unknown
z10	07/08/96	08/27/96	Methow	unknown
z11	07/08/96	08/27/96	Methow	unknown
z20	07/08/96	09/03/96	Methow	unknown
z25	07/08/96	09/03/96	Methow	unknown
z29	07/11/96	08/27/96	Twisp	unknown
z33	07/11/96	08/20/96	Chewuch	unknown
z46	07/17/96	09/03/96	Chewuch	unknown
z55	07/22/96	09/03/96	Twisp	hatchery
z58	07/29/96	08/27/96	Methow	unknown
z59	07/29/96	09/03/96	Methow	unknown

Appendix B. Egg to smolt survival

				1996 Methow Spring chinook			
Implant tag code	Fecundity	Dead eggs	Eyed eggs	Egg loss	Green egg-fry survival	Fry-smolt survival	Projected release
v42	3,964	48	3,916	1.20%	98.80%		
u24	1,511	52	1,459	3.40%	96.60%		
u75	1,146	465	681	40.60%	59.40%		
v55	5,233	35	5,198	0.70%	99.30%		
u01	3,515	16	3,499	0.50%	99.50%		
u51	4,756	97	4,659	2.00%	98.00%		
u22	3,195	62	3,133	1.90%	98.10%		
y27	5,009	63	4,946	1.30%	98.70%		
w24	5,889	109	5,780	1.85%	98.15%		
w64	4,569	76	4,493	1.66%	98.34%		
w01	3,832	94	3,738	2.45%	97.55%		
w83	4,716	105	4,611	2.22%	97.78%		
w48	4,411	197	4,214	4.46%	95.54%		
w39	5,111	51	5,060	0.99%	99.01%		
v30	3,643	47	3,596	1.29%	98.71%		
u40	4,648	146	4,502	3.14%	96.86%		
v01	5,555	44	5,511	0.79%	99.21%		
u98	5,771	71	5,700	1.23%	98.77%		
v22	5,014	91	4,923	1.81%	98.19%		
v29	3,909	84	3,825	2.15%	97.85%		
e18	4,000	74	3,926	1.85%	98.15%		
u69	4,205	92	4,113	2.19%	97.81%		
v93	5,265	43	5,222	0.82%	99.18%		
u17	4,822	38	4,784	0.79%	99.21%		
u34	5,578	667	4,911	11.96%	88.04%		
w60	5,139	216	4,923	4.20%	95.80%		
w54	5,053	58	4,995	1.15%	98.85%		
y38	5,072	86	4,986	1.70%	98.30%		
y16	4,228	79	4,149	1.87%	98.13%		
w99	3,111	71	3,040	2.28%	97.72%		
y94	4,545	159	4,386	3.50%	96.50%		
u92	4,652	27	4,625	0.58%	99.42%		
u75	5,642	112	5,530	1.99%	98.01%		
v37	4,107	32	4,075	0.78%	99.22%		
v18	3,950	18	3,932	0.46%	99.54%		
w27	4,984	84	4,900	1.69%	98.31%		
w19	4,059	150	3,909	3.70%	96.30%		
v07	5,764	104	5,660	1.80%	98.20%		
u86	3,234	14	3,220	0.43%	99.57%		
w76	5,206	70	5,136	1.34%	98.66%		
y93	2,829	195	2,634	6.89%	93.11%		
y73	4,702	292	4,410	6.21%	93.79%		
#31	4,910	113	4,797	2.30%	97.70%		
w02	3,729	45	3,684	1.21%	98.79%		
w58	4,718	108	4,610	2.29%	97.71%		
y08	4,669	45	4,624	0.96%	99.04%		
z58	2,706	943	1,763	34.85%	65.15%		
z11	3,641	106	3,535	2.91%	97.09%		
z10	4,371	40	4,331	0.92%	99.08%		
#11	4,692	27	4,665	0.58%	99.42%		
u70	5,635	115	5,520	2.04%	97.96%		
z25	4,789	81	4,708	1.69%	98.31%		
y39	4,088	84	4,004	2.05%	97.95%		
z59	2,713	62	2,651	2.29%	97.71%		
z20	156	33	123	21.15%	78.85%		
TOTAL	236,361	6,436	229,925	2.72%	97.28%		
Adjusted total	219,977	6,436	213,541	2.93%	97.07%	95.00%	202,947

1996 Chewuch Spring chinook							
apiant tag code	Fecundity	Dead eggs	Eyed eggs	Egg loss	Green egg-fry survival	Fry-smolt survival	Projected release
u16	5,122	314	4,808	6.13%	93.87%		
y82	4,266	63	4,203	1.48%	98.52%		
w30	4,003	42	3,961	1.05%	98.95%		
w17	4,607	110	4,497	2.39%	97.61%		
u09	3,776	57	3,719	1.51%	98.49%		
u27	4,319	86	4,233	1.99%	98.01%		
u97	3,231	273	2,958	8.45%	91.55%		
w51	3,954	2,060	1,894	52.10%	47.90%		
w61	3,360	461	2,899	13.72%	86.28%		
y53	2,916	373	2,543	12.79%	87.21%		
v25	3,210	48	3,162	1.50%	98.50%		
z33	4,355	58	4,297	1.33%	98.67%		
u13	3,760	44	3,716	1.17%	98.83%		
w51	4,003	73	3,930	1.82%	98.18%		
v28	3,520	86	3,434	2.44%	97.56%		
w47	4,549	75	4,474	1.65%	98.35%		
v40	4,182	53	4,129	1.27%	98.73%		
w25	3,023	114	2,909	3.77%	96.23%		
u14	3,896	82	3,814	2.10%	97.90%		
v65	4,899	59	4,840	1.20%	98.80%		
v61	3,714	635	3,079	17.10%	82.90%		
y35	4,811	22	4,789	0.46%	99.54%		
y96	3,084	105	2,979	3.40%	96.60%		
w68	2,951	46	2,905	1.56%	98.44%		
u03	4,359	151	4,208	3.46%	96.54%		
w52	4,340	281	4,059	6.47%	93.53%		
y45	2,734	146	2,588	5.34%	94.66%		
u76	4,221	156	4,065	3.70%	96.30%		
y44	3,695	85	3,610	2.30%	97.70%		
#55	2,764	120	2,644	4.34%	95.66%		
v06	3,545	50	3,495	1.41%	98.59%		
z46	4,216	546	3,670	12.95%	87.05%		
TOTAL	123,385	6,874	116,511	5.57%	94.43%		
djusted total	120,402	6,874	113,523	5.71%	94.29%	80.80%	91,672

Appendix B. Egg to smolt survival

				1996 Twisp Spring Chinook			
Implant tag code	**Fecundity**	**Dead eggs**	**Eyed eggs**	**Egg loss**	**Green egg-fry survival**	**Fry-smolt survival**	**Projected release**
y37	4,272	208	4,064	4.87%	95.13%		
z56	3,758	52	3,706	1.38%	98.62%		
w59	2,336	668	1,668	28.60%	71.40%		
v11	3,562	42	3,520	1.18%	98.82%		
w00	4,157	195	3,962	4.69%	95.31%		
v68	3,401	113	3,288	3.32%	96.68%		
u49	4,750	17	4,733	0.36%	99.64%		
u25	3,713	644	3,069	17.34%	82.66%		
u31	4,918	56	4,862	1.14%	98.86%		
u30	4,243	118	4,125	2.78%	97.22%		
w70	4,408	60	4,348	1.36%	98.64%		
v43	3,467	58	3,409	1.67%	98.33%		
u90	3,490	38	3,452	1.09%	98.91%		
y85	4,081	422	3,659	10.34%	89.66%		
z29	3,907	150	3,757	3.84%	96.16%		
y68	4,666	117	4,549	2.51%	97.49%		
y09	4,500	46	4,454	1.02%	98.98%		
v64	3,615	110	3,505	3.04%	96.96%		
w23	3,640	266	3,374	7.31%	92.69%		
v95	4,364	24	4,340	0.55%	99.45%		
u20	4,608	1,669	2,939	36.22%	63.78%		
y67	4,549	75	4,474	1.65%	98.35%		
TOTAL	88,405	5,148	83,257	5.82%	94.18%		
Adjusted total	85,847	5,148	80,699	6.00%	94.00%	95.00%	76,687

FINAL DRAFT -- APRIL 1, 1996 -- FINAL DRAFT

METHOW BASIN SPRING CHINOOK RESTORATION
1996 BROODSTOCK COLLECTION PROTOCOL

EXECUTIVE SUMMARY

Spring chinook stocks of the Methow River Basin have decreased to critically low levels and the trend is toward extinction. Recruit per spawner ratios (R/S) are mostly below 1.0 and in recent years the natural stocks have failed to replace themselves. The 1996 forecast is for only 350 spring chinook at Wells Dam, following two disastrous escapement brood years. The situation is critical, requiring unusually aggressive management intervention. In the short term, hatchery broodstock collection will take precedence over natural escapement. Management emphasis will be on rebuilding numerical run strength through existing supplementation projects or, in the worst case, total stock intervention. Genetic sub-stock integrity will be maintained where possible as insurance for future years.

A 3-tiered intervention plan for broodstock collection will be implemented in 1996.

Tier 1 - **If the spring chinook run to Wells Dam is <500 adults, capture 100% of the run at Wells Dam.**

Tier 2 - **If the spring chinook run to Wells Dam is 500-900 adults, capture 100% of marked hatchery origin adults at Wells Dam and augment specific broodstocks with collections at Foghorn (Methow), Fulton (Chewuch), and Twisp weir.**

Tier 3 - **If the spring chinook run to Wells Dam is >900 adults, all broodstock collections will be at tributary sites.**

Appendix C. 1996 Methow Basin spring chinook broodstock collection protocol

METHOW BASIN SPRING CHINOOK RESTORATION
1996 BROODSTOCK COLLECTION PROTOCOL

Background

Methow Fish Hatchery (MFH) was designed to propagate three spring chinook salmon stocks from the Methow, Chewuch, and Twisp rivers. The hatchery's production varies yearly with run strength, although the Wells Settlement calls for a production of 250,000 yearlings from each stock. The Winthrop National Fish Hatchery (WNFH) has a mitigation responsibility for another 600,000 yearling Methow River stock spring chinook migrants. Using data from the 1992 and 1993 brood years, brood stocks required to meet the combined production objectives are 454 Methow stock adults, and 134 each of the Chewuch and Twisp stocks (based on 4,400 eggs per female, a 1:1 sex ratio, and an egg to smolt survival of 85 percent). Assuming 89% adult pre-spawning survival, the planned program requires 722 adult brood fish (510 Methow stock and 150 each of Chewuch and Twisp stocks).

However, as constructed MFH is capable of safely rearing only 366,000 yearling chinook on a continuous basis. The rearing density design criteria used for all life stages was 0.75 pounds per cubic foot of container volume regardless of fish size. Fry have higher metabolic demands than larger fingerling. To account for this difference, a density index (DI) or pounds of fish per cubic foot per inch of length is utilized. The recommended maximum DI for chinook salmon is 0.125 lbs./cu. ft./inch (equal to design criteria for fish ≥ 6 inches). The major bottleneck at MFH is a deficient number (24) of start tanks, although the 12 intermediate raceways are also somewhat inadequate for the planned program size. Fifty two start tanks are necessary for the full program using a DI of 0.125 lb/cu.ft./inch. The Methow FH should only collect about 210 adults for a realistic capacity program of 350,000 smolts (116,500 smolts per stock). **Therefore, the revised program broodstock collection target for continuous production will include 430 Methow stock (360 for WNFH and 70 for MFH) and 70 each from the Chewuch and Twisp; a total production program requiring only 570 adult spring chinook salmon (21% fewer than design planning).**

Methow River Stock: The long-term goal is to collect brood fish for the Methow stock at the refurbished (1995) Foghorn Dam trap. The 1996 cycle will offer our first opportunity to trap wild Methow

broodstock at Foghorn. Trap efficiency is yet unknown, but expected to exceed 40 percent. The Methow FH outfall channel is capable of attracting salmon volunteers. In 1993, the MFH crew collected 99 volunteer salmon for Methow production. Scale pattern analysis however, indicated that 62% of these appeared to be of hatchery origin, most likely from WNFH. Volunteer collections at WNFH added another 646 salmon to the 1993 hatchery brood year. In 1994, WNFH collected 29 spring chinook, and another 17 salmon were collected at MFH, of which 14 were hatchery origin. The 1995 collections were only 7 fish volunteering to MFH, along with another 7 spring chinook which WNFH personnel captured and transported to MFH. All of the 7 females and 5 males spawned in 1995 were of hatchery origin.

Chewuch River Stock: The Fulton irrigation diversion dam on the Chewuch River, which has had variable trap efficiency, is where we collect Chewuch brood fish. Broodstock collections began in 1992, when 33 salmon were trapped, of which 20 were retained. Based upon redd count expansions, we collected and retained about 8% and 5% respectively, of the 1992 run . Denil attraction flows at the Fulton trap were improved in 1993 and we trapped 186 salmon, retaining 110 for broodstock (about 37% of the spawning run). The 1993 trap efficiency was improved to approximately 60% of the run. In 1994, we collected only 10 spring chinook at the Fulton trap. No spring chinook were trapped in 1995 due to the extreme low run size and concern for natural escapement.

Flow improvements at the Chewuch trap will allow trapping of up to 60% of the spawning run. In-season monitoring is necessary at the Chewuch trapping site to ensure meeting our broodstock collection objective without negatively impacting natural escapement.

Twisp River Stock: We collect Twisp river broodstock at a floating weir facility on the Twisp River adjacent to the conditioning pond. This weir has had relatively low (15-21%) trapping efficiency, which is reduced at high spring flows. Also there have been concerns that the weir might delay or displace natural spawning when operated late in the season. In 1992, 71 salmon were captured; 30 of which were retained for broodstock. An undetermined, but presumably large number of salmon passed the weir in moderately high flow. About 310 salmon spawned in the Twisp River in 1992, based on redd count expansions. Using this estimate, the hatchery crew trapped 20.9% of the spawning population, and retained 8.8% for broodstock. In 1993, hatchery personnel trapped 70 salmon and retained 42, which was

about 9.1% of the estimated natural escapement. The 1993 trap efficiency was lower, estimated at 15.1% (70/464) of the run. In 1994, only five salmon were collected. Because of a dangerously low adult cycle again in 1995, the decision was made to discontinue brood collection efforts and there were no spring salmon trapped on the Twisp River for hatchery broodstock.

With a full-time trapping schedule we can expect to capture up to 22% of the spring chinook spawning run which pass the Twisp weir. The overflow design allows for passage of about 80-85% of migrating chinook adults, particularly during higher spring flows. There could be delays and/or displacement of natural spawners when the weir is in place during low water in August or September.

Escapement: The 1975-1990 average Wells Dam count for spring chinook salmon was 2,579 (adults and jacks), while the most recent 5-year average (1991-95) is 58% lower (1,071 fish total). The natural spring chinook run has declined significantly from the 1960's when the average run size was about 3,200 fish. Recent distribution of redds is approximately 45% Methow River, 28% Chewuch River, and 27% Twisp River. Escapement to these streams (based on spawning

SPRING CHINOOK ADULT DISTRIBUTION ABOVE WELLS DAM 1991-1995

YEAR	Wells Adult Count	Wells Jack Count	Broodstock Trapped[1]	Redd Count	Escapement[2]
1991	687	98	92	250	550
1992	1542	31	382	738	1624
1993	2601	25	897	617	1357
1994	243	15	61	133	293
1995	72	41	14	15	33
5-yr. Avg.	1029	42	289	351	771
1975-1990	2385	194	459	314	1507

[1] *Combination of Winthrop NFH, Methow FH, Chewuch, and Twisp collections.*

[2] *Estimated escapements based on various expansions using 2.2 fish/redd, 2.187 index/total redds, and 1.496 single/cumulative redd count (Larrie LaVoy, WDFW, personal communication).*

ground surveys in index areas) is quite variable, and in the most recent two years natural escapement has been extremely low. The 1994 escapement to the Methow Basin was only 258 salmon counted at Wells Dam, and 61 salmon (23.6%) were captured for hatchery broodstock. Only 133 natural redds were subsequently counted in the basin. The 1995 cycle was a record low at only 72 adult and 41 jack spring chinook over Wells. An in-season emergency decision disallowed trapping 1995 brood spring chinook other than hatchery volunteers. This decision was based on concerns for probable low effective population size in the hatcheries and a feeling that if we don't take them all we shouldn't take any at such a low run size, allowing the stocks the maximum possible natural spawning opportunity.

1996 Forecast: The predicted (TAC - 19 January) Wells Dam run size for 1996 should fall within a range of 260 to 856 spring chinook salmon, based on a Bonneville run size of approximately 37,200 and a conversion to Wells Dam of from 0.7% (1995) to 2.3% (ten year average). The forecast averages suggest a Wells run size of 500 spring chinook in 1996, but do not account for the expected lack of 5-year-olds. Cautious pessimism (and 1996 vs 1995 upriver ratio) suggests a point estimate forecast of about 350 spring chinook crossing Wells Dam (including about 50-60 destined to the Methow FH and another 100 to Winthrop NFH).

The early prediction at Bonneville was 20,000 fish in 1995. This prediction proved overly optimistic, as only 10,000 spring chinook returned. Applying the same error rate (half of the pre-season prediction) to the 1996 cycle, we could experience another escapement failure in 1996 (an adjusted range of 130 to 428 fish at Wells). The broodstock protocol is designed to effectively deal with such a circumstance.

Natural escapement of Methow spring chinook has been low to nearly non-existent in the past two years. A similar run size for a third consecutive year will have dangerous consequences for maintenance and stability of natural stocks. In addition, several concerns have been raised over the low effective breeder size in the Methow FH. The hatchery concerns are attributed to the small number of salmon in the broodstock, unequal sex ratio, differential rates of maturation, and the division of the number of spawners into distinct mating pools. The Methow basin spring chinook could be on the threshold of extinction and intervention appears to be the most prudent course of action.

Appendix C. 1996 Methow Basin spring chinook broodstock collection protocol

The Decision Process

WDFW staff and tribal co-managers have determined that the Methow spring chinook stocks have declined to such a low status that total intervention is necessary to prevent stock extinction and begin a rebuilding process.

- Recruit per spawner ratios indicate the stocks are not replacing themselves in the wild environment.
- Escapement in the last two brood years is minimal and resultant year-classes will at best be poor contributors to future stock stability and rebuilding.
- The pre-season forecast is for another poor spring chinook run of only 350 fish to Wells Dam.
- Considering the declining escapement trend, R/S values less than 1:1, and projected low return in 1996, the situation requires unusually aggressive management intervention.
- In the short term, hatchery broodstock collection and hatchery rearing will take precedence over natural escapement, potentially offering significant survival advantages to the impoverished stocks. (The 1989 brood Chiwawa hatchery spring chinook returned 5.8 recruits for each spawner, indicating the level of benefits to be derived under relatively good survival conditions.)
- Emphasis will be on rebuilding the numerical strength of the stocks through existing hatchery supplementation programs or total run intervention.
- Because it is believed important to the rebuilding process and regardless of whether partial supplementation or total intervention is enjoined, we will attempt to maintain tributary genetic stock integrity where possible. Broodstock composition, as the proportion of natural and hatchery adults, is of less concern and fish will be collected as they occur in the run.

Conceptually, the broodstock collection protocol will be the operating sideboards for the 1996 brood year and for the short term future. Notwithstanding the pre-season prediction for a Wells Dam run size of 350 spring chinook, the broodstock protocol also defines how we will proceed with broodstock collection for the Methow FH and Winthrop NFH spring chinook supplementation programs in the event the run is significantly larger than forecast. The run size break points between each collection protocol level (tier) are based on the following:

Appendix C. 1996 Methow Basin spring chinook broodstock collection protocol

A. A desired effective population size is defined as at least 50 adult salmon, or 25 spawning pair, for each stock, regardless of whether taken into the hatchery or left in the natural environment.

B. At run sizes less than 500 adult salmon, hatchery broodstock collection will take precedence over less productive natural escapement.

C. Escapement and broodstock management will be in accordance with spring chinook pre-season TAC forecasts at Bonneville Dam as adjusted by recent conversions to Wells Dam.

D. Wells Dam is the only reasonable location to effectively intervene and trap all returning spring chinook salmon. Trapping efforts at tributary sites will only yield varying capture rates, from 15% up to about 60% of each tributary stock.

E. Recent run compositions and expected survival rates suggest the 1996 adult returns (based on the 350 fish prediction) will be 100 to Winthrop NFH, 55 to Methow FH (25 Twisp and 30 Chewuch age-4 returns), and about 195 natural salmon.

F. There will be two formal in-season checkpoints at which we will confer to refine and update the projected Wells Dam run size. The first will be on or about 15 May and will be based on spring chinook passage at Priest Rapids Dam (average 65% passage). The second formal check point will occur when we have trapped 200 spring chinook salmon at Wells Dam under Tier 1 protocol. At each juncture we will confer with co-managers to decide, based on observed run timing and magnitude, whether to continue 100% trapping at Wells or, in the event the run appears significantly larger than the Tier 1/Tier 2 cutoff of 500 adults, to switch to a Tier 2 trapping protocol from that point on.

Appendix C. 1996 Methow Basin spring chinook broodstock collection protocol

BROODSTOCK COLLECTION

Broodstock collection at Wells Dam will commence on or before 1 May and will continue through the first week of July or until such time as fresh summer chinook constitute at least 95% of arrival / passage. Trap operators will be required to identify and separate spring vs summer chinook based on body conformation and general coloration from about 28 June through the end of spring chinook passage at Wells.

TIER 1 - Wells Dam Run Size Less Than 500 Adult Spring Chinook

Trap all (100% of the run) spring chinook salmon at Wells Dam. Operate right (west) bank ladder trap 24 hours a day. Operate the left (east) bank ladder trap during all daylight hours, at least 16 hours a day. Hold broodstock temporarily at Wells Hatchery in the adult steelhead pond. Tag all salmon with individual ID numbers (VI and/or jaw tags) and take scale samples from all unmarked (no CWT) fish at the time they are transferred from Wells to the final holding facility at Methow Hatchery. Transfers will occur as necessary for optimum truck loading, but at least weekly.

All unmarked hatchery-origin salmon (from scale pattern analysis) will be d[illegible]nated the Methow hatchery stock, and transferred to Winthrop NFH. Marked hatchery fish will be mostly returns from the 1992 brood year (as 4-year-olds) from which Methow FH released 41,000 Chewuch and 36,000 Twisp yearling smolts in 1994. All marked hatchery adults will be spawned at Methow FH. We will read coded wire tags in situ during spawning to discriminate between the stocks.

All unmarked natural salmon will be treated in one of two manners: 1) If elemental scale analysis proves useful, submit scale samples for immediate analysis for stock discrimin[illegible]on and the natural adults then incorporated into stock-specific broods; or in the event this new technique cannot effectively separate the stocks, 2) unmarked natural salmon will be treated separately at Methow FH as a wild group of unknown origin.

TIER 2 - Wells Dam Run Size is 500 to 900 Adult Spring Chinook.

At run sizes from 500 to 900 fish, we will trap 100% of returning marked (adipose clip) hatchery

origin salmon at Wells Dam. This second tier also requires running the Wells Dam fish ladder traps continuously as this is the only effective way to capture all returning adults of known genetic origin. All unmarked fish will be passed over Wells Dam and allowed to migrate naturally upriver. In addition to trapping all marked fish at Wells, we will operate the tributary traps on the Methow (Foghorn Dam), Chewuch (Fulton Dam), and at the Twisp weir. Fish trapped in tributaries will be used to augment stock-specific brood collections after naturally segregating during migration. Trap efficiency differences may dictate that the Foghorn and Fulton traps be operated less than full-time (as compared to the Twisp weir) depending on the total number of adults trapped for each stock.

All unmarked hatchery fish (from scale pattern analysis) trapped in the tributaries or volunteering into either hatchery will be assigned to the Methow stock, and likely all or most will be transferred to Winthrop NFH for rearing. All marked hatchery fish will be spawned at the Methow FH and coded wire tags read in-situ to discriminate between stocks.

We will assume that natural fish trapped in the tributaries are in their river of origin and we will treat them as tributary-specific stocks to augment known marked hatchery broodstock (Chewuch or Twisp) or assumed Methow broodstock.

TIER 3 - Wells Dam Run Size greater than 900 Adult Spring Chinook.

In the event the run size is greater than 900 adult salmon, all broodstock will be collected at tributary sites (assumed known origin) or from hatchery volunteers as per the Wells Settlement Agreement. Our hatchery broodstock objective is full utilization of both the Methow FH and Winthrop NFH optimum production capacity.

Within a Wells Dam run size of between 900 and 1400 adult salmon, collections for the Twisp River stock may be less than design capacity due to low trap efficiency. Conversely, the traps at Foghorn and Fulton Dams might be operated at less than full efficiency depending on the number of adults collected at each. If the run exceeds 1,400 adults, tributary trapping should fully achieve broodstock needs for all stocks within facility capacities.

Appendix C. 1996 Methow Basin spring chinook broodstock collection protocol

Generalized Fertilization Methods (Mating Protocol)

Under the Wells Settlement Agreement, conceptual spring chinook fertilization guidelines for the Methow Complex are listed below, modified where necessary to reflect management's intent to intervene and rebuild the Methow spring chinook run. Recent history tells us we will be putting the progeny into an environment where they will achieve less than a 1:1 success rate. We will probably need to recycle the fish through the hatcheries for a second generation to achieve demographic rebuilding. At this stage it is better to avoid interbreeding as much as possible. We may need the added fitness given us by local adaptation at a later date, and there is no need to give it up now (this includes the Winthrop stock). We can always mix the stocks later; we cannot unmix them. Until or unless on-going scale analyses yield a good way to separate unmarked natural adults into each of the three stocks, we will consider them an "unknown" genetic group.

A) Broodstocks for hatchery production will be predominantly from those fish resulting from natural spawning (eg: wild fish), unless total numbers are so low that stock extinction is likely (Guiding Principles: Methow Basin Spring Chinook Supplementation Plan). In this intervention protocol, broodstock will be collected as they occur in the run, without regard to whether a fish is of hatchery or natural origin.

B) Matings will be single-pair, with a male backup and individual family incubation for each population. Under Tier 1 there will be 5 "groups" of spring chinook on station(s) at the end of broodstock collection (Winthrop or Methow, marked Chewuch, marked Twisp, unknown naturals, and a small number of known origin captive 1993 brood 3-year-olds. To maintain within-stock genetic integrity, the preferred mating procedure will be to mate only within groups with the same genetic background. This is most important where Twisp and Chewuch fish are concerned. For these two groups we will use captive jacks as backups. If mates are lacking, we will use captive jacks preferentially and as a last resort use unknown natural males. Our intent is to mate remaining natural unknowns X unknowns and Winthrop X Winthrop as separate groups. At Tier 2 run sizes greater than 500 adults (and tributary collection) we will achieve genetic stock separation, and will no longer be concerned with how to mate or distribute a genetically "unknown" natural group.

