LPL-462

Report

Lake Study Report

Scope ID: 95C056

Town of Schleswig Sanitary District No. 1

July 1998

Foth & Van Dyke

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◆ 1938 - 1998 ◆

Town of Schleswig Sanitary District No. 1
Cedar Lake Study Report

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1 Executive Summary

This report was prepared at the request of the Town of Schleswig Sanitary District No. 1 to evaluate the current trophic status of Cedar Lake, and to determine the potential impact of on-site sanitary systems on the lake's water quality. A water quality sampling program was executed to determine the lake's trophic status, while a sanitary survey was distributed to all property owners within the District and a field study was completed to determine the potential impact of private sanitary systems on the water quality of the lake. The following highlight the findings of the study and the recommendations to the Town of Schleswig Sanitary District No. 1:

- Cedar Lake can be classified as a Mesotrophic lake based on the water quality sampling results.

- Based on the data collected from the sanitary survey and on-site observations, it is possible that some on-site sanitary systems within the District are discharging wastewater into Cedar Lake and contributing to the accelerated eutrophication of the lake.

- It is recommended that the Town of Schleswig Sanitary District No. 1 proceed with the following:

  - Complete a Lake Management Plan directed towards maintaining and protecting the water quality of Cedar Lake.

  - Establish a long-term water quality testing program to accurately determine if the lake is experiencing significant changes in water quality and the rate of that change.

  - Implement one or more water quality improvement alternatives, including:
    - Educate property owners in the District.
    - Upgrade on-site sanitary systems.
    - Consider the benefits of installing public sanitary sewer.

2 Introduction

Cedar Lake is located in the east central portion of the Town of Schleswig in southwest Manitowoc County. The largest lake in the county, it covers an area of 147 acres, has 3.2 miles of shoreline, a maximum depth of 21 feet, and an average depth of 9 feet. Development has occurred on all developable lots around the lake, and these areas currently are not serviced by public sanitary sewer. All developments adjacent Cedar Lake have private, on-site septic systems which could potentially have a negative impact on the water quality of the lake.

In May, 1997 the Town of Schleswig Sanitary District No. 1 was awarded a Lake Management Planning Grant from the Wisconsin Department of Natural Resources (WDNR) to conduct a study of the water quality of Cedar Lake.

2.1 Authorization

On May 12, 1998 the Town of Schleswig Sanitary District No. 1 authorized the consulting firm of Foth & Van Dyke to complete the study of the water quality of Cedar Lake and prepare a report identifying the results. The study resulted in a collaborative effort among Foth & Van Dyke, Town of Schleswig Sanitary District No. 1, and WDNR personnel.

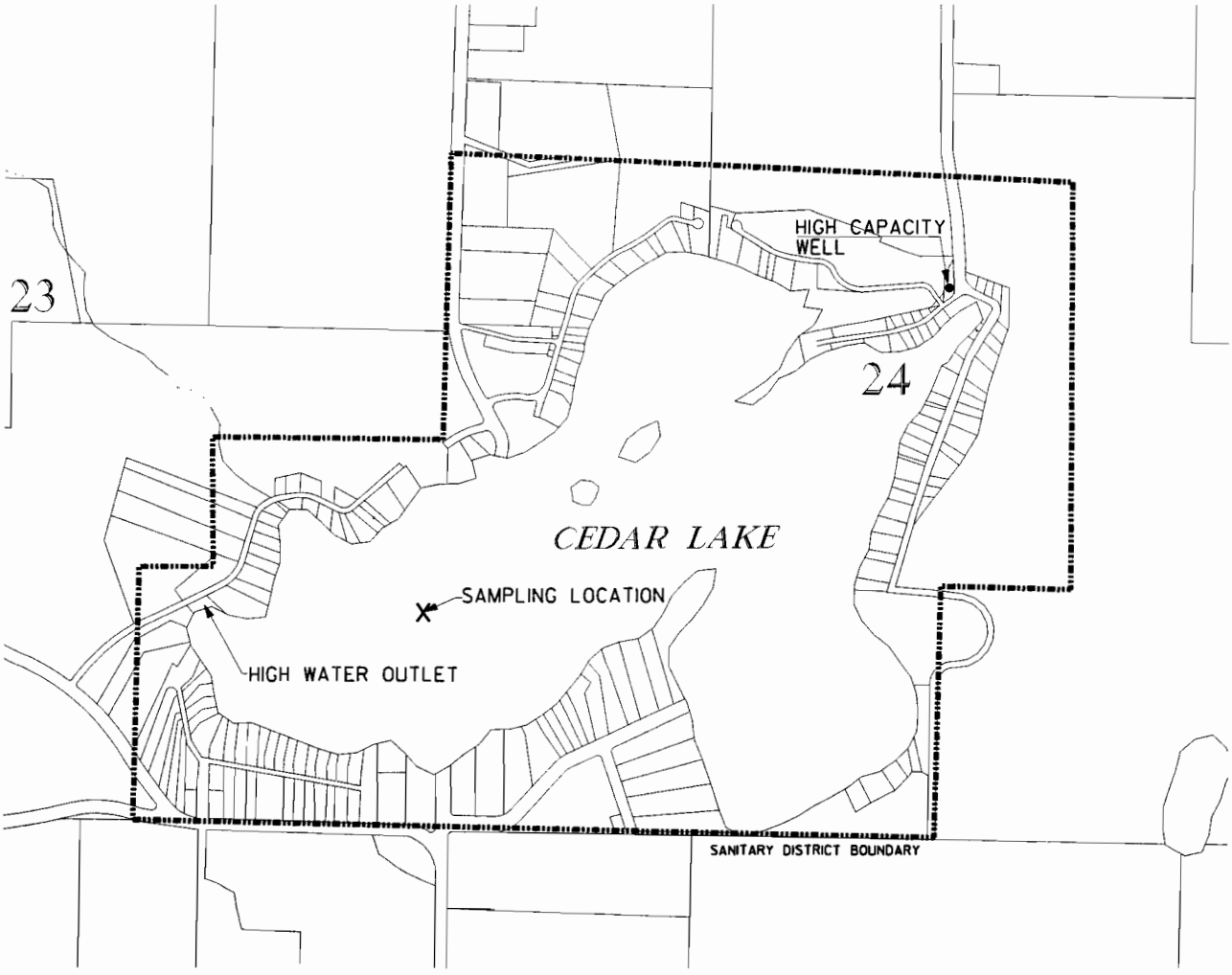
2.2 Purpose

The purpose of the study was to evaluate the current trophic status of Cedar Lake and determine the potential impact of private on-site sanitary systems on the water quality of the lake. In addition, alternatives for water quality improvement are explored, and recommendations based on the data presented in this report will be made to provide direction to the Sanitary District for future studies and/or the development of an overall lake management plan.

2.3 Project Study Area

Map No. 1 illustrates the project study area, including the location from which sampling was performed.

MAP No. 1
PROJECT STUDY AREA:
TOWN OF SCHLESWIG SANITARY DISTRICT No. 1
MANITOWOC COUNTY



SCALE

JULY, 1998

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3 Water Quality

The water quality of a lake is dependent upon a number of factors and lake characteristics. Every lake possesses a unique set of physical and chemical characteristics that may change over time. The chemical changes occur on a daily basis, while physical changes (such as plant and algae growth) occur on a seasonal basis. Seasonal changes in the physical characteristics of a lake are common because factors such as surface runoff, groundwater inflow, precipitation, temperature and sunlight are variable. A lake's water quality will vary with the seasonal changes, therefore data must be gathered over a period of time to accurately determine if a lake is experiencing significant changes in water quality and to distinguish between natural variability and human activity impacts.

To determine the water quality and trophic status of Cedar Lake, a sampling program was devised which included testing numerous characteristics of the lake. The following section explains the sampling program and its components, presents the results and analysis of the sampling conducted, and provides conclusions about the water quality of Cedar Lake. First however, it is important to identify the source of the lake's water supply as this contributes to the factors which affect the quality of its water supply. In addition, identification of the water source allows for sound management practices to be selected which reflect the specific characteristics of the lake.

Cedar Lake is classified as a seepage lake: a seepage lake is a landlocked, natural lake where water levels are maintained by the groundwater table, precipitation, and limited runoff; an intermittent stream outlet may be present. Cedar Lake's water level is primarily maintained by groundwater, therefore septic systems or other groundwater contamination sources could cause problems. In addition, runoff from various land applications can also cause problems, such as nuisance plant growth resulting from excess phosphorus. Because the lake has no natural outlet, chemicals which enter the lake stay in the lake for long periods of time, unlike lakes which have a natural outlets that provide an exit route for such chemicals. It should be noted however, that the lake district constructed an outlet during the mid-1980's to alleviate significantly high water levels; the outlet is usually dry.

