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November 17, 2005

MEMORANDUM

TO: Council Members

FROM: John Fazio, Senior Systems Analyst

SUBJECT: Analysis of the Injunctive Relief Operation for the Hydro System

Summary

The plaintiffs, in the current court hearings regarding the NOAA Fisheries' biological opinion, have filed a motion seeking an injunction from Judge Redden that would allow alternative spill and flow operations for 2006. The proposal calls for more bypass spill and greater volumes for flow augmentation. A more detailed summary of the proposed operation is provided in Appendix A. The results provided below are preliminary.

Implementing the proposed injunctive relief operation this year would have a detrimental effect on the adequacy of power supply, if increased curtailment of fish and wildlife operations during power emergencies were not allowed. Assuming the same limits on emergency operations as modeled for the biological opinion, the winter loss-of-load probability (LOLP) rises to 7.5 percent for the relief operation. That is well above the near zero value under current operations and is also above the historical 5 percent standard used by the Council. In order to restore the LOLP to an acceptable level, a more liberal allowance for emergency operations would be needed. This would result in some reservoirs not being as likely to fill to desired elevations by early April.

The injunctive relief operation would also result in both a seasonal shift in, and a net loss of, hydroelectric generation. The cost of this change is calculated by assuming that surplus generation would be sold on the market and that deficits would be made up with market purchases. For this year, the resulting average regional cost is about \$400 million, ranging from a low of about \$125 million to a high of about \$560 million (depending on water conditions). This assumes that the market would be large enough to absorb the expected changes in hydro generation -- an assumption that may not be valid under some conditions.

Methodology

Staff has completed an initial analysis of the proposed operation. The analysis was done using the GENESYS model, which simulates the operation of the northwest power supply. Two regional studies were run, one assuming the hydroelectric operation in the current biological opinion language and a second assuming the proposed operation under the injunctive relief order.

Each study began with known reservoir elevations on November 1, 2005 and simulated the operation through August of 2006. Demand assumptions were based on the Council's medium forecast (but varied due to temperature uncertainties). The full range of water conditions were used, primarily because initial forecasts for runoff volume indicate average conditions for the coming year (but the uncertainty level is very high). All regional resources, not contracted to serve out-of-region load, were assumed to be available for dispatch (including independent power producer resources). For the winter period (December through March) 3,000 megawatts of surplus out-of-region spot market supply was assumed to be available, if needed. For the summer (June through August) only 500 megawatts of spot market supply was assumed to be available.

The model was allowed to draft reservoirs below normal rule curve limits in cases of emergency (that is, when all other available resources, including spot market imports, are exhausted). This operation includes curtailing fish and wildlife operations, if necessary. The amount of this emergency draft varies from month to month and year to year depending on conditions. Emergency draft limits set in the model were determined after many discussions with system operators. The limits were based on a set of prudent and likely actions that operators would take to keep the lights on during power emergencies. When emergency hydro is used, attempts are made to replace it as soon as is physically possible.

The injunctive relief language also contains proposed changes to the operation of Canadian reservoirs. In short, Canadian projects are asked to also fill during winter months to provide more flow for fish during spring and summer. While it is quite uncertain whether the Canadians will participate, it is clear that if they do, compensation (in the form of energy deliveries to Canada) would be required. This compensation would be on the order of 800 average megawatts. This additional load was not added to the injunctive relief study. A variation of the injunctive relief operation in which the Canadians do not participate was not examined due to lack of time.

Results

The region currently has a surplus of resource capability; in particular, the annual energy capability is estimated to exceed expected demand by about 2,000 average megawatts. This surplus capability, however, is not distributed evenly across each month of the year. Over the region's peak winter demand period, the average surplus is only about 500 megawatt-months, while the average summer surplus is about 4,500 megawatt-months. (Surplus capability was calculated using hydro generation based on the biological opinion operation under critical water conditions). Changing the hydro generation pattern, as called for in the proposed operation, would put the power supply into a deficit situation over winter months.

