Pacific Northwest Project
Technical Memorandum

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And the Water Science and Technology Board, NAS Technical Committee

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SUBJECT: Economic Analysis Methodology Illustration and Review: Estimating the Value of Water for Key Resource Sectors from the Mainstem Columbia River.

1.0 Economic Analysis Methodology Illustration and General Background.

This technical memorandum focuses on water valuations relevant to new allocations from the mainstem Columbia River—specifically water allocations that would be tied to the issuance of new water right permits by the state of Washington (pending applications). Several different economic analysis methodologies are illustrated pertaining to affected economic sectors. Additionally, the methodology results are summarized and some of their implications briefly discussed, as related to resource management policy.

Some key factors and foundation assumptions for this review are noted below:

- River system regime changes caused by the issuance of new water rights (pending applications) would be small. The issuance of new WA state water rights from the mainstem Columbia River represents small, incremental changes to the overall river system flows and average volume run-offs (<0.5% of ave. volume run-off).

- These water rights would affect small increments of the flow, even under an extreme low water-year condition. Figure 1 provides a hydrologic perspective for the water withdrawals represented by the water right applications currently pending for action before the Washington State Dept. of Ecology (WADOE).

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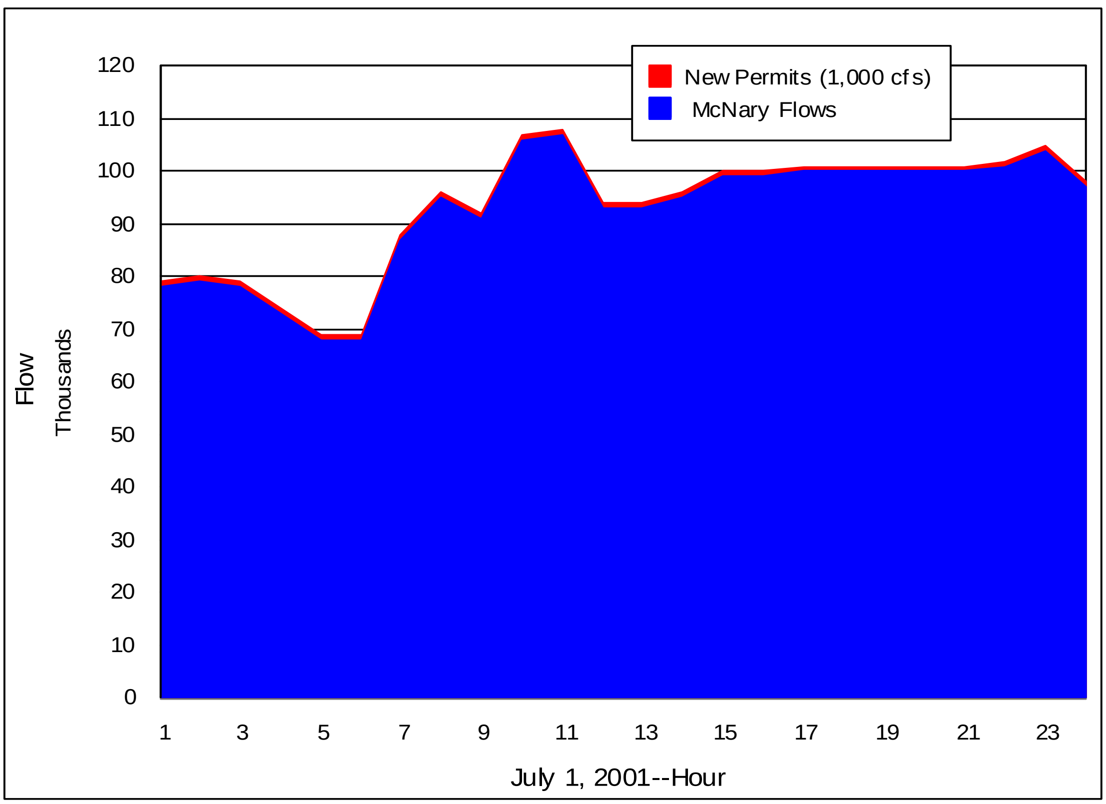
- As displayed in Figure 1, the daily net fluctuations of the flow significantly overshadow the total change to flow reductions affected by new water withdrawals. This daily net fluctuation is approximately greater than the new application water withdrawals by a factor of 38. Consequently, the new water withdrawal impacts would be little more than "noise" within the daily river operations regime. Whether there exists a measurable, or actual, relationship between the application water withdrawals and fish survival is questionable, in light of the very small hydrologic changes.

- While beyond the scope of this review, it is noted that future water system efficiencies will be taking place throughout the Greater Columbia River Basin, some of which will likely off-set the effects of any new water withdrawals. Also because the bulk of system net depletions (irrigation) are in Idaho, system efficiencies there would likely have the greatest impact on Idaho fall chinook runs.