3.1 Sampling Program

The sampling program used to determine the water quality of Cedar Lake was conducted over approximately a one year time period, beginning in May of 1997, and concluding in April, 1998. Samples were taken from the deepest point in the lake, which is illustrated on Map 1, on six separate occasions including:

- May 8, 1997
- June 12, 1997
- July 15, 1997
- August 13, 1997
- February 10, 1998 (ice on)
- April 14, 1998 (ice off - spring overturn)

WDNR personnel performed the majority of the water samples, while sample testing was completed by the State Laboratory of Hygiene. It was important to obtain samples with ice on, ice off, and in summer months to obtain data representative of the seasonal changes which affect water quality.

As mentioned previously, numerous factors were considered in the sampling program, including: Dissolved Oxygen, Temperature, Chlorophyll *a*, Total Phosphorus, Ortho Phosphorus, pH, Alkalinity, Hardness, Magnesium, Ammonium, Nitrate plus Nitrite, Kjeldahl Nitrogen (organic plus ammonium), and Secchi Disc readings. These factors were sampled at various depths in the lake ranging from surface to subsurface. Samples for the majority of these factors were taken on the first and last sample dates at surface and sub-surface levels, however all factors were not sampled on the four other dates. As the primary objective of this study was to determine the trophic status of Cedar Lake, the factors which contribute to making this determination were sampled more frequently than most other factors. These factors include Total Phosphorus (Total P), Chlorophyll *a*, and Secchi Disc readings. In addition, dissolved oxygen levels and water temperature were sampled at a number of depths for 5 of the 6 sample dates.

The following section provides the results of the sampling program, highlighting the dissolved oxygen levels, and those factors which contribute to the determination of the lake's trophic state.

3.2 Results and Analysis

The results of the sampling program conducted on Cedar Lake are displayed in Appendix A. The following section explains how a lake's trophic status is determined, and provides more detailed discussion of the sampling results of Dissolved Oxygen levels, Total Phosphorous concentrations, Chlorophyll *a* concentrations, and Secchi disc readings.

Trophic Status Indicators

The trophic state of a water body is an indicator of the nutrient levels and water clarity in a lake. Lakes can be divided into three categories based on their trophic state which include oligotrophic, mesotrophic, and eutrophic. The following provides a description of each trophic state:

Oligotrophic: Generally clear, cold lakes which are deep and free of weeds or large algae blooms. Oligotrophic lakes are low in nutrients and therefore do not support plant growth or large fish populations, however are capable of sustaining a desirable fishery of large game fish.

Mesotrophic: These lakes are in an intermediate stage between the oligotrophic and eutrophic stages. They are moderately productive, supporting a diverse community of native aquatic plants. The bottoms of mesotrophic lakes lack oxygen in late summer months or winter periods which limits cold water fish and causes phosphorus cycling from sediments. Overall however, mesotrophic lakes support good fisheries.

Eutrophic: Lakes which are high in nutrients and support a large biomass are categorized as eutrophic. These lakes are usually weedy and/or experience large algae blooms. Most often they support large fish populations, however are also susceptible to oxygen depletion which limits fishery diversity. Rough fish are common in eutrophic lakes.

The process of eutrophication is a natural aging process which occurs in all lakes, however this process may be accelerated by allowing nutrients from agriculture, lawn fertilizers, streets, septic systems, and urban storm drains to enter lakes.

The trophic state of a lake can be determined by observing three lake characteristics including Total Phosphorus concentration (Total-P) which indicates the amount of nutrients present which are necessary for algae growth, Chlorophyll *a* concentration which is a measure of the amount of algae actually present, and Secchi disc readings which is an indicator of water clarity. As expected, low levels of Total P are related to low levels of Chlorophyll *a*, which are related to high Secchi disc readings.

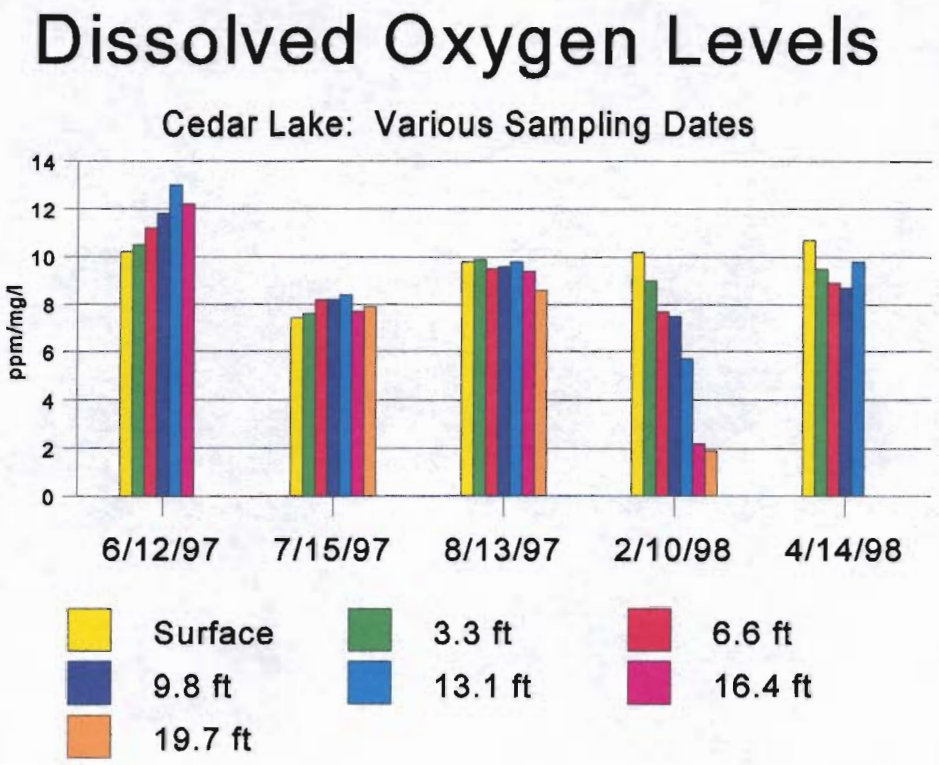
To determine the trophic state of the lake, the Carlson Trophic State Index (TSI) can be applied to each of the above noted factors. The TSI converts the actual measurement into a value which is representative of one of the trophic states. Values less than or equal to 39 indicate oligotrophic conditions, values from 40-49 indicate mesotrophic conditions, and values equal to or greater than 50 represent eutrophic conditions.

Dissolved Oxygen (D.O.) Concentration

The concentration of Dissolved Oxygen present in a lake is important as it supports aquatic life. The solubility of oxygen depends on the temperature of the water - colder water holds more oxygen than warmer water. The amount of D.O. present in lakes at different times of the day, and at different depths, is largely determined by the processes of photosynthesis and respiration. Oxygen is produced when green plants grow (photosynthesis), and is consumed through respiration. Therefore, D.O. levels tend to be higher during daylight hours (when photosynthesis occurs), and lower at night/early morning. In addition, lake depths which are below the reach of sunlight may experience oxygen depletion. Oxygen depletion is especially apparent in winter months where snow cover prevents sunlight from penetrating the water, stopping photosynthesis and causing plants to die; this is termed "winterkill" and occurs in many eutrophic lakes.

In warm water, the water quality standard for D.O. is 5 mg/l, which represents the minimum amount needed for the survival and growth of fish. D.O. concentrations between 8 mg/l and 10 mg/l indicate saturation. Figure 3-1 illustrates Dissolved Oxygen levels at varying depths in Cedar Lake on five sampling dates.

Figure 3-1



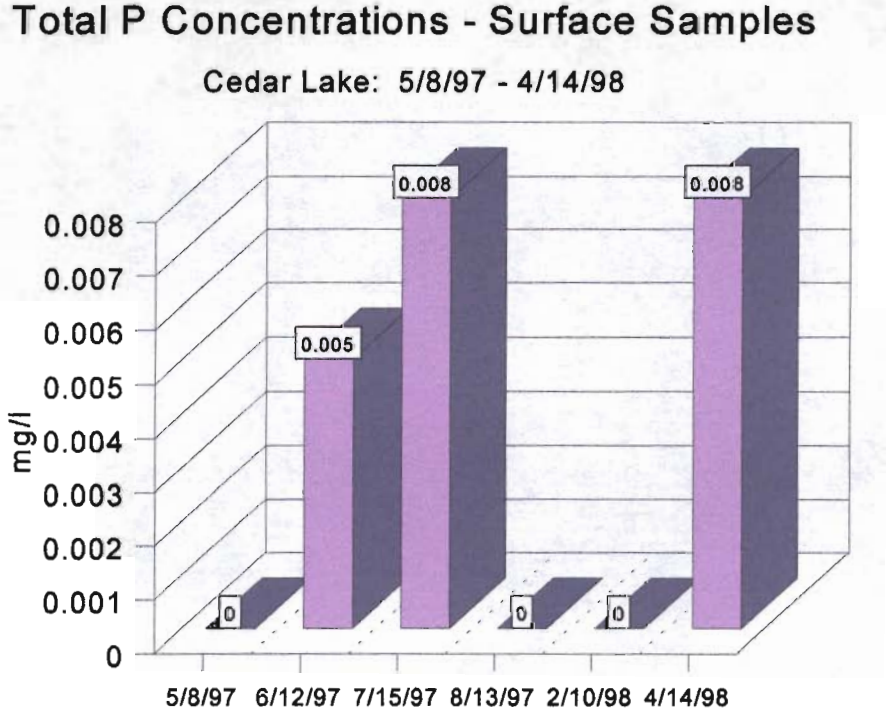
As indicated in Figure 3-1, D.O. levels in Cedar Lake exceeded the water quality standard of 5 mg/l at varying depths on 4 of the 5 sample dates. Levels at, near, or even exceeding saturation were experienced in all samples taken on 6/12/97, 7/15/97, 8/13/97 and 4/14/98. However, D.O. levels were well below saturation in the winter and oxygen depletion was experienced at depths of 16.4 ft and 19.7 ft, with D.O. concentrations around 2 mg/l. Despite oxygen depletion at these depths, fish are still able to survive in the lake by moving to more shallow areas where D.O. levels are high enough to support them. The low D.O. on 2/10/98 is a symptom of the lake's aging process and is consistent with the Mesotrophic status of the lake's water chemistry.

