SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

EVERETT

Providers of quality water, power and service at a competitive price that customers value.

December 5, 1995
PUD 20287

Ms. Lois Cashell, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street NE
Washington, D.C. 20426

Dear Ms. Cashell:

RE: Jackson Hydroelectric Project - FERC No. 2157
License Article 55 - Aquatic Resources Studies
Sultan River Gravel Quality and Quantity Study - Final Report

The Public Utility District No. 1 of Snohomish County (District) submitted the Sultan River "Gravel Quality and Quantity Study" final report on September 30, 1995 as fulfillment of one of several obligations under Article 55 of the amended Project License (17 FERC 61,056) and the Settlement Agreement (22 FERC 61,140) between the Licensees and the Joint Agencies (Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Tulalip Tribes).

Article 55 required the Licensees to consult and cooperate with the Joint Agencies in conducting a series of mitigation studies for the aquatic resources of the Sultan River. The Settlement Agreement specified a series of gravel quantity and quality studies to be conducted over time to determine the effects of project construction and operations on the Sultan River gravel habitat. Over the last twelve years the District has completed the required gravel studies according to the agreement schedule. In 1994, after a period of four years without achieving scouring flow thresholds in the Sultan River, the District initiated an additional gravel quality study to document Sultan River salmonid spawning habitat conditions under the second interim operating plan.

The final report was submitted to the Joint Agencies on August 15, 1995 for their review. On October 2, 1995 the District subsequently received a letter from Gwill Ging of the U.S. Fish and Wildlife Service commenting on the Sultan River gravel studies. Enclosed please find that letter and the District's response to comments.

CITY OF EVERETT • 3200 Cedar Street • Everett, WA 98201 • (206) 259-8800 • Fax (206) 259-8882
PUD • 2320 California Street • Everett, WA • 98201 • (206) 258-8211 • Fax (206) 258-8222

We will continue to invite the Joint Agencies to participate in the gravel monitoring activities of the District. We recognize that river systems are dynamic and expect our biological and physical knowledge of them to continue to expand. Therefore, the District remains open to discussing any future issues regarding gravel habitat of the Sultan River with the Joint Agencies.

Sincerely,

N. Craig Thompson
Assistant General Manager
Water Resources Division

Clair Olivers
Public Works Director
City of Everett

Enclosure

WMS:BFM:dkw

cc: Joint Agencies
Bell & Ingram
A. Martin, FERC (Portland)

bcc: C. Olivers - City of Everett (w/o enclosures)
B. Meaker - O1 (w/o enclosures)
M. Schuh - O1 (w/enclosures)
N. Johnson - SU (w/o enclosures)
R. Metzgar - City of Everett (w/o enclosures)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Pacific Coast Ecoregion
Western Washington Office
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192
(360) 753-9440 FAX: (360) 753-9008

September 27, 1995

Bruce Meaker, Jackson Project Manager
Snohomish County Public Utilities District No. 1
P.O. Box 1107
Everett, WA 98206-1107

Re: Jackson Hydroelectric Project - Final Report on Sultan River Gravel Quality and Quantity Studies - FERC No. 2157

Dear Mr. Meaker:

The U.S. Fish and Wildlife Service (Service) has reviewed the Snohomish County Public Utilities District's (District) document, "Final report on Sultan River gravel quality and quantity studies." The Service offers the following comments and recommendations.

The Service concurs with the study results that mitigative action for gravel quantity and quality are not needed at this time. We note, however, the hydrologic conditions were drier than normal and that the absence of flushing flows since 1990 (flows in excess of 2,500 cfs at the diversion dam and 4,000 cfs at the powerhouse) did not allow for the assessment of gravel quality following a satisfactory spill event. We agree with the District that additional monitoring is needed because of the unusual hydrologic conditions. 1

According to the report, the District proposes to monitor gravel quality following the next flushing flow or after a period of six years without a flushing flow. The data collected to date indicates that gravel quality can be maintained for at least four years without a flushing flow, at least under the conditions that occurred between 1991 and 1995. The Service is concerned that six years may be too long a period between monitoring under some circumstances, e.g., landslides. In this instance, a shorter interval would be appropriate. The proposal to monitor gravel quality after a period of six years without a flushing flow is presently acceptable to the Service provided it is acknowledged that if circumstances occur that can reasonably affect gravel quality, the interval between monitoring periods would be appropriately shortened. 2 3

In addition, the Service's concurrence with the six-year interval relates only to the monitoring of gravel quality. This should not be inferred to also mean that the Service agrees that six years is an

Henry M. Jackson Hydroelectric Project - FERC 2157

District Response to U.S. Fish and Wildlife Service Comments

1. A satisfactory spill event occurred on November 23-27, 1986 at Culmback Dam reaching a maximum of 5,545 cfs well exceeding flushing flow threshold levels of 2,500 cfs and 4,000 cfs at the diversion dam and powerhouse, respectively. Sampling for the 1987 gravel study occurred in September 1987 and the results indicated that the need for mitigative measures were not required at that time. Scour monitors were installed in the Sultan River channel in 1989 to verify the flushing flow thresholds mentioned above for the diversion dam and powerhouse. The monitors have not been assessed after a spill event in the vicinity of the flow thresholds for the diversion dam and powerhouse since placement. Therefore the District will continue to evaluate the scour monitors on an annual basis to verify the flow threshold values.

