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BMW Stakeholders Groups  
c/o Steve Lundt and Alice Wood  
via email

**Subject: Revised Outline of Scope of Services for BMW Modeling Effort**

Dear Mr. Lundt and Ms. Wood,

We at ENSR are very pleased to have been selected to develop the model for the Barr Lake and Milton Reservoir Watershed and advance the effort to construct a meaningful TMDL for those aquatic systems. An iterative process of scope development is underway and is considered the first task in our work. This revised scope outline is provided pursuant to discussions on December 12, 2006 and the comments received in writing up to that date. We understand that the actual process of getting a signed contract may take until late February, but that we should be advancing information gathering and general organizational aspects of the project and that ENSR will be authorized for this work in advance of the signed contract, with reimbursement after signing.

**Phase I. Scope Development and Data Collection:** This phase involves refining scope of work tasks as appropriate for the details of the project, identifying needed data, and acquisition and review of those data.

**Task 1. Scope Development:** ENSR will work with the designated representatives of the BMW stakeholders group to finalize a scope of services to guide work on this project. ENSR has proposed a scope and is revising to address issues raised to date, and will continue to work with stakeholders or their representatives to refine and finalize that scope.

**Task 2. Identify Data Needs and Sources:** ENSR will identify data needs and potential sources of data useful in the modeling effort, considering our own knowledge of likely sources and any sources suggested by the BMWA. A number of sources are common to most systems, and others may apply in this case. Knowledge of stakeholders will be important to the thoroughness of this effort. To date, ENSR has researched on-line resources and the stakeholders group has indicated knowledge of multiple additional sources as well as providing some existing data in an electronic format. More recent data are being added to this database under a separate contract with another firm, possibly limiting the timetable for data acquisition. It is important to complete this task as soon as possible, to facilitate other project steps in a timely manner and ensure proper costing of needed effort.

**Task 3. Acquire Data:** ENSR will collect data from identified sources and organize data in a useful manner. All relevant data will be acquired and put into a database that will support further efforts and can be used by other organizations as warranted and desired. The stakeholders group has supplied some data already, and ENSR is aware of multiple on-line sources that can be accessed. Additional data (e.g., FRICO flow records and an updated overall water quality database) are to be supplied by stakeholders or their representatives, and may take longer to develop and submit.

**Task 4. Delineate Watershed:** ENSR will create maps of the overall watershed and relevant sub-watersheds that will be used in modeling. These maps would set the hydrologic response units and loading parcels to be used in the model. This will include non-point sources and point sources, with point sources to include reservoirs that mark the upstream limits of the "datashed" as defined by the stakeholders as well as permitted discharges under the NPDES program. As the Barr-Milton watershed has a potentially complicated flow pattern, this task will require considerable input from knowledgeable parties with regard to

the spatial and temporal pattern of flow. Considerable progress has been made on determining the target area for modeling by stakeholders or their representatives, and is expected to aid timely task completion.

**Task 5. Select Watershed Model:** ENSR will determine which model(s) will work best, given the watershed information available. It is assumed at this point that the SWAT model will work well for the watershed in question, but confirmation should be made through data collection and discussion with stakeholders. Less complicated secondary models are likely to be applied as well, as simple checks on the more complicated model results on a sub-watershed, watershed or reservoir scale.

**Task 6. First Progress Workshop:** ENSR will hold a workshop for stakeholders and other appropriate parties to go over all collected data, watershed mapping, and the selection of the watershed model to be applied. This workshop will act as an update to the stakeholders, a check on work performed to date, and an opportunity for any scope adjustments based on findings to that point. Key aspects will include presentation of data upon which the watershed model depends, and outline of model function and constraints, and expected next steps in the process of model development.

**Phase II: Watershed Model Development.** This phase covers construction of the watershed model and evaluation of the strength of the link between watershed processes and in-lake conditions.

**Task 7. Develop Hydrologic Response Units:** ENSR will use collected data to establish HRUs for use in the model. This involves assigning land uses, soil types, precipitation, discharges and related information to defined sub-watersheds and linking those sub-watersheds in a manner representative of the overall watershed function. This task builds the initial model of the watershed within the model framework chosen. Major sub-watersheds have been identified by the stakeholders group, but require refinement for modeling purposes. Assigning drainage area attributes is a critical element in constructing the best possible representation of reality for this watershed.

**Task 8. Calibrate Watershed Model:** ENSR will adjust constants and the relation of variables within model sub-routines to maximize representativeness of the model for the sub-watershed and watershed overall. This process is based mainly on matching real data to predicted values from the model by model adjustments, within the parameters of the model and knowledge of watershed function. A high degree of expertise and experience is necessary to properly calibrate the model for reliable use, and this process can be time consuming.

**Task 9. Evaluate Reservoir Water Quality in Response to Watershed Model:** ENSR will compare model predictions over a time for which data are available with input and in-lake results. Note that SWAT includes an in-lake component, and simple models can be coupled to provide in-lake results without a complex modeling effort. At issue here is how well watershed events determine in-lake water quality at Barr Lake and Milton Reservoir, and how much need there is for a separate in-lake model to address in-lake processes that may be important to in-lake water quality variation and resultant algal blooms and high pH. Also included in this task are sensitivity analyses aimed at determining the relative importance of key variables in the watershed model for predicting in-lake water quality. The ability of the watershed model to predict steady state lake conditions vs. dynamic features over relevant time scales will also be evaluated.

