Bioremediation of Occom Pond at Dartmouth College

Open Water Ecosystem Restoration

Location: Occom Pond, Dartmouth College, Hanover, New Hampshire
Treatment Period: May 2006 – Fall 2008 | Case Study Reference: CS17110

Facility Profile

LOCATION	Occom Pond, Dartmouth College, Hanover, New Hampshire
Water Body	10-acre historic eutrophic pond established 1900; central campus and community landmark
Setting	Northern edge of Dartmouth College campus; adjacent to Hanover Country Club golf course; DOC House on northern shore
Ownership	Dartmouth College
Regulatory Body	NH Dept. of Environmental Services (NHDES); annual inspection by Chief Aquatic Biologist
Oversight	Dartmouth Biology Department and University Maintenance Department
ELI Treatment Team	Doug Dent, SVP/CTO, Ecological Laboratories, Inc.
Dartmouth On-Site Team	Stephen Glaholj and Robert Thebodo (application team)
Community Role	1-mile walking path; skating, polar plunge, and 25+ year pond party traditions; affluent residential neighborhood

Background

Occom Pond, located on the northern edge of Dartmouth College's campus near the Hanover Country Club golf course, has a rich history tied both to the College's founding and to local land use.

Origins and Naming: The pond is named after Samson Occom, a Mohegan scholar and minister who in 1765 traveled to England to raise funds for Eleazar Wheelock's Indian Charity School, which became Dartmouth. He raised over £12,000, making his fundraising essential to the College's creation.

Creation of the Pond: The pond was not part of the original College land. In 1897, Elizabeth Washburn Worthen proposed the idea; by 1901, her husband Professor T.W.D. Worthen had completed construction, building a dam that flooded a former cow pasture to create Occom Pond.

Community Role and Traditions: For decades the pond served as a skating rink for students and local children; the Dartmouth ice hockey team played there until the mid-1920s. The DOC House, built on its northern shore in 1929, remains a community hub. The pond continues to host seasonal gatherings and recreational use, symbolizing both Dartmouth's founding story and its campus life.

Environmental Restoration: By the early 2000s, decades of sludge buildup, algal growth, and nutrient loading had left the pond murky, malodorous, and ecologically degraded. In 2006, Dartmouth partnered with Ecological Laboratories, Inc. to restore it using MICROBE-LIFT® microbial treatment across all three ecosystem zones.

Fig 1

Fig. 1: Turbidity of the water — May 15, 2006, start of treatment

Fig 2

Fig. 2: Close-up of surface scum and turbidity — May 15, 2006

Key Challenges

Prior to treatment, Occom Pond exhibited significant signs of eutrophication; driven by nutrient overloading from fertilizer and pesticide run-off from the adjacent Hanover Country Club golf course and residential properties. There were no buffer zones to protect the pond from this run-off.

- Persistent toxic blue-green algae (cyanobacteria) blooms and surface scum
- Strong hydrogen sulfide and septic odors from organic decomposition in bottom sediment
- Large accumulated layer of bottom sludge reducing pond depth and water quality
- Murky, turbid water with very poor clarity
- High levels of BOD, COD, ammonia, nitrate, and dissolved phosphorus — all continuously elevated by fertilizer run-off
- No buffer zones to contain run-off from the adjacent golf course or residential lawns
- Above-average rainfall during treatment (8–9 inches above average in 2006) continuously reintroducing nutrients
- Historical fish kills and loss of aquatic biodiversity
- Limited institutional budget for the scale of a 10-acre lake restoration program

Objective

The College worked with Ecological Laboratories, Inc. (ELI) to develop a biological augmentation program using MICROBE-LIFT® technology to restore the pond. The purpose was to speed the biological degradation of all accumulated organic matter across all three zones of the pond's ecosystem:

Littoral Zone	Limnetic Zone	Benthic Zone
(Shoreline)	*(Open Water)*	*(Bottom Sediment)*
Biological degradation of organic matter accumulating along pond edges and nearshore areas	Microbial breakdown of suspended organic material and nutrient cycling to reduce algae drivers	Enzymatic and microbial digestion of accumulated bottom solids and internal nutrient release

Solution & Treatment Protocol

The biological augmentation program was designed as a year-long treatment initiated during the warm summer months, with dosage adjustments made monthly based on weather conditions and real-time monitoring results. During periods of heavy rainfall, dosage was reduced; increased rates were applied in August and September when rainfall was lower and biological activity peaked.

