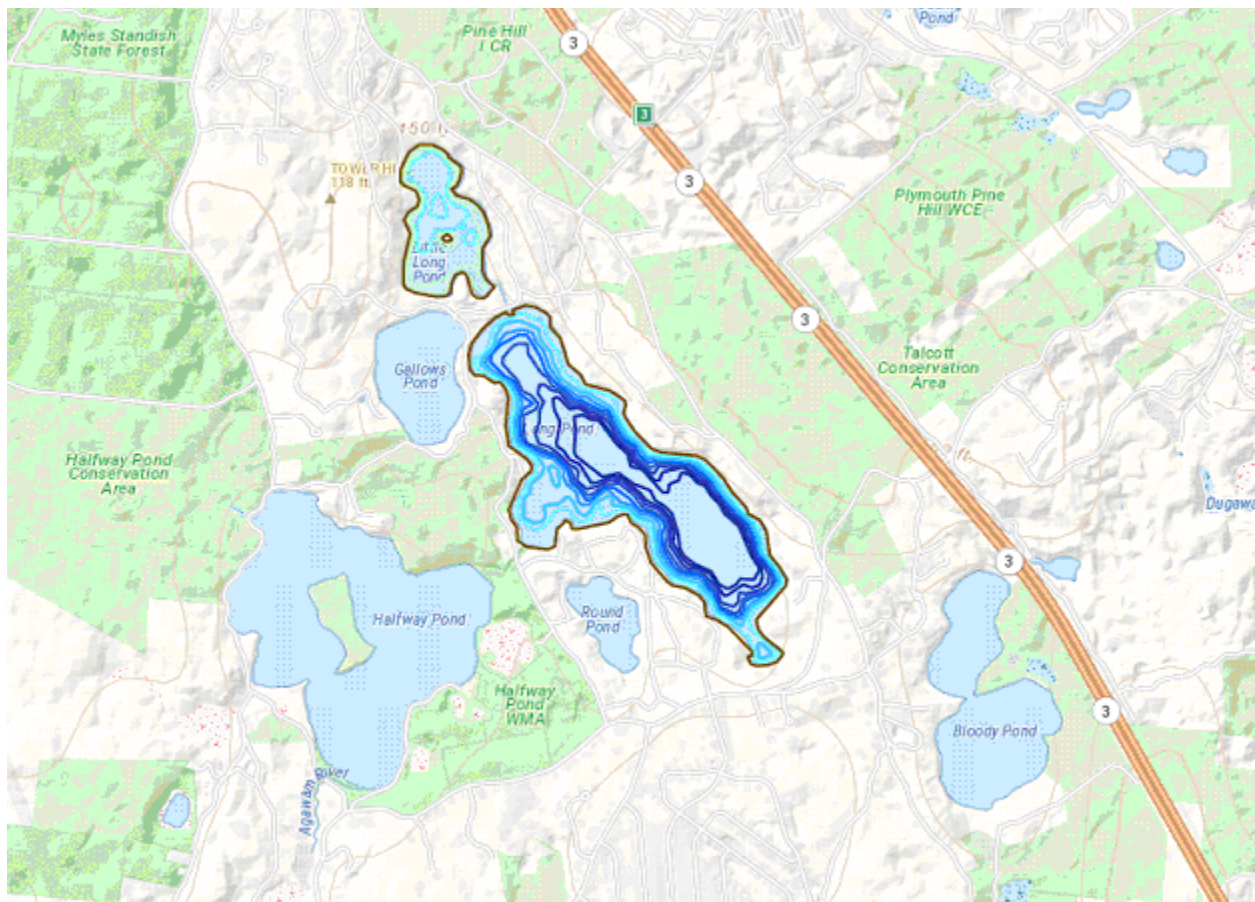


General Description of the Six Ponds of Plymouth

- Bloody Pond
- Gallows Pond
- Halfway Pond
- Little Long Pond
- Long Pond
- Round Pond

