Memorandum

Date: January 24, 2011

To: Board of Health
Board of Selectmen
Conservation Commission
Dudley Area Advisory Committee
Dudley Pond Association

From: Surface Water Quality Committee

Subject: East Dudley Pond Watershed Septic System Study Report

This report summarizes a study of phosphorus discharges associated with septic systems located on properties abutting the eastern shore of Dudley Pond. The objective of this study was to begin the process of minimizing the negative impact of septic systems on the water quality of Dudley Pond. This memo contains a summary, recommendations, background information, study methods, results and a discussion of the results as well as an appendix containing data gathered during the study.

Summary

- Dudley Pond is a Massachusetts Category 5 (worst) impaired water body, contains excessive concentrations of weed fertilizing nutrients (phosphorus) and costs the Town of Wayland (TOW) and the Dudley Pond Association (DPA) many thousands of dollars annually for weed maintenance to keep the Pond usable for recreation, free of fish kills and noxious odors.

- Phosphorus, associated primarily with surface water runoff and ground water is generally accepted as the limiting nutrient for weed growth in fresh waters.

- The major sources of phosphorus entering the Pond are thought to be primarily from septic systems and secondarily from surface water runoff.

- All of Wayland is serviced by septic systems, 106 of which are located on small lots abutting Dudley Pond and are very close to the Pond.

- The ground water elevation on the east side of the Pond is higher than the Pond water elevation, therefore any effluents from septic tanks on the east side of the Pond that intersect the ground water table most likely flow into the Pond.

- The findings from this study are:
    - 50 septic systems are located on the east side of Dudley Pond, with ages ranging from one to sixty seven years old, with an average age of 24 years for the systems where BOH records exist. It is generally accepted that septic systems have finite life of 20 – 30 years.
    - The types, age and location of 15 of these septic systems are unknown because no drawings exist in the TOW Board of Health (BOH) files.

- 103 +/- (college students away) residents live in houses abutting the Pond and are served by septic systems in the east Dudley Pond watershed, the effluents of which collectively contain approximately 155 pounds per year of phosphorus.
- 8 of these septic systems have had a Massachusetts Title 5 inspection.
- Annual water usage of these 50 properties ranges from 50 – 14,900 cubic feet per year (374 – 111,452 gallons per year) with the average household usage 5,400 cubic feet per year (40,600 gallons per year) and the average per-capita usage of approximately 54 gallons per person per day.
- Because of the small lot size and high ground water elevation in this area many of the septic systems are located close to Dudley Pond and the elevations of the septic system leach areas are close to the elevation of the ground water, which increases the probability of contaminating ground water and subsequently the Pond.
- The soils in the Dudley Pond east watershed are predominantly sandy, are very permeable and do not readily adsorb and retain phosphorus compounds.
- Of the 50 septic systems 7 systems do not have records of being pumped at all. The average time elapsed since the last pumping for the systems that had records was 4 years. There are 2 "tight" tanks amongst the 50 septic systems, both of these properties appear to have used significantly more water than their tanks can hold.
- One septic system connected to a rental property with three inhabitants failed during the summer of 2010. The TOW BOH is pursuing the situation.

Recommendations

The following are recommendations resulting from the study:

1. As stated in Wayland's Master Plan, "To address this concern [Dudley Pond] a more proactive approach toward minimizing septic system problems on private lots is recommended".

2. This study should be reviewed with the TOW BoH, DPA, Conservation Commission, Planning Board, and the Board of Selectmen (BoS).

3. For the properties where no septic system drawings and/or where pumping records are old or do not exist (15 – 20 systems) it is recommended that the BOH require that a Title 5 equivalent inspection be completed as soon as possible and a Title 5 equivalent inspection timetable be established for the balance of the systems.

4. Further Surface Water Quality Committee (SWQC) reviews need to be undertaken for septic systems with high scores resulting from this study and for systems where information such as plot plans, construction dates, pumping records are missing from BOH files.

5. Inconsistencies between water use records and tight tank pumping records need to be resolved by BOH/SWQC.

6. It is recommended that the TOW adopt a by-law that requires septic systems within the Dudley Pond watershed to be pumped at a minimum of every 3 years.

7. The SWQC should work with the BOH to obtain funding from Massachusetts Water Pollution Abatement Trust for septic system tracking software and to pay municipal employees to gather and track septic system data. For more information on this visit: http://www.wickedlocal.com/mendon/news/x1799252093/Mendon-may-join-septic-system-loan-program

8. The SWQC should continue to seek grants to in order to complete a federal and state-mandated Total Maximum Daily Load (TMDL) for phosphorus study, the objective of which is to determine the maximum amount of phosphorus that can be discharged to Dudley Pond under the State's water quality standards and develop a plan to meet that goal. Such a TMDL would be required to form a rational basis for TOW Dudley Pond watershed by-laws.

9. A public education program regarding nutrient management should be continued in the Dudley Pond watershed, with the highest priority being the eastern part of the Dudley Pond watershed.

10. An additional study of septic systems, ground water elevations and ground water/soil phosphorus concentrations should be undertaken on the properties between Dudley Pond and Route 27 by the SWQC. This study may be later extended to the entire Dudley Pond watershed, the Lake Cochituate and Sudbury River watersheds in Wayland, and the Heard Pond watershed.

11. The SWQC should prepare draft by-laws for Dudley Pond and other Wayland watersheds, modeled after other Massachusetts communities' nutrient management by-laws, for consideration by the Board of Health, Conservation Commission, Planning Board, Board of Selectmen, and interested watershed associations.

12. The TOW should commission a study of the following alternatives:
    a) A sewer system and community advanced (nutrient removal) treatment system for the properties in the east Dudley Pond watershed, at a location to be determined.
    b) A sewer system for the east Dudley Pond watershed that connects with the MWRA pump station located at the intersection of the Mass Pike and Route 27.

Background

This study was undertaken by the Wayland Surface Water Quality Committee (SWQC) because:

- The State of Massachusetts has designated Dudley Pond is a Category 5 impaired water body due to organic enrichment, low dissolved oxygen, turbidity and exotic species (Eurasian Milfoil). Range of categories 1 – 5, with 5 being the worst - Table 1 below.

- The high nutrient concentrations in Dudley Pond are the 'root cause' of excessive growth of aquatic weeds and algae. The Town of Wayland (TOW) and the Dudley Pond Association (DPA) have spent significant amounts of money for weed management in Dudley Pond over the past 30 years.