Program Goals

#	Program Goal
1	Reduce bottom solids by 6–18 inches over a 12-month period
2	Assist in controlling green water events, in combination with pond management steps
3	Reduce pond malodors (hydrogen sulfide and other septic odors)
4	Achieve a reduction of at least 20% in BOD, COD, and Suspended Solids (SS)
5	Reduce pond nutrient concentrations (nitrogen, phosphorus)
6	Improve overall water quality and clarity

Treatment Schedule

- Season: May through October/November each year (biologically active warm-weather period)
- First treatment: May 24, 2006 — data collection Phase 1: May 24 – October 13, 2006
- Applications conducted by the Dartmouth maintenance team (Glaholj & Thebodo); ELI provided continuous oversight
- Dosage modified monthly by ELI based on weather events and measured water quality results
- Bottom sediment monitored twice monthly following treatment start
- Annual NHDES and Dartmouth Biology Dept. inspection each May
- Total treatment period: May through October, 2006–2008; data collection conducted 2006 and 2007; treatment continued through October 2008 with no additional data collected following confirmed full restoration at the end of 2007

Adapting to Adverse Conditions

During Phase 1, Occom Pond experienced 8–9 inches above-average rainfall. This continuously increased organic load (BOD, COD), suspended solids, and nutrient concentrations through excessive run-off. ELI compensated by revising application rates and timing monthly. Despite this, bottom solids reduction was achieved and all restoration trajectories progressed.

Results — Water Quality Data (Phase 1: May–October 2006)

Data was tracked across four monitoring points: Outflow, East Inflow, South Inflow, and Center. Nine water quality parameters were measured, including sediment depth, organic content, BOD, COD, ammonia, nitrate, total nitrogen, dissolved phosphorus, and rainfall correlation. The following charts present all tracked data from Phase 1.

Bottom Sediment Reduction

Bottom solids were measured bi-monthly at all four locations. The second data point (approximately May 20) represents the true baseline — the first point was incorrect due to improper use of the sludge judge.

Data confirms significant reduction across all monitoring zones throughout the treatment period, accomplished despite the challenge of excessive rainfall.

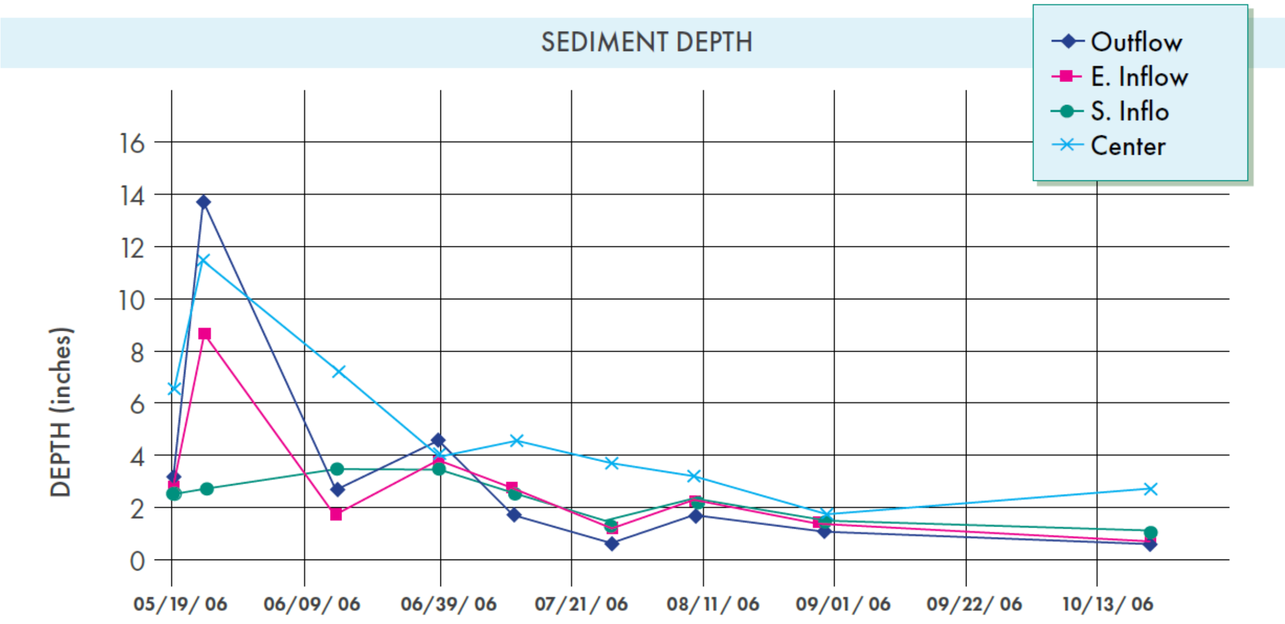

Chart 1: Sediment depth (inches) at four measurement points — bi-monthly readings, May–October 2006. True baseline = second data point.

Microbial metabolism will continue to break down organic solids until mineralization is achieved, leaving only the inorganic fraction. ELI estimated 6–12 inches of organic removal per year is reasonable depending on temperature and other environmental factors. Occom Pond's sediment showed high organic content — confirming high potential for biological removal.

