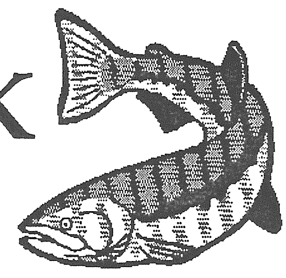
SECOND HILL BROOK
BRIDGEWATER, CONNECTICUT



KING'S MARK ENVIRONMENTAL REVIEW TEAM REPORT

King's Mark Resource Conservation & Development Area, Inc.

SECOND HILL BROOK
BRIDGEWATER, CONNECTICUT

ENVIRONMENTAL REVIEW TEAM REPORT

Prepared by the
King's Mark Environmental Review Team
of the
King's Mark
Resource Conservation and Development Area, Inc.

for the
First Selectman
Bridgewater, Connecticut

August 1997

CT Environmental Review Teams
1066 Saybrook Road
P.O. Box 70
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ACKNOWLEDGMENTS

This report is an outgrowth of a request from the Bridgewater First Selectman to the Litchfield County Soil and Water Conservation District (SWCD). The SWCD referred this request to the King's Mark Resource Conservation and Development Area (RC&D) Executive Council for their consideration and approval. The request was approved and the measure reviewed by the King's Mark Environmental Review Team (ERT).

The King's Mark Environmental Review Team Coordinator, Elaine Sych, would like to thank and gratefully acknowledge the following Team members whose professionalism and expertise were invaluable to the completion of this report.

The field review took place on Tuesday, May 6, 1997.

Arthur Christian	Supervising Civil Engineer DEP - Bureau of Water Management (860) 424-3880
Charles Galgowski	Planning Engineer USDA - Natural Resources Conservation Service (860) 487-4022
Donald Mysling	Fisheries Biologist DEP - Fisheries Division Habitat Conservation and Enhancement Program (860) 567-8998
Phillip Renn	Water Resources Coordinator USDA - Natural Resources Conservation Service (860) 487-4016

I would also like to thank William Stuart, First Selectman of Bridgewater and Walter Ostrander, homeowner, for their cooperation and assistance during this environmental review.

Prior to the review day, each Team member received a summary of the proposed project with location and soils maps. During the field review Team members were given additional information. Following the review, reports from each Team member were submitted to the ERT coordinator for compilation and editing into this final report.

This report represents the Team's findings. It is not meant to compete with private consultants by providing site plans or detailed solutions to development problems. The Team does not recommend what final action should be taken on a proposed project -

all final decisions rest with the Town and homeowner. This report identifies the existing resource base and evaluates its significance to the proposed development, and also suggests considerations that should be of concern to the Town and homeowner. The results of this Team action are oriented toward the development of better environmental quality and the long term economics of land use.

The King's Mark RC&D Executive Council hopes you will find this report of value and assistance in studying the Second Hill Brook watershed.

If you require additional information please contact:

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CT ERT Program
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Haddam, CT 06438
(860) 345-3977

Introduction

The First Selectman of Bridgewater has requested assistance from the King's Mark Environmental Review Team in conducting an environmental review of the Second Hill Brook Watershed.

Objectives of the ERT Study

The Town is requesting assistance in evaluating environmental problems in the Second Hill Brook Watershed. The main point expressed was that the Town of Bridgewater was concerned that the extensive housing developments occurring in the upstream portion of the Second Hill Brook Watershed to the north in New Milford was causing an increase in runoff volume and peak discharge. The Town of Bridgewater felt this increase in runoff volume and peak discharge in turn was causing flooding and erosion problems on Second Hill Brook as it flowed downstream into and through Bridgewater.

The ERT Process

Through the efforts of the First Selectman this environmental review and report was prepared for the Town of Bridgewater.

This report provides an information base and a series of recommendations and guidelines which cover the topics requested by the Town. Team members were able to review maps and supporting information provided by the town and homeowner.

The review process consisted of four phases:

1. Inventory of the site's natural resources which included a field review of four sites and viewing the watershed by vehicle;
2. Assessment of these resources;
3. Identification of resource areas and review of plans and reports; and
4. Presentation of education, management and land use guidelines.

The data collection phase involved both literature and field research. The field review was conducted on May 6, 1997. The emphasis of the field review was on the exchange of ideas, concerns and recommendations. Being on site allowed Team members to verify information and to identify other resources.

Once Team members had assimilated an adequate data base, they were able to analyze and interpret their findings. Individual Team members then prepared and submitted their reports to the ERT coordinator for compilation into this final ERT report.

Second Hill Brook Watershed
Bridgewater/New Milford
Drainage Area Map
1" = 2000'
A1 of 13

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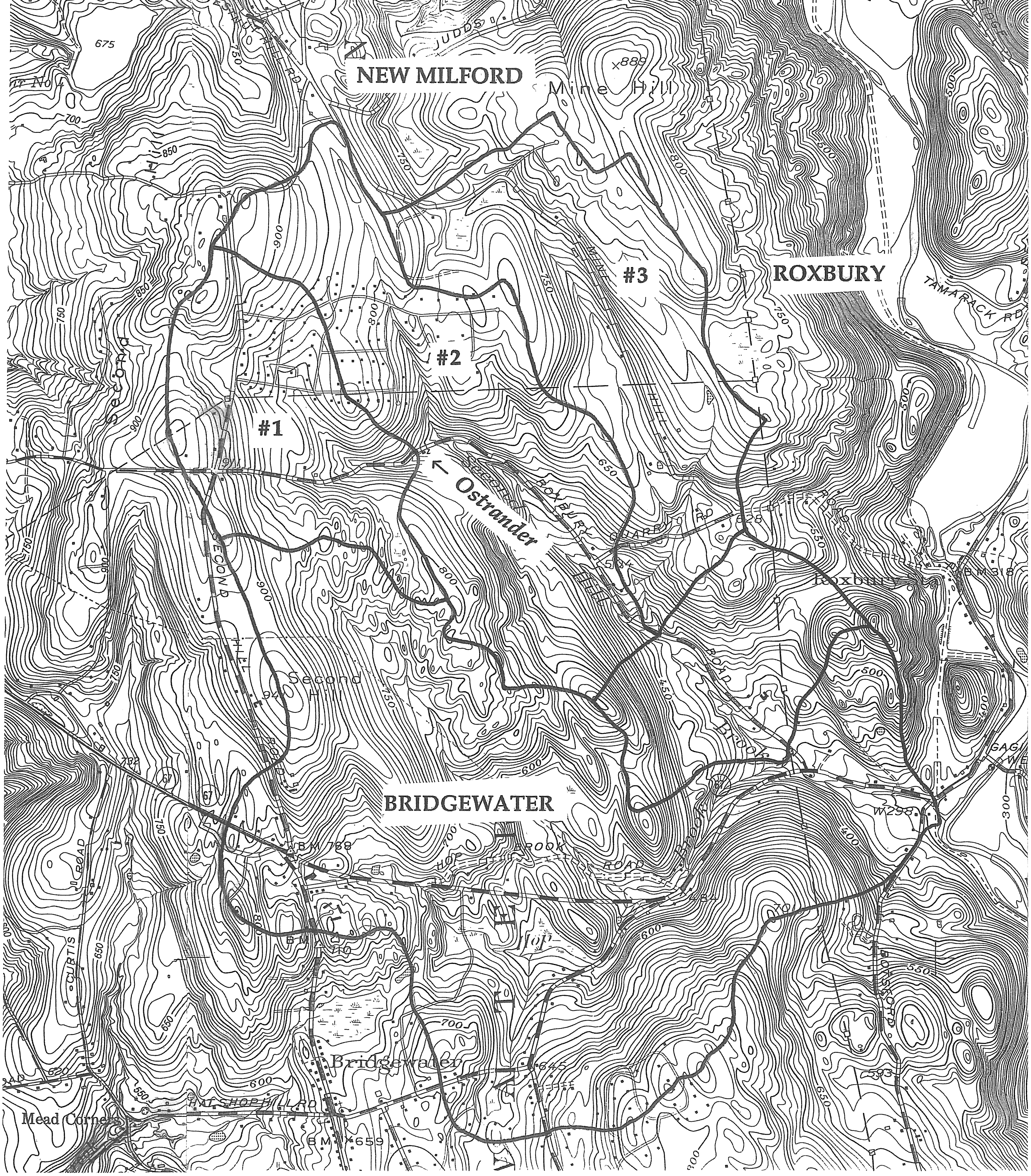

DEP ENGINEERING SITE INSPECTION

I. Existing Conditions

Portions of the Second Hill Brook Watershed are located within the Towns of New Milford and Bridgewater. Development potential of much of the New Milford section of the watershed has been reached. There has been no detention provided in the New Milford developments. There has been some stormwater improvements made in this area in the form of storm sewers, but the lots are large and well vegetated. The topography, road system and zoning of Bridgewater will not allow for large subdivision developments in their portion of the watershed

There is an erosion problem in the area of the Ostrander residence. There did not seem to be an adverse amount of erosion either upstream or downstream of this site. A bedrock outcrop in the channel bottom exists at the downstream side of the house. This outcrop would control erosion upstream of that point. This area of the brook was artificially deepened and widened after a storm in 1975.

An area exists on an adjacent tributary to the Ostrander home which could provide some detention in the watershed. This proposed detention area would have no effect on flows at the Ostrander property, since it is located on an adjacent branch of the stream, and only effects areas downstream of the confluence.

There is some minor streambank erosion throughout the stream. The rocky nature of the natural soils provides armoring to the stream bank and bottom. A sediment deposit also exists just upstream of the dam. This was the only evidence of sedimentation that was noted.

II. Mitigation Potential

Since the development potential within this watershed New Milford is near completion, there does not seem to be any prospects of installing detention in that town. There are no locations evident within the existing New Milford subdivisions that would be appropriate for the installation of stormwater detention. Detention could be undertaken on the adjacent tributary in the area of the existing beaver dam.

However, it would not solve any of the problems at the Ostrander property. The development within New Milford does not seem very dense, and the new or on-going developments have large lots with minimal disturbance of natural conditions.

