REPORT

COMMITTEE TO STUDY DREDGING OF MT. KEMBLE LAKE

Nature of the Problem

As most of you know, I am sure, every lake that ever was has a finite lifetime. Our lake is no exception. Since it was first formed over 40 years ago, it has been going through the process of eutrophication.

"Eutrophication is a natural aging process which affects every lake and dooms it to eventual extinction. Eutrophication of a lake consists of the gradual progression from one life stage to another based upon increases in the degree of nourishment. Enrichment and sedimentation are the principal contributors to the aging process. As described by Greeson (1969):

The shore vegetation and higher aquatic plants utilize part of the inflowing nutrients, grow abundantly, and, in turn, trap the sedimemts. The lake gradually fills in, becoming shallower by the accumulation of plants and sediments on the bottom and smaller by the invasion of shore vegetation, and eventually becomes dry land. The extinction of a lake is, therefore, a result of enrichment, productivity, decay, and sedimentation.

The sequence of events leading to the extinction of a lake are summarized in figure 1. (Fig. 1 & 2 on next page)

Under natural conditions, eutrophication is a slow process, but artificial enrichment resulting from man's activities can accelerate it to the degree that only a few years are needed for the complete destruction of a lake. The hastening of eutrophication by artificial enrichment is portrayed in figure 2.

Some real-estate lakes have been marred by a prolific growth of algae within 1 year of development. A dense algal growth or bloom is usually the first visual indication that a lake is in ecological trouble. A bloom imparts a greenish-yellow or brownish color to the water and often physically hinders swimming, boating, and fishing in the lake. The decay of dead algal cells may release materials with disagreeable odors to water. Of greater importance is the fact that the decay process consumes life-giving oxygen. Thus, the decomposition of dead cells in large blooms may substantially reduce the oxygen level of the lake. Moderate reductions in the oxygen level, if sustained for several days, will result in numerous disruptions in lake ecology. Severe depletions of oxygen often result in fish kills.

CONTROL OF NUTRIENT SOURCES

Although nutrient enrichment of a real-estate lake is inevitable, careful management can usually prevent it from occurring at a rapid rate. To be successful, a program for

