ENSR International
9521 Willows Road NE
Redmond, WA 98052
(425) 881-7700
FAX (425) 883-4473
www.ensr.com

August 23, 2002

Northwest Power Planning Council
Attention: Judi Hertz
Response to ISRP
851 SW 6th Avenue, Suite 1100
Portland, OR 97204

RE: Response to Comments on Proposal No. 35038 (Develop Computational Fluid Dynamics Model to Predict Total Dissolved Gas Below Spillways). ENSR Proposal Number 00953A07

Dear Sir/Madam,

This letter provides response to comments by the Independent Scientific Review Panel (ISRP) on the above referenced proposal submitted to the Northwest Power Planning Council (NPPC). In the following, the comments/questions by ISRP are repeated, in *italics*, for clarity.

1. Describe how the CFD model could be linked to the existing far-field models so that the predictions could be compatible with the existing monitoring station data.

In the proposal we have suggested the development of a near-field model for the prediction of total dissolved gas (TDG) below spillway of dams. The near-field model will encompass the spillway, stilling basin, and a part of the tailrace channel. As part of the Dissolved Gas Abatement Study (DGAS), the U.S. Army Corps of Engineers (USACE)[1] has developed a one-dimensional (MASS1) and a two-dimensional depth averaged (MASS2) far-field models[2] for simulating the transport of TDG from the tailrace of one dam to the forebay of the downstream dam. The TDG concentration at the tailrace of a dam is determined based on empirical equations developed by the DGAS program. The DGAS program does not consider the hydrodynamics of spillway and stilling basin, and entrainment of air in the plunge pool and hydraulic jump in developing TDG production equations. As a result, when project operating conditions change (for example spill pattern or management scenario), these equations cannot be used for predicting TDG. Therefore, equations developed by the DGAS program, and the far-field MASS1 and MASS2 models are not substitutes to process-based 3-D CFD models required for predicting TGD in the near-field and in the mixing zone. The proposed CFD model will eliminate the need for conducting expensive and time consuming field programs similar to DGAS. Moreover, it would also be able to provide boundary conditions to MASS1 and MASS2 for system-wide analysis of TDG.

[1] USACE, Dissolved Gas Abatement Study, Phase II, Draft Final Technical Report, U.S. Army Corps of Engineers, Portland District and Walla Walla District, 2001.
[2] M.C. Richmond, W.A. Perkins and Y. Chien, Numerical Model Analysis of System-wide Dissolved Gas Abatement Alternatives, Battelle Pacific Northwest Division, Richland, Washington, 2000.

For a given dam, the CFD model could be run for different a) spillway configurations, b) spillway flows, c) spill patterns, and d) tailrace water surface elevations. The results of the CFD model could be archived in tabular form to provide TDG boundary conditions to MASS1 and MASS2. MASS1 and MASS2 would read TDG boundary values from data files, rather than using empirical equations. We believe that MASS1 and MASS2 are already configured to read boundary data from files. If not, only minor changes in MASS1 and MASS2 may be necessary. The TDG computed by MASS1 and MASS2 using boundary conditions provided by the CFD model would be consistent with data at the fixed monitoring stations.

Our proposal concentrates on the first step, the development of a process based TDG prediction model. We must validate and verify the concepts presented in the proposal before using the CFD model in conjunction with MASS1 or MASS2 for system-wide study. Once the predictive capabilities of the CFD model have been established, we could concentrate on developing interfaces to the far field models.

2. Better justify the model development in the light of existing empirical spill/TDG data. Some points to respond to: What specific flaws or gaps in existing empirical information call for this model? If the CFD model plans are for new designs, this makes sense. However, aren't most spillways already fitted with TDG improvements (flip lips)? This would have been a valuable tool before the decision and commitment to funds to install flip-lips. Is this proposed because the Corps wants to rethink that decision? If this project is to model existing spillway and structures, it makes less sense. Is it to modify the existing spillways? Please explain what new structures are planned or contemplated and specifically how CFD modeling would benefit pre-design.

