Harvesting Cattail Biomass for Water Quality Improvement in Armstrong Lake

A Pilot Study

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Executive Summary

In August of 2025, the South Washington Watershed District (SWWD) began a pilot project to harvest invasive hybrid cattails (*Typha x glauca*) from a large wetland complex adjacent to Armstrong Lake, a 22.7-acre shallow lake in Oakdale, MN. Goals included local application of related study hypotheses regarding cattail biomass harvesting and exploring if the pilot effort could be scaled up to meaningfully and cost-effectively improve water quality. With guidance provided by Barr Engineering Co., SWWD staff led the project with field labor for the manual harvest effort provided by the Washington Conservation District (WCD) and Conservation Corps Minnesota & Iowa (CCMI).

Biomass data returns were similar to other studies, showing the cattails in this wetland contained approximately 0.2108% total phosphorus (TP) for a total estimated growing season wetland harvest yield of 788 pounds TP. Subsequent winter sampling showed a reduced potential winter harvest yield of 184 pounds TP. Chloride (Cl^-) uptake in the cattail biomass was also surveyed as a part of this study. Cattail biomass in this location averaged 2.6368% Cl^- during the growing season, equating to a potential removal of 4.94 tons Cl^-. A winter harvest was estimated to remove up to 0.86 tons Cl^-.

There remain multiple questions and concerns related to the seasonal impacts of cattail harvest methodology and the cost-benefit tradeoffs associated with the activity. However, in appropriately planned and targeted locations, SWWD believes that cattail biomass harvesting can provide a useful and cost-effective BMP in an organization's urban water quality improvement toolbox

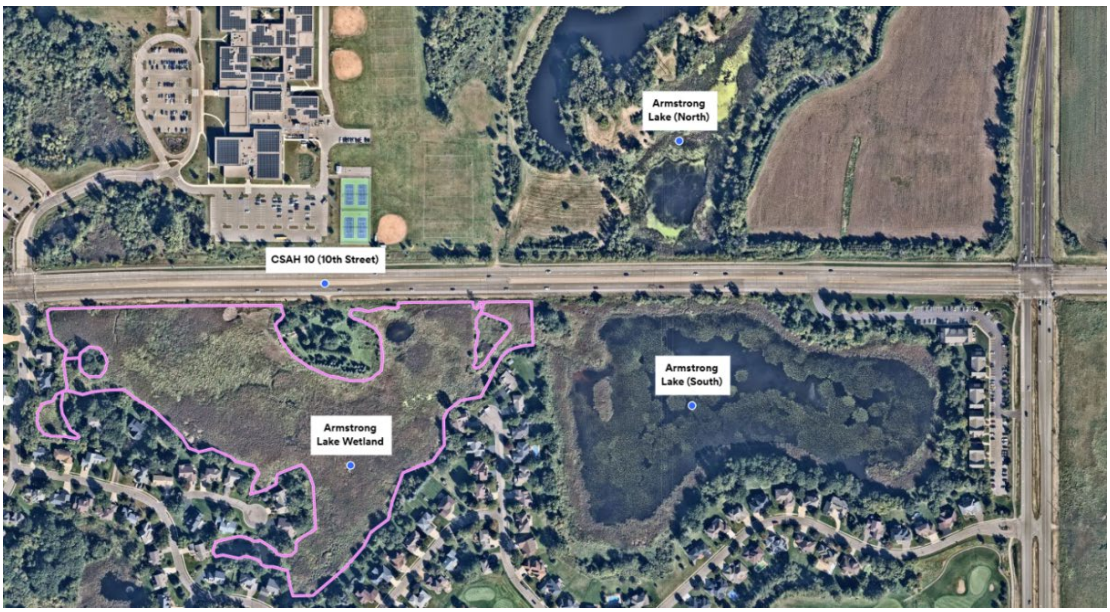

Figure 1: Armstrong Lake and Adjacent Wetland, September 2025

Introduction

In August 2025, the South Washington Watershed District (SWWD) began a pilot project aimed at surveying the potential benefits of harvesting cattails from a large wetland complex in Oakdale, MN. The goal was to learn if that effort could be scaled up to meaningfully and cost-effectively improve water quality in Armstrong Lake. With guidance provided by Barr Engineering Co. (Barr), SWWD staff led the project with field labor provided by the Washington Conservation District (WCD) and Conservation Corps Minnesota & Iowa (CCMI). The design of this project was heavily influenced by a case study review and recommendations memorandum prepared by Barr on behalf of SWWD (Barr, 2022).