Figure 1. 2001 Drought Conditions vs. Pending Water Rights (1 kcfs)
July 1, 2002, (Low-Water Condition) Hourly Flows Past the McNary Project



Source: Flow data from USACE Reservoir Control Center, Portland, OR.

- The analysis provided here deals with marginal changes in resource amounts and corresponding values—the resource changes are very small in nature, and may be beyond empirically measurable perception. Because the relative changes are small, the use of resource average economic values, in some cases, is considered acceptable.

- The economic values derived below are expressed in terms of direct net value (NED values), consistent with the dominant standards established for valuing water resource projects and program actions.[1] Also, all values are expressed as annual values in 2002$, for equivalent comparison.

- As noted in the attached comments to Dr. Daniel Huppert and the Economics Review Team, impacts to navigation, non-fisheries recreation, and flood control are not considered either significant or relevant to the water resources management decisions being evaluated by the Economics Review Team, and are thus not included within the analyses and comments provided in this technical memorandum. The four sectors of meaningful interest for economic valuation are: 1) sport and commercial fisheries; 2) irrigation; 3) municipal and industrial uses; and 4) hydropower generation.

- The analyses provided here serve to illustrate methodological approaches to estimating annual dollars/acre-ft. values for different resources. The estimates are approximate in nature, and it is expected that the Economics Review Team will further refine such estimates in their analyses.

- The analyses provided here target the potential impacts from the pending water right applications (WA State), where new water right permits would need to be granted. Any additional water withdrawals for the Columbia Basin Project lands are not included, and it is recommended that such water withdrawals be evaluated by the state as a separate management action.

2.0 Fisheries Values and Analysis Objective.

An economic valuation concerning water withdrawal impacts must include an economic valuation of water related to fish production. This necessary includes defining the physical impacts to fish—the estimated changes to production—and establishing values for the sport and commercial fisheries (including Indain fisheries).

The basis for assessing fish impacts for detailed economic analysis will depend on establishing a dollar value per acre-ft. of water directly related to fish production.

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[1] All major economic valuation review studies conducted by the federal Columbia River hydro system agencies rely primarily on direct net values to assess economic impacts. This approach has its "roots" in the economic procedures established by the U.S. Water Resources Council, "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies," Washington, D.C., 1983. Several of the major agency EISs review the net benefits methodology, for example see the Economics Technical Appendix (I) for the Corps of Engineers, et al., "Lower Snake River Salmon Mitigation Feasibility Study EIS," 2000, available at website: http://www.nww.usace.army.mil/lsr/final_fseis/study_kit/studypage.htm. Also refer to D. Huppert and D. Fluharty, "Economics of Snake River Salmon Recovery: A report to the National Marine Fisheries Service," School of Marine Affairs, UW, Seattle, 1996 (also known as the NMFS Economics Technical Committee Report).

2.1 Key Assumptions and Methodology.

Fish Impacts and Key Review Period:

- Any measurable impacts to fish are limited to migrating juvenile fish, as impacts to adults are assumed to be too small to measure or not perceptible at the water-flow changes under review. Also water temperature effects to adults would be greatest within the Snake River system.

- Because within year data for spring migrants for most years have indicated little statistical relationship between flow and survival within the mainstem river system (as well as other factors),[2] the key area of interest is on the potential impacts to juvenile fall chinook migration--the fall chinook runs would be the dominant runs affected, such as the Hanford Reach fall chinook. Within year data correspond to the water management activities and irrigation that would occur during a within year period.

- More specifically, the period of greatest interest, within year, is July-August, which captures periods of high juvenile fall chinook migration, and the period of peak water withdrawals for irrigation water rights. Monthly water withdrawals out-side the July-August period are substantially reduced.

- A low water-year condition is reviewed, as this would reflect a period of greatest fish migration impact, corresponding to an annual peak economic impact. Actual flow conditions for the 2001 water year are used in the modeling analyses.

CRiSP Model (with XT component) and Analysis Calibration:

Water Withdrawal Review and Assumptions:

- For measuring the impacts to migrating fall chinook salmon, the Columbia Basin Research (UW) CRiSP Model 1.6-1.7 series (with XT component) is used. The CBR-UW model has been, and is, widely used in the region by several federal water resource agency's, as well as the Northwest Power Planning Council staff. The technical justification for its use is concisely reviewed in the supporting documents.[3]

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[2] See footnote no.3 references; the 2000 "White Paper " on flow and survival relationships by NMFS, and the NOAA Fisheries annual reports on juvenile passage survival and flow-survival relationships available at the Northwest Fisheries Science Center website: http://www.nwfsc.noaa.gov; and results of UW CRiSP model analyses in Appendix A attachment. In 2001, the highly significant variable for survival was temperature (effects of Snake River passage). In previous years, even across very broad flow regimes, no statistical relation between flow and survival existed for spring migrants; also under low water conditions, most of the Snake River juvenile spring-summer chinook are transported from the Lower Snake River hydro projects to below the Bonneville Project; and monthly water withdrawals are much less during the high peak flow period of April-June.