Future Need for TDG Predictions: The ISRP is correct in stating[3] (page 77) that "field data have been collected in a designed program for more than 20 years". Unfortunately, multi-year, multi-million dollar field programs over the past 20 years have not eliminated the need for implementing costly and time-consuming data collection programs. For example, USACE Portland District will be collecting TDG data this year at the Bonneville Dam. The reason for conducting the $405,000 program is that the spill pattern has changed, and TDG data previously collected over the past 20 years will fail to provide any information on the expected TDG levels for the new spill pattern.

Further examples of the need for future field monitoring and data collection can be found in DGAS Phase II Report[1] (Section 11). The report states that "installation of additional deflectors is currently scheduled for the Bonneville and McNary in Fiscal Year 2002, Lower Monumental and Little Goose in Fiscal Year 2004, and The Dalles in Fiscal Year 2005, as a part of the current deflector optimization program". Installation of the powerhouse/spillway separation wall at Lower Granite, McNary and John Day have also been suggested in the study. The proposed structural modifications "could take 20 to 30 years if each dam were to be modified in a sequential process. However, if funds can be made available, this could be reduced to possibly a 15- to 20-

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[3] ISRP, Preliminary Review of Fiscal Year 2003 Mainstem and Systemwide Proposals, Northwest Power Planning Council, Portland, Oregon, 2002.

year process". Remedial measures at the dams operated by the PUDs are, in general, lagging behind the efforts made by the USACE. As a result, the issue of TDG supersaturation and its prediction are likely to persist for a long time at the non-federal dams.

The use of the current-state-of-the-art technique for predicting TDG below spillways (data collection and reporting empirical equations) requires the implementation of field data collection programs for assessing the effects of each structural change made at the spillway and dams. If the time estimate (15 to 20 years) cited above is correct, then data collection programs will continue for a long time. The design modifications will be done without the knowledge of possible positive or negative effects on TDG supersaturation. Only after implementing costly structural modifications of the prototype and conducting field monitoring it would be possible to ascertain the validity of the spillway modifications. The proposed CFD model will eliminate all these uncertainties at the design stage.

Possible Spillway Modifications: Till now, ten structural dissolved gas abatement alternatives (additional/modified spillway flow deflectors, raised negative stepped stilling basin, raised tailrace channel and deflectors, baffle chute spillway, side channel spillway, pool and weir channel, additional spillway bays, submerged conduit with deflectors, powerhouse/spillway separation wall, and submerged spillway gates) have been studied by the DGAS program[1]. An important spillway modification not considered in the study is the removable spillway weir (RSW). For the same fish passage efficiency (FPE), spillways with RSWs need less spill. The water that is not spilled could be used for power generation and thereby increase project revenue. RSWs are expected to attract the attention of dam operators as they improve the hydraulic conditions for the downstream migration of juvenile salmon. RSWs have been successfully tested at Lower Granite Dam[4] and model studies have been conducted for John Day Dam[5]. RSWs significantly alter spill volume, the spillway flow pattern and the stilling basin hydraulics[5]. Consequently, the TDG generated by a RSW will be significantly different from that generated by a spillway without a RSW. Once a RSW is installed at a spillway, all previously developed regression equations for the prediction of TDG would become useless. If the current approach for determining TDG production equations are used, then field data must be collected and the equations must be updated. The proposed CFD model would be able to predict the TDG production in a timely and cost-effective manner.

Limitations and Gaps in Data: As pointed out by the ISRP[3], near field data collection programs have been conducted at a majority of the dams outfitted with deflectors. However, field tests are typically conducted over a limited period of time and thus relate to specific spillway flow, spill pattern, total river discharge, and tailwater elevation. Field test data have been collected to cover a wide range of project operations. However, such test data do not exist for a full range of tailwater and river flow conditions at any of the projects. This is particularly true for Bonneville

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[4] S. Wittmann-Todd, K. Crum and L. Reece, Lower Granite Lock and Dam Removable Spillway Weir (RSW), Proceedings of HydroVision 2002, Portland, Oregon, 2002.