The Six Ponds form a diverse set of kettle ponds in south Plymouth. The terrain is part of the Wareham outwash plain formed by the southerly flow of glacial meltwater to the North Atlantic Ocean during the terminal glaciation, approximately 14,000 years ago. The primary constituent of the outwash plain is sand laid down as the glaciers receded to the north. There are larger rocks and the occasional very large erratic. The general topography of southeastern Massachusetts was formed by the melting, outflow, and deposition of silicates as the glacial ice retreated. The rolling terrain is a remnant of the basal ice blocks remaining as the overlying glacier receded. The larger stagnant ice blocks resulted in deeper depressions and today those depressions with bottoms below the water table have produced the kettle ponds.

The map below illustrates the location and dimensions of the Six Ponds.



This map was obtained from the Mass GIS Oliver system. The bathymetry of Halfway, Little Long, and Long Ponds has been entered into Oliver; Bloody, Gallows, and Round Ponds have not had recent bathymetric surveys by the Massachusetts Department of Fisheries and Wildlife (DFW). Additional descriptions of Little Long and Long Ponds are available from <https://docs.digital.mass.gov/dataset/little-long-pond/resource/16f0a997-24bf-4708-abd7-aa612f20375a> and <https://docs.digital.mass.gov/dataset/long-pond-plymouth/resource/f5f6de2a-32da-41de-93d7-a0347b554fd8>.

The information that follows was obtained directly from the Town of Plymouth Pond and Lake Atlas Final Report June, 2015 (https://www.plymouth-ma.gov/sites/plymouthma/files/uploads/final_plymouthpondsandlakesstewardshipatlas_june2015.pdf) The information has been reformatted but otherwise was obtained directly from Appendix B of that document.

Bloody Pond

PPALS Pond Number: 160

MassDEP PALIS Number: 94015

Area (acres): 97

Bathymetry: DFW map

Maximum Depth (m): 11.6

2014 Secchi Depth (m): 8.85

Lake Association: Six Ponds Improvement Association

OVERVIEW

Bloody Pond is located just west of Route 3 and east of Long Pond Road. The pond has two basins. Western shoreline is generally developed with single family residences, while the eastern shoreline is largely undeveloped. Access is via a footpath across town land.

According to MassDFW, Bloody Pond has been stocked with a variety of fish species and has had surveys a number of times (1). Before 1946, it was stocked with rainbow trout, brown trout, salmon, bullheads, white perch, yellow perch and crappie and was stocked in 1985 with northern pike.

Water quality samples were collected from the pond once as part of 1970s-era baseline pond survey, which also include macrophyte and phytoplankton surveys (2). The Six Ponds Improvement Association has sampled various locations in and around the pond 17 times between 2002 and 2013; only one of these sampling runs was within the PPALS sampling period (August 15 – September 30) and DO and temperature data was not available for these samplings. The 2014 PPALS sampling run appears to be one of three sampling runs conducted during the key management months of July through September.

WATER QUALITY

Bloody Pond is relatively deep with some loss of clarity at the time of the 2014 PPALS Snapshot. Temperatures and dissolved oxygen readings show a well-mixed water column with little loss of DO near the sediments; the 1970's era monitoring indicated that the pond was stratified, but no profile information is available to confirm this. Chlorophyll-a and total phosphorus readings show elevated concentrations at depth indicating some sediment nutrient regeneration. The elevated 2014 surface chlorophyll-a concentration raises some concern about nutrient inputs. 1970's-era readings showed very sparse rooted aquatic plant populations. The near-complete separation of the two basins may require separate management and monitoring strategies.

Based on the available information, Bloody Pond is not impaired. This finding is generally based on acceptable DO concentrations near the sediments and TP concentrations below ecoregion thresholds, but there are some concerns based on the high chlorophyll-a concentrations. Some of the Six Ponds monitoring suggests some sediment TP regeneration and higher TP concentrations, but definitive conclusions are constrained by the limited number of summer samplings. Additional monitoring would be required to confirm this assessment and address the readings that suggest areas for concern. Available monitoring is insufficient to resolve the need or extent of management options.