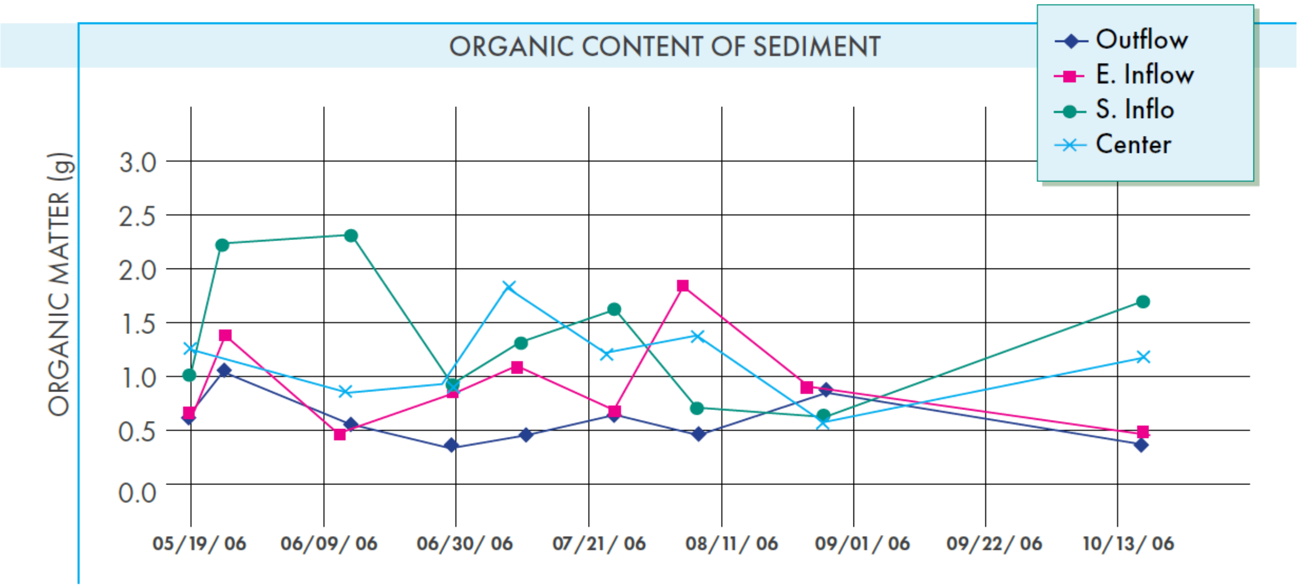

Chart 2: Organic content of sediment (g) at four measurement points — high organic fraction confirms strong potential for biological sludge removal.

Nitrogen: Ammonia, Nitrate, and Total Nitrogen

Ammonia is generated by biological breakdown of nitrogen-containing organics. MICROBE-LIFT® microorganisms convert ammonia to nitrate via nitrification, and then through denitrification to nitrogen gas — returning it harmlessly to the atmosphere. Since Occom Pond has excess nutrients from run-off, this microbial process is essential to removing nitrogen.

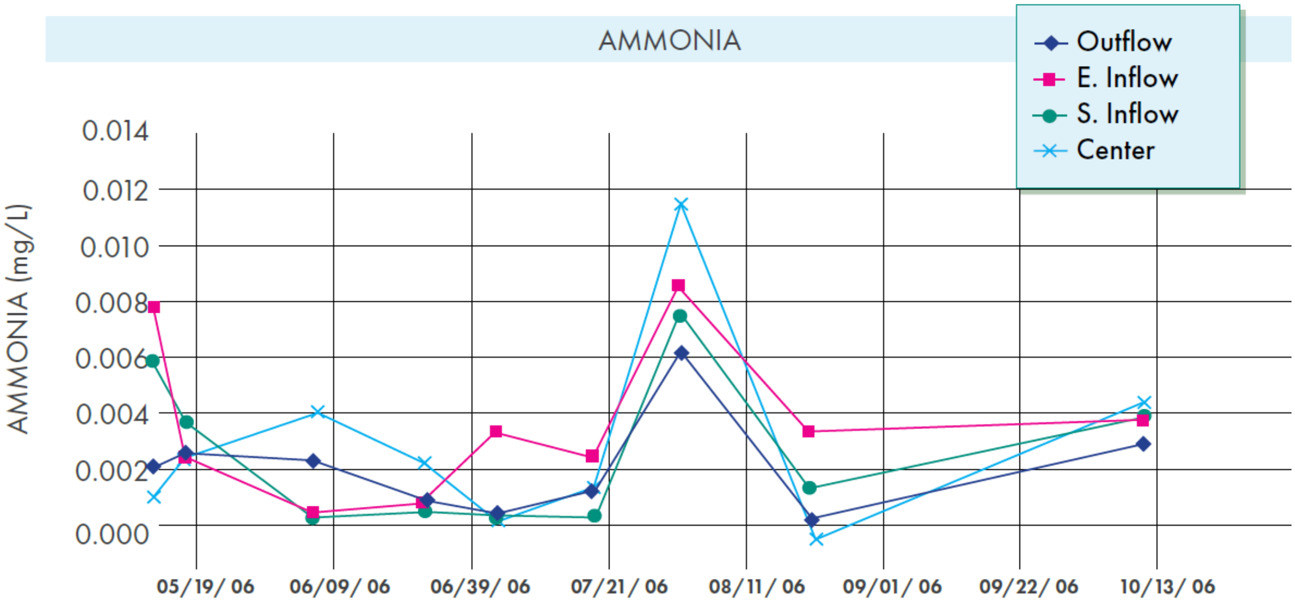

Chart 3: Ammonia (mg/L) at four measurement points. Spikes in August and September correspond to active bioaugmentation and organic digestion releasing nitrogen intermediates.