[5] K. Christison, D. Dorratcague, J.L. Lencione and M. Hansen, Surface Bypass Removable Spillway Weir Analysis, Proceedings of HydroVision 2002, Portland, Oregon, 2002.

Dam. Because of biological constraints, only low-tailwater field tests will be conducted with gate openings varying from 0.5 feet to 3 feet during the 2002 field program. This will allow gas production equations to be developed for low gate openings and low tailwater conditions, but gas production equations for larger gate openings and different tailwater will not be available. Similar situations exist at many of the other dams in the Columbia and Snake River.

As stated in our proposal, the gas production equations resulting from regression analysis are site specific. The coefficients in these equations not only vary from dam to dam, but they are also a function of spill pattern and configuration of the spillway. As a result, when project operating conditions change, these equations cannot predict TDG. We have listed many examples of possible future changes in spillway geometry and project operational scenarios earlier (**Future Need for TDG Predictions**, and **Possible Spillway Modifications**). When these changes are made, data collected in the last 20 years will be of no use. Unless alternative tools are available for predicting TDG due to spillway operation, the action agencies and PUDs must implement expensive and time-consuming field monitoring programs.

Benefits of the Proposed CFD Model: Once the proposed CFD model has been developed and its predictive capabilities have been demonstrated, it would be an efficient tool for determining TDG supersaturation in the tailrace of dams. Some of the main benefits of the model would be as follows:

- The model could be used as a design tool by evaluating various alternatives, and identifying the best alternative for reducing TDG supersaturation at the design stage. These alternatives could be evaluated in a timely and cost effective manner. The possible spillway modifications in the future have been described earlier (**Future Need for TDG Prediction** and **Possible Spillway Modifications**).

- At projects where spillway deflectors have already been constructed, the model could be used to determine TDG for flow and spill scenarios for which field data have not been collected or could not be collected. Collection of field data for high spillway discharge with low tailwater elevations are frequently not possible because of biological, hydraulic and structural constraints. Discussions under **Limitations and Gaps in Data** provide examples where such data are needed, but not available.

- The model will eliminate the need for conducting expensive field programs or at least reduce the need for future data collection. The cost of setting-up the model would be one- to two-orders of magnitude less than the combined cost of constructing prototype test structures and data collection. Considering the future data collection program indicated in DGAS Phase II report and those by the PUDs over the next two decades, the potential for saving would be considerable.

- When implementing field data collection programs, action agencies and PUDs have to wait for the spilling season, thus delaying the timely evaluation of proposed management scenarios. The CFD model will completely eliminate such a waiting period. The model could be run at any time, when managers have new ideas.

- The model would be able to provide boundary conditions to far-field TDG transport models, as described in response to Comment No. 1, for analyzing system-wide TDG supersaturation problems. The CFD model would be especially valuable when 3-D far-field TDG transport models are developed. Such models would need spatially varying (across the width as well as depth) TDG boundary conditions. The gas production equations currently available provide a single value of TDG over the entire cross-section of the river.

- An additional benefit of the model would be the 3-D characterization of the flow field in the spillway, stilling basin, and the tailrace channel. Such characterization of the flow field would be helpful in identifying the flow paths, along which juvenile fish would be transported by the flow field, or regions where the juveniles may become entrapped by eddies and vortices.

- The recently proposed Total Maximum Daily Load (TMDL)[6] states that "the point of compliance for load allocations for dams in this TMDL will be based on application of the mixing zone to the aerated zone immediately below the spillways of the dams". Characterization of the flow field by the CFD model would be helpful in delineating the mixing zone resulting from spill, and identifying the point of compliance.