A different mating procedure was discussed at our 14 March co-managers meeting. In that meeting

a scenario was proposed whereby each adult Twisp or Chewuch salmon be interbred with one of the natural "unknown" group. While this would guarantee at least a 50% genetic contribution for each pairing and double the effective population size, this procedure could preclude taking advantage of stock-specific adaptations in future generations. On the advice of WDFW genetics staff, we do not concur with such a procedure at this time.

C) If possible, live spawn males initially, using identifiers (tags) to prevent redundant primary use. The intent is to fertilize eggs from each female with sperm from a single male (with a backup male) and to use each male only twice (once as primary and once as backup). If the absolute numbers of fish or the sex ratio are incompatible with this intent, exceptions to the guidelines may be appropriate after more consultation with and following the advice of the WDFW Genetics Unit.

D) Cryopreserve milt for potential use in successive years. Priority will be placed on cryopreservation of milt from age-5 males.

Captive Brood Considerations

WDFW now has several hundred captive age-3 spring chinook from the 1993 brood year at the Methow FH (about 100 of each stock). A few males will probably mature as jacks this year, giving us a limited opportunity to maintain stock integrity where male/female ratios may be low or males are late in maturing. We should consider keeping some of the sub-yearling chinook on station (1994 brood) for the same potential future use. WDFW and co-managers should thoroughly consider the entire concept of captive broods and plan for their potential use in recovering depauperate fish stocks. Most managers continue to shy away from the use of cryopreserved sperm because of low probability of success. At best, the use of cryopreserved sperm is only seen as a secondary or backup mating procedure. The potential use of cryo should be afforded further analysis, discussion, and direction in light of recent natural stock failures.

Appendix D. Number and kilograms of spring chinook released for brood year 1996 from the Methow Hatchery

Stock	Tag code	Number tagged	Number released	Size at release (g)	Kilograms released	Release date	Type of release	Site of release
Methow	63-02/46	3,128	3,044	25.0	76	15 April 1998	Volitional	Methow River RM 45
	63-02/48	4,859	4,668	25.0	117			
	63-63/15	9,135	8,930	25.0	223			
	63-01/03	192,076	186,305	25.0	4,658			
sub total		209,198	202,947	25.0	5,074			
Chewuch	63-02/33	111,105	91,672	22.7	2,081	15 April 1998	Volitional	Chewuch River RM 6.2
sub total		111,105	91,672	22.7	2,081			
Twisp	63-63/17	4,665	4,599	30.7	141			
	63-63/16	7,477	7,370	30.7	226			
	63-61/14	67,663	45,760	30.7	1,405	15 April 1998	Volitional	Twisp River RM 5.4
		21,301	18,958	30.7	582	17 April 1998	Direct stream plant	Twisp River RM 5.4
sub total		101,106	76,687	30.7	2,354			
Total		421,409	371,306		9,509			

The performance standards outlined are for the facility when it is at maximum management capacity. Although annual production was established at 738,000 yearling smolts, the primary function of the hatchery program is to operate as a supplementation facility.

Measures	Stock	Standard set	Standard Achieved 1992	1993	1994	1995	1996
Adult capture	Chewuch	238	20 (8.40%)	110 (46.00%)	10 (4.20%)	0	65 (27.30%)
	Methow	238		99 (42.00%)	17 (7.10%)	14 (5.90%)	114 (47.90%)
	Twisp	238	30 (12.60%)	42 (18.00%)	5 (2.10%)	0	49 (20.60%)
Adult prespawn survival	Chewuch	80.00%	85.00%	94.40%	100.00%	0	97.00%
	Methow	80.00%		97.90%	100.00%	2 (83.30%)	98.30%
	Twisp	80.00%	80.00%	92.90%	100.00%	0	100.00%
Egg collection	Chewuch	350,000	47,660 (13.60%)	307,448 (88.00%)	12,734 (3.60%)	0	120,402 (34.40%)
	Methow	350,000		228,654 (65.00%)	48,546 (13.90%)	29,813 (8.50%)	219,977 (62.90%)
	Twisp	350,000	39,164 (11.20%)	126,705 (36.00%)	20,833 (6.00%)	0	85,847 (24.50%)
Green egg-fry survival	Chewuch	85.00%	88.80%	96.50%	94.60%	0	94.30%
	Methow	85.00%		96.20%	99.40%	97.90%	97.10%
	Twisp	85.00%	94.20%	97.70%	99.40%	0	94.00%
Fry-smolt survival	Chewuch	70.00%	97.20%	95.80%	98.50%	0	80.80%
	Methow	70.00%		95.90%	98.40%	99.60%	95.00%
	Twisp	70.00%	97.20%	94.30%	96.00%	0	95.00%
Fish released	Chewuch	250,000	40,862 (16.30%)	284,161 (114.00%)	11,854 (4.70%)	0	91,672 (36.70%)
	Methow	250,000		211,157 (84.00%)	4,477 (1.80%)	14,238 (5.70%)	202,947 (81.20%)
	Twisp	250,000	35,861 (14.30%)	116,749 (47.00%)	19,835 (7.90%)	0	76,687 (30.70%)
Adults upstream	Chewuch	66.00%	89.50%	65.00%	80.40%	*13 (100.00%)	0
	Methow	66.00%		88.00%	86.10%	*60 (81.10%)	0
	Twisp	66.00%	73.00%	92.00%	90.60%	*26 (100.00%)	0
Percent survival	Chewuch	1.00%	N/A	N/A	N/A	N/A	0.10%
	Methow	1.00%	N/A	N/A	N/A	N/A	N/A
	Twisp	1.00%	N/A	N/A	N/A	N/A	0.06%

* These values based upon spawner/redd ratio calculated by the Yakama Indian Nation field survey crews.

1998 PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY
NORTHERN PIKE MINNOW
REMOVAL AND RESEARCH PROGRAM
FINAL DRAFT

APPENDIX G

1998 Public Utility District No. 1 of Douglas County Northern Pike Minnow Removal and Research Program

Prepared For

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Final Draft

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Abstract

Northern Pike Minnow removal efforts took place from June 17, 1998 to September 1, 1998. Anglers used hook and line and long line removal techniques to capture northern pike minnow from 1 mile below Wells Dam upstream to the boat restricted zone (BRZ) of Chief Joseph Dam. Anglers utilized hook and line removal methods exclusively on the lower 14 mile stretch of the Okanogan River. A total of 26 anglers participated in the removal efforts.

Anglers captured a total of 7194 northern pike minnow over 10" in fork length and 153 northern pike minnow under 10" in fork length utilizing hook and line and long line removal techniques. These fish (7347 pike minnow total) were captured during 3049.25 hours of angling effort translating into an overall catch per unit effort or fish per hour (CPUE) value of 2.41. A majority of the fish were captured in the immediate 1 mile tailrace below Wells Dam (7055 fish during 2798.5 angling hours, CPUE = 2.52). Anglers caught 100 northern pike minnow in the lower Wells reservoir between Wells Dam and the town of Brewster. These captures took place during 82 hours of angling effort resulting in a CPUE value of 1.22. Upper Wells reservoir effort (between Brewster and the BRZ of Chief Joseph Dam) consisted of 108.75 angling hours during which time 139 pike minnow were captured (CPUE= 1.28). The lowest catch levels took place in the Okanogan River where anglers fished for 60 hours capturing 53 northern pike minnow (CPUE = .88).

Long line captures accounted for 42% of the overall catch (3062 northern pike minnow). A total of 475 long lines were set in the 1 mile stretch below Wells Dam. Tailrace long lines captured 2965 pike minnow (CPUE = 3.12 when estimating that each long line takes 2 hours to set, retrieve, and maintain). Anglers placed 42 long line sets in the Wells reservoir and captured 97 northern pike minnow translating into an overall CPUE value of 1.15.

Incidental catch consisted of 9 separate species. A total of 437 incidentals were captured and released representing 6% of the overall catch. The majority of the incidental species were captured utilizing hook and line removal techniques. The hook and line incidental catch consisted of peamouth (88 fish), walleye (77 fish), burbot (43 fish), smallmouth bass (22 fish), sculpin (5 fish), channel catfish (2 fish), chiselmoutn (1 fish), and bullhead catfish (1 fish). The Long line incidental catch consisted of bridgelip suckers (150 fish), burbot (16 fish), walleye (3 fish) and peamouth (1 fish). All incidentally collected fish were released in a live healthy state. No anadromous salmonids were encountered during the 1998 removal efforts.

Complete biological data was collected on 379 northern pike minnow, a 5.1% sub-sample. Biological data consisted of length, weight, sex, stomach contents, and gonad analysis. The majority (62%) of the sexed fish were female. The

average female northern pike minnow weighed 664 g (1.47 lbs), and measured 363 mm. (14.56 inches) in fork length. The average male northern pike minnow weighed 250 g (.55 lbs). and measured 272 mm. (11.81 inches) in fork length. The overall northern pike minnow length was 328 mm. (13.19 inches). Overall pike minnow weight average was 506 grams or 1.12 lbs, resulting in 8,229 lbs of pike minnow biomass removed in 1998.

From gonad analysis it was determined that pike minnow spawning efforts peaked in July during the week of 7/2/98, at which time 83% of the sub-sampled pike minnow were classified ripe. A 54% majority of the dissected stomachs were empty. The remaining stomachs contained prey items identified as crayfish (17%), unidentified fish (15%), unidentified insect (6%), smolt (4%), and unidentified plant (4%).

Introduction

A dramatic decline in the abundance of salmonid stocks (*Oncorhynchus spp.*) in the Columbia River ecosystem has driven state, federal, public and private agencies to address measures which will provide for the restoration of this resource. The removal of the highly piscivorous northern pike minnow (*Ptychochelius oregonensis*) has been recognized as an important part of restoring the salmonid stocks to the Columbia River Region (Vigg et al. 1990, Matthews et al. 1991,). Northern pike minnow removal and research was initiated on the lower Columbia River during the summer of 1990. A total of 17,334 pike minnow were captured in the test fisheries (Vigg, 1990). In 1991 a total of 39,817 fish were removed from eight US Army Corps of Engineer dams on the lower mainstems of the Columbia and Snake Rivers (Beaty et al. 1991). The success of these test fisheries prompted mid-Columbia Public Utilities to investigate pike minnow removal strategies at local hydroelectric facilities.

Public Utility District No. 1 of Douglas County (DCPUD) owns and operates Wells Hydroelectric Project, located at river mile 515 on the Columbia River (Figure 1). In 1993 the District jointly funded a juvenile salmonid predation study in the mid-Columbia region (Burley et al. 1994). This study focused on identifying areas of northern pike minnow abundance and areas of high predation on outmigrating juvenile salmonids. Density index values of pike minnow in the mid-Columbia reservoirs were as high as many reservoirs of the lower-Columbia. The immediate tailrace of Wells Dam and the outfall of Wells Hatchery were determined to be sites where large concentrations of pike minnow could be found relative to the reservoir and forebay areas surrounding Wells Dam.

Evidence of large consumption values and abundance estimates in the Wells tailrace prompted DCPUD to initiate a northern pike minnow removal fishery in 1995. The goals of this pilot project were to assess the effectiveness of several gear types for removing pike minnow, estimate the population of pike minnow and removing pike minnow from the tailrace of Wells Dam (Bickford and Klinge, 1996). During the summer of 1995 anglers captured 1198 pike minnow, most of which were caught using hook and line removal techniques. Population estimates for the Wells tailrace were estimated at fewer than 10,761 fish. A similar removal program was undertaken in 1996 with goals of increasing effort and removing as many pike minnow as possible from the Wells tailrace (Bickford, 1997). Unfortunately, difficult fishing conditions related to high river flows and velocity hampered removal efforts at Wells Dam. A total of 313 northern pike minnow were captured, most on sport fishing gear. Commercial long line gear was also utilized, and although the lines did not capture a large amount of pike minnow, CPUE levels were high when this gear was tested. Low catch rates in 1996 prompted biologists at DCPUD to switch into a northern pike minnow research phase during 1997. That year, northern

pike minnow were radio tagged throughout the Wells reservoir and tailrace. Northern Pike minnow migration patterns, spawning locations, and preferred habitats were identified throughout Wells reservoir and from the Wells tailrace 11 miles downstream to Chelan Falls (Bickford, 1999 Draft).

In an effort to increase catch levels, DCPUD entered into a contract with Columbia Predator Control for the removal of northern pike minnow in 1998. The Columbia Predator Control removal strategy focused on an incentive based fishery with a crew of experienced anglers paid on a per-fish basis (anglers hired directly by DCPUD in 1995 and 1996 had been paid by the hour). The goal of the 1998 fishery was the removal of a maximum number of northern pike minnow from Wells reservoir, the lower 13 miles of the Okanogan River, and the lower 1 mile stretch of Wells Dam tailrace.

Figure 1
Wells Dam Location

Materials and Methods

1998 Removal efforts took place within the immediate 1 mile tailrace area of Wells Dam, Wells reservoir to the boat restricted zone (BRZ) of Chief Joseph Dam, and the lower 13 miles of the Okanogan River. A scientific collection permit was obtained through Washington Department of Fish and Wildlife allowing anglers to fish in the mouth of the Wells Hatchery Outlet and the BRZ of Wells Dam. Angling efforts were initiated on June 17, 1998 and continued through August 31, 1998. Twenty-six anglers were paid a $5.00 bounty for each captured pike minnow over 10" in length, and a $1.00 bounty for pike minnow under 10" in length. Anglers turned in their catch on a daily basis at the Wells Dam boat launch or at the Columbia Predator Control field office in Pateros, Washington. Anglers were responsible for presenting daily data sheets specifying times fished to the nearest ¼ hour, locations fished, number of fish caught per location, long line set times, incidental catch, and tackle/baits used. To verify catch, northern pike minnow over 12" in length had their tails clipped, frozen and submitted to a DCPUD biologist on a bi-weekly basis. Northern pike minnow under 12" were frozen whole for length verification.

Captured northern pike minnow were divided into four primary catch locations. Pike minnow captured from Wells Dam to 1 mile downstream were designated "Wells tailrace". Fish captured from the Wells forebay to the town of Brewster were designated "lower Wells reservoir". Pike minnow collected from Brewster to the BRZ of Chief Joseph Dam were classified as "upper Wells reservoir". Captures in the Okanogan River were designated catch location "Okanogan". Daily, weekly, and seasonal CPUE rates were calculated by location and by removal technique (sport fishing vs. long line).

Both sport fishing and long line removal techniques were utilized for pike minnow capture. Sport fishermen utilized a variety of baits and tackle. Baits consisted of salmonid smolt mortalities, crayfish, worms, crickets, and chicken livers. Smolt mortalities were salvaged from Little Goose Dam, Lower Granite Dam, and McNary Dam juvenile bypass facilities. Smolt mortalities were also provided by personnel at the Wells Fish Hatchery. Columbia Predator Control provided the smolt to the anglers when supplies were available. Otherwise, anglers purchased or collected the majority of their own fishing baits. Fishing effort was applied directly from Wells Dam, from shoreline areas in Wells reservoir and tailrace, and by boat. Boat anglers constituted a large level of effort within the immediate Wells tailrace area. Boat anglers also still-fished baits in the slow-moving Wells reservoir and Okanogan River. Downriggers were fished specifically in the Wells Dam BRZ and immediate Wells tailrace.

Long line use was only authorized in the mainstem Columbia due to concerns over incidental steelhead catch in the Okanogan River. Long lines used in

1998 were from 100' to 400' in length with each ground line having from 20 to 100 gabions. Leader and hooks were then tied to each gabion. Leaders consisted of 6 pound monofilament test approximately 2 feet in length. Long lines were baited with smolt mortalities, crayfish, crickets, worms and chicken livers. Long line gear was typically checked twice daily. This allowed anglers to release all non-target fish back into the river unharmed. Long line effort for the purpose of calculating CPUE was estimated by the number of lines set. It was estimated that, on average, each line took approximately 2 hours to set, retrieve, and maintain.

Biological Data was collected on 5.1% of the weekly catch. Sub-sample data consisted of fork length, weight, sex, stomach contents, and gonad maturity. Northern pike minnow fork lengths were measured to the nearest millimeter. An Ohaus 5000 electronic scale was used to weigh fish to the nearest 2 grams. Pike minnow were sexed and identified as male, female or unidentified. Stomach contents were then visually identified. Gonad maturity was identified on a scale of 0 to 4, corresponding to the following criteria:

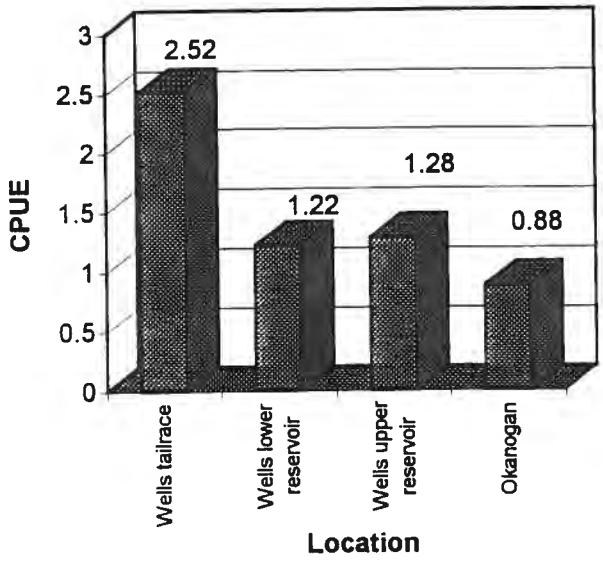
0 - Unidentified	Gonads could not be distinguished between male and female.
1 - Immature	Gonads thin and streamlined, sex may be difficult to determine.
2 - Developing	Eggs and milt do not flow easily with pressure, but sex is easily determined. Eggs are small and gray in color.
3 - Ripe	Females contain orange-colored eggs. Eggs and milt flow freely with gentle pressure.
4 - Spent	Gonad size reduced. Some eggs or sperm may still be present.

Results

A total of 7347 northern pike minnow were captured during 3049.25 hours of angling effort resulting in an overall CPUE of 2.41 fish per angling hour. A majority of the fish were over 10" in fork length (7194 fish total). Twenty-six anglers participated in removal efforts, with twelve anglers fishing on a regular basis. These twelve anglers accounted for over 80% of the total catch.

Anglers experienced the highest CPUE of 2.52 in the Wells tailrace, capturing 7055 pike minnow in 2798.5 hours of angling effort (Figure 2). Relatively low catch and CPUE rates were logged at the other three locations. Wells lower reservoir effort consisted of 100 hours during which time 82 pike minnow were captured resulting in a CPUE of 1.22. Anglers experienced a similar catch rate in the upper Wells tailrace where 139 pike minnow were captured during 108.75 hours of effort (CPUE = 1.28). The lowest catch rates were experienced in the Okanogan river, where a total of 53 fish were caught during 60 hours of angling effort (CPUE = .88).

Figure 2
CPUE By Location



The highest weekly catch levels occurred during the initial three weeks of removal efforts (Figure 3). Total weekly catch dropped in mid July, and the lowest catch totals were experienced during the last two weeks of removal efforts. Conversely, CPUE rates were the lowest at the beginning of the summer (Figure 4) and were the highest during August, at which time CPUE levels rose above 3.0.

Figure 3
Weekly Catch

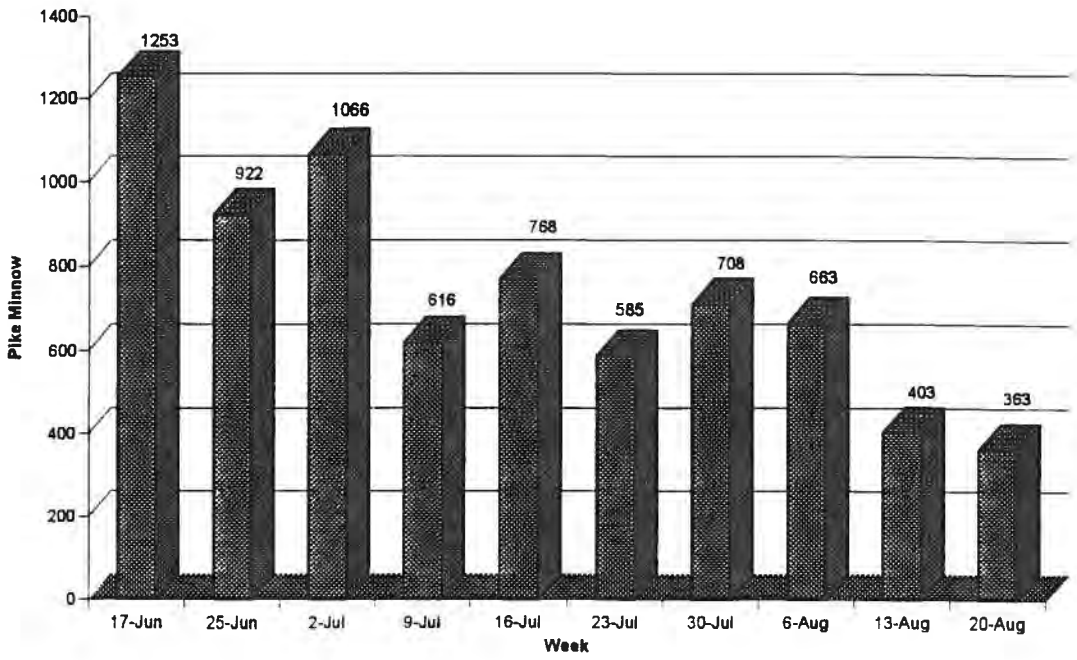
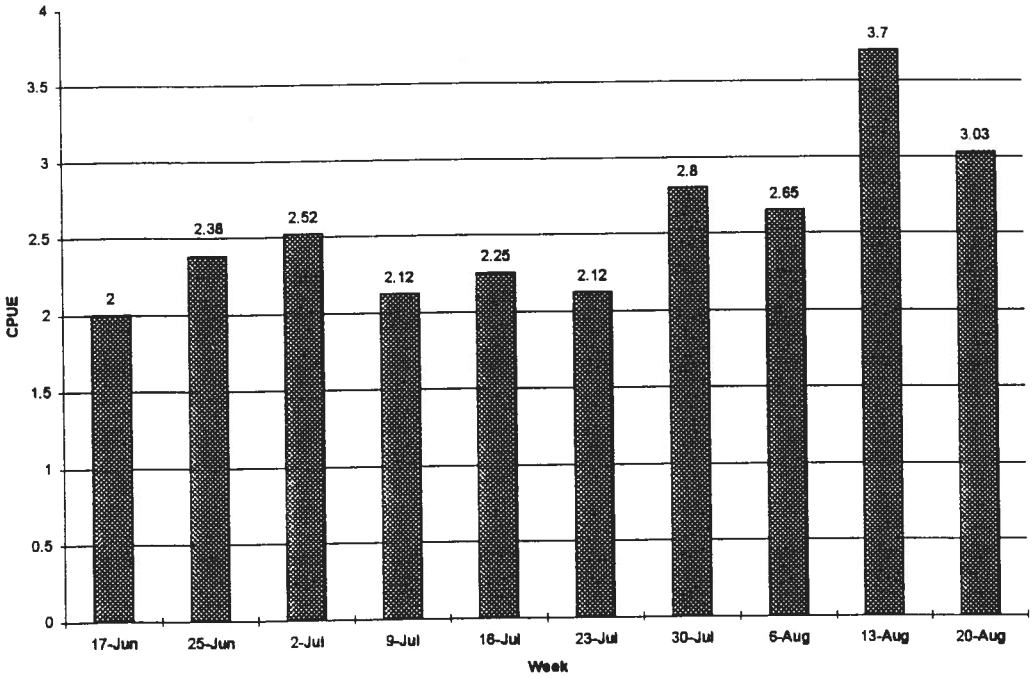


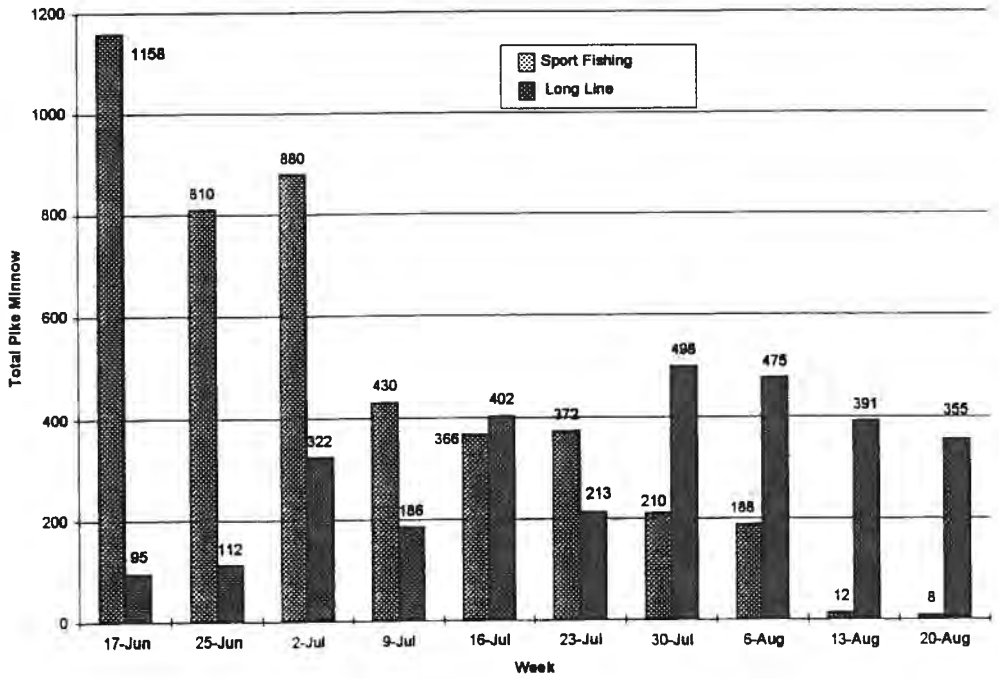
Figure 4
Weekly CPUE



During the initial week of removal efforts, anglers experienced the highest degree of success while fishing the immediate Wells tailrace. Of the 1253 pike minnow recorded in week 1, 1014 of these fish were caught in that location. The west bank, east bank, and Wells hatchery outlet in the immediate tailrace area were the most productive fishing locations. Week 1 also marked the highest degree of angler participation (21 total fishermen). Angler participation decreased drastically during week 2 (13 fishermen), a result of individuals not participating who could not catch fish during the initial week. A majority of these 13 anglers continued to participate in removal efforts for the remainder of the summer. Anglers continued to experience high catch levels in the wells tailrace until mid-July when catch rates dropped drastically. Angling attempts at fishing the Wells reservoir and Okanogan River locations were also meeting with very limited success. It became apparent that the immediate Wells tailrace was fished out (anglers were only allowed to fish up to 400 yards below Wells Dam). At that time it was decided to extend the angling boundaries to 1 mile below Wells dam in an attempt to increase catch and CPUE levels. Extending the lower boundaries also allowed anglers to set long lines in productive gravel spawning beds in the upper Rocky Reach pool (northern pike minnow spawning efforts were peaking in mid-July, another reason for the low numbers of pike minnow in the immediate tailrace area).