Nitrate accumulates from fertilizer run-off delivered by rainfall from the golf course and residential properties. High nitrate drives green water events and excess bottom plant growth, leading to eutrophication. Microbial denitrification is the primary mechanism for nitrate removal, as shown by the decline following initial rainfall-driven peaks.

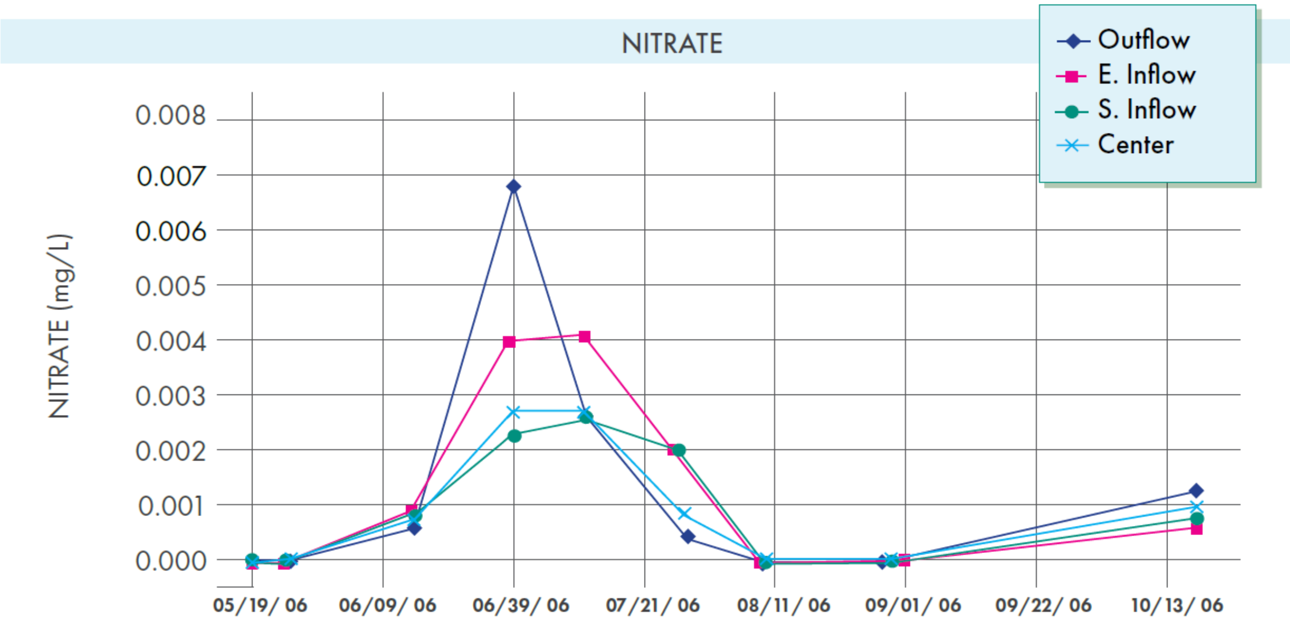

Chart 4: Nitrate (mg/L) — initial concentration spike closely tracks the first major rainfall event and fertilizer run-off pulse. Denitrification progressively reduces nitrate thereafter.