Power Supply Adequacy

One measure of a power supply's adequacy is the assessment of the likelihood of curtailment to service. This measure is commonly referred to as the loss-of-load probability (LOLP). Normally, the LOLP is calculated over the winter period for the Northwest because that is the peak demand season. Historically, the Council has used a target of 5 percent as the measure of an adequate supply, that is, the LOLP must be at 5 percent or lower. (In its Fifth Power Plan, however, the Council developed a resource strategy that not only provided an adequate supply but also minimized the likelihood of electricity price spikes. That resource strategy implies an LOLP that is much closer to zero.) Under the biological opinion operation, this winter's LOLP is near zero percent -- meaning that the power supply is adequate.

One of the reasons that the northwest power supply is currently deemed to be adequate is that fish and wildlife operations can be curtailed for short periods during power emergencies. This emergency hydro energy must be used only as a resource of last resort, and mitigating actions to restore the operation must be taken as soon as possible. Without the use of emergency hydro operations, the adequacy of the power supply under the biological opinion would be unacceptably high.

Assuming the same limits on emergency operations as modeled for the biological opinion, the winter loss-of-load probability (LOLP) rises to 7.5 percent for the relief operation.¹ That is well above the near zero value under current operations and is also above the historical 5 percent standard used by the Council. In order to restore the LOLP to an acceptable level, a more liberal allowance for emergency operations would be needed.

The summer is generally a period when the northwest is most surplus. The injunctive relief operation proposes to draft reservoirs to lower elevations by summer's end. However, due to increased bypass spill requirements, energy production in July and August is lower than it would be under the biological opinion operation. If fish and wildlife operations could be curtailed during power emergencies, then the summer LOLP should not be affected.

Economic Assessment

The expected monthly hydroelectric generation from the injunctive relief case is compared to that under current operations to assess the "power system" cost. In months when the injunctive relief case shows greater hydro generation, it is assumed that the additional energy will be sold on the market and bring in revenues. In months when hydro generation is less, the difference is assumed to be purchased from the market. Each month's energy cost or benefit is calculated and then summed to determine the expected annual cost.

An important assumption for this calculation is that the market will be large enough to supply all the energy the region may need during deficit months and that it can absorb all the surplus hydro

¹ The reason that both the biological opinion and the injunctive relief operation may affect LOLP is that they both require reservoirs to store water over winter months, which of course reduces energy production. If reservoirs are allowed to draft below fill requirements during emergencies, however, the adequacy of the power supply can be maintained.

generation. Table 1 below provides the expected monthly change in hydroelectric generation and the associated cost or benefit. The net expected energy cost for the injunctive relief case is about \$400 million for this year (November 2005 through August of 2006), ranging from a low of \$125 million to a high of \$560 million depending on water conditions.

From Table 1 below, the average January reduction in generation is over 4,600 megawatt-months. That is enough energy to supply four cities the size of Seattle for one month. In one water condition, (not shown in Table 1) the reduction in hydro generation was nearly 7,000 megawatt-months. These deficits exceed the assumed maximum available out-of-region supply of 3,000 megawatts used to assess the LOLP. However, this exercise is simply a means of estimating the cost to the power system. In the event that market supplies could not cover a northwest deficit, it was assumed that fish and wildlife operations would be curtailed up to limits allowed in the model.

Table 1
Average Change in Hydro Generation and Cost/Benefit

Period	Change in Generation (mw-months)	Cost (millions of dollars)
November	441	- \$22
December	-486	\$26
January	-4,638	\$348
February	-355	\$27
March	1,490	- \$65
April 1-15	-900	\$49
April 16-30	-527	\$28
May	1,459	- \$53
June	320	- \$12
July	-868	\$40
August 1-15	12	- \$1
August 16-31	-523	\$30
Total	-4,605	\$395

Physical Impacts

One of the obvious reasons for implementing an operation such as the one proposed under the injunctive relief is that river conditions would be more suitable for salmon. With that in mind, one of the objectives of both the biological opinion (BiOp) and preliminary injunction (PI) operations is to have reservoirs as full as possible by the beginning of the salmon migration season (early April). Table 2 below shows the likelihood that reservoirs would be at flood control elevation by April 15th for both the BiOp and the PI studies. What is clear from Table 2 is that at Libby, Horse and Dworshak, reservoirs would be more full (on average) by April 15th under the PI operation. The likelihood of Coulee being at flood control elevation, however, drops from 80 percent in the BiOp to 72 percent in the PI operation. It is not clear at this point why this is the case.