As sport fishing gear catch effectiveness dropped, anglers began setting increased numbers of long lines. By mid-July, weekly long line catch totals had surpassed that of hook and line catch (Figure 5). Over 80% of the pike minnow captured in August were caught on long line gear. Total long line catch in 1998 was 3049 pike minnow (41% of the total catch). High long line catch levels were a result of anglers ability to leave baits for several hours at different locations throughout the tailrace area.

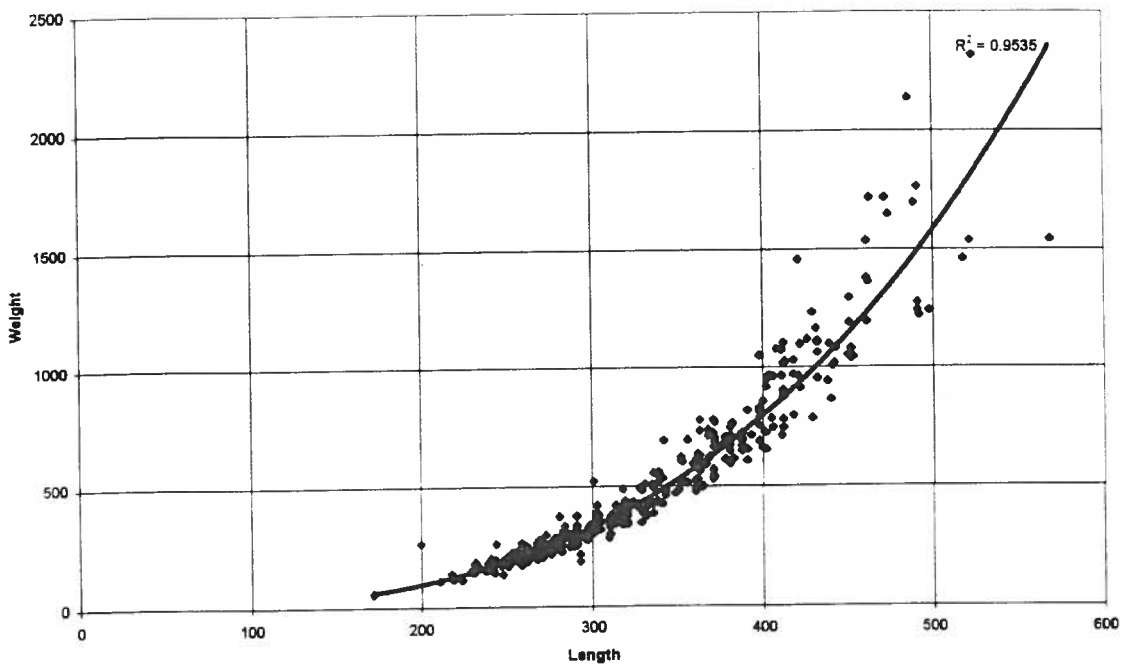
Figure 5 Weekly Catch
(Sport fishing vs. Long Line)



The most productive baits used by anglers were smolt, crickets and crayfish. These baits accounted for over 80% of pike minnow captures. Boat anglers stilll-fished baits below the Wells hatchery outlet and along the east bank below Wells Dam. When the boundaries were extended in mid-July, anglers experienced a high degree of success fishing pools and eddies below the Wells tailrace. Two anglers using downriggers in the immediate tailrace also experienced high catch rates using downriggers outfitted with 2" rapalas.

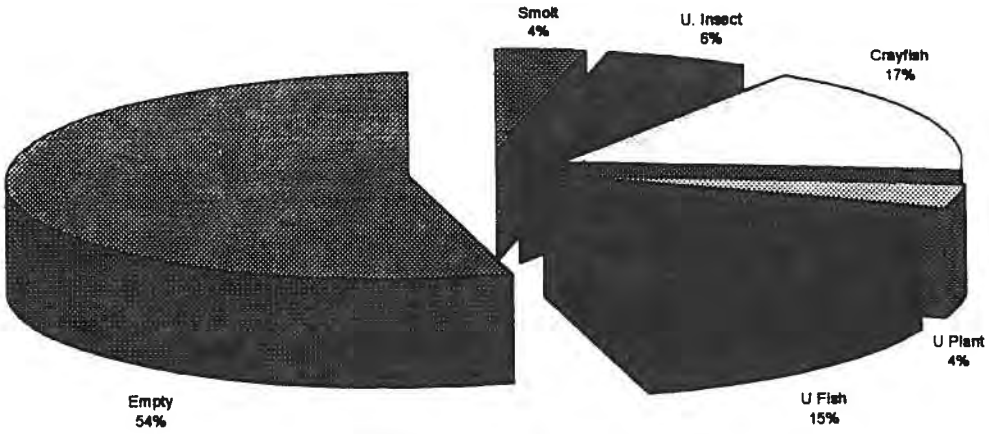
A total of 388 northern pike minnow were sexed. A 62% majority of these fish were female (62%). Fork length was measured on 388 northern pike minnow and 379 fish were weighed. A fork length-weight curve, fitted to the data resulted in a high r2 value (r2 = .95)(Figure 6). On average, males weighed 250 grams (.55 lbs) and measured 272 millimeters (11.81 inches) in fork length. Females were larger, averaging 664 grams in weight (1.47 lbs) and 363 millimeters (14.56 inches) in fork length. The overall northern pike minnow length average was 328 millimeters (13.19 inches) and overall weight average was 506 grams or 1.12 lbs, translating into a total of 8,229 lbs of pike minnow biomass removed in 1998.

Figure 6
Length/Weight Relatioships



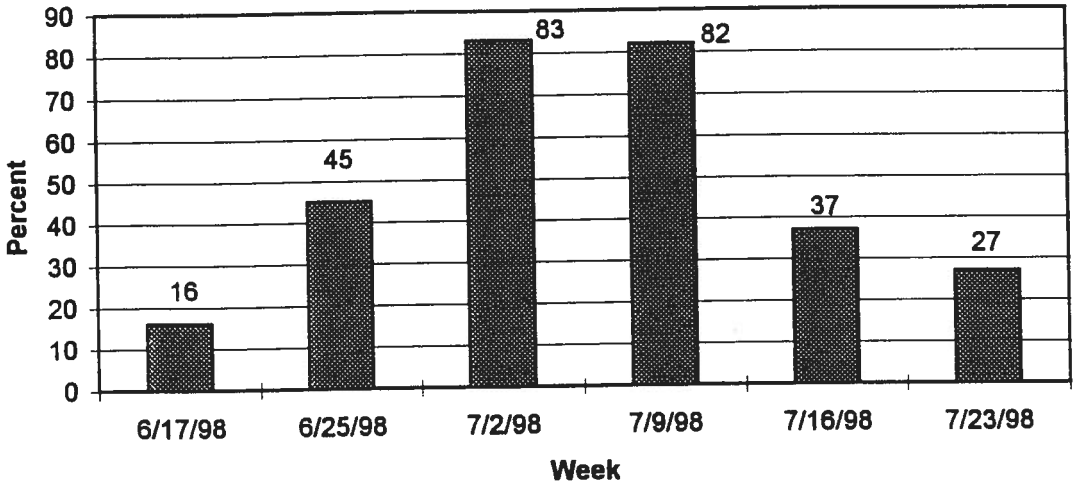
Crayfish (17%) and unidentified fish matter (15%) constituted the main prey items recorded during northern pike minnow gut analysis (Figure 7). The majority (54%) of the dissected stomachs were empty. Unidentified insects (6%), smolt (4%), and unidentified plant matter (4%) were also found in relatively small proportions. It should be noted that a high incidence of juvenile chinook salmon smolt (ranging from 100 to 150 mm in length) were observed in pike minnow stomachs collected from the Wells tailrace during the initial week of removal efforts (June 17 to June 24).

Figure 7
Stomach Contents



Gonad analysis indicated 1997 northern pike minnow spawning efforts took place in July (Figure 8). The peak spawn period occurred during the week of July 2, at which time 83% of the sub-sampled fish were classified as ripe.

Figure 8
Gonad Maturity (Percent of Weekly Subsample Classified as Ripe)



Incidental catch consisted of 9 separate species with a total of 437 non-target fish captured. Gear types proved to be very selective for northern pike minnow as incidental fish captures only accounted for 6% of the overall catch. A majority of the incidentally encountered fish were caught on sport fishing gear (Figure 9). Peamouth (*Mylocheilus caurinus*), walleye (*Stizostedion vitreum*), and burbot (*Iota Iota*) were most frequently encountered by hook and line anglers (88 fish, 77 fish, and 43 fish respectively). Bridgelip suckers (*Catostomus columbianus*) and smallmouth bass (*Micropterus dolomieui*) were encountered to a lesser extent (29 and 22 fish respectively). Anglers also encountered sculpin (*Cottus sp.*), channel catfish (*Ictalurus nebulosus* and brown bullhead catfish (*Ictalarus nebulosus*) (5 fish, 2 fish, and 1 fish respectively. Long line incidentals were comprised mostly of bridgelip suckers with 150 fish or 88% of the long line incidental catch (Figure 10). Burbot (16 fish), and walleye (3 fish) were infrequently encountered. One peamouth and one chiselmouth (*Acrocheilus alutaceus*) were also caught on the long line gear. All incidentals were released in a live-healthy state. No anadromous salmonids were encountered during the 1998 removal efforts.

Figure 9
Sport Fishing Incidental Catch
(Total Number Caught)

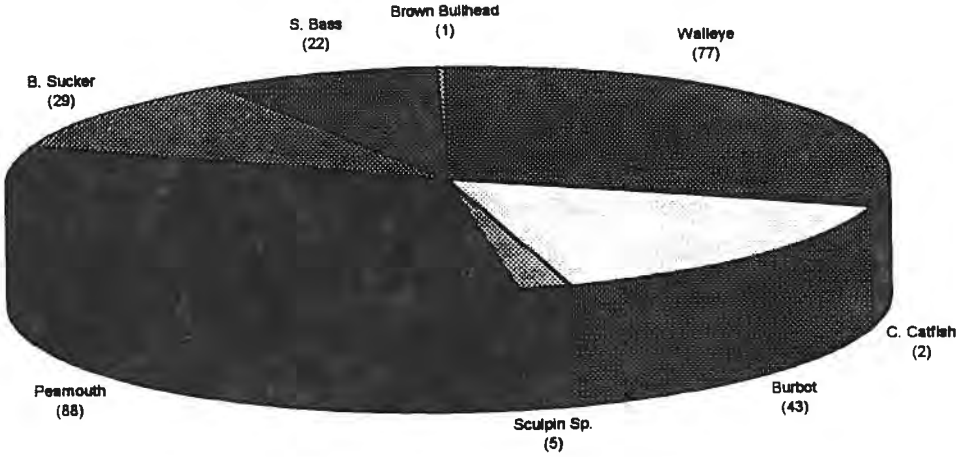
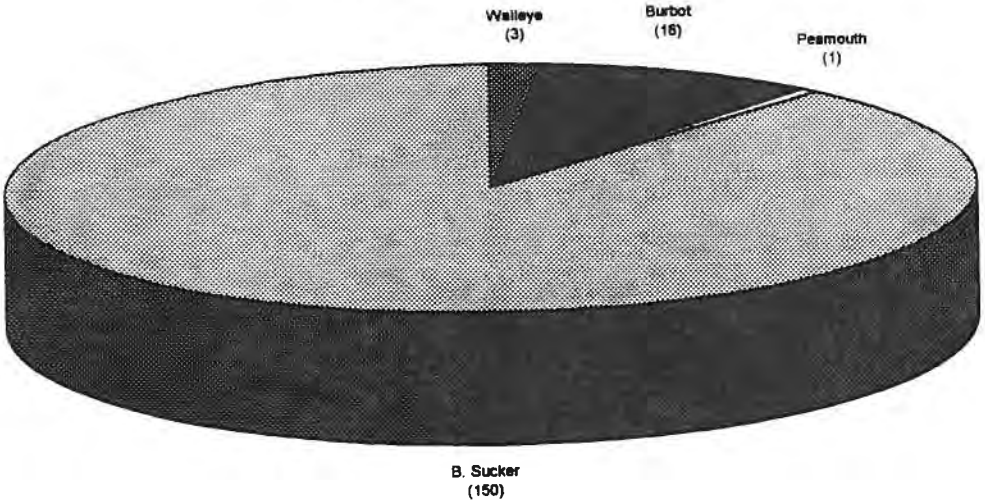


Figure 10
Long Line Incidental Catch
(Total Number Caught)



Discussion

1998 pike minnow removal efforts were highly successful at Wells Dam in relation to those which took place in 1995 and 1996 (Figure 11). The success of the 1998 fishery can be attributed to several factors. Anglers were paid on a per-fish basis in 1998 where anglers were paid by hour during the previous years. Anglers paid by the number of fish caught had the flexibility to fish the most productive hours and had greater incentive to catch fish. A similar incentive based pike minnow fishery at Wanapum Dam and Priest Rapids Dam in 1997 also produced significantly higher catch and CPUE levels relative to the previous years during which anglers were paid by hour (Jerald, 1997). A majority of anglers in 1998 focused fishing efforts on the highly productive early morning and late evening fishing periods, some even fishing throughout the night. Hourly waged anglers in 1995 and 1996 were required to fish during specific shift periods, resulting in a high degree of effort being applied during the less productive mid-day periods (Bickford 1996, Bickford 1997). During the 1998 fishing effort, anglers were highly experienced pike minnow fishermen, with most individuals having fished for similar removal programs over previous years. Evidence of this high experience level can be seen in the high CPUE levels obtained by anglers in 1998 (Figure 12).

The incentive based fishery was also efficient at eliminating individual anglers who were not effective at pike minnow capture. Less experienced anglers often "gave up" when participation in the removal efforts did not "pay off". For example, during the first week 21 anglers participated in removal efforts. By week two only 13 of the original 21 individuals remained. These 13 individuals were the most productive fishermen and constituted the bulk of the crew for the remainder of the season. Twelve anglers accounted for over 80% of the total catch in 1998, proof that experience contributed to high catch levels. Another major factor effecting the success of the 1998 fishery can be attributed to the low spill/flow conditions which occurred in the Wells tailrace. Anglers were able to effectively fish the entire tailrace area during the majority of the summer. This was not the case in 1996, as high flows in the Columbia River region hampered removal efforts at hydroelectric projects throughout the mid-Columbia (Bickford 1997, Jerald 1997, Perleberg 1996).

Figure 11
DCPUD Yearly Catch Comparison

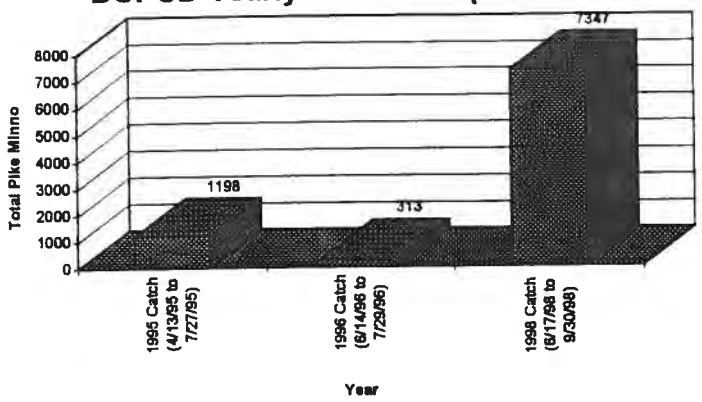
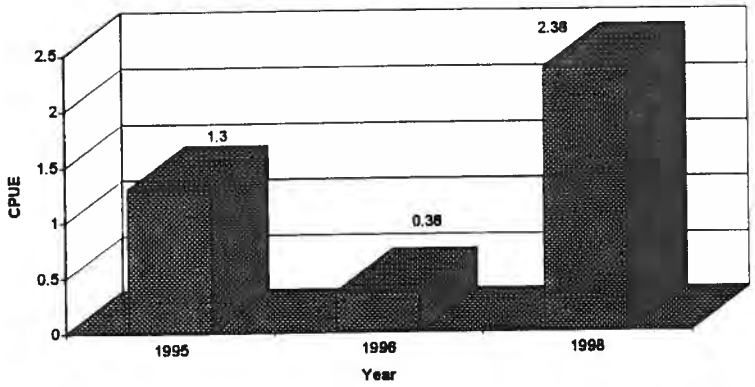


Figure 12
DCPUD Yearly CPUE Comparison



Wells reservoir and Okanogan River removal efforts met with limited success. Anglers fishing these locations typically experience CPUE rates near 1 fish per hour. The low catch rates were not adequate to keep anglers fishing the less productive locations (anglers could typically catch twice as many fish while fishing the Wells tailrace). Long line efforts also met with limited success in Wells reservoir. The largest problem encountered in reservoir long lining attempts was the fact that fishing locations would become fished out after one or two long line sets. Anglers would then need to find new productive fishing locations which were difficult to locate in the large reservoir area. Both sport fishing and long line attempts were further hampered in Wells Reservoir during August due to the abundance of millfoil and other aquatic plants. Long lines became entangled in these plants and were ineffective at capturing pike minnow.

It has been suggested and widely accepted that northern pike minnow congregate in tailrace areas and hatchery outfalls during times of peak smolt outmigrations (Bickford et al. 1996, Burley et al. 1994, Li et al. 1987). These trends were apparent in June of 1998 when anglers experienced high catch rates within the Wells tailrace near the Wells hatchery outfall area. The last two weeks of June marked the tail end of the spring smolt outmigration through Wells Dam, and smolt released from the Wells Fish Hatchery were still present in the hatchery outfall. Anglers fishing the tailrace at that time witnesses large numbers of pike minnnow regurgitating these smolt. It is probable that pike minnow congregate in the Wells Dam tailrace stimulated by high prey densities in May and June, and then migrate in July to gravel spawning beds downstream. Radio tagging experiments conducted by DCPUD in 1997 indicate northern pike minnow travel between the immediate tailrace of Wells Dam, and Chelan Falls (Bickford, 1998 Draft). Large numbers of radio tagged pike minnow were present in the Chelan Falls area during the peak spawn period of 1997. Further evidence to support this assumption can be seen in the high catch rates experienced by anglers participating in the Wenatchee Rotary Club Pike minnow Derby in Mid July of 1998. These anglers captured approximately 2000 pike minnow in three days, most of which were caught near Chelan Falls (mid-July also marked a peak of the northern pike minnow spawn in 1998).

A low incidence of juvenile salmonids were identified in dissected pike minnow stomachs. Removal efforts were not initiated until the 17th of June, at which time the yearly spring smolt release at Wells hatchery had already taken place (Osborne, personal communication). The bulk of these yearling smolt had probably began their downstream migration by the time anglers began fishing the hatchery outlet. A bulk of the downstream spring smolt migrants had also passed through Wells Dam by mid-June, (although anglers fishing the tailrace area did still witness a high incidence of juvenile salmonids being regurgitated by pike minnow). It would also be safe to assume that a majority of the "unidentified fish matter" is probably digested salmonids, as these fish were captured in the tailrace area of Wells Dam where smolt constituted the main prey item. All pike minnow stomachs identified as containing smolt came from the Wells tailrace. The main prey item, crayfish, were all identified in pike minnow collected in mid to late summer from the lower 1 mile stretch of the Wells tailrace and the Wells reservoir area. The stomach content data indicates pike minnow are stimulated by prey concentrations, feeding on smolt at the Wells tailrace in early spring and dispersing to reservoir areas to spawn, and feed on crayfish during the summer months.

Initiating removal efforts in the early spring of 1999 would ultimately result in a more efficient pike minnow removal fishery. An early start date would reduce smolt predation in the Wells tailrace area during the peak spring smolt migration and result in higher catch rates. Pre-fishing efforts by the contractor

in May and June of 1998 were highly productive. For example on May 28, a total of 45 pike minnow were caught during 5 hours of fishing effort (CPUE = 9.0). These fish were all caught in the immediate Wells tailrace. Similar catch rates were also experienced during other pre-fishing trips from May 6 to June 17. Large numbers of Pike minnow congregate at the Wells tailrace during these early spring months, feeding on the abundant smolt migrants. Angling efforts focused on these productive fishing areas and periods would result in increased catch levels and decreased smolt predation.

Vigg et al. (1990) suggested that northern pike minnow population numbers and size (age) structure analysis could predict and quantify the effects of a northern pike minnow control fishery. A decrease in size and in age structure of a pike minnow population should result in decreased salmonid predation mortality. Continued evaluation of the pike minnow fishery at Wells Dam will be important in evaluating the effects which removal efforts have in future years. Further biological data collection and possible tagging studies in the Wells reservoir should be considered. A system-wide tagging study in the mid-Columbia region could determine exploitation rates of the pike minnow fishery.

Recommendations

Continue pike minnow removal/research efforts in 1999, contracting on a per-fish incentive basis.

Initiate removal efforts in the early spring of 1999.

Begin obtaining scientific collection permits and section 10 permits in the fall of 1998 to provide for an early spring start date.

Continued use of sport fishing and long line removal techniques in Wells reservoir and tailrace locations.

Increase effort in Wells reservoir and Okanogan River by paying anglers higher bounty amounts for pike minnow collected at these less productive fishing locations.

Initiate a joint tagging study (Douglas and Chelan PUD) in Wells reservoir and Rocky Reach reservoir to determine exploitation rates of the pike minnow fisheries.

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MINUTES OF THE WELLS COORDINATING COMMITTEE FOR 1998

APPENDIX H

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
February 26, 1998

Agreements Reached:

I. GENERAL MID-COLUMBIA ISSUES

A. Spill Representatives for 1998 Migration Season

The committee agreed to keep the same agency and PUD spill representatives as in 1997 with the exception of Mosey replacing McDonald as the Rocky Reach spill representative. Heinith said he would get back to the committee on the tribal spill representatives for Priest Rapids, Wanapum, Rock Island, and Rocky Reach.

B. Preliminary Projections for mid-Columbia Runs

Brown distributed preliminary projections for the mid-Columbia runs in 1998 and emphasized that these projections are very preliminary. He also distributed an assessment of hatchery/wild steelhead from 1986-87 through 1997-98 and preliminary projections for 1998-99. Brown reviewed the origin of the projected run sizes for the various stocks and explained that spring chinook were the only fish for which he analyzed tributary turn-off.

C. Preliminary Discussion on Spring Chinook Brood Stock Collection

Brown said it is probably premature to talk about spring chinook brood stock collection. He said if things go as they had in the past, they would probably recommend collecting the entire Methow basin spring chinook run, at Wells Dam, for brood stock.

Brown reported that the captive brood fry collected from redds on the Twisp and White Rivers are rapidly running out of space. These fish will have to be released back into the wild unless space and funding are found in the near future.

II. WELLS DAM

A. Bypass Representatives for the 1998 Juvenile Migration

The committee agreed to retain the same bypass representatives at Wells Dam in 1998 as were used in 1997. The representatives are Rick Klinge (Douglas County PUD), Brian Cates (U.S. Fish and Wildlife Service), and Jerry Marco (Colville Confederated Tribes).

B. Juvenile Bypass Operating Plan for 1998

Klinge stated that Douglas PUD usually prepares an operational plan prior to the juvenile migration season. This information is presented to the NMFS as an assessment of the projected take of listed and unlisted species. Klinge distributed the plan for 1998. He pointed out that Hevlin had requested that Douglas PUD pursue a sampling program that would hold the take of

salmon to less than 20 fish. Peven pointed out that Robert Koch, NMFS, had told Chelan PUD that it is better to set the projected take higher than expected so this number won't be exceeded. Klinge and Bickford explained that the fyke netting proposed will take place before March 15 and after August 15 and will be terminated if 20 fish are taken. There was no opposition to the 1998 Bypass Operating Plan distributed by Klinge, and the committee recognized that the plan is dynamic and may change as needed during the migration season.

C. Okanogan Sockeye Program

Klinge distributed a draft report from Trumbley Environmental Consulting, Limited on the Okanogan River sockeye spawning ground surveys. The report shows that only about 19% of the fish that passed Wells Dam were accounted for on the index areas. Klinge stated that this had been a concern, but subsequently, they found fish spawning in areas outside of the index area. This was determined by pinpointing the location of radio tagged fish. Klinge said they are now questioning whether this was an unusual occurrence, in 1997, or if this had occurred in other years as well. Bickford estimates that as many as 50% of the fish spawned outside the index area. The information this year would indicate that some of the low survivals, indicated in some years, may be due to fish spawning outside the index areas and survival may not be the problem previously thought. Bickford said that 1998 is expected to be a more normal flow year and it may be worthwhile to consider applying a small number of radio tags to assess survival to the spawning area. Bickford distributed a proposal for a study to determine sockeye spawning escapement in 1998. Klinge said they would like to have a committee decision on the proposed study at the next coordinating committee meeting.

Woodin asked if there was any consideration given to repeating the sockeye holding study in 1998. Klinge said they weren't considering repeating that study in 1998.

Klinge said he wanted to discuss what would happen if the Okanogan sockeye run size in 1998 doesn't meet the Technical Advisory Committee projections. He said the brood run was only 1600 fish and he believes a run of about 4000 fish is more reasonable than the 19,000 fish TAC is projecting. He asked if it is reasonable to consider taking 250 adults for brood stock for the Cassimer Bar program when the run is that small. He said this issue will likely be a topic of discussion throughout the spring.

Klinge told Machin he appreciated her attendance at the meeting and asked her if there were any comments she would like to make. Machin pointed out that the Okanagan Bands are concerned about the removal of Okanogan sockeye from the natural spawning population. She pointed out that there has recently been a decision by the Supreme Court of Canada re-affirming aboriginal rights to the land and natural resources. She said the Okanagan Bands recognize that what has been proposed for the 1997 brood sockeye is only a stop-gap measure. They will be sending a letter to Douglas PUD pointing out that they don't consider the current program as a matter of importation of sockeye into the U.S. She pointed out that there has been a new ministry established as a result of the Supreme Court ruling which will elevate the position of fisheries within the province. It remains to be seen what effect this new ministry will have on future applications for such things as the Douglas PUD Okanogan sockeye proposal. She has met with the new minister who indicated the Department of Fisheries and Oceans and the province position relative to Okanogan sockeye are not consistent with the new ministry.

Machin suggested that an informal technical committee be established , outside of the Salmon Commission, to deal with Okanogan sockeye issues. A meeting had been held last winter

in British Columbia and Bickford and Heinith had attended. A draft report on the workshop is due to be released soon. Hevlin asked if the workshop addressed opening passage for sockeye to lakes above McIntyre Dam. Machin acknowledged that this was a sensitive issue, but consideration was given to opening passage into Skaha Lake and evaluating impacts. She said she had recently had a conversation with an attorney who indicated there is some question whether the province had ever received approval to block fish migrations at McIntyre Dam and other locations on the Okanogan River. Machin said her purpose in attending the meeting today was to express their interest in working with the coordinating committee to try to work out ways to improve Okanogan River sockeye runs.

