## 2.0 EXISTING CONDITIONS HYDROLOGY

The Pequonnock River watershed runs from north to south, extending roughly from the Monroe/Newtown corporate boundary and through Trumbull before entering Bridgeport. While there are a number of tributaries to the Pequonnock River, Booth Hill Brook is of particular interest because it enters the river immediately downstream of Twin Brooks Park, which is subject to frequent flooding. The Booth Hill Brook watershed begins in the town of Shelton but is mostly within Trumbull.

A diversion is maintained from the north branch of the Pequonnock River, in the northwest section of the watershed, forcing water from the Pequonnock River into an Aquarion owned and operated reservoir. The location of this diversion is known as Stepney Dam and consists of a spillway with a sluice gate that is set slightly below the elevation of the spillway.

Hydrologic modeling of the Pequonnock River and Booth Hill Brook watersheds was completed under current conditions. The purpose of such modeling was to evaluate current runoff and stream flow patterns. Modeling was completed using the U.S. Army Corps of Engineers' computer program HEC-HMS 3.1.0.

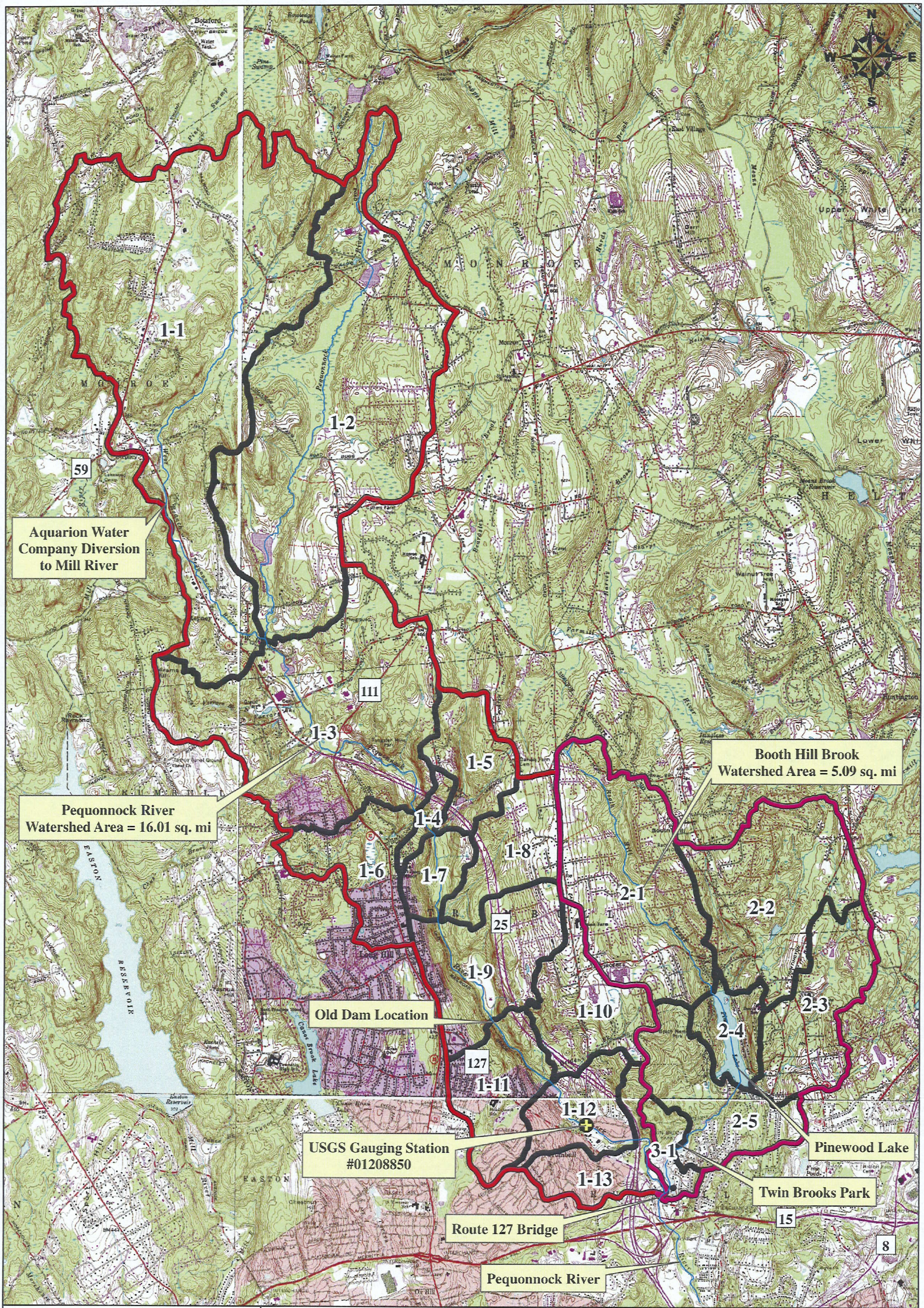
The physical representation of subwatersheds is configured in the HEC-HMS model using subbasin, reach, storage, and diversion elements. The NRCS (SCS) curve number method was used to estimate runoff rates from each subwatershed. The curve numbers were calculated based on land use conditions, soil types, and the percentage of impervious area for the subwatersheds.