Bloody Pond Sampling Snapshot

PPALS Sampling Date	09/10/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	8.85		
Maximum Depth (m)	11.0		
Surface pH	7.24	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	8.30	5.0	MassDEP
Shallow Temperature (°C)	24.2	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	6.30	1.7	CCC
Surface TP (µg/L)	8.25	10	CCC
Surface TN (mg/L)	0.37	0.31	CCC
TP ratio (deep/shallow)	2.60		

Gallows Pond

PPALS Pond Number: 120

MassDEP PALIS Number: 95059

Area (acres): 50.8

Bathymetry: Living Lakes map

Maximum Depth (m): 10

2014 Secchi Depth (m):

Lake Association: Six Ponds Improvement Association

OVERVIEW

Gallows Pond is located just west of W Long Pond Road and Long Pond. Aside from Long Pond, other ponds around Gallows Pond include: Little Long Pond, Halfway Pond, and Round Pond. The pond is a true kettlehole pond and has no direct surface water connections to any of the surrounding ponds (1). Most of the shoreline is undeveloped with some residential development along the eastern shore and a large Girl Scout Camp along the northern shore.

Water quality samples were collected from the pond once as part of 1970s-era baseline pond survey, which also include macrophyte and phytoplankton surveys (1). Pond was also sampled 10 times between 1988 and 1991 as part of two limestone additions totaling 26 tonnes to try to raise its pH (2); these sampling runs included measurements of nitrogen, metals, and DO and temperature water column profiles, but no phosphorus measurements. The Six Ponds Improvement Association has sampled various locations in and around the pond 17 times between 2002 and 2013; only one of these sampling runs was within the PPALS sampling period (August 15 – September 30) and DO and temperature data was not available for these samplings. The 2014 PPALS sampling run appears to be one of three sampling runs conducted during the key management months of July through September.

WATER QUALITY

Gallows Pond is relatively deep with significant loss of clarity at the time of the 2014 PPALS Snapshot; Secchi readings between 1988 and 1991 (2) and the 1970's-era baseline (1) generally show greater clarity.

Temperatures readings showed no stratification of the water column; the 1970's-era baseline characterizes the pond as "stratified", but temperature profile data is not presented. 2014 water column dissolved oxygen generally was generally above MassDEP minimum and similar throughout the water column except for an elevated reading at 5 m. One of the three August DO readings collected near the sediments between 1988 and 1991 was below the MassDEP minimum (2). 2014 total phosphorus concentrations have an extremely high surface concentration, but this does not match with the chlorophyll-a and TN concentrations; these results cannot be compared to the 1988 and 1991 results, since these water samples appear to have been analyzed with lab methods with detection limits too high for natural waters (2). The 1970's-era plant survey indicated only sparse rooted and emergent plants in the pond.

Based on the preponderance of available information, Gallows Pond does not appear to be impaired, but there are factors that suggest that it may be borderline impaired (e.g., occasional low DO near the sediments and the 2014 DO "bulge" at 5 m). Some of the Six Ponds monitoring suggests some sediment TP regeneration and higher TP concentrations, but definitive conclusions are constrained by the limited number of summer samplings. Additional monitoring would be required to confirm this assessment. Some of the readings suggest areas for concern, but available monitoring is insufficient to resolve the need or extent of management options.

Gallows Pond Sampling Snapshot

PPALS Sampling Date	09/10/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	4.85		
Maximum Depth (m)	10.0		
Surface pH	6.25	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	7.35	5.0	MassDEP
Shallow Temperature (°C)	24.0	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	1.02	1.7	CCC
Surface TP (µg/L)	26.9	10	CCC
Surface TN (mg/L)	0.23	0.31	CCC
TP ratio (deep/shallow)	0.27		

Halfway Pond

PPALS Pond Number: 110

MassDEP PALIS Number: 95178

Area (acres): 229

Bathymetry: DFW map

Maximum Depth (m): 4

2014 Secchi Depth (m):

Lake Association: Six Ponds Improvement Association

OVERVIEW

Halfway Pond is located to the east of Mast Road and just to west of numerous other ponds, including Long Pond, Little Long Pond, Round Pond, and Gallows Pond. It has surface inflow at its northernmost shoreline and surface outflow to the Agawam River at its southernmost shoreline (1). It is located partially within the Wareham River estuary watershed (2). Most of the shoreline is undeveloped with large lots for the existing residential shoreline development and there are four small cranberry bogs nearby.