[3] See J. Anderson, "Towards a resolution of the flow-survival debate," Columbia Basin Research, UW, Technical Paper submitted to NAS and NOAA Fisheries dated September 23, 2003 (and July 24, 2003, slide presentation by J. Anderson); J. Anderson, "Supplement to the Flow-Survival Relationship and Flow Augmentation Policy in the Columbia River Basin, Analysis of New Results," Columbia Basin Research, UW, November 11, 2002; and J. Anderson, "History of the Flow-Survival Relationship and Flow Augmentation Policy in the Columbia River Basin,"

- For this analysis, additional incremental withdrawals of 1,000 cfs (1 kcfs) were used to specify impact levels during the months of July and August. Water is withdrawn cumulatively from the Wells Pool to the John Day Pool, simulating incremental water withdrawals through the system (1/7 of the total kcfs removed from each pool). This approach tends to overstate the water withdrawal impacts in the system, compared to the actual distribution of withdrawal indicated by the applications (most withdrawals being in the lower river system).

- In previous discussions with the WADOE Spokane Office staff, it was determined that about 87 applications for new water withdrawal (WA State) existed on the river system, representing approximately 1.6 kcfs of annual use (total consumptive use, surface water and nearby wells,[4] and application "nameplate" values).

- Concerning the new applications, much of this projected water withdrawal would be within the Lower Columbia River system. Specifically, more than 75% would be withdrawn from the McNary-John Day Pools (consumptive use), the remaining occurring at or above the Rock Island Pool, above the confluence of the mainstem Columbia and Snake rivers.[5] The majority of this water would be for irrigation purposes, the remaining allocated to industrial and municipal use (such as the Quad-Cities water right, about 178 cfs).

- As discussed with the WADOE Spokane Office hydrologist, the values on the applications are "nameplate" in context, and likely do not reflect the actual quantities of use once permitted and certificated (the quantity values will be adjusted in many cases, particularly in the case of new irrigation withdrawals). Also some applications will not be acted on, as some applicants will no longer be able to pursue their original projects given the time lapse for permit review. Consequently, the primary review here deals with peak water withdrawal impacts at about 1,000 cfs (1 kcfs), but recognizing that additional permit applications could be accepted in the future (the analysis allows for review of higher water withdrawal levels, in 1 kcfs increments). The 1 kcfs is equivalent to about 118,000 acre-ft. during the months of July and August (60 days).

- Based on regional, seasonal irrigation pumping data,[6] it is estimated that approximately 50-60% of the total, seasonal irrigation pumping (water use)

Columbia Basin Research, UW, June 2001. The CRiSP Model is described in detail at the Columbia Basin Research, UW website: http://www.cbr.washington.edu.

[4] Also see D. Hupert, G. Green, and W. Beyers, "Columbia River Initiative: Economic Analysis," slide presentation, University of Washington, August 2003; and multiple personal communications with WADOE Spokane Office staff, 2002-October 2003, and WADOE spreadsheet data.

[5] WADOE Summary from Spokane Office staff, as summarized by UW Economics Review Team, August 2003 at main WADOE office in Olympia, WA (slide presentation for CRI Economics Review); and spreadsheet data.

[6] D. Olsen, "Northwest Irrigation Utilities End-Use Sector Profile," Report prepared for the Northwest Irrigation Utilities, Portland, OR, by the Pacific Northwest Project, Kennewick, WA, 1994 (source includes regional and

occurs during the months of July and August. The total irrigation season extends from March through early November.

Fish Survival and Production Assumptions:

- For analysis purposes here, the estimated 2003 juvenile out-migration is used.[7] The juvenile fall chinook out-migration for Snake River fall chinook is estimated to be about 2.1 million fish, and the Upper Columbia River fall chinook run (including Hanford Reach) is estimated to be about 22.2 million fish. Because the Snake River fish represent a small portion of the total run, they are lumped together with the Upper Columbia run when reviewing impacts (slightly overestimating impacts to the Snake River fish, as some water withdrawals only would be affecting the Mid-Columbia region). The smolt-to-adult return rate is estimated to be about 1% for both runs (NPPC and UW estimate).

- The vast majority of the Upper Columbia River out-migrating fall chinook fish originate from below Rock Island Dam (mostly Hanford Reach fish). As such, using CRiSP Model water withdrawal impact levels for fish migrating from above Rock Island Dam will overestimate the total fish impacts.

- Through the river system, the estimated impact per 1 kcfs water withdrawal is about 0.04% decline in migration survival (total system survival), to the Bonneville Dam tailrace, based on actual 2001 flow and water conditions (see Figure 2). For Hanford Reach fish, about a .01% decline in survival occurs. Total system survival includes both in-river and transportation survival (see Appendix A attached, CRiSP model output results, provided in electronic format).

- For sensitivity analysis purposes, CRiSP model calculations also are made with temperature increases beyond that which actually occurred in 2001. "Temperature loading" is created by relying on multiple year flow–temperature conditions (1990-2002) at Priest Rapids Dam.[8] This yields a temperature change estimate of about .01 degrees C for each 1 kcfs flow reduction; or a decrease in survival of about 1.3% (rate of change with temperature loading).

