23 March 1999
North Western Division
Seattle District

SYSTEM GAS ABATEMENT RECONNAISSANCE LEVEL STUDY PLAN

1. Project: Columbia River System Gas Abatement Study, Columbia River, Washington and Oregon.

2. Study Authority: 1998 National Marine Fisheries Service Biological Opinion (BiOp) which states "The Action Agencies ... shall jointly investigate operational and structural gas abatement measures at Grand Coulee and Chief Joseph Dams as part of the system-wide evaluation of gas abatement measures."

3. Study Area: The area of study encompasses the US Columbia and Snake Rivers from Grand Coulee Dam on the upper Columbia River and Lower Granite Dam on the Snake River downstream to the mouth of the Columbia River.

4. Problem and Purpose of Study: This system study is in response to concerns of significant impacts to salmon and steelhead from increased levels of total dissolved gas (TDG) in the Columbia River system ranging from downstream of Grand Coulee/Chief Joseph Dams to the mouth of the river which exceed state and federal water quality standards. TDG levels have increased throughout the river in recent years due to higher than average flow conditions resulting from Endangered Species Act (ESA) actions as well as increased flood control actions both of which require increased spill at many of the Columbia River Dams. Chief Joseph Dam is the upper boundary for the geographic range of the Upper Columbia River Evolutionary Significant Unit (ESU) within which steelhead have been listed as "endangered" under the ESA on August 18, 1997. Chinook salmon within this ESU have been proposed for listing as endangered. The primary purpose of this broad level system evaluation is to develop a plan of action that will result in system benefit reductions of TDG. The plan of action will include: (1) a determination of what can be done project by project concurrent and parallel with other ongoing gas abatement studies and (2) a priority listing ranking what modifications can be made at each project. Modification recommendations would be both structural and operational.

5. On-Going Studies: Dissolved gas abatement study efforts are underway at individual projects in the Columbia River Basin. In addition, and as called for in the BiOp, the Corps of Engineers and Bureau of Reclamation, with assistance from Bonneville Power Administration, have initiated discussions relative to a joint study to determine the optimal abatement measures for Chief Joseph and Grand Coulee Dams in combination. The Transboundary Gas Group (TGG) is working on a comprehensive system-wide evaluation, which will eventually include all significant U.S. and Canadian projects.

6. System Evaluation Methodology: A reconnaissance level evaluation of the TDG problem in the Columbia River from a system perspective will be accomplished using a (TDG) computer model (SYSTDG). This model will be used to assess how the system would best benefit from alternative solutions. The SYSTDG model will be used to predict TDG levels in the forebay and tailrace areas of the 15 projects involved once the project releases, spill and gas production functions are known and entered into the model. The model will be run under without project conditions to ascertain where the worst TDG areas in the river are likely located and where reductions to the TDG levels should be focused. The results of the model will be used to prioritize where efforts to reduce TDG should be concentrated, based on TDG reduction benefits versus cost. This reconnaissance- study should save some related CHJ and GCL study costs by eliminating some measures from consideration that were identified for intensive investigation in independent project-by-project studies. A parallel goal of this study is to develop a model that can be incorporated into the TGG study efforts.

7. Views of Federal, State and Regional Agencies: Numerous federal, state, and regional agencies are participating in Columbia River gas abatement related activities which are required by the BiOp. The Corps of Engineers and Bureau of Reclamation are working within the SCT/DGT framework to coordinate actions with water resource and fisheries agencies and tribes within the region. There is strong support within the region for a system evaluation of gas abatement measures.

8. Study Issues: This study provides a unique opportunity for the Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration to jointly work to solve a long time "hot spot" within the Columbia system. This reconnaissance level system study is viewed by the three agencies as a subset of the Transboundary Gas Group's comprehensive system-wide evaluation.

9. Estimated Study Costs and Schedule: The estimated cost to perform a reconnaissance level system evaluation study of the TDG problem in the Columbia River using a computer model is $150,000 ($50,000 for model development, $100,000 for analysis). Each agency's contribution is identified below in the cost breakdown. The dollar values reflect in-kind labor with the exception of the model development by WES funded by BPA. It will take approximately 5 months to complete the study. See paragraph 12 for study milestones.

Cost Breakdown:

BPA:	$50K to the Corps for model development by WES
BPA:	$20K for providing load input, participating in study
Corps:	$30K for NWS labor to run scenarios and do sensitivity analysis $5K for NWD Reservoir Control Center participation $5K for NWD Hydropower Branch participation
BOR:	$40K for participation in study

10. Ongoing Chief Joseph Dam Tasks:

Feasibility Study: This next level of evaluation will proceed with modeling, and design of flow deflectors, including an evaluation of installation on fewer than all 19 spillbays. Coincident with this study, the Corps will continue to explore the viability of the side channel option as a long-term alternative. The Feasibility Study will be completed by the end of 2000.