MassDFW records show that Halfway Pond was stocked with landlocked salmon from Maine in the 1870s and had been stocked with a variety of fish species prior to 1946, including: smallmouth bass, bullheads, white perch, yellow perch, pickerel, crappie and sunfish (3). Fish surveys of the pond were conducted in 1946, 1979, 1987 and 2000. There is public access via an informal access point and small parking lot provided by Wildlands Trust of Southeastern Massachusetts along the northwestern shoreline off Mast Road. According to MassDPH, there has been one closure of the pond for cyanobacteria blooms in 2014.

Water quality samples were collected from the pond once as part of 1970s-era baseline pond survey, which also include macrophyte and phytoplankton surveys (1). The Six Ponds Improvement Association has sampled various locations in and around the pond 21 times between 2002 and 2013; only one of these sampling runs was within the PPALS sampling period (August 15 – September 30) and DO and temperature data was not available for these samplings. The 2014 PPALS sampling run appears to be one of three sampling runs conducted during the key management months of July through September.

WATER QUALITY

Halfway Pond is shallow with restricted clarity at the time of the 2014 PPALS Snapshot; the PPALS Secchi reading is much deeper than the 1970s-era Secchi reading of 0.6 m (1). 2014 temperatures and dissolved oxygen concentrations show a well-mixed water column with no significant sediment oxygen demand. Comparison of shallow and deep total phosphorus and chlorophyll-a concentrations suggest, however, that the sediments were releasing significant nutrients. 2002 summer TP readings from Six Ponds Improvement Association were much higher than recorded during the 2014 Snapshot. The surface concentrations for both of these factors were above ecoregion standards, which suggest sediment releases were being mixed into the water column. The 1970's-era survey noted that most of the pond bottom was covered with dense macrophyte growth, mostly Waterweed (*Elodea sp.*)(1). An extensive plant population would tend to add large quantities of organic material to the sediments, provide dissolved oxygen to the water column during the summer, and out-compete phytoplankton for nutrients. The restricted clarity and high chlorophyll-a concentrations measured in

2014 suggest that the relationship between phytoplankton and macrophytes and the nutrient fluxes within the pond are complex. Further the role of the water budget, including outflow to the Agawam River, would be a factor that would need to be considered in water quality management.

Based on the available information, Halfway Pond is impaired. This impairment is generally based on limited clarity, TP and chlorophyll-a concentrations above ecoregion thresholds, and sediment P generation (high bottom to surface TP ratio). Additional monitoring and synthesis of available information would be required to evaluate and refine the extent of this impairment, the nutrient sources contributing to the pond, and evaluate potential water quality management strategies.

Halfway Pond Sampling Snapshot

PPALS Sampling Date	09/10/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	2		
Maximum Depth (m)	4		
Surface pH	6.80	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	8.4	5.0	MassDEP
Shallow Temperature (°C)	23.2	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	2.61	1.7	CCC
Surface TP (µg/L)	18.55	10	CCC
Surface TN (mg/L)	0.29	0.31	CCC
TP ratio (deep/shallow)	5.28		

Little Long Pond

PPALS Pond Number: 385

MassDEP PALIS Number: 95088

Area (acres): 52.2

Bathymetry: DFW map

Maximum Depth (m): 2.4

2014 Secchi Depth (m): 1.55

Lake Association: Six Ponds Improvement Association

OVERVIEW

Little Long Pond is located just west of Oar and Line Road and just north of Long Pond and Gallows Pond. The pond has surface water outflow to Long Pond (1). The eastern shoreline is completely developed with residential houses on 0.5-0.75 acre lots, while the western shoreline is partially developed. There is a paved state boat ramp that shares a parking lot with a matching boat ramp to Long Pond (2). The boat ramp is located off Clark Road at the southern end of the pond. There are no records of MassDFW management or fish stocking. According to MassDPH, there has been one closure of the pond for cyanobacteria blooms in 2012.