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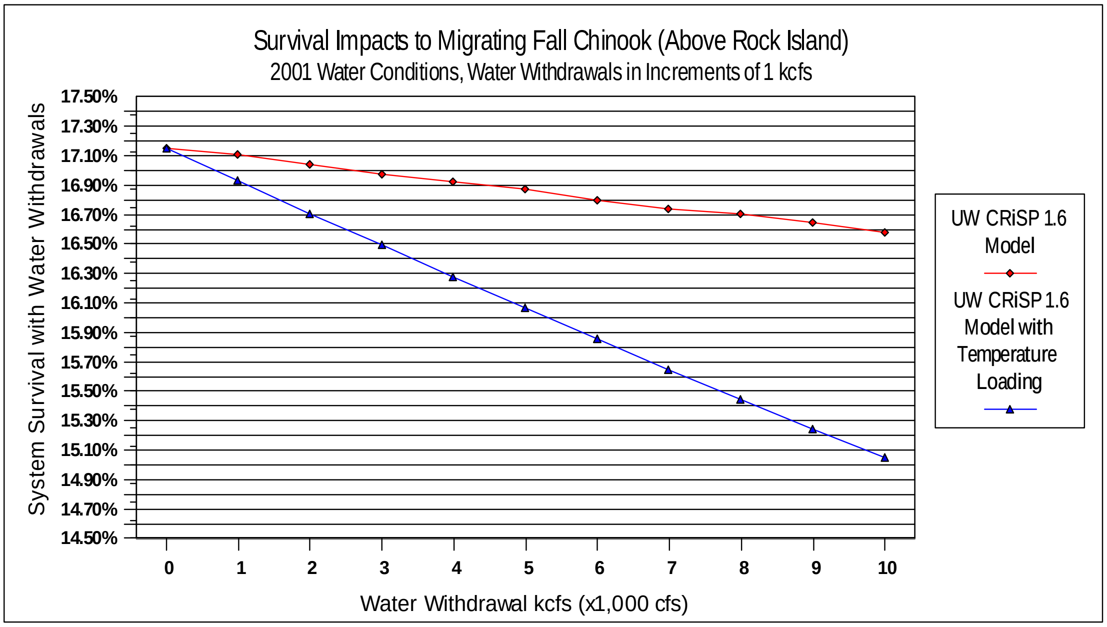
utility-specific data); and recent communications with WA State mainstem irrigators concerning seasonal pumping characteristics.

[7] Migration is based on estimates used by the Northwest Power Planning Council, as derived by Columbia Basin Research, University of Washington; see NPPC slide presentation, Fish and Energy Impacts Resulting from Reductions in Summer Bypass Spill," Portland, OR, July 16, 2003.

[8] The inter-year range is used to obtain a broader range of temperature conditions; it does not reflect empirical conditions for the 2001 water-year.

Figure 2. Simulated Water Right Withdrawals—Impacts to Juvenile Migrants



Source: Columbia Basin Research, UW, CRiSP 1.6-1.7 Model Analyses with XT Model Component.

- Based on an estimate of 24.3 million migrating fall chinook (some proportion of which migrate outside the July-August period), about a 9,720 juvenile fish decline would result from a survival rate decrease of 0.04%; or about 97 adult fish. With temperature loading conditions, about a 315,900 juvenile fish decline would result from a survival rate decrease of 1.3%; or about 3,160 adult fish.

- Assuming an average migration travel time of about 21 days (Rock Island-Hanford Reach fish to Bonneville tailrace), each 1 kcfs equals 41,580 acre-ft.[9]

<u>Fish Valuation Assumptions:</u>

- Fall chinook impacts are distributed and valued among commercial and sport fisheries. For analysis purposes here, it is assumed that fish are allocated at 60% commercial catch (including Indian fisheries and ocean catch) and 40% sport fisheries (ocean and in-river total fisheries).[10]

- For the commercial fisheries (including all Indian fisheries), it is assumed that 50% of the gross catch value represents net economic value; and that commercial

[9] Columbia Basin Research, UW estimate (average travel time, for mixed fall Chinook fish runs).

[10] The Joint Staff TAC Report," Final In-Season Fall Fact Sheet" November 25, 2002, assigns 80% of the in-river fall chinook harvest to commercial and Indian fisheries and 20% to sport fisheries. Ocean harvest allocations vary. In previous years, harvest was dominated by commercial catch (as noted by the NMFS Economics Technical Committee Report), but it appears more recently that allocations to sport fisheries are increasing.

value reflects a higher value commercial fishery, such as the Indian "river-bank" sales fisheries. It is assumed here an average gross value at about $40/fish, and net value at $20/fish.[11]

- Sport fisheries values are based on values previously derived from regional estimates, including estimates used by the NMFS Economics Technical Committee review (1996) and from the more recent applications, such as the Lower Snake River Dams mitigation EIS.[12]

- Available sport fishing value estimates suggest the following value ranges adjusted to 2002$[13] in dollars per fish: from Olsen, et al., 1991, and values used by Huppert in the NMFS Economics Technical Committee report, $63 (Columbia River Basin salmon); from Olsen et al., 1994, $97 (fall Chinook, Rogue River); from literature sources reviewed by Carter,[14] $53-$97. A marginal value per fish estimate (all Columbia River salmon and steelhead) from Olsen, et al., 1991, is $94 per fish, a total value estimate including a non-use value component (sport, option, and existence values included).