This project synopsis aims to frame the underlying problem while summarizing the field work undertaken, lab analysis conducted, and resulting data generated, including some interesting local results related to phosphorus and chloride content in cattail biomass. Readers will also learn about SWWD's experiences as the report explores concepts related to the management of harvested cattail material and extrapolates cost-benefit relationships for this work, all of which serves to continue dialogue on the topic.

Background & Problems

Armstrong Lake is a shallow waterbody located within the cities of Lake Elmo and Oakdale, Minnesota, in the northern tip of the SWWD. It is bisected into two basins by Washington County Road 10 (10th Street), with the larger southern basin serving as the primary portion of the waterbody, and the focus of SWWD monitoring efforts. The northern basin is only 6.2 acres in size. While the entire southern basin is 22.7 acres in size, only about 10 acres exhibit open water characteristics throughout a typical growing season and the lake has a maximum depth of only 5.5 feet. The Armstrong Lake watershed includes 572 acres of mixed uses including single-family residential, commercial, forested and wetland open space, and some remnant cropland.

Given Armstrong Lake's small size, even the low to moderate phosphorus contributions from its surrounding watershed are enough to contribute to nuisance algae blooms and generally poor water quality. Summer average phosphorus concentrations typically range between 60 to 100 µg/L, exceeding state water quality standards. Water clarity is poor even in years with low chlorophyll a levels due to constant water column mixing and sediment resuspension, leading to high turbidity. Chloride concentrations have also been steadily rising over the last 20 years or so, from 54 up to 202 mg/L, which is beginning to approach the MPCA chronic standard of 230 mg/L. Armstrong Lake is not currently listed on Minnesota's Section 303(d) impaired waters list.

