Preserving Walden Pond

An Interactive Qualifying Project Report
submitted to the Faculty

of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

on
07 May 1999

by

Timothy L. Briggs

Gregg D. Burnett

Danielle L. Froio

Approved by

Professor Fabio Carrera, Advisor

Professor James P. Hanlan, Advisor

"I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived."

-Henry David Thorea

Authorship Page

The study herein was completed in a combined effort by Timothy Briggs, Gregg Burnett, and Danielle Froio. All of the sections were written and edited through close consultation of each member of the group.

Acknowledgements

We would like to thank the following people for both there their time and valuable information:

Kenneth Bassett, Chairman of Walden Pond Board of Directors
& President of Sasaki Associates;
Helen Bowdoin, Education Program Director of Thoreau Institute;
John Colman, US Geological Survey Scientist;
Todd Fredrick, Director of Forest and Parks;
Tom Harris, Executive Director of the Thoreau Institute;
Karst Hoogeboom, Past Project Manager for Walden;
Dan Kuja, Park Ranger for Walden Pond;
Professor Wesley Mott; WPI Professor;
Trooper Pelligrino, Mounted State Police;
Trooper Walsh, Mounted State Police;
Members of The Walden Pond Staff who helped in so many different ways;
Professor Kent Ljungquist who helped with the preparations for this project.

And a special thanks to:

Our liaison Peg Campbell, Walden Pond Park Supervisor, for her dedicated support to our team;
Professor James Hanlan and Professor Fabio Carrera, for their continued help with our project;

ABSTRACT

Walden Pond State Reservation is a famous historical and recreational area that is in the process of improving and preserving its natural setting. The large number of people that visit the park during the summer months result in many problems that affect the environment of the pond and its surroundings. Solutions to the numerous problems resulting from overcrowding were developed through interviews, of persons with recognized expertise. Also, research of solutions that other state parks have used in response to overcrowding and related issues were incorporated.

TABLE OF CONTENTS:

List of Figures

List of Tables

List of Appendices

Executive Summary

Introduction

This study of the carrying capacity of historic Walden Pond, carried out as an Interactive Qualifying Project (IQP), began as a co-operation between Worcester Polytechnic Institute (WPI) and Walden Pond State Reservation. The famous American author and naturalist, Henry David Thoreau, resided at Walden Pond for two years. The pond and its surrounding woods inspired Thoreau's famous literary work, *Walden*. Walden Pond is one of many state parks in Massachusetts, and is managed and funded by the Department of Environmental Management (DEM). As any state park, Walden provides recreational use for the citizens of Massachusetts, as well as national and international tourists.

When the carrying capacity limit is exceeded, during the summer months, there are various problems that arise. The most prominent of these is the issue of overcrowding. The remaining issues such as deterioration of water quality, public safety, lack of visitor information, and traffic control, all spring from this initial problem of overcrowding. The project team, with assistance from Walden staff, developed goals for this project. Previous studies conducted on the pond were consulted as a means to gain a better understanding of some of the problems mentioned above. Through interviews with various people involved with Walden, the group was able to come up with recommendations to remedy the problem of overcrowding at Walden. Along with the previously mentioned recommendations, the group also designed an application for

people who buy seasonal parking passes. This application is envisioned to allow Walden staff to gain information about a small sample of the people who visit the pond.

Transportation

The background information included research on each of the five problems that arise from the issue of Walden's carrying capacity. Walden's parking lot usually fills to capacity several times a day during the summer months. This introduces thousands of cars to Walden, as well as its neighboring highways. Walden Pond is located on Route 126 in Concord, Massachusetts, as well as ten miles from the intersection of Route 126 and Route 2. Two approaches to relieving traffic congestion were researched. One method is called the supply-side approach which gives the public further resources to solve the problem, such as building new roads or re-routing roads. The other approach is called the demand-side method where the goal is to reduce the public's demand for the park. Examples of this are raising admissions to make an attraction less appealing to the public.

Water Quality

Walden Pond was formed by a glacial remnant, and is considered a "kettle" shaped pond, resulting in a sparse shoreline. The pond is stagnant, meaning that there are no tributary steams running in or out of the pond. All of these characteristics of the pond contribute to the reason why the water is so clear and pure. There are two major causes that can effect the quality of water in a pond or lake, which include either bacterial contamination or nutrient loading. Bacterial contamination is not considered a threat because of the lack of waterfowl and animals near the pond. Nutrient loading is a possible threat for two primary reasons. First, it is thought that groundwater is contaminated by a leaching field that is close to the pond. Second, it is questionable

whether or not swimmers urinate in the pond, which would result in an increase in nutrients into the pond.

Informing the Public

When dealing with environmental issues that are caused primarily by the extensive use of the reservation by the public, one starting point is to inform the public of what is happening and why. An educated public could help alleviate some of the environmental issues at hand, especially the traffic issues resulting from overcrowded parking lots. One way in which to inform the public is through advertising. Advertising is not only for selling goods, but it is a means for drawing attention to something or notifying somebody about something. Examples of advertising include: newspaper ads, press releases, broadcasts, commercials, web pages, and posters.

Overcrowding

One attempt by which to control overcrowding is through a set carrying capacity limit. Carrying capacity is a limit that National Parks or State Reservations, such as Walden Pond, set to limit the number of visitors to a place at one single time. Currently Walden has a carrying capacity of 1000 people at a time; this capacity is met several times a day during the summer. When the park reaches this limit the parking lot is closed until a time determined by the park staff. Another strategy used for dealing with overcrowding is called Limits of Acceptable Change (LAC). This strategy involves collecting data such as trail widths, and then setting a standard for that trail width. In the future, if the trail width does not meet the standards, the trail is closed, and it does not open until the problem is dealt with and fixed. LAC is seen as a reactive strategy whereas a carrying capacity limit is seen as pro-active measure.

Public Safety

The overcrowding issues, along with the recreational activities offered at Walden, make it much harder for the management to maintain public safety. Setting rules and regulations is the primary way to lower the possible safety risks involved with state parks, like Walden. Walden's staff already has a set of rules and regulations that provide for public safety as well as preserving the park's resources. The main issue regarding public safety is the fact that Route 126 runs between the parking lot and the beach. Visitors must cross this highway in order to get to the pond, and this makes an extremely dangerous environment for the visitors.

Ideas Developed to Control Overcrowding

At the start of the project a list of brainstorming ideas was developed, with focus on the major problems that result from the overcrowding of the pond. Rerouting Route 126 behind the parking lot of Walden was one idea. Other ideas include: A new entrance to Walden that would run parallel to Route 126; A rotary or turn around point about half a mile from the parking lot entrance, which enables visitors to either turn around when the lot is closed or turn around to make a right hand turn into the lot; Raise admissions to make the park less appealing; Low frequency radio signals, allowing visitors to tune to an informative AM radio station; Swimming passes that are sold days in advance; Close the parking lot and allow visitors to park at an alternative parking area, and then bus the visitors into the park.

Interviews

The main procedure employed during this study was to gather data, regarding the capacity issues mentioned above, through interviews. First, to become more familiar with the overcrowding issue present at Walden, staff members were questioned about their experiences during the summer. Professionals in various fields of expertise were then interviewed regarding their opinions and suggestions pertaining to our brainstorming ideas.

Calculating Carrying Capacities

This technique was conducted by measuring the total beach area within the park. Once the area was known, it was applied to an equation that calculated the specific area on the beach that each visitor could utilize. Once this number was calculated it could be determined if the capacity of one thousand people at one time was sufficient.

Seasonal Pass Application

A seasonal pass allows visitors to park at all the state parks within Massachusetts for a one-time fee of fifteen dollars. The pass is relatively inexpensive and anyone can purchase one. However, the staff at Walden knows nothing about the people who buy these seasonal passes. Therefore, the group devised an application that would obtain the information the staff desired. None of the results obtained from the administration of these passes are included in this report. However, knowing what audience attends may, in the future, help solve some of the capacity issues at Walden.

Results

Re-routing Route 126 is an idea that has been considered for many years and was largely supported by most of the interviewees. Many feel that this project would increase

the safety of the visitors, as well as reduce the traffic congestion resulting from overcrowding of the park.

Raising admissions was another solution that proved to reduce the number of visitors and at the same time generate more revenue. This is a difficult issue to deal with, but a slight increase in admission might not be a bad idea. The extra money that is gained through this could be used for much needed projects at various parks across the state.

Low frequency radio signals is another way to deal with the overabundance of people who visit the pond during the summer. Many interviewees agreed and supported this idea. Allowing visitors to tune into a radio station, while driving to Walden, would possibly result in less traffic congestion.

An application for the seasonal pass was constructed. Some of the information gained through the application are: name, address, how often visitors come to the park during summer and off-season, what days and times visitors come, how many people come with them, recreational activities they enjoy, and visitors' age group.

The total beach area was found to be 18,452.5 square feet. With a one thousand-person carrying capacity limit, there would be 18.5 square feet of beach for each person. The interviewees had mixed feelings about whether or not this carrying capacity, of one thousand, was too high or not.

1.0 INTRODUCTION

Walden Pond, and its woods, was once home to author and naturalist Henry David Thoreau. Thoreau lived in a one-room cabin for two years, two months, and two days, beginning in 1845.While living at Walden, Thoreau experienced and observed the natural setting of the pond and its surrounding woods. In his literary work, *Walden*, Thoreau wrote about his experiences and his love for the natural world. Thoreau's insight and documentations of natural processes led to him being credited as the father of the modern day conservation movement. Walden Pond State Reservation is the nation's first landscape recognized as a National Historic Landmark. As expressed in his book, Thoreau's wish for Walden was that it be preserved in its natural state, as he expressed in his book.

Overuse of the reservation threatens the future of the pond and woods. Presently, the park's staff encounters numerous issues and problems when the carrying capacity is reached. Carrying capacity is defined as the number of visitors allowed to enjoy the park at one time without causing the park damage. During the summer, once the park has reached its capacity, it becomes a difficult task to turn visitors away. There is no place for the traffic to turn around and thousands of cars back up on route 126 and onto route 2. Also, there are no effective communication strategies to assist with informing the public of park closings.

The goal of this Interactive Qualifying Project (IQP) is to recommend ways in which Walden Pond can continue to be preserved while at the same time making the Reservation safer and more efficient for visitors. The objectives of this project are to

examine and analyze the overcrowding that occurs during the summer, and the problems associated with it. This information gave a better idea of where to begin problem-solving strategies.

Research has been conducted involving other parks that have had similar challenges to those that Walden is experiencing now. After analyzing and examining the problems and solutions that these various parks have encountered, a comparison was made between them and Walden. The solutions used at these other parks were analyzed and considered as potential solutions for Walden.

When the carrying capacity limit is exceeded there are various problems that arise. The most prominent of these is the issue of overcrowding. The remaining issues such as deterioration of water quality, public safety, lack of visitor information and traffic control, all spring from this initial problem of overcrowding. With an increase in visitors to the park, beaches, trails and various other facilities become crowded and rundown. Not only is this detrimental to the park's natural setting, but it also causes the visitors to become uncomfortable and irritable which creates an overall negative atmosphere within the park.

The deterioration of the water quality is another major issue that the park must deal with each summer. With an increase in the number of swimmers who use the pond for recreational uses, there is a potential problem with keeping the water quality up to ecological standards. The nutrient level can increase, causing problems with the quality of the pond.

Public safety is also a key issue with which park officials are faced. There are a number of recreational activities that the park provides such as swimming, hiking, and

fishing. With various activities such as these there is no doubt that safety is going to be an important factor. The staff at Walden must be sure that all recreational activities are conducted in an appropriate manner to ensure the safety of all its visitors. Although emergency plans at Walden are intact, the park is often difficult to patrol, due to the number of visitors.

Traffic control is another issue that the Walden staff is faced with each summer. Route 126, a major roadway, runs in between Walden Pond and the parking lot. The location of this road poses a dangerous environment for the pedestrians who are crossing the road as well as for the staff directing the traffic. During the summer there are massive traffic jams that occur at the beginning of each day involving thousands of cars. The visitors are trying to get into Walden before the gates close because the park's capacity has been met. Once the gates are shut, the traffic jam continues until the park's staff can inform the visitors of when the park will reopen and ask them to move on. This traffic jam resumes about 15 minutes before the park reopens and can happen several times in a given day. The traffic issues mentioned above also create a problem for residents of Lincoln and Concord, who rely on route 126 for travel needs.

The results were presented to the Walden staff, WPI advisors as well as invited guests on Tuesday May 4, 1999. Concluding recommendations were presented to the Walden Staff and The Department of Environmental Management in an attempt to control the problem of overcrowding at Walden. The end result of this project recommends a manner in which Walden can continue to be preserved and maintained while also being accessible to a large number of visitors.

2.0 BACKGROUND INFORMATION

The purpose of this section is to research and analyze literature regarding problems that have arisen from overcrowding, including traffic issues, water quality, public information and public safety. Many other State Parks as well as National Historic Sites have had problems similar to those Walden is now facing. By researching the various techniques that have been used to handle these problems, one can get a better understanding of the possible solutions.

Walden Pond State Reservation is considered a National Historic Landscape that covers almost 411 acres. The reservation is broken up into Walden Pond and Walden Woods. Almost 650,000 national, local, and international tourists visit Walden each year for many different recreational purposes. The Department of Environmental Management has placed a one thousand person carrying capacity limit in an attempt to preserve the reservation, because of the large number of visitors during the summer months.

2.1 Public Safety

With the extensive use of the facilities at Walden Pond by the public, comes the concern of public safety for the management. When the carrying capacity of one thousand people has been reached, the park is closed but some people still try to enter, creating overcrowded beaches and hiking trails. These overcrowding issues make it much harder for the management to control public safety. Setting rules and regulations is

the first way of lowering the possible risks involved when visiting the park. Also, different ways of setting up the park's facilities can contribute to lowering risks.

Walden has set the following rules and regulations to increase public safety and preserve the park:

- The pond and surrounding paths are open to the public daily from 5 a.m. to approximately a half hour after sunset.
- Swimming across the pond is prohibited, although this occasionally happens since it is not heavily enforced.
- No dogs are permitted anywhere in the park at any time of year.
- Fires, camping, pets, bikes, off-road vehicles, motorcycles, novelty flotation devices, boats powered by internal combustion engines and wind-powered sail craft are all prohibited.
- Alcoholic beverages are prohibited.

(http://www.tiac.net/users/morganti/walden.htm#rules). In addition to the rules and regulations the State Reservation has the following Staff and Equipment to help with public safety (No Author, Goals Statement, 5):

- Year-round:
  1 Forests & Parks Supervisor IV
  1 Forests & Parks Supervisor II
  1 Recreational Facility Repairer
  1 Clerk III
  1 Visitor Services Supervisor
  1 Laborer II
- Seasonal:
  9 persons in maintenance jobs
  9 lifeguards
  2 interpreters
- Equipment:
  1997 Ford Pick-Up 200D Truck
  1987 4WD truck, used for maintenance & transportation

1987 Ford Tractor, with bucket & mover, used for mowing and plowing
1987 garden tractor, used for beach & trail maintenance
10 portable radios for communication

- Enforcement Staff: 1 Park Ranger-Seasonal
  2 State Mounted Police, at least May to October

Walden's Emergency Response Plan also states that the Ranger on duty should have a working Motorola HT 1000 or equivalent, a first aid kit, and keys to all iron and chain gates, buildings and vehicles. The Ranger should also have a list of numbers for local police and fire as well as State and Environmental Police, and Department of Environmental Management officials. The Emergency Response Plan also explains to each employee what to do in cases of missing persons, medical emergencies, indecent exposure/assault, stolen property, domestic violence, and people falling through the ice during winter months.