- Two factors are considered in whether to apply non-use (passive or existence) values to the fish resources. First, relative to the use or application of existence values or passive non-use values, their application must be consistent across all resource sectors for an equitable comparison. For example, if non-use values are included for fish resources, then they must be included for irrigated agriculture as well.[15] Otherwise, the net economic benefit comparison is not structurally equivalent among sectors. And second, while key regional applications have noted or identified existence values, they have been reluctant to apply directly such values to formal agency direct net benefit assessments (or benefit-cost

[11] Net economic value estimate of 50% consistent with D. Huppert and D. Fluharty, "Economics of Snake River Salmon Recovery: A report to the National Marine Fisheries Service," School of Marine Affairs, UW, Seattle, 1996 (also known as the NMFS Economics Technical Committee report); use of "river bank" fisheries' values should be considered as high value relative to other types of commercial fisheries; if fish predominantly range between 10-20 lbs. each, at $2.00-3.00 per lbs., then $40.00 per fish provides an acceptable mid-point estimate. All Indian catch—commercial and subsistence--is assigned commercial values, consistent with NMFS Economics Technical Committee report.

[12] Sources used are D. Olsen, J. Richards, and R. D. Scott, "Existence and Sport Values for Doubling the size of Columbia River Basin Salmon and Steelhead Runs," RIVERS Vol. 1, No.1, 1991; Olsen, et al., "Rogue River Sport Fisheries Economic Valuation Study," Report prepared for the Oregon Dept of Fish and Wildlife, the U.S. Bureau of Land Management, and the U.S. Forest Service, with Rogue Valley Council of Governments, prepared by the Pacific Northwest Project, Kennewick, WA, 1994; D. Huppert and D. Fluharty, "Economics of Snake River Salmon Recovery: A report to the National Marine Fisheries Service," School of Marine Affairs, UW, Seattle, 1996 (also known as the NMFS Economics Technical Committee report).

[13] Using GDP implicit price deflator.

[14] Unpublished review paper by Chris Carter, ODFW Economist, summarizing regional salmon economic values, "Values and Economic Impacts of Salmon and Steelhead Production, ODFW, Portland, Oregon, 2003.

[15] For example, see discussion on this subject D. Olsen and H. Ziari, "Western Irrigation Economic Benefits Review-Irrigated Agriculture's Role for the 21st Century." Report prepared for the Family Farm Alliance by the Pacific Northwest Project, Kennewick, WA, 1998; and the issue of structural equivalency for benefits also was discussed within the NMFS Economics Technical Committee , 1996, led by Dan Huppert, Ph.D., University of Washington.

analyses).[16] This reluctance is based on questions of reliability, methodology, lack of a real market transaction, the presence of altruistic intensions, and structural consistency.[17] Yet there are other regional observers who have suggested that they should be used.[18]

- In this analysis, non-use values are noted, but not directly applied to the water value estimates, given the above observations. It further is noted that the total value estimates (including non-use value) derived from Olsen, et al., 1991, are not substantially different from the sport value estimates used in this report.[19]

- All fish impacts are assigned to the commercial (and Indian) and sport fisheries; the fish impacts are small and incidental take is already allowed for in the commercial and sport fisheries. For 2001 conditions, this would suggest 97 fish lost to the fisheries, with about 58 fish within the commercial (and Indian) fisheries, and 39 fish to the sport fisheries. In dollar terms, the commercial fisheries impact would be, (58 fish) ($20) = $1,160; for sport fisheries, (39 fish) ($97) = $3,783; the total being, $4,943.

- For 2001 conditions with temperature loading applied, this would suggest 3,160 fish lost to the fisheries, with about 1,896 fish within the commercial (and Indian) fisheries, and 1,264 fish to the sport fisheries. In dollar terms, the commercial fisheries impact would be, (1,896 fish) ($20) = $37,920; for sport fisheries, (1,264 fish) ($97) = $122,608; the total being, $160,528.

- Based on the above assumptions and data, the net economic value of water for fish resources would be: ($4,943 fish value)/(41,580 acre-ft. for 21 days at 1 kcfs) = $0.12/acre-ft. Under the temperature loading sensitivity analysis, the value of water for fish resources would be: ($160,528 fish value)/(41,580 acre-ft. for 21 days at 1 kcfs) = $3.86/acre-ft.

