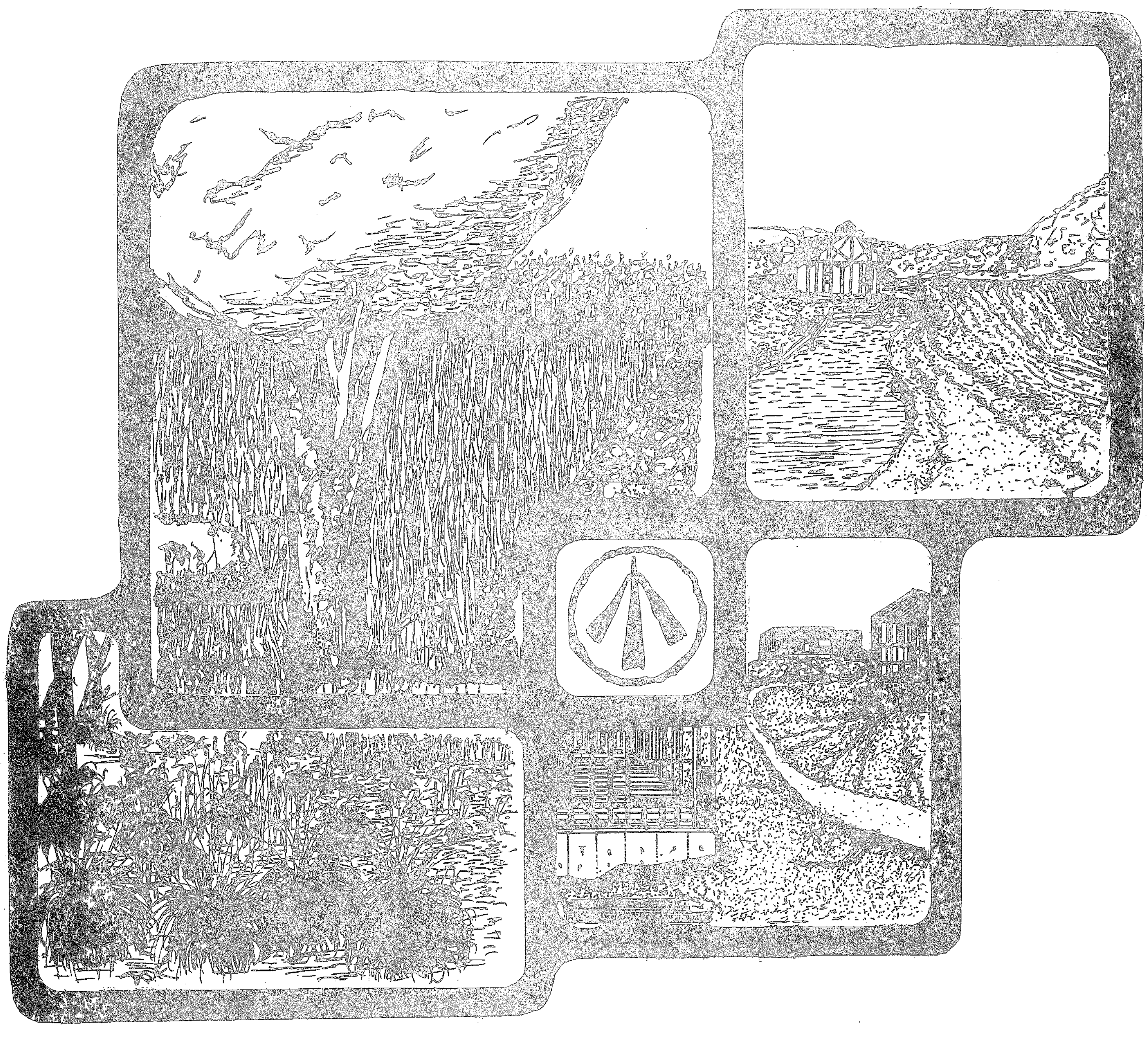
ENVIRONMENTAL REVIEW TEAM REPORT



KENOSIA AQUIFER WATERSHED
DANBURY, CONNECTICUT

KING'S MARK
RESOURCE CONSERVATION & DEVELOPMENT AREA

KING'S MARK
ENVIRONMENTAL REVIEW TEAM REPORT

ON

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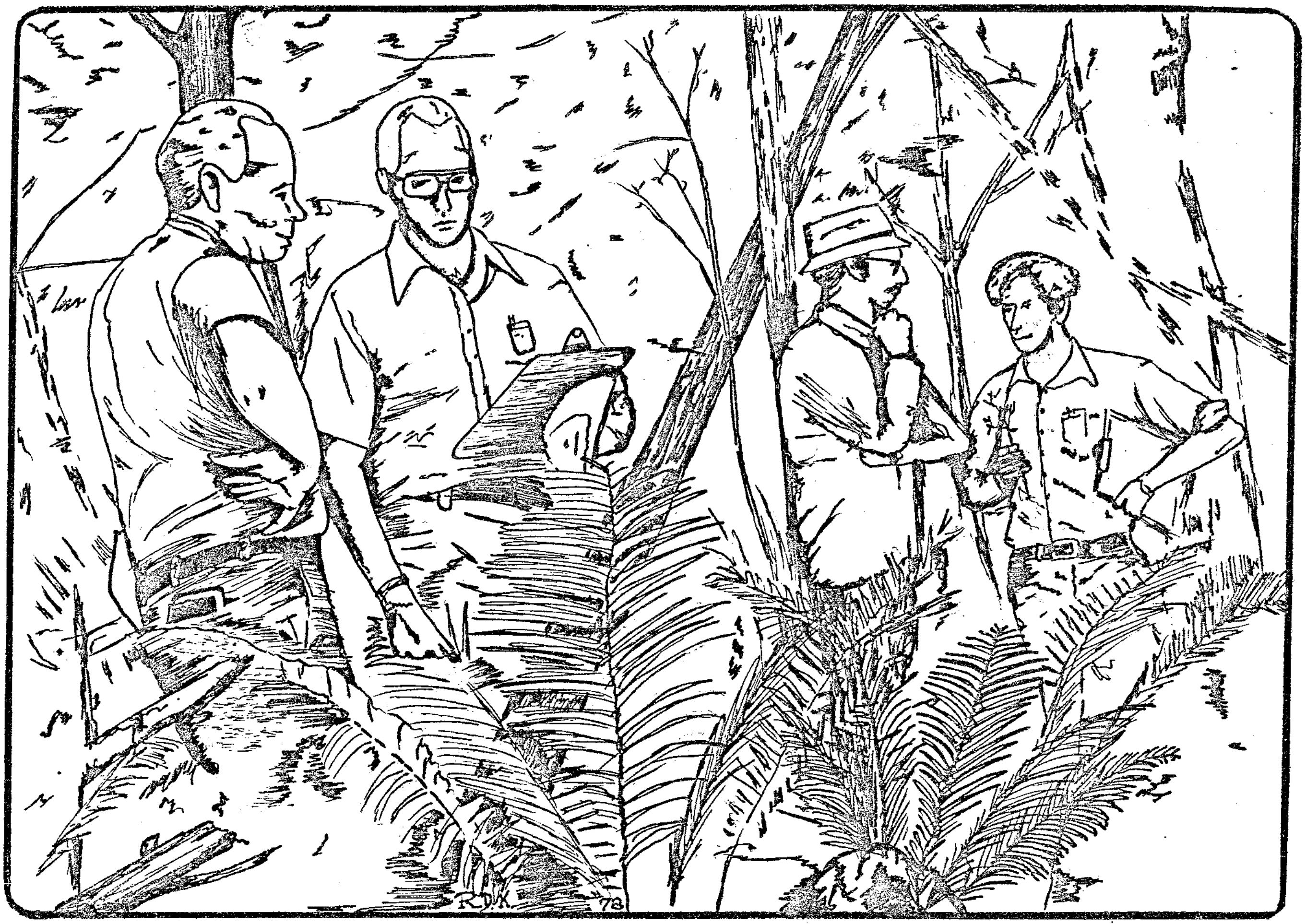

JULY 1980

King's Mark Resource Conservation and Development Area

Environmental Review Team

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ACKNOWLEDGMENTS

The King's Mark Environmental Review Team operates through the cooperative effort of a number of agencies and organizations including:

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U.S.D.A. SOIL CONSERVATION SERVICE

State Agencies

DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEPARTMENT OF HEALTH
DEPARTMENT OF TRANSPORTATION
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LITCHFIELD COUNTY SOIL AND WATER CONSERVATION DISTRICT
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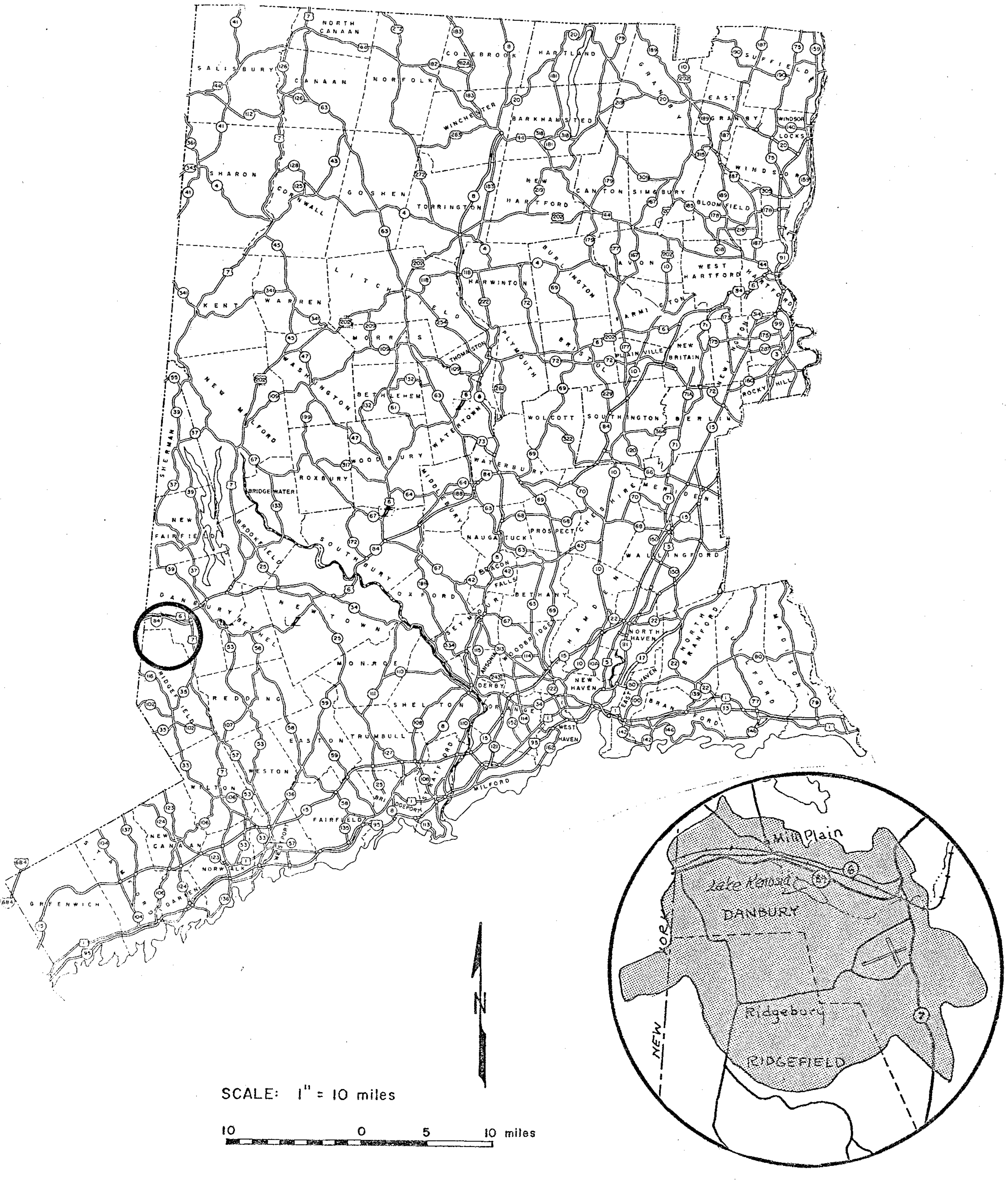
DANBURY, CONNECTICUT



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ENVIRONMENTAL REVIEW TEAM REPORT
ON
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DANBURY, CONNECTICUT

I. INTRODUCTION

In October of 1979 the King's Mark RC&D Executive Committee approved a request from the City of Danbury for an environmental review of the Kenosia Aquifer Watershed. The City's request was a joint request from the Mayor's office, Department of Health, Conservation Commission, and Environmental Impact Commission.

The Kenosia aquifer watershed area, shown in Figure 1, is recognized by all parties as a sensitive section of the City from an environmental standpoint. Located within this area are at least three significant natural resources. These include: 1) a major stratified drift aquifer (the Kenosia aquifer); 2) Lake Kenosia; and 3) Mill Plain Swamp. Each of these environmental resources is discussed in more detail below.

The Kenosia Aquifer. Recent studies have shown that water demands are growing in the Danbury area and that a major share of the City's future water supply must be met by groundwater sources.[1,2] At the present time, rapid development in western Danbury may pose a threat to the quality of the Kenosia aquifer. This aquifer, a major stratified drift aquifer in western Danbury (see Figure 2), is currently being tapped for public water supply, and is reported to be capable of supporting additional wells.[3] A recently completed report prepared by a consultant for the Housatonic Valley Council of Elected Officials, identifies the Kenosia aquifer as one of the twelve "priority aquifers" in the HVCEO region which should have "highest priority for immediate protective measures".[4] Of major concern is the zoning of a substantial portion of the Kenosia aquifer recharge area (including most of the aquifer area itself) for industrial use. To date, four known industrial waste disposal sites occur within the watershed and several water supply wells have been classified as having impaired or contaminated water quality. The increase in urban development projected for this area with the proposed new Route 7 expressway and the I-84 expansion raises legitimate concern for the protection of the Kenosia aquifer.

Lake Kenosia. Located in the northcentral portion of the study area, this lake is ± 65 acres in size and fed by a watershed of about 5 square miles (see Figure 1). The Lake is a popular recreational facility and offers opportunities for swimming, boating, and fishing. Aquatic weeds and algae have hindered the use of the Lake in recent years and residents of the Lake Kenosia area have expressed concern that additional development in the watershed may further degrade water quality and hence further erode the recreational opportunities offered by the Lake. Concern has been expressed not only with regards to accelerated eutrophication (which results in the nuisance growths of aquatic weeds and algae), but also as to the possible chemical pollution of Lake Kenosia by expanded industrial development in the area.

FIGURE I.

WATERSHED OF KENOSIA AQUIFER

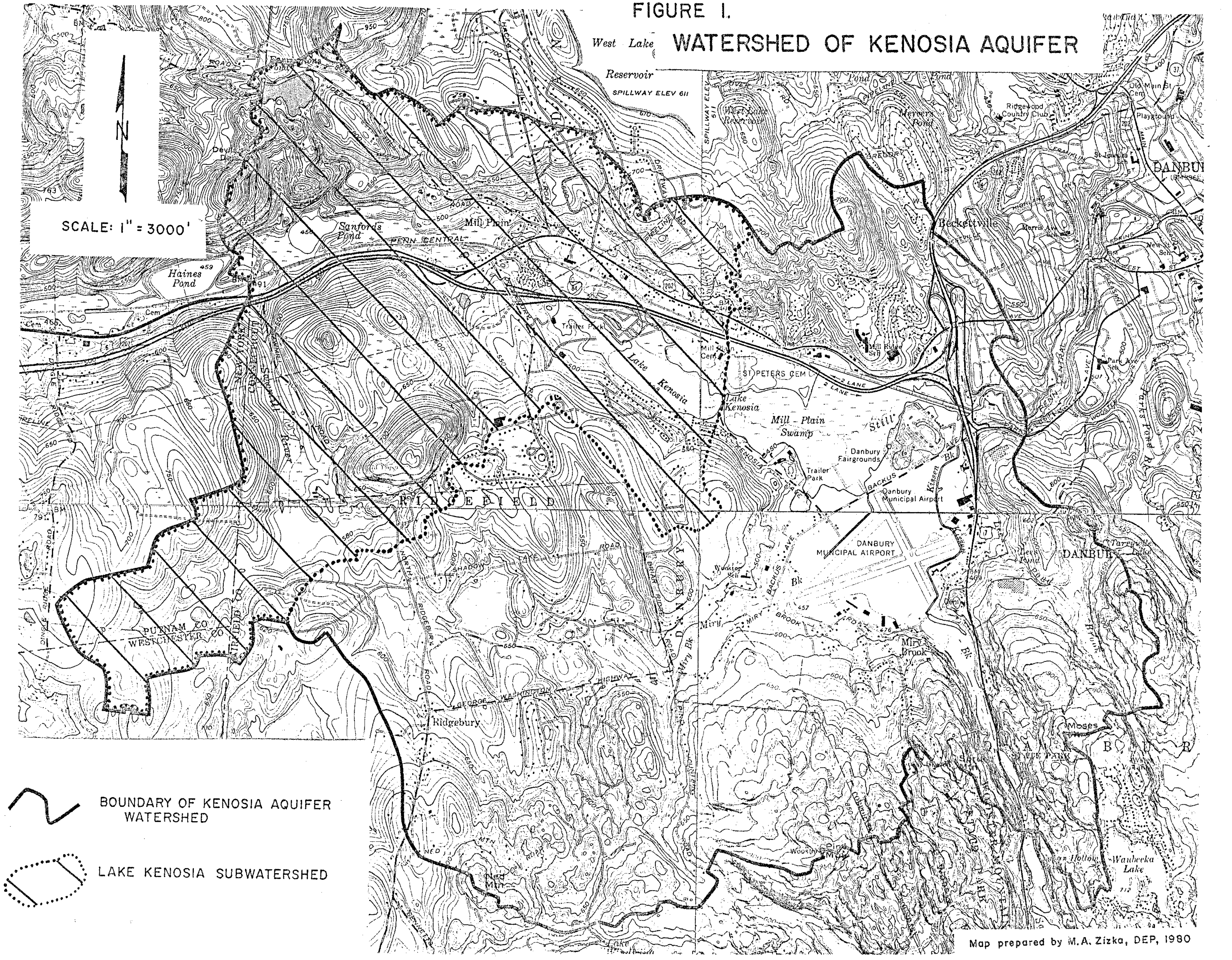
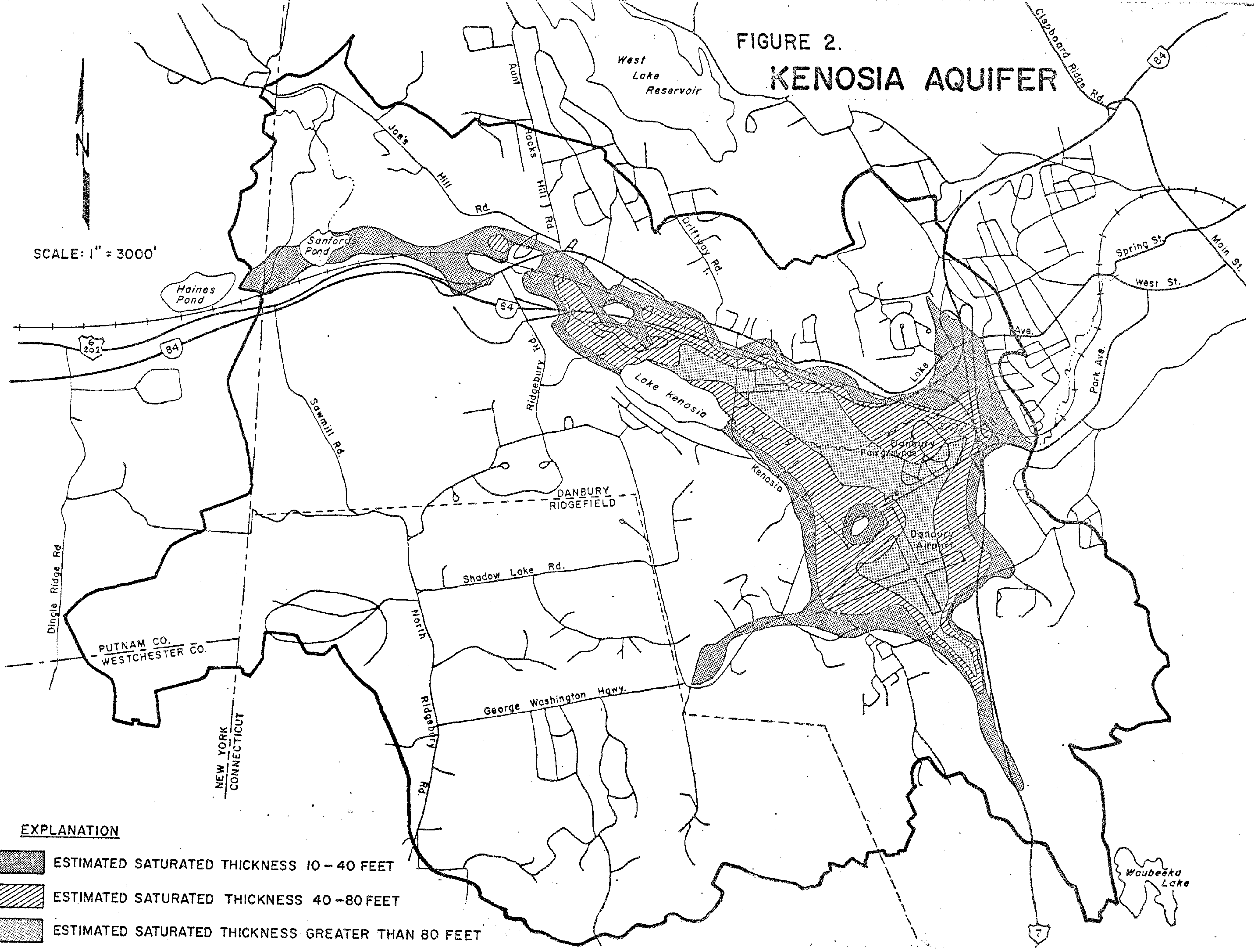


