Scope of Work
Colorado River Basin
Nonconsumptive Needs Quantification

This Scope of Work is divided into four sections as suggested in the Grant Application Instructions. Section 1 provides a description of each major task associated with the project along with a functional description of who will be completing the work and a description of the deliverables associated with the task. Section 2 lists the key personnel proposed for the project along with a brief description of their relevant project experience. Section 3 presents a detailed breakdown of the costs to complete the study and Section 4 presents the proposed Project Schedule.

Section 1 Task Summary

Introduction and Background

The Colorado Basin non-consumptive needs assessment committee has been meeting for the 18 months to complete the Colorado Basin's Nonconsumptive Needs Assessment which is required under HB05-1177. The committee's efforts have focused on three key efforts:

- Defined function environmental and recreational attributes in the basin
- Developed a matrix of attributes at risk and associated map of the areas within the Colorado Basin at risk
- Participated in pilot study of the Watershed Flow Evaluation Tool for the Roaring Fork Watershed

To further quantify flow needs within the basin, the Committee recommends that site-specific quantification of instream flow needs for the Colorado River between Kremmling, Colorado and No Name, Colorado be completed and that the Watershed Flow Evaluation Tool be completed for the entire Colorado River Basin to focus future site-specific and water management efforts.

Study Objectives

The objectives of the study are to:

- Build upon existing quantification efforts in the basin to maintain consistency in approaches and to develop a comprehensive dataset of quantification measures in the basin
- Conduct site-specific quantification of instream flow needs for Colorado River between Kremmling and No Name which would determine the current state of the aquatic ecosystem in this river reach including:

- Physical/geomorphic characteristics
- Hydrologic characteristics
- Riparian characteristics
- Instream aquatic habitat characteristics

- The site-specific quantification for the Colorado River between Kremmling and No Name would also determine expected changes as a result of hydrologic change with additional water regulation such as
  - Expected geomorphic changes
  - Expected riparian changes
  - Expected aquatic habitat changes
- Complete evaluation of Colorado River Basin using the Watershed Flow Evaluation Tool
- Conduct study within a stakeholder process with the Colorado Basin Nonconsumptive Needs Assessment Committee and Basin Roundtable

This study is divided into four tasks, addressing each of the objectives. The following is a list and description of tasks to be completed under this work plan.

Task 1 Conduct Site-Specific Quantification of Colorado between Kremmling and No Name

Task 1.1 Meeting, site visit, initial inventory, and high flow field data collection [WILL BE FUNDED UNDER ANOTHER CONTRACT INCLUDED HERE FOR PROJECT UNDERSTANDING ONLY]

Task 1.1 will consist of the following work elements:

Meeting:
There will be an initial meeting to refine the Phase 1 scope of work, schedule for the initial tasks and expected products.

Site Visit:
The site visit will be a reconnaissance level effort to familiarize the team with the project area and finalize plans for the initial inventory of field data.

Initial Inventory:
This will consist of an effort to assemble any existing physical and biological data for this reach of the Colorado River. In addition, an additional site visit will take place for both the physical and biological data collection. The data collection effort will be sufficient to qualitatively describe the existing environment within the reach and to

develop a proposed approach to quantify changes that may occur with changes in river hydrology.

- Riparian: The initial riparian inventory will use both aerial photography and ground truthing to describe the existing riparian conditions, notes on vegetative species composition, general locations of native riparian corridor and ranchland.

- Aquatic Habitat: Distinct aquatic habitat reaches exist within this reach of river, a canyon bound reach and meandering reach. General characteristics of these habitat reaches will be described using data from topographic maps, aerial photography, and field mapping of short sections (1/2 mile or less) of the river. Aquatic species information will be acquired from the Colorado Division of Wildlife data or other sources.

- High Flow Measurements: The initial site set up and high flow measurements will be collected.

Schedule:
Phase 1 will be completed between March 31st and June 30th, 2009.

Task 1.2 Completion of Data Collection [FOR THIS SUBTASK, NWCOG IS SEEKING FUNDING]

This task is contingent on completion of Task 1.3. This work assumes that River 2D will be the model used for data analysis and habitat quantification. As such, the field data collection will be consistent with those data needed to calibrate and simulate River 2D for a range of flows. The initial data collection for high flow will be collected in Phase 1. Phase 2 data collection will include mid flow and low flow data including river topography.

Schedule:
Phase 2 will be completed between July 1st and November 15th 2009.

Task 1.3 Data Analysis, Model Calibration, Model Simulation and Report [WILL BE FUNDED UNDER ANOTHER CONTRACT INCLUDED HERE FOR PROJECT UNDERSTANDING ONLY]

Data analysis, model calibration, model simulation, and report. This work will include data summary from the field data provided in Phases 1 and 2; input of data for model calibration and model simulations. Model simulations will include hydraulic and GIS habitat analysis for a range of flows for up to five species at each site. A report will be prepared to document field data collection, model calibration and simulation and results.

