COASTAL ENVIRONMENTAL SERVICES INC.

LOWER LONGWOOD LAKE RESTORATION AND MANAGEMENT PLAN

PREPARED FOR:

LOWER LONGWOOD LAKE CABIN OWNERS ASSOCIATION

PREPARED BY:

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PROJECT NO. 94-767-01

OCTOBER 1994

EXECUTIVE SUMMARY

LOWER LONGWOOD LAKE RESTORATION AND MANAGEMENT PLAN

The key findings and recommendations developed as a result of Coastal's study of Lower Longwood Lake can be summarized as follows:

1. The lake, although eutrophic, is in good "health". Current water quality conditions meet or exceed state standards established for FW2-NT waters. Also, the lake does not experience nuisance planktonic algae blooms that are characteristic of many northern New Jersey lakes.

2. In-filling, or sedimentation problems are most severe in the lake's upper end and in some of the small coves in the lower end. Reclamation of the smaller coves should be conducted using dry excavation techniques. In total, the remedial dredging of these coves would yield a maximum of 10,000 yds^3 and would cost approximately $172,500 to $230,000.

3. Mat algae control should focus on the use of copper-based products, preferably granular copper sulfate, applied at a low dose, but on a frequent basis (once every 3 weeks). This should curtail the development of obnoxious mats that impede lake use and inhibit circulation in the coves.

4. Some water lily control may be warranted. The level of control should take into account the fishery habitat and local aesthetic attributes provided by these plants. That is, there is no need to eradicate or significantly reduce their densities. Control should be based on the selective use of RODEO.

5. The residents of the community should be more thoroughly educated in respect to on-site soil erosion control, pesticide/fertilizer use and use of non-phosphorus wash products.

Lower Longwood Lake
Restoration and Management Plan

Prepared for:

Lower Longwood Lake Cabin Owners Association

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Introduction

Longwood Lake is an impoundment of the Rockaway River. Located in Jefferson Township, Morris County, New Jersey, the 48-acre lake is long and narrow, typical of most lakes created as a result of the flooding of a river valley. Development immediately adjacent to the lake is variable. The southeast shoreline is largely undeveloped, whereas the southwest and northern shorelines are characterized by different levels of residential development. To the south, development is nominal, consisting of a few scattered seasonal cabins comprising the Lower Longwood Lake Association. To the north, the density of residential development is much greater (2 to 4 units/acre), and a substantial amount of infrastructure in the form of roadways exists. All dwelling units rely on septic systems for wastewater treatment.

The lake's watershed is very large, encompassing well over 8,000 acres (Figure 1). Encompassed within the watershed are a number of other waterbodies, including Lake Swannona, Hardbargain Pond and Cozy Lake. The watershed also encompasses portions of Pine Swamp. As such, the lake is subject to inflow originating from significantly distant areas.

Concerns have arisen over time relative to a discernable decline in the lake's quality. Most noticeable was the fact that sections of the lake were filling in with sediment and subsequently becoming overgrown with emergent aquatic vegetation and mat algae. In addition, it appeared that the density of submerged, rooted aquatic plants was increasing. The overall effect of these changes was a decline in the aesthetic qualities and the recreational potential of the lake.

The members of the Lower Longwood Lake Association have attempted over time to manage the lake. Focus has been placed on the control of weed growth through the selective use of herbicides. However, given the noticeable decline in the lake's quality, particularly in respect to in-filling and weed proliferation, the Association decided to more aggressively evaluate the cause of these problems.

Coastal Environmental Services, Inc. (Coastal) was thus contracted by the Association to conduct a baseline study of the lake. Emphasis was to be placed on the collection of accurate data pertaining to water depth contours and sediment deposition patterns. It was also to include the measurement and analysis of in-lake water quality, computation of the lake's monthly hydrologic load (water inflow), and an evaluation of potentially feasible restoration/management practices. The following report provides a review and analysis of the data collected by Coastal as part of this study. It also presents a series of recommendations, each designed to address the primary lake management needs and concerns of the Lower Longwood Lake Association.

FIGURE 1

Longwood Lake
Site Location and Watershed Boundaries

Approximate scale: 1" = 4000'

Source: USGS 7.5 Minute Series (Topographic) Dover, Franklin and Newfoundland Quadrangles

Key: Watershed boundary

N

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Methodology

Coastal developed data for use in this study from four main sources:

1. Direct field surveys conducted by Coastal,

2. Secondary data (maps, reports, monitoring results) obtained through NJDEP and the U.S. Geological Survey,

3. Modeled data derived through the use of standard runoff/inflow algorithms (SCS-TR-20), and

4. Reports obtained from Endless Mountain Environmental Services pertaining to weed control efforts.

In-field surveys of the lake were conducted by Coastal on three separate dates: 10 May, 11 May, and 2 September 1994. The focus of the May sampling effort was to establish the lake's existing bathymetry. However, it also included some water quality testing. The September survey focused on water quality testing, including an evaluation of the effectiveness of the 1994 weed control effort.

Bathymetric Survey

On 10 May and 11 May 1994 Coastal conducted measurements of the lake's bathymetry. Essentially, this consisted of using a continuous recording fathometer equipped with a strip chart to measure the lake's water depths. A total of 38 transects were established along which the fathometer was passed. Every 50 feet, a spot check of water depth was conducted using a calibrated sounding line. These data points were written directly on the strip chart. Following the completion of the water depth survey, spot measurements of the depth of accumulated sediments were recorded along the same transects using a calibrated sediment probe. In total, over 140 individual measurements of water depth and 50 measurements of sediment deposition were obtained.

Both the water depth and sediment accumulation data were entered into Coastal's Geographic Information System (GIS). Maps were then generated by the GIS depicting the lake's existing bathymetric profile and patterns of sedimentation (Figures 2 and 3).

Water Quality

On 10 May and 2 September 1994, in-situ measurements of the lake's water quality were conducted. On both dates, a Hydrolab Surveyor II was used to measure in profile (from surface to bottom) dissolved oxygen (DO), temperature, pH and conductivity. These measurements were conducted at three distinct locations (Figure 4). In addition, the lake's clarity was measured (secchi disc depth) and a sample was collected for the analysis of phytoplankton composition. During both the May and September surveys weed growth was evaluated and notes recorded relative to the occurrence and density of various species.

Longwood Lake: Water Depth

Jefferson Township, Morris County, NJ

Figure 2

This figure was printed on one sheet of 11 x 22 inch paper, which could not be scanned, so it is presented on two pages.

