Canaan Street Lake
Watershed Protection Plan
Town of Canaan, NH

August 2006

Primary Contacts:

Town of Canaan

David Shinnlinger, Chair
144 Codfish Hill Road
Canaan, NH 03741

Jay Waldner, Vice Chair
91 Corno Road
Canaan, NH 03741

Dana Hadley, Town Administrator
PO Box 38
Canaan, NH 03741
(603) 523-4501

Granite State Rural Water Association

Prepared by:
Heidi Brannon
Source Water Specialist

Contact:
Jen Palmiotto
Source Water Specialist
322 Village Street
Penacook, NH 03303
Phone: (603) 753-4055
E-Mail: jpalmiotto@gsrwa.com

Canaan Drinking Water Protection Committee: *(left to right)* David Shinnlinger, John Bergeron, Robert Reagan, Tim Jennings, Jay Waldner. *(Not pictured: Wally Medeiros, Bill Wilson, Jim Linn, and Joe Damour)*

Review Annually and Update Every 3 Years

Date Reviewed	Reviewer	Changes or Comments

Canaan Street Lake Watershed Protection Plan for the Town of Canaan, NH

Adopted by the Canaan Drinking Water Protection Committee:

David Shinnlinger, Chair — Date 8/16/06

Jay Waldner, Vice Chair — Date 8/16/06

John Bergeron, Secretary — Date 8/16/06

Robert Reagan, Board of Selectmen — Date 8/16/06

Wally Medeiros, Canaan Water Board — Date 8-23-06

Tim Jennings, Cardigan Mountain School — Date 8/16/06

Bill Wilson, Canaan Health Officer — Date 8/22/06

Joe Damour, Water System Operators — Date

Jim, Linn, Canaan Resident — Date 8/23/06

Table of Contents:

Acknowledgements

This project has been funded with federal funds through a United States congressional appropriation to the National Rural Water Association and the Granite State Rural Water Association. This program was administered in cooperation with the United States Farm Service Agency. The contents do not necessarily reflect the views and policies of Farm Serviced Agency or of National Rural Water Association, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Thanks are extended to New Hampshire Department of Environmental Services for their assistance and support throughout the planning process.

Executive Summary
Canaan Street Lake Watershed Protection Plan
August 2006

Canaan Street Lake is the largest drinking water source in the Town of Canaan and supplies water to approximately 600 residents and local businesses in Canaan Village. In order to protect the quality of the Lake's water as a drinking water source the Board of Selectman appointed a Drinking Water Protection Committee to develop a Watershed Protection Plan.

The Drinking Water Protection Committee, assisted by Granite State Rural Water Association throughout the seven-month planning process, identified potential contamination sources to Canaan Street Lake and developed specific recommendations to manage water quality threats. Additionally, the plan aims to increase the understanding of the Canaan Street Lake Watershed and provide a meaningful foundation for decision-making.

Overall, the Committee found that the Canaan Street Lake Watershed is in good condition, however recent data suggests that water quality is diminishing. While the Watershed is predominantly forested, which helps maintain water quality and ecosystem functions, increasing conductivity values indicate that recreational uses and surrounding land uses are having an effect on Canaan Street Lake.

Increasing conductivity levels signify that human induced pollution is degrading Canaan Street Lake. Conductivity levels increased annually from 1998 – 2004, with a total increase of nearly 65% from original levels. Road salt is a probable factor for the increased conductivity levels, as sodium and chloride levels in the Lake have also risen. However, conductivity increases are also known to occur from most pollutants including: septic-system effluents, nutrient inputs, erosion, or any other substance that dissolves in water.

Recreational uses, especially those that utilize gasoline-powered engines, are also a source of pollutants. Typically, surface waters that serve as a drinking water supply should not be used as a recreational resource. Canaan Street Lake has a long history as a recreational amenity for Canaan and the surrounding region. To date, there is no direct evidence that the recreational activities enjoyed on the Lake are impairing its waters. However, recreational use still poses a significant risk to drinking water quality.

Finally, without a zoning ordinance, the Town has no way to regulate land use within the Watershed. Essentially, what this means is that in the future, any use – even those that are known sources of contamination to water resources – is possible. While it is difficult to envision, the development seen in the Watershed today is very different, and most probably less than, what will be seen in the Watershed in fifty to one hundred years. Studies show that as watersheds are developed and impervious cover increases, the water quality of its receiving waters is significantly degraded.

The Town of Canaan is in a unique position, in that it has the ability to protect its valuable drinking water resources before they are heavily by impacted surrounding land uses. In taking the initiative to develop a watershed protection plan now, the Town of Canaan has ensured that Canaan Street Lake will continue to supply quality drinking water and enrich the lives of residents and visitors alike.

Chapter 1 – Introduction

Clean, fresh water is necessary for life. Although seventy percent of the Earth is covered by water, only a small fraction (2.4 percent) is fresh water. Of that small fraction of freshwater, approximately ten percent (0.24 percent of the Earth's total water supply) is available for human use. The tiny fraction of available fresh water is put to work for many purposes and is often vulnerable to both natural and human induced contamination. As water has many competing uses, it is critical to manage our water resources wisely to ensure clean, fresh drinking water for present and future generations.

Recognizing the need to protect Canaan's drinking water supply, the Board of Selectmen appointed members of the community to serve on a Drinking Water Protection Committee (hereafter referred to as the Committee). The Board of Selectmen invited Granite State Rural Water Association[1] (GSRWA) to work with the Committee throughout the project. The goal of the Committee was to review the various threats to Canaan's drinking water supplies and develop a plan to protect Canaan's drinking water resources into the future.

During its first two meetings, the Committee reviewed and discussed the nine public water supplies located within Canaan, Appendix A, and chose to focus its efforts only on the Canaan Street Lake watershed and the public water supply systems located within the watershed boundaries. The Canaan Street Lake watershed provides drinking water sources to three public water systems and a large number of private wells. Plans made to protect the watershed can serve as an adaptable model for the remaining five public water systems and drinking water resources.

This plan is the culmination of seven months of research, discussion, and decision-making by the Committee. The plan identifies potential contamination sources to water resources in the Canaan Street Lake watershed and provides specific recommendations to manage these potential threats. Additionally, the plan aims to increase the understanding of the Canaan Street Lake watershed and provide a meaningful foundation for decision-making. The Town of Canaan is safeguarding its valuable water resources by implementing a Watershed Protection Plan.

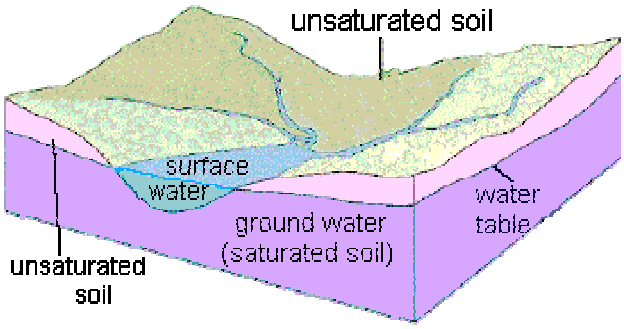
Chapter 2 – Why Watershed Planning

The Canaan Street Lake watershed is defined as the area of land and network of wetlands, ponds, and tributaries that drain to Canaan Street Lake. Canaan Street Lake's surface water basin is the land area from which all surface water drains toward the lake. The Lake's groundwater drainage basin is the subsurface area through which groundwater flows to the lake from higher elevations. One of the most important watershed concepts is that surface water and groundwater are inextricably linked. However, depending on

[1] GSRWA is a federally funded, non-profit organization that provides technical and planning assistance to rural water and wastewater systems throughout New Hampshire. GSRWA services are provided at no cost to Towns and public water systems.

factors such as soils, slopes, and surface cover, the Lake's surface and groundwater drainage basins may be different sizes. The surface water basin may be larger or smaller than the groundwater basin and vice versa.

Figure 1 *Depiction of a watershed*



Source: U.S. Geological Survey

Watershed planning and management is an approach to protecting water quality and quantity that focuses on the whole watershed. Rather than manage sources of pollution individually (such as limiting the amount of wastes discharged from a pipe into a stream), a watershed plan sets a framework to manage a variety of pollutants from multiple land use activities (including development, transportation, agriculture and forestry) that may originate anywhere in the watershed. Watershed management is also about bringing various stakeholders together in partnership to protect watershed structure and function that is essential to maintaining good water quality.

Increasingly, federal, state, and local agencies are emphasizing the importance of planning on the watershed level to control nonpoint source pollution. Nonpoint source pollution is pollution that originates from sources that are not easily attributable to a specific location or point. For instance, a septic system pipe discharging raw sewage into a lake or stream is considered a point source, whereas surface water drainage and runoff carrying herbicides and pesticides from lawn care is nonpoint source pollution. Nonpoint source pollution is the primary source of surface water pollution in the United States.

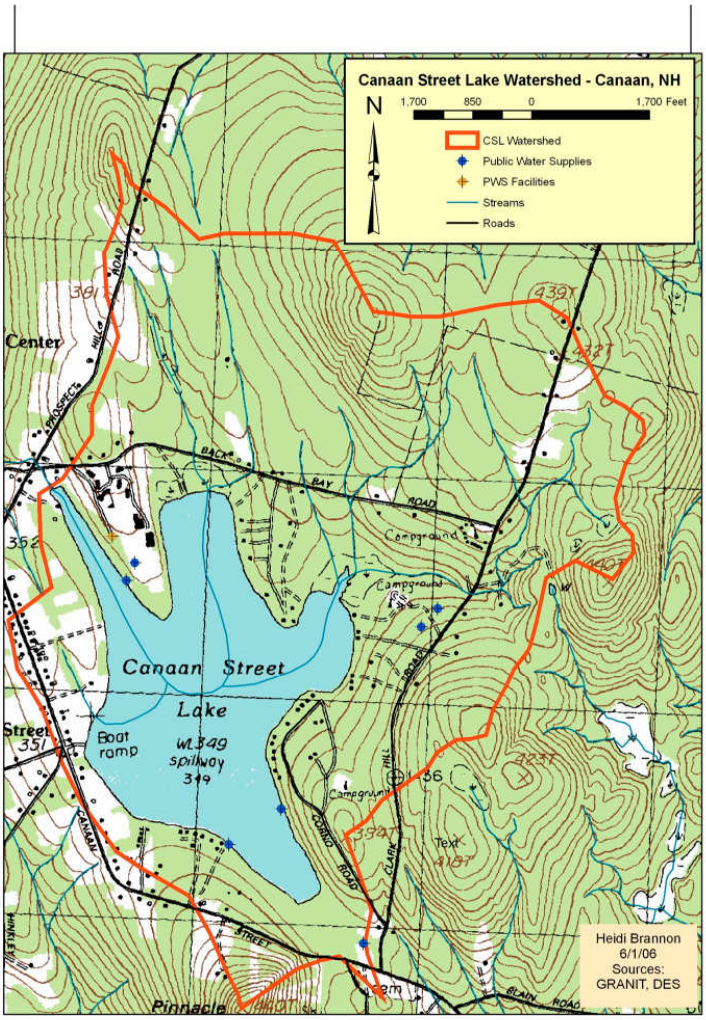
Monitoring and modeling studies indicate that nonpoint pollutant loads are directly related to watershed imperviousness (impervious cover does not allow water to infiltrate into soils). Research shows that when impervious cover exceeds ten percent of the total watershed area, pollutant loads increase and stormwater runoff makes stream channels unstable and easily eroded (Schueler, 2002). Once watershed imperviousness exceeds approximately twenty-six percent, streams become "non-supporting" – meaning stream channel stability and biodiversity are so seriously degraded that they cannot be maintained (Schueler, 2002).

Managing land use in a watershed is critical to its future wellbeing. By protecting the quality of Canaan Street Lake at a watershed level, the Town is ensuring that the Lake will continue to enrich the lives of residents and visitors alike.

Chapter 3 – Description of the Canaan Street Lake Watershed

Located in the heart of Canaan, the Canaan Street Lake watershed is a relatively undeveloped watershed, with good water quality. The watershed is relatively small, encompassing approximately two-and-a-half square miles and is located entirely in the Town of Canaan. Topography in the watershed ranges from gently sloping areas around the lake (with gradients of three to eight percent) to steep slopes (with gradients of eight to sixty percent) in the remainder of the watershed (Grafton County Soil Survey). The highest elevation point in the watershed is approximately 1,476 feet, while the lowest point is 1,142 feet at the spillway of the Canaan Street Lake Dam.

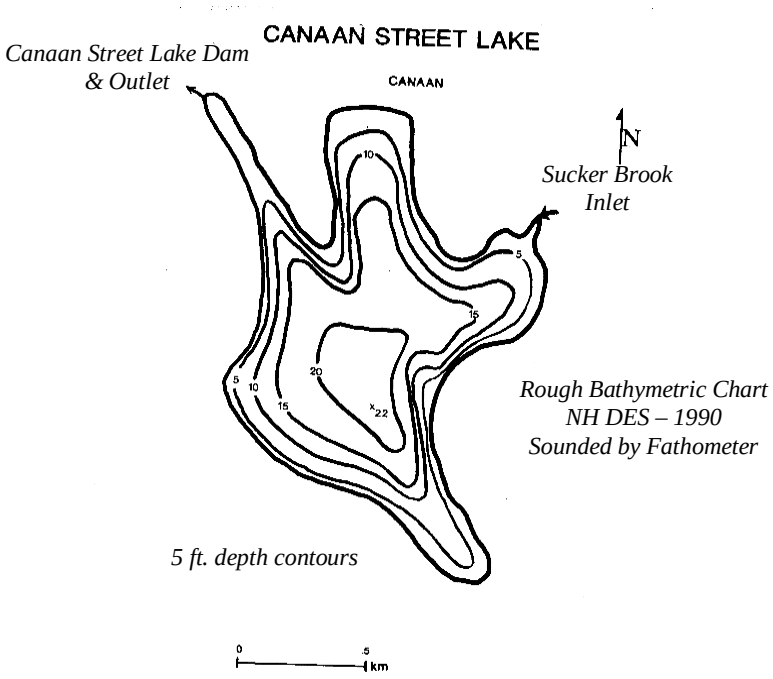
Figure 2 *Topographic Map –Canaan Street Lake Watershed*



Canaan Street Lake is 303 acres and relatively shallow in depth. The average depth of the Lake is approximately eleven feet and the maximum depth of the Lake is twenty-two

feet (Figure 3). It is estimated, that the lake has a volume of 4.1 million cubic meters or 3,330 acre-feet, and is predominantly spring fed (Hoyle, Tanner & Assoc., 2004). Sucker Brook, located in the northeast cove of the lake, is the only surface water inflow to the lake. In years of very dry weather, Sucker Brook flows only seasonally. The lake is irregular in shape and has four miles of shoreline.

Figure 3 *Bathometric Map – Canaan Street Lake*



Natural Resources

Within the watershed there are a variety of valuable natural resources that are not only aesthetically pleasing but provide valuable ecological services as well. For the most part, the watershed is predominantly forested. Natural vegetative cover provides a variety of habitat and also helps to maintain clean water supplies by filtering freshwater and reducing soil erosion and sedimentation (World Resources Institute, 2000).

Upon a review of Town files, no active timber harvesting is occurring in the watershed. However, forestry activities have taken place in the northern portion of the watershed in the recent past. Timber is also harvested when forested lots are converted for development purposes.

Wetland complexes contribute greatly to water quality protection because they remove excess nutrients and sediments that contribute to water degradation. Wetlands also provide valuable habitat for a variety of species. According to a land use analysis completed by NH DES in 2002, wetlands comprise 16.3 percent of land cover in the

watershed. From the analysis, it appears that most wetlands found in the watershed are associated with the Lake with the largest wetland complexes in the watershed on the northern lakeshore and at the tip of the lake's southern cove. These lakeshore wetlands play an important role in mitigating point and nonpoint pollution associated with land uses found along the shoreline.

According to the New Hampshire Natural Heritage Bureau, the following rare species and exemplary natural communities occur in the Canaan Street lake Watershed. (Appendix B)

- Rich mesic forest[2]
- Ginseng (Panax quinquefolius)
- Reversed Bladderwort (Ultricularia resupinata)
- Squirrel Corn (Dicentra canadensis)
- Common Loon (Gaviea immer)

Care should be taken to protect these rare species along with the valuable ecosystem services provided by the natural landscape.

Drinking Water Resources

Within the watershed there are three public water systems. These systems are: the Canaan Water Department, Cardigan Mountain School, and Crescent Campsites. A public water system is classified as any water system that provides the public with "piped water for human consumption if such a system has at least fifteen service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year" (New Hampshire Administrative Rule Env-Ws 300)[3]. Although there are three public water supplies in the watershed, no municipal water services extend into the area to serve watershed residents. Instead, Canaan residents living within the Canaan Street Lake watershed rely on private wells for their drinking water supply.

Table 1 *Active Public Water Supplies – Canaan Street Lake Watershed*

System Name	Address	System Type	Population	Well Type	Well Depth	Yield (gpm)
Canaan Water Department	Fernwood Farms Road	Community	600	Surface	--	1 million (gpd)
Cardigan Mountain School (Well #1)	Back Bay Road	Community	300	BRW	540	23

[2] "Rich mesic forests are hardwood forests growing on soils with relatively high levels of moisture, mineral nutrients, and high-quality organic matter. These forests grow at a faster rate and may have about twice as many species of herbs and shrubs as other forest types" (NH Natural Heritage Bureau).

[3] Public water supplies are further classified into three categories based upon the level of service provided. System classifications are: Community Water Systems, Non-community non-transient systems, and Non-community transient systems.