Water quality samples were collected from the pond once as part of a 1970s-era baseline pond assessment (1) and then 16 times as part of 1981 pond assessment (3). Both assessments included macrophyte and phytoplankton surveys. DO, pH, temperature, and specific conductivity profile readings, as well as phytoplankton and macrophyte measurements were collected in July 2008 (4) and October 2008 (5). The Six Ponds Improvement Association has sampled various locations in and around the pond 15 times between 2002 and 2013; only one of these sampling runs was within the PPALS sampling period (August 15 – September 30) and DO and temperature data was not available for these samplings. The 2014 PPALS sampling run appears to be one of three sampling runs conducted during the key management months of July through September.

WATER QUALITY

Little Long Pond is very shallow, but had limited clarity during the 2014 PPALS Snapshot. Secchi readings during the year-long study (3) and July 2008 (4) generally were around the same depth as the Snapshot, although the October 2008 (5) reading was a bit deeper (2.2 m, on the bottom), which would be consistent with cooler temperatures and diminished phytoplankton growth. The July 2002 Six Ponds Improvement Association sampling shows higher TP concentrations than in September 2002; both readings are above ecoregion thresholds. 2014 PPALS total phosphorus, chlorophyll-a, and total nitrogen concentrations are all exceptionally high and TP and TN concentrations are generally consistent with the data reported in the year-long sampling (3).

2014 PPALS dissolved oxygen concentrations are supersaturated with respect to the atmosphere (129% to 161%), which is usually found in ponds with excessive nutrients and large plant populations (both macrophytes and phytoplankton). Similar saturation levels (136% to 138%) were measured in July 2008 (4) and saturation levels were also elevated (112% to 116%) in October 2008 (5).

Plant surveys in Little Long Pond have found extensive rooted plants and phytoplankton populations. The 1981 pond survey found that 95% of the bottom was covered with rooted plants with Waterweed (*Elodea* sp.) as the dominant species (3). The July 2008 observations again noted *Elodea* with the emergent Water-willow (*Decodon* sp.) almost completely around the shoreline (4); these observations were confirmed in October 2008, although the more complete survey did note more extensive diversity of species (5). The two phytoplankton surveys accompanying the 2008 pond visits found Dinobryon (a yellow-green algae) and

Microcystis (a blue-green algae) as the predominant phytoplankton species. Blue-green algae are typically only a dominant species in pond settings with excessive nutrients.

Based on the available information, Little Long Pond is impaired based largely on the high nutrient levels, supersaturated dissolved oxygen concentrations, and extensive plant populations. Additional monitoring and synthesis of available information would be required to evaluate and refine the extent of this impairment, the nutrient sources contributing to the pond, and evaluate potential water quality management strategies. An additional factor to strongly evaluate in water and nutrient budget development and assessment is the outflow and potential nutrient impacts on Long Pond.

Little Long Pond Sampling Snapshot

PPALS Sampling Date	08/19/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	1.55		
Maximum Depth (m)	2.1		
Surface pH	6.97	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	12.4	5.0	MassDEP
Shallow Temperature (°C)	23.2	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	4.64	1.7	CCC
Surface TP (µg/L)	18.96	10	CCC
Surface TN (mg/L)	0.53	0.31	CCC
TP ratio (deep/shallow)	1.4		

Long Pond

PPALS Pond Number: 195

MassDEP PALIS Number: 95096

Area (acres): 221

Bathymetry: DFW map

Maximum Depth (m): 31.1

2014 Secchi Depth (m): 2.5

Lake Association: Six Ponds Improvement Association

OVERVIEW

Long Pond is located west of Long Pond Road and east of West Long Pond Road. It is also just south of Little Long Pond and nearby Gallows Pond, Round Pond, and Halfway Pond. The pond receives surface water inflow from Little Long Pond (1) and has an outlet pipe that connects it to Halfway Pond (2). There is a paved state boat ramp that shares a parking lot with a matching boat ramp to Little Long Pond (3). Most of the pond shoreline has residential development with fairly large lots (>1 acre).