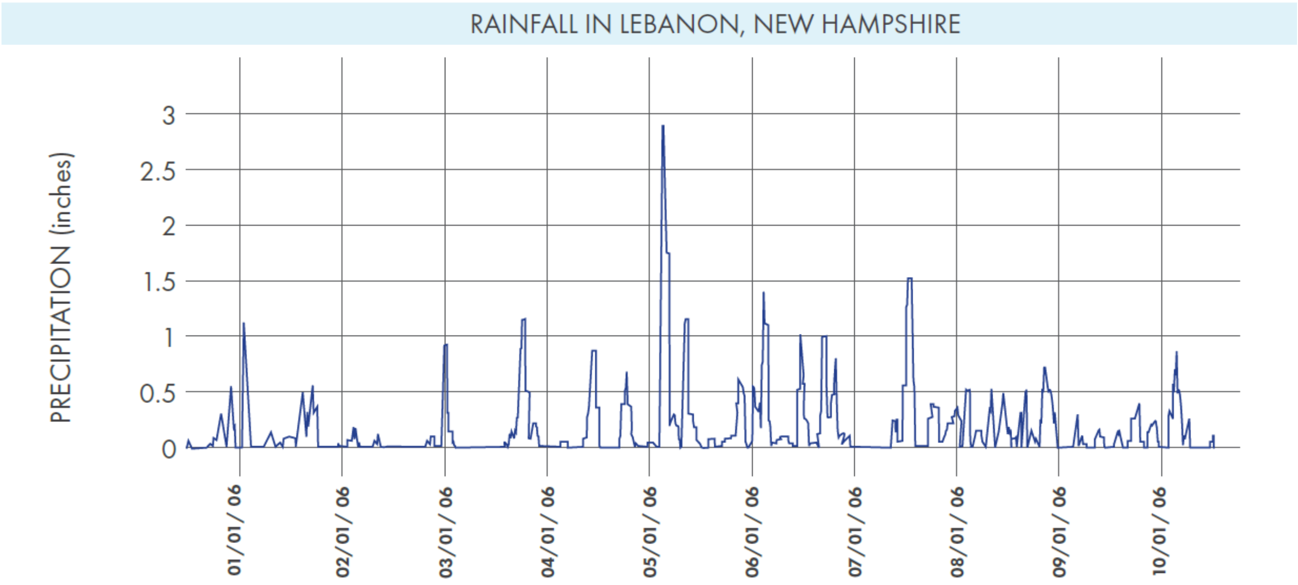

Chart 5: Rainfall in Lebanon, NH (inches) — spike correlation with elevated nitrate and nutrient concentrations in the pond demonstrates the direct run-off pathway.

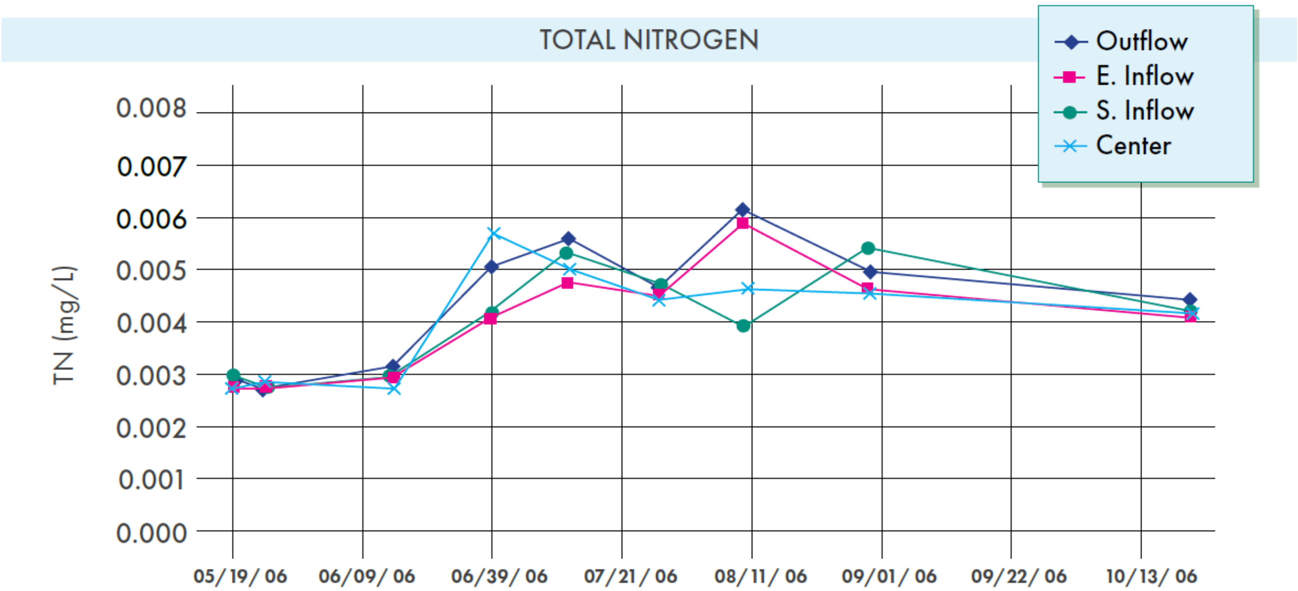

Chart 6: Total Nitrogen (mg/L) — includes all forms: ammonia, nitrite, nitrate, and organic nitrogen. Curve shows combined influence of nitrate and ammonia peaks driven by rainfall.

Dissolved Phosphorus

Phosphorus is a primary driver of algal blooms and green water events. Occom Pond sits in a bowl in close proximity to the Hanover Country Club golf course and surrounding residential home sites — both significant sources of phosphate through fertilizer run-off. The absence of any buffer system amplifies this nutrient loading directly into the pond.

