K. Elliott

MANAGEMENT PLAN FOR LAKE WYOLA SHUTESBURY, MA

JUNE, 1997

PREPARED FOR:

THE LAKE WYOLA ADVISORY COMMITTEE
TOWN OF SHUTESBURY

PREPARED BY:

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I. INTRODUCTION

Lake Wyola, located in Shutesbury, Massachusetts, is a recreational and aesthetic resource highly valued by the community. Lake Wyola is an enhanced natural 129 acre freshwater lake with many small inlets and only one outlet, the north branch of the Sawmill River. This outlet is through a man made dam. The original great pond was increased to approximately double its size by a dam built approximately one hundred years ago. Today Lake Wyola provides swimming, boating, fishing and other forms of outdoor recreation. The body of water is publicly owned, and rights of access to and use of the water sheet are owned/controlled by the Town of Shutesbury.

Public Access

The public has access to Lake Wyola at several locations. These include a public boat ramp and town beach with a parking area at the south end of the lake under the jurisdiction of the Shutesbury Conservation Commission. Public shore fishing access, as well as public conservation lands and trails along the shoreline and in the watershed are also available. Lake Wyola Park, recently purchased by the Massachusetts Department of Environmental Management (DEM), is open to the public for a fee. This facility includes a beach and camping areas. The Lake Wyola Association has three beaches which are open to Association members.

Water Draw Downs

There has been numerous water level draw downs at Lake Wyola over the years. These draw downs were carried out on an average of once every seven years primarily to maintain, or repair retention walls and shore front property as well as to remove limited amounts of sedimentation and aquatic vegetation from recreational areas. The Lake Wyola Advisory Committee (LWAC) has retained New England Environmental, Inc. (NEE) to provide a comprehensive lake management plan to insure that recreational qualities of the lake are optimized while protecting its wildlife and natural resources through careful management.

Water Quality

Water quality data collected over a period of several years indicates that the general health of Lake Wyola is very good. One way of judging a lake or ponds health is by a trophic classification assigned to it through sampling. The trophic classifications from least vegetated/productive to most vegetated/productive are: oligotrophic; mesotrophic; eutrophic; and hypereutrophic. In a survey of trophic classification for sampled lakes based solely on chlorophyll, Lake Wyola was classified as oligotrophic.

The clarity of a lake is another way of measuring its health. Higher levels of algae and suspended solids will decrease water clarity. Water clarity or transparency is measured in limnology using a Secchi disk, and is referred to as Secchi depth. The disk is a 20 cm disk painted with alternating black and white quadrants. The disk is lowered into the water and the observer records at what depth the disk is no longer visible. For northern lakes, a Secchi depth of 30 feet signifies an oligotrophic lake. In comparison, an eutrophic lake may have a Secchi depth of 3-4 feet or less. (Moore, Thornton, Lake and Reservoir Restoration Guidance Manual, 1988) The median of Secchi depth readings for Lake Wyola in 1995 was 7.1 meters, or 23.3 feet. The median of Secchi depth readings for 1996 was 5.0 meters or 16.4 feet. This would indicate a trophic level of mesotrophic. It should be noted that there are several lakes that are classified as oligotrophic in Massachusetts which have Secchi disk readings lower than 30 feet. Tanic acids and other factors may influence Secchi readings without changing a lake's trophic level.

A map of typical lake total phosphorus levels for Massachusetts lakes shows a level of 5-9 ug/l for the area in which Lake Wyola is situated. (Mattson, et al, draft GEIR, 1997) The average for total phosphorus of samples taken at the surface in Lake Wyola is 8.33 ug/l for 1995, this ignores the sample taken at 10 meters on 17 July 1995. The average for total phosphorus samples taken in 1996 is 3.86 ug/l for 1996. This would suggest that Lake Wyola's phosphorus levels are average, or typical, for lakes in this area.

Management Plan

There are four primary concerns to be addressed by this management plan: 1) the draw down rate, timing and depth; 2) aquatic vegetation removal and control measures; 3) sediment removal and control measures; and 4) bank stabilization. Copious amounts of data, including water quality sampling by resident volunteers participating in the Massachusetts Water Watch Partnership, aquatic plant identification, vegetative mapping, a video of summer conditions of the lake in 1996, and review of erosion/sedimentation sites have been utilized in the development of this management plan.

II. Drawdown Rate, Timing and Level

Correspondence with Professor Doug Smith, of the Univ. of Mass., Amherst, shows that drawdown rates not exceeding three inches per day will allow macro-invertebrates and aquatic wildlife time to relocate into suitable overwintering locations, if drawdown is carried out before overwintering begins. This rate of drawdown will also restrict the flow of water from the dam into the north branch of the Sawmill River, thus minimizing any chances of the lake drawdown causing erosion downstream. Research of the outlet structure indicates that a draw down at this rate will be possible.

In addition to the time frame mentioned above in regards to scheduling drawdown prior to overwintering of aquatic species, dissolved oxygen levels must also be considered when choosing the starting date of a lake drawdown. Fish of the Salmonoid family (Trout and Salmon) are most sensitive to lowered oxygen levels, and require a minimum of 5.0 ppm (parts per million). In cases where dissolved oxygen levels are a concern, drawdown should be held off until the fall turn over. This allows oxygen to mix thoroughly, and ensures that the drawdown is not removing the oxygen rich epilimnion and metalimnion of the summer/fall. Fall turnover usually occurs in September, but can take place during a large storm in August. The data collected on September 23, 1995 shows dissolved oxygen (DO) levels of 5.50 or higher down to 8.5 meters. Data collected on September 21, 1996 shows DO levels of 6.9 ppm or higher down to 6 meters. Because a drawdown of only 2-3 meters is proposed, these data indicate that a drawdown which begins close to these dates would not have to be dependent upon a fall turn over before it could be started. (A more complete table of sampling data can be found in Appendix I).

A draw-down starting date in early September should allow a still active aquatic wildlife community time to relocate for hibernation, while providing safe dissolved oxygen levels for the fisheries of the lake. This should be verified with a dissolved oxygen reading prior to commencement of the draw down. The date of September 2 (the day after Labor Day) is being considered for the 1997 drawdown. A drawdown on or about this date should not greatly impact recreation of the lake and allow time for all planned work to be carried out.

The level or depth of the draw down will be contingent upon several factors, but primarily upon the scope of work planed for retention wall/waterfront repair, and lake morphometry. A recent bathymetric map of Lake Wyola is not available, this information would give a more accurate picture of the lake contours, sediment deposits, and provide a better sense of how deep the draw down will need to be in order to allow the scope of work planned. At this time a draw down between six and nine feet (two and three meters) is being considered.

III. Aquatic Vegetation Removal and Control

The proposed draw down for 1997 is not designed to greatly reduce the aquatic vegetation in Lake Wyola. Lake draw down has been shown to have an effect on certain species of aquatic plants by disruption of the sediments. Some of the disruptions mentioned in the literature include compaction of the sediments, freeze/thaw cycles, and drying and aeration of the sediments which damage the root stock of various plant species. While some disruption of the lake sediments will occur during the proposed draw down, the pond is scheduled to begin refilling by November 15-30. This will limit sediment disruption, particularly by freeze/thaw cycles. Freeze/thaw cycles typically occure later than November 15. The effects of drawdown are highly variable between plant species; generally, submerged aquatic species are more often reduced than aquatic emergent species (Cooke et al. 1986, EPA 1988, Table 1). In the case of the vegetative community in the shallow waters of Lake Wyola, it is unlikely that there will be a reduction in plant density due to the draw down itself.