The erosion along the Ostrander home needs to be corrected soon. The deterioration is continuing and will not be self-correcting. Although the upstream development may have affected peak flows at this site, assessing liability for said increases would be fruitless. The erosion could be as much a result of the stream work done in 1975 as it is due to the increased flows or flow frequencies. It is recommended that the Ostranders monitor the erosion on their property and maintain it as they see appropriate. This project would not qualify for state funding under the flood and erosion control board statutes because it only affects one piece of property.

USDA - Natural Resources Conservation Service

PLANNING ENGINEER REVIEW

I. Field Visit Observations

The following was noted by the Team members from the USDA-Natural Resources Conservation Service (NRCS) at each site (see Appendix A Drainage Map).

- **First stop - Second Hill Falls on Second Hill Brook on the West side of Roxbury Road about 1100 feet from the Roxbury-Bridgewater town line.** The site contains a dam about 10 feet high with a pond just upstream of it. The pond is almost completely filled with sediment. Neighbors claim this pond was suitable for swimming in the 1970's. The USGS 1984 vintage topographic map shows the pond to have had a water surface area of about 1/2 acre.

- **Second stop - Second Hill Brook near the confluence with the tributary from Mine Hill Road.** This site showed some scouring on the streambanks. The erosion was not serious enough to warrant any streambank protection at this time.

- **Third stop - beaver pond on a tributary the west side of Mine Hill Road at the Bridgewater-New Milford Town line.** Selectman Stuart informed the group the water surface of this pond has become lower in the past few years. It appears that the beaver are not maintaining the dam to its past level. The area upstream is being developed for residential housing.

- **Fourth stop - Walter Ostrander residence, between Roxbury Road and a tributary to Second Hill Brook about 3,000 feet east of Second Hill Road.** Mr. Ostrander showed the ERT Team photographs documenting several floods and erosion damage the site has experienced since he bought the property. The site has experienced flooding and/or erosions in 1969 (or 1970), 1975 and 1995. In 1975 Mr. Ostrander had the stream channel deepened about 2 to 4 feet by his house. Mr. Ostrander claims the housing developed upstream has increased peak runoff at his house and the rate at which the stream rises has also increased. Furthermore, Mr. Ostrander has experienced the strong odor of petroleum coming from the stream on one occasion. The house is very close to the stream. When the stream was deepened, the banks were dug apparently on sideslopes steeper than 1: 1. Although the banks do not appear to be coated with riprap, the banks do not appear to have experienced extreme erosion. The banks did look a bit raw with some exposed earth.

- **Fifth stop - The ERT also drove upstream to and through the housing developments in New Milford.** The tributaries and main branch of Second Hill Brook are fairly steep on grades of about 5 percent. The streams do show some streambank erosion at several places, but none severe enough at the present time to warrant streambank protection.

II. Previous Streambank Repair

Records of the USDA Natural Resources Conservation Service show the NRCS (formerly Soil Conservation Service (SCS)) performed Emergency Stream Restoration on several locations of Second Hill Brook between the Bridgewater-Roxbury Town line and the Shepaug River in 1976. Approximately 1,000 feet of riprap was installed on 5 locations at this section of the brook.

III. Technical Release 55 - Urban Hydrology for Small Watersheds Analysis

NRCS performed *a planning level* hydrology analysis of Second Hill Brook to estimate the effects of the housing development in New Milford on increasing peak discharge downstream in Bridgewater. The Technical Release 55 - Urban Hydrology for Small Watersheds (TR-55) method was used to do this analysis. Peak discharges were calculated for 1965 watershed landuse and 1996 watershed landuse. These two TR-55 runs and the drainage area map are attached (see Appendix A). Copies of the soils map and aerial landuse maps used in the TR-55 analysis have been given to the town of Bridgewater (one copy to accompany this report). Following are the assumptions and/or techniques used in the analysis:

- Analyze the 10-year 24-hour storm using the Tabular method of TR-55 with 3 subareas.

- The subareas were delineated from a USGS topographic map with a scale of 1 :24,000 and a contour interval of 10 feet.

- The first subarea ends at the Walter Ostrander House and has 290 acres.

- The second subarea is on the main stem of the Second Hill Brook and ends at the confluence of the tributary from Mine Hill Road and the beaver pond and Second Hill Brook. This subarea has 510 acres.

- The third subarea is on the tributary from Mine Hill Road and the beaver pond and ends at the confluence with Second Hill Brook. This subarea has 434 acres.

- Land uses were determined by using the April 25, 1965 and April 15, 1996 aerial flights on file at the Connecticut Department of Environmental Protection Map Room at 79 Elm Street, Hartford, CT. Agricultural fields that had a darker tone or striations indicating furrows or row crops on the 1965 flight were assumed to be cornfields and lighter toned fields were assumed to be hayfields. The bulk of the housing on the 1996 flight was assumed to be on 1 acre lots which assumed 20 percent of the developed areas had impervious cover which was directly connected to the drainage system.

- Soils information was taken from the Litchfield County Soil Survey.

- Time of Concentration estimates were done from a visual recall of the watershed the day of the site investigation and using the USGS topographic map. Sheet flow was assumed to be 150 feet long on all subareas for 1965 and 1996 conditions. The existing road and storm sewer system was not investigated in the field to see how this might have modified time of concentrations. The same values for time of concentrations were used for the 1996 condition as the 1965 condition.

The results of the TR-55 analysis are shown in the following Table 1.

Table 1 . TR-55 Peak Discharges and Runoff Curve Numbers

Drainage Area	Runoff Curve number for 1965 Watershed Landuse	10-Year Peak Discharge for 1965 Watershed Landuse (CFS)	Runoff Curve Number for 1996 Watershed Landuse	10-Year Peak Discharge for 1996 Watershed Landuse (CFS)
Subarea 1 (Ostrander House)	70	251	70	251
Subarea 2	68	416	69	439
Subarea 3	68	354	69	373
Total		1,020		1,062

IV. Results of the TR-55 Analysis

According to this TR-55 analysis, the housing development from 1965 to 1996 has not increased peak discharges at Subarea 1 (Ostrander house) and only minimally increased peak discharges at the confluence of subarea 2 (the main stem of Second Hill Brook) and subarea 3 (the tributary from Mine Hill Road). This is because the runoff curve numbers changed very little and the time of concentration was kept the same for the 1965 and 1996 conditions.

The curve numbers changed very little because a one acre house lot on a C hydrologic soil has a runoff curve number of 79, a cornfield on a C soil has a runoff curve number of 82 and a significant amount of the development occurred on cornfields. This planning level TR-55 assumed some fields were planted to corn as determined by the 1965 aerial map. An in-depth interview of town residents and past owners of the farmland might give a more accurate estimate of the land actually planted to corn in 1965. This could change the TR-55 model.

This planning level TR-55 also did not do an in-depth field investigation to fine tune time of concentrations. Such an investigation might show some changes in time of concentrations, which in turn could change the peak discharges.

The results of this planning level TR-55 analysis should be tempered with actual field observations of peak discharges of residents living in the watershed. Furthermore, field observations of flow should be tempered with the fact that different weather patterns prevail in different decades. For example, the 1960's were a very dry decade.

V. Future Impacts

Regarding the future, this TR-55 model and the 1996 aerial photographs indicate that future housing development on the Second Hill Brook Watershed in New Milford has a strong possibility of increasing runoff volume and peak discharges. This is because the bulk of the undeveloped land left is in woods. Woods on a C hydrologic soil group has a runoff curve number of 70, while 1 acre housing has a runoff curve number of 79. Consequently future housing development will tend to increase runoff volume which can lead to an increase in peak discharges.

Increases in peak discharge can increase flooding and streambank erosion. Typically, longer time of concentration flow paths and detention ponds have been used to reduce peak discharges. However in doing so, the longer time of concentration flow paths and/or detention ponds create longer durations of moderately high stream flow which can also cause erosion problems. For this reason, it is important to control runoff volume as well as peak discharge. By minimizing the increase in runoff volume, both peak discharge and duration of moderately high stream flow can be controlled.

Techniques to minimize the increase in runoff caused by development are to maintain soil infiltration. This can be achieved by minimizing the paved and roofed areas, using porous road surfaces, directing roof and road runoff to infiltration areas and maintaining woodland and wetland as much as possible. Rigorous stormwater modeling of these various design techniques can show what the impacts of future development will be.

In Connecticut, drainage policy is set by each individual town. Bridgewater could ask New Milford to manage future housing development to minimize future increases in runoff volume and peak discharge. However, there is no statewide policy mandating New Milford do this.

VI. Mitigation of Present Conditions

At the Ostrander residence, further increasing the channel depth could increase the channel capacity and armoring the channel could reduce stream erosion. Flood proofing the house with a flood wall could also reduce flooding of the house. All three techniques would be very expensive. Aesthetically blending these techniques to the site would be challenging.

The beaver pond on Mine Hill Road most likely achieves some flood control of that tributary. Further hydrologic study could show if this site could be utilized for any significant flood control. If so, a manmade dam could be built to achieve this. A beaver dam should not be counted on for flood control, since beaver do not usually build dams with the inherent safety factors of modern manmade dams. Also, beaver frequently abandon dam sites when their food supply runs out.

The pond at Second Hill Falls could be dredged out. With time it will fill in again. The watershed has steep profile streams which do carry a certain amount of bedload from natural erosion, road sanding, agriculture and construction activity. When the water reaches the lower velocities in the pond, the sediment drops out. Controlling upstream erosion could reduce the frequency of clean out. Or building a smaller pond at the site with the stream channel diverted around the pond could reduce sedimentation into the pond during flood stages. During normal flow times a moderate size pipe could gravity feed a constant supply of cool water to the pond.

AQUATIC RESOURCES

I. Site Description

Within the bounds of the Second Hill Brook Watershed Study, Second Hill Brook is contained in a channel approximately 12 feet in top of bank width and normal flow depths averaging 1 foot. The moderate to steep gradient channel creates surface flow predominated by shallow riffle interspersed by moving pool. Stream substrate is composed of ledge, boulder, cobble, gravel, coarse sand, and sand-silt fines. Dense growths of hardwoods and woody shrubs predominate as riparian vegetation and provide much of Second Hill Brook with a nearly complete canopy. Physical in-stream habitat is provided by the water depth in pools, boulders, undercut banks, and fallen or overhanging vegetation provides in-stream cover.