Adopting Efficient State-of-the-Art Technology: Historically, data collection and fitting empirical equations through data for the analysis of a problem have been used when no other physically based scientific and engineering approach were available. It was the right approach twenty years ago when the action agencies and PUDs started field monitoring programs and reporting best-fit equations. However, with the advances made in computational technology and CFD modeling, especially in the last five years, this method of predicting TDG at the tailrace of dams has been rendered obsolete, inefficient, time-consuming, and costly. CFD modeling techniques have matured enough to provide conceptually elegant and practical (efficient, less costly and time-consuming) alternative. It is high-time for all concerned with TDG super-saturation in the Columbia and Snake Rivers to take the next logical step—develop a physically based, analytical tool for the prediction of TDG resulting from the operation of spillways. The USACE is supporting the effort as the CFD model will provide an efficient and cost-effective design tool for its future needs as discussed earlier. This tool will also be available to others in the region, such as the PUDs with similar needs.

3. *Describe how other dam spillways besides Bonneville could be used in the calibration/validation process to make the model less specific to Bonneville Dam.*

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[6] P.J. Pickett and R. Harding, Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas, Review Draft Report 2-13-02, Prepared jointly by Oregon Department of Environmental Quality and Washington State Department of Ecology, 2002.

The fundamental contributions of our study would be the development of algorithms for a) air entrainment into the spillway flow, b) determining bubble size distribution, c) tracking of bubbles throughout the model domain, d) interaction between air bubbles in the flow water mass, e) mass exchange between bubbles with flow field, and f) mass exchange between water and atmosphere at the free surface. As described in the proposal, we would develop these algorithms using hydrodynamic information (velocity distribution, pressure field, turbulence characteristics, solubility of air in water at a specified temperature, and ambient TDG concentration) computed by the CFD model. Once these algorithms have been developed, applying the model to a different dam or overflow hydraulic structure will not be a conceptually challenging task.

In the proposal, we proposed the simulation of TDG at the Bonneville Dam for demonstrating the applicability of the algorithms developed as part of the study. The main reason for selecting the Bonneville Dam, as opposed to other dams in the Columbia and Snake Rivers, is the availability of extensive field data for the validation and verification of the algorithms. The CFD model itself is not tied to any specific hydraulic structure. As with any CFD model, the proposed model could be applied to different dams on the Columbia and Snake Rivers by changing the model input. The steps necessary for applying the model to a different dam would be as follows:

a) generate computational grid, incorporating specific geometry of the spillway, stilling basin, and bathymetry of the tailrace channel,

b) develop and specify appropriate initial and boundary conditions for the simulation scenario,

c) post processing of model results, and

d) compare model prediction with field data, if available.

The first step is one of the most time consuming parts of model development. During this step, initial model simulations must be made by refining the grid and performing a grid sensitivity analysis. Such analysis is necessary to assure grid independent solutions. Once the grid has been finalized, the second and third steps must be repeated for each flow scenario. The last step is not necessary, however comparing model results with data, if available, could provide additional confidence in model predictions.

Note that in the proposal we have identified 12 tasks that would be necessary for the initial model development, when algorithms for air entrainment, bubble size distribution, transport of bubbles, mass transfer between bubble and air, and interaction between atmosphere and water will be developed. In the subsequent applications, calibration/verification of the proposed CFD model would not be necessary. Therefore, it would not be necessary to implement Tasks-b, d through f, and h through j, thereby considerably simplifying model applications to different dams.

In our proposal, we suggested the development and verification of the CFD model in the context of the Bonneville Dam only. However, the ISRP's recommendation for applying the model to other dams is a constructive suggestion for demonstrating the general applicability of the CFD model. To demonstrate the applicability of the CFD model to different dams, we propose the simulation of TDG in the tailrace of Wanapum Dam or Rocky Reach Dam, Washington on the Columbia River. Both Grant County PUD[7] and Chelan County PUD[8] have expressed strong interest in our study, and indicated that data to verify the model would be available. During the study we would review data from both the PUDs and select the dam with the most complete data set for model verification.