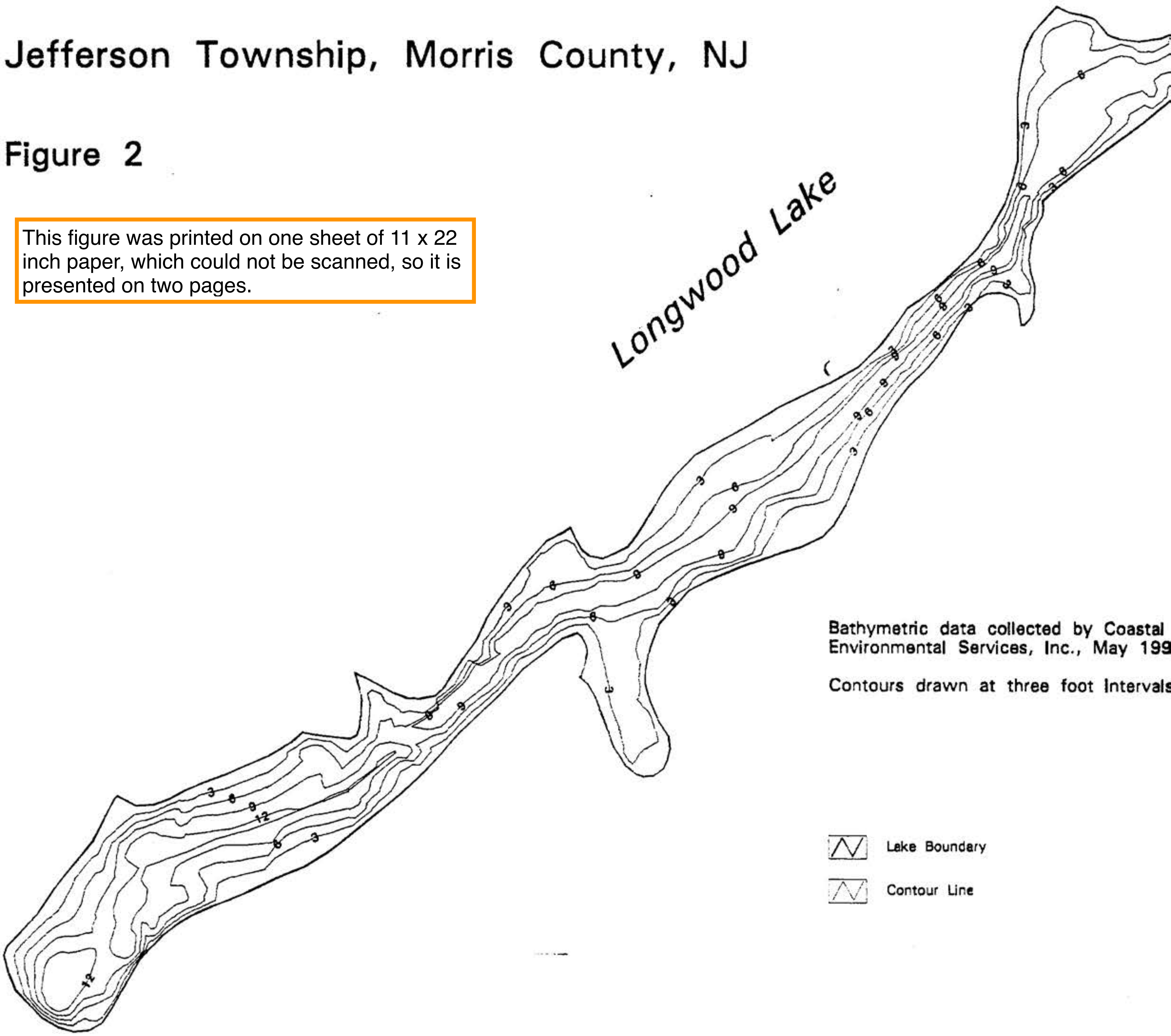
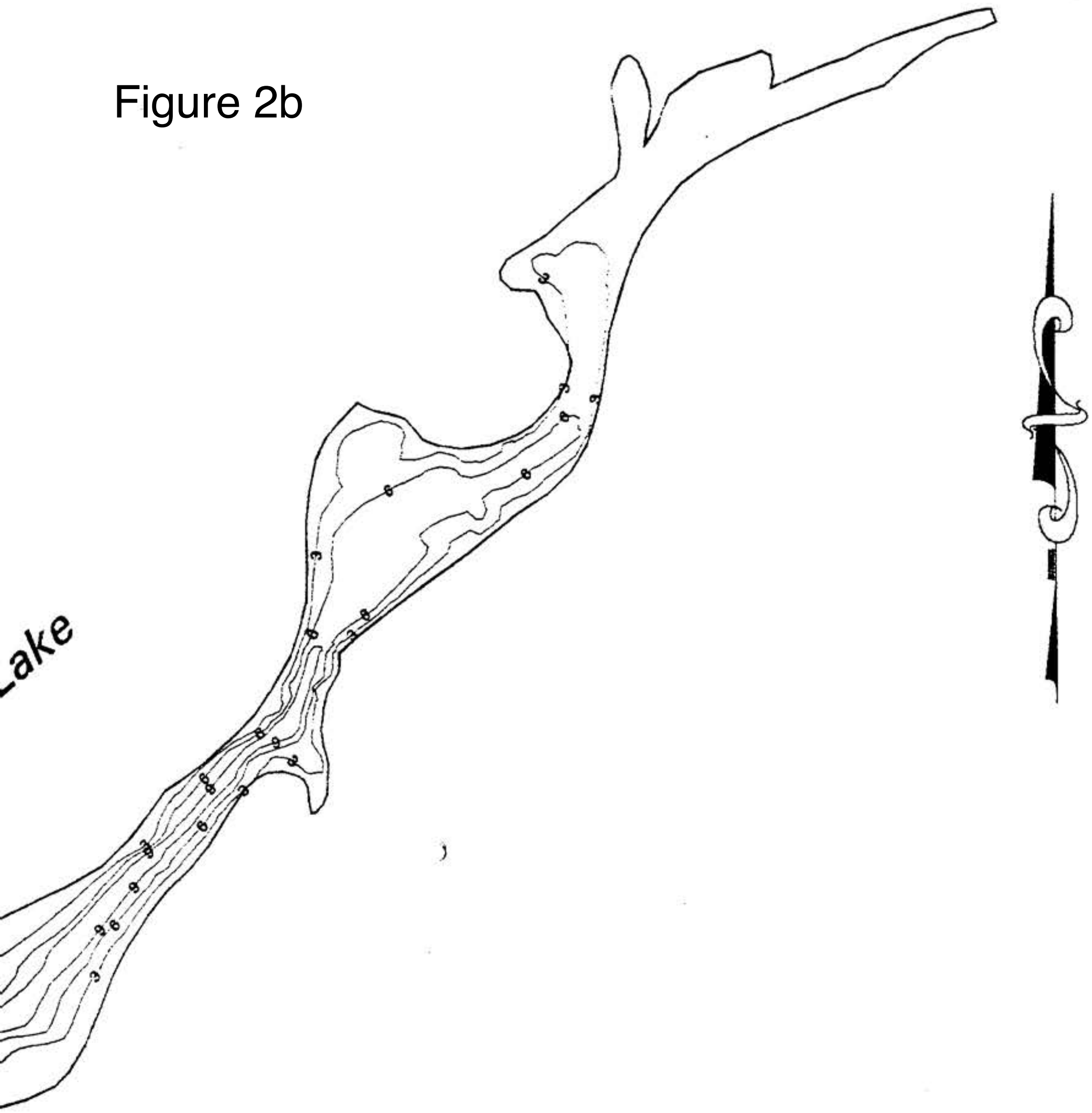