- The aquatic weed that is the major symptom of the problem in Dudley Pond is Eurasian Milfoil. Fortunately, to date, there has not been a documented blue-green algae bloom in Dudley Pond,

despite the fact that there was a blue-green algae bloom “epidemic” in the northeast during the summer of 2009. The reasons for the epidemic are not known.

Massachusetts Category 5 Waters
"Waters requiring a TMDL"

NAME	SEGMENT ID	DESCRIPTION	SIZE	POLLUTANT NEEDING TMDL [EPA APPROVAL DATE-DOCUMENT CONTROL NUMBER]
Lake Cochituate (82126)	MA82126_2008	[Carling Basin] Natick	14.3 acres	-Priority organics -(Exotic species*)
Lake Cochituate (82127)	MA82127_2008	[South Basin] Natick	240 acres	-Priority organics -Organic enrichment/Low DO -(Exotic species*)
Concord River (8246500)	MA82A-07_2008	From the confluence of the Assabet and Sudbury rivers, Concord to the Billerica Water Supply intake, Billerica.	10.4 miles	-Metals -Nutrients -Pathogens -(Exotic species*)
Concord River (8246500)	MA82A-08_2008	From the Billerica Water Supply intake, Billerica to Rogers Street bridge, Lowell.	5.1 miles	-Metals -Nutrients -(Exotic species*)
Concord River (8246500)	MA82A-09_2008	From the Rogers Street bridge, Lowell to the confluence with the Merrimack River, Lowell.	0.90 miles	-Metals -Nutrients -Pathogens -Noxious aquatic plants -(Objectionable deposits*)
Dudley Pond (82029)	MA82029_2008	Wayland	83.2 acres	-Organic enrichment/Low DO -Turbidity -(Exotic species*)
Eames Brook (8248125)	MA82A-13_2008	From the outlet of Farm Pond, Framingham to the confluence with the Sudbury River, Framingham.	0.57 miles	-Cause Unknown -Taste, odor and color -Noxious aquatic plants -(Exotic species*) -(Objectionable deposits*)
Elizabeth Brook (8247150)	MA82B-12_2008	From the outlet of an unnamed pond (Delaney Project on Stow/Harvard border) west of Harvard Road, Stow to the inlet of Fletchers Pond, Stow.	3.7 miles	-Cause Unknown
Farm Pond (82035)	MA82035_2008	Framingham	140 acres	-Noxious aquatic plants -Turbidity -(Exotic species*)
Fort Meadow Reservoir (82042)	MA82042_2008	Marlborough/Hudson	248 acres	-Pesticides -Nutrients -(Exotic species*)
Framingham Reservoir #1 (82044)	MA82044_2008	Framingham	118 acres	-Metals -(Exotic species*)
Framingham Reservoir #2 (82045)	MA82045_2008	Framingham/Ashland	114 acres	-Metals -Turbidity
Grist Mill Pond (82055)	MA82055_2008	Sudbury/Marlborough	16.7 acres	-Nutrients -Organic enrichment/Low DO -Pathogens -Noxious aquatic plants -(Exotic species*)

Table 1 – Massachusetts Partial Category 5 List

- It is generally accepted that any aquatic weed/algae management program should be comprised of two parts:
  1) Managing weeds and algae (symptoms of the problem) on a year to year basis, and
  2) A long range program to minimize the amount of weed nutrients entering the pond.

- Previous studies [(1)] of Dudley Pond have indicated that ground water flows into Dudley Pond on the east side of the Pond and out of the Pond on the west side of the Pond.

- With the exception of two properties all (106) residential properties abutting the Pond dispose of sanitary sewage via either septic systems or cesspools, which can, under ideal circumstances, remove the nutrients contained in the leachate.

- Based on past Dudley Pond studies, SWQC has data that allows estimates of the phosphorus load on Dudley Pond from rain water runoff: 2007 Watershed Nutrient Load Sampling and Assessment (Geosyntec)

- This study is the first step in an attempt to understand and quantify the possible Dudley Pond phosphorus load coming from septic systems in important portions of the Dudley Pond watershed.

- During 2009 the SWQC submitted a grant application to the State for funding to complete a FY 2010 phosphorus total maximum daily load (TMDL) study, which was not funded. The objectives of a TMDL would be to identify and quantify the sources of phosphorus entering Dudley Pond, the maximum phosphorus load that the Pond can tolerate and make recommendations as to how to minimize the sources. The 1983 IEP Dudley Pond report was a TMDL for that point in time and indicated that surface water runoff was the largest source of phosphorus compounds entering Dudley Pond. The 1983 IEP report recommended changes in paving and catch basins around the Pond, some of which were completed and are thought to have reduced runoff sources of phosphorus. The objective of the 2009 SWQC TMDL grant application was to update the 1983 IEP study and also provide a scientific/legal basis for TOW watershed by-laws. The grant application can be found by visiting 2010 MA DEP 604b Grant Application - Dudley Pond TMDL. SWQC has updated and resubmitted the application in for FY2011.

- Select Massachusetts communities with similar problems have enacted watershed by-laws to minimize nutrients from surface water runoff and septic systems; however, the SWQC is unable to recommend a Dudley Pond watershed nutrient minimization by-law to the TOW Conservation Commission until we understand the how much phosphorus Dudley Pond can tolerate, how much phosphorus is stored in the Pond sediments and how much phosphorus is entering the Pond annually from surface water runoff and ground water (septic systems). A TMDL study will provide much of this information.

Study Methods

a) Property drawings from the TOW surveyor's office were reviewed to obtain street addresses of the properties abutting the east shore of Dudley Pond (Figure 1 below).
b) Wayland Board of Health (BOH) septic system files were reviewed to gather property owner names, septic system type, date of construction, existence of a Title 5 file, septic system plot plans and elevations, ground water elevations, bottom of leach field elevations, soil percolation

rates, distance of the leach field to Dudley Pond, the most recent date the septic tank was pumped and the date that the septic system data was gathered from the BOH files.

c) The Wayland Department of Public Works supplied water usage records for the addresses of the properties abutting the east shore of Dudley Pond. Annual average water use was calculated based on the two most recent years of usage.

d) The Wayland Town Clerk's office provided voter listing data for the properties abutting the east shore of Dudley Pond.

e) Since the TOW was not allowed to disclose the number of people that are eighteen years old or less inhabiting the subject properties, a summary of the raw data collected was distributed to Dudley Pond abutters to verify the number of people living in each of the houses on the properties abutting the eastern shore of Dudley Pond.

f) Based on the number of people living in the houses abutting the eastern shore of Dudley Pond the yearly load of sewage borne phosphorus was estimated based on data from Ohio State University, the US EPA and the United Nations. A septic system score was calculated based on the formula below.