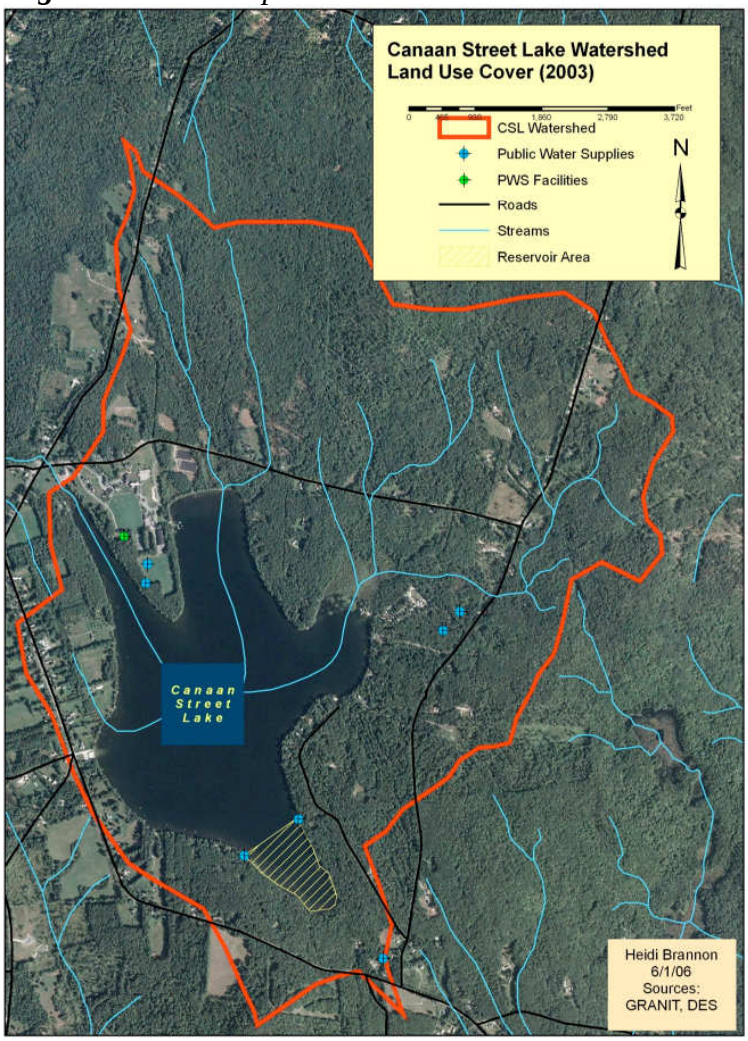
System Name	Address	System Type	Population	Well Type	Well Depth	Yield (gpm)
Cardigan Mountain School (Well #2)	Back Bay Road	Community	300	BRW	525	12
Crescent Campsites-North	Fernwood Farms Road	Non-community Transient	211	BRW	500	3
Crescent Campsites-South	Fernwood Farms Road	Non-community Transient	25	BRW	190	15

Source: NH DES

The Canaan Water Department is the only water system that obtains its water from Canaan Street Lake, which has served as Canaan's municipal water supply since 1890. The Water Department supplies drinking water to approximately six hundred residents and local businesses in the Village area. The surface intakes for the Town's water treatment plant are located in the Lake's southern cove. Water is pumped from the surface intakes into three slow sand filtration boxes at the water treatment plant. Once the water is filtered, it is disinfected and piped to a 294,000-gallon storage tank for distribution to the system's service connections. The Water Department has a safe yield of one million gallons per day from the Lake (Hoyle, Tanner and Assoc., 2004).

Cardigan Mountain School and Crescent Campsite rely on bedrock wells for their water source. Management activities taken to protect water quality throughout the watershed will benefit groundwater sources, including the numerous private wells present in the watershed. Source protection plans for Cardigan Mountain School and Crescent Campsites can be found in Appendix C.

Figure 4 *Aerial Map – Canaan Street Lake watershed*



Land Use

For the most part, the Canaan Street Lake watershed remains largely undeveloped. Camp style residences predominate on the eastern shore of the Lake. The western shore was developed in the mid-1800s and has many large homes from that time period. Except for the Historic District, there are no zoning requirements within the watershed. The Historic District is limited to the area bordering Canaan Street[4]. Within the Historic District, new

[4] "The Canaan Historic District… includes properties extending from the Old North Church, southward along Canaan Street, past the Museum and Meeting House, and continuing past the Pinnacle House, to approximately the highest point on Canaan Street. The easterly boundary is Canaan Street Lake, and the westerly boundary is a line 500 feet west of Canaan Street" (Canaan Historical Society).

lots must meet a two-acre minimum and only low-intensity uses that are consistent with stated architectural and environmental criteria are allowed.

The majority of homes around Canaan Street Lake are used seasonally, although some have been converted to full time residences. While it appears that the majority of the shoreline is forested, in places where homes and summer camps are located, vegetative buffers[5] have been removed. And, in some instances, notably along the Lake's western shore, large areas of lawn cover extend directly to the lakeshore.

Cardigan Mountain School, located on the northwestern peninsula of the lake, occupies a seventy-three acre parcel of lakefront property along with larger landholdings within the watershed. Besides being the largest property holder on the lake, Cardigan Mountain School is also the most intensive land use within the watershed. The School maintains numerous school buildings, dormitories, athletic fields, and open areas. While the greater part of CMS property is developed, the School retains a vegetative buffer along the most of its shoreline.

The second most intensive land use along the lakeshore is Crescent Campsites. Crescent Campsites, located on a twenty-five acre parcel along the northeastern shore of Canaan Street Lake, is open seasonally from May through October. Facilities located at Crescent Campsites include: seventy-six campsites with water, sewer, and electrical hookups, a beach and swimming area on Canaan Street Lake, a boat launch, and other camping amenities. Visitors to Crescent Campsites tend to be seasonal campers who stay at the Campsites for an extended period of time. The owners of Crescent Campsites are in the midst of renovations to their property. Once renovations are complete, they will offer seventy-five seasonal campsites and eight transient tent sites (S. Chiodo, personal communication).

Water Based Recreational Resources

Canaan Street Lake has a long history as recreational resource. The Lake provides many recreational activities, including: swimming, fishing, boating, water-skiing, ice fishing, ice-skating, snowmobiling, and the occasional seaplane landing. Water resources in the watershed are also important for habitat and fisheries, significant natural communities, aesthetics, and drinking water supplies.

The Town Beach, located off Canaan Street, is a frequent destination for Canaan residents and visitors alike. In the summer time, the beach serves as an access point for swimmers and boaters. In the winter time the beach is used to access the lake ice for ice fishing and snowmobiles. Additionally, there are many private beaches around the lake at individual residences and campgrounds that provide access to the lake for recreational purposes.

[5] Vegetative buffers (also known as riparian buffers) are strips of naturally vegetated land adjacent to streams, rivers, and lakes that help maintain water quality. Research has shown that vegetative buffers: help filter runoff by removing sediment and other pollutants, protect stream banks and shoreline from erosion, and provide wildlife benefits.

The boat ramp at the Town Beach that is open to all boaters, except one and two person personal watercraft (jet skis). Typically, during the summer holidays and weekends, there are about six to seven motorboats on the water. Motorboats range from pontoon boats to high-speed powerboats used for waterskiing and tubing activities. From observation, it appears that about fifty percent of residents with waterfront property have a docked motorboat. Additionally, Crescent Campsites, located off Fernwood Farms Road, operates a boat ramp and maintains three boat docks, with a total capacity of fourteen boats, for seasonal campers. Canoes, kayaks, and sailboats are also used with increasing frequency on Canaan Street Lake.

The Canaan Water Department's surface intakes are located approximately 3,000 feet southeast of the Town Beach. According to Env-WS 386.18, Protection of the Purity of Canaan Street Lake and Its Watershed, recreational activities are prohibited in the surface intake area. (Appendix D)

Chapter 4 - Water Quality of Canaan Street Lake

The State has collected water quality data for Canaan Street Lake since 1979. Data collection is facilitated through two programs: the New Hampshire Lakes and Ponds Inventory, which classifies lakes and ponds throughout the state based on their trophic level[6]; and the Volunteer Lake Assessment Program (VLAP), which utilizes local volunteers to collect annual water quality samples. The New Hampshire Department Environmental Services (NH DES) collected samples for the Lakes and Ponds Inventory from Canaan Street Lake in 1979, 1991, and 2005[7]. The Canaan Lake Association has collected VLAP data annually since 1988.

According to data collected through both sampling programs, the water quality of Canaan Street Lake has remained relatively stable. Key parameters worth noting are: the trophic level, flushing rate, and the present elevated levels of sodium and chloride.

While the trophic level of the lake has yet to be determined for the 2005 inventory, the 1979 and 1991 inventories classified Canaan Street Lake as oligotrophic. Oligotrophic lakes are characterized by clear water, low levels of nutrient enrichment, low productivity, few aquatic plants, the presence of a cold-water fishery, and a high dissolved oxygen content. It is unlikely that the Lake's trophic level has changed since the 1991 classification, as the majority of its water quality parameters have remained unchanged. The only parameters that have increased since 1991 are sodium, chloride, and the water's apparent color.

[6] A lake's trophic level is determined by a number of factors including: water transparency; nutrient enrichment; planktonic growth; presence of aquatic plants; type of fishery (cold or warm water species); and dissolved oxygen content. These factors give an indication of the lake's productivity level. Lakes with low levels of productivity are classified as oligotrophic and highly productive lakes are considered eutrophic. Lakes that fall in between the oligotrophic and eutrophic classifications are mesotrophic.

[7] Although the data to update the 1991 Lakes and Ponds Inventory was collected in 2005, NH DES is in the process of analyzing the data to determine if Canaan Street Lake's classification has changed.

The 1991Lakes and Pond Inventory notes that Canaan Street Lake has a flushing rate of 0.7 times per year, which is significantly lower than the state average[8]. Based upon the calculated flushing rate, it takes approximately seventeen months for the water in Canaan Street Lake to be replaced by new fresh water. The low flushing rate increases the Lake's vulnerability to nutrient and/or pollutant inputs because they are not readily flushed from the Lake by fresh water. Instead, excess nutrients and pollutants have a longer residence time in the lake and may have more significant negative impacts on water quality.

Under certain conditions, the slow flushing rate, combined with the Lake's relatively shallow depths, may make the lake more susceptible to eutrophication. This is especially true if nutrient levels in the lake increase. If the Lake's water quality parameters shift towards those that are more characteristic of a eutrophic lake, it is possible that Lake water will require more intensive treatment or become unsuitable as a drinking water source. Eutrophic lakes are highly productive and often recognizable by an abundance of aquatic plants, mats of algae, or surface scums.

VLAP data also indicates similar issues. Table 1, on page ten, summarizes VLAP data along with selected parameters from the Lakes and Ponds Inventory. For the most part, tested water quality parameters for Canaan Street Lake remain below the state average and are indicative of good water quality. However, annual increases in conductivity and the presence of toxic cyanobacteria are water quality concerns. (For a more in depth analysis of water quality parameters, please see Appendix E.)

[8] Average flushing rate for lakes in New Hampshire is 3.0 times per year.

Table 2 *Summary of Tested Water Quality Parameters – Canaan Street Lake*

Tested Parameter	*Lake Average*	*Comments*	*State Average*
Biological Parameters			
Algal Abundance *(Chlorophyll-a)*	2.50 mg/m^3	Average indicates "good" water quality. However, annual fluctuations in data make it difficult to discern a trend.	7.02 mg/m^3
Phytoplankton	Most frequently sampled: 1. *Dinobryon* 2. *Asterionella* 3. *Tabellaria*	Species are typical of NH's less productive lakes and suggest good water quality. Overall, presence of phytoplankton is sparse.	N/A
Cyanobacteria	Sampled species: 1. *Anabaena* 2. *Microcystis* 3. *Coeleosphaerium*	*Anabaena* and *Microcystis* are toxic species of cyanobacteria. Relative abundance of either species is sparse and no toxic blooms have been documented.	N/A
Transparency *(Secchi Depth)*	4.8 meters "Exceptional"	Values fall into either "good" or "exceptional" water clarity categories. Max – 6.3 meters (1999) Min – 3.3 meters (2002)	3.7 meters "Good"
Chemical Parameters			
Total Phosphorous	7.75 ug/L (epilimnion) 8.38 ug/L (hypolimnion)	Levels have fluctuated but trend is not increasing. Averages are considered "ideal" concentrations.	12 ug/L (epilimnion) 14 ug/L (hypolimnion)
Nitrogen[9]	*Nitrate* < 0.05 mg/L *Total Kjedhal Nitrogen* < 0.25 mg/L (summer) 0.3 mg/L (winter)	Measurements for nitrate and Total Kjedhal Nitrogen are relatively unchanged from 1991 values	N/A
pH	7.09 (epilimnion) 6.97 (hypolimnion)	Lake pH is approximately neutral.	6.6 – slightly acidic
Acid Neutralizing Capacity	9.09 mg/L Highly Sensitive to Sensitive	Values have fluctuated widely from year to year. Max – 10.95 mg/L (1988) Min – 6.5 mg/L (1998)	6.7 mg/L – Highly Sensitive
Sodium[10]	6.5 mg/L	71% increase from 1991 value (3.8 mg/L) 160% increase from 1979 value (2.5 mg/L)	N/A

[9] Values for nitrogen are from the NH DES Lakes and Ponds Inventory (2005). Nitrogen concentrations are measured in two forms nitrates and Total Kjedhal Nitrogen.

[10] Values for sodium are from the NH DES Lakes and Ponds Inventory (2005).

Tested Parameter	*Lake Average*	*Comments*	*State Average*
Chloride[11]	11 mg/L	120% increase from 1991 value (5 mg/L) 267% increase from 1979 value (3 mg/L)	N/A
Conductivity	75 uMhos (2005)	While the 2005 value decreased 4.6% from 2004 (78.46 uMhos), the overall trend is increasing.	A value of 100 uMhos is indicative of human impacts.
Apparent Color[12]	Summer Ave. 20 Winter Ave. 24.5	Water is clear to light tea colored. The color value has increased slightly since the 1991 Inventory when it measured 18 color units.	N/A
Dissolved Oxygen & Temperature	64.9% (hypolimnion) 69° F (hypolimnion)	Values have fluctuated annually. Max – 96.6% (2002) Min – 3.2% (1996)	N/A
Other Parameters			
Turbidity	0.4 NTUs (epilimnion) 0.5 NTUs (hypolimnion)	Sampling indicates that turbidity is low. However, concern exists over effects of motor boating on turbidity.	Max – 22.0 NTUs Median – 1.0 NTUs Min – 0.1 NTUs
Bacteria[13] *(E. coli)*	20 *E. coli*/100 mL	Samples from designated beach areas are not to exceed 88 *E. coli*/100 mL.	N/A
Invasive& Exotic Plant Species	Purple Loosestrife	Present in wetland on western shore near Town Beach and near the Lake's outlet.	N/A

Increased conductivity is directly related to human activity within the watershed. Under "natural" conditions, a lake's conductivity typically remains constant. Any major changes in conductivity over the course of several years, or within a very short period of time, indicates that pollution may be occurring from sources such as: road salt application; faulty septic systems; agricultural runoff; urban runoff; or development activities. Considering that sodium and chloride concentrations have also increased in Canaan Street Lake, the application of road salt to Canaan Street and other paved areas in the watershed is a probable cause for conductivity increases. However, effluent from aging septic systems and runoff from residential land uses around the lake are another potential source of pollutants that contribute to increased conductivity. If nutrient inputs are a factor in the Lake's increased conductivity, there is the potential for greater algal growth, which includes blooms of cyanobacteria.

[11] Values for chloride are from the NH DES Lakes and Ponds Inventory (2005).

[12] Value for apparent color is from NH DES Lakes and Ponds Inventory (2005).

[13] The average given for bacteria reflects only two sampling periods, which took place in 2003 and 2004.

While cyanobacteria are naturally present in all NH lakes, they serve as a reminder of a water body's delicate balance (VLAP, 2003). Typically, as nutrient concentrations in a water body increase, so does the abundance of cyanobacteria. Increased nutrient additions from surrounding land uses, like applying fertilizers to lawns, could create favorable conditions for a cyanobacteria bloom. The toxic cyanobacteria *Anabaena* and *Microcystis* are present in Canaan Street Lake. *Anabaena* produces nurototoxins that can interfere with nerve functions almost immediately upon ingestion and *Microcystis* is a hepatotoxin that attacks liver functions (VLAP, 2003). The ramifications of a toxic algae bloom in Canaan Street Lake would be significant, as prevailing winds push any matter suspended in the lake towards the Water Department's surface water intakes. The water treatment facility is not able to remove such dangerous toxins from the water supply.

The only facet of the Lake's water quality that poses a challenge for water treatment is the presence of organic matter. During water treatment, organic matter, such as algae and plant detritus, combines with chlorine, used to disinfect the water, and forms carcinogenic disinfectant byproducts (DBPs). To address the health risks caused by DPBs, the Environmental Protection Agency (EPA) recently lowered the maximum amount of DBPs allowable in community drinking water supplies. Since the rule change, the Canaan Water Department has not been able to meet the new standard. While lowering DBPs in the water supplied by the treatment plant will require a treatment upgrade, increases in the Lake's turbidity would compound the current treatment problem.

Turbidity is a water quality concern because turbidity measures the amount of suspended materials in the water. If turbidity is not eliminated prior to disinfection, organic matter attached to sediments will combine with chlorine to form carcinogenic DBPs. As a result, increased turbidity will lead to increased treatment costs because sediments and organic matter must be completely removed prior to water disinfection. Although VLAP results indicate that turbidity is low in Canaan Street Lake, studies show that in shallow lakes turbidity increases with motor boating. Boating affects turbidity because movement of the boat across the water's surface, along with action from the prop, stir-up bottom sediments in shallow areas. The re-suspended sediment takes many hours to settle out of the water column and makes the water more turbid (Yousef et al., 1980). Activities that cause erosion and the subsequent sedimentation of surface waters are also sources of turbidity.

While all the data collected for Canaan Street Lake indicates good water quality, it must be noted that testing does not take place frequently enough to accurately determine water quality trends. For example, VLAP sampling takes place once a year in July or August. While the sampling period does help track water quality from year to year, it does not provide enough information to accurately determine seasonal changes in water quality trends. If sampling were completed more frequently, it would be possible to ascertain more accurate trends in seasonal values. For instance, understanding seasonal trends in total phosphorous will help determine if nutrient enrichment[14] is a concern. Accurately

[14] Nutrient enrichment is a water quality concern because under the right conditions, algae and aquatic plants will continue to grow and multiply well beyond the amount needed to support the food web. The

identifying water quality trends is critical to understanding lake health and helps identify necessary corrective actions.

Chapter Five – Identified Threats & Management Objectives

A review of potential contamination sources (PCSs) was completed in order to identify areas where corrective and preventative measures in the watershed are necessary. The review included information compiled from a variety of sources including: NH DES source water assessment reports, a database search using NH DES on-line OneStop Database, a review of town documents, and a windshield survey of the watershed.