Long Pond is the deepest pond in Plymouth and because of this depth, MassDFW has focused fisheries management on trout and salmon stocking. Prior to 1948, however, fisheries management included stocking a diverse number of fish species, including brook, brown and rainbow trout, chinook salmon, landlocked salmon, sockeye salmon, smallmouth bass, bullheads, white perch, chain pickerel, walleye, rainbow smelt and alewives (3). The pond is now annually stocked with brook trout, brown trout, rainbow trout, and Atlantic Salmon.

Water quality samples were collected from the pond once as part of a 1970s-era baseline pond assessment (1) and then 16 times as part of 1981 pond assessment (4). Both assessments included macrophyte and phytoplankton surveys. The Six Ponds Improvement Association has sampled various locations in and around the pond 22 times between 2002 and 2013; two of these sampling runs were within the PPALS sampling period (August 15 – September 30). DO, pH, temperature, and specific conductivity profile readings, as well as phytoplankton and macrophyte measurements were collected in July 2008 (5) and October 2008 (2).

WATER QUALITY

Long Pond is deep and had very limited clarity in all runs where Secchi readings were collected, although more recent summer readings are ~2 m less than those collected for the 1981 assessment (4). The available temperature profiles [Aug 2014 (PPALS); July 2008 (5) & October 2008 (2)] all show stratification around 8-10 m depth with deep temperatures meeting the MassDEP cold water fishery criterion ($\leq 20^{\circ}\text{C}$). The accompanying dissolved oxygen profiles all show DO concentrations below the MassDEP regulatory minimum at depths of 14-16 m and deeper. In addition, the two summer DO profiles both have supersaturated conditions in the upper layer with maximum concentrations near the top of cold water layer. This pattern suggests that phytoplankton are concentrating here to utilize high nutrient releases from the cold layer. All DO profiles have anoxic concentrations (<1 mg/L) in the deepest waters with the October 2008 profile having anoxic conditions extending 13 m from the sediments (2). Comparison of surface and deep TP and TN PPALS readings showed increased deep concentrations consistent with sediment nutrient regeneration. Chlorophyll-a concentration show a

maximum at 9 m depth, which would be near the DO supersaturation depth and consistent with an active phytoplankton community growing on regenerated TP in the cold layer. The rooted plant survey conducted for the 1981 assessment noted no submerged plants and very sparse emergent plants (4). The July 2008 survey noted emergent rooted plants ringing most of the pond with limited submerged species “growing between cobble substrates” (5). This assessment was confirmed in the October 2008 survey (2). The July 2008

phytoplankton tow (5) found a diverse population of 27 noted species dominated by green algae (Gloeocystis and Staurastrum) and blue-green algae (Microcystis). The October 2008 tow showed a shift in the population with blue-green algae (Aphanocapsa) as the dominant species. Blue-green algae dominance is generally associated with high nutrient availability, while green algae tend to dominate in moderate nutrient settings.

Based on the available information, Long Pond is impaired. This impairment is generally based on consistently limited clarity, summer dissolved oxygen hypoxia and anoxia in the deep cold water layer, supersaturation dissolved oxygen conditions at the warm water/cold water boundary, and high nutrient and chlorophyll concentrations. Additional monitoring during summer conditions would help clarify, evaluate and refine the extent of the impairment, the nutrient sources contributing to the high phosphorus levels, and evaluate potential water quality management strategies.