To provide independent verification of the model, we would implement steps (a) through (c) without making any changes to algorithms developed for (a) air entrainment into the spillway flow, b) bubble size distribution, c) tracking of bubbles, d) interaction of bubbles with the flow and among themselves, e) mass exchange between air bubbles with flow field, and f) mass exchange between water and atmosphere. Acceptable prediction of TDG in the tailrace of Wanapum and/or Rocky Reach Dam would illustrate that the algorithms developed in the proposed study are generic, and are not tied to a particular dam. This application would provide independent verification of the CFD model.

Our proposal does not include a task and budget for applying the CFD model to a different dam. Therefore, we are submitting a revised budget incorporating the additional costs involved in implementing the ISRP's recommendation. The revised budget is $257,796 excluding in-kind contributions of field data at a value of $405,000 by USACE for Bonneville Dam, $175,000 by Chelan County PUD for Rocky Reach Dam, and $300,000 by Grant County PUD for Wanapum Dam.

4. Justify this expenditure as a BPA-funded project rather than as a Corps project, considering its close association with the hardware of a dam.

As indicated in our response to Comment No. 3, we would develop a generic CFD model as part of the study. The algorithms for (a) air entrainment into the spillway flow, b) bubble size distribution, c) tracking of bubbles, d) interaction of bubbles with the flow and among themselves, e) mass exchange between air bubbles with flow field, and f) mass exchange between water and atmosphere, would not be tied to any specific dam. The main reason for selecting the Bonneville Dam for the initial model development is the availability of data for the validation and verification of the algorithms. Once the model has been developed, and its applicability demonstrated, it could be used at other dams throughout the region. As indicated in our response to Comment No. 3, we would demonstrate the predictive capability of the model by applying it to the Bonneville Dam, operated by the USACE, as well as to Wanapum Dam and/or Rocky Reach Dam, operated by Grant/Chelan County PUDs, respectively. These dams represent significantly different spillway geometries, tailrace bathymetries, spillway flows, spill patterns, and tailrace water surface elevations. Successful predictions of TDG at these dams

[7] Mr.Steve Brown, Hydroposer Engineering Manager, Grant County PUD, (509) 754-3541/3117.

[8] Mr. Scott Kreiter, Natural Resources Manager, Chelan County PUD, (877) 894-2892/6352.

will provide independent validation and verification of the proposed CFD model.

Currently, process based analytical tools are not available for predicting TDG downstream of dams. The action agencies and PUDs are likely to be interested in utilizing the proposed model once we have demonstrated its predictive capabilities. However, it is not possible to demonstrate the utility of the model without conducting the fundamental research necessary for its development. Recognizing the need for such a predictive tool, the USACE Portland District, Grant County PUD and Chelan County PUD are actively supporting the proposal by providing valuable data. Additional funding is necessary for conducting basic research in developing the model. Therefore, the Council's support would be extremely helpful in developing a predictive tool that could be used at all dams in the Columbia and Snake River system, as well as at dams and over-flow hydraulic structures outside the Pacific Northwest.

If you have any questions concerning our response, revised budget, or need any additional information, please call us at (425) 881-7700.

Sincerely,

Charles E. "Chick" Sweeney, P.E.
National Hydraulic Engineering Program Manager

Liaqat A. Khan, Ph.D., P.E.
Senior Technical Specialist

Enclosures: 35038 Budget: Revised Cost Estimate

CC
1. Dr. Laurie L. Ebner, USACE Portland District, Portland, Oregon
2. Mr. Steve Brown, Grant County PUD, Ephrata, Washington
3. Mr. Scott Kreiter, Chelan County PUD, Wenatchee, Washington

Bonneville Power Administration
FY 2003 Provincial Project Review

Mainstem & System-wide Province

First, read the help documents

Please carefully read the **Proposal Development and Selection Criteria** document, which contains information on the review process, and the **instructions** document, which provides field- and content-related help for the form. If you are missing either document, please visit http://www.cbfwa.org/reviewforms/systemwide/default.htm or call 503-229-0191.