All identified PCSs threaten not only the environmental health of Canaan Street Lake but also the drinking water supplied by the Canaan Water Department. Any decline in the Lake's water, which is the Town's municipal water source, will eventually increase the Department's treatment costs. Under extreme circumstances, degradation of the Canaan Street Lake's water quality could force the Town of Canaan to change to another drinking water source. New sources of water are costly to develop and come with no guarantee that water quantity or quality will meet Canaan's needs.

5.1 Land Use Threats

Below is a review of land use threats identified within the watershed. Each land use topic is followed by management objectives and corresponding strategies of achievement. While the land use topics are in no order of significance, the listed management objectives and the strategies for achievement are given hierarchically in order of importance. (The Committee's recommendations are also provided in tabular format in Appendix F.)

I. Road Management

Roads allow for the movement of people, goods, and services important to our daily lives. However, road surfaces accumulate pollutants deposited from vehicles during travel. Typical pollutants associated with roads are: nutrients, metals, oils and grease, salts, and volatile organic compounds. Road drainage systems also collect contaminants from atmospheric deposition, soil erosion, street dirt and litter, leaf litter, and animal waste (Jeer et al, 1997). Many of the substances that accumulate on roadways are toxic and have negative health effects on humans and the environment. When a storm event happens, these pollutants are washed from the road surface, especially paved, impervious roads, into nearby surface waters, or infiltrate into groundwater. Potential spills of hazardous materials and fuels during transport or vehicular accidents also represent a

excessive growth, and the subsequent die off, of algae and aquatic plants can seriously impact water quality, cause fish kills, and create unpleasant taste and odor problems (Mason, 2002).

high risk to water quality, especially since many transportation routes run alongside surface water resources.

In the Canaan Street Lake watershed, there are approximately 4.7 miles of public roads, maintained by either NH DOT or the Town of Canaan, and many private roads and driveways. Of primary concern is the portion of Canaan Street, which is in close proximity to Canaan Street Lake. Water quality concerns regarding this portion of the road stem from poor drainage and the application of road salt. While road salt is applied to the road for winter safety, it is extremely soluble in water and can contaminate wells and surface waters. At high concentrations salt can impact human and environmental health. (Sodium causes hypertension in humans, while chloride is toxic to fish and aquatic organisms.)

Water quality data collected for VLAP indicates that conductivity levels have significantly increased in Canaan Street Lake since sampling began in 1988. According to NH DES's recent update of its Lakes and Ponds Inventory, sodium and chloride levels have also increased over the last twenty years. Road deicing materials are a known contributor to increased conductivity values. During storm and snowmelt events, runoff from Canaan Street travels towards the Town Beach, where it runs directly into the Lake.

Additionally, dirt roads in the watershed also pose challenges to water quality. For example, the erosion of earthen drainages along Fernwood Farms Road contributes a significant amount of sediment to Sucker Brook, which is Canaan Street Lake's primary inlet. Sediment has negative environmental effects because it buries aquatic habitat, increases water temperature, decreases dissolved oxygen, and increases turbidity (Jeer et al., 1997).

After reviewing the status of public roads within the watershed and their associated potential contaminants, the Committee developed the following objectives to address identified issues.

Objective #1: Resolve drainage issues along Canaan Street with the assistance of New Hampshire Department of Transportation (NHDOT).

Objective #2: Reduce the application of deicing agents along Canaan Street in areas in close proximity to the lake.[15]

Objective #3: Remediate drainage issues on town maintained roads.

Objective #4: Establish town road standards for the watershed to ensure that new roads do not negatively impact water quality.

[15] The Committee is aware of the unsafe road conditions caused in a previous experiment where NH DOT eliminated road salt applications to Canaan Street. The Committee is not suggesting that this experiment be repeated. However, with improved drainage and a properly engineered road base, it is expected that the applications of de-icing chemicals could be dramatically reduced.

Strategies for Achievement:

A. Implement a comprehensive and collaborative town road maintenance management program in the watershed that safeguards public safety, identifies ecologically sensitive areas, identifies corresponding low salt zones, and uses techniques for minimizing the use of de-icing materials.

- **Potential Lead Agency & Partners:** Board of Selectmen, Road Agent, Canaan Water Department, NH DOT, NH DES, University of New Hampshire Stormwater Center
- **Potential Funding Source:** NH DOT, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program, Town of Canaan
- **Benchmark:** A comprehensive road maintenance plan is established for roads within the watershed. The plan is well understood and put into action by the Board of Selectmen and the Road Agent and the requirements of the plan are met by the Highway Department.

B. Work with NH DOT to identify and resolve drainage issues on sections of Canaan Street in close proximity to Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, NH DOT, Canaan Road Agent, Canaan Water Department, NH DES
- **Potential Funding Source:** NH DOT, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Drainage issues are identified and resolved so that road runoff no longer enters Canaan Street Lake.

C. Work with NH DOT to reduce winter salt application along the portion of Canaan Street that borders Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, NH DOT, Road Agent, Canaan Water Department, NH DES
- **Potential Funding Source:** NH DOT, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program,
- **Benchmark:** Salt application on state maintained roads in close proximity to Canaan Street Lake is reduced or eliminated.

D. Identify appropriate stormwater management methods (e.g. vegetative buffer strips, swales, or ditching) to resolve erosion problems along Fernwood Farms Road that contribute sediment to Sucker Brook.

- **Potential Lead Agency & Partners:** Board of Selectmen, Road Agent, Canaan Water Department, NH DES, University of New Hampshire Stormwater Center
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program

- **Benchmark:** Road drainages along Fernwood Farms Road are stabilized so that the erosion of sediment no longer impacts Sucker Brook.

E. Identify appropriate stormwater management methods to minimize stormwater runoff from the Town Beach parking area from entering Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Road Agent, Canaan Water Department, NH DOT, NH DES, University of New Hampshire Stormwater Center
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Runoff is prevented from entering Canaan Street Lake at the Town Beach.

F. Create a road design standard that mitigates stormwater runoff and minimizes the negative environmental effects of any new town roads constructed within the watershed.

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, Road Agent, University of New Hampshire Stormwater Center, NH DOT, NH DES
- **Potential Funding Source:** Town of Canaan
- **Benchmark:** Future road design and construction will minimize impact on water quality and the environment by better managing stormwater runoff.

II. Septic System Management

A septic system processes and provides treatment for wastewater generated from flushing toilets, taking showers, doing laundry, and disposing of anything down a sink or other drains. A properly functioning septic system can process household wastewater and destroy disease-producing bacteria. However, when not properly maintained or used, septic systems pose a significant risk to water quality and human health. When functioning improperly or incorrectly sited, septic systems are potential sources of bacteria, viruses, and protozoa, which can cause gastrointestinal illness, cholera, hepatitis A, or typhoid if consumed. Additionally, if improperly used, such as for the disposal of paints, solvents, petroleum products and other household hazardous wastes, septic systems can be a source of chemical compounds (Jeer et al., 1997). All residences and facilities located within the watershed rely on septic systems to process wastewater as the municipal sewer system does not extend into the watershed.

Regular maintenance of septic systems requires that the accumulated wastes in the septic tank be pumped out approximately every three to five years. Unfortunately, once installed, individual systems often receive little attention from homeowners and problems may go unnoticed until system failure occurs. Septic failures can occur if: a septic system is improperly sized and more wastewater is entering the system than it was originally designed to handle, by improperly disposing of household hazardous wastes,

and if soils are not suitable for wastewater treatment and the installation of a septic system (EPA).

It is difficult to assess the current status of septic systems in the Canaan Street Lake watershed. Town records provide little information regarding septic system types and installation dates for parcels within the watershed. It is estimated however that approximately fifty percent of parcels[16] in close proximity to the shoreline may have aging septic systems that are not designed to process wastewater and protect water quality. Along with road salt, failing septic system may also be responsible for the Lake's increased conductivity.

Based upon the available information[17], the Committee developed the following objectives for septic system maintenance:

Objective #1: Minimize the negative impacts of existing septic systems in the watershed through proper maintenance and timely replacement.

Objective #2: Minimize the environmental impact of new septic systems within the watershed.

Strategies for Achievement

A. Conduct education and outreach about proper use and maintenance of septic systems.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Water Department, Canaan Drinking Water Protection Committee, Canaan Lake Association, Cardigan Mountain School
- **Potential Funding Source:** Town of Canaan, NH DES Small Outreach and Education Grant program for Nonpoint Pollution, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Homeowners within the watershed properly use and maintain their septic systems.

B. Conduct a septic system survey to collect information about septic systems within 250 feet of Canaan Street Lake. Collect information regarding system type, installation date, location, and maintenance.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Water Department, NH DES, Canaan Lake Association

[16] Estimation is based on an informal windshield survey of the properties around Canaan Street Lake and a review of available town documents.

[17] The Committee is aware that the Town must collect more data regarding the status of septic systems in the watershed in order to fully determine the feasibility of recommendations C – F.

- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Pertinent information is collected and on file for septic systems located within 250 feet of Canaan Street Lake.

C. Consider adoption of a Septic System Tracking Program for parcels in the watershed within 250 feet of Canaan Street Lake. A Tracking Program would facilitate the registration of identified septic systems and encourage or require regular inspection and maintenance.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Health Officer, NH DES, NH Department of Health and Human Services
- **Potential Funding Source:** NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Town adopts a Septic System Tracking Program to improve septic system maintenance.

D. Consider implementing a Municipal Septic System Maintenance Program for properties in the watershed and within 250 feet of Canaan Street Lake. Under a Municipal Septic System Maintenance Program, the Town could assume inspection and maintenance of specified septic systems.

- **Potential Lead Agency & Partners:** Board of Selectmen, Water Department, Health Officer, Municipal Wastewater Treatment Department
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** The Town has determined the feasibility of implementing a Municipal Septic System Maintenance Program and is able to make a decision whether or not to proceed towards commencing the program.

E. Establish a minimum set back of 125 feet from Canaan Street Lake and its tributaries, where feasible, for new and replacement septic systems

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, NH DES, Upper Valley Lake Sunapee Regional Planning Commission
- **Potential Funding Source:** N/A
- **Benchmark:** Septic system setback from Canaan Street Lake and its tributaries is 125 feet.

F. Consider constructing a municipal sewer system to homes and facilities near Canaan Street Lake in the future.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Wastewater Department, Cardigan Mountain School
- **Potential Funding Source:** Town of Canaan, undetermined
- **Benchmark:** A feasibility study to serve homes and facilities in close proximity to Canaan Street Lake with a municipal sewer system is complete and the Town has considered whether or not to proceed with extending municipal sewer services.

III. Recreational Management

Canaan Street Lake has a long history as a recreational resource for the Town of Canaan, the surrounding area, and even the greater New England region. Recreational activities that take place on/or in Canaan Street Lake are: boating (both motorized and non-motorized), swimming, fishing, waterskiing, ice fishing, snowmobiling, and occasional seaplane activities. While these activities are beneficial to those that utilize the lake for recreation, recreational activities can have a negative impact on the lake's water quality and jeopardize the lake as a drinking water source.

The American Water Works Association discourages body contact recreation, e.g. swimming, and use of gasoline engines in water sources that supply public drinking water (AWWA, 2004). Swimming and other body contact activities have the potential to introduce pathogens, such as cryptosporidium and other fecal contaminants, into water supplies. Some of these pathogens, like cryptosporidium, are very difficult to treat and are resistant to disinfection.

Gasoline-powered engines, especially carbureted two-cycle engines, pose a significant risk to drinking water resources. Carbureted two-cycle engines exhaust approximately thirty percent of their unburned fuel directly into the water (Correll, 1999). Depending on water and air temperatures, roughly half of the exhausted fuel evaporates immediately while approximately fifteen percent persists in the water column for some amount of time (Kratzenberg, 1997). Gasoline that is directly exhausted to the water column introduces volatile organic chemicals (VOC) into the lake, which are difficult to remove.

Two polluting substances associated with the operation of gasoline-powered engines are the gasoline additive MtBE and motor oil. A small amount of MtBE can render water undrinkable (NH DES). MtBE can cause kidney and liver damage. Once introduced into water supplies, MtBE is extremely difficult to remove and treat. While MtBE is being phased out of gasoline, the environmental effects of other gasoline oxygenates, like ethanol, are unknown (Susca, personal communication). Motor oil also persists in the environment and contains harmful metals and toxins (EPA). One pint of spilled motor oil can cause an oil slick approximately one acre in size, whereas a gallon of motor oil can contaminate up to one million gallons of water (EPA).

Required VOC testing of the Lake[18], proscribed by NH DES Water Supply Engineering Bureau, show that VOCs have not been detected in the Lake. The last VOC sampling took place in July 2005. However, the sampling date occurred mid-week when motorboats are less likely to be using the lake. Depending upon the compound, some chemicals associated with fuels and motor oils will rapidly volatize into the air, but others will persist in the water column. Additionally, as discussed earlier, motor boating may also increase the turbidity of Canaan Street Lake, which can lead to higher treatment costs and greater health risks.

Seaplane operation on Canaan Street Lake represents less of an environmental risk than lake contact activities and carbureted two-cycle engines. Risk of pollution from seaplanes is lower because seaplane exhaust is discharged to the air, aviation fuel does not contain MtBE or motor oils, and there is a minimal amount of contact time with the water surface (Seaplane Association, 2000). Although risks to water quality from seaplanes are significantly lower, the size and layout of Canaan Street Lake requires seaplanes to take off and land near the surface water intakes. If a catastrophic seaplane crash were to occur close to the intakes, the effects could be significant and costly.

Finally, threats to water quality also occur from winter recreational activities when the lake freezes over. The presence of ice on the lake allows for ice fishing and motor vehicle operation on the lake. Operating vehicles on the ice allows for automotive fluids and deicing salts to be deposited on the lake surface. The refueling of snowmobiles, ice augers, and other gasoline-powered engines poses a contamination risk if gasoline is spilled on the lake or in close proximity to it. Fishing activities (in all seasons) may be a source of organics to the lake water if bait or fish parts are left on or disposed of in the lake.

Based upon the above information, the Committee developed the following objectives to address the risks posed to Canaan Street Lake by recreational activities:

Objective #1: Heighten recreational users awareness of potential water quality impacts to Canaan Street Lake.

Objective #2: Reduce impacts of current recreational uses on Canaan Street Lake's water quality.

Objective #3: Conduct more frequent water quality sampling in order to effectively evaluate the impacts of recreational activities.

Objective #4: Assess the impact that motorized boating has on Canaan Street Lake's water quality.

[18] In order to stay compliant with the Safe Drinking Water Act, the Canaan Water Department must conduct water quality tests to show that it meets water quality standards set by the EPA and NH DES.

Strategies for Achievement

A. Maintain and support the New Hampshire Lake Association's Lake Host Program.

- **Potential Lead Agency & Partners:** Town of Canaan, Canaan Water Department, Canaan Lake Association, NH Lakes Association, NH DES
- **Potential Funding Source:** NH DES Grants for Exotic Aquatic Plants; NH DES Milfoil and Other Exotic Plant Prevention Grants
- **Benchmark:** Lake Host Program is supported and maintained.

B. Conduct an Education & Outreach Campaign that targets recreational users and user groups (e.g. snowmobiling clubs) to inform them of the importance of protecting Canaan Street Lake's water quality.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Lake Association, Cardigan Mountain School, Area Schools, Recreational User Groups, Crescent Campsites, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Small Outreach and Education Grant Program for Nonpoint Pollution, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Town is continually informing recreational users about the importance of protecting Canaan Street Lake.

C. Encourage boaters to properly transport, handle, store, and use fuels and motor oil so that these contaminants are prevented from entering the lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Drinking Water Protection Committee, Canaan Lake Association, Area Schools, Recreational Groups, NH DES, Boating Industry
- **Potential Funding Source:** Town of Canaan, NH DES Small Outreach and Education Grant Program for Nonpoint Pollution, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Boaters are well educated about the importance of properly handling fuels and oils.

D. In winter, limit refueling of gasoline-powered engines to shore and prohibit the use automobiles on lake ice.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Lake Association, Recreational Groups, NH DES, NH Department of Fish & Game
- **Potential Funding Source:** undetermined

- **Benchmark:** Gasoline-powered engines are refueled prior to being taken onto lake ice and automobiles are prohibited from traveling on the lake ice, with the exception of transporting bobhouses.

E. Continue existing water quality testing (VLAP) and increase the frequency of testing during the summer months.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Lake Association, Cardigan Mountain School, Mascoma Valley High School, Recreational Groups, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Water quality testing of Canaan Street Lake continues and is conducted at more frequent intervals.

F. Study the effects that recreational activities and gasoline-powered engines have on the lake. Studies should include a survey of recreational activities, including those utilizing gasoline-powered engines (all seasons); types of engines used on the lake; and more frequent volatile organic chemical testing (especially during summer months).

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Lake Association, Cardigan Mountain School, Area Schools and Universities, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program;
- **Benchmark:** Town has collected data on the impact that recreational activities have on the water quality of Canaan Street Lake, is able to determine their level of risk, and can develop recommendations to appropriately mitigate recreational impacts.

G. Study the effects motorized boating has on turbidity in Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, , Canaan Lake Association, Area Schools & Universities, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Town has completed a study on the impact motorized boating has on turbidity; can determine the appropriate level of risk to water quality; and develop further recommendations of how to mitigate negative impacts appropriately.

H. Consider establishing No Wake Zones in sensitive areas (near protected surface water intake) and shallow waters.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Drinking Water Protection Committee, Canaan Lake Association, NH DES, NH Department of Safety – Marine Patrol
- **Potential Funding Source:** undetermined
- **Benchmark:** No Wake Zones are established to protect sensitive areas and shallow waters.

IV. Land Use Management

Zoning regulation is a tool that allows communities to define and direct future land use by determining what land uses are acceptable in a given area. Without a zoning ordinance, the Town of Canaan has minimal oversight regarding future development and its subsequent land use. The lack of zoning is considered a potential contaminant source because any land use is acceptable in any given area, even those that are disruptive or potentially harmful.