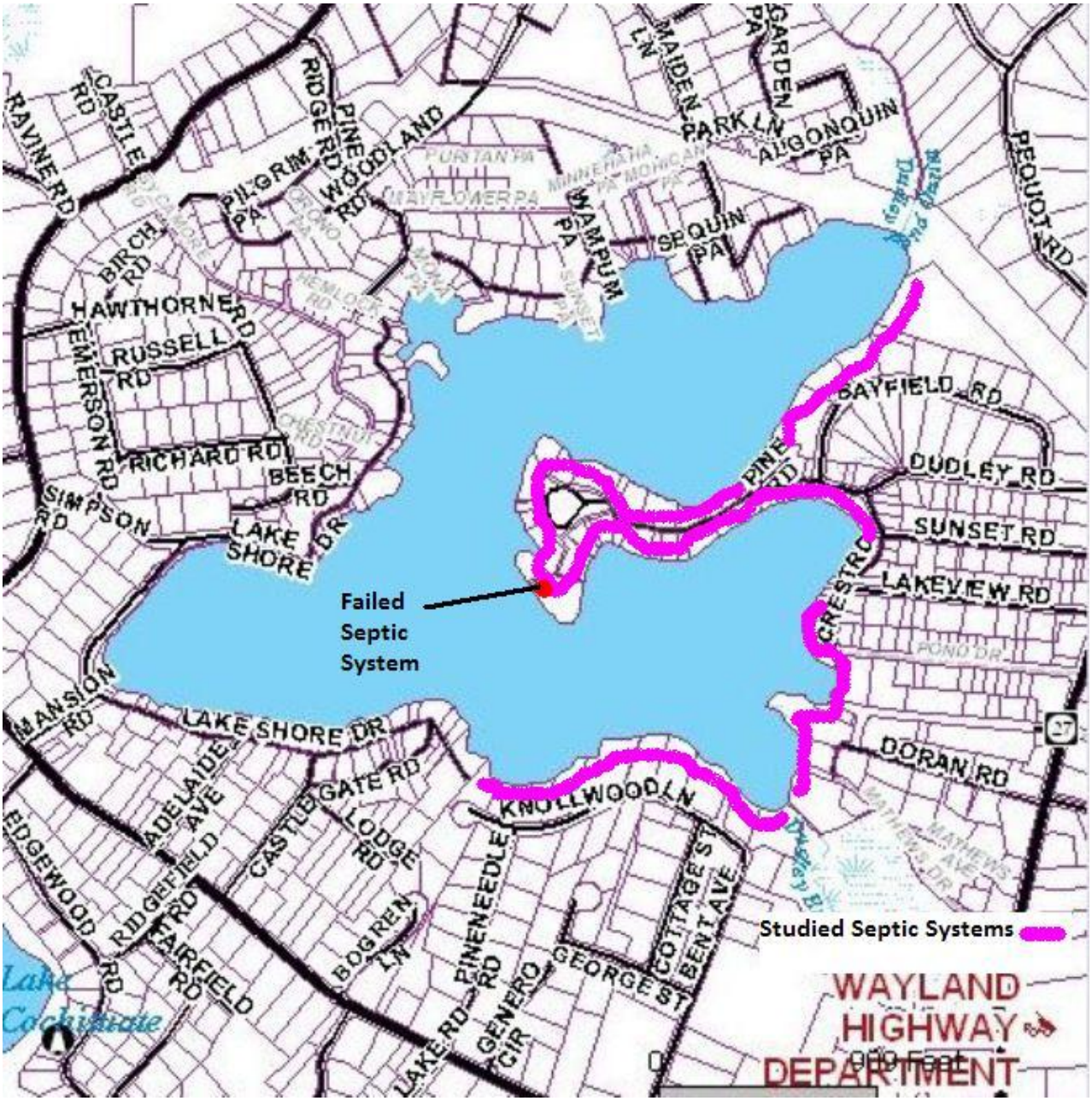

Figure 1 – Locations of Septic Systems Studied

A weighted 'interest scoring' model based of these factors was used to prioritize systems which need further attention.

FACTORS CONSIDERED:

a) Number of persons in the dwelling
b) Cubic Feet of water billed per year
c) Type of septic handling system
d) Construction date of septic system
e) Existence of a Title-V inspection on file with the BoH
f) Existence of a drawing/plan locating and describing the system on file with the BoH
g) Vertical separation between the leaching system and groundwater
h) Percolation rate
i) Distance from the leaching system to the pond
j) Last pump-out date

Each factor was ranked on a 0-10 scale (a higher rank represented a higher likelihood of a nutrient contribution. Some properties had no available file. In others there was missing data. Some groundwater elevations were estimated. Where the leaching system depth was unknown, it was assumed to be at half the distance to groundwater not exceeding 10'. Missing data was scored pessimistically.

Next, each factor was assigned a weight based on how important it was considered to be. For example: The score for the number of persons in the house was more heavily weighted than whether or not there was a drawing.

All factors x their weightings were totaled by parcel; smaller scores represent potentially a smaller source of pollution.

RATIONALES:

- A high water use flushes more phosphorus into the Pond and is therefore a direct function of the potential to pollute.
- An old system has a greater potential to pollute than a new system and is therefore the age of the system is a direct function of the potential to pollute.
- A system that has not been pumped recently has a greater potential to pollute than a system that had recently been pumped and therefore the number of years since the last pumping is a direct function of the potential to pollute.
- A system where the elevation of the bottom of the leach field is close to the elevation of the groundwater has a greater potential to pollute and therefore an inverse function of the potential to pollute.
- A low percolation rate (minutes/inch) is an indication of a soil that has high permeability (granular soil e.g. sand) and therefore fewer sites on which pollutants can adsorb, hence less chance that pollutants will be removed from the sewage and therefore an inverse function of the potential to pollute.

