2014 Monitoring Report For

West Hill Pond

Prepared For:

West Hill Pond Association

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Summary

This report is a summary of observations and results of testing at West Hill Pond from the two visits; April 21, and August 12, 2014 to measure key indicator parameters: The plant nutrients: Total Phosphorus Nitrogen, the Water Clarity, and Dissolved Oxygen, and to assess the status of Aquatic Plants in the lake.

Total phosphorus in the water column determines lake condition due to direct relationship to water clarity. Average total phosphorus in the water column measured during the spring in West Hill Pond was 17.3 parts per billion (ppb) higher than all prior April results (2013, 2012, and 2011). The surface concentration was 27 (ppb) an alarmingly high level that requires verification. Bottom water phosphorus concentration was also very high in August at 254ppb, higher than all prior bottom samples.

Nitrogen occurs in three forms[1] in lakes, nitrate, ammonium, both available to plants including plankton, and in an organic particulate form. Nitrate is generally not detected, and ammonium occurs only in bottom water but doesn't appear to be increasing. Organic nitrogen has been high in prior visits but was very low in 2014.

Total phosphorus in August was 9 ppb in the photic zone (down to about 30 feet), for the second year in a row, well above the long-term average. The photic zone long-term average is now 6.7ppb, steadily rising since monitoring began in 2002 when it was 4ppb.

Water Clarity is controlled by quantity of sediments and phytoplankton suspended in the water but in-turn governs the mixing depth and depth of oxygen diffusion. West Hill Pond water clarity in August 2014 was 22 feet (6.9 meters), the second year-in-a-row August clarity was below the mean of 7.5m. Water clarity in April 2014 was 5.9m, furthering the trend of poor spring water clarity in West Hill Pond.

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[1] There is also nitrogen gas (N_2) but this form is mostly inert

Aquatic Plants occur in a number of forms, emergent on the shoreline, floating-leaved in shallow water and submersed in the water. Some submersed plants can grow to the surface and form floating leaves. Aquatic plants in West Hill Pond were surveyed on August 12, 2014. There are no exotic or invasive species found during that survey. However, aquatic plants appear to be spreading and becoming more pronounced in West Hill Pond. Although still scarce overall, survey results show that at least three native species, large-leaf pondweed, red-leaf pondweed, and tape-grass have proliferated in West Hill Pond. A preliminary relationship appears to exist between dense plant stands and storm-water outfall points. Base-flow and storm-water sampling is now being conducted to determine if runoff water is contributing nutrients and sediments to the lake that fuel excessive plant growth.

Background

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 (19.3 meters) with relatively steep sides along most of the basin. The littoral zone, the shallow shoreline where rooted aquatic plants can grow, is mostly narrow around the lake such that only about 75 acres of the total lake surface area can support rooted aquatic plants.

The lake has a small watershed of 790 acres, about 3.0 times the area of the lake. Subtracting the lake area from the total watershed area leaves 499 acres of land that drains to the lake. The flushing rate of lake water is estimated to be very slow, about 20% per year. The long retention of 4.8 years, suggests that material residence time will be at least as long. Long material residence time mean that most insoluble material will remain in the lake indefinitely because they will settle to the bottom in deep water.

2014 Monitoring

Northeast Aquatic Research has conducted one water quality sampling visit to West Hill Pond in each of the years; 2002, 2004, 2006, 2008 and 2010. Beginning in 2011, two visits have been made to the lake, first in April with second in July/August coordinated with approximate time of year as 2002-2010 visits.

Two field visits were made to the lake in 2014, the first on April 21, 2014, and the second on August 12, 2014. During each trip, water clarity was measured using a Secchi disk and underwater view scope, dissolved oxygen and water temperature readings were made at each meter depth, and three water samples were collected (1, 8-10, and 16-18 meters). Samples were analyzed for total phosphorus, ammonia nitrogen, nitrate nitrogen (surface only), and organic nitrogen.

During the August 2014 visit, the aquatic plants were surveyed around the perimeter of the lake. The survey recorded species presence, relative abundance, and approximate density.

Total Phosphorus

Background

Phosphorus is the principal nutrient feeding planktonic phytoplankton in freshwater lakes. Phosphorus in the water column can be in several forms so traditionally the test Total Phosphorus is used to measure all forms collectively. Planktonic phytoplankton is free floating single cells or colonies of plants that live in the water column of a lake. Because plankton are suspended in the water, they are dependent on the quantity of phosphorus dissolved in the lake water. Therefore, increasing phosphorus concentration in the water causes increased planktonic algae numbers. As the number of cells in the water increases, the water clarity declines. Phosphorus can then be related to water clarity as is shown **Figure 1** below. The chart shows the relationship between increasing phosphorus and declining clarity in a widespread sampling of Connecticut lakes conducted in the 1970's.