Besides allowing potentially contaminating land uses, unregulated development of the Watershed could lead to its eventual "over-development." According to a Build-Out Analysis of Canaan, under the current "no zoning" conditions an additional 451 residential units could be built within the watershed (Upper Valley Lake Sunapee Regional Planning Commission, 2004). Increased development also means a relative increase in impervious cover throughout the watershed. As noted earlier in Chapter 2, impervious cover decreases the ability of the watershed to provide valuable ecological services, increases nonpoint pollution loads, and negatively impacts local hydrology. Along with increasing impervious cover, residential development poses threats to water quality from several sources including: storage of household heating fuels; on-site septic systems; improper disposal of household hazardous wastes; and improper application of lawn and garden chemicals and fertilizers.

Presently, the only "zoning" district that exists within Canaan is the Historic District, which is located partially in the watershed. The Historic District encompasses the properties on either side of Canaan Street and dictates some property use restrictions. Lots within the Historic District may have low-impact commercial uses on the property and must meet a minimum two-acre lot requirement.

After careful review of risks that the lack of zoning poses to the quality of Canaan Street Lake the Committee has developed the following objectives:

Objective #1: Establish a Watershed Protection Area encompassing the Canaan Street Lake watershed.

Objective #2: Within the Watershed Protection Area, create a Shoreland Protection District to provide a higher level of protection in the immediate vicinity of Canaan Street Lake.

Strategies for Achievement

A. Outreach and Education on why establishing a zoning district is critical to protecting the quality of Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Water Board, Canaan Water Department, Canaan Drinking Water Protection Committee, Canaan Lake Association, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Community has a better understanding of how a zoning district is beneficial and will help protect the water quality of Canaan Street Lake.

B. Establish boundaries for the Watershed Protection Area that accurately reflect, and coincide with, the watershed boundary for Canaan Street Lake.

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, Canaan Water Department, NH DES, Upper Valley Lake Sunapee Regional Planning Commission
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** Boundaries of the Watershed Protection Area accurately reflect the watershed boundary for Canaan Street Lake.

C. Develop lot requirements and land use restrictions within larger Watershed Protection Area. The Watershed Protection Area should include: density controls, prohibit contaminating land uses, address stormwater management, and limit impervious cover.

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, NH DES, Upper Valley Lake Sunapee Regional Planning Commission Canaan Lake Association, Affected Property Owners
- **Potential Funding Source:** N/A
- **Benchmark:** A comprehensive set of zoning requirements is established within the watershed to protect Canaan Street Lake.

D. Delineate a Shoreland Protection District. The District should include the area of land within 250 feet of Canaan Street Lake.

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, Canaan Water Department, NH DES, Upper Valley Lake Sunapee Regional Planning Commission

- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** The Shoreland Protection District is accurately mapped and delineated.

E. Develop lot requirements and land use restrictions within the Shoreland Protection District. Utilize the NH Shoreland Protection Act (RSA 438-B) for guidance. (Appendix G)

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, NH DES, Upper Valley Lake Sunapee Regional Planning Agency, Canaan Lake Association, Affected Property Owners
- **Potential Funding Source:** N/A
- **Benchmark:** A comprehensive set of zoning requirements is established to protect the shoreland area of Canaan Street Lake.

F. Adopt Watershed Protection Area and Shoreland Protection District in Canaan's zoning ordinance.

- **Potential Lead Agency & Partners:** Planning Board, Board of Selectmen, Canaan Drinking Water Protection Committee, Canaan Water Department, Canaan Lake Association
- **Potential Funding Source:** N/A
- **Benchmark:** The Town has adopted the Watershed Protection Area and the Shoreland Protection District.

V. Land Conversion & Site Development

Land conversion and site development has the potential to occur throughout the watershed. When areas of natural cover are converted for development purposes, vegetation is removed, the ground surface is disturbed, and hydrogeological processes are altered (Jeer et al., 1997). If drainage, grading, and re-vegetation are not well planned during site development activities, they can contribute a significant amount of sediment from soil erosion to surface waters. Forestry operations can also be a significant source of sediment if vegetative buffers are not maintained along water resources and if logging roads are constructed improperly (Jeer et al., 1997).

The sediment that is washed into streams, rivers, ponds and lakes from construction sites is considered to be the greatest single nonpoint pollutant in the United States (Jeer et al., 1997). Impacts of sedimentation on fisheries include reduction in water clarity, increased water temperature, decreased dissolved oxygen levels, and filling in of spawning habitat. Impacts of sedimentation on wetlands include reduction in flood storage capacity. Sedimentation can also have negative impacts on drinking water supplies by damaging water treatment pumps, increasing treatment costs, and increasing the production of carcinogenic disinfection byproducts (Jeer et al., 1997).

Maintaining natural land cover is one of the surest ways to protect water quality. Forests and natural vegetation maintain the hydrogeologic cycle by stabilizing soils, filtering pollutants, and providing water storage. Since natural land cover permits the infiltration of water, and thus filtration of pollutants, it also contributes the lowest pollutant load to water resources.

The committee developed the following objectives to address water quality concerns associated with land conversion and site development:

Objective #1: Educate watershed residents about the importance of maintaining buffers and natural vegetation.

Objective #2: Conserve key parcels within the watershed, focusing on the following areas: land surrounding surface water intakes; wetlands; steep slopes; and undeveloped waterfront properties.

Objective #3: Ensure site plan and subdivision review requirements adequately protect water quality from erosion and sedimentation. Revise requirements where necessary.

Strategies for Achievement

A. Conduct an education and outreach program for watershed residents, contractors, and developers on the importance of maintaining natural vegetation and controlling erosion. For instance, provide homeowners and contractors with information on maintaining a protected shoreline.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Drinking Water Protection Committee, Canaan Water Department, Canaan Conservation Committee, Cardigan Mountain School, Canaan Lake Association, Local Contractors and Developers; NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** An ongoing education and outreach program is established in Canaan to facilitate the use of proper erosion control practices during site development.

B. Work to place undeveloped properties surrounding the surface water intakes into conservation.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Drinking Water Protection Committee, Canaan Water Department, Canaan Conservation Commission, Canaan Lake Association, NH DES, Affected Property Owners

- **Potential Funding Source:** NH DES Water Supply Land Grant Program; LCHIP; Town Funds
- **Benchmark:** Undeveloped properties bordering the "reservoir" area are placed into conservation to protect water quality near surface water intakes.

C. Identify key parcels in the watershed for conservation (e.g. wetlands, steep slopes, sensitive habitat, shoreland properties).

- **Potential Lead Agency & Partners:** Town of Canaan, Canaan Drinking Water Protection Committee, Canaan Conservation Commission, NH DES, NH Natural Heritage Bureau, Affected Property Owners
- **Potential Funding Source:** NH DES Water Supply Land Grant Program, LCHIP, Town Funds
- **Benchmark:** Key parcels for conservation are identified and placed into conservation.

D. Adopt erosion and stormwater management controls for new development. Incorporate new guidelines into site plan and subdivision review.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Drinking Water Protection Committee, NH DES, US EPA, Army Corps of Engineers
- **Potential Funding Source:** N/A
- **Benchmark:** Local regulation exists to minimize erosion and stormwater runoff from new developments.

VI. Management of Point Sources

Within the watershed there are no sources of pollution that meet the true definition of a point source. However, several potentially contaminating activities exist in the watershed that require state permits. While these activities are not point sources in the traditional sense, they are included in this section due to their known location and their ability to potentially contaminate either surface or groundwater.

The identified sites are associated with the operation of Cardigan Mountain School and include:

1. Three known groundwater hazard sites
    a. The School's septic leach field. However, the leach field does not pose a threat to the Canaan Street Lake watershed, as it is located just beyond the watershed boundary, is in good condition, and is well maintained.
    b. The sites of two leaking underground heating oil tanks. Both tanks were removed upon discovery (1991 and 1995) and the sites were completely remediated to NH DES's satisfaction.
2. Five underground storage tanks containing #2 heating fuel.

3. One dual, aboveground storage tank that contains gasoline and diesel fuel for maintenance equipment.
4. Cardigan Mountain School is classified as a "hazardous waste handler" under Resource Conservation and Recovery Act[19] (RCRA).

Upon review of the identified regulated sites, it was determined that Cardigan Mountain School follows regulatory standards and employs best management practices to minimize potential contamination threats.

The operational underground fuel tanks meet current safety and leak protection standards and are monitored annually by NH DES. The aboveground storage tank is located on an impervious surface that allows for spill containment. However, the tank is located within twenty feet of a storm drain that feeds directly to Canaan Street Lake and discharges near the outlet dam. The School has plans to relocate the aboveground tank to a safer location within the next year.

Based upon the available information, the Committee established the following objective:

Objective: Maintain communication with Cardigan Mountain School about the status of its regulated storage facilities.

Strategies for Achievement

A. Keep communication open between Cardigan Mountain School and the Canaan Water Department regarding the status of the Schools regulated storage facilities. One method of maintaining open communication between the School and the Town is to schedule and annual meeting between appropriate School and Town officials.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Cardigan Mountain School, Health Officer
- **Potential Funding Source:** N/A
- **Benchmark:** Open communication regarding the protection of the Canaan Street Lake watershed between Cardigan Mountain School and the Town continues and an annual meeting date is established.

5.2 Other Concerns

In addition to direct water quality threats caused by surrounding land uses, the Committee has expressed concern regarding non-land use activities in the watershed. These concerns range from improving knowledge of the reservoir area, the need for local enforcement of new and existing regulations, the lack of a detailed Emergency Spill

[19] RCRA sites store, manage, or generate hazardous substances, which may be highly flammable, corrosive, or toxic and require careful handling and/or disposal.

Response Plan, garnering community support in protection activities, and expanding the source protection process.

I. Demarcation of the "Reservoir" Area

The "reservoir" area is established under NH DES Administrative Rule Env-Ws 386.18, Protection of the Purity of Canaan Street Lake and Its Watershed. The Rule states, "A person shall not trespass, boat, bathe, swim, fish or carry on any activity whatever whether of recreational, occupational or other nature, in the waters or on the ice of Canaan Street Lake, south of a line about 1,200 feet northwest of the lake's southern most part…"

Keeping recreational users out of the reservoir area is critical to protect the surface water intakes as well as limit the potential for contaminants to be introduced in close proximity to the intakes. Signs are posted on the shore at either side of the line to inform users of the lake that the area is restricted. Traditionally, watershed residents have placed buoys in the summer months to visibly demarcate the line. In 2006, the Town assumed responsibility for placing the buoys to mark the reservoir area during the summer. No markers are placed in winter to keep winter enthusiasts out of the area. Based upon this information, the committee has determined the following objective:

Objective: The reservoir area is well marked, in all seasons, and its use restrictions are respected and enforced.

Strategy for Achievement:

A. Work to place year-round markers to demarcate the reservoir area.

- **Potential Lead Agency & Partners:** Board of Selectmen Canaan Water Department, Canaan Drinking Water Protection Committee, NH DES, NH Department of Fish & Game (Winter Enforcement), NH Department of Safety – Marine Patrol (Summer Enforcement)
- **Potential Funding Source:** Town of Canaan
- **Benchmark:** Year-round markers are placed to demarcate the reservoir area.

II. Local Enforcement

Local enforcement is critical in ensuring protection of drinking water resources. Without consistent enforcement of established regulations, the recommendations identified in this plan will not safeguard Canaan's drinking water resources. Part of developing a local enforcement plan is working with state and regional officials to determine official jurisdiction and enforcement responsibilities. Enforcement of regulation is a necessary requirement to providing access to quality drinking water and maintaining Canaan's quality of life.

Based upon identified issues for local enforcement, the Committee has developed the following objectives:

Objective #1: Regulations for the protection of Canaan's water resources are consistently enforced.

Objective #2: State, regional, and local jurisdiction is clearly defined.

Strategy for Achievement:

A. Develop a local enforcement plan and identify proper enforcement agents.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Health and Building Inspector, Canaan Water Department, Canaan Drinking Water Protection Committee, NH DES
- **Potential Funding Source:** N/A
- **Benchmark:** Canaan has determined who will enforce local regulation, has established set standards for enforcement, and has properly equipped the enforcement officer(s) to carry out their duties. Enforcement actions are taken when necessary, but in a manner that respects individual property rights.

B. Bring town, county, and state officials together to clarify questions regarding jurisdiction of activities associated with Canaan Street Lake and to investigate issues regarding authority, enforcement, and compliance.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan Drinking Water Protection Committee, NH DES, NH Department of Fish & Game (Winter Enforcement), NH Department of Safety – Marine Patrol (Summer Enforcement)
- **Potential Funding Source:** Town funds
- **Benchmark:** Meetings are conducted and questions regarding jurisdiction are resolved.

III. Emergency Spill Response Plan

An Emergency Spill Response Plan is critical for protecting the quality of Canaan Street Lake. Dangerous spills could be the result of a vehicular accident on nearby roads, boating accidents, refueling of recreational equipment, snowmobiling accidents, a sinking vehicle, or a seaplane accident. Developing a detailed Emergency Spill Response Plan will help direct local emergency departments on how to take action and possibly minimize harm to the drinking water supply if a spill ever occurs.

The Committee's objective regarding the Emergency Spill Response in the watershed is:

Objective: Local emergency response departments are prepared for emergencies that may threaten the water quality of Canaan Street Lake.

Strategy for Achievement

Develop a comprehensive Emergency Spill Response Plan to minimize contamination of Canaan Street Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, Canaan's Emergency Services, Canaan Drinking Water Protection Committee, NH DES
- **Potential Funding Source:** N/A
- **Benchmark:** An Emergency Spill Response Plan is developed, in effect, and practiced on a regular basis.

IV. Education & Outreach

Education and Outreach is critical to achieving comprehensive protection of the Canaan Street Lake watershed. Outreach and education will help create an awareness of the value of Canaan Street Lake, educate people about what's threatening its water quality, and encourage protective actions and behavioral change. Reaching out to community members also invests them in the process and helps build local support for the implementation of regulations and corrective actions.

Objective: Develop a local awareness of the need to protect Canaan Street Lake and other local water resources.

Strategies for Achievement

A. Develop a watershed outreach campaign to inform local residents about the importance of protecting Canaan Street Lake. The outreach campaign should educate homeowners about how to reduce risks from potentially contaminating activities at their homes like septic systems, heating fuel tanks, and yard care.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board , Canaan Drinking Water Protection Committee, Canaan Lake Association, Cardigan Mountain School, Local Recreational Groups, UNH Cooperative Extension, NH DES
- **Potential Funding Source:** Town of Canaan, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Benchmark:** An ongoing watershed outreach plan is developed and in effect.

B. Make information regarding the Watershed Protection Plan easily available at the following locations: on Town website and at the Town Office and Library.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board , Canaan Drinking Water Protection Committee, Canaan Lake Association, Local Recreational Groups,
- **Potential Funding Source:** Town of Canaan
- **Benchmark:** Information regarding the plan and its recommendations is available at key locations throughout Canaan.

C. Post information about how to protect Canaan Street Lake at the Lake's public access points and in local newsletters.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department Canaan Drinking Water Protection Committee, Canaan Lake Association, Cardigan Mountain School, Local Recreational Groups
- **Potential Funding Source:** Town of Canaan, In-kind donations
- **Benchmark:** Helpful tips on how to protect Canaan Street Lake are posted at the Lake's public access points and circulated in local newsletters.

D. Take advantage of Project WET in local schools to teach students about the importance of water resource protection. (State Contact: Jessica Morton, Coordinator. NH DES, PO Box 95, Concord, NH 03302. (603) 271-4071)

- **Potential Lead Agency & Partners:** Canaan Drinking Water Protection Committee, Mascoma Valley SAU, Cardigan Mountain School, NH DES
- **Potential Funding Source:** undetermined
- **Benchmark:** Project WET curriculum and activities are being utilized in local schools to educate students about water resources.

V. Comprehensive Testing Program

The Committee recognizes that more water quality data needs to be collected prior to the implementation of its recommendations. While VLAP, NH DES, the Town of Canaan, and the Canaan Water Department have conducted a significant amount of testing, the data collected is, at this time, insufficient to scientifically support some recommendations made in this plan. In light of this, the Committee realizes that some of the recommendations made in this plan might be "hard sell." However, the previously collected data does suggest a gradual decline in lake water quality.

Without fully understanding the causes behind degrading water quality, the Town will not be able to appropriately manage and mitigate pollution sources and identified water quality threats. Consequently, absent the data, the Committee has attempted to make the strongest recommendations possible that will result in the full protection of water supplies within the Canaan Street Lake watershed.

Based upon the recognized need for more scientific study of Canaan Street Lake the committee has identified the following objective:

Objective: A comprehensive testing regime and body of data regarding the water quality of Canaan Street Lake exists.

Strategy for Achievement

Hire a qualified, experienced environmental scientist or engineer to prepare a comprehensive testing regime for the Lake.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Water Department, NH DES, UNH, Plymouth State
- **Funding:** NH DES Watershed Assistance Grant Program,
- **Benchmark:** A testing regime is determined and carried out by the Town.

VI. Plan Implementation & Expansion of the Drinking Water Protection Process

While the Committee has accomplished the goal of drafting the Canaan Street Lake Watershed Protection Plan, the next step in the process is for the plan to be adopted and implemented. On way to ensure implementation is reappoint the Committee for another year, so that they can begin the plan's implementation.

Additionally, the process that was applied toward protecting the Canaan Street Lake watershed should also be expanded and applied to the remaining five public drinking water systems located outside the watershed. Each of these water systems will benefit from source protection and should be included in water resource protection efforts. Also, consideration should be given to protecting Canaan's stratified drift aquifer.

The Committee's objectives for plan implementation and the expansion of the drinking water protection process are:

Objective #1: The Canaan Street Lake Watershed Plan is adopted and implemented.

Objective #2: All drinking water resources in Canaan have some level of water quality protection.

Strategies for Achievement

A. Reappoint the Canaan Drinking Water Protection Committee for an additional year to shepherd implementation of the Canaan Street Lake Watershed Plan.

- **Potential Lead Agency & Partners:** Board of Selectmen, Canaan Drinking Water Protection Committee
- **Potential Funding Source:** N/A
- **Benchmark:** Canaan's Drinking Water Protection Committee is reappointed and the recommendations made in the plan are being implemented.

B. Extend the Source Protection Process to include all public water supplies in Canaan and other valuable drinking water resources such as local aquifers.

- **Potential Lead Agency & Partners:** Board of Selectmen, Planning Board, Canaan Drinking Water Protection Committee, NH DES, Granite State Rural Water Association, Upper Valley Lake Sunapee Regional Planning Commission
- **Potential Funding Source:** N/A
- **Benchmark:** Canaan's drinking water resources are included in a Town-wide drinking water protection plan.