FIGURE 2.
KENOSIA AQUIFER



Adapted from Connecticut Water Resources Bulletin No. 21, Plate B, Part 1, 1972

Mill Plain Swamp. This ± 200 acre area is located between Lake Kenosia and the Danbury Fair Grounds (see Figure 1). This wetland, one of the largest in Danbury, is noted in the Connecticut Natural Area Inventory as the home of a rare species, as well as a valuable wildlife and recreation area. Concern has been expressed that future development upstream of this wetland will adversely impact wetland and wildlife resources.

* * * * *

The City of Danbury has expressed interest in protecting the above natural resources while at the same time not imposing unreasonable limits upon development in the area. As a first step towards reaching this goal, the City requested the assistance of the ERT to provide pertinent background information on the subject area and situation. Specifically, the ERT was asked to do the following:

1. Provide a general natural resources inventory of the Kenosia aquifer watershed.

2. Discuss the surface and groundwater hydrology of the Kenosia aquifer watershed.

3. Comment on the general environmental health of Lake Kenosia, the Kenosia aquifer, and Mill Plain Swamp.

4. Identify existing and potential land uses which may adversely impact water quality.

5. Identify those portions of the watershed most vulnerable to groundwater contamination.

6. Discuss strategies available for protecting and enhancing water quality in the subject area.

The ERT met and field reviewed the area on January 30, 1980. Team members for this review consisted of the following:

Bill Buckley........Sanitary Engineer...........State Department of Health

Brian Curtis........Hydrogeologist..............State Department of Environmental Protection

Brian Emerick.......Lakes Specialist............State Department of Environmental Protection

Ken Faroni ....Regional Planner............Housatonic Valley Council of Elected Officials

Charlie Fredette....Lakes Specialist............State Department of Environmental Protection

Ken Metzler.........Ecologist...................State Department of Environmental Protection

Robert Orciari......Fishery Biologist...........State Department of Environmental Protection

Ed Rizzotto.........Recreation Specialist.......State Department of Environmental Protection

Robert Rocks........Forester....................State Department of Environmental Protection

Frank Schaub........Sanitary Engineer............State Department of Health

David Thompson......District Conservationist.....U.S.D.A. Soil Conservation Service

Allan Williams......Environmental Analyst........State Department of Environmental Protection

Mike Zizka..........Geohydrologist...............State Department of Environmental Protection

Prior to the review day, each team member was provided with a background statement on the project, a checklist of concerns to address, and a series of resource maps of the subject area. Following the field review, individual reports were prepared by each team member and forwarded to the ERT Coordinator for compilation and editing into this final report.

This report presents the team's findings and recommendations. Following a summary statement, the contents of the report are presented in two major sections: 1) a natural resource inventory and evaluation, and 2) a discussion of management considerations for aquifer and lake protection. It should be noted that some management suggestions are presented in the inventory and evaluation portion of this report as they seemed to "fit" better there.

It should be recognized that this report is not a "management plan" for the Kenosia area. The report does however present information which can assist the City in making environmentally sound decisions in the Kenosia area. Further, the report provides a data base from which a "management plan" could be developed.

Any questions regarding the contents of this report, or requests for additional information, should be directed to Richard Lynn (868-7342), Environmental Review Team Coordinator, King's Mark RC&D Area, P. O. Box 30, Warren, Connecticut 06754.

* * * *

II. SUMMARY

Kenosia Aquifer

1. The watershed (drainage area) of the Kenosia aquifer contains about 13.5 square miles with the Kenosia aquifer comprising approximately 2.5 square miles.

2. Many of the soils in the Kenosia aquifer watershed present severe limitations for urban development. Poorly planned development on these soils can have a significant adverse impact on surface and ground water quality. Future land use decisions in this watershed should therefore take into careful consideration the limiting factors of various soil types and plan accordingly. Comprehensive erosion and sediment control plans for new development are essential.

3. The Kenosia aquifer area is underlain by stratified drift deposits ranging from fine grained material (sand, silt, clay) to coarse grained materials (sand and gravel). Although the coarse grained deposits are superior in terms of groundwater transmission, their ability to purify contaminated water is limited. While bacterial contaminants may be quickly oxidized and destroyed in the unsaturated upper portion of the deposit, chemical and particulate contaminants are less likely to be removed because of the dearth of silt and clay particles. Till and fine grained stratified drift deposits, on the other hand, may do a much better job of purifying polluted groundwater but these deposits generally do not transmit water in sufficient volume to meet public water supply needs.

4. The three production wells installed adjacent to Lake Kenosia have a combined yield in excess of two million gallons per day. Existing data indicate that the Lake Kenosia valley will support a total pumpage on the order of four mgd. Water quality from the existing production wells is good to excellent.

5. A recent report by the USGS identifies and discusses the major "non-point" sources of groundwater contamination in Connecticut. Among the sources listed in that publication, the following are believed to be particularly relevent to the Kenosia situation: septic systems, transportation related activities, urban run-off, industrial stockpiles and waste disposal, storage tanks for chemical and petroleum products, and direct chemical applications. To the extent that industrial development, transportation facilities, and residential development serve as sources of these contaminants, these land uses are incompatible with the extraction of high-quality groundwater from the Kenosia aquifer.

6. The City of Danbury already has a number of land use regulations which serve to protect groundwater quality. These include subdivision regulations, zoning regulations, wetland regulations, and the local health code. The inclusion of several provisions to existing regulations and additional management strategies would, however, strengthen existing land use regulations. It is suggested that the City of Danbury consider the adoption of an aquifer protection district and/or a watershed protection district to protect Lake Kenosia, the Kenosia Aquifer, and Mill Plain Swamp. This would involve amendments to the existing zoning regulations and would create an overlay district on the official zoning map. The fundamental purpose of such a district would be to preserve and protect the quantity and quality of the City's water resources while, concurrently, maintaining the economic viability of industrial and commercial zones.

7. The most positive action the City of Danbury could take toward aquifer protection would be to restrict certain types of industrial and manufacturing processes within the direct recharge area of the aquifer. In situations where this is not feasible or development on the aquifer has already been completed, strict regulation of activities within the area of concern should be considered. It would be advisable to identify and investigate all existing potential sources of groundwater pollution such as manufacturing firms, buried fuel oil and gasoline storage tanks, metal processing manufacturers, fertilizer and sodium chloride storage areas, and other sources of potential pollution to preclude future pollution of the aquifer and surface waters as experienced in the past. It would also be advisable for the City Health Department to develop a plan for emergency action in the event of chemical spills or accidents. This effort should be coordinated with the appropriate state agencies. Continued surveillance of septage disposal areas and other dump sites within the recharge zone would be desirable to minimize the likelihood of adverse effects on groundwater quality.

8. The City of Danbury has the responsibility of providing an adequate supply of pure drinking water for its future needs. Ground water supplies are very susceptible to contamination from a variety of sources and once contaminated, they usually remain so for an indeterminable period of time. There are only a limited number of ground water resources available within Danbury to meet drinking water demands. Appropriate protection efforts implemented at the present time, which may be labeled as unnecessary by those who are more short-sighted or unknowing of the consequences of contamination, will be greatly valued by Danbury's future generations.

Lake Kenosia

1. Lake Kenosia is characterized by abundant growths of aquatic plants during the summer months which are indicative of a eutrophic lake. The shallowness of the lake coupled with the impending urban development in the watershed, indicates that the lake is very susceptible to accelerated eutrophication and its attendent water quality problems (nuisance growths of aquatic weeds and algae). This is a significant concern with the present use of the lake for swimming and boating and also from an aesthetic standpoint.

2. The Connecticut DEP is in the second year of a eutrophication survey of Connecticut lakes. Lake Kenosia is one of the lakes being surveyed during this 1980 season. The testing program will involve both spring and summer sampling and will also include an evaluation of aquatic plants in the lake. The results of this investigation will be available in the fall of 1980. After this effort is completed, a more definite statement can be made regarding the eutrophic status of the lake.

3. Even though fishing pressure is light, Lake Kenosia is considered a good bass lake and is a very important fisheries resource to anglers with small row boats. The inlet stream to Lake Kenosia has considerable value since it is known to support native brook trout. Careful land management practices within the watershed of Lake Kenosia would help to protect this fisheries resource. In this regard, the establishement of a streambelt buffer zone and the careful control of new development would be particularly desirable.

4. The practices described to protect the Kenosia aquifer will also serve to protect the water quality of Lake Kenosia. In addition, however, efforts to control the accelerated eutrophication of Lake Kenosia should be considered. Protection *strategies here should be aimed towards limiting the nutrient loading of the lake and might include such provisions as erosion and sedimentation controls, proper maintenance of septic systems, establishment of streambelt buffers, utilizing non-phosphate detergents, controlling agricultural and fertilizer run-off, and public awareness/education of pollution sources.*

Mill Plain Swamp

1. *One of the largest wetlands within the City of Danbury, Mill Plain Swamp provides potential water supply, wildlife, flood control, pollution filtration, recreation, and ecological study values and opportunities.*

2. *Since the swamp is underlain and influenced by calcareous bedrock, the potential for unusual plant or animal species is high. This is evident in the apparent high pH of the substrate and the suspected occurrence of the bog turtle.*

3. *Mill Plain Swamp is considered to be a valuable natural resource in the Danbury area. Consideration should be given to protecting this wetland from negative impact by curtailing direct disturbance to the wetland, by minimizing the risk of pollution from the watershed and by avoiding significant changes in stream flows into and through the wetland.*

III. NATURAL RESOURCE INVENTORY AND EVALUATION

A. Geology

The Kenosia Aquifer watershed lies within the Bethel, Brewster, Danbury, and Peach Lake topographic quadrangles. Bedrock geologic maps of the Danbury quadrangle (Connecticut Geological and Natural History Survey Quadrangle Report No. 7) and the Brewster and Peach Lake quadrangles (New York Map and Chart Series No. 11) have been published. A surficial geologic map of the Danbury quadrangle is open-filed at the Department of Environmental Protection's Natural Resources Center. Generalized bedrock information for the watershed may be found in the Preliminary Geological Map of Connecticut, 1956, Connecticut Geological and Natural History Survey Bulletin No. 84.

The general rock types found within the watershed may be described with reference to the major topographic zones. The steep northern highland section of the watershed, north of the Kenosia valley, is underlain by a gneiss complex. Most of the gneisses in this area are rich in hornblende, plagioclase, and quartz, with minor biotite and apatite. Also included in the complex are calc-silicate granulites, amphibolite, and mafic igneous rocks. The Kenosia valley, including the Danbury Airport and Mill Plain Swamp areas, are underlain by rocks of the Manhattan Formation and by the Inwood Marble. The Manhattan Formation is principally sillimanite-garnet-biotite gneiss with minor mica schist and quartzite. The Inwood Marble contains both calcitic and dolomitic forms. The Fordham Gneiss underlies most of the southern highland area of the watershed. This unit consists largely of hornblende-biotite andesine gneiss and is probably the most widely outcropping rock type within the study area.

The general surficial geology of the watershed is shown on the Kenosia Aquifer Recharge Area map (see Figure 3). This map omits certain surficial units that do not have substantial significance in terms of groundwater supplies. Omitted units include alluvium (relatively thin sediment deposits by modern streams), swamp deposits (peat and muck, clay, silt, and sand), and artificial fill (man-made deposits, such as those forming the base of Interstate 84 at the eastern edge of the watershed). These units may be inferred in part from the soils map accompanying this report.

The two major surficial geologic materials in the watershed are till and stratified drift. Till consists of rock particles that range in size from clay to large boulders, and in shape from flat to angular to rounded. Till was deposited directly from glacier ice, which had accumulated and transported the rock particles from areas generally to the north. The lack of meltwater transport explains the nonsorted nature of the till components. Stratified drift, on the other hand, was deposited by glacial meltwater and tends to exhibit at least a rudimentary sorting. Sandy or gravelly layers are most common in the upper parts of these deposits, but silty or clayey layers are often present as well. The texture of any given portion of a stratified drift deposit may be explained by the energy of the meltwater which ultimately deposited it. High-energy streams, for instance, would have allowed only the coarser, heavier particles (sand and gravel) to drop out while stagnant or sluggish water would have allowed deposition of fine particles.

The numerous test holes recorded in the stratified drift of the Kenosia valley show a fairly consistent pattern, at least in the central section of the

FIGURE 3.

KENOSIA AQUIFER RECHARGE AREA

Direct Recharge Area (those areas of till, bedrock and stratified drift from which groundwater flows directly into the aquifer)

- Portion covered by till
- Portion covered by stratified drift of less than 10 feet saturated section
- Portion covered by stratified drift of greater than 10 feet saturated section (Kenosia aquifer)

Indirect Recharge Area (the upstream drainage area of streams that traverse the stratified drift aquifer. Rain that falls on this area moves first into a surface water body and then, under pumping conditions, into the aquifer.

- Portion covered by till
- Portion covered by stratified drift of less than 10 feet saturated section

Map prepared by M.A. Zizka, DEP, 1980

valley. Coarse-grained sand and gravel is usually found immediately overlying bedrock. This material, in turn, is overlain by layers of finer-grained sands, silts, and clays. Coarser sand and gravel may or may not be present near the surface, depending on the particular location within the valley. This pattern indicates that meltwater initially took the form of streams at the onset of glacial retreat. With continued wastage of the ice, outlets in the valley became plugged with ice blocks and rock debris, causing a lake to form behind the plug or plugs. It seems clear that the major blockage occurred in the Still River valley, just east of the Route 7 Interstate 84 junction at the eastern edge of the Kenosia Aquifer watershed. The low-energy lake environment allowed increasingly finer-grained sediments to be deposited and caused the broad, flat surface that characterizes the Danbury Airport-Mill Plain Swamp areas. As sediments built up to the lake's surface and the glacial dam or dams were breached, a sluggish stream system reemerged in the Kenosia valley, depositing coarser materials on the lake sediments. Swamps formed in those parts of the valley where shallow water remained, and continued growth and deposition of vegetation over post-glacial time resulted in occasionally thick accumulations of peat and muck. Test holes by Geraghty and Miller[5] in the swampy area near the Jensen mobile-home park west of Lake Kenosia showed as much as 43 feet of organic deposits.