## 2.1 Model Development

Partial mapping of the Pequonnock River and Booth Hill Brook watersheds was obtained from the town of Trumbull and the town of Monroe. Information presented on this mapping includes topography with two-foot contours, roadways, and buildings. Where necessary, base mapping was supplemented with USGS maps (1:24,000 scale) and aerial photography. Watershed and subwatershed boundaries were delineated based on topography and field verified to reflect the presence of storm drain routing. The Pequonnock River and Booth Hill Brook watersheds were divided into a total of 19 subwatersheds for this analysis as shown on Figure 3.

Land use under existing conditions was determined from existing 2002 GIS mapping and supplemental field investigations. Land use in the watershed was classified as brush, developed, open space, water, and woods. Land use mapping for the study area is shown in Figure 4.

Soil types in the watershed were determined from the DEP's GIS database of the NRCS soil survey for Fairfield County, Connecticut. The NRCS divides soils into four Hydrologic Soil Groups: A, B, C, or D, depending on their infiltration capacity and ability to absorb water. Group A soils have the highest infiltration capacity. Hydrologic Group B soils have moderate infiltration capacity and consist of moderately well to well-drained soils. Group C soils have low infiltration rates and consist of soils with a layer that hinders the downward movement of water. Group D soils have the lowest infiltration capacity and, hence, generate the highest runoff rates. The hydrologic soil groups of the study area are shown in Figure 5. It should be noted that a large portion of this watershed is Hydrologic Soil Goup B soils, indicating they would have a moderately high infiltration rate.