Figure 2b



Bathymetric data collected by Coastal Environmental Services, Inc., May 1994

Contours drawn at three foot Intervals

0 1000 FEET

0 300 METERS

0 1/4 MILE

Lake Boundary

Contour Line

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Longwood Lake: Accumulated Sediment Depths

Jefferson Township, Morris County, NJ

Figure 3

This figure was printed on one sheet of 11 x 22 inch paper, which could not be scanned, so it is presented on two pages.

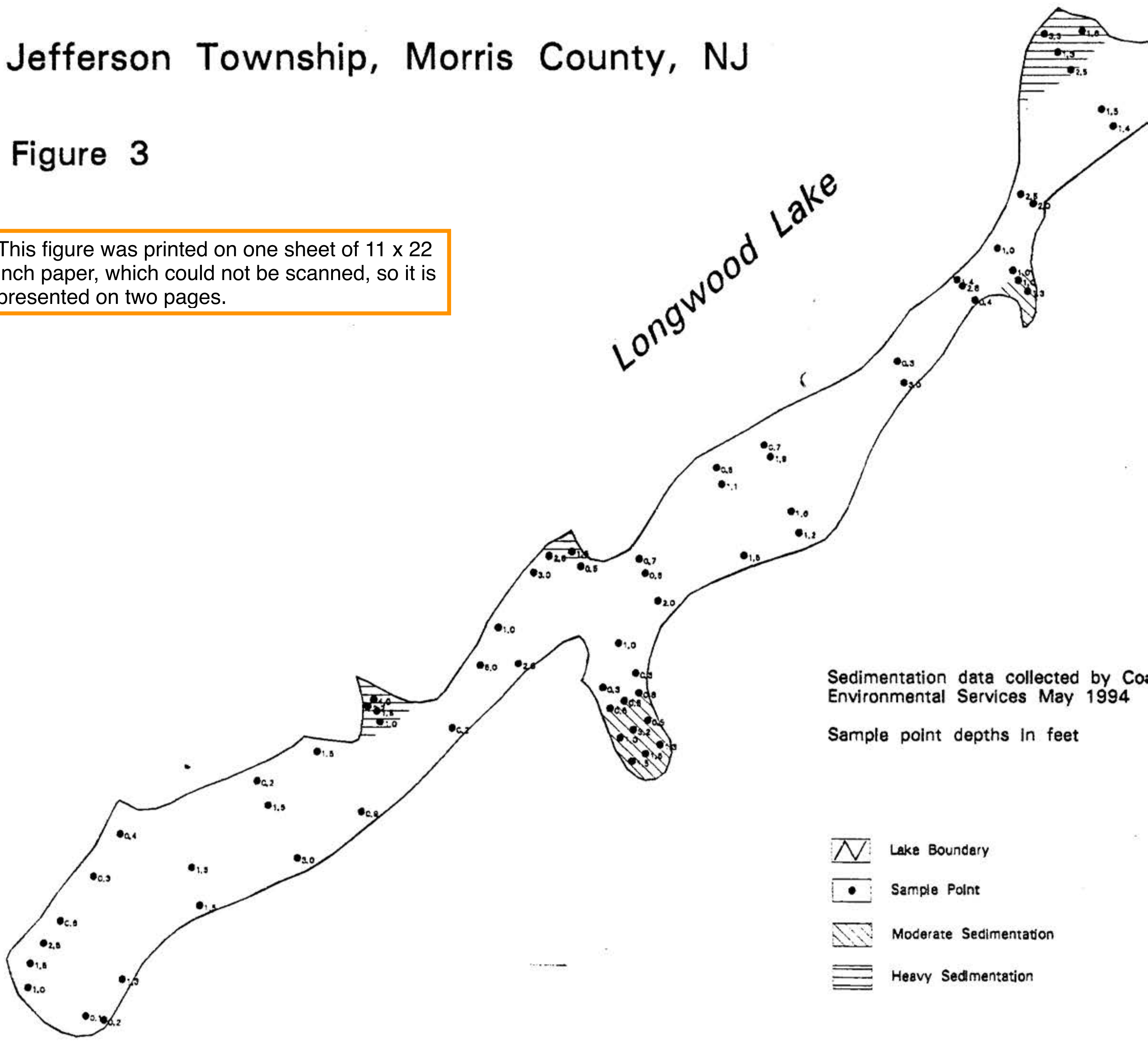
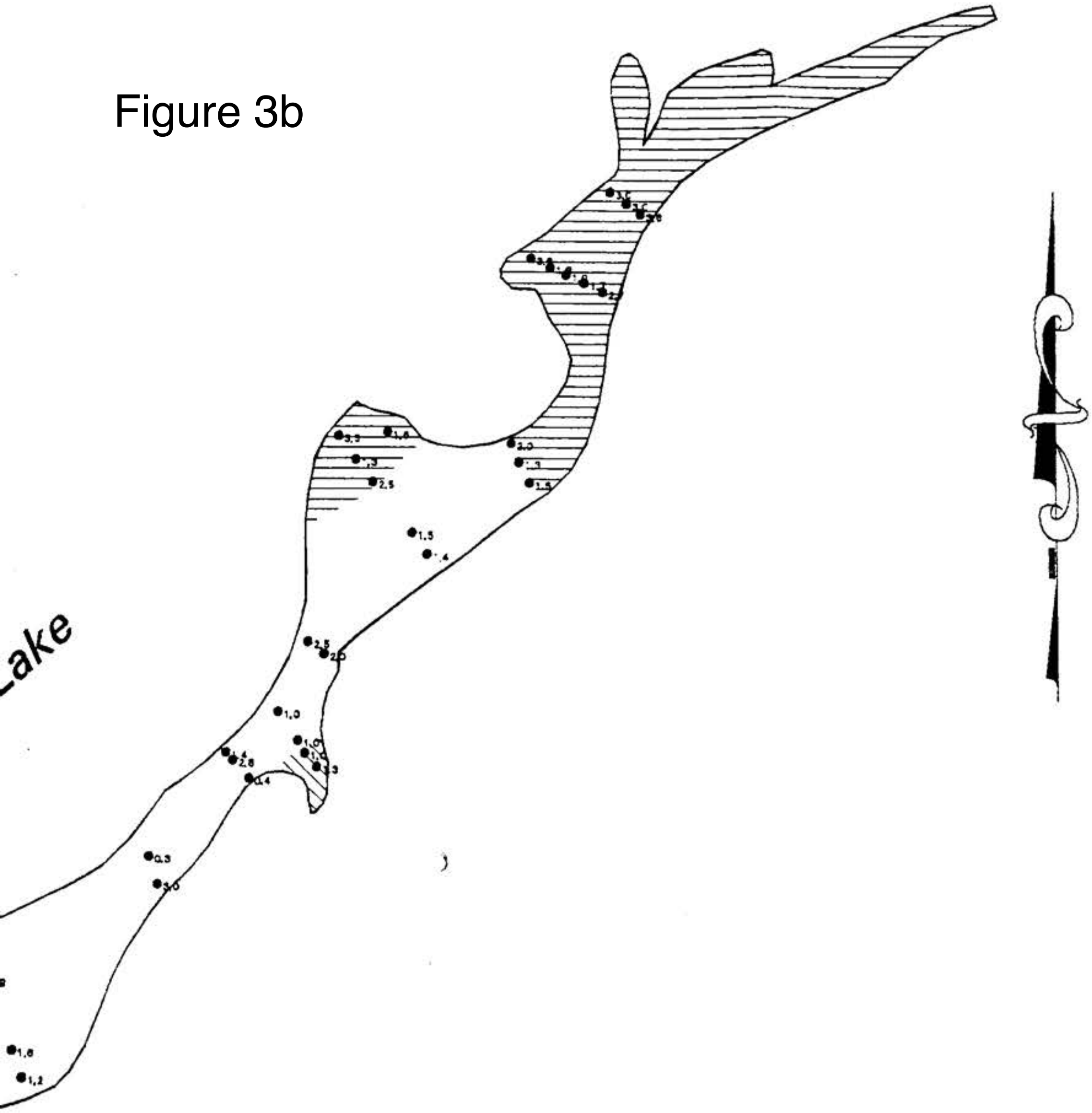


