2006 Monitoring Report For

West Hill Pond

Prepared For:

West Hill Pond Association

Prepared By:

Northeast Aquatic Research

George W. Knoecklein

74 Higgins Highway

Mansfield Center, CT 06250

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SUMMARY

West Hill Pond continues to exhibit excellent water quality.

The methods used to determine this fact in West Hill Pond are to; 1) monitor the levels of key indicator parameters once during the summer, and 2) to assess the existing condition of the aquatic plants. Both these were accomplished in 2006, as part of a regularly occurring bi-annual program.

The key indicator parameters are Water Clarity, and the plant fertilizers Phosphorus and Nitrogen.

Water Clarity has consistently been very high at West Hill Pond. Connecticut Lakes with clarity readings over 20 feet are considered to be exceptional. This has been the case for West Hill Pond.

Phosphorus is the primary indicator for lake health. Connecticut lakes with phosphorus levels below 10 parts per billion (ppb) are considered exceptional. West Hill Pond has consistently had values below this level. However, there is a possible trend of increasing levels of this plant nutrient in the lake. This possibility will need to be watched in the future monitoring.

Nitrogen is a secondary indicator of lake health. Connecticut lakes with nitrogen levels below 200 parts per billion are considered exceptional. West Hill Pond has consistently had values that are just above this level. It is not unusual for nitrogen levels be slightly over 200 ppb in exceptionally clean lakes such as West Hill Pond.

Aquatic Plants are scarce in West Hill Pond. The community is indicative of exceptional clear water lakes with very low nutrient levels. No exotic, nuisance, or invasive species were found.

INTRODUCTION

West Hill Pond is a 261 acre lake located in the towns of Barkhamsted, and New Hartford, CT. The lake has a maximum depth of 63 feet with relatively steep sides along most of the basin. The lake has a small watershed of 790 acres, or about 3.0 times the area of the lake. A watershed of this size contributes, on average, an annual quantity of water, as surface runoff, equal to about 20 % of the total lake volume. This amount of runoff will replace, or flush, the lake once every 4.8 years. This is a very long residence time indicating that materials in the lake tend to remain there for at least four, maybe, five growing seasons before being flushed out.

One field visit was made to the lake on August 24, 2006 in order to collect water quality data and to survey the existing aquatic plant community. Prior trips have been made on August 19, 2004, and July 23, 2002. During each trip, water quality testing was conducted that included; measuring the Secchi disk depth, recording the dissolved oxygen and temperature of the water at each one meter depth from top to bottom, and collecting water samples from 1, 10, and 18 meters. The samples were analyzed for total phosphorus, ammonia nitrogen, nitrate nitrogen (surface only), organic nitrogen, alkalinity, conductance, turbidity, total iron, and pH. In addition to collecting lake water quality data, the shoreline of the lake was surveyed for the presence of aquatic plants especially invasive species.

2006 WATER QUALITY RESULTS

Water Quality Analysis

Total Phosphorus

Total phosphorus is generally the limiting plant growth nutrient in freshwater. The growth of microscopic algae will be directly related to the quantity of available phosphorus in the water and the decrease in water clarity is a direct result of high growths of microscopic algae. The quantity of the nutrient has been shown to be the primary cause of nuisance algae blooms in lakes. Lake health can be ranked, or assessed, based on the level of total phosphorus contained in the lake during growing season. The grouping of lakes into different trophic categories is based on only a few factors with phosphorus being the main one. A trophic category is a way of ranking the degree of plant growth that occurs in a lake, ranging from very clear water with no weeds or algae (oligotrophic), to lakes with excessive amounts of weeds and very green water (eutrophic). The ranking of trophic categories is presented in **Table 1**.

Table 1. Ranges of Concentrations for Parameters used to Rank Lake Trophic Categories.