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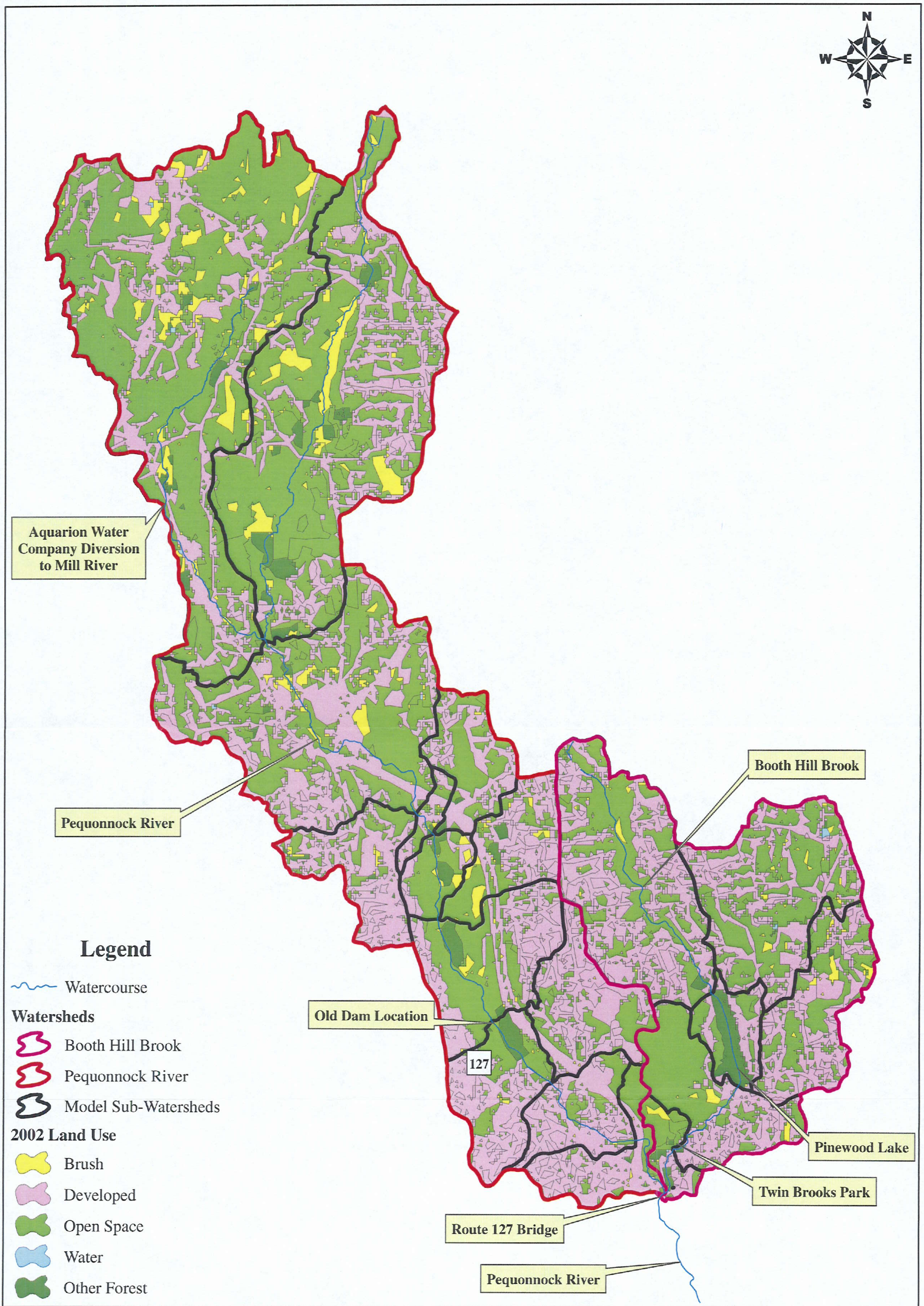
| Sub-Watershed Map | | LOCATION: Trumbull & Monroe, CT | |
| MMI#: 3247-01-1<br>MXD: H:Fig3-Sub-Watershed.mxd<br>SOURCE: CT DEP | N | DATE: Oct. 2007<br>SCALE: 1" = 3,500' | SHEET: Figure 3 |
| Pequonnock River Flood Control Study | | | |