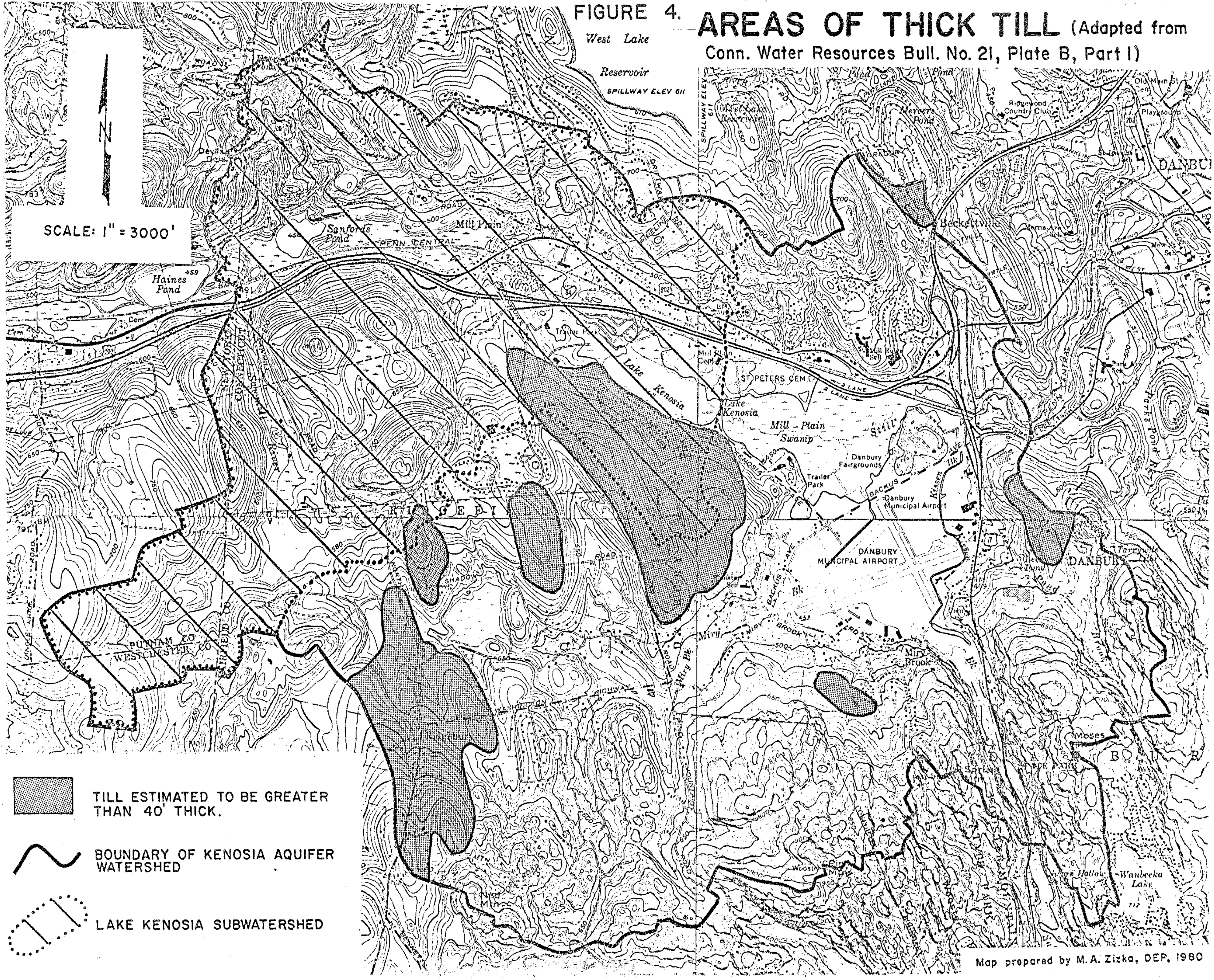
Till covers the bedrock in most of the upland parts of the watershed. The general thickness of the till probably is less than 15 feet, but in a few areas, the till may be more than 40 feet thick. Figure 4, adapted from Connecticut Water Resources Bulletin No. 21, Plate B, Part 1, shows those areas. In the irregular, knobby topography near the southern boundary of the watershed, as well as in the steep areas north of the Kenosia valley, bedrock probably is less than 10 feet from the surface in most places.

B. Hydrology

The watershed of the Kenosia Aquifer contains approximately 8,650 acres, or about 13.5 square miles. The Kenosia Lake subwatershed contains approximately 3,235 acres, or about 5.1 square miles. The major portions of both drainage areas lie to the south of the Kenosia valley. North of the valley, the tributary streams within the watershed are short and usually follow steep to precipitous channels. The tributary streams south of the valley are much longer and tend to follow moderately sloping to gently sloping paths. The major tributary stream within the watershed is Miry Brook, which has a drainage area of approximately 3,175 acres or about 5 square miles. This area is comparable in size to the Kenosia Lake subwatershed. About two-thirds of the Miry Brook drainage area lies within the Town of Ridgefield. The other notable tributary streams in the Kenosia Aquifer watershed are Sawmill River, at the western boundary, and Kissen Brook and Lee's Pond Brook, both near the eastern boundary.

The general groundwater flow pattern in the watershed parallels the surface flow pattern to a great extent. The shape of the water table (that level below which all rock and soil spaces are filled with water) is largely conformable with the surface topography, although minor surface features may not be reflected in the water table. The rate of groundwater movement depends upon the slope and the nature of the material through which the water is passing. In general, groundwater will pass most quickly through materials with large, continuous spaces.

FIGURE 4. **AREAS OF THICK TILL** (Adapted from Conn. Water Resources Bull. No. 21, Plate B, Part I)



Gravelly stratified drift is usually the best medium for subsurface flow. The variable, nonsorted nature of till makes it a fair to poor conductor of groundwater, with the most rapid movement typically occurring in the upper few feet, which tend to be coarser. Groundwater passes through the bedrock in this area mostly by way of fracture networks within the rock.

Because the flow of groundwater is most rapid in coarse stratified drift, this material holds the best potential for high-yielding wells. The term "aquifer" refers to any material which is capable of supplying usable amounts of groundwater; hence, it is misleading to use the term only in connection with stratified drift. Nevertheless, the slow transmission of water through till and bedrock usually restricts well yields from those sources to amounts suitable only for individual domestic or small commercial purposes. Substantial public-water-supply needs can be met only by surface reservoirs or by coarse-grained stratified drift deposits.

Groundwater and surface water in all parts of the watershed are hydrologically connected. Groundwater is discharged to the surface in the form of springs or streams, or occasionally in a sheet-like flow. Surface flow is maintained during dry seasons by continuous groundwater discharge from storage. Since precipitation can penetrate stratified drift more easily, more storage of groundwater per inch of rainfall will occur in a given volume of stratified drift than in the same volume of till. Hence, streams in till-covered areas react more quickly and noticeably to weather variations; wet conditions may rapidly produce torrents, whereas dry conditions may dry up small streams.

Surface flow, in some instances, may become groundwater flow. A stream flowing down a till-covered hillside may disappear into coarse stratified drift near a valley center. Also, artifically induced flow of surface water into the ground may take place when groundwater wells are placed near streams or ponds, and the "cone of depression" (the localized drawdown of the water table in the vicinity of a pumping well) extends beneath the surface water body.

The interrelation of groundwater and surface water allows the designation of specific areas within the watershed as "direct recharge" areas and "indirect recharge" areas. "Direct recharge" areas are those which naturally supply groundwater to an aquifer. "Indirect recharge" areas are those which supply streams passing over the aquifer; the streams, in turn, normally supply groundwater only by artificially induced pumping conditions. The direct and indirect recharge areas designated on the Kenosia Aquifer Recharge Area Map are only estimates based on the probable "normal" conditions. Drainage areas of small tributary streams are not included in the "direct recharge" area because under "normal" conditions the groundwater in those areas would discharge to the streams before reaching the aquifer. Under dry conditions, however, the streams may cease to carry water and groundwater would then pass directly into the aquifer. Conversely, areas included in the "direct recharge" zone may contain temporary streams during wetter periods.

An estimate may be made of natural recharge to the Kenosia Aquifer by means of a method described in Connecticut Water Resources Bulletin No. 21. An analysis by this method indicates that the average annual recharge is approximately 4.09 million gallons per day (mgd); that the recharge equaled or exceeded seven years in ten is approximately 3.44 mgd; and that the long-term minimum recharge is 1.64 mgd.

Inasmuch as coarse-grained stratified drift deposits are superior in terms of groundwater-transmission characteristics, their ability to purify contaminated water is limited. While bacterial contaminants may be quickly oxidized and destroyed in the unsaturated upper portion of the deposit, chemical and particulate contaminants are less likely to be removed because of the dearth of silt and clay particles. Till, on the other hand, may do a much better job of purifying polluted groundwater.

Proximity to rivers and the typical level topography historically has induced industry to move into areas underlain by extensive stratified drift deposits. These factors also have fostered the construction of major transportation lines (highways and railroads) in these areas. Such considerations partly account for the existence of U.S. Routes 6 and 202, Interstate 84, and the Penn Central Railroad near Kenosia Lake, as well as for the presence of the Danbury Airport, Danbury Fairgrounds, and the several industries in the area. To the extent that these transportation facilities, industries, and of course the residential sections, serve as sources of pollutants, they are incompatible with the extraction of high-quality groundwater from the stratified drift deposits. Salts and industrial wastes are perhaps the most serious potential problems in view of the inability of coarse stratified drift to cleanse groundwater of most of these contaminants.

C. Soils

A detailed soils mapping of the Kenosia Aquifer watershed has recently been completed by the U.S.D.A. Soil Conservation Service. Copies of this detailed mapping are available from the Fairfield County Conservation District together with detailed soils interpretation information.

For the purposes of this report, the soils of the Kenosia Aquifer watershed may be classified into five major natural soil groups. The geographic distribution of these natural soil groups is shown in Figure 5, which may be found in the back pocket of this report. A brief description of each of these soil groups is presented below together with comments on the general suitability of the soil groups for various land uses.

GROUP A - Terrace soils over sands and gravels (excluding the poorly and very poorly drained terrace soils).

These soils occur above flood plains in river and stream valleys. They are underlain by water--deposited beds of sand and gravel. In most places a few inches to three feet of loamy or fine sandy material cover the older, coarser water deposits. Nearly all sources of sand and gravel, and many of the important sources of water supply,are in areas associated with the terrace soils.

Although terrace soils are generally suitable for community development (i.e. earthmoving is readily done and soil conditions are favorable for buildings, parking lots, and landscaping),care must be taken not to pollute groundwater resources. Rapid percolation rates are characteristic of these sandy and gravelly soils and this can lead to inadequately renovated effluent or leachate reaching the underlying water table. Obviously in areas where these soils are recharging a public water supply well, great care is needed in the siting and design of any land use which may represent a threat to groundwater quality.

GROUP B - Upland soils over friable to firm (permeable) glacial till - (excluding the poorly and very poorly drained upland soils).

The soils in this group as well as those in the following two groups (Group C and D) are all upland soils that were formed in areas of glacial till. Glacial till is the predominant unconsolidated overburden material (surficial geologic material) found in Connecticut today.

The soils in this group are formed in the thicker, unconsolidated deposits of till usually occurring on hillsides. They generally have good potential for community development except where steep slopes or stoniness present problems.

GROUP C - Upland soils over compact (non-permeable) glacial till (hardpan) - (excluding the poorly and very poorly drained compact till soils).

These upland soils occur mostly on the tops and slopes of drumlins, (hills that were smoothed and elongated north to south by the movement of glaciers). The soils are underlain by compact glacial till and have a hardpan or fragipan 16 to 36 inches below the soil surface. Permeability above the hardpan is moderate but the pan drastically reduces percolation. During wet seasons, excess water in the soil moves downslope above the hardpan. This characteristic presents formidable problems in the design and construction of septic system absorption fields that function satisfactorily. Septic systems may be flooded by a seasonally high or perched water table and effluent may "break out" down slope of the septic system leaching fields. Careful design and engineering is also required to prevent groundwater seepage into basements and frost heaving of roads and driveways. Steep slopes and stoniness may also present problems in certain areas.

GROUP D - Upland soils - rocky and shallow to bedrock.

The soils in this group occur mostly in the rougher areas of the uplands. They may occupy narrow ridge tops but most often are on steep side slopes. They are characterized by stoniness and shallow depths to the underlying bedrock. In most places, hard rock is less than 20 inches below the soil surface. These areas provide contrast in the landscape and scenic overlooks, but in most cases pose severe limitations for urban development. Occasionally pockets of deeper soils can be found within this soil group which are more suitable for development purposes (e.g., an individual home site).

GROUP E - Inland Wetland Soils.

This group includes all soils classified as inland wetlands according to P.A. 155 as amended, Connecticut's Inland Wetlands and Water Courses Act. These soils typically have a water table within 6 inches of the soil surface during the wetest part of the year. The high water table often persists into late spring and may reoccur after prolonged or heavy summer rains. Some of these soils are very poorly drained and have water ponded on the surface for significant periods in winter and spring. By definition, well drained and moderately well drained flood plain soils also qualify as inland wetland soils in Connecticut.

Inland wetland soils present severe limitations for most urban uses. Development is very costly and requires complete alteration of the resource base. Intensive drainage and land fill measures are required to overcome wetness. Inland wetlands and watercourses are regulated in the State of Connecticut because they provide valuable functions and are critical, fragile, and irreplaceable natural resources. They are also an important part of the larger hydrologic system. Disturbance of these areas should be kept to a minimum.

Other lands.

The Natural Soils Group Map (Figure 5) also shows borrow and fill land or made land. These are altered areas, where the original soil no longer exists for one reason or another. These areas are not classified into Natural Soil Groups. They are variable in nature and on-site investigation is required for determining suitability or limitations for any intended use.

CRITICAL SOIL AREAS

Figure 6, also found in the back pocket of this report, identifies those areas of the watershed characterized by "critical" soils. These soil areas pose severe limitations for urban development. In addition, if improperly used or developed, these soils have high potential for adversely impacting water quality. The critical soil areas shown in Figure 6 include the following:

- inland wetland soils
- areas within the 100 year flood hazard area
- areas characterized by steep slopes (greater than 15%)
- shallow to bedrock soils (hard rock is within 20 inches of the soil surface)

It should be recognized that these critical soil areas are not the only areas within the watershed where soils present limitations for development (for example, hardpan soils present problems as do the rapidly draining terrace soils). These areas are, however, among the most important ones that should be carefully considered when managing for optimum water quality. Development, if it is to occur in these areas, must be very carefully planned and managed with appropriate controls in order to protect water quality.

EROSION AND SEDIMENT CONTROL

All of the soils in the Kenosia aquifer watershed are erodible. In the interests of protecting water quality in Lake Kenosia and Mill Plain Swamp, it is very important that all future development in the watershed implement plans for effective erosion and sediment control. These plans are particularly critical in streambelt areas and on those lands immediately surrounding Mill Plain Swamp and Lake Kenosia. Erosion and sediment control practices are described in the "Erosion and Sediment Control Handbook--Connecticut (USDA Soil Conservation Service, 1976). Additional assistance in the preparation and review of erosion and sediment control plans is available from the Fairfield County Conservation District.

IN CONCLUSION

Many of the soils in the Kenosia watershed present severe limitation for urban development. Poorly planned development on these soils can have a significant adverse impact on surface and ground water quality. Hence, future land use decisions in this watershed should take into careful consideration the limiting factors of various soil types and plan accordingly. It should be noted that the general soils map included in this report does not replace the need for more detailed information concerning individual soil mapping units when site specific information is required.

D. Wildlife and Forest Management

As shown in Figure 9 (see back pocket of this report), quite a substantial portion of the Kenosia Aquifer Watershed is undeveloped. The woodlands, wetlands, and open lands comprising this undeveloped land offer habitat for wildlife as well as potential for woodcrop utilization. Wildlife and forest management concerns are addressed below.

1. WILDLIFE

At present, three major wildlife habitat types may be found within this watershed. These include upland woodland, farmland/orchards and wetlands. These areas are roughly identified in Figure 9.

It should be recognized that wildlife will often find optimum conditions at the edges of habitat types. These areas provide vegetation diversity, which in turn allows for wildlife variety and abundance. It is not at all uncommon for wildlife to utilize more than one habitat type to meet their needs. The basic requirements of wildlife which habitat must satisfy are food, water and cover. These needs may change daily and especially seasonally; as a result there may be considerable overlap in the utilization of habitat types by individual wildlife species.

Upland Woodland - The upland woodland habitat type is found primarily in the southeastern portion of the watershed; however, smaller blocks are present throughout the entire study area. Upland Central Hardwoods dominate the area. The main constituents of the overstory in this area are red oak, white oak, black oak, shagbark hickory, pignut hickory, mockernut hickory, and scattered tulip tree, black birch, white ash, sugar maple and red maple. The mast (nuts such as acorns) produced by these species provide wildlife with a valuable source of food. In some areas hemlock makes up as much as 50% of the overstory. Hemlock provides excellent cover and winter feed, especially for deer. Understory vegetation consists of hardwood tree seedlings, mountain laurel, witch-hazel, hemlock seedlings, flowering dogwood and maple leaved viburnum.

Some of the wildlife populations which utilize this habitat type are white-tailed deer, ruffed grouse, gray squirrel, chipmunk, shrew, deer mice and assorted birds, including crows, chickadees, woodpeckers and bluejays. Red squirrel may be found in the areas where hemlock are present, along with nesting hawks and owls.

Farmland/Orchard - The farmland/orchard habitat type offers great diversity of vegetation, and as a result a large variety of wildlife populations are present. Vegetation types range widely and include: active agricultural land, orchards, open field(grazed and ungrazed) and old fields reverting to mixed hardwoods. The transition zones or edges which are present between these vegetation types are especially valuable to wildlife because they offer a variety of high quality food and cover. The brush, shrub, and weed species which dominate this habitat type are valuable because they also provide "overwintering" wildlife with a source of winter food in the form of seeds. These seeds are made available because snow cover is lessened in some areas by wind action.

Examples of wildlife species utilizing this diverse habitat type are white-tailed deer, gray squirrel, eastern cottontail rabbit, skunk, raccoon, opossum, chipmunk, meadow vole, shrew, deer mice, white-footed mice, various reptiles, eastern wild turkey, American woodcock, ring-necked pheasant, mourning doves and crows. Many predator species including red fox, gray fox, hawks and owls use this habitat as their major hunting grounds. A great variety of perching birds are attracted to these areas because of the high quality food, cover and nesting sites they offer. The bird families most frequently observed in these areas include warblers, wrens, sparrows, cardinals, thrushes, meadow larks, jays, finches and starlings.

Wetland - An indepth description of the major wetland wildlife habitat type may be found in the "Mill Plain Swamp" section of this report.

Impact of Urbanization on Wildlife - With future industrial and residential development of this watershed, a general decline in many of the above wildlife populations will undoubtedly take place. Destruction of suitable habitat is the primary factor which threatens these populations.

As a general rule, the more intensive the land use, the greater the impact on natural wildlife populations. Hence, some habitat losses can be compensated for by utilizing a development concept of minimal disturbances, including minimal destruction of vegetation along with nondevelopment of sensitive areas such as wetlands and the retention of open space areas. Clustering development and planning sizeable open space areas is the best way to protect wildlife habitat in an urbanizing area.

Food and cover elements can be enhanced by the use of fruit bearing shrubs (including crab apple, Autumn olive, silky dogwood, and flowering dogwood) for ornamentals when landscaping urbanizing areas. Planting hedgerows of conifers such as white pine and hemlock will also help to improve cover. Undeveloped streambelt zones offer migrating and hunting corridors for many species of wildlife and should be given high priority for retention as open space.

2. FOREST MANAGEMENT

The Forestry Unit of the Department of Environmental Protection encourages all woodland owners to manage their forest lands. When properly prescribed and executed, forest management practices will increase the production of forest products, improve wildlife habitat and enhance the overall condition of the woodland with minimum negative environmental impact. The Department of Environmental Protection regional forester may be contacted at 758-1753 to provide basic advice and technical assistance in woodland management; services of a more intensive nature are available from private consulting foresters.

Healthy woodlands provide a protective influence on water quality. They stabilize soils, reduce the impact of precipitation and runoff and moderate the effects of wind and storms. By so doing, woodlands help to reduce erosion, siltation and flooding. Research has shown that soils protected by the cover of litter and humus associated with woodland areas contribute little or no sediment to streams.

The harvesting of trees is a major tool used in forestland management. The actual cutting of trees causes no erosion or sedimentation. The soil disturbances associated with transportation of the felled trees (i.e. access roads, skid trails and yarding areas) do however have the potential to degrade water quality by stimulating erosion and sedimentation. These impacts can be lessened by proper planning, placement, construction and maintenance of access roads, skid roads and yarding areas.

A series of Best Management Practice (BMP) recommendations, designed to minimize the negative impact of silvicultural activities on water quality, has been drafted and will be published and made available by the DEP Forestry Unit around September of 1980. The implementation of these BMP's will most likely be of a voluntary nature, through an accelerated education program and perhaps an incentive program.