Long Pond Sampling Snapshot

PPALS Sampling Date	08/19/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	2.5		
Maximum Depth (m)	28.2		
Surface pH	8.43	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	6.73	5.0	MassDEP
Shallow Temperature (°C)	24.5	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	2.13	1.7	CCC
Surface TP (µg/L)	12.99	10	CCC
Surface TN (mg/L)	0.55	0.31	CCC
TP ratio (deep/shallow)	4.4		

Round Pond

PPALS Pond Number: 231

MassDEP PALIS Number: 95123

Area (acres): 22.0

Bathymetry: 1992 Living Lakes Report
map

Maximum Depth (m): 6.1

2014 Secchi Depth (m):

Lake Association: Six Ponds Improvement Association

OVERVIEW

Round Pond is located east of West Long Pond Road and south of Cornish Field Road. It is also just west of Long Pond and east of Halfway Pond. The pond is a true kettlehole pond and has no surface water inflow or outflow (1). Development around the pond is mostly residential with parcels ≥ 1 acre, although there is a large camp parcel along the eastern shoreline. There is no formal access. There are no records of MassDFW management or fish stocking.

Water quality samples were collected from the pond once as part of a 1970s-era baseline pond assessment (1) and then 10 times between 1987 and 1991 as part of a pH assessment (2). The Six Ponds Improvement Association has sampled various locations in and around the pond 17 times between 2002 and 2013; one of these sampling runs was within the PPALS sampling period (August 15 – September 30). The 1970s-era baseline included macrophyte and phytoplankton surveys, which have not been repeated. The 1992 pH assessment focused on the impact of two additions of a combined 9.5 tonnes of limestone to the pond to raise its pH; sample analysis included nutrients and metals. Association sampling included a wide suite of compounds in the earlier samples and has narrowed mostly to nutrients in the more recent samples.

WATER QUALITY

Round Pond is shallow and had very changeable clarity when Secchi readings were collected, varying over a range of 3.3 to 6.5 (PPALS, refs 1 & 2). The available temperature profiles (PPALS, ref 2) show a generally well-mixed water column with similar temperatures from surface to bottom. The dissolved oxygen profile is generally similar to the temperature profile, except the PPALS profile had anoxic conditions at the deepest recording. Comparison of surface and deep total phosphorus PPALS readings showed increased deep concentrations consistent with sediment nutrient regeneration, but since total nitrogen concentrations were similar at shallow and deep samples, this suggests that the low DO/sediment TP regeneration is somewhat transitory. Chlorophyll-a concentration showed a maximum in the surface sample, which seems to suggest a watershed, rather than sediment, nutrient source. It is also possible that Round Pond was on the edge of an algal bloom when PPALS samples were collected. The plant survey conducted for the 1970s-era baseline pond assessment noted sparse macrophytes with limited submerged, emergent, and floating plants (1).

Based on the available information, Round Pond is borderline impaired based mostly on the high surface water chlorophyll-a concentration and deep anoxic dissolved oxygen measurement. This characterization is generally based on consistently limited clarity, summer dissolved oxygen hypoxia and anoxia in the deep cold water layer, supersaturation dissolved oxygen conditions at the warm water/cold water boundary, and high nutrient and chlorophyll concentrations. Additional monitoring during summer conditions would help clarify, evaluate and refine the extent of the impairment, the nutrient sources contributing to the high phosphorus levels, and evaluate potential water quality management strategies.

phosphorus levels, and evaluate potential water quality management strategies.

Round Pond Sampling Snapshot

PPALS Sampling Date	09/10/2014		
Parameter	Pond	Standard/Limit	Standard Source
Secchi Depth (m)	3.65		
Maximum Depth (m)	8.0		
Surface pH	6.19	6.5 – 8.3	MassDEP
Deepest DO (mg/L)	0.37	5.0	MassDEP
Shallow Temperature (°C)	24.6	28.3	MassDEP
Surface Chlorophyll-a (µg/L)	7.32	1.7	CCC
Surface TP (µg/L)	5.57	10	CCC
Surface TN (mg/L)	0..18	0.31	CCC
TP ratio (deep/shallow)	1.85		