Klinge distributed a letter he received recently from the province which included a summary of constraints to the sockeye proposal. Klinge pointed out that previous discussion with the province indicated they were looking for a large, expensive, environmental study before they would consider allowing the sockeye program to go forward as proposed. Woodin stated that it may be worthwhile proposing to do a risk assessment. Klinge acknowledged that an informal technical forum to work on this possibility was a good idea even though a risk assessment may not be what the province is looking for and the concept may be turned down.

Heinith raised a question concerning disposition of the 1997 brood fish. He asked for discussion on the potential for taking these fish back to the southern basin of Lake Osoyoos for release instead of releasing them in the lower Okanogan River as the committee had agreed last summer when brood stock collection was being debated. Klinge pointed out that the Douglas PUD position is in response to considerable opposition, from Canadian agencies, to the net pen program. The province has problems with even releasing fish in the vicinity of Zosel Dam since it has been shown that a portion of the fish hold-over in Lake Osoyoos and emigrate the following spring. Machin pointed out that it appears Department of Fisheries and Oceans regional personnel are sympathetic to what the Okanagan Bands would like to see done.

Heinith said that it may be a good idea to get together, on an informal basis, with the Canadian interests following the release of the ESSA report.

Woodin asked that Douglas PUD and Colville Tribal representatives get together to assess other supplementation options for Okanogan sockeye such as, what the production potential of the Cassimer Bar facility would be for an alternative to the existing sockeye program.

The next meeting of the Wells Coordinating Committee will be March 26, 1997 at the West Coast Sea/Tac Hotel.

ATTENDANCE LIST

Name	Representing
Cary Feldmann	Puget Sound Energy
Steve Hays	Chelan County Public Utility District
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Jerry Marco	Colville Confederated Tribes
Stuart Hammond	Grant County Public Utility District
Stephen Brown	Grant County Public Utility District
Chris Carlson	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bob Heinith	Columbia River Intertribal Fisheries Commission(by Phone)
Bill Hevlin	National Marine Fisheries Service
Bryan Nordlund	National Marine Fisheries Service
Dawn Machin	Okanagan Nation Fisheries Commission
Tracy Steig	HTI (Chelan Consultant)
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
March 26, 1998

Agreements Reached:
1. The committee decided to establish the third Tuesday of each month as the time for Mid-Columbia Coordinating Committee meetings.
2. The committee approved the adult sockeye radio telemetry study, proposed by Douglas PUD, as modified by committee request.

I. GENERAL MID-COLUMBIA ISSUES

A. Scheduling of the March 26 Meeting

The chairman apologized for the confusion regarding the date of the March meeting. Because of the confusion and scheduling difficulties the Columbia River Intertribal Fisheries Commission representative, who also represents the Umatilla Tribe and the Yakama Tribe, was unable to attend. A letter was sent from Intertribe to the chairman on March 25, expressing concern regarding the potential for the coordinating committee to take action, on two issues of extreme importance to tribal interests, without their representation. The letter was discussed at the start of the March 26 meeting. The committee members present at the meeting recognized that there were tribal concerns regarding the two issues (Rocky Reach Stipulation, and Chelan PUD Survival Study) and that it would be necessary to have tribal representation present to resolve those matters. Woodin commented, in regard to the survival study, that the committee was to operate by consensus and since it was obvious that there wasn't consensus on the proposed survival study, that WDF&W would not be in a position to release Turtle Rock chinook yearlings for the study until consensus was reached. Peven indicated that Chelan PUD would likely elevate the issue to the policy level because of the importance of the study to the HCP process.

The committee discussed the possibility of sending a letter from the committee members present to the Yakama and Umatilla Tribes expressing the need for representation that would allow more timely resolution of matters of concern to the tribes. It was agreed that a letter would be drafted and circulated to those members present for review and comment.

It was suggested that, for planning purposes, a certain day each month be established for Mid-Columbia Coordinating Committee in the interest of more efficient scheduling. Several suggestions were considered and it was subsequently decided that the third Tuesday of each month be set aside for coordinating committee meetings.

In spite of the confusion regarding the March meeting date and the fact that not all committee members were present at the meeting, there were items on the agenda that needed resolution prior to the start of the juvenile migration. Therefore, the committee decided to go ahead with the March meeting as scheduled.

B. Spring Chinook Captive Brood Stock Program

Hammond reported that the PUD's would be meeting tomorrow (March 27) to "brain-storm" what might be done to accommodate the fish currently being held for a captive brood stock program. Brown said he would be available, in his office, if the PUD's needed his input. Hammond suggested setting aside a date, in early April, for a committee conference call if necessary to resolve the situation with the fish currently being held since they will be released back to the wild by the middle of the month if provisions haven't been made for them to be retained by that time. The committee designated April 9 from 9 AM until noon for such a conference call. The chairman was directed to set up the conference call if requested by any member.

Brown said he had previously distributed a run size projection for the 1998 spring chinook run. He said WDF&W had made one change in the 1998 spring chinook brood stock collection plan compared to the 1997 plan. He said that instead of a three tiered approach, as used in 1997, they were proposing to collect all spring chinook passing Wells Dam in 1998.

II. WELLS DAM

A. Wells Pilot Survival Study

Bickford asked Hevlin about the Section 10 permit Douglas PUD had requested for the activities associated with the proposed pilot survival study. Hevlin explained that processing of the permit, which began in September 1997, was reset as a result of the Douglas application for a Section 10 permit for fykenetting at Wells Dam for bypass operation purposes. He said the matter is outside of his jurisdiction and he suggested that Bickford work with Kock or Darm at NMFS to try to expedite the permit processing. Woodin suggested mentioning to Darm the WDF&W process for emergency authorization to proceed with requested hydraulic work while the process for project approval is proceeding. Brown also mentioned that WDF&W had requested a Section 10 permit for operation of the Rock Island bypass trap in mid-December and had not received the permit, as yet. Hammond asked the question, " what do we do when the fish arrive - does WDF&W operate the bypass trap, Douglas PUD do the pilot survival study, or Grant PUD salvage fish from gatewells without a permit?" No one had an answer.

Peven pointed out that the Department of Agriculture, who is the contractor for the Rocky Reach/Rock Island predator control studies, was having difficulty getting a Section 7 permit for predator control work which is scheduled to extend into September because of Grant PUD's success last year. The NMFS feels extending the predator control effort that late in the year could result in some incidental adult steelhead take.

B. Okanogan Sockeye Radio Telemetry Study

Bickford reviewed the study proposed at the last coordinating committee meeting and stated that Douglas PUD would like a committee decision on the study so they would know whether or not to proceed. Klinge stated that Douglas feels the proposed study represents, in their opinion, a better way to assess survival to the spawning grounds than what has been done historically. Woodin asked if they had built in for the possibility of tag failure. Bickford said they felt 40 tags would be adequate but they would agree to add 10 additional tags to a total of 50. The committee approved the proposed sockeye radio telemetry study as modified.

C. Okanogan Sockeye Rearing Program

Klinge reported that he and Marco had not been able to get together to discuss Woodin's request to assess the potential of the Cassimer Bar Hatchery to accommodate an alternative program, especially the capacity to rear yearling sockeye. Klinge said that in reviewing space and water availability it appears up to 200,000 sockeye could be reared to yearling size i.e. 15 fish per pound. He said they have not looked at such things as how two brood years could be accommodated at the same time and how this would effect rearing capability.

The next meeting of the Wells Coordinating Committee will be held April 21, 1998 in Wenatchee.

ATTENDANCE LIST

Name	Representing
Cary Feldmann	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Paul Wagner	Washington Department of Fisheries and Wildlife
Jerry Marco	Colville Confederated Tribes
Stuart Hammond	Grant County Public Utility District
Joe Lucas	Consultant for Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Mike Erho	The Committee

Counts of fish handled at the Rocky Reach juvenile facility, 1998

collection date: _____

collection start time: _____

collection source: _____

collection stop time: _____

smolts

species	ad-clip	non-ad clip	Total
chinook-1			
chinook-0			
steelhead			
sockeye			
coho			
Total			

incidental catch

species	count
Steelhead adult	
hatchery rainbow trout	
bull trout	
whitefish	
Squawfish	
pacific lamprey (adult)	
pacific lamprey (ammocoete)	
chiselmouth	
peamouth	
red-side shiner	
sucker sp.	
stickelback	
other	
Total	

Comments:

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
April 21, 1998

Agreements Reached:
1.

I. GENERAL MID-COLUMBIA ISSUES

A. Spring Chinook Captive Brood Stock Program

A meeting was held in Wenatchee on April 13, 1998 to discuss the potential for moving forward on the spring chinook captive brood stock program that had been initiated by WDF&W in 1997. Naturally spawned eggs were collected from redds on the White River in the Wenatchee Basin and the Twisp River in the Methow Basin. In addition, fry from the 1996 brood Twisp River marked adults spawned at the Methow Hatchery, were set aside for the captive brood program. No long term provisions had been made to rear these fish to maturity so the meeting was convened to explore means for continuation of the program pending completion of the HCP process and funding provided through that means for permanent captive brood facilities.

Hammond referred to the chairman's summary of the meeting. He said Grant PUD is trying to do what they can to see that, at least in the short-term, the fish currently being held for captive brood purposes are provided for. Woodin said that in their budget cutting process they have scheduled the Colville Hatchery for closure and use of that facility for a captive brood program was a possibility for the intermediate term. Peven reported that John Kerwin, WDF&W, had mentioned Waikiki Springs near Spokane as a possible site for a long-term captive brood facility. The committee was informed of conversation between the chair and Tom Scribner, Yakama Indian Nation, regarding tribal concerns with a captive brood program. There has been no further contact with Scribner regarding their concerns.

There will be further exploration of potential sites to accommodate a spring chinook captive brood stock program in the short term (until September 1998), intermediate term (until the HCP process is in place), and long-term.

B. Spring Chinook Brood Stock Collection Protocol

Brown summarized the previously discussed protocol for 1998 brood collection. He said the feels the earlier projections for run size were probably optimistic. He sees no reason to change the protocol discussed previously for the Methow River which calls for 100% collection of spring chinook passing Wells Dam. On the Wenatchee River, there will be collection of up to 200 coded wire tagged fish at Tumwater Dam. The Chiwawa weir will be operated 24 hours per day for four days each week with the weir lowered for the other three days. The fish collected on the Chiwawa will be added to those collected at Tumwater Dam with the total not to exceed 200 fish.

C. Mid-Columbia Spill Transfer Priorities

Hevlin reported on discussions with Bolyvon Tanovan, Corps of Engineers, regarding spill transfer priorities for reducing total dissolved gas. He said he pointed out to Tanovan that the priorities agreed to by the Mid-Columbia Coordinating Committee representatives were different than had been included in the TDG management plan. Hevlin will follow up on the matter, with Tanovan, to see that the mid-Columbia priorities are put in place.

D. Adult Radio Tag Study

Hevlin reported on the adult radio tagging study being implemented by the Corps of Engineers for 1998. He said they have plans to release the following numbers of tagged adult salmon:

Spring and summer chinook combined	1000
Fall chinook	1000

Ladder exits at Rocky Reach and Rock Island can be monitored as well as the ladder at Priest Rapids. The antennas at Wanapum, used for evaluating effects of the video counting installation, and the antennas that would be installed at Wells Dam under a proposed ladder study could all utilize the radio tagged fish that will be released under the Corps study. Hevlin said he would like to see some monitoring in tributaries in the mid-Columbia. Peven said the PUD's may be able to provide some tributary monitoring. Woodin suggested that the project sponsor be asked to consider adding tributary monitoring to their protocol.

E. Dissolved Gas Team/System Configuration Team Joint Meeting and Mid-Columbia Tour

Hevlin pointed out that the DGT and SCT will be touring hydroprojects in the mid-Columbia and conducting a joint meeting during May 20-22. Included on their itinerary are visits to Rocky Reach, Chief Joseph, and Grand Coulee Dams and the Lake Rufus Woods commercial net pens. Their meeting will be held on May 21 in Grand Coulee. Since the next Mid-Columbia Coordinating Committee meeting and tour of activities will be May 19-20 Hevlin suggested coordinating the mid-Columbia tour with that of the DGT and SCT.

F. Monthly Meeting Schedule for the Mid-Columbia Coordinating Committee

The committee recognized the benefits of establishing a monthly meeting date and discussed possible changes to the previously agreed third Thursday of each month for these meetings. It was decided that for May and June the committee meetings will be held on the third Thursday as decided previously. **Chairman's note: It was subsequent decided to change the meeting date to the third Tuesday of each month.**

II. WELLS DAM

A. Pilot Survival Study

Klinge reported the pilot survival study has been moving smoothly. Both hatchery and in-river migrants are being tagged. The first in-river fish were collected for tagging on April 15 and the first release of hatchery fish on April 17. The second release, including both hatchery and in-river fish was on April 19. Reservoir releases are made at 9 AM with tailrace releases at 1 PM. Klinge said they have been very careful to make the conditions experienced by both tailrace and reservoir released fish as close to equal as possible. The releases should be complete with the releases on Saturday, April 25. Hammond asked Klinge which PIT tags were used for the pilot

study and Klinge said they used 400 kHz tags. Bernheisel asked why in-river collected fish were being released, after barging, in the reservoir rather than in the Methow River. Klinge responded by saying that the intent of using in-river fish was to compare results with the hatchery fish to determine which fish would be the most appropriate for future studies. Since the hatchery fish were being released in the reservoir it was necessary to also release the in-river collected fish in the same location.

Bernheisel asked if the Winthrop Hatchery spring chinook were all fin clipped this year. Cates said he thought that all of the Winthrop spring chinook were marked this year.

B. Bypass Operation

Klinge said the bypass team agreed to began operation of the Wells Juvenile Bypass at 8 PM on April 15. The hydroacoustic index was low up to the time operations began. Since the brood year for this year's migration was all taken into the hatchery there were no natural spring chinook above Wells Dam to migrate this year. Hevlin asked if they received the Section 10 permit in time to do any fyke netting. Klinge said they received the permit after the time frame requested for fyke netting.

C. Total Dissolved Gas Monitoring

Klinge reported that Douglas PUD has a new tailrace monitor for TDG since last year. They are collecting TDG data now and reporting information to the Corps. He reported that the forebay level has been running about 106% with the tailrace about 1.3% higher since the bypass began operating.

D. Ladder Evaluation

Klinge reminded the committee of the effort last year to try to understand the uneven flow within the Wells entrance pools. Sverdrup has been working with the PUD to try to understand the reasons for the uneven flows. Sverdrup feels that since the adult passage facilities were designed to operate with a one foot differential between the entrance pool and the tailwater some of the uneven flow may be due to operation with a one half foot greater differential than the facilities were designed for. Douglas PUD is planning to propose a study to evaluate the relative passage efficiency of one foot versus one and one half foot differential using the fish the Corps study will be radio tagging at Bonneville Dam. Klinge said they estimate that about 135 of the 500 summer chinook to be tagged will pass Wells Dam. Klinge asked for an indication of support from the committee before they develop the proposal. They want to get moving on this right away to allow the necessary contractual arrangements to be made. Hevlin said before he could make a call on the study he would need a study plan which he could discuss with Rainey and Nordlund. Woodin said the one and one half foot differential was expected to attract fish from the tailrace and the greater differential would be more critical under higher tailwater (runoff) conditions. This year probably wouldn't be critical. Brown pointed out that they will be collecting summer chinook brood stock three days out of the week beginning July 6.

Klinge said he feels the one and one half foot differential caused uneven flows that could impact passage. He feels that operating at design criteria of one foot differential could result in improved adult passage. Hevlin asked for Douglas PUD to prepare a preliminary study plan which the committee could review for general support or lack of support.

Hevlin asked if Douglas PUD planned to monitor fall-back. Klinge said this might be accomplished by configuring the antennas for that purpose. He also pointed out that fall-back information for summer chinook is complicated by Wells Hatchery summer chinook over-shooting the hatchery and passing Wells Dam.

E. Okanogan Sockeye

Marco distributed a letter from the University of Alaska requesting five to thirty sockeye smolts for their genetic study. Marco was bringing it to the attention of the committee for decision on whether or not to send the fish to them. The committee agreed to have some fish diverted through the bypass system at Rocky Reach made available for the Alaska researchers.

Woodin inquired about the status of the culture program at Cassimer Bar. Marco reported the fish are doing well and they are starting to mark the accelerated fish at this time. The yearling group, incubated on chilled water, are doing real well and are scheduled to be moved to net pens in Lake Rufus Woods in early June.

The next meeting of the Wells Coordinating Committee will be May 19-20 and will include a tour of activities at mid-Columbia Projects.

ATTENDANCE LIST

Name	Representing
Cary Feldmann	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Jerry Marco	Colville Confederated Tribes
Stuart Hammond	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Brian Cates	U. S. Fish and Wildlife Service
Lee Bernheisel	Okanogan Wilderness League
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
May 19, 1998

Agreements Reached:
1.

I. GENERAL MID-COLUMBIA ISSUES

A. Letter to Tribes Regarding Committee Representation

Woodin explained the reasoning behind the letter which was drafted to send to the Yakama and Umatilla Tribes regarding committee concerns with tribal representation on the coordinating committee. He said he had agreed to finalize the letter and would like to have all comments in by June 15. Hevlin said that before he could sign the letter he would have to get agency approval and, because of agency directives and sensitivity requirements, the letter would have to be "soft".

B. Hanford Reach Fall Chinook Stranding Study

A short video was shown during the lunch break. Woodin followed-up with a draft letter to Chelan, Douglas, and Grant PUD's advising them of the stranding problem observed in the Hanford Reach in 1998 and requesting project operational modifications for the remainder of the 1998 juvenile rearing period. It was pointed out that copies of the letter would be sent to the Corps, Bureau of Reclamation, BPA, and others. Woodin said the letter may be sent by WDF&W or it could be sent out by the Fish Passage Advisory Committee. It is being discussed at the FPAC meeting today. The letter would call for flows to be kept above 150 kcfs at Priest Rapids and fluctuations around that flow reduced. Below 150 kcfs fluctuations should be limited and above 150 kcfs the problem is reduced. Peven asked Woodin if the early fall chinook emergence contributed to the problem. Woodin said the peak of emergence and large flow fluctuations occurred at the same time. Hevlin asked, if the letter was addressed to the PUD's will the federal water management parties view the matter as a PUD problem? Hevlin said it is important to try to get all the operating entities involved to find a solution to the problem. Hammond expressed real concern regarding the letter being distributed, as written, without pointing out that Grand Coulee and Chief Joseph operations contribute to the problem.

C. Spring Chinook Captive Brood Stock Update

Bugert gave the committee a progress report on activities associated with the captive brood program. The proposed program is being viewed in three time frames; short-term (through 7/98), intermediate-term (until HCP funding available), and long-term (under HCP provisions). Several sites have been visited to assess their utility for the captive brood program. To date, Waikiki Springs (near Spokane) appears to hold the most promise for the long-term. If hurdles can be overcome, it may be possible to have facilities available there in the intermediate-term.

Other options are being explored for a contingency plan pending resolution of Waikiki Springs availability. A deadline of June 30 was set to develop a plan for accommodating the fish, currently being reared at the Winthrop Hatchery. Bugert presented the idea of forming a working group to develop plans for continuing the program beyond September 15 when the fish will have to be moved from the Methow Hatchery. Cates, Brown, Marco, Klinge, Hevlin, and Hammond expressed interest in participating on a working group. It was suggested that Scribner also be added to the working group.

Hammond stated that Grant PUD feels that by June 30 it must be obvious that progress is being made toward use of the Waikiki Springs site or there will need to be a parallel track for consideration of an alternate site. He said Grant PUD has committed to support for the short-term program with the understanding that there will be mitigation credit for Grant's participation in the program in the long-term. Woodin observed that the current fish production in the mid-Columbia is the result of mitigation agreements so he doesn't see a problem in working toward mitigation credit to Grant PUD for the captive brood program.

D. Icicle Creek Adult Passage

Cates reported that there has been increasing interest in providing adult salmon and steelhead passage into the upper Icicle Creek watershed above the barrier at the Leavenworth Hatchery. It has been suggested that a symposium be convened to consider opening the creek to passage for anadromous fish. He stated that it is likely that mid-Columbia participants will hear about opportunities for active involvement. He wanted to make sure that committee members wouldn't be "blind-sided".

II. WELLS DAM

A. Proposed Ladder Study

Bickford reviewed the ladder study proposed for Wells Dam. He explained that they were proposing to use the summer chinook tagged at Bonneville Dam to look at reducing fall-out at the side entrances to the fishways and to shorten the time fish spend in the entrance pool. They would be looking at passage under test (1 foot differential and side entrance closed) and control (1 1/2 foot differential and side entrance open) conditions. The intent in 1998 would be to target summer chinook tags rather than sockeye tags as was the case in the 1997 study. Woodin questioned whether reducing attraction flow would cause longer residence in the tailrace in favor of trying to reduce residence in the entrance pool. Nordlund asked for clarification on the increase in ladder flow mentioned in the proposal. Bickford said they wouldn't be increasing ladder flow, just the percentage of total flow that the ladder flow represents.

Klinge stated that the adult passage facilities were originally designed to operate at 1 foot differential and was changed about 10 years ago to 1 1/2 foot differential. Nordlund said that when he and Larry Basham of the Fish Passage Center were at Wells Dam last year or in 1996, they noticed hot spots of velocity through the diffusion gratings.

Woodin suggested that the study could be designed to operated one ladder as a test and the other ladder as a control. Bickford pointed out that operating in that way would be complicated by the effect of the east ladder trap operation on passage. Woodin said that it may be necessary to consider brood stock collection above Wells Dam in lieu of ladder trapping if such trapping is impacting passage at Wells.

Woodin said he would like to understand the hydraulics if the side entrance was closed and the 1 1/2 foot differential maintained. Klinge and Bickford explained the physical layout of the Wells Dam adult passage facilities and discussed the rationale for the proposed study.

Klinge suggested that the committee provide comments to Douglas within two weeks. Bickford said he would really like to schedule a conference call, in the near future, to discuss the proposed study. The committee agreed to meet by conference call on June 4 at 11 AM.

Woodin pointed out that the number of tagged summer chinook available for the study would likely be more than discussed in the proposal, which was based on 1997 tag detections at Wells Dam.

B. Wells Pilot Survival Study

Bickford discussed the preliminary recoveries of PIT tagged fish and pointed out the recoveries thus far, of in-river fish, are much higher than for tagged hatchery fish(14% to ~5.5%). The timing to downstream recovery points favors the in-river fish by a large margin. In-river fish even beat the releases below Rock Island to recovery at McNary and have even been recovered in the estuary. The hatchery fish are currently peaking at McNary while the in-river fish re mainly moving past McNary.

C. Wells Dam Operations

Klinge distributed a summary of Total Dissolved Gas monitoring for the Wells forebay and tailwater. He reported a general 2% increase in TDG from the forebay to tailwater. Lorz asked if the TDG data is being put reported on the Internet. Klinge said the data is being reported but not all reports include all the data. He went on to say that last week they had a transmission problem and lost about 20% of the data for that week. They have the problems worked out now and, overall, have lost little data over the season.

Klinge showed the seasonal hydroacoustic monitoring data and pointed out that the indices were lower in 1998 than seen previously. The increase in the indices follows the release of hatchery fish from the Methow Basin and probably also includes sockeye and steelhead that are being released above Wells Dam. Hevlin questioned whether the index accurately represents the actual run timing.

D. Okanogan Sockeye

Klinge reported that 82,000 zero-age sockeye will be released next week at about 60-105 fish per pound at the mouth of the Okanogan. These fish have received a ventral clip. An additional 58,000 fish will be transferred to the net pens in Lake Rufus Woods and are currently about 180 per pound. They should be moved to the net pens in the next couple weeks and will be released next spring. Klinge said that the hatchery crew would like to mark these fish before they are taken to the net pens. He asked the committee if there would be a problem placing an adipose clip on these fish given the fact that the Lake Wenatchee sockeye program uses an adipose clip. There was discussion of the pros and cons of placing an adipose clip on the Okanogan fish. Woodin pointed out that there are alternatives to fin-clipping for differentiating stocks. Elasomer and V I tags could be used instead of fin clips. Woodin said it would be useful to have some basin-wide discussion on sockeye marking. Klinge said he, Marco, and Woodin will discuss the matter further by phone and attempt to come to some resolution of the problem of sockeye marking.

E. Adult Sockeye Brood Stock Collection

Klinge presented an accounting graph of sockeye passage at Wells related to recruitment. Overall, the recruitment has been about at the maintenance level. Over the past five years, recruitment has been as low as 0.1 to 1. He is concerned that the low returns expected in 1998 and 1999 may be seriously impacted by taking fish for a less than successful program. Douglas PUD is proposing to initiate the summer chinook option under the Wells Settlement Agreement. Klinge said Douglas is proposing to continue biological studies associated with Okanogan sockeye, such as spawning ground counts, etc. And raise 15,000 pounds of summer chinook at the Carlton Pond. Woodin said it is a higher priority, in his mind, to continue exploring sockeye supplementation alternatives rather than adding to summer chinook production. He said other options such as stream-side incubators, and spawning channels may be viable options in the future. Bickford pointed out that Douglas PUD has had some preliminary discussions with the Canadian entities on sockeye spawning channels. Hevlin said he feels Douglas PUD raised some valid points and he could support foregoing sockeye brood stock collection in the low run years. Bickford stressed that Douglas PUD is not proposing to give up on sockeye production but the fact is, the Canadians have made it very clear that they will not allow movement of hatchery fish from the U. S. Into Canada. Douglas PUD would like to explore alternatives to the existing program with the Canadians during the next several years. Marco remarked that he feels the existing program hasn't been given an adequate chance for success by using yearling fish. It was agreed that this matter would be discussed at the next coordinating committee meeting, after members have had a chance to discuss policy implications with their respective organizations.

The next meeting of the Wells Coordinating Committee will be June 16 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Rod Woodin	Washington Department of Fisheries and Wildlife
Jerry Marco	Colville Confederated Tribes
Tom Lorz	Columbia River Intertribal Fisheries Commission
Stuart Hammond	Grant County Public Utility District
Chris Carlson	Grant County Public Utility District
Curt Dotson	Grant County Public Utility District
Stephen Brown	Grant County Public Utility District
Mike Nicholls	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Bryan Nordlund	National Marine Fisheries Service
Brian Cates	U. S. Fish and Wildlife Service
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
JUNE 16, 1998

Agreements Reached:
1.

I. GENERAL MID-COLUMBIA ISSUES

A. Hanford Reach Stranding Study

Paul Wagner, WDF&W, reviewed the work being done on the Hanford Reach stranding study funded jointly by Grant PUD and Bonneville Power Administration. He explained that they are at the mid-point of a three year study. Emergence of chinook fry in the Hanford Reach was early in 1998 due to warmer water temperatures and the mild winter. There are major differences between 1997, a 100 year flood event with flows up to the vegetative zone and 1998 with chinook rearing taking place in shoreline shallow areas and backwaters. Wagner showed slides of various entrapment areas where juvenile fish have been observed stranded or entrapped. Besides checking entrapment areas Wagner said they have also excavated 6000 lineal feet of randomly selected gravel bar type habitat and found few salmonids. In addition to direct mortality from stranding, there are mortalities caused by thermal effect at water temperatures beginning at about 26 degrees C. Wagner said stranding or entrapment was observed in 45 of 51 miles of the Hanford Reach. In addition, there are numerous islands with many more miles of shoreline where stranding or entrapment could take place.