- The potential impact of a septic system that is located a short distance from the Pond is greater than a septic system that is a long distance from the Pond and is therefore distance from the pond is an inverse function of the potential contribute phosphorus to the Pond.

The weighted score is an arbitrary numbers, but provides a way to compare the relative pollution potential of the septic systems on the properties abutting the east shore of Dudley Pond. Septic systems with a high score provide a way to prioritize septic systems that need further review as potential sources of Dudley Pond phosphorus contamination. A low score indicates that the septic system is less likely to be a potential source of phosphorus pollution for Dudley Pond.

Results

The data gathered during this study appears in the appendix of this report and this data is summarized in the section.

- **Number of Septic Systems** – 50 septic systems are on properties that abut the east shore of Dudley Pond, 16 of which did not have any drawings in the BOH file, which prevented a preliminary evaluation of these systems.

- **Numbers of People** – 103 people use the septic systems on properties abutting the east shore of Dudley Pond. The number of people that use individual septic systems ranges from 1– 5.

- **Water Usage** - Average water usage for the past two years for these 50 properties ranged from 50 to 14,900 cubic feet per year (374 to 111,452 gallons per year) , with an average household use of approximately 5,400 cubic feet per year per property (40,600 gallons per year). The average per capita usage is approximately 2,600 cubic feet per person per year or 54 gallons per person per day.

- **System Types -** The following are the numbers and types of septic systems found on the properties abutting the east shore of Dudley Pond.

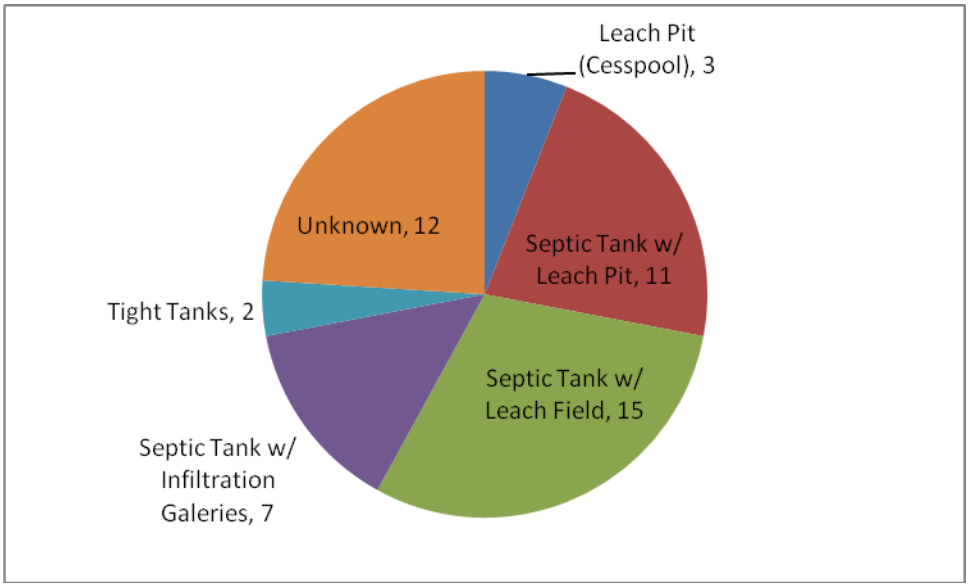

Figure 2 - Types of Dudley Pond Septic Systems

- **Septic System Age -** The ages of septic systems on properties abutting the east shore of Dudley Pond appear in Figure 3 below.

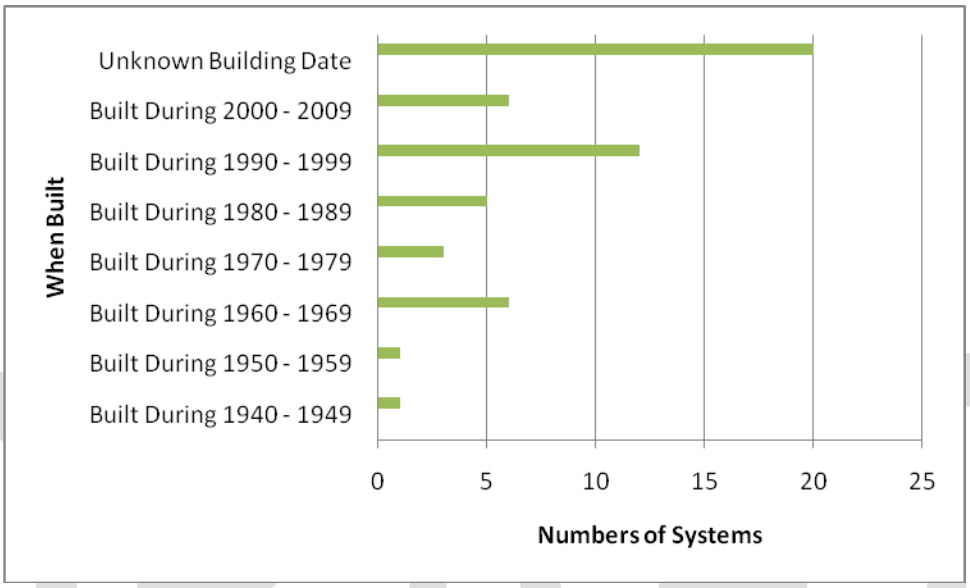

Figure 3 - Ages of Dudley Pond Septic Systems

- **Title V –** Seven of the 50 septic systems studied have had a Massachusetts Title 5 inspection.

- **Proximity to Ground Water** – The greatest separation between the bottom of the leach area and ground water was located on Dudley Rd. with 48 feet of separation between of the elevation of the bottom of the leach area and the ground water table. The least separation was 0.5 feet located on Crest Rd. It should be understood that ground water was not found in test holes of approximately twelve feet and as a result the ground water elevation is not known for most properties on Knollwood Lane and Dudley Rd. Where the depth to ground water is not known, it was assumed that the ground water elevation was the same elevation as the water level in Dudley Pond, which depending on the season is approximately 150 feet. Additionally it should be recognized that the elevation of Dudley Pond varies approximately one foot, depending on the season and rainfall.

  Septic systems located on Mathews, Cross, Pond, Crest, Lakeview and Bayfield, where the grade elevation is close to the ground water elevation, have a limited difference in elevation between the bottom of the leach areas and ground water. There were ten properties on Mathews, Cross, Pond, Crest, Lakeview, Dudley and Bayfield Rd where the ground water has been measured at elevations greater than 150 feet, which supports the information found in the 1983 IEP Report that claims the groundwater elevation is higher than the Dudley Pond water level on the east side of the Pond and therefore ground water flows into the Pond.