Schedule:
Phase 3 can begin during data collection; however, the majority of the work will be completed after all field data collection is complete. Phase 3 would be completed between September 15th, 2009 and March 15th, 2010.

Task 2 Apply Watershed Flow Evaluation Tool throughout Colorado River Basin

Completion of this task is based on the following assumptions:

- Completing this task will be contingent on recommendation and acceptance of Watershed Flow Evaluation Tool by Colorado Basin Roundtable Nonconsumptive Subcommittee and Colorado Basin Roundtable
- Any site-specific quantifications completed in the basin will be considered to take precedent over the Watershed Flow Evaluation Tool results and these site-specific quantifications will be used to validate results from the Watershed Flow Evaluation Tool

Task 2.1 Stakeholder Meeting and Facilitation

Public Outreach

NCNA Sub-Committee and Consultant team will develop and hold a minimum of three public meetings to gain additional public input and provide public education about the NCNA process. The public will be able to suggest other stream reaches that may be added to the mix for evaluation and quantification. Other means of public outreach, both within and outside the Basin, will also be developed using various media and forums. The final report will also be distributed to various public outlets and be available through the IBCC web site.

Project Team Meetings and Coordination

The primary means of coordinating on project activities will take place through the Colorado Basin Nonconsumptive Needs Assessment Sub-Committee. The Consultant team will meet with the Sub-Committee and interested Stakeholders on a bi-monthly basis – or as needed -- during the course of the project. At a minimum the CDM project manager will meet with the Sub-Committee and interested Stakeholders. When key deliverables are presented to the Committee other project team members will attend the Sub-Committee meetings. It is anticipated that other project team members will attend up to four subcommittee meetings. The CDM team will also develop monthly status reports on study progress to be sent to the Sub-Committee and all interested Stakeholders.

The following topics will be discussed during the bi-monthly – or as needed -- Sub-Committee and Stakeholder meetings:

- Review of scope of work
- Review schedule
- Coordination with Colorado Division of Wildlife and stakeholders on past quantification efforts in the Colorado Basin and what data is available for comparison with Watershed Flow Evaluation Tool Results

- Locations to apply the Watershed Flow Evaluation Tool
- Summarize where we have Colorado Decision Support System (CDSS) baseline nodes throughout the basin and develop stakeholder agreement on main nodes to be considered in the basin based on where the tool will be applied
- Discuss how CDSS model will be simulated and garner support from stakeholder group on this item
- Discuss work products that will be developed from the Watershed Flow Evaluation Tool and how these can be integrated into other basin efforts
- Results of Watershed Flow Evaluation Tool GIS Risk mapping
- Comparison of results with other quantification efforts in the basin
- Review of memos summarizing Tasks 2.2, 2.3 and 2.4
- Draft report summarizing study results
- Utilizing work efforts in coordination with other studies in the basin such as the supply availability study
- Training and use of the Watershed Flow Evaluation Tool. The final product will be available for use by others outside this NCNA work team.

Task 2.2 Inventory Hydrologic Data

The Consultant team will complete the following work elements in inventorying hydrologic data:

- Summarize Colorado Decision Support System (CDSS) baseline and non-baseline nodes
- Recommend additional CDSS baseline nodes
- Inventory USGS gages
- Get agreement from stakeholders on nodes that will be modeled using CDSS
- Based on stakeholder input, assess what other hydrologic models are available in the basin for comparison with the CDSS results such as Denver's PACSIM model.

Consultant team will prepare mapping of the basin showing DSS nodes, USGS gages, and watersheds that have models other than the CDSS. Consultant team will prepare brief memo that describes the hydrologic data inventory and major decision items that will need to be completed by the stakeholder group regarding the inventory.

Task 2.3 Hydrologic Modeling using the Colorado Decision Support System (CDSS) and Calculate Flow Statistics

The Consultant team will complete the following elements for the hydrologic modeling:

- Recommend conditions and assumptions used to generate hydrology from CDSS model to stakeholder group and get agreement from stakeholder group on conditions
- Assume that limited number of additional baseline nodes will need to be added based on stakeholder input but will be limited based on budgetary constraints with consideration of model simulation
- Utilizing CDSS model, run baseline and current conditions hydrology for nodes agreed upon in Task 2.1
- Daily and monthly data will be generated from model for agreed upon nodes from Task 2.1
- Quality Assurance/Quality Control of model output
- Review model output and compare to other hydrologic models in the basin if available. This assumes that other existing model output will be available from the model owner and that the Consultant team will not have to simulate other existing models for model output.