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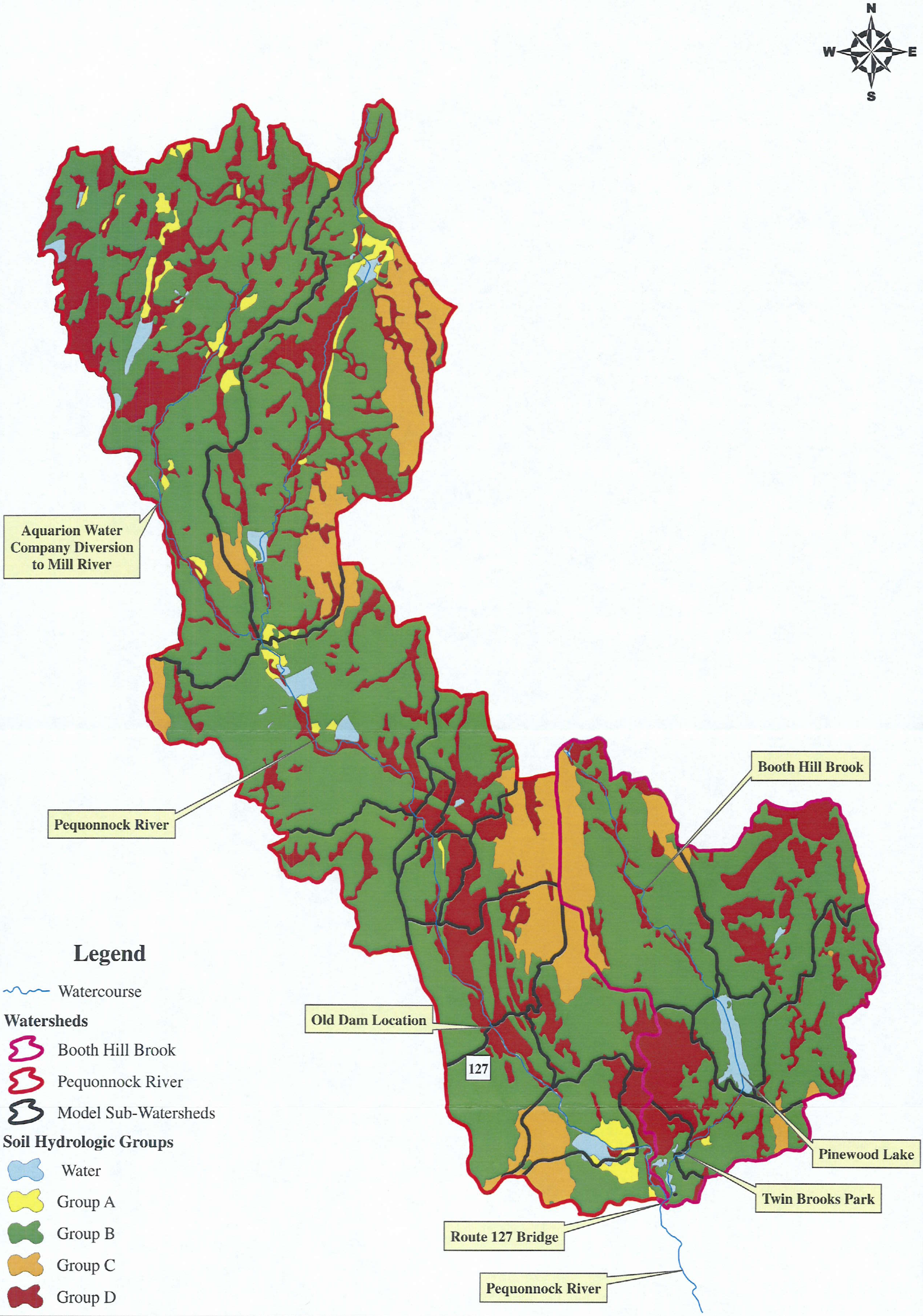
| *Engineering, Landscape Architecture and Environmental Science*<br>MILONE & MACBROOM®<br>99 Realty Drive<br>Cheshire, Connecticut 06410<br>(203) 271-1773 Fax: (203) 272-9733<br>www.miloneandmacbroom.com | Land Use Map<br>MMI#: 3247-01-1<br>MXD: H:Fig4-LandUse.mxd<br>SOURCE: CT DEP | Pequonnock River<br>Flood Control Study | LOCATION: Trumbull & Monroe, CT<br>DATE: Oct. 2007<br>SCALE: 1" = 3,500'<br>SHEET: Figure 4 |

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| MMI#: 3247-01-1<br>MXD: H:Fig5-Soils.mxd<br>SOURCE: CT DEP | Pequonnock River Flood Control Study | DATE: Oct. 2007<br>SCALE: 1" = 3,500'<br>SHEET: Figure 5 |

Based on the soil types and land use, weighted curve numbers were developed for each subwatershed. Areas of imperviousness, including water areas, were not analyzed by soil type but instead were assigned a curve number (CN) of 98. The CN values for each subwatershed are show in Table 2, and worksheets used to develop these values are in Appendix A.

The time of concentration for each watershed, defined as the time it takes a drop of water to travel from the most hydrologically distant point in the watershed to the watershed outlet, was also determined for each subwatershed. Time of concentration values are also presented in Table 2, and worksheets used to calculate these values are in Appendix B.