Category	T.P. (ppb)	T. Nitrogen (ppb)	Secchi Depth (m)
Oligotrophic	0 – 10	0 – 200	6+
Oligo-mesotrophic	10 – 15	200- 300	4 - 6
Mesotrophic	15 – 25	300 - 500	3 - 4
Meso-eutrophic	25 – 30	500 - 600	2 - 3
Eutrophic	30 – 50	600 - 1000	1 - 2
Highly Eutrophic	50+	1000+	0 - 1

The results of total phosphorus testing in West Hill Pond in 2006 are presented in **Table 2**. The concentrations of phosphorus from the top and middle sample depths were 6 and 9 ppb respectively, while the bottom sample was higher at 121 ppb. The average of the three samples is given at the bottom of the table. The top two samples represent the zone of the water where algae can grow, the concentration of phosphorus in those samples (1 meter, and 10 meters) is an indicator of algae growth potential. The mean of the top two samples in 2006 was 7.5 ppb, which is within the acceptable range for oligotrophic lakes (see Table 1 for the ranges of concentration within each trophic category). The 2006 results are slighted elevated over the data collected in 2002 and 2004. The means from the top two samples from the three years are; 2006 = 7.5 ppb, 2004 = 5.5 ppb, and 2002 = 4 ppb. These data show a trend of increasing phosphorus concentrations at those depths between 2002 and 2006 with a steady increase of about 27% between each data point or almost 50% between 2002 and 2006. The average concentration, using all of the 1 meter and 7 meter samples, is 5.7 ppb, well within the acceptable range for oligotrophic lakes, see **Figure 1**.

The 18 meter sample (15 meters was the deepest water found in 2002 and 2004) represents bottom water where different conditions occur. The three data points so far collected are; 2006 = 121 ppb, 2004 = 154 ppb, and 2002 = 20 ppb. The phosphorus values are higher near the bottom because of some amount of re-mineralization and internal release from deep sediments is occurring there due to the lack of dissolved oxygen in the water near the bottom. There was a large difference between the 2002 value and both the 2004 and 2006 values but it is possible that the difference was due an earlier sampling date in 2002 as opposed to the latter two years when sampling was done in August and not July. Typically, August and September show the highest bottom water concentrations of phosphorus and have more intense reducing conditions at the bottom of deep lakes. The July 2002 sampling may have been early enough in the season as to not detect phosphorus accumulations at the bottom.

Table 2. Total Phosphorus Results for West Hill Pond.

