Sediment Transport, Supply and Stability in the Hells Canyon Reach of the Snake River (E.1-1)

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I. Introduction

Idaho Power Company (IPC) studied the supply and movement of sediment above, through, and below the Hells Canyon Reach of the Snake River. The study addressed how the supply of sediment to the Hells Canyon Reach from the mainstem Snake River upstream of and within the Hells Canyon Complex has changed, what happens to sediment that is supplied to this reach from tributaries in the reach and how this supply might change under different operating scenarios of the Hells Canyon Complex.

The supply and movement of sediment is important for salmon spawning, recreational activity areas, heritage sites, and bank integrity. The report addresses two main questions. First, how has the construction and operation of the Hells Canyon Complex affected the supply and movement of sediment in the Snake River downstream of the complex? Second, what are the resulting effects to sediment-related features in the downstream reach?

II. Conclusions

1. "The storage capacity of the HCC is only about 10% of the average annual volume of the Snake River as given by calculated inflow to Brownlee Reservoir. Therefore, the HCC has a relatively small effect on the hydrograph downstream of the complex." (Page 2, Paragraph 3)

Response: The BLM agrees with this statement regarding the peak flows. However, the Hells Canyon Complex has significant impacts on seasonal and daily discharge rates. Prior to the complex, the change in discharge over a six-hour period was approximately 250-500 cfs. Following closure the Hells Canyon Complex discharge over a six hour period increased to 11,950-12,070 cfs. Hourly ramping rates range from 2,000-3,000 cfs. These fluctuations are believed to affect riparian plants, wildlife use, aquatic organism habitat, heritage resources, and recreation resources from Hells Canyon Dam to Asotin Washington.

2. "Changes in the river observed since the construction of the HCC (such as shrinking sand beaches) may be caused by human activity higher in the Snake River Basin since the mid-1800s and not by construction and operation of the HCC." (Page 2, Paragraph 4)

Response: The BLM does not agree with this conclusion. The applicant presents no evidence to support this conjecture. No studies or literature is presented to support the theory that a "slug" of sediment moved through the Hells Canyon Reach. The BLM does agree that the mainstem dams and tributary water storage projects above Hells Canyon Complex have reduced peak flows and decreased the volume of fine and coarse sediment transported downstream past Weiser when compared to pre-regulation conditions.

The construction of the Hells Canyon Complex has created a series of reservoirs that have impounded the Snake River. These pools trap run-off and sediment from Snake River tributaries such as Pine and Indian creeks in Hells Canyon Reservoir, Wildhorse River in Oxbow Reservoir, and Brownlee and Eagle creeks in Brownlee Reservoir. These resources were previously contributed to the Hells Canyon Reach.

The BLM believes that operation of Hells Canyon Complex does have an effect on the Hells Canyon Reach of the Snake River. The shrinkage of beaches and terrace erosion that have changed the river since closure of Brownlee Dam may be related to hydropower ramping rates. Daily and hourly ramping by the Hells Canyon Complex changes the ebb and flow of water through fine sediments at a rate not experience prior to Hells Canyon Complex construction thus causing excessive erosion.

3. "The transport competency of the Snake River upstream of the HCC is insufficient to mobilize and transport materials such as those found in the riverbed of the Hells Canyon reach. Therefore, no supply of bed-materials would be available from sources upstream of the HCC under historical hydrologic conditions." (Page 2, Paragraph 5)

Response: The BLM disagrees with this statement. The Snake River may not mobilize and transport the large materials found in the riverbed of the Hells Canyon Reach, but it does move sand and small gravel particles. IPC's data show that nearly 100,000 cubic yards of sand- and gravel-size particles are transported into Brownlee Reservoir annually. This estimate is based on the applicants finding that 62,000 acre feet of sediment has accumulated since closure of Brownlee Dam. Approximately 4% of the stored sediment in Brownlee Reservoir is composed of sand and larger materials. These smaller elements are vitally important to maintenance of salmon spawning and recreation related sand and gravel bars. Therefore, the BLM believes that the Hells Canyon Complex is responsible for the loss of significant amounts of sand and gravel needed for the maintenance of health and diversity in the Hells Canyon Reach.