Chapter 6 – Emergency Response Plans

Emergency Response Plans describe the steps that would be taking if any or all of the sources from these public water systems become contaminated, decline in yield, or were lost for any reason. At this time, the State of New Hampshire only requires that Emergency Response Plans be completed and on file for Community Water Systems. Both the Canaan Water Department and Cardigan Mountain School have completed minimum requirements of an Emergency Response Plan. These plans are on file and can be reviewed at NH DES in Concord, NH. However, despite the fact that the Canaan Water Department has a completed plan on file with NH DES, it is still in the Town's best interest to conduct a detailed Emergency Response Plan for local emergency providers.

Chapter 7 - Conclusion

The Canaan Drinking Water Protection Committee worked with a variety of individuals, groups, and agencies to develop this Watershed Protection Plan. The next step is to share the plan with the community to develop local support for implementation. Additionally, it is important that the Canaan Drinking Water Protection Committee continue to exist in order to shepherd implementation of these recommendations. As evidenced by this plan, the Committee has already played an important role in developing watershed awareness, identifying current concerns, and has begun to plan for the future of the Canaan Street Lake watershed.

The management objectives and strategies identified in this plan represent one step in a multiple stage process to protect water quality. As strategies are implemented and goals and objectives are met, new ones need to be developed and the watershed plan will need to be amended to reflect these changes. No planning process is complete without a review of the benchmarks set forth in a management plan. The benchmarks outlined in Chapter V should be revisited periodically to evaluate whether strategies have been successfully implemented. In order to keep the plan current and practical, and for this plan to be successful, benchmarks will need to be met or exceeded.

The Committee believes that Canaan Street Lake and all other drinking water sources within the Town should be considered as long-term resources that need to be properly protected for all generations. Preservation of these resources should occur in a manner that maintains water quality so that it is as good, or better, in one hundred years as it is today. Without comprehensive protection, that is adjusted to address future threats, Canaan's drinking water resources run the risk of being contaminated and potentially unusable for future generations.

References

AWWA 2004. Recreational Use of Domestic Water Supply Reservoirs. American Water Works Association of Policy on Public Water Supply Matters. Adopted by the Board of Directors June 13, 1971, reaffirmed January 28, 1979, and January 25, 1987, revised June 23, 1996, and June 13, 2004.

Canaan Historical Society. "Canaan Historic District." http://members.aol.com/CanaanStreet/HDC.html

Corel, M. 1999. Carbureted Two-stroke Marine Engines: Impacts on the Environmental and Voluntary Policy Options to Encourage Their Replacement. Pollution Prevention Team, Oregon Department of Environmental Quality. Portland, Oregon.

Chiodo, Sharon. Personal Communication. 23 August 2006. Owner, Crescent Campsites

Estabrook, Robert. Personal communication. 17 July 2006. Phone conversation. Chief Aquatic Biologist, New Hampshire Department of Environmental Services.

Homer, J.W., 1998. A Soil Survey of the Grafton County Area, New Hampshire. US Department of Agriculture and Natural Resources Conservation Service.

Hoyle, Tanner, and Associates, Inc., 2004. Water System Engineering Study prepared for Town of Canaan, NH. Burlington, VT.

Kratzenburg, G. Untitled. Federal Office of Transport, Switzerland. 1997

Jeer et al., 1997. Nonpoint Source pollution: A Handbook for Local Governments. American Planning Association Advisory Service, Report Number 476. Washington, D.C.

Mason, C., 2002. Biology of Freshwater Pollution, Fourth Edition. Pearson Education Limted. Edinburgh Gate, England.

NH DES, 2006. OneStop Environmental Database. http://www2.des.state.nh.us/OneStop/.

NH DES, 2003. Volunteer Lake Assessment Program: 2003 Annual Report. Concord, NH.

NH DES, 2001. Source Water Assessment Reports for Canaan Water Department, Crescent Campsites North & South, and Cardigan Mountain School. Concord, New Hampshire.

NH DES, 1991. New Hampshire Lakes and Ponds Inventory. Concord, New Hampshire.

Schueler, T.R. 2002. The Importance of Imperviousness. Pages 7-8 *in* T.R. Schueler and H.K. Holland The Practice of Watershed Protection. Center for Watershed Protection, Maryland.

Seaplane Pilots Association. 2000. "Seaplane Environmental Issues." http://www.seaplanes.org/advocacy/index.htm.

Susca, Paul. Personal Communication. 18 August 2006. Phone Conversation. Environmental Program Manager, Drinking Water Source Protection Program. New Hampshire Department of Environmental Services.

Waukewan Watershed Advisory Committee, 2004. Management Plan for Lake Waukewaun Watershed. Palmiotto, J., New Hampshire Rural Water Association.

U.S. EPA. Septic Systems. 12 August 2006. http://cfpub.epa.gov/owm/septic/home.cfm?program_id=70

U.S. EPA. Used Oil Management Program. 9 August 2006. http://waterontheweb.org/under/waterquality/index.html.

U.S. Geological Survey. Water Science for Schools: What is Groundwater. http://ga.water.usgs.gov/edu/earthgw.html

Upper Valley Lake Sunapee Regional Planning Commission, 2004. "Build Out Analysis: Canaan, NH." Lebanon, New Hampshire.

Yousef, et al., 1980. "Changes in phosphorous concentrations due to mixing by motorboats in shallow lakes." Water Research. 14:841-852.

Glossary

Algae Bloom: Population explosion of phytoplankton in response to changing environmental conditions, including nutrient over-enrichment from wastewater and non-point sources. Blooms can result in oxygen depletion and biological impacts. www.wetmaap.org/References/glossary.html.

Atmospheric Deposition: The contribution of atmospheric pollutants or chemical constituents to land or water ecosystems. Deposition results from materials in rain or snowfall, combined with dry dust fallout. Increasingly, atmospheric sources are recognized as a significant source of nutrients and contaminants to coastal systems. www.wetmaap.org/References/glossary.html.

Community Water System: serve at least 25 residents on a year round basis. Examples include municipal water systems and systems that serve mobile home parks, condominiums, and single-family housing developments. (Env-Ws 300)

Disinfectant Byproducts: Pollutants formed when organic materials in a drinking water source react with the disinfectant, such as chlorine or ozone. Trihalomethanes (THMs) are a major group of disinfection byproducts. www.abag.ca.gov/bayarea/sfep/reports/soe/soegloss.htm. . Exposure to DBPs in drinking water has been linked to the development of bladder cancers and may cause some risk to reproductive health (EPA).

Ecological Services: services which humans derive from ecological functions such as photosynthesis, oxygen production, water purification and so on. www.eman-rese.ca/eman/reports/publications/rt_biostrat/cbs28.htm.

Epilimnion: Epilimnion is the top-most layer in a thermally stratified lake, occurring above the deeper hypolimnion. It is warmer and typically has a higher pH and dissolved oxygen concentration than the hypolimnion. http://en.wikipedia.org/wiki/Epilimnion.

Eutrophic: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms. Used of a lake or pond. www.bbmwd.org/vocabulary.htm

Flushing Rate: represents the volume of water that passes through the lake's outlet in one year and signifies how often the water in the lake is replaced by fresh water. (Jeer et al., 1997).

Hypolimnion: The hypolimnion is the bottom and most dense layer of water in a thermally stratified lake. It is the layer that lies below the thermocline. Typically, it is non-circulatory and remains cold throughout the year. http://en.wikipedia.org/wiki/Hypolimnion

Impervious Cover: Land surfaces with a low capacity for soil infiltration, for example paving, roofs, roadways, or other human structures. The presence of impervious cover increases runoff and affects the quantity and composition of nonpoint source. www.wetmaap.org/References/glossary.html

Non-community Non-transient Water System: serve at least 25 people, for at least 6 months per year. These systems typically serve daycare facilities, schools, and commercial properties. Typically, non-community non-transient systems serve the same groups of people on a regular basis. (Env-Ws 300)

Non-community Transient Water System: serve at least 25 people, for at least 60 days per year. These water systems serve restaurants, campgrounds, motels, recreational areas, and service stations.

Nonpoint Source Pollution: Pollution from many diffuse sources that cannot be attributed to one identifiable "point," such as a discharge pipe. NPS pollution is caused by precipitation, atmospheric deposition, percolation, and runoff containing sediments, nutrients, and organic and toxic substances generated by various land uses and human activities. Rainfall can cause soil erosion and create runoff, which carries sediments and pollutants to receiving water bodies. www.scdhec.com/ocrm/html/glossary.html

Oligotrophic: The state of a poorly nourished, unproductive lake that is commonly oxygen rich and low in turbidity. Relatively low amounts of nutrients (phosphorus and nitrogen) in the water column. Refers to an unproductive, nutrient poor lake that typically has very clear water. www.great-lakes.net/humanhealth/about/words_o.html

Point Source Pollution: pollution originating from a single point such as pipes, ditches, wells, vessels, and containers. www.nwrc.usgs.gov/fringe/glossary.html

Sanitary Protective Radius: a 75-100 foot radius around a well, which must be controlled by the water supplier through ownership or easement. The extent of the Sanitary Protective Radius is dependent of the permitted production volume of the well. (NH DES)

Source Water: Untreated water (i.e., raw water) used to produce drinking water. www.cdc.gov/mmwr/preview/mmwrhtml/ss5108a4.htm

Storm water Runoff: The water, which is not absorbed into the ground during and after a storm which then flows over the land. www.cascadelink.org/neigh/ghfl/pcpAppendixB.html

Stratified Drift Aquifer: a geologic formation of predominantly well-sorted sediment deposited by or in bodies of glacial melt water, including gravel, sand, silt, or clay, which contains sufficient saturated permeable material to yield significant quantities of water to wells. (NH DES)

Synthetic Organic Chemicals: Man-made (anthropogenic) organic chemicals. Some SOCs are volatile; others tend to stay dissolved in water instead of evaporating. www.afrpa.hq.af.mil/kelly/Terms/sterms.html

Thermocline: the level dividing a lake into two layers, an upper warmer one (epilimnion) and a lower colder one (hypolimnion). The temperature usually drops several degrees centigrade over just a few meters at this level. www.unep.or.jp/ietc/publications/short_series/lakereservoirs-3/8.asp

Trophic State: the degree of biological productivity of a water body. Biological productivity generally relates to the amount of algae, aquatic plants, fish and wildlife a water body can produce and sustain. www.cityoforlando.net/public_works/stormwater/lakes/glossary.htm

Vegetative Buffers: Vegetated areas adjacent to streams, ponds, etc., that protect those water resources from pollution, prevent erosion of the banks of these water resources, provide wildlife food and cover, and shade the adjacent water, moderating temperatures for aquatic species. www.chaddsfordpa.net/glossary.htm

Volatile Organic Chemicals: these are chemicals of an organic nature (containing hydrogen, oxygen, and carbon), which readily volatilize, or travel from the water into the air. Most such substances are industrial chemicals and solvents. These potentially toxic chemicals are used as solvents, degreasers, paints, thinners, and fuels. Because of their volatile nature, they readily evaporate into the air, increasing the potential exposure to humans. Due to their low water solubility, environmental persistence, and widespread industrial use, they are commonly found in soil and water. http://www.nalms.org/glossary/lkword_v.htm

Watershed: The area of land from which rainfall (and/or snow melt) drains into a single point. Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridges of higher ground generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed. www.soil.ncsu.edu/publications/BMPs/glossary.html

Watershed Imperviousness: the percentage of impervious cover by area within a development site or watershed, often calculated by identifying impervious surfaces from aerial photographs or maps. www.epa.gov/watertrain/protection/glossary.html

Wellhead Protection Area: the surface area under which groundwater flows to a producing well. For bedrock wells, a WHPA is typically a fixed circle where the radius is determined by

the maximum daily amount of water withdrawn from the well. For gravel wells, the WHPA is calculated from existing hydrogeologic information regarding subsurface flow. (NH DES)

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.
www.ieca.org/Resources/Reference/DefinitionsTZ.asp

APPENDIX A:
PUBLIC WATER SUPPLIES
CANAAN, NH

Active Public Water Supplies – Canaan, NH

EPA PWSID	SYSTEM NAME	ADDRESS	SYSTEM TYPE	POPULATION	WELL TYPE	WELL DEPTH	YIELD (Gpm)
351010	**CANAAN WATER DEPT**	**FERNWOOD FARMS RD**	**Community**	**600**	**Surface**	**--**	**1 million (gpd)**
354010	**CARDIGAN MOUNTAIN SCHOOL**	**BACK BAY RD**	**Community**	**300**	**BRW**	**540**	**23**
354010	**CARDIGAN MOUNTAIN SCHOOL**	**BACK BAY RD**	**Community**	**300**	**BRW**	**525**	**12**
353010	COUNTRY VILLAGE MHP	STEVENS RD	Community	50	BRW	0*	30
353010	COUNTRY VILLAGE MHP	STEVENS RD	Community	50	BRW	650	0.00‡
353020	PLEASANT VALLEY MHP	SOUTH RD	Community	73	BRW	335	50
356020	BARKER STEEL CO INC	RTE 4	Non-community Non-transient	35	BRW	490	50
355060	INDIAN RIVER SCHOOL	ROYAL RD, RTE 4	Non-community Non-transient	600	BRW	820	9
355030	MASCOMA VALLEY REG HIGH SCHOOL	27 ROYAL RD, RTE 4	Non-community Non-transient	530	BRW	410	33
357040	**CRESCENT CAMPSITES NORTH**	**FERNWOOD FARM RD**	**Non-community Transient**	**211**	**BRW**	**500**	**3**
357030	**CRESCENT CAMPSITES SOUTH**	**FERNWOOD FARM RD**	**Non-community Transient**	**25**	**BRW**	**190**	**15**

Source: NH DES

*Indicates that the well's depth is unknown.
‡Indicates that the well's yield is unknown.
Public water supplies located within the Canaan Street Lake Watershed are denoted in boldface type.

APPENDIX B:
KNOWN OCCURANCES
RARE & EXEMPLARY SPECIES
CANAAN STREET LAKE WATERSHED

New Hampshire Natural Heritage Bureau

Known occurrences of rare species and exemplary natural communities in the Canaan Street Lake Watershed (HUC 12 code 010801060101)

Name - Occurrence # (unique identifier)	Quality Rank	Precision	Listing Status State	Listing Status Federal	Last Obs
Natural Community					
Rich mesic forest - 037	B-	S	--	--	2000
Plant species					
Ginseng (Panax quinquefolius) - 026		M	T	--	1992
Heart-leaved Twayblade (Listera cordata) - 007	H	M	T	--	1908
Reversed Bladderwort (Utricularia resupinata) - 005		M	T	--	1963
Squirrel Corn (Dicentra canadensis) - 022	B	S	T	--	2000
Vertebrate species					
Common Loon (Gavia immer) - 025		M	T	--	2000
Common Loon (Gavia immer) - 188		S	T	--	2003
Common Loon (Gavia immer) - 216		S	T	--	2003

Ranks
A-D = Excellent (A) to poor (D)
H = Historical (not observed within the last 20 years)
X = Extirpated
T = Threatened

Precision
S = Location known to within ca. 300 feet
M = Location known to within ca. 1.5 mile
M = Location known only to place name (ca.5 miles)

31 May 2006

APPENDIX C:
SOURCE PROTECTION PLAN
CARDIGAN MOUNTAIN SCHOOOL
&
CRESCENT CAMPSITES

Source Protection Plan for Cardigan Mountain School & Crescent Campsites

In addition to addressing water quality threats to Canaan Street Lake, this plan is also concerned with protecting the water quality of Cardigan Mountain School and Crescent Campsites, which are registered public water supply systems.[20]

Both Cardigan Mountain School and Crescent Campsites obtain their water from groundwater sources. Like a watershed, it is important to note that groundwater sources also have "land" areas that contribute water to a producing well. Depending on a water system's classification[21], each system is required to maintain specific drinking water protection areas. The size and type of the protective areas are dependent upon the type of groundwater source being utilized (bedrock or gravel) and the quantity of water pumped from the well. Between the two systems, the ground water protection areas employed are: Wellhead Protection Areas and Sanitary Protective Radii.

While the recommendations generated in Chapter Five provide protection to all drinking water supplies in the watershed[22], including private wells, this Plan specifically addresses Cardigan Mountain School and Crescent Campsites by identifying specific threats to each system's sources and suggesting management recommendations to mitigate the identified threats.

Cardigan Mountain School

I. Description

Cardigan Mountain School develops its water supply from two bedrock wells located in an athletic field at the southern end of its property. Well #1 has a depth of 540 feet and yields twenty-three gallons per minute. Well #2 has a depth of 525 feet, yields twelve gallons per minute, and is located in a below-grade vault.

Water from the wells is pumped to a pump house where the flow from each well is combined and chlorinated for disinfection purposes and transferred to a 100,000-gallon storage tank. Water is then pumped and distributed to the campus buildings by a hydro-pneumatic system. Also installed on the system, is a fire pump capable of pumping 1,000

[20] New Hampshire Drinking Water Rules define a public water system as "a system for the provision to the public of piped water for human consumption if such a system has at least 15 service connections or regularly serves and average of at least 25 individuals daily at least 60 days out of the year." (Chapter Env-Ws 300)

[21] Public water supplies are further classified into three categories based upon the level of service provided. System classifications are: Community Water Systems; Non-community non-transient systems; and Non-community transient systems.

[22] Due to the fact that the Canaan Water Department develops its drinking water from Canaan Street Lake, the objectives and recommendations in Chapter 5 addresses potential threats to the system's water supply. For more detail about the Water Department's delivery system and water quality please see Appendix G.

gallons per minute at ninety pounds of pressure for approximately one hour. The fire pump pressurizes four municipal fire hydrants located around campus, and charges the sprinkler systems located within campus buildings. The Cardigan Mountain School fire hydrants are frequently tapped by the Canaan Fire Department to rapidly fill truck tankers supporting their fire fighters at off-campus, private property fires.

The system has twenty-three service connections and serves a population of 300 people. Water provided by Cardigan Mountain School has met all the State and Federal Safe Drinking Water Act requirements set for drinking water quality. The School has also established a Wellhead Protection Area (WHPA), over the area of land under which groundwater flows towards the School's wells, and a Sanitary Protective Radii for each well.