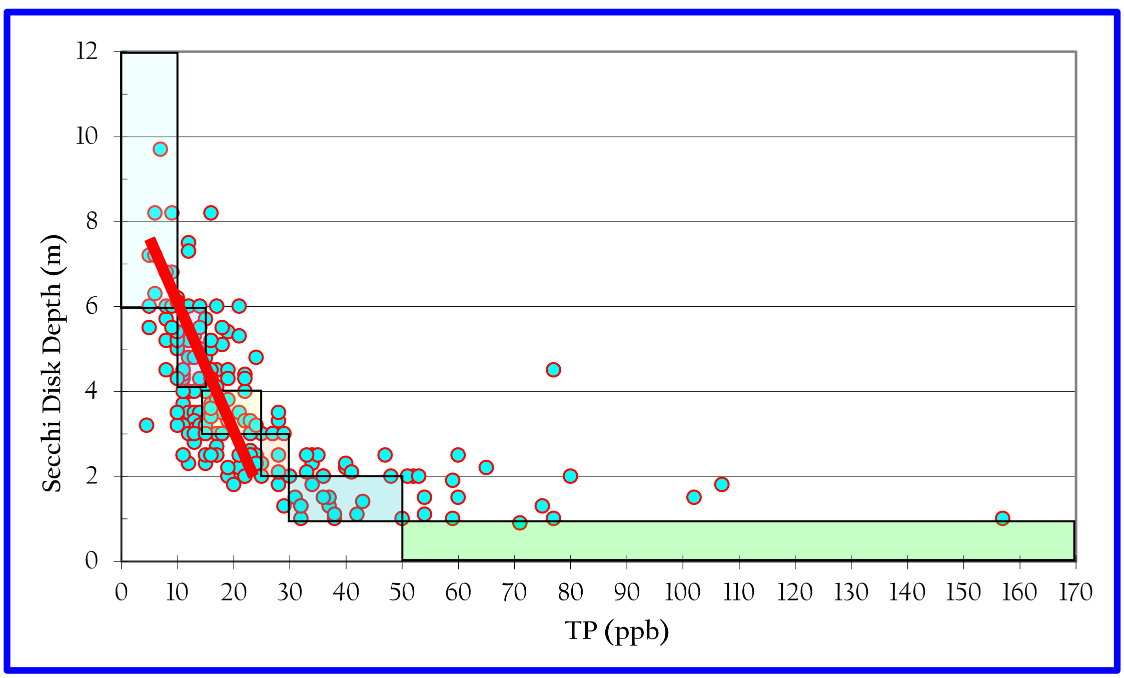

Figure 1 – Relationship between increasing phosphorus concentration and decreasing water clarity

Three important functions of the relationship shown in Figure 1 are critical to the monitoring, preservation, and protection of very clear Connecticut lakes, specifically like West Hill Pond.

1) There is a very rapid, linear decrease in water clarity as phosphorus increases from zero to about 20ppb (red line in Figure 1).
    a. With very low phosphorus (<5ppb) water clarity can be 10m or more (light blue rectangle).
    b. With each increase of 5ppb phosphorus, the water clarity declines by about a meter, continuing until phosphorus reaches about 20ppb when water clarity averages 3m. Further increases in phosphorus cause water clarity to decline slower eventually leveling off at around 1.5 meter clarity.
2) When phosphorus is less than 20ppb, water clarity readings vary considerably with the same phosphorus concentration.
    a. This means that although increases in phosphorus cause declines in clarity, trends are often not apparent due to natural variability.
3) Phosphorus concentration can continue to increase past 30ppb with little further decline in clarity.
    a. Once phytoplankton reach growth rates of a full bloom (water clarity of about 1 meter) their numbers cause shading to those below causing general light limitation to the population.
    b. However, reclaiming lakes that have more than 30ppb phosphorus requires significant reductions before any increases in clarity can be realized.

One of the primary goals of lake management is tracking changes in this clarity/phosphorus relationship over time. A comprehensive lake monitoring plan includes collecting nutrient and water clarity data monthly beginning in April and ending in November. Sampling throughout the entire season is necessary because a lake progresses through a series of thermal stages during the year which have profound influence on lake condition. Each stage effects distribution of nutrients and types of algae in the water column in different ways.

At West Hill Pond, one lake visit in mid-August was made to track possible seasonal worst-case conditions within the lake. Such conditions are defined here in two ways. The first involves the time of the year when loss of dissolved oxygen in the deepest water is at its maximum, and bottom phosphorus will occur at its highest concentration for the summer. The second involves the time of year when aquatic plants are at seasonal maximum growth.

Difficulties with this supposition are worth noting:

1. The timing of highest bottom phosphorus and most severe loss of dissolved oxygen may not be synchronized with maximum phosphorus occurring after maximum time of oxygen loss.
2. Maximum of either may occur in September or even October.
3. Oxygen loss may affect sediments in shallower depths in July.
4. Aquatic plants may not reach maximum growth until September.
5. Curly-leaf pondweed may have completed its seasonal growth cycle by August so would not be visible at that time.
6. One survey of aquatic plants done in August to specifically search for new invasive species is not adequate to evaluate plant removal programs.
7. Lake changes occurring at other times during the season go unobserved. One visit per year is adequate as long as no changes are detected. Once changes are noted than decisions about possible causes will be based on that snapshot in time. Without information from these other months, it is impossible to understand how or why the lake is changing.

August Phosphorus Results

Epilimnion

Phytoplankton grows in waters receiving sunlight, which for West Hill Pond is approximately the top 7 meters, determined by summer Secchi disk depth and location of the thermocline (layer of water where temperature changes rapidly). This layer of a lake is referred to as the epilimnion, defined as the equally warm, upper water layer that receives sunlight (see temperature profile data shown in Figure 8 on page 18). Phosphorus concentrations from 1 and 10 meters represent the photic zone or the epilimnion of West Hill Pond and so regulate the planktonic algae growth potential. Phosphorus from the bottom sample represents the combined increases due to re-cycling and internal release from the sediments, which occurs when oxygen is lost in deepest water.

The results of all summer total phosphorus testing in West Hill Pond are presented in Table 1 below.

Table 1 – Summer total phosphorus concentrations (ppb) for West Hill Pond

Depth (m)	August 14, 2012	July 16, 2013	August 12, 2014
1	4	7	9
10	9	11	9
Ave of 1 and 10	6.5	9	9
18	99	57	254
Average of all	*37*	*25*	*91*

Depth (m)	August 9, 2011	August 5, 2010	August 24 2008	August 24, 2006	August 19, 2004	July 23, 2002
1	5	4	3	6	4	5
10	8	11	6	9	7	3
Ave of 1 and 10	6.5	7.5	4.5	7.5	5.5	4
18	156	53	19	121	154	20
Average of all	*56*	*23*	*9*	*55*	*55*	*9*

The total phosphorus concentration at 1m and 10m has varied over a very similar range 3 and 9ppb (11 ppb, at 10m). However the average phosphorus concentration at these two depths has slowly increased over the period that NEAR has been visiting the lake (Figure 2). The chart shows that the value (average of 1 and 10m samples) has fluctuated between a low of 4 ppb and a high of 9 ppb. The long-term average is 6.7 ppb using the

2014 data. However, this average has been slowly going up since monitoring began (Figure 3). Initially, the average concentration from 1 and 10m was 4 ppb, now its 6.7ppb.