The fact that the draw down will not greatly affect the plant community of Lake Wyola may actually be beneficial. The densely vegetated areas at the south end of the lake take up large quantities of nutrients from the water and substrate as they grow. This helps to reduce the nutrients available to algae, and thus reduces the chance of algal blooms. This vegetated area of the lake also acts as a nursery to young fish and the macro-invertebrates upon which both young and adult fish feed. Shade is created by the vegetation, keeping water temperatures lower during the summer, and providing cover for larger fish. The vegetation also provides cover and food for waterfowl and other wildlife associated with bodies of water. It would be inappropriate to conduct aquatic vegetaion removal in this area.

Appropriate sites of vegetation removal would include areas of recreation such as beaches, and swimming/docking areas adjacent to private property. Vegetation removal can be carried out in recreation areas by means of raking and other hand tools for gathering vegetation while the substrate is exposed. This raking also creates some disruption of the roots of aquatic plants, thus further reducing vegetation in these areas. These techniques are expected to be carried out most frequently in front of both private homes and the above mentioned public and town beaches.

Some areas with heavy vegetation that are also sites for recreation, such as the channel leading from the public boat ramp, may require alternative techniques for vegetation removal in addition raking. The use of construction equipment may be considered to remove larger amounts of vegetation from some of these areas during drawdown, and other forms of harvesting or hydroraking should be considered during the interim period between drawdowns if dense vegetation returns.

Benthic Barriers

In addition to vegetation removal, the installation of a small area of a benthic barrier (a type of underwater ground cloth) in front of the town beach may reduce the dense vegetation currently present beyond the areas of bare sand. Benthic barriers are composed of materials which will block light, thus limiting photosynthesis. Some common materials used are polyester, PVC liner, and PVC coated fiberglass screen. A layer of this material is placed over the substrate, forming a barrier to vegetation. The barriers block light to the substrate and prevent shoots growing from root stock in the substrate from reaching into the water column. The barrier allows gasses to escape and is securely anchored to prevent dislodging or "ballooning".

There are some detriments to using benthic barriers. Installation and preventing shifting or movement can be difficult. Rootstock under the barrier will send shoots to the edges of the barrier. These shoots will grow densely around the edges and through any cracks or gaps in the barrier. The barrier must be picked up and cleaned every one to three years to prevent plants from growing into sediments deposited onto the barrier. Benthic barriers can adversely affect benthic organisms and bottom spawning fish populations, such as trout. Benthic barriers are non-specific with regard to plant species, and will affect beneficial species as well as nuisance species.

If properly maintained and periodically removed and cleaned, the aquatic vegetation of a given area can be greatly reduced, and seeds and plant fragments will be less likely to root into sediments that would form on the barrier. This technique can be labor intensive, but may be a viable option if the area is small enough to be manageable. Maintenance of the barriers will have to be carried out by divers during the interim years between years with draw downs. Research should be carried out to determine which material will best suit the needs of the site, and how best to attach it to the substrate. The establishment of benthic barriers adjacent to the public beach will offer an opportunity to determine the effectiveness of a benthic barrier in the lake. If it is found that the barriers are an economic solution to vegetation control, and do not disrupt the benthic fauna of the lake significantly, benthic barriers may be considered in other areas of recreational use. A study of the public beach barrier's impacts on the benthic community would be helpful in determining whether additional installations should be carried out.

Boat Channel

The channel leading from the public boat ramp may require minor dredging in addition to vegetation removal if sections of the channel no longer have the proper depths to support boat launching. Research shows that 90% of ponds dredged to reduce aquatic vegetation have experienced regrowth within two years. While dredging should not be expected to provide a long term solution to the vegetation density of the channel, the combination of raking and dredging will help reduce vegetation in this area. Any spoils from dredging the channel need to be completely removed from the lake to prevent the creation of additional shallow water areas. A benthic barrier in the channel may provide an additional reduction in vegetation, however, special consideration must be given to anchoring the barrier in this area where the turbulence from motorboats is concentrated.

Herbicides

At this time the use of chemical herbicides to reduce aquatic vegetation in Lake Wyola is not necessary, and possibly harmful to the long term health of the lake. While many aquatic herbicides are reported to have little or no detrimental effect upon the untargeted aquatic community, there remains some uncertainty of the long term effects of herbicides in aquatic systems. Until there is specific nuisance vegetation which cannot be controlled by other methods, NEE recommends that herbicide treatments should not be considered at this time.

IV. Sediment Removal and Control Measures

There are several sites of sediment deposition in and around Lake Wyola. Many of these are minor in and of themselves and can be removed at the time of drawdown with wheelbarrows or small earth moving equipment. Areas of major concern are the sediment deposits from the road leading to the public boat ramp, the sand washing out from the town beach, and inlet at Fiske Brook, which has been filling with sediment along Lakeview Road. These areas will require more intensive work if sediments are to be removed. Removing the large volumes of sediment deposited at the boat ramp and the inlet at Fiske Brook will require heavy equipment, and a contractor familiar with removing and dewatering dredge materials. Additional volumes of sediment are entering the Lake from bank erosion, soil erosion on private property, road grading within the watershed, and sand from winter storms.

Siltation removal should be expected to return each site to conditions existing before sediment deposition occured. The amount of siltation to be removed from each site should be determined by these pre-existing conditions. Siltation removal should not be allowed to create areas that exceed previous depths.

All areas of sediment removal will provide adequate protection against silt/sediments re-entering the lake through the use of siltation barriers. These barriers may consist of silt fencing and/or hay bales, as well as any other materials deemed necessary per site. This will apply to sites on private property as well as larger sediment removal projects

Source Reduction

Several approaches to reducing sedimentation in the watershed should be considered for the long term health of Lake Wyola. Any sediments flowing into a body of water will have an effect upon the vegetation growing within it and in consequence, the lake's general health. Aquatic vegetation is dependent on several key factors to allow growth. Amongst the more important of these are sunlight, nutrients, and an optimum temperature range. Sedimentation can increase the levels of all three of these within a water body. When sediments are deposited the substrate is slowly built up, creating shallower areas. As an area grows more shallow, conditions become increasingly more beneficial to plant growth. Shallow waters allow more sunlight to reach the substrate which provides for higher levels of photosynthesis. The increased light levels also warm the water within the shallows, which allows the vegetation to grow more quickly and over a longer period of the year.

Sediments also import nutrients into the water system, which can lead to algal blooms. In the majority of lakes and ponds in Massachusetts the scarcest nutrient is phosphorus (Mattson, et al, draft GEIR, 1997). Naturally occurring organic sediments flowing into a water body are not the only sediments that carry phosphorus. Sand and gravel are capable of carrying and readily releasing high levels of phosphorus into water.

