APPENDIX B

Target Flow Memorandum
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Memorandum

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To: Distribution

cc: Keith Binkley – Snohomish County PUD

From: Dudley Reiser/Mike Gagner – R2 Resource Consultants

Subject: Sultan River Instream Flow Study – Target Flow Ranges

Based on a review of previous instream flow studies completed in the Sultan River (R.W. Beck 1980; Gerke and Easterbrooks (1978), and Magee (1967)), an evaluation of channel characteristics and habitat types that will be measured (following our field reconnaissance and transect selection effort) as part of the study and their sensitivity to flows, and the periodicities of the target species and lifestages, R2 has proposed specific target flows for each of the three study reaches in the Sultan River (Table 1). A total of five flows are proposed for each reach, the first three of which would be used to obtain complete depth-velocity data sets and water surface elevations (WSE) at all transects, and the last two flows (the two highest) used to obtain supplemental WSE measurements.

It is assumed that development of habitat-flow relationships will include both Chinook and steelhead spawning, fry, juvenile and adult lifestages. Periodicities of these two species assume that the majority of Chinook spawning would occur from mid-September through November, and steelhead spawning from March through mid-June. Chinook fry/juvenile rearing would occur from January through August; steelhead rearing would occur year-round. Consideration was therefore given to selecting a flow range that would likely capture the peaks of the habitat-flow relationships for these lifestages. However, safety considerations also entered into the selection of the upper flow for which a complete velocity set would be measured.

The target flows are presented in the attached table (Table 1) and the rationale for each flow range described below.

Table 1. Proposed target flows for field measurement for each of the three instream flow study reaches of the Sultan River, Washington.

Reach	Existing Instream Flow Requirements	Modeled Flow Range - Suggested in RSP3	Proposed Target Flows (Q) (first three flows will include depth-velocity sets)	Extrapolation Range[1] (based on Qs with D-Vel sets)
3	Year-round: 20 cfs	20 to 1,000 cfs	Q1 – 20cfs Q2 – 150 cfs Q3 – 300 cfs Q4* - 500 cfs Q5* – > 750 cfs	Conservatively – 8 cfs to 750 cfs; probably higher given additional WSEs at higher Qs
2	11/1 to 1/15: 95 cfs 1/16 to 2/28: 150 cfs 3/1 to 6/15: 175 cfs 6/16 to 9/14: 95 cfs 9/15 to 9/21: 145 cfs 9/22 to 10/31 155 cfs	50 to 1,500 cfs	Q1 – 95 cfs Q2 – 200 cfs Q3 – 400 cfs Q4* - 600 cfs Q5* – > 800 cfs	Conservatively – 38 cfs to 1000 cfs; probably higher given additional WSEs at higher Qs
1	6/16 to 9/14: 165 cfs 9/15 to 6/15: 200 cfs	100 to 1,500 cfs	Q1 – 165 cfs Q2 – 300 cfs Q3 – 500 cfs Q4* - 700 cfs Q5* – > 800 cfs	Conservatively – 66 cfs to 1250 cfs; probably higher given additional WSEs at higher Qs

[1] The range of flow extrapolation will adhere to Washington State Guidelines (WDFW/WDOE 2004) that specify limiting the range of extrapolation to flows at which all Velocity Adjustment Factors (VAFs) are between 0.80 and 1.20, and for which no simulated velocities exceed 10 fps.

* Estimated target flows - only Water Surface Elevations measured at these flows

Reach 3 – Culmback Dam to Diversion Dam
Existing Flow Release – 20 cfs (year-round)

R2 reviewed the R.W. Beck (1980) study completed in 1980 that utilized test release flows of 75 cfs, 178 cfs, and 352 cfs to develop habitat-flow relationships. R2 is proposing a similar, although slightly lower flow release plan that will include three primary flows in which depth-velocity sets will be measured, and two secondary higher flows in which WSEs will be

measured. The three primary flows would include the existing 20 cfs minimum flow requirement, a mid-flow of 150 cfs, and an upper flow of 300 cfs. With this range of flows, R2 will be able to develop a hydraulic model that will be able to conservatively extrapolate flows from 8 cfs to 750 cfs. With the measurement of two higher secondary flows (500 cfs and > 750 cfs), R2 believes extension of the extrapolation range beyond 8-900 cfs should be possible, while still adhering to the WDFW/WDOE (2004) guidelines, providing a range of flows that should capture (based on review of R.W. Beck (1980) report) the peaks of all target lifestages. This is especially true for spawning, since review of the R.W.Beck data suggests a distribution of gravel that was then concentrated more along the channel margins than currently exists. Thus, under current conditions, we would expect the peaks of the spawning curves to occur at slightly lower flows than occurred based on 1980 data. Regardless, the proposed range of flows (including the two secondary flows) to be measured should provide a flow extrapolation range similar to that applied in 1980.