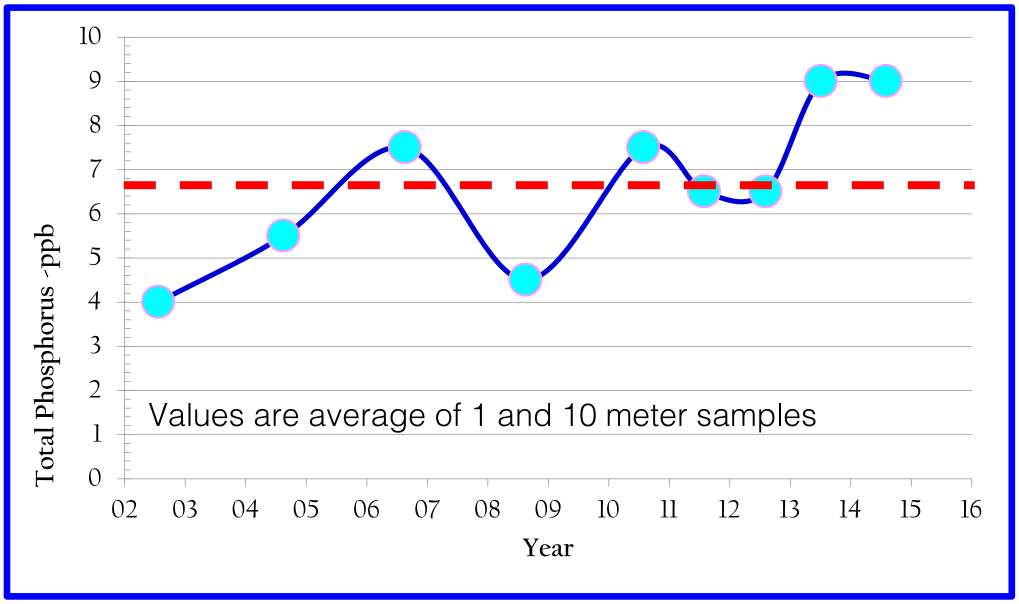

Figure 2 – Average phosphorus concentration from 1 and 10 meter summer samples, red dashed line shows long-term average of 6.7 ppb

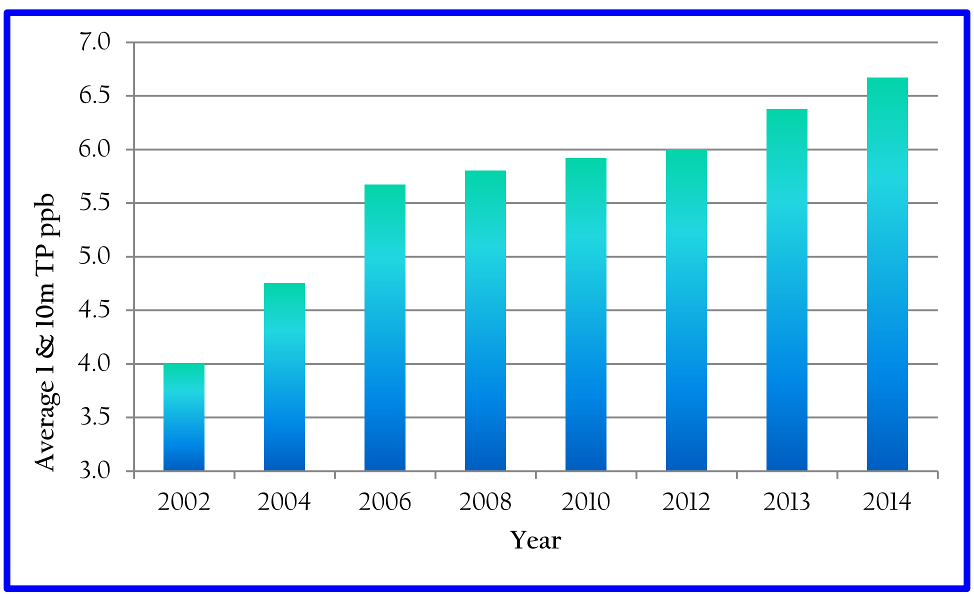

Figure 3 – Long-term average phosphorus concentration from 1 and 10 meters

Hypolimnion

Hypolimnion water, below about 10m is cold, dark, and usually devoid of dissolved oxygen (see **Figure 8**). The bottom phosphorus concentration in 2014 was 254ppb, well above any value we have collected up to this point (**Figure 4**). Data from the bottom sample in August shows considerable range of phosphorus concentration, between 19 and 254ppb, evidence that maximum bottom phosphorus does not always occur at the time of sampling. Bottom concentration needs to be sampled in September and October to determine when annual maximum occurs in the lake. The current monitoring frequency is missing important evidence about trends of internal loading of phosphorus from bottom sediments into lake water.

The large jump in phosphorus concentration from 57ppb to 254 ppb in a single year is alarming and suggests that internal phosphorus loading was more acute in 2014 than any of the previous years.