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[16] See assessment and discussion by Huppert and Fluharty, "Economics of Snake River Salmon Recovery," 1996; Corps of Engineers, "Lower Snake River Salmon Mitigation Feasibility Study EIS," 2000; Independent Economic Analysis Board, Northwest Power Planning Council, "Review of Economic Appendix I of the Corp's Lower Snake Feasibility Study," NPPC, Portland, Oregon, 2000.

[17] This has been a topic of great debate within the regional economic forums formed to review the federal agencies' river system EISs, as well as within the NMFS Economics Technical Committee review. Other skeptics of existence value estimates include: H-P. Weikard, "The Existence Value Does Not Exist and Non-Use Values Are Useless," Dept. of Social Sciences, Wageningen University, The Netherlands, Paper prepared for the European Public Choice Society, Belgirate-Lago Maggiore, Italy, 2002; Marvin Shaffer, "Limitations on the Concept of Value: Implications for the Role and Application of Cost-Benefit Analysis," Discussion Paper, Department of Economics, University of Queensland, May 2000; R. Nelson, "Does Existence Value Exit? Environmental Economics Encroaches on Religion," School of Public Affairs, University of Maryland (from the Independent Review, Vol. 1, No.4, 1997); as well as other sources.

[18] See comments offered by J. Loomis, "Passive Use Values of Wild Salmon and Free-Flowing Rivers," Agricultural Enterprises, Inc, Ft. Collins, CO, 1999. These views are consistent with the positions of some other resource economists.

[19] We also note the total use values estimated by D. Layton, G. Brown, and B. Plummer, "Valuing Multiple Programs to Improve Fish Populations," Paper prepared for the WA State Dept. of Ecology by Dept. of Environmental Science and Policy, UC Davis, 1999 (Draft).

2.2 Observations and Discussion.

- For analysis purposes here dealing with the existing water right applications, the estimated impacts to water values for fish resources are about $0.12/acre-ft. under actual 2001 conditions, and $3.86/acre-ft. for the sensitivity analysis with temperature loading.

- It should be explicitly noted that the above estimates (impacts) for fish values are based on a low water-year condition like 2001. Under average or high water years, fish impacts (and thus economic values) are not expected to be perceptible or measurable. Consequently, the value per acre-ft. would be much less than noted above, when the values are estimated over an annualized, net present value time horizon (for an equitable comparison among water value sectors). In most years across the present value time horizon, the fish impact value would be zero (where impacts to production are not measurable).

3.0 Irrigated Agriculture—Analysis Objectives.

3.1 Key Assumptions and Methodology.

- Based on the study methodology remarks made by the Economics Review Team, it is assumed that enterprise budgeting will be used to estimate the primary water values for irrigated agriculture. While this is an acceptable method to pursue, it has been our experience that this method can underestimate actual values. This occurs, in part, because farm operators have a tendency to make rapid and creative adjustments to production costs, in order to maximize net returns at any given time. As such, printed data/analyses for farm enterprise budgeting can be quickly out-dated (including data used for sensitivity analyses or linear programming).

- Where data allow, a methodology that can provide a more explicit value of water for agricultural is the review of direct water purchases. Water marketing does exist within Eastern Washington and the affected area. We do not extend (or intend to offer) a detailed review here, but we do note some prominent examples.

- Franklin County Water Conservancy Board Chairman Henry Johnson's declaration identifies several water right sales, with municipal, state, and private sector purchases ranging between $450-1,000 purchases.[20]

- The Benton County Water Conservancy Board has been involved in several water right changes/transfers, where water marketing has occurred; also the BCWCB is frequently asked to recommend a water purchase price—request from both buyers and sellers.[21] The BCWCB is aware of two recent transactions where the sale

[20] Declaration of R. Henry Johnson Regarding Assignment of the State of Washington, Dept. of Natural Resources, Dated May 11, 2002, Kennewick, WA (document provided to Economics Review Team, August 2003).

[21] Darryll Olsen, Ph.D. is Chairman of the Benton County Water Conservancy Board, Kennewick, WA.

price for water was established at $1,000 per acre-ft. (one-time, full capital value). One involved a sale from irrigated orchard ground to a power plant (McNary Pool Water); and the second involves a water right transfer from orchard to grape ground (deep well water source, Lower Yakima Valley.)

- A recent review of water right sales and leases in the Lower Yakima Valley reveals annual water right leases of about $107-127/acre-ft., under 2001 low water-year conditions.[22]

- If the market value for water is assumed to be about $500 to $1,000 per acre-ft. (capital value), then estimates of annualized values can be made given various assumptions about cost of capital interest/discount rates and the time period for commercial lending. For example, using a capital value range of $500-600, with a 7-8% interest/discount rate range,[23] covering a conventional farm loan period of 15 years, the estimated value range would be between $54.90/acre-ft. to $116.83/acre-ft. A mid-point estimate would be about $86.00/acre-ft.

- It further is noted that the water market sales approach can be verified by examining the value of agricultural lands, with and without irrigation. For example, on the Horse Heaven Hills (irrigation served by the John Day Pool), the value (market price) per acre of dry-land wheat operations can be compared to the value of irrigated lands. This comparison will reinforce a market-price of $1,000 per acre-ft. (or higher).