2. The results of the 1994 gravel study documented that the gravel quality of the Sultan River is at levels similar to all other years sampled. During the period of November 8-19, and 23-29, 1995 two spill events occurred at Culmback Dam which both exceeded flushing flow thresholds at 5,141 and 11,140 cfs, respectively. Therefore, the District proposes that the next gravel quality study be conducted six years post 1995 (e.g. 2001) if no flushing flows occur in the interim or after any other period of six years without a flushing flow. The District will continue to evaluate the scour monitors annually to verify the flow thresholds of 2,500 cfs and 4,000 cfs at the diversion dam and powerhouse, respectively.

3. The District concurs that if natural events (e.g. landslides) occur or further scientific knowledge indicates the biological health of the river may be at risk then the gravel quality sampling schedule could be altered.

4. Agreed

acceptable period between flushing flows. The Service believes high flow events are important to the biological health of the river in ways that cannot be assessed simply by measuring the percentage of fines in the substrate. The issue of how frequently flushing flows should occur downstream from Culmback Dam is still outstanding. The Service is comfortable with the progress that is being made. 4

Please call Mr. Gwil Ging at 360-753-6041 if you have questions regarding this letter.

Sincerely,

for Nancy J. Gloman

David C. Frederick
Supervisor

gg/jmc
FERC 2157
c: FERC, Portland, Oregon (Arthur Martin)
FERC, Wash. D.C. (Lois Cashell)
NMFS, Seattle (Jon Linvog)
WDFW, Mill Creek (Gary Engman)
Tulalip Tribes, Marysville (David Somers)

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

EVERETT

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September 30, 1995
PUD 20245

Ms. Lois Cashell, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street NE
Washington, D.C. 20426

Dear Ms. Cashell:

RE: Jackson Hydroelectric Project - FERC No. 2157
License Article 55 - Aquatic Resources Studies
Sultan River Gravel Quality and Quantity Study - Final Report

Please find enclosed the report "Gravel Quality and Quantity Study". Public Utility District No. 1 of Snohomish County is submitting this report as fulfillment of one of several obligations under Article 55 of the amended Project License (17 FERC 61,056) and the Settlement Agreement (22 FERC 61,140) between the Licensees and the Joint Agencies (Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Tulalip Tribes).

Article 55 required the Licensees to consult and cooperate with the Joint Agencies in conducting a series of mitigation studies for the aquatic resources of the Sultan River. The Settlement Agreement specified a series of gravel quantity and quality studies to be conducted over time to determine the effects of project construction and operations on the Sultan River gravel habitat. Over the last twelve years the District has completed the required gravel studies according to the agreement schedule. Gravel quantity studies (supply) were conducted in 1984 following construction. Gravel quality studies were conducted pre-project construction (1982), immediately following construction (1984) and three years post construction (1987). These studies addressed Sultan River conditions for project operations under interim operating rule curves established when the project was first allowed to generate power commercially in 1984.

Under license Article 57, a second interim operating plan (58 FERC 62,224) was approved by the FERC in 1992. In 1994, after a period of four years without achieving scouring flow thresholds in the Sultan River, the District initiated an additional gravel quality study to document Sultan River salmonid spawning habitat conditions under the second interim operating plan. The 1994 study report is included in this final report on gravel studies.

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We will continue to invite the Joint Agencies to participate in the gravel monitoring activities of the District. We recognize that river systems are dynamic and expect our biological and physical knowledge of them to continue to expand. Therefore, the District remains open to discussing any future issues regarding gravel habitat of the Sultan River with the Joint Agencies.

Sincerely,

N. Craig Thompson
Assistant General Manager
Water Resources Division

Original signed by
Clair Olives dkw

Clair Olivers
Public Works Director
City of Everett

Enclosure

WMS:BFM:dkw

cc: Joint Agencies
Bell & Ingram
A. Martin, FERC (Portland)

bcc: C. Olivers - City of Everett (w/o enclosures)
B. Meaker - O1 (w/o enclosures)
M. Schuh - O1 (w/enclosures)
N. Johnson - SU (w/o enclosures)
R. Metzgar - City of Everett (w/o enclosures)

HENRY M. JACKSON HYDROELECTRIC PROJECT

(Federal Energy Regulatory Commission Project No. 2157)

Licensees

Public Utility District No. 1 of Snohomish County
and City of Everett, Washington

GRAVEL QUALITY AND QUANTITY STUDY

Final Report

Prepared By:

Murray Schuh
Fisheries Biologist

Bruce Meaker
Jackson Project Sr. Manager

Snohomish County Public Utility District No. 1
P.O. Box 1107
Everett, Washington 98206

September 1995

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INTRODUCTION

Purpose

This report presents the results of field work conducted between 1982 and 1994 on streambed sediment transport and river channel gravel quality in the Sultan River. The river is located in Snohomish County, Washington site of the Henry M. Jackson Hydroelectric Project (FERC Project No. 2157). The work was done to partially fulfill aquatic resource studies requirements of the FERC License articles and the Uncontested Offer of Settlement with the Joint Agencies for Project No. 2157.