Another main issue of public safety that needs to be dealt with is that route 126 runs through the reservation. The park entrance is located on one side of the busy highway and the parking lot on the other. This makes a dangerous environment for the public, having to walk across the highway and avoid oncoming traffic. There has been talk of rerouting route 126 but a realistic tangible time line and master plan to accomplish this has not been established.

2.2 Transportation

Traffic control and safety are vital when dealing with a National Historic site that thousands of people flock to every year. Once automobiles started to become more accessible after World War II, the crowds at Walden Pond began to total as many as

20,000 people on some days (http://www.nanosft.com/walden). Currently there is a limit of 1000 people allowed in the park at one time, but the park often fills to capacity several times a day during the summer months. Although the parking lot holds a maximum of 350 cars, there are thousands of cars trying to get into the park. This introduces a major traffic jam outside of Walden that extends to its neighboring highways.

Walden Pond is located off of Route 126 in Concord, Massachusetts. The parking lot is located about one fifth of a mile from the intersection of route 2 and route 126. It is about one hundred yards before crossing the Lincoln town line (http://www.nanosft.com/Walden). There is a small fee ($2) that is charged for parking. The price was dropped from five dollars a car in 1997 by the state, which is in charge of setting the entrance fee. A season's pass is fifteen dollars and buses are charged twenty dollars to enter. Charging by vehicles instead of by person attempts to promote car-pooling and introduces fewer cars to the site. The park is only allowed to charge guests from Memorial Day to Labor Day (www.nanosft.com/Walden).

When dealing with a lot of cars at a beautiful historic site like Walden, it must be questioned whether or not these cars' exhausts are causing insurmountable damage to the surroundings and the air quality. Car emissions can count for over ninety percent of certain pollutant's existence in some cities. The pollutants that these cars exhaust include Carbon Monoxide, or CO, caused from incomplete fuel combustion within the engine. Hydrocarbons are also a major problem that comes from unburned fuel and are the major cause of smog. Other less critical toxins that are still dangerous, such as Nitrogen oxides, Sulfur oxides, and particulates, come from the automobiles as well. All of these

automobile emissions are deadly to humans and wildlife exposed in excessive amounts (Meyer and Miller, 53).

With a large increase in traffic, the traffic flow and other potential delays or problems must be considered. Experts, on traffic flow, have devised formulas to calculate the traffic flow for these specific problems. The time that it will take to travel to a destination is equal to the time it would take if there was no traffic divided by the quantity of one minus q divided by c, or $t = t_0/((1-q)/c)$ (Meyer and Miller, 326). In this model q represents the volume of flow using that road, and c is the capacity of that road, both measured in units of vehicles per hour. Also t_0 equals the time if there was no traffic and t equals the new time based on the capacity and flow. The quantity q/c will be between zero and one, and as either the volume of the road increases or the capacity of the road decreases the destination time will also increase. This formula is specifically designed for highways like Route 126.

When there is a lot of congestion caused by traffic, there are two approaches to help solve this problem. The first approach is the supply-side approach. This approach will supply the public with more assistants to solve the problem. This means more roads are added to give the road a higher capacity and thus less congestion. There is also a demand-side approach that employs tactics dealing with lowering the public's demand. A great example of this would be to hike prices up and make an attraction have less appeal to the public due to cost (Downs, 23).

There are many factors that contribute to a road's capacity. Some of these factors include lane width, which ideally is twelve feet for heavy volumes of traffic, and lateral clearance that won't cut down the use of the lane width. Shoulders are also a necessity so

broken down vehicles and accidents won't stop all use of the road. Other factors include road conditions, alignment, and the distribution of cars using the road. All of these conditions can be looked into if a supply-side approach is used (Pignataro, 183).

Traffic Safety is not only a consideration at Walden, but also at other well-visited sites and landmarks. The Yosemite National Park Rangers, for example, were advised to emphasize safe driving and cite traffic law offenders in August 1998. This was in response to the twelve major accidents, one fatal, that occurred at Yosemite between January 1, 1998 and July 1, 1998. There were at least ten reported killings of deer and other wildlife by motorists in that time frame. Tickets as high as one hundred and ten dollars have been issued to try to solve these unsafe driving problems (http://www.nps.gov/htdocs_4/yose/news_98/traffic.htm,). Currently no traffic fatalities have occurred at Walden, but thousands of people cross route 126 every year and the safety of the pedestrians must be considered as a critical factor.

2.3 Water Quality

Many Historical Sites as well as National Landmarks are faced with the problem of overcrowding. During the summer months the number of visitors and tourists that visit these sites are much higher than during the off season months. One of the main concerns park officials' face is the problem of deteriorating water quality. Water quality is "a term used to describe the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose or use (e.g., recreation, drinking water)." (Baystate Environmental Consultants, 111) Ponds and lakes are not like swimming pools where facility managers can just add chlorine to control the growth

of bacteria and the addition of nutrients. Plant life and the fish population need to be taken into account when trying to deal with water quality. This section discusses various ways in which water quality may deteriorate. Focus was placed on nutrient loading as well as a brief discussion on bacterial contamination. By taking a closer look at the problems involving water quality a deeper understanding of what is happening and what may happen at Walden Pond is achieved.

2.3.1 Environmental and Ecological Setting

To get a better understanding of the water quality issues present at Walden Pond it helps to know where the pond is located and what its environmental and ecological settings are like. See Figure A1 for the location of Walden Pond. As stated in Appendix A, the pond was formed by a glacial remnant that left behind a steep sided, "kettle shaped", basin 100 feet deep. See Figure A2 for a Bathymetric map of the pond which shows the difference in depths of water in various sections of the pond. The approximate size of the ponds covers 60 acres. See Table A1 for more characteristics of the pond. An unusual characteristic of the pond is that it has no surface-water inflow or outflow. The source of tributaries for the pond are primarily from underground sources which are most likely contained within the park's borders, as well as from rain, snow and other forms of precipitation. Thus, making Walden Pond a seepage lake. Figure A3 shows the subsurface watershed, which is the area of the drainage basin that contributes to groundwater flow. The subsurface watershed is the area bounded by the solid line on the figure mentioned above, and is estimated to be 185 acres (Baystate Environmental Consultants, 111). This figure also depicts the surface watershed, which "includes the area of the drainage basin that contributes surface runoff" (Baystate Environmental

Figure A1 " Locus Map"

Figure A2 " Bathymetric Map"

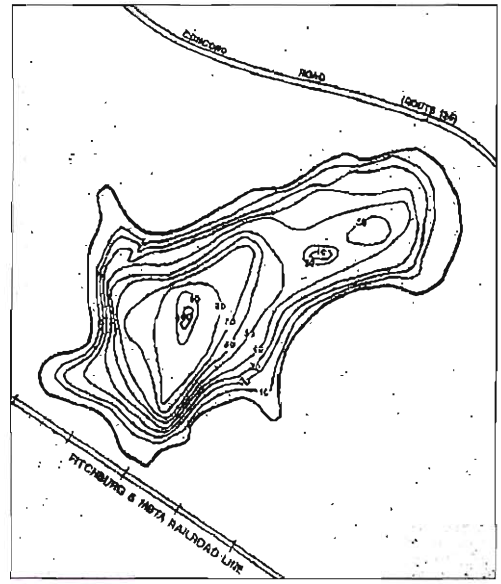


Table A1 "Characteristics of Walden Pond"

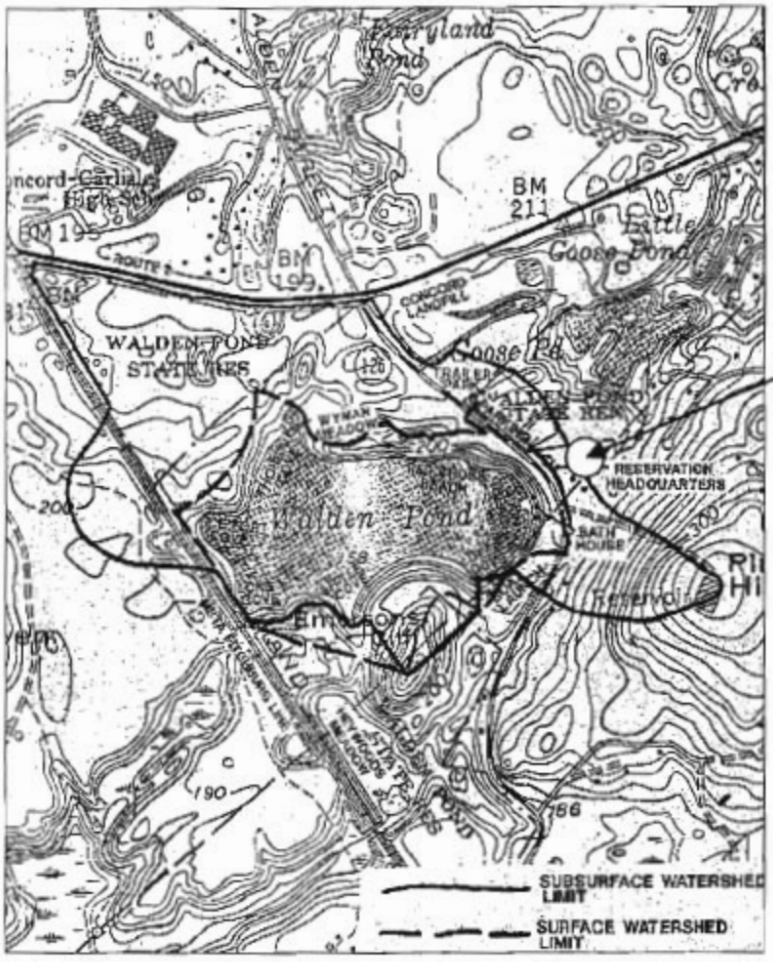
Parameter	
Area (HA)*	23.5
Mean Depth (m)	11
Maximum Depth (m)	31
Volume (m3)	2,946,475
Estimated Mean Detention Time (yrs)	4.3
Estimated Response Time (yrs)	1.8-3.0
Maximum Length (m)	838.2
Maximum Width (m)	533.4
Shoreline Length (m)	2560.3
Shoreline Irregularity**	1.49
Surface Watershed Area (HA)	41.5
Subsurface Watershed Area (HA)***	98.7
% of Watershed Occupied by lake***	24
Estimated Trophic Status	early mesotrophic

*Estimated Elevation 158 feet

**Ratio of shoreline length to circumference of circle with same area as pond (Sometimes termed "Shoreline Development")

***Groundwater and Surfaces Watershed

Figure A3 "Watershed Map"



Consultants, 6). The surface watershed is bounded by the dashed line, and is significantly smaller than the subsurface watershed.

Another important feature of the pond to be considered is the hydrologic cycle that the pond experiences. A hydrologic cycle is "the circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages and processes such as precipitation, interception, runoff, infiltration, percolation, storage,

evaporation, and transpiration" (Baystate Environmental Consultants, 103). Walden receives 55% if its inflow from groundwater, and the remaining 44% from precipitation. Ground water out-seepage controls 74% of outflow from the pond. The remaining 26% of outflow from the pond is due to evaporation from the pond's surface water (Baystate Environmental Consultants, 50).

2.3.2 The Purity of Walden Pond

There have been references to Walden Pond as having perfectly clean water. One of the reasons for the clarity of the water is because of the fact that the pond is fed by underground springs. The absence of tributary streams running in and out of the pond along with the lack of shoreline development are other reasons why the water is so clear. (http://www.tiac.net/users/morganti/walden.htm#pond) Many people are not well informed or are uneducated when it comes to the water conditions at Walden. This lack of knowledge may be detrimental to the pond because, if people think there are no problems, then they will continue to swim at the pond. However, if they were aware of some of the issues that have arisen then people might be more likely to cut down on the number of times they use the pond during the summer.

2.3.3 Nutrient Loading in Walden Pond

Nutrient loading is a problem that is relevant to Walden Pond, unlike bacterial contamination. One form of nutrient loading comes from visitors urinating in the pond. Another form of nutrient loading exists when eroded embankments allow rainwater to carry nutrient enriched soil into the pond. Other potential sources of nutrient loading include: waterfowl, groundwater inputs, internal nutrient release from sediments, septic system leachate, and fish stocking/fishing activities. (Baystate Environmental

Consultants, 111) This type of water deterioration, known as nutrient loading, does not cause health risks, but instead it raises ecological problems within the pond itself.

"Despite the role of Walden Pond as a cultural and environmental icon, little is known about the pond's ecological features, such as its internal nutrient cycling or the structure of its food web, nor have consistent measurements been made to determine whether these features are changing or are stable" (Colman). In 1995, Baystate Environmental Consultants, Inc prepared a report on the Study of Trophic Level Conditions at Walden Pond. During 1994, the water from Walden was sampled from two areas of the pond four times, once during each of the following months: January, April, June and August. Both of the two sampling sites, the shallow basin (WP-1) and the deep basin (WP-2) were sampled at three different levels. See figure A4 for the locations of the water sampling.