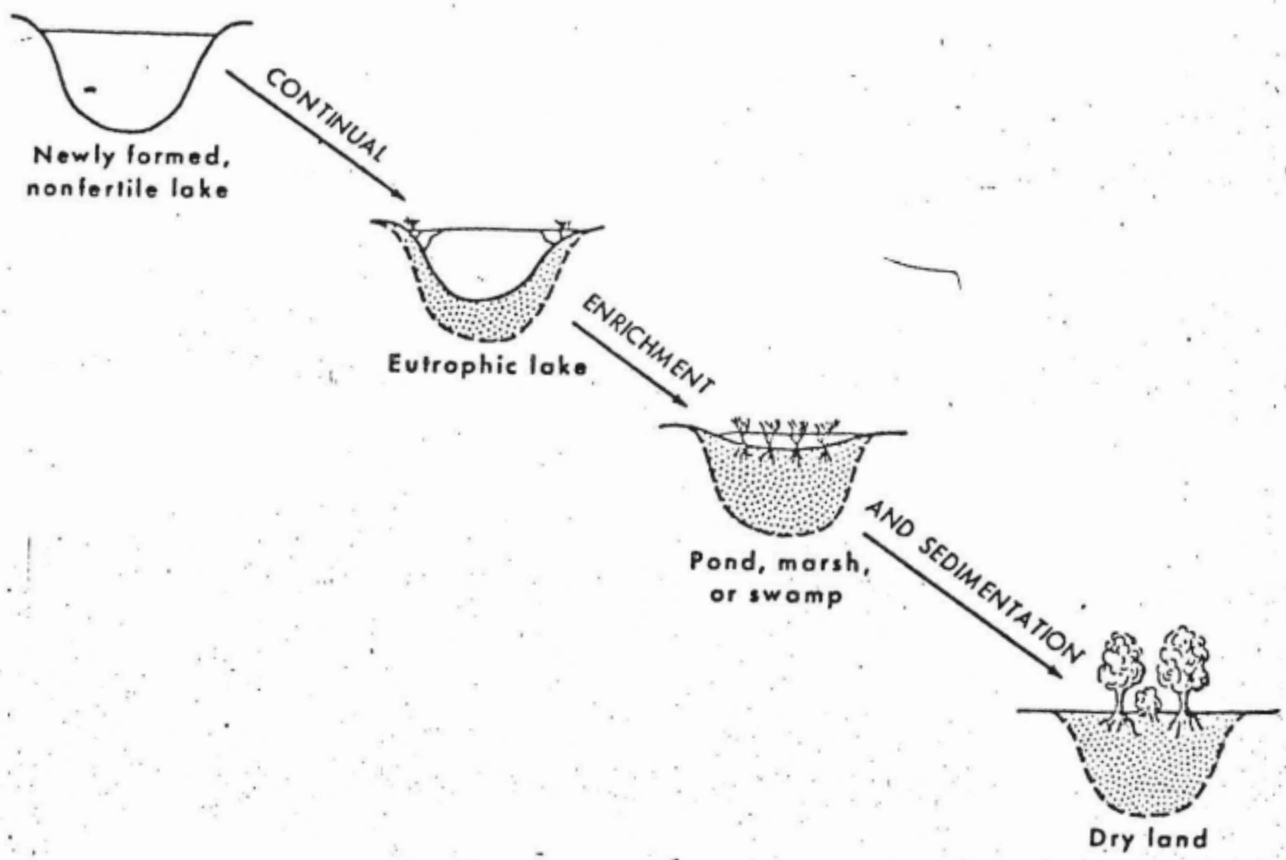

Figure 1.—Eutrophication—the process of aging by ecological change. (Modified from Greeson, 1969.)