Project Background

The 112 megawatt Henry M. Jackson Hydroelectric Project (Jackson Project) is located on the Sultan River in northwest Washington (Figure 1). The Public Utility District No. 1 of Snohomish County (District) is the owner and operator, however, the project is co-licensed with the City of Everett.

The Sultan River drainage has been historically managed for the City of Everett's water supply. The City of Everett's Diversion Dam located at river mile (RM) 9.7 was constructed in 1929 to divert water to Lake Chaplain (14,000 acre-foot reservoir). To increase the capacity of Everett's water storage, Stage 1 of Culmback Dam was constructed in 1965 at RM 16.5 of the Sultan River forming Spada Lake, a 34,240 acre-foot reservoir.

In 1976, constructing the Stage 2 hydroelectric facilities of the Jackson Project became economically attractive due to projected load growth and notice of insufficient allocation from the Federal power marketing authority (Bonneville Power Administration). Hence, Spada Lake reservoir storage capacity was increased in 1984 to 153,260 acre-feet by raising the height of Culmback Dam 62 feet. The project was designed to take advantage of 1,100 feet of hydraulic head and 159 inches average annual precipitation at Culmback Dam. The Sultan River Project was named in honor of the late U.S. Senator Henry M. Jackson.

Instream flow and municipal water supply requirements take priority over power production after high flow periods (flood control) or when storage is reduced at Spada Lake. The schedule of water priorities led to a unique "plumbing" design and operating scheme. Water is routed from Spada Lake to the powerhouse via eight miles of power tunnel and pipeline dropping 1,100 feet in elevation. Water destined for Everett's municipal supply and required instream flows for the Sultan River is re-routed uphill 400 feet over four miles to Lake Chaplain. Water to provide adequate instream flows is diverted through another one and one-half mile tunnel and pipeline discharging into the Sultan River 5.2 miles upstream of the powerhouse. Due to the sizable hydraulic head, water is transported through the entire system by gravity flow.