Important notes

- This form is to submit projects or proposals for BPA FY 2003-5 funding for Mainstem & System-wide Province only.
- This document is only available for Word97/Word2000/WordXP. Do not save down to older formats, or use in another word processor such as WordPerfect, even if it supports Word conversions. You will lose the auto-calculations, and won't be able to add or delete table rows. You may also risk not being able to re-open the document.
- Some help text is included as "hidden" comments on the data form, which is displayed by resting the mouse cursor over any yellow text (usually section headings or field names)
- Use these keystroke macros to assist you in the form. If the macros aren't available (nothing happens when you press these keys), then you need to enable macros in Word: In Word97, close the proposal, then open again and choose Enable macros if prompted. In Word2000/XP, close the proposal, choose Tools, Macro, Security, and set the security level to medium. Re-open the proposal and choose Enable macros when prompted.

To	Press
insert rows in tables	Alt-R and you'll be asked whether to insert a row at the current position or add one to the end of the table
delete rows in tables	Alt-D at the row you want to delete
calculate budget totals	Alt-C either periodically, or when you're done with the form
Spellcheck	Alt-S

Steps to complete the form

1) First, read the help documents (get them at http://www.cbfwa.org/reviewforms/systemwide/default.htm)
2) There are two documents to this form:
   a) Part 1 (**blank_sys.doc)** consists of administrative and budgeting information. Your input is restricted to the grey fields.
   b) Part 2 (**narrative.doc)** allows you to describe your project at length, including maps, tables, graphics, etc.
3) Save this as something other than blank_sys.doc. Preferably, use the BPA 9-digit project number, like "198906200.doc" or if your project has no project number, the first few words of the title, like "RestoreFish.doc", and a proposal number will be assigned to you by BPA upon receipt of your proposal.
4) Your cursor is already in the first input field, Title of Project, so start typing

5) Fill in all fields (gray boxes) pressing Tab to advance from one field to the next
6) Press Alt-C when complete to calculate totals
7) Save document, then open **narrative.doc** to begin Part 2.
8) Please print the completed documents. Part 1 prints in landscape (sideways) orientation, Part 2 in portrait (regular).

Save the documents and then **email** your forms and any attachments to fwproposals@bpa.gov. **NOTE: BPA cannot receive e-mails larger than 5 MB.** Or mail paper and diskette(s) to:

Bonneville Power Administration
Attention: Cate Hanan - KEWB-4
FY 2003 Proposals – Mainstem & System-wide Province Review
905 NE 11th Avenue
Portland, OR 97232

9) Monitor the http://www.efw.bpa.gov/cgi-bin/FW/02MainstemSystemwide.cgi.website to verify your project funding request is received and posted correctly.

All projects must be received no later than 5:00pm PST on Monday, June 3, 2002.
No late proposals will be reviewed for FY 2003 funding.

PART 1 of 2. Administration and Budgeting

Section 1 of 10. General administrative information

Title of project
Develop Computational Fluid Dynamics Model to Predict Total Dissolved Gas Below Spillways

BPA project number

Business name of agency, institution or organization requesting funding
ENSR International, Inc.

Business acronym (if appropriate) ENSR

Proposal contact person or principal investigator:

Name	Charles E. "Chick" Sweeney, P.E.
Mailing Address	9521 Willows Road NE
City, ST Zip	Redmond, WA 98052
Phone	425-881-7700
Fax	425-883-4473
Email address	csweeney@ensr.com

Manager of program authorizing this project Alan R. Foster

Location of the project

Latitude	Longitude	Description

Target species

All

Short description

Develop a computational fluid dynamics model to predict total dissolved gas levels below spillways that can be used to manage operation of a particular project and/or to predict benefit of proposed structural changes prior to their implementation.