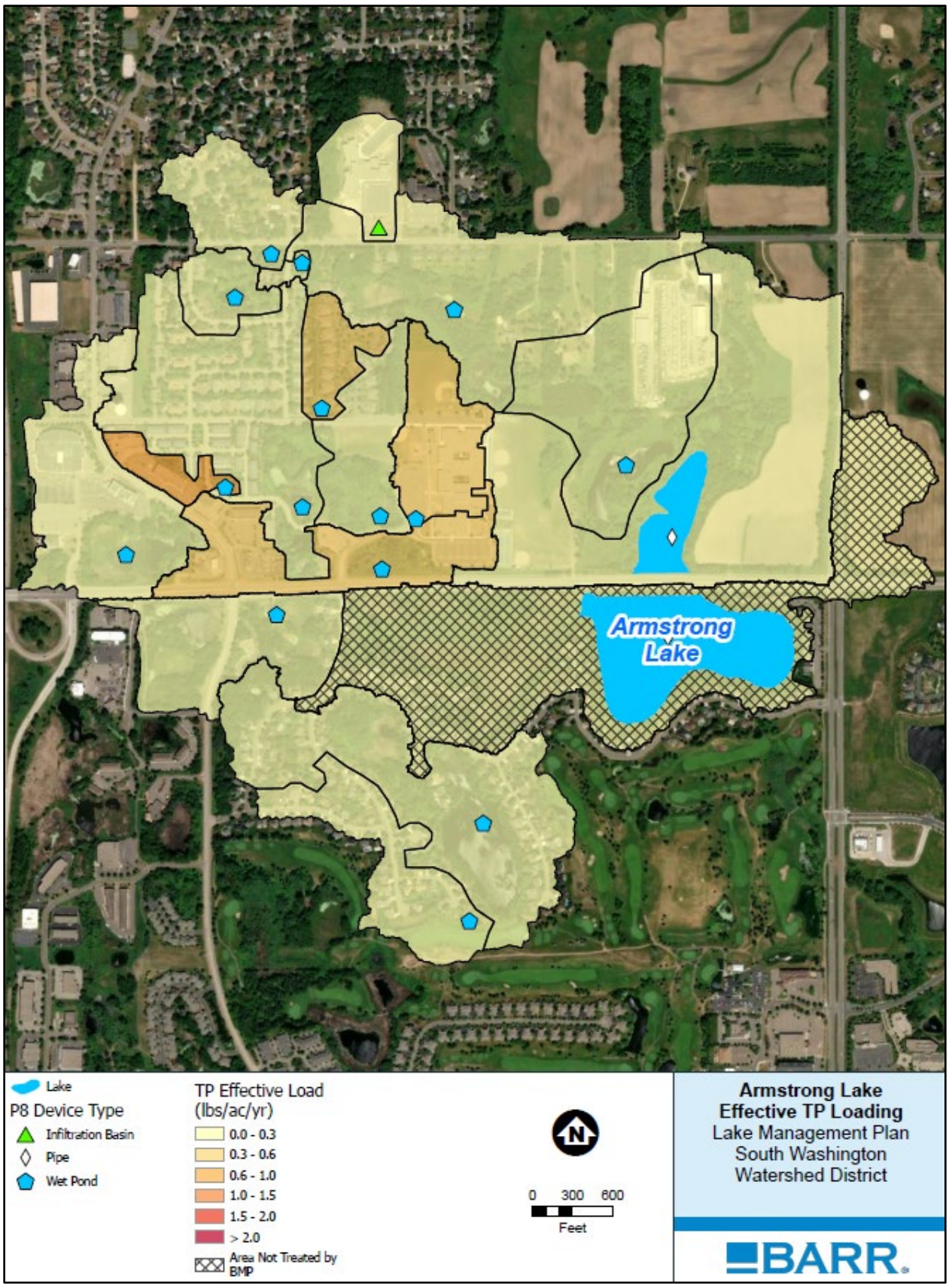

Figure 2: Armstrong Lake Effective TP Loading (Barr, 2025)

A variety of wet stormwater ponds associated with commercial and residential developments provide some treatment of stormwater runoff throughout the watershed. However, prospects for more advanced best management practices (BMPs) to remove phosphorus from runoff are challenging due to limited remaining opportunities for redevelopment in this area. A few small-scale residential BMPs have been implemented in the past, but the primary targets for additional BMPs are road corridors and commercial property. There simply isn't much, if any, available land remaining in these areas for larger BMPs.

Figure 3: Armstrong Lake Wetland Delineation (Barr, 2023)

Armstrong Lake is bordered to the west by a large wetland feature of approximately 21 acres in size. Of this, 11.2 acres (53.3%) are predominantly covered by invasive hybrid cattail (*Typha x glauca*). Roughly 300 acres of the lake's 572-acre watershed drain through the western wetland complex. The concept of using cattail harvesting within this adjacent upstream wetland to reduce nutrient loading into the lake was identified and reviewed as a potential BMP in both the Armstrong Lake Subwatershed Retrofit Analysis (SWWD, 2018) and Northern SWWD Stormwater BMPs Feasibility Study (Barr, 2019). In the 2018 Armstrong

Lake Subwatershed Retrofit Analysis, cattail harvesting was identified as the top ranked of five BMPs for phosphorus removal with a potential annual reduction range of 40 pounds (winter harvest) to 350 pounds (growing season harvest). These estimates were re-confirmed in the Northern SWWD Stormwater BMPs Feasibility Study in 2019.

A 2011 University of Manitoba study showed that harvesting cattails and clearing deadfall can result in greater numbers of emerging plants and an overall increase in cattail biomass production in the years following harvest (Grosshans, 2011). The study also concluded that an early fall harvest would yield the greatest benefits for nutrient removal via biomass harvesting. Cattail Management in the Northern Great Plains by Svedarsky, et al. provides a valuable literature review and cattail harvesting concept guide that greatly influenced the design of this project (U of MN, 2016). SWWD set out to test the feasibility of some of these theories locally in the fall and winter of 2025-2026.

Methods

SWWD contracted with the Washington Conservation District (WCD) to provide field labor for a small manual harvest of cattail biomass from the Armstrong Lake Wetland on August 25-28, 2025. WCD ultimately brought on a crew from Conservation Corps Minnesota & Iowa (CCMI) for four days of work. High water levels within the wetland limited the areas the crew could work in safely, keeping them to the northern edge of the wetland just west of a large upland area owned by the City of Oakdale, which was used by the crew as access and staging for the operation. Crew members utilized hand-operated brush cutters and weed whips to mow cattail stalks above the water line. Cut materials were then hauled to the nearby staging area on small sleds. In total, approximately 0.4 acres of cattail-dominated wetland were mowed and harvested by the crew, confirmed by a GPS survey completed by WCD staff on August 29.