2006

Depth (m)	August 24 (ppb)
1	6
10	9
18	121
Average	*55*

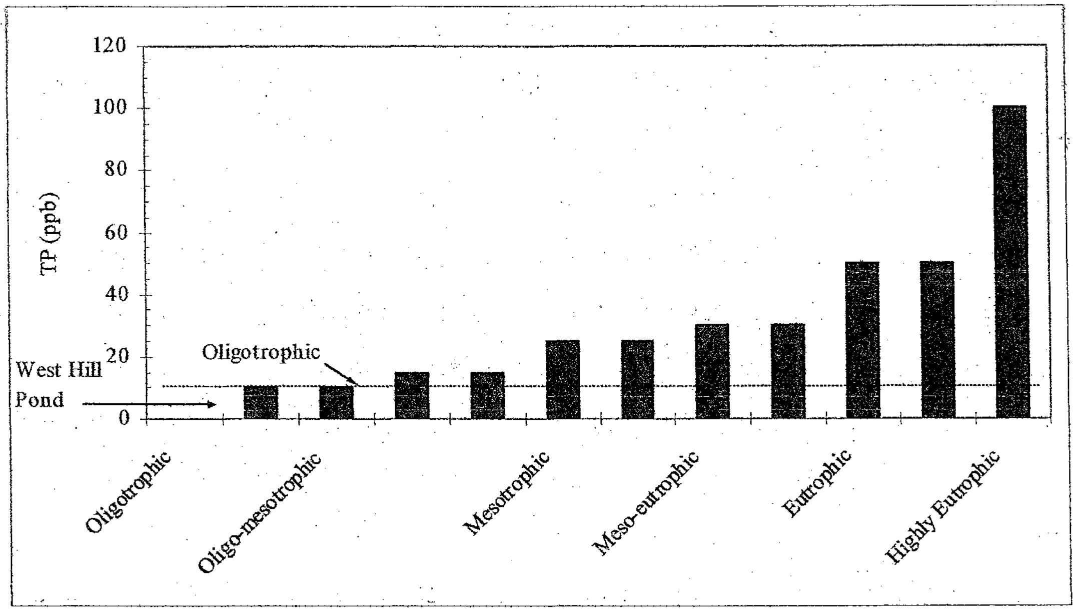
2004

Depth (m)	August 19 (ppb)
1	4
7	7
15	154
Average	*55*

2002

Depth (m)	July 23 (ppb)
1	5
7	3
15	20
Average	*9*

Figure 1. Trophic Categories For Phosphorus Showing Position of West Hill Pond.



Nitrogen

Water was collected for analysis of the three nitrogen forms most common in lakes, ammonia, nitrate, and organic nitrogen (**Table 3**). The levels of nitrogen in the lake were show a range of variation typical for Connecticut lakes. There was no detectable nitrate or ammonia at the surface. These two forms are used by algae in the water so having these two forms below detection means that nitrogen will be co-limiting with phosphorus.

Ammonia was detectable at the bottom but this was due to the anoxic (no oxygen) condition present there. When dissolved oxygen is absent, ammonia can be released from the sediments. The 2006, the quantity of ammonia at the bottom was comparable to that obtained in 2004, between 810 and 870 ppb, typical for bottom waters of deep lakes that experience oxygen loss. In 2002, the accumulation of ammonia at the bottom was only about a third as much as was observed in 2004 and 2006, further indication that the sampling date in 2002 was early in the season.

The organic nitrogen in the water is a measure of the amount of decay resistant nitrogen such as microscopic plant material and other organic debris that has accumulated in the lake. Again, the top two sampling depths can be used to assess the quantity of nitrogen in the lake. This value is used as an indicator of the lake trophic status in a similar fashion as was discussed for total phosphorus. In 2006, the average of the 1 and 10 meter samples was 222 ppb while in 2004 the value was 338 ppb representing a decrease of about 50% between 2004 and 2006.

At the bottom, the organic nitrogen faction was higher due to the anoxic conditions occurring there. In 2006, the concentration was 1,760 ppb while in 2004 it was 1,350 ppb. Again, this higher bottom concentration of organic nitrogen can be attributed to the anoxic conditions there. The higher ammonia and organic nitrogen were separated from the upper layers of the lake by a strong thermocline positioned between 6 and 8 meters which would strongly limit any diffusion of these high concentrations upward.

Using the average of the top and middle samples from 2004 and 2006 the concentration of nitrogen in West Hill Pond is over the oligotrophic threshold but below the quantity needed for a mesotrophic lake.

Table 3. Nitrogen Series Results From West Hill Pond, 2006

Depth (m)	Nitrate (ppb)	Ammonia (ppb)	Organic (ppb)
1	< 20	< 10	193
10		< 10	251
18		810	1,760

