STORMWATER RENOVATION

AND

MANAGEMENT PLAN

FOR THE

LAKE POCOTOPAUG WATERSHED

PREPARED FOR THE

TOWN OF EAST HAMPTON

March 1995

WMC CONSULTING ENGINEERS
630 OAKWOOD AVENUE
WEST HARTFORD, CONNECTICUT 06110

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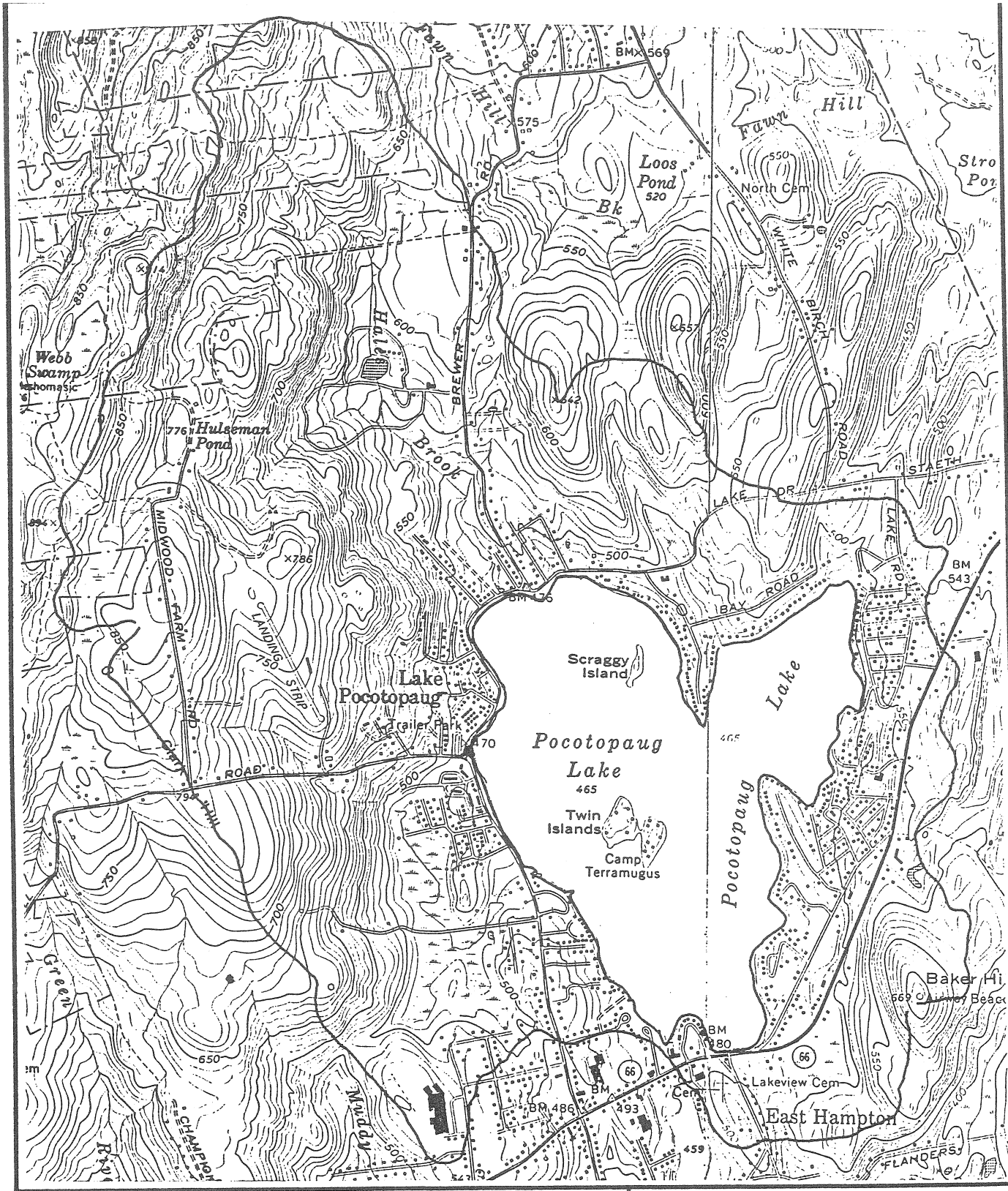

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PROJECT LOCATION AND WATERSHED AREA MAP

LAKE POCOTOPAUG
EAST HAMPTON

1. Study Background and Objectives

I. Lake Pocotopaug

The 512 acre freshwater Lake Pocotopaug is located in the Town of East Hampton, Connecticut. Lake Pocotopaug is considered a major recreational resource by the Town and is used for boating, swimming and fishing. As such, the lake is also a substantial economic resource, and further enhances the town by providing aesthetic value to not only the Town's residences but also to those traveling the State highway through Town.

Lake Pocotopaug has, in the past, experienced severe algae blooms, turbid lake water and runoff laden with sediments, organic material and nutrients from the watershed. These events occur with noticeable frequency and have in the past limited recreational uses and impacted the aesthetics of Lake Pocotopaug[6].

The Town has recognized that without proper and continuing watershed management, it is probable in the future that the lake will experience additional algae blooms with increasing frequency and of a longer duration. Furthermore, without a management plan in effect, sediment and nutrient laden runoffs to the lake will continue adding to the algae problems and thus will limit this valuable resource.

This being the case, the Town has formed various Committees to identify problems, determine their causes, and recommend a course of action in an effort to improve and manage lake water quality. One of the most important conclusions of these Committees was the recommendation to develop and implement a watershed management plan. An integral part of any watershed management plan is how to manage and control stormwater inputs to the lake. To this end, the Town of East Hampton retained the services of WMC Consulting Engineers to develop a stormwater renovation and management plan, which can then be incorporated into an overall watershed management plan for Lake Pocotopaug, if desired by the town.

II. The Stormwater Renovation and Management Plan

The objective of this Stormwater Renovation and Management study is to present, for possible implementation, recommended improvements and control measures to the existing stormwater runoff system entering Lake Pocotopaug, in an attempt to reduce sediment, nutrient and pollutant loading to the lake. The Stormwater Renovation and Management Plan recommendations can be implemented in conjunction with the an overall watershed management plan.

By identifying existing and potential problems and/or sources of sediment, nutrient and pollutant loading to Lake Pocotopaug, as well as providing potential solutions, the measures presented in this report should provide a significant step towards improvement of the existing lake water quality. The final stages for recommended improvements includes the final design and initiation of construction of the proposed improvements.

2. Evaluation of Existing Information, Land Use and Stormwater Drainage Policies

I. Planning & Zoning & Subdivision Regulations

The Planning, Zoning & Subdivision Regulations, in general, provide adequate regulations pertinent to the protection of a watershed. Only minor additions would be in order as follows:

- The regulations should expand on the definition of a buffer to include a wetlands buffer zone as explained in the next section of this report.

- The regulations should include a required referral to the Wetlands Commission for any activity proposed in a wetlands buffer zone, or a Watershed Management Zone (not a separate zone, but an overlay zone, with specific regulatory requirements).

- There are specific regulation revisions or additions that could be made to reduce potential impacts to the lake. For example, Requirements for Certification/Approval of Erosion and Sedimentation Control Plan (Reference 1 - Zoning Regulations page 68, Section 27.3.1) - Plan Requirements, subsection E "The operation and maintenance program for proposed soil erosion and sedimentation control measures", should also include a description of a detailed checklist such as that provided in section 2.II of this report.

- Conditions of Approval (Ref. 1 page 69,70), should include specific requirements for maintenance and the required response time to make erosion and sediment controls effective. Additional "teeth" or clarification should be given to the enforcement section that follows; namely, in addition to any stop work order, a required time to respond, actions by the Town to repair/remedy the problem, and the required back charging or reduction in the performance bond amount to be returned to the individual, should be detailed.

- Section B.2 - General (Ref. 1 page 72), section b, should also include a requirement for design of sediment removal and stormwater renovation for present and for future 100 percent upstream development per Zoning, stormwater runoff flows.

- Section B.3.j outlet structures, (Ref. 1 page 74), should require a design check of, and/or a designed stable outlet and stable discharge channel with recommended improvements to downstream areas. The design should require field investigation, and design and checks of the entire downstream flow path.

  Typically, closed storm drainage systems function as intended up to the point of discharge. Most fail at the discharge due to erosion of the outfall area and progressive channel scour due to the inability of the stream channel to resist the erosive force of increased flows and higher velocity. Both are undesirable for a number of reasons, but mainly due to sedimentation and increased turbid conditions downstream of the outfall.

- Section B.3.m (Ref. 1 page 75), should include a requirement for use of specially designed vegetated swales/channels within a Lake Watershed Management Zone (Lake WMZ).

The channels should provide catchments (small berms to collect sediment and slow water velocity to around 1 f.p.s.) and drops to aerate stormwater. Increased sediment, organic and nutrient removal with grassed waterways is well documented. An additional requirement for grassed waterways should be the estimation of effectiveness of the sediment traps and a schedule of maintenance. The Universal Soil Loss Equation (USLE) could be utilized for this estimate[8].

- Section B.5 - Detention Basins, (Ref. 1 page 75), the use of sedimentation basins in place of detention basins should be required for developments when within the Lake WMZ. The sediment basins should be required along with, or in place of the use of Gross Particle Separators (GPS).

  Sedimentation basins should be planted with various wetland plantings if the plantings would be sustainable. Sustainable conditions for wetland plantings would require the sediment basin to be a wet type basin, having a year round ground water after construction to within 18 inches of the surface to ensure survival of the plantings.

  The use of stormwater recharge basins or subsurface recharge should be encouraged where feasible[6]. Feasibility would depend upon such factors as surficial geology and land area availability. Additional consideration should be given to small developments or individual developments without sufficient land area requiring them to contribute to funding of a regional Town constructed and maintained sediment basin or other local watershed management project.

- Section E - Site Access and Parking, (Ref. 1 page 79), the use of porous type pavement designs should be required in the Lake WMZ where subsurface conditions are favorable to stormwater recharge. Subsurface conditions should provide for a moderate permeability greater than 0.27 in/hr. and the depth to the water table or bedrock of 2 to 4 feet. The porous pavements should be utilized on low volume roads, parking areas and road shoulders where grades are very gentle to flat[14]. In addition, parking areas should be designed to discharge, as a minimum, the first flush of stormwater runoff to a combination of the following:

  1. Vegetated swales.
  2. Catch basins with sumps and outlet hoods.
  3. Gross Particle Separators (GPS).
  4. Sediment basins.
  5. Recharge basins.

  The design of these stormwater renovation measures should include an operation and maintenance schedule along with an estimated cost to maintain, in order to allow for an appropriate maintenance bond, per section 28 of the Zoning Regulations.

- Section 29 - Special Permits (Ref. 1 page 86), special permits should be required of all development within the newly established Lake WMZ.

- Zoning should be revised within a new established Lake WMZ to, in general,:

  1. Encourage and require the retention of natural impervious surfaces (Contiguous Open Spaces, Open space wetland and watercourses corridors).

  2. Minimize removal of natural vegetation (Cluster Developments).

  3. Promote infiltration of stormwater runoff.

  4. Minimize impervious surfaces, required maximum impervious areas.

  5. Reduced density zoning; Lake WMZ maximum density independent of sewers and other utilities, dependent on proximity to wetlands and watercourses.

  6. Prohibit development on steep slopes (in excess of 15 percent, for example).

  7. Require frequent inspections of new developments and compliance with regulations.

  8. Encourage land acquisition by the Town of environmentally sensitive areas.

  9. Require land use deed restrictions within the WMZ, such as restriction of use of fertilizers and pesticides, required maintenance of septic systems, etc..

- Section II.3 - Application Procedures (Ref. **13** page 2), require the design of all septic systems be by a Connecticut Registered Professional Engineer. The design should incorporate evaluation of phosphorus and nitrogen removal or renovation to drinking water standards prior to leaving the property limits or reaching a wetland or watercourse within the Lake WMZ. In lieu of a septic design meeting these requirements, the design of a sewage system connection and/or extension of the Town's sewer system should be required. This should also be required in Section IV.7.

- Section IV.6 - General Requirements for the Subdivision of Land (Ref. **13** page 8), no exception to the minimum usable land required should be permitted if the lot is to be serviced by a sewer system. This would be consistent with the preceding recommendations.

- Section V.6.NN (Ref. **13** page 13), the Commission should require impact statements for developments within the Lake WMZ. Additional information that should be included in the impact statement: sediment, phosphorous, nitrogen loadings for present, proposed, and proposed with treatment (renovation) to be utilized.

- Section VI.7 - Open Space Objectives and Section VI.8 - "Waivers of Open Space" (Ref. 13 page 15), the objectives of the open space regulation should be revised to be consistent with the previous recommended revisions to the Zoning Regulations.

- In General, the Subdivision regulations should be consistent with the Zoning and Wetlands regulations, if amended.

- Section IX - Soil Erosion/Sediment Control (Ref 13 page 20), should permit no exceptions to comply with this regulation based on cumulative disturbed area. A less intensive requirement for small projects could be required, in which the owner or contractor certifies knowledge of proper erosion and sedimentation control and is required to install measures prior to construction based on a standard check list (see typical check list in section II of this report which could be developed into a standard list for small projects under the 1/2 acre limit), followed by notification to the Town and the Town issuing a certification to proceed, and follow-up inspections by town.

  Regardless of the size of the project, the limits of proposed grading and clearing should be established prior to approval of the proposed activity and should be delineated in the field (orange surveyors flagging tape could be used for smaller projects while orange construction safety fence should be used for larger projects, especially in proximity to wetlands or watercourses) and approved by the Town prior to the installation of sediment control measures. The owner/contractor should also be required to post a bond.

II. Inland Wetlands & Watercourses Regulations

In general, the current Inland Wetlands & Watercourses Regulations are typical for the State. While these generally provide adequate protection to regulated areas, they are not specifically designed for a particular area or to protect a watershed or a lake environment from area runoff.

The regulations could be enhanced to provide additional protection and benefits to the Lake Pocotopaug watershed, if several items or regulations were amended to the current regulations in conjunction with Planning & Zoning changes. These changes are as follows:

- A special review, permit and regulation Zone within the Town - A Lake Pocotopaug Watershed Management Zone (Lake WMZ) - Inland Wetlands and Watercourses.

- Required Referral to the Planning & Zoning Commission, as well as compliance with all applicable Planning & Zoning Regulations.

- Creation of a buffer zone requirement in the lake watershed management zone. Certain land use activities in an area upslope of a wetland or watercourse could be permitted only by special permit. The primary benefit of the buffer zone is that, should erosion and sediment control measures fail, there is a buffer zone which can mitigate the effects of the failure. On the other hand the buffer zone concept should be researched for legality and enforceability.

- Require compensatory wetlands creation for altered or destroyed wetlands or watercourses.

- Development of an Erosion and Sedimentation Control Plan. This could be required for all new construction or land disturbances within the Lake WMZ. Practicality would limit oversight to only projects impacting more than a certain size area ($^1/_2$ acre is suggested) upslope of a wetland or watercourse, special concern projects and a project that lies within the new buffer zone. The E & S Plan should include engineering and architectural drawings and site specific sequences of construction. Additionally check lists such as the typical one that follows could be developed to aid in proper installation and functioning of erosion and sediment controls through out a proposed project duration. Construction should be phased so as to minimize the extent and time soils are exposed to erosion. The use of such a check list would require inspection and enforcement by the Town in order to be effective.

Typical Erosion and Sediment Control Checklist

EROSION AND SEDIMENT CONTROL CHECK LIST				
WORK DESCRIPTION, LOCATION AND EROSION & SEDIMENT CONTROL MEASURES	DATE INSTALLED	INITIALS	DATE REMOVED	INITIALS
a) LIMITED CLEARING.				
b) INSTALLATION OF FLORESCENT CONSTRUCTION FENCING.				
c) INSTALLATION OF EROSION AND SEDIMENT CONTROLS.				
d) CLEARING AND GRUBBING.				
e) INSTALLATION OF TEMPORARY DIVERSION PIPE.				
f) PLACE TEMPORARY OUTLET SPLASH PAD FOR TEMPORARY PIPE.				
g) DIVERT BROOK; PLACE SAND BAGS ACROSS BROOK TO CREATE DIVERSION DIKE.				
h) REMOVE EXISTING HEAD AND END WALLS. SAVE FOR REUSE.				
i) EXCAVATE, REMOVE EXISTING CULVERT.				
j) CONSTRUCT INLET AND OULET EROSION PROTECTION, PLACE NEW CULVERT.				
k) CONSTRUCT HEAD AND ENDWALLS, BACKFILL.				
l) REMOVE SAND BAG DIKE, REMOVE TEMPORARY DIVERSION SPLASH PAD AND PIPE.				
m) FINAL GRADE, LOAM, FERTILIZE, SEED, PLACE EROSION CONTROL BLANKETS.				
n) REMOVE CONSTRUCTION FENCING AND RESTORE ALL DISTURBED AREAS AS IN STEP (m).				
o) CONTINUOUS INSPECTION OF EROSION PRONE AREAS AFTER RAINFALL EVENTS IN EXCESS OF 1"/HR INTENSITY OR A RAINFALL EVENT WITH A TOTAL PRECIPITATION OF 1/2" OR MORE (NOTE THIS WILL REQUIRE A RAIN GAUGE KEPT ON SITE AND RECORD OF RAINFALL KEPT FOR EACH RAINFALL EVENT. THE GAUGE SHALL BE SO LOCATED SUCH THAT THE GAUGE WILL REPRESENT THE DEPTH OF RAINFALL THAT MAY OCCUR OVER THE PROJECT SITE.).				
p) INSPECTION OF EROSION PRONE AREAS MONTHLY FOR A PERIOD OF ONE YEAR AFTER THE COMPLETION OF CONSTRUCTION.				
q) APPROPRIATE MEASURES TO CORRECT DEFICIENT ITEMS SHALL BE MADE UNTIL THOSE ITEMS ARE DEEMED STABLE AND NON-ERODING.				
NOTE: FOLLOW UP INSPECTIONS AND MAINTENANCE OF EROSION & SEDIMENT CONTROLS, REPAIR OF ERODED AREAS, PLACEMENT OF ADDITIONAL MEASURES, REMOVAL OF SEDIMENT FROM E&S MEASURES, ETC.				
INSPECTION DESCRIPTION				
ACTION REQUIRED				
ACTION TAKEN				
FOLLOW UP OF ACTION AND INSPECTION.				
INSPECTION DESCRIPTION				
ACTION REQUIRED				
ACTION TAKEN				
FOLLOW UP OF ACTION AND INSPECTION.				
INSPECTION DESCRIPTION				
ACTION REQUIRED				
ACTION TAKEN				
FOLLOW UP OF ACTION AND INSPECTION.				

NOTE:

1) THIS FORM SHALL BE UPDATED WEEKLY AND REPORTS AND COPIES SENT TO THE APPROPRIATE TOWN AGENCY FOR APPROVAL WEEKLY UNTIL THE COMPLETION OF THE PROJECTS PHASES.

2) CONSTRUCTION MAY NOT PROCEED UNTIL THE CHECK LIST IS APPROVED BY THE TOWN AND A PRECONSTRUCTION MEETING IS HELD WITH THE TOWN AND THE CONTRACTOR.

3) BOTH THE TOWN'S WETLANDS AGENT AND THE CONTRACTOR MUST DATE AND INITIAL CHECK LIST.

4) IF ITEMS ARE NOT INSTALLED PROPERLY OR NEED REPAIR NOTE IN LOWER HALF OF CHECK LIST, DATE AND INITIAL BY TOWN AND CONTRACTOR.

As the check list suggests, inspections of the regulated activity would be conducted weekly and prior to and after major rainfall runoff events. For example, inspections could be conducted after an inch or more of rainfall has occurred during any single storm event. Storm events typically occur over a 24 hour period and may be intensive during only a portion of the rainfall period.

III. Road Standards and Road Study

The Town of East Hampton Street Standards are detailed and should only require minor revisions to reflect future amendments to Zoning, Planning and Wetlands Regulations made to assist in an overall Lake Watershed Management Plan.

General recommendations and revisions to the Standards are as follows:

- Incorporate Planning & Zoning, Wetlands Regulations recommended amendments and goals in the Road Standards.

- Section 04.01.3 - New Street Construction (Ref. 2 page 04-02), drainage designs should provide for a reduction of sediment, phosphorous and nitrogen imported to the lake and should include calculations to determine present, future and future with stormwater treatment estimates of sediment and nutrient loadings expected. This should be applicable to new roadway designs as well as reconstruction and rehabilitation of existing roadways.

- Section 05.02.03 - Intersections (Ref. 2 page 05-02), The spacing of intersections requirements could be increased to encourage the use of shared driveways and cluster type developments. This would also necessitate the revision of the block dimensions, Section 05.02.04.

- Drainage of streets should, where possible, be by sheet flow to roadside vegetated swales with catchments, i.e. small berms to slow stormwater and permit sediment deposition and stormwater infiltration.