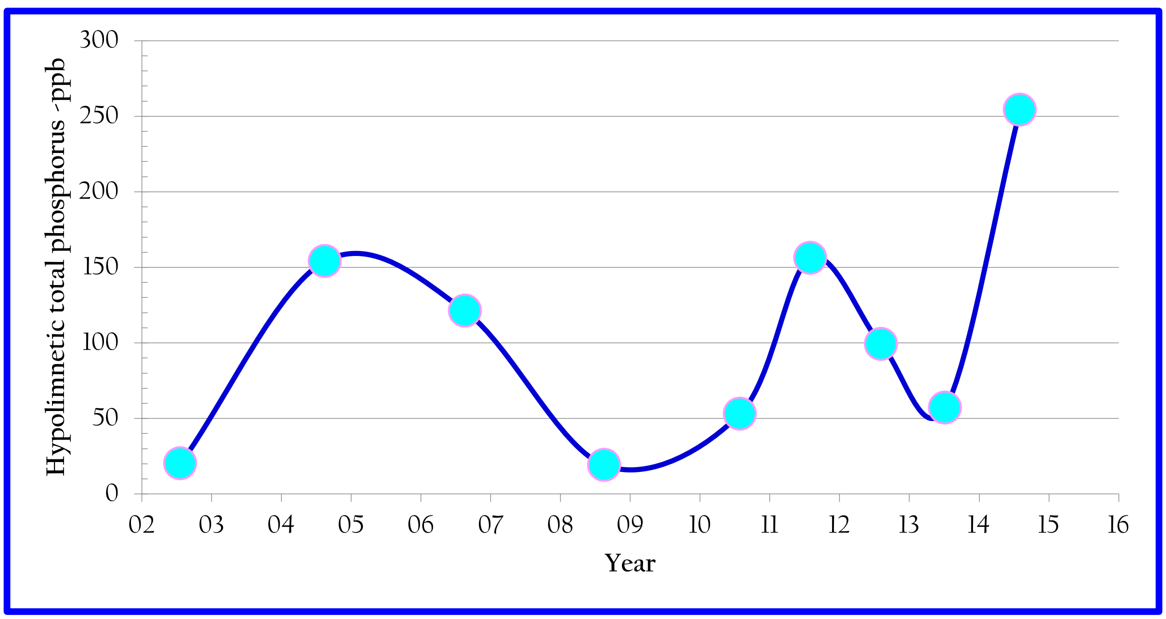

Figure 4 – Maximum annual phosphorus concentration from bottom water sample

April Phosphorus Results

The principal source of phosphorus to a lake is from the watershed. Most hydraulic flow to a lake occurs between November and May meaning that usually most surface water nutrient loading occurs during that same time period. Phosphorus concentration at the time of ice-out can be used to predict the annual load by assuming that most annual phosphorus load has occurred by that time and that the whole water column at the time of April sampling is homogeneous, or well mixed from top to bottom.

The Spring Phosphorus concentration is an average of all phosphorous concentrations from three depth-discrete water samples collected from the lake in April (Table 2). The April 2014 phosphorus concentration of 27ppb at 1m was considerably higher than any prior value. The April 2013 value was 15 ppb. Prior results are; 10.3 ppb in April 2012, and 8.7 ppb in April 2011.

Table 2 – Spring phosphorus concentrations and predicted annual phosphorus loads to West Hill Pond

Depth (m)	April 21, 2014	April 24, 2013	April 24, 2012	April 21, 2011	
1	27	6	5	7	
10	11	22	9	9	
18	14	17	17	10	
Average	*17.3*	*15.0*	*10.3*	*8.7*	
					average
Spring ppb=›	17.3	15.0	10.3	8.7	12.8
Model			Kg P/year		
Kirchner and Dillon	253	219	151	127	188
Vollenweider	200	173	119	100	148
Jones and Bachmann	149	129	89	75	111
Chapra	300	260	178	151	222
Average	*225*	*195*	*134*	*113*	*167*

The models predict that the annual load of phosphorus to West Hill Pond potentially ranges between 75 kg P/yr. and 300 kg P/yr., depending on which model is considered. or 165 pounds/yr. to 661 pounds/yr. Because the models all use the spring phosphorus concentration and because the spring concentration has been steadily increasing the estimated load to the lake has steadily increased since April sampling started in 2011.

A nutrient allocation plan divides the estimated load by the acres of the drainage basin, 500 acres. However, at this point the spring concentration is not stable and is varying between 8.7 and 17.3ppb. This fluctuation is too large to estimate allowable export of phosphorus from the drainage basin.

Nitrogen

Background

Nitrogen is the second most important plant nutrient in lakes, but has a primary role in the growth of rooted aquatic plants. All nitrogen data collected to-date is given in **Table 3**. In the past, water was collected for analysis of the three nitrogen forms most common in lakes: ammonia, nitrate, and organic nitrogen or Total Nitrogen (TN) in 2013 and 2014 due to change in laboratory. Total nitrogen encompasses all forms of nitrogen in the water sample, including organic nitrogen. Nitrate and ammonia are inorganic forms of nitrogen that are usable by phytoplankton. Organic nitrogen collectively refers to nitrogen in less usable forms. In previous years, organic nitrogen accounts for nearly all nitrogen in the epilimnion, while ammonia is common in the hypolimnion in August.

Nitrate-Nitrogen Results

Nitrate-nitrogen was below the laboratory detection limit of 3ppb in all samples collected in 2014. Prior to 2013, Nitrate was also usually below the lab detection limit of either 10 or 20ppb depending on the technique used by the laboratory, which was switched to a more sensitive test in 2011. In 2008, some trace nitrate was detected in surface water.

Ammonia-Nitrogen Results

Ammonia can be used directly by phytoplankton but is also toxic at high levels. In August 2014, ammonia was below the detection limit of 3 ppb at the surface and at 10 meters. Bottom water ammonia was 854 ppb, most likely released from the sediments during the anoxic conditions that occur at the bottom in the summer. Ammonia in 2014 was higher than most recent summer values but similar to concentrations seen in 2004 and 2006 (range in bottom ammonia concentrations is 273 ppb to 870 ppb).

The 2013 bottom water ammonia concentration was 370 ppb, a relatively low value; however this data was collected almost a full month prior to August data from prior years. The longer anoxia persists in the hypolimnion, the higher the ammonia level will be. It is possible that data from September, and possibly October, would be even higher than data collected in August, and that August may not be the worst case scenario for elevated bottom-water nutrients.

Organic-Nitrogen Results

The organic nitrogen component in lake water is a result of decaying microscopic plant material and organic nitrogen from watershed sources. Average epilimnetic organic nitrogen in West High Pond has ranged between a low of 142 ppb to a high of 338 ppb. Results from 2014 show epilimnetic organic nitrogen was 173 ppb, well within the established range. Bottom water organic nitrogen is typically composed mostly of ammonium, although during some years ammonium is only part of the total.

Table 3 - Nitrogen series results from August water sampling of West Hill Pond.