Typically there are two major categories that nutrient contributions originate from: in-lake sources and watershed sources. In-lake sources include a variety of nutrient origins such as precipitation, waterfowl feces, and urination from swimmers and fish stocking/fishing activities. Watershed sources include storm water runoff, feeder streams, and groundwater input. Since Walden Pond has no feeder streams, surface water inputs are minimal. Table A2 shows a list of the estimated phosphorus and nitrogen loading to Walden Pond from the point sources mentioned above. Groundwater, atmospheric sources, waterfowl and swimmers each contribute 20% of the potential loading of phosphorus to Walden Pond each year. As for nitrogen loading, swimmers, groundwater, and precipitation were all estimated to contribute more than 90% of the annual loadings. (Baystate Environmental Consultants, 111)

Once the samples were tested and analyzed and the research was completed. The "results indicated low to moderate nutrient concentrations and lake fertility, placing

Figure A4 "In-Lake & Stormwater Sampling Locations"

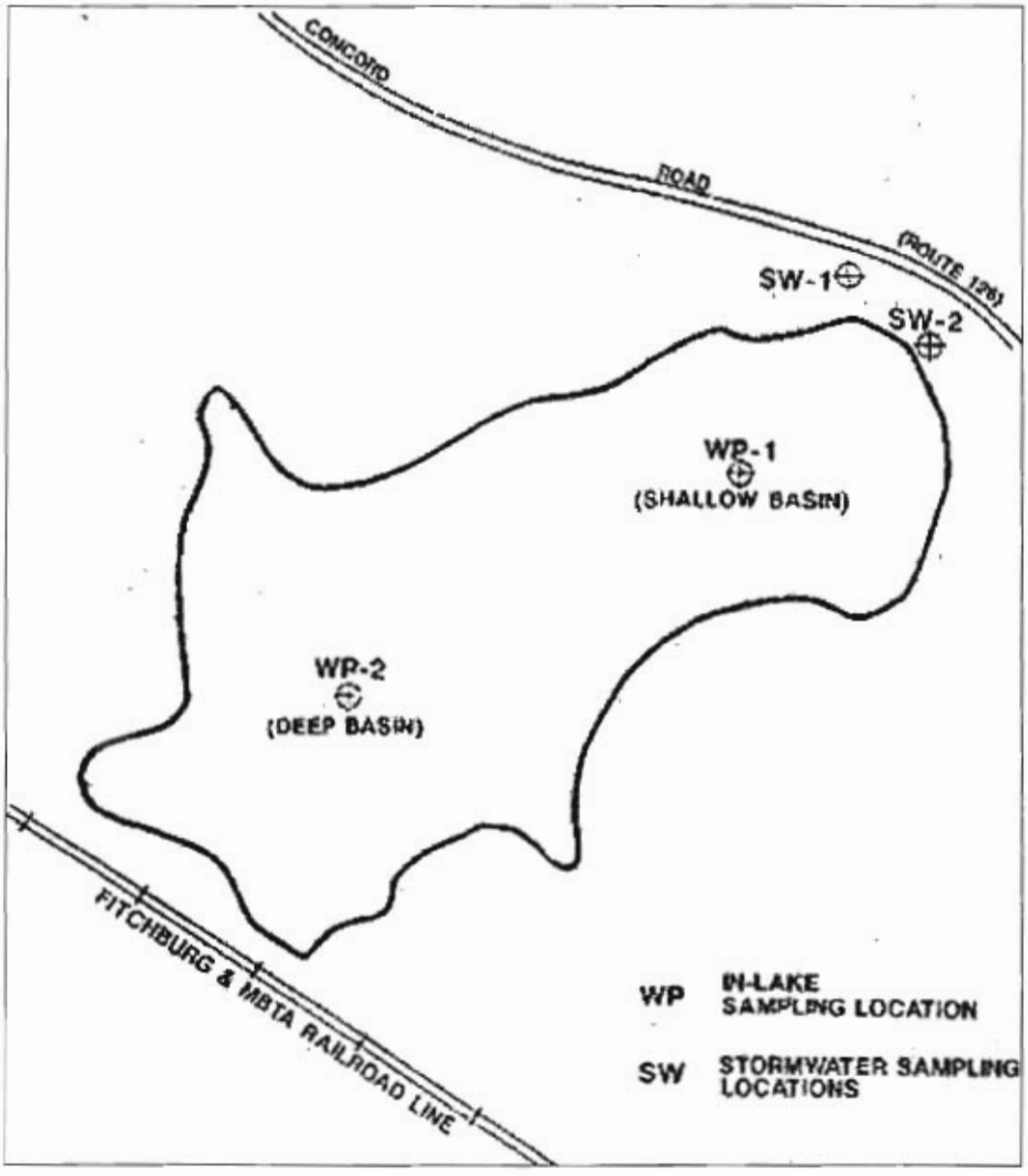


Table A2 "Estimated Loads of Phosphorous and Nitrogen in Walden Pond"

	Phosphorous		Nitrogen	
Source	*kg/yr*	*%*	*kg/yr*	*%*
Precipitation	6.8	26.6	89	12.8
GroundWater	5.2	20.3	420.5	60.7
Runoff	0.8	3.1	5.8	0.8
Remineralization	2	7.8	0.04	0.01
Waterfowl	4.8	18.8	33.3	4.8
Fish	0.7	2.7	6	0.9
Swimmers	5.3	20.7	138.7	20
Total	25.6	100	693.3	100

* Swimmer totals are assuming that 50 percent of the swimmers urinate in the pond

Walden Pond at the low mesotrophic level. At the current trophic level, Walden Pond is likely to be subject to occasional episodic algal blooms when nutrient and water conditions reach certain threshold level." (Baystate Environmental Consultants, 111) Although the pond shows low levels of nutrient concentrations, it is most likely that these concentrations are much higher then those present back in the 1800's when Thoreau lived at the pond. This means that, in another hundred years, nutrient loading may be a

problem for Walden. With the use of Nutrient Budget Models and other ways to monitor the water quality, the problem of nutrient loading in the future may be detected.

2.3.4 Cases of Bacteria Outbreaks in Other State Parks

Bacterial contamination is not a threat to Walden at this time so it will be referred to and explained concisely. Bacterial contamination can become an issue when feces are added to the pond. Bacteria can also become a threat if there are sites near the pond, such as landfills, that contaminate groundwater. There have been various other State Parks that have dealt with the problem of water deterioration in their recreational lakes and ponds. Although Walden is not likely to experience a bacteria outbreak, as mentioned above, the issue as it pertains to other state parks will be covered briefly since this type of outbreak can not be ignored completely.

Colorado was forced to close Boyd Lake State Park in July during the summer months of 1996 due to a *shigella* outbreak. Shigella is most common in overcrowded areas that have poor water supplies. (No Author, *Water/Engineering & Management*, 14) Although Walden is thought to have a good water supply, there is a septic system located close to the beach. With proper upkeep, maintenance and regular checking, there is little chance that the septic system will cause problems for Walden. Walden's records show that the system was last checked during the summer of 1997 by an outside consultant.

Another State Park that experienced deterioration in their lake's water quality was Stonelick Lake State Park, located in Clermont County, Ohio. Fecal coliform bacteria were found in the lake during the summer of 1990. In the case of Stonelick Lake, the high levels of bacteria were not thought to have come directly from people swimming in the lake, but from the malfunctioning of on-site sewage systems as well as livestock

operations near the lake. Like Boyd Lake State Park, Stonelick Lake State Park was also shut down and its water quality was evaluated. Tests proved that the park's wastewater lagoon and on-site septic systems caused the infestation of the bacteria in the bathing water. (Ingram, 19-23) There is a threat of contaminated ground water coming from areas in the vicinity of Walden. From a map of the pond (See Figure A3) and its surroundings, it can be seen that to the east of the pond there is a septic leach field. To the northeast there was a former trailer park area, and to the north there is a municipal landfill area. To alleviate the fear of these areas contaminating groundwater, the US Geological Survey has set up testing wells in various places to test the quality of the ground water. It has also been concluded that groundwater in this area flow northeasterly; therefore the groundwater present near these threatening sites flows away from the pond.

2.3.5 Cultural Eutrophication and Trophic State

The U.S. Geological Survey (USGS) and the Massachusetts Department of Environmental Management (DEM) are conducting an investigation on the cultural eutrophication of Walden Pond. Cultural eutrophication is "an accelerated form of the natural process in which extra soil and nutrients are derived from people's use of fertilizer, rerouting of surface drainage, and disposal of domestic and industrial waste. There are many negative results that can come along with cultural eutrophication, some of which include increased growth of aquatic plant life, overabundance of decayed plants and eroded soil within the pond and a decrease in water clarity." The investigation mentioned above will measure all of these factors and devise a baseline date set on

Walden Pond's trophic state. Trophic state is defined as a measure of the pond's ability to sustain and support plant growth. (Colman)

2.3.6 Aspects of The USGS/DEM Cooperative Study

"The study is designed to establish the status of ecological features of the pond: to determine whether it is in a stable or changing tropic state, to determine the dynamics of nutrient cycles in the pond, and to quantify inputs from nutrient sources." (Colman) Some ecological aspects of the pond that may be monitored include the trophic state. This kind of monitoring includes obtaining data about oxygen and temperature measurements, mixing rates and fluxes, as well as oxygen generation and consumption. Nutrient Dynamics is another way to monitor the pond. This type of monitoring allows researchers to determine basic limnology about the pond such as dominant planktonic and benthic algae and the cycling of nutrients. This data can then be used to determine if Walden Pond would react differently than other ponds when excess nutrients are added. Nutrient sources are the last aspect being monitoring in this investigation. A nutrient source is considered a location where nutrients originate. The DEM and USGS have chosen three major nutrient sources to focus upon. These sources include swimmers, atmospheric input, and ground water sources. Swimmers input will be found by monitoring the increase of urine within the pond during the summer. Atmospheric input will be determined using samples from a wetfall-dryfall collector. Sources contributing to ground water input will first be defined, and then with the use of monitoring wells, ground water input will be determined (Colman).

2.3.7 Thermal Stratification

Being a temperate-zone pond, Walden experiences changing periods of thermal stratification and mixing throughout the year. The mixing and stratification that develops causes many chemical and biological processes that occur within the pond. (Colman) This mixing and thermal stratification occurs during the change of seasons, when the temperature of the atmosphere and water are changing. The best way to define thermal stratification begins with a description of the three layers of water that exist and the changes that occur within these layers during the change of seasons. During the summer the top layer, called the epilimnion, is warmed and is always in contact with the atmosphere. Dissolved oxygen, which is an essential life support for aquatic life, is in great abundance in this layer because of photosynthesis that occurs between the sunlight and the plant life of the pond. In the metalimnion, the middle layer, the temperature of the water decreases as depth increases. This layer also acts as a barrier, which ensures that mixing does not occur between the top and bottom layers. The bottom layer, called the hypolimnion, remains colder and thus denser then the two layers above it. There is not much dissolved oxygen in this layer because of the absence of sunlight. When winter sets in, the temperature of the epilimnion (top layer) drops until it reaches the temperature of the metalimnion (middle layer) and finally the hypolimnion (bottom layer). Once the temperature is uniform throughout the pond, water is allowed to mix freely and dissolved oxygen is then dispersed uniformly with depth. After ice forms over the pond's surface, the entire water body is isolated from the atmosphere and the pond continues to mix.

When spring comes, the ice begins to melt and a second mixing occurs before the surface begins to warm and return to "summer stratification" (Colman).

2.4 Informing the Public

When dealing with environmental issues that are caused primarily by the extensive use of the reservation by the public such as water pollution, overcrowding, traffic problems, and public safety, one starting point is to inform the public of what is happening and why. An educated public could help in some of the environmental issues at hand, especially the traffic issues dealing with overcrowded parking lots. A study, conducted for the National Parks and Conservation Association (NPCA), by the Human Dimensions in Natural Resources Unit of Colorado State University (CSU), showed that 9 out of 10 respondents to their survey, said they would use public transportation to national parks if it would cut down the traffic congestion and make for easier travel (http://npca.org/98posurv/intro.html). This displays how the public is willing to change their ways to help improve the traffic problems the park faces.

When people think about advertising, they typically think of the selling of goods, not public issues that need to be addressed such as those at Walden Pond. Advertising means drawing attention to something or notifying or informing somebody of something. To inform a large number of people about something, public announcements are the way to advertise (Dyer, 2). Ads in newspapers, a web page, television commercials, posters, fliers, and broadcasting over the radio are all effective ways of advertising. Holding lectures and seminars at nearby schools and institutions, are also ways of informing the public.

Effective and efficient advertising starts with two kinds of market information. Productive advertisers obtain the key facts on (1) just who the people in a market are and where they are located, and (2) how they live and why they buy (Gray, 5). This statement about advertising is focused on consumer advertisements and the selling of goods. The key facts, though, are still relevant in Walden Pond's situation; the advertisers still need to know whom the people they are educating, where they come from and how they live. These facts are important in order to make the advertising effective in getting public attention and conveying its message. This strategy is called pinpointing your market, and is basically described as knowing where to focus your advertising.

An advertiser likes to know how effective an advertisement was for their purpose. Research on the influence or effects of advertising is multi-faceted and can be approached from all different angles. One way is to examine the influence of ads on the individual and look for evidence of the ability of the advertising media to shape and sometimes change a person's behavior, opinions and attitudes (Dyer, 72). This is the kind of research that the Management Department at Walden Pond would be concerned with, because they are not trying to sell a product but educate the public in hopes that they will be more conscientious about these issues.

One way to get high advertising performance at low cost is the goal for any- one in the advertising business. This example could be very effective for the management at Walden Pond. The magazine called Outside, reaches about 225,000 readers, who are known for reading the ads more than the articles. A typical half page two color ad had a space cost of four thousand dollars per issue. This means a high performance story can be sold for well under a nickel per prospect. This is the case in many well-conceived

advertisements in special interest magazines. The readers will read the ads and respond to you at a minimal cost (Gray, 217). The problem is that Walden Pond currently does not have a budget set for advertising and would need to find a sponsor to incorporate the advertisement methods above.

2.5 Overcrowding

Carrying capacity is a limit that National Parks or State Reservations, such as Walden Pond, set to limit the number of visitors to a place at one single time. This is so the park doesn't become destroyed and lose the beauty that attracts so many people. This even becomes more important when the park is used for a wide number of recreational purposes that actually lead to the deformation of the park and its facilities. On the other hand, carrying capacities do limit the number of people who can enjoy the park.

There are several parameters that go into determining the carrying capacity of a site. The parameters that determine carrying capacity include how large the particular area is, what kind of wildlife lives in the area, and the recreational activities that are involved. In a research paper by Mark Behn, Fabio Carrera, and Jeff McGuire, the authors break down carrying capacity into four categories.