Unlike most WHPAs for bedrock wells, the size and shape of the School's WHPA was determined using a fixed radius that was modified based upon groundwater flow. If the watershed boundary did not bisect the WHPA, it would be a circle with a fixed radius of approximately 4,200 feet. However, the western side of the WHPA follows the watershed boundary for Canaan Street Lake because groundwater flows outside of the boundary do not flow towards Cardigan Mountain School's wells. Additionally, due to differences in production volume, each well has a separate Sanitary Radius. Well #1 has a Sanitary Radius of 200 feet and Well #1 has a Sanitary Radius of 175 feet.

II. Identified Contaminants

Below is a summary of PCSs identified by a review of NH DES Source Water Assessment Reports, NH DES on-line OneStop Database, NH DES Sanitary Surveys, Cardigan Mountain School's Drinking Water Protection Plan, and a windshield survey of the area.

According to the review of available data, Well #1 has one identified PCSs within its Sanitary Protective Radius. Well #2 also has an identified PCSs within its sanitary radius, although it is not from a land use. Additionally, three other PCSs have been identified within 1,000 feet of the wells. The risks listed below are in no order of priority.

Parking Area

A parking area is within Well #1's Sanitary radius and located approximately 175 feet, upslope of the well. The parking area provides vehicular access to the back entrance of the School's sports complex and its practice fields. Additionally, the School parks buses overnight in the same vicinity.

Since they are impervious, paved parking areas collect nonpoint pollutants, like oil and gas, deposited from vehicles. Nonpoint pollutants that collect on the parking area are likely to be washed from the pavement when storm event or snowmelt occurs and transported onto the fields that house the School's wells. Volatile Organic Chemicals (VOCs), like the gasoline additive MtBE, are just some potential contaminants present in stormwater flows from transportation related surfaces.

Underground Storage Tanks
Cardigan Mountain School has five underground storage tanks in operation, which store heating fuel for the School's facilities. Currently, all underground storage tanks in use at Cardigan Mountain School meet the current standards for tank safety and leak detection. However, in the early 1990s two tanks at the school were found to be leaking heating fuels into the surrounding environment. Upon discovery of the leaks, the School removed the tanks and has since remediated both sites to NH DES's approval. Leaking underground storage tanks can introduce VOCs into the ground and potentially contaminate groundwater supplies.

Lawn Cover
According to the Source Assessment Report conducted by NH DES in 2001 for Cardigan Mountain School more than ten percent of the WHPA has agricultural cover. Due to assessment methods used, open fields and/or lawns are included in the agricultural assessment. Based upon a windshield survey of the School's WHPA, it appears most of the agricultural area counted in the Source Water Assessment are grassed areas associated with the School and surrounding residential development.

In order to protect the quality of their wells Cardigan Mountain School does not apply fertilizers or pesticides to the athletic fields where the wells are located. The School does apply fertilizers and pesticides to its upper fields and grassed areas. A portion of these upper fields is located within 1,000 feet of the Well #1. Fertilizers and pesticides applied to lawns can contaminate groundwater supplies if applied improperly. However, fertilizer application to the School's upper fields does not pose a significant risk to the School's water supply.

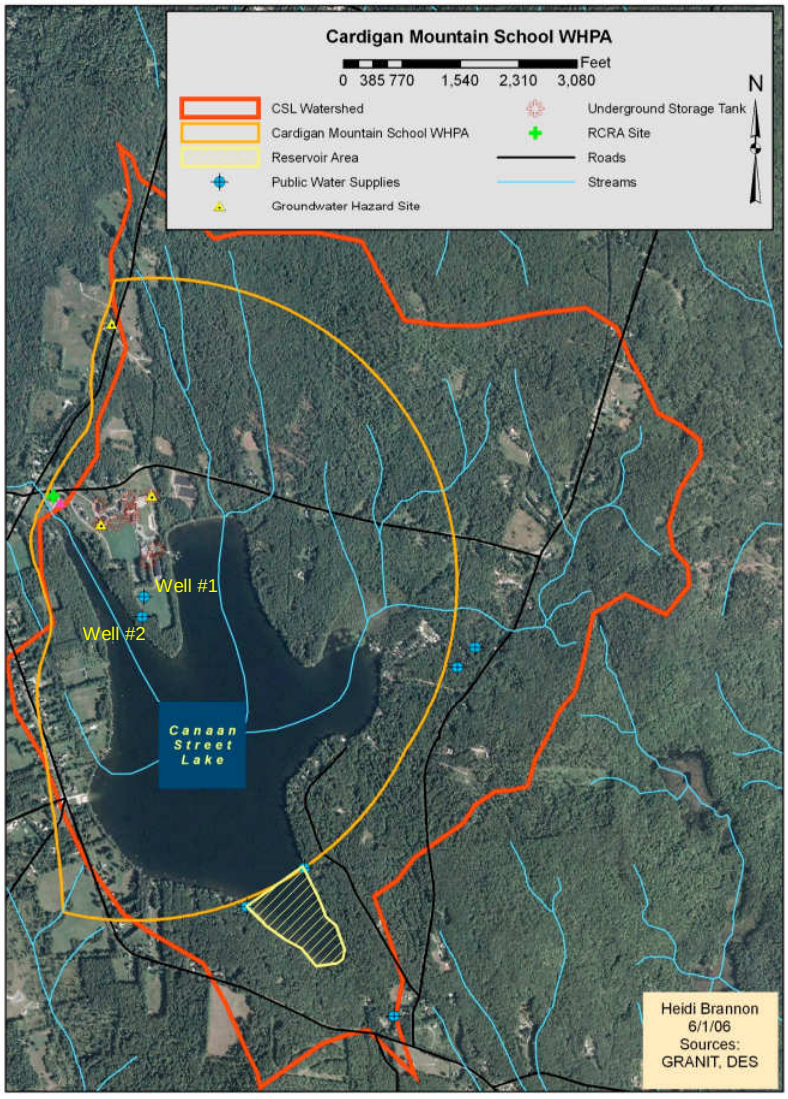
Buried Well
Well #2 is housed in a below grade vault, meaning the well is located under the surface level of the ground. According to Sanitary Surveys completed by NH DES, a buried well is subject to contamination if flooding occurs. Additionally, inspection and maintenance of the well is made more difficult as the well is not easily accessible.

On-Site Septic Systems
Three of the School's on-site septic tanks are located within 1,000 feet of well #1. Effluent from these tanks is pumped away from the wells to a larger tank located at the intersection of Back Bay Road and Alumni Drive, where the effluent is pumped to the School's leach field located outside of the Canaan Street Lake watershed. It is unlikely that the School's septic system is a threat to its drinking water supply. While the School's septic system is not a threat, a large portion of the developed areas of the Canaan Street Lake watershed falls within the WHPA for Cardigan Mountain School. With no municipal sewer in the area, each residence must rely on on-site septic systems to treat their household wastewater. As noted earlier in the plan, septic systems can be a source of disease causing pathogens if not properly maintained as well as a source of harmful chemicals if improperly used to dispose of household hazardous wastes.

Hazardous Waste Handler

Cardigan Mountain School is registered with the State under the Resource Conservation and Recovery Act (RCRA). RCRA sites store, manage, or generate hazardous substances, which may be highly flammable, corrosive, or toxic and require careful handling and/or disposal. In researching the RCRA manifests for Cardigan Mountain School on NH DES's One-Stop on-line database, it appears that the School mainly generates waste oils from maintenance activities. The generated wastes are not a threat to the School's water supply, as long as best management practices are followed and the wastes are properly stored and handled.

Figure 1 *Cardigan Mountain School*



III. Recommendations

Cardigan Mountain School has a Well Head Protection Plan that addresses the identified contaminants listed in Section II above. The plan has been in effect since 1991 and is on file at Cardigan Mountain School. The plan has been reviewed and the recommendations suggested for the identified threats are still valid. Below is a brief summary of the School's water quality management efforts.

- No fertilizers/pesticides applied to fields where water supply wells are located
- Send informational mailings every three years about water quality protection to residences within the School's WHPA
- Underground storage tanks undergo regular inspection by NH DES. Non-compliance issues are repaired.
- Hazardous materials are handled and disposed of properly.

To the extent practical, the School and the Town of Canaan may want to coordinate educational mailings within the watershed to minimize costs.

Crescent Campsites

I. Description

Crescent Campsites obtains its water from two bedrock wells, which are identified by NH DES as separate regulated drinking water systems. The two systems are connected, but only for emergency purposes. During normal system operation, the connection between the two systems is valved off and they run independently of each other. The system descriptions are as follows:

Crescent Campsites – South obtains its water from a single bedrock well, with a reported depth of 190' and yield of fifteen gallons per minute. The well is located approximately twenty-two feet north northeast of the owner's trailer in a below grade, concrete tiled vault. Water is pumped from the well via submersible pump to two Well X-Trol captive air pressure tanks located inside the workshop building. Water from this system is distributed on one line to the trailer and another is metered and distributed to forty campsites. (NH DES Sanitary Survey)

Crescent Campsites – North obtains its water from a single bedrock well, which has a reported depth of 500 feet and yield of thre gallons per minute. The well is located approximately seventy feet east of the new pump house. Former overburden water supply sources (dug wells and spring) are not connected with the current system. Water is pumped via submersible pump from the well to three Well X-Trol captive-air pressure tanks located inside the pump house. There is a meter in place and water is distributed to the thirty-five sites served by the system.

At this time there is no continuous water treatment for either system. As the wells sit idle over the winter months, stagnated water in the wells has the ability to develop bacterial

activity. In order to remove any bacteria that may have developed over the winter months, both systems undergo shock chlorination treatment prior to the opening of the Campsite for seasonal use. As a non-community transient system, shock treatment is usually effective in eliminating bacteria from the system. However, according to water quality results provided on NH DES's OneStop on-line database, total coliforms were present in samples taken in May 2003 and June 2001. Coliform bacteria are an indicator that disease-causing organisms may be present in the water supply. Bacteria have not been present in water samples collected for either system since June 2003.

As a non-community transient system, Crescent Campsites is not required by NH DES to establish a WHPA for their drinking water source. However the Campground is required to apply a sanitary radius around each well. For *Crescent Campsites – South* the sanitary radius is seventy-five feet. The sanitary radius for *Crescent Campsites – North* is 150 feet.

II. Identified Contaminants

Below is a summary of PCSs identified by a review of NH DES Source Water Assessment Reports, NH DES on-line OneStop Database, NH DES Sanitary Surveys, and a windshield survey of the area. Five potentially contaminating activities have been identified, two of which are located in the sanitary radius for *Crescent Campsites – South*. Due to the close proximity of the two systems the identified PCSs apply to both water sources.

Aboveground Fuel Tanks
The Campsite has two aboveground storage tanks located within 500 feet of *Crescent Campsites – North* and within 250 feet of the *Crescent Campsites – South*. The closer tank stores propane while the second tank stores diesel fuel. The diesel storage tank is located on an impervious surface and is down gradient from both wells. Unlike other fuels, propane does not pose a contamination risk to soil and water (Campbell-Parnell, 2006). While the diesel tank does not pose a significant risk to the water supplies, there is still the possibility of contamination if a leak occurs.

On-Site Septic Systems
As noted previously, on-site septic systems can be a source of harmful pathogens if improperly maintained or sited. The septic systems for Crescent Campsites are located approximately 1000 down gradient of both water supplies. Additionally, there is a separate septic system for the owner's home located approximately 200 feet south of the *Crescent Campsite – South* and just outside the well's sanitary radius. Again, septic systems can be a source of harmful pathogens and chemicals if improperly maintained or used.

Minor Road
Both Fernwood Farms Road and the Campsite's private road pass in close vicinity of either water source. Fernwood Farms Road is within 250 feet of the *Crescent Campsite - South,* while the private road passes directly through the well's sanitary protective radius.

For *Crescent Campsite – North*, Fernwood Farms Road is approximately 500 feet from the water source and the private road passes within 150 feet of the source. Roads are considered a potential contamination source because of the potential for spill from vehicles along with their ability to contribute to nonpoint pollution. VOCs are just some potential contaminants.

Home Parking Area
The parking area for the owner's residence is located within the sanitary protective radius of *Crescent Campsite – South*. According to NH DES, the only activities to take place within the sanitary protective radius are those directly related to the functioning of a well or those that are non-threatening to water quality. The presence of vehicles parked within the sanitary protective radius does pose a risk to the well's water quality. Vehicles are known source of VOCs that pollute water supplies.

Dumpster
According to NH DES Sanitary Survey for Crescent Campsites, the Campsite's dumpster is listed as a PCSs. While the dumpster is mostly used to dispose of general wastes, it could potentially cause contamination if it is used to dispose of hazardous materials, such as batteries, motor oils, or cleaning products. If hazardous materials are disposed of in the dumpster, they may accumulate and be released onto the ground through holes in the dumpster or when the dumpster is emptied. The dumpster is located down gradient and within 500 feet of either source and is not a significant threat to either water source. However, it still poses a minimal contamination risk.

III. Recommendations

After reviewing the potential source of contamination for the Crescent Campsite systems, the following management priorities were developed.

Source Protection Education
Produce and distribute a source protection brochure describing the sources of the Campsites's water, the necessity for protecting these sources, and tips to protect the Campsites drinking water supplies.

Management of Diesel Fuel Tank
Install a secondary containment structure adequate to contain a spill equal to 110 % of the container's total capacity. The containment structure may be a berm made from an impervious surface, such as concrete, as long as no unsealed cracks or holes are present. (NH DES)

Septic System Maintenance
Appropriate maintenance and use of the septic systems located on the Campsite's property is key to their proper functioning. Generally, septic tanks should be cleaned out every three to five years, depending on the size of the tank and the amount and quality of solids entering the tank. Checking the sludge and scum build-up within the tank can also

help determine when maintenance needs to occur. Tank cleaning should be done by a commercial septic tank cleaning service at regular intervals (Jemison 2004).

Relocation of Parking Area

Parking next to the well for *Crescent Campsite – South*, makes the source vulnerable to contamination from spills or leaks associated with the vehicles. Ideally, parking should be relocated away from the well and outside of its sanitary protective radius. However, if relocation is not a possibility, vehicles should be well maintained to minimize any fluid leaks. Additionally, the Campsite may want to monitor *Crescent Campsite – South* for VOCs.

Management of Dumpster

Potential contamination threats from the dumpster can be minimized by: relocating the dumpster a safe distance away from the Campsite's water sources or locating the dumpster on an impervious surface, such as a concrete slab, that prevents spills from leaching into surrounding soils

APPENDIX D:
NH DES ADMINISTRATIVE RULE: 386.18 "PROTECTION OF THE PURITY OF CANAAN STREET LAKE & ITS WATERSHED"

Env-Ws 386.18 Protection of the Purity of Canaan Street Lake and Its Watershed.

(a) The purpose of this rule is to protect the purity of water of Canaan Street Lake which is the principle drinking water supply for the town of Canaan.

(b) This section shall be effective within the Canaan Street Lake watershed above the outlet dam which is located at approximate latitude 43° 39'30", longitude 72° 01'45", in the town of Canaan.

(c) Any person violating these rules shall, in accordance with RSA 485:26, be guilty of a misdemeanor if a natural person or guilty of a felony if any other person.

(d) Under the provisions of RSA 485:24, the town of Canaan and its agents may enter at reasonable times any land or property within the drainage areas tributary to the Canaan Street Lake public water supply in the town of Canaan for the purpose of investigating sanitation within the watershed and other sources of potential water contamination.

(e) Where any provision of these rules is in conflict with state law or other local ordinances, the more stringent provision shall apply. These rules shall not amend or alter any federal or state law or rule or local ordinance or rule.

(f) Any deviations from these rules shall be by written consent of the division in accordance with Env-Ws 386.03 and the town of Canaan. These provisions shall not apply to employees of the board of water commissioners engaged in the performance of necessary duties for the protection and control of said pond.

(g) The town of Canaan shall post a summary of the prohibitions contained in (h) below at all public access locations where persons might reasonably be expected to access Canaan Street Lake or its tributaries. This posted summary may also contain any prohibitions enacted by local ordinance.

(h) These restrictions shall include:

(1) A person shall not build, continue or maintain a building or structure of any kind in which animals or fowl are kept, within 75 feet of Canaan Street Lake or within 75 feet of any inlet or tributary thereto, except in such cases as the board of water commissioners may allow, and under such rules as it may require;

(2) A person shall not permit wastes, or waters that have been used for washing or cleansing either materials, persons, or food, to run into said lake, or into any inlet or tributary thereto;

(3) A person shall not throw or deposit any dead animal, fish, or parts thereof, or any food or article perishable or decayable, or any dung either human or animal, into said

lake, or permit any above wastes to remain within 75 feet of any inlet or tributary thereto, or on the ground surface within 75 feet of any inlet tributary thereto;

(4) A person shall not throw any sawdust or allow any sawdust to fall into said lake, or into any inlet or tributary thereto;

(5) A person shall not trespass, boat, bathe, swim, fish or carry on any activity whatever whether of recreational, occupational or other nature, in the waters or on the ice of Canaan Street Lake, south of a line about 1,200 feet northwest of the Lake's southern most part , beginning at a point on the westerly shore at the center line of the road which exists adjacent to the present property line between Gorand and Lamson, and extending across said Lake to the stone jetty on the easterly shore. The 2 extremities of such a line to be properly marked by the local water works authority so that they can be readily identified and observed by the general public;

(6) These provisions shall not apply to employees of the board of water commissioners engaged in the performance of necessary duties for the protection and control of said pond; and

(7) A person shall not throw, deposit or allow to remain upon the ice of the waters of said pond, or upon that of any inlet or stream tributary thereto, any matter, waste, or materials such as are described in (2), (3) and (4) above.

Source. #6521, eff 6-4-97 (See Revision Note at chapter heading for Env-Ws 300)

APPENDIX E:
WATER QUALITY RESULTS
CANAAN STREET LAKE

Algal Abundance

Chlorophyll-a concentration is used as an indicator of algae abundance. Since algae contain the green pigment chlorophyll, the concentration of chlorophyll-a found in the water gives an estimation of the concentration of algae. Although algae is naturally present in all lakes and ponds, an excessive amount of any type is not beneficial. Algal concentrations can increase with additional phosphorus inputs from nonpoint sources in the watershed.