- **Percolation Rates** – Most of the measured percolation rates found in the BOH files were 2 minutes/inch. Many files had percolation rates assumed to be 2 min/in or less. Of all the

measured percolation rates there was one measured at 0.2 min/in, one at 0.3 min/in and one at 10 min/in. Where no percolation rate information was available, for septic system scoring purposes, it was assumed that the percolation rate was 2 min/in, which is consistent with the soil types on the east side of Dudley Pond area.

- **Distance from the Pond** – The closer a septic system is to Dudley Pond, the greater the chance for pollution. Of the 50 septic systems reviewed only 34 had plans and elevation drawings on file with the BOH indicating the distance from the Pond. The average distance of the septic systems from the Pond is 97 feet, the minimum distance is 10 feet and the maximum is 270 feet. The property with 270 feet from the septic system to the Pond is on Pond Dr. and the septic tank is located across the street on TOW property.

- **Year Pumped Last** – Of the 50 septic systems reviewed 6 properties did not have pumping records in the BOH files. The average interval between pumping, where records were available, was 3.9 years. The longest interval since the last pumping was 24 years and the shortest interval between pumping was less than a year. Dates of most recent pumping are shown in Figure 5 below.

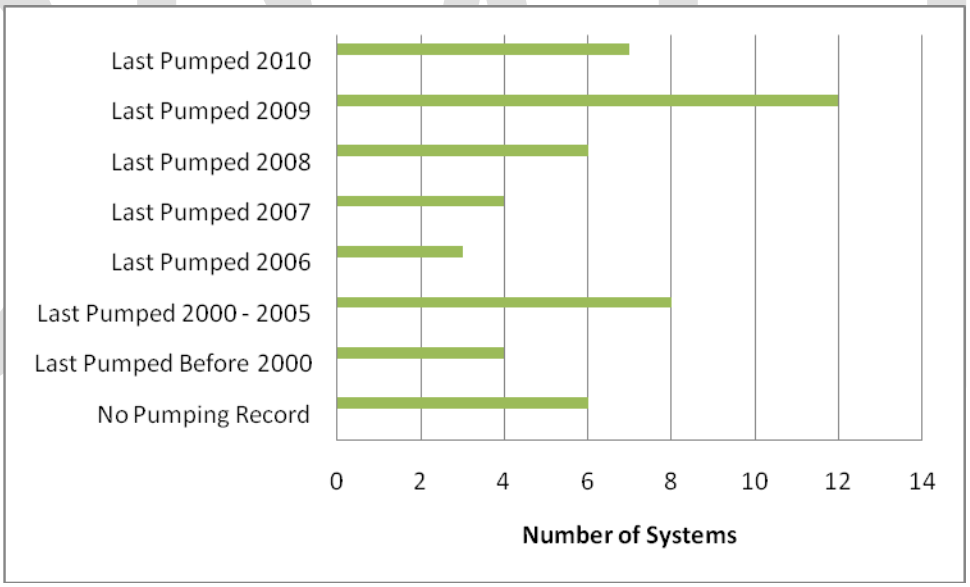

Figure 5 - Most Recent Pumping

- **Pounds of Phosphorus Discharged** – According to the US EPA, Ohio State University and The United Nations:
  http://www.epa.gov/nrmrl/pubs/625r00008/625r00008.pdf
  http://ohioline.osu.edu/b854/b854_1.html
  http://www.fao.org/docrep/t0551e/t0551e03.htm

  The phosphorus content of domestic sewage is approximately 1.5 pounds of phosphorus per year per person. With 103 people using septic systems on the east side of Dudley Pond this means that approximately 155 pounds of phosphorus compounds are discharged into the soil from septic systems abutting the east side of Dudley Pond every year, with the average of 3.16 pounds of phosphorus per septic system discharged each year. The maximum was estimated to be 7.5 pounds of phosphorus per system per year and the minimum was 0 pounds of

phosphorus per septic system per year.

- **What does this mean?** Based on SWQC's 2007 milfoil harvesting costs and a Cornell study [(1)], the phosphorus contained in one person's untreated sewage per year all reached Dudley Pond it would result in approximately 1,900 wet pounds of milfoil and costs the town $267 per year in weed harvesting costs.

- **Septic System Scores** – An arbitrary, unit-less septic system score was calculated for the systems, where the data was available to do so. There was adequate data to score 24 of the 50 septic systems. The scores ranged from 0.06 to 457,634. A low score is good and a high score indicates that the system should be reviewed as do the systems that did not have enough data to be scored.

- **Tight Tanks** – There are two "tight" tanks among the 50 septic systems reviewed. A tight tank is a collection tank that holds the sewage and has to be periodically pumped to remove accumulated sewage. One of these tanks has a volume of 5,000 gallons and the other 4,400 gallons. These two properties used significantly more water between pumping than the tight tanks can hold, which raises the questions, such as
  1) Where did the water go?
  2) Are the tight tanks leaking?

- **Failed System** – The septic system on the Dudley Pond peninsula is located on the adjacent property and has failed. The failure of this system is called a "break out", which involves septage leaking out onto the surface of the ground. The BOH is aware of this situation, which is complicated because the property is a rental property with three inhabitants and is in foreclosure.

Discussion

This section contains a discussion of the results summarized in the previous section.

- **Number of Systems –** 16 of the 50 systems evaluated did not have drawings in the BOH file, which prevented a preliminary SWQC evaluation of these systems. These 16 systems should be required to have a Title 5 inspection to insure that they comply and are not contributing to the nutrient problem in Dudley Pond.

- **Numbers of People** – During this study it was learned that approximately 103 people are contributing sewage containing nutrients to the soil and possibly to the ground water which is flowing into Dudley Pond. This number of people varies during the year primarily because of college attendance.