The D.O. levels remained fairly consistent among the varying sample dates and depths ranging from approximately 7 mg/l to 13 mg/l, with the exception depletion at the lower depths in winter. This is characteristic of lakes which support relatively few plants and animals, whereas D.O. levels fluctuate considerably in lakes with high biological activity.

Total Phosphorus Concentration (Total P)

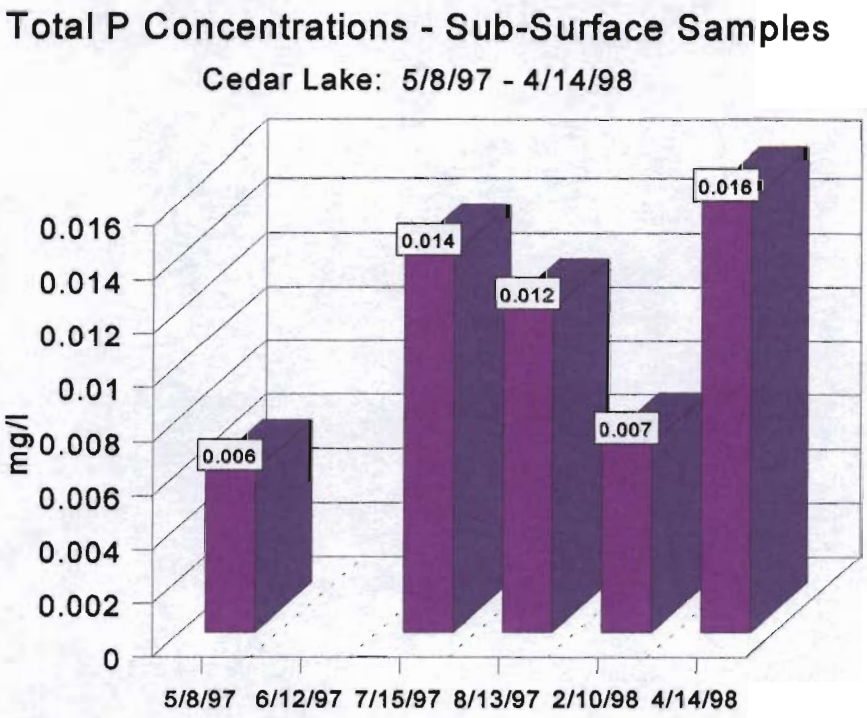
Phosphorus is the key nutrient which influences plant growth in over 80% of the lakes throughout Wisconsin, and promotes excessive aquatic plant growth. This chemical is generated from a number of sources including many human-related activities such as human and animal wastes, soil erosion, detergents, septic systems, and runoff from farms and/or lawns. Two types of phosphorus analyses can be conducted which include soluble reactive phosphorus and total phosphorus; total phosphorus is a better indicator of the nutrient status of a lake because its levels remain more stable. The concentrations of Total P detected at the surface (0 - 3.3 ft) and sub-surface (13.1 - 19.7 ft) in Cedar Lake are presented in Figures 3-2 and 3-3, respectively, while the corresponding surface and sub-surface TSI values are presented in Figures 3-4 and 3-5.

Figure 3-2



Note: "0" indicates no detection.

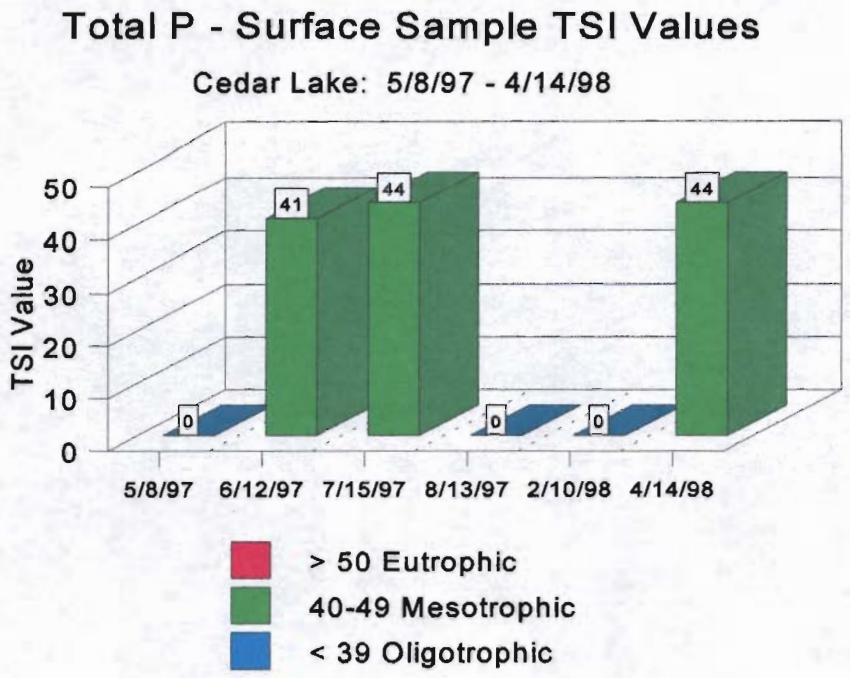
Figure 3-3



Total P concentrations should be maintained below 0.02 mg/l for natural lakes in order to prevent nuisance algae blooms (Understanding Lake Data). As indicated in Figure 3-2, the surface Total P concentrations in Cedar Lake remained below 0.02 mg/l for all samples taken with the highest concentration detected being 0.008 mg/l. There was no detection of Total P at the surface in samples taken on 5/8/97, 8/13/97, and 2/10/98.

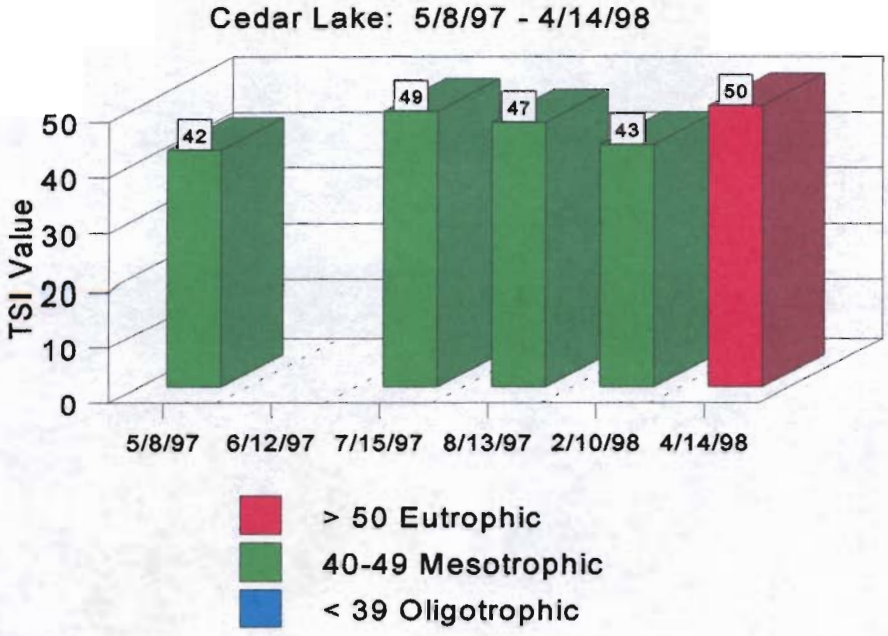
The sub-surface samples shown in Figure 3-3 also remained below 0.02 mg/l, though were higher than Total P concentrations at the surface. Some sub-surface samples indicated Total P concentrations of 0.014 mg/l and 0.016 mg/l, which are relatively close to the level that needs to be maintained. Overall, the sample results indicate the water quality of Cedar Lake is at a Mesotrophic level.