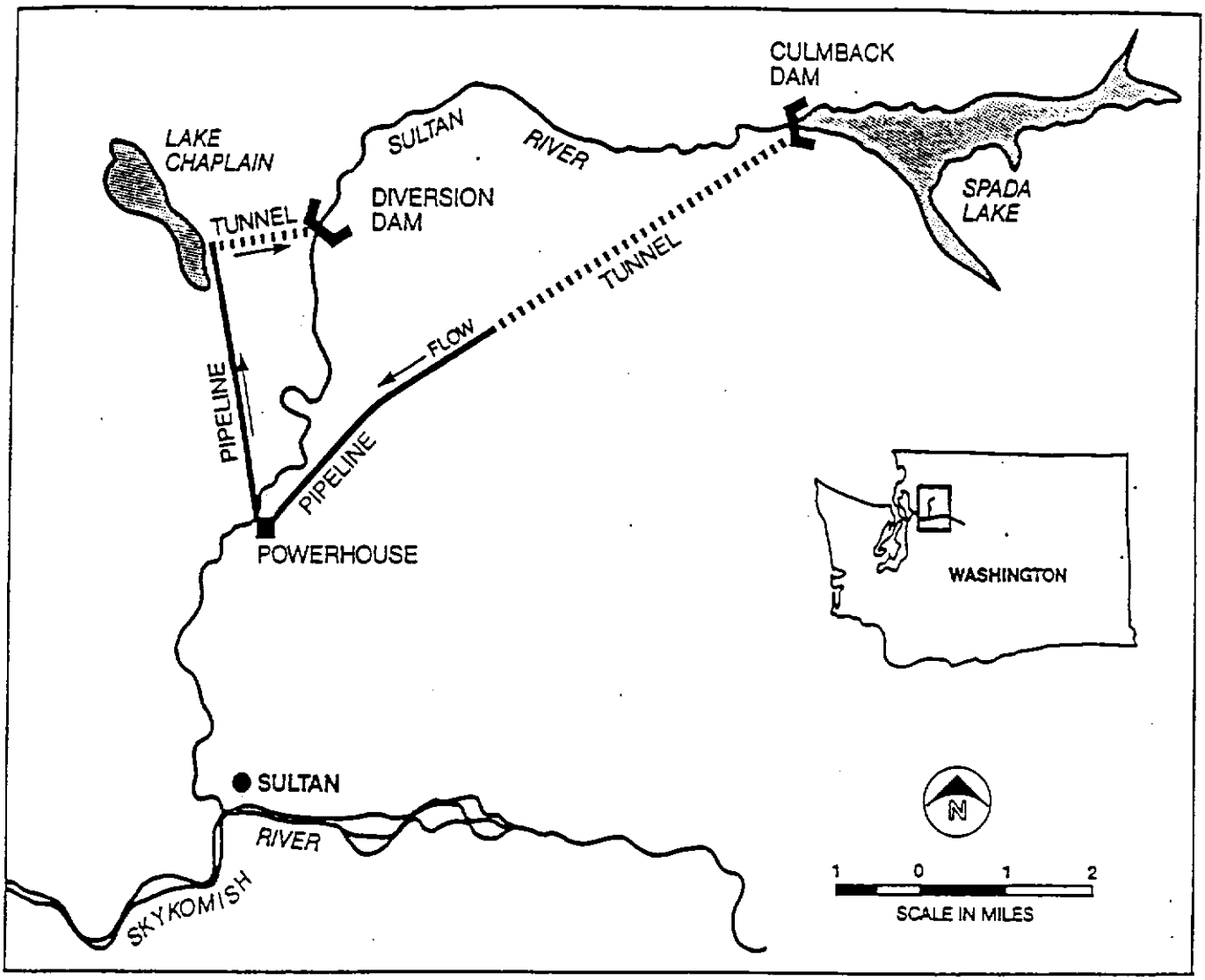


Figure 1
JACKSON HYDROELECTRIC PROJECT

As part of the process to obtain a Federal Energy Regulatory Commission (FERC) license to construct Stage 2 of the Jackson Project, an Uncontested Offer of Settlement was made between the Co-Licensees (District and City of Everett) and the Joint Agencies (JA): Washington Department of Fisheries (WDF), Washington Department of Game (WDG), National Marine Fisheries Service (NMFS), United States Fish and Wildlife Service (USFWS), and the Tulalip Indian Tribes (TT). WDF and WDW have since merged to the Washington Department of Fish and Wildlife. The Uncontested Offer of Settlement requires the Co-Licensees "to determine the percentage of fines in the spawning gravels from the Diversion Dam to the Skykomish River prior to Stage 2 construction, upon completion of project construction, and three years after initial project operation. Also, to conduct a study to determine if project operation causes significant depletion of spawning gravels from the diversion dam to the Skykomish River." Subsequent, and in addition to the Uncontested Offer of Settlement, the Co-Licensees initiated (with Joint Agencies concurrence) a study to determine the percent of fines in the spawning gravels from the diversion dam to the Skykomish River ten years after initial project operation. Hence, the Sultan River gravel study is comprised and reported as two separate components, gravel quality and gravel quantity. The Uncontested Offer of Settlement was subsequently approved by FERC, and the gravel study requirements were incorporated in the Aquatic Resources Plan required under Article 53 of the project license.

Anadromous Fish Resource

The Sultan River and its tributaries provide spawning and rearing habitat for chinook, coho, chum, and pink salmon, steelhead and sea-run cutthroat trout. Dolly Varden char have not been observed spawning in the Sultan River, however, they use the river as rearing habitat. These fish species have access from the mouth of the Sultan River to the Everett Diversion Dam (a barrier to upstream migration) at RM 9.7.

Chinook and coho salmon, and summer and winter-run steelhead trout use the entire available river reach to the diversion dam (RM 9.7). Chum and pink salmon primarily use the lower reach of the river, however, pink salmon have been observed upstream of the powerhouse (RM 4.5).

Because of these fishery resources an aquatic resource mitigation plan was required for the project. River gravel quality and quantity are two of several fish mitigation requirements.

This summary report compiles the gravel study reports prepared to fulfill the requirements of the Uncontested Offer of Settlement and includes the additional gravel quality study completed ten years after initial Jackson Project hydroelectric power operation in 1994.

STUDY OBJECTIVES

Gravel Quality

The gravel quality study was designed to document temporal changes in the textural composition of spawning gravels which may be attributable to the construction and operation of the Jackson Project. The primary objectives of the gravel quality study, developed cooperatively with the Joint Agencies, are:

- o to determine the spatial variability of sediment samples among selected spawning reaches from the diversion dam downstream to the river mouth (anadromous zone);
- o to determine the vertical heterogeneity of sediments within and among spawning reaches; and
- o to compare pre-construction sediment composition with that of post-construction.