For baseline and current conditions, the Consultant team will calculate the following flow statistics that are related to aquatic ecology using IHA software or other methods in Excel:

- mean annual flow (MAF) for each year and per record (1)
- mean of Aug. and Sept. flow for each year and per record (2)
- metrics in (2) above divided by metric (1) above, that is Aug + Sept average/MAF
- 30 day high flow (moving average across average daily flow series) for each year and average per record
- annual peak flow (daily average) for each year and average per record
- Additional statistics may be developed based on geomorphic conditions in the watershed

The Consultant team will prepare a memo that describes the model simulation conditions, model output and flow statistics. The memo will also address any quality

assurance issues or concerns with the model simulation output and any comparison with other models.

Task 2.4 Review Watershed Flow Evaluation Tool Ecological Flow Curves and GIS Mapping of Flow Statistics/Ecological Flow Curves Using Risk Framework

The Consultant team will complete the elements for this task:

- Review existing flow ecology curves and compare to relevant studies that have been conducted in the Colorado River Basin
- Peer review existing flow ecology curves with local basin Colorado Division of Wildlife biologists and other experts
- Based on metrics for biological indicators generated during the Watershed Flow Evaluation Tool Pilot Study, generate risk framework mapping of flow conditions vs. the biological indicators. The biological indicators include: trout, riparian, invertebrates, and warm water fishes.
- Facilitate dialogue with local biologists and stakeholders on distribution of biological indicators throughout the basin
- GIS maps will show areas that have various levels of support for the biological indicators based on the flow metrics calculated in Task 2.3

The Consultant team will prepare a memo that describes any recommended changes to the flow ecology curves and the GIS mapping. Consultant team will generate GIS mapping that can be utilized by stakeholder group.

Task 2.5 Compare Results of Watershed Flow Evaluation Tool with Other Basin Efforts

The Consultant team will compare the results of the flow evaluation tool with other efforts occurring in the Basin such as the Wild and Scenic efforts or the Grand County Stream Management Plan. The Consultant team will prepare a memorandum describing this comparison and summarize any suggested changes to the technical elements of the Watershed Flow Evaluation Tool.

Task 2.6 Finalize Watershed Flow Evaluation Tool, Develop Draft and Final Report and Final Presentation

Based on comments from stakeholders and comparison efforts in Task 2.5, the Consultant team will finalize the technical elements of the Watershed Flow Evaluation tool. The Consultant team will also develop the following work products which will document the study efforts:

- Develop Draft and Final Report based on memorandums throughout Task 2

- Develop Final Presentation regarding study results that will be presented at Colorado Basin Roundtable and CWCB Board

Deliverables will be produced in electronic format for distribution to stakeholders.

Section 2 Key Personnel

Relevant project experience for the key personnel proposed for the Colorado River Basin Nonconsumptive Needs Quantification are discussed in this section.

Colorado Basin Roundtable and Non-Consumptive Use Needs Assessment Sub-Committee – Project oversight and Facilitation

The NCNA Sub-Committee will hold primary responsibility for the oversight and progress of this project. The Sub-Committee and Co-Chairs will meet or otherwise communicate on a regular basis with the Project Manager to ensure timely compliance with the Scope and schedule. The Sub-Committee will review drafts of the Report, Flow Evaluation Tool and Data, and report regularly to the Basin Roundtable as a whole. The Sub-Committee will also be responsible, with the Project manager and primary Consultants for Public Outreach, meetings and education.

Nicole Rowan, P.E. –Project Management

Ms. Rowan has over 13 years of water resources engineering experience and is a senior project manager who focuses on water supply, watershed management and natural resources projects. She was the project manager for the Statewide Water Supply Initiative (SWSI) and is the project manager for CDM's current contract with the Colorado Water Conservation Board to provide technical support to the Interbasin Project Compact process.

Tim Cox, Ph.D., P.E. – Hydrologic Modeling

Dr. Cox has a diverse background in water supply planning and water quality management planning. He has broad skills in applying mathematical programming, water quality models, and water supply allocation models in addressing western water resources issues. Dr. Cox has used the CDSS model in examining water allocation and environmental flow need as part of the SWSI project.

Ming Yen-Tu, Ph.D., P.E. – Hydrologic Modeling

Dr. Tu has a broad background in water resources planning and management, mathematical programming, numerical analysis, and hydrologic, hydraulic, and hydrodynamic analyses. In addition, he has extensive experience in developing optimization models to analyze large-scale water distribution systems with reservoir operations and water allocations.

Rebecca Dunavant – Environmental Scientist

Ms. Dunavant is an environmental scientist who specializes in water resource related projects. She has worked on various surface water quality projects and has knowledge of the associated regulatory requirements. Ms. Dunavant is responsible for the GIS

mapping and biological risk indicators for the Watershed Flow Evaluation Tool pilot study.