Town Beach

The town beach adjacent to the boat ramp has been subject to severe erosion during the past year(s) from both surface runoff and from groundwater seeps within the beach area. It is evident from several deep gullies running through the beach area that the sand brought in for the beach is being eroded into Lake Wyola. One option to reduce erosion in this area is to install a small retention wall (e.g. a wood crib wall) which could create a level area of either sand or grass for sun bathing and picnicking.

The providing of portable toilets adjacent to the town beach should be continued. One or more trash cans placed in the vicinity of the parking area and beach may be better utilized than the burlap bags used in the past.

Public Boat Ramp and Parking Area

The access road and parking area of the public boat ramp and town beach has contributed large amounts of sediment (sand and gravel) to Lake Wyola due to uncontrolled stormwater runoff and road wash-outs. By regrading and possibly paving the parking lot and the lower section of the road, such that water is diverted into a grass swale (see Figure 2), the source of sediments in this area could be greatly reduced. This approach may require stormwater treatment or catch basins. A second option would be to divert the runoff from the road and parking lot into one or more small detention basins. Detention basins act as a settling out site for suspended particles carried in the runoff waters. The sediments deposited into these basins are dredged on a regular basis to maintain the basins' effectiveness. The potential basin location noted by LWAC during its May 17, 1997 site visit would receive runoff from most of the access road. The runoff from the remaining section of road and the parking area could diverted into a second basin located at the end of the parking area. If a second basin is not a feasible option, paving the parking lot and the lower section of the access road would greatly reduce the amount of potential sediments entering Lake Wyola.

With the purchase of Bennett Beach by the DEM, there is a chance of increased boat traffic on Lake Wyola. It is imperative that incoming boats be monitored for any invasive exotic aquatic vegetation. An increase in use of the boat ramp may justify a user fee, which in turn could provide funding for one or more persons to monitor incoming boats, and oversee washing/brushing before a boat is allowed into the lake. At this time there are no aquatic invasive exotic species in Lake Wyola. These nuisance species would greatly reduce the health and well being of the lake.

Fiske Brook Inlet

The deep pool located at the inflow of Fiske Brook along Lakeview Road has been growing more shallow due to sediment deposition. Local residents have indicated that this deep pool was created approximately thirty years ago by dredging, and that the island in close proximity to this pool was created by deposition of the dredge spoils. The sources of sediment into the pool appear to be twofold.

Fiske Brook is contributing some sediment to the deep pool, but this sediment appears to be the result of natural erosion processes, and not due to any significant erosion in the upper watershed of this brook. The dredged pool at the inlet to Lake Wyola is presently acting in a similar fashion to a detention basin. When a flow of water from Fiske Brook reaches the Pond with its greater depth, the water is slowed. This lowers the flow's ability to keep sediments in suspension, the larger particles drop out first, and progressively smaller particles drop with further decrease in speed.

The second source of sediment entering the pool appears to be winter sands washing into Lake Wyola from Lakeview Road. The installation of catch basins with deep sumps (4') at the intersection of the road and the brook would effectively reduce the amount of sediment contributed by Lakeview Road into Lake Wyola. The deep pool at the southern side of Lakeview Road is presently acting as a sedimentation basin for Lake Wyola, and is effectively reducing the sediment load from settling further into Lake Wyola. A dredging schedule of every twenty years or more should be sufficient to maintain the desired depth of the pool. The construction of a shallow underwater berm across the inlet of Fiske Brook (south of Riverview Road) should be investigated as a possible measure to significantly reduce sediment loading into Lake Wyola by creating a sedimentation basin at this location. The trapping of sediments will require a more frequent maintenance dredging of this area, but it will mean reduced maintenance within the Lake, and generally improved water quality.

Other Sources of Sediment

Although there are no primary sources of sediments into Lake Wyola, the cumulative effect from multiple properties, dirt roads, and secondary sources are cumulative, and their effect may be of great significance. These sediment deposits are from various sources, including winter sanding on the paved roads around the lake, erosion and runoff from the many dirt roads and driveways around the lake, bank erosion within Lake Wyola, particularly from private properties, and erosion sediments washing into South Brook and other minor tributaries and thus into the lake. These issues would best be addressed in a comprehensive watershed management plan.

The watershed management plan should include a schedule for road sweeping, water bar maintenance on dirt roads, public education for reduction of erosion on private property, and possibly monitoring of private lands in close proximity to the lake. An effective watershed management plan will be a key factor in maintaining the continued good health of Lake Wyola.

Bank Erosion

Sedimentation due to bank erosion is a significant factor which contributes to the degradation of water quality, the loss of fish and wildlife habitat, and property values. Although New England Environmental, Inc. has not conducted a comprehensive investigation of the possible causes of bank erosion on Lake Wyola, our initial investigation has concluded that the cutting of vegetation from the banks by property owners and the wave impacts caused by boat wakes and prevailing winds are the primary causes of bank undercutting and slumping.

The primary response by property owners to bank stabilization is to build concrete retaining walls or other hard structures to protect their properties. While this approach is effective in stabilizing the banks, it also reflects wave energy, thereby creating bank erosion problems elsewhere. There are several measures which may be used to prevent future bank erosion and to create a more natural Lake shore. The first measure is to educate property owners not to cut all of the vegetation on the bank, as the root structure from vegetation is very effective in stabilizing and protecting the bank. Property owners should be encouraged to either plant additional shrubs (these can be low varieties which will not disrupt the view), or to leave a vegetated buffer between the lawn and the bank. The second measure is to attempt to reduce boat wakes. This would be difficult, however, as there are many factors that influence the size of the wake created by a boat. Speed limits and restrictions on motor size may not be effective, as some boat types produce a larger wake at slow speeds than fast. A reduction in the number of motorized boats on the lake may be the only effective option.

There are several techniques for bank stabilization using "soft" engineering techniques, often referred to as soil bioengineering. These techniques use structural materials, such as coconut BioLogs (Figure 3), brush layering (Figure 4), or wood crib walls with vegetation (Figure 5). Rock gabion baskets are an inexpensive method of creating a bank retaining wall, and these can be inter planted with vegetation to reduce the wave energy, and to create a more natural looking structure. The use of the Coconut BioLogs, planted with aquatic and herbaceous shore plants, has been effectively used for many lake shore bank stabilization projects in Massachusetts. These are relatively inexpensive, protect banks from wake impacts, and create a natural shoreline.

V. WETLAND PERMITS REQUIRED FOR LANDOWNERS DURING LAKE DRAWDOWN

The Massachusetts Wetlands Protection Act, administered by the Shutesbury Conservation Commission and by the Department of Environmental Protection (DEP) requires that all activities within wetland resources areas (pond, bank, vegetated wetlands, land under the pond) be permitted.

To facilitate work which may be proposed by landowners during the next drawdown of Lake Wyola, the Shutesbury Conservation Commission will be providing "packages" of all forms, and information required to be submitted along with a description of the proposed work. The forms (Notice of Intent) are lengthy, and sometimes difficult to understand. They are reviewed by both the Shutesbury Conservation Commission and by the DEP so it is important that all information is correct and complete, and that the proper filing fee (see table below) is submitted to avoid projects being rejected. All landowners proposing work within wetland resources will be required to notify abutters of proposed work. There will be a Public Hearing held by the Shutesbury Conservation Commission to review requests.