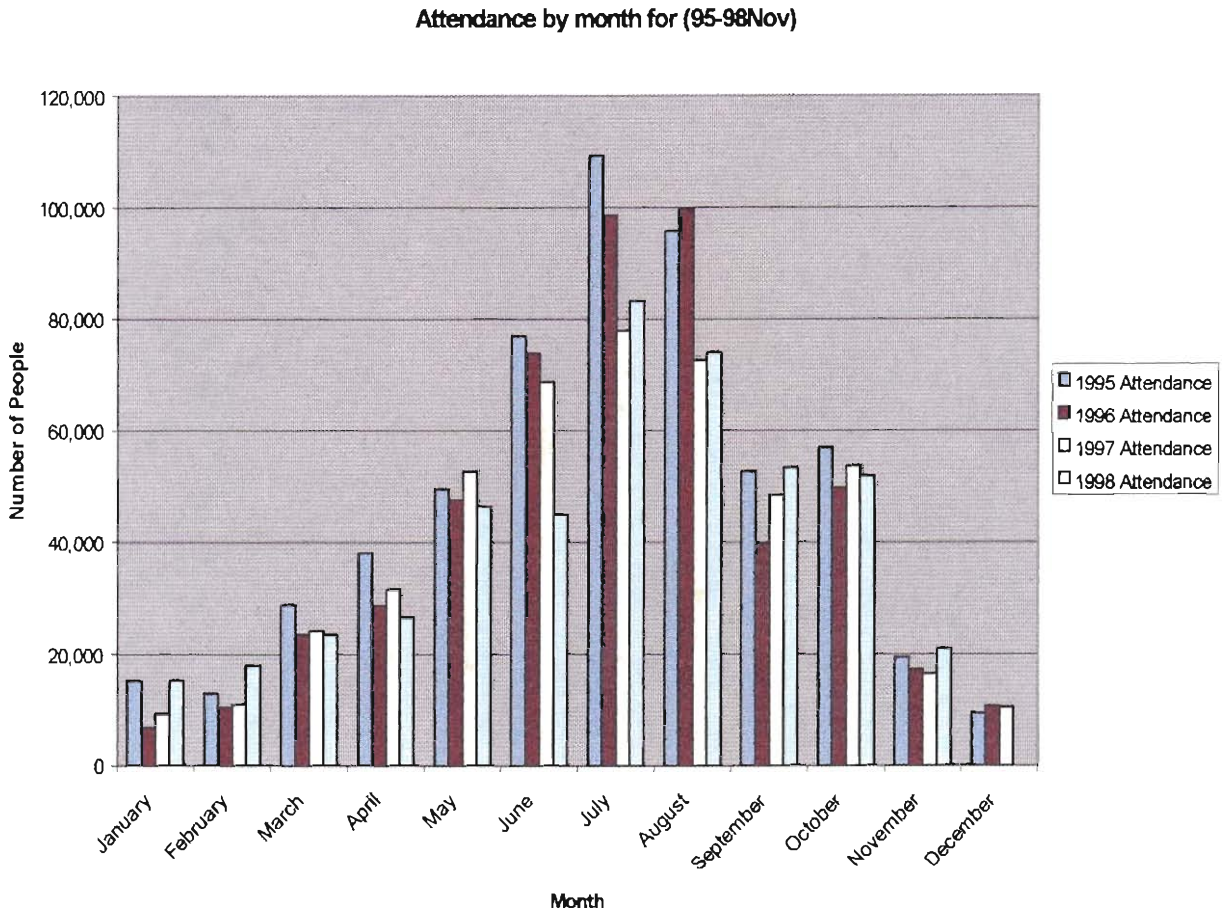
- Ecological capacity is the amount of impact that the ecological system can take without being destroyed. In particular this deals with vegetation, animals and the surrounding waterways and soil.
- Social capacity is defined as the maximum number of people who can use the site without ruining the experience for the visitors.

- Physical capacity can be described as the number of people who should be allowed on a specific piece of land.
- Facility capacity is the physical limits that the facility has in terms of necessities for the visitors. This includes bathhouses, parking space, and the number of staff members (Behn, 14).

Currently Walden has a carrying capacity of one thousand people at a time that is met several times during a day on some summer days. When the park fills, the parking gate on route 126 closes so no other visitors may enter until a few hours later when some of the other guests have left. Walden Pond had over 450,000 visitors last year alone and on average entertains more than 500,000 guests a year. Since 1995 was a hot summer, it had high attendance rates. In that year, 565,060 guests visited this historic site. In July of 1995 it had 109,244 people, nearly 20 percent of its yearly guests in one month. The park was also closed 61 times in 1995 for a total of 140.5 hours. Over one third of these closings were on Sundays and over 20 percent occurred on Saturdays. These attendance statistics are based on the number of cars that enter Walden's parking lot and do not account for the thousand of people who walk to the site each year. It also doesn't account for the boaters who park at the boating ramp, or groups that go to the group area (Information obtained from Walden files; See Table A3 on next page).

When the park closes park supervisors post a time between 2 to 4 hours later when the park will open back up. This is better than letting a person in for everyone, who leaves, so the park is not constantly filled to its capacity. During this shut down time usually 40 percent of the park's visitors leave voluntarily. The park shuts down when the Walden staff estimates that the park has reached capacity and does not keep the exact

Table A3 "Attendance by Month"



limit. The parking lot holds about 350 cars and, when this fills, the staff assumes that the park has reached its capacity. Cars are not allowed to wait on Route 126 until the park reopens, even though many people try (Goals Statement, 12).

Many other parks find it hard to keep their beauty while having a high number of visitors. This is the case for the Delaware Water Gap National Recreation Area (DWGNRA). This park receives around 4.37 million visitors in one year and the staff works hard to restore its beauty. This park incorporates a reactive strategy that is called

Limits of Acceptable Change. This strategy includes taking data measurements that show the park is starting to deteriorate, such as the widths of trail ways, the water quality levels, traffic and other issues. There is a reasonable standard to which these calculations are held. If at anytime these standards are not met then the problem is dealt with. For instance, a path or pond might be closed or a new capacity limit might be enforced if the problem continually occurs. The DWGNRA also finds it difficult to upgrade their services to visitors. Although a proposed visitor's center at the DWGNRA would greatly improve the quality of the park, it is feared that it will also draw more visitors from Interstate 80 that passes by the park. This, unfortunately, would cause more deterioration to the park's surroundings (www.libertynet.org/drkn/factsheets/Carrying_Capacity.html).

Using Limits of Acceptable Change (LAC) is regarded as an effective tool and is endorsed by the National Park Services. LAC is even used at the Grand Canyon where overnight visitors are limited and users must have reservations and permits. The only downside to using LAC is that it is a reactive strategy. Meaning that it doesn't prevent damage but controls the level of decay and then repairs it. Carrying capacity, on the other hand, is seen as a pro-active measure that tries to stop the problem before it occurs.

2.5.1 Restoration Project at Walden Pond

Over 500,000 people come to Walden every year and it has had a negative effect on the shorelines, causing heavy erosion. A Restoration Project has been incorporated at Walden Pond to restore the banks to its native condition that has not been seen for 75 years. Three techniques were used to help restore the banks at Walden.

1. Brush Layering is to cut living plants from other sites and bring it to the restoring location. The branch cuttings are then layered between lifts of soil so the leafy end is

exposed. This builds the slope of the bank up with alternating layers of new soil and brush.

2. Bundled Fascines are long bundles of branch cuttings bound together by twine so all the leafy ends are facing one way. They are placed in shallow trenches and they are held in place with wooden stakes. Fascines begin to grow as soon as these are in place.
3. Live Staking is the final technique used. Easily rooted species are staked to the ground using three-foot long cuttings that have been stripped of all their branches. They are hammered until only six inches of the stake is above the ground and their purpose is to hold down erosion control materials like the bundled fascines mentioned above (Restoration Project Pamphlet).

Along with these techniques, thirty thousand native plants have been grown from seeds and cuttings from the reservation to grow trees and shrubs on the bioengineered vegetation. The area where the restoration is being done is also fenced off with "Do Not Enter" postings to give the plants a chance to grow. It will take two to five years to be able to notice the regrowth that is occurring.

3.0 Methodology

There were four main methodologies employed in this project to find ways in which Walden Pond overcrowding problems could be solved. These four methods are brainstorming ideas, interviewing, gathering public information, and determining the carrying capacity for Walden Pond. The following is a background on why each of the methodologies was employed during this project.

3.1 Brainstorming Ideas

The first methodology employed was to create different ideas that could solve some of the problems that exist at Walden Pond. These problems are overcrowding, public safety, informing the public, traffic congestion, and water quality. It is important to think of as many ideas as possible. Each idea attempted to solve either all of the problems that exist at Walden or were aimed at just one of the problems and needs to be employed with other ideas to completely solve Walden's problems. Brainstorming allows for old ideas to be re-evaluated, as well as new ideas to be investigated.

3.2 Interviews

Interviewing was a tool used throughout the project that helped to give a better understanding of Walden's problems and also solutions that could be used. By interviewing the staff at Walden it was discovered what solutions they have tried in the past, and how they could be built upon. Interviewing other people with specific backgrounds was also helpful in the project to gather more information. They were also

encouraged to give their input on other solutions and explain how they would feel if a particular solution was implemented.

Since Walden is a historic site, there are many societies that look out for the well being of the park. It was also beneficial to interview members of these societies, such as the Thoreau Society and Walden Woods, to get their input on how they feel the park should be preserved and what solutions they feel should be used. Interviews also take place with experts in traffic as well as public safety to see potential problems that were overlooked and the best ways to solve them.

There are a few things to remember when conducting interviews. It is important not to mislead the interviewees with questions that can lead to bias end results. In other words, the questions must be worded so they are clear and not confusing. It is also important to analyze why two interviewees would feel differently about the same idea. Does the interviewee represent an organization? Does the interviewee benefit from the idea?

3.3 Collecting Data

There are other creative solutions that could be developed if it is known who the target audience is. For example, if most of the people coming to the park are from two towns, then a system could be developed whereby each town is allowed admission on alternating days during the summer. To this point, no information is gathered on the people who attend Walden Pond and therefore this lack of detailed information limits the ability to develop these creative ideas. A survey was designed to give to people before they buy a season pass. The information on it asks for the visitor's name, address, as well as information on how often they visit the park and what recreational needs they take part

in. It also asks them if they are interested in receiving information in the mail about Walden Pond. Since Walden Pond sells 2300 season passes each year, this will provide a good sample of the visitors who come to the park. The questions that are asked are straightforward so they do not add a bias similar to the interview questions.

3.4 Carrying Capacity

Walden Pond has a carrying capacity, setup by the DEM, of 1000 people allowed in the park at one time. This is enforced by allowing all 332 parking spaces at Walden to fill assuming there are 2.5 people in every car. It is also assumed 140 people walk into the park during this time. Walden Pond is in the process of a restoration project that was done because of wear and tear on the park. It is important that the two million-dollar project has a chance to flourish. Two questions are now raised. Is the 1000 person carrying capacity too high and causing excessive damage to the park? Or are more than one thousand people getting into the park?

The two largest beaches, the Main Beach and the Red Cross Beach, were measured to find out the actual beach area of the park. This should determine how much beach space each person has and see if the space is sufficient for the 1000 person capacity limit. If this space is ample then the number of people getting into the park needs to be looked at and a new figure for people per car should be calculated.

4.0 Procedure

The main procedure employed by this study was to gather data through the use of interviews. Ten interviews were set up to gather information from experts in the several fields of concern to Walden Pond administrators. The questions for the interviewees were selected based on the interviewee's background and expertise. Complete transcripts of all interviews are presented in Appendix C. Through these interviews, feedback was obtained on the brainstorming ideas that were generated to solve some of Walden Pond's issues. Interviews with individuals, educated in various fields, helped to clarify which strategies are superior for addressing issues such as: overcrowding, traffic, public safety, water quality, and public information. Each person who was interviewed was also asked if they could suggest any other references in their field that would also be useful. The interviewees and their titles are listed below:

- Helen Bowdoin, Education Program Director at the Thoreau Institute;
- Ken Bassett, President of Sasaki Association, Chairman of Walden Pond Board of Directors
- John Colman, USGS scientist, recent study done on Walden Pond's water quality
- Tom Harris, Executive Director of the Thoreau Society
- Todd Frederick, Director of Forests and Parks for the DEM
- Peg Campbell, Walden Pond Park Supervisor

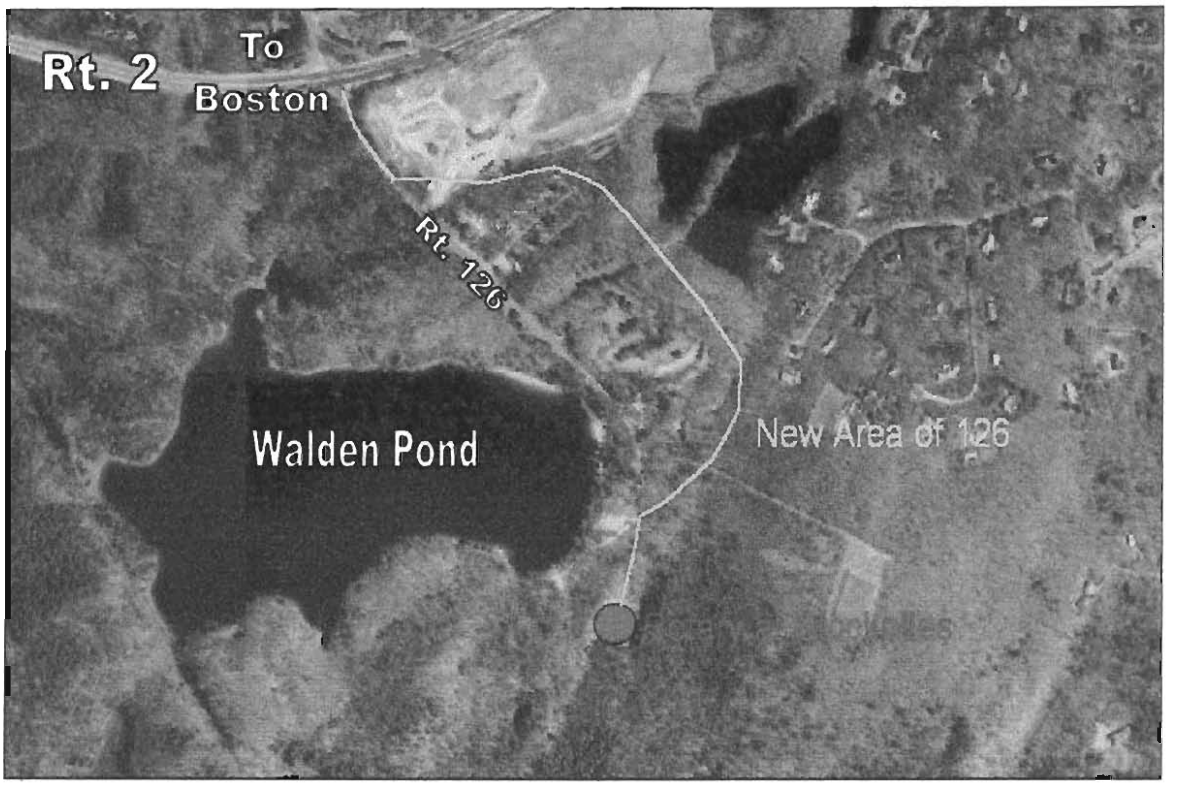
- Karst Hoogeboom, Former Project Manager at Walden Pond, and presently the Project Manager for the Big Dig
- Dan Kuja, Park Ranger
- Trooper Pellegrino, State Trooper
- Trooper Walsh, State Trooper

These interviewees were asked about specific proposed solutions that have been put forward in an effort to try and improve the overall quality of the park. These tenative tentative proposals are presented below:

1. Rerouting 126 - This plan would make Route 126 retain the same intersection with Route 2, but 126 would branch off at the trailer park and wrap around the back of the parking lot. This would make it a right hand turn into the parking lot. The road would meet up with the original Route 126 after the boat ramp entrance. See figure A5.
2. Road Parallel to Route 126 - This idea would make a separate entrance off Route 126 for Walden Pond only, and would run parallel to Route 126.
3. Rotary at Stockpile - The plan would be to place a rotary past the current entrance to Walden and not allow left hand turns into the parking lot. People would turn at the rotary and take a right hand turn into the parking lot. It would also give visitors a place to turn on Route 126 when the park is closed. See figure A5.
4. Raising Admissions - Raising the admissions, from two dollars, would lower attendance and bring in more money for the DEM.