Figure 3b



Sedimentation data collected by Coastal Environmental Services May 1994

Sample point depths in feet

0 1000 FEET

0 300 METERS

0 1/4 MILE

- Lake Boundary
- Sample Point
- Moderate Sedimentation
- Heavy Sedimentation

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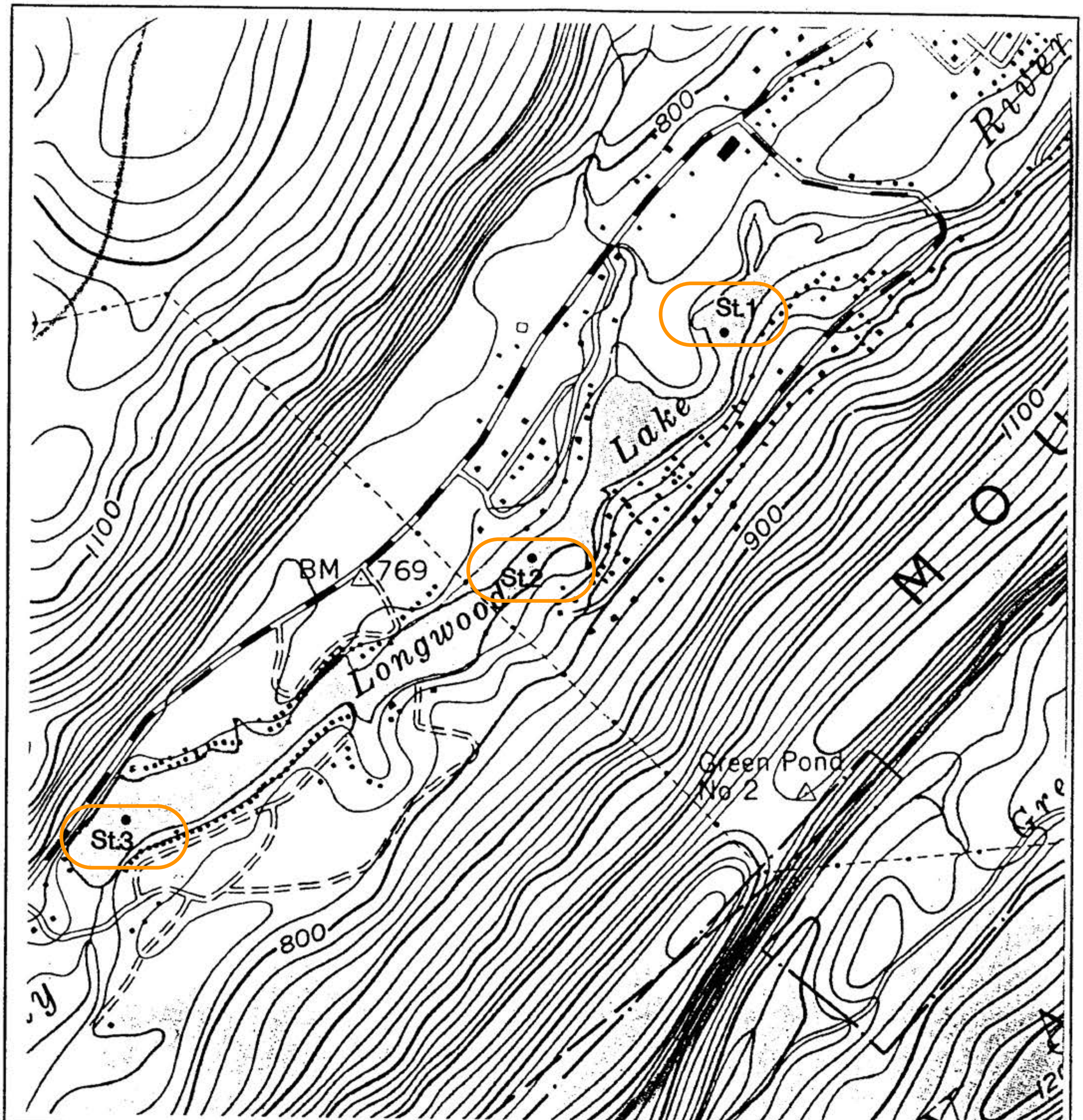

KEY:

St. 1: Upper Lake Station
St. 2: Mid-Lake Station
St. 3: Lower Lake Station

SOURCE:

USGS 7.5 Minute Series (Topographic)
Dover Quadrangle

APPROX. SCALE: 1" = 1000'

N

FIGURE 4

LONGWOOD LAKE
WATER QUALITY SAMPLING STATIONS

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Discussion of Results

Bathymetric Survey

The existing mean water depth of the lake is 7.0 feet. This is based on the result of over 140 individual spot checks of water depth as well as interpretation of the continuous recording fathometer data (Figure 2). Historical records show the mean depth to be 6.7 feet. Unfortunately the historical records have been found to be erroneous, and therefore it cannot be determined if the difference between historical and current depths is significant. In addition to the state's depth evaluation of the lake being wrong, the historical measurement of lake surface area was also miscalculated. The historical record shows the lake as being 24 acres in size. However, measurement of the lake's surface area using three different techniques yielded a surface area value of 48 acres.