Generally a concentration of chlorophyll-a of less than 4 mg/m^3 indicates that water quality conditions are "good" and representative of oligotrophic lakes. NH DES classifies chlorophyll-a concentrations of 5.1-15 mg/m^3 as "more than desirable," and a concentration greater than 15 mg/m^3 as "nuisance amounts" indicative of eutrophic conditions. The mean chlorophyll-a concentration for New Hampshire lakes is 7.02 mg/m^3.

Since VLAP monitoring began at Canaan Street Lake in 1988, chlorophyll-a measurements have fluctuated between 1.80 mg/m^3 and 6.92 mg/m^3. Fluctuations in the data make it difficult to discern whether the overall amount of chlorophyll-a is increasing or decreasing. A trend line on the graphed data by NH DES implies that the presence of chlorophyll-a in the lake water is slightly increasing (VLAP 2003). However, both the trend line and annual results remain well below the state average. The presence of chlorophyll-a in 2004 was measured at 2.50 mg/m^3.

Phytoplankton

Phytoplankton serve as indicator species of general lake quality. An abundance of cyanobacteria (blue-green algae), such as *Anabaena*, *Aphanizomenon*, *Oscillatoria*, or *Microcystis* may indicate excessive phosphorus concentration or that the lake ecology is out of balance. On the other hand diatoms such as *Asterionella*, *Melosira*, and *Tabellaria* or golden-brown algae such as *Dinobryon* or *Chrysosphaerella* are typical phytoplankton of New Hampshire's oligotrophic lakes. In shallow warm waters with minimal wave action (such as a cove), filamentous green algae, may grow in a form that looks like a mass of green cotton candy (VLAP 2003).

Phytoplankton populations go through a natural succession over the course of the growing season. For example, in the spring diatom algae are most abundant. During the months of May and June green algae are typically the dominant species. From mid to late summer, blue green algae often dominate. Many factors influence this succession including light, nutrients, water temperature, and the amount of grazing from zooplankton.

At Canaan Street Lake, phytoplankton data is readily available for the period from 1988-2004. Ten of these sampling events took place during the month of July when green algae are typically most abundant. Over the course of the seventeen-year sampling history, the golden-brown algae, *Dinobryon*, were most frequently encountered followed by diatoms *Asterionella*, and *Tabellaria*, which occurred with equal frequency. All of these algae species are typical of New Hampshire's less productive lakes, suggesting

good water quality. There are, however, several recorded samplings of toxic blue-green algae (i.e. *Anabaena* and *Microcystis*). Overall, the presence of all phytoplankton in the lake is relatively sparse (VLAP, 2004).

Cyanobacteria

Cyanobacteria are a type of blue-green algae and have been identified in some of the oldest fossils known on Earth (3.5 billion years old). Today, they are one of the largest, most important groups of bacteria and are rich in chemical diversity. For example, the cyanobacterium *Spirulina* has long been valued for its protein content. However, some species of cyanobacteria are toxic to humans and animals.

Cyanobacteria naturally occur in all New Hampshire lakes and ponds and are part of the aquatic food web. In New Hampshire, the four most common cyanobacteria include: *Anabaena, Aphanizomenon, Oscillatoria,* and *Microcystis*. Although they are the most common cyanobacteria found in our lakes, they are also toxic to animals and humans. *Anabaena* and *Aphanizomenon* produce neurotoxins that can interfere with nerve function almost immediately upon ingestion. *Oscillatoria*, and *Microcystis* are best associated with producing hepatotoxins, which attack liver function.

Cyanobacteria typically form in shallow, warm, slow moving or still water. Typically, as nutrient concentrations in a water body increase, so does the abundance of cyanobacteria. A large mass of cyanobacteria in a body of water is called a bloom. When a bloom rises to the surface of the water, it is known as surface scum or a surface water bloom.

As mentioned in the previous section, *Anabaena* and *Microcystis* have been present in water samples from Canaan Street Lake. Although no blooms have been documented, the presence of toxic cyanobacteria serves as a reminder of a water body's delicate balance. The non-toxic cyanobactria *Coeleosphaerium* has also been present in water samples.

To reduce the potential of a toxic bloom, watershed residents should continue to act to reduce nutrient loading into the lake by eliminating fertilizer use on lawns, keeping a natural buffer along the lake shoreline, revegetating cleared areas along the shoreline, and properly maintaining septic systems and roads.

In addition, NH DES recommends that residents observe the lake in September and October during fall lake turnover to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing will affect their buoyancy and cause them to rise to the surface and bloom. Wind and current tend to "pile" cyanobacteria into scums that accumulate in downwind sections of a lake. The ramifications of a toxic algae bloom in Canaan Street Lake could be significant as the wind typically blows any matter suspended in the lake towards the surface water intakes of the Canaan Water Department. If a bloom occurs, the NH DES VLAP coordinator should be contacted.

Transparency

Transparency is a function of water clarity and is influenced by water color and the quantity of algae or particulate matter present in a waterbody. Transparency measurements are taken using a Secchi disk, which is a twenty-centimeter disk with alternating black and white quadrants. The Secchi disk is lowered into the water to the limit of visibility, at which point its depth is recorded. Lakes with "exceptional" clarity have a Secchi depth reading greater than 4.5 meters. "Good" water clarity ranges between 2 - 4.5 meters and water with poor clarity has a transparency measurement of less than 2 meters. The mean transparency of New Hampshire lakes is 3.7 meters.

Canaan Street Lake's water clarity has varied between "exceptional" and "good" during the past seventeen years of sampling. According to the VLAP data, the trend in water clarity has not significantly changed since monitoring began in 1988, although measurements do fluctuate from year to year. The maximum Secchi depth measured for the lake was 6.3 meters in 1999 and the minimum depth measured was 3.3 meters in 1992. In 2003, the Secchi depth was 4.5 meters.

Total Phosphorous

Total phosphorus is a measure of all the forms of phosphorus (organic and inorganic) found in lake water. Phosphorus is a plant-limiting nutrient in fresh water systems – meaning that the amount of available phosphorus influences the amount of plant and algae growth. Plants require phosphorous to grow. However, under natural conditions, phosphorous is not readily available in the environment. Since phosphorus is necessary for plant growth, phosphorous concentrations relate directly to the lake's trophic state. Lakes with higher concentrations of total phosphorous have greater amounts of plant growth and may be classified as a eutrophic lake.

Total Phosphorous Values & Corresponding Trophic Status

Total Phosphorous Value	Typical Trophic Status	Amount is Considered:
TP < 10 ug/L	Oligotrophic	Ideal
TP > 20 ug/L	Eutrophic	More than desirable
TP > 40 ug/L	Eutrophic	Detrimental

In New Hampshire's lakes and ponds, total phosphorous concentrations occur at such low levels than most increases are attributed to human activities within the watershed. During the summer, the median total phosphorus concentration in the epilimnion of New Hampshire's lakes and ponds is 12 ug/L. The median summer total phosphorus concentration in the hypolimnion of New Hampshire lakes and ponds is 14 ug/L. Increased phosphorous levels encourage excessive plant growth and algal blooms. Phosphorous sources around a lake can include septic systems, animal wastes, fertilizer, road and construction erosion, and natural wetlands (VLAP 2003).

The average total phosphorous concentration for Canaan Street Lake from 1988 – 2003 is 7.75 ug/L in the epilimnion and 8.38 ug/L in the hypolimnion. Total phosphorous values have fluctuated some over the sixteen year period, but the overall trend has remained relatively stable and below the state average (12 ug/L) for surface water. Concentrations

of total phosphorous in the deeper waters of the lake are also below the state average (14 ug/L) and showing declining trends over the sixteen-year sampling period (VLAP 2003).

Total phosphorous readings taken at the inlet to Canaan Street Lake have fluctuated widely during sampling dates. Fluctuations at the inlet most likely correspond with land use changes upstream that may be introducing sediment or other phosphorous containing substances to the lake during storm events. NH DES recommends that streams be sampled at points where phosphorous may be entering the system, for instance above and below a road crossing, in order to pinpoint pollution sources.

Nitrogen

Data for Nitrogen concentrations in the lake is limited to data collected during the various NH DES Lakes and Ponds Inventory surveys. The Inventory, measures Nitrogen as Nitrate and total Kjedhal Nitrogen. Nitrate measurements were less than 0.05 mg/L and Total Kjedhal Nitrogen was measured at 0.43 mg/L and .34 mg/L in 1991. Additionally, in 2005, DES collected water samples from Canaan Street Lake to update the Inventory report. The 2005 data indicates that nitrates still measure less than 0.05 mg/L and total Kjedhal nitrogen measured below 1991 levels at less than 0.25 mg/L and 0.30 mg/L (Estabrook, personal communication).

pH

pH measures acidity on a logarithmic scale of 0 to 14. Low pH values indicate higher levels of acidity while high pH values are non-acidic or basic. A pH value of seven is considered neutral. pH essentially measures the amount of hydrogen ions present in a substance. As the number of hydrogen ions increases so does its acidity. The pH of lake water is important to the survival and reproduction of fish and other aquatic organisms. For fish, a pH below 5.5 severely limits their growth and reproduction. Fish typically thrive in water where the pH is between 6.5 and 7.0 (VLAP, 2003).

Most lakes exhibit lower pH in the hypolimnion than they do at the surface. Decomposition carried out by bacteria on the bottom of the lake causes pH to drop while photosynthesis by phytoplankton in the upper layers of the water column increases pH (VLAP, 2003). The pH of a lake may be influenced by wetlands where tannic and humic acids are released to the water by decaying plants, thereby creating more acidic waters (VLAP, 2003). Stormwater runoff and snowmelt are also acidic. After a significant storm or melt event, the surface water of a lake may be more acidic than the water at the bottom. It takes a lake many weeks to recover from an acid input from stormwater runoff.

The mean pH for New Hampshire lakes is 6.6, which is slightly acidic. Due to the presence of granite bedrock in the state and the deposition of acid rain, many lakes throughout the state have slightly acidic waters. Annual sampling data for Canaan Street Lake shows that the lake has an average pH of 6.97 in the hypolimnion and 7.09 in the epilimnion, which makes the lake water approximately neutral.

Acid Neutralizing Capacity

Acid neutralizing capacity (ANC) is often referred to as alkalinity. ANC is the measure of a lake's capacity to neutralize acid inputs. New Hampshire lakes historically have low alkaline waters due to the State's granitic bedrock. However in recent years, the overall alkalinity, or buffering capability, of New Hampshire lakes is decreasing. If the buffering capacity of a lake is lost, aquatic life will be adversely affected by acid inputs (NH DES, 2004).

The mean ANC for New Hampshire lakes is 6.7 mg/L. For the past seventeen years, the average ANC for Canaan Street Lake measured above the state average at 9.09 mg/L. However, the value has fluctuated from year to year with the median ANC value for Canaan Street Lake being 9.3 mg/L. The minimum value recorded was 6.5 mg/L in 1998 and the maximum value recorded was 10.95 mg/L in 1988. The ANC value reported in the 2004 VLAP report is 6.6 mg/L.

Acid Neutralizing Capacity Ranges for NH Lakes & Ponds

Category	ANC (mg/L)
Acidified	<0
Critical	0-2
Endangered	2-5
Highly Sensitive	5-10
Sensitive	10-20
Not Sensitive	>20

Sodium

The median value for Sodium concentration in New Hampshire Lakes is 3.1 mg/L. Data for Sodium concentrations in Canaan Street Lake is limited to data for the NH DES Lakes and Ponds Inventory. In 1979, sodium measured 2.5 mg/L and in 1991 the concentration of sodium increased to 3.8 mg/L. Since 1991, the sodium concentration in the lake has increased. According to the data collected in 2005 for the Lakes and Ponds Inventory, Canaan Street Lake's sodium concentration has increased to 6.5 mg/L (Estabrook, personal communication).

Chloride

Typically the chloride content in New Hampshire lakes is naturally low. Water bodies located in remote areas away from development generally have Chloride concentrations less than 2 mg/L. Higher values are generally the result of salt inputs from road corridors and septic systems. The median value for chloride for New Hampshire lakes is 4mg/L. The maximum value is 198 mg/L. Chloride levels in Canaan Street Lake were measured as part of the NH DES Lakes and Ponds Inventory in 1979, 1991, and 2005. The initial value recorded for the lake in 1979 was 3 mg/L. By 1991, chloride had increased to 5 mg/L. Measurements taken in 2005 show that chloride continues to increase and is now at 11 mg/L.

Conductivity

Conductivity measures water's ability to conduct an electrical current and is directly related to the number of ionic particles present. As the number of ions in the water increase so does its conductivity. New Hampshire's waters typically have low conductivity values (NH DES 2004). High conductivity values, or conductivity values that are increasing, may indicate that pollution is occurring from sources such as road salt, faulty septic systems, agricultural runoff, or urban runoff (VLAP 2003).

Due to variations in watershed geology, conductivity values are not easily classified as being good or bad (VLAP Report 2003). However, values in New Hampshire lakes that exceed 100 uMhos/cm are generally indicative of anthropogenic effects. A lake's conductivity typically remains constant throughout the seasons. Any major changes in conductivity over the course of several years, or within a very short period of time, may indicate significant human impacts. For example, if conductivity values suddenly increase within a six-month period, land-clearing activities with no erosion controls, may be the source of increased conductivity values.

In New Hampshire, conductivity values less than 50 uMhos/cm are typical of oligotrophic lakes. The mean conductivity value for New Hampshire lakes is 62.1 uMhos/cm. Conductivity has been measured for Canaan Street Lake since 1988. Over the last sixteen years, values for specific conductance have increased annually. In 1988, conductivity measured at 48.0 uMhos/cm. In 2004, conductivity values measured 78.46 uMhos/cm, which is a 63.5 percent increase. Increased conductivity is typically directly related to human activity within the watershed. However in 2005, conductivity values dropped 4.6 percent to 75 uMhos. Further testing needs to be completed to understand if the drop in conductivity is sustained or a random occurance.

Apparent Color

Apparent color is a visual measure of the color of the water. Water becomes colored by decaying organic matter or by naturally occurring metals, such as iron or manganese, in soils. A lake with highly colored water generally has extensive wetlands along the shore, or within its watershed, and often a mucky bottom. Often, eutrophic lakes tend to have highly colored water. Water color is measured in color units and classified into the following categories:

Measurement	Color Classification
0 – 24	Clear
25 – 40	Light Tea Color
40 – 80	Tea Color
>80	Highly Colored

The State median for apparent color is 28 color units. Canaan Street Lake has been gaining in color since measurements were first taken for the 1979 Lakes and Ponds Inventory. In 1979, the water had 10 color units and the 1991 Inventory reported that Canaan Street Lake has 18 color units, classifying the water as clear. In 2005, the lake had an average of 20 color units in the summer and 24.5 in the winter, indicating that the

water is taking on a sight tea color. The cause behind the change in water color is unknown.

Dissolved Oxygen and Temperature

The presence of dissolved oxygen is critical to bottom-dwelling organisms as well as fish and amphibians. Many species, such as trout, are intolerant of low oxygen conditions. The concentration of dissolved oxygen found in water is closely tied to water temperature as cold water holds more oxygen than warm water. As a result, the concentration of dissolved oxygen fluctuates with the seasons and lakes will have higher dissolved oxygen concentrations during the winter, spring, and fall.

In the summer, dissolved oxygen concentrations decrease. Lower oxygen concentrations are due in part to warmer water temperatures and lake stratification. As a lake stratifies colder water sinks to the bottom and warm water rises to the surface. A layer known as the thermocline forms between the warm surface water and colder depths that impedes lake mixing and the diffusion of dissolved oxygen. After a lake has stratified, the dissolved oxygen in the hypolimnion is not typically replenished until lake turnover in the fall.

As no new oxygen is available in the hypolimnion, the diffused oxygen is gradually used up by bottom dwelling organisms and the process of decomposition. In some cases, the diffused oxygen may be completely depleted. Extremely low levels of dissolved oxygen, or in cases where there is no oxygen at all (anoxic conditions), are detrimental to living biota. When dissolved oxygen concentrations in the hypolimnion fall below 1 mg/L, phosphorus which was previously unavailable and trapped in sediments is released and made available for plant growth.

The dissolved oxygen concentration for Canaan Street Lake is relatively high at all depths. From 1988 – 2003 the average concentration of dissolved oxygen in the hypolimnion (deep water) is 64.9 percent. However, dissolved oxygen values in the hypolimnion have fluctuated between 3.2 percent in 1990 and 96.6 percent in 2002. The relatively high dissolved oxygen concentration in the hypolimnion is due to the shallow nature of Canaan Street Lake and not to cold temperatures. The average water temperature during the sampling period was 20.6° Celsius (69° Fahrenheit). Shallow lakes weakly stratify and do not form a thermocline. Instead, they are continually mixed by wind and wave action, which diffuses oxygen throughout the water column (VLAP).

Turbidity

Turbidity measures the amount of suspended matter such as clay, silt, and algae, which scatter and absorb light rather than allowing it to travel through water in straight lines. Turbid conditions have negative impacts on aquatic species, increase public health risks in drinking water supplies, and pose challenges to the drinking water resource manager during water treatment. High turbidity readings are often found in water adjacent to construction, logging, and other sites where vegetation is removed and soil is left exposed. In such situations, storm events erode unstable soils and cause turbid conditions downstream.

In New Hampshire, the median value for turbidity in lakes and ponds is 1.0 NTUs. The minimum value recorded for New Hampshire lakes is less than 0.1 NTUs and the maximum value is 22.0 NTUs. VLAP monitors began taking turbidity measurements for Canaan Street Lake in 1997. The average turbidity for water in the epilimnion (surface) is 0.4 NTUs and the average turbidity for water in the hypolimnion (deep water) is 0.5 NTUs. Both measurements are below the state average.

Bacteria

Surface waters contain a variety of microorganisms including bacteria, fungi, protozoa, and algae. Most of these occur naturally and have no impact on human health. However, where warm-blooded animals such as humans, ducks, geese, beaver, or pets are present, health risks from water contact are present. Warm-blooded animals contribute bacteria to surface water bodies through fecal waste. Sources of fecal waste may be from leaky septic systems or sewer pipes, runoff from wildlife areas, or heavily used swimming and beach areas (VLAP 2003).