Figure 4: GPS Harvest Delineation (WCD)

SWWD staff collected representative samples of both flowering and non-flowering harvested cattail plants including leaves, stems, and flowering parts (if present) for lab analysis on August 25 and 27. Two (2) flowering and two (2) non-flowering samples were taken each day, for a total of eight (8) cattail samples. Two (2) samples of reed canary grass were also collected in the same manner for general comparison. Each individual sample was cut into smaller pieces for storage in one gallon zip lock bags. Total mass for each sample was collected using a digital scale in the field and samples were held on ice in a cooler before being transferred to a refrigerator at the SWWD office. All samples were delivered to the University of Minnesota's Research Analytical Laboratory (RAL) on August 27.

Samples were dried and ground by RAL staff before conducting the following analyses:

- Elemental Analysis by Inductively Coupled Plasma – Optical Emission Spectrometry
  - Dry ashing method (485°C ashing temperature)
  - Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, Zn
- Nutrient Extraction with Colorimetric Analysis – $CaSO_4$ Extraction
  - NO_3^-N, Cl^-
- One set of duplicate samples were analyzed for quality control (no issues noted)
- SWWD was primarily interested in results for P, NO_3^-N, and Cl^-

SWWD staff returned to the harvest site one week later to complete a series of cattail stem counts to aid in estimating the number of plants, and biomass, of cattails within the wetland. Ten (10) sample locations were established by randomly throwing a ball to different points within the harvested wetland area. The final resting location of the ball was set as the center of a 24" x 24" stem count plot. Cut cattail stems were counted in each plot, and the data was used to extrapolate later calculations.

To provide a comparison between late summer and winter cattail harvesting, and an estimate of nutrients lost due to seasonal senescence, an additional six (6) representative cattail samples were collected from the adjacent perimeter of the originally harvested portion of the Armstrong Lake Wetland on February 11, 2026, and submitted to the RAL for the same analytical processing.

Data Results & Findings

Data returns from this project provided a variety of interesting and relevant findings.

Wetland Area & Cattail Biomass Estimates

Armstrong Lake Wetland total area: 21 acres (914,760 ft^2)
Armstrong Lake Wetland cattail-dominated area: 11.2 acres (487,872 ft^2)

Cattail stem counts: range of 10-34 stems per 4 ft^2, average of 17.6 stems per 4 ft^2
Estimated total number of cattail plants in 11.2-acre harvestable area: 2,146,637

Cattail biomass per plant stem: range of 12-198 g, average of 79 g (growing season, wet)
Cattail biomass per plant stem: range of 11-57 g, average of 31 g (winter, dry)

Estimated growing season biomass of harvestable cattail in wetland: 169,584 kg (187 tons)
Estimated winter biomass of harvestable cattail in wetland: 66,546 kg (73 tons)

The harvested cattail biomass was left onsite to dry in an upland location for about two weeks before being loaded into a commercial roll-off container by the City of Oakdale. At the time it was hauled to a commercial composting facility, the 0.4-acre harvest area yielded a total of approximately 30 cubic yards of plant material. There was a noticeable presence of reed canary grass within the harvested material. However, its relatively low biomass and the low percentage of reed canary grass versus cattail in the harvested material led us to disregard it for the purpose of this analysis.

Nitrate-Nitrogen (NO3-N) Results

Data returns for NO_3^-N showed samples ranging from 1.41-11.62 mg NO_3^-N per kg of biomass, for an average of 0.0008%. The scale of NO_3^-N removal associated with a large-scale cattail harvest in this location is insignificant. A successful summer harvest could be expected to remove 1.36 kg of NO_3^-N (3 lb). Winter results were even lower, with plants containing roughly half of the NO_3^-N found during the growing season.

Total Phosphorus (TP) Results

The cattails harvested during the growing season contained a range of 1,322-3,398 mg TP per kg of biomass, for an average of 0.2108%. While this is a seemingly small number, when extrapolated out to a full-scale growing season harvest, the estimated total mass of phosphorus potentially removed from this wetland grows to 357.5 kg (788 lb) on average. The total estimated range is between 456-1,214 lbs TP per harvest. This result, based on field data, exceeds all previous TP reduction estimates SWWD had generated for the activity.