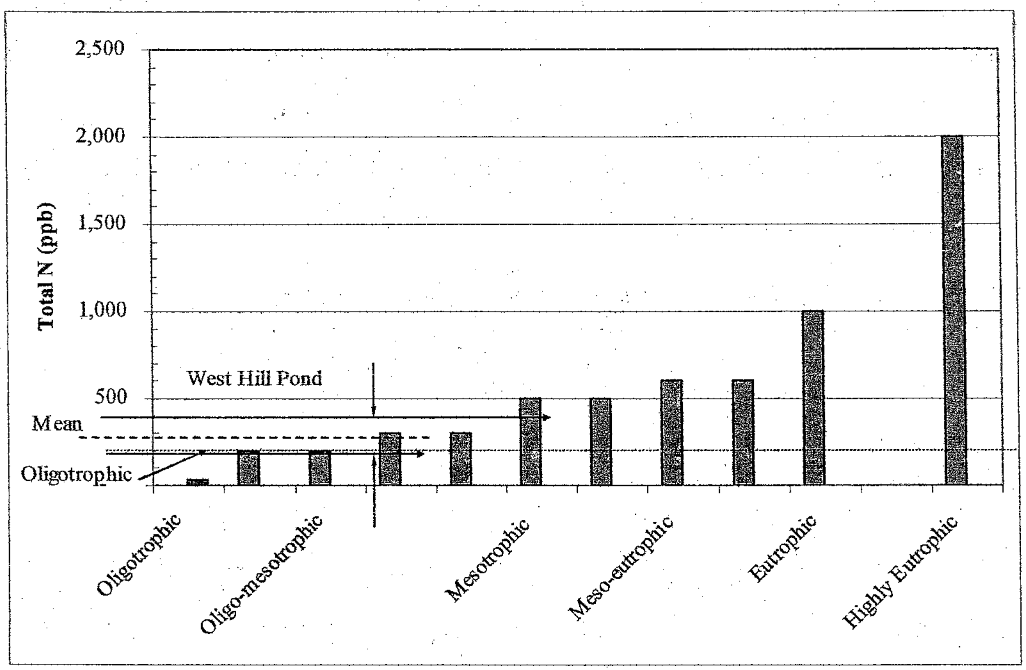
2004

Depth (m)	Nitrate (ppb)	Ammonia (ppb)	Organic (ppb)
1	< 20	< 10	292
7		< 10	384
15		870	1,350

2002

Depth (m)	Nitrate (ppb)	Ammonia (ppb)	Organic (ppb)
1	< 20	< 10	295
7		< 10	
15		306	

Figure 2. Trophic Categories For Total Nitrogen Showing Position of West Hill Pond



Secchi Disk Depth

The Secchi disk depth is a measure of the water clarity. The disk is lowered into the water until the point where it is no longer visible. The depth of the disk at that point is measured and recorded as the Secchi depth. That depth is used as a measure of light transmission into the lake. Secchi depth in West Hill Pond was measured once during the 2006, 2004, and 2002 seasons (**Table 4**), and 8 times between the years 1974 and 1993.

Table 4. Secchi Disk Depth At West Hill Pond During 2004.

2006	August 24
Depth m (ft	6.0 (19.8)
2004	August 19
Depth m (ft)	9.7 (31.8)
2002	July 23
Depth m (ft)	6.5 (21.3)

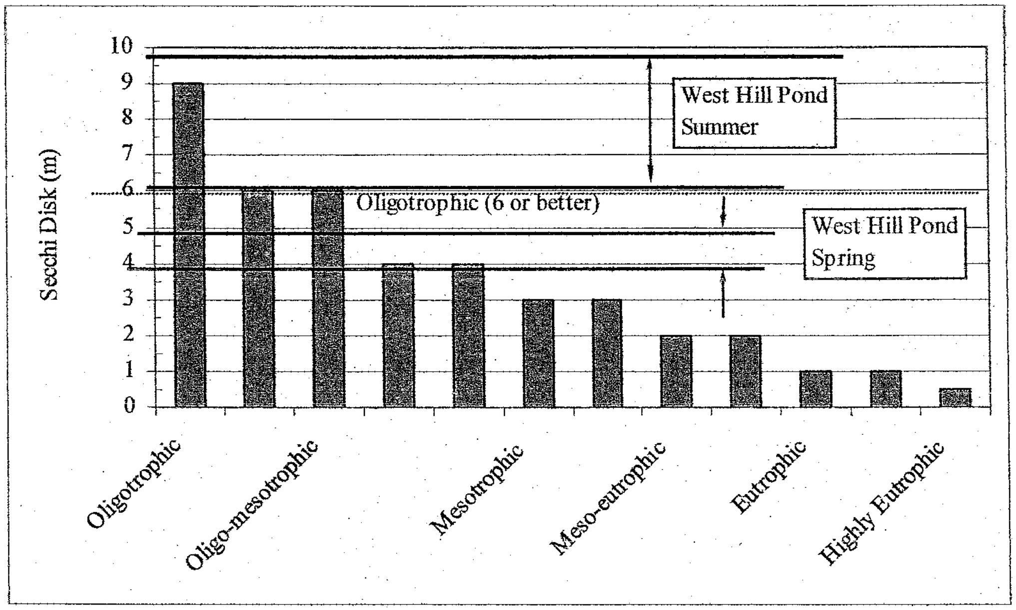
The Secchi disk depth reading for 2006 was 6 meters within the acceptable levels for oligotrophic lakes (see **Figure 3**). In 2004, the water clarity reading was the best on record for the lake at 9.7 meters. Prior Secchi disk depth readings from West Hill Pond (**Table 5**) show that during the summer the water clarity has a strong oligotrophic characteristic, however, the record also indicates that water clarity in the spring is lower than the summer readings with values between 4 and 6 meters.