William J. Miller, Ph.D. – Site-Specific Quantification and Watershed Flow Evaluation Tool Application

Dr. Miller will be responsible for directing and participating in all aspects of the proposed work. Dr. Miller is the President and Senior Aquatic Ecologist for Miller Ecological Consultants, Inc. Dr. William J. Miller has over 30 years experience in fisheries, instream flow, and aquatic ecology studies. He has worked extensively throughout the western U.S. and is a recognized expert in the areas of instream flow, water temperature modeling and habitat assessments. Dr. Miller's experience includes research and evaluations for several threatened, endangered, and candidate aquatic species in the Colorado River and Platte River basins. He has extensive experience in designing and conducting studies using the Instream Flow Incremental Methodology (IFIM), instream water temperature modeling and developing and implementing ecological models for aquatic systems. Dr. Miller is a former member of the USFWS Instream Flow Group. He is co-author on the Stream Network Temperature Model, Instream Flow Information Paper 16. Dr. Miller is a Certified Fisheries Scientist (No. 2008). Dr. Miller's experience includes designing and directing basin wide instream flow evaluations. He has completed instream flow evaluations for US Forest Service, US Fish and Wildlife Service, Bonneville Power Administration, U.S. Army Corps of Engineers, and the Department of Justice. Dr. Miller developed a GIS based methodology for determining flow/habitat relationships for aquatic species using 2 dimensional hydraulic modeling and habitat evaluations. Dr. Miller has presented his research at international conferences in Japan and New Zealand.

Kristin Swaim M.S. – Site-Specific Quantification

Ms. Swaim is a fishery biologist for MEC. Ms Swaim has over 8 year experience in fishery and aquatic ecology. Ms. Swaim has assisted with instream flow studies and aquatic ecology studies on both cold water and warm water ecosystems. Ms. Swaim has field experience in data collection for both biological and physical data for aquatic ecosystems.

Samuel T. Combs, Ph.D., P.E. – Site-Specific Quantification

Dr. Combs is a staff associate for MEC that would be available for assistance with model calibration and simulations, if needed. Dr. Combs is a hydraulic engineer and has provided support to MEC for software development and problem solving for unique solutions to complex hydraulic analysis.

Brian Bledsoe, Ph.D. – Watershed Flow Evaluation Tool Application

Dr. Bledsoe is an Associate Professor in the Department of Civil and Environmental Engineering at Colorado State University. He has managed externally funded research program in surface water quality, stream and watershed rehabilitation, and multi-scale biophysical linkages in aquatic ecosystems. His recent projects include

grants from the National Science Foundation, U.S. EPA, Water Environment Research Foundation, and the U.S. Forest Service to examine water quality benefits of stream restoration practices, effects of urbanization on the physical character of aquatic habitat, channel erosion and nutrient loading, and analysis of physical, chemical and biological characteristics of streams.

LeRoy Poff, Ph.D. - Watershed Flow Evaluation Tool Application

Dr. Poff is a Professor in the Department of Biology at Colorado State University. Dr. LeRoy Poff's research, teaching and outreach activities are motivated by a desire to advance an interdisciplinary understanding and management of freshwater ecosystems, especially streams and rivers. Dr. Poff focuses primarily on how the diversity and function of plant and animal communities respond to natural and human-caused changes in environmental factors (e.g. stream flow patterns) over time. His work has been both basic and applied, and has been supported by the National Science Foundation, the U.S. Environmental Protection Agency, the U.S. Forest Service, and the U.S. Geological Survey.

John Sanderson, Ph.D. - Watershed Flow Evaluation Tool Application

John Sanderson is Senior Freshwater Ecologist at The Nature Conservancy of Colorado. He joined The Nature Conservancy in 2005 after completing his Ph.D. in Ecology at Colorado State University. John has been working on conservation of streams and wetlands in Colorado since 1994. He has been assisting various roundtables, the CWCB, and CDM with implementation of the non-consumptive needs assessment, particularly with development of approaches to priority setting and the Watershed Flow Evaluation Tool. Other relevant current projects include establishing flow guidelines for the North Fork Cache la Poudre River through a Shared Vision Planning process and a statewide assessment of river ecosystems called Freshwater Measures of Conservation Success.

Thomas Wilding, Ph.D. - Watershed Flow Evaluation Tool Application

Thomas Wilding is a PhD student at Colorado State University, working with LeRoy Poff on the ecological effects of flow alteration. Thomas worked on the Water Flow Evaluation Tool, deriving the flow-ecology relationships. He has 10 years experience with regional government, providing scientific input for water resource planning and permitting. His skills include habitat modeling (PHABSIM) and the monitoring of streams and lakes.

Section 3 Budget

A detailed breakdown of the estimated labor and other direct costs for the proposed project is presented in the following pages.

Section 4 Project Schedule

The proposed project schedule is presented on the following page. It is anticipated that the project will be completed within twelve months.