5. Low Frequency Radio Signals - This plan would allow for signs on Route 2 to ask motorists to tune to a radio station. The radio station would give updates on the park including park closings. This would allow people to turn around before they get to close to Walden when the park has been closed and thus not add to the traffic congestion.
6. Pamphlets - Making pamphlets that would be passed out to visitors who show up when the park is closed. It would tell the visitors of alternative sites in the local area that would fill some of the same recreational needs that Walden has.
7. Swimming Passes - Buying swimming passes days in advance, would allow people to come to the park only if they had called in advance and bought a swimming pass. The number of passes given out on a single day would be limited.
8. Close the Parking Lot - Close the parking lot and have visitors bused in from a local business that may have extra parking, or the local high school. The current parking lot would be used in the off season and for handicap parking during the summer.

Figure A5 "Orthophoto Image of Walden"



4.1 Carrying Capacity

The next step in the procedure was to analyze equations or methodologies frequently used by professionals to calculate carrying capacities. This helped to fit Walden Pond's capacity to its specific terrain. Data was collected on the size of the beaches and the designated group areas as seen on the maps. This showed the average area of land that each swimmer, boater, hiker, and picnicker has based on the current carrying capacity of one thousand people. If these areas are unacceptable for these specific Walden Pond activities, then an acceptable area will be determined and a new carrying capacity will be suggested.

4.2 Collecting Data

The final step in the procedure was to collect more information on the visitors who frequently come to Walden Pond. Currently no information is gathered on any of the visitors who come to Walden. A form has been designed that asks the visitor for their name, mailing address, telephone number, email address, the average number of visits they make to the pond each year, and which recreational activities the visitor participates in at Walden Pond. This form will be given to people who buy DEM season passes at Walden Pond. Currently twenty-three hundred people buy season passes at Walden, which will provide a good sample of the people who attend Walden each year. These forms will be made available to the season pass holders in advance through the Walden Pond website, or through ads in local newspapers. To obtain a season pass, both the form and fee will be collected. The data collected from these forms will not be used in this project because no season passes will be sold in the time period when this project is being undertaken. However, knowing what audience attends the park will be a useful tool for future project groups to analyze more creative solutions to solve Walden Pond's concerns directly based on the people who visit the facility.

5.0 Results

5.1 Rerouting Route 126

Rerouting Route 126 is an idea that has been considered for many years now and has support from most of the interviewees. Each interviewee has brought up several advantages to rerouting 126. Karst Hoogeboom, former Project Manager at Walden, pointed out that currently when driving down Route 126 the pond is visible from the road, and there are many disadvantages to this. Hoogeboom felt if the road was rerouted it would move the car noise away from the pond, and also avoid potential environmental disasters. Hoogeboom noted "if there were an accident and an oil spill in this area right here next to the headquarters. Those catch basins go either into the pond or onto the shoreline above the pond. Whatever that contamination is will go right into the pond." He also pointed out that, since the pond does not have any inlet or outlet streams, whatever enters the pond stays there for an extended amount of time. The pond being so close and visible from the road also makes it very tempting for people to drop their passengers off on the side of the road when the park is closed.

In a recent study done by the DEM, they found that Massachusetts park visitors were concerned mostly with cleanliness and safety when attending a recreational facility (Sandler, 16). However, the current road set up at Walden is very dangerous. Walden Pond has thousands of visitors that cross Route 126 every day during the summer to get from the parking lot to the pond. Helen Bowdoin, the Education Program Director at the Thoreau Institute, voiced her concern. "It's a miracle that there aren't a lot of accidents

because you get baby carriages, you get wheelchairs, you name it, its crossing route 126." Peg Campbell, the Walden Pond Supervisor, had similar concerns as she tells stories of sitting in her office and hearing car tires screeching to a stop. Rerouting Route 126 would minimize a large number of these public safety issues currently at Walden.

Another dangerous issue is that most of the traffic comes from Route 2 which makes it a left hand turn into the parking lot, so traffic must be crossed. Rerouting Route 126 would make this a right hand turn and get cars into the parking lot, and off of the roads, quicker. Kenneth Bassett, President of Sasaki Associates in Watertown and Chairman of Walden Pond, acknowledged that this was one of the benefits that a consulting firm had discovered in its recent proposal to Walden. He also stated that rerouting Route 126 is something that the Board of Directors is strongly in favor of. Bassett also stated that he couldn't estimate exactly what the cost would be but did not see it as an expensive project in terms of road construction. He said, "Well it's not a five million-dollar project but it's probable more than five hundred thousand dollars. Maybe it's a million and half-dollars or something like that."

John Colman, USGS scientist, said rerouting Route 126 would decrease the amount of salt that goes into the pond during the winter, but that it really doesn't effect the pond that much now. He also added "I'd say that probably the pond doesn't really have a water quality problem, that we are certain of."

5.2 Road Parallel to 126

In an effort to keep Route 126 open for travel by Concord and Lincoln natives, the idea of making a separate entrance to Walden off of Route 2 was discussed. This option had some interviewees concerned. Ken Bassett felt that this was not a good idea since

cars were traveling sixty to seventy miles per hour on Route 2 and would be expected to slow down to five miles per hour to turn into a parking lot entrance. Currently Route 126 provides a zone in which cars can slow down from seventy miles per hour on Route 2 to thirty-five miles per hour on Route 126, before slowing to 5 miles per hour at the parking lot, thus providing a smoother transition. He also pointed out that the state would never allow for two signalized intersections right next to each other on Route 2. Karst Hoogeboom also voiced the opinion that several problems would arise from this option. He felt that "in an ideal world" it might work, but there are too many design flaws with it.

5.3 Rotary at the Stockpile

Not allowing for a left hand turn into the parking lot and placing a rotary down the road was an attempt to get the benefits of right hand turns into the parking lot at a lower cost than rerouting Route 126. This had mixed results. Although Kenneth Bassett felt that this would upset the towns of Lincoln and Concord, he felt that maybe a U-turn should be incorporated into rerouting Route 126 so, once the park closed, people would have a place to turn around and leave the area.

Todd Frederick, Director of Forest and Parks for the DEM, felt this idea had some merit, however he didn't think it was a good idea when looking at the long term goal of trying to reroute Route 126. He also felt that environmentally this idea might not be the ideal solution since it would have all the construction right next to the pond. Although, once the park is full it would be quicker to clear people off the road.

5.4 Raising Admissions

Raising the price of admissions is another option that might make the site less attractive and also generate more money to incorporate some of these ideas. Todd Frederick pointed out that at his next DEM board meeting this is exactly what is going to be discussed. Frederick said "It makes some sense to raise the fee and also to charge at other parks that don't charge for whatever reason." He also pointed out that Walden can not simply raise its admissions. Ultimately the governor has final say on what the fees are and only supporting documentation can be provided to help support admission recommendations. Frederick also points out that charging ten dollars would probably still draw large crowds, but the idea might be useful when incorporated with other ideas.

Karst Hoogeboom said that he feels it is dangerous to link the money needed for projects to the price of admissions. He pointed out that Walden does not get the money it generates at the pond but instead funds go into a general park pool where it draws money from. Peg Campbell also thought it is dangerous to raise the prices to the point where not everyone can enjoy the park because it is too expensive. Some families don't have a lot of resources and still want to cool off during the summer or enjoy the Thoreau experience. Helen Bowdoin also added that a lot of people can't afford to go away for vacation and want to swim, but the resources need to be protected at the same time. So, it is a tough issue to take a stand on.

5.5 Low Frequency Radio Signals

Using low frequency radio signals would allow people to tune to an AM radio station prior to coming too close to Walden and find out about park closings. This would allow visitors to turn around before getting to close to the park and help with the traffic congestion. This idea got very good support in the interviews. Todd Frederick mentioned that Horse Neck Beach, in West Port, uses this method to inform people not to make a twelve-mile ride down the road to get to the park when it is closed. He felt that this solution makes a lot of sense and it is something that he would like to see.

Karst Hoogeboom also felt that the low frequency radio system is a good idea. He said "That (the radio signals) would be something that is relatively inexpensive and easy to do, I think that should be done." He also added it's important to let people be informed of park closings as soon as possible.

Horse Neck Beach in Massachusetts currently uses this method to inform its visitors of park closings before they take a twelve-mile drive on the road that leads to the park. This option was very expensive and results in construction that would have to be done near the pond in a large field the DEM would have to buy. This is because of the large area of copper wire that is under ground. It is also because if construction was done near this site the radio signal would be lost, which happened at Horse Neck a few years back. This system is useful however because the radio message can instantly be changed with a phone call from the park supervisor.

5.6 Pamphlets

The pamphlet would be designed so that it informed visitors, who were not allowed into the park, of other places they could fulfill their recreational desires that are met at Walden Pond. There are a few problems that this would cause. First there are hundreds of thousands of people who visit Walden each year and the supply of these pamphlets would have to be almost never ending. There is also a fear that some or most of these pamphlets would end up on the side of the road, or even in the pond. Peg Campbell expressed her concern over both matters pointing out that 3000 pamphlets would be given out in a single day. That's 21,000 a week and over 200,000 during the summer months.

5.7 Buy Swimming Passes

Buying swimming passes a few days in advance would be an attempt to limit the people who are allowed to come to the pond each day. Many interviewees were very intrigued by this idea. Karst Hoogeboom felt it is a good idea but it would require policing to be sure that the right people are getting into the park each day. Todd Frederick also showed interest in this but thought it might be difficult to enforce this system as well. Peg Campbell also felt policing would be difficult and also introduce thousands of phone calls to Walden each year.

5.8 Close the Parking Lot

This plan calls for parking at a local site and having the visitors bused into Walden. The parking lot at Walden would be closed all summer except for handicapped visitors and elderly people. This idea also had the interest of some of the interviewees. Similar to the swimming passes, there was concern over how these parking lots would be policed. Karst Hoogeboom pointed out that if you went to a local high school or business that has unlimited parking it would be extremely hard to monitor who gets into the park. Dan Kuja, a DEM Ranger, pointed out that few people would be willing to take on the traffic issues that Walden faces and introduce them into their location. This solution also adds a yearly fee to the DEM to rent buses, parking lots, and bus drivers. In the long run this solution is not as cheap as first thought.

Currently, Acadia Park in Maine uses this system. The difference is this park is on an island and has millions of visitors each year. This makes it more practical for this park. Every time Walden closed the buses would be idle for two hours and the park would be paying for it.

5.9 Season Pass Form

The form was constructed to provide the park with information on the visitors that come to the park. The form was designed with the help of the Walden staff, using

information they would like to gather about the visitors. See Appendix D for the form that was designed.

5.10 Carrying Capacity

The following data was collected from the beaches at Walden Pond. The main beach was measured using a fifty-foot measuring tape and the square area was found to be 9,846.5 square feet. The Red Cross Beach was also measured and this area came out to be 8,606 square feet. The calculated area of these two beaches is 18,452.5 square feet. With a thousand people capacity limit there would be 18.5 square feet of beach for each person who comes to the pond. This is assuming all 1000 people go onto these two beaches. Since some people will be fishing, walking the paths, lying in the group area, or settling on the beach stonewall and other areas this beach area per person increases and is enough area of land if only 1000 people are on the land.

The interviewees disputed whether the capacity at Walden is too big. Helen Bowdoin and Tom Harris both felt that the number of people allowed into the pond seems a bit high and would like to see the number re-evaluated. Karst Hoogeboom felt it is very important to protect the appearance of Walden. He thought that the one thousand person capacity limit wouldn't destroy the park as long as the staff makes sure the visitors stay off the banks and other places they are not supposed to go. Hoogeboom felt a lot of the staff spends their time patrolling traffic which takes time away from monitoring people in the park and other duties. He felt rerouting Route 126 would free staff up for other tasks.

6.0 Analysis and Conclusions

One recommendation that has strong support is to re-route 126. This has been a long sought after project that has been considered for many years. After reviewing the results, it can be seen that there are a number of benefits to this project. A major benefit gained from this type of project would be the increase in safety for visitors to the pond. Visitors would no longer have to cross a main road to get from the parking lot to the beach.

Another benefit involves the environmental state of the pond. The risk of environmental disaster, to the pond, caused by an accident on route 126, such as an oil spill, would be reduced. Another positive outcome from the re-routing of route 126 would be less traffic congestion around the entrance to the parking lot. If the road was rerouted then the majority of visitors would be taking a right hand turn into the parking lot, as opposed to the left hand turn that is in effect now. It is also beneficial for the plan to have a turn around right after the park entrance to provide any easy way for the cars to turn around after the park closes. A right turn only lane into the park should also be provided so that traffic traveling from Lincoln to Concord can still get through by passing on the left.

Another suggested recommendation is to slightly raise the admission to the park. This increase in admission would not have to be tremendous, perhaps involving an increase in the admission from the current two dollar fee to five dollars per car. It is also recommended that season passes and buses be raised from fifteen and twenty dollars respectively to twenty five dollars apiece. By raising the admission more revenue would

be collected, and could in turn be used to fund projects in and around Massachusetts State Parks. The intent is to increase the revenue accumulated from state parks, and to give this money back to the parks to fund much needed projects.

Given the large number of people who are turned away once the parking lot is closed, much thought was given to finding a solution. The use of a low frequency radio station to inform visitors of the park closings and traffic conditions is a recommendation for this problem. By informing visitors about the park closing, the traffic around the entrance would be greatly reduced. Visitors would hear that the park was closed even before getting close to the park. This would prevent them from coming to the park. The radio station would also inform the visitors of when the park would reopen. Currently, no DEM parks have a radio system that is environmentally and ecologically to the best interest of Walden Pond. But cheaper methods using cell towers or other radio signals should be investigated.

There are numerous other ways in which this informative radio station could benefit the park staff as well as the visitors. The radio station could also provide people with other areas that are nearby which provide recreational activities similar to Walden's. Announcements educating people about some of the problems present at Walden, could also be another benefit of this radio station.

Another recommendation is to require people who purchase seasonal passes to fill out a form. This form would allow for a better understanding of what type of people buy seasonal passes and where they live. Other information that could be requested on the form could be the number of times people come to Walden during the summer, as well as

the recreational activities they participate in. A draft of this form can be seen in Appendix D.

It is recommended that the forms be passed out at the gate when the money is collected. The visitors then go park and fill out the form. This is so there will be no back up at the gate. A season pass will not be given to the visitor until the form is turned in at the gate. It will serve as a receipt for the pass. The park worker, at the gate fills out the receipt section of the form, when the form is given to the visitor.

After studying some of the problems that are present at Walden due to overcrowding, a conclusion regarding the carrying capacity was reached. After measuring the two beaches used by visitors during the summer months it was concluded that there was enough room for one thousand visitors to use the beach at one time. However, this one thousand carrying capacity should be monitored more closely. It seems as though most of the time there may be a lot more than 1000 people present on the beach at a given time. This may be due to the counting method used to determine the number of people present in the park at a given time. Currently each car, including busses and vans, entering the parking lot is expected to hold 2.5 people. A recommendation to remedy this problem is to recalculate the average number of people that attend the park in the summer months. It is also recommended to count the number of people who walk into the park each day and determine the correct number of parking places that should be used at Walden Pond.