Certain types of bacteria serve as indicators of the presence of fecal contamination and may also be used as an indicator species for the presence of other pathogens, such as viruses or protozoa like *Giardia* or *Cryptosporidum*. Some pathogens, particularly the protozoans, such as *Cryptosporidum*, are difficult to treat because they are so small that they often pass through filters and are resistant to chlorine treatment. Currently, reliable methods are not available to water system operators to readily test for these pathogens. Fecal coliform analysis supplemented with analysis for *Escherichia coli (E. coli)* are the most reliable indicators available for identifying fecal wastes.

Invasive and exotic plant species

Purple loosestrife (*Lythrum salicaria*) is present in the wetland on the western shore of the lake near the Town Beach as well as in the shallow cove near Cardigan Mountain School's maintenance building. Purple loosestrife adapts readily to natural and disturbed wetlands. Once established, purple loosestrife forms dense homogeneous stands and replace native grasses, sedges, and other flowering plants that serve as important food sources for wildlife. Purple loosestrife also reduces wildlife habitat (Swearingen).

Mercury

New England reportedly has the highest deposition rates of Mercury in the country (10-30 micrograms per square meter). Major sources of Mercury deposition in New England are from the emissions of municipal waste incinerators, coal and oil boilers, and medical waste incinerators (USGS 2003). Studies conducted by the New Hampshire Department of Health and Human Services (DHHS) indicate that some freshwater fish in the state contain varying levels of Mercury and pose a potential health risk. A statewide advisory is in effect which recommends that people limit their fish consumption. The advisory is based on a thorough review of more than 1,200 freshwater fish sampled from 150 water bodies throughout the state.

APPENDIX F:
TABLE OF MANAGEMENT OBJECTIVES & STRATEGIES FOR ACHIEVEMENT

Management Objectives and Strategies for Achievement

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
Road Management	Resolve drainage issues along Canaan Street near the Lake.	Work with NH DOT to identify and resolve drainage issues along Canaan Street near the Lake.	Board of Selectmen, NH DOT Canaan Road Agent NH DES Canaan Water Department	NH DOT NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Runoff from Canaan Street no longer drains into Canaan Street Lake.	
	Reduce application of deicing chemicals along Canaan Street near the Lake.	Work with NH DOT to reduce salt application to the portion of Canaan Street that is in close proximity to the Lake.	Board of Selectmen NH DOT Canaan Road Agent NH DES Canaan Water Department	NH DOT NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	The application of deicing chemicals is reduced.	
	Remediate drainage issues on Town maintained roads.	Identify appropriate storm water management methods to resolve drainage and erosion problems along Fernwood Farms Road.	Board of Selectmen Road Agent Canaan Water Department NH DES UNH Storm water Center	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Road drainages along Fernwood Farms Road are stabilized and erosion problems are resolved.	
		Identify appropriate storm water management method to minimize runoff from the Town Beach from draining into Canaan Street Lake	Board of Selectmen Road Agent Canaan Water Department NH Dot NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Runoff from the Town Beach no longer enters Canaan Street lake	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Implement a comprehensive Town road management program in the watershed that safeguards public safety, identifies ecologically sensitive areas, and determines low salt zones.	Board of Selectmen Road Agent Canaan Water Department NH DOT NH DES UNH Storm water Center	Town of Canaan NH DOT NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	A comprehensive road maintenance program is established for roads within the watershed.	
	Establish town road standards for the watershed to ensure that new roads do not negatively impact water quality.	Create road design standard that mitigates for storm water runoff and minimizes the negative environmental effects of any new town roads.	Planning Board Board of Selectmen Road Agent UNH Storm water Center	Town of Canaan	Future road design and construction will minimize impact on water quality and the environment by better managing storm water runoff.	
Septic System Management	Minimize the negative impacts of existing septic systems in the watershed.	Conduct education and outreach about the proper use and maintenance of septic systems.	Board of Selectmen Canaan Water Department Drinking Water Protection Committee Cardigan Mountain School Canaan Lake Association	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Homeowners within the watershed properly use and maintain their septic systems.	
		Conduct a septic survey to collect information about septic systems within 250 feet of Canaan Street lake.	Board of Selectmen Planning Board Canaan Water Department	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Pertinent information is collected and on file for septic systems located within 250 feet of Canaan Street Lake.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Consider implementing a septic system-tracking program for parcels within 250 feet.	Board of Selectmen Planning Board NH DES NH Department of Health and Human Services	Town Funds NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Septic system tracking program is adopted to help facilitate proper maintenance.	
		Consider implementing a municipal septic system maintenance program for properties within 250 feet of Canaan Street Lake.	Board of Selectmen Planning Board Municipal Waste Water Treatment Department NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	The town has determined the feasibility of implementing a municipal septic system maintenance program.	
	Minimize the environmental impacts of new septic systems within the watershed.	Establish a minimum septic system setback of 125 feet from Canaan Street Lake and its tributaries where feasible.	Board of Selectmen Planning Board NH DES Upper Valley Lake Sunapee Regional Planning Agency	N/A	Septic system setback from Canaan Street Lake and its tributaries is 125 feet.	
		Consider constructing a municipal sewer system to homes and facilities near Canaan Street Lake in the future.	Board of Selectmen Planning Board Canaan Wastewater Department Cardigan Mountain School NH DES	Town of Canaan	A feasibility study is constructed to determine the practicality of building a municipal sewer system within the watershed.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
Recreational Management	Heighten recreational users awareness of potential water quality impacts to Canaan Street Lake.	Maintain and support the NH Lake Association's Lake Host Program.	Board of Selectmen Canaan Water Department Canaan Lake Association NH Lakes Association NH DES	NH DES Grants for Exotic Aquatic Plants NH DES Milfoil and other Exotic Plant Prevention Grants	The Lake Host Program is supported and maintained.	
		Conduct education and outreach campaign that targets recreational users and user groups to inform about protecting the Lake's water quality	Board of Selectmen Water Department Drinking Water Protection Committee Canaan Lake Association Cardigan Mountain School Area Schools Recreational Groups Crescent Campsites NH DES	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Town is continually informing recreational users about the importance of protecting Canaan Street Lake.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
	Reduce impacts of current recreational uses on Canaan Street Lake's Water quality. .	Encourage boaters to properly handle, store, and use fuels and motor oils.	Board of Selectmen Canaan Water Department Drinking Water Protection Committee Canaan Lake Association Recreational Groups Crescent Campsites NH DES Boating Industry	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Boaters are well educated about properly handling fuels and oils.	
		In winter, limit refueling of gasoline-powered engines to shore and prohibit the use of automobiles on lake ice	Board of Selectmen Canaan Water Department Canaan Lake Association Recreational Groups NH DES NH Department of Fish and Game	Undetermined	Gasoline powered engines are refueled prior to being taken on the ice and vehicles are prohibited from traveling on the lake ice.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
	Conduct more frequent water quality testing to effectively evaluate the impacts of recreational activities.	Continue existing VLAP testing and increase its frequency during summer months.	Board of Selectmen Canaan Water Department Canaan Lake Association Cardigan Mountain School Mascoma High School Recreational Groups NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Water quality testing of Canaan Street Lake continues and is conducted more frequently.	
	Assess the impact that motorized boating has on Canaan Street Lake.	Study the effects that recreational activities have on the lake, especially motor boating.	Board of Selectmen Canaan Water Department Drinking Water Protection Committee Canaan Lake Association Area Schools and Universities NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Town has collected data on the impact that recreational activities have on the water quality of Canaan Street Lake.	
		Study the effects that motorized boating has on turbidity in Canaan Street Lake.	Board of Selectmen Canaan Water Department Canaan Lake Association Area Schools & Universities NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Town has completed a study on the impact that motorized boating has on turbidity, determine its level of risks, and decide on the appropriate management activity.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Consider establishing a no wake zone in sensitive areas (near surface intakes) and shallow waters.	Board of Selectmen Canaan Water Department Drinking Water Protection Committee Canaan Lake Association NH Department of Safety – Marine Patrol.	Undetermined	No wakes zones are established to protect sensitive areas.	
Land Use Management	Establish a Watershed Protection Area	Conduct outreach and education on why establishing a zoning district is critical to protecting the quality of Canaan Street Lake.	Board of Selectmen Planning Board, Canaan Water Department Drinking Water Protection Committee NH DES	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Community has a better understanding of how a zoning district is beneficial and will help protect water quality.	
		Establish boundaries for the Watershed Protection Area that accurately reflects the watershed boundary.	Planning Board Board of Selectmen Canaan Water Department NH DES Upper Valley Lake Sunapee Regional Planning Agency	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Boundaries for the Watershed Protection Area accurately reflect the watershed boundary for Canaan Street Lake.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Develop lot requirements and land use restrictions within the Watershed Protection Area.	Planning Board Board of Selectmen Canaan Water Department NH DES Upper Valley Lake Sunapee Regional Planning Agency Affected Property Owners	N/A	A comprehensive set of zoning requirements is established within the watershed.	
	Within the Watershed Protection Area, create a Shoreland Protection District to provide a higher level of protection in the immediate vicinity of Canaan Street Lake.	Delineate the Shoreland Protection District to include the area of land within 250 feet of Canaan Street Lake.	Planning Board Board of Selectmen Canaan Water Department NH DES Upper Valley Lake Sunapee Regional Planning Agency	Town of Canaan NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	The Shoreland Protection District is accurately mapped and delineated.	
		Develop lot requirements and land use restrictions within the Shoreland Protection District.	Planning Board Board of Selectmen Canaan Water Department NH DES Upper Valley Lake Sunapee Regional Planning Agency Affected Property Owners	N/A	A comprehensive set of zoning requirements is established to protect the shoreland area of Canaan Street Lake.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
Land Conversion & Site Development	Educate watershed residents about the importance of maintaining buffers and natural vegetation	Conduct an education and outreach program for watershed residents, contractors, and developers about the importance of maintaining vegetative buffers and managing erosion.	Board of Selectmen Planning Board Drinking Water Protection Committee Canaan Water Department Canaan Conservation Commission Local contractors and developers Watershed Residents NH DES	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	An ongoing education and outreach program is established.	
	Conserve key parcels in the watershed focusing on the following areas: the land around the "reservoir area", wetlands, steep slopes, and undeveloped parcels.	Work to place property surrounding the "reservoir area" into conservation.	Board of Selectmen Planning Board Drinking Water Protection Committee Canaan Water Department Canaan Conservation Commission NH DES	Town of Canaan LCHIP NH DES Water Supply Land Grant Program	Undeveloped properties bordering the "reservoir area" are placed into conservation to protect water quality near the surface water intakes.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Identify key parcels in the watershed for conservation (e.g. steep slopes, wetlands, sensitive habitats, and shoreland properties.)	Board of Selectmen Planning Board Drinking Water Protection Committee Canaan Water Department Canaan Conservation Commission NH DES	Town of Canaan LCHIP NH DES Water Supply Land Grant Program	Key parcels are identified and placed into conservation.	
	Ensure site plan and subdivision review requirements adequately protect water quality from erosion and sedimentation.	Adopt erosion and stormwater management controls for new development and incorporate new guidelines into site plan and subdivision review.	Board of Selectmen Planning Board Drinking Water Protection Committee NH DES US EPA Upper Valley Lake Sunapee Regional Planning Agency	N/A	Local regulation exists to minimize erosion and stormwater runoff from new development.	
Management of Point Sources	Maintain communication with Cardigan Mountain School regarding its regulated facilities.	Keep communication open between Cardigan Mountain School and the Town by scheduling an annual meeting between appropriate officials.	Board of Selectmen Canaan Water Department Cardigan Mountain School Health Officer	N/A	Open communication between the School and the Town continues.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
Demarcation of the Reservoir Area	The reservoir area is well marked and its use restricts are reported and enforced.	Work to place year-round markers to demarcate the reservoir area.	Board of Selectmen Canaan Water Department Drinking Water Protection Committee NH DES NH Department of Fish & Game NH Department of Safety – Marine Patrol	Town of Canaan	Year-round markers are placed to demarcate the reservoir.	
Local Enforcement	Regulations for the protection of Canaan's water resources are consistently enforced.	Develop a local enforcement plan and identify proper enforcement agents.	Board of Selectmen Planning Board Health Officer Canaan Water Department NH DES	Town of Canaan	Canaan has determined who will enforce local regulation and has established set standards for enforcement.	
		Bring town, county, and state officials together to clarify questions regarding jurisdiction over activities associated with Canaan Street Lake.	Board of Selectmen Canaan Water Department Health Officer NH DES NH Department of Safety NH Fish and Game	Town of Canaan	Meetings are conducted and questions regarding jurisdiction are resolved.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
Emergency Spill Response Plan	Local emergency response departments are prepared for emergencies that may threaten the water quality of Canaan Street Lake.	Develop a comprehensive Emergency Spill Response Plan to minimize risks to Canaan Street Lake.	Board of Selectmen Canaan Water Department Canaan's Emergency Services NH DES	Undetermined	A comprehensive spill response plan is developed, in effect, and practiced on a regular basis.	
Education and Outreach	Develop a local awareness of the need to protect Canaan Street Lake.	Develop a watershed outreach campaign to inform local residents about how they can help protect the Lake.	Board of Selectmen Planning Board Canaan Water Department Drinking Water Protection Committee Cardigan Mountain School Crescent Campsites Recreational Groups NH DES UNH Cooperative Extension	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	An ongoing watershed outreach plan is in effect.	
		Make information regarding the Watershed Protection Plan easily available online and at the Town offices.	Board of Selectmen Planning Board Drinking Water Protection Committee Canaan Lake Association	Town of Canaan	Information regarding the plan and its recommendations is available at key locations.	

Identified Threats	Objective	Strategies	Lead Agency(s)	Funding Source	Bench Mark	Date Initiated
		Post information about how to protect Canaan Street Lake at the Lake's public access points.	Board of Selectmen Planning Board Drinking Water Protection Committee Canaan Water Department Canaan Lake Association Crescent Campsites	Town of Canaan NH DES Small Outreach and Education Grants NH DES Watershed Assistance Grant NH DES Drinking Water Source Protection Grant	Helpful times on how to protect Canaan Street Lake are posted at the Lake's public access points and circulated in local newsletters.	
		Take advantage of Project WET in local schools. (Contact: Jessica Morton, Coordinator. NH DES 603-271-4071)	Drinking Water Protection Committee Mascoma Valley SAU Cardigan Mountain School NH DES	Undetermined	Project WET curriculum and activities are being utilized in local schools to educate students.	
Comprehensive Testing Program	A comprehensive testing regime and body of data regarding the water quality of Canaan Street Lake exists.	Hire a qualified and experienced environmental scientist to prepare a testing regime for Canaan Street Lake	Board of Selectmen Canaan Water Department NH DES Local Universities	NH DES Watershed Assistance Grant Program	A testing regime is determined and carried out by the Town.	

APPENDIX G:
MINIMUM RESTRICTIONS
NH SHORELAND PROTECTION ACT

Shoreland Protection

Environmental Fact Sheet

New Hampshire Department of Environmental Services
29 Hazen Drive Concord NH 03301

Print Version

SP-6 **1997**

Minimum Shoreland Protection Standards, RSA 483-B

LIMITS WITHIN THE PROTECTED SHORELAND

Prohibited Uses (*RSA 483-B:9, II*) **250 ft**

· Establishment/expansion of salt storage yards, auto junk yards, solid waste & hazardous waste facilities.
· Use low phosphate, slow release nitrogen fertilizer from 250 feet to 25 feet.

Uses Requiring State Permits

· Public water supply facilities (*RSA 483-B:9, III*)
· Public water & sewage treatment facilities (*RSA 483-B:9, IV*)
· Public utility lines (*RSA 483-B:9, IV-b*)
· Existing solid waste facilities (*RSA 483-B:9, IV-c*)
· All activities regulated by the DES Wetlands Bureau per RSA 482-A (*RSA 483-B:9, II(c)*)

Other Restricted Uses

· All new lots, including those in excess of 5 acres, are subject to subdivision approval by DES. (*RSA 483-B:9, V(b)(1)*)
· Setback requirements for all new septic systems are determined by soil characteristics. (*RSA 483-B:9, V(b)(2)*)
· Minimum lot size in areas dependent on septic systems determined by soil type. (*RSA 483-B:9, V(e)(1)*)
· Alteration of Terrain Permit standards reduced from 100,000 square feet to 50,000 square feet. (*RSA 483-B:6, I(d)*)
· Total number of residential units in areas dependent on on-site sewage & septic systems, not to exceed 1 unit per 150 feet of shoreland frontage. (*RSA 483-B:9, V(e)(2)*)

NATURAL WOODLAND BUFFER RESTRICTIONS (*RSA 483-B:9, V(a)*)

150 ft

· Where existing, a natural woodland buffer must be maintained.
· Tree cutting limited to 50% of the basal area of trees, and 50% of the total number of saplings in a 20 year period. A healthy, **well-distributed stand** of trees, saplings, shrubs, and ground covers must be maintained.
· Stumps and their root systems must remain intact in the ground within 50 feet of the reference line.
· The opening for building construction is limited to 25 feet outward from the building, septic system, and driveway.
· The opening for accessory structures is limited to 10 feet outward from the footprint.

NEW SEPTIC SYSTEM LEACHFIELD SETBACKS (*RSA 483-B:9, V(b)(2)*)

· 125 feet where soil down gradient of leachfield is porous sand & gravel. **125 ft**
· 100 feet where soil maps indicate presence of soils with restrictive layers within 18 inches of natural soil surface. **100 ft**
· 75 feet where soil map indicates presence of all other soil types. **75 ft**
· 75 feet minimum setback from rivers.

PRIMARY BUILDING LINE*

· Primary structure setback 50 feet from the reference line. (*RSA 483-B:9, II(B)*) **50 ft**

· Fertilizer use is prohibited within 25 feet of reference line. (*RSA 483-B:9, II(d)*) **25 ft**
· Accessory structure setback 20 feet from the reference line. (*EnvWs 1405.04*) **20 ft**

REFERENCE LINE (*RSA 483-B:4, XVII*)

· For coastal waters = highest observable tide line
· For rivers = ordinary high water mark
· For natural fresh waterbodies = natural mean high water level
· For artificially impounded fresh waterbodies = water line at full pond

* If a municipality establishes a shoreland setback for primary buildings, whether greater or lesser than 50 feet, that defines the Primary Building Line for that municipality.