- Section 05.02.06 - Side Slopes (Ref. 2 page 05-05), slope grading limits not steeper than 2' horizontal to 1' vertical are typical maximums. Requirements for reverse slope benching should be required for slopes adjacent to sensitive areas (near wetlands or watercourses, or within buffer zones) or whenever the vertical interval of any 2 to 1 through 5 to 1 slope exceeds 15 feet. Benches should be located so as to divide the slope face as equally as possible and should convey stormwater runoff or other waters to a stable outlet. Drainage and other water should be directed away from the slope or carried to a lower elevation by the use of storm drainage piping (cmp with concrete anchors works well)[8].

- Section 05.02.08.2 - Driveways (Ref. 2 page 05-06), driveway surfaces should be defined, specified as porous bituminous concrete pavement or stable processed aggregate surface.

- Section 06.02.01.4 & 8 - Design General Requirements (Ref. 2 page 06-03), the placement of pipes section should specify additional criteria for placement of pipes near slopes. Drainage pipes should extend beyond the toe of the fill slopes and not terminate at or on a slope. Likewise, stormwater runoff should not be permitted to leak off over slopes, a design which will fail in most applications resulting in erosion.

- Section 06.02.01.8 (Ref. 2 page 06-03), energy dissipaters should be required at all outlet structures to prevent scour erosion and future failure of the outlet structure.

- Section 06.02.01.11 (Ref. 2 page 06-04), the use of channels should be encouraged, vegetated roadside swales, vegetated channels with designed catchments and elevation drop structures (earth and riprap or gabions) all could result in the reduction of sediments and nutrient transport to the lake. These types of channels or swales should also result in increase ground water infiltration and peak flow discharge attenuation.

- Section 06.02.03.3 (Ref. 2 page 06-08), the design of open channels should require the attenuation of peak flow, retain sediment, reduce nutrient transport, and increase infiltration.

- Section 06.02.04. Detention Basins (Ref. 2 page 06-04), this section should be replaced or require the installation of sediment and stormwater renovation basins. Sediment basin design should be based on the "Connecticut Guidelines for Soil Erosion and Sediment Control"[8].

- Section 06.03.05 Catch Basins (Ref. 2 page 06-14), catch basins should be required to have outlet hoods to reduce floatables (organic materials and oils) from being discharged. The use of a gross particle separator with a catch basin top should be required where heavy sediment loads can be expected. Heavy loadings may occur at areas such as low points in roads, intersections and near some types of land uses like new construction areas, farming areas, timber harvesting areas, gravel roads and parking areas.

- The maintenance of catch basins, gross particle separators, sediment basins, swales etc. may require the use of somewhat specialized equipment. The Town should consider the use of equipment specifically design for the maintenance of these structures mentioned. The use of a vacuum type catch basin cleaner in place of the clam shell type now used by the Town is more effective in removing accumulated sediments and organics from basin sumps. A small articulated excavator/back hoe is useful for maintaining sediment basins and swales. If the Town decides to remove sediments from the lake it should consider the acquisition of a hydraulic dredge.

- Section 06.03.08.2 (Ref. 2 page 06-14), channel stabilization should require the use of geotextile fabrics and erosion control blankets, flexible non-structural channel linings and structural interlocking concrete pavers.

- Section 06.04.04 (Ref. 2 page 06-16), dewatering of excavations should be discharged to previously constructed and approved temporary sediment basins designed to handle the anticipated maximum flow rates and sediment loads.

IV. W.P.C.A. Ordinance and Sewer Maps

Generally, the WPCA ordinances are in conformance with good watershed management practices, and no comments are necessary.

V. Plan of Development

The "Plan of Development" Town of East Hampton, Connecticut May 1989 (reference 19) is, in general, consistent with recommendations made in this report. Several topics of the Plan of Development directly relate to Lake Pocotopaug and it's water quality.

The Water Quality section of the Plan (p.18) classified Lake Pocotopaug as a mesotrophic lake, but reports classify the lake as eutrophic since 1992. The Plan also recommends the continued monitoring and management of the lake to maintain it's current condition. This statement should also be revised to: In order to return the lake's water quality to previous conditions, lake management must be implemented. The Plan, (p.19) notes adverse impacts to the lake's water quality from lake over-use, discharges of oil and gas from motor boats, erosion and sedimentation and areas under development.

The Wetlands and Flood Plains section of the Plan (p.22) identifies inland wetlands and flood plains as important environmentally sensitive areas that should be preserved with boundaries (buffer zones) directly adjacent to wetlands. Further, the Plan states their significance as performing one or more of the following functions: water supply, flood control, sediment control, natural habitat for beneficial aquatic organisms, wildlife or vegetation, as well as aesthetic, recreational, historic and educational, and economic uses. The Pine Brook Wetlands, containing large and small wetlands and the Pine Brook - Pocotopaug Aquifer is also identified as a proposed public water supply source further emphasizing protection of the wetland areas to ensure quality of water.

The Groundwater section of the Plan (p.25) states that due to increased development in Town, the groundwater table has been lowered. This would apply to the Lake Pocotopaug watershed, resulting in less groundwater for dilution of nutrient input and flushing. This also relates to the importance of maintaining groundwater quality for public water supply.

The Land Use Control and Monitoring section of the Plan (p 26) indicates implementation of a groundwater protection strategy and providing comprehensive regulation of potential contaminating factors. (Public Act 82-279 "An Act Concerning the Protection of Public Water Supply" directs municipal planning and zoning commissions to protect present and future water supplies). Table VI "Potential Land Use Impacts To Ground Water" (p.27) of the Plan ranks land uses with potential adverse impacts to groundwater. The Plan recommends further protection of groundwater by amendment of zoning regulations in aquifer protection zones. Further, the plan identifies the need for more personnel to oversee and follow-up with inventory and monitoring to ensure protection.

The Plan states that maximum protection of groundwater occurs where land is left as open space or developed for recreational use. The Plan then concludes encouragement of open space and recreational use in aquifer protection zones and the implementation of a public water supply system. Water diversion away from the Lake, however, reduces nutrient dilution and lake flushing action by reducing groundwater quantities. Consideration should be given to development of a water supply system drawing from aquifers down gradient of the Lakes' water supply.

The Plan further recommends actions to preserve water quality (p.30). The Plan continually recommends, throughout the report, to continue public acquisition of environmentally sensitive areas and to seek State funds to acquire lands.

VI. Lake Studies, Reports, Recommendations

The lake studies and reports have concluded that Lake Pocotopaug will continue to experience severe nuisance algae blooms and decreased transparency due to cultural eutrophication of the lake without implementation of a watershed management plan. The reports (references 4,5,6, & 7) have further shown that lake quality is dependent upon watershed land use and development. These studies and reports determined that phosphorus is a limiting nutrient, however, one report determined that inorganic nitrogen (ammonia and nitrate) must also be addressed in a watershed management plan (ref. 6 p.8). Further, the studies and reports concluded that, in order to accomplish improved lake water quality, a watershed management plan must be developed and implemented.

Recommendations of the studies and reports, in general, identify actions to increase lake water transparency and reduce export of phosphorous and sediment from the watershed. The studies and reports recommend the following:

- Obtain funding to finance future lake watershed management projects.
- Public education of the causes of lake eutrophication.
- Use of non-phosphorus fertilizers and detergents and increased septic system maintenance.
- Increased use of vegetated buffer zones.
- Revised land use regulations and policy.
- Stormwater management in the watershed, reduce quantity and increased quality of runoff.
- Land acquisition of environmentally sensitive areas.
- Create incentives for creation and retention of undeveloped open spaces and buffer zones along wetlands and watercourses.
- Increase Town inspection and enforcement related to actions which may adversely impact lake water quality by qualified personnel.

These recommendations are consistent with our findings and observations. Further, our recommendations expand on these recommendations, which are repeated throughout the studies and reports.

3. Inventory of Existing Watercourses & Natural Drainage Systems

WMC performed an inventory of existing watercourses and natural drainage systems involving field inspections and reconnaissance of the watershed to locate and describe existing conditions and potential problem areas that have been shown to provide or may provide sediment, nutrient and pollutant loading to Lake Pocotopaug. In conjunction with this inventory, an inventory of existing hydraulic structures and man-made storm drainage systems was performed and is described in detail in the following section of this report.

The watercourses and natural drainage systems are identified on the plan entitled "Inventory Map Of Watercourses and Drainage Systems In The Lake Pocotopaug Watershed", Figure 1.

- Tributary Streams. The description of watercourses and natural drainage systems follows in the Appendix I - Field Reconnaissance Summary. The following watercourses are described in Appendix I:
    - Hales Brook inventory number 49 and 56.
    - O'Neill's Brook inventory numbers 21, 16 and 15.
    - Christopher Brook inventory numbers 73,74,75, and 70.
    - Hazen's Brook inventory number 34.
    - Day's Brook inventory number 17.
    - Brooks at Lake Drive inventory numbers 53 and 54.
    - Brook near Spellman's Point at Lake Drive and Bay Road inventory numbers 32B, 32A, and 32C.

  It has been observed that the Hales Brook, Day Brook and Christopher Brook watersheds contribute substantial sediment and nutrient loads and therefore are a significant potential pollution source to Lake Pocotopaug.[6] The watersheds' contribution to sedimentation can be confirmed by observation of the inlet and outlet areas of the cross culverts that convey Hales Brook and Christopher Brook to the lake, where accumulated sediment is clearly visible at both locations. Sedimentation at the outlet of Day Brook to the lake was also evidenced by the unconsolidated sand delta at the lake.

  Past sedimentation has occurred on a large scale in the O'Neill Brook watershed area of the lake. Watershed development along with erosion and sedimentation control failures have been documented, i.e. Baker Hill Development, however this particular development may not have been the major cause of sedimentation of the O'Neil Brook area.[4]

- Swales. Swales are small intermittent streams and roadside ditches that intercept and convey stormwater runoff from upslope areas to the inlets of cross- culverts. Many of these swales erode during significant runoff events (significant meaning any event producing stormwater in sufficient quantities to induce erosion in the swales). Additionally, swales along roads collect and convey sediment washed from pavements and drives to the inlets of cross culverts. The swales are typically eroded earth ditches formed when runoff concentrates at low points, or are crudely constructed road side swales. The constructed swales typically are gravel surfaced and are not resistive to erosive forces of the stormwater runoff collected and appear to be undersized in most cases.

  Sediment transported from upland areas and from erosion of the swales deposits at inlets, outlets and in the cross culverts themselves. This results in the reduced stormwater capacity of the culverts, as well as sediment and pollutant deposition in Lake Pocotopaug.

Reference should be made to the inventory numbers for the corresponding descriptions of the watercourses and natural drainage systems and recommended improvements that should be implemented in an overall lake watershed management plan. Existing land uses, specific types and sources of nutrient loadings and sediment loadings to the lake are described in detail in Appendix I for these areas.

4. Inventory of Existing Hydraulic Structures and Manmade Storm Drainage Systems

Similar to the inventory of existing watercourses and natural drainage systems described in the preceding section, the inventory of existing hydraulic structures and man-made storm drainage systems locates and describes existing conditions and potential problem areas that have been shown to provide, or may provide, sediment, nutrient and pollutant loading to Lake Pocotopaug.

The existing hydraulic structures and man made storm drainage systems are identified on the plan entitled "Inventory Map Of Watercourses and Drainage Systems In The Lake Pocotopaug Watershed", Figure 1. Descriptions of the drainage systems and recommended improvements that should be implemented in an overall lake watershed management plan and existing land uses, specific types and sources of nutrient loadings and sediment loadings to the lake are described in detail in Appendix I for these areas.

- Catch basins. Catch basin systems in the lake area are, in general, in fair to good condition, constructed of concrete block or precast concrete. Most have limited sumps or sediment storage capacity below outlet invert elevations due to construction or due to insufficient maintenance. Accumulated sediment and organic debris in the basins and drains limit capacity to convey stormwater and retain only the heaviest sediment particles and debris. In many of the catch basin systems, new sediment loads pass unattenuated through to discharge points at the lake. The locations of these catch basins with limited sediment removal capacity are evidenced by sediment deltas and deposits of organic matter in the lake at the outfall locations.

- Leak-offs (areas where confined runoff is allowed to leave the road). Street and road leak-offs, located at low points in the road and at other areas are, in general, unpaved, gravel mini-swales conveying street drainage down the roadside embankments, directly or indirectly to the lake. Others are incidental leak-offs created naturally at low points in roads where stormwater has concentrated and discharged at a single point.

  Occasionally, stormwater leaks off in the form of dispersed runoff along the roadsides where there are no curbs. This would generally be preferable to leak-offs, except that the banks are not vegetated in most cases and are subject to erosion. In addition, many of the constructed leak-offs do not discharge to stable bases. Therefore, undermining of paved lead-offs and road pavement as well as erosion of road banks has occurred, resulting in sedimentation of the lake at these locations.

- Cross-Culverts. Cross-culverts for conveying stormwater runoff under roads to discharge points at the lake are varied in type & size. Stormwater culverts vary in size from 12" to 48" in diameter and are either reinforced concrete pipe (rcp) or corrugated metal pipe (cmp).

- Stream culverts. Typically reinforced concrete pipe culverts or elliptical metal pipe of various sizes. Almost all have some reduction in actual design or theoretical capacity due to the accumulation of sediment at the inlet, outlet or within the culvert. This reduced capacity, in some cases, increases the possibility of ponding at inlets, which may actually increase sediment retention.

  Inlets and outlets for cross-culverts, as well as other drainage systems, are typically overburdened by sediment and other debris due to sediment loads and the need for increased maintenance. Inlets and outlets typically are unprotected and ground cover vegetation at inlets and outlets is limited, providing little or no protection against erosion and scour. The discharge velocities at many outlets causes scour or erosion downslope areas or lake shores, due to this lack of outlet protection.

  Other outlets cantilever out over the lake or are submerged in the lake. These provide excellent protection against scour of the lake bed (and subsequent sedimentation) during normal lake level periods. However, during low lake level periods when the lake bed is exposed, these discharges scour and erode the lake bed, increasing sedimentation and transporting the material to deeper portions of the lake.

5. Hydrology & Analysis of Hydraulic Structures

I. Hydrology and Hydraulics

Hydrology and analysis of hydraulic structures, wetlands and watercourses has been evaluated to determine adequacy for existing and potential development of the watershed. The results of this analysis are tabulated in Appendix II - Drainage Capacity, of this report.

The method used for analysis of existing systems in this report was the Rational Method. The Rational Method is a method of estimating rainfall runoff quantities from comparable drainage areas. The method is suitable for small watershed areas (<200 acres), such as those tributary to the drainage systems in the lake area, and utilizes several factors in estimating the runoff, including time of concentration (the time required for runoff from the most remote point in the drainage area to arrive at the outlet), the characteristics of the land area (i.e. woodlands, lawn areas, paved surfaces, etc.) and drainage area size (the area over which the rain falls, from which it flows over the land to the point of discharge).

Time of concentration for each discharge was determined with the aid of the Seelye nomograph and the Kirpich nomograph, standard charts utilized for determining time of concentration (Tc).

Runoff coefficients (C) used were based on two primary land uses; Residential with a C value of 0.3 and Woods & Rural Residential (primarily woods) with a C value of 0.2.

Drainage areas were determined by first locating the discharges on a base map (Figure 1), then overlaying this map on a USGS topographical map of the watershed. Finally tributary areas for each discharge to the lake where determine utilizing this map and knowledge of the watershed topography. These drainage areas are shown on Figure II - Drainage Areas Map.

Once drainage areas were determined by the Rational Method, they were compared to the capacity of the discharge structure being studied. The structures were analyzed under inlet control conditions with a 2 ft. maximum head since experience indicates that, given the observed conditions and construction of the discharge structures, inlet control flow conditions will likely control. For this analysis, it was assumed that the structures were structurally sound, in good condition, and clear of sediment or debris that might reduce capacity. It was also assumed that maintenance of structures determined to have adequate capacity would be continued in the future. The existing systems provide little or no sediment or pollutant removal capabilities. The majority of these drainage systems were installed "as needed" to convey stormwater runoff to the lake without consideration for sediment and pollutant removal prior to discharge. Thus, while they transmit stormwater discharge efficiently in most cases, significant sediment and pollutant load from tributary areas reaches the lake.

II. Soils Description

The soil types and their corresponding characteristics within the Lake Pocotopaug watershed have been classified by the Soil Survey of Middlesex County, Connecticut. The predominate soil types by name are:

- Canton.
- Charlton.
- Hollis.

The Canton, Charlton and Hollis soils are characteristically excessively drained soils to well drained loamy soils on glacial till uplands. The predominate hydrologic soil group within the lake watershed is Group C. Hydrologic soil groups are typically used to determine peak rates of runoff from a watershed and consist of three classes or groups:

- A - This hydrologic soil group consists of soils with high infiltration rates and low runoff potential.

- B - This hydrologic soil group consists of soils with moderate infiltration capacity and moderate runoff potential.

- C - This hydrologic soil group consists of soils with low infiltration capacity and high runoff potential. The soils within this group typically are sandy clay loam with a layer that impedes downward movement of water. Transmissivity is in the range of 0.05 to 0.15 inches/hour.

The Canton, Charlton and Hollis soils which comprise the majority of the soil types in the watershed have been determined to have a slight erosion problem in their natural state. Canton, Charlton, and Hollis soils typically result in only slight to moderate building development problems mainly due to steep slopes and large stones.

Similarly, individual sewage disposal system construction and development would experience the same limitations as for building development. The soils exhibit marginal qualities for uses like construction of embankments for ponds and grassed waterways due to the presence of large stones, steep slopes and a high erodability potential. Wetlands plants have a poor potential for success in these soil types. Additionally, permeability of these soils range from 0.6 to 6.0 inches per hour to a depth of around 15 to 30 inches typically with a low shrink-swell potential[15].

Given this information, it can be concluded that stormwater infiltration practices in the watershed are feasible as well as the use of grassed waterways and wetlands creation, if properly designed on a location by location basis. The previous data also suggest that the soils present certain development difficulties for building, street construction and septic system construction as well as the need to consider the erosion potential of the soils. This leads to the recommendation for increased review of designs and inspection of construction activities to ensure reduced erosion, sediment phosphorous and nitrogen transport to the lake.

III. Hydrologic Significance of Wetlands

The wetlands in the lake watershed are significant in reducing the nutrient transport and sediment loadings to the lake. Wetland areas further serve to attenuate peak stormwater flows to the lake. Wetlands accomplish nutrient, sediment and organic and non-organic material reductions mainly due to the ability of wetland plants to act as filters and to fix or remove these pollutants from surface waters. However, during the fall and winter, wetland plants decay and release these nutrients. This delayed release after the growing season is unlikely to contribute to the nuisance algae blooms.

Wetland areas also allow reductions in pollutants by permitting water to be retained in generally quiescent conditions, causing removal of suspended sediments. This ability to retain surface water also results in a wetlands capability to reduce or attenuate peak stormwater runoff. This reduces downstream flooding, erosion and sedimentation and turbid lake conditions.

Several wetland areas are located throughout the lake's watershed and are of equal importance in the reduction of sediments and nutrient transport to the lake. Reference should be made to the "Draft Report: Land Use And Phosphorus Input To Lake Pocotopaug" December 21, 1993 Prepared By: Land Use Subcommittee East Hampton Lake Advisory Committee, reference 6 of this report.

The storage capacity of these wetland areas ranges from 2 acre-feet to 135 acre-feet, totaling approximately 400 acre-feet. These areas vary in type from small ponds to large swamps and have available head ranging between approximately 1.5 feet to 5 feet. These areas currently act as sediment basins, particularly the areas with undersized cross culverts.

The potential for stormwater renovation is excellent. The large swampy areas act as filters, removing sediments and absorbing nutrients. They, and the small ponds as well, also act as detention basins, allowing suspended solids to settle and slowing discharge velocities, reducing downstream scour and erosion.

Wetlands, in general, should be kept in their natural state by prohibiting alteration or elimination. They may be enhanced by increasing wetland areas, creating wetlands by constructing them or by increasing the impounded surface water.

IV. Estimated Nutrient and Sediment Export to the Lake

Based upon the data collected for this report, as well as for previously prepared reports, it is well documented that stormwater runoff contributes significant quantities of sediment and nutrients to the lake. The draft report entitled "Land Use and Phosphorus Input To Lake Pocotopaug" prepared by the Land Use Sub-Committee of the East Hampton Lake Advisory Committee, has suggested that approximately 791 pounds per year of phosphorus is contributed to the lake from runoff from watershed land. Of this total, approximately 577 pounds (73%) reportedly emanates from developed areas while the remainder is from undeveloped watershed land.

The watershed for Lake Pocotopaug is primarily wooded which is not as significant a contributor of sediment to the lake. Therefore, the quantity of sediment material transported to the lake from the wooded areas, overall, is relatively small in relation to the area of the entire watershed.