Figure 3-4



Note: "0" indicates no detection.

Figure 3-5



In terms of trophic status, the Total P concentrations found in Cedar Lake indicate that the lake's trophic status ranges from Oligotrophic to Mesotrophic at the surface (Figure 3-4), and from mesotrophic to eutrophic in the sub-surface (Figure 3-5). Eutrophic status was detected in April, 1998 in the sub-surface, having a TSI value of 50. The majority of other samples from the surface and sub-surface indicated mesotrophic status, with TSI values ranging from 41 to 49.

Chlorophyll a Concentration

Chlorophyll *a* is a green pigment which is present in all plant life and is necessary for photosynthesis. The amount of chlorophyll *a* present in a lake is dependent upon the amount of algae present, and is therefore used as a common indicator of water quality. It is also one of three characteristics used to determine the trophic state of a lake. Figure 3-6 identifies the concentration of Chlorophyll *a* detected in Cedar Lake on three occasions, while Figure 3-7 illustrates the corresponding TSI values.

Figure 3-6

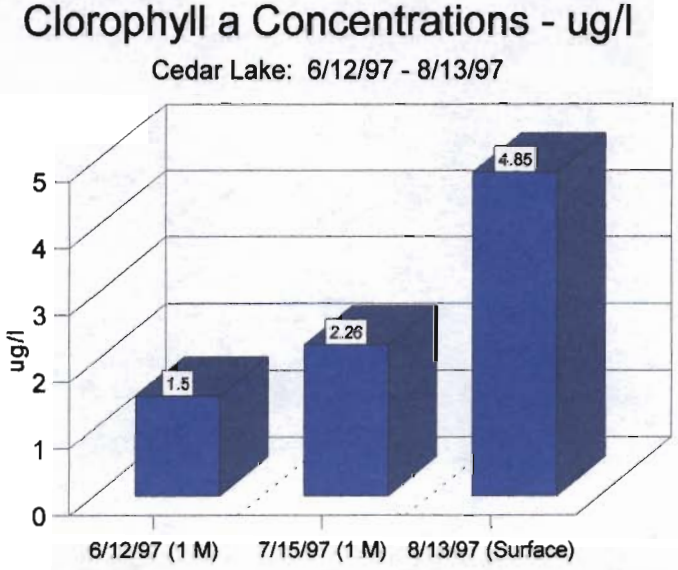
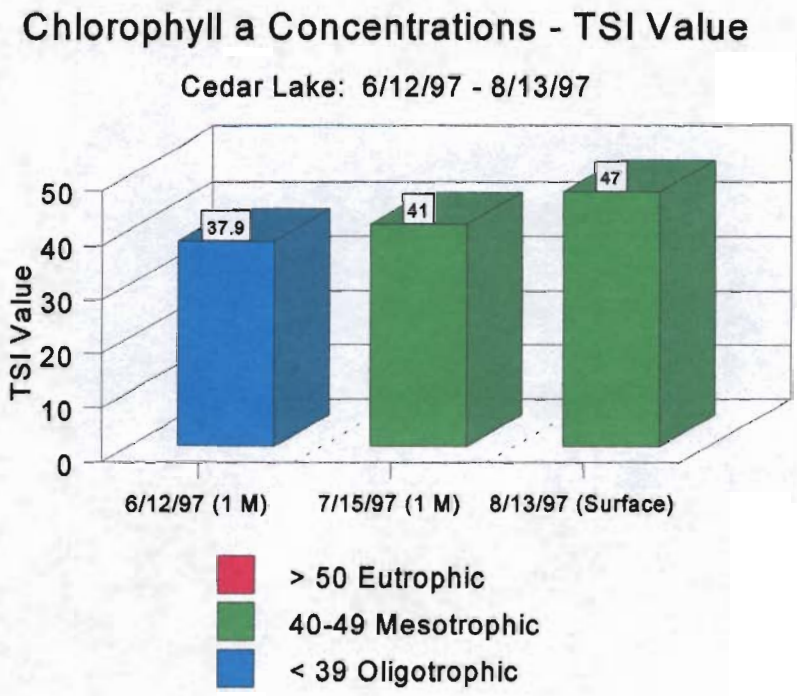


Figure 3-7



Chlorophyll *a* concentrations were sampled on three dates, all of which were taken during the summer months. Based on the results of the Chlorophyll *a* samples, the trophic status of Cedar Lake was identified as being near the high end of Oligotrophic in early summer and gradually changed to the high end of mesotrophic status near the end of summer, indicating the amount of algae in Cedar Lake increased throughout the summer months.

Secchi Disc Reading

A Secchi disc reading is a measure of water clarity; it is not a direct measure of water quality related to chemical and physical properties. However, water clarity is often indicative of a lake's overall water quality, especially the amount of algae present. Secchi disc readings are taken by lowering an 8 inch disc into the water, and taking the average of the depth where the disc disappears from sight and where it becomes visible again when raised. The Secchi disc reading can be used to determine the trophic state of a lake. Figure 3-8 provides the Secchi disc readings from Cedar Lake on five sampling dates, and Figure 3-9 displays the representative TSI values for these readings.

Figure 3-8

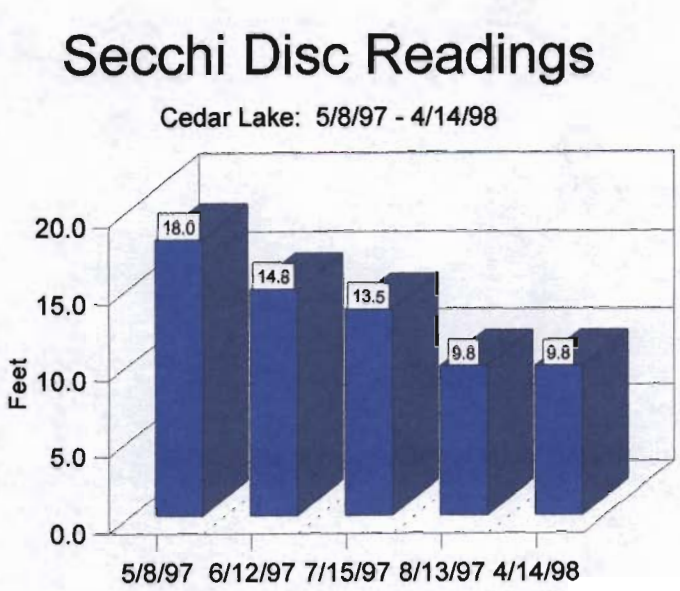


Figure 3-9

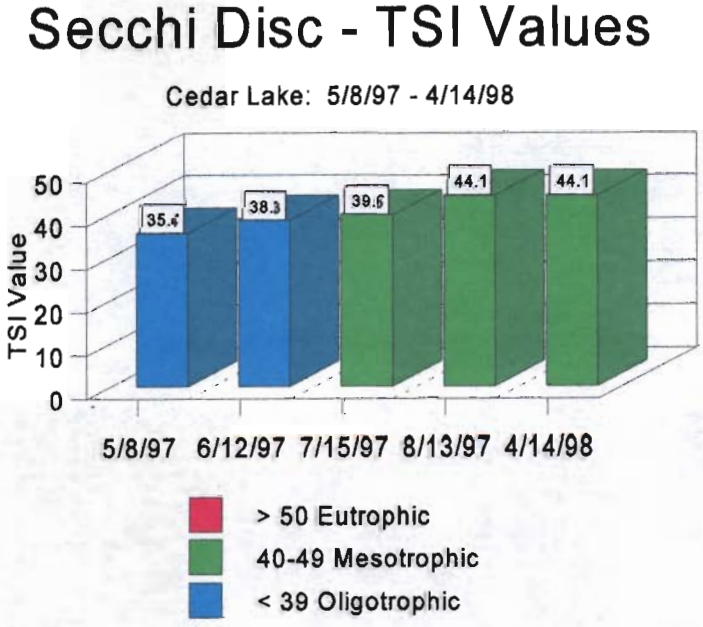


Figure 3-8 depicts that the water clarity of Cedar Lake gradually decreased between May, 1997 and April, 1998 from visibility at 18.0 feet to visibility at 9.8 feet, respectively. These readings indicate the lake's water quality ranges from fair to good.

The trophic status of Cedar Lake, as illustrated in Figure 3-9, gradually changed from oligotrophic on the first two sample dates, to mesotrophic on the remaining three sample dates.

3.3 Conclusions

Results from the sampling program indicate that D.O. concentrations in Cedar Lake reached levels at, near or even exceeding saturation on the majority of sample dates at all depths. However, during the winter D.O. levels remained below saturation with oxygen depletion experienced at depths of 16 feet or greater.