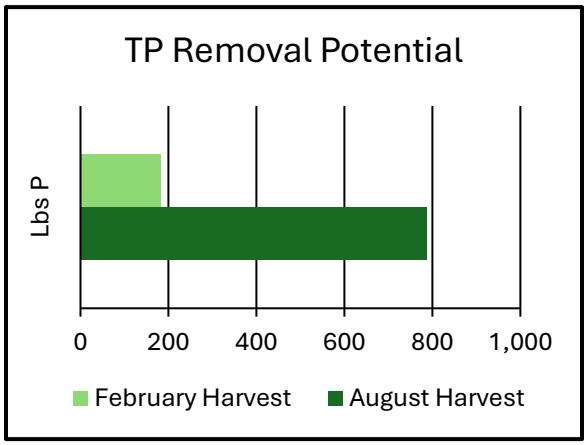

Figure 5: TP Removal Potential

The cattails harvested during the winter contained a range of 865-2,403 mg TP per kg of biomass, for an average of 0.1260%. Due to the lower total biomass available for harvest, and the lower retained phosphorus, the potential winter phosphorus removal is estimated at 83.8 kg (184 lb).

Recently completed in-lake modeling for the South Basin of Armstrong Lake shows typical expected TP loads from the surrounding watershed as ranging between 17 and 65 pounds annually depending on precipitation patterns. As expected, wetter years will result in higher watershed TP loads. We can reasonably presume that removing hundreds of pounds of TP from the upstream wetland through biomass harvesting will not result in an equivalent direct reduction for Armstrong Lake itself. However, if repeated removals can again turn the wetland into a TP sink by encouraging the growth of "replacement" cattail biomass, it is fair to conclude that watershed loading through this wetland to Armstrong Lake can be significantly reduced on an annual basis compared to the current condition. About 50% of Armstrong Lake's watershed lies upstream of the wetland complex, including nearly all the densely developed commercial areas.

Chloride (Cl-)Results

The harvested cattail biomass also confirmed a suspected propensity to retain a high concentration of Cl^-, ranging from 18,867-34,223 mg Cl^- per kg biomass, for an average of 2.6368%. Extrapolated out to a full-scale growing season harvest, the estimated total mass of Cl^- potentially removed from this wetland is 4,485 kg (4.94 tons) on average. The total estimated range is between 3.79-6.00 tons Cl^- per harvest.

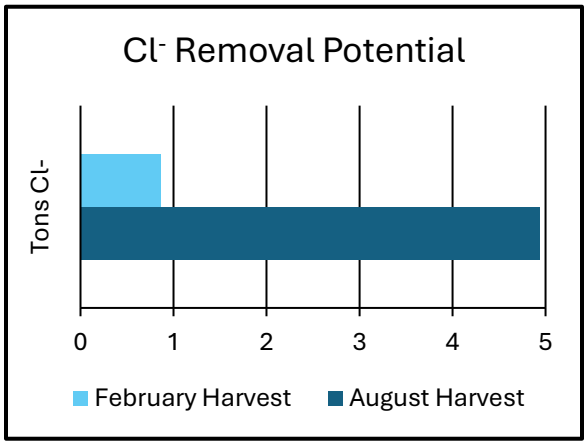

Figure 6: Cl^- Removal Potential

The cattails harvested during the winter contained a range of 4,894-24,632 mg Cl^- per kg of biomass, for an average of 1.1745%. There was a much more distinct difference noted between non-flowering (average 6,130 mg/kg) and flowering cattails (average 22,975 mg/kg) in the winter. Samples collected during the growing season did not exhibit a noticeable difference. In fact, non-flowering cattails exhibited slightly higher Cl^- content during the growing season. Due to the lower total biomass available for harvest, and the lower retained chloride, the potential winter chloride removal is estimated at 781.6 kg (0.86 tons).

Pilot Project Costs & Outcomes

SWWD set out to complete this pilot project with minimal investment as a proof of concept. Direct costs incurred to complete 0.4 acres of manual harvesting work and data analysis included the following:

Field labor for harvesting work (WCD)	$	3,136.50
Field labor for harvesting work (CCMI)		5,400.00
Disposal (commercial composting) of harvested cattail material		750.00

Laboratory Analysis – Growing Season (RAL)			962.50
Laboratory Analysis – Winter (RAL)			627.50
	TOTAL	**$**	**10,876.50**

Based on lab analysis and extrapolation, the pilot project's harvest of 0.4 acres removed up to 28 pounds of TP from the Armstrong Lake Wetland at a rate of $388 per pound. An additional 352 pounds of Cl^- were removed from the system by this effort.