2014 Depth (m)	Nitrate (ppb)	Ammonia (ppb)	Total (ppb)
1	‹ 3	‹ 3	172
10	‹ 3	‹ 3	175
18	‹ 3	854*	648*
2013 Depth (m)	**Nitrate (ppb)**	**Ammonia (ppb)**	**Total (ppb)**
1	‹ 3	‹ 3	145
10	‹ 3	6	159
18	6	370*	344*
2012 Depth (m)	**Nitrate (ppb)**	**Ammonia (ppb)**	**Organic (ppb)**
1	‹10	‹ 10	290
10	‹10	20	330
18	‹10	660	1,580
2011 Depth (m)	**Nitrate (ppb)**	**Ammonia (ppb)**	**Organic (ppb)**
1	‹10	‹ 10	250
10	‹10	‹ 12	265
18	‹10	720	2,140
2010 Depth (m)	**Nitrate (ppb)**	**Ammonia (ppb)**	**Organic (ppb)**
1	‹20	‹ 10	118
10		‹ 10	165
18		450	455
2008 Depth (m)	**Nitrate (ppb)**	**Ammonia (ppb)**	**Organic (ppb)**
1	33	‹ 10	300
10	‹ 20	‹ 10	375
18	‹ 20	273	1,650
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

(*Laboratory error, total nitrogen should not be less than ammonia value – brought to lab's attention.)

Secchi Disk Depth

Secchi disk depth is related to the quantity of plankton in the water which is related to the concentration of phosphorus in the water as shown in Figure 1. Oligotrophic lakes are those with the lowest phosphorus (less than 10ppb) and greatest water clarity (better than 6 meters). West Hill Pond has traditionally been an Oligotrophic lake meeting both those criteria. One of the principal goals of lake monitoring is to track changes in clarity over time as an indicator of changing phosphorus conditions.

The August 2014 Secchi disk depth reading was 6.9 meters, slightly less than the long-term summer average of 7.5 meters (Figure 5). Summer Secchi disk depths have varied between a high of 9.7m and a low of 6m between 2002 and 2014, with most values within the range of 6 to 8 meters indicating that the mean of 7.5m has not changed significantly during the period of monitoring. All summer Secchi disk readings measured by NEAR are given in (Table 4). All Secchi disk depths for West Hill Pond that we have on file are given in Table 5.

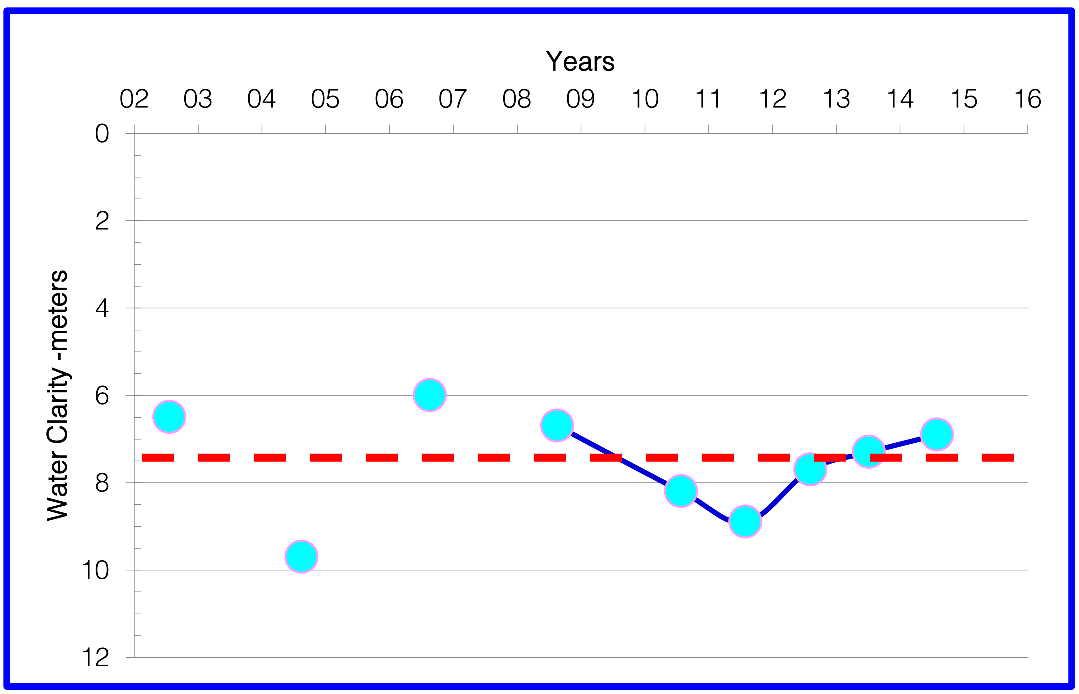

Figure 5 – August (July in 2013) water clarity in West Hill Pond, red dashed line is long-term average of 7.6 meters

Table 4 – August (July in 2013 and 2002) Secchi disk depths for West Hill Pond

Date	Meters	Feet
8/12/2014	6.9	22.6
7/16/2013	7.3	24.0
8/14/2012	7.7	25.3
8/9/2011	8.9	29.2
8/5/2010	8.2	26.9
8/15/2008	6.7	22.0
8/24/2006	6.0	19.7
8/19/2004	9.7	31.8
7/23/2002	6.5	21.3

Table 5 - Record of Secchi disk depth readings at West Hill Pond

Date	Depth (meters)	Date	Depth (meters)	Date	Depth (meters)	Date	Depth (meters)
4/23/74	5.5	5/21/06	4.2	5/6/07	6.4	8/5/10	8.2
7/2/74	6.8	6/8/06	4.7	6/6/07	7	8/14/09	6.9
8/22/74	7.2	6/21/06	5.3	7/1/07	4.4	8/31/10	5.8
4/21/89	4.9	7/12/06	5.7	7/17/07	5.9	4/21/11	3.5
8/17/89	7	7/30/06	6.1	8/5/07	5.9	8/9/11	8.9
7/20/92	7.3	8/26/06	6	9/13/07	8.1	4/24/12	6.35
6/23/93	9.4	8/26/06	7.5	10/9/07	6.9	8/14/12	7.7
8/2/93	6.4	9/13/06	7.4	11/11/07	4	4/24/13	5.1
7/23/02	6.5	10/1/06	8.2	8/15/08	6.7	7/16/13	7.3
8/19/04	9.7	3/10/07	6.4	7/2/09	4.6	4/21/14	5.9
						8/12/14	6.9

The range in Secchi disk depth values for West Hill Pond is large, from a low of 3.5 meters to a high of 9.7 meters (Figure 6). The large range in seasonal and year-to-year clarity should be better understood because poor clarity indicates periodic increases in either sediments and/or phytoplankton which suggests phosphorus loading to the lake is erratic and needs to be controlled. Fifteen of the 41 (37%) Secchi disk depth measurements shown in Figure 6 are less than 6m. Monthly averages (Figure 7) show the spring months of April and May and the early summer month of July have average clarity of less than 6 meters. These Secchi measurements suggest that watershed loading of phosphorus is occurring during the winter and spring months.