A unnamed Second Hill Brook tributary was also within the study bounds. Although contained within a somewhat smaller channel, it exhibited similar in-stream and riparian characteristics as those of Second Hill Brook.

Although there has been some residential and agricultural development, the watershed remains primarily forested. The limited development to date provides a means of maintaining stream water quality. The Department of Environmental Protection classifies Second Hill Brook and it's unnamed tributary as *Class AA* surface waters. Designated uses for surface water of this classification are existing or potential public drinking water supply, fish and wildlife habitat, recreational use, agricultural and industrial supply, and other purposes. Recreational uses may be restricted.

II. Aquatic Resources

Second Hill Brook and it's unnamed tributary are prime examples of a cold-water streams. A formal finfish resource inventory of Second Hill Brook had been conducted by the Fisheries Division in 1991. That survey focused on a 150 foot stream reach downstream of the Roxbury Road crossing, Bridgewater. Survey results (see Appendix B) revealed a finfish population composed of brook trout *(Salvelinus fontinalis)* and blacknose dace *(Rhinichtys atratulus)*. Several age-size classes of brook trout were collected which is indicative of a naturally developed, self-sustaining population.

Although not subject to Fisheries Division survey, the unnamed tributary is anticipated to contain a finfish population similar to that of Second Hill Brook.

III. Impacts

As previously mentioned, limited development within the Second Hill Brook watershed has maintained water quality and physical habitat conditions at levels supportive of intolerant finfish species such as brook trout. However, residential development in headwaters of the watershed is reported to have a noted affect on storm flow frequencies, erosion, and increased sediment transport. Continued development within the remaining, predominantly forested watershed has the potential to adversely impact aquatic habitats and resources should mitigative measures not be implemented. Anticipated impacts include:

- Soil erosion and subsequent sediment transport through increased runoff from unvegetated areas. Excessive erosion, sediment transport, and sediment deposition can degrade both water quality and physical habitat, in turn affecting the resident finfish population. Specifically, excessive siltation has the potential to:
    - cause a depletion of oxygen within the water column
    - disrupt fish respiration and gill function

- reduce water depth resulting in a reduction of habitats used by finfish for feeding, cover, and spawning
- reduce finfish egg survival
- reduce aquatic insect production
- promote aquatic plant growth

- Development adjacent to streams often results in the alteration or removal of riparian vegetation. Changes to riparian vegetation can result in the following:
    - remove the natural "filtering" effect of vegetation which has the ability to prevent sediments, nutrients, fertilizers, and other non-point source pollutants from upland sources from entry into streams; such non-point source pollutants can degrade habitat and water quality
    - increase stream water temperature during the summer months (thermal loading) while decreasing winter water temperatures to levels causing a complete ice cover
    - decrease stream bank stability thereby increasing surface water siltation and habitat degradation
    - eliminate or drastically reduce the supply of large woody debris provided to streams; such material provides critical physical habitat features for numerous species of aquatic organisms
    - reduce a substantial proportion of food for aquatic insects which in turn constitutes a reduction in a significant proportion of food available for resident finfish
    - stimulate excessive aquatic plant growth
    - decrease the riparian corridor's ability to serve as a "reservoir" storing surplus runoff for gradual release back into the streams during summer and early fall low flow periods
- An influx of stormwater drainage may cause aquatic habitat degradation due to the release of pollutants from developed areas. Such pollutants include gasoline, oil, heavy metals, road salt, fine silts, and coarse sediments.

- Nutrient enrichment from fertilizer runoff from manicured lawns will stimulate aquatic plant growth. Herbicide runoff from manicured areas may result in fish kills and water quality degradation.

IV. Recommendations

The greatest extent of existing, large scale development, namely residential housing, within the Second Hill Brook watershed is located within the Town of New Milford. As impacts from these developments have reportedly impacted resources within the bounds of the town of Bridgewater, it would seemingly prove beneficial for the regulatory boards of both municipalities to form a cooperative partnership in undertaking studies designed to ascertain the extent of off-site impacts from existing development and develop mitigation strategies. Similarly, the regulatory boards of both municipalities should jointly review future development proposals which may potentially present cross-jurisdictional impacts.

Whether it be subject solely to Town of Bridgewater or of multijurisdictional review, the following measures should be incorporated into the design of proposed development in effort to mitigative impacts to Second Hill brook and it's tributary:

- Maintain at a minimum a 100 foot open space buffer zone along any development's encroachment to perennial watercourses and 50 feet along those surface waters of intermittent flow regime. Activities resulting in alteration of riparian habitat should be prohibited within these riparian zones. Research has indicated that buffer zones of these widths prevent damage to aquatic ecosystems that are supportive of diverse species assemblages. These buffers absorb surface runoff, and the pollutants they may carry, before they enter wetlands or surface waters. Please refer to the attached documentation presenting Fisheries Division policy and position regarding riparian buffers for additional information (see Appendix B).

- Design and implement stormwater management systems to contain stormwater runoff on-site and not allow a direct discharge to surface waters. Ideally, stormwater containment areas should not be constructed in watercourses but rather be located in upland areas.
- Driveway and roadway crossings of watercourses and wetlands should be avoided. Unavoidable crossings should be by span bridge. Areas for crossings should be carefully selected to minimize riparian and wetland impacts.
- Establish comprehensive erosion and sediment control plans with mitigative measures (haybales, silt fence, etc.) to be installed prior to and maintained through all development phases. Land clearing and other disturbance should be kept to a minimum with all disturbed areas being protected from storm events and restabilized in a timely manner.
- Limit any regulated activities adjacent to riparian buffer zones to historic low precipitation periods of the year. Reduced precipitation periods of summer to early fall provide the least hazardous conditions when working near sensitive aquatic environments.
- Limit liming, fertilizing, and the introduction of chemicals to developed land susceptible to runoff into surface waters.

APPENDIX A

Drainage Area Map
TR55 Second Hill Brook Watershed 1965
TR55 Second Hill Brook Watershed 1996
Soils Map
Land Use Aerial 1965
Land Use Aerial 1996

Second Hill Brook Watershed
Bridgewater/New Milford
Drainage Area Map
1″ = 2000′
A1 of 13

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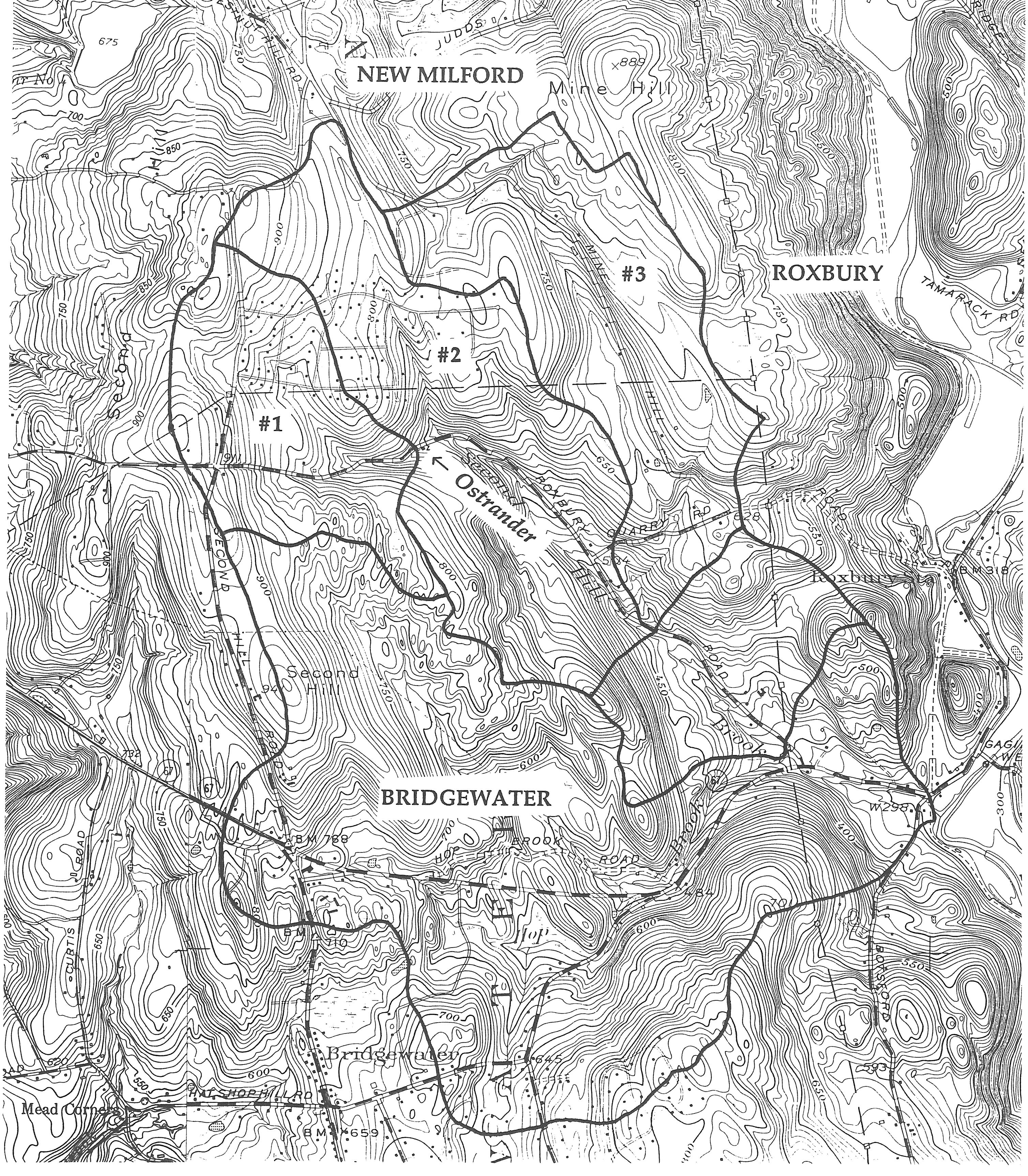