The permitting process will take 4-8 weeks to complete, depending on the complexity of each application. The construction of new retaining walls may require site plans to be prepared by an engineer or environmental firm.

The Lake Association wishes to discourage the addition of any new sand to beach areas. As stated above, the addition of sand to the lake system will in all likelyhood increase aquatic vegetation.

TYPE OF PROJECT	TOTAL FILING FEE	SHUTESBURY SHARE	STATE SHARE
Beach Nourishment (adding new sand to beach)	$250.00	$137.50	$112.50
Removal of Sedimentation (i.e., pulling sand back onto beach from pond or removal of silt and soil from pond resulting from road washouts)	$55.00	$40.00	$15.00
Removal of Aquatic Nuisance Vegetation (up to 5,000 square feet)	$55.00	$40.00	$15.00
New Docks or Dock Repair Minimum fee is $50.00. Maximum is $1,000	$2.00/linear foot of Bank (not length of dock).	$25.00 + ½ (Total cost - $25.00)	½ (Total cost -$25.00)
Bank Stabilization through Bio-Engineering (does not include retaining walls)	$55.00	$40.00	$15.00
Retaining wall repair or new retaining walls Minimum of $50.00, Maximum of $1000.00	$2.00/linear foot of Bank	$25.00 + ½ (Total cost - $25.00)	½ (Total cost -$25.00)

VI. SUMMARY/RECOMMENDATIONS

1. The dam, outlet structure and numerous bank stabilization structures should be maintained through the use of draw downs scheduled at regular intervals of five to ten years. These draw downs should begin on or near September 1, and should not exceed three inches per day until the desired level is reached. A refill date on or about November 15-30 will allow the lake levels to rise in time to protect overwintering aquatic life. This schedule will also protect the fish species present in the lake by insuring levels of dissolved oxygen greater than 5.0 ppm within the upper portion of the lake. Draw downs will also allow an opportunity to clear some of the aquatic vegetation away from beaches and other areas of recreational use.

2. Vegetation may be controlled in some areas of high recreational use by using benthic barriers.

3. Controlling sediment deposition is of primary concern for the long term health of the lake and will require a detailed assessment of the watershed to determine the options available for reducing the current rate of siltation.

4. A plan to reduce erosion from the public boat ramp access road and the public parking area should be initiated. This plan should include the use of waterbars, detention basins, and/or grassed swales to reduce sedimentation into Lake Wyola, and regrading to direct the sheet flow away from the Lake. Paving the lower portions of the access road and the parking area should be considered.

5. The construction of a small retaining wall, such as a log crib wall, at the town beach would slow the flow of sand from the beach into the lake. A new level area may be created of either sand or grass for sun bathing and picnicking .

6. A plan should be developed with the Town of Shutesbury DPW and others to reduce sediment loading into Lake Wyola through proper maintenance of the unpaved roads in the watershed. The placement of new waterbars along these roads should direct runoff into upland areas rather than into wetlands or streams which feed into the Lake.

7. Any new construction within the Lake Wyola watershed should incorporate a sedimentation and erosion control plan approved by the Conservation Commission and

Planning Board.

8. Vegetation removal can be carried out in recreation areas and on private properties by means of raking and other hand tools for gathering vegetation while the substrate is exposed.

9. The use of construction equipment may be considered to remove larger amounts of vegetation and sediment from specific areas of concern during drawdown, and other forms of dredging or hydro raking should be considered during the interim period between draw downs if excessive sediments or dense vegetation returns. The channel leading from the public boat ramp may require minor dredging.

10. Until there is specific nuisance vegetation which cannot be controlled by other methods, NEE recommends that no herbicide treatments be considered at this time.

11. The installation of catch basins with deep sumps at the intersection of the Lakeview Road and Fiske Brook would effectively reduce the amount of sediment contributed into Lake Wyola from road sanding in winter.

12. The feasibility of a regular road sweeping program to reduce the accumulation of winter sands on paved roads around the Lake should be investigated.

13. The construction of a shallow underwater berm across the inlet of Fiske Brook (south of Riverview Road) should be investigated as a possible measure to significantly reduce sediment loading into Lake Wyola by creating a sedimentation basin at this location. A dredging schedule of every twenty years or more should be sufficient to maintain the desired depth of the pool.

14. The cutting of vegetation from the banks by property owners and the wave impacts caused by boat wakes and prevailing winds are the primary causes of bank undercutting and slumping. Public education of these issues should be implemented by LWAC.

15. Lake shore property owners should be educated in the use of bank stabilization methods using "soft" engineering techniques (bioengineering), such as coconut fiber BioLogs, brush layering, or vegetated crib walls.

VII. References

Cooke et al. 1986, EPA 1988, In Fugro, Cushman Pond Drawdown Impact Evaluation, Literature Review of Drawdown Impacts,Table 1

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, Second Edition. The New York Botanical Garden.

Hannon, Michele, editor. 1997. Massachusetts Natural Heritage Atlas 1997-98 Edition. Natural History & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife.

Horsley and Witten, Inc. 1997. Lake and Pond Management Coursebook 1996 New England Lake Conference Edition

Mattson, Mark D., Godfrey, Paul J., Barletta, Regina A. And Aiello, Allison. 1997 Eutrophication and Aquatic Plant Management in Massachusetts Draft Generic Environmental Impact Report.