Until the above mentioned BMP's are published, the "Timber Harvesting Guidelines" of the Wood Producer's Association of Connecticut may serve as guidelines to maintain water quality in a managed woodland. The principles set forth in this publication are aimed at protecting the forest ecosystem from thoughtless timber harvesting practices that may lower environmental quality in both the long and short run. Examples of recommended harvesting controls under these guidelines include:

- locate yarding areas well away from streams and keep the area as small as possible,
- carefully layout skid trails and logging roads; avoid steep slopes,
- near streams only a portion of the timber volume should be harvested. This harvested volume will vary in individual cases, but generally 50 percent of the volume should be left to guarantee protection of the stream to provide shade and a filter strip. Trees growing in wetlands have a shallow root system and can suffer windthrow if a sufficient residual volume is not retained.
- avoid felling trees into streams and remove promptly any debris which finds its way into streams,
- stream crossings, when necessary, should be made at right angles to the stream, and where banks are low and bottom is rock or compacted gravel,
- within 100 feet of all roadways, a sufficient volume of timber should be retained to act as a screen between the roadway and the harvesting operation.

G. Mill Plain Swamp*

This 150± acre wetland is bounded on the north by Interstate 84; on the east and southeast by the Danbury Fairgrounds, on the southwest by Kenosia Avenue and development along that way; by Lake Kenosia on the west; and by St. Peter's Cemetery on the northwest. It is a streamside bottomland wetland system which, in conjunction with Lake Kenosia and a small swamp to its west, is considered to be the headwaters of the Still River. The watershed above

*The term "swamp" is a specific class of wetland. Although the majority of the site is shrub or wooded swamp, there are areas of open water, wet meadow, and marsh. Accordingly, it is more appropriate to speak of the entire site as "wetland", except when referring to it by its proper name.

the wetland's outlet is 13.5 square miles (8650 acres), hence the wetland comprises approximately 2% of the watershed. About half of the flow within the wetland appears to be from Lake Kenosia; the other half is derived from the hills to the south, southeast, and north. Because there is no published water quality or quantity information, it is difficult to describe the quality of the water on site as well as the degree to which the water table fluctuates within the wetland. One might speculate that the existence of extensive submergent vegetation coupled with the growth of purple loosestrife may indicate that accelerated enrichment (eutrophication) is in progress.

Mill Plain Swamp is one of the largest wetlands remaining in the City of Danbury, and is the largest stream-linked wetland along the Still River in Danbury. The nearest sizable wetlands in the proximity of Mill Plain Swamp are found over 3,000 feet upstream to the west, 6,000 feet (not stream-linked) to the southwest, and over 12,000' to the east (also not stream-linked).

From a comparison of 1934 and 1975 aerial photographs, it is apparent the wetland was originally more extensive and more diverse. The site has been encroached upon by highway development, commercial and industrial building, and a commercial fairgrounds. Relocation and/or channeling of the Still River has occurred in the northeast section near the fairgrounds and the railroad tracks. Internally, however, the wetland shows only a few signs of physical alteration.

It should be noted that the wetland is listed in the Connecticut Natural Area Inventory as the home of a rare species, as well as a valuable wildlife and recreation area. It should be noted that the wetland appears to be entirely privately owned, with no formalized protection to date.

1. PHYSICAL CHARACTERISTICS

According to current natural resource maps, the surface layer of Mill Plain Swamp is shallow peat (less than 15' deep) and muck soils. These materials overlie stratified drift greater than ten feet thick, which in turn overlies Inwood Marble (2/3 of the site) or Manhattan Formation gneiss (in the north central and northeast sectors).

The entire wetland, and some distance beyond, is located in the 100 year flood hazard zone as delineated by the Federal Emergency Management Agency, National Flood Insurance Program (see Figure 6 in back pocket of this report). It is important to note that considerable public funds have been invested in the Danbury Local Protection Flood Control Project along the Still River. Any upstream development in the Lake Kenosia - Mill Plain Swamp watershed which would even partially degrade that level of protection would be a violation of public trust.

Considering its location and size, the wetland is likely attenuating downstream flooding. However, a detailed hydraulic analysis would be necessary to determine its true flood control value. Generalized Soil Conservation Service flood assessment techniques do indicate this type of site is most valuable in attenuating peak flows from the high percent storms (a 2 year - 24 hour storm vs. a 100 year - 24 hour storm).

2. BIOLOGIC CHARACTERISTICS

Due to the large size of Mill Plain Swamp, the variation in the depth of the muck, and the seasonal variation in the water table, a diversity of wetland types can be found. Each wetland class is distinguished by the surface water depth during the vegetative season and the composition and structure of the vegetation. In addition, each wetland type has a different wildlife value, functional role and recreational potential. The description and classification of wetlands in this section follows that of Golet and Larson.[6]

Bordering the edge of Mill Plain Swamp is a zone of deciduous wooded swamp. Red maple and black ash are the dominant tree species. The shrub cover varies with some areas dense and other areas more widely dispersed. The more common shrub species include winterberry, poison sumac, arrowwood, sweet pepper bush, high-bush blueberry, swamp azalea, and shadbush. Although most of the herbaceous species were not distinguishable during the time of the ERT field review, the more recognizable herbs include skunk cabbage, cinnamon fern, royal fern, crested wood fern, and willow herb. The moss cover is conspicuous with delicate fern moss the dominant species. Sphagnum moss is rare in occurrence in Mill Plain Swamp.

Wooded swamps provide a significant habitat for upland species such as deer and rabbits (sighted) and support a great diversity of breeding song birds in the summer (suspected). This wetland type occupies approximately 35% of the swamp.

Towards the center of Mill Plain Swamp, the wooded swamp changes in character and grades into a sapling shrub swamp. Here the vegetation is more open with young red maple, black ash, and elm growing on widely dispersed hummocks. Interspersed among the hummocks are clumps of bushy shrubs such as red osier dogwood, swamp rose, and winterberry. The ground cover is also very hummocky with tussock sedge the most conspicuous species. Other recognizable species include wood grass, royal fern, poison ivy, and crested wood fern.

The sapling shrub swamp has a similar wildlife value to a wooded swamp and is generally transitional in nature. The hummocky nature of the swamp is maintained by wind throws with the uprooted mound creating a suitable base for tree seedlings to become established. Sapling swamps are generally young stages of wooded swamps. This wetland class occupies approximately 50% of the swamp.

Again, as progression is made toward the center of the swamp, the character of the vegetation changes. The central portion of the swamp is very open with five interspersed wetland types. These are aquatic shrub swamp, ungrazed meadow, shallow marsh, deep marsh, and vegetated open water.

The aquatic shrub swamp is distinguished by a dense cover of button bush, swamp rose, and willow growing in areas with standing water for most of the year. Since this wetland type is located near the marsh types, the aquatic shrub swamp creates a significant habitat for wood ducks and redwing black birds (suspected). The aquatic shrub swamp type occupies only a small portion of Mill Plain Swamp.

Bordering the shrub swamp types and grading toward the Still River is a zone of marsh and ungrazed meadow. The ungrazed meadow is found in small areas on the flood plain bordering Still River and is dominated by a 3 - 4 foot cover of rice-cut-grass. The ungrazed meadow provides significant cover and food for ducks, muskrats (sighted), and pheasants (reported). The marsh types occupy a larger area and can be distinguished by the depth of the surface water during the vegetative season. The deep marsh (standing water deeper than 6") occupies a smaller area in the swamp and is dominated primarily by cattail and purple loosestrife. Muskrat lodges were located within this area. The shallow marsh has more areal coverage and in addition to cattail has a signficant coverage of purple loosestrife. Since purple loosestrife is an aggressive species, it may spread rapidly and change the character and value of the marsh. Marsh types generally have a high wildlife value and provide cover and nesting sites for waterfowl, rails, redwing blackbirds, and other species. During the winter, marsh vegetation provides cover for rabbits and ring-necked pheasants (reported).

The last wetland type in Mill Plain Swamp is provided by the Still River. This slow-moving stream meanders through the swamp and provides areas of open water as resting sites for waterfowl, habitat for fishes, and a possible habitat for the bog turtle (see section below). In some places the river has a large number of aquatics with a common occurrence of coontail, water milfoil, and water lily.

The following species of flora and fauna were observed in Mill Plain Swamp during the ERT's field review. (Note: All plant nomenclature follows Fernald, M. L., Gray's Manual of Botany, New York, American Book Company, 1950).

Trees:	Red maple	*Acer rubrum*
	Black ash	*Fraxinus nigra*
	American elm	*Ulmus americana*
	Slippery elm	*Ulmus rubra*
Shrubs:	Winterberry	*Ilex verticillata*
	Poison sumac	*Rhus vernix*
	Red-osier dogwood	*Cornus stolonifera*
	Arrow-wood	*Viburnum recognitum*
	Swamp rose	*Rosa palustris*
	High-bush blueberry	*Vaccinium corymbosum*
	Buttonbush	*Cephalanthus occidentalis*
	Alder	*Alnus sp.*
	Willow	*Salix sp.*
	Shadbush	*Amelanchier sp.*
Herbs:	Skunk cabbage	*Symplocarpus foeditus*
	Tussock sedge	*Carex stricta*
	Crested wood-fern	*Dryopteris cristata*
	Cinnamon fern	*Cinnamon fern*
	Wool grass	*Scirpus sp.*
	Poison ivy	*Rhus radicans*
	Royal fern	*Osmunda regalis*
	Virginia bower	*Clemetis virginiana*
	Water cress	*Cardamine pensylvanica*
	Willow-herb	*Epilobium sp.*
	Money wort	*Lysimachia nummulavia*
	Aster	*Aster sp.*
	Smartweed	*Polygonum sp.*
	Sensitive fern	*Onoclea sensibilis*
	Water dock	*Rumex sp.*
	Dodder	*Cuscuta sp.*
	Cattail	*Typha latifolia*

Herbs:	Purple loosestrife	*Lythrum salicaria*
	Duck weed	*Lemna minor*
	Rice-cut-grass	*Leersia oryzoides*
	Coontail	*Ceratophyllum sp.*
	Water milfoil	*Myriophyllum*
	Water lily	*Nymphaea oderata*
Moss:	Delicate fern moss	*Thuidium delicatulum*
	Sphagnum moss	*Sphagnum teres*
		Sphagnum spp.

Birds: sighted species

Swamp sparrow	*Melospiza georgiana*
Starling	*Sturnus vulgaris*
Mallard	*Anas platyrhynchos*
Black duck	*Anas rubripes*

Mammals: sighted species

Muskrat (lodges only)	*Ondotra zibethicus*
White-tail deer	*Odocoelius virginianus*

It should be noted that while only a few species of mammals and birds were sighted during the ERT field review, this class of wetland can be expected to harbor about fifty species of mammals and birds during the spring and summer.

3. RECREATION

Occasional canoers use Mill Plain Swamp, but it is reported to more often be the scene of waterfowl hunters in small boats. Some trapping of muskrats may occur but this has not been confirmed. Because only landowner permission would be required in addition to a standard hunting and trapping license, there is no governmental record of trapping results. Some hunting of deer and wild pheasants may also occur, but this too has not been confirmed. The Still River within the wetland does provide suitable habitat, and is known to be fished, for bass, pickerel, sunfish, and perch.

4. THE BOG TURTLE

The North American bog turtle (Clemmys muhlenbergii Schoepff) has remained one of the more poorly known freshwater species because of its uncommon and discontinuous occurrence. The turtle has a spotty distribution extending from upper New York and eastern Pennsylvania to the Appalachian Mountains in North Carolina. Bog turtles live in bogs, swamps, and wet meadows traversed by clear slow-moving streams where sun penetration is great and humidity high in warm weather. An abundance of grassy or mossy cover in conjunction with a mucky substrate is characteristic of most areas where bog turtles are found. Due to its disjunct and relatively uncommon distribution, the bog turtle has been suggested to be threatened with extinction. However, the secretive nature of this species and the scanty field data may not give a realistic indication of the actual size of the population throughout its range.

In Connecticut, the distribution of the bog turtle is apparently restricted to the western border, where it appears to be closely associated with calcareous wetlands. Here the sightings are relatively few with much of the information either dated or unconfirmed. Since the bog turtle appears to be uncommon in Connecticut, has a specialized habitat, and is valued for sale in the pet trade, it is considered to be in serious danger of extirpation. Major threats include irresponsible collecting, urban development, filling and draining of wetland habitats, and associated vegetation changes. The bog turtle has been offered some protection in Connecticut and conservation efforts should focus on the actual abundance and distribution of the species and the prime habitat areas that need to be protected. In addition, information on the location and size of populations should remain confidential, in fear that the populations would be raided by collectors.

Mill Plain Swamp in Danbury is a suspected location for bog turtles in Connecticut. Bog turtles were sighted there in 1973 and the information was passed by word of mouth to a DEP official. Since the time of the sighting, the information has neither been field-checked nor verified. In gross appearance, Mill Plain Swamp has all the characteristics associated with bog turtle habitat. The center of the swamp is very open and is traversed by a relatively clear slow-moving stream with a mucky bottom (Still River). The stream is bordered by meadow and marsh vegetation dominated by grasses, sedges, and emergents. Toward the edges of the swamp, the marsh grades into an open shrub swamp with a hummocky cover of tussock sedge, grading into a forested swamp dominated by red maple and black ash. In the marsh, several lodges were observed suggesting an active population of muskrat. The abundance of sedge tussocks and the occurrence of muskrat burrows would offer any existing population of bog turtles protection from summer heat (that the turtles will seek such protection has been documented). In contrast, the abundance of purple loosetrife may alter the character of the Swamp over time and possibly pose a future threat to any existing population. The quality of the water moving through the Swamp may also render the habitat unsuitable for bog turtles. This is possible due to the apparent eutrophication of Lake Kenosia and the rumor that chemicals have been used in the lake to control aquatic weeds.

Due to the nature and time limitations of the ERT, it is impossible to comment on the presence or health of bog turtles in Mill Plain Swamp. However, since there has been a sighting and the habitat appears to be suitable for bog turtles, the potential for an existing population is high. Extreme caution should be exercised in using any of this information in determining the future of Mill Plain Swamp. The present status of the bog turtle in Connecticut and throughout the entire range is not known. This is very true for Mill Plain Swamp. In lieu of the fact that a study is being proposed by DEP in conjunction with other northeast states to determine the present locations, size, and habitat requirements of the bog turtle (anticipated starting date - Spring 1980), it may be wise to postpone any decisions until the study is completed. Then, perhaps, a more objective view can be made on the significance of the bog turtle and the need for protection of its habitats.

5. SIGNIFICANT FACTORS FOR THE CITY'S CONSIDERATION

Mill Plain Swamp, one of the largest wetlands within the City of Danbury, provides potential water supply, wildlife, flood control, pollution filtration, recreation, and ecological study values and opportunities. Although the regional wildlife value of the wetland is moderate (the dominant wetland types are shrub swamp and wooded swamp rather than marsh), the increased development and disturbance of both uplands and wetlands within the region will give Mill Plain Swamp an increasingly higher local value. In addition, since the Swamp is underlain and influenced by calcareous bedrock, the potential for unusual plant or animal species is high. This is evident in the apparent high pH of the substrate (indicated by a lack of ericaceous shrubs) and the suspected occurrence of the bog turtle.

Although further field investigation and research is necessary in order to make an accurate determination of the value and functional roles of Mill Plain Swamp, the present conclusion is that Mill Plain Swamp is a valuable natural resource in the Danbury area and consideration should be given to protecting this resource until additional research or information proves otherwise. Further development within the watershed will likely have a negative impact on the wetland if: 1) development introduces pollutants into the watershed, 2) if there are changes in peak flows along the Still River, 3) there is additional encroachment into the wetland, 4) the density of nearby development increases to the level that the wetland cannot be properly policed, and 5) the present ownership changes priorities from non-development to development. It is likely that the more the surrounding land is developed, the greater will be the significance of a protected Mill Plain Swamp.

One final note. This ERT survey was conducted on a frigid winter day. It is difficult to determine the value of any wetland based on a single visit, especially in the winter when evidence of most biologic activity is scarce and the ground and water are frozen. It is very possible that detailed field work in the spring or summer would discern many more positive attributes of the wetland.

F. Lake Kenosia

1. INTRODUCTION TO LAKE EUTROPHICATION*

A decline in the quality of many Connecticut lakes has been observed during the recent past. Many lakes have exhibited excessive growth of plant life (especially algae) during the warmer seasons which represent symptoms that the lakes are becoming more fertile and productive. Attempting to improve or maintain the present quality of Connecticut's lakes is very important because the lakes are an increasingly valuable natural resource, providing multiple uses including recreation and aesthetic pleasure.

Eutrophication may be broadly defined as the process of enrichment of a water by nutrients and organic matter (which results in high biological productivity) and filling-in by sediments (which results in a decreased volume of a water body). Eutrophication is a natural aging process occurring in all lakes. This process, very simply depicted in Figure 7, shows a lake gradually filling in, becoming more productive of plant life and shallower. Eventually, the lake transforms into a pond, then to a marsh or swamp, and finally it reverts to a dry land form. Eutrophication, therefore, is a process by which a lake gradually evolves from a condition of low productivity (oligotrophic - few nutrients) to a highly productive condition (eutrophic - many nutrients).

Oligotrophic lakes are characterized by deep basins with large volumes of deep water, low organic and nutrient content, high concentration of dissolved oxygen at all depths throughout the year, and low biological productivity. Oligotrophic lakes are typically limited in plant and animal life due to their low organic and nutrient content.

*Adapted from the "King's Mark Environmental Review Team Report on the Eutrophication of Lake Waramaug", 1976 and the "Lake Waramaug Watershed Management Plan", Lake Waramaug Task Force, 1978.