Based upon calculations performed for this report, a total of approximately 4000 cubic feet of sediment is transported to Lake Pocotopaug annually. The area immediately surrounding the lake is fairly dense residential lots and is the primary source of sediments, particularly when a property is being developed and proper erosion and sediment control measures are not utilized.

It is extremely difficult to predict reductions in sediment and nutrient transport to the lake resulting from implementation of the recommendations from this report, due to variables such as frequency of maintenance of the structures, the highly variable nature of storm events, etc. We have, however, attempted to estimate reductions in sediment loads. These estimates are based upon a catch basin with hood removing approximately 50% of the sediment reaching it, a detention structure, such as a gross particle separator, removing 70% and a sedimentation pond removing 80% of the sediment. As noted, these trap efficiencies range from 50% to 80%, and therefore, 100% retention of the sediment is not possible. However, when used in combination, i.e. series, overall removal efficiencies increase.

Sediment retention is only possible if the method used is maintained on a regular basis. A catch basin with a standard 3 foot sump, for example, has only 36 cubic feet of storage. A number of drainage sub-areas produce quantities of sediment that cause one or more of the detention structures to reach storage capacity relatively quickly. Leaves and other debris can greatly reduce the storage capacity of sediment basins and structures and further the need for routine maintenance of these methods.

The following pages present a tabular summary of estimated sediment removal based upon the recommendations of this report, and the removal efficiencies noted. The table also lists the estimated cost of construction (exclusive of easement acquisition, design and construction engineering, contingency, interest during construction and administrative costs) of the recommended structures and the advantages/disadvantages of each.

Reductions in phosphorus loadings are even more speculative than sediment removal, since many of the structures recommended in this report are designed to eliminate the majority of heavier sediments from entering the lake. Reportedly, more phosphorus is contained in the smaller, lighter sediment particles, which are typically passed through catch basins and gross particle separators. The most efficient method of removing smaller soil particles is through the use of wet bottom sedimentation basins with long residence times and limited chance for short circuiting.

Quiescent settling of solids in these types of basins can minimize sediment and nutrient transport to the lake. Based upon this fact, sedimentation basins located in the stream channels entering the lake, will probably have the most effect, in terms of sediment and nutrient removal, and will provide the best cost/benefit of all of the recommendations contained within this report.

Because estimates of reduction of nutrient loadings to the lake are highly speculative, we recommend implementation of the recommendations of this report on a staged basis, allowing for monitoring of water quality pre and post construction of the particular structure. In this manner the Town can determine the success of nutrient and sediment removal on a factual basis. Previously obtained water quality results can be utilized as a basis for these evaluations.

Matrix Of Recommended Options For Watershed Management

Subdrainage Area	*Proposed Construction*	*Estimate of Sediment Removed* (cubic feet/year)	*Estimated Cost*	*Advantages*	*Disadvantages*
A: Hale's Brook WMC Areas 47-49 & 56.	Catch Basin w/ Hood (4) Sediment Pond-47 Gabion Dams (5) Detention Structure Misc. Drainage	36 6 405 21 TOTAL = 468/94%	$7,000.00 79,075.00 72,400.00 5,000.00 204,500.00 TOTAL = 367,975.00	Relatively easy to install. Provides flood storage. Uses natural detention area. Designed for sed. removal.	Small capacity Property or easement req'd Floods upstream areas Maintenance required.
B: Brook @ Candlewood Dr. WMC Area 53	Sediment Pond Misc. Drainage	116/80%	60,550.00 500.00 TOTAL = 61,050.00	Provides flood storage.	Property or easement req'd
C: Unnamed WMC Areas 31,38-40,54 &55.	Catch Basin w/ Hood (5) Sediment Pond-54 Misc. Drainage	61 53 TOTAL = 114/71%	2,500.00 31,250.00 23,750.00 TOTAL = 57,500.00	Relatively easy to install. Provides flood storage.	Small capacity Property or easement req'd
D: Brook @ Spellman's Pt. WMC Areas 32A-C.	Gabion Dam-32A Earth Berm-32B Misc. Drainage	33 85 TOTAL = 118/77%	2,240.00 5,175.00 49,625.00 TOTAL = 57,040.00	Uses natural detention area. Uses natural detention area.	Floods upstream areas Floods upstream areas
E: Unnamed WMC Areas 33,36 &37.	Catch Basin w/ Hood (5) Misc. Drainage	33/88%	8,750.00 42,500.00 TOTAL = 51,250.00	Relatively easy to install.	Small capacity
F: Haven's Brk. WMC Area 34.	Sediment Pond-34 Misc. Drainage	42/80%	138,875.00 55,700.00 TOTAL = 194,575.00	Provides flood storage.	Property or easement req'd
G: Unnamed WMC Areas 23A-B,24-26,35 & 76.	Catch Basin w/ Hood (9) Misc. Drainage	102/72%	13,000.00 43,300.00 TOTAL = 56,300.00	Relatively easy to install.	Small capacity

Trap Efficiencies: Catch Basin w/Hood - 50% Detention Structure - 70% Sediment Pond - 80%
Earth Berm - 80% Gabion Dam - 80%

NOTE: Miscellaneous Drainage includes proposed projects to facilitate the collection of stormwater and upgrade the flow capacities of existing drainage structures/systems.

Subdrainage Area	*Proposed Construction*	*Estimate of Sediment Removed* (cubic feet/year)	*Estimated Cost*	*Advantages*	*Disadvantages*
H: Unnamed WMC Area 27.	Catch Basin w/ Hood (2) Misc. Drainage	68/75%	1,000.00 6,250.00 TOTAL = 7,250.00	Relatively easy to install.	Small capacity
I: Unnamed WMC Areas 28-30A.	Catch Basin w/ Hood (2) Detention Structure Gabion Dam-28 Misc. Drainage	6 309 33 TOTAL = 348/72%	1,000.00 5,000.00 1,120.00 81,500.00 TOTAL = 88,620.00	Relatively easy to install. Designed for sed. removal. Uses natural detention area.	Small capacity Maintenance required. Floods upstream areas
J: Unnamed WMC Areas 9-15.	Catch Basin w/ Hood (4) Misc. Drainage	24/75%	7,000.00 45,850.00 TOTAL = 52,850.00	Relatively easy to install.	Small capacity
K: O'Neil's Brook WMC Area 21.	Sediment Pond Misc. Drainage	144/80%	$148,150.00 9,900.00 TOTAL = 158,050.00	Provides flood storage.	Property or easement req'd
L: Unnamed WMC Area 22.	Catch Basin w/ Hood (4) Misc. Drainage	15/94%	7,000.00 22,750.00 TOTAL = 29,750.00	Relatively easy to install.	Small capacity
M: Day's Brook WMC Areas 16-20.	Catch Basin w/ Hood (4) Misc. Drainage	78/33%	7,000.00 22,300.00 TOTAL = 29,300.00	Relatively easy to install.	Small capacity
N: Unnamed WMC Areas 2-8B.	Catch Basin w/ Hood (13) Misc. Drainage	170/49%	22,750.00 43,325.00 TOTAL = 66,075.00	Relatively easy to install.	Small capacity
O: Swamp @ Welles Avenue WMC Areas 1,71 &72..	Catch Basin w/ Hood (3) Sediment Pond-72 Misc. Drainage	19 111 TOTAL = 130/76%	5,250.00 30,000.00 3,000.00 TOTAL = 38,250.00	Relatively easy to install. Provides flood storage.	Small capacity Property or easement req'd

Trap Efficiencies: Catch Basin w/Hood - 50% Detention Structure - 70% Sediment Pond - 80%
Earth Berm - 80% Gabion Dam - 80%

NOTE: Miscellaneous Drainage includes proposed projects to facilitate the collection of stormwater and upgrade the flow capacities of existing drainage structures/systems.

Subdrainage Area	*Proposed Construction*	*Estimate of Sediment Removed* (cubic feet/year)	*Estimated Cost*	*Advantages*	*Disadvantages*
P: Christopher Brook WMC Areas 59,60, 70,73-75.	Gabion Dam-70 Sediment Pond-59 Sediment Pond-73 Detention Structure Misc. Drainage	242 150 215 6 TOTAL = 613/91%	3,710.00 150,000.00 125,000.00 5,000.00 385,750.00 TOTAL = 669,460.00	Uses natural detention area Provides flood storage. Provides flood storage. Designed for sed. removal.	Floods upstream areas Property or easement req'd Property or easement req'd Maintenance required.
Q: Unnamed WMC Areas 41-43,57,58,61-69.	Catch Basin w/ Hood (23) Detention Structure (2) Misc. Drainage	227 82 TOTAL = 309/76%	26,500.00 10,000.00 92,725.00 TOTAL = 129,225.00	Relatively easy to install. Designed for sed. removal.	Small capacity Maintenance required.
R: Unnamed WMC Area 44.	Catch Basin w/ Hood Misc. Drainage	36/44%	500.00 19,825.00 TOTAL = 20,325.00	Relatively easy to install.	Small capacity.
S: Unnamed WMC Areas 45 & 46.	Catch Basin w/ Hood (4) Misc. Drainage	54/75%	4,500.00 8,250.00 TOTAL = 12,750.00	Relatively easy to install.	Small capacity.
T: Unnamed WMC Areas 50-52.	Catch Basin w/ Hood (7) Misc. Drainage	54/76%	7,250.00 57,650.00 TOTAL = 64,900.00	Relatively easy to install.	Small capacity.
		TOTAL = $2,212,495.00 *(Say $2,213,000)*			

Trap Efficiencies: Catch Basin w/Hood - 50% Detention Structure - 70% Sediment Pond - 80%
Earth Berm - 80% Gabion Dam - 80%

NOTE: Miscellaneous Drainage includes proposed projects to facilitate the collection of stormwater and upgrade the flow capacities of existing drainage structures/systems.

6. Watershed Management Plan

In summary, sedimentation entering the lake is evident at many discharge locations and in several of the coves of Lake Pocotopaug, as documented in Appendix I - Field Reconnaissance Summary and in the many studies and reports done to date and included as reference in Appendix III - References.

Erosion is a natural process whereby soil is worn away from the land by various actions such as wind and water runoff which results in sedimentation of the lake. Sedimentation may be a dominant cause of phosphorus enrichment of lake waters and a contributing factor in the eutrophication of the lake. Sedimentation also reduces water depths, creating shoals which are conducive to the growth of aquatic plants. Associated organic matter, decomposed by micro-organisms, contributes to oxygen depletion in these shallower waters. In addition, sediment can be a carrier for pollutants such as salt, oil and heavy metals (from wear of vehicle parts) from roadways. Thus, it can be seen that control of erosion and sedimentation is an important step in improving the water quality for recreational uses and for ultimately improving the lake.

An evaluation of available data has been conducted, resulting in corresponding specific recommendations for the existing information reviewed. Further, the field reconnaissance of Lake Pocotopaug develops specific recommendations for each stormwater discharge to the lake which should be implemented as part of an overall watershed management plan to reduce the amount of organic material, phosphorus (P),nitrogen (N), turbidity, and sediment presently entering Lake Pocotopaug.

The specific recommendations presented can be summarized in general and follow along with additional general recommendations:

- Community action program implementation:

    1. Conduct annual lake cleanup days or week. Citizens could remove shoreline organics by raking, reclaiming beach sand and reconstructing beaches. Beach reconstruction should be resistant to erosion by increased use of terracing and increased use of vegetative covers.

    2. Annual collection of leaves by the Town in the Lake Watershed Management Zone. In order to encourage action in number 1 above and collection of leaves or other yard debris by residents, provide several community collection dumpsters where residents would deposit racked leaves, yard debris, shoreline organics and debris, etc.

    3. Conduct a revegetation day by providing free or at cost plants and seedlings to Lake Watershed Management Zone residents etc.

    4. Provide Town services to area residents that wish to convert sand beaches to vegetated areas, increase buffers at wetlands and watercourses or develop and/or enhance wetland areas.

5. Continue public education on the effects of land development on water quality, the proper use fertilizers and pesticides, the implications of use of phosphate detergents and washing of automobiles near catch basins, wetlands and watercourses and the implications of failing septic systems, as well as functioning septic systems (increased loadings of phosphorus and nitrate to surface and ground waters that flow to the lake).

6. Provide non-phosphorous fertilizers to Town residents at cost to encourage non-phosphorous fertilizer use and provide instruction on their proper use. Notify property owners of free soil testing conducted by the Connecticut Agricultural Experiment Station to determine the exact need for fertilizer use.

- Construct detention structures along the length of tributary streams. Detention structures could consist of a weir structure to detain flow and increase sediment removal. Where possible, construct sedimentation ponds (sedimentation ponds usually require a greater area and longer time of detained water to reduce sedimentation than detention ponds). Hales Brook should receive priority consideration.

- Require the connection of building drains and roof drains to infiltration systems for all new construction and renovations.

- Require the installation of porous pavements for parking lots and low volume roads. Require the installation of crushed stone drives in place of gravel driveways as a minimum. Pave gravel roads in the watershed.

- Increase monitoring of sewage collection systems in watershed to prevent leakages to the lake. Require mandatory septic tank pumping once every three to five years as a minimum.

- Require design of new septic systems to consider reduction of phosphorus and nitrogen levels in leaching structure effluent to meet drinking water standards by the time the effluent either crosses a property line or reaches a body of water.

- Reduce the frequency of lake drawdowns and chemically treat in-lake sediments (use of aluminum sulfate {alum} with sodium aluminate {to prevent changes in lake pH} to form a 1-2 inch layer of aluminum hydroxide which will cover sediments rich in phosphorus thus reducing internal loading) in order to reduce sediment resuspension and erosion at discharge points to the lake.

- Concurrent with lake drawdowns, "dry" excavate unconsolidated sediments at discharge points.

- Dredge lake coves and other areas to remove sediments and increase lake depth.

- Install hoods on existing catch basins to reduce floatables and sediment transport to the lake.

- Install new drainage systems with designed sediment and organics removal. Install street curbing along the lake, catch basins with sumps and hoods and gross particle separators designed for the first flush of stormwater.

- Increase inspection and maintenance of drainage structures.

- Increase inspections of erosion and sediment controls and of new septic system construction.

- Increase fines for non compliance.

- Install shoreline protection and revegetate shoreline.

- Install inlet and outlet erosion protection for drainage structures.

- Install stream bank stabilization, revegetate banks.

- Revise/amend Zoning regulations and land zoning and consider an overlay zone for the lake.

- Revise and amend Subdivision regulations.

- Revise and amend Wetland and Watercourse regulations.

- Revise and amend Road Standards.

- Land acquisition of environmentally sensitive areas.

- Require boat ramp construction to be erosion resistant.

- Increase street sweeping and maintenance on an as needed basis.

- Monitor existing land uses for consistent use.

- Require implementation of best management practices for agriculture in the watershed. Contact the USDA-Soil Conservation Service, the Univ. of Connecticut Cooperative Extension Service and the Connecticut Agricultural Experiment Station for further assistance regarding:

    1. Winter cover crops.
    2. Terracing.
    3. Fencing to protect wetlands.
    4. Stormwater diversion and runoff treatment.
    5. Storage areas for animal wastes.

- Discourage large flocks of waterfowl by construction of walls and revegetating shores with shrubs.

7. Costs and Funding

Many of the recommendations contained in this report are non-structural in nature, primarily addressing existing Town regulations and policies. Following review of these recommendations by the appropriate agencies, boards or commissions, these recommendations should be relatively straight forward to implement.

Other recommendations are structural in nature, and will require construction of catch basins, detention structures and sedimentation basins. Typical structures that can be utilized are shown in Appendix VI.

A matrix of recommended improvements was presented on pages 18 - 20 of this report, along with an opinion of the construction cost for implementing the recommendations. The estimated construction cost of these recommendations is significant, amounting to approximately $2,213,000. These costs are based upon contracting out the construction work, and significant cost savings can be realized by having Town forces due much of the work. Provided with appropriate budgets and manpower, the recommended structural solutions contained in this report can be performed by the Town public works department.

Other costs which must be added to the construction costs are summarized below:

Estimated Construction Cost	$2,213,000
Engineering, Legal & Administrative Costs (30%)	$ 664,000
Contingency (10%)	$ 222,000
Easement Acquisition (1%)	$ 23,000
Total Estimated Cost	$3,122,000

Grant Program

Sources of grant funds should be explored for providing funding towards implementation of the recommendations of this report.

One source of grant funds appears to be the Federal Clean Water Act, Section 319 grants. This grant program may be suitable for Lake Pocotopaug, since it can provide funding for projects such as those recommended herein, and the program does not require public access to the lake. Importantly, this report can serve as a basis for applying for funding under the program.

The 319 program can provide 60% grant funds with a 40% match with Town funds or in-kind services. Typically, the State of Connecticut receives approximately $800,000 annually from the Federal government for this program.

Many projects compete for the funds and because of the funding limitations, the Town could not obtain full funding for the entire project recommended in this report. Typically, grants are in the $50,000 range.

Due to the local interest in preserving Lake Pocotopaug, it is recommended that the Town break the project up into smaller sub-projects, and apply for these funds as soon as possible.

As noted, this report can serve as a basis for the funding application, and WMC will prepare the application on behalf of the Town, if so desired.

Appendix I - Field Reconnaissance Summary

The following format is used to describe and locate the results of the watershed field reconnaissance:

Point No.) Location
- Land Use
- Description of Evidence, Source & Type Of Pollution Likely Cause Or Evident Cause Of Pollution.
- Recommendations To Reduce Or Eliminate Pollution Source.

Certain types of stormwater discharges and types of pollution or other input into the lake which would, overall, lead to a degradation of the lake's water quality occur frequently in the watershed. A brief explanation of these proceed the detailed descriptions and recommendations in the field reconnaissance in order to reduce repetitive descriptions, explanations, and recommendations.

<u>These are:</u>

1. The presence of leaves or other organic composting adjacent to the lake results in leaching or nutrients and discharges of organics to the lake where they eventually add to the nutrient load on the lake. The reduction of nutrient input/loading has been determined to be a means of controlling and reducing the nuisance algae blooms and turbidity of the lake.[5]

   The noted presence or description of organics at a point in the detailed field reconnaissance would indicate the previously stated reasons for concern and the following general recommendation.

   - Request and inform lake front and adjacent landowners to collect and compost at the Town's compost area, leaves and other debris which may make it's way to the lake.
   - Remove the debris encroaching into streams, wetlands or with a specific distance of a wetland or watercourse.

2. Stormwater runoff over paved surfaces, like parking lots and street/highways washes these impervious areas of deposited sediments. These sediments may consist of organic material and inorganic material. Of even greater concern is the washing of oils and floatables into the lake along with these sediments.

   The noted presence or description of untreated stormwater runoff from impervious areas at a point in the detailed field reconnaissance would indicate the previously stated reasons for concern and the following general recommendation.

   - Installation of catch basins with sumps and hoods as a minimum is recommended. While catch basins with sumps and hoods are gross particle separators in a sense; they are not specifically designed as such.

- Where specifically identified, a gross particle separator (GPS) designed to treat the first flush of stormwater should be installed. The first flush of stormwater is typically the first inch of runoff and the treatment of this volume provides three identifiable benefits: The first being the removal of oils, floatables and fine sediments, thus reducing lake turbidity and improving lake water quality; The second being the treatment of first flush of stormwater flow enables the GPS to be designed significantly smaller and less expensive; and Thirdly, the GPS then would typically require less maintenance than a GPS that would attempt to treat all stormwater flows.

3. The use of land for beaches and boat ramps is consistent with the overall use of the lake, however these areas typically provide sediment to the lake as evidenced by topography, erosion of adjacent steep banks from concentrated runoff, erosion of sand and exposed earth, sediment in the lake and scour holes from boating activity.

   The noted presence or description of a beach area or boat ramp areas at a point in the detailed field reconnaissance would indicate the previously stated reasons for concern and the following general recommendation.

   - Replace sand boat ramp/beaches with grassed land or installation of a crushed stone boat ramps or similar erosion resistive cover for this and other ramps/beaches. The use of silt fencing or sand bags in place of the former recommendation could be utilized as a minimum or temporary improvement.

4. Where untreated stormwater runoff from roads or other sources flows overland and leaks off to unprotected soils, typically, the result is repeated erosion and sedimentation of the lake or tributary wetland or watercourse. In addition to these concerns, the untreated runoff provides additional sediment that may consist of organic material and inorganic material. Of even greater concern is the washing of oils and floatables into the lake along with these sediments.[6]

   The noted presence or description of these non storm drainage areas or road leak-offs to overland areas at a point in the detailed field reconnaissance would indicate the previously stated reasons for concern and the following general recommendation.

   - Install curbing and cb's with sumps and hoods. Construct discharges to a stable non-erosive outlet, a riprap splash pad to grass lined swale to riprap outfall at lake. An alternative would be the installation of a discharge pipe to a riprap plunge pool at the lake. Swales could incorporate drops (small dams) to catch sediment and slow the runoff velocity.

5. The erosion of the lake shoreline by wave action undercutting lake banks and erosion of nearby land due to lack of vegetation to protect against stormwater runoff adds sediment to the lake resulting in reduced lake depths and input of organics/nutrients to the lake.