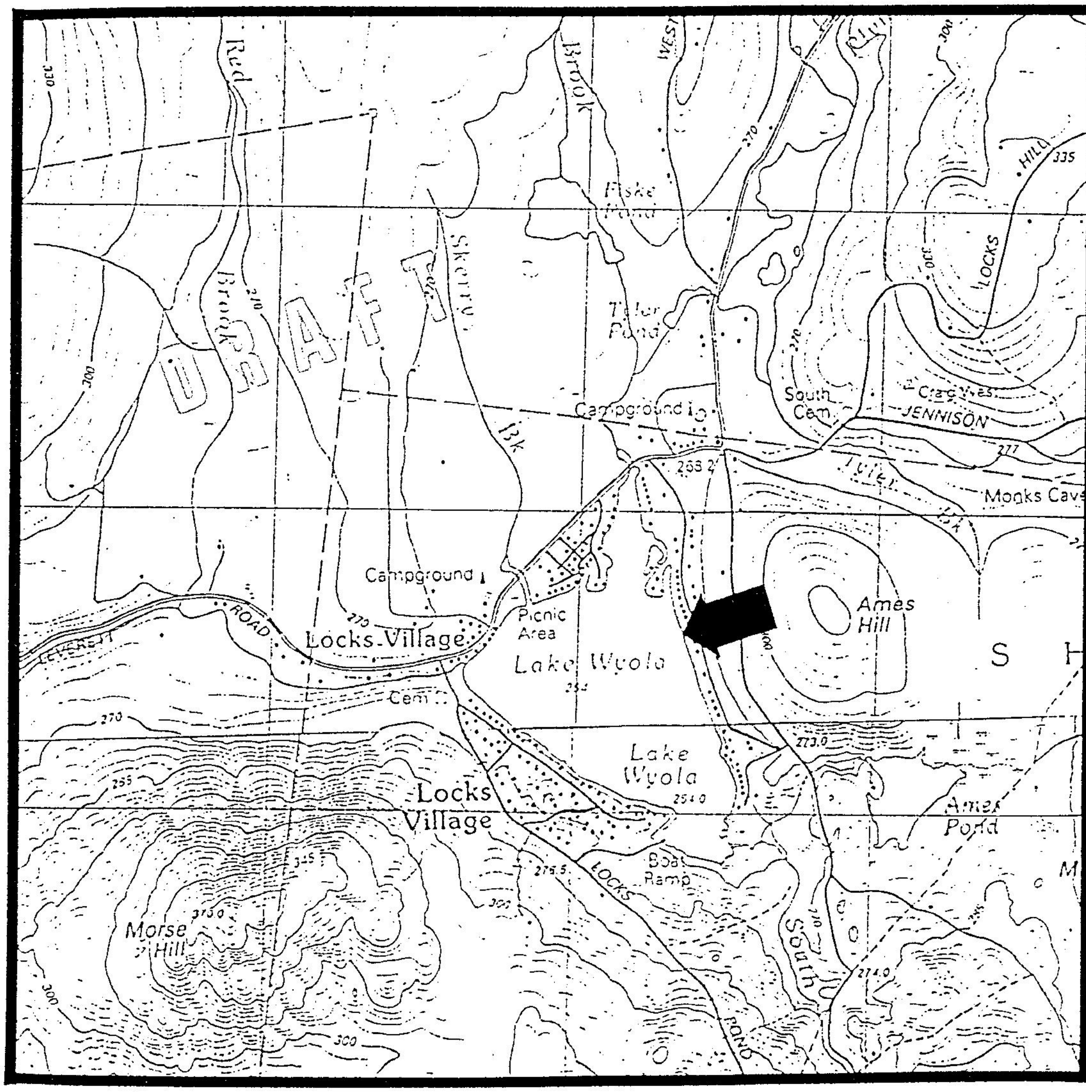
Reed, Porter B., Jr., Compiler. 1997. 1996 National List of Vascular Plant Species That Occur in Wetlands. U.S. Fish and Wildlife Service

United States Environmental Protection Agency. 1988. The Lake and Reservoir Restoration Guidance Manual First Edition

F:\SHARED\LET97\1354MAN.PLN

FIGURE 1

USGS SITE LOCUS MAP



SCALE: 1:25,000
Shutesbury/Orange Quadrangle, 1990

Appendix I

WATER QUALITY DATA

Appendix I

DATE	Depth (Meters)	Temp. (C)	D.O. (ppm)		Secchi Depth (Meters)	Total Phos. ug/l	Nitrate mg/l
Lake Wyola - Shutesbury Massachusetts Field Sampling Data for 1995	Dissolved O2 Profile						
15-Apr						13(surface)	
20-May	0.05	15.00	10.10		3.90	7	
	1.00	15.00	10.10			(surface)	
	2.00	15.00	10.00				
	3.00	15.00	10.00				
	3.50	14.70	10.00				
	4.00	14.50	10.00				
	4.50	13.00	10.00				
	5.00	12.40	10.20				
	5.50	12.00	10.00				
	6.00	11.20	9.60				
	6.50	10.50	9.20				
	7.00	10.00	8.80				
	7.50	9.40	7.60				
	8.00	8.80	6.40				
	8.50	8.50	5.80				
	9.00	8.40	5.20				
	9.50	8.00	3.40				
	0.20	15.00	10.00				
	Note 1						
17-Jun	0.10	21.80	8.80		5.75	35	0.011
	1.00	21.20	8.95			(10M w/sam	
	2.00	21.20	8.95				
	3.00	20.80	8.80				
	4.00	19.50	8.80				
	4.50	18.00	9.20				
	5.00	15.80	9.00				
	5.50	14.30	9.00				
	6.00	13.00	6.30				
	6.50	12.50	5.80				
	7.00	11.50	5.00				
	7.50	11.00	3.40				
	8.00	10.50	2.60				
	8.50	10.00	2.00				
	9.00	9.80	1.30				
	4.50	18.00	8.90				
22-Jul	0.25	25.60	7.00		7.10		
	1.00	25.50	6.90				
	2.00	25.20	6.90				
	3.00	25.20	6.90				
	4.00	25.00	6.60				
	4.50	23.00	6.60				
	5.00	20.70	6.30				

Appendix I

Lake Wyola - Shutesbury Massachusetts
Field Sampling Data for 1995

DATE	Dissolved O2 Profile Depth (Meters)	Temp.	D.O.		Secchi Depth (Meters)	Total Phos. ug/l	Nitrate mg/l
22-Jul	5.50	19.40	6.40				
	6.00	17.00	5.90				
	6.50	15.30	4.00				
	7.00	14.70	3.00				
	7.50	13.50	2.00				
	8.00	12.50	0.65				
	8.50	12.00	0.40				
	9.00	11.50	0.30				
19-Aug	0.10	26.30	7.60		7.40		
	1.00	26.50	7.40			4	<0.005
	2.00	26.50	7.40			6	0.034
	3.00	26.20	7.30				
	4.00	26.00	7.20				
	4.50	25.80	7.10				
	5.00	25.00	6.80				
	5.50	23.00	6.00				
	6.00	21.40	4.30				
	6.50	19.00	2.10				
	7.00	17.50	1.90				
	7.50	16.00	1.10				
	8.00	15.00	0.70				
	8.50	13.80	0.40				
	9.00	12.80	0.30				
	9.50	12.10	0.30				
23-Sep	0.10	18.00	9.60		8.00	13	0.01
	1.00	18.00	9.50			7	0.01
	2.00	18.00	9.40				
	3.00	18.00	9.40				
	4.00	18.00	9.30				
	5.00	18.00	9.30				
	5.50	18.00	9.20				
	6.00	18.00	9.20				
	6.50	18.00	9.10				
	7.00	17.90	9.10				
	7.50	17.80	9.10				
	8.00	17.60	9.10				
	8.50	16.70	5.50				
	9.00	14.50	0.90				
	9.50	14.00	0.50				