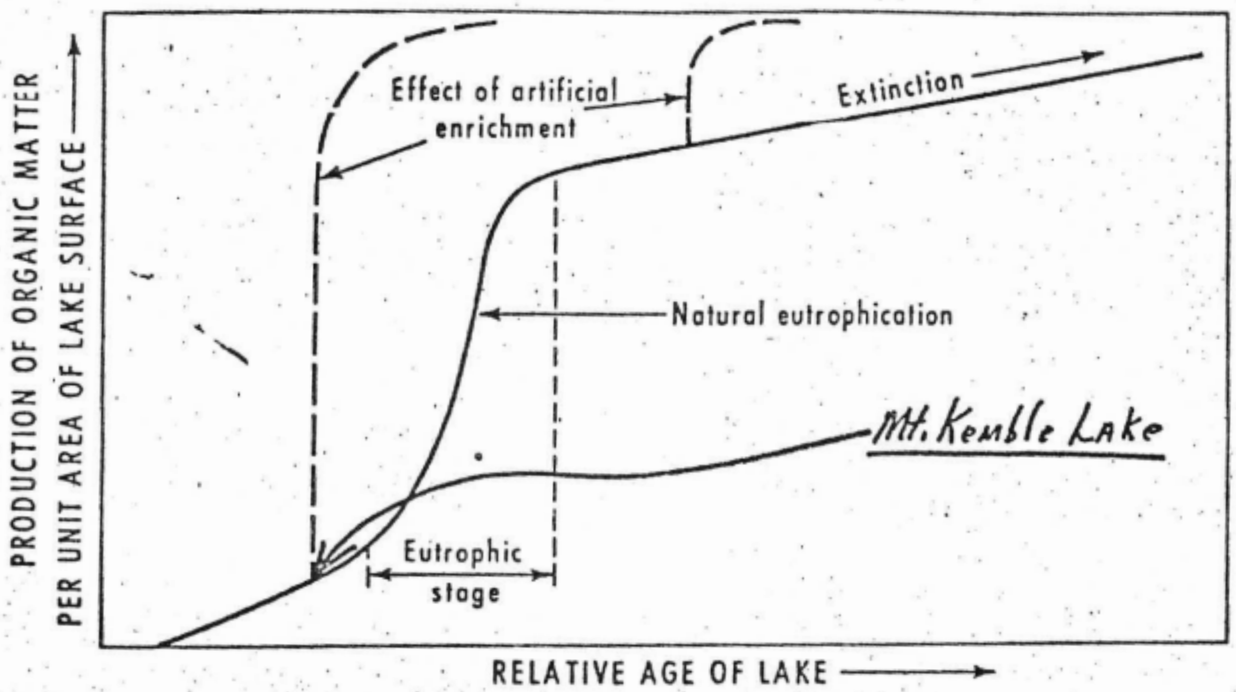

Figure 2.—Hypothetical curve of eutrophication showing the effect of artificial enrichment. (Modified from Hasler, 1947.)

eutrophication control must minimize the potential nutrient contributions from both acute and chronic sources. Acute sources are those which can rapidly add large quantities of nutrients to the lake; the main sources are poorly operating sewage disposal systems. Chronic sources are those which continually add small quantities of nutrients to the lake. Chronic sources usually result from the normal day-to-day and year-to-year activities of urban living.

The most frequent acute source of nutrients is septic tank seepage. Many older real-estate lake communities disposed of sewage exclusively through septic tank systems. The systems were often unwisely located, poorly designed and improperly installed. Nutrients from many of these systems quickly reached the lakes and resulted in massive growths of algae.

A seepage-contaminated lake can usually be improved in quality if the flow of nutrients is stopped. However, since a lake entraps nutrients, the process of recovery or nutrient cleansing may be slow, and complete recovery is usually impossible. Furthermore, where seepage has badly polluted a lake, worthwhile improvement will generally require the complete banning of septic tanks and their replacement with a sewerage system.

Planning is the key to effective eutrophication control. From this standpoint, the use of septic tanks is not recommended for real-estate lake communities. However, if septic tanks are already installed and the systems are properly located and designed, periodic inspection of performance may prevent large quantities of nutrients from entering the lake. If faulty systems are detected, immediate redesign is necessary.

Rapid eutrophication of a lake can also be caused by nutrient influx from a stormwater-drainage system. In this case, the rate of nutrient enrichment can be reduced through a coordinated program to periodically clean the roads and parking lots which contribute to the stormwater flow. The stormwater pollution problems can be entirely solved, however, only by rerouting the drainage system to circumvent the lake. This action is not always possible, because the stormflow may be needed to maintain the desired water level of the lake. Seepage from a faulty sewerage system is another potential cause of rapid eutrophication. This problem requires quick repair or relocation of the sewer pipes in order to protect the lake. Lawn fertilizer is the most prevalent source of nutrient in real-estate lake developments. After heavy storms, water will flow overland into streams or directly into the lake. As it passes over fertilized lawns and around fertilized shrubs, the water becomes charged with nutrients and eventually carries them into the lake.

Other chronic nutrient sources are leaves and nutrient-rich sediments. The amounts of these materials which enter the lake can be minimized by controlling the sources.

SEDIMENTATION

SOIL SEDIMENT

Most sediment problems in real-estate lakes arise directly or indirectly from construction activities. Areas under active construction are usually the largest contributors of sediment to lakes. However, the erosion of improperly stabilized surfaces, such as hillsides, streambanks, and shorelines, can also contribute large amounts of sediment, and in addition they simultaneously despoil the esthetic quality of the landscape.

The basic principle of sediment-control management is the complete stabilization of soil particles or, at least, the containment of eroded particles on an individual development site. Once sediment is in transit, the processes of erosion accelerate, and the costs of control rapidly increase. Complete sediment control during development is impossible, but the severity of problems can be lessened by minimizing the potential for erosion. This management concept involves minimizing both the areal extent that is laid bare to erosional forces and the length of time that the land is exposed. Developmental practices to achieve this goal include the leaving of vegetation in place until just before construction, the disturbance of only as much area as is needed at one time, the early installation of storm drains, and the stabilization of the land surface as quickly as possible.

Once sediment reaches a stream, control procedures increase in cost and decrease in efficiency. However, in many drainage areas, sedimentation basins (our breeder pond) on streams above the lake may be quite effective in reducing the potential contribution of sediment.