The noted occurrence of shoreline erosion, lake bank under cutting and near shore areas eroding would indicate the need to implement the following recommendation to reduce sediment and organics/nutrient loading to the lake.

- Install riprap shoreline protection or stone gabion walls to protect the shore from further erosion. This will also serve to limit lake encroachment by unauthorized filling activities. The adjacent land should be revegetated or vegetation that covers and fixes soils preventing erosion should be planted. This may include various types of grasses, native shrubs and trees, all of which should act as a filter strip removing most sediments from upslope areas. The restriction of recreational users and unauthorized use should be encouraged to prevent damage to the vegetated filter strip areas and prevent further loss of vegetation covering soils with a high erosion potential.

Field Reconnaissance of Lake Pocotopaug Watershed

1) Wells Ave. Lot #1

- Cottages
- Leaves composting/leaching of nutrients from the leaf compost pile, swale discharging to the lake and scouring.
- Install catch basins (cb) with hoods at the end of Wells Ave. and discharge to a grass swale. Request and inform lake front and adjacent landowners to collect and compost at the Town's compost area, leaves and other debris which may make it's way to the lake.

2) West Point Rd.

- Cottages
- 12" CMP discharging from catch basin (cb)in West Point Rd. to the lake, pipe is submerged when the lake is at its normal level. The outfall is eroding and scouring the lake bed during draw downs of the lake. Runoff from the road transports typical sediments and associated organics and inorganics.
- Install catch basin (cb) with sump and hood to trap heavy sediments and retain "floatables" such as oils and leaves. These installations require regularly scheduled maintenance with vacuum type catch basin cleaning equipment. Install riprap/plunge pool at the pipe outlet to reduce scouring of lake bed during low lake level periods.

3) West Point Rd. Opposite pole #368

- Cottages
- 12" CMP discharging from catch basin (cb) in West Point Rd. to the lake, pipe is submerged when the lake is at its normal level. Basin with low sump and debris in basin. The outfall is eroding and scouring the lake bed during draw downs of the lake. Runoff from the road transports typical sediments and associated organics and inorganics.
- Install catch basin (cb) with sump and hood to trap heavy sediments and retain "floatables" such as oils and leaves. This installations require regularly scheduled maintenance with vacuum type catch basin cleaning equipment. Install riprap/plunge pool at the pipe outlet to reduce scouring of lake bed during low lake level periods.

4) Donut Shop & Wells Rd.

- Cottages
- Pavement runoff from the Donut Shop and the existing roadway. Parking lot runoff, roadway runoff, as well as neighboring lawn runoff discharging to the lake. Runoff from the road transports typical sediments and associated organics and inorganics to the lake. Lawns are typically fertilized and leach nutrients to the lake.
- Install catch basins (cb) with sump and hood to trap heavy sediments and retain "floatables" such as oils and leaves. This installation require regularly scheduled maintenance with vacuum type catch basin cleaning equipment. Install riprap/plunge pool at the pipe outlet to reduce scouring of lake bed during low lake level periods.

5) The Chatham Apartments

- Parking lot
- Parking lot and runoff from the road transports typical sediments and associated organics and inorganics to the lake. This runoff drains, untreated, directly into the lake.
- Install catch basins with sump and hood and maintain these installations. Install riprap/plunge pool at the outlet to reduce scouring of lake bed. Request and inform lake front and adjacent landowners to collect and compost at Town compost area, leaves and other debris which may make it's way to the lake.

6) High Street.

- Beach front/boat ramp
- Erosion of steep banks from concentrated runoff as evidenced by topography, erosion of sand and exposed earth and sedimentation of the lake.
- Replace sand boat ramp/beaches with grassed land or installation of a crushed stone boat ramps or similar erosion resistive cover for this and other ramps/beaches. The use of silt fencing or sand bags in place of the former recommendation could be utilized as a minimum/temporary improvement. During lake drawdown, provide silt fence or staked hay bales at low waters edge to prevent beach sand from transport to deeper sections of the lake.

7) Rt. 66 at "beach" and near poles #756 & 757.

- Road/Highway
- Road as previously described contributes to degradation of the lake. Runoff from the high point of Rte 66 near West St. concentrates along the lake side gutter and discharges via a road leak-off to the lake and beach area causing erosion and sedimentation of the lake as evidenced by topography eroded slopes at leak off area and sediment at/in the lake.
- Replace the current method of draining Rte 66 (gutter flow to a paved leakoff) with curbing and catch basins with sumps and hoods. Protect outlet for new discharge location with riprap plunge pool and riprap swale extending into the lake in order to prevent scour/erosion of the lake bed. Revegetate the old beach area up to the lake's edge. Install riprap slope protection in steep highway bank areas.

8a) Rt. 66 at shore between pole # 756 & 757

- Roadway/beach front.
- Untreated stormwater from the catch basin at the southern edge of Rt. 66, where a 36" dia. reinforced concrete pipe (rcp) discharges at an endwall without scour/erosion protection. Erosion of the beach, and excessive velocity at the outfall with no erosion protection is evidenced by scouring and sediment delta.
- The implementation of 7)'s recommendation and the installation of a riprap plunge pool and riprap discharge swale extending into the lake in order to reduce scour, erosion and sedimentation. Improve beach area per 7)'s recommendation above.

8b) Rt. 66 at shore between pole # 756 & 757

- Roadway/beach front
- Runoff from the catch basin at the southern edge of Rt. 66, discharging through a 24" dia. RCP at the endwall. Erosion of the beach, and excessive velocity at the outfall with no erosion protection.
- Implement the recommendations of 7) and 8) at this location too.

9) Rt. 66 at shore between pole #757 & 756.

- Old Beach/shore area.
- Wave Erosion, lake wave action washes beach sands into the lake reducing water depths as evidenced by extent of sand into lake and erosion of bank areas.
- Revegetate the old beach area up to the lake's edge install riprap slope protection in steep highway bank areas.

10) End of Meeks Pt. Rd. near home #71.

- Road/Residential.
- Untreated stormwater runoff leaking off and concentrating and flowing overland to the lake causing erosion and sedimentation of the lake. This is evidenced by the eroded swales in the area and deposits of sediment along the flow path to the lake.
  Further confirmation was obtained from interviewing a local resident.
- Install curbing and cb's with sumps and hoods at the west side near the end of Meeks Point Road. Construct discharge to stable non-erosive outlet (a riprap splash pad to grass lined swale to riprap outfall at lake). An alternative would be the installation of a discharge pipe to a riprap plunge pool at the lake)

11) End of Meeks Pt. Rd. at home #49.

- Road/Residential.
- Untreated stormwater runoff leaking off and concentrating flow to a small hand dug dirt swale depositing sediment into the lake. Runoff is from the high point of Meeks Hill Rd. Evidence is identical to 10) above.
- Install curbing and cb's with sumps and hoods at the west side near the end of Meeks Point Road. Construct discharge to stable non-erosive outlet (a riprap splash pad to grass lined swale to riprap outfall at lake. An alternative would be the installation of a discharge pipe to a riprap plunge pool at the lake). Swales could incorporate drops (small dams) to catch sediment and slow the runoff velocity.

12) Meeks Pt. Rd. opposite pole #193.

- Road/Residential.
- New construction with exposed soils is a potential source for erosion and sedimentation by wind and stormwater runoff. Some sediment on the road from tracking was evident.
- Implement temporary cover for stock piled fill if exposed for more than one month.

13) Meeks Pt. Rd. near pole #196.

- Residential.
- Erosion of exposed soil stockpile, sedimentation of downslope drainage swale that flows to the lake. This is evidenced by topography and sedimentation adjacent to and downslope of the soil stockpile, the swale along the length of Meeks Point and discharges to the lake.
- Enforcement of erosion and sediment control regulations. Require temporary vegetative cover and installation of silt fence/sediment control measures.

13b) Meeks Pt. Rd.

- Residential.
- 12" pvc yard drain outlet
- Untreated stormwater runoff, provide sump with hood.

14) End of O'Neill Lane.

- Residential.
- Bank erosion at the lake as evidenced by soil deposition in lake and bank undercutting. The erosion of lake banks caused by exposed and unprotected soils to wave action.
- Protect the bank with riprap and revegetate where appropriate.

15) Cove at O'Neill Lane, O'Neill's Brook.

- Road/Residential/Commercial
- Dredged material from the cove placed near the shore is eroding back to the cove. Stormwater runoff from adjacent lands is eroding exposed soils and causing sedimentation of the cove as evidenced by adjacent delta with like soils. It is likely that the majority of these materials and the noted shallow depth of the cove with several deltas is due to the documented upstream failure of the Rte. 66 condominium development's detention pond, since the lands surrounding the cove appear to be flat and well vegetated, or non-erosive in nature.

- It is recommended that the cove be dredged to increase its depth, provide additional storage/settling area for future inputs and removal of organics with associated nutrients. The dredging spoils should be removed from the immediate area of the lake or if too wet, contained in upland areas with appropriate erosion and sedimentation protection in place to prevent migration of the material back to the lake. The banks of the cove should be protected with riprap to prevent further undercutting/erosion.

16) O'Neill Lane

- Wetland swamps, O'Neill's Brook.
- Encroachment into the swamp areas, leaves and miscellaneous residential debris encroach into wetlands/swamps.
- Request and inform lake front and adjacent landowners to collect and compost at Town compost area, leaves and other debris which may make it's way to the lake. Require landowners to remove debris from swamp/wetlands area while issuing a cease & desist order if the individuals responsible can be identified.

17) Old Marlborough Rd

- Day's Brook
- Stream outlet point to the lake, minor erosion and sedimentation as evidenced by the fine sand delta at the lake.
- Reconstruct swale to a size appropriate for it's drainage area, replant vegetation in and along the swale, create drops and catchments to retain sediment and install a riprap plunge pool at the stream outlet .

18) Marlborough Rd.

- Road/Residential/Lawn.
- Untreated stormwater runoff from yard drain in the lawn area of Home No. 16 and street runoff. It should be noted that the discharge point is just upslope of the waterfront home opposite the yard drain. The discharge is to an endwall and then flows overland to the lake under the adjacent house.
- Install new cb with sump and hood to discharge to a new vegetated swale and install a riprap plunge pool at the stream outlet.

19) Marlborough Rd. home #16

- Residential.
- Stormwater runoff on steep gravel driveway causing erosion and sedimentation as evidenced by sand in and along the road leading to Day's Brook.
- Install cbs with sumps and hoods, pave steep gravel drives adjacent to swales, add vegetated collector swales along roadside to direct flows the brook as an alternative to installation of catch basins.

20) Marlborough Rd. near/at pole #766.

- Agricultural/residential. Day's Brook
- An 18" corrugated metal pipe (cmp) culvert drains wetlands and upslope greenhouses area where new construction was on-going. See also point number 17 descriptions.
- Reconstruct swale to a size appropriate for it's drainage area, replant vegetation in and along the swale, create drops and catchments to retain sediment and install a riprap plunge pool at the stream outlet.

21) Marlborough Rd. near/at pole #774, O'Neill's Brook.

- Agricultural/Residential.
- A 32" CMP cross culvert drains wetlands, O'Neill's Brook and detention basins upstream which are a likely source of nutrient loading to the lake as evidenced by the algae growths witnessed in the detention pond. Stormwater discharges are eroding the swale banks both upstream and downstream as evident by the deep bank under cutting along the swale. Some apparent encroachment into wetlands with debris was also observed both upstream adjacent to the greenhouses and downstream at a residence.
- Cease and desist orders for both upstream and downstream owners should be issued once the exact extent of encroachment has been determined. The owners should then be required to remedy the situation. The greenhouse detention basin should be inspected by the owners and the Town to determine if it is functioning as intended and cleaned if necessary.

The existing swale to the lake should be cleaned of sediment, revegetated and provided with catchments to collect sediment. At the upstream point of the culvert, installation of a detention structure would retain additional sediments and nutrients.

22) Day's Point Rd.
- Road/Residential.
- Untreated stormwater runoff as evidenced by the lack of drainage system and sediment accumulation at low points in the road which eventually migrate to lake.
- Installation of a storm drainage system utilizing catch basins with sumps and hooded outlets. Additional roadway sweeping in this area should be required.

23) Wangonk Trail at pole #1533
- Road/Residential.
- A 15" cmp discharges street drainage to the lake. The outfall is eroding and scouring the lake bed during drawdown or low lake level periods. Untreated stormwater discharge.
- Install catch basins (cb) with sump and hood to trap heavy sediments and retain "floatables" such as oils and leaves. These installations require regularly scheduled maintenance with vacuum type catch basin cleaning equipment. Install riprap/plunge pool at the pipe outlet to reduce scouring of lake bed during low lake level periods.

24) Wangonk Trail.
- Road/Residential.
- Steep unprotected slopes appear to be eroding to the lake causing sedimentation as evidenced by rill type erosion of the slopes. Untreated stormwater discharges to the lake from cb.
- The steep slopes adjacent to the lake in this area should be revegetated with the use of erosion control netting to ensure success. Further runoff above the slope should be redirected away from the slopes to prevent further erosion. Installation of a hood on the outlet of the existing cb should be installed along with outfall outlet protection.

25) South Wangonk Trail lot # 4.
- Beach front/boat ramp.
- Sand fill without erosion and sediment protection is eroding to the lake as evidenced by erosion of sand and exposed earth and sedimentation of the lake.
- Riprap the banks of the beach area, replace sand boat ramp/beaches with grassed land or installation of a crushed stone boat ramp or similar erosion resistive cover. The use of silt fencing or sand bags in place of the former recommendation could be utilized as a minimum/temporary improvement.

26) Terminus of Poe Trail.
- Parking lot/beach.
- Erosion of gravel parking area as well as beach erosion into the cove due to street stormwater runoff, wave erosion and runoff erosion at the 4" pvc ramp drain as evidenced by topography lack of drainage system, erosion of soils at the drain and lake bank undercutting.
- Install catch basins with sumps, hoods, revegetate the existing swale and remove the ramp drain.

Riprap the banks of the beach area and replace sand boat ramp/beaches with grassed land or installation of a crushed stone boat ramp or similar erosion resistive cover. The use of silt fencing or sand bags in place of the former recommendation could be utilized as a minimum/temporary improvement.

27) Clearwater Estates near pole #214.

- Road/Residential.
- A 12" pvc stormwater drainage pipe from the Clearwater Estates discharges into the lake causing erosion of the lake bed and sedimentation as evidenced by the presence of a scour hole and proceeding delta. The pipe drains a yard drain in a lawn area and several cb's in the parking areas.
- Install sumps and hoods on existing cbs, increase the length of the existing 12" pvc extending further into the lake and install a riprap plunge pool at the outlet point.

28) Brook Trail at Pole #213.

- Road/Residential.
- An 18" cmp and a 12" pvc discharge untreated stormwater runoff into an existing unprotected swale causing bank erosion of the swale. At the outfall of the swale, an 18" rcp discharges to the beach area. Erosion and sedimentation is evidenced by the swale bank undercutting and scour and sediment deposition at the outfall locations.
- Install sumps and hoods on existing cbs, increase the length of the existing 18" rcp and install a riprap plunge pool at the outlet point. Install sediment/debris traps in the existing swale. Revegetate swale with erosion netting to ensure success.

29) Hawthorne Street at intersection with Mark Twain at pole #224

- Road/Residential.
- A 42" rcp carrying a combination stream and street stormwater drain discharges to the lake causing erosion and sedimentation as evident by the scouring and sediment delta at the outfall location. Several gravel streets in this section of Town result in tracked sediment onto paved roads which was evident at the time of the survey.
- Pave gravel roads or install crushed stone on Lowell Road and Tennyson Road. Install riprap plunge pool at outlet. Dredge cove at storm drain outlet. Install a Gross Particle Separator (GPS) just upstream of discharge to the lake. Adjacent private land could be utilized for a first flush sedimentation and detention basin as an alternative to a GPS.

30A) Emerson/Hawthorne Rds."lot 3".

- Road/Residential.
- Stormwater discharge from a 15" steel pipe from a yard drain, erosion at outlet as evidenced by scour and sediment at discharge point.
- Install hood on outlet pipe from catch basin. Install riprap outlet protection or plunge pool to protect against scour and sedimentation of lake.

30B) Rte. 66 near pole number #802.

- Road/Woods.
- This low area, that eventually drains to the lake, is evident per topography and does not currently appear to be a major source.
- Depending upon upstream development, the area could be utilized for the installation of a sedimentation basin to treat stormwater prior to discharge to the lake.

31) Terminus of Spellman Point Road.

- Resident/roadway.
- Stormwater discharge to the lake via an 18" RCP. Debris and sediment at outfall, scouring of lake bed evident.
- Install riprap plunge pool/splash pad at outfall and install hoods on cb outlet pipes.

32-A) Bay Road/Spellman Point Road at cove at pole #1203 near pump station location.

- Residential/roadways & woods.
- Fawn Hill Brook discharge to lake transporting sediment and nutrients. This is evidenced by 24" CMP cross culvert draining the upgradient wetlands, erosion of stream bank and scouring and sedimentation at brook discharge to lake.

- Installation of riprap plunge pool at outlet of culvert at Bay Road, revegetate stream with spot erosion control netting, provide stream elevation drops with catchment areas for sediment (small earth/riprap protected berms) along length of stream. Improve inlet of culvert to detain and retain additional stormwater.

32-B) lake Drive near pole #2391, Sample Points "19 & 20".

- Woods/roadway.
- Fawn Hill Brook drains upslope areas and roadway and flows to Bay Road at point 32-A described above. Untreated road runoff and increased flows produce flows causing erosion of stream banks as evidenced by stream bank erosion and sedimentation transport to lake. A 24" rcp cross culvert drains upstream wetlands and 18" rcp outlets from street drainage system to the downstream side of the cross culvert.
- Install hoods on existing catch basins and provide riprap outlet protection at 18" rcp discharge point. Provide spot stream bank protection down to point 32-A.

33) Bay Rd./Lake.

- Roadway/Residential.
- Wave action is causing erosion on unprotected shoreline areas as evident by lake bank erosion.
- Provide lake bank stabilization with riprap, gabions or reinforced concrete walls.

34) Bay Rd./Lake Cove, Hazen's Brook.

- Woods.
- Stream transporting debris and sediment to Lake cove as evidenced by unconsolidated/organic material delta and shallow waters. Reduced wetlands areas due to leaves and brush encroachment into wetland areas.
- Require landowners to remove debris from wetland areas while issuing a cease & desist order if the individuals responsible can be identified. The installation of a small sedimentation basin above the nearby pump station at the 12" cmp culvert would aid in the reduction of sediment and other loading s to the lake. The cove should be dredged of unconsolidated material to increase water depths and remove a source of nutrient input to the lake. If the upstream sedimentation pond was constructed it could serve as a retention pond for dredging activities.

35) Wangonk Trail.

- Beach Area/Roadway/Residential.
- Erosion of the steep sandy beach due to exposure and steepness of slope is adding sediments to the lake as evidenced by rill type erosion of the beach and sediment in the lake at this point.
- Terrace the sand beach area and install a grass or other vegetative type landscaping strip in front or the lake and each terrace wall to catch eroding sand and to reduce exposed sand. Install steps for users and install minor drainage to prevent concentrated runoff erosion of the beach area. The use of silt fencing or sand bags in place of the former recommendation could be utilized as a minimum/ temporary improvement.

36) Bay Rd. at home #57.

- Residential/Roadway.
- Untreated stormwater discharges to the lake via a 4" steel yard drain. Sediment from the roadway/driveways as well as lawn discharges direct since yard drain was almost completely full and small in size.
- Install cb with sump and hood redirecting driveway drainage to the catch basin; the basin should only minimal maintenance due to the limited drainage area.

37) Bay Rd. at pole #2905.

- Roadway/Residential.
- Runoff concentrated from low point in Bay Road onto gravel driveway causing erosion and sedimentation as evident by sediment and topography.
- Install storm drainage system with curbing along the lake side of Bay Road discharging to point 34.

38) Spellman Point/Marshall Rd.

- Residential/Roadway.
- Storm drainage discharge to the lake via an 18" RCP flared end transporting organics to the lake as evidenced by debris in outlet pipe and scour erosion at outlet pipe
- Clean the sumps of two street and one yard type catch basin of debris and remove accumulated debris around the yard drain. Install hoods on the outlet pipes of the basins and install riprap outlet/splash pad (plunge pool) at the 18" rcp flared end section.

39) Spellman Point Rd. at "Lund/Kroeber Mailbox" & pole # 319.

- Residential/Roadway.
- Debris at the edge of the lake bank is falling into the lake adding organic and sediment as evidence by debris in the lake at this point.
- Request and inform lake front and adjacent Landowners to collect and compost at the Town's compost area, leaves and other debris which may make it's way to the lake. Require landowners to remove debris encroaching into the lake while issuing a cease & desist order.