**Task 10. Select In-Lake Model(s) to be Applied to Barr Lake and Milton Reservoir:** ENSR will determine the level of complexity needed for an in-lake model to adequately reflect conditions in the two target waterbodies and recommend any model(s) to be applied. There will most definitely be an in-lake model, and probably more than one, but the recommendation for which model(s) should not be made until the watershed model is constructed and tested. Key aspects include processing inputs to accurately represent water quality averages, ranges and temporal variability and accounting for the impact of water level fluctuations related to irrigation withdrawals and scheduled refills.

**Task 11. Second Progress Workshop:** ENSR will hold a workshop for stakeholders and other appropriate parties to go over the construction, calibration and operation of the watershed model, its implications for in-lake water quality, and recommendations for in-lake model application. The watershed model will be demonstrated and the results of sensitivity analyses will be provided. The focus on this workshop will be on how well the model represents the actual processes in the target watershed and what needs remain for adequately representing in-lake processes and resultant water quality.

**Phase III: In-Lake Model Development and Response Testing.** This phase completes model development and initiates scenario testing for possible future conditions and management options.

**Task 12. Develop In-Lake Model(s):** ENSR will develop any in-lake model recommended and accepted under tasks 10 and 11 above. Most models require mainly the input data from the watershed, but other features of the chosen in-lake model are likely to require adjustment to achieve calibration. Sensitivity analysis, trend assessment and quantification of uncertainty would be conducted to determine model reliability in making projections. As with the watershed model, it is likely that additional simple models will be applied to check the results of any more sophisticated in-lake model, as warranted.

**Task 13. Test Model Response to Possible Scenarios:** ENSR will apply the combined watershed/in-lake model to existing conditions and to several scenarios representing expected changes in watershed features or management approach. These scenarios will form the basis for explaining complete model function and constraints, and for selecting the scenarios to be tested in Task 17.

**Task 14. Evaluate Limits to Potentially Achievable Conditions:** ENSR will run the model to determine the expected in-lake conditions associated with scenarios representing the limits of management (e.g., maximum practical BMPs), potential “natural” conditions (e.g., no human development), nutrient levels that result in acceptably low bloom frequency and any related pH compliance, water clarity and chlorophyll levels that support desired uses, and other alternatives linked to desired conditions. These scenarios will define water quality based on expected “background” or “optimal” conditions, although such conditions may not necessarily be readily achievable. These limits will be considered in the third workshop as part of the consideration of management scenarios for testing, and form the basis for evaluating practical limits to setting water quality targets.

**Task 15. Third Progress Workshop:** ENSR will hold a workshop for stakeholders and other appropriate parties to go over the completed model and its application to scenarios that illustrate its utility, expected response to changes, and determination of limits to management success. Scenarios to be evaluated with the model will be generated from this workshop.

**Task 16. Finalize Scenarios to be Evaluated:** ENSR will prepare a list of the scenarios to be tested, with a description of the input approach associated with each, for approval by the designated representatives of the stakeholder group. This list will follow from task 15, with any adjustments found appropriate in reviewing the approach necessary to evaluate the selected scenarios.

**Task 17. Test Selected Watershed Change and Management Scenarios:** ENSR will test the scenarios approved by the stakeholder group and provide a discussion of results. This discussion will include the relation of scenario results with desirable water quality, allowing the stakeholder group and regulators to consider appropriate numeric targets in light of expected resulting conditions and potential for achievement. ENSR will provide assistance to the CDPHE in setting any numeric standard deemed appropriate.

**Task 18. Desirable Load Reductions:** ENSR will determine pollutant loading reductions associated with achieving pH standards and any other designated water quality target using the model. These are derived from refinements of scenarios that represent load reductions that may or may not achieve desired conditions; by refining the scenarios to achieve the desired conditions, desirable load reductions can be

determined more precisely. Both the overall load reduction and the allocation among sources and/or sub-watersheds can be delineated from this exercise if so desired. Methods for achieving these reductions will be described, considered and recommended.

**Task 19. Fourth Progress Workshop:** ENSR will conduct another workshop for stakeholders and other interested participants to discuss the results of scenario runs, associated load reductions, and approaches to achieving desirable conditions and associated loads. The focus will be on the direction and magnitude of possible change through management scenarios and how these relate to achievement of desired conditions in Barr Lake and Milton Reservoir.

**Task 20. Model Training:** ENSR will conduct training for interested parties to facilitate use of the model by parties other than ENSR in furthering management of the Barr-Milton Watershed. This training is envisioned as a hands-on workshop covering a full day, whereby participants can repeat the exercises run by ENSR in applying the model and make changes to observe the effect or create new scenarios. Ideally, trained persons will be able to use the model for further evaluation of refinements in any management plan without consulting aid, although such aid will be made available.

**Task 21. Reporting:** ENSR will prepare written updates prior to each workshop and will prepare a final report that describes the development and testing of the models, application to the watershed, scenario testing, assessment of water quality resulting from scenarios, loading limits and possible allocations, and recommendations for next steps in achieving desired conditions.