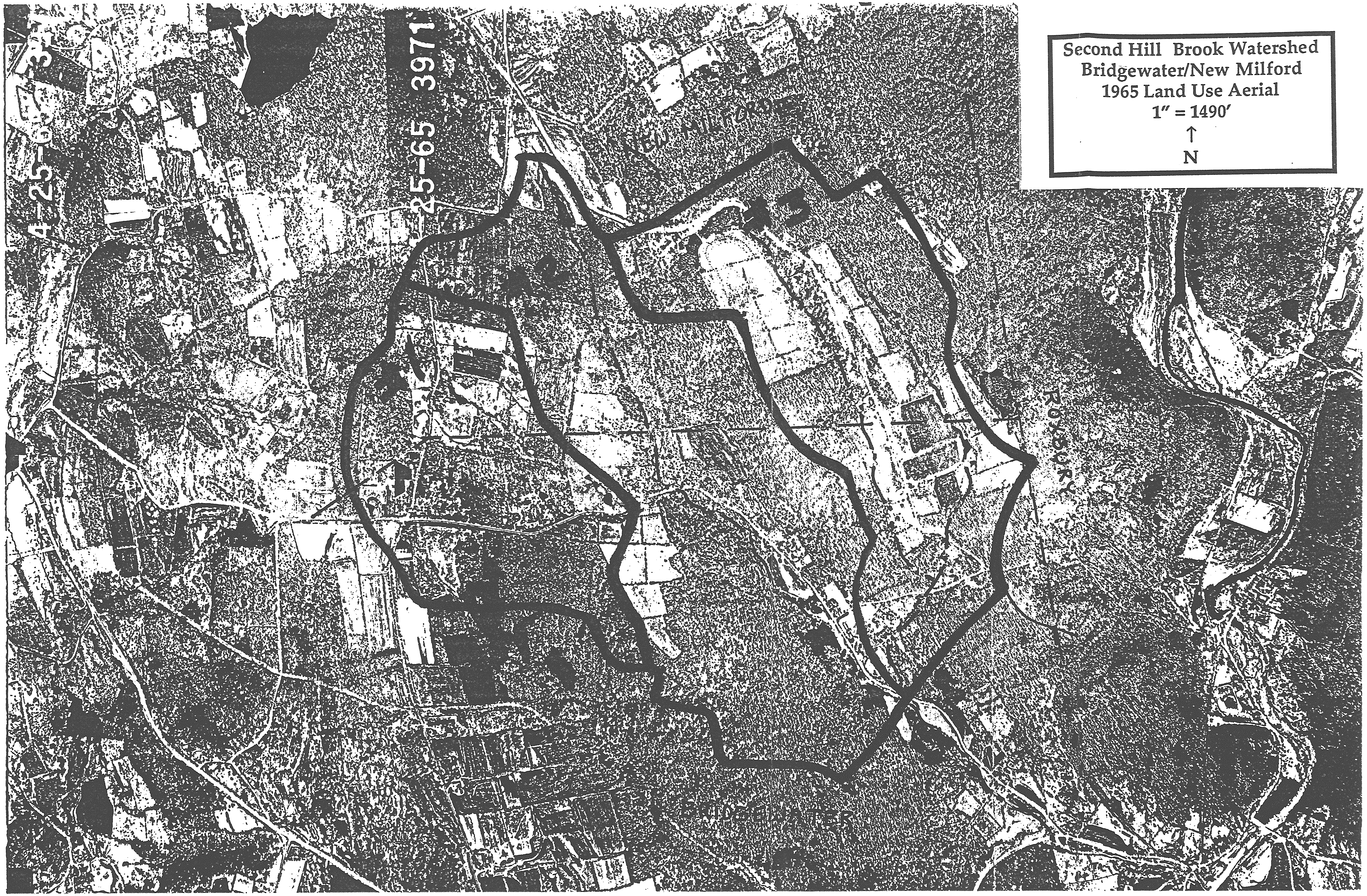

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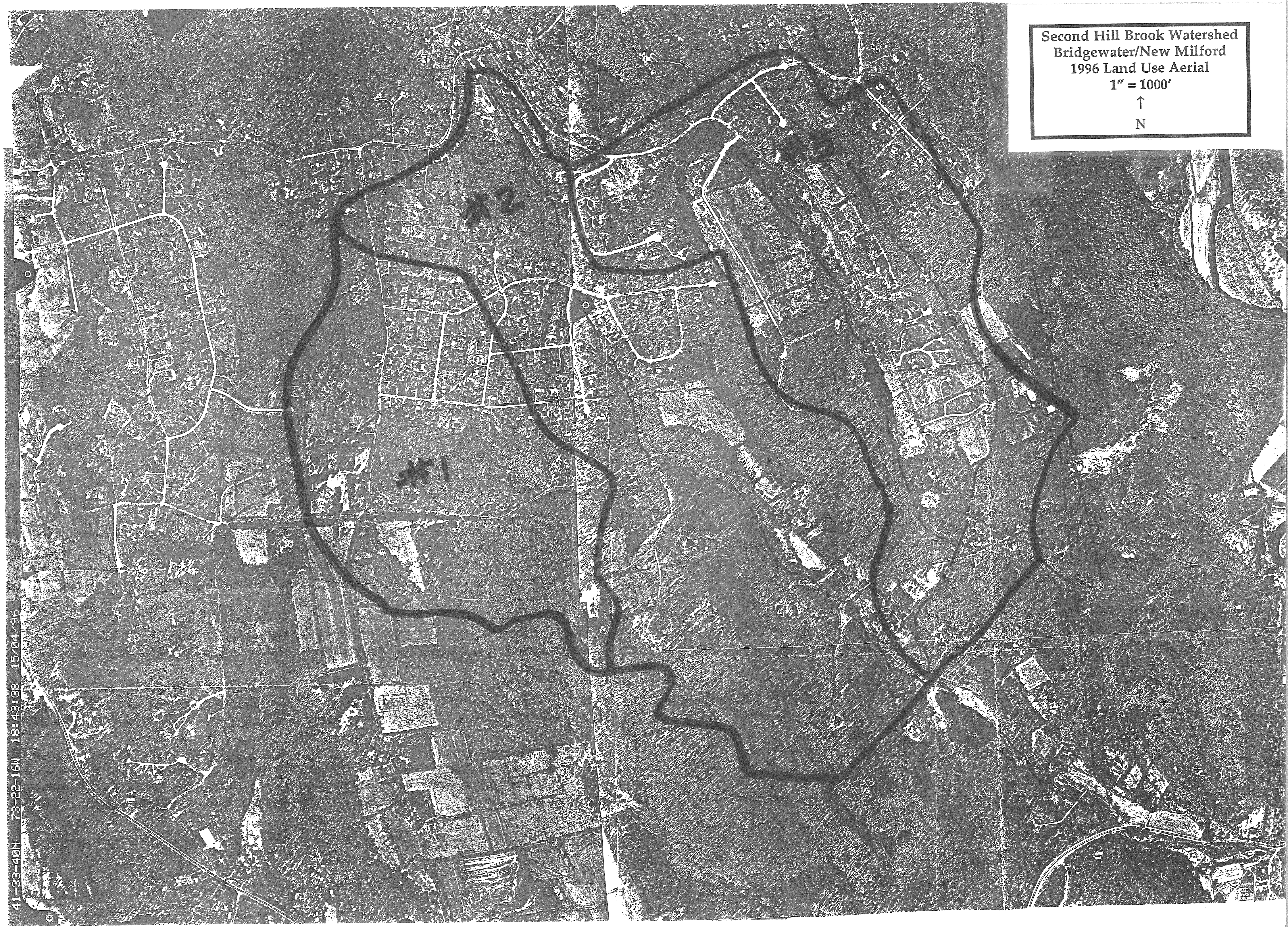
1965 FLIGHT OF NEW MILFORD AND BRIDGEWATER SECOND HILL BROOK
SCALE 1" = 1490 FT


Second Hill Brook Watershed
Bridgewater/New Milford
1996 Land Use Aerial
1″ = 1000′
N
#1
#2
#3
41-33-40N 73-22-16W 18:43:38 15/04/96

TR55 SECOND HILL BROOK WATERSHED - 1965

RUNOFF CURVE NUMBER COMPUTATION   Version 2.00

Project : BRIDGEWATER ERT   User: CEG   Date: 05-20-97
County : LITCHFIELD   State: CT   Checked: CEG   Date: 5/20/97
Subtitle: 1965 CONDITIONS
Subarea : 1

COVER DESCRIPTION			A	B	C	D
			Hydrologic Soil Group Percent (CN)			
CULTIVATED AGRICULTURAL LANDS						
Row crops	SR + Crop residue	good	-	-	5(82)	-
OTHER AGRICULTURAL LANDS						
Meadow -cont. grass (non grazed)		----	-	4(58)	10(71)	-
Woods		good	-	7(55)	70(70)	3(77)
Farmsteads		----	-	-	1(82)	-
Total Area (by Hydrologic Soil Group)				11	86	3

SUBAREA: 1   TOTAL DRAINAGE AREA: 100 Percent   WEIGHTED CURVE NUMBER: 70

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-20-97
County : LITCHFIELD State: CT Checked: CEG Date: 5/20/97
Subtitle: 1965 CONDITIONS
Subarea : 2

COVER DESCRIPTION		A	B	C	D
		Hydrologic Soil Group Percent (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Residential districts (by average lot size)	Avg % imperv				
1 acre	20	-	1(68)	-	-
CULTIVATED AGRICULTURAL LANDS					
Row crops Contoured (C)	good	-	-	7(82)	-
OTHER AGRICULTURAL LANDS					
Meadow -cont. grass (non grazed)	----	-	1(58)	11(71)	-
Woods	good	-	20(55)	60(70)	-
Total Area (by Hydrologic Soil Group)			22	78	
			====	====	

SUBAREA: 2 TOTAL DRAINAGE AREA: 100 Percent WEIGHTED CURVE NUMBER: 68

RUNOFF CURVE NUMBER COMPUTATION

Version 2.00

Project : BRIDGEWATER ERT — User: CEG — Date: 05-20-97
County : LITCHFIELD — State: CT — Checked: CEG — Date: 5/20/97
Subtitle: 1965 CONDITIONS
Subarea : 3