The main intent of the study is to perform the textural composition sampling, both pre- and post-project in substrate that is suitable as spawning habitat for salmon and steelhead. Throughout this report, the terms pre-project and pre-construction refer to conditions which followed the Stage 1 construction of Culmback Dam (1965) and preceded Stage 2 completion and operation of the Jackson Project (1984). To address study intent, sample site selection on the basis of documented spawning riffles (high use areas favored) and distribution over the area accessible to anadromous fish (to represent differing river reach characteristics) was preferred by the Joint Agencies. The focus of the study effort is to ensure that the Sultan River spawning gravel quality is adequate to yield high rates of embryonic survival of salmonids.

Gravel Quantity

The primary objective of the gravel quantity and distribution study is to forecast and document potential changes in Sultan River spawning habitat conditions which may be attributable to operation of the Jackson Project. The project has significantly altered flow conditions in the 16.5-mile reach of the Sultan River downstream of Culmback Dam. Gravel of suitable quantity and quality for salmonid spawning must be available in this river reach to protect and preserve this resource. It was agreed to by the Joint Agencies that three basic parameters for designing the gravel quantity study and subsequent field work and site selection are as follows:

- o determination of historical and existing gravel recruitment sources;
- o channel armor scouring downstream from the powerhouse; and
- o change of gradation in the spawning gravel mix.

Seasonal timing of transport and availability of gravel were additional concerns identified by the Joint Agencies. The intent of the study is not only to identify gravel source areas and transport, but to determine flow thresholds and develop mechanisms to ensure gravel transport through the river system, in the event that mitigative action is warranted.

METHODS

Gravel Quality

Five salmonid spawning reaches in the Sultan River were selected as sampling sites representing various physical river conditions with input from and approval of the Joint Agencies. The streambed sediment samples were collected during each of three specified temporal intervals and additionally in 1994, using a tri-tube freeze-core sampler. Collection of samples commenced in April/May 1982 to establish an index of baseline data prior to the onset of Jackson Project construction in June 1982. The post-construction samples were collected in February/March 1984, and in September 1987 and 1994, three and ten years after initial operation of the project. WDF requested that the timing of 1987 sampling effort be shifted to the fall (just prior to the onset of salmon spawning) to assess gravel quality after a long period of flow stability. The previous samples were collected in the winter/spring while salmon and steelhead eggs were incubating in the gravel. Gravel samples were analyzed separately by wet sieving through graduated geometric screens to separate particle size groups. Volumetric displacement of the material from each sieve was measured.

The sampling site configuration was altered in the 1994 study due to a high level of gold prospecting occurring in the Sultan River which raised concern over sample bias. After a site visit with the Joint Agencies, it was agreed to sample three new transects in proximity to the historical transects. This was necessary to avoid areas impacted by excavation and deposition of streambed materials directly related to prospecting activities.

There is a general consensus among fisheries biologists that the textural composition of spawning substrates effects survival of salmonid embryos to emergence, however, no unified methodology for collecting and interpreting gravel quality has been adopted. Mortality is believed to be a result of a reduction of oxygenated water to the incubating embryos or the trapping of alevins during the emergence period. Both causes are directly related to the proportion of fine sediments within the spawning gravel. Consequently, researchers have used an estimate of the percentage of fines less than a specific diameter (e.g., 0.841 mm, 1.0 mm, 3.3 mm, or 6.5 mm) to interpret the suitability of streambed materials for spawning and incubation.

The computer program SEDIMENT was used to summarize the volumetric and gravimetric data at the University of Washington, Seattle, Washington. This program calculates the percentage of sample collected by each sieve and the percentage of sample which is smaller than each sieve diameter. The percentage of fines which pass through the 0.841 mm diameter

sieve is used in the statistical comparisons. Appendices A, B, C, and D present the consultants reports on textural composition of gravels for 1982, 1984, 1987, and 1994, respectively.

Gravel Quantity

Gravel recruitment source areas were determined by geological reconnaissance and aerial photography (helicopter), development of river condition maps, and mapping of salmonid spawning sites. The aerial reconnaissance was ground truthed to verify local geological and various river conditions. Gravel transportation and scour were evaluated by textural analysis, sediment flushing operations, analysis of sediment yield and bedload transport, and forecasting of gravel spawning habitat conditions due to project operations.

Three sites within the study area were selected for detailed field examination, mapping, sampling and bed material analysis. These sites were selected to represent various physical river reach conditions in the reach accessible to anadromous fish. Gravel flushing operations at the diversion dam were evaluated and a gravel marking experiment was conducted to monitor transportation. Appendix E presents the consultants report on Sultan River gravel quantity.

RESULTS AND CONCLUSIONS

Gravel Quality

The textural composition of Sultan River streambed sediments at salmonid spawning reaches immediately following Jackson Project construction (1984) and three and ten years post-construction (1987 and 1994) was generally similar to that evaluated for the same sites prior to construction (1982). The noteworthy exception was the most upstream sampling station which had the coarsest gravel in 1987, in contrast with 1982 and 1984, when it had the finest gravel of all stations sampled. This may be explained by the fall sample timing and gold dredging activities that occurred in the vicinity a few weeks prior to gravel sampling. There was no clear spatial trend in the geometric mean diameter (dg) among sample stations in 1984 or 1987, whereas, a trend of smaller dg with increased distance upstream was suggested by the 1982 baseline data. The dg at the three most downstream stations has been relatively stable over the three sampling periods and the dg at the two upstream stations has increased significantly since project construction.