Once sediment reaches the lake, the cost of management increases sharply. Hopefully, if the rate of sedimentation is high, the problem will have been envisioned during planning, and a sedimentation basin will exist where the stream enters the lake. Management can then focus on maintenance of the basin, which must be emptied periodically.

In the absence of an inlet basin, sediment will accumulate throughout the lake. Then the real headaches begin. As sediment deposits build up, the esthetic quality of the lake is impaired and potential recreational use of the lake is diminished. Management of the problem may require sediment removal from many areas of the lake. Unfortunately, nearshore areas, such as coves, are often virtually inaccessible to heavy equipment. Open-water areas often require the building of underroads in order to place the dragline and to move the sediment hauling trucks.

LEAVES

Not only soil particles, but leaves can cause sediment problems in real-estate lakes. In forests most leaves remain in the vicinity of where they originally fall, ultimately decomposing and adding to the forest litter. In contrast, in a real-estate lake development, the leaves fall on lawns, roadways, and parking lots. Very often a large portion of these leaves ends up in the streams and storm-drainage systems. The lake then becomes the final settling place of the leaves as they are deposited in a mixture with soil sediment. Where the volume of leaves reaching the lake is large, the deposition may rapidly fill the discharge areas of the stream. Rapid filling and clogging is often especially bad in developments where the storm-drainage system is routed to the lake.

Good management practices can minimize the deposition of leaves in a real-estate lake. Periodic cleaning of parking lots and roadways during autumn can greatly reduce the potential loading. On individual properties, leaves will decompose if left in place, but if raked, they should be disposed of in such a manner that they will never reach the lake. This rules out the disposal of leaves along streambanks and drainage ways."

SUMMARY

We are now into stage two. As the lower graph on page 2 shows, we can expect that the effect of artifical enrichment from all of our septic tanks and lawn fertilizers, etc. can speed up this process dramatically over the next 5 - 10 years. Our lake is presently in the preeutrophic stage poised on the brink of the steep incline of the lower graph. We have all seen the first signs of the process, namely the large algae blooms we have every summer. We have been using the most common control method - copper sulfate.

"Algal blooms are caused by an over abundance of the wrong kinds of algae. Copper sulfate can control the growth of these species of algae, but its addition to water also causes undesirable effects.

Nonselectivity in toxic effect is the major problem caused by the use of $CuSO_4$. The chemical kills almost all forms of plankton, not merely the massive growths of undesirable forms which constitute an algal bloom. Because plankton are vital links in the food chains, their mass destruction results in less food for the fish population. Fish normally do not feed upon the species of algal which predominate during blooms. If these species were used as food, fish would be the ideal control for algal blooms.

A second problem with $CuSO_4$ is the buildup of copper concentration in bottom sediments. This accumulation can cause the concentration of copper in water to remain high throughout the year. If this condition arises, algaecidal effects of the copper may become a permanent feature of the lake.

The use of $CuSO_4$ is a stopgap measure, for as the dead algae cells undergo decay, large quantities of nutrients are recycled to the water. Quite often the recycled nutrients stimulate a new bloom as soon as weather conditions are favorable and the copper concentration of the water has decreased below the algaecidal level. In any event, most of the nutrients are entrapped by the lake and are held available for future algal growth.

Because algal blooms are cyclic, extremely large blooms are usually of short duration. Thus, $CuSO_4$ can be regarded as an extreme measure, to be used only when a bloom is becoming prolific enough to be intolerable even for a short period of time. Algal blooms can be prevented or limited permanently only by minimizing the nutrient influx."