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Percent (CN)			
CULTIVATED AGRICULTURAL LANDS						
Row crops	Contoured (C)	good	-	-	5(82)	-
OTHER AGRICULTURAL LANDS						
Meadow -cont. grass (non grazed)		----	-	-	17(71)	-
Woods		good	2(30)	13(55)	63(70)	-
Total Area (by Hydrologic Soil Group)			2	13	85	

SUBAREA: 3 TOTAL DRAINAGE AREA: 100 Percent WEIGHTED CURVE NUMBER: 68

TIME OF CONCENTRATION AND TRAVEL TIME   Version 2.00

Project : BRIDGEWATER ERT   User: CEG   Date: 05-20-97

County : LITCHFIELD   State: CT   Checked: CEG   Date: 5/20/97

Subtitle: 1965 CONDITIONS

Subarea #1 - 1

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.1	I					0.446
Shallow Concent'd		1900	.076	U					0.119
Open Channel		1800	.047		.04	6	8.47		0.078
Open Channel		1000	.05		.04	10.5	10.7		0.034

Time of Concentration = 0.68*
=====

Subarea #2 - 2

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.047	H					0.346
Shallow Concent'd		2350	.055	U					0.173
Open Channel		2800	.064		.04	10.5	10.7		0.084
Open Channel		4500	.043		.04	20	14.9		0.133

Time of Concentration = 0.74*
=====

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Open Channel		4900	.043		.04	20	14.9		0.145

Travel Time = 0.14*
=====

Subarea #3 - 3

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.033	H					0.399
Shallow Concent'd		1850	.043	U					0.154
Open Channel		3500	.026		.04	10.5	10.7		0.164
Open Channel		4350	.053		.04	20	14.9		0.116

Time of Concentration = 0.83*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated ---
--- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-20-97
County : LITCHFIELD State: CT Checked: CEG Date: 5/20/97
Subtitle: 1965 CONDITIONS

Total watershed area: 1.928 sq mi Rainfall type: III Frequency: 10 years

	Subareas		
	1	2	3
Area(sq mi)	0.45	0.80	0.68
Rainfall(in)	4.7	4.7	4.7
Curve number	70*	68*	68*
Runoff(in)	1.82	1.67	1.67
Tc (hrs)	0.68*	0.74*	0.83*
(Used)	0.75	0.75	0.75
TimeToOutlet	0.14*	0.00	0.00
(Used)	0.10	0.00	0.00
Ia/P	0.18	0.20	0.20

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) 1	2	3
11.0	28	8	11	9
11.3	37	10	15	12
11.6	48	13	19	16
11.9	65	18	25	22
12.0	78	21	31	26
12.1	98	26	39	33
12.2	132	34	53	45
12.3	207	50	85	72
12.4	335	79	138	118
12.5	525	121	218	186
12.6	740	172	307	261
12.7	920	218	379	323
12.8	1020P	250	416P	354P
13.0	984	251P	396	337
13.2	770	202	307	261
13.4	572	151	227	194
13.6	434	114	173	147
13.8	346	90	138	118
14.0	291	74	117	100
14.3	240	60	97	83
14.6	207	52	84	71
15.0	179	44	73	62
15.5	157	39	64	54
16.0	138	34	56	48
16.5	118	29	48	41
17.0	101	25	41	35
17.5	91	22	37	32
18.0	81	20	33	28
19.0	66	16	27	23
20.0	58	14	24	20

22.0	49	12	20	17
26.0	0	0	0	0

P - Peak Flow   * - value(s) provided from TR-55 system routines

TR55 SECOND HILL BROOK WATERSHED - 1996

RUNOFF CURVE NUMBER COMPUTATION — Version 2.00

Project : BRIDGEWATER ERT — User: CEG — Date: 05-21-97

County : LITCHFIELD — State: CT — Checked: CEG — Date: 5/21/97

Subtitle: APRIL 15, 1996 CONDITIONS

Subarea : 1

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
		Percent (CN)			
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Residential districts	Avg % imperv				
(by average lot size)					
1 acre	20	-	5(68)	15(79)	-
OTHER AGRICULTURAL LANDS					
Meadow -cont. grass (non grazed)	----	-	-	4(71)	-
Woods	good	-	7(55)	66(70)	3(77)
Total Area (by Hydrologic Soil Group)			12	85	3

SUBAREA: 1 — TOTAL DRAINAGE AREA: 100 Percent — WEIGHTED CURVE NUMBER: 70

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-21-97
County : LITCHFIELD State: CT Checked: CEG Date: 5/21/97
Subtitle: APRIL 15, 1996 CONDITIONS
Subarea : 2

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Percent (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Residential districts (by average lot size)	Avg % imperv				
1 acre	20	-	1(68)	22(79)	-
OTHER AGRICULTURAL LANDS					
Meadow -cont. grass (non grazed)	----	-	1(58)	2(71)	-
Woods	good	-	20(55)	54(70)	-
Total Area (by Hydrologic Soil Group)			22 ====	78 ====	

SUBAREA: 2 TOTAL DRAINAGE AREA: 100 Percent WEIGHTED CURVE NUMBER: 69

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-21-97
County : LITCHFIELD State: CT Checked: CEG Date: 5/21/97
Subtitle: APRIL 15, 1996 CONDITIONS
Subarea : 3

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Percent (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Residential districts	Avg % imperv				
(by average lot size)					
1 acre	20	-	6(68)	7(79)	-
2 acre	12	-	-	12(77)	-
OTHER AGRICULTURAL LANDS					
Meadow -cont. grass (non grazed)	----	-	-	5(71)	-
Brush - brush, weed, grass mix	good	-	-	3(65)	-
Woods	good	2(30)	7(55)	58(70)	-
Total Area (by Hydrologic Soil Group)		2	13	85	
		====	====	====	

SUBAREA: 3 TOTAL DRAINAGE AREA: 100 Percent WEIGHTED CURVE NUMBER: 69

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-21-97

County : LITCHFIELD State: CT Checked: CEG Date: 5/21/97

Subtitle: APRIL 15, 1996 CONDITIONS

Subarea #1 - 1

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.1	I					0.446
Shallow Concent'd		1900	.076	U					0.119
Open Channel		1800	.047		.04	6	8.47		0.078
Open Channel		1000	.05		.04	10.5	10.7		0.034

Time of Concentration = 0.68*
=====

Subarea #2 - 2

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.047	H					0.346
Shallow Concent'd		2350	.055	U					0.173
Open Channel		2800	.064		.04	10.5	10.7		0.084
Open Channel		4500	.043		.04	20	14.9		0.133

Time of Concentration = 0.74*
=====

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Open Channel		4900	.043		.04	20	14.9		0.145

Travel Time = 0.14*
=====

Subarea #3 - 3

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	3.3	150	.033	H					0.399
Shallow Concent'd		1850	.043	U					0.154
Open Channel		3500	.026		.04	10.5	10.7		0.164
Open Channel		4350	.053		.04	20	14.9		0.116

Time of Concentration = 0.83*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated ---
--- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : BRIDGEWATER ERT User: CEG Date: 05-21-97
County : LITCHFIELD State: CT Checked: CEG Date: 5/21/97
Subtitle: APRIL 15, 1996 CONDITIONS

Total watershed area: 1.928 sq mi Rainfall type: III Frequency: 10 years

	Subareas		
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Area(sq mi)	0.45	0.80	0.68
Rainfall(in)	4.7	4.7	4.7
Curve number	70*	69*	69*
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Tc (hrs)	0.68*	0.74*	0.83*
(Used)	0.75	0.75	0.75
TimeToOutlet	0.14*	0.00	0.00
(Used)	0.10	0.00	0.00
Ia/P	0.18	0.19	0.19

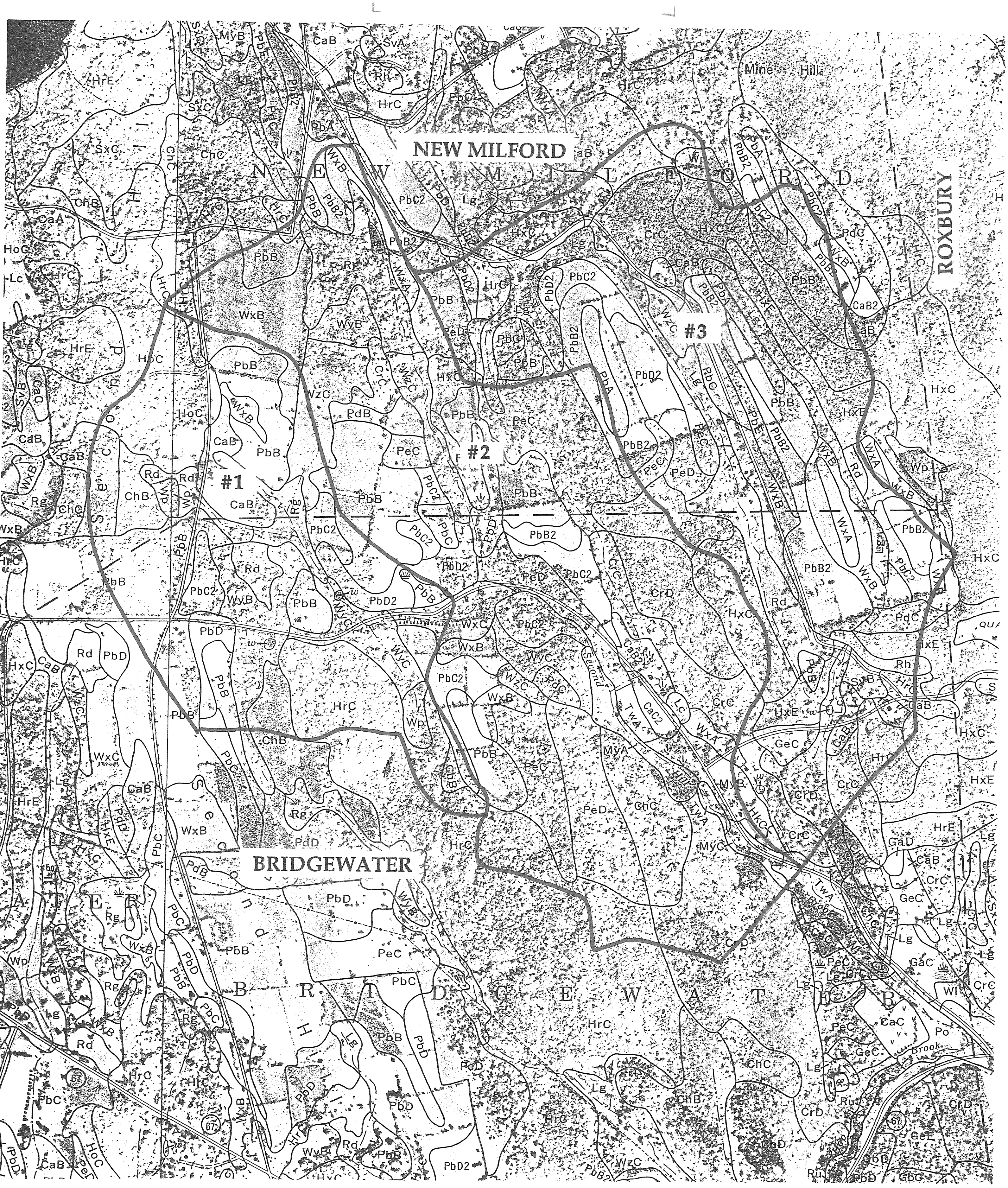
Time	Total	Subarea Contribution to Total Flow (cfs)		
(hr)	Flow	1	2	3
11.0	31	8	12	11
11.3	41	10	17	14
11.6	52	13	21	18
11.9	72	18	29	25
12.0	86	21	35	30
12.1	108	26	44	38
12.2	145	34	60	51
12.3	224	50	94	80
12.4	359	79	151	129
12.5	552	121	233	198
12.6	779	172	328	279
12.7	960	218	401	341
12.8	1062P	250	439P	373P
13.0	1022	251P	417	354
13.2	793	202	319	272
13.4	588	151	236	201
13.6	445	114	179	152
13.8	355	90	143	122
14.0	298	74	121	103
14.3	245	60	100	85
14.6	211	52	86	73
15.0	183	44	75	64
15.5	160	39	65	56
16.0	139	34	57	48
16.5	119	29	49	41
17.0	102	25	42	35
17.5	91	22	37	32
18.0	85	20	35	30
19.0	64	16	26	22
20.0	58	14	24	20

