Toward the Development of a Cumulative Effects Monitoring Program for the Lower Columbia River

Executive Summary

Prepared for:

Columbia River Integrated Environmental Monitoring Program
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Prepared – September 2003 – by:

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Introduction

The transboundary reach of the Columbia River extends some 60 km from the Hugh Keenleyside Dam to the international border. This portion of the Columbia River and its tributaries, which is commonly referred to as the lower Columbia River basin, generates a host of benefits to the people of the Northwest, both in Canada and the United States. In addition to myriad instream water uses (i.e., fish and aquatic life), the Columbia River provides an important source of raw water for municipal water supplies, irrigation, livestock watering, and industrial water uses. The Columbia River and its tributaries have also been impounded extensively to support hydroelectric power production, water storage, and flood control. Importantly, the river has also been used to dispose of municipal and industrial wastes, including pulpmill and smelter effluents. Recreation and aesthetics also represent important uses of the aquatic environment that generate social and economic benefits to area residents.

Balancing the diverse and often conflicting uses of the Columbia River represents a formidable management challenge. Recognizing that the issues and concerns in the lower Columbia River basin cannot be effectively addressed by a single organization, key stakeholders initiated the Columbia River Integrated Environmental Monitoring Program (CRIEMP) in 1991. The objectives of this program were to share environmental information, co-ordinate the monitoring activities of the participating organizations, evaluate the state-of-the environment in the lower Columbia River by means of field monitoring, and communicate the results of environmental monitoring programs to the public. Between 1991-1993, CRIEMP investigated water quality conditions in the lower Columbia River. The information gained from this initiative has substantially improved our understanding of environmental conditions in the lower Columbia River basin.

Due to the success of the CRIEMP initiative, CRIEMP II was launched in 2001 with a broader mandate than was the case for the original program, one that included coordinating the integration of environmental monitoring programs and applying the resultant information to assess the cumulative effects (CEs) of multiple human activities in the lower Columbia

River basin. Such CEs are important to assess and manage because they have the potential to impair beneficial water uses in a manner and to an extent that would not be predicted based on the environmental assessments for single activities or development. This report was prepared in response to the need for a monitoring program to assess the CEs of multiple disturbance activities in the lower Columbia River basin.

Ecosystem-Based Framework for Cumulative Effects Assessment

In pursuing the cumulative effects assessment (CEA) agenda, the members of the CRIEMP Technical Committee have agreed to adopt the ecosystem approach. Implementation of the ecosystem approach requires a framework in which to develop and implement management policies for the ecosystem. In general, this framework is comprised of three functional elements (CCME 1996). The first element of the framework is a series of broad management goals (i.e., ecosystem goals), which articulate the long-term vision that has been established for the ecosystem. These goals must reflect the importance of the ecosystem to the community and to other stakeholder groups. The second element of the framework is a set of *objectives* for the various components of the ecosystem which clarify the scope and intent of the ecosystem goals. The final element of the framework is a set of *ecosystem indicators* (including specific *metrics and targets*), which provide an effective means of measuring the degree to which each of the ecosystem goals and objectives are being attained.

Cumulative effects assessment is a relatively new discipline that has been developing over roughly the past 15 years. Over that time, a variety of approaches have been developed to support the assessment of cumulative environmental effects, each of which have certain advantages and limitations. In this study, seven major approaches to CEA were considered for use in the lower Columbia River basin, including: the environmental checklist approach; the interactive matrices approach; the network analysis approach; the environmental auditing approach; the landscape perspective approach; the spatial analysis approach; and, the ecological modelling approach. Because there is no general agreement on which of these approaches in most relevant for assessing CEs, each of the methods were evaluated in terms of its practicality, simplicity, flexibility consistency, sensitivity, and resolution.

Application of these criteria in a preliminary evaluation of the various approaches suggests that no single procedure is likely to fully meet the needs for CEA in the lower Columbia River basin. For this reason, elements from several of these approaches were incorporated into a broad ecosystem-based framework for assessing CEs in this river system. Consistent with the ecosystem-based framework, a long-term vision for the future was established by the CREIMP II Technical Committee for the lower Columbia River basin.

> *"Our vision of the lower Columbia River embodies a productive ecosystem that enhances the natural aquatic and terrestrial environments and balances these values with human-based values (economic, traditional, cultural, recreational, social, aesthetic, and health). The vision recognizes existing constraints which are a result of historical decisions. A collaborative integrated monitoring approach to accurately understand and communicate the status and changes in the ecosystem is the role of CRIEMP."*

Ecosystem goals and more specific ecosystem objectives were also developed to support the cumulative effects assessment process. The ecosystem goals emphasize the importance of maintaining a productive and diverse aquatic ecosystem, protecting drinking water supplies; preserving traditional culture and lifestyles, and making management decisions that do not compromise the ability of future generations to meet their needs. To support the design of a CE monitoring program, the ecosystem goals were further clarified and refined to establish ecosystem objectives that are linked more closely to measurable attributes of the aquatic ecosystem.