4. "Less than 4% of the sediment trapped in Brownlee Reservoir (the uppermost dam in the HCC and the first of the three constructed by IPC) is larger than fine sand. All of the features of interest downstream are largely made up of sediments larger than fine sand." (Page 2, Paragraph 6)

Response: The BLM disagrees with this conclusion. The annual loss of approximately 100,000 cubic yards of sand and fine gravel to the area below Hells Canyon Dam is considered significant by the BLM. There is a component of material smaller than very

fine sand that helps pack sandbars together to form better cohesion. The loss of this material, which makes up 96% of the sediment in Brownlee Reservoir, should not be overlooked in its importance to maintaining sandbar integrity. Furthermore, the fine silts would have been annually deposited along the river bank where eddies and backwaters formed. These materials would have been trapped by riparian plants that have been lost. Few riparian plants remain along the Snake River because there is no longer a sediment component in the annual floodwaters to supply a rooting medium. Only a relatively few riparian plants still exist in a few protected locations.

Due to the high gradient and narrow canyon there are limited areas for material to be deposited below Hells Canyon Dam. Loss of even limited amounts of sediment availability to areas that need small amounts for maintenance is significant.

5. "The trapping of fine sediments in Brownlee Reservoir has not caused the downstream river to become more "sediment hungry" because the size and concentration of these sediments has no effect on transport capacity in the Hells Canyon reach of the Snake River." (Page 2, Paragraph 7)

Response: The BLM disagrees with this conclusion. The Hells Canyon Complex has created a sediment trap in Brownlee Reservoir. Currently, material smaller than fine sand transported into the Hells Canyon Complex settles to the bottom. The flows coming out of the Hells Canyon Complex at Hells Canyon Dam are relatively sediment free. Flowing clean water has greater transport capacity than water carrying sediment. Therefore, the flows coming out of Hells Canyon Dam meet the definition of a "sediment hungry river". Grams and Schmitt (1999) found that their study bars, previously covered by sand, are becoming armored with small gravel. This is indicative of clear-water flows eroding fine materials from previously stable bars.

6. "Because the basic form and character of the river were established under vastly higher flow conditions, the bed and bank materials provide extremely limited opportunity for river movement." (Page 2, Paragraph 8)

Response: The BLM agrees with the statement but not the context. The issue is not how the form and character of the Snake River was established. The issue is the erosion of finer sediments from relatively small areas that are important archeological and recreational sites. These areas of high public use and prehistoric value are currently being eroded by clearwater flows.

7. "River banks in Hells Canyon are very stable except at a few locations. A study of shoreline erosion (Holmstead 2001) indicates that the Hells Canyon reach is one of the most stable of the reaches studied (from Weiser upstream of the HCC to the Salmon River). Erosion occurred at 60 sites, or in 3.92 miles out of 125 miles (on both sides of the river), an area that accounts for about 3.1% of the reach. Most sites were above the range of typical flow fluctuation (Holmstead 2001)." (Page 82, Paragraph 1)

Response: The BLM disagrees with this conclusion because it is out of context with the issues of concern. IPC's statement concerning relative bank stability does not focus on the most important issue. Bank locations are eroding that have high public use and/or cultural values. Cultural sites are currently being lost to river erosion. The 3.92 miles cited by the applicant that are eroding may represent the areas of greatest concern.

8. "Continuing supplies of sands, gravels, and cobbles from local sources below Hells Canyon Dam have not been affected by the construction and operation of the HCC." (Page 2, Paragraph 9)

Response: The BLM agrees that this is a valid conclusion. However, the method of collecting data for estimating the bedload output from these tributaries does not appear to have been conducted with great scientific rigor. Statements in the text would indicate that the sampling procedure may have been biased. Estimating the frequency and contribution of large sluice-out events that occur relatively frequently was not included.

9. "Human activities in and above the Hells Canyon area, such as mining and grazing modified hill slope processes from the mid-1800s to the mid-1900s. These activities probably introduced an unusually large sediment supply to the river that decreased as the activities that introduced them also decreased. This "slug" of sediment may be working its way out of the Hells Canyon system." (Page 2, Paragraph 9)

Response: This statement is unsupported conjecture. There is no documentation of sediment affects on the Snake River during the period prior to the closure of Hells Canyon Complex. Grams and Schmitt's 1999 report points out that there has never been a sediment budget developed for the Snake River. The three locations that have been sampled provide a wide scatter of data points that were insufficient to draw any conclusions about the annual sediment yield of the Snake River. Therefore, the applicant's conclusion is not based on any measurable sediment production information.