Sediment stratification was detected during all four years of sampling. The combined mean values of the upper three inches of substrate contained significantly lower percentage of fines and greater geometric mean particle size than did the underlying nine inches of sediment.

Quantitative predictive models of salmonid fry survival based on sediment quality do not currently exist. The paucity of data from properly designed field studies prevents the ability to model survival-to-emergence of salmonid fry. For this reason the data presented in these reports should only be used as a general indication of salmonid spawning gravel quality in the Sultan River. However, laboratory studies indicate that survival to emergence decreases at the

threshold of 15% fines (Bjornn and Reiser, 1991). Figure 2 presents data from all four sampling years where the percent fines all fall below the threshold value.

In summary, the textural composition of Sultan River spawning gravels following project construction and operation continues to be of relatively good quality and potentially provides suitable conditions to yield high rates of embryonic survival of salmonids. Based on the data indices, the need for mitigative measures to improve gravel quality is not indicated.

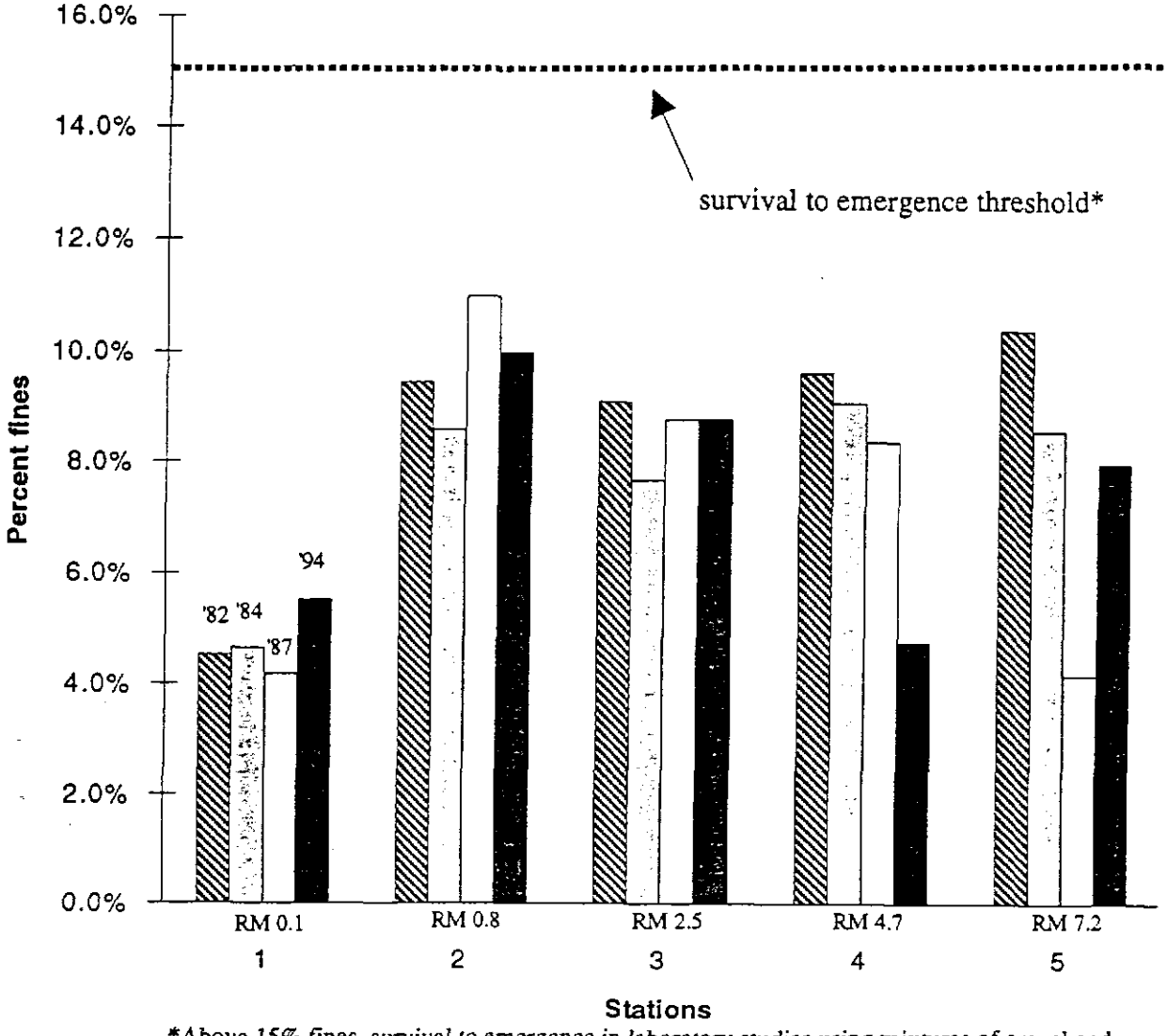
Gravel Quantity

The results of the river gravel quantity study indicate that the major source area for Sultan River gravel and bedload material is located between RM 11.2 and Culmback Dam (RM 16.5) on the left bank of the river (Figure 3). In particular, the north flank of Blue Mountain has several ancient and recent large slope failures, the largest of the observed landslides is termed the "Blue Mountain Slide". The south flanks of the Pilchuck-Sultan ridge is a secondary gravel source located on the right bank of the river in this reach, along with the local bedrock source. Several small tributaries which discharge from these ridges have gravel fans at their mouths and some were found to be deeply incised into glacial drift. This upper river reach is where the most severe flow modifications have occurred. Sediment is transported to the lower river only when spill occurs at Culmback Dam. Sediment sources downstream of RM 11.2 include tributary creeks and occasional landslides which flank the river. Although these lower river gravel sources regularly supply coarse sediment, the rate of sediment supply is judged to be much less than for the area upstream of RM 11.2.