In terms of trophic status indicators, it was mentioned that low levels of Total P are related to low levels of Chlorophyll *a*, which are in turn related to high Secchi disc readings. The sample results for Cedar Lake were consistent with this, whereby the lake experienced increasing Total P concentrations, increasing Chlorophyll *a* concentrations, and decreasing Secchi disc readings. Therefore during the sampling period, the overall water quality of Cedar Lake as indicated by TSI Values gradually decreased, however is still of good quality. In general, Cedar Lake can be classified as a Mesotrophic lake based on the Total P concentrations, Chlorophyll *a* concentrations, and Secchi disc readings collected from May, 1997 through April, 1998.

The data presented in this report however, does not completely reflect the health of Cedar Lake. A lake's aging process transitions from Oligotrophic through Mesotrophic to Eutrophic. The rate of this aging process is very important. Data from several years is needed to accurately show whether a lake is experiencing significant changes in water quality as year-to-year changes in lakes are an indication of the rate of change. As a Mesotrophic lake, Cedar Lake's aging process is progressing towards a Eutrophic condition. Human activity can accelerate this aging process. Continued monitoring will be needed to follow and predict this process.

4 Sanitary Survey

A sanitary survey was distributed to all property owners within the Town of Schleswig Sanitary District No. 1 in July, 1997. The purpose of the survey was to collect input regarding private wastewater and water supply systems to aid in evaluating the potential impact of private sanitary systems on the water quality of Cedar Lake.

Currently, all residences are equipped with private, on-site septic systems, including septic tanks and fields, holding tanks, mound systems and other systems. Private septic systems can potentially have a negative impact on the water quality of the lake if they are improperly installed (including poor location selection) or maintained. The waste products of these systems contain nutrients which promote nuisance plant and algae growth. If these waste products enter the lake, the process of eutrophication can be accelerated and water quality may decrease.

The results of the survey are presented and analyzed in this section, along with a discussion of on-site observations, and conclusions.

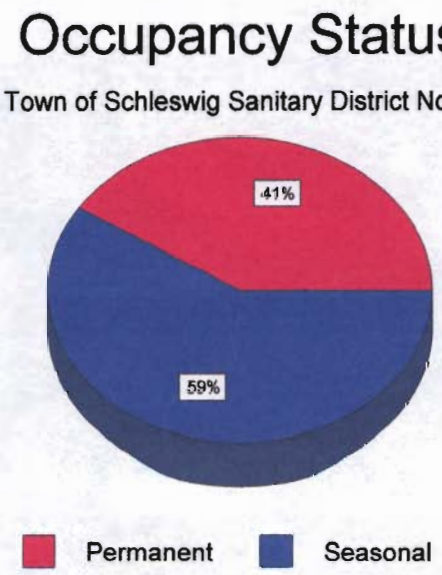
4.1 Survey Results and Analysis

The following identifies the results of the majority of the survey responses which were received from 68 of the 141 property owners along Cedar Lake for a response rate of 48.2 percent. The survey results are categorized into data concerning occupancy status, lake management planning concerns, wastewater disposal systems, and water supply systems. The complete results of the Sanitary Survey are included in Appendix B.

Occupancy Status

Figure 4-1 displays the occupancy status of the dwellings along Cedar Lake, including Permanent and Seasonal. The majority of respondents, 59%, indicated that their dwellings are for seasonal use, while the remaining 41% of the respondents use their dwelling as a permanent residence.

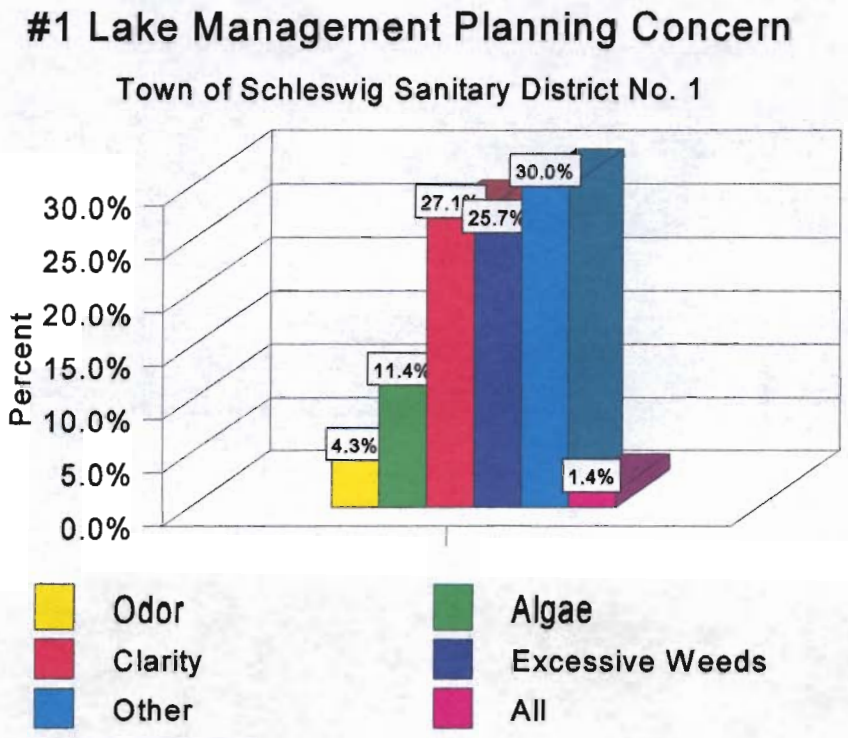
Figure 4-1



Lake Management Planning

Survey respondents were asked to identify the number one lake management planning concern they have regarding the water quality of Cedar Lake. Concerns including odor, algae, clarity, and excessive weeds. In addition, this question provided the opportunity for respondents to identify their opinions or suggestions as to lake management planning concerns other than odor, algae, clarity or excessive weeds. The results of this question are presented in Figure 4-2, and reveal that the greatest number of respondents (30%), identified concerns other than those provided as the number one lake management planning concerns. Some of the "other" concerns included: the high number of boats/small watercraft, especially those with high horse-power engines, leaking septic systems, low water levels, mud/muck, pollution, and no concerns (water quality is good). Water clarity ranked second, identified by 27.1 percent of respondents, followed by excessive weeds, identified by 25.7 percent of respondents. Algae and odor were of least concern, while one respondent indicated that all of the concerns listed were important.

Figure 4-2



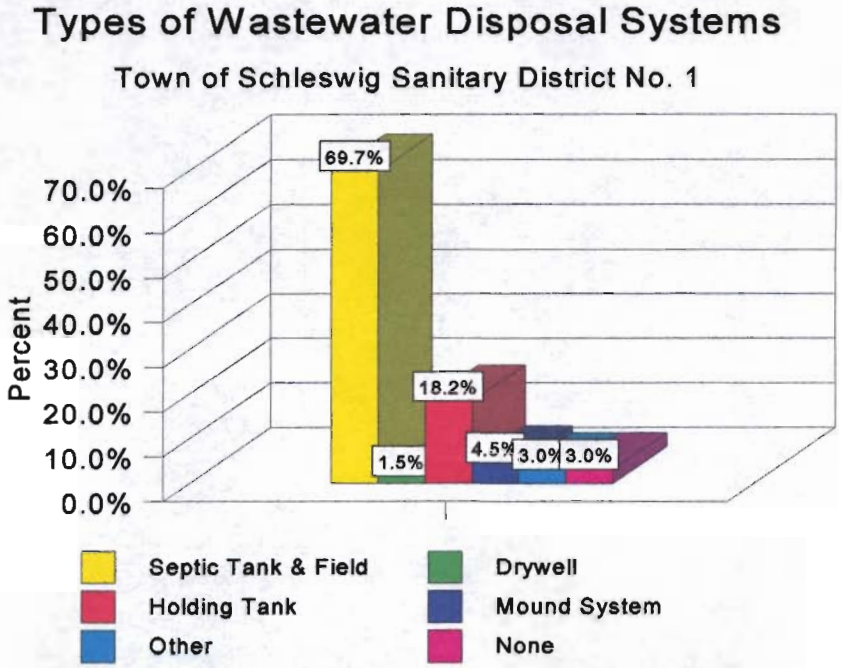
Wastewater Disposal Systems

The following identifies the characteristics of the wastewater disposal systems along Cedar Lake, including type of system, age of system, time from last maintenance, and problems experienced with the systems.

Type of System

The distribution of the various types of wastewater disposal systems along Cedar Lake is presented in Figure 4-3. Over two-thirds of the respondents (69.7 %) have a septic tank and field as their sanitary system. Holding tanks comprised 18.2 percent of the systems. The remaining approximately 10 percent of sanitary systems are distributed among mound systems, drywells, other systems and no systems.