22.0	48	12	19	17
26.0	0	0	0	0

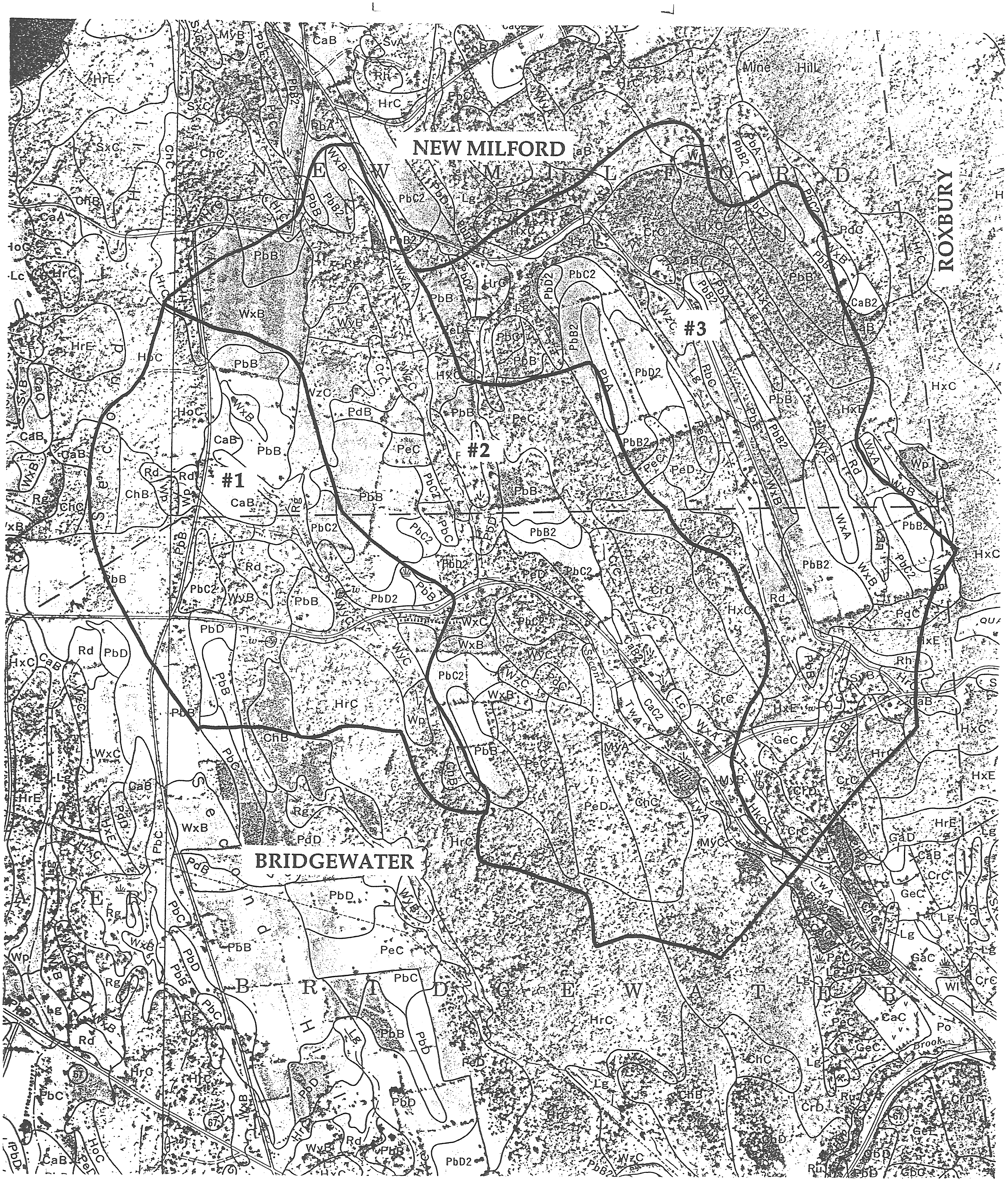
P - Peak Flow * - value(s) provided from TR-55 system routines

Scond Hill Brook Watershed
Bridgewater/New Milford
Soils Map
1" = 1320'

⇑



Scond Hill Brook Watershed
Bridgewater/New Milford
Soils Map
1″ = 1320′



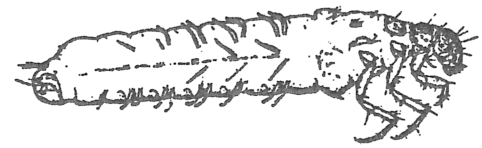
APPENDIX B

Second Hill Brook Fisheries Survey
Policy Statement - Riparian Corridor Protection
Position Statement - Utilization of 100 Buffer Zones to Protect Riparian Areas in Connecticut

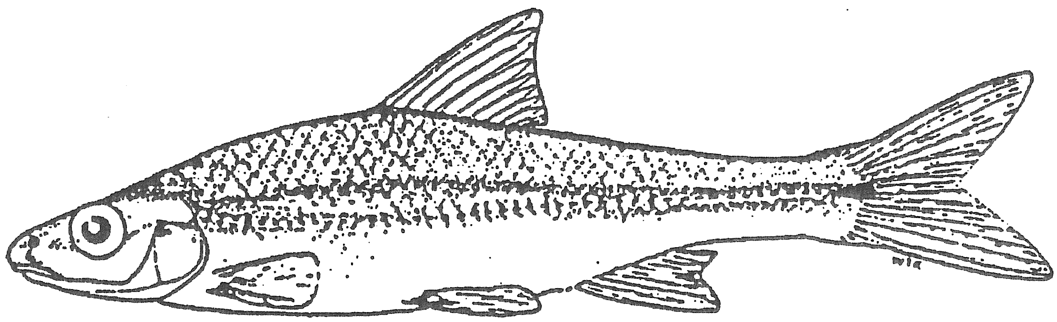
STATE OF CONNECTICUT
DEPARTMENT OF
ENVIRONMENTAL PROTECTION

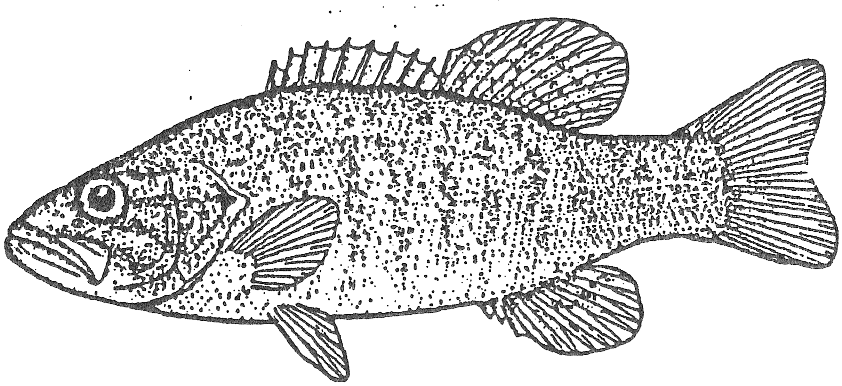
Timothy R.E. Keeney
Commissioner

Federal Aid to Sport Fish Restoration
F-66-R-4: Progress Report
April 1, 1991 - March 31, 1992



A Survey of Connecticut Streams and Rivers - Lower Housatonic River and Naugatuck River Drainages





By

Neal T. Hagstrom   Michael Humphreys   William A. Hyatt

Fisheries Division
Rm. 255, State Office Building, Hartford, CT 06106

STREAM NAME : **TRIB TO TRANSYLVANIA BROOK** SITE #: 3141

SITE DESCRIPTION: PARALLEL TO RTE 67, UPSTREAM FROM ROXBURY-WOODBURY TOWN LINE, ROXBURY.

