

Memorandum

To: Frank DeMarco – County Counsel,
Siskiyou County, CA

From: Stuart L. Miner – Brownfield Partners, LLC
John Lambie – E-pur, LLC

Re: Preliminary Review of Klamath River Dam **CC:**
and Sediment Investigation

Overview

Brownfield Partners, LLC (BP) and E-pur, LLC (E-pur) have performed a preliminary review of documents addressing dam removal and sediment evaluations on the Lower Klamath River hydropower system owned and operated by PacifiCorp. Our review on behalf of Siskiyou County was performed in a very short time frame and included a limited number of selected reports taken from a very large body of studies and investigations. For this reason, our review and findings should be considered of a preliminary nature. A list of thirteen documents related to sediments that we were able to obtain and read is attached as Table 1.

Summary Recommendation

There have been numerous studies of Klamath River hydropower dams performed since 2001 for a number of different “clients” and with different goals and purposes. These studies include, for example:

1. Studies completed by PacifiCorp on dam retention for relicensure by the Federal Energy Regulatory Commission (FERC);
2. Studies done by FERC on alternative energy generation alternatives; and
3. Studies done by intervenors to the FERC relicensing process that have looked at dam removal.



Based on the studies reviewed by BP and E-pur, no entity has completed an independent analysis of alternatives for the dam and hydropower generation that objectively looks at the risks and cost/benefit ratio of a realistic range of possible alternatives from dam removal to alternate hydropower generation alternatives. The 2006 Klamath River Dam and Sediment Study, itself states:

- "It (2006 Study) makes no attempt to provide a comprehensive or final analysis of dam removal as a project management alternative."
- "Nor does this report attempt to characterize in detail any adverse affects associated with the dam removal scenario presented."

The 2006 Study also presents in Appendix J a comprehensive list of "Additional studies and analyses that would be necessary precursors to dam removal."

Therefore, BP and E-pur strongly recommend that such a multi-disciplinary study that evaluates the economics and predictable engineered outcomes to modifications to the hydropower system be undertaken by Siskiyou County or by a group of potential settling parties to the FERC relicensing. Assistance to fund such a study could be sought from a state agency such as the California Resources Agency.

Review of Existing Sediment Studies for Klamath River Dam System and Concepts of Dam Removal

PacifiCorp performed an evaluation of the quantity and the likely sedimentary textures (e.g. grain-size and wood content) of the sediments (JC Headwaters 2003). They estimated that there is roughly 14.5 million cubic yards of sediment behind the 4 dams under discussion for removal (Boyle, Copco 1, Copco 2, and IronGate Dam). Most of this sediment is in the silt size-fraction.

American Rivers, a public interest group, completed a rudimentary evaluation of potential sediment transport after dam removal using Stillwater Sciences in 2004. This study did not use an accepted and well vetted engineering model for sediment transport¹. Stillwater had data from PacifiCorp's 2003 work but failed to take advantage of the detailed topographic profiles of sediment in the reservoir to perform a sediment transport analysis. Further they used a model that they coded the software for that accounts for only sand sized sediment deposition and re-

¹ The model used, DREAM-1, was designed by Stillwater Sciences to simulate deposition of coarse sediment like sand.



transport; the majority of sediment in the Klamath River reservoirs is silt sized or finer according to the 2003 and subsequent 2006 data. The depositional behavior and re-transport of those grain size fractions intermixed with sand and some gravel has not been evaluated. Stillwater Sciences has not done a useable analysis of the expected sediment depositional behavior of the Klamath River without the lower four dams. The river bed within and below the dam areas will re-equilibrate to the old hydraulic character of the Klamath River but the time scale for this and consequences for this have not been appropriately evaluated.

Potential consequences of downstream sediment deposition include:

- Raising the bed height of the river several feet;
- Entrapping fine grained sediment within the gravel beds below the dams such that it will take large floods (i.e. 100-year return frequency) events to hydraulically rework them to a native state suitable for benthic habitat conducive to healthy salmonid fisheries in these reaches;
- Deposition of polluted sediment into the riverbed and overbank sediment deposits depending on the timing and form of reservoir drawdown; and
- Polluting the mouth of the estuary with a large quantity of neutrally buoyant organic waste particles which contain the majority of toxins in the reservoirs.

The California State Coastal Conservancy (the Conservancy) has funded a number of studies and evaluations since 2006. A re-estimate of the quantity of sediment behind the dams was made by Dennis Gathard, PE in 2006 using the PacifiCorp data from 2003; Gathard estimates that roughly 20 million cubic yards of sediment is resident in the reservoirs behind the three dams mentioned with Copco 2 being devoid of sediment. Gathard Engineering then evaluated how a channel would cut through and carry sediment out of the reservoir stockpile; however he relied upon estimates of sediment concentration that are based upon the limited analysis performed by Stillwater Sciences; no study has been done that evaluates the "competency" of stream flow in a dynamic model to carry sediment and re-transport it.