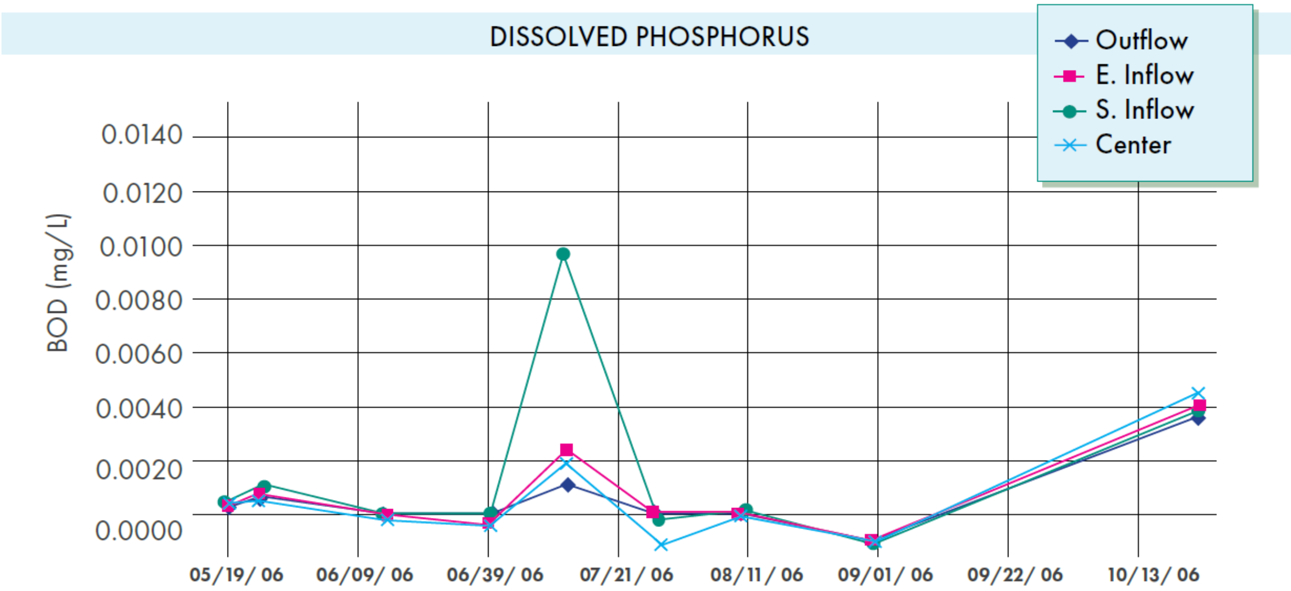

Chart 7: Dissolved Phosphorus (mg/L) — peak coincides with major rainfall event delivering fertilizer-laden run-off. South Inflow zone shows highest phosphorus loading, consistent with proximity to run-off sources.

Biochemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

BOD represents organic contamination arising from: (a) soluble organics released from bottom solids during digestion, (b) slow-to-degrade compounds converted to degradable material by MICROBE-LIFT® microorganisms, and (c) organic matter delivered in influent waters. BOD peaked on June 30, coinciding with the season's heaviest rainfall event.

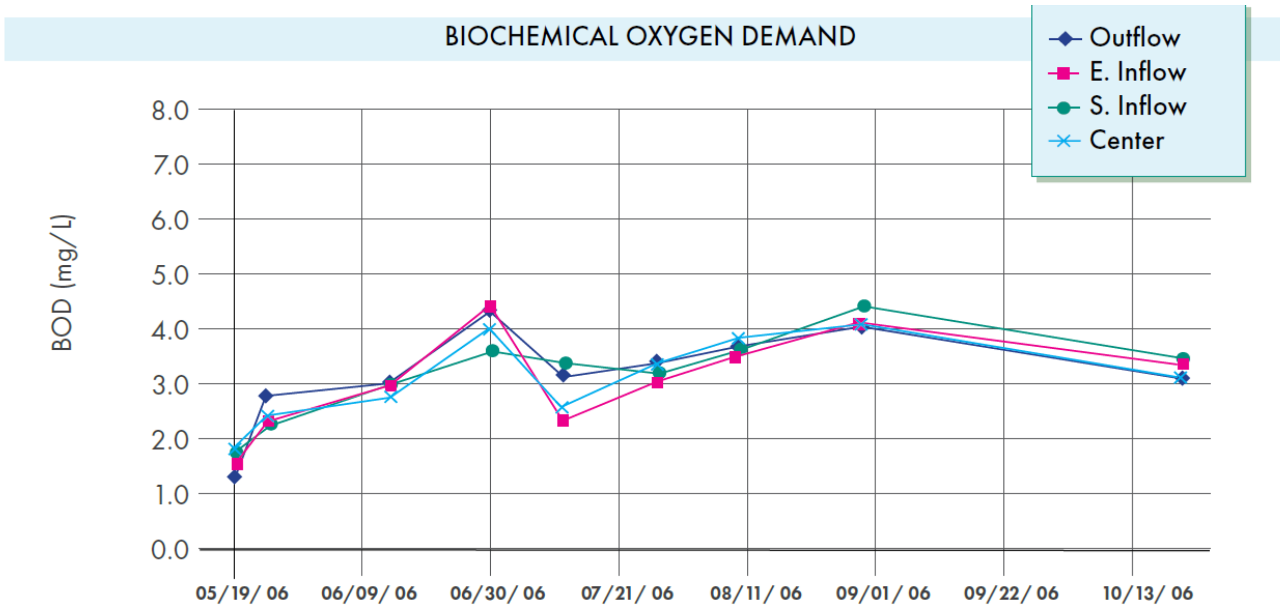

Chart 8: Biochemical Oxygen Demand (BOD, mg/L) — increased deposit of organic matter with heavy rainfall peaking June 30. Outflow BOD remains managed as microbial digestion maintains pace with organic loading.