Wagner explained that there are two occurrence periods. low flow from about March 12 to May 5 when stranding and entrapment was primarily on gravel bar zones and after May 5 when high water resulted in more stable conditions and fluctuations were primarily in the vegetative areas where less stranding and entrapment occurs. Also, fish are becoming larger and by the second occurrence period fish are beginning to move to offshore areas for rearing. By the end of June or early July the majority of the fall chinook will have left the Hanford Reach. Wagner said their work will continue in order to identify resident fish stranding and entrapment.

Wagner said they have found that fluctuations during low flows result in more severe stranding and entrapment. Heinith asked if they had set up any transects to monitor elevation changes related to flow. Wagner said they had developed a model that appears to be quite accurate in terms of physical changes in response to flow. Heinith asked what range of fluctuation they had observed and Wagner said up to twelve vertical feet in April. Wagner concluded by saying that things had looked pretty grim in early April.

B. Spring Chinook Captive Brood

Bob Bugert reviewed the current brood years of spring chinook currently being held. These are:

Brood year	Stock	Size	Number
1996	Twisp River	10 per pound	500 (hatchery spawned)
1997	Twisp River	120 per pound	650 (hatchery spawned)
1997	Twisp River	60 per pound	923 (redd excavation)
1997	White River	?	527 (redd excavation)

Bugert said the fish hadn't been tagged yet but could be by the end of the month.

Bugert said there had been considerable activity checking out potential sites for holding the fish currently being reared at the Methow Hatchery. The most attractive sites, to date, are Bonneville Hatchery and Abernathy Hatchery. Either of these sites would require contract arrangements until permanent facilities become available under HCP arrangements. Kevin Amos was contacted and indicated to Bugert that there would be no fish health restrictions regarding either of these sites. For the long-term, there are two potential sites that are being checked out, Waikiki Springs near Spokane, and unnamed springs near Gloyd Seeps in the Moses Lake area. Waikiki Springs has about 22 cfs of spring water available. Application has been made for a water right at this location. At the Gloyd Seeps site, a commercial operator is currently raising Arctic char. This property is bordered on three sides by WDF&W property. It has been reported that there is ample water in the 12-14 degree C. range available for a captive brood program. Water quality information is being sent for review.

Bugert said the third item he wants to report on is discussion on the issue of mitigation crediting for a captive brood program. Grant PUD has stressed the importance of resolving this issue in order for the captive brood program to move forward. Bugert said this is a complicated issue but discussions are taking place and several concepts have been considered. One involves a calculation of smolt equivalents and the other involves determination of adults to be produced.

Bugert said discussions with Grant PUD representatives indicated Grant would feel comfortable proceeding with a short-term program under some contracting arrangement while a long-term program and crediting arrangements were being worked out. Hammond said the crediting arrangement is a key issue for Grant PUD. He said the effort to date is to provide for the fish on hand and probably the 1998 brood. Grant PUD is most concerned about the long-term costs and crediting arrangements. While contracting is attractive for the short-term, it is critical to Grant to actively pursue long-term facilities and crediting. Woodin said it would be desirable to have some kind of agreement that would carry the short-term program over to long-term arrangements under the HCP or some alternative arrangement. Hammond said that would fit into his frame of reference.

Bugert pointed out a caution that there will be additional brood years added and the short-term program will be expanding. He said we don't want to get down the road when the fish are at two or three pounds, and then have negotiations fall apart and have to dispose of the fish. Heinith said there needs to be more discussion between the Joint Fisheries Parties since he is not sure what the impact of the captive brood program might be on existing production. Bugert agreed that there needs to be further discussion prior to the end of the month since that is the time agreed to for having a program coming together for transferring fish from the Methow Hatchery by September 15.

Heinith asked if there were any successful captive brood programs around. Bugert mentioned the Snake River sockeye and the most successful program that he has heard of, the Hurd Creek chinook program which is in its eighth year of operation. Bodega Bay, and Bonneville Hatchery are two other captive brood facilities visited. Bugert explained how a mid-

Columbia captive brood program would fit with an adult based supplementation program. Bugert pointed out that at the May 19 coordinating committee meeting an ad hoc committee was formed to deal with the captive brood question. He suggested convening that committee to iron out details insofar as Joint Fisheries Parties coordination is concerned. He pointed out that Scribner was assigned to that ad hoc group and asked Heinith if he thought that would be adequate representation for the tribal interests. Heinith said he was comfortable with Scribner being involved in those discussions. Bugert and Woodin will set up contact between the parties on the ad hoc committee to coordinate among the JFP. Bugert said it is important to come to some understanding prior to June 30 so the Methow Hatchery folks can be instructed to release the fish if some agreement can't be reached.

II. WELLS DAM

A. Bypass Operation and Hydroacoustic Index

Klinge said the spring bypass operation at Wells Dam ended June 10. Klinge distributed a memo from the bypass team explaining the rationale for the termination of bypass operation. He explained that the bypass was re-started June 16 due to an increase in the hydroacoustic index on June 13-15. The shutdown lasted six days.

Klinge explained that the adjustments to the hydroacoustic index are based on historic fyke net data rather than actual fyke netting. Douglas PUD didn't receive their section 10 permit until after the period requested for fyke netting.

B. 1998 Pilot Survival Study

Bickford handed out a preliminary summary of PIT tag detections from Rocky Reach down river to the Columbia River estuary. He reviewed the preliminary results of the downstream detections compared to the stated goals of the pilot study. The first goal, to assess detection rates of hatchery vs. in-river migrants, 26.5% of the in-river fish have been detected at down-river recovery points with a range of 20.3 to 34.4% for the various release groups. For the hatchery fish, 25.5% have been detected at the down-river sites with a range of 21.8 to 28.7%. Bickford said the detection rates appear to be comparable.

The second goal was to estimate detection rates at ($\alpha = 0.10$ & $\varepsilon = 0.10$). Bickford said this goal was accomplished. He said survival rates could be derived at ($\alpha=0.10$ & $\varepsilon= 0.10$).

The third goal was to assess the models assumed detection rates at the various downstream sites. For Rocky Reach, McNary, John Day, and downstream of John Day, only the detections at Rocky Reach failed to achieve the assumptions in the model. At that location the model assumed 13.5% while the actual detections were 8.4%.

Bickford said travel time information would be completed once the data has been finalized, but he made the following observations. There were obvious differences between the in-river fish and hatchery fish. The hatchery fish averaged about 180 mm in length and based on assay work appeared to be smolted. The in-river fish averaged about 135 mm and did not appear to be smolted. The in-river fish were the first to be detected at Bonneville Dam and the estuary sites. Bickford said detections peaked in two modes consistently across all four recovery sites and the fish appear to have mixed thoroughly at all sites for all release groups.

Klinge discussed 1999 survival study plans. He said they are looking at both in-river and hatchery chinook as potential test animals but they have not made a decision, as yet. He said there

is also a possibility that they could take advantage of the excess steelhead juveniles that are available this year and use steelhead as test animals. He also pointed out that it would be possible to rear the progeny of stray spring chinook at the Methow Hatchery for test animals. They are planning to use 10-20 replicates with 2,500 to 3,000 fish per release at each release site. Woodin remarked that there is a surplus of fish at Ringold that are being assigned to programs and locations. These fish could potentially be used for test purposes if a facility could be located to rear the fish.

C. Okanogan Sockeye Program

Klinge reported that the 1997 brood sockeye that were to be reared to yearling size in Lake Rufus Woods net pens, will not be transferred to the net pens because the commercial operators were concerned about the potential disease ramifications on potential sales of trout to the state. Klinge distributed a memo which outlined this situation and suggested potential alternatives. One alternative involved rearing fish to yearling size at Cassimer Bar and the other suggested alternative is to release the fish immediately. He said his conversation with the hatchery manager at Cassimer Bar led him to believe that they could rear the number on hand to yearling size at that facility. Marco said their assessment was that with the addition of two vinyl raceways they could rear 80,000 fish to yearling size. With the existing raceways and circular ponds they could rear 40,000 fish to yearling size. If they had the additional raceways they could rear 58,000 fish to yearling size and hold adults for a 1999 program. Klinge said he and Marco would get together to come up with an acceptable program. Woodin suggested that it could be advantageous to rear two groups at two different densities. Klinge said that could be a viable option if all other concerns could be addressed, like separating out fish that tested high for BKD. Marco pointed out that, looking to the future, a yearling program using 80,000 fish would only require approximately 124 adults for brood stock. Over the next few years, very few sockeye are expected in the run.

Heinith asked Klinge about plans for spawning ground surveys for this fall. Klinge said they had earlier proposed to forego spawning ground surveys and used radio tagged fish to assess spawning escapement. The committee had, at that time, suggested 50 tagged fish be used instead of the 40 they had proposed. He said they will spend time on the spawning grounds to look for fin clipped fish from Cassimer Bar Hatchery. Heinith suggested working with the Canadian Tribes as a gesture of good will. Klinge pointed out that radio tagging in 1997 showed a substantial percentage of the tagged fish spawned in areas outside the spawning grounds normally surveyed. They feel radio tags would be a more reliable determinant of spawning escapement.

The next meeting of the Wells Coordinating Committee will be held on July 8, 1998.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Rod Woodin	Washington Department of Fisheries and Wildlife
Paul Wagner	Washington Department of Fisheries and Wildlife
Jerry Marco	Colville Confederated Tribes
Bob Heinith	Columbia River Intertribal Fisheries Commission
Stuart Hammond	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bryan Nordlund	National Marine Fisheries Service
Brian Cates	U. S. Fish and Wildlife Service
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
JULY 8, 1998

Agreements Reached:
1.

I. GENERAL MID-COLUMBIA ISSUES

A. Mid-Columbia Survival Study - 1999

Klinge distributed a memo outlining the Douglas PUD request for study fish for survival studies in 1999. Peven pointed out that Chelan and Douglas PUD's had been discussing the potential for a joint survival study in 19999. Peven asked the committee if they would support a joint survival study if the logistics can be worked out. Hevlin and Cates said, given the number of fish required for these studies, it would make sense to have joint studies, to the extent possible, to reduce the total number of test fish used. Cates asked Klinge and Peven if they were considering using species other than steelhead in 1999. Peven said they were not considering other species, at this time, but a firm decision had not been made on the matter as yet. Hevlin asked Hammond if Grant PUD had considered how they might fit into a 1999 survival study. Hammond said they have embraced the concept of a pilot survival study but have not had discussions with Chelan and Douglas regarding incorporating Wanapum and Priest Rapids survival studies into the Chelan and Douglas plans. He went on to say that they would be discussing the matter further and explore the potential for participating in such studies in 1999.

II. WELLS DAM

A. Wells Reservoir Resident Fish Study

Hevlin inquired about the resident fish study proposed by Douglas PUD. This proposal had been submitted to NMFS as part of an application for a Section 10 Permit. Hevlin said that when he is asked to comment on proposals such as this, he usually refers to consideration by the Mid-Columbia Coordinating Committee. Klinge said he could send it out to the committee for comment, if that would help.

B. Okanogan Sockeye

The chair distributed a memo from Larry Brown concerning WDF&W's position regarding release of 1997 brood sockeye currently being reared at Cassimer Bar Hatchery. There suggestion was to release the fish in or near the lower Okanogan River as soon as possible since they understood the projected size of those fish, if held for yearling release, would be approximately three fish per pound. Klinge said Douglas PUD also had concerns about the projected release size for these fish. He went on to say that, given the Larry Brown memo, this may be a good time to step back from the existing program, especially given the low adult escapement expected in 1998 and 1999. He said the PUD would be pursuing discussions with the

Canadian parties in a search for a meaningful Okanogan sockeye enhancement effort that would have the support of the parties north of the border. He said he would be looking at stream side sockeye enhancement efforts on the Cedar River to see whether there might be other enhancement options for Okanogan sockeye.

Marco said he didn't feel the Colville Tribe could support the actions suggested in the memo from Larry Brown. He said he wasn't sure where the projections of three fish per pound came from. He said there is no question that the fish will be large but he didn't feel they would be three to the pound. He said he and Klinge had discussed the possibility of conducting rearing density studies and he would like to see collection of about 100 adults from the 1998 brood year in order to have adequate fish to conduct the studies. Klinge said that Douglas PUD feels that the potential for enhancing Okanogan sockeye lies north of the border and they feel it is fruitless, at this point in time, to conduct additional rearing studies. They feel that this would be a good time to change direction in Okanogan sockeye enhancement and explore other options. Hevlin said he feels that the brood stock collection should be discontinued. When asked by Marco for an explanation of his position, Hevlin said this was based on the fact that few fish from previous year's releases have been seen during collection activities or on the spawning grounds. In addition, he said it now appears that survival of adults, from Wells Dam to the spawning grounds, may not be the problem we thought it might be. Klinge said it is Douglas PUD's intent to bring to the committee new options for consideration.

The committee agreed to meet by conference call on Tuesday, July 14 at 1:30 PM to try to resolve what to do with the 1997 brood fish and what to do about collection of 1998 brood adults.

The next meeting of the Wells Coordinating Committee will be August 12 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Jerry Marco	Colville Confederated Tribes
Stuart Hammond	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Bryan Nordlund	National Marine Fisheries Service
Brian Cates	U. S. Fish and Wildlife Service
Tracy Steig	HTI (Grant PUD contractor)
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
AUGUST 12, 1998

Agreements Reached:

1. The committee agreed to support Douglas PUD's initiative to explore other sockeye enhancement options in British Columbia as long as support for the existing program continued.

2. The committee agreed to support collection of 30 additional adult sockeye for brood stock for the Cassimer Bar Hatchery in 1998.

I. GENERAL MID-COLUMBIA ISSUES

A. Adult Steelhead Radio Tag Study

Hevlin said he would like to have a more detailed discussion on the objectives for an adult steelhead tagging study in 1999. He said a steelhead study should include tracking fish onto the spawning grounds. Brown said he could see some complications in such a study based on the origin of the fish, hatchery or wild, or release location, upper Methow or lower Methow. Hevlin said these complications dictate more discussion and input from people currently doing such work in other locations in the Columbia Basin. Brown said if a more detailed discussion is planned for the next meeting, a study plan should be developed, for review, in advance. The PUD's agreed to provide a preliminary study plan prior to the next meeting and Hevlin will invite knowledgeable people to the meeting for the discussion.

B. Juvenile Survival Studies

Bickford and Lucas distributed information regarding proposed juvenile survival studies in 1999. Chelan PUD had previously sent a study proposal to the committee. Peven reported that Chelan, Douglas, and Grant PUD's were holding discussions on coordination of juvenile survival studies. They will report on these discussions and the expected coordination at a later meeting.

Bickford said the Douglas proposal involves the use of 90,000 PIT tagged steelhead which would include releases at Wells tailrace, Pateros, and the Okanogan River at Crazy Rapids. This would allow 15 replicates of 2,000 fish each or 10 replicates of 3,000 fish each. The precision will be about the same with either 15 or 10 replicates and is estimated to be plus or minus 4.1% at the 95% level or plus or minus 3.1% at the 90% confidence level.

There was discussion regarding coordination of the three proposed studies to maximize benefits and expected precision of results. It was pointed out that all release groups need to be handled identically which complicates the coordination of the three studies.

Brown said he would favor an earlier start on releases of the replicates than proposed in the Chelan PUD proposal. He pointed out that the large smolts at the Wells Hatchery tend to migrate a little earlier. In addition, as the end of May approaches, many of the fish remaining in the ponds are likely to be non-migrating residuals.

Lukas said there isn't any information on survival of smolts at Priest Rapids and Wanapum. Grant PUD is desirous of assessing survival in 1999 and, if possible, they would like to coordinate with the Chelan and Douglas PUD studies. Lukas said he would like feed-back from the committee regarding support for the concept of a Wanapum/Priest Rapids juvenile survival study. Brown said that, given the mid-Columbia steelhead listing, 1999 may be the only opportunity to do a steelhead survival study in the foreseeable future. The inadvertent, excess egg take at Wells Hatchery in 1998 resulted in fish being available for survival studies in 1999 and there are approximately 60,000 fish that could be available for the proposed Grant PUD study.

Woodin expressed general support for coordination of the survival studies but he cautioned that he wants to see very specific objectives and goals for the studies being proposed. He said he is less concerned about the Douglas PUD study since they are far ahead in the assessment of post bypass development. He is less comfortable with the proposed Chelan and Grant PUD studies and so the goals and objectives are much more critical. Just because fish are available doesn't justify a study. It was also pointed out that an early start on securing the necessary Section 10 permits is an important consideration.

The committee requested that Chelan and Grant PUD's develop detailed goals and objectives for committee review prior to the next meeting. The committee asked the PUD's to continue pursuing coordination of the proposed 1999 survival studies and to develop detailed study plans for review.

Hammond raised a question regarding possible pursuit of the concept of in-river PIT tag detection. He said there will likely be many years of survival studies and in-river detection could save time, money, and fish in the future. Hevlin said the work NMFS has been doing in the lower Columbia is experimental in nature and he would discourage duplicate efforts in the mid-Columbia at this time. Woodin said it may be more productive to look into the use of radio-tags for survival studies, as had been proposed by Grant PUD in the past. Peven said Skalski and Giorgi were developing a model for using radio tags for survival studies. Woodin said it would be worth considering looking into the use of radio tags, along with the PIT tag survival studies if the goals and objectives for the survival studies are adequately developed.

C. Spring Chinook Captive Brood Stock Program

Hammond summarized the captive brood stock meeting of August 11. A commercial aquaculture group has facilities near Rochester which could handle up to 175 family groups. State and Federal managers were present at the meeting and discussion centered on providing for the fish, currently being held at the Methow Hatchery, for a one year period while discussions on a long-term program were progressing. Lorz reported that the Yakama and Umatilla Tribes were drafting a letter to the committee regarding the captive brood program and they apparently feel the matter should be resolved in the U.S. vs. Oregon forum. Peven asked where this leaves the matter insofar as the Mid-Columbia Coordinating Committee is concerned. Woodin said he would make a point of discussing the matter with the WDF&W representative to the U.S. vs. Oregon discussions.

II. WELLS DAM

A. Hatchery Activities

Klinge asked Brown if he could give review the spring chinook status on the Methow. Brown said the intent of the brood stock collection protocol for 1998 was to collect the entire

Methow River run at Wells Dam. The run forecast was for 330 fish and the final count was 409. There could have been several additional spring chinook collected with the Wells summer chinook. A total of 110 fish went to Winthrop Hatchery which left 173 adipose clipped fish and 123 unmarked fish at the Methow Hatchery. The first two days of spawning were August 4 and August 11. He will have more information on spawning results at a later date. Woodin asked Brown if adipose present fish were routinely checked for coded wire tags. Brown said no, but this could be done.

Brown went on to review the brood stock collection status for steelhead, summer chinook, and sockeye. Steelhead collection at Wells Hatchery is behind schedule as only 23 fish have been collected to date. Summer chinook volunteers to the Wells Hatchery are on schedule with 1029 collected out of a target of 1275. Summer chinook trapping at the Wells east ladder trap has produced 143 adipose clipped and 257 unmarked fish with a target of 598.

Brown then reviewed the status of brood stock collection on the Wenatchee system. At the Dryden trap, 10 unmarked and three adipose clipped steelhead have been trapped while at the Tumwater trap they have collected 20 unmarked steelhead. Sockeye collection is complete and the fish are being held in the Lake Wenatchee net pens where they are experiencing some mortality, probably due to warmer than normal lake water temperatures. Summer chinook collection at the Dryden left bank trap has been very effective. All of the brood stock is being collected at that point and trapping has been discontinued at the Tumwater trap. For spring chinook in the Wenatchee system, they have collected 33 hatchery and 9 wild with three of the hatchery and 9 wild collected at the Chiwawa weir and the remainder from the Tumwater trap.

Peven reported that the Chelan PUD spawning ground survey crew had encountered a fisherman on the Chiwawa River that had caught and released a number of bull trout last week. The fisherman stated that he had also caught bull trout on the Chiwawa the previous week. Peven remarked that it was necessary for their survey crew to get a section 10 permit to walk in the area for their spawning ground surveys due to bull trout harassment concerns. However, fishermen can legally fish as long as they don't target bull trout and they release the fish they catch.

B. Update on 1998 Wells Dam Activities

Klinge reported that the Wells Bypass Team had concluded the run was over and the bypass was closed on August 11. They will continue to monitor hydroacoustically and will fyke net on August 17 so they will know by August 18 how the monitoring information relates to fish passage. He reminded the committee that the Wells Bypass Team uses the historic fyke net data for in-season species composition.

Klinge distributed a graph showing the Total Dissolved Gas data from Wells for the entire spring and summer migrations. The TDG level was relatively moderate during the season and the 24 hour average seldom exceeded 115%.

Bickford distributed information on the radio tagged adult summer chinook ladder passage study at Wells Dam. A total of 286 fish were tagged at Bonneville Dam and 35 of these have passed Wells. A number of fish are still in the tailrace. Project passage time is one half of what it was last year. This is due, in part, to lower flows. The trapping schedule for the east and west ladder traps are having some effect on passage. The ratio of the number showing at Wells to the total released at Bonneville, is identical to the 1997 ratio. Bickford pointed out that more fish are passing through the west ladder in 1998 compared to 1997.

C. Squawfish Removal Program

Bickford reported that the squawfish removal program has removed 5,918 fish with a cpue of 2.3 fish per angler hour. The program will continue through August. Longline gear has been has proven to be very effective during the summer period. Seven radio tagged squawfish were caught out of the 18 tagged and released in 1997. Bickford projected an exploitation rate of 39% assuming no mortality on tagged fish from 1997 release to 1998 recovery. All the radio tagged fish had grown two to three inches between release and recovery.

D. Sockeye Radio Telemetry Study

Bickford reported that 49 sockeye had been tagged and released. None of the tagged fish died during the tagging or while they were held prior to release. Two of the tagged fish moved back downstream below Wells and later re-ascended the ladders at Wells. One fish has been detected passing Zosel Dam at the outlet of Lake Osoyoos.

E. Sockeye Program Proposal

Klinge referred to his August 6 letter to the committee regarding the process Douglas PUD would like to pursue for addressing Okanogan sockeye. He referred to discussions between Douglas PUD and representatives from agencies in British Columbia which sought to find common ground regarding how each viewed sockeye enhancement options. Douglas PUD would like to retain someone to explore options for sockeye enhancement in British Columbia and come back to the committee in 12 months with new recommendations for sockeye enhancement. Hevlin remarked that this represented a real positive step. He asked if Douglas PUD would propose to have a Canadian biologist do the work. Klinge said they hadn't made any decisions on a particular individual or organization but their intent would be to have someone familiar with the area and what would be necessary to work within the Canadian system. Feldman asked if there was a possibility that a popular option could be developed that wouldn't necessarily meet the political situation or a political solution might be developed which wouldn't meet the biological need. Bickford pointed out that they would like to see a program developed that addressed the biological needs or limiting factors and which would be politically acceptable. Bickford said they had found the Department of Fisheries and Oceans to be generally supportive of Okanogan sockeye enhancement. The B.C. Ministry of Environment has been less supportive of sockeye enhancement due, primarily, with their concerns regarding the current programs emphasis on artificial propagation and the impact those efforts might have on sport fisheries within their jurisdiction. They did, however, support the concept of enhancement by use of habitat improvement or low tech spawning channels.

Woodin complimented Douglas PUD on their efforts to work with the Canadian entities and asked if some program were found to be biologically and politically acceptable, would Douglas be willing to spend dollars to fund such a program. Klinge said that Douglas wasn't opposed to putting money into a program that made sense biologically and which was politically acceptable but that they could not at this time make any commitments since the various options had not been identified. Woodin stated that he felt since there was no guarantee that funding would be available for implementing any program identified in the future he would encourage Douglas PUD to continue the current hatchery program. Marco said he felt the proposal was and either/or situation and if that was the case he would be opposed to the proposal. If he considers this as a preliminary move toward HCP habitat activity then it may have merit. Feldman asked

Klinge if Douglas PUD was proposing to abandon the Cassimer Bar program prior to having an alternative program ready to pursue as a result of the proposal. Klinge said that if there was some reason to believe the current program was biologically effective it would be easier to justify continuing the current program. However, Klinge said what he was looking for as a result of the discussion was support for the Douglas PUD proposal to pursue options for sockeye enhancement in British Columbia. He said Douglas PUD would continue to support the hatchery based supplementation program, envisioned in the Wells Settlement Agreement, while exploring other enhancement efforts in B.C. The committee agreed to support the Douglas PUD initiative to explore other sockeye enhancement options in British Columbia with the understanding that Douglas PUD would continue support for the hatchery based supplementation program envisioned in the Wells Settlement Agreement until such time as an alternative program has been identified and brought to the committee.

F. 1998 Sockeye Brood Stock Collection

Marco presented information on the collection of adult sockeye for Cassimer Bar Hatchery broodstock and the status of the sockeye count at Wells Dam. They have collected 71 sockeye adults out of a total run, to date, of about 3500 fish over Wells Dam. This represents about 2% of the run. In view of the run being larger than anticipated at the last meeting, Marco said they would still like to collect additional brood stock for a yearling rearing program. They had originally proposed to collect 136 adults and later modified that to 102. If they pursue a yearling program they would like to reduce the size of the smolts either through chilling during incubation or rearing in net pens where the winter water temperature would be around 30° F. Marco said there is some possibility that the Lake Rufus Woods net pen operator could be interested in accommodating the program. Woodin said an additional 31 sockeye adults could be collected at Wells during steelhead/summer chinook collection activities. Klinge said that Douglas PUD's opposition to sockeye collection this year was based on the low projected run size. Now it appears the warm water temperatures this year may be a factor that could reduce the escapement to the spawning grounds. Woodin said that might be a reason to collect additional fish. Feldman stated that based on his experience with Baker River sockeye, he doesn't see a problem in taking an additional 30 fish because of the potential for learning something that may be helpful in the future. The committee agreed to support collection of 30 additional sockeye adults for brood stock for the Cassimer Bar Hatchery within the constraints of the existing trap operations at Wells Dam.

G. Wells Survival Study - 1998

Bickford reviewed the results of the pilot study in relation to the four study goals as follows:

Goal 1. Estimate recapture and detection rates for downstream recovery sites
Result: The study results exceeded the study goal

Goal 2. Assess CJS Model Assumptions
Result: Not all releases conformed to all of the CJS and Ricker model assumptions at all recapture sites. Therefore each group treated as an independent event and assumptions and parameters selected on a release by release basis

Goal 3. Estimate survival rates through Wells Dam with precision ($\alpha = 0.10$ & $\varepsilon = 0.10$)

Result: The survival precision goal was exceeded during the pilot study

Goal 4. Determine feasibility of conducting a full survival study at Wells Dam with precision ($\alpha = 0.05$ & $\varepsilon = 0.05$)

Result: A full study was determined to be feasible with current recapture rates

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The next meeting of the Wells Coordinating Committee will be September 22 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Tracy Yount	Chelan County PUD
Jerry Marco	Colville Confederated Tribes
Tom Lorz	Columbia River Intertribal Fisheries Commission
Stuart Hammond	Grant County Public Utility District
Joe Lukas	Grant County Public Utility District
Rick Klinge	Douglas County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Bryan Nordlund	National Marine Fisheries Service
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Brian Cates	U. S. Fish and Wildlife Service
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
SEPTEMBER 22, 1998

Agreements Reached:

1. The committee agreed to form a Survival Study Technical Sub-Committee to look at protocols that might be used for future survival studies at mid-Columbia projects.