Overall, winter cattail harvests appear to have the capacity to remove roughly 20-25% of the mass of phosphorus and chloride as a late growing season harvest. However, there is significant uncertainty surrounding the conditions of the wetland in late August and if those conditions would prevent a large-scale harvesting operation. How much physical impact or sediment disturbance would be expected within the wetland? What type of equipment would be required? Are there contractors available to complete the work? Would targeted manual harvesting, possibly on a larger scale, be a more prudent programmatic approach?

Conclusions & Continued Study

The pilot project has been successful in establishing a local proof-of-concept; there are measurable pollutant reduction benefits to be realized within the Armstrong Lake watershed by this type of project. Several things remain unclear, however, including the costs and impacts of scaling this effort up to a full-basin removal, what portion of the pollutant removal benefits can be realized in Armstrong Lake itself (in both the short-term and long-term), and what ecological community changes may result over time after repeated cattail harvests.

Full-Basin Harvesting Feasibility

Completing a full-basin harvest with a crew providing manual labor, like the approach SWWD took in 2025 is not a feasible option. Cattail fringes around the perimeter of the basin could be harvested in this fashion, provided that multiple access points could be secured, but crew safety will always be a concern, and seasonal high water could derail the operation entirely. Hiring a contractor with amphibious equipment to complete the growing season harvest would be essential – and likely significantly more costly. Additional research in this area is required before pursuing a full basin growing season cattail harvest in this location.

Regardless of regulatory jurisdiction, attention must also be paid to Minnesota Department of Natural Resources recommendations regarding the timing of a full-basin harvest. Despite their non-native, invasive status, narrowleaf and hybrid cattail still provide important habitat for a wide variety of fauna. Disturbing these areas at critical times (waterfowl nesting, for example) could be detrimental to desired and/or protected native species.

Additionally, even with amphibious or very low-weight-ratio tracked harvesting equipment, there are bound to be significant short-term disturbances to the surface sediment profiles within the wetland. If weather patterns do not provide enough post-harvest time for the wetland to heal before large rain events, disturbed nutrient-rich sediments could be mobilized from the wetland and downstream into Armstrong Lake, negating potential benefits from the harvest itself.

Previous studies have also focused on the concept of harvesting cattail biomass for use as agricultural fertilizer. Shredding and spreading the biomass over area croplands could help to "naturally" enrich crop soils. Additional study would be needed to review any concerns about transport of other stormwater pollutants (chloride, heavy metals, PFAS, PAHs, etc.) to croplands via the cattail biomass.

Growing Season vs. Winter Harvesting

From a gross pollutant removal perspective, completing a harvest during the late growing season provides the most benefit by far. Data gathered indicates that a winter harvest may only provide 20-25% of the phosphorus and chloride removal potential. However, completing a winter harvest in strong frozen conditions in January or February would minimize both the ecological and sediment disturbance potential of the operation while also possibly resulting in a reduced project cost. A warm winter season could derail this option as strong ice cover and frozen ground would be required to support the weight of traditional harvesting equipment; even this assumption would be subject to additional investigation.

Based on the data gathered, SWWD sees the greatest potential value in targeted manual cattail harvesting during the growing season. If a CCMI crew were hired and managed internally by SWWD staff, one week of harvesting work could conservatively remove 20 pounds of phosphorus at a cost (crew labor plus disposal) of roughly $6,200 ($310/pound TP removed). Incorporating this as a type of targeted operational BMP, like street sweeping or operating an alum facility, could have long-term sustainable and reproduceable benefits for surface water resources within the watershed.

Ecological Benefits of Cattail Harvesting

Many wetland areas within the SWWD exhibit varying degrees of monotypic stands of narrowleaf and hybrid cattail, be they covering the entire basin or lining the fringe of open water areas. Strengthening the ecological diversity of these habitats by disturbing and/or diminishing the cattail density aligns strongly with SWWD's resource improvement goals beyond simply reducing nutrient loading to surface waters. It will be important to watch how the vegetative community within the Armstrong Lake Wetland pilot project area reacts over the coming seasons. The harvesting activity completed here was not undertaken with the stated purpose of eliminating or even reducing the cattail stand. However, if this additional

benefit can be achieved slowly and sustainably over time, it would provide further evidence in support of SWWD pursuing cattail harvesting as a programmatic BMP in this location – and possibly others.

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