Table 2 also includes the refill probabilities when no emergency hydro operations are allowed. This additional draft is referred to as hydro flexibility or in Table 2 as “flex.” The amount of hydro flex used in the BiOp case is sufficient to keep the LOLP down while at the same time not affecting the April refill probabilities. For the PI case, this is also true at all reservoirs except Hungry Horse, where the refill probability drops from 62 percent under the no-flex case to 58 percent when flex is used. Overall, the prudent use of hydro flexibility (that is, being able to curtail fish and wildlife operations during emergencies) has only a small effect on spring refill probability. The increases in refill probabilities under the PI operation are not large (and in Coulee’s case it is lower) but what is not shown is the total volume in storage at these projects. Unfortunately that information was not available at the time of this writing.

Table 2
Probability of Being at Flood Control Elevation by April 15th

	Libby	Horse	Coulee	Dworshak
BiOp (with flex)	40	54	80	72
BiOp (no flex)	40	54	80	72
PI (with flex)	42	58	72	74
PI (no flex)	42	62	72	74

Table 3 below provides the expected change in average monthly river flows for both current operations and the injunctive relief operation. The largest changes occur in the lower Columbia River where, for the most part, flows during the migration season increase. On the Snake River, increases in flows are observed in April through July, with reductions in August.

Impacts to reservoir elevations are provided in Table 4. There is no change in elevation at Albeni Falls. The largest changes appear at Grand Coulee and Dworshak reservoirs. The end-of-August elevation at Grand Coulee is expected to be near 1,270 feet or about 10 feet lower than under current operations. At Dworshak, the expected end-of-August elevation will be about 1,535 feet, a little more than 6 feet lower than under current operations. If the proposed operation is implemented this year and if it were to become a permanent operation, the lower end-of-summer elevations would have carry-over effects for the next operating year (September of 2006 through August of 2007).

The injunctive relief proposal also affects other fish and wildlife operations. For example, under the current biological opinion, Vernita Bar redds are dewatered in 3 out of 50 water years (in at least one month from December through May). Under the relief operation, redds are dewatered in 30 out of 50 years.

The dewatering of Chum salmon redds below Bonneville Dam decreases under the relief operation. Redds are dewatered (in at least one month between November and April 15th) in 27 out of 50 years for the proposed operation and 38 out of 50 years under the biological opinion. This effect is caused by the seasonal shifting of hydro generation and because flows increase when emergency drafts occur.

Table 3
Expected Monthly Average Flows

Month	Lr Grn Base	Lr Grn PI	Diff	McNary Base	McNary PI	Diff
Nov	23322	23322	0	112267	116067	3800
Dec	32241	32241	0	135070	130218	-4852
Jan	36803	36803	0	171170	111491	-59679
Feb	43756	43813	58	147232	141508	-5723
Mar	52927	51200	-1727	160378	180979	20601
Apr1	74383	76156	1773	191152	169529	-21623
Apr2	85402	87096	1694	223941	213710	-10230
May	105259	105281	22	268468	312653	44184
Jun	99862	99837	-25	299208	316167	16958
Jul	52118	55562	3443	224183	228818	4634
Aug1	32021	30986	-1035	174572	192138	17565
Aug2	28323	25474	-2849	142122	139484	-2637

Table 4
Expected Change in End-of-Period Reservoir Elevations (feet)

Month	Libby	Horse	Albeni	Coulee	Dwrshk
Nov	-9.2	0.0	0.0	-2.7	0.0
Dec	-4.3	0.0	0.0	-3.0	0.0
Jan	-3.3	4.3	0.0	21.2	0.0
Feb	-2.8	4.0	0.0	16.0	0.0
Mar	-2.6	2.0	0.0	-9.1	5.1
Apr1	-2.6	0.7	0.0	-1.1	3.1
Apr2	-2.7	0.2	0.0	0.9	0.3
May	-2.7	1.2	0.0	-2.3	0.0
Jun	-1.6	1.5	0.0	-1.3	0.0
Jul	-0.3	0.0	0.0	-1.5	-12.5
Aug1	-0.2	0.0	0.0	-8.4	-11.9
Aug2	-0.1	0.0	0.0	-8.9	-6.4