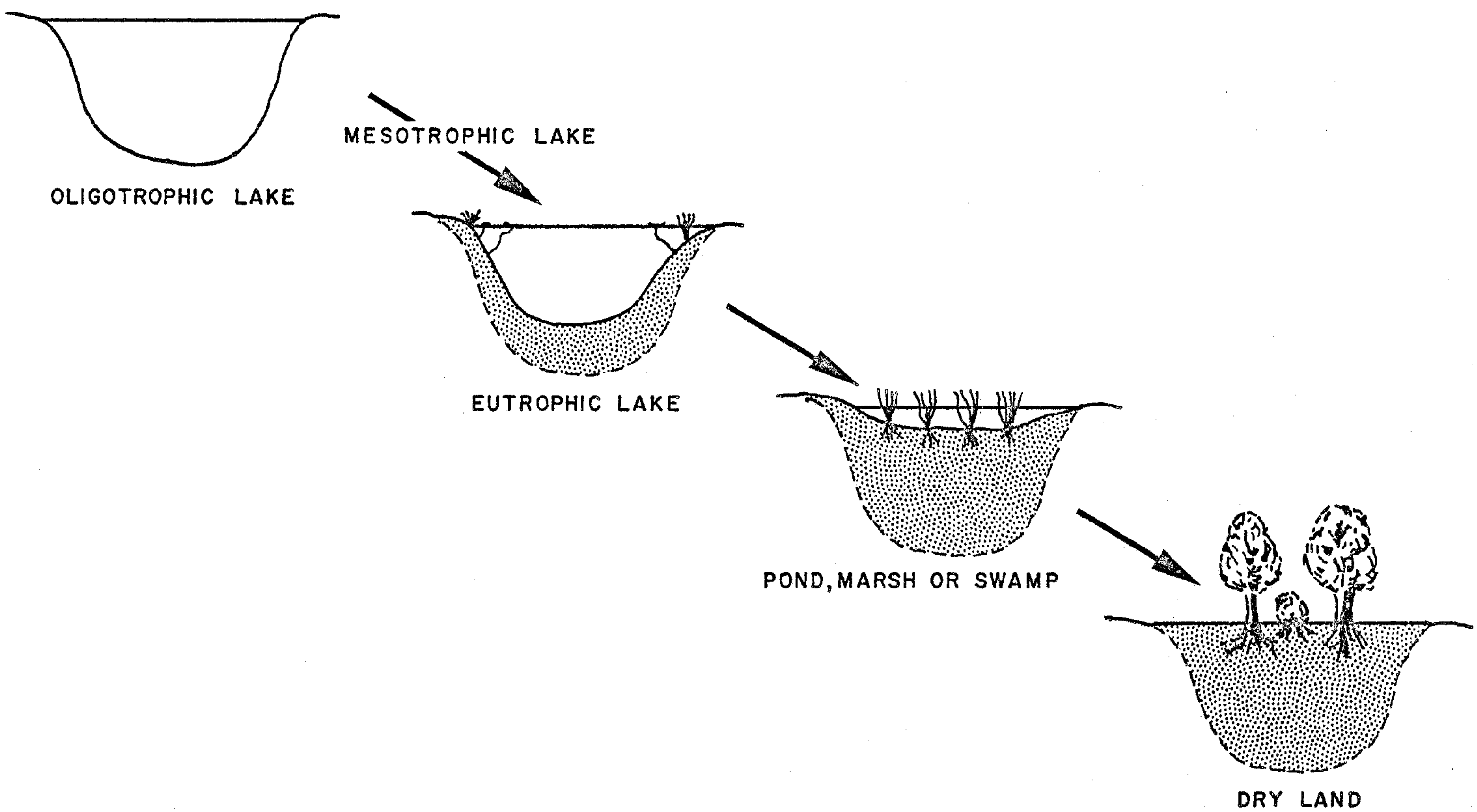


FIGURE 7. EUTROPHICATION – THE PROCESS OF AGING BY ECOLOGICAL SUCCESSION

(GREESON, 1969)

The second stage of lake enrichment is mesotrophy. Mesotrophic lakes are characterized by increased concentrations of plant nutrients and dissolved materials, and thus increased plant production. Mesotrophic lakes are moderately productive but have not yet developed nuisance conditions.

Eutrophy is the final stage of a lake before enrichment, filling, and the extinction process is complete. The characteristics of a eutrophic lake are high concentrations of plant nutrients and dissolved materials, excessive algal production (diatoms, green, and blue-green algae) and other aquatic plant growth, oxygen depletion in the deeper bottom water, discolored turbid water, and objectionable taste and odor. The reduction of oxygen in the deep waters is a result of the increased lake productivity. As a lake becomes more productive, large amounts of organic matter (from plants, algae, and other organic wastes in the watershed) sink and settle on the bottom. Bacteria then decompose the organic matter at increasing rates. Bacteria consume oxygen in their activities, as do the animals which live in these bottom waters. Plants also use oxygen in night-time respiration. Soon the oxygen supply which is typically low anyway in bottom waters, becomes depleted.

Under completely natural conditions the process of eutrophication is usually very slow and gradual, and can only be measured on a geologic time scale. However, the natural process can be greatly accelerated by the activities of man in the watershed through his practices of land use. This accelerated nutrient enrichment of lakes due to man's influence in the watershed is often called "cultural" eutrophication. The key concern regarding eutrophication is, therefore, the rate at which it is occurring and the extent to which man is causing the process to accelerate.

The term "eutrophic" means well-nourished; thus, eutrophication refers to the addition of nutrients (naturally or artifically) and to the "effects" these added nutrients have on a body of water. Some nutrients enter a lake naturally transported by rain, ground water, or decaying leaves. Nutrients can also be attached to soil particles (sediment) which have eroded off the land and are washed into a lake. Human activities can greatly increase the amount of nutrients entering a lake especially via household sewage wastes, phosphate detergents, agriculture or lawn fertilizer runoff, clearing of forest lands, road building and other construction. Whether natural or man-induced, the increase in nutrient supply has a direct relationship to the increase in algae and other plant growth in a lake. In essence, the nutrients serve to fertilize a water body, thus making it more productive (in much the same way nutrient-containing fertilizer is applied to a garden to make it more productive).

In order for the algae to greatly flourish in a lake, certain critical plant nutrients must be entering a lake from its watershed. The nutrients nitrogen and phosphorus have received the most attention in lake studies as being the important potential contributors to lake fertility. The nutrient phosphorus is believed to be the nutrient most likely to limit or control the growth of algae in Connecticut lakes.

Among the major means by which plant nutrients and other elements essential for plant growth reach lakes are via sediment transport from the watershed, atmospheric precipitation, ground water transport from septic systems, and point source (direct) discharges. Eutrophication is hence a complex process involving many interrelated factors. This makes it difficult to understand and control. There are a few management options available for reducing eutrophication once it occurs, but the best management is prevention. In most cases, effective watershed management can prevent or reduce the rate of lake eutrophication.

2. GENERAL DESCRIPTION OF LAKE KENOSIA

Lake Kenosia has the following physical characteristics:

Surface Area - 65 acres	Volume - 28,028,768 cu. feet
Maximum Depth - 15 feet	Drainage Area - 5.1 square miles
Mean Depth - 11.6 feet	Retention Time - .106 years or 38.5 days *

The watershed of Lake Kenosia is shown in Figure 1. As can be seen from Figure 1, Lake Kenosia is fed primarily by the headwaters of the Still River which enters the lake in its northwestern corner. This inlet stream is part of a wetland/stream corridor which originates in the Sanfords Pond area. Water from the surrounding hillsides drains into this wetland/stream corridor, and from there flows easterly to Lake Kenosia via the feeder stream. Lake Kenosia is also fed by direct precipitation and sheet run-off from the north and south. According to the U.S.G.S. topographic map, one other perennial stream feeds the lake; this stream, shown in Figure 1, flows northerly into the southeastern portion of the lake.

There is a dearth of information on the water quality of Lake Kenosia and the timing of the ERT field review (mid-winter) was not conducive to observing aquatic vegetation and algae. However the lake is characterized by abundant growths of aquatic plants during the summer months which are indicative of a eutrophic lake. The shallowness of the lake (see Figure 8), coupled with the impending urban development in the watershed, indicates that the lake is very susceptible to accelerated eutrophication and its attendant water quality problems (nuisance growths of aquatic weeds and algae). This is a significant concern with the present use of the lake for swimming and boating and also from an aesthetic standpoint.

The Connecticut DEP is in the second year of a eutrophication survey of Connecticut lakes. Lake Kenosia is one of the lakes being surveyed during this 1980 season. Testing is being performed by the Connecticut Agricultural Experiment Station for phosphorus, nitrogen, temperature, and dissolved oxygen profiles; transparency (by sechhi disk); and chlorphyll A. The testing program will involve both spring and summer sampling and will also include an evaluation of aquatic plants in the lake. The results of this investigation will be available in the fall of 1980. After this effort is completed, a more definitive statement can be made regarding the eutrophic status of the lake.

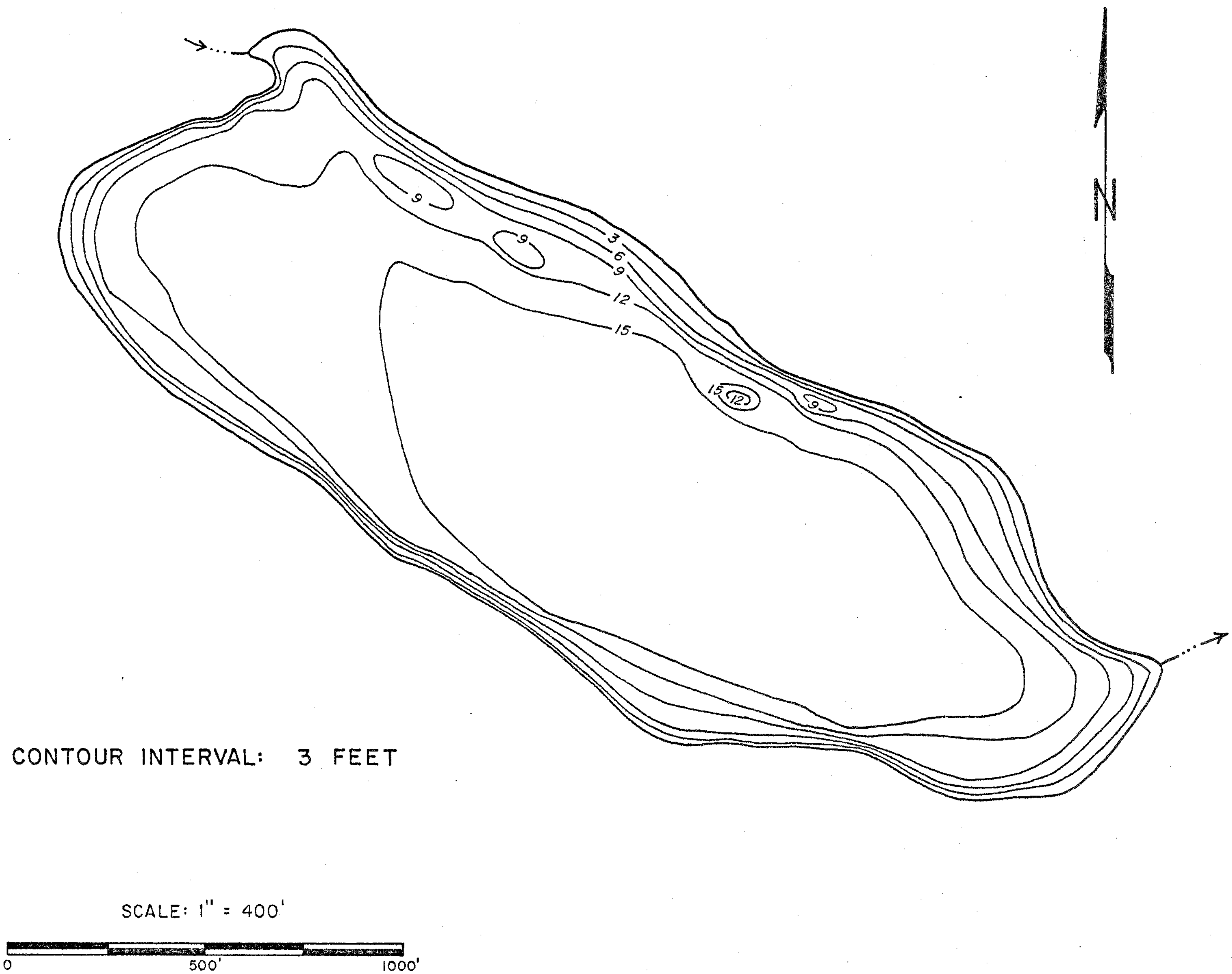
3. FISHERIES

As previously mentioned, Lake Kenosia is a relatively shallow body of water, with most of its littoral area having abundant growths of aquatic plants during the summer months. The Lake is sufficiently deep to prevent weeds from growing over its entire surface area, but is not deep enough to contain much cold bottom water during the summer. Therefore, survival of cold water species of fish, such as trout, would be quite low. Trout stocking would only provide a "put-and-take" fishery, in which little additional growth by the trout could be expected. Because of its relative shallowness, Lake Kenosia is considered

* Average annual retention time, does not consider withdrawal from the Kenosia aquifer.

FIGURE 8.

LAKE KENOSIA BATHYMETRIC MAP



CONTOUR INTERVAL: 3 FEET

SCALE: 1" = 400'

PREPARED BY ROBERT ORCIARI, DEP, 1980

a warm water habitat, capable of supporting naturally reproducing populations of largemouth bass, sunfish, yellow perch, pickerel, and bullheads. Largemouth bass and several species of sunfish are known to be abundant and provide good fishing. Access for fishermen is provided by a State-owned boat launching facility located next to the lake's outlet. Fishing pressure on Lake Kenosia is rather light. This may be due to the close proximity of much larger lakes, the nuisance growths of water weeds, and the City ordinance restricting the use of outboard motors. Even though fishing pressure is fairly light, Lake Kenosia is considered a good bass lake and is a very important fisheries resource to anglers with small row boats. Fishing should continue to be good, as long as pollution does not become excessive.

Lake Kenosia's main tributary is small and would not be considered important for recreational fishing. However, the inlet stream does have considerable value, since it is known to support native brook trout. Because of the scarcity of native brook trout populations in southwestern Connecticut, precautions should be made for preserving the inlet streams population. In order to provide shade and prevent erosion, a naturally vegetated streambelt should be allowed to remain along both sides of the brook. Greater than normal loads of silt, which would fill in gravel spawning areas of trout and smother aquatic insects, should not be allowed to enter the stream. Accumulated oils on parking lot and road surfaces should also not be allowed to wash directly into the stream.

Lake testing by The Department of Environmental Protection during this spring and summer will likely confirm that Lake Kenosia is already eutrophic. Considering that the surrounding area of the lake is highly developed and mostly unsewered, nutrient inputs to the lake are probably substantial. The Lake often exhibits the soupy-green coloration that is indicative of abundant unicellular algae. However, the present water quality does not hinder the existing warm water fish and modest increases of nutrients, above the already substantial levels, should not negatively affect fish populations in the future. It is likely that slight increases of nutrients would actually increase the standing crop or total biomass of fish in Lake Kenosia. However, any increase in eutrophication, brought about by additional loads of plant nutrients, would lower the aesthetic value of the lake and cause a subsequent reduction in the quality of fishing.

Excessive algae and plant growth, caused by large increases of nutrient inputs, would be detrimental to the fish population in Lake Kenosia. Large fluctuations of dissolved oxygen and pH would occur daily in the upper water column. Bottom food production would be reduced by oxygen depletion in the lower water column. Predator-prey relationships would be altered to the detriment of largemouth bass.

Poor land management practices may cause additional problems with the fisheries of Lake Kenosia. Excessive silt could increase the lake's turbidity, and when deposited, could increase the available bottom area for weed infestations. Also, oil from roads and parking lots would reduce the food value of fish by tainting their flesh. Finally, increased development around the shore, along with the aforementioned problems, would greatly lower the aesthetic value of Lake Kenosia. Careful land management practices are therefore needed to protect the fisheries resource at Lake Kenosia.

G. Land Use

1. EXISTING LAND USE

The drainage divide and the recharge area of the Upper Still River drainage basin, for general planning purposes, is essentially identical to the watershed of the Lake Kenosia aquifer. For this reason, the land use data provided below is summarized for the Upper Still River drainage basin and is graphically displayed in Figure 9 (presented in the back pocket of this report). Land use data for such an extensive area is provided for descriptive purposes only and is not necessarily indicative of problems associated with water quality contamination.

Table 1. Land Use in the Upper Still Drainage Basin

	Acres	
Land Use	Danbury	Ridgefield
Low density residential (½ acre lots or greater)	1157	769
High density residential (Less than ½-acre lots)	743	6
Institutional (schools, churches, etc.)	102	12
Commercial	318	-
Industrial	583	6
Open land (meadow, parkland, golf courses, etc)	275	131
Agriculture (cropland, orchard, and animal farms)	190	57
Resource extraction (sand & gravel-active/ inactive)	11	-
Wetlands	1087	385
Water	459	28
Woodland	2630	1046
Total area (does not include N.Y. State land)	9995	

An extensive area of land within the direct aquifer recharge area remains in a relatively "open" condition including the Danbury Fairgrounds, the municipal airport, St. Peter's Cemetery, Mill Plain Swamp, and the municipal park on the north shore of Lake Kenosia. Commercial and industrial land use within the direct recharge area is generally confined to "strip" development along the major roadways including Route 7, Lake Avenue (Mill Plain Road), Kenosia Avenue, Miry Brook Road, and Backus Avenue. Transportation is a major land use category within the watershed. Development in the upland areas of the watershed generally consists of low to moderate residential density (½ - 2 acres).

Inland wetlands, in aggregate, comprise a substantial land area within the watershed of the Lake Kenosia aquifer.

Four known industrial waste disposal sites occur within the study area.[7] Two sites involve metals only and are located in the Ridgebury Road vicinity. The two other sites involve metals and organics or solvents; one of these sites is located along Ridgebury Road while the other is located along Mill Plain Road north of Lake Kenosia.

Several water supply wells within the Kenosia aquifer watershed have been classified as having "impaired" or "contaminated" water quality.[8] Five wells tapping unconsolidated surficial deposits have the "impaired" water quality classification and generally occur near the intersection of Ridgebury Road and I-84; one public water supply well tapping bedrock at the north shore of Lake Kenosia has been "contaminated". "Impaired" means that water quality has been changed to the extent that concentrations of selected constituents (includes arsenic, cadmium, chloride, chromium, copper, detergents, hydrocarbons, lead, nitrate + nitrite, and sodium) exceed background levels. "Contaminated" means the degradation of natural water quality, as a result of human activities, to the extent that its usefulness is diminished.[9]

Major future development within the watershed of the Kenosia aquifer includes the completion of Union Carbide and possible satellite companies, I-84 expansion, the new Route 7 expressway, the phasing of construction for the WESCONN campus, the possibility of a regional mall at the Danbury Fairgrounds, and additional industrial/commercial development in the respective zones.