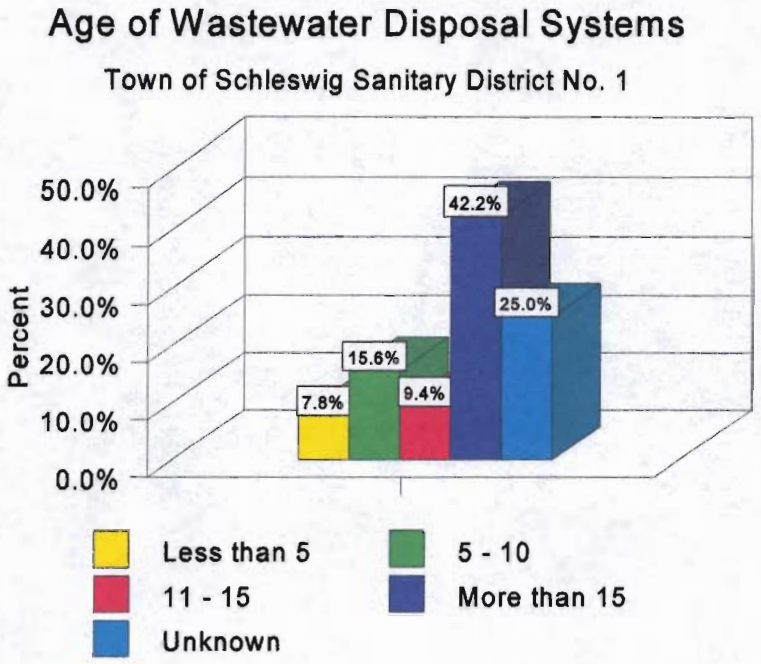
Figure 4-3



Age of System

Figure 4-4 displays the ages of the private sanitary systems as indicated by survey respondents. The majority of these systems (42.2%) are more than 15 years old, followed by 15.6 percent which are 5 to 10 years old. Systems less than 5 years old and 11 to 15 years old each comprised less than 10 percent of all sanitary systems. One quarter of the respondents were uncertain as to the age of their sanitary systems; it can be concluded that these systems are older and were most likely constructed over 15 years ago.

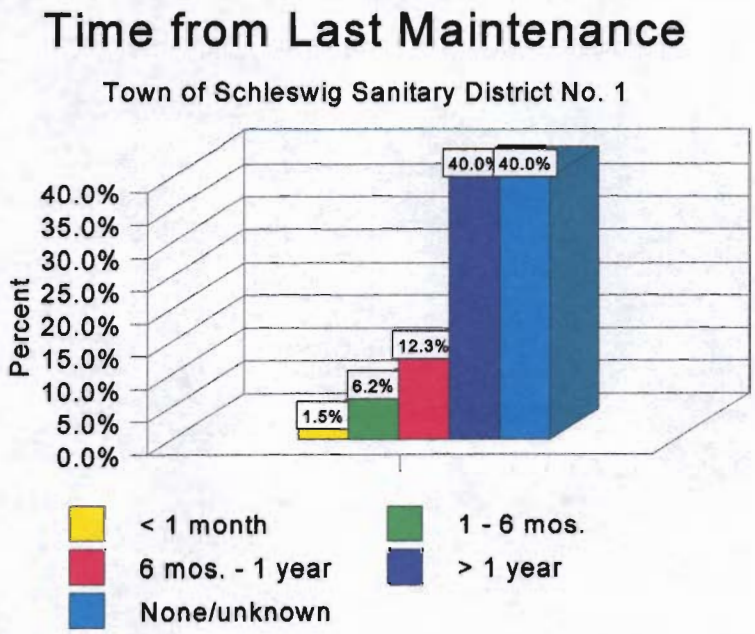
Figure 4-4



Time from Last Maintenance

The time period since the last maintenance was performed on the wastewater disposal systems along Cedar Lake is presented in Figure 4-5. Forty percent of respondents indicated it has been longer than 1 year since the last time their sanitary system was maintained, while another 40 percent did not know when the last maintenance was performed on their system. Approximately 20 percent responded that their systems had been maintained within the past year. Maintenance (pumping) should be performed at least once every year or every other year for conventional and mound systems, and should occur frequently (upon alarm) for holding tanks. It is hard to determine from the data collected if the sanitary systems within the Town of Schleswig Sanitary District No. 1 are being properly maintained, however it can be assumed that at least the 40 percent of respondents who reported not knowing when maintenance was last performed on their systems are not practicing proper maintenance.

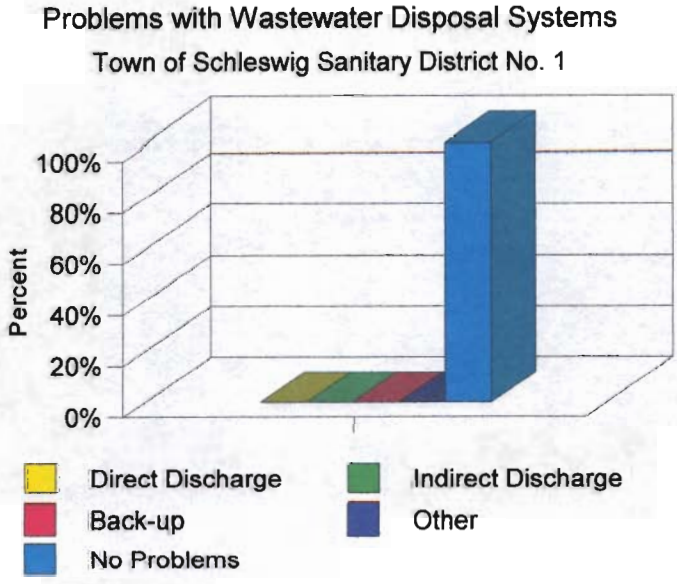
Figure 4-5



Problems with Wastewater Disposal Systems

Respondents were asked to identify any problems which were experienced from their wastewater disposal systems. Problems include direct discharge to the surface, indirect discharge (seepage), back-up into the house, other problems, and no problems experienced. One hundred percent of the respondents indicated they had not experienced any problems with their wastewater disposal systems (See Figure 4-6).

Figure 4-6



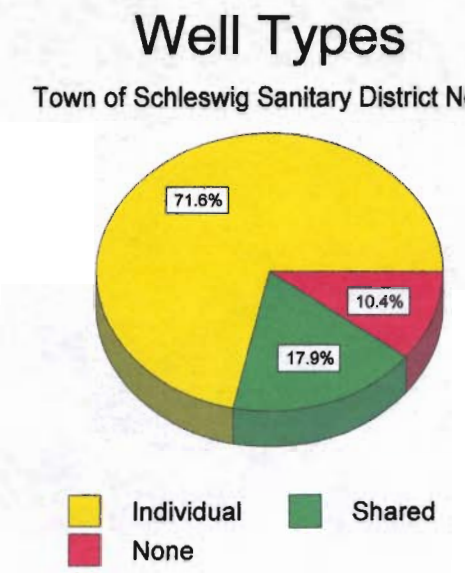
Water Supply Systems

The following identifies the characteristics of the water supply systems along Cedar Lake, including the types of wells, ages of wells, and problems experienced with these systems.

Types of Wells

Figure 4-7 displays the types of wells (i.e. individual, shared, none) in operation along Cedar Lake. Based on survey responses, over 71 percent of the wells in the Town of Schleswig Sanitary District No. 1 are individual wells, while nearly 18 percent are shared, and approximately 10 percent do not have a well.

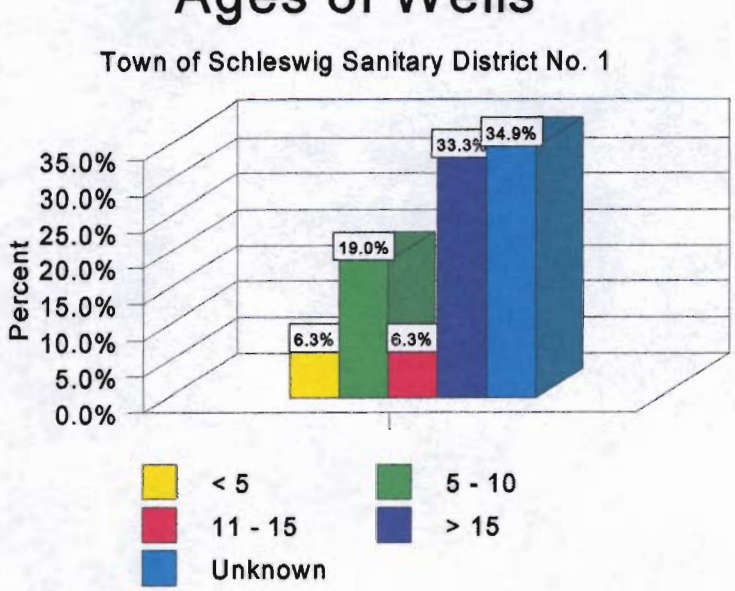
Figure 4-7



Age of Wells

The ages of the wells in the Town of Schleswig Sanitary District No. 1 are illustrated in Figure 4-8. According to the results of the survey, approximately one-third of the wells in the District are more than 15 years old, and another one-third are less than 15 years old - primarily from 5 to 10 years old. The ages of the remaining one-third of the wells are unknown.

