The recent high water levels in Silver Lake have caused severe problems with one house, damaged the foundations of several others, and flooded many septic systems. High water levels have also encroached on the wetlands on the northwest side of the lake, possibly affecting nutrient storage/export. Shorelines have been inundated causing shoreline erosion, including extensive slumping in some areas. Other lakes in the area, such as Shell Lake, located about 13 miles to the north, have also experienced high-water problems in recent years.

The recent decline in lake water quality appears to be associated with the high water levels in the lake. Prior to 2000, the average summer water quality in Silver Lake was very good (total phosphorus concentrations of about 5-8 µg/L, chlorophyll a concentrations of about 0.9 to 3.7 µg/L, and Secchi depths of about 3.5 to 5.3m; figure 3), and the lake was typically classified as oligotrophic. However, data collected in 2002 and 2003 show a marked decline in water quality (total phosphorus concentrations of about 16-19 µg/L, chlorophyll a concentrations of about 4.5 µg/L, and Secchi depths of about 2.3 to 3.3m) and the lake was classified as moderately mesotrophic. This decrease in water quality coincided with the very high water levels in the lake indicating the recent degradation in lake water quality may be climatically driven.

Barron County and lake residents want to understand what is causing the recent high water levels in the lake and recent degradation in water quality. This information is needed to develop a management plan that if implemented could improve the water quality of the lake and possibly alleviate the high-water problems. To understand what has caused the recent degradation in water quality and what actions can be taken to improve the lake's water quality, it is essential to identify and quantify present and potential phosphorus sources. To quantify present phosphorus sources, it is essential to develop detailed water and phosphorus budgets for the lake that include contributions from meteorological inputs, ground-water and surface-water flow, and water loss from evaporation from the surface of the lake. To develop a long-term plan for the lake, these efforts should be done in collaboration with a detailed watershed study that allocates contributions to various locations and land uses in the watershed.

In many lakes with significant surface watersheds, phosphorus loadings from sources other than runoff are usually minor contributors to the total loading. However, in Silver Lake, ground water and precipitation could be significant phosphorus-loading sources to the lake. In addition, the high water levels may have caused the wetlands on the northwest side of the lake to become a more important source of phosphorus, may have induced increased shoreline erosion of nutrient-rich soils, and may have inundated septic systems. For lake-management purposes, it is desirable to know the contributions of phosphorus from the various sources and how sensitive the lake is to incremental increases or decreases in phosphorus loading. If ground water is a significant contributor, identification of the ground-water contributing area is needed to define "sensitive" areas where activities have the most potential to adversely affect the quality of the lake; an example being residential septic systems.

A proposal has been submitted to study the nutrient and water budget of Silver Lake, quantify the relative contributions of sources of phosphorus that may be related to the recent decline in water quality (including that from ground water and near-shore erosion),

use sediment core data to determine if deteriorated water quality also occurred during periods of previous high water levels, and use water-quality models to determine how much of the phosphorus loading would need to be reduced to improve the water quality of the lake.

Objectives:
The objectives of this proposed study are to:

1. Develop a detailed water budget for the lake by measuring all major inflow and outflow sources and estimating the magnitude of minor sources.
2. Develop a ground-water model for the area around Silver Lake and use it to determine ground-water contributing areas and flow paths from recharge to discharge into the lake.
3. Determine a detailed phosphorus budget by quantifying the phosphorus loading associated with each water inflow and outflow source, including contributions from the wetlands.
4. Map shoreline erosion and estimate the importance of this erosion to the phosphorus budget.
5. Evaluate the current lake-water quality (trophic state) relative to long-term trends.
6. Evaluate current relations between water quality and measured water and phosphorus loading through the use of selected models in WiLMS and the WDNR's Seepage Lake Model.
7. Use the calibrated model or models to predict the likely response of Silver Lake to phosphorus-loading changes associated with various lake-management actions that might be implemented.
8. Relate historical lake-water quality (from available measured data and inferred from sediment-core analysis) with historical precipitation and lake-stage records to assess the effect of climatic (non human) factors on lake water quality.
9. Evaluate the effectiveness of possible scenarios at modifying the water level of the lake.

Study Schedule:

	ACTIVITY DATE
Reconnaissance to select monitoring locations and design gages	October 2004
Install lake-stage and precipitation gages	October-November 2004
Install near-lake piezometers (small-diameter wells)	November 2004-June 2005
Setup GFLOW model with preliminary simulations to identify calibration data needs	January – March 2005
Install outlying piezometers with Geoprobe	Spring or summer 2005
Shoreline erosion survey	Spring or summer 2005
Conduct level survey to link monitoring network to common datum	Summer 2005
Operate and maintain water and phosphorus budget data-collection network	Nov. 2004 –Nov. 2006
Collect and analyze sediment cores from the lake	June 2005 –Nov. 2006

Compile first year of data and publish	Dec. 2005 - Mar. 2006
Analyze and interpret data--compute water and phosphorus budgets, and apply GFLOW, MODFLOW, DLM,WiLMS, and Seepage Lake models etc.	January 2006 - June 2007
Compile second year of data and publish	Dec. 2006 – Mar. 2007
Preliminary results presented at annual Lake meeting	Summer 2007
Prepare report	April – December 2007
Transmit draft report to Lake Association	January 2008
Publish and distribute final report	June 2008