An evaluation of sediment depth, grain-size, and some sediment quality characteristics on three of the reservoirs, JC Boyle, Copco 1 Reservoir, and Iron Gate Reservoir, was performed by Shannon & Wilson in 2006 (GEC 2006 Appendix D). Five locations in the JC Boyle Reservoir, twelve locations in the Copco 1 Reservoir, and nine locations in Iron Gate Reservoir were sampled for sediment depth and quality. Sediment quality was generally benign with respect to metals, PCBs, or herbicides pesticides. One detection of ethylbenzene was reported in the few samples analyzed for volatile organic chemicals (VOCs). Six samples showed evidence of



creosote compounds (i.e. naphthalene and phenanthrene as examples of PAHs in creosote) at low concentrations. One notable concern is that one sediment sample for each of the three reservoirs was analyzed for dioxins and it was found in all three samples in the range of 2.5 to 4.8 picograms per gram or parts per trillion (ppt) TEQ as 2,3,7,8-TCDD. The Canadian advisory for salmonid habitat is 1 ppt 2,3,7,8-TCDD. The Oregon residential soil screening level for human health is 3.6 ppt 2,3,7,8-TCDD and the California residential soil screening level for human health is 4.6 ppt. One or two of the samples exceed those standards for dioxins depending upon which states screening level you compare. The sediment tested is in California. Dioxins are known human carcinogens and they are bioaccumulative within the food chain. Dioxin is a known constituent in pentachlorophenol and there are known pentachlorophenol usage and spill sites on the Upper Klamath River Lake. More analysis of the potential for impact from release of these sediments in the reservoirs for dioxin quality is warranted.

Summary Points on Sediments

- Studies are preliminary and unreliable on outcomes of sediment transport after dam removal
- Potential short-term and long-term salmonid habitat disruption cannot be estimated as a result of the lack of studies
- Sediments appear to be generally benign but more testing for ubiquitous cancer causing chemicals such as dioxin are necessary

Detailed Recommendations

It is recommended that Siskiyou County should:

1. Request that detailed studies of sediment transport and redeposition be done using well-vetted public-domain sediment models such as HEC-RAS from the Army Corps of Engineers;
2. Request that an evaluation of the probable sediment loads be compared to aquatic habitat requirements to estimate the impact to the fisheries habitat that is to be restored by these proposed actions;
3. Require that further evaluation be done of sediment toxicity for dioxin and related compounds;



4. Require the broad stakeholder group to complete an engineering evaluation/cost analysis or engineering feasibility study in advance of any decision on dam relicensing, removal. A more comprehensive evaluation would look at:
 - a. Habitat impacts for each alternative,
 - b. Economic impacts to County government from each alternative,
 - c. Economic impacts to County resident groups from each alternative,
 - d. Probable water quality impacts,
 - e. Potential human health risks, and
 - f. Other potential impacts (e.g. construction issues)
5. Organize the stakeholder group to obtain grant funding or other funding source for the necessary studies.

Closing

We are pleased to provide this preliminary review and analysis for Siskiyou County. As noted in the Introduction, our analysis and conclusions are based on a very short-term review of a limited number of studies. We believe the conclusions made are supportable and accurate. However, we strongly recommend that Siskiyou County pursue a more comprehensive analysis of this issue, as noted above.

Please let us know if you would like our further assistance in evaluating matters on the Klamath River system.

Attachments: Table 1 Documents Identified and Reviewed by Brownfield Partners and E-pur

**Siskiyou County Dam Removal Documents Review
By Brownfield Partners and E-pur, llc**

| Table 1 - Sediments Studies Identified and Reviewed | | | |
|--|----------------|--|---|
| Author | Date | Title | Prepared For |
| Stillwater Sciences | Sept. 6, 2007 | A first-order estimate of fine sediment trapping potential within Iron Gate Reservoir for upstream drawdown and dam removal | American Rivers |
| Stillwater Sciences | August 8, 2007 | Biological rationale for a proposed reservoir drawdown period for Klamath River dams | American Rivers |
| Stillwater Sciences | July 25, 2007 | A first-order estimate of the potential downstream change in suspended sediment concentration in the Klamath River following dam removal | American Rivers |
| Gathard Engineering Consulting | June 2007 | Klamath River Reservoir Sediment Erosion and Trapping Model | California State Coastal Conservancy and Ocean Protection Council |
| Gathard Engineering Consulting | June 2007 | Evaluation of Alternatives to Reservoir Lowering Start Date from Those Proposed in Nov. 2006 FERC Report | California State Coastal Conservancy and Ocean Protection Council |
| Gathard Engineering Consulting | 2006 | Dam and Sediment Removal | California State Coastal Conservancy and Ocean Protection Council |
| PanGeo | Nov. 27, 2006 | App K to GEC – “Preliminary Assessment of Slope Stability , Iron Gate and Copco Dams, and Reservoirs, under Rapid Drawdown | California State Coastal Conservancy and Ocean Protection Council |
| Shannon & Wilson | 2006 | Sediment Sampling, Geotechnical Testing and Data Review Report Segment of Klamath River, Oregon and California - Appendix D to GEC 2006 | California State Coastal Conservancy and Ocean Protection Council |
| Shannon & Wilson | 2006 | Upland Contaminant Source Study- Appendix A to GEC 2006 | California State Coastal Conservancy and Ocean Protection Council |
| Stillwater Sciences | Sept. 2006 | Re-evaluation of Stillwater 2004 Preliminary Simulation Results | Conservancy via GEC |

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| Author | Date | Title | Prepared For |
| Stillwater Sciences | May 2004 | A Preliminary evaluation of the potential downstream sediment deposition following the removal of Iron Gate, Copco, and JC Boyle dams, Klamath River | American Rivers |
| G&G Associates | 2003 | Klamath River Dam Removal Investigation | American Rivers, California Trout, Friends of the River, Trout Unlimited, World Wildlife Fund and the Klamath River Inter-Tribal Fish and Water Commission. |
| JC Headwaters | April 2003 | Bathymetry and Sediment Classification of the Klamath Hydropower Project Impoundments | PacificCorp |