- **Water Usage** – It is believed that most of the water purchased from the TOW for the properties abutting the east shore of Dudley Pond is used for domestic purposes and seasonal landscape watering. Water use data is gathered approximately twice a year by the TOW DPW and

[1] Effect of Milfoil (*Myriophyllum Spicatum* L.) on Phosphorus Movement Between Sediment and Water,

John H. Peverly and John Brittain, Department of Agronomy, Cornell University, Ithaca, New York

landscape watering is reflected in water usage during the growing seasons. With an average water use per property of 5,400 cubic feet, the properties with much greater water usage than the average are most likely using a significant amount of water for landscape watering. The average water usage on a per person basis is 54 gallons per person per day, which is lower than the USEPA's average per household of 69.3 gallons per capita per day, as shown in Table 2 below.

Fixture/use	Gal/use: Average range	Uses/person/day: Average range	Gal/person/ day: Average range[c]	% Total: Average range
Toilet	3.5 2.9–3.9	5.05 4.5–5.6	18.5 15.7–22.9	26.7 22.6–30.6
Shower	17.2[d] 14.9–18.6	0.75[d] 0.6–0.9	11.6 8.3–15.1	16.8 11.8–20.2
Bath	See shower	See shower	1.2 0.5–1.9	1.7 0.9–2.7
Clothes washer	40.5 —	0.37 0.30–0.42	15.0 12.0–17.1	21.7 17.8–28.0
Dishwasher	10.0 9.3–10.6	0.10 0.06–0.13	1.0 0.6–1.4	1.4 0.9–2.2
Faucets	1.4[e] —	8.1[f] 6.7–9.4	10.9 8.7–12.3	15.7 12.4–18.5
Leaks	NA	NA	9.5 3.4–17.6	13.7 5.3–21.6
Other Domestic	NA	NA	1.6 0.0–6.0	2.3 0.0–8.5
Total	NA	NA	69.3 57.1–83.5	100

[a] Results from AWWARF REUWS at 1,188 homes in 12 metropolitan areas. Homes surveyed were serve by public water supplies, which operate at higher pressures than private water sources. Leakage rates might be lower for homes on private water supplies.
[b] Results are averages over range. Range is the lowest to highest average for 12 metropolitan areas.
[c] Gal/person/day might not equal gal/use multiplied by uses/person/day because of differences in the number of data points used to calculate means.
[d] Includes shower and bath.
[e] Gallons per minute.
[f] Minutes of use per person per day.

Table 2 – Residential Water Use by Fixture or Appliance [2]

The water that is used for domestic purposes results in sewage that carries pollutants and nutrients into septic systems and subsequently into the soil and in some cases into the groundwater. Water that is used for watering landscape during the growing season carrying landscape chemicals that percolate into the soil and may also runoff with rainwater into the Pond. Larger volumes of water used do not necessarily contain more pollutants and nutrients, but higher volumes of water have a tendency to flush nutrients, particularly phosphorus, which is loosely bound to granular soils, into the ground water and subsequently into the Pond. Unfortunately the groundwater on the east shore of the Pond flows into the Pond. So water

[2] *Design Manual: Onsite Wastewater Treatment and Disposal Systems*, EPA/625/R-00/008, pg 3 - 5 February 2002

conservation is important in the Dudley Pond watershed, but very important for the properties in the eastern part of the Dudley Pond watershed. For the above reasons it is recommended that public education and water conservation be actively promoted by the SWQC, DPW, and the DPA in the east Dudley Pond watershed.

- **Types of Systems** – A schematic of a Leach Pit (Cesspool) is shown in Figure 4 and a schematic of a Septic Tank with a leach field is shown in Figure 5.

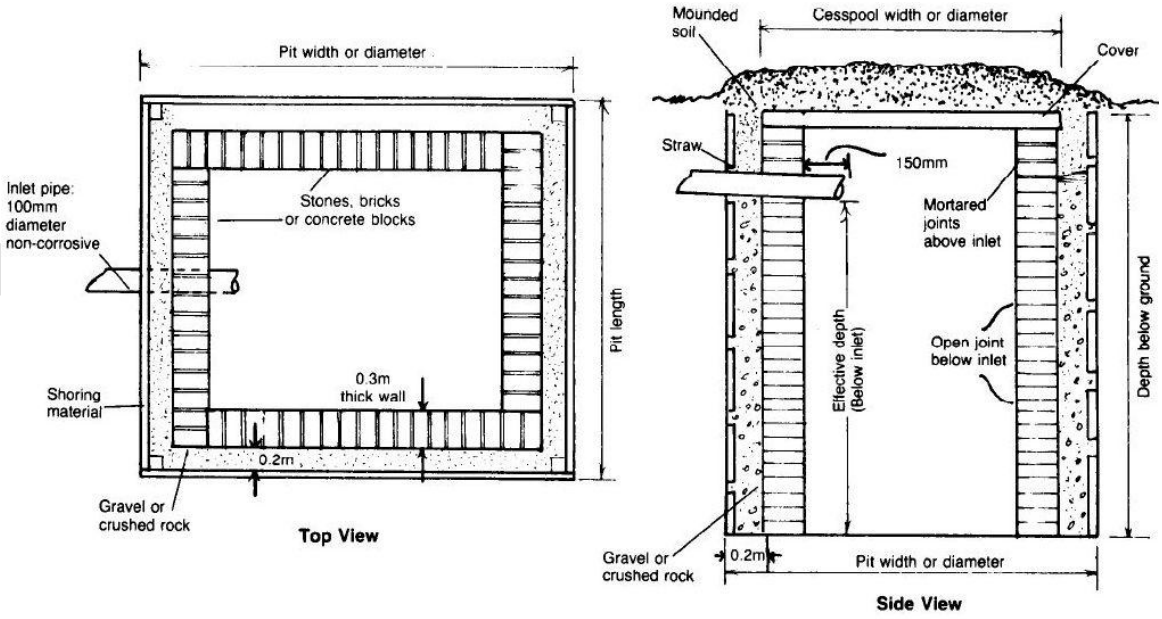

Figure 4 - Leach Pit (Cesspool)