Reach 2 – Diversion Dam to Powerhouse
Existing Flow Releases: range of 95 cfs to 175 cfs

The Easterbrooks and Gerke (1978) study that employed a "Usable Width" analysis included the measurement of four test flows ranging from 50 cfs to about 200 cfs. These flows were measured at six transects within three sites below the Diversion Dam. When all three sites were combined, their analysis resulted in a recommended flow of 175 cfs for fall Chinook salmon spawning. A flow of 205 cfs was indicated for one of the sites when considered separately. R2 is proposing a primary flow range of from 100 cfs to 400 cfs, and two secondary flows that will be greater than 600 cfs. The three primary flows would include the 95 cfs minimum flow requirement, a mid-flow of 200 cfs, and an upper flow of 400 cfs. With this range of flows, R2 will be able to develop a hydraulic model that will be able to conservatively extrapolate flows from 38 cfs to 1000 cfs. With the measurement of two higher secondary flows (≈ 600 cfs and > 800 cfs), R2 believes extension of the extrapolation range beyond 1200 cfs should be possible ,while still adhering to the WDFW/WDOE (2004) guidelines. This would provide habitat-flow relationships over a range of flows from 2 to 5 times higher than those measured by Easterbrooks and Gerke (1978) which R2 believes should capture the habitat peaks of all target lifestages.

Reach 1 (Reach 1A and 1B) – Powerhouse to Mouth
Existing Flow Releases: range of 165 cfs to 200 cfs

In 1967, a Washington Department of Fisheries (WDF) study was conducted in the Sultan River below the present location of the powerhouse to determine fishery needs in the lower three miles of the river below the canyon section (Magee 1967). For this, four typical spawning sections were evaluated at flows ranging from 30 to 500 cfs. The results indicated that a minimum of 200 cfs and 165 cfs were needed for salmon spawning and rearing, respectively, which are the existing seasonally required minimum instream flow releases. For this reach, R2 is proposing a primary flow range of from 165 cfs to 500 cfs, and two secondary flows that will be greater than 700 cfs. The three primary flows would include the 165 cfs minimum flow requirement, a mid-flow of 300 cfs, and an upper flow of 500 cfs. With this range of flows, R2 will be able to develop a hydraulic model that will be able to conservatively extrapolate flows from 66 cfs to 1250 cfs. With the measurement of two higher secondary flows (≈ 700 cfs and > 800 cfs), R2 believes extension of the extrapolation range beyond 1200 cfs should be possible, while still adhering to the WDFW/WDOE (2004) guidelines. This would provide habitat-flow relationships over a range of flows that are more than two times higher than those measured by Magee (1967), which should capture the habitat peaks of all target lifestages, as well as allow for an assessment of the relationship of mainstem to side-channel flow/stage connectivity. The assessment of side channel habitat – flow relationships is one of the main objectives of the instream flow analysis in Reach 1A.

Schedule

A detailed schedule for completing the field measured flows is under development. To the extent the prescribed flows in each reach can be provided, a tentative plan would be to complete the three sets of depth-velocity measurements over a three week period, with each week entailing the measurement of flows within a specific reach. For a given week, Day 1 (and Day 2 if needed) would entail mobilization, transect establishment, and surveying; Day 3 would involve low flow measurements; Day 4 – mid-flow measurements; and Day 5 – high flow measurements. This sequence would be repeated for each week. The two secondary flow measurements (WSEs) for each reach would likely be collected opportunistically and in conjunction with other resource studies (e.g. recreation flow release).

Literature Cited

Easterbrooks, J.A., and R. J. Gerke. 1978. Sultan River flow study. A report prepared for the Snohomish County PUD. Washington Department of Fisheries.

Magee, J.K. 1967. Direct testimony and related exhibits of John K. Magee before a Federal Power Commission hearing, Project No. 2157. In the matter of PUD No. 1 of Snohomish County and City of Everett, Washington. 1967.

R.W. Beck and Associates. 1980. Evaluation of instream flows for the Sultan River from Culmback Dam to the diversion dam. Sultan River Project, FERC Project No. 2157. Public Utility District No. 1 of Snohomish County, Washington.

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