COD measures both biodegradable (BOD) and non-biodegradable organics. In Occom Pond, COD was largely controlled by the introduction of slow-to-degrade material via rainfall events. High-rate MICROBE-LIFT® microorganisms converted non-biodegradable fractions to BOD, enabling biological oxidation and progressively reducing total COD over the treatment period.

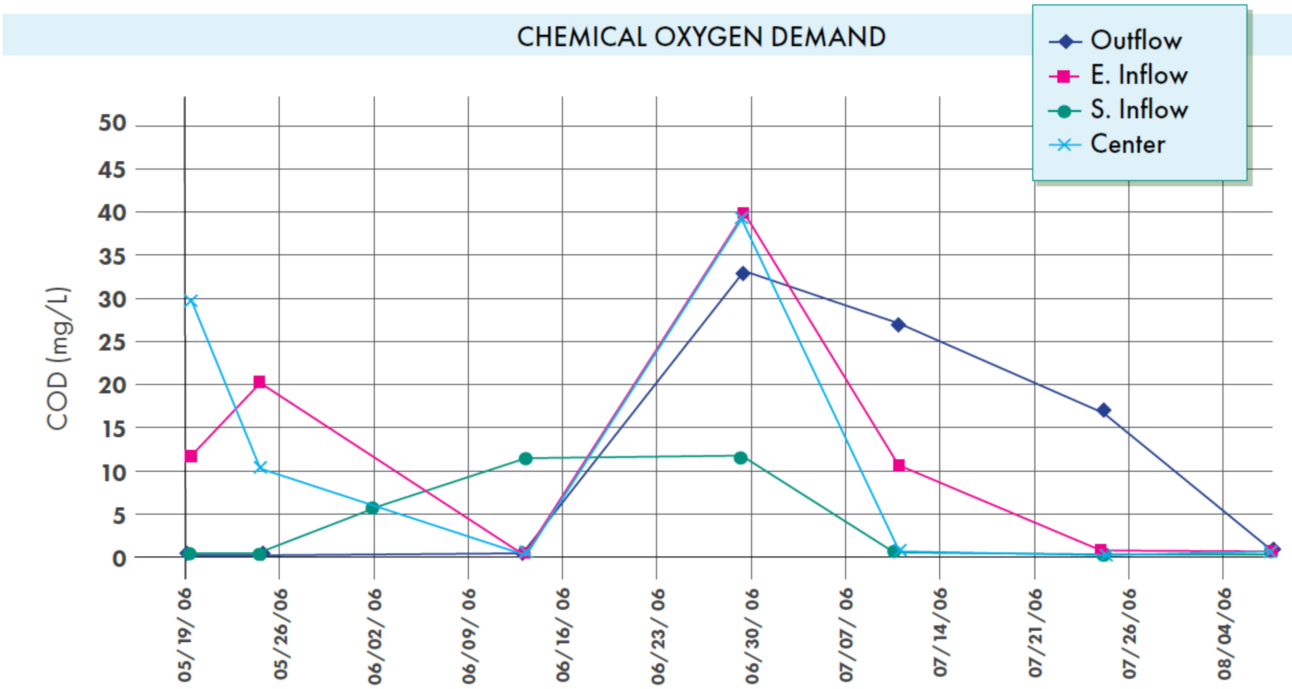

Chart 9: Chemical Oxygen Demand (COD, mg/L) — increases in influent during heavy rainfall events are followed by decreases in outflow as microbial activity degrades organics. Note higher frequency monitoring during this period.

Phase 1 Conclusions (First Six Months)

The first phase of treatment with MICROBE-LIFT® technology was designed to span twelve months; this section summarizes the first six months of treatment. Goals: enhanced water quality, odor reduction, and reduction in bottom solids.

During Phase 1, the augmentation program was negatively impacted by above-average rainfall. Heavy rain events were countered by revisions in treatment programs via changes in application rates and timing. Despite this adversity:

- Bottom solids were significantly reduced — the most impressive result given the adverse conditions
- Hydrogen sulfide and other septic odors were eliminated
- Surface scum was controlled relative to pre-treatment pond history
- All tracked water quality parameters improved or were managed within expected ranges

The data was so encouraging that Dartmouth College made a commitment to continue the program for two additional years. The photographic and qualitative results from Years 1 and 2 follow.