7.0 Recommendations

This section is provided to give an outline of future projects that could further help the DEM at Walden Pond. The first recommendation for a future project is to further investigate radio tower options for Walden Pond. Currently the system the DEM uses at Horse Neck Beach would not be beneficial to Walden economically. Investigation into local cell towers and cheaper forms of communication should be done. It could also be useful to look into using a statewide network for the DEM. Areas to place towers far enough away from the pond must also be looked into.

The second recommendation for a project is to analyze the data collected from the season pass form designed in this project. The season pass was unable to be administered during this term because no passes were sold in this time period. This new project will look at different ways to tackle the overcrowding problems at Walden, with the intention of pinpointing its audience. It will also look into getting sponsors to support Walden and its projects based on the interests the users have.

The last recommendation for a project at Walden is to recalculate the number of passengers in each car during the summer months and determine how many parking spaces should be available during the summer. It is also necessary to calculate the number of people that walk or bike in during this time. An accurate count of the actual number of people entering the park needs to be established to make sure that the carrying capacity is not exceeded.

APPENDIX A

Walden's Background

The creation of Walden Pond began by the action of a glacial remnant over 10,000 years ago. As the glacier melted and moved southward, it left behind a steep-sided basin 100 feet deep, and is today known as Walden Pond. Unlike other ponds, Walden's water level remains consistent through wet and dry spells. This is a result of Walden Pond's having a band of permeable material. When ponds have less permeable bands, rain does not drain during wet spells and water quickly evaporates off of the surface during dry spells.

Henry David Thoreau's love for nature and grief over his older brother's death led him to live in the woods and further his career as a writer. In 1845 Ralph Waldo Emerson, one of Thoreau's close friends and himself a famous writer, offered him use of a wood lot at Walden Pond that he had recently purchased. Thoreau's early interest in the natural setting of Concord, where he grew up, deeply influenced his choice to accept this gracious offer. Thoreau developed his concept of land conservation, over a period of two years, while living in a hut he built for himself at Walden. In 1854 Thoreau published the book, Walden. This book described Thoreau's observations and experiences while living at the pond. The publication of this book gave both him and the pond literary and historical significance that is still present today.

After Thoreau's death various projects were developed to attract the public to Walden Pond. In 1866, The Fitchburg Railroad built an excursion park near Walden Pond, which included concessions, swings, bathhouses, and other recreational facilities. The park further expanded in the late 1800's to include athletic facilities. This excursion

park that once served fund-raisers, festivities, and cultural events burned down in 1902, and was never rebuilt.

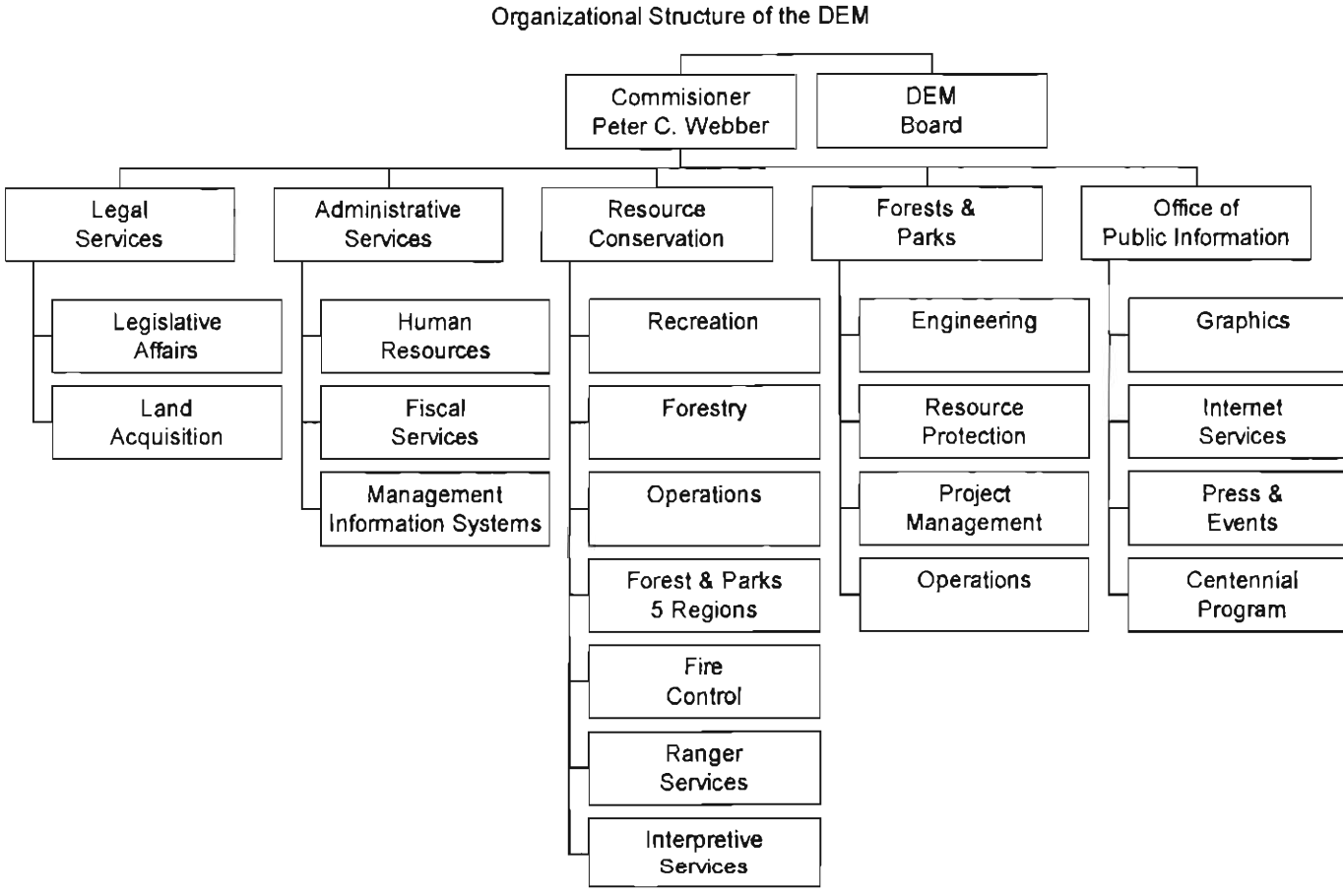
In 1913 the town of Concord began to take a more active role in the development of recreational activities at Walden by offering swimming lessons to the public as well as assisting in the pond's maintenance. As automobiles became more popular, numbers of visitors increased to 20,000 people per day. In 1922, family members of Emerson, Forbes, and Heywood, all of who were non-conformist writers and friends of Thoreau, granted the 80 acres surrounding the pond to the Commonwealth of Massachusetts. They donated this land with the intention of preserving Walden Pond and its woodlands to ensure present and future public enjoyment. In the deeds, dated June 29, 1922, it specifies that the land must be used for bathing, boating, picnicking, and fishing. Amusements such as hunting, trapping, camping, motion pictures, dancing, and athletic events are prohibited. Any violations of this deed and the land would be given back to the estates of these families. The Commonwealth of Massachusetts gave Middlesex County the responsibility for the care and upkeep of Walden Pond.

As the pond became more popular, the number of visitors grew to astounding new heights. As early as 1935, close to 485,000 people visited Walden Pond in one year, and on certain days, such as Sunday, overall attendance reached numbers as high as 25,000. Walden Pond became a Registered National Historic Landmark by the National Park Service (NPS) in 1965. Finally, in 1975, the Massachusetts Department of Environmental Management (DEM) gained full responsibility, from Middlesex County, to regulate and supervise the park. The DEM made many renovations to restore Walden's natural setting. This included renovating bathhouses to make them fit in more

closely with the natural setting, as well as repairing the damaged banks of the pond. Most importantly, the DEM incorporated a regulation that restricts the number of visitors to 1,000 at any given time. This carrying capacity was set so people could enjoy a mixture of recreational resources while at the same time honoring the cultural and historic background that Thoreau created so many years ago.

The DEM maintains management of more than 267,000 acres of land and water within the Commonwealth of Massachusetts. In 1974 The Department of Natural Resources was replaced by the DEM. There are five major divisions within the DEM, which include: Legal Services, Administrative Services, Divisions of Forests and Parks, Division of Resource Conservation, and Office of Public Information. (See Figure A6) Each of the above divisions is responsible for different areas of management. However, the main goal represented in the DEM's mission statement brings all five divisions together to focuses upon two objectives. These two primary objectives are 1) to conserve and protect certain resources of the state of Massachusetts, and 2) to make available these resources for the enjoyment of the citizens of the state (Behn, 6).

Figure A6 " Organizational Structure of the DEM"



APPENDIX B

Thoreau Institute
&
Walden Woods Project

Thoreau Society

The Thoreau Society was established in 1941 and is the oldest and largest membership based society that has been established for an American writer. The society's goals are to honor the great Henry David Thoreau, to educate people about his life and his teachings, and to research his works. They feel by doing this they will stimulate people's interest in Thoreau and more people will join their cause. This society is also concerned with the preservation of Walden Woods, the Maine Woods, the Estabrook Woods, as well as Henry David Thoreau's birthplace.

Currently it costs 35 dollars for a U.S. citizen to join with special rates for families, 50 dollars, and students, 15 dollars. With membership one receives the Thoreau Society Bulletin, a quarterly newsletter that has articles about Thoreau and his contemporaries as well as news about upcoming events. There is also a Concord Saunterer that is given yearly to the members that contains 200 pages of in-depth essays of Walden and how Thoreau's thinking influences our society today. Along with this the society has made over 32 booklets since 1941 that can be purchased through the organization. They are also in the process of placing all these booklets on the web to make them more accessible. The society also sponsors lectures, annual gatherings, and excursions for its members.

The Thoreau Society and the Walden Woods Project have also developed the Thoreau Institute. This is a building that is located half a mile from Walden Pond. It is a center for the collection of Thoreau's works and related sources. It contains a library, media center, reading room, and accommodations for prestigious guests. Several

educational programs on Thoreau are also held at the Institute over the year. The offices of the Thoreau Society as well as the Walden Woods Project are also located here in the Thoreau Institute. (www.walden.org/society).

Walden Woods Project

The Walden Woods Project is another society that is involved in the preservation of Walden Pond State Reservation. Walden Woods Project is a non-profit land conservation organization that was founded in 1990 by Don Henley, the famous music artist and activist. Henley not only founded the Walden Woods Project, but also established the Thoreau Institute. Due to these great achievements, he was awarded the National Humanitarian Award by President Clinton.

The Walden Woods Project was formed because of the threat of development near the pond and the surrounding woods. This began during the late 1980's when a group of developers proposed to construct an office building and a condominium complex in Walden Woods. The Walden Woods Project was quickly formed, and immediately began to raise money. They succeeded by raising sufficient funds to purchase the woods that were in danger of being destroyed by developers.

The mission of the Walden Woods Project evolved into its current two-fold setup. The first part of the mission is to protect land of ecological and historical significance surrounding Walden Pond. The second part of their mission is to support the Thoreau Institute and its educational initiatives related to the study of the environment and the humanities.

The Walden Woods Project is still active today in protecting the Walden Woods. One of the most recent threats is a landfill located at the intersection of routes 2 and 126, which is in close proximity to Walden Pond. This landfill is endangering the quality of water in the pond by possibly contaminating ground water.

APPENDIX C

Interviews

Interview w/ Todd Fredrick

On April 13, 1999 an interview with Todd Fredrick was conducted at Walden Pond. The interview was held at 2:00 p.m. with Tim Briggs, Gregg Burnett, and Danielle Froio in attendance. Todd Fredrick is the Director of Forests and Parks for the DEM. He has been in this position for six years. Todd Fredrick was given a summary of the brainstorming ideas that have been developed during this project.

Q: How would Walden Pond go about adjusting its admission prices?

A: That's a timely question. In that earlier, I report to, as well as a commissioner, a seven-member board that's appointed by the governor and today was our monthly board meeting. We move the meetings around to different facilities, it gives people a chance to see what's out there. The local park users may go to the meetings as well. The topic for the next board meeting, in the middle of May, is actually going to be user fees. And taking a look at the two dollar fee. Is that an appropriate fee? Back in '93 it was a five dollar fee, Governor Weld then wanted to increase public access to its' facilities by making them more affordable to more people. They then rolled the fee back to two dollars. So we are going to take a look at that. It makes some sense to raise the fee and also to charge other parks that don't charge for whatever reason. It could be political or the administration at one time or another decided not to charge a fee at that particular park. We only make recommendations to the Secretary of Administration and Finance. The person holding that position reports to the governor. The governor ultimately has the final say over who that individual is, but that person makes the final policy decision on wether fees are adjusted upwards or downwards. We can supply all sorts of supporting documentation but I can't as Director sit here and say we are going to charge more at this park than another park. Charging and collecting established fees at facilities where we don't collect presently, sure we can do that. But adjusting fees is not something that I can do, and that has been an ongoing recommendation for years. But then it becomes a public policy issue as to what is fair. If its five dollars is that fair? I think here you could charge ten dollars and still have cars backed up, so that is a tool to manage visitors, it might not be number one but its one of the tools of the box.

Q: Do you think that buying swimming passes days in advance would work? Do you think it would be a useful solution or do you feel it would cause more problems?

A: A couple of the solutions you have recommended to date certainly merit more investigation. The swimming pass is interesting, I have to explore more how it would work. I think what you're saying is you have an appointment that you could come to the facility by order in advance and you'd kind of sell the place out. Maybe that does make some sense and you should see what Dave Hall, the Regional Director who reports to me in this area, would think about it. But the secondary challenge you would have to that or the primary challenge to that would be people are still going to show up. So the publicity campaign would be that this is the way we are going to do it around Walden and try getting the word out to the greater number of people. You know, on hot days people

haven't looked at the newspaper, they don't know the rules and regulations, and they don't know how you manage Walden. They may not tune into AM radio because who listens to AM radio, probably not people who come here. So its signage and education and putting things on the website, on our website, or that way. But that's sort of an interesting idea, you get more people through the gate quicker and you don't have that exchange of money maybe we could manage that level a little bit better. Or maybe offer a discount to people who do that or something, but that's going to sell out then we are going to have to deal with that issue.

Q: Do you know of any other parks that have similar overcrowding issues and how they have dealt with these issues?

A: Here in Massachusetts?

Q: Yes, here in Massachusetts.

A: No, this is really the first attempt the state has used in managing use through the parking lot. At the time it made a lot of sense but now the use has changed and people are starting to come on bicycle. And the beaches are getting overcrowded and its not just the car thing anymore. We are using the Walden example, you know the work you folks are doing, and have hired some private contractors too, to look at the carrying capacity here. Now there are some formulas we can then use and apply them to other facilities. But right now this is the only one that has a managed capacity for day use. Wachusett Mountain ski area has a long term lease with the Commonwealth and we limit the number of skiers by the number of tickets sold on a given day and when they reach that threshold stop selling tickets. But that's about it and it happens about 14 times during the season where they have those turn away days where they actually close down the park. I know Arcadia up in Maine has a similar type of thing. I don't know if you're looking at what they're doing up there where they bus people in. It's kind of a limited number and they are working with the community and talking about even going further than that where you buy a chit to get through. But some forests or national parks you have to plan ahead to do it. You know maybe we need to take that step here but I don't know politically we'll be able to go from where we are now to you have to have a reservation to get in. That's the sort of the stuff I'm familiar with to date.