Appendix A

2006 Flow and Spill Operations Proposal²

Spring spill: Provide spill at the following projects in the following amounts between the following dates:

From April 3, 2006 through June 20, 2006 on the Snake River, and from April 10, 2006 through June 30, 2006 on the Columbia River (spill figures are in thousand cubic feet per second or a percentage of the total river flow) unless this spill would cause an exceedance of the applicable Total Dissolved Gas (“TDG”) limits, in which case spill would be limited to avoid exceeding the gas cap. *Italicized entries indicate changes from the current BiOp operation.*

	<u>Day</u>	<u>Night</u>
<i>Bonneville</i>	<i>100 kcfs</i>	<i>120 kcfs</i>
The Dalles	BiOp level	BiOp level
<i>John Day</i>	<i>45%</i>	<i>45%</i>
<i>McNary</i>	<i>55%</i>	<i>55%</i>
Ice Harbor	BiOp level	BiOp level
Lower Monumental	BiOp level	BiOp level
<i>Little Goose</i>	<i>30%</i>	<i>45 kcfs</i>
Lower Granite	BiOp level	BiOp level

Summer spill: Provide spill at the following projects in the following amounts between the following dates:

From June 21, 2006 on the Snake River and from July 1, 2006 on the Columbia River, through August 31, 2006 on both rivers (also subject to compliance with the applicable gas cap):

	<u>Day</u>	<u>Night</u>
<i>Bonneville</i>	<i>100 kcfs</i>	<i>120 kcfs</i>
The Dalles	BiOp level	BiOp level
<i>John Day</i>	<i>45%</i>	<i>45%</i>
<i>McNary</i>	<i>60%</i>	<i>60%</i>
Ice Harbor	BiOp level	BiOp level
<i>Lower Monumental</i>	<i>35 kcfs</i>	<i>35 kcfs</i>
<i>Little Goose</i>	<i>30%</i>	<i>45 kcfs</i>
<i>Lower Granite</i>	<i>21 kcfs</i>	<i>21 kcfs</i>

Flow conditions: Improve river flow conditions and provide a more natural hydrograph in the lower Snake and Columbia Rivers by:

(a) Maintain all FCRPS storage reservoirs (i.e., Dworshak, Grand Coulee, Hungry Horse, and Libby) at their upper flood control rule curve elevation on a bi-weekly basis (i.e., each reservoir would be at its upper rule curve elevation on or about the 15th and 30th of each

² Summarized by John Shurts.

month) from February 1, 2006, through April 30, 2006, and, through the Columbia River Treaty forum, ensure that Duncan, Arrow, and Mica reservoirs are maintained at their upper flood control rule curves on a bi-weekly basis during this same period, subject to weather related or other actual power generation emergencies. (Footnote: Identification of such emergencies and appropriate responses to them would be discussed in advance with the plaintiffs to the extent possible much as occurred during this past summer).

(b) Provide at least 500,000 acre feet of water from non-treaty Canadian storage or Lake Roosevelt (if necessary), and an additional 130,000 acre feet of water from non-treaty Canadian storage or Banks Lake (if necessary) for summer flow augmentation, with specific use of this water determined through in-season collaboration between the defendants, and state and tribal fishery managers.

(c) During both spring and summer seasons as described above for spill operations, operate the reservoirs above each of the projects on the lower Snake and lower Columbia Rivers at Minimum Operating Pool (i.e., with fluctuations up to one foot above the minimum operating pool elevation for each reservoir), with the exception of John Day Pool, which would be operated at Minimum Irrigation Pool, and The Dalles and Bonneville Pools, which would be operated according to the 2004 BiOp.

(d) Manage the flows and the storage described above to provide an average May flow peak at The Dalles of approximately 345,000 cubic feet per second (kcfs) with a gradually receding hydrograph following that, assuming that 2006 is an average water year.

Footnote: Because it is not possible at this time to foresee likely water conditions in the Snake River during the summer of 2006, NWF reserves the right to seek additional injunctive relief, by a supplemental motion to be filed on or before March 1, 2006, for summer flows in the Snake River only if NWF concludes that such relief is needed to further reduce the risk of harm to listed salmon.

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