2. EXISTING SEWER SERVICE AREAS

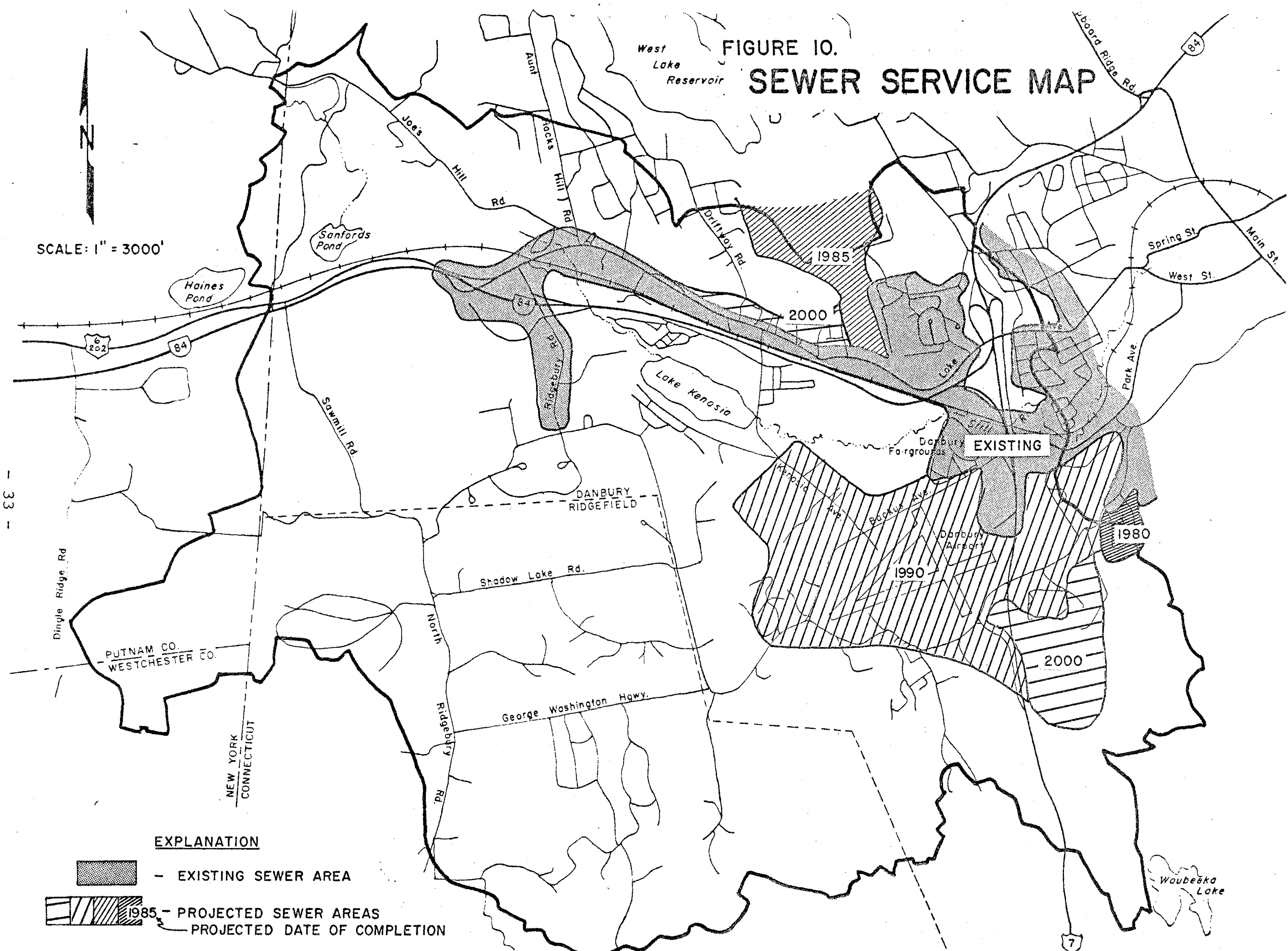
The present system extends westward from the Mill Plain Ridge area along Lake Avenue (Mill Plain Road) to the Union Carbide site (see Figure 10). Sewer service then extends southward along Ridgebury Road to the intersection with Briar Ridge Road. Sewer service is also provided to the Route 7 - Backus Avenue intersection including the Danbury Fairgrounds and southward along Route 7 to the Miry Brook-Wooster Heights intersection.

Future sewers are programmed but not necessarily guaranteed for major "strip development" areas. Sewer expansion is programmed westward along Backus Avenue to the intersection of Miry Brook Road and then eastward along Miry Brook Road and a portion of Sugar Hollow Road to Old Boston Post Road by 1990, encompassing the airport area. Residential areas along Mill Plain Road from and including Crestdale Road to Driftway Road are programmed for sewers by the year 2000. Areas southeast of the airport along Route 7 are also earmarked for sewer service.

3. EXISTING WATER SERVICE

City water extends from the Mill Plain Ridge area to the intersection of Backus Avenue, Park Avenue and Route 7 and southward along Route 7 to the Miry Brook-Wooster Heights intersection including the Wallingford Road area (see Figure 11). Residential areas on the south shore of Lake Kenosia are also on public water including Boulevard Road, Ken Oaks Drive, and Windaway Road and extending westward along Briar Ridge Road to Blueberry Lane.

FIGURE 10.
SEWER SERVICE MAP



Adapted from "208" Sewer Service Map, May 1978

4. LAND USE POLICY - DANBURY'S PLAN OF DEVELOPMENT

Local land use development and policy formulation must be considered and understood in an historical context to appreciate current land use in the Kenosia aquifer watershed. The 1967 Plan of Development established the land use policies for locating the growth which occurred in the 70's. The major land use development policy of the 1967 Plan was to "strengthen the tax base by encouraging industrial development."

Two huge areas were proposed for extensive industrial development: the Beaver Brook district north and south of Newtown Road and the area bordering the airport extending from Route 7 westward to the New York State line. The former area was designated for "heavier" industrial uses whereas the latter was proposed for "light" industry. "Light" industries do not inherently produce great amounts of liquid waste and,therefore, do not necessarily need on-site treatment facilities. Figure 12 depicts the zoning in the Kenosia aquifer watershed.

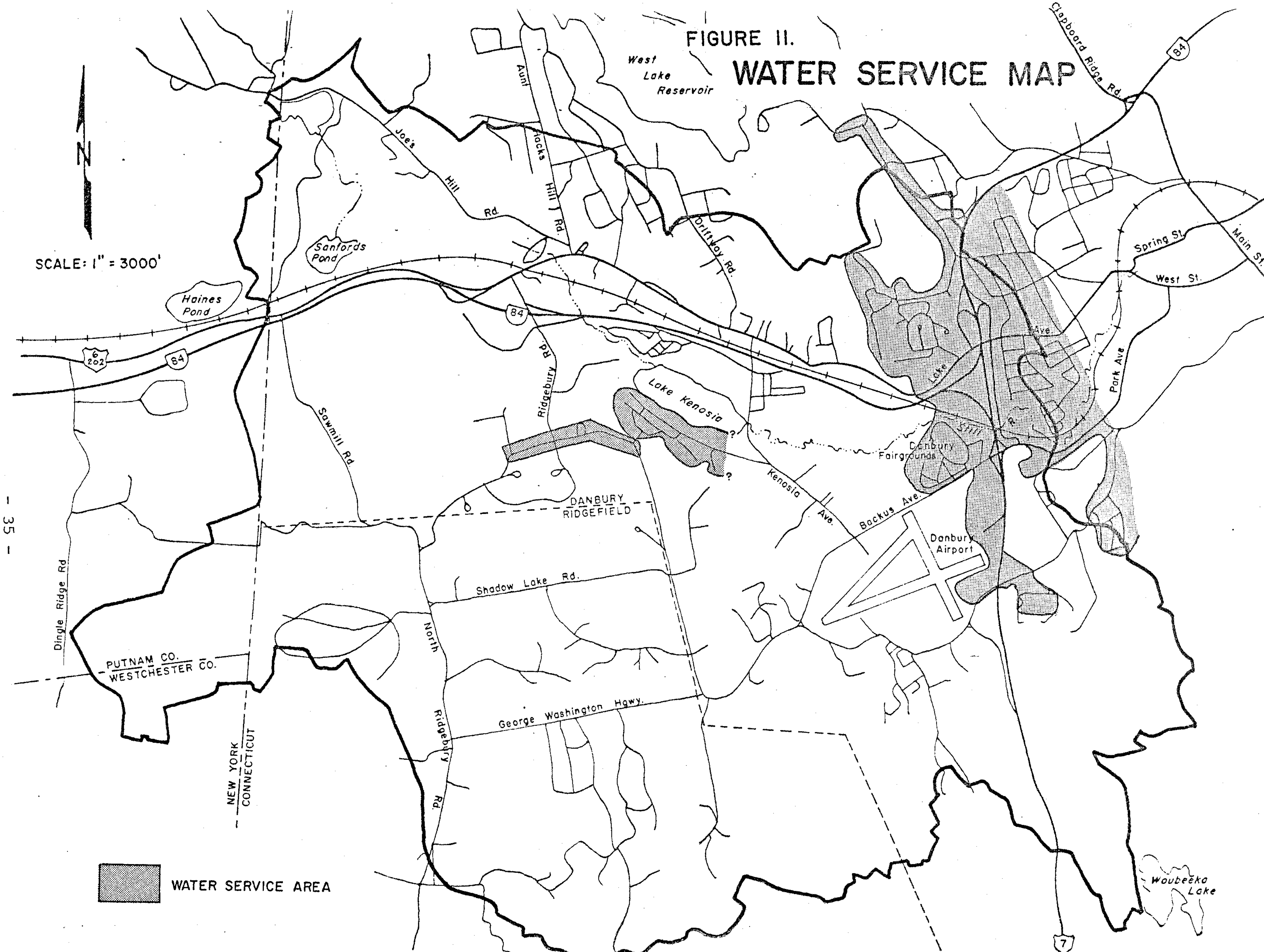
The City has indeed achieved its primary goal to strengthen the tax base as evidenced by a recent January 1980 article in "The Danbury News Times" entitled "Record City Growth to Soften Tax Increase". Growth has occurred to such an extent that the 1978 Plan of Development Update (now adopted) softened its stance on the rate of growth by amending the primary land development policy to "maintain a balanced tax base."

The 1978 Plan Update continues, "The primary goal of the Danbury land development policy is to keep the community in balance and to balance the tax base by encouraging industrial development. Perhaps one of the most serious considerations in choosing industrial sites is the question of access.... Danbury must continue to take full advantage of the circumstances by providing land with suitable controls and availability of utilities (emphasis added)."

The 1967 Plan of Development and the 1978 Plan update emphasize access as the primary criterion for locating industry. Increased emphasis is now warranted towards restricting the types of industry and developing suitable site controls to protect and maintain groundwater quality.

FIGURE II.

WATER SERVICE MAP



Adapted from "208" Water Utility Service Map, February 1978

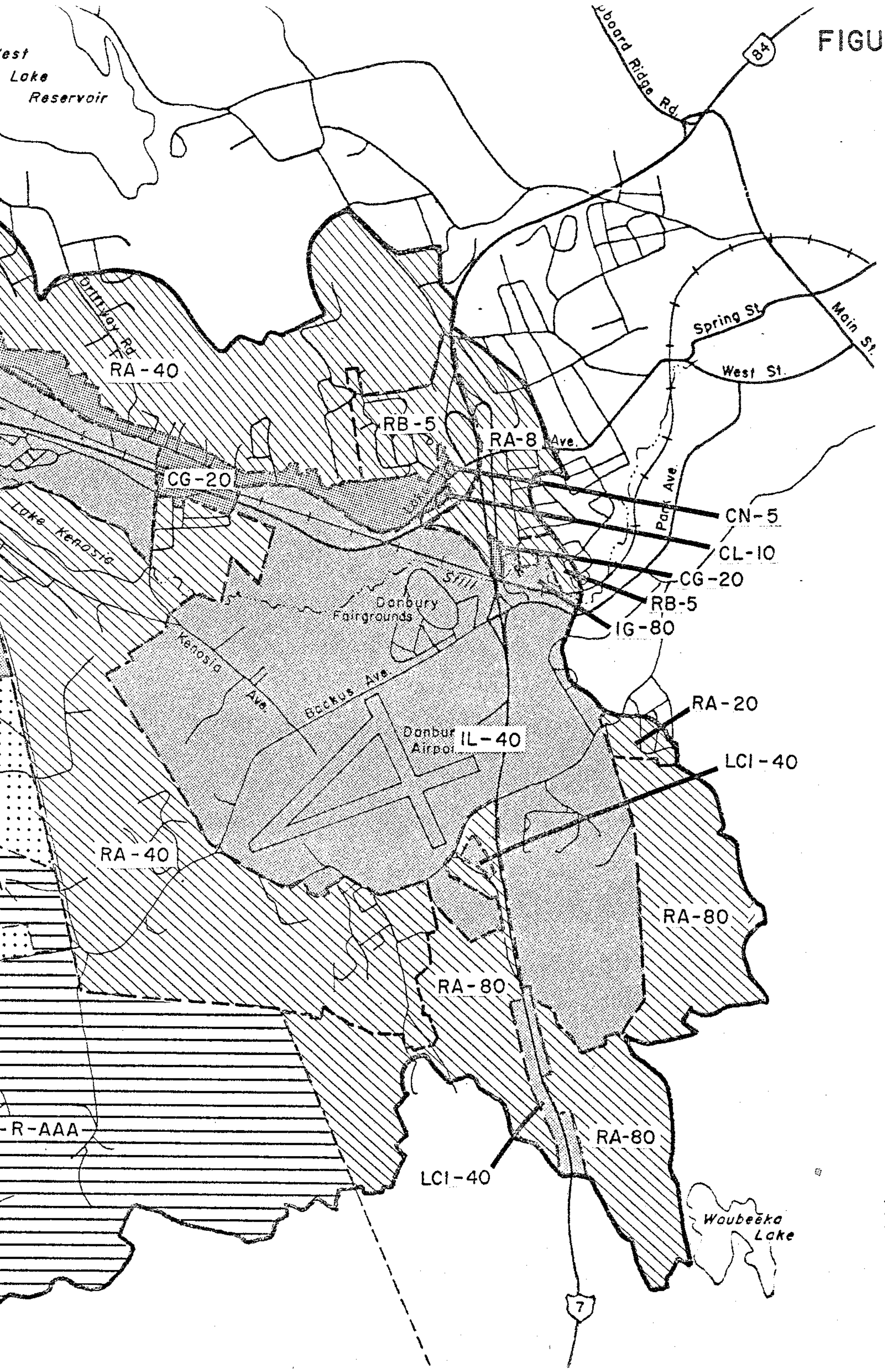


FIGURE 12.

ZONING MAP

DANBURY

COMMERCIAL ZONES

CL-10 Light Commercial

CN-5 Neighborhood Commercial

CG-20 General Commercial

INDUSTRIAL ZONES

IL-40, LCI-40 Light Industry

IG-80 General Industry

RESIDENTIAL ZONES

RA-8, RA-20, RA-40, RA-80 Single Family Residential

RB-5 Multi-Family Residential

RIDGEFIELD

COMMERCIAL ZONES

CDD, Commercial Development District

RESIDENTIAL ZONES

R-AA, R-AAA, Single Family Residential, 2-3 acre

IV. MANAGEMENT CONSIDERATIONS

A. Aquifer Protection

1. INTRODUCTION

An analysis of groundwater resources in the City of Danbury was conducted by the consulting firm of Geraghty and Miller in 1967 to determine the most feasible locations for the installation of public water supply wells.[11] A test drilling program was initiated in the Lake Kenosia aquifer at several locations and the findings/recommendations are summarized below:

. Three production wells installed adjacent to Kenosia Lake have a combined yield in excess of two million gallons per day (mgd). Existing data indicate that the Lake Kenosia valley will support a total pumpage on the order of four mgd. To achieve this total yield, additional production wells can be located on the Kovacs property, Jensen property, and/or northwest of Interstate 84 in the area referred to as Mill Plain (p. 29, 30).

. The valley area south of Danbury Airport offers promise for groundwater development, although testing in the area located no site suitable for construction of a high capacity well (p. 18).

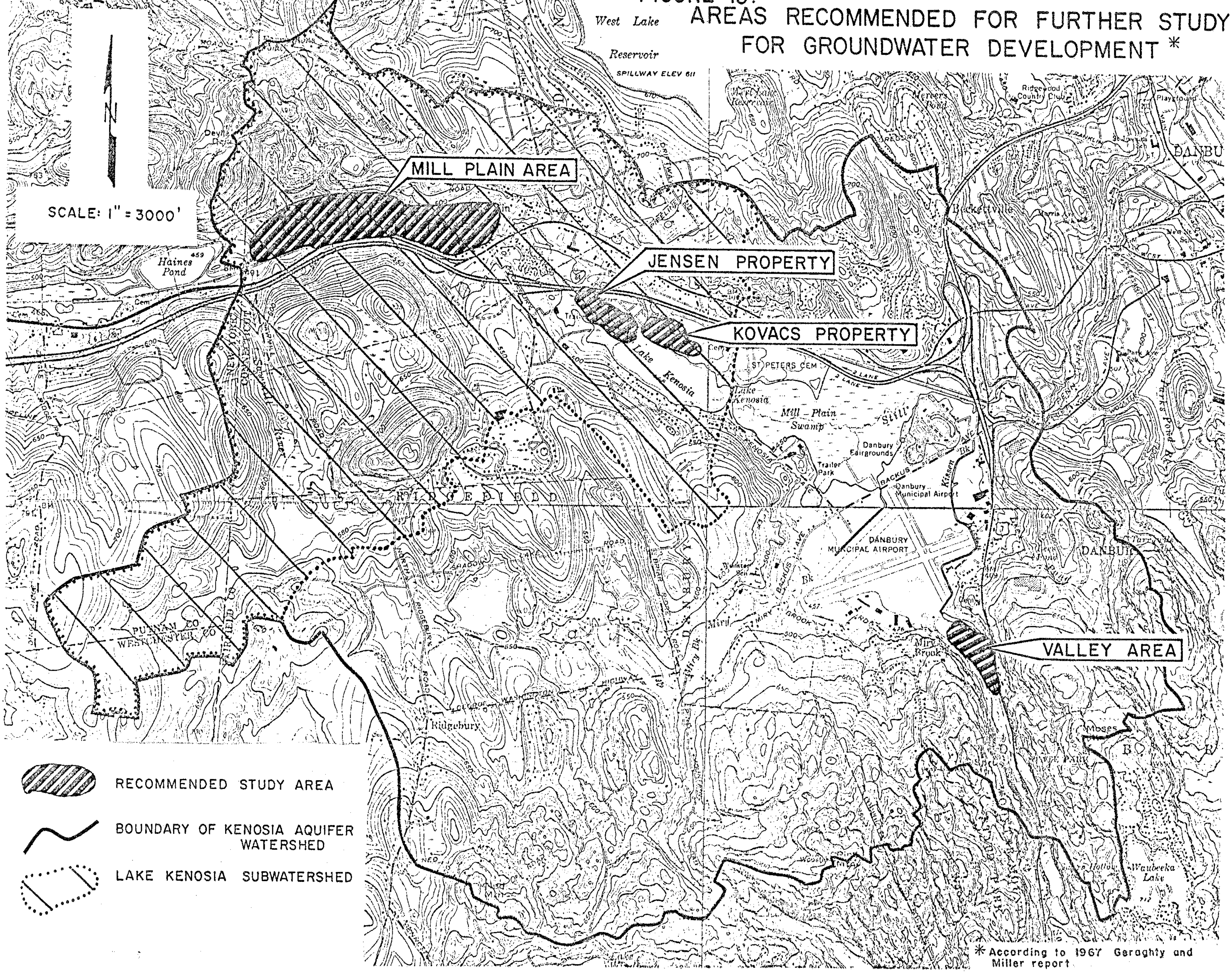
. The pumping of two production wells, at a combined yield of 500 gallons per minute (gpm) and approximately 70' and 40' from the Lake Kenosia shore, resulted in "no measurable interference between the lake and the groundwater system due to pumping" (p. 12).

. Water from the production wells on the Kovacs property is of excellent quality. Water from the well on the Owens Property is relatively hard, however no treatment is required if water from this well is mixed with water from wells on the Kovacs property (p. 30, 31).

. Potential sites for future groundwater development should be protected from industrial and urban encroachment (p. 34, 35).