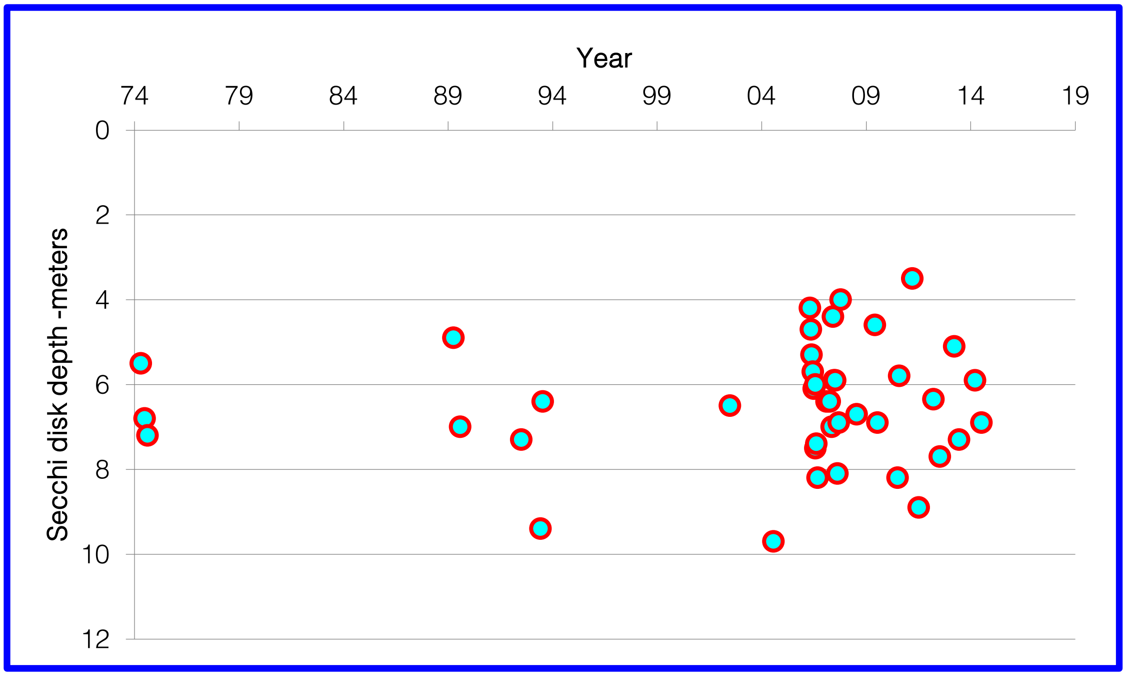

Figure 6 – Long-term record of water clarity readings at West Hill Pond

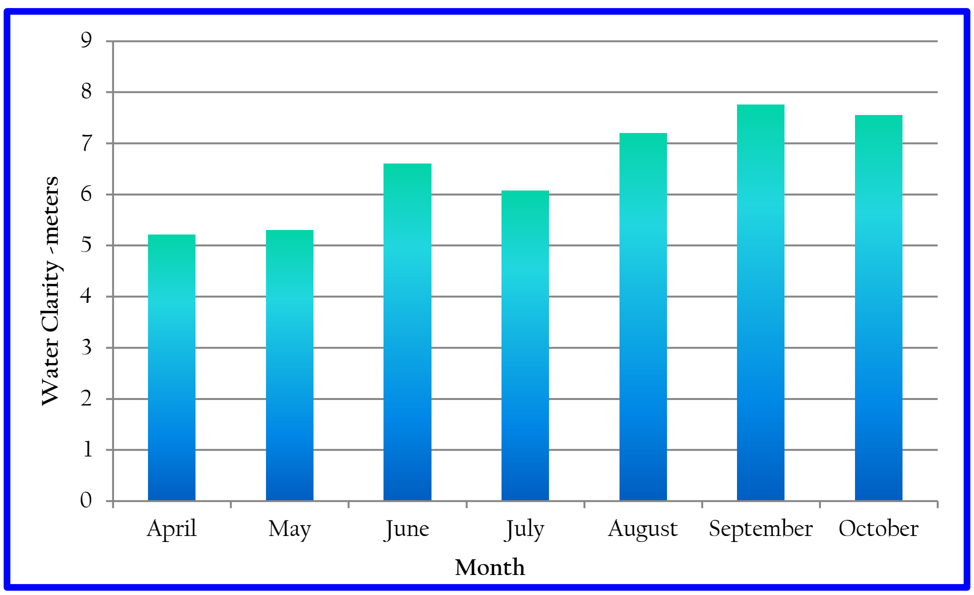

Figure 7 – Monthly average Secchi disk depths at West Hill Pond

Temperature / Oxygen Profiles

The water temperature and dissolved oxygen concentration was measured at each 1 meter depth from surface to the bottom of the water column in deepest location in the lake twice in 2014. The August profile (Figure 8) showed that the lake had a well-defined thermocline, or temperature gradient, between 6 and 10 meters. Dissolved oxygen was excellent between the surface and a depth of 10 meters, or the entire epilimnion. Below this depth, dissolved oxygen plummets to <1 mg/L at 14 meters, meaning that all water below 14 meters is anoxic, or devoid of oxygen.

The layer of water at 9-10 meters has slightly higher dissolved oxygen due to suspended phytoplankton at those depths.