SAMPLE LENGTH : 50. SAMPLE DATE: 07/30/1991

PHYSICAL			CHEMICAL	MEAN	STD
AIR TEMP. . . .	:20.00	(C)	DISSOLVED OXYGEN (mg/l). . :	9.50	0.10
WATER TEMP. . .	:16.00	(C)	pH . . . . :	7.10	0.00
VELOCITY. . . .	: 0.063	(m/s)	COND . . . . . (uS/cm3). . :	69.33	0.58
DISCHARGE . . .	: 0.008	(m3/s)	ALKALINITY .(mg CaCO3 eq/l):	10.53	0.46

	MEAN	STD	
WIDTH. . . . . :	2.82	1.75	(m)
DEPTH. . . . . :	5.05	4.26	(cm)

DOMINANT SUBSTRATE TYPE. . :	4		POOL/RIFFLE RATIO . .:	0.47
TYPE THREE SUBSTRATE . . . :	17.4	(%)	AIR/WATER TEMP. RATIO:	1.25
EMBEDDEDNESS OF TYPE THREE :	47.50	(%)		
OVERHEAD CANOPY. . . . . . :	1.00	(%)		
INSTREAM SHELTER . . . . . :	5.420	(m2)		

BIOLOGICAL

SPECIES	POPULATION SIZE (Number/ha)	STANDARD ERROR (Number/ha)
Salvelinus fontinalis	6808.	0.0
Rhinichthys atratulus	283.	0.0

STREAM NAME : **SECOND HILL BROOK** SITE #: 3142

SITE DESCRIPTION: 100 M DOWNSTREAM OF ROXBURY RD., BRIDGEWATER.

SAMPLE LENGTH : 50. SAMPLE DATE: 08/22/1991

PHYSICAL			CHEMICAL	MEAN	STD
AIR TEMP. . . .	:18.00	(C)	DISSOLVED OXYGEN (mg/l). . :	9.13	0.06
WATER TEMP. . .	:17.00	(C)	pH . . . . :		
VELOCITY. . . .	: 0.184	(m/s)	COND . . . . . (uS/cm3). . :	145.33	1.15
DISCHARGE . . .	: 0.045	(m3/s)	ALKALINITY .(mg CaCO3 eq/l):	42.63	0.21

	MEAN	STD	
WIDTH. . . . . :	2.59	0.73	(m)
DEPTH. . . . . :	9.93	9.87	(cm)

DOMINANT SUBSTRATE TYPE. . :	3		POOL/RIFFLE RATIO . .:	1.16
TYPE THREE SUBSTRATE . . . :	35.0	(%)	AIR/WATER TEMP. RATIO:	1.06
EMBEDDEDNESS OF TYPE THREE :	5.71	(%)		
OVERHEAD CANOPY. . . . . . :	1.00	(%)		
INSTREAM SHELTER . . . . . :	2.390	(m2)		

BIOLOGICAL

SPECIES	POPULATION SIZE (Number/ha)	STANDARD ERROR (Number/ha)
Salvelinus fontinalis	926.	0.0
Rhinichthys atratulus	154.	0.0
Unknown cyprinid	231.	0.0

DEPARTMENT OF ENVIRONMENTAL PROTECTION
INLAND FISHERIES DIVISION

POLICY STATEMENT
RIPARIAN CORRIDOR PROTECTION

I. INTRODUCTION, GOALS, AND OBJECTIVE

Alteration and exploitation of riparian corridors in Connecticut is a common event that significantly degrades stream water quality and quantity. Inasmuch as riparian ecosystems play a critical role in maintaining aquatic resource productivity and diversity, the Inland Fisheries Division (Division) recognizes that rigorous efforts are required to preserve, protect, and restore these valuable resources. Consequently, a riparian corridor protection policy has been developed to achieve the following goals and objective:

Goals

Maintain Biologically Diverse Stream and Riparian Ecosystems, and

Maintain and Improve Stream Water Quality and Water Quantity.

Objective

Establish Uniform Riparian Corridor Buffer Zone Guidelines.

II. DEFINITIONS

For the purpose of implementing a statewide riparian corridor protection policy, the following definitions are established:

Riparian Corridor: A land area contiguous with and parallel to an intermittent or perennial stream.

Buffer Zone: An undisturbed, naturally vegetated area adjacent to or contained within a riparian corridor that serves to attenuate the effects of development.

Perennial Stream: A stream that maintains a constant perceptible flow of water within its channel throughout the year.

Intermittent Stream: A stream that flows only in direct response to precipitation or which is seasonally dry.

III. RIPARIAN FUNCTION

Naturally vegetated riparian ecosystems perform a variety of unique functions essential to a healthy instream aquatic environment. The delineation and importance of riparian functions are herein described. Vegetated riparian ecosystems:

* Naturally filter sediments, nutrients, fertilizers, and other nonpoint source pollutants from overland runoff.

* Maintain stream water temperatures suitable for spawning, egg and fry incubation, and rearing of resident finfish.

* Stabilize stream banks and stream channels thereby reducing instream erosion and aquatic habitat degradation.

* Supply large woody debris to streams providing critical instream habitat features for aquatic organisms.

* Provide a substantial food source for aquatic insects which represent a significant proportion of food for resident finfish.

* Serve as a reservoir, storing surplus runoff for gradual release into streams during summer and early fall base flow periods.

IV. RIPARIAN CORRIDOR BUFFER ZONE GUIDELINES

Recognizing the critical roles of riparian corridors, the Division provides buffer zone guidelines that are designed to bring uniformity and consistency to environmental review. The guidelines are simple, effective, and easy to administer. The following standard setting procedure should be used to calculate buffer zone widths.

Perennial Stream: A buffer zone 100 feet in width should be maintained along each side.

Intermittent Stream: A buffer zone 50 feet in width should be maintained along each side.

Buffer zone boundaries should be measured from either, (1) edge of riparian inland wetland as determined by Connecticut inland wetland soil delineation methods or (2) in the absence of a riparian wetland, the edge of the stream bank based on bank–full flow conditions.

The riparian corridor buffer zone should be retained in a naturally vegetated and undisturbed condition. All activities that pose a significant pollution threat to the stream ecosystem should be prohibited.

Where the Division policy is not in consonance with local regulations and policies regarding riparian corridor buffer zone widths and allowable development uses within these areas, local authorities should be encouraged to adopt the more restrictive regulations and policies.

12/13/91
Date

James C. Moulton
Acting Director

POSITION STATEMENT
UTILIZATION OF 100 FOOT BUFFER ZONES TO PROTECT RIPARIAN AREAS
IN CONNECTICUT
BY

BRIAN D. MURPHY
TECHNICAL ASSISTANCE BIOLOGIST
INLAND FISHERIES DIVISION

I. INTRODUCTION

One tenet of the Inland Fisheries Division Policy on Riparian Corridor Protection is the utilization of a 100 foot buffer zone as a minimum setback along perennial streams. The adoption of such a policy is sure to be controversial. Laymen, developers and natural resource professionals alike will ask questions such as: Why was a standard setting method adopted? What's magical about 100 feet? Will 100 feet be sufficiently protective, or will it be overly protective? In response, this paper outlines the ramifications of adopting a riparian corridor policy including the use of a 100 foot buffer zone.

II. STANDARD SETTING VERSUS SITE SPECIFIC BUFFER ZONES

There are two approaches for determining buffer zone width; standard setting and site specific. Standard setting methods define an area extending from the streambank edge or highwater mark to some landward fixed point boundary. Site specific methods utilize formulas that incorporate and consider special site specific land characteristics, hence, the calculation of a variable width buffer zone. In both case, buffers are employed to define an area in which development is prohibited or limited.

A major advantage of standard setting methods is that they are easy to delineate and administer, thereby improving the consistency and quality of environmental assessments. Furthermore, valuable staff time would not be required to determine site specific buffer zones along each and every watercourse of concern.

The exact width of a buffer zone required for riparian corridor protection is widely disputed (Bottom et al. 1985 and Brinson et al. 1981). Buffer width recommendations found in the literature vary from as little as 25 feet to as great as 300 feet (Palfrey et al. 1982). The 100 foot buffer is widely accepted in Connecticut having been adopted by numerous inland wetland and conservation commissions as an appropriate minimum setback regulation for streambelts. In addition, Division staff have been recommending the utilization of the 100 foot buffer zone to protect streambelts since the early 1980's. Scientific research has not been generated to dispute the adequacy of utilizing 100 foot buffer zones to protect Connecticut's riparian corridors. In fact, to ensure that riparian functions are not significantly altered, recent scientific information points towards maintaining buffer zones that would be at a minimum, 100 feet in width (see section III).

Site specific methods define buffer widths according to the character and sensitivity of adjacent streamside lands. These buffer widths, also referred to as "floating buffers," consider physical site characteristics such as slope, soil type, and vegetative cover. The advantage of site specific methods is that buffer widths are designed using site characteristics and not an arbitrary predetermined width. Unfortunately, there is no "one" universally accepted formula or model and none have been developed for use in Connecticut. Most formulas are based on the degree to which sediment can be removed or filtered by natural vegetation, thus, the primary useage is sediment control. Other weaknesses of site specific techniques are (1) all areas must be evaluated on a case-by case basis and, (2) the subjectivity of different techniques (i.e. if the evaluation technique is inadequate, the buffer width will also be inadequate).

Additionally, these formulas only concentrate on one specific riparian function at a time and do not take into account multiple riparian functions, especially those of inland fisheries values as discussed in Section III. Consequently, site specific formulas approach riparian function on a single dimension rather than taking a more realistic, holistic approach.

In the absence of a scientific model to determine buffer widths suitable to protect Connecticut's riparian corridors, the utilization of a standard setting method is environmentally and politically prudent.

III. RIPARIAN FUNCTION

To assess the efficacy of a 100 foot buffer zone, the literature was searched to identify studies which have applied a quantitative approach to buffer width determination. Literature was searched for studies which both support and dispute the 100 foot zone. The following is a summary "by riparian function" of quantitative studies which assess buffer widths.