Q: Do any of the ideas previously discussed stand out as good or bad ideas, or is there something that you'd like to see?

A: Yeah, that buying in advance thing is kind of intriguing I'm just not sure how you would manage it, I'd like to explore it a little bit further. The radio one is one that we do use at Horse Neck Beach, down in West Port near New Bedford its route 80 or 88 I don't remember the route number. But it's quite a ways to get in the facility as you come off route 195 and they have an AM frequency down there because they sell that place out all the time on the weekends. And inform people not to take that ten-mile or twelve mile ride down route 80 to get in, some still do, but the place is full. That's something that we've always talked about doing here but we haven't had the monetary resources so we

haven't done it. That one makes sense and I agree with it. The idea of this road going through is kind of interesting too, explore that a little bit. This one (rotary) I don't know in short term and if it wasn't Walden Pond and so close to this type of resource maybe it would fly a little bit better. My initial take on it is in theory it makes sense but to do construction there when our long term goal is to reroute 126 back around the other side I don't think we'd want to go down that road. But maybe some leg of route 126 relocation. That one, the past one, and the radio jumped out at me.

Interview w/ Kenneth Bassett

On April 14, 1999 an interview with Ken Basset was conducted over the phone. The interview was held at 2:00 p.m. with Tim Briggs, Gregg Burnett, and Danielle Froio in attendance. Ken Bassett is the Chairman of the Walden Pond Board of Directors and also the President of Sasaki Associates. Sasaki is an Engineering firm out of Watertown Massachusetts. Ken Basset was given a summary of the brainstorming ideas that have been developed during this project.

Q: Would you be able to estimate how much it would cost to reroute 126?

A: I really don't know. It's not a very big project in the scheme of things. I would be surprised if well it's not a five million-dollar project but it's probable more than five hundred thousand dollars. Maybe it's a million and half-dollars or something like that. I have no idea at this point really. In comparison to roadway projects I don't see it as an expensive project. Partly because it doesn't involve land acquisition for the most part.

Q: What is your idea of rerouting 126? Do you think it a good idea?

A: Well, it's an idea that has a long history. Even before I got involved in 1970, I think I got in matters in 1973. Even prior to that there have been ideas about relocating 126 away from the edge of the pond. So it's an idea that has been around a long time. It makes a lot of sense. When I got involved in Walden Pond matters back in '73. There were parking lots; there were lots of cars parked on the pond on the Walden Pond side of the road. Areas, which are for the most part green, back at that time, were very large parking lots. Those have all been removed over the years and relocated across the road into the area of the present parking lots. That relocation of the parking lots away from the edge of the pond was done for obvious environmental reason's and in a sense created the present conflict between the pedestrian traffic and the auto traffic and we knew that at the time but we also knew that the long range plan of what we wanted to do was to move the road out beyond the parking lots. We believed it's the right thing to do.

Q: Do you think that the rotary at the stockpiles would help traffic congestion along route 126 when parking lots are closed?

A: My initial reaction is that it would probable not solve any real problems. The problem it might elleviate is people who could not get in the parking lot, might have a place to make a reverse turn to get back onto route 2. However, some of the studies that have been done the last several years actually create another way of doing that which is to create an entry drive from the newly created 126 that would allow people to come in make a reverse turn and come back out the road, if the lots were fill. So that you could accomplish some of the same thing by having a u turn within the arrival area as opposed to the public road. And I think one of the problems with the rotary is why it might help solve the problem, albeit a seasonal problem, for the pond users I think it would be

somewhat disruptive to the other traffic flows that come through the area. And are not related to Walden Pond at all so it would serve as kind of an impediment in traffic flow which I'm sure that the state and the towns might have some very serious concerns and questions about. But its an interesting idea, and I don't think you should throw out the idea from the work that you're doing I think it does address one issue and gives people something to think about.

Q: The other idea we are thinking about is making an entrance off route 2 that is for just Walden Pond parallel to route 126 so the gate on route 2 would close when the park is full. Do you think this is a good idea?

A: I don't think that would work very well. What you have to do is take the traffic speeds from the speed of route 2 down to the speed of the parking lot. Which are taking people that are moving 60 to 70 miles per hour down to 5 miles per hour in a parking lot and what you have now is you have the movement from route 2 to route 126 which takes you from one speed to a medium speed and then from route 126 you can then turn into another road way which is your entrance and would take you down to 25 miles per hour and then down to five miles per hour. The other problem with putting another entrance on route 126 is the state would never allow you to never have two intersections so close together. That is an intersection that would have to be signalized for people coming to Walden and also an intersection for route 126. They would never approve that.

Q: Do you have any information that deals with traffic flow comparing right hand turns to left hand turns?

A: There was an analysis done. If you've seen, I don't know if you've seen the diagrams that depict how route 126 might be relocated. There was a memorandum done by the traffic consultants that analyzed what the benefits would be of moving the road and having basically most of the cars that come from route 2 make a right hand turn into the parking lots compared to what they do now which is make a right hand turn into the parking lots. So there is a memo somewhere and I will get my hands on it for you.

Interview w/ Helen Bowdoin and Tom Harris

On April 15, 1999 an interview with Helen Bowdoin and Tom Harris was conducted at the Thoreau Institute. The interview was held at 11:00 a.m. with Tim Briggs, Gregg Burnett, and Danielle Froio in attendance. Helen Bowdoin is the Education Program Director at the Thoreau Institute and her background is in local land protection. Tom Harris is the Executive Director of the Thoreau Society. Helen and Tom were given a summary of the brainstorming ideas that have been developed during this project.

Q: Do you think that the current 1000 person carrying capacity is appropriate for the conservation of Walden?

Helen: Probably, I should make clear from the outset that I'm not able to speak for the entire Institute. I'm not the Executive Director and we haven't established any written formal policy regarding many of these questions that you are probably going to ask. I should make this disclaimer at the outset, but I also feel comfortable saying we feel that a thousand is high and have thought so for some time. We have, I'm sure you are probably already aware of this, but the way people come and go over a period of a long day when there is lots of daylight means that in fact it really isn't a thousand but it may be closer to three thousand. So then of course there are people walking in, but there is an early morning set, a mid day set and an evening set, we really have three plus thousand visitors at the pond. We would like to see that lower.

Tom: You want that in terms of numbers, I can't give that. We haven't done any, well its tough to give a specific number I think. If a thousand is the number that it is now there are a lot of people out there. If a thousand is the number now, that seems a bit high.

Q: Do you have any recommendations for possible solutions to solve the problems at Walden of overcrowding?

Helen: I think the main thing is, when I said we feel a thousand is too many, I can't tell you what the right number is, but I think a thousand is too high. But I think in a very, very basic simple way we would want to recommend that the DEM consider perhaps reducing some of those parking spaces. It's a very first and obvious step it brings up a whole question of where do you limit use. There is a limit now of the number of parking spaces but in the summer there are many, many people in the city that can't afford to go to the Cape. Or can't afford to go to Nantucket, or Maine or wherever, and all they can afford is to come out here and swim. So it's a very, very difficult problem, it's not an easy problem to take a stand on. But I think at the same time our feeling is to protect the natural resource space for the future and to offer the people that do come, a good solid educational experience. It maybe in the long term what's best is to limit the number of parking spaces.

Tom: I'm going to agree with Helen a lot. She's put a lot more time into this than I have. It is tough. I've heard a lot of these recommendations listed on here before. In addition to the number of people down at the pond the congestion of cars even when the lot is closed. You have 126 lined up with cars backed up in the summer. I think that's a certain stress at Walden Pond that can be looked at in some of these ideas and can be remedied. I haven't looked at the details of all the different possibilities as much as I would. But we're interested in all the same things, we want people to have access to it, but when they have access to it we want them to have a real experience, not one of traffic congestion.

Q: What do you see as the main problem is at Walden Pond due to overcrowding? Do you think its public safety, water quality, erosion from trampling of wildlife, or something else?

Helen: I wouldn't want to have to pick just one of them, but just to say that they're all important. So I guess that in a way that dodges your question but in another way I'll say that I do think public safety is near the top of the board. I realize that public safety is a very important issue with the number of pedestrians that cross route 126. Which to me is miracle that aren't a lot of accidents because you get baby carriages, you get wheelchairs, you name it its crossing route 126. So that's first but also the question of where people should be allowed to go. As you know they spent nearly 2 million dollars on the bank restoration project, and that's all taxpayer money and so I would not want to see that area become destroyed so they are all questions that must be looked at and dealt with.

Tom: As you look at the pond, when we were out there a couple of years ago, and you could see the heavily trampled banks, the washouts, and all those kind of things. But they have done a great job of building that back up. But with the same number of people at the same number of time will that ruin the banks again.

Helen: I actually asked that same question to the man who was the principle design person for that. And Karst would be very good at answering this, but he basically said that he would never design a project like that. He would have used more natural regrowth stuff. But naturally, because it is Walden he wanted to do the very best that he could to respect the landscape, but what he said was that you can't guarantee this natural regrowth will be okay.

Q: So would you say that you are in favor of rerouting route 126?

Helen: I am very strongly in favor of rerouting route 126. And you can probably get more information on this from Ken Bassett.

Interview w/ Troopers Pellegrino and Walsh

An interview was conducted on April 15, 1999 at 1:00 p.m. The interview took place at Walden Pond with Tim Briggs, Gregg Burnett, and Danielle Froio in attendance. Trooper Walsh has been working at the Walden Park for five summers and Trooper Pellegrino has been at Walden since 1996. We were unable to record the interview but the Troopers gave us an idea of how chaotic the situation at Walden Pond gets during the summer months.

The troopers informed us that their main duties are to patrol Walden Pond and the area, similar to the way highway state troopers patrol the highway in their cars. The only difference is that they use horses to get to places where cars can't go. The troopers explain how some visitors often become agitated in the hot summer days when they can't get into the park. They also explain their attempt to get cars trying to travel down Route 126 through the traffic jams. They travel down the middle of the road on their horses and have Walden Pond visitors pull towards the center of the road. This allows for travelers not going to Walden to pass on the right and help relieve some of the traffic congestion.

Interview w/ Karst Hoogeboom

This interview was conducted on April 20, 1999 at 2:30 p.m. The location of the interview was the Mass Highway Building. Karst Hoogeboom the interviewee was the Project Manager for Walden for almost 10 years. He has worked on most of the capital projects for Walden. He has also worked with the staff at Walden to develop some of the procedures for dealing with the visitors.

Q: Your were involved with the bank restoration project, do you feel that the capacity of 1000 people right now is too high, and do you think it should be cut back at the same time the bank restoration project is still trying to re-grow?

A: I guess I'm not sure about that. The project was structured so that the 1000 person capacity would have as little impact on it as possible. I don't know what the right capacity is there. I know with more staff you can do a better job dealing with visitation. One of the problems the park has had in the past has been inadequate staffing so they're really, in effect, just doing crowd control rather than active protection of the resource. So, I think that the park could handle the 1000 person capacity if they had the right staff, or if they had the staff focusing their attention on the resource rather than traffic on management, which is often the most visible problem and it's the one that gets all the attention. I think that the most important thing to do with a facility like Walden is to protect the resource, because it's deeded to the state, the pond itself and some of the land around it, and then there have been subsequent purchases to bring it up to the acreage they have now, that the constituency is much greater than the day to day recreational users that Walden has. It holds a strong place in people's minds and hearts, who have never been there, and I think that's important to respect that. And to make sure that the resources at Walden are protected for the future for them and for future generations.

Q: Do you think that re-routing 126 would enable the staff to re-focus their attention to that?

A: Absolutely, yes I do I think that one of the problems you have with Walden is that it has grown without conscious plan toward its overall development, so its grown piecemeal. And I think that the relocation of the road would allow you to re-organize a lot of the circulation, and make it more efficient and make it more able to be managed by the staff that is there now or allow the staff to focus on some of the resource issues a little bit more

Q: Some of the concerns we've had with other people is that there isn't enough money available for a lot of these projects. Do you think that raising the admissions would help?

A: Well it's, I think that's always a dangerous way to do it because it then becomes a very much fee driven, every thing is fee driven, and right now I don't know how it has worked out if you were to add up the revenues from parking and place them against the expenses of operation or the expenses of improvements, but I think that if you directly link the improvements or the protection to the revenues that you are really putting a lot of pressure on that resource and I'm not sure if that's what you want to end up with. There really ought to be some filter between the two. I'm not saying that the money generated at Walden should not go towards Walden, but that maybe right now that the case is that it all goes to the general fund and then the legislature would give the department a budget. And the department manages the budget for all the parks, one of which is Walden, so whether the money goes directly to the department for allocation as the department sees fit or whether there is some sort of an oversight committee like the Walden Pond Board of Directors. I'm not sure what the right thing is without studying it. I wouldn't link one directly to the other.

Q: Of the ideas that we went over before would you like to see any further investigation into any of them or suggest any that might be bad at the same time

A: I'm not sure that the rotary approach is going to have much visible benefit. Obviously the route 126 re-location would solve some of the design issues at Walden, but one of the most important things that the route 126 re-location does is it moves the road further away from the pond. It helps to increase the distance between the car noise and the pond. It also helps to address potential environmental impacts, if there were an accident and an oil spill in this area right here next to the headquarters. Those catch basins go either into the pond or onto the shoreline above the pond. Whatever that contamination is will go right into the pond. As you probably know Walden is a ground water fed pond and has no inlet or outlet so that anything that gets into the pond stays there for quite a long period of time. So those are two important reasons why the re-location of route 126 should take place. The third is obviously the re-organization of all the infrastructure there which would allow it to work more efficiently. Swimming passes in advance I think is maybe a good idea but that would, unless I don't understand it, require a lot more policing I would think to ensure that the right people are allowed to swim. It also takes away the random visitation from visitors to the area. The entrance off route 2, in an ideal world, would be a great thing but I do, as Ken Bassett does, see a lot of problems with that. The low frequency radio tower I think it's important to let people know as soon into their trip as possible what the status of the parking is at Walden, so that would be something that is relatively inexpensive and easy to do, I think that should be done. Remote parking, I would worry that unlimited parking would lead to unlimited use. I'd want to make sure that the amount of parking be strictly controlled. You would still have a problem with people being dropped off around the perimeter and walking in. The pamphlets, I think that's a good idea one idea that you haven't mentioned here is an alternative swimming site, this is the closest swimming spot to Boston for most people

perceptually, I don't know if that is actually true or not, but if there is another way to provide pond swimming somewhere else that might take a lot of the pressure off of Walden. I think that for a lot of the people that come to Walden during the summer time they just want to cool off they just want to be out in the woods it's not that Walden is where they want to be, they just want to be somewhere other than where they are at the moment. Whatever get s done I think ought to accommodate Thoreau pilgrims or the tourists that are coming to the area who want to go to Walden because it is Walden. Often during the day in the summertime there is no way for them to get there and they have to come back at 7:00 at night or they have to get there at 6 or 8 in the morning in order to be able to take a walk around the pond so that needs to be taken into account in whatever is done here.