40) Spellman Point Rd. at House No. 81

- Residential.
- New Construction location with potential sedimentation into the lake via overland flow or the storm system.
- Continue inspections of erosion and sediment controls. Require the owner/contractor to re-install some areas of incorrectly maintained silt fence, install an anti-tracking pad to prevent sediment transport on to roads.

41) Lake Drive at West Boulevard.

- Roadway/Residential.
- Sediment and organic material being carried into the lake via catch basin and 18" rcp as evidenced by sediment and organics in catch basin and at outfall.
- Clean basin sumps and install hood on existing outlet pipe from catch basin. Extend the storm drain outlet to the lake and install a riprap plunge pool.

42) Lake Drive

- Roadway/Residential.
- Wave erosion of lake shoreline as evidenced by lake bank undercutting.
- Protect shoreline from wave erosion with placed riprap and/or gabions. Revegetate with grass, shrubs and trees along the shoreline of the lake.

43) Lake Drive.

- Roadway/Residential.
- Stormwater discharge to the lake via 15" rcp.
- Clean basin sumps and install hood on existing outlet pipe from catch basin. Install a riprap plunge pool at outfall. Protect lake bank from erosion by use of riprap and revegetate along the shoreline of the lake.

44) Lake Drive.
- Roadway/Residential.
- Stormwater discharge to the lake via a 20" RCP.
- Clean basin sumps and install hood on existing outlet pipe from catch basin. Install a riprap plunge pool at outfall. Protect lake bank from erosion by use of riprap and revegetate along the shoreline of the lake.

45) Lake Drive.
- Roadway/Residential.
- Untreated stormwater discharge via a 4" PVC at the roads edge to the lake.
- Install catch basins with sumps and hoods on outlet pipes, extending the outlet to the lake at new riprap plunge pool. Protect lake bank from erosion by use of riprap and revegetate along the shoreline of the lake.

46) Lake Drive at House No. 53.
- Roadway/Residential.
- Direct discharge to lake via catch basins and 10" cmp. Organics and sediment to the lake and scour erosion at outfall as evidenced by material at outfall and scour in lake.
- Clean existing catch basin sumps or provide new basins with increased sump capacity. Install hoods on outlet pipes from catch basins. Install a riprap plunge pool at outlet.

47) Lake Drive near Lakewood Road.
- Roadway/Residential.
- Untreated stormwater discharge to the lake via a roadside 15" rcp cross-culvert at a low point in Lake Drive. An 8" clay pipe discharges to just upstream of the 15" rcp cross culvert inlet. Organics and sediment discharged to the lake as evidenced by material at outfall at lakes edge. Scour erosion also evident at outfall location.
- Installation of a small sedimentation pond is possible on this undeveloped lot and should be considered in place of this recommendation install a smaller pipe sized to restrict flow an detain stormwater. Install riprap plunge pool and riprap swale at the drain outlet.

48) Lake Drive near Lakewood Road.
- Roadway/Residential.
- Stormwater discharge to lake via a 12" cmp from a single catch basin at Lakewood Road; catch basin drains roads and lawns areas. Observed scour erosion and transported organics and sediment at 12" cmp outfall location.
- Install catch basins with sumps and hoods in Lake Drive and in Lakewood Road. Install riprap plunge pool and riprap swale at the drain outlet.

49) Lake Drive at Hales Brook.

- Roadway/Residential/Woods.
- Non-point source Hales Brook as evidenced by reduced water depths upstream and downstream of Lake Drive as well as the unconsolidated deposits forming a 100 ft+ delta into the lake. Hales Brook flows under Lake Drive via three cmp culverts; two 40"x24" culverts (one at a lower elevation than the other two culverts) and one 42"x28" cmp culvert. Upstream along the brook, new construction without proper erosion and sedimentation controls was observed, along with encroachment into the wetlands with leaves and miscellaneous debris. The gravel road also adds sediment as evidenced by some erosion of the road surface.
- Upstream along Hales Brook, install catchments (small earth berms)to retain sediment and organics. Dredge area along brook and in brook just upstream of Lake Drive and dredge unconsolidated sediment delta at outfall to the lake.
  The upstream area should be increased in depth to increase potential for sediment removal (Ref.5 p41). Install riprap inlet and outlet protection for culverts and riprap channel swale extending into lake to reduce scouring during high stream flows and/or low lake level periods.

50) Lake Drive near Hale Road.

- Roadway/Residential.
- Concentrated stormwater runoff from roadway transports sediments from street and fines from Hales Road, a gravel surfaced road as evident by washed sand into Lake Drive and sediment at low point that leaks off to the lake.
- Pave or provide crushed stone surface for gravel roads in the watershed. Install catch basins with sumps and hoods. Install curbing on the lake side of Lake Drive.

51) Lake Drive near Mott Hill Road.

- Roadway.
- Discharge street runoff to lake via a catch basins at Mott Hill Road. A 15" RCP outlets to the lake with scour erosion at the outfall.
- Install hoods on the existing catch basin outlet pipes. Install riprap plunge pools at drain outlet at lake.

52) Lake Drive and Candlewood Drive.

- Roadway.
- Stormwater discharge to the lake via catch basins discharging to the lake
- Install hoods on existing catch basins outlet pipes. Install riprap plunge pool outlet protection for drains at lake. Additionally, redirect this existing discharge to point number 53 described below, at the upstream inlet side of the culvert at point number 53.

53) Lake Drive at pole #642.

- Roadway.
- Non point source stream discharges to the lake via a 36"w x 24"h box culvert.
- Install inlet and outlet riprap protection. Increase inlet pool size to act as sediment pond and, if possible, install sediment basin at undeveloped lot between Candlewood Drive and inlet of this culvert. Install catchments along stream to reduce sediment and organics to the lake. Revegetate spot areas with grass and shrubs. Install sediment pond at inlet to 15"cmp cross culvert at Raymond Road. Request and inform landowners to collect and compost at the Town's compost area, leaves and other debris which may make it's way to the lake.

54) Lake Drive near Raymond Road at pole #944.

- Roadway/Woods.
- Non point source stream discharges to lake via a 15" cmp cross culvert.
- Install riprap inlet and outlet protection. Create inlet pool to retain sediment. Spot revegetate with grass and shrubs.

55) Lake Drive at mail box 111 near pole #946.

- Roadway.
- Road stormwater discharge to the lake via 15" rcp, scour erosion at outfall and organics and sediment transport to the lake as evidenced by material at outfall and scour hole. Non-point source. Runoff from the roadway.
- Install hood on existing catch basin outlet pipe. Install riprap outlet protection at drain discharge to lake.

56) Mott Hill Road at pole # 970 (A.K.A. Brewer Rd. per USGS) "Sample Pt. 14".

- Woods.
- Non-point source, stream discharges under Mott Hill Road via a 24" rcp cross culvert to the confluence with Hales Brook.
- Install riprap inlet and outlet protection at 24" rcp cross culvert while forming inlet and outlet pools to retain sediments. Install sediment catchment/detention structure on the downstream side of the road prior to the confluence with Hales Brook.

57) Boulder Road.

- Roadway/Residential.
- Non-point source, new construction with exposed soils unprotected downslope area by improperly installed silt fence but tracked sediment on road surface. Miscellaneous encroachment with yard debris into wetland areas. Sedimentation and erosion of gravel driveways occurring near the top of the hill as evidenced by silt and sand deposits.
- Require installation of anti-tracking pad at construction sites by owner/contractor. Increase inspections of construction activities requiring earth work or the disturbance of soils. Request and inform lake front and adjacent landowners to collect and compost at Town compost area, leaves and other debris which may make it's way to the lake. Install crushed stone driveways or pave.

58) Terminus of Ola Road.

- Roadway/Residential.
- Non-point source new construction with exposed soils protected downslope area by silt fence but tracked sediment on road surface from site.
- Increase inspections of new construction site require maintenance of anti-tracking pads and street sweeping by contractor. Install crushed stone driveways or pave.

59) Clark Hill Rd. "Sampling Pts. 7 & 8" At Christopher Brook.

- Roadway/Woods.
- Non-point source Christopher Brook discharges through a 36" rcp cross culvert at Clark Hill Road.
- Install inlet and outlet riprap protection at cross culvert install sediment basin upstream of Clark Hill to reduce sediment loads to lake.

60) Midwood Farm Rd.

- Woods/Farm.
- Non-point source land use; logging activities, farming, and some new residential and utilities construction.
- Continue to monitor land uses educate landowners regarding composting, farming techniques. Contact Local Soil Conservation District for supplemental material to give to landowners. Increase inspection of new construction to ensure proper erosion and sedimentation controls. Spot check logging area to ensure best management practices.

61) Lake Drive near Clark Hill Road at pole #911.

- Roadway/Residential/Parking Areas.
- Stormwater runoff to the lake via storm drainage system in condominium development and Lake Drive/Clark Hill street system to a 30" rcp outfall to lake. Unprotected outlet at 30" rcp scours lake bed, as well as a catch basin in line without a sump located in the road result in sedimentation and deposition of organics as evidenced by sediment and organics at the outfall.
- Install GPS on main storm drainage for streets and install GPS in condominium development prior to system exit from property. Install hoods on exiting catch basins and clean all catch basin sumps. Install riprap outlet plunge pool and swale for 30" rcp.

62) Lake Drive near Clark Hill Road at pole #911.

- Roadway.
- Untreated stormwater discharge to the lake via a paved leakoff. Sediments and organics transported to the lake as evidenced by sediments and organics at the outfall location.
- Install curbing along lakeside of street and install catch basins with sumps and hoods on the outlet pipes.

63) Lake Drive near pole #912.
- Roadway.
- Sediment and organics are being transported to the lake via the storm drainage system in Clark Hill Roads 36" rcp which discharges to the lake as evidenced by sediment and organics at the outfall location.
- Install GPS in Clark Hill Road drainage system and install riprap plunge pool at outlet. Install hoods on outlet pipes from existing catch basins.

64) North Main Street opposite Clark Hill Road.
- Roadway.
- Bank erosion from concentrated street stormwater runoff as evidenced by sediment deposits and erode flow paths and from lake wave action undercutting lake bank.
- Install curbing and catch basins with sumps and hoods (note some may be submerged but wet basin efficiency is greater than for dry basins)on the lake side of the road. Install riprap or gabion lake bank protection increase vegetation.

65) North Main Street at CL&P 914 .
- Roadway.
- Stormwater discharge from streets via a 12" rcp from catch basin carrying sediments and organics to the lake as evidenced by the deposits at the outfall location. Some lake bank erosion was observed at this location.
- Install hood on existing catch basin outlet pipe and clean basin sumps. Install riprap plunge pool at the outlet. Install additional catch basins with sumps and hoods on outlet pipes and curbing along lake side of street. Install riprap or gabion lake bank protection increase vegetation.

66) North Main Street at pole #905 across from Bobby's Street.
- Roadway/Residential.
- Stormwater discharge from streets through grassed leakoff trapping most sediment but evidence of minor erosion due to concentrated flow at lake bank.
- Install curbing and catch basins with sumps and hoods on the lake side of the road. Install riprap outlet plunge pool. Install riprap or gabion lake bank protection increase vegetation.

67) North Main Street between Bobby's Road and Barbara Lane.
- Roadway/Residential.
- Stormwater discharge to the lake via a catch basin 15" cmp. Scour erosion at outfall.
- Install hood on outlet pipe, clean sump of basin and install a riprap plunge pool at the outfall.

68) North Main Street opposite Lake Boulevard near pole #901.
- Roadway.
- Non-point stormwater sheet flow from streets.
- Install curbing and catch basins with sumps and hoods on outlet pipes.

69) North Main Street near Marine Boat Repair & Service.

- Roadway.
- Stormwater discharge from newly constructed twin 18" ADS drainage pipe with a flared ends and new riprap outlet protection.
- Install hoods on existing basins outlet pipes if not currently proposed for the new construction which was in progress at the time of this field reconnaissance. Clean basin sumps upon completion of construction and maintain.

70) North Main Street near Marine Boat Repair & Service.

- Roadway/Commercial/Residential/Woods.
- Three 24" RCP cross culverts convey Christopher Brook under the North Main Street. Two of the culverts are at a lower inlet elevation than the third. Significant amounts of sediment and organics are transported through to the lake as evidenced by shallow lake depths and unconsolidated material deposition along the brook and the formation of a delta at the mouth of the brook. The proximity of a marine or other engine service and repair service to the lake is a likely candidate for pollution discharges to the lake as evidenced by oil stained pavement and various service liquid containers on-site as well as the nature of repair businesses.
- Dredge the inlet and outlet area of the cross culverts, the brook bottom and sides and the mouth of the brook at the delta. Increase the inlet and outlet pool depths at the culverts. Protect stream banks with riprap revetments or gabions along with the use of vegetative methods. Install gabion berm near stream lake interface to enhance trapping of heavy sediments. Install oil trap drain and oil trap tank at marine service area and require service area to be contained to the effective area of the oil trap drain to reduce the likelihood of oil or other pollution discharges to the lake. Revegetate upstream bank area and provide increase buffer areas between stream and land uses. Construct small sediment ponds/catchments along brook.

71) Sears Lane.

- Roadway/Residential.
- Untreated stormwater runoff from the street to a leakoff.
- Install catch basin with sump and a hood on the outlet pipe. Install riprap outlet protection.

72) Sears Place/Private Drive at House #46 "Bourne" at pole #887.

- Roadway/Residential.
- Concentrated runoff in earth swale discharging to the lake.
- Install small detention basin at end of swale near lake to trap sediments and organics.

73) Christopher Lane "Sample Pt. 5".

- Roadway/Woods.
- Non-point source Christopher Brook discharges through a 24" rcp cross culvert with flow north to south.
- Install detention structure to increase the removal efficiency of the upstream wetland area. Install inlet and outlet riprap protection creating a small pool at both ends.

74) Christopher Lane "Sample Pt. 4".

- Roadway/Woods.
- Non-point source Christopher Brook discharges through a 24" rcp cross culvert with flow south to north.
- Increase upstream pool area and install inlet and outlet riprap protection.

75) Pond at Christopher Lane.

- Roadway.
- A 67"x18" weir with bypass swale controlled by owner discharges Christopher Brook. Diversion of high flows around pond.
- Downstream pond with diversion ditch for high flows (high sediment/organic/nutrient loads) should be filled and flows directed to the pond. Diversion of high flows should not be permitted unless required to insure safe operation. Owner should ensure capacity and safety of dam and weirs. Owners permission to dredge the pond in the future should be obtained.

76) Lake Street at pole #245.

- Roadway/Residential.
- Upstream new construction, swale discharges to lake via a 15" cross culvert. Erosion of earth is evident at the outlet of the culvert due to the concentrated runoff on exposed erosive soils.
- Install riprap inlet and outlet protection at the culvert create/improve existing swale by re vegetating with the use of erosion control netting. Create drops/catchments along swale to improve sediment removal. Increase inspections of new construction activities require as a minimum crushed stone driveways adjacent to steep slopes and wetlands and watercourses.

Appendix II-Point Discharge Calculations

Appendix II

LAKE POCOTOPAUG DRAINAGE STUDY
Point Discharge Calculations - Outlet Points

Prepared For the Town of East Hampton, Connecticut
JANUARY, 1995

RATIONAL METHOD (Q = cia)
Peak Discharge = Coeficient of Runoff x Rainfall Intensity x Drainage Area

Tributary Drainage Areas for Outlets/Discharges To Lake Pocotopaug

Discharge Area No.	Coeff. of Runoff	Drainage Area (Ac.)	Tc (Minutes)	Rainfall Intensity (In/Hr) 10 Yr.	25 Yr.	50 Yr.	100 Yr.	Peak Discharge (Cubic Feet per Second) 10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm	Outlet Description	Est. Outlet Cap. (C.F.S)	Insufficient Capacity Adequate Capacity	Notes and Recommendations
2 (existing)	0.30	1.58	17.0	4.3	5.1			2.0	2.4			12" CMP	4 .0	Adequate Capacity	Fully Developed
(proposed)	0.30	1.58	17.0	4.3	5.1			2.0	2.4						
3 (ex.)	0.30	1.71	15.0	4.6	5.3			2.4	2.7			12" CMP	4.0	Adequate Capacity	Fully Developed
(prop.)	0.30	1.71	15.0	4.6	5.3			2.4	2.7						
8A (ex.)	0.30	16.59	24.0	3.6	4.3			17.9	21.4			36" RCP	62.0	Adequate Capacity	Fully Developed
(prop.)	0.30	16.59	24.0	3.6	4.3			17.9	21.4						
8B (ex.)	0.30	26.87	38.0	2.6	3.1			21.0	25.8			24" RCP	26.0	Adequate Capacity	Use additional 24" RCP
(prop.)	0.50	26.87	38.0	2.6	3.1			34.9	41.6					Insufficient Capacity	Total Capacity = 52 c.f.s.
17 (ex.)	0.24	72.58	41.0	2.4	2.9	3.2		41.8	50.5	55.7		Stream			Includes Areas 19 and 20.
(prop.)	0.50	72.58	41.0	2.4	2.9	3.2		87.0	105.2	116.1					
21 (ex.)	0.25	43.58	34.0	2.8	3.3	3.7		30.5	36.0	40.3		32" CMP	43.0	Adequate Capacity	Use additional 36" RCP
(prop.)	0.50	43.58	34.0	2.8	3.3	3.7		61.0	72.0	80.6				Insufficient Capacity	Total Capacity = 105 c.f.s.
23B (ex.)	0.30	3.00	25.0	3.5	4.2			3.2	3.8			15" CMP	8.0	Adequate Capacity	Fully Developed
(prop.)	0.30	3.00	25.0	3.5	4.2			3.2	3.8						
27 (ex.)	0.30	12.03	21.0	4.0	4.5	5.1		14.4	16.2	18.4		12" PVC	7.5	Insufficient Capacity	Use additional18" RCP
(prop.)	0.30	12.03	21.0	4.0	4 5	5.1		14.4	16.2	18.4					Total Capacity = 21.5 c.f.s.
28 (ex.)	0.30	5.01	19.0	4.1	4.7			6.0	7.0			18" RCP	14.0	Adequate Capacity	Fully Developed
(prop.)	0.30	5.01	19.0	4.1	4.7			6.0	7.0						
29 (ex.)	0.25	89.96	27.0	3.3	3.9	4.3		74.2	87.7	96.7		42" RCP	87.0	Insufficient Capacity	Use additional 48" RCP
(prop.)	0.50	89.96	27.0	3.3	3.9	4.3		148.4	175.4	193.4					Total Capacity = 202 c.f.s.
30A (ex.)	0.30	1.99	18.0	4.1	4.8			2.4	2.9			15" STEEL	9.5	Adequate Capacity	Fully Developed
(prop.)	0.30	1.99	18.0	4.1	4.8			2.4	2.9						
31 (ex.)	0.50	2.23	9.0	5.6	6.5			6.2	7.2			18" RCP	14.0	Adequate Capacity	Fully Developed
(prop.)	0.50	2.23	9.0	5.6	6.5			6.2	7.2						
32C (ex.)	0.20	149.82	58.0	1.9	2.2	2.5		56.9	65.9	74.9		Stream		Includes Areas	Includes Areas
(prop.)	0.50	149.82	58.0	1.9	2.2	2.5		142.3	164.8	193.4				32A and 32B	32A and 32B
34 (ex.)	0.20	32.44	20.0	4.0	4.6	5.1		26.0	29.8	33.1		12" CMP	5.0	Insufficient Capacity	Replace with 36" RCP
(prop.)	0.30	32.44	20.0	4.0	4.6	5.1		39.0	44.7	49.6					Capacity = 62.0 c.f.s.
36 (ex.)	0.30	0.62	14.0	4.8	5.4			0.9	1.0			4" STEEL	1.0	Adequate Capacity	Fully Developed
(prop.)	0.30	0.62	14.0	4.8	5.4			0.9	1.0						
38 (ex.)	0.30	4.29	14.0	4.8	5.4			6.2	7.0			18" RCP	14.0	Adequate Capacity	Fully Developed
(prop.)	0.30	4.29	14.0	4.8	5.4			6.2	7.0						
41 (ex.)	0.30	4.52	21.0	4.0	4.5			5.4	6.1			18" RCP	14.0	Adequate Capacity	Fully Developed
(prop.)	0.30	4.52	21.0	4.0	4 5			5.4	6.1						
43 (ex.)	0.30	3.14	21.0	4.0	4.5			3.8	4.2			15" RCP	9.0	Adequate Capacity	Fully Developed
(prop.)	0.30	3.14	21.0	4.0	4.5			3 8	4.2						