1:40-scale Section Model: A 1:40-scale section model would be used to select a spillway deflector design. This section model would include one complete spillway bay with adjacent piers and a half of each bay adjacent to the complete bay. This model would be used to evaluate and select the most effective spillway flow deflector design to reduce -as saturation levels. Various designs would be evaluated based on the flow conditions in and downstream of the stilling basin through observing aerated flow patterns, dye movement, and some point velocity measurements. The existing design and one deflector design would be selected for detailed evaluation and performance comparisons including installation of pressure cells to document the pressures at selected locations on and in the vicinity of the deflector and the stilling basin baffle blocks. Construction, evaluation and data documentation will take approximately 8 months to complete

1:80-scale General Model: A 1:80-scale general model would be used to evaluate the with-deflector condition performance characteristics of the stilling basin, the potential to transport material into the stilling basin and identify any unacceptable flow conditions due to the three-dimensional characteristics of the spillway and powerhouse flows. The proposed general model would include the spillway, powerhouse (downstream side detailed only), and the channel for about 2,500 feet downstream from the spillway. Recently observed damage to the stilling basin following the spill operations during the 1997 snow melt season supports the need for this model which would be used to document the three-dimensional flow conditions downstream of the spillway for various flow combinations involving the spillway and the powerhouse. The existing design and the deflector design selected from the section model would be installed in this model and flow conditions would be evaluated to determine impacts of the deflectors on stilling basin performance, flow conditions in the channel downstream of the basin, and transport of abrasive material into the stilling basin under various powerhouse operating plans, spillway bay operating plans and deflector lateral placement schemes. Flow conditions would be documented using dye, surface confetti, and point velocities. The area immediately downstream of the end sill would be constructed with a moveable bed to assist in qualitatively evaluating the movement of bed material. If adverse flow conditions were identified, corrective activities would be identified and might include design modifications and /or optimizing spillway bay operation patterns. A number of spillway bay operation and powerhouse flow combinations would be evaluated. Construction, evaluation, and data documentation will take approximately 9 months to complete.

Near Field TDG Studies: These studies are to be directed at describing spatial and temporal dynamics in TDG both near the structure and downstream in the receiving waters. The information gained can be used to better understand the gas exchange processes both near the dam and downstream, an essential step in evaluation of structural modifications for gas abatement. TDG within the stilling basin and throughout the tailwater channel will be measured

with an array of dissolved gas instruments. The array of instruments will provide direct assessment of the vertical, lateral, and longitudinal Gradients in TDG levels. Mixing between powerhouse and spillway releases will also be investigated, since this interaction may be important to the total flux of TDG introduced into the Columbia River. The influence of the tailwater depth on the exchange of gas during spillway operation will also be investigated by controlling hydropower releases. At selected cross-sections, TDG will be monitored and velocities will be measured with an acoustic Doppler current profiler to allow TDG flux computations. Testing, evaluation, and. documentation will take 8 months to complete.

11. Ongoing Grand Coulee Dam Tasks:

Feasibility Study: This study is investigating the feasibility for gas abatement of structural alternatives at Grand Coulee Dam. The Feasibility Study will be completed by the end of 2000.

Gas Bubble Disease in Resident Fish Below Grand Coulee Dam: The Bureau of Reclamation and USGS are funding a three-year research effort in cooperation with the Colville Confederated Tribes to investigate whether gas-supersaturated water from Grand Coulee Dam may cause gas bubble disease (GBD) in resident fish in Rufus Woods Lake. Resident fish populations have not been examined systematically and may be protected from GBD by behavioral depth compensation. This research will (1) determine the species composition and distribution in the lake so that we can determine where and when to collect fish, (2) determine the prevalence and severity of GBD in fish collected, (3) determine the significance of observed signs of GBD, and (4) determine if fish are protected from the adverse effects of GBD by depth compensation.

12. Study Milestones:

Milestone	Date
Initial Technical Meeting	1/6/99
Complete Study Plan	3/19/99
3 Agency Approval	4/2/99
Brief SCT	4/22/99
Start SYSTDG Model Development	4/9/99
Complete Model Development	6/9/99
Collect Input Data	4/30/99
Run Scenarios	7/16/99
Analyze Output	8/6/99
Develop Prioritized Project List	8/27/99