Photographic Results — Before, Year 1, and Year 2

Fig. 3: Water condition prior to treatment — May 14, 2006

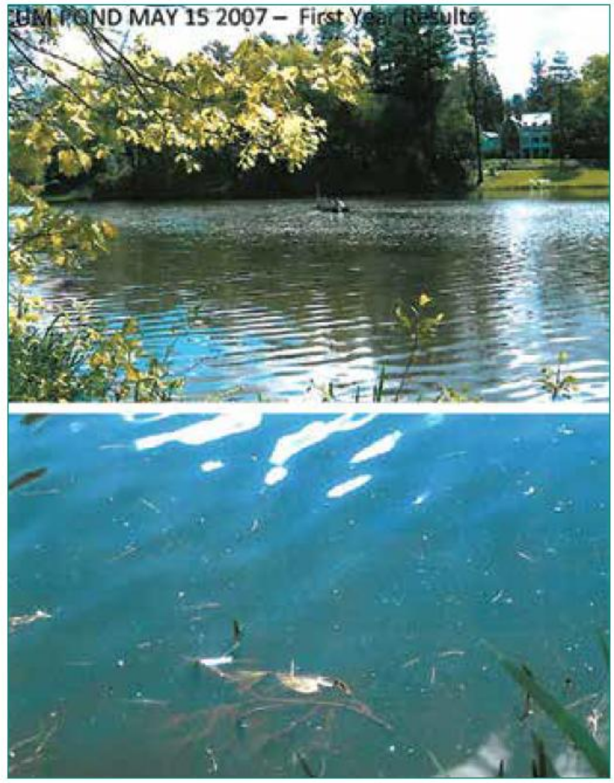

Fig. 4: Year One results — May 15, 2007 after one year of MICROBE-LIFT® treatment

Fig. 5 & 6: Year Two — May 15, 2008. After two years of treatment the pond water is very clear. Pond returned to pristine condition; stocked goldfish clearly visible at the surface.

Year-by-Year Results Summary

Phase 1 May–Oct 2006	• Treatment initiated May 24, 2006 by Dartmouth team under ELI guidance • Rapid elimination of hydrogen sulfide and other septic odors following first treatment • Surface scum controlled throughout the season • Bottom solids significantly reduced despite 8–9 inches above-average rainfall • BOD, COD, nitrogen, and phosphorus tracked; all managed within expected ranges • Results so strong that Dartmouth committed to a full two-year program continuation
Year 1 May 2006 – May 2007	• No algal blooms recorded during the treatment period • Zero fish kills • Enhanced water visibility progressively improving throughout the season • Continued bottom sediment reduction via biological mineralization • Annual NHDES and Dartmouth Biology Dept. inspection confirmed progress • Year 1 photo (Fig. 4, May 2007) shows dramatically clearer water vs. 2006 baseline
Year 2 May 2007– Fall 2008	• Full ecosystem restoration confirmed by Dartmouth Biology Department, achieved end of Year 2 • Pond water very clear; stocked goldfish visible at surface (Figs. 5 & 6) • Restoration achieved three years ahead of the original five-year program schedule • Zero fish kills; natural aquatic life and wildlife activity fully restored • Biological treatment continued through Fall 2008 to consolidate long-term gains • Full ecosystem restoration confirmed by Dartmouth Biology Department end of 2007 — two years into a program designed for five; data collection closed at that point; biological treatment continued through October 2008 to consolidate gains, with no further university data collection

Full Outcome Comparison

Parameter	Pre-Treatment Condition	Post-Treatment Outcome
Odor	Persistent H_2 S and septic odors	**Eliminated rapidly after first treatment**
Algal Blooms	Recurring surface algae & cyanobacteria	**No algal blooms during any treatment year**
Water Clarity	Murky, turbid; poor visibility	**Very clear — goldfish visible at surface by Year 2**
Bottom Sediment	Large accumulated sludge layer	**Significantly reduced; mineralization ongoing**
Fish Kills	Historical fish kills recorded	**Zero fish kills in 2006, 2007, and 2008**
Surface Scum	Persistent surface scum	**Controlled throughout treatment period**
Nutrients (N/P)	Elevated from fertilizer run-off	**Managed via denitrification and microbial uptake**
Overall Ecosystem	Severely eutrophic; degraded	**Fully restored — 3 years ahead of 5-year schedule**

Operational Benefits

- Non-chemical, environmentally safe treatment; no harm to native fish, wildlife, or aquatic invertebrates
- Safe for all pond recreational uses throughout the treatment period, including swimming and winter activities
- Dartmouth maintenance staff could conduct all applications without specialized chemical handling equipment
- Dosage flexibility allowed program adaptation to adverse weather conditions in real time
- Supports institutional sustainability and environmental stewardship objectives
- Restored a historically significant 100-year-old campus and community landmark
- ELI R&D Grant Funding Program made the project financially viable; product supplied at $8/gallon vs. standard $24–$28/gallon end-user pricing
- Full restoration achieved 3 years ahead of the projected 5-year program timeline