Tributary Drainage Areas for Outlets/Discharges To Lake Pocotopaug

Discharge Area No.	Coeff. of Runoff	Drainage Area (Ac.)	Tc (Minutes)	Rainfall Intensity (In/Hr) 10 Yr.	25 Yr.	50 Yr.	100 Yr.	Peak Discharge (Cubic Feet per Second) 10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm	Outlet Description	Est. Outlet Cap. (C.F.S)	Insufficient Capacity Adequate Capacity	Notes and Recommendations
44(ex.)	0.21	57.60	33.0	2.9	3.4	3.8	4.1	35.1	41.1	46.0	49.6	20" RCP	18.0	Insufficient Capacity	Replace with Twin 36" RCP
(prop.)	0.40	57.60	33.0	2.9	3.4	3.8	4.1	66.8	78.3	87.6	94.5				Total Capacity = 124.0 c.f.s.
45 (ex.)	0.30	0.49	13.0	5.0	5.6			0.7	0.8			4" PVC	1.0	Adequate Capacity	Fully Developed
(prop.)	0.30	0.49	13.0	5.0	5.6			0.7	0.8						
46 (ex.)	0.30	8.36	16.0	4.5	5.2			11.3	13.0			10" CMP	4.5	Insufficient Capacity	Fully Developed. Replace with
(prop.)	0.30	8.36	16.0	4.5	5.2			11.3	13.0						18" RCP - Capacity = 14.0 c.f.s.
47 (ex.)	0.30	0.40	11.0	5.4	6.3			0.6	0.7			15" RCP	9.0	Adequate Capacity	Fully Developed
(prop.)	0.30	0.40	11.0	5.4	6.3			0.6	0.7						
48 (ex.)	0.55	4.71	19.0	4.1	4.7			10.6	12.2			12" CMP	5.0	Insufficient Capacity	Fully Developed. Replace with
(prop.)	0.55	4.71	19.0	4.1	4.7			10.6	12.2						18" RCP - Capacity = 14.0 c.f.s.
49 (ex.)	0.20	863.16	67.0	1.8	2.1	2.4	2.7	310.7	362.5	414.3	466.1	2 @ 40"x24"	130.0	Insufficient Capacity	Use additional Twin 8'x4' Concrete
(prop.)	0.28	863.16	67.0	1.8	2.1	2.4	2.7	435.0	507.5	580.0	652.5	& 42"x28"			Box Culverts - Tot. Cap.= 658 c.f.s.
51 (ex.)	0.40	5.72	9.0	5.6	6.5			12.8	14.9			15" RCP	9.0	Insufficient Capacity	Fully Developed. Replace with
(prop.)	0.40	5.72	9.0	5.6	6.5			12.8	14.9						24" RCP - Capacity = 25.0 c.f.s.
52 (ex.)	0.43	2.37	7.0	5.9	6.9			6.0	7.0			15" RCP	9.0	Adequate Capacity	Fully Developed
(prop.)	0.43	2.37	7.0	5.9	6.9			6.0	7.0						
53 (ex.)	0.25	37.61	39.0	2.5	3.0	3.3		23.5	28.2	31.0		3'x2' Conc.	51.0	Adequate Capacity	
(prop.)	0.30	37.61	39.0	2.5	3.0	3.3		28.2	33.8	37.2		Box Culvert			
54 (ex.)	0.24	22.04	28.0	3.1	3.8			16.4	20.1			15" CMP	8.0	Insufficient Capacity	Replace with 24" RCP
(prop.)	0.30	22.04	28.0	3.1	3.8			16.4	20.1						Capacity = 25.0 c.f.s.
55 (ex.)	0.27	12.83	24.0	3.6	4.3			12.5	14.9			15" RCP	9.0	Insufficient Capacity	Replace with 24" RCP
(prop.)	0.40	12.83	24.0	3.6	4.3			18.5	22.1						Capacity = 25.0 c.f.s.
70 (ex.)	0.23	496.24	86.0	1.5	1.7	1.9	2.2	171.2	194.0	216.9	251.1	24" RCP	25.0	Insufficient Capacity	Includes Areas 59, 73, 74, and 75.
(prop.)	0.30	496.24	86.0	1.5	1.7	1.9	2.2	223.3	253.1	282.9	327.5				Replace w/ Twin 7'x4' Box Culv. Cap. = 345.0 c.f.s.
61 (ex.)	0.50	7.19	25.0	3.5	4.2			12.6	15.1			30" RCP	40.0	Adequate Capacity	Fully Developed
(prop.)	0.50	7.19	25.0	3.5	4.2			12.6	15.1						
62 (ex.)	0.50	0.37	4.0	6.1	7.1			1.1	1.3			Paved			Fully Developed
(prop.)	0.50	0.37	4.0	6.1	7.1			1.1	1.3			Leakoff			
63 (ex.)	0.25	47.91	34.0	2.8	3.3			33.5	39.5			36" RCP	62.0	Adequate Capacity	
(prop.)	0.30	47.91	34.0	2.8	3.3			40.2	47.4						
65 (ex.)	0.50	1.73	7.0	5.9	6.9			5.1	6.0			12" RCP	6.0	Adequate Capacity	Fully Developed
(prop.)	0.50	1.73	7.0	5.9	6.9			5.1	6.0						
67 (ex.)	0.50	2.95	6.0	6.0	7.0			8.9	10.3			15" CMP	8.0	Insufficient Capacity	Fully Developed. Replace with
(prop.)	0.50	2.95	6.0	6.0	7.0			8.9	10.3						18" RCP - Capacity = 14.0 c.f.s.
71 (ex.)	0.49	2.81	7.0	5.9	6.9			8.1	9.5			Paved			Fully Developed
(prop.)	0.49	2.81	7.0	5.9	6.9			8.1	9.5			Leakoff			
72 (ex.)	0.30	20.17	23.0	3.7	4.4	4.9		22.4	26.6	29.6		Swale			Fully Developed
(prop.)	0.30	20.17	23.0	3.7	4.4	4.9		22.4	26.6	29.6					
20 (ex.)	0.22	67.64	40.0	2.5	2.9	3.3		37.2	43.2	49.1		18" CMP	12.0	Insufficient Capacity	Replace with 36" RCP
(prop.)	0.28	67.64	40.0	2.5	2.9	3.3		47.3	54.9	62.5					Capacity = 62.0 c.f.s.
23A (ex.)	0.30	14.70	25.0	3.5	4.2			15.4	18.5			15" CMP	8.0	Insufficient Capacity	Use additional 18" RCP
(prop.)	0.30	14.70	25.0	3.5	4.2			15.4	18.5						Total Capacity = 22.0 c.f.s.

LAKE POCOTOPAUG DRAINAGE STUDY
Point Discharge Calculations - Upland Areas

Prepared For the Town of East Hampton, Connecticut

JANUARY, 1995

RATIONAL METHOD (Q = cia)
Peak Discharge = Coeeficient of Runoff x Drainage Area x Rainfall Intensity

Upland Tributary Drainage Areas for To Lake Pocotopaug

Discharge Area No.	Coeff. of Runoff	Drainage Area (Ac.)	Tc (Minutes)	Rainfall Intensity (In/Hr) 10 Yr.	25 Yr.	50 Yr.	100 Yr.	Peak Discharge (Cubic Feet per Second) 10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm	Outlet Description	Est. Outlet Cap. (C.F.S)	Insufficient Capacity Adequate Capacity	Notes and Recommendations
32B (ex.)	0.20	110.75	46.0	2.2	2.6	2.9	3.2	48.2	57.6	64.2	70.9	24" RCP	25.0	Insufficient Capacity	Use additional 42" RCP
(prop.)	0.30	110.75	46.0	2.2	2.6	2.9	3.2	72.3	86.4	96.3	106.4				Total Capacity = 113.0 c.f.s.
32A (ex.)	0.20	146.08	54.0	2.0	2.3	2.6	3.0	58.4	67.2	75.9	87.6	18" RCP	14.0	Insufficient Capacity	Includes Area 32B. Use additional
(prop.)	0.30	146.08	54.0	2.0	2.3	2.6	3.0	87.6	100.8	113.9	131.4				Twin 36" RCP - Tot. Cap. = 138.0 c.f.s.
59 (ex.)	0.20	138.87	34.0	2.8	3.3	3.7	4.1	77.8	91.7	102 8	113.9	36" RCP	62.0	Insufficient Capacity	Use additional 48" RCP
(prop.)	0.30	138.87	34.0	2.8	3.3	3.7	4.1	116.7	137.5	154.1	170.8				Total Capacity = 177.0 c.f.s.
73 (ex.)	0.20	312.49	68.0	1.8	2.1	2.3	2.6	112.5	131.2	143.7	162.5	24" RCP	25.0	Insufficient Capacity	Includes Area 59. Replace with Twin
(prop.)	0.30	312.49	68.0	1.8	2.1	2.3	2.6	168.6	196.7	215.4	243.5				6'x3' Conc. Box Culvert - Tot. Cap. = 282.0 c.f.s.
74 (ex.)	0.20	476.07	78.0	1.7	2.0	2.3	2.6	161.9	190.4	219.0	247.6	Twin	55.0	Insufficient Capacity	Includes Areas 59 & 73. Replace with Twin
(prop.)	0.30	476.07	78.0	1.7	2.0	2.3	2.6	242.8	285.6	328.5	371.3	24" RCP			7'x4' Conc. Box Culvert - Tot. Cap. = 376.0 c.f.s.
75 (ex.)	0.20	482.07	78.0	1.7	2.0	2.3	2.6	163.9	192.8	221.8	250.7	67"x18"	27.0	Insufficient Capacity	Includes Areas 59, 73, 74. Pond acts as a detention
(prop.)	0.30	482.07	78.0	1.7	2.0	2.3	2.6	245.9	289.2	332.6	376.0	Weir			basin. Use Twin 7'x4' Box Culvert - Cap=376.0 c.f.s
76 (ex.)	0.30	6.86	26.0	3.4	4.1			7.0	8.4			15" RCP	9.0	Adequate Capacity	Fully Developed
(prop.)	0.30	6.86	26.0	3.4	4.1			7.0	8 4						

Appendix III - References

1) Town of East Hampton Zoning Regulations Effective Date: September 15,1990 amended to July 1, 1994.

2) Town of East Hampton Street Standards November 25, 1986 revised to November 24, 1994.

3) Town of East Hampton Inland Wetlands and Watercourses Agency Regulations Approved: 11/23/87, revised to 12/20/93 and effective 01/15/94.

4)"Status Report On Lake Pocotopaug Diagnostic And Management Assessment" February 1993 Fugro-McClelland (East), Inc. Prepared for the Town of East Hampton, Connecticut.

5) "Diagnostic And Management Assessment Of Lake Pocotopaug" December 1993 Fugro-McClelland (East), Inc. Prepared for the Town of East Hampton, Connecticut.

6) "Draft Report: Land Use And Phosphorus Input To Lake Pocotopaug" December 21, 1993 Prepared By: Land Use Subcommittee East Hampton Lake Advisory Committee.

7) "Reflections on Lake Pocotopaug" Number 1 Lake Pocotopaug Newsletter Spring 1994. Lake Advisory Committee.

8) "Connecticut Guidelines for Soil Erosion and Sediment Control" The Connecticut Council On Soil and Water Conservation. January 1988.

9) "On-site Environmental Mitigation For Construction Activities" Connecticut Department of Transportation Office of Environmental Planning January 1986.

10) "A Watershed Management Guide For Connecticut Lakes" Connecticut Department of Environmental Protection Bureau Of Water Management Revised 1991.

11) " The Lake and Reservoir Restoration Guidance Manual" First Edition US EPA, EPA 440/5-88-002 February 1988.

12) "Timber Harvesting and Water Quality in Connecticut - A Practical Guide for Protecting Water Quality While Harvesting Forest Products" Prepared by: Connecticut RC&D Forestry Committee, 1990.

13) "Subdivision Regulations 1949 East Hampton Subdivision Regulations" Effective July 1,1992.

14) "Standards and Specifications for Infiltration Practices" Stormwater Management Division Water Resources Administration Maryland Department of Natural Resources. February 1984.

15) "Soil Survey Of Middlesex county, Connecticut" USDA SCS February 1979.

16) "Logging and Water Quality in Connecticut" DEP State of Connecticut Third Printing, June 1984.

17) Telephone Conversation with Tim Dodge, Natural Resources Conservation Service (a.k.a. Soil Conservation Service) and Roy Seelye, WMC Consulting Engineers. January 9, 1995.

18) Telephone Conversation with Marla Butts, Ct. DEP Inland Water Resources Division and Roy Seelye, WMC Consulting Engineers. January 1995.

19) "Plan of Development" Town of East Hampton, Connecticut May 1989.

Appendix IV - Sediment Pond and Trap Locations, Descriptions & Costs

Appendix IV

Sediment Pond and Sediment Trap Locations, Descriptions and Estimated Construction Costs.

Inventory Point No.	*Location of Sediment Pond or Trap.*	*Description of Sediment Pond or Trap.*	*Estimated Construction Cost.*
No. 21	Marlborough Road at Pole #774 & Pump Sta. D/S in O'Neill's Brook.	Excavated sediment pond inline with O'Neill's Brook . Approximate size: 200'x200'x4'.	(200')(200')(4')/27yd^3/ft^3=5926 yds^3. (5926 yds^3)(25$/yds^3)= $148,150
No. 28	Brook Trail near Clearwater Estates at swale behind develop.	Gabion dam/weir structure. Approximate size: 24'Lx3'Wx6'H.	(24')(3')(6')/27yd^3/ft^3= 16yds^3. (16 yds^3)(70$/yds^3)= $1,120
No. 32-A	Bay Road at pole #1203 near pump station. Fawn Hill Brook.	Gabion dam/weir structure. Approximate size: 24'Lx3'Wx3'H. Spaced every 200': 1-d/s, 3-u/s.	(4)(24')(3')(3')/27yd^3/ft^3= 32yds^3. (32 yds^3)(70$/yds^3)= $2,240
No. 32-B	Lake Drive near pole #2391. Fawn Hill Brook.	Construct earth berm along Lake Drive at u/s side, with multipipe outlet culvert (for various storm frequencies) which would flow under Lake Drive.	(200')(14')(2')/27yd^3/ft^3=207 yds^3. (207 yds^3)(25$/yds^3)= $5,185 add outlet work of $1,000=$6,185
No. 34	Terminus of Bay Road at pump sta. access road. Hazens Brook.	Construct earth berm/sediment pond u/s of pump sta. access road. Approximate size: 150'x100'x10'.	(150')(100')(10')/27yd^3/ft^3=5555 yds^3. (5555 yds^3)(25$/yds^3)= $138,888
No. 47	Lake Drive west of near Lakewood Road.	Excavated sediment pond for slope seeps, misc.runoff and redirected storm drain from Point No.48	(200')(100')(4')/27yd^3/ft^3=2963 yds^3. (2963 yds^3)(25$/yds^3)= $74,075 add drainage work of $5,000=$79,075.
No. 49	Lake Drive at Hales Brook.	Gabion dam/weir structure. Spaced: 1-u/s of inlet pond at Lake drive. 1- at confluence of Hales Br.& brook from No.56 Mott Hill Rd. 1-at Hulseman Pond. 1-at confluence of brook from Hulseman Pond and Hales brook. 1- 1000ft d/s of the previous weir at confluence of Hales and drained swamp. Approximante typical size:48'Lx6'Wx6'H.	(5)(48')(6')(6')/27yd^3/ft^3= 320yds^3. (320 yds^3)(70$/yds^3)= $22,400 add access roads (5)($10,000)=$72,400

No. 53	Raymond Road u/s of 15" cmp and Lake Drive near pole #642 u/s of box culvert.	Excavated sediment pond inline with Brook at Raymond Road Excavated Sediment pond at Lake drive relocate Lake Dr. Drainage. Approx. sizes: 2- 100'x100'x3'.	(2)(100')(100')(3')/27yd^3/ft^3=2222 yds^3. (2222 yds^3)(25$/yds^3)= $55,550 add relocated drainage at Lake Dr $5,000 = $60,550
No. 56	Mott Hill Road at culvert inlet for brook.	Install detention structure on cross culvert (c.b. type structure with multi inlets for various storm frequencies).	Lump sum item $5,000
No. 59	Clark Hill Road at "sampling pts. 7&8" at 36" rcp cross culvert, 2,300 ft uphill from int. with Lake Drive.	Install detention structure on cross culvert (c.b. type structure with multi inlets for various storm frequencies).	Lump sum item $5,000
No. 70	Lake Drive at Christopher Brook.	Gabion dam/weir structure. Spaced: 1-at brook and lake interface 1- u/s of cross culverts at Lake Drive. Approximante typical size:20'Lx6'Wx6'H.	(2)(20')(6')(6')/27yd^3/ft^3= 53yds^3. (53 yds^3)(70$/yds^3)= $3,710 add misc work (2)($5,000)=$13,710

Appendix V - Cost Estimate (Detailed)

LAKE POCOTOPAUG DRAINAGE STUDY
COST ESTIMATE - Point Discharge Drainage Areas

Prepared for the Town of East Hampton, Connecticut

January, 1995

Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
2	Catch Basin with Hood	Each	2	$ 1750.00	$ 3,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
3	Catch Basin with Hood	Each	1	1750.00	1,750.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
8a	Catch Basin with Hood	Each	2	1750.00	3,500.00
	36" Reinforced Concrete Pipe	L.F.	100	95.00	9,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
8b	Catch Basin with Hood	Each	2	1750.00	3,500.00
	24" Reinforced Concrete Pipe	L.F.	80	75.00	6,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
17	Reconstruct Swale	C.Y.	150	10.00	1,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
21	36" Reinforced Concrete Pipe	L.F.	80	95.00	7,600.00
	Clean and Reshape Swale	C.Y.	230	10.00	2,300.00
	Construct Sedimentation Basin	C.Y.	5926	25.00	148,150.00
23b	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	30	45.00	1,350.00
27	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	18" Reinforced Concrete Pipe	L.F.	120	50.00	6,000.00
28	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	18" Reinforced Concrete Pipe	L.F.	120	50.00	6,000.00
	Gabion Dam	C.Y.	16	70.00	1,120.00
29	Bituminous Concrete Pavement	Ton	25	50.00	1,250.00
	Dredge Cove	C.Y.	1000	50.00	50,000.00
	Gross Particle Seperator	Each	1	5,000	5,000.00
	48" Reinforced Concrete Pipe	L.F.	200	115.00	23,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
30a	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00

Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
31	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
34	36" Reinforced Concrete Pipe	L.F.	60	95.00	5,700.00
	Dredge Cove	C.Y.	1000	50.00	50,000.00
	Construct Sedimentation Basin	C.Y.	5555	25.00	138,875.00
36	Catch Basin with Hood	Each	1	1750.00	1,750.00
38	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Rebuild Existing CB (Hood & Sump)	Each	3	500.00	1,500.00
41	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
	18" Reinforced Concrete Pipe	L.F.	50	50.00	2,500.00
	Riprap Plunge Pool	C.Y.	10	500.00	5,000.00
43	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Riprap Bank Protection	C.Y.	300	25.00	7,500.00
44	36" Reinforced Concrete Pipe	L.F.	160	95.00	15,200.00
	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Riprap Bank Protection	C.Y.	175	25.00	4,375.00
45	Riprap Bank Protection	C..Y.	120	25.00	3,000.00
	4" PVC	L.F.	50	20.00	1,000.00
	Catch Basin with Hood	Each	2	1750.00	3,500.00
46	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	18" Reinforced Concrete Pipe	L.F.	80	50.00	4,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
47	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Construct Sedimentation Basin	C.Y.	3163	25.00	79,075.00
48	Catch Basin with Hood	Each	4	1750.00	7,000.00
	Catch Basin	Each	2	1000.00	2,000.00
	15" Reinforced Concrete Pipe	L.F.	300	45.00	13,500.00
	18" Reinforced Concrete Pipe	L.F.	330	50.00	16,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00

Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
49	8'x4' Concrete Box Culvert	L.F.	300	400.00	120,000.00
	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Dredge Stream/Reshape Channel	C.Y.	50	10.00	500.00
	Clear Brush/Debris	L.S.	1	500.00	500.00
	Dredge Cove	C.Y.	1000	50.00	50,000.00
	Gabion Dam	C.Y.	320	70.00	22,400.00
	Access Drives	LS	5	10,000	50,000.00
51	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	24" Reinforced Concrete Pipe	L.F.	100	75.00	7,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
52	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	15" Reinforced Concrete Pipe	L.F.	300	45.00	13,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
53	Riprap Existing Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Construct Sedimentation Basin	C.Y.	2422	25.00	60,550.00
54	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	24" Reinforced Concrete Pipe	L.F.	150	75.00	11,250.00
	Construct Sedimentation Basin	C.Y.	1250	25.00	31,250.00
55	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	24" Reinforced Concrete Pipe	L.F.	150	75.00	11,250.00
70	7'x4' Concrete Box Culvert	L.F.	300	400.00	120,000.00
	Dredge Stream/Reshape Channel	C.Y.	50	10.00	500.00
	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Riprap Bank Protection	C.Y.	100	25.00	2,500.00
	Gabion Dam	C.Y.	53	70.00	3,710.00
61	Gross Particle Seperator	Each	1	5,000	5,000.00
	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Riprap Swale	C.Y.	100	25.00	2,500.00
62	Bituminous Concrete Curb	L.F.	400	2.00	800.00
	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	150	45.00	6,750.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00

Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
63	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	15" Reinforced Concrete Pipe	L.F.	150	45.00	6,750.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Gross Particle Seperator	Each	1	5,000	5,000.00
	Riprap Bank Protection	C.Y.	100	25.00	2,500.00
65	Catch Basin with Hood	Each	2	1750.00	3,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Rebuild Existing Cb (Hood & Sump)	Each	2	500.00	1,000.00
	Riprap Bank Protection	C.Y.	100	25.00	2,500.00
	Bituminous Concrete Curb	L.F.	1000	2.00	2,000.00
67	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
	18" Reinforced Concrete Pipe	L.F.	150	50.00	7,500.00
71	Catch Basin with Hood	Each	1	1750.00	1,750.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
72	Construct Sedimentation Basin	C.Y.	1200	25.00	30,000.00
20	36" Reinforced Concrete Pipe	L.F.	150	95.00	14,250.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Dredge Stream/Reshape Channel	C.Y.	100	10.00	1,000.00
23a	18" Reinforced Concrete Pipe	L.F.	200	50.00	10,000.00
	Catch Basin	Each	2	1000.00	2,000.00
	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	280	45.00	12,600.00
32b	42" Reinforced Concrete Pipe	L.F.	150	105.00	15,750.00
	Rebuild Existing CB (Hood & Sump)	Each	2	500.00	1,000.00
	Riprap Bank Protection	C.Y.	125	25.00	3,125.00
	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Earth Berm	C.Y.	207	25.00	5,175.00
32a	36" Reinforced Concrete Pipe	L.F.	300	95.00	28,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Gabion Dam	C.Y.	32	70.00	2,240.00
59	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	48" Reinforced Concrete Pipe	L.F.	150	115.00	17,250.00
	Construct Sedimentation Basin	C.Y.	6000	25.00	150,000.00
	Gross Particle Seperator	Each	1	5,000	5,000.00

Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
73	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	6'x3' Concrete Box Culvert	L.F.	300	400.00	120,000.00
	Construct Sedimentation Basin	C.Y.	5000	25.00	125,000.00
74	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	7'x4' Concrete Box Culvert	L.F.	300	400.00	120,000.00
75	Regrade/Fill Diversion Ditch	C.Y.	350	10.00	3,500.00
76	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	SUBTOTAL				$ 1,895,095.00

LAKE POCOTOPAUG DRAINAGE STUDY
COST ESTIMATE - Non-Point Discharge Drainage Areas

Prepared for the Town of East Hampton, Connecticut

January, 1995

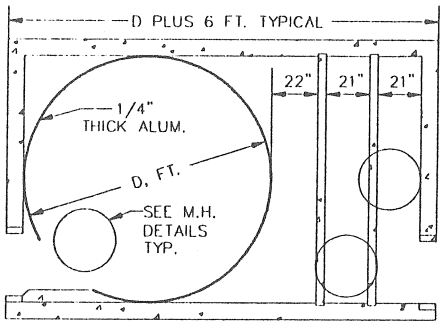
Drainage Area	Recommended structures	Unit	Quantity	Unit Price	Total Cost
1	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	50	45.00	2,250.00
	Construct Grass Swale	C.Y.	50	10.00	500.00
4	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	150	45.00	6,750.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
5	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	250	45.00	11,250.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
6	Install Crushed Stone Boat Ramp	C.Y.	15	15.00	225.00
7	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	150	45.00	6,750.00
	Construct Grass Swale	C.Y.	50	10.00	500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Bituminous Concrete Curbing	L.F.	300	2.00	600.00
9	Riprap Slope Protection	C.Y.	110	25.00	2,750.00
10	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	250	45.00	11,250.00
	Bituminous Concrete Curbing	L.F.	300	2.00	600.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
11	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	230	45.00	10,350.00
	Bituminous Concrete Curbing	L.F.	200	2.00	400.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
14	Riprap Slope Protection	C.Y.	200	25.00	5,000.00
15	Dredge Cove	C.Y.	300	50.00	15,000.00
16	Catch Basin with Hood	Each	2	1750.00	3,500.00
18	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	50	45.00	2,250.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Construct Grass Swale	C.Y.	20	10.00	200.00

Drainage Area	Recommended Structures	Unit	Quantity	Unit Price	Total Cost
19	Construct Grass Swale	C.Y.	100	10.00	1,000.00
	Bit. Concrete Pavement - Driveway	S.Y.	100	13.50	1,350.00
22	Catch Basin with Hood	Each	4	1750.00	7,000.00
	15" Reinforced Concrete Pipe	L.F.	500	45.00	22,500.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
24	Erosion Control Netting	S.Y.	200	5.00	1,000.00
	Rebuild Existing CB (Hood & Sump)	Each	1	500.00	500.00
25	Install Crushed Stone Boat Ramp	C.Y.	15	15.00	225.00
	Riprap Slope Protection	C.Y.	75	25.00	1,875.00
26	Catch Basin with Hood	Each	2	1750.00	3,500.00
	15" Reinforced Concrete Pipe	L.F.	175	45.00	7,875.00
	Install Crushed Stone Boat Ramp	C.Y.	100	15.00	1,500.00
	Riprap Slope Protection	C.Y.	125	25.00	3,125.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
33	Riprap Slope Protection	C.Y.	100	25.00	2,500.00
35	Regrade Beach Area (Terrace)	C.Y.	300	10.00	3,000.00
37	Catch Basin with Hood	Each	4	1750.00	7,000.00
	15" Reinforced Concrete Pipe	L.F.	850	45.00	38,250.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Bituminous Concrete Curbing	L.F.	750	2.00	1,500.00
42	Riprap Slope Protection	C.Y.	200	25.00	5,000.00
50	Catch Basin with Hood	Each	3	1750.00	5,250.00
	15" Reinforced Concrete Pipe	L.F.	120	45.00	5,400.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Bituminous Concrete Curbing	L.F.	250	2.00	500.00
	Bituminous Concrete Pavement	Ton	600	50.00	30,000.00
56	Riprap Culvert Inlet/Outlet	C.Y.	20	25.00	500.00
	Gross Particle Seperator	Each	1	5,000	5,000.00
64	Riprap Slope Protection	C.Y.	100	25.00	2,500.00
	Catch Basin with Hood	Each	3	1750.00	5,250.00
	15" Reinforced Concrete Pipe	L.F.	250	45.00	11,250.00
	Riprap Plunge Pool	C.Y.	10	25.00	250.00
	Bituminous Concrete Curbing	L.F.	250	2.00	500.00

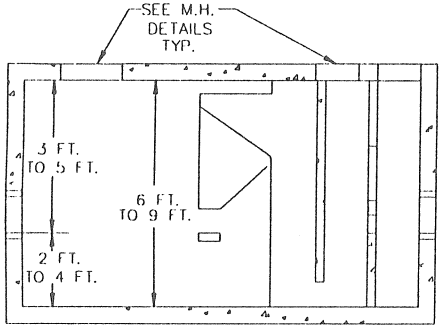
Drainage Area	Recommended structures	Unit	Quantity	Unit Price		Total Cost
66	Riprap Slope Protection	C.Y.	100	25.00		2,500.00
	Catch Basin with Hood	Each	2	1750.00		3,500.00
	15" Reinforced Concrete Pipe	L.F.	250	45.00		11,250.00
	Riprap Plunge Pool	C.Y.	10	25.00		250.00
	Bituminous Concrete Curbing	L.F.	200	2.00		400.00
68	Riprap Slope Protection	C.Y.	100	25.00		2,500.00
	Catch Basin with Hood	Each	3	1750.00		5,250.00
	15" Reinforced Concrete Pipe	L.F.	175	45.00		7,875.00
	Riprap Plunge Pool	C.Y.	10	25.00		250.00
	Bituminous Concrete Curbing	L.F.	200	2.00		400.00
69	Rebuild Existing CB (Hood & Sump)	Each	2	500.00		1,000.00
	SUBTOTAL				$	317,400.00
	TOTAL				$	2,212,495.00

Figure II - Drainage Areas Map

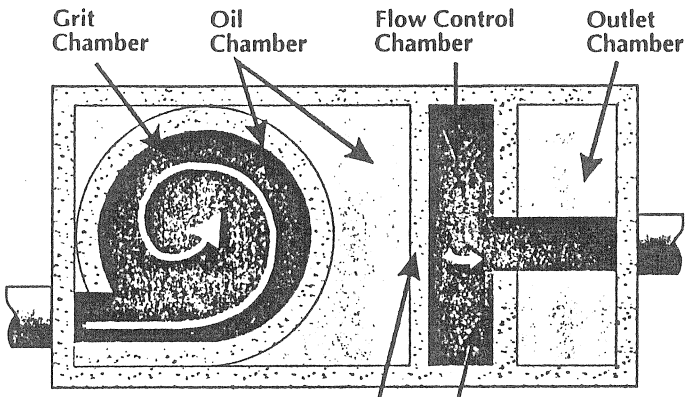
Appendix VI - Typical Sedimentation Control Measures and Dredging Method



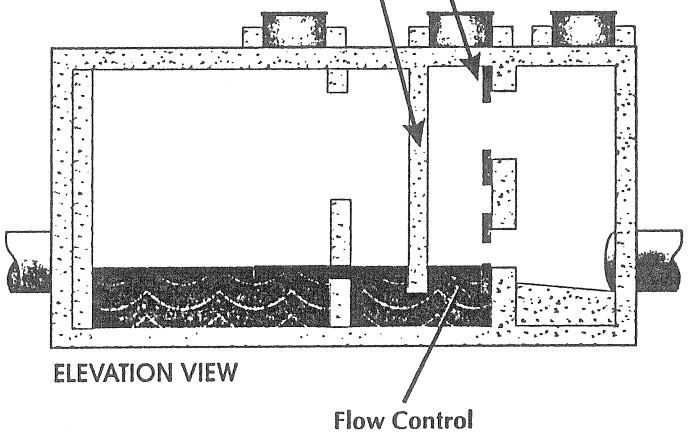
PLAN VIEW



ELEVATION VIEW



PLAN VIEW



ELEVATION VIEW

GROSS PARTICLE & OIL SEPARATOR

VOTECHNICS' STORMWATER TREATMENT SYSTEM
N.T.S.

NOTE: CHECK GRAPHIC SCALES BEFORE USING DRAWINGS

NO.	DATE	DESCRIPTION
		REVISIONS

SUPV.	A.R.W.
DESIGN	P.E.K.
DRAWN	P.E.K.
CHECKED	S.R.M.
DATE	03/13/95

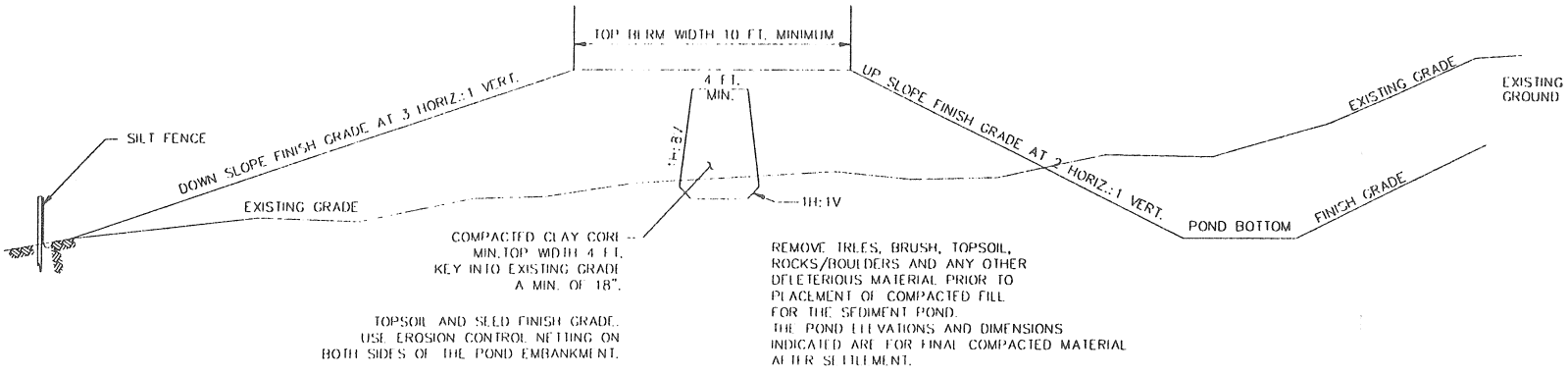
SCALE
N.T.S.

WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
630 OAKWOOD AVENUE
WEST HARTFORD, CT 06110
(203) 953-9624

PREPARED FOR
TOWN OF EAST HAMPTON

GROSS PARTICLE SEPARATOR
LAKE POCOTOPAUG

SIZE	PROJECT	FILE NAME	NUMBER	REV	SHEET OF
D	LAKE POCOTOPAUG	DETAIL - 94086			



TYPICAL SEDIMENT POND CROSS SECTION DETAIL

(N.T.S.)

NOTE: CHECK GRAPHIC SCALES BEFORE USING DRAWINGS

NO.	DATE	DESCRIPTION
		REVISIONS

SUPV.	A.R.W.
DESIGN	P.E.K.
DRAWN	P.E.K.
CHECKED	S.R.M.
DATE	03/13/95

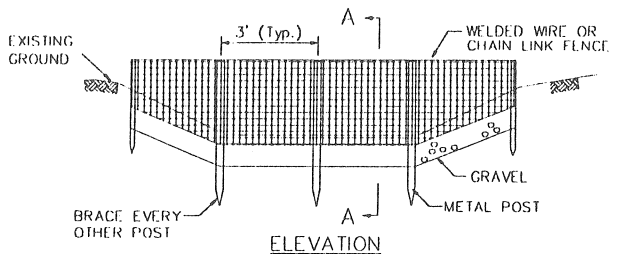
SCALE
N.T.S.

WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
610 OAKWOOD AVENUE
WEST HARTFORD, CT. 06110
(203) 953-9624

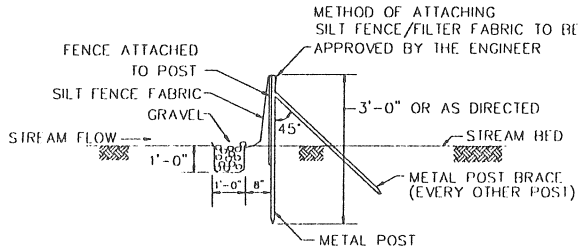
PREPARED FOR
TOWN OF EAST HAMPTON

SEDIMENT POND DETAIL
LAKE POCOTOPAUG

SIZE	PROJECT	FILE NAME	NUMBER	REV.	SHEET
D	LAKE POCOTOPAUG	- DETAIL -	94046		OF



ELEVATION

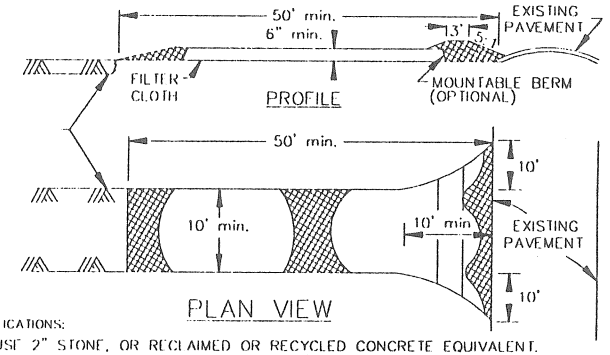


SECTION A–A

NOTE:: USE EXXON GEOTEXTILE
GTF100S-105S SEDIMENTATION CONTROL
SILT FENCE FABRIC WITH REINFORCING MESH
AND DEPTH GAUGE FOR PROPER TOE-IN DURING INSTALLATION.

BRACED SILT FENCE

N.T.S.



PLAN VIEW

CONSTRUCTION SPECIFICATIONS:

1) STONE SIZE - USE 2" STONE, OR RECLAIMED OR RECYCLED CONCRETE EQUIVALENT.
2) LENGTH - AS REQUIRED, BUT NOT LESS THAN 50 FT (EXCEPT ON A SINGLE RESIDENCE LOT WHERE A 30 FT MINIMUM LENGTH WOULD APPLY).
3) THICKNESS - NOT LESS THAN SIX (6) INCHES.
4) WIDTH - TEN (10) FT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
5) FILTER CLOTH - WILL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING OF STONE. FILTER WILL NOT BE REQUIRED ON A SINGLE FAMILY RESIDENCE LOT.
6) SURFACE WATER - ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED ACROSS THE ENTRANCE. IF PIPING IS IMPRACTICAL, A MOUNTABLE BERM WITH 5:1 SLOPES WILL BE PERMITTED.
7) MAINTENANCE - THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS-OF-WAYS MUST BE REMOVED IMMEDIATELY.
8) PERIODIC INSPECTION AND NECESSARY MAINTENANCE SHALL BE PROVIDED AFTER EACH RAINFALL.

STABILIZED CONSTRUCTION ENTRANCE

(N.T.S.)

NOTE: CHECK GRAPHIC SCALES BEFORE USING DRAWINGS

NO.	DATE	DESCRIPTION
REVISIONS		

SUPV.	A.R.W.
DESIGN	P.E.K.
DRAWN	P.E.K.
CHECKED	S.R.M.
DATE	03/13/95

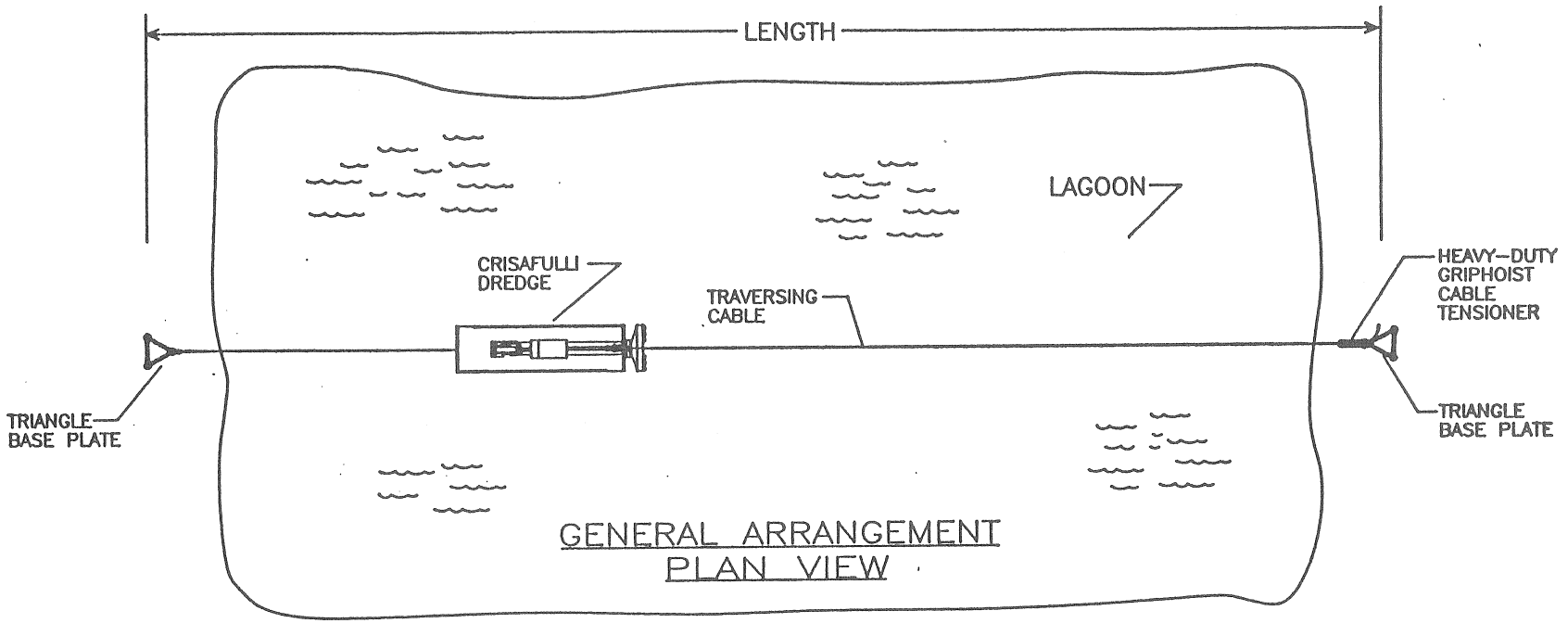
SCALE
N.T.S.

WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
630 OAKWOOD AVENUE
WEST HARTFORD, CT 06110
(203) 953-9624

PREPARED FOR
TOWN OF EAST HAMPTON

MISCELLANEOUS DETAILS
LAKE POCOTOPAUG

SIZE	PROJECT	FILE NAME	NUMBER	REV	SHEET	OF
D	LAKE POCOTOPAUG	- DETAIL	94046		1	

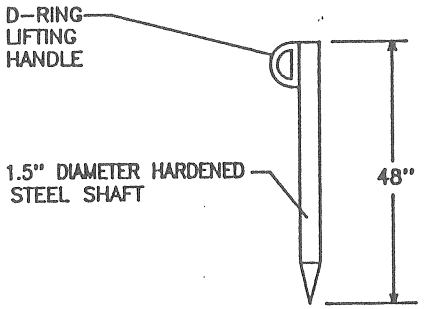


GENERAL ARRANGEMENT
PLAN VIEW

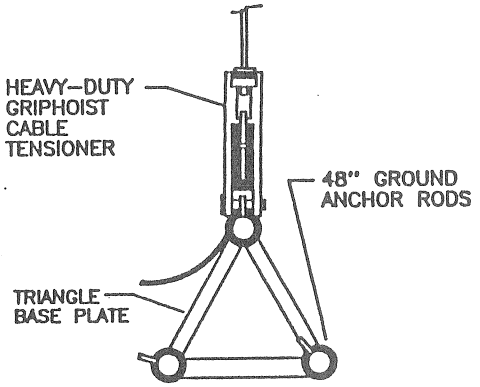
PARTS LIST

ITEM	DESCRIPTION	QUANTITY
1.	TRIANGLE BASE PLATES	2 EACH
2.	ENDLESS CABLE TENSIONER	1 EACH
3.	48" GROUND ANCHORS	6 EACH
4.	TRAVERSING CABLE (W/ HOOK)	1 EACH

* When ordering, please specify the dimensions of the area to be dredged and add about 10' to 15' feet extra to allow for the base plate offset as shown.



ANCHOR ROD
DETAIL



BASE PLATE
DETAIL

CRISAFULLI PUMP COMPANY, INC.

P.O. BOX 1051 GLENDIVE, MONTANA 59330 | PHONE: 1-800-442-PUMP

2-POST TRAVERSING CABLING SYSTEM
GENERAL ARRANGEMENT

No Scale | Drawn By: CKR | Ckd. | Date: Apr.5.1990 | Drawing # CPC-89254

NO.	DATE	DESCRIPTION
		REVISIONS

SUPV A.R.W.
DESIGN P.E.K.
DRAWN P.E.K.
CHECKED S.R.M.
DATE 03/13/95

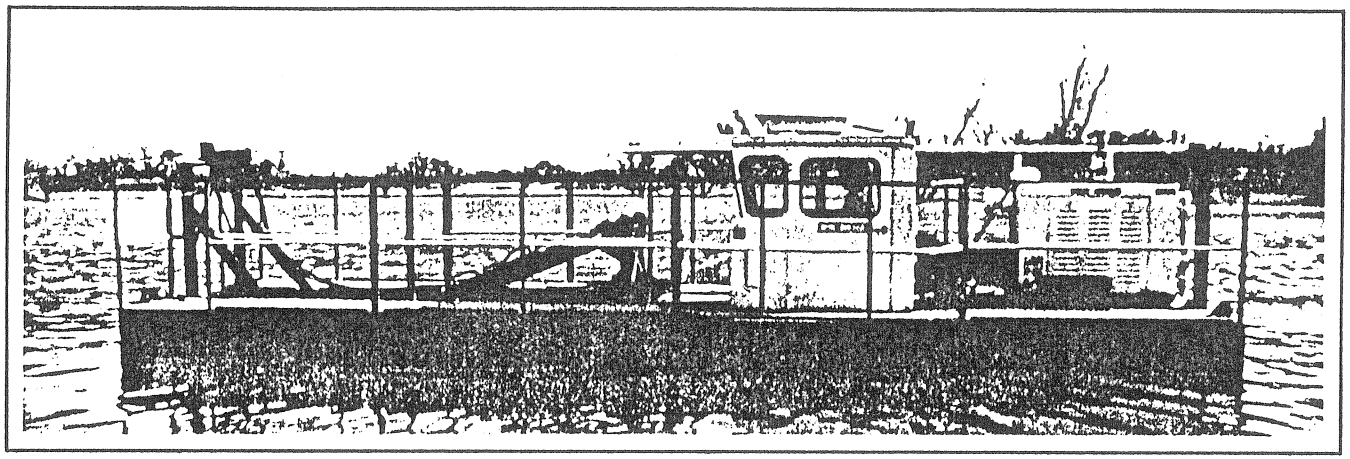
SCALE
N.T.S.

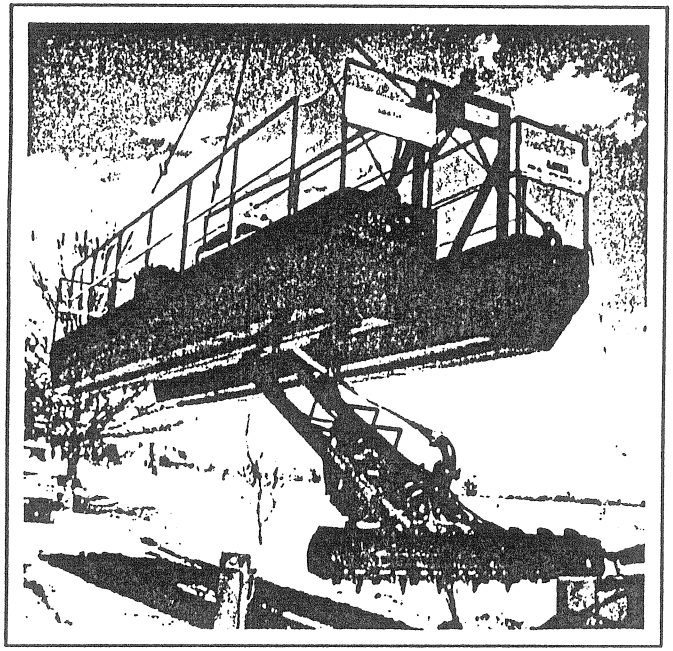
WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
630 OAKWOOD AVENUE
WEST HARTFORD, CT. 06110
(203) 953-9824

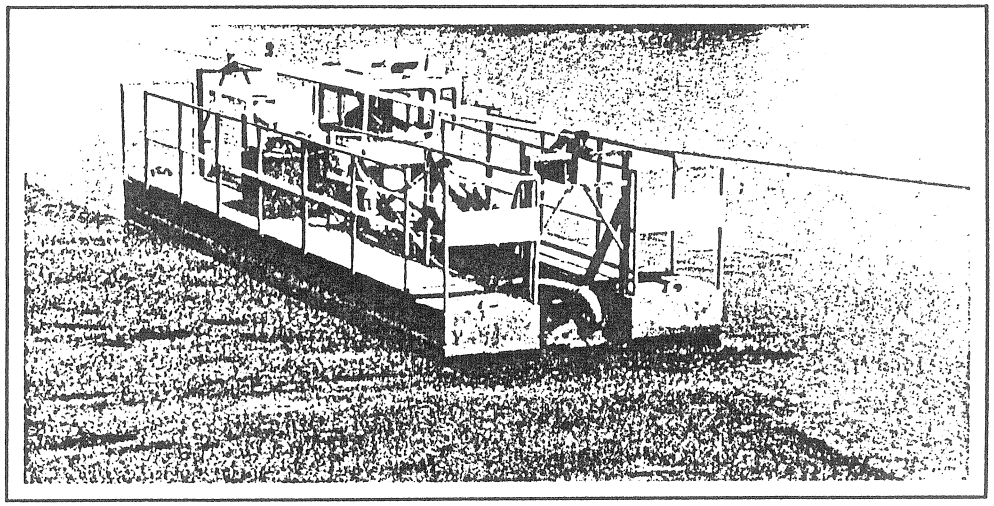
PREPARED FOR
TOWN OF EAST HAMPTON

TYPICAL DREDGE OPERATION
LAKE POCOTOPAUG

SIZE	PROJECT	FILE NAME	NUMBER	REV	SHEET OF
D	LAKE POCOTOPAUG	DETAIL	940M8		







NOTE: CHECK GRAPHIC SCALES BEFORE USING DRAWINGS

NO.	DATE	DESCRIPTION
		REVISIONS

SURV. A.R.W.
DESIGN P.E.K.
DRAWN P.E.K.
CHECKED S.R.M.
DATE 03/13/05

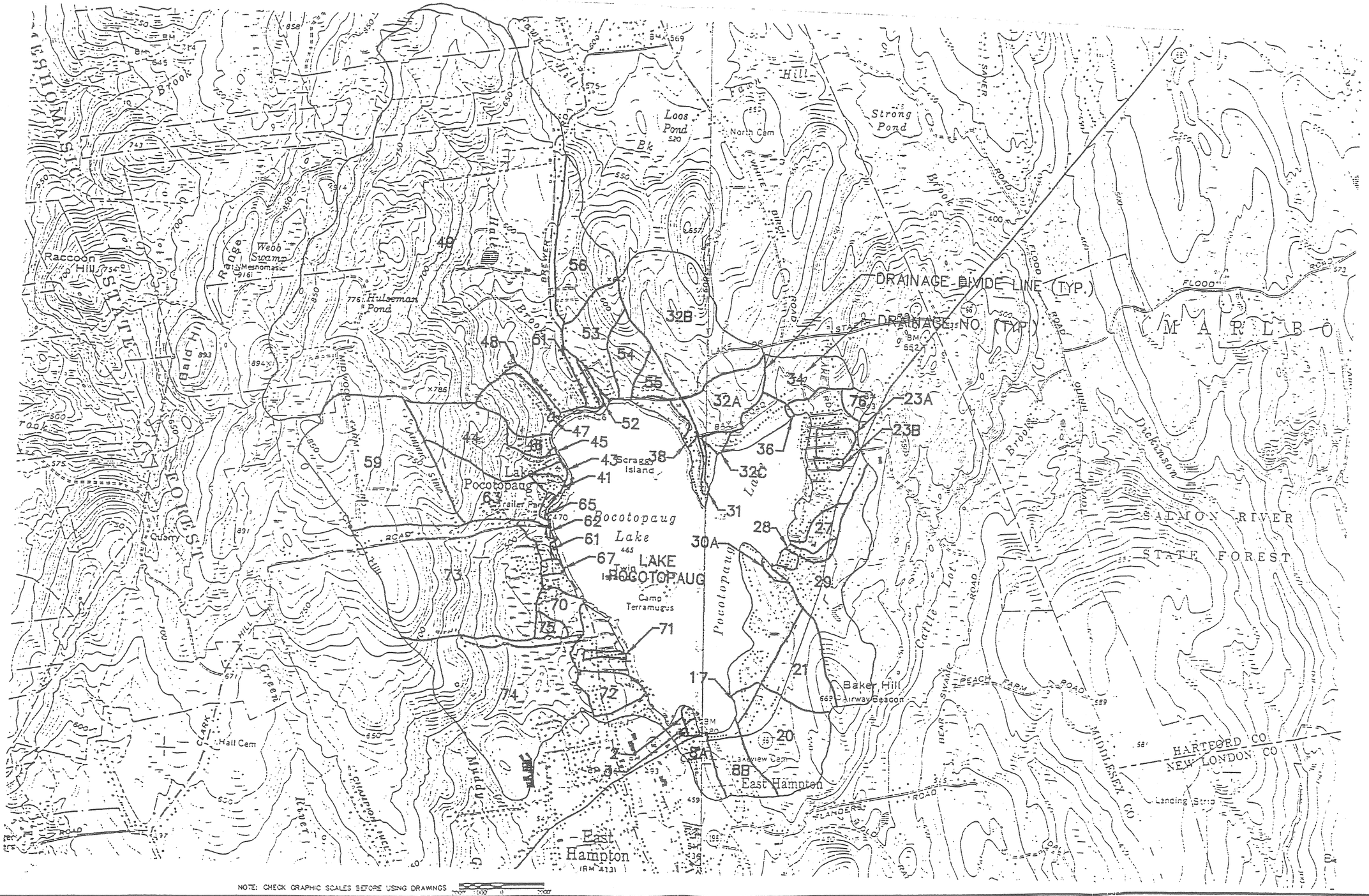
SCALE
N.T.S.

WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
430 OAKWOOD AVENUE
WEST HARTFORD, CT. 06110
(203) 953-9624

PREPARED FOR
TOWN OF EAST HAMPTON

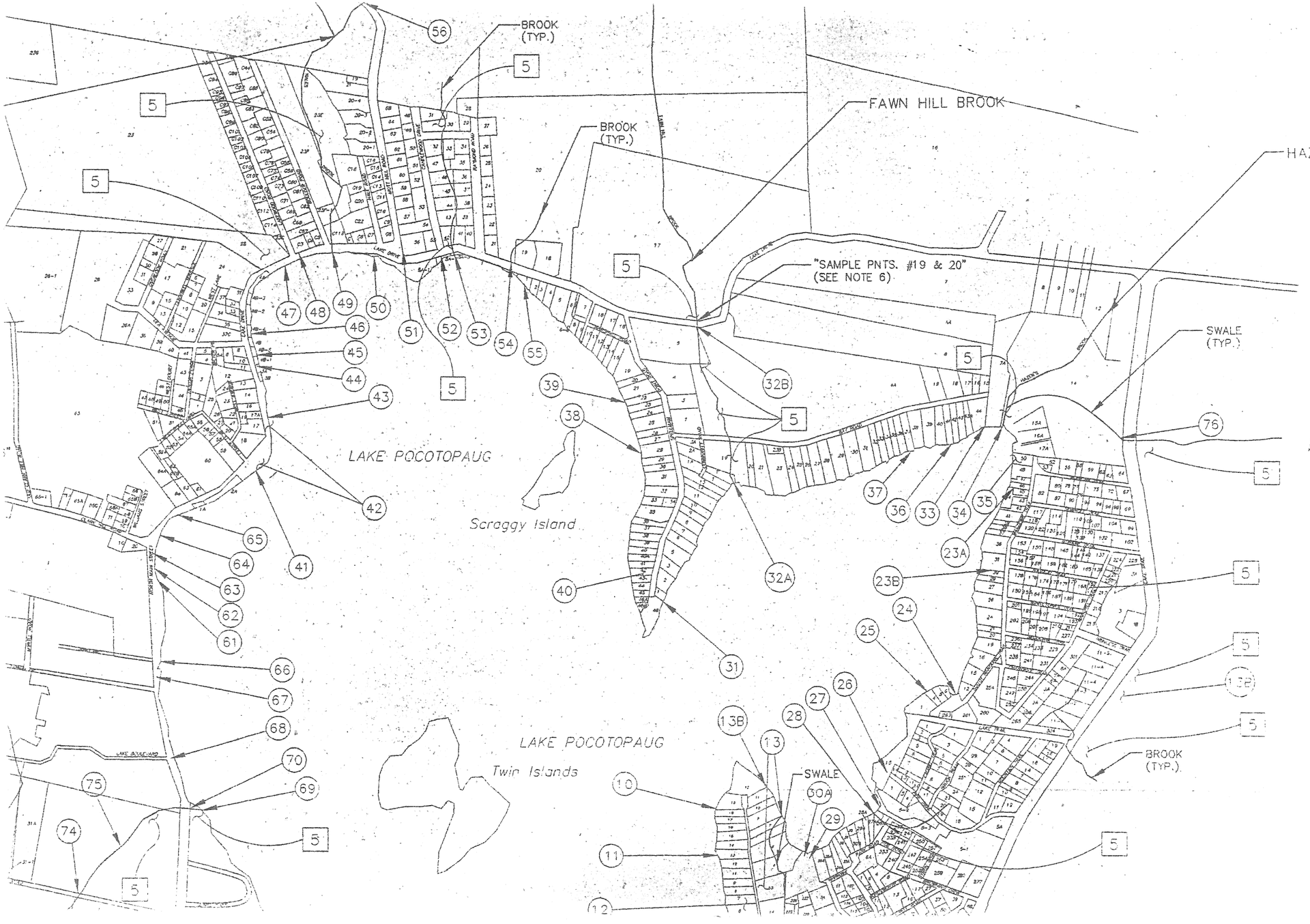
TYPICAL DREDGE OPERATION
LAKE POCOTOPAUG

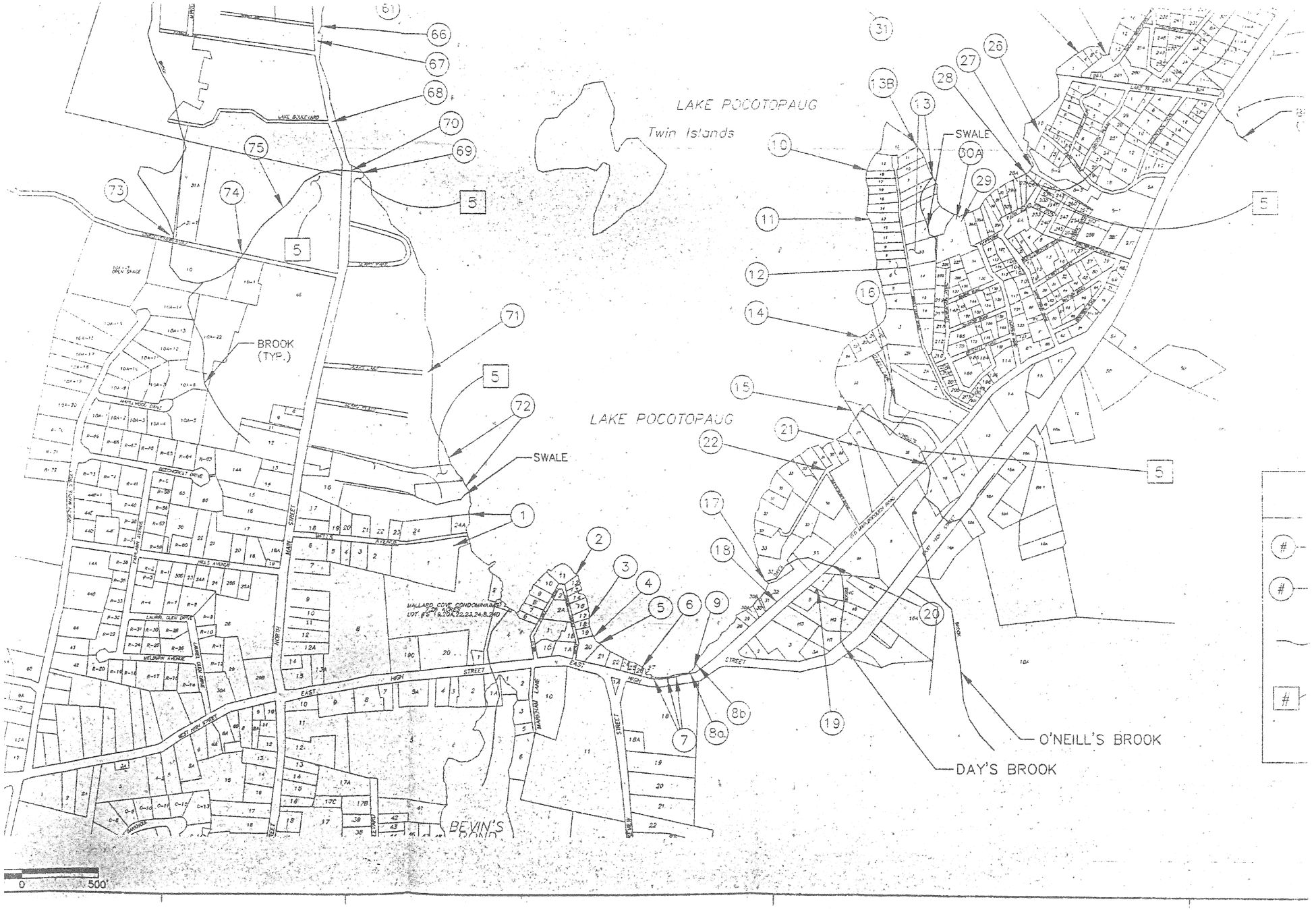
LAKE POCOTOPAUG		DETAIL	94086	SHEET
D				
921	PROJECT	FILE NAME	NUMBER	REV



NOTE: CHECK GRAPHIC SCALES BEFORE USING DRAWINGS

	SOFT. J.A.C.		SCALE 1" = 2000'	WMC CONSULTING ENGINEERS	PREPARED FOR THE TOWN OF EAST HAMPTON	FIGURE 2: DRAINAGE AREAS POCOTOPAUG LAKE DRAINAGE STUDY
	DESIGN P.E.K.			WENGELL, McCONNELL & COSTELLO 530 OAKWOOD AVENUE WEST HARTFORD, CT 06110 (203) 953-9624	TOWN HALL 20 EAST HIGH STREET EAST HAMPTON, CT 06424	D - POCOTOPAUG - AREA - 94026 - SHEET 1
	DRAWN J.I.					
	CHECKED P.E.K.					
	DATE 12/23/94					


BROOK (TYP.)
FAWN HILL BROOK
"SAMPLE PNTS. #19 & 20" (SEE NOTE 6)
SWALE (TYP.)
LAKE POCOTOPAUG
Scraggy Island
LAKE POCOTOPAUG
Twin Islands
SWALE
BROOK (TYP.)


LAKE POCOTOPAUG
Twin Islands
LAKE POCOTOPAUG
SWALE
SWALE
BROOK
(TYP.)
O'NEILL'S BROOK
DAY'S BROOK
BEVIN'S
0
500'