3.2 Observations and Discussion.

- For analysis purposes here and given the above assumptions, an irrigated agriculture water value of $86.00/acre-ft. is provided.

- Because market values are an expression of the annualized values over time and should reflect the capitalized value of net returns to the water right holders, it would be expected that the annualized water market values should be consistent with values derived from a farm enterprise budget. That is, it should be expected that the annual enterprise budget values fall within a range between $54.90/acre-ft. and $116.83/acre-ft., where similar cropping patterns are observed (predominantly high-value crops).

[22] T. White, "Yakima River Storage Enhancement Initiative, Technical Paper, Water Sales, Leases, and Conservation." Prepared for the Washington Infrastructure Services by T. White, Consulting Economist, Portland, Oregon, January 2002.

[23] Nominal or market interest/discount rates are used here to be equivalent to the market-based values reflected by the other resource sectors. Real or social time preferences rates could be used, but for comparison purposes, other sector values would need to be expressed in similar terms.

4.0 Municipal Water—Analysis Objective.

The municipal and industrial sectors are included within the existing applications for new Columbia River water rights. As such, the value of water for these sectors should be quantified.

4.1 Key Assumptions and Methodology.

- Municipal and industrial water values usually exhibit the highest value for the use value sectors, because of the municipal/industrial sectors' higher willingness-to-pay and ability-to-pay for water. This value can be set at the marginal value of irrigation water transfers or the cost of new water supply sources. The value range is very broad for the municipal/industrial sectors, but it is also a high value range.

- Because the net economic value of water for the municipal/industrial sectors is effectively the marginal value of water for the irrigation sector (water sold from the irrigation sector to municipal/industrial sectors), the value level is set at or above $86.00 acre-ft.

4.2 Observations and Discussion

- It is estimated here that the municipal/industrial sectors' net economic value of water is equal to or greater than $86.00/acre-ft.

5.0 Hydropower Generation--Analysis Objectives.

Hydropower generation could be affected by additional water withdrawals, reducing power generation potential through the mainstem river system. This reduction in power output can be measured by estimating the power loss throughout the system, determining the marginal value of power, quantifying in dollar terms the power loss, and then converting the dollar loss to dollars per acre-ft. (power value impacts divided by total acre-ft. withdrawn from the system). This allows for a dollars per acre-ft. comparison that can be contrasted to other resource sectors.

5.1 Key Assumptions and Methodology.

- For analysis purposes here, the focus is on the July and August period, the period of highest water withdrawal for irrigated agricultural and a period of relatively high marginal power values relative to other time periods, when irrigated agriculture would be withdrawing water from the system. Estimating the power impact values for this period has the result of overestimating the annual dollars per acre-ft. impact, as water withdrawals (including municipal withdrawals) for the other period would be reduced, as well as marginal power values. It is expected that the Economics Review Team will assess the full annual period, and their estimate of power impacts, in dollars per acre-ft., will be less than that expressed in this analysis. Nevertheless, the methodological approach should be approximately the same.

- The estimates for power loss values are obtained from the Northwest Power Planning Council staff, with the power system operated under current conditions.[24] Power generation is based on a monthly 50-year average.

- These NPPC data provide estimates of the total system power production at each hydro project site in terms of MW/kcfs. For example, the July-August monthly average MW/kcfs value for the Wells Dam is 33.25; and for the McNary Dam, 14.35. The higher the elevation in the system, the more power is generated per acre-ft. of water, as the water passes through multiple power projects.

- A 1 kcfs water withdrawal at Wells Pool, for July-August, can be converted to MWhs by the following calculation: (33.25 MW) (24 hours) (60 days) = 47,880 MWhs, or 47,880,000 kWhs. For a 1 kcfs water withdrawal at McNary Pool: (14.35 MW) (24 hours) (60 days) = 20,664 MWhs, or 20,664,000 kWhs.

- The NPPC staff have estimated near-term (2005-2006), average monthly wholesale power prices for July and August at 27-40 mills/kWh, with further staff estimates suggesting a higher range up to 45 mills/kWh.[25] For analysis purposes here, 40 mills/kWh will be used for the July-August time period.

- At 40 mills/kWh, a 1 kcfs water withdraw at Wells Pool, for July-August, represents a dollar value impact of: (47,880,000 kWhs) ($0.04) = $1,915,200; for McNary Pool: (20,664,000 kWhs) ($0.04) = $826,560.

- As noted above, 1 kcfs is the amount of peak flow roughly equivalent to the water withdrawals of the existing Washington state water right applications. Focusing on the July-August period (60 days), 1 kcfs for 60 days is equivalent to 118,800 acre-ft.

- Given the above, the power impact value for a 1 kcfs withdrawal at Wells Pool would be: $1,915,200/118,800 = $16.12/acre-ft.; and for McNary Pool, $826,560/118,000 = $7.00/acre-ft.