I. GENERAL MID-COLUMBIA ISSUES

A. Spring Chinook Captive Brood

The chairman distributed a packet of correspondence related to the spring chinook captive brood issue. Included in the packet were the following letters: September 2 letter from Heinith to Woodin; September 10 letter from Parker to Woodin; September 11 letter from Woodin to Heinith and Hammond; and September 21 letter from Doug Ancona to Woodin. Hammond said that the Ancona letter dated 9/21 affirms Grant PUD's commitment to fund the existing program through June 30, 1999. It was pointed out that the long-term program, to be developed prior to June 30, will be the focus of considerable effort beginning with the meeting on October 8.

Parker said that the tribes are interested in pursuing acclimation facilities for steelhead on the Wenatchee and Methow Rivers. Brown and Woodin pointed out that WDF&W is already moving in that direction. This year they had planned to use spring chinook acclimation facilities in the Methow Basin for steelhead acclimation after the chinook had left.. Because the chinook were slow leaving the ponds they were not able to use them for steelhead this year. In the Wenatchee Basin, Brown said they planned to use one of the Chiwawa River acclimation ponds for steelhead in 1999 since both ponds would not needed for chinook at the current low population level.

B. Steelhead Adult Radio-Telemetry Study

Bickford said a three PUD study proposal was distributed to the committee in August. This proposal involves tagging 400 adult steelhead at Priest Rapids in 1999. Monitoring would take place there and at Wanapum, Rock Island, Rocky Reach, and Wells. Brown said it would be a good idea to coordinate trapping with on-going stock assessment study at Priest Rapids. It was felt that such coordination was desirable and could be done. Brown said their schedule for stock assessment study trapping calls for trapping every Tuesday and every other Thursday. He said they currently have a Section 10 Permit covering this trapping effort. Bickford said his plans were to coordinate with Brown to take advantage of the WDF&W trapping effort and not add to it. Hevlin noted that he had previously expressed interest in having some assessment of the distribution of radio tagged steelhead. He talked to Ted Bjornn about the level of effort needed to monitor distribution. Bickford said Douglas PUD had previously offered to monitor for radio tagged fish at the mouth of the Methow and Okanogan Rivers. Their was some discussion concerning the possibility of aerial flights to monitor distribution within mid-Columbia tributaries with no conclusions being reached.

II. WELLS DAM

A. Wells 1999 Survival Study Proposal

Bickford reviewed the proposed study plan for the 1999 Wells Survival Study which was developed based on input received on the original proposed study plan. The revision involved consolidation of release sites based on weighting reservoir miles and origin of steelhead smolts above Wells Dam. Bickford explained benefits which would be realized by the consolidation of release sites. This consolidation would reduce the total number of test animals required for the study from 90,000 to 60,000 and simplify the logistics involved with paired releases. The proposal called for release of tagged fish in the vicinity of Brewster instead of the Pateros and Savage Rapids on the Okanogan River.

Marco expressed concern regarding the possible under-assessment of the effects of passage through the inundated portion of the Okanogan River by consolidating release sites. Discussion continued on the issue of whether or not to include specific assessment of survival from release in the Okanogan River in the proposed study protocol. Alternative plans were suggested in addition to the modified plan Bickford proposed. One was to have two paired release studies, one which would include releases in the Okanogan and the Wells tailrace while the other would consist of Methow(Pateros) and Wells tailrace releases. A compromise was reached wherein the Methow(Pateros) releases would be paired with the Wells tailrace releases and would be the primary objective of the steelhead survival study. There would also be a pilot study effort which would involve release of tagged steelhead at Savage Rapids on the Okanogan River which would be a stand alone study where the Okanogan releases would not be paired with the Wells tailrace releases. Bickford made it clear that he did not want to see the Okanogan portion of the study in any way jeopardize the integrity of the Methow portion of the study since that system produces nearly all of the wild steelhead above Wells Dam and approximately 80% of the hatchery steelhead. Woodin suggested starting the Okanogan releases one day early and making one additional Wells tailrace release. Bickford will prepare a revised study plan, which reflects the understanding arrived at during the foregoing discussion, to present at the next coordinating committee meeting for final decision.

The next meeting of the Wells Coordinating Committee will be October 20, 1998 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Steve Hays	Chelan County Public Utility District
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Thad Mosey	Chelan County Public Utility District
Todd West	Chelan County Public Utility District
Steve Parker	Yakama Nation
Paul Ward	Yakama Nation
Jerry Marco	Colville Confederated Tribes
Bob Heinith	Columbia River Intertribal Fisheries Commission
Stuart Hammond	Grant County Public Utility District
Joe Lukas	Grant County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Bob Dach	National Marine Fisheries Service
Ben Sandford	National Marine Fisheries Service
Steve Smith	National Marine Fisheries Service
Brad Eppard	National Marine Fisheries Service
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Mike Erho	The Committee

WELLS 98-10

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
OCTOBER 20, 1998

Agreements Reached:
1.

I. GENERAL MID-COLUMBIA ISSUES

A. Quantitative Analytical Reports for Mid-Columbia Projects

Hevlin referred to a memo sent to committee members last week that is a follow-up on discussions held with Grant PUD on October 8. Hevlin said the memo and the discussion today will serve to inform Chelan and Douglas PUD's of the discussion of the QAR at the Grant PUD meeting. The QAR is expected to be a parallel effort that would be done in cooperation or in conjunction with the PATH effort. Hevlin informed the committee that the Implementation Team would be meeting with PATH on November 11. He explained that the IT was made up of mid-level policy people and serves to oversee the work of PATH. Hevlin said he was hopeful that the Mid-Columbia PUD's could be represented at the November 11 meeting to see what the IT is considering in terms of QAR's. Hevlin went on to explain that the QAR analysis would be a template for long-term evaluation of the HCP's for Chelan and Douglas PUD's and a long-term agreement with Grant PUD that was discussed at the October 8 meeting. He said NMFS will be expecting to use the QAR's during consultations in 1999 and long-term consultation efforts in 2000.

Peven said the schedule outlined by Hevlin represents an ambitious schedule for this effort given previous work that has been done. He said he would propose that the PUD's get their heads together and report back to the full committee at the next meeting. Hevlin said that at the Grant PUD meeting they had discussed the possibility of including spring chinook in the QAR's. Hevlin said if there are any questions on the QAR to call him or Chris Toole.

Heinith said the NMFS memo had important implications for the tribes. He said the Framework process would have to be considered in the QAR. He pointed out that the QAR and the Framework Process were on similar tracks. Parker said it is not clear to him which process is expected to give direction for the future. It was recognized that the Framework is a much broader effort where the QAR is limited to listed species. Heinith said what would appear to be helpful to the PUD's would be to know what their obligations will be in the future. Woodin said it is important to look at the effect of down-river actions on the recovery efforts in the mid-Columbia.

Hammond asked Hevlin about the status of the Biological Assessment. Grant PUD is hopeful of seeing something as early as possible. Hevlin said he didn't have any information on when the BA would be released.

B. Spring Chinook Captive Brood Program

Brown reported that the 1998 brood year spring chinook eggs, collected for the Twisp River captive brood program, are now at the AquaSeed facilities near Rochester. The 1998 White River and Nason Creek eggs are in the process of being collected and will all be moved to Rochester by the end of next week. There are currently seven families represented in the 1998 brood year Twisp River collections, four families with an additional four to go in the White River collections, and 18 with two to go for the Nason Creek collections.

Brown said that fish from the 1996 and 1997 brood years, being held under the captive brood program, are still being held at the Methow Hatchery pending completion of provisions for them to be moved to the AquaSeed facilities. Hammond told Brown that a proposed contract between Grant PUD and AquaSeed had been prepared and sent to AquaSeed. The contract has not been finalized, as yet. There are some additional contractual arrangements, between Grant and AquaSeed, that need to be finalized such as provision for disease surveillance.

Parker said the Yakama Tribe had been contacted by Al Wright requesting their input on a "wish-list" of compensation measures that Grant PUD could do over the next several years. Parker said the tribes are especially interested in acclimation facilities. He said they are preparing information to distribute to the coordinating committee.

II. WELLS DAM

A. 1999 Wells Dam Survival Study

The chairman summarized the history of the discussions that had taken place since the 1999 Wells Survival Study was proposed at the August 12 Wells Coordinating Committee meeting. A study plan was distributed at the August meeting and based on input from the committee a revised plan was discussed at the September 22 coordinating committee meeting. As a result of committee input at the September meeting a final draft study plan was distributed to the committee on October 1. The final draft study plan was discussed with the Wells coordinating committee by conference call on October 6. It was pointed out that Douglas PUD was running out of time to make the necessary arrangements and order tags for a 1999 study.

Heinith said the tribes would like to see the report on the 1998 Wells Pilot Survival Study and have that reviewed before they could give approval for the study. He estimated it would take them two weeks for such a review. Bickford said it would be difficult to meet that kind of schedule and still meet ordering and permit requirements in time to conduct a study in 1999. He said he is in the process of incorporating the input from LGL and John Skalski into the final report. He said he is hesitant to rush the final report without having it reviewed by those involved. Parker asked if Heinith was primarily interested in understanding the underlying assumptions that were used. Heinith said that was an important aspect of the study that should be reviewed. Bickford offered to meet with the people that Heinith wanted to review the 1998 report and discuss the assumptions from the 1998 report. Parker asked if there was a possibility that Bickford could make the data analysis portion of the report available for review. Bickford said he would have to talk to Skalski to see if he was comfortable releasing that section of the report. Hevlin said he felt there had been enough time to consider this study. He felt there should be a vote and then get on with the study. Parker suggested a middle ground wherein the tribes would give conditional support for the study pending review, within the next two weeks, of the 1998 report elements that Bickford is able to supply. Heinith said another issue is to move toward development of the radio telemetry studies for use in survival studies so that fewer fish would be

required. Bickford pointed out that the fish being considered for the 1999 studies are over and above the number Douglas PUD is obligated to produce. The Douglas PUD obligation is approximately 450,000 steelhead annually and they are currently rearing over 800,000.

Feldman said that, in his opinion, Bickford is being asked to meet an unreasonable schedule for reporting 1998 study results. It was pointed out that the survival study model is not new but has been used extensively in the Snake River and was investigated at Wells Dam by the pilot survival study conducted in 1998. Smith said there hasn't been technical opposition to the Snake River survival studies for three years. He said that the information generated from those studies has been used in the PATH process. Heinith said there have been concerns raised by the SRG such as the assumptions for mixing.

There was discussion concerning the radio telemetry portion of the 1999 study plan. Peven stated that between the study that Douglas PUD was proposing and what Chelan PUD was proposing many of the question surrounding the use of this technology for survival studies should be answered in 1999.

Parker asked what would happen if Douglas PUD went ahead with preparation for the proposed survival study and later a fatal flaw was discovered. There was discussion, at this point, about where the committee was in terms of support for the study. Bickford said Douglas PUD is unwilling to go ahead without full committee support which is not available, at this time. He said he would try to get a portion of the 1998 report to Heinith and Parker if they would agree to give there decision within two weeks.

Woodin suggested that Douglas PUD consider going ahead with a study outside of the coordinating committee and make the results available to the coordinating committee to use or not use as the decide. Bickford said they were unwilling to follow that suggestion, at this time. Parker acknowledged the tribal reluctance to support the proposed study, at this time, has both technical and policy roots. The technical questions can be addressed when they receive the information that Bickford said he would furnish and they have a chance to review that information. Heinith said that assuming they receive the data and assumptions used from Bickford as soon as possible, they would commit to conduct their review and have a decision by the end of the month. It was agreed that there would be a conference call on November 2 at 9 AM to render a decision on the technical issues concerning the proposed study. Parker and Heinith suggested that the policy questions concerning the proposed study could be resolved by Douglas PUD agreeing to conduct three years of evaluation to address the issue of adjustment to hatchery compensation levels envisioned under the Wells Settlement Agreement. Bickford said he would discuss that possibility with people at Douglas.

The Next meeting of the Wells Coordinating Committee will be November 12 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Steve Parker	Yakama Nation
Paul Ward	Yakama Nation
Bob Heinith	Columbia River Intertribal Fisheries Commission
Stuart Hammond	Grant County Public Utility District
Shane Bickford	Douglas County Public Utility District
Bill Hevlin	National Marine Fisheries Service
Bob Dach	National Marine Fisheries Service
Brian Nordlund	National Marine Fisheries Service
Ben Sandford	National Marine Fisheries Service
Steve Smith	National Marine Fisheries Service
Brad Eppard	National Marine Fisheries Service
Brian Cates	U.S. Fish and Wildlife Service
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Mike Erho	The Committee

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
NOVEMBER 12, 1998

Agreements Reached:

1. The coordinating committee members present at the meeting re-affirmed support of the proposed Wells Project steelhead survival studies in 1999.

I. GENERAL MID-COLUMBIA ISSUES

A. Section 10 Permit Applications

Brown distributed a memo outlining the WDF&W allocation for hatchery propagated steelhead. He pointed out that the original permit application didn't cover all the fish that are currently being reared so they are preparing an application for a permit modification. The release of the extra fish falls within the plus or minus 10% release number in the Section 10 Permit. He is awaiting clarification on this issue from NMFS. They will need to address the 160,300 fish necessary for the survival studies since the Section 10 Permit requires fish to be released in the areas and in ways that will contribute to recovery of the listed stock. Woodin asked why it was necessary for WDF&W to request modification of their permit if Chelan and Douglas PUD's are requesting Section 10 Permits for the same fish for survival study purposes. Dach said the last he had heard was that NMFS would be expecting a modification request for the WDF&W Section 10 Permit and applications from Chelan and Douglas PUD's for their survival study fish.

Brown pointed out that their Section 10 Permit requires an annual report which must be accepted by NMFS before the Section 10 Permit can be renewed for the next year. He said the annual report, which he had submitted in August, covered the excess production.

B. Steelhead Acclimation

Brown pointed out that his handout, at the meeting, addressed the WDF&W position regarding steelhead acclimation in 1999. Klinge said they need to be aware of the existing water rights for the Twisp and Chewuch spring chinook acclimation facilities that are referred to in Browns memo. These water rights were based on the needs for spring chinook and may not cover the period needed to acclimate steelhead following spring chinook release. Klinge said Douglas PUD wanted to avoid a re-occurrence of the problem that was experienced with coho acclimation at the Chewuch pond several years ago. Brown stated that there was a misunderstanding, at that time, concerning who would look after the coho when they were placed in the acclimation pond following spring chinook release. He stated emphatically that if steelhead were placed in those ponds following release of spring chinook in 1999, the WDF&W would assume responsibility for the care of the fish.

C. 1999 Steelhead Adult Radio Telemetry Study

Bickford summarized the discussion that had taken place previously regarding the adult steelhead study and the only question remaining that he was aware of was the level of monitoring that would take place in the tributaries. Dach said he had not seen the proposed study plan but after he has had an opportunity to review it he would provide written comments. Bickford said the primary objective of the study was to collect passage information at the mid-Columbia projects. Monitoring into the tributaries is over and above the primary objective. Hammond pointed out that the source of the fish for the study was the adult trap at Priest Rapids. He stated that it was the intent of the PUD's to coordinate the collection of fish for radio tagging with the ongoing WDF&W stock assessment trapping at Priest Rapids. He stated that some work will be necessary on the left bank ladder trap at Priest Rapids to get the trap ready for the trapping season in 1999. Bickford said he would see that Dach got a copy of the previously submitted study proposal.

D. Quantitative Analytical Report

Dach said any questions on the QAR should be directed to Hevlin or Toole at the NMFS office in Portland. He said there will be a conference call on November 23 and any interested party is invited to participate. He went on to say there will also be a joint meeting on the QAR in Portland at which time it is hoped that the mid-Columbia PUD's will be represented along with the Corps, Bureau, BPA, NMFS and possibly others. Dach said he would send out a notice to the committee regarding the conference call on November 23. He said Hevlin is setting up the meeting which will probably be on December 1.

Klinge mentioned there had been some discussion among the PUD's on this issue and there was some uncertainty regarding how the QAR fits into the overall scheme of things. He said there will be a PUD response to the earlier NMFS correspondence on the QAR. Dach said the meeting on December 1 would be important for the PUD's to attend.

E. Vernita Bar Flows

Dach said NMFS was initially concerned that Grant PUD would not be able to handle the Vernita Bar flows without additional assistance. There analysis now indicates that Grant PUD could handle the fluctuations below Priest Rapids by operations at Wanapum and Priest Rapids. Dach admitted there analysis was not detailed and could have benefited by additional information. Dach said he had originally planned to present a seven dam plan of action to handle the fluctuations in the mid-Columbia. Since there analysis indicates Grant has the capacity to handle these fluctuations with Wanapum and Priest Rapids he decided to not present this plan. Hammond said that given all the constraints on Wanapum and Priest Rapids operations, it is unlikely that the fluctuations could be handled by only Wanapum and Priest Rapids. He said this matter is being addressed in a multiple disciplinary group and this is where resolution of the problem will be appropriately pursued. Dach said they could go to FERC for resolution but, in that case, the resulting solution would probably only include the Grant PUD projects. Hammond said he believes the appropriate forum is the inter disciplinary group that has been set up to address the Hanford Reach flow concerns. Dach said they are concerned that this process is unlikely to come up with a multi-party understanding that would be available in the spring of 1999. Hammond said

Grant PUD has met with BPA but it was pointed out that all of the parties haven't been at the same place at the same time to discuss operations that would address the problem in spring 1999. Dach said time is of the essence if a solution is to be available in spring 1999.

F. Housekeeping Items

The chairman asked the committee members for help in up-dating the mailing lists for the Mid-Columbia and Wells Coordinating Committees. A listing was circulated to the members to indicate obsolete addresses.

Bob Dach had asked about the use of e-mail for official correspondence for committee business. It was agreed that e-mail was an excellent tool for correspondence within the committee but that it's use didn't meet the possible legal requirements for official correspondence and these should be sent by regular mail.

An updated list of committee members and coordinating committee attendees was developed with phone numbers, fax numbers, and e-mail addresses. The chairman will make these available to the committee when all of the information is validated.

At the request of Bob Heinith the chairman stated that the findings of the committee would receive high priority during the coming winter months and he was hopeful that these would be available for committee review as they are completed.

II. WELLS DAM

A. 1999 Wells Project Steelhead Survival Study

The chairman called attention to the memo distributed to the committee dated November 4 which covered the outcome of a November 2 conference call concerning the proposed Wells Project Survival Study in 1999. At that time committee members agreed unanimously to support the proposed study and Douglas PUD agreed to discontinue their formal dispute resolution process. This understanding was re-affirmed by the committee members present at the meeting.

B. Okanogan Sockeye

Klinge reported on progress in discussions between Douglas PUD and Canadian interests on sockeye enhancement efforts in Canada. He reported that Douglas PUD had initiated a contract with the British Columbia Conservation Foundation which had sub-contracted with Chris Bull to put together a comprehensive review of potential enhancement measures that could be pursued in British Columbia. Klinge mentioned that Bull is working with other environmental groups and tribes in British Columbia with the intent of having a draft report available by spring 1999. Klinge said Douglas PUD would like to bring to the committee a list of sockeye measures, to be considered, that would have the support of the Canadian interests. He said he was hopeful of having progress reports, for committee review, as the process continues. Klinge said there is a spirit of cooperation in Canada that wasn't present a couple of years ago. Klinge said this effort is directed toward sockeye enhancement although other species may also benefit from whatever measure or measures may be selected. The area they are targeting for this review is from Lake Osoyoos to Okanogan Falls at the outlet of Lake Okanogan. He said the effort is beginning to pick up speed now that the contract is in place.

C. Okanogan Sockeye Radio-Tagging and Spawning Ground Surveys

Bickford reported that they have determined that there was a problem with the detection equipment and possibly the tags used in the adult sockeye radio tagging project used to detected survival to the spawning grounds in 1998. These problems resulted in tags not being detected at Zosel Dam. He reported that about 500 fish were observed on the spawning grounds during their survey last week. Aerial surveys have recovered 21 of the 49 tags released, some of which were outside of the spawning area and were assumed to be on dead fish. It is estimated that up to 10% of the tags may have been unusable. Bickford said that next week they are planning to recover some of the tags to try to assess the percentage of bad tags. Klinge and Bickford said none of the 100 or so fish they looked at on the spawning grounds were tagged or marked Cassimer Bar fish.

Bickford said in 1997 only 40% of the tagged fish were found in the index area and 60% outside the index area. So far, in 1998 the distribution is reversed with 60% in the index area and 40% outside the index area. He pointed out that 1997 was a high flow year as opposed to 1998 which was an extremely warm year with the Okanogan River temperatures staying above 21 degrees C. until the end of September.

The next meeting of the Wells Coordinating Committee will be January 13, 1999 at Sea/Tac.

ATTENDANCE LIST

Name	Representing
Cary Feldman	Puget Sound Energy
Chuck Peven	Chelan County Public Utility District
Robert McDonald	Chelan County Public Utility District
Paul Ward	Yakama Indian Nation
Stuart Hammond	Grant County Public Utility District
Shane Bickford	Douglas County Public Utility District
Rick Klinge	Douglas County Public Utility District
Bob Dach	National Marine Fisheries Service
Brian Nordlund	National Marine Fisheries Service
Mark Schneider	National Marine Fisheries Service
Brian Cates	U.S. Fish and Wildlife Service
Rod Woodin	Washington Department of Fisheries and Wildlife
Larry Brown	Washington Department of Fisheries and Wildlife
Al Giorgi	BioAnalysts (Chelan consultant)
John Skalski	University of Washington (Chelan consultant)
Mike Erho	The Committee

1998 MEMBERSHIP LIST
OF THE
WELLS COORDINATING COMMITTEE

APPENDIX I

Appendix I

1998 Membership list of the Wells Coordinating Committee

Ron Boyce
Oregon Department of Fish and Wildlife

Mike Erho
Wells Coordinating Committee Chairman

Cary Feldmann
Power Purchasers

Bob Heinith
Umatilla Tribes

Bob Dach
National Marine Fisheries Service

Rick Klinge
Douglas County P.U.D.

Jerry Marco
Colville Confederated Tribes

Steve Parker
Yakama Indian Nation

Brian Cates
U.S. Fish and Wildlife Service

Rod Woodin
Washington Department of Fish and Wildlife

THE LONG TERM SETTLEMENT AGREEMENT FOR THE WELLS HYDROELECTRIC PROJECT

APPENDIX J

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Public Utility District No. 1 of Douglas County, Washington	)	Project No. 2149 Docket No. E-9569

SETTLEMENT AGREEMENT

This Settlement Agreement is entered into this 1st day of October, 1990, by the Public Utility District No. 1 of Douglas County, Washington (the PUD), Puget Sound Power & Light Company, Pacific Power and Light Company, the Washington Water Power Company, Portland General Electric Company (collectively the Power Purchasers), the Washington Department of Fisheries, the Washington Department of Wildlife, the Oregon Department of Fish and Wildlife, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Umatilla Reservation, and the Confederated Tribes of the Colville Reservation (collectively the Joint Fishery Parties).

I. GENERAL

A. PURPOSE AND SCOPE

1. This Agreement establishes the PUD's obligations with respect to the installation and operation of juvenile downstream migrant bypass facilities and measures; hatchery compensation for fish losses; and adult fishway operation at least until March 1, 2004, as described in subsection I.C. For purposes of the Wells Project, these measures, in conjunction with existing hatchery

compensation programs, and when carried out pursuant to this Agreement, shall be conclusively considered to fulfill the PUD's obligation to protect, mitigate, and compensate for the anadromous fish resource at least until March 1, 2004. These measures are expected to contribute to the Northwest Power Planning Council's goals of rebuilding the natural spawning populations of salmon and steelhead in the Columbia Basin and providing harvest opportunities.

2. This Agreement establishes the Joint Fishery Parties' obligations in support of this settlement. This Agreement also requires evaluation programs for fishery measures and establishes procedures for coordination between the PUD and Power Purchasers and the Joint Fishery Parties.

3. It is the intent of the Parties that this Agreement shall be the basis for the dismissal of the Mid-Columbia proceeding, Docket No. E-9569, insofar as it pertains to the Wells Project, and for compliance by the PUD with the Northwest Power Planning Council's 1987 Columbia River Basin Fish and Wildlife Program, as amended.

4. The fish passage, mitigation, and compensation measures set out in this Agreement are intended to implement Article 41 of the License for Project No. 2149 issued by FERC to the PUD. The PUD's obligations under this Agreement shall be enforceable as if they were conditions of its FERC license. Notwithstanding any other provision of its FERC license, once this Agreement is approved by FERC the PUD shall be bound by the terms of this

Agreement.

5. For purposes of this Agreement, except under subsections VI.B, VII.B and E, VIII.B and D, the Power Purchasers collectively will be a single Party. For all purposes under this Agreement, except under subsections VI.B, VII.B and E, VIII.B and D, the Power Purchasers shall participate through a single representative, whom they will designate from time to time.

B. DURATION

The term of this Agreement shall commence on the date of execution by all Parties and shall continue for the term of the current license for the Wells Project, plus the term of any annual licenses which may be issued after the current license has expired.

C. MODIFICATIONS TO THE AGREEMENT

1. Notwithstanding subsection I.B, at any time after March 1, 2004, any Party may request all other Parties to commence negotiations to modify the terms and conditions of this Agreement in whole or in part. Any such modification shall be subject to FERC approval, except that the Parties may agree to implement on an interim basis, pending FERC approval, any measure not requiring prior FERC approval. No Party shall file a petition with FERC pursuant to subsection I.C.2 to modify this Agreement without first presenting the proposed modification to all Parties and allowing a reasonable opportunity to negotiate, not to exceed 90 days without consent of all Parties.

2. Subject to the limitation stated in the above subsection, at any time after March 1, 2004, any Party to this Agreement may:

(a) Request the imposition by the FERC of different, additional, reduced or modified fish protection measures;

(b) Bring any cause of action, raise any defense or claim, or rely on any theory related to this Agreement in any appropriate forum;

(c) Petition any appropriate administrative agency or political body for relief, including the deletion or addition of one or more measures otherwise in effect under this Agreement; or

(d) Take other appropriate action relating to any issue or matter addressed by this Agreement or which could have been addressed by this Agreement or that otherwise relates to the fisheries issues of the Wells Project.