Data collected by Coastal personnel indicate that sediment accumulation has occurred in Longwood Lake. The data indicate that sediment accumulation throughout the lake is variable and averages four to five feet. The lake's upper area, as well as a few of the small coves are all fairly heavily silted in (Figure 3). It appears that the central trough of the lake is responsible for most of the depth of the lake.

Water Quality

The water quality data are summarized in Tables 1 and 2. Essentially, based on the results of the in-situ surveys, the lake would be classified as being in good condition. In general, these data show the lake as having acceptable DO levels, moderate pH and uniform temperature distribution. In addition, the lake's clarity is very good even though it has a somewhat tea-color appearance.

More specifically, the DO concentrations measured in the lake were, with one exception, well in excess of the state standard for FW-2 Non-Trout Waters. This means that there is ample oxygen to support fish and other aquatic life forms. The one exception was the low DO measured in September near the lake's spillway at a depth of approximately 10 feet (3 m). A DO concentration of 1.8 mg/l is well below that considered acceptable for warm water fish (4.0 mg/l). However, it is not unusual to measure very low DO levels in the deeper portions of lakes during the summer months. Bacterial decomposition is accelerated when waters become warm in the summer, and this promotes oxygen consumption. Unless this DO is replenished by plants or algae via photosynthesis, or as a result of water column mixing, levels much lower than measured in the lighted, shallow sections of the lake will persist. As such, although the concentration of DO measured at 3 m on 2 September is suboptimal, it is <u>not</u> posing any serious problem to the lake's biota.

The lake's pH ranged from slightly acidic to slightly alkaline. Once again, these values are well within the range for FW2-NT waters. These data show that some minor seasonal variations exist, but for the most part, the lake's pH is near neutral.

Examination of the data show the lake's temperature to be fairly uniform from surface to bottom. This is to be expected, given the riverine nature of the lake. Such systems tend to be well mixed from surface to bottom. Accordingly, the prevailing water

Table 1

In-Situ Water Quality
Longwood Lake, Jefferson, New Jersey

11 May 1994

Station	Parameter					
	Total Depth (m)	Dissolved Oxygen (mg/l)	Temperature (°C)	pH	Conductivity (mu/s)	Secchi Depth (m)
Upper Lake*	0.7	9.44	16.21	7.06	0.236	TB
Mid-Lake*	3.0					1.7
0.5	---	9.17	17.20	7.07	0.238	---
1.0	---	9.02	16.80	7.03	0.240	---
2.0	---	8.71	15.91	7.01	0.239	---
3.0	---	8.81	14.73	7.05	0.231	---
Lower Lake*	3.0					1.4
0.5	---	9.76	16.83	7.17	0.241	---
1.0	---	9.67	16.80	7.09	0.241	---
2.0	---	7.99	14.73	6.88	0.238	---
3.0	---	7.77	14.00	6.83	0.237	---

TB = To bottom, secchi depth greater than total depth

* Upper Lake - approximately downstream from Rockaway River inlet
Mid-Lake - below power lines
Lower Lake - in vicinity of spillway

A Secchi disk is a metal disk, 8 inches in diameter, that is lowered into the water on a cord. The depth that the Secchi disk can no longer be seen through the water is the Secchi depth. When the water transparency is high, the Secchi depth is high. When the water transparency is low and cloudy, the Secchi depth is low

Table 2

In-Situ Water Quality
Longwood Lake, Jefferson, New Jersey

2 September 1994

Station	Parameter					
	Total Depth (m)	Dissolved Oxygen (mg/l)	Temperature (°C)	pH	Conductivity (mu/s)	Secchi Depth (m)
Upper Lake*	0.5	6.26	18.23	6.81	0.268	TB
Mid-Lake*	2.5					TB
0.5		7.64	21.14	6.98	0.257	
1.0		6.77	20.92	6.88	0.256	
2.0		6.58	20.54	6.81	0.256	
2.5		6.52	20.50	6.78	0.255	
Lower Lake*	3.0					2.1
0.5		6.80	20.97	6.81	0.255	
1.0		6.93	20.92	6.78	0.254	
2.0		6.43	20.72	6.68	0.254	
3.0		1.80	20.30	6.48	0.254	

TB = To bottom, secchi depth greater than total depth

* Upper Lake - approximately downstream from Rockaway River inlet
Mid-Lake - below power lines
Lower Lake - in vicinity of spillway

A Secchi disk is a metal disk, 8 inches in diameter, that is lowered into the water on a cord. The depth that the Secchi disk can no longer be seen through the water is the Secchi depth. When the water transparency is high, the Secchi depth is high. When the water transparency is low and cloudy, the Secchi depth is low temperatures of the lake showed little difference whether measured near the surface or close to the bottom. For comparative purposes, Lake Hopatcong displays significant differences (4-5°C) in temperature as one proceeds from surface to depths of approximately 10-12 feet (the maximum depth of Longwood Lake). However, Hopatcong is much less prone to vertical mixing than a riverine system such as Longwood and thus tends to stratify.

The lake's clarity was very good, ranging from 1.4 m (4.5 feet) to 2.5 m (8.3 feet). The lower secchi readings recorded in May reflect the effects of stormwater and its promotion of increased turbidity. Conversely, when the September data were recorded, no rainfall had occurred over the past few days, and as a result, the lake was very clear. The lake's clarity is also due to the low concentrations of planktonic algae occurring in this system. The riverine, well mixed nature of Longwood Lake is not particularly conducive to planktonic algae bloom formation. Therefore, surface scums of planktonic species do not tend to develop.

However, it should be stressed that although the lake's clarity was very good on the two dates monitored by Coastal, there was evidence that at times, more turbid conditions are experienced. It was observed in various coves and shallow sections of the lake that a considerable amount of sediment had accumulated. In addition, the plants removed for examination by Coastal staff had a fair coating of sediment. These observations suggest at times that the lake is subjected to high sediment loads which create turbid conditions that impact clarity.

The slightly acidic, low alkaline waters of Longwood Lake aid in preventing the establishment of unpleasant and environmentally harmful surface scums or blooms of blue-green algae (cyanobacteria) such as *Anabaena*, *Aphanizomenon* and *Microcystis*. Another factor that contributes to this includes the lake's high flushing rate. Whenever and wherever possible, minimizing the transport of nutrients, especially phosphorus, to the lake will ensure that scum-forming blue-green algae are not provided with the opportunity of becoming established at Longwood Lake.