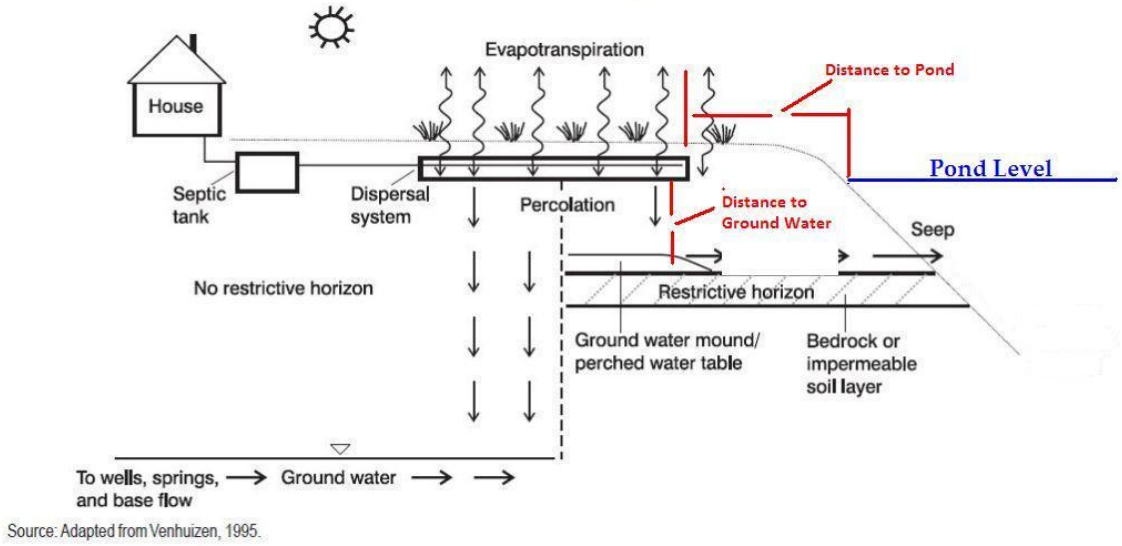

Figure 5 - System Proximity to Pond [3]

[3] Ibid, pg 1 - 7

- **Septic System Age** – The functioning of conventional septic systems depends on the adsorptive capacity of the soil to remove phosphorus and other contaminants from sewage. Since the adsorptive capacity of a septic system for phosphorus is finite, the useful life of a septic system is finite, unless technology is installed to remove phosphorus compounds from the septic system effluent before it is discharged to the soil. With a very high density of septic systems east of Dudley Pond, many of which are old (avg. age 24 years old), there is concern that the phosphorus in the sewage being discharged into the east part of the Dudley Pond watershed is not being adequately removed to protect the health of Dudley Pond. This problem is compounded where groundwater flows into the Pond as it does on the east side of Dudley Pond.

- **Title 5** – A Title 5 inspection form can be found at the following site. http://www.mass.gov/dep/water/approvals/t5forms.htm#inspect Many communities that have water bodies that are suffering from nutrient overloading are passing by-laws requiring Title 5 inspections within a given period of time so that failing septic systems can be remediated. Since Dudley Pond has been identified as Category 5 impaired water bodies, it is recommended that Wayland adopt watershed by-laws that mandate a timetable for Title 5 inspections. To view such a community watershed by-law visit: http://google.whatifnet.com/search?q=Regulation+64&btnG=Search&entqr=0&output=xml_no_dtd&sort=date%3AD%3AL%3Ad1&client=nantucketma&ud=1&oe=UTF-8&ie=UTF-8&proxystylesheet=nantucketma&site=nantucketma

- **Proximity to Ground Water** – Most of the removal of pollutants from septic system effluent occurs in the non-saturated zone (above the water table) of the soil. Having the bottom elevation of the leach area very close to the ground water elevation is not good because contamination of ground water becomes more likely. The septic systems located on Knollwood Lane and Dudley Rd., because of being located at higher elevations, have a large number of feet vertically separating the bottoms of leach areas and the groundwater table. Ideally it is best to have as much separation between the bottom elevation of leaching area and the groundwater elevation to facilitate removal of pollutants, particularly in cases where the ground water is flowing into the Pond. (ref. Figure 5 above) Many communities require a minimum separation five feet or more between the bottom elevation of the leach area and groundwater elevation in watersheds of impaired water bodies. http://google.whatifnet.com/search?q=Regulation+64&btnG=Search&entqr=0&output=xml_no_dtd&sort=date%3AD%3AL%3Ad1&client=nantucketma&ud=1&oe=UTF-8&ie=UTF-8&proxystylesheet=nantucketma&site=nantucketma

  It is recommended that Wayland adopt watershed by-laws that mandate a minimum separation of the leach area and the groundwater table in watersheds around Dudley Pond, Heard Pond and North Pond of Lake Cochituate. Since the elevation of water table on the east side of Dudley Pond is greater than the elevation of the Pond it is a reasonable assumption that ground water on the east side of the Pond is flowing into the Pond. The 1983 IEP report measured the elevation of the water table around the perimeter of Dudley Pond and also concluded that the ground water was flowing into the Pond on the east side. This finding raises a number of issues, such as:
  1) What is the ground water profile farther to the east of the Pond? and
  2) Is the soil associated with the ground water on the east side of the Pond saturated with phosphorus compounds, resulting in the nutrients from many of the properties east of Dudley

Pond entering the Pond via ground water?

Ground water elevations between the Pond and Route 27 should be investigated as well as the phosphorus content of the ground water at various locations in this area.

- **Percolation Rates** – The percolation rate or percolation rate is a measure of how readily water moves through soil and is measured by the number minutes that it takes the water level in a test hole to decrease one inch. Low percolation rates (minutes per inch) are associated with granular soils such as sand. High percolation rates are associated with soils that have clay and/or organic materials present that inhibit the movement of water. From a hydraulic point of view having a low percolation rate is good; however, most sandy soils with low percolation rates have limited sites that adsorb and hold nutrients such as phosphorus compounds. Unfortunately, from a nutrient retention point of view, most of the soils around Dudley Pond have low percolation rates and do not have a high capacity adsorb and retain large amounts of phosphorus compounds.

- **Distance to the Pond** – Having a long horizontal distance (ref. Figure 5) between septic systems and the Pond above the water table is ideal to maximize the treatment of pollutants and to remove phosphorus compounds contained in domestic sewage. However, some of the properties along Crest Rd, Pond Rd. and Lakeview are so small that it is difficult to locate a septic system more than forty or fifty feet from the Pond. One of the owners of the property on Pond Rd solved this problem by locating their septic tank on TOW property approximately 270 feet to the east of the Pond. Others solved this problem by installing a tight tank. The septic systems that are close to the Pond merit further review such as a Title 5 inspection, to insure that they are not sources of nutrients contaminating Dudley Pond.