The areas identified in the 1967 Geraghty and Miller report as having highest potential for groundwater development are shown in Figure 13. These sites can be evaluated on the basis of more recent information. The Kovacs property is presently being tapped for public water supply and the property may support additional wells.[8] The Jensen property contained a community water supply well (tapping bedrock) serving a trailer park. This well was contaminated by degreasing agents and had to be abandoned. This site is considered unfeasible at the present time for public water supply development. Much of the stratified drift deposit in the Mill Plain Area is inferred to be of fine grained composition; however further on-site testing would be needed for confirmation. It should be noted that much of this area is reasonably well protected due to the extensive areas of inland wetlands and the large lot residential zone (2 acres) which covers the western two-thirds of the area. The eastern third of the area is zoned for commercial use. The Valley area south of the Danbury Airport also appears to be underlain primarily by fine grained deposits, but may contain lenses of sand and gravel capable of supporting municipal wells. This area is presently undeveloped and is reasonably well protected as the entire valley is composed of inland wetlands. The land is presently zoned IL-40 in the northern half of the Valley (in the broad, flat area) and RA-80 in the sourthern half.

FIGURE 13.
AREAS RECOMMENDED FOR FURTHER STUDY FOR GROUNDWATER DEVELOPMENT *



* According to 1967 Geraghty and Miller report

Existing data therefore indicate that the watershed areas deserving the highest level of protection are the areas that recharge 1) the present Lake Kenosia well fields, 2) the Mill Plain aquifer zone, and 3) the valley south of the Danbury Airport. This is not to suggest that other parts of the Kenosia aquifer do not have a high water supply potential; it merely indicates that with the current limited subsurface data the three segments identified seem to afford the best possibilities. While protection of the drainage areas of these segments should therefore be a priority, protection of other portions of the aquifer should not be foregone.

Proper management and protection of the Kenosia aquifer is a requisite but complex issue for the City of Danbury due to the areal extent of the stratified drift deposit; the various commissions, departments and associated regulations which govern land use; the complexity of hydrologic processes, in particular, groundwater flow; and the wide spectrum of possible sources of contamination and contaminants.

The next few sections of this report attempt to provide some insight into tackling the formidable problem of groundwater protection by 1) identifying the major sources of groundwater contamination in Connecticut, 2) discussing current land use regulations in the City of Danbury, 3) identifying some of the strategies used by other communities in Connecticut to protect groundwater quality and finally 4) by discussing the steps the City may take to formulate a comprehensive aquifer management strategy.

2. SOURCES OF POLLUTION

Variations in the use of land can result in a spectrum of possible sources of contamination. A pollutant introduced into an aquifer through infiltration will tend to move downgradient with the groundwater flow. From a source of pollution, a plume of contaminants can often be detected extending downgradient within an aquifer and dissipating with distance.

Stratified drift aquifers are normally highly susceptible to contamination due to the geologic unit's high hydraulic conductivity (the ability of a porous medium to transmit a fluid), the proximity of the water table to the land surface, and intensive development in contiguous areas. Several incidents have occurred in the State which bear this out:[12]

* Ledyard - hydrocarbons traveled a distance of 9000' through stratified drift/crystalline bedrock before impacting 10 wells;
* Plainfield - degreasing agents traveled 1200' - 2000' through stratified drift overlying faulted crystalline bedrock and contaminated a public water supply well;
* Plainville - detergents traveled 1400' through stratified drift and affected 2 public supply wells.

The U.S. Geological Survey has recently published a report entitled "Major Sources of Ground-water Contamination in Connecticut" (Water Resources Investigations Open-File Report 79-1069 by Handman, Grossman, et al prepared in cooperation with the Connecticut Department of Environmental Protection, 1979).

The following discussion focuses on those non-point sources of pollution, identified in the USGS report, which are believed to be particularly relevant to the Kenosia area. For a more detailed discussion of the effects of these pollutants on groundwater, the interested reader is referred to the USGS report.

a. Septic Systems - Waste water disposed of through septic systems may pollute groundwater if the effluent is not satisfactorily attenuated as it percolates downward through unsaturated soil. Groundwater is most susceptible to degradation from septic systems in areas where soils are shallow, where the water table is high, and/or where housing is dense. As shown in Figures 5 and 6, these limiting factors are present in major portions of the Kenosia watershed. Another area of concern is where soils are highly permeable (e.g. sand and gravel soils). In these areas, effluent can percolate rapidly to the water table and contaminate groundwater.

The zoning map presented in Figure 12 of this report shows that a major part of the Kenosia aquifer is zoned for industrial use. Figure 10 shows that public sewers now extend to portions of the existing industrial zone and that sewers are programmed for most of the aquifer area by 1990. Although this will obviously relieve concern with regard to septic system waste disposal, it should be recognized that the extension of public sewer systems within the aquifer recharge area may not necessarily improve groundwater quality within the area served. Typically, the introduction of public sewers to a particular area tends to increase the density of development which in turn increases the potential sources of pollution associated with additional roads (sodium chloride for snow and ice control; oil, gasoline, and anti-freeze leaks from additional motor vehicles and parking lots) and the potential to develop land which prior to sewer construction was considered unsuitable for development.

As shown in Figure 12, about 50 to 60 percent of the Kenosia watershed is zoned for 1 and 2 acre residential dwellings. Typical sewage discharges associated with residential use should not pose a threat to aquifer water quality with strict compliance to state and local health codes. Assuming proper engineering of septic systems in soils that would otherwise inadequately renovate wastewater, individual residences located on 1 and 2 acre lots should have minimum impact on groundwater quality. Obviously, introduction of chemicals into individual subsurface sewage disposal systems could represent a threat to groundwater quality but the potential for use of septic tank additives is significantly reduced in areas where sewage disposal systems have been constructed in compliance with health code regulations.

b. Transportation related activities - Salt storage piles should not be located within the recharge area of high yield public water supply wells. This becomes more critical over the stratified drift soil deposits of the aquifer itself. If, however, salt storage piles are to be located in an aquifer recharge area, the concentrated salt should be enclosed by a covered structure and the salt/sand mixture should be covered with tarpaulins or other movable coverings. Both the concentrated salt and the salt/sand mixture should be located on a concrete or asphalt pad designed to minimize leaching of salt into the groundwater. Surface water should be intercepted upslope and as close to the salt storage area as possible and diverted away. Suitable diversion methods would include curbing, storm drains, or open channels. The need to maintain safe roadways through the use of deicing chemicals precludes the abandonment of the use of salt. Salt application rates to road surfaces should, however, be consistent with the guidelines published in the Snow and Ice Removal Policy of the Connecticut Department of Transportation. If problems with high sodium concentrations in groundwater do arise, which is not expected if these guidelines are adhered to, additional action can be taken at that time.

It should be noted that Section 19-13-B-32(h) of the Public Health Code addresses this issue specifically and states: "Where sodium occurs in excess of 15 mg/l in a public drinking water supply, no sodium chloride shall be used for maintenance of roads, driveways, or parking areas draining to that water supply except under application rates approved by the commissioner of health, designed to prevent the sodium content of the public drinking water from exceeding 20 mg/l."

Vehicle spills of any oils or chemicals during transport should be acted upon promptly by contacting the State Police and the Spill Section of the Hazardous Materials Management Unit of the Department of Environmental Protection.

c. Urban Runoff - Urban runoff resulting from precipitation or snow melt is typically collected in a storm drain and discharged to a surface water body or drainage swale. The runoff can generally be characterized as having a certain biological oxygen demand, and as containing varying concentrations of petroleum, grease, suspended solids, phosphorous, nitrogen, lead, chromium, copper, nickel and zinc. The concentrations vary widely and are dependent upon a number of factors including: intensity and characteristics of land use, intensity of rainfall, the time period within the rainfall event itself, the size of the area contributing runoff to the collection system and the diluting effect of runoff contributed from non-urban areas. Much urban runoff flows into surface waters and does not infiltrate groundwater to any great extent. In addition, most soils have a considerable capacity to renovate the quality of urban runoff: biological oxygen demand, and to a lesser extent petroleum, are acted upon by soil bacteria; suspended solids are filtered out at the surface; phosphorous is effectively adsorbed to soil particles; and metals may be effectively removed depending upon various soil conditions including its cation exchange capacity and pH. It is therefore not expected that typical urban runoff from a light industrial or commercial area will have a severely detrimental direct impact on groundwater quality. However, as explained in the Hydrology section of this report, pollution of surface waters may ultimately affect the ability to obtain suitable groundwater supplies. Moreover, the gravelly soils of the aquifer area itself are less well suited to many of the renovative functions described above.

Development of areas within the Kenosia aquifer watershed may in some cases reduce the amount of groundwater that enters, and hence is available from, the aquifer. Most types of development, including residential, industrial, and commercial uses, reduce the amount of rainfall that can percolate into the ground. This is a result of both the establishment of impermeable surfaces and the removal of vegetation. In addition, storm drainage systems may divert into surface water courses water that normally would enter the ground. Of course, withdrawal of water from individual wells within the watershed also reduces the amount of water reaching the aquifer unless the water is returned to the ground after use (e.g. by septic systems).

In the regions identified as indirect recharge areas, development should not lessen the amount of groundwater entering the aquifer, since the groundwater in those areas discharges to the surface before reaching the aquifer zone. However, widespread development in the direct recharge areas could be a problem. If development does occur in these areas, landowers could be encouraged to divert the water from their storm drainage systems into retention ponds, thus allowing the water to re-enter the groundwater systems.

Increases in surface runoff following development have a potential for causing increased erosion, particularly in the steeply sloped areas of the watershed. Peak flows in streams may become significantly higher than they were before development. The erosion hazards can be greatly mitigated by the adoption of zero-increase-runoff requirements for developments. These regulations call for the use of engineering techniques such as runoff retention basins in order to prevent peak flow increases. The requirements are generally tied to the pre-development peak flow levels during a storm of large magnitude and infrequent occurence, such as the 50 year storm.

d. <u>Industrial Stockpiles and On-site Waste Disposal</u> - It is not expected that any large scale industrial stockpiles of materials which could potentially contaminate public water supply wells will be permitted by the City within well recharge areas. Even if proper controls are in force, the potential for an accident always exists. The effect of a large scale input of contaminants from an industrial stockpile would be severe.

All on-site disposal of non-domestic wastewaters is controlled through the State Discharge Permit Program, persuant to Section 25-54i of the Connecticut General Statutes, implemented through the Water Compliance Unit of the Department of Environmental Protection. Any person or municipality wishing to discharge process or industrial wastewaters to the groundwaters of the State must apply for a State Discharge Permit. If the Department of Environmental Protection finds that the proposed discharge or proposed system to treat such discharge will cause pollution of any ground or surface waters, the application for a permit to discharge the wastewater will be denied. If DEP finds that the discharge or proposed system to treat such discharge will not pollute the waters of the State, the applicant must submit designs and specifications for the proposed treatment system and the permit process proceeds. During the initial phase of determining if the waters of the State will be polluted by the proposed discharge, all effects are considered, including potential impact upon any existing or proposed public water supply wells. Therefore, regulated on-site disposal of wastewaters should not lead to any serious contamination of the City's wells. However, the possibility of clandestine waste disposal must also be considered.

e. <u>Storage Tanks for Chemical and Petroleum Products</u> - It is not recommended that large scale storage of chemicals or petroleum be permitted in the recharge areas of public water supply wells. It is advisable to locate such facilities in other areas of the City where the consequences of a spill or accident would be less severe. For storage tanks which are located in the recharge area, certain precautions should be taken. The City should certainly consider each proposed development to insure that certain provisions and requirements are met such as a spill containment plan, security precautions, no drains in containment or use areas, etc. The installation of all fuel tanks, above ground and underground, should be inspected by the local fire marshall or building inspector to insure compliance of the State Fire Marshal's Code. It is advisable to pressure test all underground tanks for leaks on a periodic schedule (1 - 2 years) and require replacement of the tanks as they approach the end of their useful life. Above ground field or chemical tanks within recharge areas should also be periodically inspected (1 - 2 years) for deterioration or leakage. It is recommended that all residential underground fuel storage tanks be prohibited in recharge areas in favor of in-basement tanks.

f. <u>Direct Chemical Application</u> - Large scale application of fertilizer should be made at rates commensurate with nutrient uptake by crops. Any large scale user should consult with the Cooperative Extension Service of the University of Connecticut regarding this matter.

3. EXISTING LAND USE REGULATIONS-CITY OF DANBURY

The City of Danbury has several commissions whose primary purpose is to husband the municipality's use of the land and concurrently protect the quality of ground and surface waters. The table below lists the local commissions and their respective administrative regulations. Following the table, a synopsis of selected land use regulations is presented to manifest the town's numerous protection strategies.

Local Agency	Regulation
Planning Commission	Subdivision regulations/site plan review
Zoning Commission	Zoning regulations
Environmental Impact Commission	Wetlands and Watercourses
Department of Public Works	Sewer Ordinance
Health Department	State/Local health code
Conservation Commission	No regulations

a. Subdivision Regulations

These regulations, administered by the Planning Commission, have the goal of assuring that the subdivision and resubdivision of land creates suitable building sites while promoting the health, safety, and general welfare of the community. Provisions include regulating lot and street layouts, utilities, open space, and retention of natural features. The Environmental Impact Commission reviews all applications if inland-wetlands are involved or by request of the Planning Commission. Road developments are normally phased to reduce erosion and sedimentation from land disturbance. Storm drainage systems are reviewed by the Engineering Department and ordinarily the 25-year storm is utilized for runoff computations and design standards.

b. Flood Plain Regulations/Districts

The primary purpose of these regulations, incorporated within the zoning regulations (Section 7A), is to prevent increased flooding due to the development/encroachment on floodplains and the associated economic costs. The "Flood Hazard Boundary Map", prepared under the national standards established by the U.S. Department of Housing and Urban Development, delineates areas of the 100-year flood. Within the study area, lands that would be inundated by such a storm include Mill Plain Swamp, lands contiguous to the inlet of Lake Kenosia, the airport, and the banks of Kissen Brook (see Figure 6 in back pocket of this report).

Site development standards required in these areas have the dual benefit of addressing aquifer recharge areas and the flood-carrying capacity of an area. In essence, the flood plain regulations establish a stream-belt preservation concept. A site plan is required for any development or activity and a permit is required for all proposed construction. The requirements in Section 7A supersede all other regulations. Specific provisions include: all fill must not retard streamflow or reduce flood storage volume; floodproofing of buildings and attendant utility and sanitary facilities must be designed and approved by a professional engineer or architect; no subsurface waste disposal system shall be located within the boundaries of the floodplain of the 100-year storm unless the lowest elevation of the leaching system is more than 24" above the elevation of the 100-year storm.

c. State/Local Health Code

At the time of this writing, the City of Danbury and the State of Connecticut were proposing revisions to their respective codes. Key provisions of the latest revisions are highlighted below:

State Health Code proposed revisions (1/11/80)

Sec. 19-13-B103d(e) (presently 19-13-B20f) Location of subsurface sewage disposal systems

The horizontal separating distance between any part of the sewage disposal system and

- a well, spring, or domestic water suction pipe shall be based upon the on-site withdrawal rate of the well.

- any watercourse shall be 50' (presently 25').

- a groundwater interceptor drain upgradient from the sewage disposal system shall be 25' (presently unaddressed).

- loose or open-jointed, perforated, slotted, or porous pipe drain located downgradient from the leaching system shall be 50' (presently unaddressed).

Sec. 19-13-B103d(k) (presently 19-13-B20m). Disposal of Sewage in areas of "special concern".

Areas of special concern shall include "areas with a minimum soil percolation rate faster than 1"/minute, or maximum groundwater level less than 3' below the surface, or ledge rock less than 5' below the surface, or soils with slopes exceeding 25%, or consisting of soil types interpreted as having severe or very severe limitations for on-site sewage disposal by the National Cooperative Soil Survey of the S.C.S., or designated as wetlands by State statute." In such areas of special concern, the local director of health may require additional soils data and engineering feasibility studies to ensure that any proposed system in such areas will work.

Local health code provisions (2/15/80)

- When soils have a hardpan within 36" from the surface, percolation tests shall be conducted within the hardpan to determine the true minimum percolation rate.

- Sec. XII C.: If any water treatment devices are needed (e.g. water softener), no permit for the installation of such devices shall be granted unless "the applicant supplies the results of a water analysis from an approved laboratory that demonstrates the need for treatment. In addition, a statement from the water treatment contractor that the treatment method is the proper one; that its backwash or other wastewater does not discharge into the septic system, groundwater or surface waters of the city...or pollute the groundwater must be submitted to the Director of Health."

d. Zoning Regulations

The zoning regulations were reviewed with respect to permitted uses under the appropriate zoning categories, site plan requirements, and removal of earth materials. Existing zoning within the recharge area includes IL-40 (Light Industrial), CG-20 (General Commercial), RA-40 (Single Family Residence-1 acre), LCI-40 (Limited Roadside Commercial-Industrial), and IG-80 (General Industrial). As virtually the entire direct recharge area is zoned IL-40 and CG-20, these zoning categories will be discussed.

Danbury's zoning regulations are inclusionary in that land development within zoning boundaries is limited to permitted uses listed. A summary of permitted uses within each category is presented below. The maximum building coverage, defined as the percentage which the aggregate area of all roofed buildings on the lot bears to the lot area, in the IL-40 zone is 30% and in the CG-20 zone is 33 1/3%. These percentages, by definition, do not include impervious areas for parking and sidewalks. Performance standards are established for all development proposals (Sec. 6D) with respect to air, noise, and odor quality.

IL-40 Zone

Permitted Uses

Hotel/motel
Carpentry, woodworking
Research/testing laboratories
Manufacturing, compounding, processing, packaging or treatment of candy, cosmetics, drugs, pharmaceuticals, and toilet supplies
Manufacture of electrical equipment
Machine manufacturing
Assembling or finishing of articles made from selected previously prepared materials
Manufacture of optical goods, business machines, precision instruments, surgical and dental instruments and equipment
Manufacture and essembling of toys, sporting goods, etc.
Plants for printing, engraving, bookbinding, and other reproduction services
Laundry, cleaning, dyeing, and diaper service, provided water and sewers are available
Automotive service stations
Repair, including full body paint spraying and all body and fender work
A public school
Wholesale bakery
Wholesaling or distribution
Warehousing or moving/storage establishment
Truck terminal
Firehouse, police station, or post office
Telephone exchange, transformer substation, water pumping station
Radio or television station, excluding towers constructed for transmitting
Accessory uses incidental to a permitted use.
Offices for business, banking or professional purposes and corporate administrative offices
Metal finishing, plating, grinding, polishing, cleaning and rustproofing, stamping and extrusion of small products
A "club", as the term "club" is defined in this ordinance
A municipal airport operated by the City of Danbury, together with such accessory uses as are customarily incidental to a municipal airport
Passenger terminals, hangar and storage space, aircraft maintenance shops, aircraft rental facilities or flight instruction facilities

Special Exception Use

Farming, dairy, truck or nursery
Sewage pumping station, sewage treatment facility
A fair ground and automobile race tracks and appurtenances thereto
Indoor ice skating rinks and uses accessory and related thereto

CG-20 Zone

Permitted Uses

Personal services - barbershops, tailors, etc.
Business offices
Hotels/Motels
Restaurants
Auto service stations, public garages, public parking areas
Auto repair work (including full body paint spraying)
Cleaning, laundering, dyeing where water/sewers are available
Printing, engraving, or other reproduction services
Ambulance service
Glass installation
Public services
Wholesale bakery
Wholesaling/distribution
Warehousing, moving & storage establishment
Truck terminal
Monument sales establishment
Upholsterer, carpentry, woodworking and millwork manufacture
Storage and sales of building materials
Storage sale or repair of light and heavy contractor's equipment
Assembly hall, dance hall, club
Veterinary hospitals, boarding kennels and breeding kennels
Churches, rectories, or parish halls
Libraries or museums
Public parks, playgrounds, or recreation areas, operated by a governmental unit
Firehouse, police station or post office
Telephone exchange, transformer substation, water pumping station bus waiting room, or similar public utility use
Radio or television station, excluding towers construced for transmitting
Accessory uses incidental to permitted use

Special Exception Uses

Sewage pumping station
Sewage treatment facility
Garden apartments

A site plan is required for all permitted uses in the industrial and commercial zones. The site plan application requires detailed data including a description of the site, existing/proposed grades, landscaping requirements, and sewage disposal and storm drainage provisions. The City Planning Office has recently formulated revisions to the site plan requirements. An additional provision includes the consideration for the employment of retention facilities to reduce the downstream impact of a development proposal. Site plans may be sent to other city commissions for review at the discretion of the Planning Commission.