RPAs. View guidance on proposal development and selection criteria named mainstem_systemwidecriteria.pdf, available as a link from the main proposal solicitation page. Indicate what, if any, ESA Biological Opinion action(s) will be met by the proposed project. Explain how and to what extent the project meets the ESA requirement.

NMFS and/or FWS Reasonable and Prudent Alternatives (RPA)

RPA Number	Description
133	As part of DGAS, the Corps shall complete development of a TDG model to be used as a river operations mamagement tool by spring 2001. Once a model is developed, the applications and rsults shall be coordinated through the Water Quality Team. The Corps shall cordinate the systemwide mamagement applications of gas abatement model studies with the annual planning process, the Transboundary Gas Group, the Mid-Columbia Public Utilities, and other interested parties.
134	The Crops shall continue the spillway deflector optimization program at each FCRPS project and implement it, as warranted. The Corps and BPA shall conduct physical and biological evaluations to ensure optimum gas abatement and fish passage conditions. Implementation decisions will be based on the effect of spill duration and volume on TDG, spillway effectiveness, spill efficiency, forebay residence time, and total project and system survival of juvenile salmon and steelhead passing FCRPS dams.
135	The Corps shall include evaluations of divider walls at each FCRPS project in the spillway deflector optimization program. Desing development and construction of divider walls would begin only ofter coordination within the annual planning process, and only if warranted.

Information transfer The expected outcomes of this project are (check one) ☐ quantitative ☒ qualitative ☐ indirect Data generated by this project are (check one) ☐ primary ☒ derived ☐ indirect Are there restrictions on the use of the data? (check one) ☒ none ☐ non-commercial use only ☐ educational use only ☐ requires prior approval ☐ sensitive ☐ proprietary, no public distribution	Where do the data reside (check one or more)? Private/managed locally: ☐ printed ☒ electronic Public access: Printed at ☐ BPA ☒ Peer-reviewed journal or other Internet at ☐ BPA ☐ StreamNet ☐ Fish Passage Center ☐ DART or other web address
In what other ways will information from this project be transferred or used? A published report, conference presentation, and the peer reviewed journal article.	

Section 2 of 10. Past accomplishments

Year	Accomplishment
2001	Three-Dimensional Computational Fluid Dynamics (CFD) Modeling of the Forebay of The Dalles Dam, Oregon. Prepared for USACE Portland, Oregon.
2001	Computational Fluid Dynamics (CFD) Modeling of Howard Hanson Dam. Prepared for USACE Seattle District, Washington.

Section 3 of 10. Relationships to other projects

Project #	Project title/description	Nature of relationship
200005800	Supersaturated Water Effects on Adult Salmonids	Quantatitive prediction of supersaturation downstream of spillway as functions of spill, spillway geometry (spillway deflector, divider walls), and tailrace water level.

Section 4 of 10. Estimated budget for Planning & Design phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcon-tractor
1) Develop a near-field CFD model that can predict total dissolved gas below spillways.	a: Develop Computational Grids: Bonneville and Wanapum/Rocky Reach Dam spillways.	1.34 month	22,170	☐
2) Develop a near-field CFD model that can predict total dissolved gas below spillways.	b: Simulate Free Surface Flow and Hydraulic Jump	0.60	8,967	☐
3) Develop a near-field CFD model that can predict total dissolved gas below spillways through a project-specific application to a section of the Bonneville and Rock Island Dam spillway.	c: Grid Refinement and Sensitivity Analyses: Bonneville and Wanapum/Rocky Dam spillways.	1.08	18,576	☐
4) Develop a near-field CFD model that can predict total dissolved gas below spillways.	d: Develop Algorithm for Free Surface Air Transfer at Bonneville Dam spillway.	0.74	13,324	☐
5) Develop a near-field CFD model that can predict total dissolved gas below spillways.	e: Simulate Transport of Air Bubbles at Bonneville Dam spillway.	0.50	7,822	☐
6) Develop a near-field CFD model that can predict total dissolved gas below spillways.	f: Develop Algorithm for Mass Transfer From Bubbles at Bonneville Dam spillway.	0.83	17,628	☐
7) Develop a near-field CFD model that can predict total dissolved gas below spillways.	g: Obtain and Analyze Field Data at Bonneville, Wanapum and Rocky Reach Dams.	0.60	17,785	☒
8) Develop a near-field CFD model that can predict total dissolved gas below spillways.	h: Determine Rate of Air Entrainment at Bonneville Dam spillway.	0.50	11,632	☐
9) Develop a near-field CFD model that can predict total dissolved gas below spillways.	i: Develop Equation for Air Entrainment at Bonneville Dam spillway.	1.0	19,988	☐