Sediment Control

Width, slope and vegetation have been cited as important factors in determining effectiveness of buffer zones as sediment filters (Karr and Schlosser 1977). Wong and McCuen (1981), who developed and applied a mathematical model to a 47 acre watershed, found that a 150 foot zone along a 3% slope reduced sediment transport to streams by 90%. Mannering and Johnson (1974) passed sediment laden water through a 49.2 foot strip of bluegrass and found that 54% of sediment was removed from the water. Trimble and Sartz (1957) developed recommendations as to width of buffer areas between logging roads and streams to reduce sediment load. They determined a minimum strip of 50 feet was required on level land with the width increasing 4 feet for each 1% slope increase. Buffer widths as determined by Trimble and Sartz (1957) have been characterized as evaluated guesses rather than empirically defined widths (Karr and Schlosser 1977). Rodgers et al. (1976) state that slopes greater than 10% are too steep to allow any significant detention of runoff and sediment regardless of buffer width. After a critical review of the literature, Karr and Schlosser (1977) determined that the size and type of vegetative buffer strip needed to remove a given fraction of the overland sediment load cannot be universally quantified. Existing literature does suggest that 100 foot riparian buffers will assist with sediment entrapment, although efficacy will vary according to site conditions.

Temperature Control

Brown and Brazier (1973) evaluated the efficacy of buffer widths required to ameliorate stream water temperature change. They concluded that angular canopy density (ACD), a measure of the ability of vegetation to provide shading, is the only buffer area parameter correlated with temperature control. Results show that maximum angular canopy density or maximum shading ability is reached within a width of 80 feet. Study sites were 9 small mountain streams in Oregon that contained a conifer riparian vegetative complex. Whether or not maximum angular canopy density is reached within 80 feet in a typical Connecticut deciduous forest riparian zone is doubtful. Tree height in Connecticut riparian zones is smaller than in Oregon (Scarpino, personal communication), therefore buffers greater than 80 feet in width would be required for temperature maintenance in Connecticut.

Nutrient Removal

Nutrient enrichment is caused by phosphorous and nitrogen transport from, among other things, fertilized lands and underground septic systems. Most research on nutrient enrichment has focused on overland surface flow. Karr and Schlosser (1977) report that 88% of all nitrogen and 96% of all phosphorous reaching watercourses in "agricultural watersheds" were found to be attached to sediment particles; thus, successful nutrient removal can be accomplished through successful sediment removal. There are conflicting reports on the ability of buffer widths to remove nutrients with most research being tested on grass plots. Butler et al. (1974) as cited by Karr and Schlosser (1977) found that a 150 foot buffer width of reed canary grass with a 6% slope caused reductions in phosphate and nitrate concentrations of between 0–20%. Wilson and Lehman (1966) as cited by Karr and Schlosser (1977) in a study of effluent applied to 300 m grass plots found that nitrogen and phosphorous concentrations were reduced 4 and 6%, respectively. Studies on subsurface runoff as cited in Clark (1977) found high concentrations of nitrates at 100 feet from septic systems with unacceptable levels at 150 feet. Clark (1977) recommended that a 300 foot setback be used whenever possible, with a 150 setback considered adequate to avoid nitrate pollution. Environmental Perspective Newsletter (1991) states that experts who commonly work with the 100 foot buffer zone set by the Massachusetts Wetlands Protection Act are increasingly finding that it is insufficient since many pollutants routinely travel distances far greater than 100 feet with nitrate–nitrogen derived from septic systems moving distances of greater than 1000 feet. Research indicates that the adoption of 100 foot buffer widths for Connecticut riparian zones will assist with the nutrient assimilation; albeit, complete removal of all nutrients may not be achieved.

Large Woody Debris

The input of large woody debris (LWD) to streams from riparian zones, defined as fallen trees greater than 3 m in length and 10 cm in diameter has been recently heralded as extremely critical to stream habitat diversity as well as stream channel maintenance. Research on large woody debris input has mainly been accomplished in the Pacific Northwest in relation to timber harvests. Murphy and Koski (1989) in a study of seven Alaskan watersheds determined that almost all (99%) identified sources of LWD were within 100 feet of the streambank. Bottom et al. 1983 as cited by Budd et al. (1987) confirm that in Oregon most woody structure in streams is derived from within 100 feet of the bank. Based on research done within old–growth forests, the Alaska region of the National Marine Fisheries Service, recognizing the importance of LWD to salmonid habitat, issued a policy statement in 1988 advocating the protection of riparian habitat through the retention of buffer strips not less than 100 feet in width (Murphy and Koski 1989). All research findings support the use of a 100 foot buffer zone in Connecticut for large woody debris input.

Food Supply

Erman et al. (1977) conducted an evaluation of logging impacts and subsequent sediment input to 62 streams in California. Benthic invertebrate populations (the primary food source of stream fishes) in streams with no riparian buffer strips were compared to populations in streams with buffer widths of up to 100 feet. Results showed that buffer strips less than 100 feet in width were ineffective as protective measures for invertebrate populations since sediment input reduced overall diversity of benthic invertebrates. Buffer strips greater than 100 feet in width afforded protection equivalent to conditions observed in unlogged streams. The ultimate significance of these findings is that fish growth and survival may be directly impacted along streams with inadequate sized riparian buffer zones. All research supports the feasibility of implementing a 100 foot buffer zone in Connecticut to maintain aquatic food supplies.

Streamflow Maintenance

The importance of riparian ecosystems in terms of streamflow maintenance has been widely recognized (Bottom et al. 1985). In Connecticut, riparian zones comprised of wetlands are of major importance in the hydrologic regime. Riparian wetlands store surplus flood waters thus dampening stream discharge fluctuations. Peak flood flows are then gradually released reducing the severity of downstream flooding. Some riparian wetlands also act as important groundwater discharge or recharge areas. Groundwater discharge to streams during drier seasonal conditions is termed low flow augmentation. The survival of fish communities, especially coldwater salmonid populations is highly dependent upon low flow augmentation (Bottom et al. 1985). Research, although documenting the importance of riparian zones as areas critical to streamflow maintenance, has not investigated specific riparian buffer widths required to provide the most effective storage and release of stream flows.

IV. OTHER POLICY CONSIDERATIONS

Measurement Determination

The proposed policy states that buffer zone boundaries should be measured from either the edge of the riparian inland wetland as determined by Connecticut inland wetland soil delineation methods or in the absence of a riparian wetland, the edge of the streambank based on bank-full flow conditions. This boundary demarcation is absolutely necessary to ensure that all riparian wetlands are protected. For example, if all measurements were to start from the perennial stream edge and extend landward for a distance of 100 feet, many riparian zones that contain expansive wetlands greater than 100 feet in width would be left unprotected.

Also, since boundary demarcation includes wetland delineation, the ultimate width of the buffer will vary according to site specific features. Consequently, buffer width determination as stated by Division policy is a "hybridization" of both standard setting and site specific methods. This hybridization of methods is advantageous since it acknowledges the sensitivity of streamside wetlands.

Home Rule

Where the Division policy is not in consonance with local regulations and policies regarding riparian corridor buffer zone widths, local authorities would be encouraged to adopt the more restrictive regulations and policies. This feature incorporates flexibility to acknowledge the importance of local "home rule" regulations or policies already in accepted practice. Conversely, towns and cities without accepted policies and regulations could choose to enact the Division policy.

Allowable Uses in Buffer Zones

The Division policy states that "the riparian corridor buffer zone should be retained in a naturally vegetated and undisturbed condition and that all activities that pose a significant pollution threat to the stream ecosystem should be prohibited." In essence, the buffer zone becomes an area where no development should be allowed. For this policy to be effective, there should be no exceptions, a blanket restriction of all uses would be recommended. Further clarification and more precise definitions of allowable uses will, however, be required in the future if the policy evolves into a departmental regulation.

Recently, the Connecticut Supreme Court has ruled that local agencies can prohibit specific development within buffer zones. The *Lizotte v. Conservation Commission of the Town of Somers, 216 Conn.320 (1990)* decision ruled that the construction or maintenance of any septic system, tank, leach field, dry well, chemical waste disposal system, manure storage area or other pollution source within 150 feet of the nearest edge of a watercourse or inland wetland's seasonal high water level can be prohibited (Wetlands Watch 1990). If this decision is a precursor of the future, Connecticut courts will continue to the support the use of buffers, especially those which restrict or prohibit detrimental activities.

V. CONCLUSIONS

The following actions are required to preserve, protect, and restore Connecticut's riparian corridors:

1. The Inland Fisheries Division needs to adopt and implement the proposed policy so that staff can use it as a guideline to assist cities, towns, developers and private landowners with making sound land use decisions. This policy will act to solidify a collective position concerning riparian corridor protection.

2. While the proposed policy in its "current form," represents a recommendation from the CTDEP Inland Fisheries Division, the ultimate goal of the Division should be to progressively implement this policy as either a CTDEP regulation or State of Connecticut statute.

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ABOUT THE TEAM

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state and regional agencies. Specialists on the Team include geologists, biologists, soil scientists, foresters, climatologists and landscape architects, recreational specialists, engineers and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC&D) Area - an 83 town area serving western Connecticut.

As a public service activity, the Team is available to serve towns within the King's Mark RC&D Area - **free of charge.**

Purpose of the Environmental Review Team

The Environmental Review Team is available to assist towns in the review of sites proposed for major land use activities or natural resource inventories for critical areas. For example, the ERT has been involved in the review of a wide range of significant land use activities including subdivisions, sanitary landfills, commercial and industrial developments and recreation/open space projects.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision making. This is done through identifying the natural resource base of the site and highlighting opportunities and limitations for the proposed land use.

Requesting an Environmental Review

Environmental reviews may be requested by the chief elected official of a municipality or the chairman of an administrative agency such as planning and zoning, conservation or inland wetlands. Environmental Review Request Forms are available at your local Soil and Water Conservation District and through the King's Mark ERT Coordinator. This request form must include a summary of the proposed project, a location map of the project site, written permission from the landowner/developer allowing the Team to enter the property for the purposes of a review and a statement identifying the specific areas of concern the Team members should investigate. When this request is reviewed by the local Soil and Water Conservation District and approved by the King's Mark RC&D Executive Council, the Team will undertake the review. At present, the ERT can undertake approximately two reviews per month depending on scheduling and Team member availability.

For additional information regarding the Environmental Review Team, please contact the King's Mark ERT Coordinator, Connecticut Environmental Review Team, P.O. Box 70, Haddam, CT 06438. The telephone number is 860-345-3977.