# East and West Twin Lakes

## Phosphorus Management & Action Plan

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## Overview of Sediment Phosphorus Fractionation

Sediment phosphorus fractionation results from both East Twin and West Twin indicate that internal phosphorus loading is present across the system, but its magnitude and risk vary significantly by location. Fractionation analysis separates total phosphorus into chemical forms that differ in stability and likelihood of release, allowing us to distinguish between sediments that act as active phosphorus sources versus those that function more as long-term phosphorus sinks.

Across both basins, total sediment phosphorus ranges from moderate to very high, with several sites exceeding 200 mg/kg. However, total phosphorus alone does not determine internal loading risk. Instead, the proportion of phosphorus present in loosely bound, iron-bound, and organic forms provides the clearest indication of how likely phosphorus is to be released into the water column and contribute to algae growth.

**Loosely Bound Phosphorus (Labile P)**

Loosely bound phosphorus represents the most immediately bioavailable fraction, capable of being released with minor disturbance, mixing, or chemical changes. Elevated concentrations of this fraction are a strong indicator of internal loading risk.

Both basins contain locations with elevated loosely bound phosphorus, but the highest values occur at select low-solids sites, including East Twin Site 3 and multiple West Twin locations (e.g., West Twin 6, 7, and 10). These sites are characterized by soft, unconsolidated sediments and low percent solids, which increases susceptibility to physical disturbance and diffusion-driven release. In contrast, sites with higher sediment solids (such as West Twin 8 and East Twin Site 5) show much lower loosely bound phosphorus, indicating more stable sediment conditions.

**Iron-Bound Phosphorus (Fe-P)**

Iron-bound phosphorus can remain stable under oxygenated conditions but is vulnerable to release during low-oxygen events. This fraction plays a major role in seasonal phosphorus cycling, particularly in shallow lakes that stratify.

Several sites in both East and West Twin show measurable iron-bound phosphorus, but iron binding potential varies. East Twin Site 3 exhibits high iron-bound phosphorus combined with low iron-binding potential, suggesting that phosphorus may be released when redox conditions change. Some West Twin sites show moderate iron-bound phosphorus but appear more stable due to higher solids and lower organic content.

Overall, iron-mediated release remains a conditional risk, particularly during summer or under ice cover.

**Organic Phosphorus (Org-P)**

Organic phosphorus is associated with decomposing organic matter and represents a delayed but persistent source of internal loading. As organic material breaks down, phosphorus can be gradually released into porewater and the water column.

Organic phosphorus is present at moderate levels across both basins, with particularly high organic matter content at East Twin Site 3 and West Twin low-solids locations. These areas exhibit high porosity and low bulk density, conditions that favor ongoing nutrient recycling. While organic phosphorus does not typically drive immediate bloom events, it contributes to long-term background nutrient enrichment and sustains eutrophic conditions over time.

**Aluminum-Bound Phosphorus (Al-P)**

Aluminum-bound phosphorus is one of the most stable fractions, remaining bound across a wide range of oxygen and pH conditions. A higher proportion of phosphorus in this form indicates effective long-term immobilization.

Both East Twin and West Twin sediments show very high aluminum binding efficiency, and aluminum-bound phosphorus represents a meaningful fraction of total phosphorus at multiple sites. This suggests that aluminum-based binding mechanisms are already active in the system and that additional aluminum- or lanthanum-based treatments are well suited for shifting phosphorus from bioavailable forms into stable sediment pools.

**HCl-Extractable and Residual Phosphorus**

HCl-extractable phosphorus represents phosphorus bound in calcium-based mineral forms, while residual phosphorus reflects the most permanently bound and biologically unavailable fraction.

Several sites in both basins show moderate to high HCl-bound and residual phosphorus, particularly where sediment solids are high and organic matter is low. These locations currently act as phosphorus sinks, storing nutrients in stable mineral forms rather than releasing them to the water column. In contrast, sites with low residual phosphorus and low HCl-P formation potential correspond closely with areas of higher internal loading risk.

**<u>Overall Interpretation</u>**

Taken together, the sediment data indicate that internal phosphorus loading in the East Twin–West Twin system is spatially variable, driven primarily by sediment stability, organic content, and phosphorus fractions rather than total phosphorus alone. A subset of low-solids, high-porosity sites act as internal loading hotspots, while other areas are currently functioning as relatively stable phosphorus sinks.