In the spring the pelagic (i.e. open water) community was dominated by a bloom of the chrysophyte *Dinobryon* (Table 3). This alga is quite common in low nutrient, slightly acidic waters. When in high enough concentrations this organism is known to produce taste and odor problems. However, most chrysophytes prefer relatively low water temperatures. Therefore, any taste and/or odor problems that may arise are only temporary and usually dissipate once the water temperature increases over the summer months. Also, the grazing activities of zooplankton ("micro-animals" that live in the open water) aid in keeping chrysophyte numbers in check.

In addition to the chrysophyte *Dinobryon*, a wide variety of diatoms were also identified during the spring sampling event (Table 3). The cell walls of these algae are made of glass and they are an excellent source of food for zooplankton. The high numbers of *Dinobryon* and the large diversity of diatoms gave the waters of Longwood Lake a slightly brownish tinge. This is due to some of the auxiliary photosynthetic pigments that these algal groups possess. However, since these organisms do not form surface scums, the clarity of Longwood Lake during the spring season was relatively high. Other algae identified during the spring sampling event included a variety of green algae and several genera of eugleniods; both groups are good sources of food for zooplankton.

Table 3

Plankton Community
Longwood Lake, Jefferson, New Jersey

Sampling Date	Phytoplankton	Zooplankton
11 May 1994	A bloom of the chrysophtye *Dinobyron*, and a diverse assemblage of diatoms (*Navicula*, *Asterionella*, *Cymbella*, *Melosira***, *Fragilaria***, *Gomphonema*, *Cocconeis*, *Tabellaria*, *Cyclotella*, *Syndera* and *Pinnularia*). Green algae included *Ankistrodesmus*, *Chlorella*, *Eudorina*, *Spirogyra*, and *Pediastrum*. Other algae included *Oscillatoria*, *Phacus* and *Trachelomonas*.	The rotifers were the dominant group of zooplankton. The dominant rotifer was *Kellicottia*; other rotifers included *Asplanchna* and *Keratella*. Other zooplankton included the cladocerans *Bosmina* and *Chydorus* and the copepod *Cyclops*.
2 September 1994	Large surface mats of benthic algae were observed floating on the lake's surface. Mat algae included green algae (*Oedogonium*, *Spirogyra*, *Ulothrix*), blue-greens (*Lyngbya*) and diatoms (*Fragilaria* and epiphytic diatoms). The dominant phytoplankter was the chrysophyte *Synura*. Other common algae were *Dinobryon*, the diatom *Fragilaria* and the green alga *Eudoronia*. Other algae included a variety of greens, a few diatoms and very few blue-greens. The ribbon-like diatom *Fragilaria* was the dominant epiphyte growing on the submersed aquatic plants of Longwood Lake.	Large-bodied, herbivorous (algae eating) cladocerans, such as *Daphnia*, were the dominant zooplankton group. The herbivorous copepod *Diaptomus* was also common. A few *Cyclops*, *Ceriodaphnia* and *Bosmina* were also present. Rotifers included *Polyarthra*, *Kellicottia* and *Keratella*.

* = common genera.

During the fall sampling event, the dominant pelagic alga was the chrysophyte *Synura* (Table 3). A variety of green algae and several genera of diatoms were also identified at this time. Once again the water clarity of Longwood Lake was excellent; at two of the three sampling stations the Secchi disk could be seen all the way to the bottom.

In the fall, as was probably the case over a significant part of the summer season, large mats of benthic algae floating on the surface produced aesthetically displeasing conditions. These algal mats originate from the bottom, eventually detach and end up floating on the surface of the lake. The mat algae consisted of several genera of green algae, one genus of blue-green and a variety of epiphytic diatoms. Some of these algal mats initially begin growing on the aquatic plants that cover a large proportion of the bottom. The relatively clear waters of Longwood Lake permit a substantial amount of light to reach the bottom sediments, thus allowing for the growth of benthic algae and aquatic plants.

Hydrologic Budget

A lake's hydrologic budget is defined by the volume of water entering the lake and the volume of water lost via evaporation and downstream discharge. The calculation of a lake's hydrologic budget necessitates a fairly comprehensive evaluation of the various sources and losses of water. For a riverine lake system however, a substantial amount of valuable information can be obtained from the analysis of surface inflow data. This is basically because such systems are less affected by evaporation, groundwater recharge and direct precipitation inputs than are "conventional" lake systems. As such, if an accurate representation of surface inflow can be developed, a considerable amount of insight can be garnered in respect to the lake's flushing rate, internal mixing dynamics and processes that affect the transport and settling of sediments.

The watershed of Longwood Lake is exceptionally large. Encompassing 8,283 acres, the watershed includes a number of other lakes as well as a fairly large wetland complex (Pine Swamp). The watershed to lake ratio for Longwood Lake is 172:1. Ratios of this magnitude normally signal that a significant amount of hydrologic loading can be expected. Although this will usually result in a well mixed, quickly flushed lake system (both of which are desirable qualities), it also means that the externally generated pollutant load will be high. Thus, the amount of nutrients and sediments contributed to the lake from its surrounding watershed can be expected to be excessive. As a result, one would predict the opportunity to exist for the rapid in-filling of coves and backwaters that do not benefit from the direct flushing action of the hydrologic load.

To obtain a greater understanding of the lake's hydrologic characteristics, Coastal conducted an analysis of the lake's surface water inflow dynamics. Essentially, this entailed calculation of the volume of inflow contributed from the surrounding watershed. In order to better define and quantify the magnitude of this load, it was calculated on a monthly basis using normalized rainfall data.

The methodology employed was the rational method for the calculation of hydrologic loading (SCS, TR-20). The watershed boundaries were delineated from USGS topographic quadrangles. The area encompassed within these boundaries was digitized to yield an estimate of watershed acreage. Land use, soil, and topographic features of the watershed were evaluated and runoff coefficients were ascribed. National Oceanic and Atmospheric Administration (NOAA) data were obtained (Boonton Reservoir Recording Station) and the 40-year normalized monthly rainfall data were downloaded. Using historical rainfall data (1951 through 1973) in combination with the watershed acreage and runoff coefficients, estimates of monthly surface inflow were computed. The accuracy of these data were then verified by their comparison to USGS stream flow data for the Rockaway River and Whippany River.

The annual discharge rate for the lake is 56,893,000 cubic feet per year. Given a volume of 1.47×10^7 cubic feet, the annual flushing rate is thus approximately 38 times yr^{-1}. The inverse of the flushing rate, the hydraulic detention or residence time, is 0.0258 years. These calculations indicate that total volumetric exchange occurs approximately every 9.6 days. The results of this analysis are presented in Table 4.