Calculations of bedload transport conclude that the Sultan River is gravel supply limited in the study area. The gentle gradient and the braided pattern of Sultan River in the Spada Lake area suggests that the study area was supply limited with regard to bedload transport prior to construction of Culmback Dam. Streambed armor will be disrupted (removal of fines) and gravel and bedload material from the upper reach of the river (RM 14.5) will be transported to downstream areas when the flushing flow thresholds of 2,500 cfs and 4,000 cfs are achieved at the diversion dam and powerhouse, respectively. A one-day flow of 5,000 cfs in that reach would be capable of transporting all of the sediment supplied to the reach for a typical year. Due to project related flow modifications, bedload material transportation will take place infrequently when spills occur at Culmback Dam. Gravel transport will be aided by raising the sluice gate at the diversion dam when spill events occur at Culmback Dam. The reduced exposure of the sediments to historically frequent high flows associated with pre-project conditions may benefit the fishery by avoiding scour of redds and subsequent mortality of incubating eggs and/or alevins.

The average volume of streambed material generated and transported in the reach upstream of the diversion dam is estimated to be in the range of 3,000 cubic yards (3,900) tons per year. Streambed slope analysis indicates that material transported by the upper river will be deposited in the lower three mile river reach, resulting in growth of gravel bars and possible channel migrations. Gravel bar growth downstream of the diversion dam may result in a net increase in

Figure 2. Average percent fines (PFW - volumetric) < 0.841 mm for all four strata at each station on the Sultan River for all study years (1982 - 1994)



*Above 15% fines, survival to emergence in laboratory studies using mixtures of gravel and sand decreases rapidly (Bjornn and Reiser, 1991).