Figure 4-8



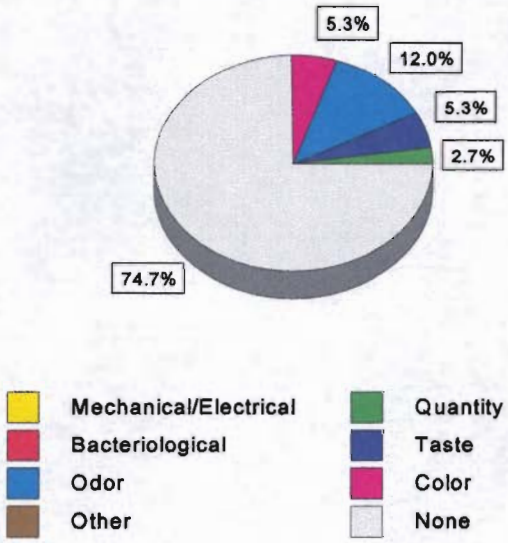
Problems Experienced with Wells

Survey respondents were asked to identify any problems experienced with their water supply systems, including mechanical/electrical, quantity (volume/pressure), and quality such as bacteriological, taste, odor, color, or other, or to indicate if no problems were experienced. Figure 4-8 displays that approximately three-quarters of all respondents do not have any problems with their wells. The remaining one quarter however, did indicate some problems. Approximately 22 percent experienced problems with well water quality, including 12 percent having odor problems, and taste and color were each experienced by 5 percent of respondents. Problems with well water quantity were indicated by approximately 3 percent of respondents, while mechanical/electrical and bacteriological problems were not experienced at all.

Figure 4-9

Problems with Water Supply Systems

Town of Schleswig Sanitary District No.1



4.2 Onsite Observations

Visual observations were made of the lots located around Cedar Lake. The suitability of the land for on-site septic systems, and the types of systems currently in place were examined.

The south shore of the lake is relatively uniform with homes about 10 feet above the lake level. Lots are generally adequate for conventional septic systems in this area. Septic systems observed along the south shore were mound systems or were trench systems located over 100 feet away from the lake. These are well-designed and will provide excellent treatment prior to discharge to groundwater. Some smaller lots have systems that cannot treat all the wastewater generated. In these cases, the wastewater is not adequately treated or the amount of wastewater is reduced by washing clothes off-site.

The homes on the east, north and west sides of the lake have much more challenging terrain for septic systems. Lots are small with many having a severe slope that does not allow septic systems, or are near lake level which precludes conventional septic systems. Most newer homes have holding tanks to collect wastewater.

4.3 Conclusions

Based on the data collected from the sanitary survey and the observations from the field study, the following conclusions can be drawn:

- Over two-thirds of the on-site sanitary systems within the Town of Schleswig Sanitary District No. 1 are conventional septic systems, however only approximately one-third of the property in the District is suitable for this type of system due to steep slopes, low areas, small lots grouped together, etc.

- Over 40 percent of sanitary systems in the Town of Schleswig Sanitary District No. 1 are more than 15 years old, while another 25 percent can be assumed to be over 15 years old (ages unknown by owners). Codes may have been more lenient at the time these systems were constructed, therefore they may not be ideally located or constructed by today's standards.

- All survey respondents indicated that no problems were experienced with their systems, however they may not be educated on how to detect wastewater discharging to the surface or discharging indirectly.

Therefore, it is possible that some sanitary systems within the District are discharging wastewater into Cedar Lake and contributing to the accelerated eutrophication of the lake.

5 Alternatives for Water Quality Improvements

The following presents some alternatives which may be implemented to improve the water quality of Cedar Lake, and to slow the process of eutrophication. Alternatives include educating Town of Schleswig Sanitary District No. 1 landowners on ways they can contribute to improving the lake's water quality, improvements that can be made to sanitary systems, and the installation of a public sanitary sewer system. Additional materials are attached in Appendix C.

5.1 Education

There are numerous ways individual landowners can contribute to maintaining or improving the water quality of Cedar Lake through various land practices. Land owners should be provided with educational material explaining proper land practices and the benefits of them.

A number of human activities add nutrients to the water which promote excessive plant growth. The best long-term solution to control/prevent excessive plant and algae growth and improve water quality then is to prevent surplus nutrients and sediments from entering the water. Surface water runoff is a major source of nutrients and sediments in lakes. It should be noted, however, that variations in the natural environment (i.e. temperature, weather conditions, etc..) can also cause excessive plant growth.

This section identifies the ways in which private landowners can help to improve the lake's water quality by reducing surface water runoff and controlling soil erosion:

1) Landscaping Along the Waterfront

Landscaping along the shoreline is best kept in its natural state and provides several benefits which include:

- protecting the water quality of the lake by filtering nutrients and pollutants from runoff before reaching the lake
- preserving the beauty of the shoreline by preserving the natural appearance and screening development from view
- providing wildlife habitat
- protecting the shoreline from erosion
- shading lakeshore water minimizing aquatic plant growth near shore
- low-maintenance care

These benefits can be achieved by doing the following:

- Preserve Natural Shoreline Buffers: Leave the shoreline in a natural state if it has not yet been altered. In areas where the land slopes to the water, construct a berm back from the shore to detain runoff, allowing time for infiltration and evaporation of water.(local zoning regulations restrict shoreline vegetation removal)

- Restore Shoreline Buffer Areas: Leave a strip of unmowed grass, preferably 20 feet wide or more, along the shoreline; native flowers, shrubs and grasses will naturally grow in this area. Native species, including trees, may also be planted in these areas to add variety and provide more immediate results without requiring the use of fertilizers. The wider the buffer area, the greater the benefits.

- Shoreline Paths: Create pathways to the shoreline which follow natural contours rather than descend straight downslope to minimize erosion. Use wood chips or gravel for paving so runoff is not directed into the lake.

- Limit paved or impermeable areas. Dominating the landscape with driveways, patios, decks, and roofs increases the amount and velocity of runoff, carrying sediments and nutrients which cause nuisance plant growth, damage aquatic habitat, hinder recreational activities, and speed the eutrophication of the lake. Reduce the amount of runoff from driveways and patios by constructing them with porous paving bricks, and diverting water to areas where it can evaporate or soak into the soil.

- Minimize land slopes. Keeping the land as flat as possible reduces erosion. Terracing should be used to flatten areas of steep slope, such as those along the east shore of Cedar Lake.

2) Lawn/Garden Care

It was observed during the field study that much of the lake is surrounded by well-kept lawns. The fertilizers and pesticides frequently used to maintain these laws and gardens can reach the water and negatively affect the water quality of the lake. A minimal amount of lawn area is recommended to maintain good water quality; ideally, native, low-maintenance groundcovers should be planted in place of lawn. There are ways however, to care for lawns and gardens which will preserve the water quality of the lake, including:

- Proper use of fertilizers and pesticides, including the use of no- or low-phosphorus containing fertilizers. Use fertilizer only if there is a nutrient deficiency present as shown by a soil test. For pesticides, avoid application 1) if rain is likely, 2) near the shoreline, and 3) near a well, do not dispose of them down a toilet or drain, do not mix different pesticides, and carefully follow the directions on the label.

- Choose a grass type or groundcover that is appropriate for your site and soils which requires minimal maintenance, fertilizer and pesticide application.

- Leave grass clippings on the lawn. This will provide up to one-half of the nitrogen the lawn needs. Do not burn grass clippings and leaves near the shore or rake them into the water.

- Do not mow more than ⅓ of the height of grass blades. Set the mower blade to 2 - 2 ½".

- Locate gardens away from the shoreline.
- Control garden pests by using natural controls and pest predators rather than pesticides.
- Add nutrients to gardens by composting aquatic weeds.
- Divert runoff from waterways. Downspouts should be directed to areas where infiltration can occur and not to areas of steep slope. Planting beds are a good location to direct downspout runoff.
- During construction, minimize soil disturbance and revegetate bare areas as soon as possible.

5.2 Sanitary System Improvements

Properly functioning sanitary systems are designed to remove the majority of disease-causing organisms and some nutrients and chemicals from household water and wastewater, keeping them from entering surface water and groundwater. However, these systems are not designed to treat many water-soluble pollutants. It is necessary, therefore, to take extra care in the maintenance of private sanitary systems, especially those located near surface waters or where groundwater is close to the surface. Malfunctioning, unmaintained, or improperly installed sanitary systems can result in the release of nutrients such as phosphorus which encourage nuisance weed and algae growth in the lake.

The following provides improvements that can be made to upgrade malfunctioning or improperly installed/located sanitary systems, and also identifies ways in which property owners can reduce the risk of a malfunctioning sanitary system through proper maintenance and waste reduction practices.

Based on the sanitary survey results and on-site observations presented in Section 4, there are sanitary system improvements which can and should be made to failing systems, and to reduce the risk of malfunctioning systems discharging wastewater into Cedar Lake. These improvements include:

- Relocate drainage fields on sites away from the lake, especially in areas of steep slope (i.e. uphill/across street from property if possible).
- Construct a cluster system with a number of other residents whereby one sanitary system has the capacity to be shared by multiple households. This is especially encouraged in areas where many small lots are grouped together and sufficient room is not available for individual systems. Nine households located on the south side of Cedar Lake currently have this type of system in operation.