Areal water load (qs) is an important function in the determination of phosphorus retention. This value represents the amount of water exchanged on an areal basis over the course of a year. A lake having a high qs would be expected to flush fairly frequently. This is the case with Longwood Lake. The ratio of annual inflow to lake surface area (Q/SA) was used to compute qs. For Longwood Lake, qs was calculated to be 27.35 ft yr^{-1}.

For those lakes with a short hydraulic retention time (less than approximately 34 days), flushing is fairly frequent and the associated areal waterload is usually high. Under such circumstances the bio-uptake of available phosphorus by phytoplankton is reduced due to the rapid passage of water through the lake. Thus, much of the available phosphorus entering such lakes may pass through the system only partially utilized. The magnitude of the lake's productivity is therefore less than would be expected on the basis of phosphorus loading alone.

The model of Kirchner and Dillon (1974) was used to predict the annual phosphorus load retained in Longwood Lake (Equation 1). The R value represents the average percentage of the annual phosphorus load retained in the lake. The phosphorus retention coefficient generated for Longwood Lake is 0.443. This indicates that on average, 44.3% of the phosphorus entering the lake is retained. R values greater than 0.6 are usually associated with lakes that support excessive densities of phytoplankton (i.e. prone to planktonic algae blooms). This value is important in that it largely determines the amount of phosphorus that is actually available for algal uptake. The higher the R value, the greater the likelihood that algae will have sufficient opportunity to assimilate available phosphorus. Lakes with a substantial annual hydrologic load flush frequently and typically have a lower phosphorus retention rate, and thus support a less dense assemblage of planktonic algae than do infrequently flushed lakes.

Equation 1: $R = 0.426e^{(-0.027qs)} + 0.574e^{(-0.00949qs)}$

Where: R = Phosphorus Retention

$qs = \text{Areal waterload} = \dfrac{\text{Annual outflow from lake}}{\text{Surface area of lake}}$

e = 2.718 (natural log)

Table 4

Hydrologic Characteristics
Longwood Lake, Jefferson, New Jersey

Rainfall - Historical Data (Feet/Month)	C	Q (Feet^3/Month)	V/Q (months)	V/Q (days)
January - 0.2536	0.4	36,549,897	0.402	12.46
February - 0.2681	0.4	38,639,698	0.380	11.78
March - 0.3307	0.4	47,661,872	0.308	9.55
April - 0.3537	0.4	50,976,729	0.288	8.93
May - 0.3064	0.4	44,159,654	0.333	10.32
June - 0.3196	0.4	46,062,094	0.319	9.89
July - 0.3626	0.4	52,259,434	0.281	8.71
August - 0.4183	0.4	60,287,152	0.244	7.56
September - 0.3081	0.4	44,404,666	0.331	10.26
October - 0.3081	0.4	44,404,666	0.331	1.026
November - 0.3740	0.4	53,902,450	0.273	8.46
December - 0.3445	0.4	49,650,786	0.296	9.18
Annual total		56,893,000	0.0258 yr	0.31 mo 9.60 d
Mean depth = 7.064 ft. Volume = 1.47 x 10^7 ft^3				

C = Assumed run-off coefficient (Rain water into lake)/(Total rainwater)

Time for lake to be completely flushed.

Recommended Restoration and Management Activities

The data compiled in this study, although not exhaustive in comparison to state and federally funded lake monitoring projects, was comprehensive enough to address the lake association's major concerns. First, these data show that in general, the lake is in good condition. In-situ measurements of lake quality parameters identified that the lake easily meets the state standards established for FW2-NT waters. In addition, the lake is well mixed, it flushes rapidly and is not prone to planktonic algae blooms.

Sedimentation problems in the lake are largely restricted to the upper end of the lake and the numerous small coves. The upper end's in-filling, as well as the coves, appears, based on visual sediment evaluations, to be due primarily to upstream erosion. However, the development of dense stands of aquatic plants in these areas has contributed, over time, to the accumulation of organic detrital sediments. The combined effect of internal sediment deposition resulting from the decay of plant tissue and upstream sediment influx has been the apparent significant loss of water depth and open water habitat.

Sedimentation in the other smaller coves appears to be due to localized erosion events (including storm related runoff) and organic sediment deposition (leaves, aquatic plants and decayed mat algae). Of the two sources, the latter seems to be the prevalent cause for infilling. This is based largely on the comparison of the sediment composition of cove versus upper lake samples. The cove samples were "muckier", and thus more organic in nature. Given the dominant soil types of the area and the predominant land use immediately adjacent to the lake, this suggests that internal, as opposed to external, processes are most responsible for the in-filling.

It should be emphasized that the data collected on Longwood Lake indicate that a strong coupling exists between the phyto- and zooplankton communities. In the spring the dominant zooplankton were several genera of small-sized organisms called rotifers. Although rotifers feed primarily on bacteria and detritus, they are typically common in the spring, before algae-eating zooplankton numbers increase in the early summer. In the fall large numbers of large-bodied, highly herbivorous (i.e. algae eating) zooplankton, such as *Daphnia* and *Diaptomus*, were identified (Table 3). These organisms keep algal concentrations in check by grazing upon them.

Restoration of the lake in respect to in-filling, should at this time be restricted to reclamation of the three smaller coves in Lower Longwood Lake (Figure 5). Restoration of the upper section of the lake is not currently recommended for two reasons: (1) cost and (2) inability of the association to curtail subsequent refilling. Restoration of the coves is, however, feasible.

First, the overall expense should not be excessive. It is anticipated that approximately 2600 cubic yards of sediment could be removed from Cove A, approximately 2100 cubic yards of sediment from Cove B and 6800 cubic yards from Cove C. If done as a "dry" excavation, following the partial lowering of the lake (via siphon), it should be possible to keep costs in the 15 to 20 dollars per cubic yard range, or between $172,500 and $230,000. This is particularly true if the spoils (i.e. the excavated sediment) were disposed of on-site, on Association property.