These results highlight the importance of targeted phosphorus mitigation and provide a strong scientific baseline for tracking change. By repeating sediment fractionation following phosphorus inactivation treatments, future sampling can document shifts in phosphorus from loosely bound and redox-sensitive forms into mineral-bound fractions. This approach provides a measurable, defensible metric for evaluating treatment effectiveness and long-term progress toward improved water quality.

## Management Recommendations and 2026 Action Plan

**<u>Management Recommendations</u>**

Sediment phosphorus fractionation results from East Twin and West Twin Lakes indicate that internal phosphorus loading remains an active and ongoing contributor to water quality conditions, particularly in areas with low sediment solids, high porosity, and elevated proportions of bioavailable phosphorus. While portions of the lake system currently store phosphorus in relatively stable forms, multiple locations function as internal loading hotspots, where phosphorus can be released to the water column during mixing events, low-oxygen conditions, or physical disturbance.

These findings indicate that algae management alone will not achieve sustained water quality improvement. Instead, reducing the availability of sediment phosphorus is necessary to interrupt the eutrophication cycle and support long-term lake recovery. The data further demonstrates that a lanthanum-based phosphorus mitigation approach is appropriate for this system, as lanthanum-modified bentonite (LMB) effectively binds sediment- and water-column phosphorus into highly stable, insoluble forms that are unavailable for algal uptake.

Importantly, the fractionation results establish a clear baseline condition, allowing future sediment resampling to be used as a defensible, quantitative measure of management success.

## 2026/2027 Action Plan

### 1. Target Internal Loading Hotspots

In 2026, management efforts should focus on strategic LMB applications, with emphasis on areas identified as internal loading hotspots through sediment fractionation (e.g., low-solids, high-releasable phosphorus sites). Targeting these locations will maximize treatment efficiency by directly reducing the most active sources of internal phosphorus loading while supporting lake-wide water quality improvement.

**2026 Actions:**

- Finalize priority treatment zones.
- Focus management efforts on low-solids, high-releasable phosphorus areas to maximize phosphorus reduction efficiency.
- Avoid uniform lake-wide treatment in favor of a targeted, data-driven approach.

### 2. Implement Lanthanum-Based Phosphorus Mitigation

In addition to hotspot treatment, lanthanum-based applications can be used more broadly to maintain and reinforce phosphorus stability in areas currently acting as sinks. This approach helps prevent future phosphorus mobilization and supports consistent, long-term nutrient control across both East Twin and West Twin basins.

**2026 Actions:**

- Apply LMB at dosages informed by sediment phosphorus concentrations and treatment acreage outlined in the mitigation dashboard.
- Conduct targeted water quality monitoring at application sites to monitor declining water column phosphorus.
- Schedule applications to align with favorable lake conditions and minimize sediment disturbance.

### 3. Post-Treatment Sediment Resampling and Evaluation

Sediment sampling and phosphorus fractionation should be repeated in early 2027 following 2026 lanthanum-based treatments to measure progress and document effectiveness. Changes in phosphorus distribution, specifically reductions in loosely bound and redox-sensitive fractions and increases in stable, permanently bound forms, will serve as a clear, defensible metric of success.

**Late 2026 / Early 2027 Actions:**

- Collect follow-up sediment samples at treated and reference locations.
- Repeat phosphorus fractionation analysis to evaluate:
    - Reductions in loosely bound and redox-sensitive phosphorus
    - Increases in lanthanum-bound and residual phosphorus
    - Decreases in overall releasable phosphorus

These metrics will be compared directly to baseline conditions to document treatment effectiveness.

**4. Adaptive Management and Long-Term Planning**

Results from post-treatment fractionation will be used to refine future management actions, including treatment timing, application areas, and dosage strategies. This adaptive approach ensures that phosphorus mitigation efforts remain data-driven, cost-effective, and responsive to lake conditions, while building a long-term record of improvement.

**Post-2026 Actions:**

- Use fractionation results to refine treatment locations, dosage strategies, and application frequency.
- Identify areas transitioning from phosphorus sources to stable sinks.
- Maintain sediment fractionation as a recurring annual monitoring tool to guide long-term investment and management decisions.

## Expected Outcomes

Implementation of this management and action plan is expected to:

- Reduce internal phosphorus loading across both basins
- Shift phosphorus into stable, permanently bound sediment forms
- Decrease nutrient availability for algae growth
- Improve water clarity and lake stability
- Establish a data-driven framework for long-term nutrient management