- Change from conventional septic systems to holding tanks in areas of steep slope, where small lots are grouped together, and in low areas. Holding tanks can be successful if properly maintained.

- The Sanitary District could develop ordinances allowing them to keep records of septic, mound and holding tank pumping frequencies for all systems in the District. This would encourage proper system maintenance.

In addition to sanitary system improvements, several recommendations are identified for properly maintaining private sanitary systems, whereby increasing the life of the system, reducing the chances of system malfunction, and more importantly reducing the incidence of allowing pollutants and nutrients to enter the lake (and groundwater):

- Decrease the amount of water used. There are several ways this can be achieved including using water-efficient appliances and flow restrictors, not letting faucets run unnecessarily, do dishes/laundry only when needed (full loads), etc.

- Use no- or low-phosphate laundry detergents and minimize the use of fabric softeners and water additives which contain phosphates. Detergents with less than 0.5% phosphate are considered low phosphate; usually liquid detergents are free of phosphates. Do not use detergents which contain fillers.

- Do not dump/pour products which contain contaminants, including pesticides, household chemicals, and solvents, or oil or grease down drains, on the ground, or down the driveway. Try to use products that are non-hazardous or less-hazardous.

- Divert discharge from wash water and water softeners from the lake; direct this water to the sanitary system.

- Avoid the use of garbage disposals.

- Don't drain sump pump water into the sanitary system, as this could increase the chance of a system overload.

- Have conventional and mound system tanks pumped at least once every year or every other year. Have holding tanks pumped upon alarm.

Malfunctioning sanitary systems can be detected by the following:

- Backup of sewage in drains or basement.

- Wet areas or ponded water over the drain field.

- Grass over the drain field is bright green (indicates effluent at the surface).

- An increase in aquatic plant growth along property's shoreline.
- Drains or toilets drain slowly.
- Sewage odors.
- Bacteria or nitrates detected in a nearby well water test.
- Biodegradable dye flushed through the system is detectable in the lake.

5.3 Sanitary Sewer

The installation of public sanitary sewer for the Town of Schleswig Sanitary District No. 1 is another alternative available to improve the water quality of Cedar Lake. A feasibility study of wastewater collection and treatment method alternatives for the Sanitary District was conducted in 1995 by Foth & Van Dyke. The results of the study found that the best alternative would be a combined gravity/low pressure sewer for wastewater collection. All wastewater would be pumped to the City of Kiel for treatment and disposal. A copy of the feasibility study update which was presented to the Town of Schleswig Sanitary District No. 1 on August 10, 1996, is included in Appendix D.

There are numerous advantages to proceeding with the installation of a public sanitary sewer system, including:

- Eliminates contamination of lake waters
- Improves drinking water quality
- Eliminates waste trucks in the District
- Improves the value of properties
- Eliminates the need for replacement systems
- Improves overall environmental impact
- Eliminates maintenance of on-site systems

There are however, a few disadvantages to installing public sanitary sewer. The first disadvantage is the cost and associated unit assessments per RUE. Second is the inconvenience created due to construction of the system, however this occurs only initially for a limited time. Third, the installation of public sanitary sewer may promote growth within the district.

6 Recommendations

This section provides recommendations which the Town of Schleswig Sanitary District No. 1 should implement to maintain and protect the water quality of Cedar Lake.

6.1 Lake Management Plan

It is recommended that the Town of Schleswig Sanitary District No. 1 prepare a Lake Management Plan. A Lake Management Plan identifies the plan of action to be taken towards maintaining and protecting the water quality of a lake, including determining needs, setting goals, gathering and analyzing information, and developing alternative courses of action. Activities which could be included in the plan are:

- Water Testing
- Educating the Public
- Evaluation of Runoff
- Land Use Planning
- Weed Harvesting
- Evaluating and Developing Ordinances Related to Sanitation, Zoning, or Pollution Control
- Developing Management and Implementation Plans for Lake Protection

6.2 Future Water Quality Testing

Water quality testing is recommended to be continued in the future. The testing completed as part of this report provides only a snapshot of Cedar Lake's water quality. In order to accurately determine if the lake is experiencing significant changes in water quality, and the rate of that change, data from several years needs to be collected and analyzed.

A long-term sampling program should be established, specifically including the testing of the trophic status indicators - Total P, Chlorophyll *a*, and Secchi disc readings. Testing should be completed on a quarterly basis and include samples from both spring and fall overturn. Secchi disc readings should be taken on a weekly or bi-weekly basis from April through November.

6.3 Water Quality Improvements

It is recommended that alternatives for water quality improvement be implemented. Alternatives may include educating the public, upgrading on-site sanitary sewer systems, and/or the installation of a public sanitary sewer system.

The installation of a public sanitary sewer system should be considered for the long term maintenance and protection of Cedar Lake's water quality. Cedar Lake is very sensitive to pollution because it is landlocked, therefore pollutants which enter the lake remain in the lake as no natural outlet exists. This may cause the lake to progress to eutrophic status more rapidly. It

would be more feasible to spend less money now to ensure protection of the lake's water quality rather than spend more money later to clean up the lake and then ensure protection.

7 Implementation

The Town of Schleswig Sanitary District No. 1 can begin the process of implementing the recommendations provided in Section 6 by applying for grants to assist with costs, and sending out educational flyers to the property owners throughout the District, and planning for the installation of a public sewer system.

Lake Management Planning Grants are available from the Wisconsin Department of Natural Resources which provide cost sharing for the development of lake management plans and related activities. There are two application cycles to apply for these grants which include February 1 and August 1 of each year.

In addition, Lake Management Protection Grants are also available to assist in with the costs of implementing the recommendations of a lake management plan. The development of local regulations and ordinances, and lake improvement activities may be funded through these grants. Applications are accepted on May 1 of every year.

Educational flyers should be distributed to all property owners within the Town of Schleswig Sanitary District No. 1, identifying ways they can contribute to the protection of Cedar Lake's water quality.

The District should begin planning for the installation of a public sewer system in the future to ensure the protection of the water quality of Cedar Lake. On-site systems, even if upgraded, still pose the threat of nutrients and contaminants discharging into the lake thereby accelerating the process of eutrophication. Therefore, to ensure the protection of the water quality of Cedar Lake for years to come, public sanitary sewer should be installed.

Appendix A

Cedar Lake - Manitowoc Co.

Lake Planning Grant LPL-462 Storet #363120

Date	Depth M	D.O. ppm/mg/l	Temp Centigrade	Chl a ug/l	Chl a TSI	Total-P mg/l	Total-P TSI	Ortho-P mg/l	Ca mg/l	Cond. umhos/cm	pH stand units	Alkalinity mg/l	Hardness mg/l	Mg mg/l	NH3-N mg/l	NO2-NO3-N mg/l	Kjel-N mg/l	Secchi M	Carlson TSI
5/8/97	1					ND		ND	27	341	8.53	167	170	25	ND	0.031	0.4	5.5	35.4
	6.4					0.006	42	ND	27	342	8.56	167	170	25	ND	0.03	0.4	5.5	
6/12/97	0	10.2	23.8																38.3
	1	10.5	22.9	1.5	37.9	0.005	41	ND										4.5	
	2	11.2	20.2																
	3	11.8	18.8																
	4	13	16.4																
	5	12.2	16.6																
	6.5																		
7/15/97	0	7.4	25.5																39.6
	1	7.6	25	2.26	41	0.008	44	0.002										4.1	
	2	8.2	23.5																
	3	8.2	23.5																
	4	8.4	23																
	5	7.7	22																
	6	7.9				0.014	49	0.002											
8/13/97	0	9.8	23	4.85	47	ND		ND											44.1
	1	9.9	23															3	
	2	9.5	23																
	3	9.6	23																
	4	9.8	22.5																
	5	9.4	22.5																
	6	8.6	22			0.012	47	ND											
	6.2																		
02/10/98	0	10.2	2.8			ND		ND											
	1	9	3.5																
	2	7.7	4.2																
	3	7.5	4.4																
	4	5.7	4.6																
	5	2.2	5																
	6	1.9	5			0.007	43	ND											
	7.5																		44.1
04/14/98	0	10.7	10.9			0.008	44	ND	27	337	8.4	164	170	24	0.021	0.011	0.44	3	
	1	9.5	10.9																
	2	8.9	10.9																
	3	8.7	10.9																
	4	9.8	10.9			0.016	50	ND	27	336	8.4	164	170	25			0.43		

The Carlson Trophic State Index (TSI) is applied to chlorophyll a, total phosphorus and secchi disc transparency. TSI values <39 indicate an oligotrophic conditions, 40-49 mesotrophic, and >50 eutrophic conditions. ND indicates no detection, NLR indicates no lab results.

Modified for Wisconsin