Table 5. Record of Secchi Disk Depth at West Hill Pond.

Date	Secchi Disk Depth (meters)
4-23-74	**5.5**
7-2-74	6.8
8-22-74	7.2
4-21-89	**4.9**
8-17-89	7.0
7-20-92	7.3
6-23-93	9.4
8-2-93	6.4
7-23-02	6.5
8-19-04	9.7
8-24-06	6.0

Bold indicates spring readings

Figure 3. Trophic Categories For Secchi Disk Showing Position of West Hill Pond.



Temperature / Oxygen Profiles

One profile of the temperature and oxygen of the water column was taken in 2006. The profile showed that the lake had a well defined thermocline, or temperature gradient, between 7 and 9 meters.

The lake had excellent dissolved oxygen levels in the top 10 meters. A deep-water oxygen maximum was detected between 6 and 9 meters due to algae that reside on the thermocline, a typical occurrence for very clean clear lakes such as West Hill Pond. Below 9 meters the oxygen declined slowly with depth until reaching anoxic levels at 12 meters. This was higher in the water then was observed in 2002 when the water became anoxic at about 15 meters, but almost identical to the depth observed in 2004. This is further indication that sampling in July measured the early development of oxygen loss conditions in the lake. The oxygen at the very bottom was essentially zero which provided the conditions for the re-mineralization of phosphorus and ammonia.

Aquatic Plants

A survey of the aquatic plants in the lake was conducted on August 24, 2006. There were generally few aquatic plants found in most areas of the littoral zone (shallow near-shore regions of the lake). The most plentiful plant was water lobelia which formed carpets of tiny basal rosettes with many patches around the lake. Basal rosettes are circular groups of tiny leaves that grow at the ground level. The plant also sends up a slender shoot that emerges from the water surface so that tiny flowers will form in the air. These carpets of basal rosettes look like the bottom of the lake has been painted green.

The locations and species of aquatic plants observed in the lake was identical to the last two surveys. The species observed during the three seasons are listed in **Table 6,** along with the letter code used on the map provided in the last report. No nuisance plant beds were observed in the lake. **No** invasive species were seen in 2006.

Table 6. Aquatic Plant Species List for West Hill Pond.

Common Name	**Scientific Name**	**Map Code**	**Notes**
Burreed	*Sparganium sp*	Not shown	Emergent on shore
Cattail	*Typha sp*	Not shown	Emergent on shore
Tape Grass	*Vallisneria americana*	V	Send small spaghetti like strands to the surface
Pondweed	*Potamogeton bicupulatus*	P	Common pondweed
Pondweed	*P. epihydrus*	P	Common pondweed
Water Lobelia	*Lobelia dortmanna*	L	Isolated shoot in 3-4 feet of water mostly just basal leaves
Pipewort	*Eriocaulon septangulare*	Not shown	Isolated shoot in 3-4 feet of water mostly just basal leaves
Chara	*Chara sp.*	Not shown	Deep water plant
Nitella	*Nitella sp.*	Not shown	Deep water plant
Water Naiad	*Najas flexilis*	Not shown	Rarely reaches the surface
Water Naiad	*Najas guadalupensis*	Not shown	Rarely reaches the surface
Spikerush	*Eleocharis acicularis*	Not shown	Tiny plant on bottom
Yellow water lily	*Nuphar variegata*	YWL	Floating leaved plant in sheltered coves
Filamentous Algae	*Spirogira sp*	FA	Located at storm water discharge outfalls
Bulrush	*Scripus spp.*	Not shown	Shoreline plant
Arrow Head	*Sagitaria cristata*	Sc	Tiny plant on bottom
Quillwort	*Isoetes sp.*	Q	Tiny plant on bottom
Aquatic Moss	*Fontinalis sp.*	F	Shallow water
Golden-pert	*Gradiola aurea (?)*	G	Very shallow water