Appendix I

Lake Wyola/Shutesbury Massachusetts, Field Sampling Data for 1996						
	Dissolved O2 Profile			Secchi Depth	Total Phos.	Nitrate
DATE	Depth	Temp.	D.O.			
	(Meters)	(C)	(ppm)	(Meters)	ug/l	mg/l
					1 M	1 M
					9 M	9 M
20-Apr	0.10	7.70	ND	4.50	5	0.011
	1.00	7.50	ND		ND	{0.065}
	2.00	7.40	ND			@Town Beach
	3.00	7.30	ND			<1 Meter
18-May	0.25	13.80	10.20	5.00	ND	0.046
	0.25	13.80	9.90		ND	0.122
	1.00	13.80	9.50			
	2.00	13.70	9.30			
	3.00	13.00	9.00			
	4.00	12.90	8.70			
	4.50	12.30	8.40			
	5.00	11.90	8.00			
	5.50	11.30	7.80			
	6.00	11.00	7.60			
	6.50	10.20	7.10			
	7.00	10.00	6.80			
	7.50	8.70	5.90			
	8.00	8.00	5.30			
	8.50	8.00	4.80			
	9.00	8.00	4.50			
	9.50	8.00	4.00			
15-Jun	0.10	24.00	8.20	1.00	ND	ND
	1.00	24.00	7.40		ND	ND
	2.00	23.50	7.40			
	2.50	17.50	8.00			
	3.00	17.30	7.80			
	4.00	16.00	7.90			
	5.00	14.00	8.00			
	6.00	12.50	6.50			
	7.00	11.00	5.40			
	8.00	10.00	3.70			
	9.00	9.50	2.50			
20-Jul	0.20	23.20	7.80	4.00	6	BDL
	1.00	23.20	7.80		4	0.023
	2.00	23.20	7.60		@7M	@7M
	3.00	23.20	7.60			
	3.50	23.20	7.50			
	3.50	23.00	7.00			
	4.00	17.80	3.90			
	4.50	16.00	4.00			
	5.00	14.80	3.60			
	5.50	13.00	2.50			
	6.00	11.80	2.10			
	6.50	10.80	1.20			

Appendix I

Lake Wyola/Shutesbury Massachusetts, Field Sampling Data for 1996

DATE	Dissolved O2 Profile Depth	Temp.	D.O.	Secchi Depth	Total Phos.	Nitrate
	(Meters)	(C)	(ppm)	(Meters)	ug/l	mg/l
					1 M	1 M
					9 M	9 M
20-Jul	7.00	10.20	0.70			
	7.50	10.00	0.50			
	8.00	10.00	0.50			
14-Aug	0.10	24.00	8.00	5.00	3	BDL
	1.00	24.00	7.60		3	0.009
	2.00	23.80	7.60			
	3.00	23.50	7.30			
	3.50	22.50	4.90			
	4.00	20.60	3.20			
	4.50	19.00	1.90			
	5.00	17.00	1.40			
	5.50	15.00	1.20			
	6.00	14.00	1.10			
	6.50	12.50	0.50			
	7.00	12.00	0.40			
	7.50	11.20	0.40			
	8.00	10.80	0.40			
	8.50	10.40	0.40			
	9.00	10.30	0.40			
30-Aug	0.10	24.00	7.60	5.00	ND	ND
	1.00	24.00	7.40		ND	ND
	2.00	24.00	7.40			
	3.00	23.80	7.40			
	3.50	23.20	6.30			
	4.00	22.80	4.10			
	4.50	20.60	1.90			
	5.00	18.00	1.20			
	5.50	16.00	1.00			
	6.00	14.80	0.80			
	7.00	12.50	0.50			
	8.00	11.20	0.40			
	9.00	10.60	0.40			
21-Sep	0.10	18.20	8.60	6.10	4	BDL
	1.00	18.20	8.60		2	BDL
	2.00	18.00	8.60			
	3.00	18.00	8.50			
	4.00	18.00	8.40			
	5.00	17.60	8.20			
	5.50	17.50	7.90			
	6.00	17.10	6.90			
	6.50	15.80	4.10			
	7.00	13.10	0.70			
	7.50	12.10	0.40			
	8.00	11.50	0.20			

Appendix I

Lake Wyola/Shutesbury Massachusetts, Field Sampling Data for 1996

DATE		Dissolved O2 Profile Depth	Temp.	D.O.		Secchi Depth		Total Phos.		Nitrate
		(Meters)	(C)	(ppm)		(Meters)		ug/l		mg/l
								1 M		1 M
								9 M		9 M
21-Sep		8.50	10.80	0.20						
		9.00	10.70	0.20						
		9.50	10.20	0.20						
19-Oct		0.10	12.00	9.60		5.50		ND		ND
		1.00	12.00	9.60				ND		ND
		2.00	12.00	9.60						
		3.00	12.00	9.50						
		4.00	12.00	9.40						
		4.50	12.00	9.40						
		5.50	12.00	9.40						
		6.50	12.00	9.40						
		7.50	11.80	9.40						
		8.00	11.70	9.40						
		8.50	11.70	9.40						
		9.00	11.70	9.40						
		9.50	11.70	9.40						