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
10) Develop a near-field CFD model that can predict total dissolved gas below spillways.	j: Validate Equation for Air Entrainment at Bonneville Dam spillway	0.84	17,642	☐
11) Make the model formulation, techniques, and user defined subroutines available to others throughout the regions via general documentation of the study in a report and through conference presentations and a journal article.	k: Analyze Model Results at Bonneville Dam and Wanapum/Rocky Reach Dam	1.34	31,002	☐
12) Make the model formulation, techniques, and user defined subroutines available to others throughout the regions via general documentation of the study in a report and through conference presentations, a journal article, presentation to BPA and USACE.	Reporting and Presentation	1.83	71,260	☐
		Total	$257,796	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Out year estimated budgets

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget				

Section 5 of 10. Estimated budget for Construction/Implementation phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
				☐
				☐
				☐
				☐
		Total	$ 0	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Out year estimated budgets for construction/implementation phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget				

Section 6 of 10. Estimated budget for Operation & Maintenance phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
				☐
				☐
				☐
				☐

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
		Total	$ 0	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Out year estimated budgets for operations & maintenance phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget				

Section 7 of 10. Estimated budget for Monitoring & Evaluation phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
				☐
				☐
				☐
				☐
		Total	$ 0	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Out year estimated budgets for monitoring & evaluation phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget				

Section 8 of 10. Estimated budget summary

Itemized estimated budget

Item	Note	FY 2003
Personnel	FTE: 1.000	243,684
Fringe benefits	Included in Personnel	
Supplies, materials, non-expendable property		
Travel		3,300
Indirect costs		
Capital acquisitions or improvements (e.g. land, buildings, major equip. over $10,000)		
NEPA costs		
PIT tags @$2.25/ea	# of tags:	
Subcontractor		
Other	Computer, postage, phone, etc.	10,812
	Total BPA funding request	$257,796

Total estimated budget

Total FY 2003 project cost	$257,796
Amount anticipated from previously committed BPA funds (carryover)	-
Total FY 2003 budget request	$257,796

FY 2003 forecast from FY 2001	
% change from forecast	0.0% increase

Reason for change in estimated budget

Reason for change in scope

Cost sharing

Organization	**Item or service provided**	**Amount ($)**	**Cash or in-kind?**
USACE, Portland	Field Data Collection	405,000	in-kind
Public Utility District of Grant County	Field Data Collection	300,000	in-kind
Public Utility District No. 1 of Chelan County	Field Data Collection	175,000	in-kind
			cash
	Total cost-share	$880,000	

Out year budget totals

	FY 2004	**FY 2005**	**FY 2006**	**FY 2007**
Planning & design phase	0	0	0	0
Construction/impl. phase	0	0	0	0
O & M phase	0	0	0	0
M & E phase	0	0	0	0
Total budget	$ 0	$ 0	$ 0	$ 0

Other budget explanation

Part 1 of 2 complete!

Press Alt-C to calculate totals on the document. If any totals don’t match, you’ll see a message.
Then save this document, and open “narrative.doc” to begin Part 2, which includes Sections 9-10.