- The existing water right applications (consumptive use), representing about 1 kcfs peak usage, primarily withdrawing water from the John Day, McNary, and Wells pools. Approximately 75% of the water withdrawal would occur at or below McNary Pool, and about 25% at or below the Wells Pool.

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[24] Northwest Power Planning Council Staff, Portland Oregon, spreadsheet data for MW/kcfs, for mainstem hydropower projects operating under the 2000 NOAA Fisheries Biological Opinion, received October 2003.

[25] Personal communications with Northwest Power Planning Council Staff, October 2003.

- Under the above assumptions, the weighted average value for the power system impacts, from the new water rights (based on existing applications), would be about $9.28/acre-ft.

5.2 Observations and Discussion.

- Relying on the above assumptions, an average weighted value of $9.28/acre-ft., is calculated for the value of water for power resources—foregone hydropower production.

- The Economics Technical Committee will likely be estimating the hydropower costs across the full monthly range of water withdrawals and marginal power costs. It is likely that their dollars per acre-ft. estimate for power resources will be less than the value calculated above.

6.0 General Analysis Summary and Observations.

Economic Value of Water Summation:

- The estimated water value for fish resources is approximately $0.12/acre-ft. under actual 2001, low water conditions (and $3.86/acre-ft. for the sensitivity analysis with temperature loading). Because this impact level is not expected to occur during average or high water years, the value levels above overstate the average annual impacts.

- The estimated water value for irrigated agriculture is approximately $86.00/acre-ft., depicting recent water market sales.

- The estimated water value for the municipal and industrial sectors is equal to or greater than $86.00/acre-ft.

- The estimated water value for hydropower production is approximately $9.28/acre-ft. (high value estimate).

6.1 Economics Issues for Further Review.

Economic Theory and Water Allocation:

- For this analysis, the relative ranking of resource net benefit values, in terms of dollars per acre-ft. of water, is consistent with previous water value estimates for the Columbia River.[26] For this review, direct net benefits per acre-ft. of water may be ranked, from highest to lowest, as: Municipal/industrial, irrigated agriculture, hydropower, and fish resources.

[26] See D. Olsen, J.Anderson, and J. Pizzimenti, "Columbia River Flow Targets and Augmentation Program Review," Report prepared for CSRIA, EOIA, IWUA, WSWRA, prepared by the Pacific Northwest Project, Kennewick, WA, 1998.

- The basis for the Economics Review Team's analysis project is tied solely to the question of whether mitigation is required or should be required relative to the issuance of new water rights from the mainstem Columbia River. This question necessarily leads to two consecutive paths: one theoretical, which serves as the foundation for the second path; the second path dealing with the pragmatic application of any mitigation requirements.

- Concerning the first path, economic theory turns to benefit-cost analysis as an applied means of measuring social welfare changes caused by resource development or allocation decisions. What is being primarily determined is whether net system efficiency gains would result, and to a lesser extent whether the potential Pareto criterion is met (where no party is made worse off by the policy action, while some other party gains). The emphasis tends to focus on net efficiency improvements, rather than fulfilling the Pareto criterion. In theory, the gainers would be able to compensate the losers, thus leaving no one being worse off given the policy decision at hand.

- In the present case, it is the desire to move "compensation" from theory to practice that drives the state (WADOE) toward securing "mitigation" dollars from the water right holders. The perception exists that "surely there must be a loser to receive compensation" if new water rights are issued.

- Based on the above analysis, any additional allocation of water for new water rights to the municipal/industrial and irrigation sectors would represent a net system efficiency gain.[27] Additionally, the only appreciable, negative net economic impacts that do occur affect the hydropower production sector—not the fish resources.

- Some policy makers may argue that the relative net gain to efficiency improvements alone are sufficient to proceed with the allocation of water rights; others may favor an option to grant the water rights but also seek a compensation strategy.

<u>Pragmatic Application of the "Compensation:"</u>

- The second path deals with the pragmatic means and decision by which policy makers compensate the "losers," thus not only inducing higher levels of efficiency but also fulfilling the Pareto criterion via compensation. In this case, a policy decision to require a fixed-fee, annual payment by the water right recipients equal to the value of the hydropower sector's loss would be sufficient.

[27] Moreover, it would strongly suggest that current uses of large volumes of water, allocated to system flow augmentation, to support fish resources (including existence value) are highly inefficient. Any change to move water back to a more efficient allocation of resources should be preferred.

- Based on the above analysis, the annual, fixed-fee payment would be no more than $9.28/acre-ft., for the mainstem Columbia River applications. How the hydropower sector uses this compensation is discretionary. The hydropower managers could either directly acquire additional power resources, or they could use the funding to off-set some existing cost obligations—such as fish and wildlife program expenses.

- Concerning any mitigation efforts, the concept of “bucket-for-bucket” water replacement being considered by the state is not supported by benefit-cost analysis or economic compensation requirements. The mitigation emphasis would be on direct dollar-for-dollar impact compensation, not acre-ft. per acre-ft. replacement of water.