## TABLE 2
## Hydrologic Input Data

| Sub-watershed | Subwatershed Description | Area (acres) | Curve Number (CN) | Time of Concentration ($T_c$ in hours) |
|---|---|---|---|---|
| 1-1 | West Branch Pequonnock | 2,951 | 68 | 4.753 |
| 1-2 | Mainstem Headwaters | 2,291 | 71 | 3.720 |
| 1-3 | Below Junction With W. Branch | 1,628 | 70 | 3.688 |
| 1-4 | Mainstem Between Tributaries | 76 | 76 | 0.426 |
| 1-5 | Tributary From East | 319 | 74 | 0.697 |
| 1-6 | Tributary From West | 397 | 73 | 0.865 |
| 1-7 | Mainstem | 172 | 70 | 0.598 |
| 1-8 | Tributary From East | 365 | 79 | 0.964 |
| 1-9 | Mainstem Above Old Dam Site | 592 | 75 | 1.281 |
| 1-10 | Belden Brook | 433 | 76 | 2.635 |
| 1-11 | Mainstem Above Belden Brook | 424 | 74 | 1.144 |
| 1-12 | Mainstem Above Route 25 Bridge | 318 | 76 | 1.717 |
| 1-13 | Mainstem Above Junction With Booth Hill Brook | 281 | 75 | 1.555 |
| 2-1 | Headwaters of Booth Hill Brook | 1,041 | 73 | 1.928 |
| 2-2 | North Tributary to Pinewood Lake | 854 | 73 | 2.953 |
| 2-3 | South Tributary to Pinewood Lake | 522 | 72 | 7.929 |
| 2-4 | Pinewood Lake | 214 | 77 | 0.933 |
| 2-5 | Booth Hill Brook Between Pinewood Lake and Pond 5 | 505 | 74 | 3.980 |
| 3-1 | Twin Brooks Area, Above Route 127 Bridge | 123 | 76 | 1.890 |

Rainfall data for the analysis was taken from the Connecticut Department of Transportation Drainage Manual updated October 2000. These are based on the United States Weather Bureau's Technical Paper-40 (TP-40) published in 1961 based on data from 1931 through 1961 and the NOAA Technical Memorandum "NWS Hydro-35" published in 1977. This data has been the standard rainfall-duration-frequency data used in hydrologic analyses in Connecticut since its publication. Twenty-four hour rainfall rates for the 2-, 10-, 25-, 50-, and 100-year return frequency storm events were used as presented in Table 3.

The University of Connecticut (UConn) Departments of Natural Resources Management and Engineering have prepared new rainfall-duration-frequency data for Connecticut.

This data has been published in draft form in a paper entitled "Rainfall in Connecticut" and provides more current rainfall data for storm event analysis than is presented in TP-40. Table 3 provides a summary of the TP-40 and UConn rainfall data.

**TABLE 3**
**Rainfall Depths of Flood Events in Connecticut**

| | **Storm Frequency (years)** | | | | | |
|---|---|---|---|---|---|---|
| | **2** | **5** | **10** | **25** | **50** | **100** |
| | **Rainfall in Inches** | | | | | |
| UConn 24-hour Rainfall | 3.45 | 4.40 | 5.1 | 6.3 | 7.45 | 8.65 |
| TP-40 Rainfall for Fairfield County | 3.3 | 4.3 | 5.0 | 5.7 | 6.4 | 7.2 |

Data developed by the UConn demonstrates a higher total rainfall for storm events than that previously published in TP-40. For example, the UConn 100-year frequency, 24-hour duration rainfall is 20% higher than that of TP-40. For the smaller, more frequent storm events, the increase is less significant. TP-40 is the design standard that is used for hydrologic analysis in Connecticut; therefore, that rainfall data was used here. Use of the UConn data would produce flow rates that are higher than those calculated by MMI. The Town may wish to consider using the more conservative UConn data if design of the alternatives is pursued in the future.

At Stepney Dam, there is currently no flood storage available, so this was not modeled as a reservoir. The Aquarion diversion was incorporated into the existing conditions model to reflect the loss of water from the watershed. Diverted flows were calculated based on current configuration of the sluice gate. See Appendix C for calculations.