3. In any action under this subsection I.C, the petitioning Party shall have the burden of proof. The Parties will continue to implement this Agreement pending final resolution of any modification sought in the FERC, or until the relief sought becomes effective by operation of law, or unless otherwise agreed.

4. With respect to any petition or suit filed pursuant to this subsection I.C and any subsequent judicial review thereof, nothing in this Agreement shall bar, limit or restrict any Party from raising any relevant issue of fact or law, regardless of whether such issue is or could have been addressed by this Agreement. Notwithstanding any other provision of this Agreement, no claim shall be made for damages arising from the failure to provide or the provision of inadequate downstream fish passage facilities or programs, or upstream adult passage facilities, or

both, that might have arisen during the period March 7, 1979, through March 1, 2004.

5. Notwithstanding any other provision of this subsection I.C, any Party may participate in any legislative or administrative proceeding dealing with fish protection or compensation issues provided, that, consistent with this subsection, no Party shall advocate or support the imposition of fish protection, mitigation, or compensation measures at the Wells Project that are different from or in addition to those required by this Agreement until after March 1, 2004.

6. The Parties intend that this subsection I.C shall apply to each and every provision of this Agreement, and therefore the terms of this subsection are hereby incorporated by reference into and shall apply to every other provision of this Agreement as if set out fully in each such provision.

D. RESOLUTION OF DISPUTES

1. Any dispute between the Parties concerning compliance with this Agreement shall be referred for consideration to the Wells Project Coordinating Committee (the Coordinating Committee) established under Section V. The Coordinating Committee shall convene as soon as practicable following issuance of a written request by any Party. All decisions of the Coordinating Committee must be unanimous. In the event the Coordinating Committee cannot resolve the dispute within fifteen (15) days after its first meeting on a dispute, it will give notice of its failure to resolve the dispute to all Parties. Thereafter, if the dispute qualifies

under subsection I.D.2, any Party may request the FERC to refer the dispute to (1) the presiding judge in the Mid-Columbia proceeding; or (2) in the event the Mid-Columbia proceeding is terminated, to the Chief Administrative Law Judge of the Commission; or (3) to the Division of Project Compliance and Administration within the Office of Hydropower Licensing, or its successor (any one of which is hereinafter referred to as the Decisionmaker), in the order listed herein (unless otherwise agreed by the Parties or directed by FERC), for expedited review in accordance with the procedures set forth in this subsection. Any issue in dispute that is not subject to the expedited review process may be referred to the FERC for resolution pursuant to the FERC's Rules of Practice and Procedure.

2. The expedited review process specified in this subsection shall be utilized, unless otherwise agreed pursuant to subsection I.D.5, to resolve any issue(s) in dispute between the Parties that arises under this Agreement where the amount in controversy is less than $325,000 (1988 dollars). For the purpose of this subsection I.D, the amount in controversy shall be determined by calculating the difference between the calculated annual cost of the Joint Fishery Parties' proposal for resolution of the dispute and the calculated annual cost of the PUD's proposal for resolution of the dispute.

3. Under the expedited review process, each Party that desires to present an initial position statement to the Decisionmaker shall file the statement with the Decisionmaker and all other Parties within twenty (20) days of mailing of notice by a

Party that expedited review is requested. Responsive statements shall be filed and served within forty (40) days of the mailing of the notice. The Decisionmaker shall set a date for submission of any briefing, affidavits or other written evidence and a further date for hearing of oral evidence and argument. Except by agreement of all Parties involved in the dispute, the hearing shall be held not later than seventy (70) days after the date of mailing of the requesting Party's notice or as soon thereafter as the Decisionmaker shall be available. The hearing shall be held in Seattle, Portland or any other location agreed upon by the Parties, or mandated, upon a finding of special circumstances, by the Decisionmaker. The Decisionmaker shall decide all matters presented within fifteen (15) days of the hearing or as soon thereafter as possible.

4. All decisions under the expedited review process shall be effective upon issuance and pending appeal, if any. Nothing in this subsection I.D shall limit or restrict the right of any Party to petition the FERC for de novo review of any decision under the expedited review process. All such appeals shall be in accordance with the FERC's Rules of Practice and Procedure.

5. The Parties may agree to refer any issue subject to expedited review to a third party Decisionmaker other than someone within FERC for processing pursuant to this subsection or as otherwise agreed by the Parties.

E. EFFECTIVE DATES

1. Except as otherwise specified in this subsection I.E, this Agreement shall become effective upon the issuance of a final order by the FERC approving this Agreement.

2. Notwithstanding subsection I.E.1 above, the Parties will immediately upon execution of this Agreement, implement the provisions of the Agreement that do not require formal FERC approval.

3. The Parties agree to immediately seek interim approval by the FERC of Section IV of this Agreement in order to implement construction of hatchery facilities.

II. JUVENILE FISH PASSAGE

A. GENERAL SCOPE OF JUVENILE PASSAGE MEASURES

1. Subject to the schedules, criteria, and conditions in this Agreement, the PUD will fund the installation, operation, maintenance, and evaluation of juvenile fish bypass systems and measures at the Wells Project. Bypass systems and measures are those intended to attract and route juvenile salmonids past operating powerhouse generating units.

2. All facilities under this Agreement shall be designed and constructed using quality materials and then current engineering standards for the purpose of obtaining a high quality product designed to require low maintenance and have a long useful life.

B. BYPASS SYSTEM

The PUD will continue to implement a program of controlled spill using five (5) bypass baffles at the Wells Project to meet the criteria set out in subsections II.C, D, and E.

C. NORMAL BYPASS OPERATIONS CRITERIA

1. No turbine will be operated during the juvenile migration period unless the adjacent bypass system is operating according to the following criteria.

2. The five (5) bypass system bays will be Nos. 2, 4, 6, 8, and 10. Operation of the turbines will be in pairs with the associated bypass system bays, as follows:

Turbines Operated	Bypass Bays Operated
1 and/or 2	2
3 and/or 4	4
5 and/or 6	6
7 and/or 8	8
9 and/or 10	10

(For example, if turbines 1, 5, and 6 are operating, bypass systems 2 and 6 will be operating.)

3. At least one bypass will be operating continuously throughout the juvenile migration period, even if no turbines are operating.

4. The bypass systems and spillgates will be operated in configuration K of the 1987 bypass system report (bottom spill, 1 foot spill gate opening, 2,200 cfs, vertical baffle opening) for all bypass system bays.

5. If top spill is shown to be as effective as bottom spill in bypass bays 2 and 10, then top spill will be allowed in these bays.

6. If the Chief Joseph Dam Uncoordinated Discharge Estimate is 140,000 cubic feet per second (140 Kcfs) or greater for the following day, all five bypass systems will be operated continuously for 24 hours regardless of turbine unit operation.

7. If the Chief Joseph Dam Uncoordinated Discharge Estimate is less than 140 Kcfs, bypass system operation will be as follows:

Number Turbines Operating	Minimum Number Bypass Systems Operating
10	5
9	5
8	4
7	4
6	3
5	3
4	2
3	2
2	1
1	1
0	1

D. BYPASS OPERATIONS TIMING CRITERIA

1. Bypass systems will be in place at least two (2) weeks prior to preseason forecasted beginning of juvenile migration.

2. Bypass systems will remain in place for at least two (2) weeks after the juvenile migration period ends.

3. Monitoring of fish runs will begin when bypass baffles are in place and will end when the baffles are removed.

4. Bypass systems will be available to operate continuously, 24 hours per day, during the juvenile migration period.

E. BYPASS PERFORMANCE CRITERIA

1. At a minimum, bypass system operations will be provided as described in subsections II.B, C, and D for the entire juvenile migration period as defined in the annual operations plan under subsection II.F, and subject to the provisions of subsection II.F.3.

2. Bypass operations as described in subsections II.B, C, and D are intended to provide fish passage efficiency (FPE) of at least eighty percent (80%) for the juvenile spring migration, and FPE of at least seventy percent (70%) for the juvenile summer migration. For purposes of this Agreement, FPE is expressed by the following formula:

Where A = Sum of daily migrants successfully passed by the device during the spring or summer migration

and B = Sum of daily migrants passing through the turbine unit intakes during the same migration

$$FPE = \frac{A}{A + B} \times 100$$

3. If bypass operations under subsections II.B, C, and D do not meet the minimum FPE levels specified in subsection II.E.2, the PUD will modify those operations by implementing one or more of the following measures:

(a) Change in configuration or addition of lights or other physical changes.

(b) Change in "normal operation" under subsection II.C to operation of five bypass system bays at forecast flow of 120 Kcfs.

4. Unless and until these modifications are in place to meet the minimum FPE levels specified in subsection II.E.2, or if these modifications are not sufficient to meet the FPE levels specified therein, then the PUD will increase spillbay bypass flow up to two times normal operation (up to a total of 4.4 Kcfs) per bypass at night (1 hour before sunset to sunrise) for the period:

(a) During which 80% of the spring migration pass the Wells Project;

(b) During which 80% of the summer migration pass the Wells Project, or for 40 days, whichever is less.

5. If portions of the runs do not receive protection at the minimum FPE levels specified under subsection II.E.2, then compensation will be provided based on the difference between the minimum FPE levels specified in subsections II.E.2 and 3 and the actual FPE achieved during the evaluation provided under subsections II.H.1 and 2. The appropriate level of compensation will be calculated based on actual loss. The form of this additional compensation (i.e., fish production) will be determined by the Joint Fishery Parties in consultation with the PUD.

F. <u>ANNUAL OPERATIONS PLANS</u>

1. The PUD will develop an annual bypass systems operations plan consistent with the criteria in subsections II.B, C, D, and E in consultation with the Joint Fishery Parties by the December prior to each migration period. The plan will be reviewed and approved by the Coordinating Committee by March 1 of each year. The plan will be developed from inseason projected hatchery release

dates from facilities above Wells and previous passage monitoring data. The plan will contain predicted dates for the beginning and end of the juvenile migration period; criteria for identifying the beginning and end of the spring and summer runs; and procedures for bypass operations within the constraints of subsections II.B, C, D, and E, including dates for installation and removal of spill baffles, dates for run time monitoring, and criteria for initiation and cessation of bypass operations. If unanimous agreement cannot be reached within the Coordinating Committee regarding all items in the plan, disagreements will be resolved by expedited dispute resolution under subsection I.D.

2. A Bypass Team will be established composed of one representative each for the Party fishery agencies, the Party tribes, and the PUD.

3. Notwithstanding the provisions of subsections II.F.1 and 2 above, the Bypass Team may agree to relax the operations and performance criteria of subsections II.C and E for a period between the end of the juvenile spring migration and the beginning of the juvenile summer migration. Such a modification can only be made with the agreement of all of the members of the Bypass Team, and will be limited to one or more of the following measures:

(a) Less than continuous 24-hour operation of bypass systems.

(b) Fewer than one bypass system operated for two adjacent turbines operated.

(c) Less than 1 foot spill gate slot opening.

4. Once the annual bypass plan is adopted, decisions regarding adjustments to the plan will be made by unanimous agreement of the Bypass Team. If unanimous agreement cannot be reached, the decision on such adjustments will be by majority vote of the Bypass Team.

G. ANNUAL PASSAGE MONITORING PLAN

1. The PUD shall develop an Annual Passage Monitoring Plan, in consultation with the Joint Fishery Parties for review and approval by the Coordinating Committee by March 1 of each year. The Plan will include development of inseason indices of relative fish abundance on a daily basis and annual estimates of juvenile migrant production. Estimates of relative abundance will be used to guide bypass operations decisions under subsections II.E.4, II.F.1, II.F.3, and II.F.4. Estimates of juvenile migrant production will be used as the basis for compensation adjustments (Hatchery-Based Compensation - Phase IV) as provided in subsection IV.A.3.

H. FPE EVALUATION PLAN

1. The PUD shall develop an FPE evaluation plan, in consultation with the Joint Fishery Parties, for review and approval by the Coordinating Committee by March 1, 1990. The purpose of the plan shall be to evaluate whether minimum FPE levels set out in subsection II.E are being met. The plan will provide for evaluation beginning in 1990 and continuing for at least three consecutive years after baffles are installed and operating in accordance with this Agreement in all five (5) bypass bays. If physical or

operational changes are made to the bypass systems, additional FPE evaluation under a new or amended plan will be required to provide at least three consecutive years of evaluation after completion of the changes.

2. It is the goal of evaluations under the plan to be able to determine FPE within plus or minus five percent (5%) at the ninety-five percent (95%) confidence level. If the FPE point estimates are equal to or greater than eighty-five percent (85%) for the spring run and seventy five percent (75%) for the summer run, then the accuracy of plus or minus ten percent (10%) at the ninety percent (90%) confidence level is acceptable. If the FPE point estimate for the spring run is between eighty (80) and eighty-five (85) percent, or the FPE point estimate for the summer run is between seventy (70) and seventy-five (75) percent, the PUD will implement one of the following actions:

(a) Take the necessary steps to achieve a FPE accuracy of plus or minus five percent (5%) at the ninety-five percent (95%) confidence level, or

(b) Take steps outlined in subsection II.E.3 to increase the FPE point estimates to eighty-five percent (85%) and seventy-five percent (75%) for the spring and summer runs, respectively.

3. The PUD will fund a biometrician or statistician selected by unanimous agreement of the Coordinating Committee to review the draft plan to ensure that the plan meets the objectives of subsections II.H.1 and 2, and to review results developed under the plan.

III. ADULT FISH PASSAGE

A. GENERAL SCOPE OF ADULT PASSAGE MEASURES

The current operating and maintenance criteria for facilities for the passage of adult anadromous fish over the Wells Project Dam are specified in this Section III. Changes in these criteria must be by unanimous agreement of the Coordinating Committee.

B. WATER DEPTH CRITERIA

The water depth over the weirs of the adult fish ladder will be 1.0 to 1.2 feet.

C. ENTRANCE CRITERIA

1. Head: 1.5 feet

2. Gate Settings:

a) March 1 - November 30

		Side Wing Gate	End Wing Gate
(i)	Spill less than 80 Kcfs	4 ft	6 ft
(ii)	Spill greater than 80 Kcfs	Closed	8 ft

(iii) Low level fixed orifice entrance to be open whenever side gate is closed.

b) December 1 - February 28

(i) Side and end gates open 2 feet six days per week for 24-hour periods.

(ii) Side and end gates open 4 feet and 6 feet, respectively, one day per week for a 24-hour period.

D. ATTRACTION JET CRITERIA

1. Jets are located in a vertical line immediately upstream of the side wing gates.

2. Lower jet (30-inch diameter) will operate only when the low level fixed orifice entrance is open.

3. Three 24-inch diameter jets (at elevations 700, 708, and 717 msl) will each be discharging when tailwater reaches that level.

E. STAFF GAUGE AND WATER LEVEL INDICATOR CRITERIA

Staff gauge and water level indicators will:

1. Be located upstream and downstream of all entrances, and at convenient locations for viewing along ladder.

2. Be located upstream and downstream of adult fishway exit trashrack.

3. Be readable at all water levels and be kept clean.

4. Be checked against panel board water surface readings to insure proper adjustment of water level sensing equipment.

F. TRASHRACK CRITERIA

1. Visible buildups of debris will be cleaned immediately from picketed leads near counting stations, and from trashracks at adult fishway exits.

2. The staff gauges upstream and downstream of the adult fishway exit trashrack will be monitored for water surface differential, which will reflect buildup on submerged trashrack. The trashrack will be cleaned immediately if the differential reading is greater than 0.3 feet.

G. MONITORING AND EVALUATION OF ADULT PASSAGE

1. In 1990, the PUD, in consultation with the Joint Fishery Parties, will develop a study plan to determine the extent of adult

delay and mortality at the Wells Project. The study plan will be reviewed and approved in advance by the Coordinating Committee. Studies will begin in 1991 and continue for a period of time determined by the Coordinating Committee based on preliminary results.

2. If the study identifies delays and/or mortality, the operating criteria specified in this Section III will be changed to alleviate these problems. If changes in the operating criteria do not alleviate the problems, adult passage facility modifications will be made. Provided, however, that any disagreements over the appropriateness of facility modifications of $325,000 or less (1988 dollars) may be taken through the expedited dispute resolution procedure in subsection I.D. And, provided further, that any disagreements over the appropriateness of facility modifications of more than $325,000 (1988 dollars) may be resolved under the FERC Rules of Practice and Procedure at any time.

IV. HATCHERY-BASED COMPENSATION

The PUD will fund a hatchery-based compensation program (the "Program") as provided in this Section IV. The Program will include the design, construction, operation, maintenance and evaluation of facilities required to implement the elements of a production plan (the "Production Plan") as set forth in this Section. The purpose of the Program is to mitigate for fish passage losses at Wells Dam. The Program is composed of adult collection sites; a central hatchery facility for incubation, early

rearing, and adult holding; and acclimation facilities in the tributaries above Wells Dam for final rearing and release.

A. PRODUCTION PLAN

1. The Joint Fishery Parties have developed the Production Plan to define the requirements of hatchery-based compensation under this Agreement. The Production Plan describes juvenile rearing and release requirements, including species mix and target release sizes; and related broodstock requirements under subsection IV.D.

2. The Production Plan will be reviewed annually by the Joint Fishery Parties, and may be modified by the Joint Fishery Parties in consultation with the PUD. Modifications to the Production Plan may include changes to the species mix and rearing and release strategies as required to accommodate the Joint Fishery Parties' management needs. Modifications to the Production Plan will not require an increase in the rearing capability of the Program beyond that required to satisfy Phases One and Two of the Production Plan as shown in subsections IV.A.3(a) and (b) or Phases Three and Four of the Production Plan to be determined as shown in sections IV.A.3(c) and (d). The Production Plan and any modifications thereto will be consistent with guidelines and procedures developed under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program.

3. The Production Plan is comprised of four phases of hatchery-based compensation as described below. It also includes related broodstock requirements under subsection IV.D.

(a) Phase One

Phase One will begin in 1991 and will consist of the following compensation elements:

(1) 49,200 pounds of spring chinook yearlings at about 15/pound;

(2) 8,000 pounds of sockeye juveniles at about 25/pound; and

(3) 30,000 pounds of steelhead smolts at about 6/pound

(4) After 1991, space to rear additional steelhead will be provided by the PUD at Wells Hatchery, if such space is available and not needed to meet other PUD fish production responsibilities. The PUD will not be obligated to fund or supply well water to rear the fish.

(b) Phase Two

Phase Two will begin after evaluation of the Phase One Production Plan and will be restricted to the Program required by either the Phase Two A or Two B Production Plan as shown below. At the time of implementation, the Phase Two A or Phase Two B Production Plan may be modified based on other Phase One evaluations described in subsection IV.C, Studies and Evaluations, subject to the provisions of subsection IV.A.2.

(1) Phase Two A

Increase sockeye production from 8,000 pounds to 15,000 pounds of juveniles at about 25/pound.

(2) Phase Two B

(i) Eliminate sockeye production;

(ii) Add 15,000 pounds of summer chinook yearlings at

about 10/pound; and 6,500 pounds of zero-age summer chinook juveniles at about 40/pound.

(c) Phase Three

Phase Three will begin as soon as practicable following Coordinating Committee approval of the results of the Wells Project juvenile mortality/survival study or no later than the third brood year after Coordinating Committee determination of the adjustments required and will consist of the following compensation elements:

(1) Except for steelhead, which shall remain at 30,000 pounds, adjust compensation requirement to reflect the difference between the juvenile mortality rate determined by the mortality/survival study under subsection IV.C.5 and the assumed mortality rate shown in Appendix A; and

(2) Adjust compensation requirement to reflect unavoidable and unmitigated adult losses, as determined by Coordinating Committee approved estimates from studies conducted under subsection III.G, and converted to juvenile production based on adult to smolt ratio estimates as described in Appendix B.

(d) Phase Four

Phase Four will begin at such time as the Coordinating Committee approved five-year rolling average estimate of juvenile run size, estimated as described in subsection IV.C.6 and Appendix A, increases to at least 110% of the 9,034,700 estimated juvenile migrant salmon production used to establish the Phase One and Phase Two compensation levels shown in subsections IV.A.3(a) and

IV.A.3(b). Phase Four will consist of compensation adjustment, if requested by the Joint Fishery Parties, to reflect the percentage increase in juvenile run size, except for steelhead, which shall remain at 30,000 pounds. The Joint Fishery Parties, in consultation with the PUD, will determine the appropriate form of compensation (i.e., fish production) for any adjustments required in Phase Four.

B. COMPENSATION PROGRAM

1. The facilities provided in the Program will be designed, constructed, operated, maintained, and evaluated to produce the hatchery-based compensation set forth in the Production Plan.

2. If the evaluations described in subsection IV.C indicate that the Program is not meeting the production levels called for in the Production Plan, then reasonable modifications to the Program will be made.

3. The PUD will only be obligated to assure the capability of facilities provided under this Agreement to produce high quality juvenile fish at the compensation levels shown in subsection IV.A.3.

4. The Program facilities described in this Agreement are in addition to the existing mitigation program at Wells. The existing mitigation program at Wells consists of annual production of 50,000 pounds of steelhead and 56,500 pounds of summer chinook salmon. Under the 1984 Mid-Columbia Stipulation, which expired in 1989, 400,000 summer chinook at 90/pound have been reared at Wells for release into the Methow River. This production will continue until

Phase One production is initiated. Nothing in this Agreement will affect the annual production of 25,000 pounds of steelhead under the Oroville-Tonasket agreement between the PUD and the U.S. Bureau of Reclamation.

5. Facilities provided in the Program will consist of:

(a) Phase One

Phase One compensation facilities, including satellite facilities, shall be capable of rearing and releasing 57,200 pounds of salmon and 30,000 pounds of steelhead annually.

(b) Phase Two

Phase Two compensation facilities shall be capable of increased production to accommodate the Production Plan as described in subsection IV.A.3(b).

(c) Phase Three

Phase Three compensation facilities shall be capable of production levels to reflect the compensation adjustments which may be required as described in subsection IV.A.3(c).

(d) Phase Four

Phase Four compensation facilities shall be capable of production levels to reflect the compensation adjustments which may be required as described in subsection IV.A.3(d). Facilities for the required adjustments will be constructed by the PUD as soon as practicable and be operational no later than the third brood year following the Joint Fishery Parties request under subsection IV.A.3(d).

6. Production and acclimation facilities used in the Program shall be consistent with planning efforts underway by the Northwest Power Planning Council to the fullest extent practicable. The biological criteria and guidelines described in subsection IV.D shall apply to production and acclimation facilities used in the Program.

C. STUDIES AND EVALUATIONS

1. The PUD will develop and fund studies in 1990, approved by unanimous agreement of the Coordinating Committee, to determine:

(a) Potential for spawning and rearing sockeye in unutilized habitat in the Okanogan and Similkameen systems;

(b) Potential for establishing sockeye populations in the new habitat.

2. The PUD will fund the Joint Fishery Parties' effort to determine the success of Phase One sockeye compensation based on review of smolt production. The Joint Fishery Parties may make this determination after the evaluation of the third brood year's production.

3. The PUD will fund the Joint Fishery Parties to develop and conduct studies to evaluate the adequacy of the Program and the effectiveness and success of the Production Plan subject to the provisions of Section V, Coordinating Committee. The studies will meet standards developed for similar efforts under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. The studies will pass the test of reasonableness with respect to cost and duration.

(a) The studies will involve marking a portion of the juvenile fish produced under subsection IV.B and will involve recoveries of juvenile and adult fish to estimate various parameters such as fish health, fishery contribution, survival, spawning time and spawning locations.

(b) The PUD will fund recovery efforts at Wells Dam and hatchery and tributary spawning areas above Wells Dam. Existing recovery operations, currently funded through different sources, will be utilized to the extent possible. Approved studies may require the PUD's participation in funding a portion of other recovery efforts.

(c) The evaluations provide data necessary to determine the success of the Program to produce the intended compensation levels and the effectiveness of the Production Plan to meet management objectives.

(d) Evaluation of the Production Plan and Program effectiveness will be initiated in Phase One for all species in the Production Plan.

(e) To the extent that the Joint Fishery Parties elect to modify the Production Plan, the PUD will fund studies to evaluate the modifications. The studies will be mutually agreeable and are intended to evaluate only the changes called for in the modification. The studies will be consistent with the provisions of Section V, Coordinating Committee.

(f) The PUD will fund an analysis of annual fish production and adult contribution to harvest and escapement to be conducted

by the Joint Fishery Parties. The analysis will be consistent with the provisions of Section V, Coordinating Committee. Draft and final reports will be provided to the Parties.

5. No later than 1990, a Wells Project juvenile mortality/survival study will be developed by the PUD in consultation with the Joint Fishery Parties and approved by unanimous agreement of the Coordinating Committee. The studies will begin in 1991, after the installation of new turbine runners at the Wells Project, for the purpose of determining juvenile losses.

6. The PUD will provide data from its ongoing, annual adult passage monitoring program that will allow the Joint Fishery Parties to compute the five-year rolling average estimate of juvenile run size which will be the basis for Phase Four compensation, as indicated in subsection IV.A.3(d). Calculation of increases in juvenile run size will be based on fish from existing mitigation programs, natural production and future compensation programs. The method of calculation will be as described in Appendices A and B.

D. PRODUCTION/ACCLIMATION FACILITIES

Production and acclimation facilities under this Section shall be consistent with planning efforts underway by the Northwest Power Planning Council to the fullest extent practicable. The following biological criteria and guidelines shall apply to production and acclimation facilities under this subsection IV.D. Criteria are not to be exceeded. Guidelines are not to be exceeded if practicable.

1. Salmon Criteria

(a) Adult Holding

(i) Density not to exceed one (1) fish per ten (10) cubic feet of space.

(ii) Flow must be at least one (1) gallon per minute per 20 pounds of fish.

(b) Juvenile Rearing

(i) Density not to exceed 0.75 pounds of fish per cubic foot of rearing space for yearling chinook to a size of 10 fish per pound. Maximum density is achieved at release date. The density through out the rearing period is proportionately lower and directly related to fish size.

(ii) Pond or raceway loading rate not to exceed 6.0 pounds of fish per gallon of water per minute inflow for yearling chinook at a size of 10 fish per pound. Maximum loading rate is achieved at release date. The loading rate throughout the rearing period is proportionately lower and directly related to fish size.

(iii) Density for sockeye juveniles in net pens not to exceed 0.33 pounds of fish per cubic foot of rearing space.

(c) Water Supply

(i) Water will be of highest quality practicably available at appropriate sites. Ground water may be required at sites. All water supplies will be pathogen free if practicable. The water source must not preclude transfer of the stocks being reared to their point of origin due to presence of fish disease organisms in the rearing water supply.

(ii) Reuse of water is not acceptable for either egg incubation or juvenile rearing.

(iii) Reuse water is acceptable for adult holding.

(iv) Effluent water from egg incubation may require treatment for fish diseases (e.g., chlorination/dechlorination).

(v) Construction of facilities must accommodate the potential to treat the juvenile rearing and adult holding water for disease pathogens.

(d) General

(i) Facilities must have the capability to maintain stock segregation from adult holding through incubation and rearing.

(ii) Facilities must have reasonable capability to provide for isolation and treatment of diseased fish.