Interview w/ John Colman

This interview was conducted on April 22, 1999 at 10:00 AM, in the conference room of the Walden Pond headquarters. The people present at the meeting were Gregg Burnett, Tim Briggs and Danielle Froio. John Coleman works for the US Geological Survey (USGS), and has been conducting a water quality study at Walden Pond for two years.

Q: How long have been researching the water quality here at Walden?

A: We've had two field seasons, so its been about two years.

Q: Could you give us a brief description of what your study is?

A: We're looking at, essentially, the nutrient budget. We have to sort of define water quality to study it, and we've chosen to look particularly at water clarity. And it seems that algae growth is the principle possibility that would cause water clarity to change. We're trying to evaluate what the ecology of the pond is so that we can determine how much algae there is and what controls the algae; so that in terms of if its a stable formation or if its getting better or its getting worse. Along with that there are some sort of obvious, and the way, so its water quality goes back to algae goes back to what causes algae and that's nutrients. Another water quality issue is bacteria, and that is what is generally monitored at beaches to find out if you can swim in it or not. We don't that that swimmers are a cause of bacteria. Bacteria are usually from some sewage: from animals, horses, from waterfowl, that kind of thing. Swimmers are not effecting the bacteria so we're not really concerned with that. We don't think that people are affecting the bacteria of the pond. Except its if you bring dogs in or effect the drainage from the parking lots, and stuff like that. Going back to nutrients there are some obvious point sources of nutrients around like the land fill the trailer park and the septic leach field behind the headquarters. And the park wanted us to find out once and for all whether groundwater from these areas goes into the pond, and to do that we have to determine the contours of the water's surface, the water table, and see which way its flowing. This involves putting in a lot of wells, surveying the wells and creating a map that shows which way the water flows. And this is what we've come up with, with one month of data. (he show us a map) The way this thing works. These black lines are water contours and the flow is perpendicular to the contours. This contour is higher that this one is higher than this one so the water flows down this way. These blue lines show the area where water is contributing, the water that falls from rain, goes down the water table and enters the pond all within the blue line. Then outside the blue line is where pond is discharging into the groundwater flowing to the Sudbury River that wraps around the pond over here. So the incredible questions are like; well is the landfill within a contributing area? And it looks like it isn't, that water from the landfill flows north across route 2. The trailer park doesn't look like it is, and this is kind of a divide right in here between the trailer park water is flowing this way on one side of the divide and the other way on the other side of the divide. The septic leach field, though, appears to be going into the pond. We've gone down the shore here and found higher conductance and

higher nitrate levels . The deal about nutrients though and algae is that, algae will only grow to the extent that which ever nutrient is limiting is in supply. And for freshwater systems it is usually phosphorous that plants run out of first. Of all the other nutrients they'll need another good candidate is nitrogen, you can look at the ratios that these two elements occur in the water and decide which of these two elements they're going to run out of first. And by doing that kind of investigation for Walden it looks like phosphorous is limiting at least to floating algae which is the ones that decrease water clarity. So of the nutrients that come in from the septic leach field, nitrogen flows with the flow readily. Phosphorous is scrubbed out by the sandy gravel between the leach field and the pond. Phosphorous really likes to stick to solid states as different ion hydroxides. So we really don't see any evidence of phosphorous coming through. In fact we have wells that are almost on top of the leach field, we get real high conductance which is evidence that the water is at high nitrate. So that is sort of the story about the ground water contributing area and what nutrient load it might have. We are also looking at atmospheric deposition and trying to figure out what extent that's a source of nutrients to the pond. And then the other possibility is that swimmers might be providing phosphorous and that would be from people urinating in the pond. That we don't really know how big of a problem that is. But, if you figure out how many people swim and say suppose 50% of them urinate, and how much phosphorous is in urine you can calculate out a number. And that number is fairly large compared to the other sources of phosphorous. So that's potentially source but no one knows if it is really there or not. What we're planning to do this summer is to have a swimmer education program to make people aware of the ecology of the pond and what the nutrient cycle has to do with the growth of algae. Then asking people to make sure they use the bathrooms so they don't urinate in the pond. We have a way, although we can't tell how much phosphorous people contribute to the pond, we can tell if the total conduction of algae in the pond is less or not, using a baseline parameter to measure and see the impact of the program. And that's called looking at the oxygen removal rate in the deep water of the pond. The point is that we have baseline date on the amount of algae that was produced in the past and can compare that in the future and see if there are any changes.

Q: Would you say that nutrient loading is one of the major problems of the pond, more than bacterial contamination?

A: I'd say that probably the pond doesn't really have a water quality problem, that we are certain of. There is the possibility that some of the deep growing algae which are, it's a complex ecological system, it's a possibility that some of the deep growing algae which is a species called nitella might be sort of on the verge of having trouble continuing, and that would potentially be a water quality problem. But its not obvious that even that problem is so, I couldn't really definitely say that there is a nutrient problem in the pond, and I don't think there is any evidence of a bacteria problem. Presumably the beach is monitored you can look at the data and actually see what the bacteria levels are.

Q: I've read some of the other water quality study that was done here a few years ago, and they said that in the future the trophic level/state of the pond is changing. Do you think that in the future that might pose a problem for Walden?

A: Well that's part of the reason we initiated our database collection, and out base line data collection. And in these three years that we have data, the trophic level of the pond is decreasing. There has been less production from 1997. 96 was the one that had the highest, 97 a little bit less and 98 I think was about the same a s 97. It seems from that point to be a little bit stable maybe even getting a little bit better.

Q: Do you think that the carrying capacity has an effect on the water quality?

A: Well I mean it could be erosion, except that the bank restoration program has gone in and fixed that possibility. I also don't think that erosion release nutrients because I don't think that the soils around here have much nutrients in them. So it would be mostly just kind of an esthetic problem. And then, the other problem would be well, people are using the facilities here which stresses the leach field. I kind of described this thing where the phosphorous doesn't really come through from the leach field so that's sort of out. The swimmers are a possible impact that's related to capacity consideration. But who knows if we have the swimmer education program they may respond to it. Other than that we really don't know for sure what the magnitude of the problem with the swimmers is. Maybe no one urinates we really don't know. That's kind of an open question. By the way a question that often comes up is: look if there is potentially all of this urine coming in why isn't there a lot of bacteria? The answer is that urine, in a healthy person, is almost sterile it doesn't have bacteria in it. So that's not an issue the issue here would be nutrients.

Q: There is talk about re-routing route 126. If they take out the road do you know how much impact that would have on water quality with all the construction that would go on?

A: Well, presumably, they'll do a good job on keeping erosion from happening. If that is the case then the actual stuff running down the hill, I don't think that will have much impact. You know they salt that road and there is some salt coming into the pond from the road. And depending upon how far they move it (route 126) lets see they'll move it over here, it'll still be in the contributing area. There is a little bit of direct run off from the road sort of down the path to the pond which carries a little bit of phosphorous with it, and that would stop but its estimated to be a small part of the phosphorous.

Interview w/ Peg Campbell

Q: How do you feel about raising admissions at the park?

A: I don't think raising admissions is the answer to our capacity issue I think it just prohibits people with less money.

Q: How do you feel about the public safety issue with the road now the way its situated where you have to cross the road

A: Public safety is our priority here I am amazed with number of shrieking car tires that we hear that someone hasn't been hit by a car. Considereing that somewhere in the range of 600000 plus people cross the road.

Q: How would you feel abou the idea of people buying swimming passes days in advance?

A: I would like to see a system before I could comment on that . I would like to see how that would be executed.

QL What do you think of the solution to close the parkin g lot and having people bussed in from the local high school or a company that has ample parking space.

A: I think that would be to allow during the summer months restricted to the summer months and allow people to come in if the ywere senior citizens or if they were handicapped or potentially none swimmer people. I don't know how you would regulated that but I like the idea of people parking maybe on 128 so the traffic impact at the high school is to close to us, but I like the idea because in their transportation to the reservation could be a good opportunity for interpative programs.

Q: Can you talk aobut some of the advantages and disadvantages to handing out pamphlets or alternative sites to people who don't get in the park?

A: For us to produce as many pamphlets that we would need sort of goes against our mission as just having tons of paper that we just, I'm sure there would be a large amount that would just get thrown on the ground. We don't often have the time, in the summertime, because they're on a state road and they're really busy to give instructions on how to get to another park in any great detail. So it would benefit if you could give something out to people. We have done that but you can not keep up with the demands. Figuring that 1000 people get in a day just as many get turned away. And if we close three time a day that's 3000 pieces of paper seven times a week that would be 21000 pieces of paper for one week times 10. It doesn't become an affordable solution.

Q: The way its set up know using 2.5 people for each vehicle do you think that more than 1000 people are getting into the park.

A: I think its something that we need to examine, and I think that we can do that fairly simply by running a few days where we test that.

Q: Do you think that 1000 is to high of a capacity limit?

A: I feel with the bank restoration it took away a lot of beach space where people used to spreading out putting their blankets and hanging out. And I think people disagree with that to come here three years ago and see that mostly Thoreau's cove and from Red Cross beach down to Thoreau's Cove was all lawn chairs and people hanging out on the banks. And then to put a five wire fence up and to insist that beach space wasn't taken away just isn't an accurate depiction of what the reality is at Walden Pond. So we have in the last year not opened the dirt parking lot because water levels were really high and because bank restoration project, which is a necessary and worthwhile project. I think that we need to cut back on the number of people we have coming in.

Appendix D

Walden Pond Season Pass Form

Receipt: (for office use only)

Paid:_____ **Pass #:**_____

Walden Pond Season Pass Form

Fill out this form and turn in at entrance gate to obtain a season pass. Passes cost $15. No passes will be given prior to completion of this form. Thank you.

Name: _____ Address: Street _____

E-mail Address _____ Town/City, Country_____

Phone Number (____)_____-_____ State, Zip Code_____

Are you interested in receiving information on Walden Pond through the mail? Yes No

On average how many times do you visit Walden Pond during the summer? _____

On average how many times do you visit Walden during the off-season? _____

Which activities do you take part in while visiting Walden Pond (circle all that apply)?

Swimming Sunbathing Boating Fishing Hiking Picnicking

Cultural Enrichment All of the above Other: _____

Have you ever been on a guided tour of Walden Pond? Yes No

How many cars does your family own? _____

How many people usually come with you on your visits to Walden in the summer?_____

What hours do you prefer to come to Walden (Circle all that apply)?

Before 10a.m. 10a.m.-12p.m. 12-2p.m. 2-4p.m. 4-6p.m. After 6p.m.

How long do you usually stay at Walden during your visits? _____

*Please respect the Restoration Project and stay off all restricted areas. Thank you.

REFERENCES:

Baystate Environmental Consultants, Inc. (BEC). Final Report: Study of Trophic Level Conditions of Walden Pond Concord, Massachusetts. Commonwealth of Massachusetts Department of Environmental Management: April 1995.

Behn, Mark, Fabio Carrera, Jeff McGuire. A Carrying Capacity and Attendance Management Strategy for Massachusetts State Parks, Beaches and Reservations. Massachusetts Institute of Technology: 11 May 1998.

Colman, John A., Marcus C. Waldron. Walden Pond, Massachusetts: Environmental Setting and Current Investigations. USGS Fact Sheet: June 1998.

Colorado State Parks Keep Beach Closing to a Minimum. Water/Engineering & Management v.145 no. 11, Nov. 1998, 14.

Downs, Anthony. Stuck in Traffic: Coping with Peak Hour Traffic Congestion. Washington D.C.: The Brookings Institution, 1992.

Dyer, Gillian. Advertising as Communication. London, England: Metheun & Co. Ltd, 1982.

Gray, Ernest. Profitable Methods for Small Business Advertising. New York, New York: John Wiley & Son, Inc., 1984.

Hollingsworth, John E., Richard E. Holt, Willis Hults. Using a filter to remove Giardia cysts. Public Works v.117, March 1986, 74-75.

Ingram, Timothy. A preliminary investigation into the bacteriological water quality problems of Stonelick Lake State Park, Ohio. Journal of Environmental Health v.55, April 1993, 19-23.

Jones, John Philip. When Ads Work- New Proof that Advertising Triggers Sales. New York, New York: Lexington Books, 1995.

Lowry, William R. The Capacity for Wonder: Preserving National Parks. Washington D.C.: The Brookings Institution, 1994.

Meyer, Michael D., Eric J. Miller. Urban Transportation Planning: A Decision-Orientated Approach. New York, New York: McGraw-Hill Book Company, 1984.

Pignataro, Louis J. Traffic Engineering: Theory and Practice. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1973.

Reid, Chad. Fact Sheet: Carrying Capacity in Delaware Water Gap National Recreation Area; available from http://www.libertynet.org/drkn/factsheets/Carrying_Capacity Internet: accessed 8 February 1999.

Sandler, Richard and Associate. Recreation Consumer Attitude Survey; CRC Direct Marketing Services for the DEM: June 1994.

Restoration Project Pamphlet. Restoring the shore at Walden Pond State Resorvation. Department of Environmental Management: 1996.

Thoreau Society and Walden Woods Project Homepage. Available from http://www.walden.org/society/. Internet, accessed on 01 March 1999.

Walden Pond State Reservation. Available from http://www.tiac.net/users/morganti/walden.htm. Internet, accessed on 22 January 1999.

Walden Pond State Reservation. Guidelines for Operations And Land Stewardship. G.O.A.L.S. Statement

Yosemite National Park Public Information Office. Traffic Safety Enforcement Slated for Yosemite National Park Roads; available from http://www.nps.gov/htdocs4/yose/news_98/traffic.htm; Internet; accessed 28 January, 1999.

Personal Interviews:

Bassett, Kenneth. President of Sasaki Associates, Chairman of Walden Pond Board of Directors. Phone interview. Concord, MA: 14 April 1999.

Bowdoin, Helen and Tom Harris. Educational Program Director at the Thoreau Institute and Executive Director of the Thoreau Society, respectively. Thoreau Institute. Concord, MA: 15 April 1999.

Campbell, Peg. Park Supervisor of Walden Pond. Walden Pond. Concord, MA: April-May 1999.

Colman, John. USGS scientist, author of study done on Walden's water quality. Walden Pond. Concord, MA: 22 April 1999.

Frederich, Todd. DEM Director of Forests and Parks. Walden Pond. Concord MA: 13 April 1999.

Hoogeboom, Karst. Former Project Manager for Walden Pond, Project Manager for the Big Dig. Massachusetts Highway Department Buiding. Boston, MA: 20 April 1999.

Kuja, Dan. DEM Park Ranger mostly stationed at Walden Pond. Walden Pond. Concord, MA: April-May 1999.

Troppers Pellegrino and Walsh. State Troppers stationed at Walden Pond. Walden Pond. Concord, MA: 15 April 1999.