Bold = indicates species were observed in 2006

SUMMARY

Monitoring data collected during the 2006 season indicated that West Hill Pond was oligotrophic with respect to total phosphorus, and Secchi depth. Nitrogen data showed slightly more nitrogen than the oligotrophic requirements. Total phosphorus results from the top and middle water depths show a trend of increasing concentration between 2002 and 2006. The average concentration of these two depths has increased about 50 % over that time frame. If this trend continues, additional lake sampling visits will be required to verify these levels and to determine potential sources. Deep water chemistry showed that anoxic conditions released phosphorus and nitrogen from the sediments. A strong thermocline restricted diffusion of this material upward. The oxygen profile showed very healthy oxygen content at most all depths with some deep (6 – 9 meters) water algae causing excellent content at the mid depth region. Anoxia was about the same in 2006 as reported in 2004, while both years were more intense then was noted in 2002 causing higher phosphorus and nitrogen at the bottom. The later summer sample date is implicated as the primary reason the deep water showed higher levels of phosphorus, nitrogen and oxygen loss.

Water clarity was excellent, at 6.0 meters. Historic Secchi disk depth show that summer Secchi disk readings are all indicative of an oligotrophic lake. Readings collected in the spring show poorer clarity during April and May suggesting that the spring water clarity is not as good as the summer.

The aquatic plant survey showed the lake supports very little plant growth. Water lobelia was by far the most common species in the lake. Generally, the plant was present only as a basal rosette of tiny leaves. I suspect that there are significant beds of deep water plants, nitella and chara, that probably grow to water depths of 20 to 30 feet. These could be investigated using an Aquaview underwater camera. Along the west shore, there are isolated beds of emergents, burreed and cattails and some small beds of water lilies and tapegrass.

Filamentous algae was noted in three shallow water, near shore, areas apparently associated with storm water outfalls. This may be of concern because the algae may

indicate areas of localized enrichment of nutrients and organic sediments. Because the watershed of the lake is small relative to the size and volume of the lake, storm water conveyance may carry a large percentage of the drainage basin runoff to the lake. A long term goal of the association should be to evaluate storm water infrastructure around the lake and assess the potential for making improvements such that adequate detention, infiltration and renovation occurs prior to discharge into the lake. This situation does not appear to be an alarming one that requires immediate attention but a management plan should be adopted within the next few years that calls for steps which will begin to address upgrades.

The level of monitoring conducted during this survey appears adequate based on the high water quality of the lake however, the trend of increasing phosphorus should be noted as a possible cause for more frequent water quality tests. Otherwise, sampling every two years will enable the lake association to monitor the other conditions of the lake.

A bi-annual (once every two years) aquatic plant survey also appears to be sufficient to monitor the lake for changes in the plant community. However, I want to stress that professional surveys need to be in concert with routine observations made by lake residents during the summer. Familiarity should be established with all the common native plants in the lake so that when something different appears it can be noted immediately. This is particularly important for the boat ramp area. Don't hesitate to contact me at any time a new or unknown plant is located. You can send me a sample for quick identification.

Storm water appears to be bringing sediments into the lake. A volunteer effort can be made to map all of the inflow points to the lake. This can be done easily by a two phased plan. First, take a slow cruise around the lake and note all the points of entry of water to the lake including small streams and pipe outfalls. Second, drive around the lake and look for the sites noted from the water. Walk down to the lake and try to determine if this was the place you noted from the lake cruse. Follow this pipe or stream channel back to the road and make notes about the conditions you observe. Generally in this way you can inventory many of the places where water is routed to the lake.