(iii) Protection from mammalian and avian predators must be provided.

2. Salmon Guidelines

(a) Water Temperatures

(i) Egg incubation - no greater than 55°F nor less than 38°F.

(ii) Fry starting - 48-52°F.

(iii) Juvenile rearing - not to exceed 52°F.

(iv) Adult holding - not to exceed 55°F.

(b) Release Size, Time, and Location

(i) Yearling spring chinook - 15 fish/pound in late April.

(ii) Yearling summer chinook - 10 fish/pound in late April.

(iii) Subyearling summer chinook - 40 fish/pound in June.

(iv) Subyearling sockeye - 25 fish/pound in June.

(v) Juvenile fish will be acclimated and released in tributaries above Wells Dam.

(c) Adult Brood Stock

(i) Sufficient adults of the appropriate species and stocks will be trapped and held to meet the egg requirements for each phase of salmon production.

(ii) Fifty percent (50%) of the adults trapped will be females and it is assumed there will be

approximately eighty percent (80%) survival of eggs from trapping of females to ponding of fry.

(iii) Adult brood stock will be collected at the following sites:

a) Spring chinook - Chewack River, Methow River above Winthrop, and Twisp River above river mile 2.0.

b) Summer chinook and sockeye - at Wells Dam

(iv) Tributary brood stock collection facilities will require an annually installed rack and a semi-permanent box trap.

(v) Wells Dam brood stock collection may require a separator/sorter in the left bank fishway. The final design of the left bank trap and any modification of the right bank trap will be approved by unanimous agreement of the Coordinating Committee.

(vi) The adults will be transferred in a water-to-water system from traps to tank trucks to holding ponds.

(vii) The PUD shall provide funds for personnel to separate and sort adult fish in the right bank fishway at Wells Dam and at other required adult collection sites. All brood stock collection shall be conducted in a manner to

minimize delay of non-target species and individual fish.

3. Steelhead Criteria

The goal for this program is to use the existing facilities including well and river water, raceways, rearing ponds, house, shop, freezer, office, etc., in the manner they are being used now. Most of the following criteria and guidelines fit the existing program.

(a) Adult Holding

(i) Density not to exceed 2.5 pounds of fish per cubic foot of water.

(ii) Flow must be at least one gallon per minute for 3.3 pounds of fish.

(b) Juvenile Rearing

(i) Density: Calculated density limit not to exceed Pipers density formula: $W = D \times V \times L$ where

W = Permissible weight in pounds.

D = Density index (.25 for raceways and .03 for rearing ponds).

V = Useable volume in container in cubic feet.

L = Fish length in inches.

ii) Water flow: Calculated flow should not allow weight to exceed Pipers flow formula:

$W = F \times L \times I$ where

W = Permissible weight in pounds.

F = The loading factor from Table 1.

L = Fish length in inches.

I = Water flow in gallons per minute.

Table 1. Load factor as related to water temperature and elevation.

Water Temperature(°F)	Load Factor(lbs/in/gpm) Raceways(1)	Rearing Ponds(2)
40	2.70	3.62
41	2.61	3.53
42	2.52	3.44
43	2.43	3.35
44	2.34	3.26
45	2.25	3.17
46	2.16	3.08
47	2.07	2.99
48	1.98	2.90
49	1.89	2.81
50	1.80	2.72
51	1.73	2.65
52	1.67	2.59
53	1.61	2.53
54	1.55	2.47
55	1.50	2.42
56	1.45	2.37
57	1.41	2.33
58	1.36	2.28
59	1.32	2.24
60	1.29	2.21
61	1.25	2.17
62	1.22	2.14
63	1.18	2.10
64	1.15	2.07

1) From Piper et al. 1978
2) From Wells hatchery

(c) Water Supply

(i) Water supply to be of highest quality practicably available using ground and river water. Any disease contracted because of water source

must not stop release of fish in local watersheds.

(ii) Reuse water not acceptable for egg incubation.

(iii) Reuse water normally acceptable (unless disease problem) for adult holding.

(iv) Effluent water from egg incubation will require treatment for fish diseases.

(v) Adult holding and juvenile rearing water may have to be treated for disease pathogens.

(d) General

(i) Facilities must have reasonable capability to provide for isolation and treatment of diseased fish.

(ii) Protection from mammalian and avian predators must be provided.

4. Steelhead Guidelines

(a) Water Temperatures

(i) Egg incubation: 38°F to 55°F

(ii) Fry starting: 48°F to 54°F

(iii) Juvenile Rearing not to exceed 57°F

(iv) Pre-smolt not to exceed 54°F

(v) Adult holding not to exceed 54°F

(b) Release age, time, size and location

(i) Released as yearlings

(ii) April 10 to May 10 at six to the pound.

(iii) Juvenile steelhead will be released in tributaries or into the mainstem above Wells Dam.

(c) Adult Broodstock

(i) Fifty percent (50%) will be females and assume eighty percent survival of eggs to ponding of fry.

(ii) Adults will normally be trapped at the existing facilities on the right bank, however new trap at left bank may be used sometimes.

(iii) Adults will be transferred in water from traps to holding ponds.

V. WELLS PROJECT COORDINATING COMMITTEE

A. COORDINATING COMMITTEE

There shall be a Wells Project Coordinating Committee composed of one (1) technical representative of each Party to this Agreement. The Coordinating Committee shall meet whenever requested by any two (2) Parties following a minimum of ten (10) days written notice (unless waived), or pursuant to subsection I.D, and shall act only by unanimous agreement of all Parties. Any Joint Fishery Party may, at any time, elect by written notice not to participate in the Coordinating Committee. The PUD shall fund a neutral third party to record and distribute minutes of Coordinating Committee meetings.

B. USE OF COMMITTEE

The Coordinating Committee will be used as the primary means of consultation and coordination between the PUD and the Joint Fishery Parties in connection with the conduct of studies and implementation of the measures set forth in this Agreement and for dispute resolution pursuant to subsection I.D. All study designs and modifications to study designs will be subject to agreement by all Parties.

C. STUDIES AND REPORTS

1. All studies and reports prepared under this Agreement will be available to all Parties as soon as reasonably possible. Draft reports will be circulated through Coordinating Committee representatives for comment, and comments will either be addressed in order or made an appendix to the final report.

2. All studies will be conducted following accepted techniques and methodologies in use for similar studies in the Columbia Basin. All studies will be based on sound statistical design and analysis.

3. Fish passage efficiency tests will be conducted using hydroacoustic means and direct capture methods for species identification.

VI. JOINT FISHERY PARTIES' RESPONSIBILITIES

A. LIMITATION OF MID-COLUMBIA PROCEEDING

The Joint Fishery Parties agree to join with the PUD to request that the FERC terminate the Mid-Columbia proceeding insofar

as it pertains to the Wells Project. The Parties specifically agree to reserve the right to enforce the terms and conditions of this Agreement before the FERC.

B. SUPPORT FOR RELICENSE

The PUD's FERC license for the Wells Hydroelectric Project expires in 2012. The Joint Fishery Parties agree to be supportive of the PUD's new or renewal license application to the FERC, provided that the PUD has adhered to the terms and conditions of this Settlement Agreement, as well as any future terms, conditions, and obligations agreed upon by the Parties hereto or imposed upon the PUD by the FERC. To the extent that the PUD has met such terms and conditions, the Joint Fishery Parties agree that the PUD is a competent license holder with respect to its obligations to anadromous fish resources. Nothing in this paragraph shall limit or preclude any Party hereto from requesting at the time of any license renewal the provision of or supporting different, modified or additional fish protection measures and compensation; or from requiring that the fishery protection measures contained in a competing license application be included as a condition of the PUD's new license, or in the absence of such additional or modified measures in a new license, or in the absence of measures contained in a competing license application requested by the Joint Fishery Parties, from requesting that the PUD's new or renewal license application be denied.

C. STIPULATION OF ADEQUACY

The Joint Fishery Parties stipulate that the performance of the PUD's responsibilities under this Agreement constitutes adequate fish protection and full compensation for all fishery losses caused by the Wells Project at least until March 1, 2004. It is further stipulated that this Agreement satisfies any obligations of any Party relating to the adequacy of fish protection and compensation for fish losses caused by the Wells Project, and arising under applicable laws and regulations, including but not limited to the Federal Power Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Electric Consumers Protection Act of 1986, at least until March 1, 2004. This Agreement shall not otherwise affect the rights of any Party except as expressly covered by this Agreement.

D. FISH AND WILDLIFE PROGRAM

The Joint Fishery Parties stipulate that the performance of the PUD's responsibilities under this Agreement shall constitute full compliance with the applicable provisions of the Northwest Power Planning Council's 1987 Fish and Wildlife Program, at least until March 1, 2004. The Joint Fishery Parties stipulate that the PUD shall receive full credit for its hatchery production in meeting any requirements that may be established as a result of implementation of Section 203 of the Council's Program.

E. LIMITATION ON REOPENING

The Joint Fishery Parties shall not invoke or rely upon any reopener clause set forth in any license applicable to the Wells

Project for the purpose of obtaining additional fish measures or changes in project structures or operations pertaining to fishery issues until after March 1, 2004.

F. ADDITIONAL MEASURES

The Joint Fishery Parties shall refrain from contending on their own behalf or supporting any contention by other persons in any proceeding or forum that additional fish measures or changes in project structures or operations pertaining to fishery issues should be imposed at the Wells Project until after March 1, 2004.

VII. MISCELLANEOUS

A. COOPERATION

The Parties shall cooperate in conducting studies and shall provide assistance in obtaining any approvals or permits which may be required for implementation of this Agreement.

B. NOTICES

All written notices to be given pursuant to this Agreement shall be mailed by first-class mail, postage prepaid, to each Party at the address listed below or such subsequent address as a Party shall identify by written notice to all other Parties. Notices shall be deemed to be given three (3) days after the date of mailing.

C. WAIVER OF DEFAULT

Any waiver at any time by any Party hereto of any right with respect to any other Party with respect to any matter arising in

connection with this Agreement shall not be considered a waiver with respect to any subsequent default or matter.

D. ENTIRE AGREEMENT -- MODIFICATIONS

All previous communications between the Parties hereto, either verbal or written, with reference to the subject matter of this Agreement are hereby abrogated, and this Agreement duly accepted and approved, constitutes the entire agreement between the Parties hereto, and no modifications of this Agreement shall be binding upon any Party unless executed or approved in accordance with the procedures set forth in subsection I.C.

E. BENEFIT AND ASSIGNMENT

This Agreement shall be binding upon and inure to the benefit of the Parties hereto and their successors and assigns provided, no interest, right or obligation under this Agreement shall be transferred or assigned by any Party hereto to any other Party or to any third party without the written consent of all other Parties, except by a Party:

(a) To any person or entity into which or with which the Party making the assignment or transfer is merged or consolidated or to which such Party transfers substantially all of its assets; or

(b) To any person or entity that wholly owns, is wholly owned by or is wholly owned in common with the Party making the assignment or transfer.

F. FORCE MAJEURE

The PUD shall not be liable for failure to perform or for delay in performance due to any cause beyond its reasonable control. This may include, but is not limited to, fire, flood, strike or other labor disruption, act of God, act of any governmental authority or of the Joint Fishery Parties, embargo, fuel or energy unavailability, wrecks or unavoidable delays in transportation, and inability to obtain necessary labor, materials or manufacturing facilities from generally recognized sources in the applicable industry. The PUD will make all reasonable efforts to resume performance promptly once the force majeure is eliminated.

G. INFLATION CALCULATIONS

All dollars specified in this Agreement are 1988 dollars. Dollar figures shall be adjusted annually for each year after 1988 based on the "Consumer Price Index for All Urban Consumers" published by the Bureau of Labor Statistics of the U.S. Department of Labor. If this index is discontinued or becomes unavailable, a comparable index agreeable to all Parties will be substituted.

H. METHOW RIVER HATCHERY WATER SUPPLY

1. The PUD agrees to cooperate with the Washington Department of Fisheries (WDF) to secure the necessary water rights and permits for facilities to be provided under this Agreement.

2. With respect to the proposed Methow River hatchery, the Parties agree that WDF and the PUD may utilize for the proposed Methow River hatchery facility up to 7 cfs of the water right now

held by the U.S. Fish and Wildlife Service (FWS), and subject to full or partial recall by FWS for any reason. The PUD shall not obtain legal title or ownership of the FWS water right.

3. To the extent that the utilization of water does not occur or is recalled or returned to FWS, the PUD and WDF shall use their best efforts to acquire an alternative source of water that meets applicable State requirements for water rights in order to satisfy obligations under this Agreement.

4. The PUD agrees to cooperate with WDF to secure the necessary permits in order to construct and provide for the operation of the proposed Methow River hatchery. The hatchery will be designed and constructed with the capability of installing pump-back facilities for returning the flow to the point of diversion.

5. If hatchery and/or river water supply requirements dictate the need for installation of a pump-back scheme, the PUD shall install and WDF shall operate the pump-back facilities.

VIII. REGULATORY APPROVAL

A. FERC ORDERS

All Parties agree to join in the filing of an offer of settlement with the FERC based on this Agreement and to request that the FERC issue appropriate orders approving the settlement. All Parties shall refrain from seeking judicial review of the FERC orders approving this Agreement.

B. PERFORMANCE CONTINGENT ON APPROVAL

Performance of all Parties' obligations under this Agreement

is expressly made contingent on obtaining all necessary regulatory approvals, specifically including all FERC orders referred to in subsection VIII.A above, and all applicable federal, state and local permits. It is expressly agreed by all Parties that this Agreement shall be submitted to the FERC as a unit and any material modification of its terms, approval of less than the entire Agreement, or addition of material terms by the FERC shall make this Agreement voidable at the option of any Party.

C. NO PREJUDICE

All Parties stipulate that neither FERC approval nor any Party's execution of this Agreement shall constitute approval or admission of, or precedent regarding, any principle, fact or issue in the Mid-Columbia proceedings, or any other FERC proceeding, including subsequent modification proceedings under Section I.

D. EXECUTION

This Agreement may be executed in counterparts. A copy with all original executed signature pages affixed shall constitute the original Agreement. The date of execution shall be the date of the final Party's signature. Approval of this Agreement must be acknowledged by the Commissioner of Indian Affairs and the Secretary of the Interior, or their delegates, to the extent required by 25 U.S.C. § 81.

E. AUTHORITY

Each Party to this Agreement hereby represents and acknowledges that it has full legal authority to execute this Agreement and shall be fully bound by the terms hereof.

F. ACTION FOR NONCOMPLIANCE

Notwithstanding any other provision of this Agreement, any Party may seek relief arising solely from noncompliance with this Agreement by any Party; provided, all requests for specific performance of any provision of this Agreement shall be filed with the FERC pursuant to subsection I.D.

IN WITNESS WHEREOF, the Parties have executed this Agreement the day and year first written above.

APPENDIX A

JUVENILE MIGRANT LOSS ESTIMATES USED FOR COMPENSATION PLANS IN THE WELLS DAM SETTLEMENT AGREEMENT

1. Steelhead

The number of juvenile steelhead migrants killed by passage through the Wells Project reservoir and dam were not estimated for the purposes of this Settlement Agreement. As an alternative the parties have agreed to continue steelhead production programs and plans initiated under previous Mid-Columbia settlements.

2. Salmon Loss Estimates

The number of juvenile salmon migrants killed by passage through the Wells Project reservoir and dam were estimated as follows:

a. The number of juvenile migrant salmon, by species and race, entering the Wells Reservoir was estimated for natural production by applying sex ratios, egg per female data and theoretical egg to migrant survival rates to the numbers of adults passing above Wells Dam to spawn. These juvenile migrant numbers were computed annually and averaged over the passage years 1975-1984 for spring and summer chinook and averaged over the passage years 1975-1986 for sockeye. The recent average level of hatchery releases at Winthrop National Fish Hatchery were added to the spring chinook migrant estimates. The resulting estimates of average annual numbers

of juvenile migrant salmon entering Wells reservoir are:

Spring Chinook	=	1,504,400
Summer Chinook	=	2,913,300
Sockeye	=	4,617,000
Total	=	9,034,700

b. The total project mortality at Wells, including reservoir mortality, was estimated to be 14%. Applying this mortality rate to the population estimates in Item 1 above results in the following estimates of juvenile migrants killed by species:

Spring Chinook	=	210,600
Summer Chinook	=	407,900
Sockeye	=	646,400
Total loss	=	1,264,900

3. Derivation of Production Plan

a. The Phase I compensation Production Plan and Program is an initial step in production which is not intended to provide full compensation for juvenile migrant losses. The lack of full compensation is due to the experimental nature and developmental aspects of the sockeye Production Plan and Program.

b. To accommodate logistic and per-unit cost factors in Phase I development, about 225,000 (15,000 pounds) spring chinook were substituted for 231,000 sockeye.

c. Items (1) through (3) below describe the derivation of the hatchery-based compensation levels included in the body of the Agreement.

(1) Steelhead production is set at 30,000 lbs./year to continue the successful program initiated under prior Mid-Columbia Settlement Agreements.

(2) Phase I compensation includes a pilot program for hatchery production of sockeye. The sockeye production level is set to allow assessment of Program success rather than provide full compensation for the estimated juvenile losses at Wells.

(3) The Phase II Chinook/Sockeye Production Plan is sized to mitigate for estimated juvenile losses:

	Estimated Annual Losses at Wells	Annual Production Phase IIA or Phase IIB	
Spring Chinook	210,600	450,000	450,000
Summer Chinook	407,900	400,000	810,000
Sockeye	646,400	375,000	-
TOTALS	1,264,900	1,225,000	1,260,000

4. Chelan PUD/Douglas PUD Compensation Exchange

In recognition of the specific requirements for spring and summer chinook rearing facilities and the characteristics of the water supply at the PUD's proposed spring chinook rearing facility on the Methow River, the Joint Fisheries Parties, Douglas PUD and Chelan County PUD have reviewed the respective compensation

obligations of Douglas PUD as set forth in this Agreement, and Chelan County PUD under terms of the Rock Island Settlement. In consideration of biological efficiency and logistical effectiveness, the parties have agreed to adjusted compensation obligations under this agreement and the Rock Island Settlement in the following manner:

a. Douglas PUD will assume responsibility for 19,200 pounds of Methow River sub-basin spring chinook production.

b. Chelan PUD will assume responsibility for 40,000 pounds of Methow River summer chinook production.

The resulting changes in production with the Douglas-Chelan compensation exchange agreement are (number of juveniles/year):

	Douglas Production	Chelan Production
Spring Chinook	Increases 288,000	Decreases 288,000
Summer Chinook	Decreases 400,000	Increases 400,000
Sockeye	No Effect	No Effect

c. The resultant Douglas PUD annual compensation program under this agreement (Phase II Production) is:

Phase IIA

30,000 lbs. of Steelhead @ 6/lb.

49,200 lbs. of Spring Chinook @ 15/lb.

15,000 lbs. of Sockeye @ 25/lb.

OR

Phase IIB

30,000 lbs. of Steelhead @ 6/lb.

49,200 lbs. of Spring Chinook @ 15/lb.

15,000 lbs. of Summer Chinook @ 10/lb.

6,500 lbs. of Summer Chinook at 40/lb.

APPENDIX B

DETERMINATION OF RESPONSIBILITY FOR HATCHERY COMPENSATION

For each year of determination, calculate an average smolt output as follows:

1. Calculate a 5-year running average adult run (by species) for naturally spawned fish (Ays) as follows:

$$\bar{A}ys = \frac{Ay + Ay\text{-}1 + Ay\text{-}2 + Ay\text{-}3 + Ay\text{-}4}{5}$$

Where Ay is the total adult count for each species at Wells minus the hatchery escapement for the species in year y;

Ay-1 = the same in the previous year (y-1) and so on.

2. Multiply Ays by the average expected adult to smolt production factor Kys for each species, where Kys is calculated as follows:

a. Spring Chinook:

Ksp = 0.94 (Wells Dam to spawner survival)
x 0.50 (sex ratio) x 5000 (eggs/female)
x 0.10 (av. survival to smolt) = 235

b. Summer Chinook:

Ksu = 0.94 x 0.50 x 5000 x 0.30 = 705

c. Sockeye:

$$Kso = 0.94 \times 0.50 \times 2700 \times 0.12 = 152$$

3. Add the number of hatchery smolts HSys by species, which is a running average of the same 5 years as in Ays.

$$\overline{HSys} = \frac{HSy + HSy\text{-}1 + HSy\text{-}2 + HSy\text{-}3 + HSy\text{-}4}{5}$$

4. Total smolts (by species):

$$\overline{S}ys = Kys \times \overline{A}ys + \overline{HS}ys$$

5. Grand Total = Sum of all species:

$$Sgt = \overline{S}sp + \overline{S}su + \overline{S}so + \ldots$$

6. If other salmon species or races, for which the above smolt production factors (Kys) do not apply, become established in the production areas above Wells Dam, appropriate K factors for these fish will be established by consensus of the Coordinating Committee. Juvenile migrant production will be computed for these species or races. These numbers will be included in the grand total for juvenile migrant production and the 5-year running averages.

WELLS PHASE IV THEORETICAL CALCULATION EXAMPLE

NATURAL PRODUCTION

DATA USED IN EXAMPLE CALCULATION OF NATURAL PRODUCTION

Adult Count	Ay	Ay-1	Ay-2	Ay-3	Ay-4	5 Year Average
Spring Chinook	3,000	2,200	3,100	5,000	2,900	3,240
Summer Chinook	2,400	2,800	3,700	4,000	4,700	3,520
Sockeye	40,000	20,000	35,000	15,000	30,000	28,000

Ay = Wells Count Minus Hatchery Escapement for Year Y

Ksp = Calculated Spring Chinook Smolts

Ksu = Calculated Summer Chinook Smolts

Ksoe = Calculated Sockeye Smolts

Spring Chinook $\bar{A}y$

$$= \frac{Ay + Ay\text{-}1 + Ay\text{-}2 + Ay\text{-}3 + Ay\text{-}4}{5}$$

$$= \frac{3000 + 2200 + 3100 + 5000 + 2900}{5}$$

$$= 3240$$

Summer Chinook $\bar{A}y$

$$= \frac{Ay + Ay\text{-}1 + Ay\text{-}2 + Ay\text{-}3 + Ay\text{-}4}{5}$$

$$= \frac{2400 + 2800 + 3700 + 4000 + 4700}{5}$$

$$= 3520$$

Sockeye $\bar{A}y$

$$= \frac{Ay + Ay\text{-}1 + Ay\text{-}2 + Ay\text{-}3 + Ay\text{-}5}{5}$$

$$= \frac{40{,}000 + 20{,}000 + 35{,}000 + 15{,}000 + 30{,}000}{5}$$

$$= 28{,}000$$

Ksp, su, soc = Adult/redd factor x sex ratio x eggs/female x eggs to smolt survival x dam count minus hatchery return

Calculated Average Total Smolts (Natural)

Spring Chinook Ksp = .94 x .50 x 5000 x .10 x 3240
= 235 x 3240
= 761,400

Summer Chinook Ksu = .94 x .50 x 5000 x .30 x Ay
= 705 x 3520
= 2,481,600

Sockeye Ksoc = .94 x .50 x 2700 x .12 x Ay
= 152 x 28,000
= 4,263,800

Average Total Natural Smolts

= Ksp + Ksu + Ksoc
= 761,400 + 2,481,600 + 4,263,800
= 7,506,800

HATCHERY PRODUCTION

DATA USED IN EXAMPLE DETERMINATION OF HATCHERY PRODUCTION

SMOLT PRODUCTION IN MILLIONS BY YEAR

Hatchery	Y	Y-1	Y-2	Y-3	Y-4	5 Year Average
Winthrop	1.5	1.1	1.0	.95	.95	1.1
Methow	.8	.8	.675	.40	.25	.585
Twisp Acclimation	.40	.40	.40	.25	.2	.33
Sockeye Net Pens	.2	.2	.2	.15	.1	.17

Hatchery Smolt Production

Winthrop Hatchery = $\frac{1{,}500{,}000 + 1{,}100{,}000 + 1{,}000{,}000 + 950{,}000 + 950{,}000}{5}$

= 1,100,000

Methow Hatchery = $\frac{800{,}000 + 800{,}000 + 675{,}000 + 400{,}000 + 250{,}000}{5}$

= 585,000

Twisp
Accl. Pond= $\frac{400,000 + 400,000 + 400,000 + 250,000 + 200,000}{5}$

= 330,000

Sockeye
Net Pens* = $\frac{200,000 + 200,000 + 200,000 + 150,000 + 100,000}{5}$

= 170,000

*Need Adjustment Factor For Survival To Migration

Average Total Hatchery Smolts

Winthrop	=	1,100,000
Methow	=	585,000
Twisp	=	330,000
Net Pens	=	170,000
		2,185,000

Average Total Hatchery/Natural Smolts
(5 Year Average for Years Y-4, Y-3, Y-2, Y-1 and Y)

Natural	=	7,779,000
Hatchery	=	2,185,000
Total	=	9,964,000

PHASE IV DETERMINATION

Base Number Smolts Used for Initial Compensation = 9,034,700

Calculated Average Natural + Hatchery Smolts in Years Y-4, Y-3, Y-2, Y-1 and Y = 9,964,000

Calculated Average Natural + Hatchery Smolts Minus Base Number Smolts = 929,300

Difference Between Base Number Smolts and Calculated Natural + Hatchery Smolts X Wells Project Mortality Rate = 929,300 X .14

= Additional Smolts Possible Under Phase IV 130,102

FOR PUBLIC UTILITY DISTRICT NO. 1
OF DOUGLAS COUNTY, WASHINGTON:

Howard Frey
Commissioner

Michael Gerwin
Commissioner

T. James Davis
Commissioner

FOR PUGET SOUND POWER & LIGHT COMPANY:

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FOR PACIFIC POWER & LIGHT COMPANY:

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FOR THE WASHINGTON WATER POWER COMPANY:

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FOR PORTLAND GENERAL ELECTRIC COMPANY:

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FOR THE WASHINGTON DEPARTMENT
OF FISHERIES:

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FOR THE WASHINGTON DEPARTMENT
OF WILDLIFE:

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OF DOUGLAS COUNTY, WASHINGTON:

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OF WILDLIFE:

Ray Ryan 6/11/90
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FOR THE OREGON DEPARTMENT OF
FISH AND WILDLIFE:

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FOR THE NATIONAL MARINE
FISHERIES SERVICE:

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FOR THE U.S. FISH & WILDLIFE SERVICE:

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FOR THE CONFEDERATED TRIBES AND BANDS
OF THE YAKIMA INDIAN NATION:

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OF THE UMATILLA INDIAN RESERVATION:

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FISH AND WILDLIFE:

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FOR THE U.S. FISH & WILDLIFE SERVICE:

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Marvin L. Plenert, Regional Director
FOR THE U.S. FISH & WILDLIFE SERVICE

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FOR THE CONFEDERATED TRIBES
OF THE UMATILLA INDIAN RESERVATION:

Edward H. Patawa

FOR THE CONFEDERATED TRIBES
OF THE COLVILLE RESERVATION:

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