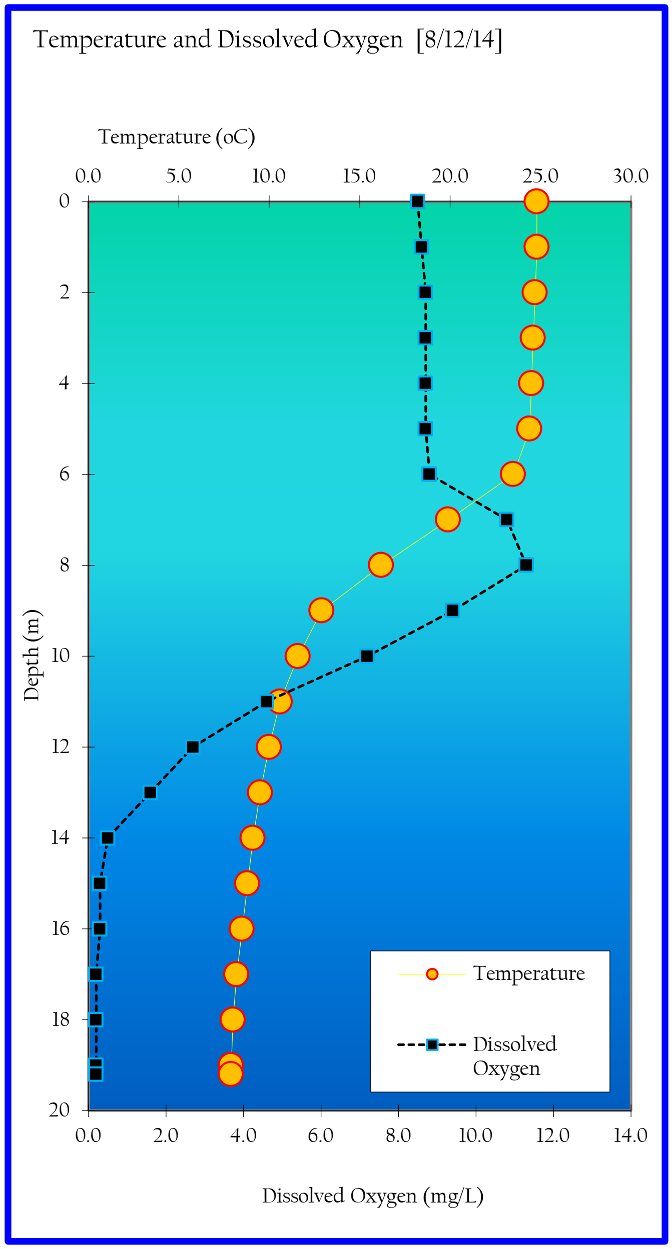

Figure 8 – Water column profile of West Hill Pond showing changes in water temperature and dissolved oxygen content with depth

The calculated anoxic boundary on August 12, 2014 was 13.6 meters - the depth where dissolved oxygen fell below 1 mg/L. The record of depth-to-anoxia in August is shown in Figure 9. The measurement in 2014 was near equal to the average summer depth measured on visits since 2002. However, with only one summer profile it is difficult to decipher any trends in the location of the anoxic boundary over the years. Loss of oxygen in deepest water continues until the lake mixes in the late fall. No measurements have been made after August so it is unknown if anoxic water reaches higher into the water column during September or October.

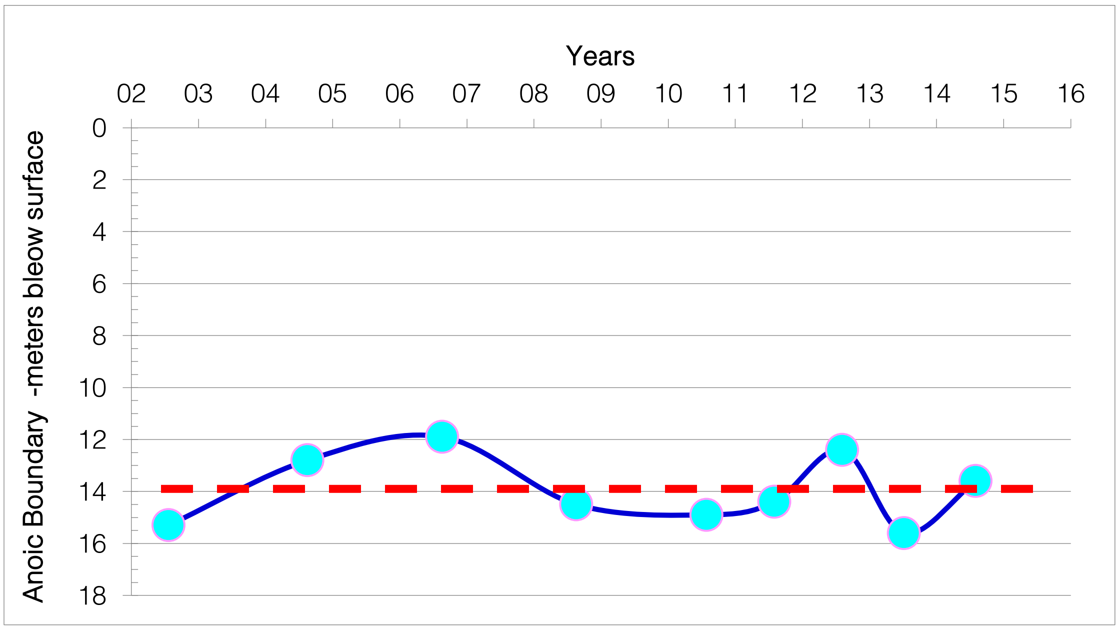

Figure 9 – Record of depth-to-anoxia at time of August sampling in West Hill Pond with long-term average, 14 meters, shown by red dashed line

Aquatic Plants

A survey of the aquatic plants in West Hill Pond was conducted on August 12, 2014. No invasive aquatic plant species were found during the survey. The aquatic plant species observed in 2014, as well as all prior surveys conducted by NEAR are listed in Table 6. There have been only a few species that have been noted during all surveys, red-leaf pondweed, tape grass, and yellow-water lily.

