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D R A F T M E M O R A N D U M

DATE: March 16, 2004

TO: Ron Miska, Marin County Open Space District

FROM: PWA

RE: **Bolinas Lagoon Ecosystem Restoration Project (ERP) – Adaptive Management Plan**

PWA Ref. #: 1686 (Task 5)

Bolinas Lagoon Adaptive Management Plan

1 OVERVIEW

The Marin County Open Space District (MCOSD) is committed to protection and sound management of the natural resources of Bolinas Lagoon. In an effort to develop a sound management plan for the Lagoon which receives community support and meets the environmental regulations, the District has hired Philip Williams & Associates (PWA) to predict future Lagoon morphology and ecology and determine if any intervention is required to meet the desired management goals and objectives.

Previous tasks in this multi-phase study have included review of the *Bolinas Lagoon Ecosystem Restoration Feasibility Study and Draft EIR/EIS* and previous reports, development of a conceptual model, and articulation of draft management objectives, indicators and targets. In this task of our Phase 1 study, we describe, in broad terms, how an adaptive management plan can be developed and implemented for Bolinas Lagoon. This includes developing a decision-making framework and preliminarily identifying key variables to monitor in the system. We also describe how this plan could build upon findings from the current study.

2 WHAT IS AN ADAPTIVE MANAGEMENT PLAN?

An adaptive management plan establishes clear management goals and a structured decision making framework in which management decisions and actions are based on explicit conceptual models of system function and monitoring of key physical and ecological variables. The adaptive management process acknowledges that uncertainties exist in our understanding of ecosystem functions and provides an operational framework for updating management plans based on improved understanding of ecosystem dynamics (Holling, 1978 and Walters, 1986). As new insight on ecosystem functions emerges through periodic monitoring and analysis, this information is fed back into the planning and management process.

This allows for conceptual models, goals, objectives, and key indicators to be re-evaluated and, if needed, revised to reflect the most current understanding of the Lagoon. Such re-evaluation is essential in developing effective management actions to achieve desired goals.

3 DEVELOPMENT OF AN ADAPTIVE MANAGEMENT PLAN FOR BOLINAS LAGOON

The Bolinas Lagoon Adaptive Management Plan should be administered by the MCOSD, with assistance from the Bolinas Lagoon Technical Advisory Committee (BLTAC). The operational framework for the Bolinas Lagoon Adaptive Management Plan is shown in Figure 1.

The plan should be based on an explicit conceptual model of Bolinas Lagoon in order to select appropriate physical and ecological indicators and to establish effective intervention measures that could be implemented, if needed, to return physical or ecological conditions to a desirable state. In an earlier task of Phase 1 of this study, we developed a conceptual model describing the fundamental cause and effect linkages between physical and ecological processes (PWA, 2003a). However, we also identified a number of key uncertainties on the rates and magnitudes of important physical processes (e.g., watershed and littoral sediment inputs) and the present distribution of Lagoon habitats. In Phase 2 of the current study, we will collect additional data and perform further analyses to fill these data gaps. Based on these findings, the existing conceptual model may be refined.

In addition to being founded in an explicit conceptual model, an adaptive management plan will require that overall goals be translated into operational objectives and that specific indicators identified. Indicators are measurable biological, ecological, and physical variables that provide a simple method for measuring, either quantitatively or qualitatively, the degree to which each management objective is met. Each indicator will have a threshold target value or a range of target values specified, one limit being the tolerable level and the other being the desirable. Previously agreed upon goals adopted by the MCOSD and BLTAC in the *Bolinas Lagoon Management Plan Update* of 1996 have been summarized and translated into a draft set of operational objectives and indicators (PWA 2003b). We will work with the MCOSD and BLTAC to review and, if necessary, revise this set of objectives, indicators, and targets after completion of our 50-year predictions of ecosystem evolution.

As shown in Figure 1, initiation of an adaptive management program will require the development and implementation of a detailed monitoring plan. This should occur after Phase 2 of the current study, after the objectives, indicators and targets have been agreed upon and a 50-year prediction of Lagoon evolution presented to the MCOSD and BLTAC. The monitoring plan will track key physical and ecological indicators (e.g., habitat distribution) to determine if target values or thresholds are exceeded. Along with the monitoring plan, specific intervention measures should be identified to return indicators to desirable levels if thresholds are exceeded.

4 IMPLEMENTAION OF THE ADAPTIVE MANAGEMENT PLAN

Implementation of the Bolinas Lagoon adaptive management plan will consist of regular monitoring, analysis of this data, periodic revisions to the conceptual model, and implementation of pre-planned and appropriate intervention measures only if thresholds are exceeded. The lower section of Figure 1 illustrates this process graphically.

If target values are not exceeded, no action should be taken, and the monitoring program should continue. However, if targets or thresholds are exceeded, preplanned intervention measures should be implemented to return a specific indicator back to a desirable target value or set the system on an evolutionary trajectory towards a desirable target value. The management interventions should be preplanned and consistent with the conceptual model. Implementation of these measures would be targeted and dependent on which indicator or indicators exceed threshold values. The adaptive management plan should also provide a means for updating preplanned intervention measures if the conceptual model is revised.

The analysis of monitoring data will also provide an opportunity to confirm or refute hypotheses established in the conceptual model and to assess the accuracy of the predicted Lagoon evolution. For example, the existing conceptual model identifies infrequent large floods as the primary source of watershed sediment inputs to the Lagoon. If monitoring data over decadal time scales does not support this hypothesis, the conceptual model can be refined. Similarly, if analysis of monitoring data suggests that Year 50 predictions are not accurate, the conceptual model may need to be revisited.

LIST OF PREPARERS

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LIST OF FIGURES

REFERENCES

Holling, C.S., 1978. Adaptive environmental assessment and management. John Wiley & Sons, New York.

Philip Williams & Associates, Ltd. and Wetlands Research Associates, 2003a. Bolinas Lagoon Conceptual Model. Draft technical memorandum for Marin County Open Space District.

Philip Williams & Associates, Ltd. and Wetlands Research Associates, 2003b. Management Objectives, Indicators and Targets. Draft technical memorandum for Marin County Open Space District.

Walters, C., 1986. Adaptive management of renewable resources. Macmillan, New York.

Williams, P.B. and Cuffe, C.K., 1994. The management implications of the potential for closure of Bolinas Lagoon. *Shore & Beach*, Vol. X, p.3-12.