Section 8.B., Removal of Earth Materials, allows the Zoning Commission, after public hearing, to permit the removal of sand, gravel, etc., in any zone under specified conditions:

- Preparation and submission of a site plan including the area to be excavated and necessary drainage provisions.
- Submission of sufficient soil and groundwater data.
- Amount and type of material to be excavated and startup and completion dates.

e. Wetlands and Watercourses Regulations (Chapter 23 of Danbury Code of Ordinances)

These regulations adhere closely to the prescribed State inland-wetland regulations and serve the primary purpose of protecting, preserving, and maintaining wetlands and watercourses from unnecessary and undesirable disturbance and pollution. A permit is required for any "regulated activity" and the application must include but is not limited to the following:

- A site plan requiring detailed information as requested by the City Environmental Impact Commission according to its evaluation requirements.
- Soil sample data (delineation of inland-wetlands boundary).
- Inventory of flora and analysis of the potential impact.
- Analysis of fill material.
- Hydrologic characteristics-flow rates.

Section 23-7 (5) of these regulations essentially requires the submission of a local environmental impact statement including consideration of possible alternatives and their respective impact, the relationship of short-term uses vs. long-term productivity, and identification of irreversible resource commitments. Sec. 23-8 requires the applicant to submit a statement of findings that no further technical site plan improvements are probable and that the public benefits of the proposed activity outweigh any degradation of the wetland/watercourse.

4. LOCAL ATTEMPTS TO PROTECT GROUNDWATER - VARIATIONS ON A CENTRAL THEME

Recognizing the need to protect aquifers presently in use or viewing them as a potential future water supply source, several municipalities have opted to formulate local protection controls. These land use controls include adoption of local health codes; revisions to zoning, subdivision, and inland-wetland regulations; and inclusion in the local Plan of Development of a formal policy stating the protection and maintenance of groundwater supplies as a primary goal. Various attempts are presented below to serve as a "shopping list" for the City of Danbury to consider. Local officials ultimately will choose the most appropriate options.

. Several towns in the Housatonic Valley Region have adopted (or are in the process of adopting) more stringent health code requirements with respect to subsurface sewage disposal requirements:

- The Sherman health code requires any portion of a sewage disposal system to be horizontally separated 75'-150' from specific surface waters (as opposed to 50'-100' for the presently proposed revisions to the State Health Code).
- The Newtown health code requires a 100' horizontal separating distance for any stream not specified in the code and 150'-200' for specific water bodies.
- The Town of Redding is proposing requirements similar to the Newtown example.

. The Town of Bloomfield has adopted an oil recycling ordinance which prohibits the discharge of any oil to the ground or a watercourse. More specifically, oil must be collected in containers and taken to recycling centers. Sellers of oil are required to post notice that used oil must be taken to recycling centers.

. The Towns of East Lyme, Farmington, and Woodbury have identified stratified drift deposits as sensitive areas within their respective Plans of Development and accordingly have afforded an increased policy emphasis on groundwater protection. The Town of Farmington has adopted a limited aquifer protection ordinance in conjunction with their flood plain regulations. Aquifers contiguous to the Farmington River are shown on the official zoning map. The interpretation of the boundary is left to the discretion of the Planning and Zoning Commission. Specific zoning provisions include:

- If there is a reasonable likelihood that such runoff will cause pollution of the aquifer, the storm water runoff from impervious surfaces may be required to be collected in detention basins designed with an impervious surface with storm sewers leading to the river, or by other means affording an equivalent degree of protection to the aquifer.
- Prohibition of the storage or processing of materials that are buoyant, flammable, explosive, poisonous or otherwise injurious to human, animal, or plant life or to the aquifer.
- No greater than 20% of the total parcel shall be paved or roofed.

The Town of Woodbury, after public hearing, officially approved the establishment of a "Well Field Conservation Area" for the area of town known as the "Middle Quarter Area." The "Pomperaug Aquifer" was identified as a major existing/potential water supply source for the Town. All development proposals within the "Middle Quarter District" are subject to separate planning, use, design, and development standards and all proposals must submit a site development plan and receive a special permit from the Commission according to the amended Woodbury Zoning Regulations. The "Well Field Conservation Area" is identified on the official zoning map and "no use which will result in groundwater pollution shall be permitted."

Specific provisions within Woodbury's zoning regulations include:

- No use shall be permitted until the applicant provides evidence satisfactory to the Commission that chemical wastes from industrial and commercial processes shall meet the standards set forth in the Connecticut Public Health Code Regulations Sec. 19-13-B102.

- The maximum permissible building coverage shall be 10% of the lot and the maximum permissible total ground area coverage (including buildings and impervious cover) shall be 50% of the lot area excluding for both computations that portion of the lot covered by inland-wetlands, watercourses, and Well Field Conservation Areas.

. The Town of Brookfield has strengthened its local zoning regulations in response to a consultant's assessment of existing major aquifers and land use regulations. The Town has afforded protection to aquifers proposed for future use through the establishment of "Restricted Industrial Districts" and the promulgation of Flood Plain Regulations.

Specific provisions include but are not limited to:

- Sec. 313.2(b)(14): If the ultimate, specific use is not known at the time of application for "design review" approval, the Commission may approve the site plan only.

- Sec. 602.3: Technical water quality standards are established which specify acceptable discharge levels of effluent into the soil to prevent soil and water contamination for lands directly overlying the aquifer and upland areas. Additionally, the applicant has the burden to prove: the site's suitability for receiving/attenuating effluents, wastewater flow rates and concentrations, soil characteristics to a depth of 10' and direction of groundwater flow.

- The maximum allowable effluent concentrations shall be determined by DEP. The discharge of radioactive materials and pesticides is prohibited.

- "Recommended" maximum wastewater loading rates per acre by soil type and slope are included.

5. FORMULATING A COMPREHENSIVE MANAGEMENT STRATEGY

A realistic and meaningful assessment and formulation of a land use protection strategy for ground waters used as public water supplies and analysis of potential land use problems (based upon present zoning) should encompass only those areas which directly or indirectly recharge existing or potential well fields. Within the watershed of the Kenosia Aquifer, the direct recharge area, shown in Figure 3, is considered the most "sensitive" land with respect to developing a comprehensive water quality protection strategy and protecting the City's public water supply.

The adoption of an aquifer protection district and/or watershed protection district to protect Lake Kenosia, the Kenosia aquifer, and Mill Plain Swamp should be considered by the City (model regulations are currently under review by the Zoning Commission). An aquifer or watershed protection district recognizes the inherent relationships between land use and water quality and the interdependency between surface and ground water.

The establishment of an aquifer/watershed protection district would involve amendments to the existing zoning regulations and would create an overlay district on the official zoning map and would supersede all other regulations as is similar to the City's current Flood Plain Districts. The primary purpose of an aquifer/watershed protection district is to prevent the detrimental use of watershed lands and to preserve and protect the quantity and quality of the City's water resources while, concurrently, maintaining the economic viability of industrial and commercial zones.

Existing local regulations, in aggregate, are relatively comprehensive with respect to the protection of surface and groundwater quality. The inclusion of several provisions to existing regulations and additional management strategies would, however, strengthen existing land use regulations. Again, the strategies presented below are to serve as "considerations" from which local officials can choose. This section should be viewed in conjunction with other local efforts presented herein. Specific proposals will be reviewed by local officials and the HVCEO staff in the near future to formulate a comprehensive aquifer protection strategy.

a. The most positive action the City of Danbury could take toward aquifer protection would be to restrict certain types of industrial and manufacturing processes within the direct recharge area of the aquifer. In situations where this is not feasible or development within the direct recharge area has already been completed, strict regulation of activities within the area of concern should be considered. It would be advisable to identify and investigate all existing potential sources of groundwater pollution such as manufacturing firms, buried fuel oil and gasoline storage tanks, metal processing manufacturers, fertilizer and sodium chloride storage tanks, and other sources of potential pollution to preclude future pollution of the aquifer and surface waters as experienced in the past. It would also be advisable for the City Health Department to develop a plan for emergency action in the event of chemical spills or accidents. This effort should be coordinated with the appropriate state agencies. Continued surveillance of septage disposal areas and other dump sites within the recharge zone would be desirable to minimize the likelihood of adverse effects on groundwater quality.

b. Within the direct recharge areas, permitted uses promulgated in the City's zoning regulations for the IL-40 and CG-20 zones should be reviewed based upon their potential impact to groundwaters. A useful information source which the City may choose to consider in this evaluation is the Industrial Site Constraint Manual[13] prepared jointly by the Connecticut 208 Program and the Connecticut Department of Environmental Protection. In this manual a variety of standard industrial types are discussed from the standpoint of siting requirements and common concerns. The City may also call upon the Water Compliance Unit of the Department of Environmental Protection for assistance in evaluating a specific industry or commercial establishment for its possible effects on groundwater quality. Based upon a preliminary assessment, auto service stations; printing, engraving and bookbinding firms; and metal finishing and plating industries are potentially harmful land uses now permitted within the recharge areas.[14]

Printing and publishing firms generate low quantities of wastewater but the wastewater characteristics require careful consideration. Solvents (chlorinated hydrocarbons) are used to clean printing presses. Other wastewater characteristics include oil and grease and dissolved and suspended solids. Discharge of these wastewaters to sanitary sewers may require pretreatment while discharge to groundwaters would have significant environmental impacts since chlorinated hydrocarbons are persistent compounds which are not readily biodegradable and are possibly carcinogenic.

Metal plating (electroplating) industries result in significant quantities of potentially harmful wastes. These operations normally use degreasing solutions and residuals include waste oils which cannot be handled at a sewage treatment plant. Effluent from an electroplating shop will definitely contain heavy metals. On-site disposal of wastewaters could result in groundwater contamination.

The manufacture of electrical equipment as a permitted use in the IL-40 zone would require the input of as much technical data as early as possible in the review process as there is a wide range of wastewater characteristics associated with this industrial group. Wastewater may be pollutant-free, in the case of light switch industries, or may include heavy metals and lead with the manufacture of transformers or batteries.

c. For land use activites which are to be permitted within the recharge area of existing and future public water supply wells, local review procedures should be established or expanded to include consideration of the following provisions, or any other which are deemed appropriate, in the handling, transport or generation of potential contaminants. Each proposed development should undergo this or a similar review procedure to determine its potential impacts upon groundwater quality.

- Provisions for the containment of any spills in a chemical storage or use area, including a spill containment plan, necessary clean up equipment, and telephone contacts with a number of spill clean up companies.

- No drains to ground or surface waters within the containment or use area.

- Operational procedures for filling and emptying tanks including surveillance in case of accidents or mishaps.

- Storage tank security including enclosure of the area to protect against vandalism.

- Parking lot delivery vehicles in easily observable areas protected from vandalism.

d. The installation of any underground fuel storage tanks should be prohibited in the direct recharge area. Existing underground fuel storage tanks should be annually air tested for leaks. All tanks with detected leaks should be replaced, or repaired and then retested. Also, as tanks near the end of their useful life (e.g. 15-20 years) they should be replaced. Within the indirect recharge area, more stringent structural design standards are warranted (current revisions to the State Building Code are in progress).

e. Expansion of the sewer service area within the direct recharge area should be limited and not over-designed to allow an increase in density beyond the inherent limitations of the land. Sealed joints should be required to prevent sewage effluent infiltration into the unsaturated zone. Future areas should not be developed under the assumption that an area is programmed for sewer expansion as the current 201 facilities study being conducted by a consultant for the City may determine that future sewer hook-ups may be limited by the assimilative capacity of the Still River.

f. Other management strategies include:

- Use of pervious parking areas as a means of on-site recharge where "non-point" pollution sources are not a problem.

- For the removal of earth materials, a minimum separating distance should be established from the bottom of any excavated area to the maximum height of the groundwater table.

- Appropriate density limitations for industrial and commercial site coverage including buildings plus impervious parking areas.

- In cooperation with the State Highway Department, identify areas where road salting should be limited or prohibited. Similar to State road signs which identify public water supply watersheds, the direct recharge area of the aquifer should be identified on roadways to afford caution when potentially hazardous materials are in transit.

g. Finally, it should be noted that the lack of a major river and the improbability of creating a substantial impoundment in the Kenosia valley may preclude any notions of using waterpower for future industries, even as the costs of fossil fuels increase. It may therefore be prudent for the City of Danbury to remove from the current industrial zone any portions of the Kenosia Aquifer area deemed suitable for public water-supply development, together with as much of the immediate upstream watershed as is possible to serve as a partial buffer for pollutants. New industrial zones may be created, if needed, in till-covered areas, although industries needing a substantial water supply might not be able to locate in these areas.

To conclude, it is clear that the City of Danbury has the responsibility of providing an adequate supply of pure drinking water for its future needs. Ground water supplies are very susceptible to contamination from a variety of sources and once contaminated, they usually remain so for an indeterminable period of time. There are only a limited number of ground water resources available within Danbury to meet drinking water demands. Appropriate protection efforts implemented at the present time, which may be labeled as unnecessary by those who are more short-sighted or unknowing of the consequences of contamination, will be greatly valued by Danbury's future generations.

B. Lake Maintenance

The water quality protection strategies discussed in the preceeding section will also serve to protect and preserve Lake Kenosia from a public health standpoint. Basically, these protection strategies should focus in two areas: 1) existing land uses which represent a threat to lake water quality should be surveyed from time to time to ensure compatability with efforts to protect the lake; and 2) new development proposed in the watershed of Lake Kenosia should be very carefully controlled to prevent degradation of the lake. As with the Kenosia aquifer, to the extent that an increased number of potential contaminants are utilized in an industrial zone, this land use represents a greater threat to the health of the lake than a residential zone.

Efforts to protect Lake Kenosia must deal not only with public health related concerns (e.g. chemical pollution), but also with the problem of eutrophication. The accelerated eutrophication of Connecticut lakes has been shown to be related to changes in the type and intensity of land uses.[15] As the watershed of a lake is changed in character from woodland to more intensive land uses, such as agriculture, residential, commercial and industrial uses, so too does the nutrient loading on a lake change. Basically, the more intensive the land use changes are, the greater the resultant nutrient loading and therefore the degree of accelerated eutrophication.[16]

It is difficult to predict how the incremental development of the Kenosia Lake watershed according to the existing zoning will affect the Lake. However, as more of the watershed is converted from woodland to residential and industrial development, a change in the water quality of Lake Kenosia should be expected.

A key component to understanding Lake Kenosia and developing an effective Lake Kenosia Management Program is the lakes retention time. This has been calculated to be an astonishingly short 38.5 days. This means that, on the average, the entire volume of water in Lake Kenosia is replaced every 38.5 days. Many lakes with large surface areas and small watersheds have residency times covering several years, and one to two years is not unusual. The short retention time of Lake Kenosia indicates that, for an effective management plan, the primary problem to address is the quality of water being generated in the watershed. The size of Lake Kenosia's watershed is 50 times greater than the surface area of the lake; hence even in a small rain storm large quantities of water gathered by the watershed move through the lake. Therefore a program concentrating on an in-lake solution to Kenosia's problems (weed harvesting, chemical treatment, etc.) will be mostly a waste of time and money. However, it seems likely that an effective watershed management program could provide dramatic results in a comparatively short period of time.

Effective watershed management depends upon an understanding of the sources of nutrients which are being generated in the watershed and are reaching the lake. As discussed previously, major sources of nutrients may include surface runoff from developed areas, septic systems, phosphate detergents, agricultural or lawn fertilizer runoff, road building and other construction.

There are several land use practices that can be instituted to ameliorate the influence of intensified land uses on water quality. While these practices are considered "best management practices" the degree of water quality protection afforded by these practices is not quantifiable. Some of the control strategies that should be reviewed and considered for appropriateness in the Lake Kenosia watershed include:

- Strict enforcement of a local erosion and sedimentation control ordinance.
- Correction of any existing erosion sources.
- Proper maintenance of existing storm drains and installation of new drains where appropriate.
- Proper management and maintenance of septic tanks.
- Protection of existing streams and wetlands.
- Establishment of streambelt and watercourse buffer regulations.
- Review and modification of existing zoning based on natural resource capabilities and features.

Effective watershed management to protect lake water quality necessitates a long term commitment to planning and implementing appropriate management strategies. The Lake Waramaug Task Force in Northwestern Connecticut has recently prepared and is in the process of implementing a watershed management plan for Lake Waramaug, a eutrophic lake. The management recommendations made in the plan may offer some insight to the citizenry of Danbury in protecting the water quality of Lake Kenosia. Among these recommendations are the following:

- Establish a revitalized Lake--Authority--.
- Seek and retain adequate on-going professional assistance.
- Develop and implement a comprehensive and on-going information and education program in the watershed to promote sound watershed management.
- Carry out an on-going water testing program in the watershed of a manageable nature to monitor water quality trends or changes over time.
- Implement to the extent possible the practices needed to control existing erosion, sediment and nutrient run-off in the watershed.
- Implement and enforce effective and uniform streambelt regulations in the watershed to protect all watercourses.

The Lake Waramaug experience offers a good case study for all organizations interested in protecting lakes from excessive algae and weed growth. The "Lake Waramaug Management Plan", available from the Northwestern Connecticut Regional Planning Agency office in Warren, is recommended reading.

The establishment of a highly motivated and committed "Lake Kenosia Task Force", similar to the one formed at Lake Waramaug, is perhaps the singlemost important step concerned citizens of Danbury could take to protect Lake Kenosia.

FOOTNOTES

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13. Standard Industrial SIC Code. (DEP-Water Compliance Unit).

14. Ibid

15. Norvell, W. A.; Frink, C. R., <u>Water Chemistry and Fertility of Twenty-Three Connecticut Lakes</u>, Connecticut Agricultural Experiment Station Bulletin 759, October 1975.

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