Table 6 - Aquatic plant species list for West Hill Pond

Common Name	Scientific Name	2002	2004	2006	2008	2010	2011	2012	2013	2014
Robust submersed aquatic plants										
Red-leaf Pondweed	*Potamogeton epihydrus*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Large-leaf Pondweed	*Potamogeton amplifolius*	N	N	N	Y	Y	Y	Y	Y	Y
Tape Grass	*Vallisneria americana*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Spiral-fruited Pondweed	*Potamogeton spirillus*	N	N	N	N	Y	N	N	N	N
Water Naiad	*Najas flexilis*	Y	N	Y	Y	Y	Y	Y	Y	Y
Southern Naiad	*Najas guadalupensis*	N	Y	Y	Y	N	N	N	N	N
Water Weed	*Elodea nuttallii*	N	N	N	Y	Y	Y	Y	Y	Y
Snail-seed pondweed	*Potam. bicupulatus*	Y	Y	Y	Y	N	N	N	N	N
Capillary Pondweed ***	*Potamogeton berchtoldii*	N	N	N	N	Y	N	N	N	N
Water Starwort	*Callitriche heterophylla*	N	N	N	N	Y	Y	N	N	N
Oakes Pondweed	*Potamogeton oakesianus*	N	N	N	N	Y	N	N	N	N
Berchtold's Pondweed	*Potamogeton berchtoldii*	N	N	N	N	Y	Y	N	N	N
Robbins Pondweed	*Potamogeton robbinsii*	N	N	N	N	N	N	N	N	Y
Diminutive submersed aquatic plants										
Water Lobelia	*Lobelia dortmanna*	Y	Y	Y		Y	Y	Y	Y	Y
Leafless Milfoil	*Myriophyllum tenellum*	N	N	N	N	Y	Y	N	Y	Y
Waterwort	*Elatine minima*	N	N	N	N	Y	Y	Y	N	Y
Aquatic Moss	*Fontinalis* sp.	Y	Y	Y	Y	Y	N	Y	N	N
Submersed Arrowhead	*Sagittaria graminea*	N	Y	Y	Y	Y	Y	Y	Y	Y
Submersed Bulrush	*Scripus subterminalis*	N	N	N	N	Y	N	N	N	N
Quillwort	*Isoetes* sp.	N	Y	Y	Y	Y	N	N	Y	Y
Muskgrass/stonewort	*Nitella / Chara* spp.	Y	Y	Y	Y	Y	N	N	N	Y
Submersed Spikerush	*Eleocharis acicularis*	Y	Y	Y	N	Y	Y	N	Y	Y
Filamentous Algae	*Spirogira* sp.	N	N	N	N	Y	Y	N	Y	Y
Pipewort	*Eriocaulon septangulare*	N	N	Y	N	N	N	N	N	N
Golden-pert	*Gradiola aurea*	N	Y	Y	Y	N	N	N	N	N
Floating leaved plants found in sheltered coves										
Yellow Waterlily	*Nuphar variegata*	Y	Y	Y	Y	Y	Y	Y	Y	Y
White Waterlily	*Nymphaea odorata*	N	N	N	N	Y	N	N	N	N
Floating Burreed	*Sparganium fluctuans*	N	N	N	N	N	N	N	N	Y
Submersed aquatic plants found in coves										
Bladderwort	*Utricularia radiata*	N	N	N	N	Y	Y	N	N	N
Creeping Buttercup	*Ranunculus repens*	N	N	N	N	Y	N	N	N	N
Water Purslane	*Ludwigia palustris*	N	N	N	N	N	N	Y	N	N

***Endangered Species in CT
Y = Yes, present during the survey
N = No, not observed during the survey

Large-leaf pondweed was noted for the time in 2010 when several beds were noted along the shoreline. This species was probably present around the rocks in the center of the lake but that area was not looked at in the early surveys. Locations where large-leaf pondweed was found in 2014 are shown in Figure 10 as yellow circles. Each circle represents a location were between 1 and several to many plants were found, however no place were many plants were found was larger than about 100 square feet.

Red-leaf pondweed has also shown increases over the years. Some areas showed larger beds—northeastern cove--but most locations shown in Figure 10 were individual plants.

There have also been increases in the amount of tape grass, not shown, along the south western shore, and filamentous algae along most shorelines.

Figure 10 – Locations of pondweeds in West Hill Pond during survey in 2014, yellow circles = large-leaf pondweed, blue squares = red-leaf pondweed

Summary

Water quality data collected in 2014 show that that West Hill Pond generally continues to exhibit oligotrophic conditions with respect to total phosphorus, total nitrogen and water clarity as measured by the Secchi disk.

However, snapshots of increased bottom-water phosphorus in the summer, combined with anoxic conditions, suggest that the internal loading of phosphorus from the sediments was stronger in 2014 than it has been in the past. It is also possible that internal loading has occurred to such an extent in prior years but has remained undetected until this point because the lake remains understudied. Only two visits to the lake are made each year. Complete seasonal information on the lake has yet to be collected so there is no way to compare seasonal fluctuations in nutrients that may contribute to decreased water clarity in the future.

Phosphorus concentrations from spring 2013 were higher than all prior spring data, with average water column phosphorus concentration exceeding 10 ppb. Then again in 2014, heightened spring phosphorus concentrations were recorded at a water column average of 17.3 ppb, well above the hoped-for <10 ppb. Summer photic zone phosphorus was also higher than all prior measurements. <u>We strongly encourage that full seasonal sampling of the lake (monthly between April and November) is conducted annually</u> to better understand the current condition of the lake and whether possible changes are occurring in the nutrient content over time. Without such knowledge, negative trends in lake condition are likely to remain undetected.

The aquatic plant survey records show aquatic plant growth in the lake appears to be increasing. There appears to be increases in the distribution, proliferation, and density of plants in West Hill Pond, as well as in the number of species inhabiting the lake Large-leaf pondweed and red-leaf pondweed have become common and tape-grass is becoming common. Suction harvesting has appeared to now limit most large-leaf pondweed to around the island in the center of the lake. Other species of pondweed have been noted recently as has common water weed. More growths of filamentous algae were noted in the lake in 2013 than were seen in 2012. Specific investigation should be made in the vicinity of the beach at the south end of the lake to determine if aquatic habitats have been lost due to smothering by migrating beach sand.

Storm-water and background stream runoff may be high in nutrients and sediments. Dense aquatic plants grow at the outfalls of the three highest rated inlets, with beds of lower density plants occurring at a number of the other inlets. Water sampling of each of these inflows should be made during both dry and wet weather conditions to determine the nutrient and sediment contributions from these drains. A long-term storm-water/runoff remediation plan needs to be developed.