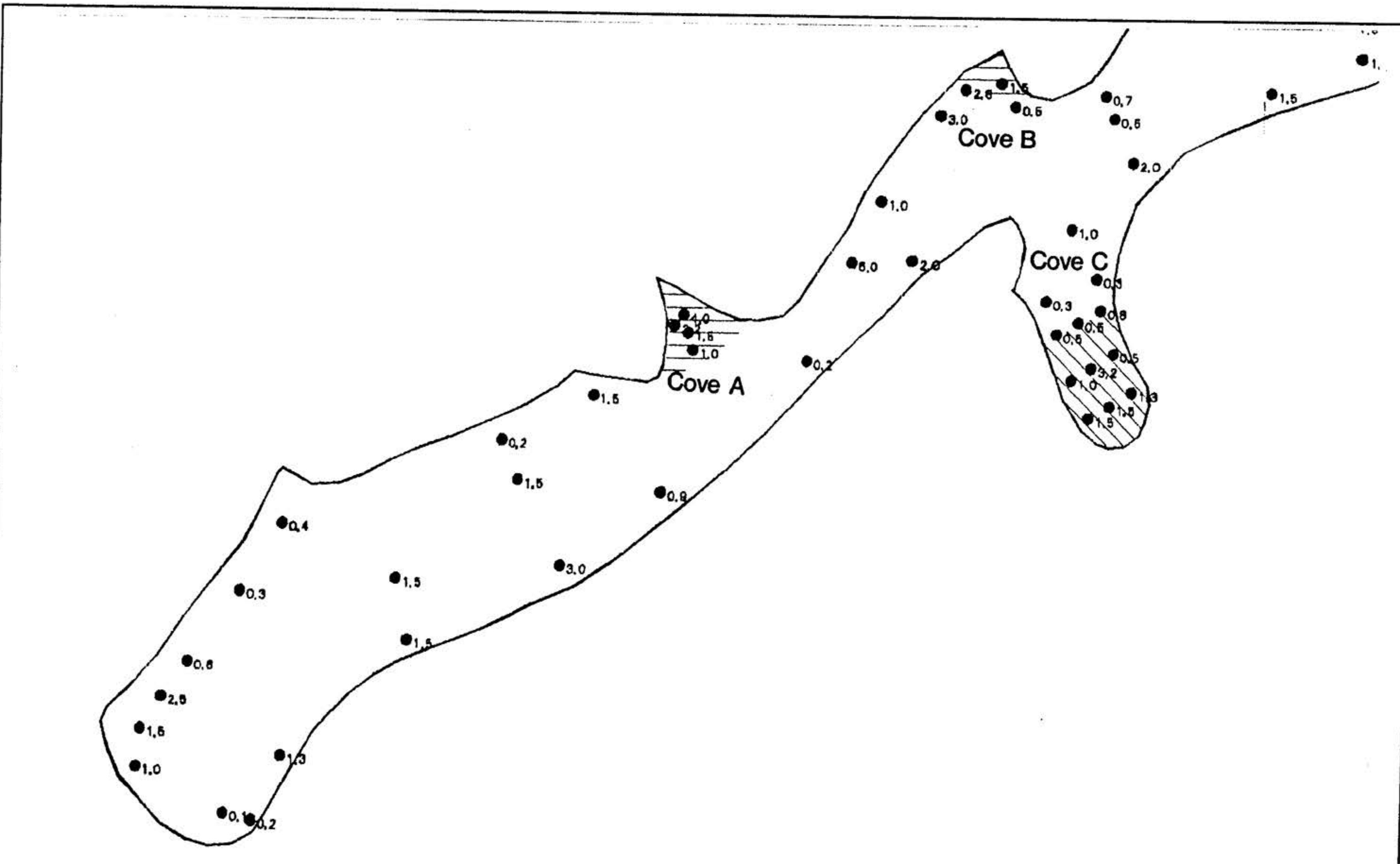

FIGURE 5

LONGWOOD LAKE
COVES A, B AND C

Source:

Sedimentation data collected by
Coastal Environmental Services
May 1994

NOT TO SCALE

2 Research Way
Princeton, NJ

COASTAL
ENVIRONMENTAL SERVICES INC.

1099 Winterson
Linthicum, MD

Second, most of the infilling of these three coves appears to be due to internal deposition of organic detritus. A more aggressive mat algae and macrophyte control program should help alleviate subsequent in-filling.

Third, given that most of the drainage to these coves originates on Association property, it should be easier to police and control potential erosive events, thereby circumventing future soil transport. This could be accomplished largely through a public education effort, whereby residents would be informed of proper soil erosion control, problems with improper disposal of leaves and recommendations concerning alternative landscaping techniques.

Copper applications specifically aimed at controlling the growth of phytoplankton (open water algae) are not recommended since large, aesthetically displeasing surface scums or blooms were never established in Longwood Lake. Also, the high flushing rate within the main body of the lake would reduce the effectiveness of an applied algicide. Only if large, reoccurring algal surface scums or blooms were present should algicide copper treatments be considered for Longwood Lake.

While copper applications are not recommended for the algae in the open water of the main body of Longwood Lake, a certain amount of chemical treatment appears to be necessary in some of the small, shallow coves of the lake. In order to maximize the effectiveness of these chemical treatments, as well as reduce the cost and the amount of copper being added to the lake, the growth of the benthic algae in the coves should be monitored over the spring and summer growing seasons. If the development of the algal mats is monitored, even if done so only visually, then chemical applications can be timed to control the algal mats before they are "out of control". Also, the application of algicides to a large amount of algal biomass can yield harmful environmental perturbations, such as low dissolved oxygen concentrations or death of non-target organisms. Therefore it is not advisable to wait until a large amount of benthic mat algae has developed prior to initiating a treatment. Doing so could lead to negative, secondary impacts.

Algicide applications should be conducted at low dose concentrations, <u>before</u> large aesthetically displeasing mats have developed. A State certified applicator should be used in the application of any algicide or herbicide. Algicide treatments should <u>not</u> be on a rigid weekly or monthly schedule, but should be conducted when the establishment of large mats seems apparent in the near future. Once again, this means that the development of the algal mats in the coves needs to be monitored. Prevailing weather conditions in the immediate future (temperature, precipitation, etc.) should also be considered when deciding when an algicide application should be conducted. All of the actions recommended above will increase the effectiveness of the algicide treatments, reduce the overall costs and potential waste associated with algicide treatments and minimize any unwanted ecological perturbations.

Summary

Longwood Lake is a quickly flushed riverine type lake system. The lake's large watershed area results in a significant influx of runoff and water loading. Associated with this is apparently a fair amount of sediment. However, the flushing dynamics of the lake help "buffer" the potentially devastating impacts normally observed of lakes having such a large watershed to lake ratio. As a result, phosphorus retention is low, planktonic algae blooms are non-existent and in-filling (due to upstream erosion events) is limited largely to the upper lake.

In general, the lake therefore displays conditions that are consistent with FW2-NT waterbodies and shows signs of nominal eutrophication. Immediate management of the lake should focus on three items:

1. Control of nuisance densities of macrophytes (weeds).

2. Control of mat algae densities in the shallow coves, and

3. Restoration dredging of the three small coves in the lower Longwood Lake.

The algae and weed problems are best addressed through implementation of a well designed algicide/herbicide program. The sedimentation problem could be corrected by localized dredging of the coves using conventional equipment following the partial drawdown of the lake. Since the lake lacks a gate valve control, it will be necessary to accomplish the lowering using siphons.

In addition to these measures, the residents of the lake's immediate watershed should be educated in respect to management techniques which will limit localized erosion and in-filling problems.