- **Year Pumped** – Septic systems require pumping to remove accumulated solids so that the solids do not flow into the leaching area and reduce the permeability of the soil causing hydraulic failure. When septic systems are pumped the company that pumps the septic system is required to submit a record of pumping ("ticket") to the BOH containing the owner's/renter's name, date, volume of septage pumped, where the septage was discharged as well as a cursory inspection of the system. The BOH stated that filing of septage pumping "tickets" occurs within 6 months of when the BOH receives them. By not pumping septic tanks frequently enough the nutrients contained in the sludge will be solubilized and pass out of the septic tank and into the leach field along with solids. Communities that have water bodies that are overloaded with nutrients are passing by-laws that require septic systems that are within the watershed to be pumped every two to three years. It is recommended that Wayland consider a by-law with such a requirement, particularly within the watersheds of Dudley Pond, Heard Pond and North Pond of Lake Cochituate.

- **Phosphorus Pollution** – According to the USEPA the distribution of sources of phosphorus within a household are shown in Table 3 below.

Parameter		Garbage disposal (gpcd)[c]	Toilet (gpcd)[c]	Bathing, sinks, appliances (gpcd)[c]	Approximate total (gpcd)[c]
BOD_5	mean	18.0	16.7	28.5	63.2
	range	10.9–30.9	6.9–23.6	24.5–38.8	
	% of total	(28%)	(26%)	(45%)	(100%)
Total suspended solids	mean	26.5	27.0	17.2	70.7
	range	15.8–43.6	12.5–36.5	10.8–22.6	
	% of total	(37%)	(38%)	(24%)	(100%)
Total nitrogen	mean	0.6	8.7	1.9	11.2
	range	0.2–0.9	4.1–16.8	1.1–2.0	
	% of total	(5%)	(78%)	(17%)	(100%)
Total phosphorus[d]	mean	0.1	1.6	1.0	2.7
	range	—	—	—	—
	% of total	(4%)	(59%)	(37%)	(100%)

[a] Adapted from USEPA, 1992.
[b] Means and ranges for BOD, TSS, and TN are results reported in Bennett and Linstedt, 1975; Laak, 1975;Ligman et al., 1974; Olsson et al., 1968; and Siegrist et al., 1976.
[c] Grams per capita (person) per day.
[d] The use of low-phosphate detergents in recent years has lowered the TP concentrations since early literature studies; therefore, Sedlak (1991) was used for TP data.

Table 3 - Residential Wastewater Contribution by Source [(4)]

A pond or lake with a phosphorus (total phosphorus) concentration of greater than 25 – 30 ppb is considered eutropic (over fertilized) according on the Carlson Tropic State Index. Historically the total phosphorus concentration in Dudley Pond has been in the range of 20 – 50 ppb. If a year's worth of sewage from one person were dumped into Dudley Pond the result would be an increase of approximately 0.7 ppb phosphorus concentration in the Pond. Because the discharge from Dudley Pond is intermittent, most of the phosphorus that enters the Pond stays in the Pond and is converted to biomass (algae and/or weeds), which die seasonally, decompose and the phosphorus from the decomposing biomass is reincorporated into biomass during subsequent growing seasons. As a result a small number of failed septic systems can result an unacceptable accumulation of phosphorus over time; which is the case for Dudley Pond.

- **TMDL** – In order to propose watershed nutrient by-laws for Dudley Pond a defensible basis is needed. A Total Maximum Daily Load (TMDL) study, which is mandated by the State for Category 5 impaired waters, will provide that basis. In 2009 SWQC applied for a State grant to fund a phosphorus TMDL study. This grant application was not funded; however, the SWQC will continue to seek funding to complete a Dudley Pond TMDL for phosphorus as mandated by the State.

- **Septic System Scores** – Septic systems found to have relatively high scores merit further review to determine why the score is high and what can be done about lowering the score. As information regarding properties that were found to be missing is determined, septic systems scores should be calculated and reviewed.

- **Tight Tanks –** One of the properties is serviced by a 4,400 gallon tight tank and has one person using the system. The last pumping record in the BOH file for this property was November 2009 (a year ago). The average water usage at this address for the last two years was 2,150 cubic feet per year (16,082 gallons per year). It appears a year has passed since the last pumping and approximately 16,000 gallons of water have been used with a 4,400 gallon tank to collect the sewage. This situation merits review to insure that sewage is not leaking from the "tight" tank.

[4] Ibid, pg 3 - 11

Another property has a 5,000 gallon "tight" tank. Over the past two years this property used on average 9,100 cubic feet of water per year (68,068 gallons per year) and the last record of pumping of the tight tank was 2008. This system should also be reviewed to insure that it is not leaking.

Failed Systems – With three people renting a house located Dudley Pond peninsula with a failed septic system could potentially be contributing 4.5 pounds per year of phosphorus into the Pond, resulting in an increase of the Pond total phosphorus concentration of 2.1 ppb. Based on USEPA data 25% of septic systems in Massachusetts have failed. [5] If this is the case it is expected that there are probably other Dudley Pond septic systems within the 50 systems reviewed that have failed. Since the BOH is aware of the septic system failure and the incorrect location for this property, it has been assumed that the BOH will deal with this situation based on the applicable laws that are currently in place. This property is located near the southern tip of the peninsula in Dudley Pond and is very close to Sample Point C, which was part of the Pond circulator performance evaluation program. The water quality parameters associated with Sample Point C gathered during 2007, and 2008 were often very different than the other sample points as can be seen in Table 4 below.

Table 4 - Summary of Unusual Water Chemistry at Sample Point C

Occurrence	Depth	Date
Season's High Temperature	1'	8/27/08
Season's High Temperature	1'	7/10/07
Season's Highest % Dissolved Oxygen	9'	4/25/08
Season's Highest & Lowest pH	1' & Bottom	9/15/07
Season's Highest Total Phosphorus	6'	4/25/08
Season's Highest Total Phosphorus	1'	11/18/07
Lowest November Secchi Disc Depth	3+ m	11/18/08
Season's Lowest ORP	Bottom	7/10/08

*This table was taken from the 2008 Dudley Pond Circulator Evaluation Report prepared by the SWQC.

It is not clear whether the failed septic system influenced the water chemistry data taken at Sample Point C during the 2007 and 2008 seasons.

[5] Ibid, pg 1 - 7

Appendix

The spread sheet containing the data gathered during this study can be obtained from Steve Calichman, TOW BOH.