Assessment of Cumulative Effects

To support the development of a CE monitoring program, a proscriptive CE assessment was conducted for the lower Columbia River basin. This assessment of cumulative environmental effects involved several steps that link stressors to receptors in the river basin. These steps included: identification of the human activities that could affect the study area; identification of the types and probable locations of the environmental changes that could occur in response to the human activities; identification of the types and probable locations of receptors that could be affected by the environmental changes; identification of the types of ecosystem functions that could be altered by the environmental changes and the locations of such alterations; selection of cumulative effects indicators (CEIs; a special type of ecosystem indicator) from the list of receptors and ecosystem functions that were identified previously; and, implementation of the CEA.

The human activities that occur in the lower Columbia River basin give rise to numerous stressors, each of which has the potential to cause or substantially contribute to adverse effects on the aquatic ecosystem and/or its uses. Rather than address each of them individually, these stressors were classified into a series of stressor groups to simplify the process of establishing linkages between stressors and receptors. The five stressor groups that were established included: aquatic contamination; flow regulation; climate change; introduced species; and, land use change. Subsequently, linkage diagrams were prepared for each stressor group that described the types of physical and chemical changes that were likely to be associated with various disturbance activities. In turn, this information was used to identify the types of biological effects that could occur in response to such physical and chemical alterations.

While the linkage diagrams provide essential information for assessing the effects of each individual stressor group, it is necessary to consider the combined effects of multiple stressor groups to support an assessment of CE in the lower Columbia River basin. To facilitate this process, simple interactive matrices were prepared that described how two stressor groups, when acting together, could exacerbate changes in the physical and chemical characteristics of the aquatic ecosystem. In turn, this information was used to develop a total of 10 CEs hypotheses that identified the receptors that were most likely to be affected by such alterations and the types of effects that were most likely to occur in response to exposure to multiple stressor groups. Each of these hypotheses was then critically evaluated to determine its relative priority for testing in a retrospective CE assessment. The results of this assessment suggested that flow regulation-contamination interactions, climate change-contamination interactions, land use change-contamination interactions, and land use change-climate change interactions are the most likely to cause CEs in the lower Columbia River basin. Linkage diagrams were prepared for each of these priority stressor group interactions.

Cumulative Effects Monitoring

Subsequent examination of the linkage diagrams for the most important interactions among the stressor groups provided a basis for identifying the physical, chemical, and biological attributes of the aquatic ecosystem that were most likely to change in response to multiple human activities. These attributes of the aquatic ecosystem were termed CEIs. From this list of candidate CEIs, the types (or classes) of CEIs that should be considered for inclusion in a cumulative effects monitoring (CEM) program for the lower Columbia River basin were identified and included: aquatic plant community; riparian plant community; benthic invertebrate community; fish community; aquatic-dependent wildlife community; fish health; health of aquatic-dependent wildlife; hydrology; water chemistry; physical characteristics of water; sediment chemistry; tissue chemistry; aquatic habitat; and, climate.

Following the identification of the key classes of CEIs, the essential elements of a CEM program were identified. The core elements of the CEM program included climate monitoring, hydrological monitoring, aquatic habitat monitoring, water quality monitoring, sediment quality monitoring, tissue monitoring, and biological monitoring. Next, metrics (i.e., measurable attributes of an indicator) were established for each CEI to facilitate CEM program design. In addition, sampling sites and monitoring frequencies were established for each metric to further refine the design of the CEM program. As such, substantial progress has been made on the design of a CEM program for the lower Columbia River basin.

Next Steps

Although a substantial amount of progress has been made on the development of a CEM program for the lower Columbia River basin, several important steps need to be completed to facilitate its implementation. First, ongoing environmental monitoring programs in the basin need to be reviewed to identify the elements of the CEM program that are already being conducted and those that need to be implemented under the CRIEMP CEA initiative. Next, a data archiving system needs to be developed to facilitate compilation of historical and new CEM data. Third, CEM program elements that have been identified need to be translated into a monitoring program design. Fourth, a sampling and analysis plan (SAP) needs to be prepared to address the components of the CEA monitoring program that will be undertaken by the CRIEMP Committee. Fifth, numerical or narrative targets need to be established for each of the metrics that were selected for inclusion in the CEM program for the lower Columbia River. Finally, the results of the CEM program should be applied to assess the cumulative environmental effects of multiple disturbance activities in the lower Columbia River basin. The results of this assessment should be communicated to the public and applied to identify the management actions that are needed to mitigate or eliminate any CEs that are identified. In addition, these results should be used to identify critical data gaps and to design research programs to fill these data gaps.

References

CCME (Canadian Council of Ministers of the Environment). 1996. A framework for developing ecosystem health goals, objectives, and indicators: Tools for ecosystem-based management. Water Quality Guidelines Task Group. Winnipeg, Manitoba.