10. *"There is no evidence that Brownlee Reservoir (the upper most reservoir in the HCC) has trapped significant quantities of sediment in sizes that could affect any of the important resources. More than 96% of the material trapped in Brownlee Reservoir is smaller than fine sand and therefore smaller than the majority of material found in the sandbars in Hells Canyon." (Page 82, Paragraph 3)*

Response: The BLM disagrees with this conclusion. The annual loss of approximately 100,000 cubic yards of sand and fine gravel to the area below Hells Canyon Dam is considered significant by the BLM. There is a component of material smaller than very fine sand that helps pack sandbars together to form better cohesion. The loss of this material, which makes up 96% of the sediment in Brownlee Reservoir, should not be overlooked in its importance to maintaining beaches, riparian zones, and sandbars.

Due to the high gradient and narrow canyon, there are limited areas for material to be deposited below Hells Canyon Dam. Loss of even limited amounts of sediment for

maintenance of areas that historically stored small amounts of finer sediments is significant.

11. "The Snake River upstream of HCC is incapable of transporting sediment of the size found in the riverbed in Hells Canyon under current hydrological conditions." (Page 82, Paragraph 4)

Response: The BLM agrees with the statement but disagrees with the inference the applicant is creating with this statement. The movement of materials of this larger size is not a concern. The Snake River may not mobilize and transport the large materials found in the riverbed of the Hells Canyon Reach, but it does move sand and small gravel particles. The applicant's data show that a substantial amount of sand-and gravel-size particles are transported into Brownlee Reservoir annually. A total of 4% of the stored sediment is composed of sand and somewhat larger materials. These smaller elements are vitally important to maintenance of salmon spawning and recreation related sand and gravel bars. Therefore, the BLM believes that the Hells Canyon Complex is responsible for the loss of significant amounts of sand and gravel needed for the maintenance of health and diversity in the Hells Canyon Reach.

12. "There are tributaries in Hells Canyon not affected by the HCC that supply sediment in the size range useful for maintaining the sandbars and gravel bed spawning sites in Hells Canyon." (Page 82, Paragraph 5)

Response: The BLM agrees with this statement. However, the documented decline in the number of sandbars indicates that the supply contributed by these tributaries is insufficient to maintain the bars at levels that were present when Brownlee Dam was closed. This is supported by the sandbar studies conducted by Grams and Schmitt (1999).

13. "There is clear visual evidence that many of these tributaries have supplied sediment to the Snake River in Hells Canyon in recent years under current hydrologic conditions." (Page 82, Paragraph 6)

Response: The BLM agrees with this statement.

14. "Mineralogical composition of bed-material sediments suggests that these sediments are of local Hells Canyon origin. The lack of minerals characteristic of the upper regions of the Snake River Basin suggests that riverbed material in the Hells Canyon reach were not transported from the upper parts of the basin (Miller et al. 2002)." (Page 82, Paragraph 7)

Response: The BLM agrees that the mineralogical composition of bed-materials is of local Hells Canyon origin, but it is not relevant to their concerns. The output of sand and gravel from local tributaries is not adequate to maintain the sand and gravel bars that are a major concern of the BLM. The lack of upstream fine sediment transport diminishes the availability of bar maintenance material. Clear water flows are believed to have eroded

bar-materials that were generated from above the HCC, leaving only locally generated mineralogy.

It is also probable that the annual output of 16 million tons of material from the adjacent Snake River tributaries cited by the applicant, composed of a high percentage of larger bed-material, including sand and gravel, replaced or buried all of the bed-material that may have been present from upstream sources at the time of closure. The finding that the existing bed material was not transported from above Hells Canyon Dam agrees with the mineralogical composition report by CH2MHILL. During the 44 years since closure, it is reasonable to assume that only local material would remain in the bed of the Snake River.

Sediment Sampling

15. "Shallow sediment samples, up to approximately 5-feet deep were collected every 5 miles along the thalweg from Brownlee Dam to RM 340, or approximately 8 miles upstream of the reservoir (Figure 1-1 and Figure 2-1)." Paragraph 6 states: "Multiple locations in and around the thalweg were sampled at RM 330 and RM 335 in an effort to recover sediment. As determined from the depth-sounder on the sampling boat, and manual probing with a spud rod (Vanoni 1977), the reservoir substrate at RM 330 consisted primarily of large rock-likely bedrock, boulders and large cobble. With nearly every deployment of the sediment sampler in this vicinity, the sound of the sampler impacting rock substrate could be heard. Very few fine-grained sediments were recovered at this location. The only two samples recovered within the vicinity of the thalweg consisted of 10 to 15 grams of sand and fine gravel (Appendix D1)." (Page 2-11, Paragraph 6)

Response:
The applicant's sampling plan required them to take sediment samples at 5 mile intervals the length of Brownlee Reservoir. They use a mixture of sampling techniques. The applicant focused on collecting fine sediment samples even in the area of the upper reservoir where gravel and coarse sand are abundant. Taking samples 5 miles apart using varied collection methods at the head of the reservoir along the thalweg may have miscalculated the amount of sand and larger particle sizes available. This collection of data does not appear to meet scientific sampling standards that would provide a statistically valid sample size.