APPENDIX II

TYPICAL DETAILS

FIGURE 2. TYPICAL GRASS-LINED CHANNEL

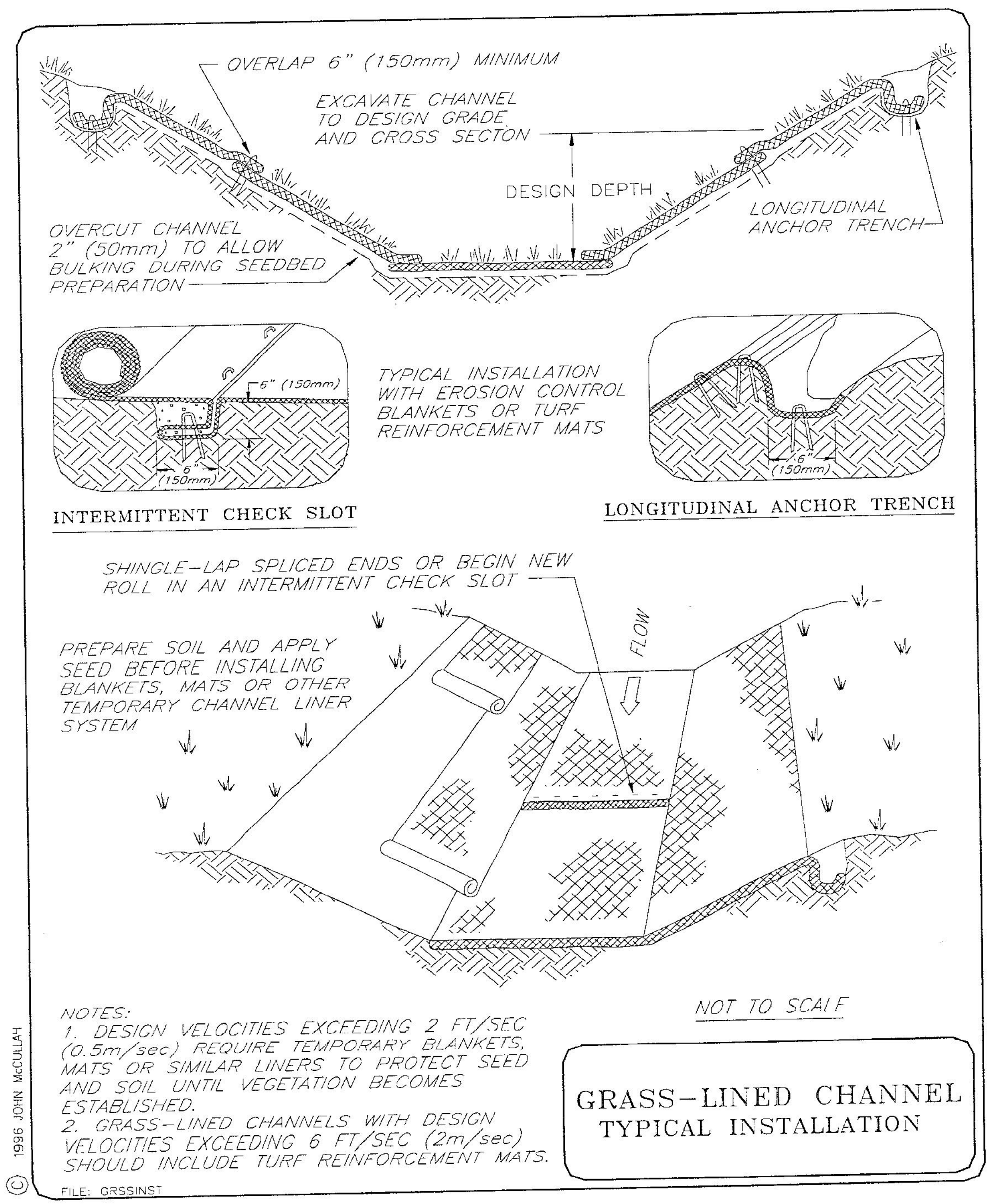


FIGURE 3. BANK RECONSTRUCTION USING BIOLOGS

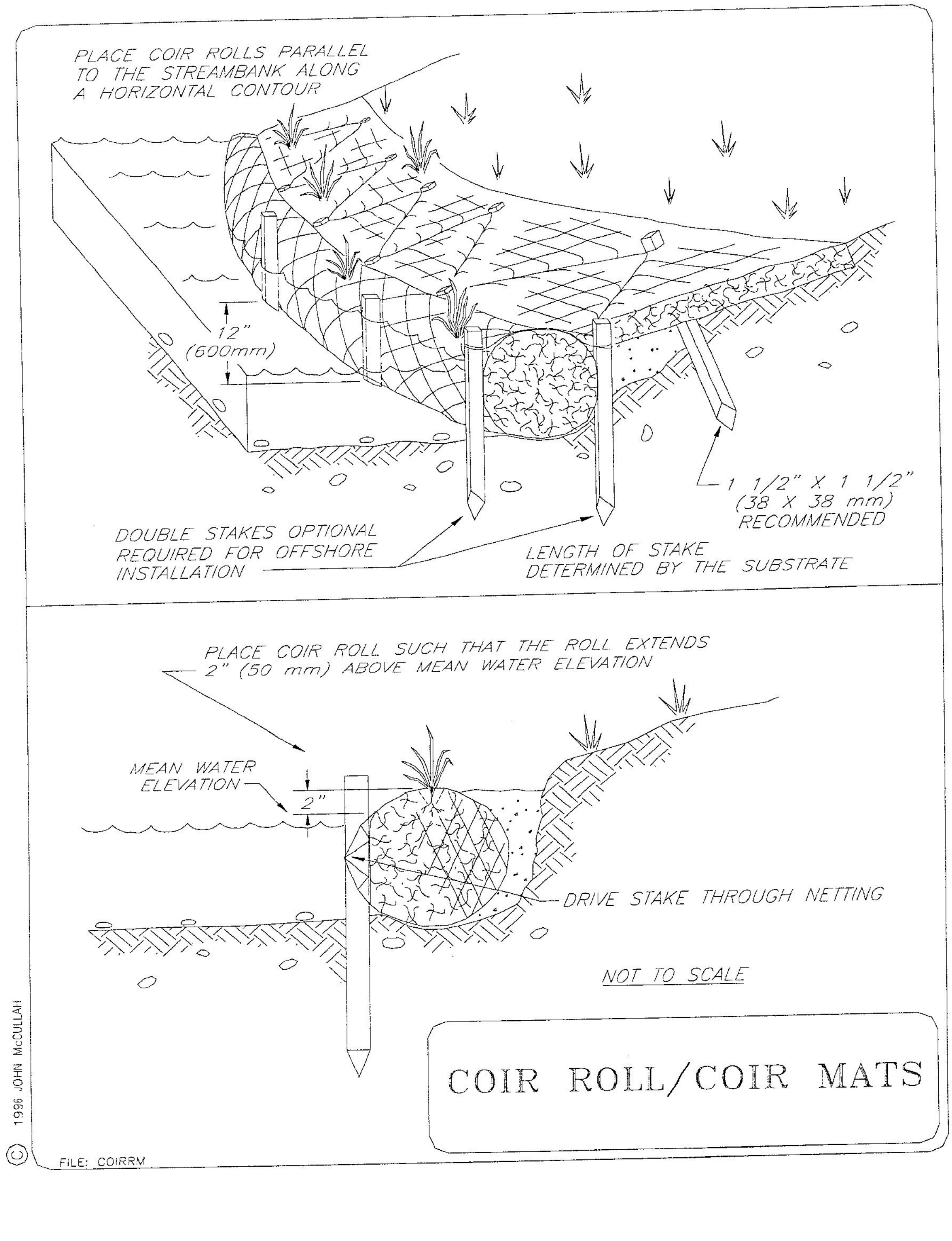


FIGURE 4. BANK RECONSTRUCTION USING BRUSH LAYERING WITH NATIVE VEGETATION

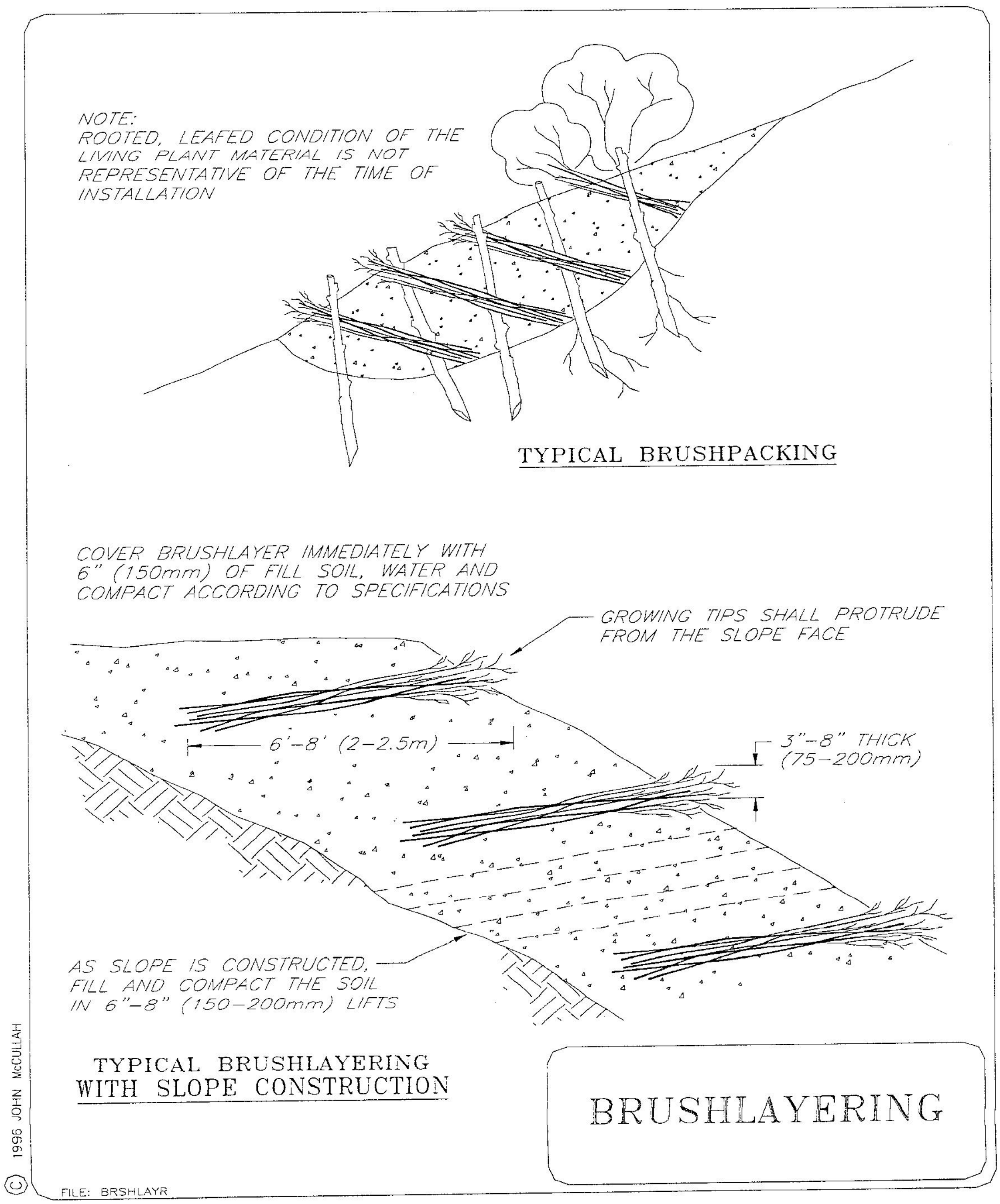
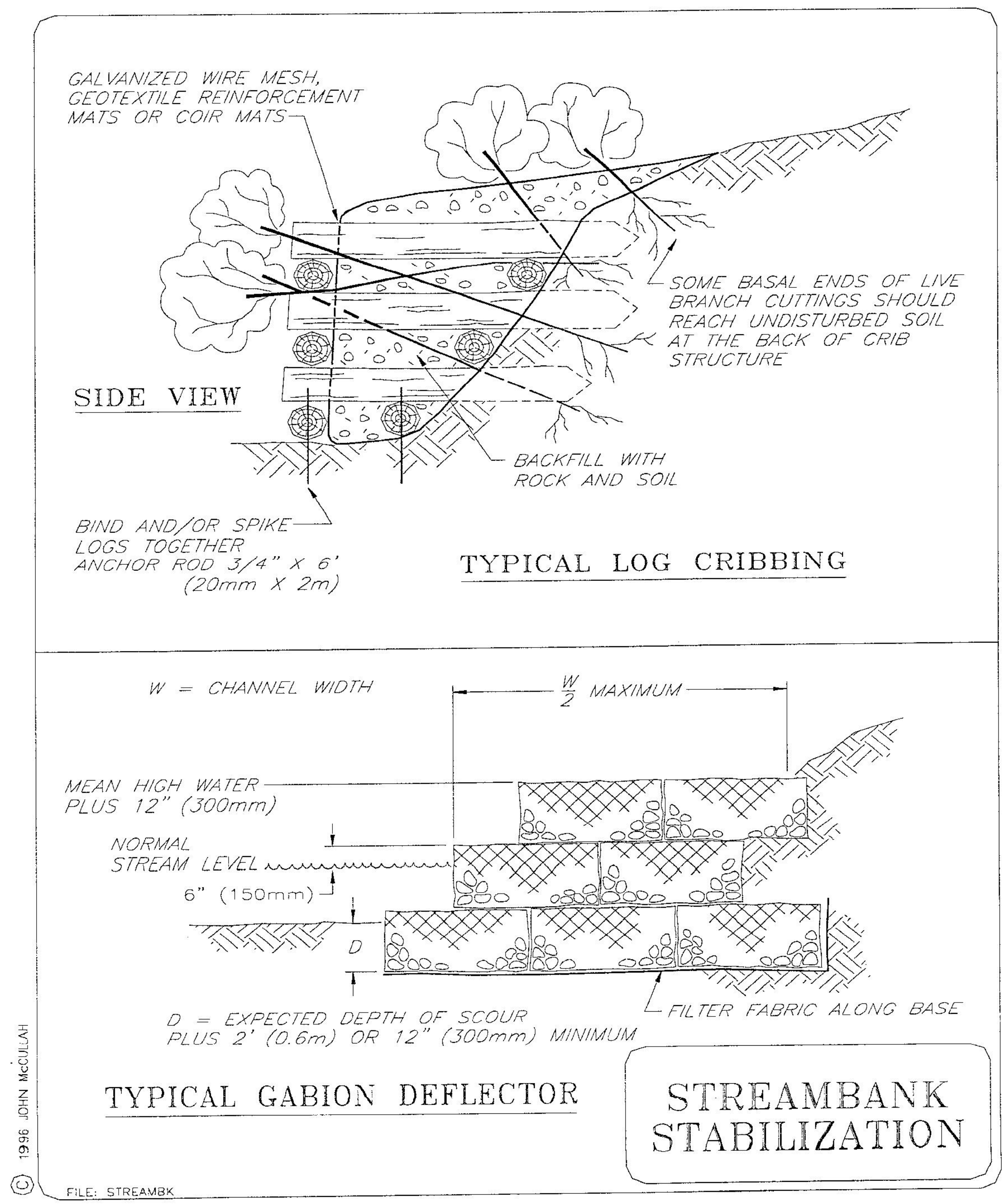


FIGURE 5. BANK STABILIZATION USING WOOD CRIB WALL WITH NATIVE VEGETATION



LAKE WYOLA
(Shutesbury)

General Information:

Wyola is a 129-acre lake located in Shutesbury a little over four miles west of Route 202. Depth averages 11 feet with a maximum depth of 33 feet. The lake usually has about 10% trout water by volume. The bottom is predominantly mud with scattered areas of gravel. Aquatic weeds are very heavy in the eastern corner of the lake, while moderate to sparse along the remaining shoreline.

The shoreline is 60% developed with year round homes and summer cottages. Boat access is provided at the southern end of the lake by a paved ramp located off Locke's Pond Road. Shoreline access is limited to the boat landing area and a few undeveloped areas around the lake. Summer recreational usage is high with swimming, boating and fishing popular.

This lake can be located on the U.S.G.S. topographical quad maps titled "Millers Falls" and "Shutesbury." Nearby fishing areas include the Sawmill River and Quabbin Reservoir.

Fish Populations:

The fish population was most recently studied during a 1978 summer survey. Nine species were collected including chain pickerel, yellow perch, pumpkinseed, brown bullhead, golden shiner, bridled shiner, banded killifish, fallfish and white sucker.

Fishing:

Lake Wyola is stocked in the spring with brook trout and in the fall with rainbow trout. Year round fishing for trout exists, with peak pressure from April through June. Ice fishing is very popular for chain pickerel as well as trout.

March 1993