### 2.1.1 Reservoir and Reach Storage

There are some natural waterbodies and low-lying areas within the Pequonnock River and Booth Hill Brook watersheds that serve to store water during flood events. These locations were identified and incorporated into the model where possible to increase the accuracy of the models representation of the watershed. In evaluating the effectiveness of storage areas at reducing peak flow rates, consideration must be given to location in the watershed. Storage areas located in the upper third of a watershed may not be effective at reducing peak flows given the limited watershed area contributing runoff. Control of peak flows is also dependent on the timing of the peak flow from each subwatershed. Providing detention in the lower portion of a watershed may actually increase peak flows, holding the water such that its discharge overlaps with the peak flow from the upstream watershed area.

Reservoir storage is characterized in hydrologic modeling by stage-discharge and stage-storage curves. As rainfall increases, water surface stage (or elevation) begins to rise. As the stage increases, the discharge from and volume of water stored in the reservoir area increases. These relationships define the storage area's capacity. Limited data was available for the natural storage areas located within the study area. In those instances, the storage volumes were estimated based on existing topographic information. Discharge capacities were estimated based on outlet configurations determined during field investigations. Backup calculations are presented in Appendix C.

Water storage also occurs in channel "reaches." Reach storage accounts for the time it takes the stream's discharge to flow from the upper portion of the subwatershed to the outlet of the subwatershed. There were no reach storage areas identified within the study area given the steep channel slope and narrow valley through which the main stem travels.

In developing the Pequonnock River and Booth Hill Brook hydrologic model, MMI evaluated reservoir storage areas within the watershed as described below.

Pinewood Lake: This area is located in the Booth Hill Brook watershed in subwatershed 2-4. The contributing watershed area includes subwatersheds 2-1, 2-2, and 2-3, in addition to the direct drainage from 2-4. These subwatersheds are primarily developed residential areas. Town staff have reported that the water surface elevation of this impoundment can be manually lowered before a storm event. However, this has not been included in the existing conditions analysis, so the model represents actual field conditions.

Twin Brooks Park Area: This recreational area includes five substantial ponds, some of which Booth Hill Brook is routed through. This area is prone to flooding at higher flows and acts as one large storage area. MMI observed during a field visit that the Pequonnock River appears to flood directly into the park during higher flows. This was modeled as a reservoir storage area in the existing conditions model. This storage area is controlled by the discharge capacity at the Route 127 bridge.

## 2.2 Existing Conditions Results

The peak discharge from the watershed was calculated for a variety of storm events using the HEC-HMS model. In Table 4, these computed values were compared to the existing 1997 FIS flow rates at selected locations along the Pequonnock River. The flows predicted in the HMS model developed by MMI are higher than those in the FIS. This is attributed to the more detailed methodology employed by MMI as well as the increased development in the watershed that has occurred since FEMA determined flow rates in 1979. Model output is presented in Appendix D.

**TABLE 4**
**Comparison of Calculated Flows with FEMA FIS Flood Values**

| Storm Event | FIS Flows | Current HEC-HMS | % Difference |
|---|---|---|---|
| **At the corporate limit, located ~7,000' downstream of Route 127[1]** | | | |
| 10-year storm | 2,023 | 3,896 | 93 |
| 50-year storm | 5,144 | 6,272 | 22 |
| 100-year storm | 7,343 | 7,906 | 8 |
| **400' upstream from Brock Street** | | | |
| 10-year storm | 1,624 | 3,386 | 108 |
| 50-year storm | 4,109 | 5,230 | 27 |
| 100-year storm | 5,876 | 6,345 | 8 |

Note: 1. HMS flows were calculated based on the ratio of watershed areas between Route 127 (the downstream limit of MMI's model) and the watershed outlet.

The HMS model also predicts the peak water surface elevation within the storage areas in the watershed. The normal water surface elevations for the ponds at Twin Brooks Park as reported on the Town's topographic mapping range from 83.3 to 85.0 feet NGVD29. At elevation 90 feet NGVD29, water will flow over Brock Road in the park area, and the park is completely flooded. Based on MMI's existing conditions model, this flood elevation would occur during the two-year return frequency event.

Approximately at elevation 92, flood waters would be approaching residential homes in the proximity of Twin Brooks Park. At elevation 94 feet NGVD29, Route 127 is overtopped, and this level of inundation is predicted during the 10-year storm event. During the 100-year storm event, the water surface elevation through the park is predicted to be slightly more than 98 feet NGVD29.