The statement by the applicant that there was a substantial amount of coarse rocky material indicates that they may have biased their sample by only obtaining finer material than was representative of the general bed-material. The area between RM 330 and RM340 are areas where heavier bed-material settles out. A visible check from the Farewell Bend truck stop and weigh station (RM 335) indicates large gravel and sand bars are present in the river. Whether this material was historically present or has been deposited was not discussed.

It appears that much of the sampling was directed at mineralogy rather than obtaining an accurate estimate of particle size in the upper end of the reservoir. Very few samples

were taken in the area that has the predominance of sand- and gravel-size that is of greatest concern.

The report does not include the study sampling design or a precise map of all sample locations. There was no statement that the results of their sampling method would be statistically supportable. Many of their conclusions are based on the composition of the Brownlee Reservoir sediment samples. If the sampling scheme is unsupportable the conclusions would also be unsupportable.

Appendix Review

Special Appendix A-B for Technical Report Appendix E. 1-1
There are three parts to this report. 1) The report by CH2MHILL should be accepted only after the sampling scheme is examined and validated by a geomorphologist. 2) The mineralogy examination is clearly presented and thorough. The BLM should accept the mineralogy findings. 3) The appendix of the report presents sampling logs and tables.

Special Appendix C-F for Technical Report Appendix E. 1-1
This appendix is properly numbered and all tables are labeled.

III. Study Adequacy

1. The study is not adequate. The Brownlee Reservoir sampling design is not presented in detail. The study design for collecting sediment needs a complete review by qualified specialists in the field of geomorphology. The description of techniques used and the frequency and location of samples appears inadequate.

2. The examination of the mineralogy was conducted using a qualified laboratory and appears to be of high quality.

3. A number of assumptions about sediment transport are based on empirical equations. These equations need to be reviewed by a qualified specialist in that field before the BLM accepts the findings.

4. The conclusion appear strongly biased toward a predetermined conclusion that no sediment problems can be attributed to the Hells Canyon Complex

IV. BLM Conclusions and Recommendtions

Conclusions

1. The sediment sampling procedures do not appear to be statistically valid. If the sampling is not statistically valid, the conclusions presented by the applicant cannot be validated.

2. The applicant makes a number of statements that are speculation without supporting evidence. One such statement is that a “slug” of sediment caused by the mid-1800 anthropogenic activities upstream from the HCC created sandbars that are now being removed from the system.

3. The applicant has created a good inventory of existing fall chinook salmon spawning bars. The spawning bars in the river should be continually monitored to ensure that there is no net loss. The chinook spawning bar study period of record is not long enough to verify that they will remain stable.

4. The presentation of data by the applicant is designed to show that they are not affecting the river below Hells Canyon Dam. The statement that only 3.1% of the river bank shows erosion in the reach below Hells Canyon Dam is an attempt by the applicant to dismiss previously documented beach and terrace erosion. The applicant did not compare the amount of bank area that is erodible with the bank area that is solid rock and not erodible. Such a comparison would produce an entirely different picture of the extent of the erosion occurring in the Hells Canyon Reach.

5. The premise that upstream dams have eliminated 85% of the sediment watershed and supply is emphasized. The bed-material produced by the remaining 15% of the area is minimized or discounted. The amount of sand and gravel in Brownlee Reservoir is discounted as insignificant when, in fact, is may be very significant. Only a few depositional areas in the Snake River below Hells Canyon Dam can actually store sand or gravel. Therefore, a limited but steady contribution may have been enough to maintain those areas.

6. The applicant makes no correlation between beach sand loss and the loss of terraces that are supported by these beaches. They do not take responsibility for the affects of ramping on beach or terrace erosion. They feel that the high flow events that the applicant cannot control are causing the terrace erosion.

<u>Recommendations</u>

1. A team of highly qualified geomorphologists well versed in sampling methodologies and statistical analysis should be commissioned to provide an unbiased opinion of the methods used and conclusions reached in the *Sediment Transport, Supply and Stability in the Hells Canyon Reach of the Snake River* report.