RESULTS OF THE COMMITTEE

This committee, during the fall months, has tried to determine 1) if we should dredge the lake, and 2) roughly how much it would cost. On both points we have not been very successful mostly due to our late start. A rough survey in the late fall from boats, showed that the upper ¼ of the big lake (about 1.8 acres) had an average depth of water of about 2½ feet with a maximum depth of 4 feet. There was on the bottom a layer of muck ranging from 1 - 3 feet with the average about 2½ feet. In the breeder pond (about 1½ acres) the average depth of water was about 3 feet with a maximum depth of about 5 feet in the main channel. The bottom as expected was much firmer and varied in depth from 6 inches to 2½ feet with an average of about 2 feet. There is probably more material in the breeder pond but our method of probing the bottom with concrete reenforcing rods would not penetrate the firmer, larger sized material that should have fallen out in the breeder pond.

What would be the advantages of dredging both the upper ¼ of the main lake and the breeder pond?

1) The breeder pond would becomes a more effective sediment trap offering more protection for the main lake.
2) The new overall depth of both would be such that bottom algae and plant growth, except along the shore, would decrease since light does not penetrate below a depth of 3 feet.
3) The creeping of the sedimentation down the main lake would be halted for the time being.
4) Swimming and boating would be possible in the lower end of the main lake again.
5) If the filling-in process continues, a fire hazard may develop. There would be insufficient depth of water at the pumping stations near shore to fight a fire of any size.

The overall process of eutrophication is a gradual one that creeps up on you. If the lake is not dredged and taken care of there will be no major calamity like the dam being worked out but gradually over the years the upper ¼ of the lake and the breeder pond will become mud flats with a stream running through. The second ¼ of the lake will be filled with silt but as the water at present is deeper the effect won't be noticed right away. In every lake community the residents reach a border point beyond which they will not go with regards to the esthetic quality of the lake. If your border is ¼ of the main lake and the breeder pond badly silted and large algae blooms, then now is the time to tackle this problem. If you are willing to wait until ½ or 1/3 is very shallow and the upper ¼ is all mud, then you still have some time.

What would it cost.

None of the major dredging companies the committee talked to would give a firm estimate without a look at the bottom. Since winter was coming on it was not possible to draw down the lake for that purpose. One contractor gave a rough rule of thumb type answer of $3,200 per acre-foot. If we assume 3.3 acres in total and want to remove an average of three feet of bottom sediment, it would cost about 3.3 x 3 x $3,200 = $31,680. Although this is very rough, the estimates would probably range from $25,000 to $50,000.

Recommendations

The committee recommends that the following plan and time table be adopted by the vote of the membership as a mandate for the next board to carry out.

1) Draw down both lakes in the spring of 1973.
2) During this time obtain estimates on dredging with respect to both time and cost from the following companies who are expert in the dredging of lakes.
    a) H.W.Alward Inc., Basking Ridge, N.J.
    b) Farber Construction Co., Green Village, N.J.
    c) Wm. Hearle & Son, Pegnamrock, N.J.
    d) Grey Construction Co., Morristown, N.J.
    e) Millbrook Landscaping Co., Millbrook, N.J.
3) Hire Expert advice from a recognized authority to determine the rate of sedimentation if the Board determines this is necessary.
4) Call a special meeting during the summer of 1973 for the purpose of authorizing or not a contract for dredging and approving a financial plan to be worked out in conjunction with the Board of Directors of the Lakeshore Company.

5) Plan to begin work after completion of (4) in the fall of 1973 with work to be completed in the spring and/or fall of 1974.
6) Set up an action program to minimize sedimentation and nutrient inflow in the future. Such items to be included would be:
   a) Spring and fall cleanup of leaves from parking lots, culverts and roads. The fall cleanup to be done several times during the fall to reduce the number of leaves reaching the lake.
   b) Inspection of our drainage area for unprotected slopes which could be planted and stabilized before erosion occurs.
   c) Set up a regular inspection of <u>all</u> septic tanks within our watershed area (including those upstream).
   d) Make an attempt to reduce the amount of fertilizer used within the watershed. In particular home owners and farms would be asked to reduce their use.
   e) Have added to our regular water analysis tests for detergents, nitrates and phosphates to keep track of the problem.

Committee

Harry Dugger, Chairman
Robert Vannote
Dan Reall
Robert Gray
Charles Jenkins

Note: The single spaced material was quoted directly from Geological Survey Circular 601-G, "Real-Estate Lakes."