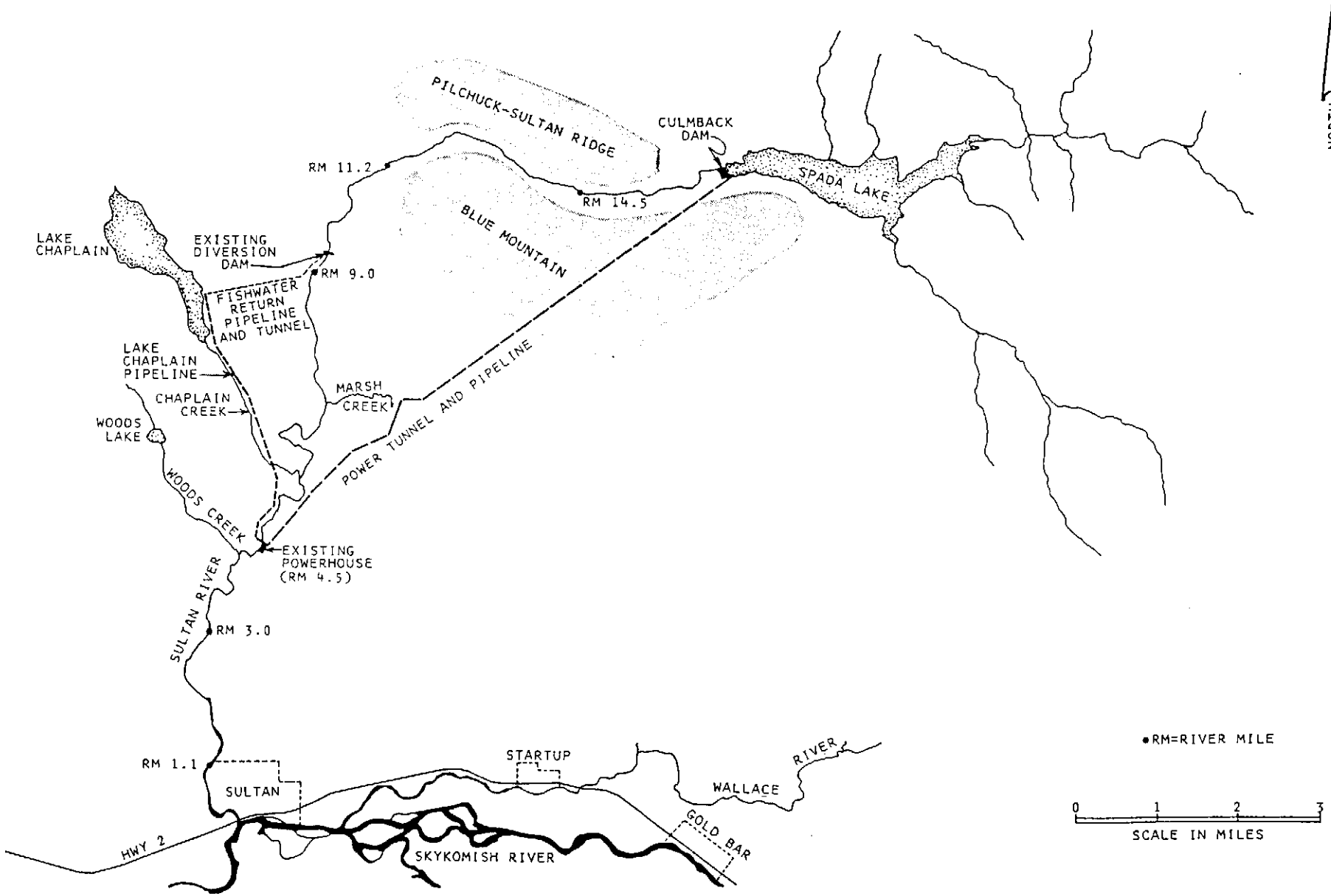


Figure 3: Location Map of River Gravel Source Areas(Shaded)

usable salmonid spawning habitat. Project operations have reduced frequent high flow events (35,000 cfs maximum) providing stability to salmonid spawning and rearing habitat.

SUMMARY

The gravel quality and quantity studies performed on the Sultan River indicate that the need for mitigative action is not required at this time. The 1994 Gravel Quality Study documented percent fines well below threshold levels found to decrease salmonid survival to emergence in laboratory studies (Bjornn and Reiser, 1991) after a period of four years without a spill event or scouring flows in the Sultan River. Given the complexity of the Sultan River system and the information obtained thus far on streambed sediment, the District realizes that the results are not final. Thus, streambed sediment/river gravel must remain an open issue with the Joint Agencies.

MONITORING PLAN

The District proposes to continue monitoring streambed sediment quality and bedload transport. The key common factor for gravel quality and quantity is the frequency of a flushing river flow. A flushing flow is defined as a flow sufficient to disrupt streambed armor and transport sediment downstream. Flushing flow thresholds have been suggested to be 2500 cfs at the diversion dam and 4,000 cfs at the powerhouse by previous study of the Sultan River (Appendix E). Assuming that a flow of this magnitude occurs periodically from Culmback Dam downstream, then Sultan River gravel quality and quantity should remain in satisfactory condition for fish production.

The flushing flow threshold values were determined by the District's consultant Dr. Tom Dunne and have not been verified. Accordingly, the District set scour monitors in the bed of the Sultan River in 1989 to document scour depth and sediment deposition as related to flows. During the 1990 flood event, a flushing flow in excess of 16,000 cfs at Culmback Dam occurred on the Sultan River. Since then no flushing flow has occurred. The present time (mid-1995) constitutes the longest period in Stage 2 of the Jackson Project without a flushing flow. Thus, scour monitor data sufficient to evaluate the flushing flow threshold values does not exist at this time. The District will continue to evaluate the scour monitors annually to compile data necessary to evaluate the flushing flow threshold values.

The District will continue to raise the diversion dam sluice gate when a spill event occurs at Culmback Dam. The present operating procedure is to raise the gate on the receding side of the peak flow. As previously agreed with the Joint Agencies, they will be notified in advance of pending sluice gate raising operations.

Having gone a period of four years without spill, and concluding that Sultan River gravels provide conditions which yield a high rate of embryonic salmonid survival, the District proposes to conduct gravel quality monitoring after a period of six years without flushing

flows. This frequency should adequately document gravel condition and identify any need for mitigative action. The results of the 1994 study documented that gravel quality is at levels similar to all other years sampled. Therefore, the District proposes that the next gravel quality study be conducted six years post 1994 (e.g. 2000) if no flushing flows occur in the interim. In the event that streambed sediment quality should decline to an unacceptable level then a flow release could be made from Culmback Dam. The timing of the release would occur to replicate a historical winter season high flow and would be coordinated in advance with the Joint Agencies.

REFERENCES

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19: 83-138.