Millstone River Watershed

Flood Damage and Mitigation Analysis Report

Hurricane Floyd Flooding, September 17, 1999
Griggstown Causeway Looking Toward the Millstone River with Muletenders' Barracks on right

USDA Natural Resources Conservation Service
Assisting
Hunterdon County
Mercer County
Middlesex County
Monmouth County
Somerset County
and
Respective Soil Conservation Districts

December 2004

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Mission Statement

The Natural Resources Conservation Service provides leadership in a partnership effort to help people to conserve, maintain, and improve our natural resources and environment.

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Gregory J. Westfall
Water Resource Planner

EXECUTIVE SUMMARY

Flooding has been a natural phenomenon in the Millstone River valley for many years. U.S. Geological Survey (U.S.G.S.) hydrologic data indicate that major floods occurred in 1936, 1938, 1948, 1955, 1960, 1961,1971, January 1996, October 1996, September 1999 for the lower Millstone River valley, from Princeton and South Brunswick Townships and Rocky Hill Borough through Franklin, Montgomery and Hillsborough Townships including Millstone and Manville Boroughs. The three largest floods on the Millstone River prior to 1921, when the Blackwell Mills gage station records begin, were 1810, 1882 and 1896 (Ross, 1969). Historical accounts (1896 State Geologist Annual Report) show that the flood of 1882 was the largest known flood to have occurred prior to 1962 (Thomas, 1962). The USGS stream gage station located at Blackwells Mills shows that the top ten recorded flows since 1921 have occurred in 1938, 1946, 1949, 1971, 1978, 1979, 1994, 1996, 1997, and 1999.

The September 16-17, 1999 Tropical Storm Floyd flood event was the largest flood of record in many locations here and elsewhere in New Jersey. Damages, due to Floyd, in Manville, Zarephath (Franklin Township) and Millstone Borough, the top three damage centers, have been estimated to be over $200 million (Economic Development Administration, 2000).

Following Tropical Storm Floyd (September 16-17, 1999) and its associated flooding, the Natural Resources Conservation Service (NRCS) was contacted by then-Congressman Robert Franks and Congressman Rush Holt regarding the use of the PL83-566 Program to develop a watershed plan to reduce future flood losses in the Millstone River watershed. In early 2000, the Millstone River Watershed Steering Committee, made up of representatives of five counties and numerous municipalities, was formed.

The Committee identified seven objectives for the watershed planning effort with flood damage reduction being the top priority. The Committee directed NRCS to identify the location, type and extent of flood damages from the Tropical Storm Floyd event and other historical flood events. Based on interviews of municipal officials and data from the National Flood Insurance Program flood claims, the Committee identified two priority study areas in the watershed. These areas were the lower Millstone River corridor in Manville, Franklin, Hillsborough, Millstone, Montgomery, Princeton, Rocky Hill and South Brunswick and the Harrys Brook watershed in Princeton Township. It was determined that further study will be made on the Harrys Brook watershed. The Lower Millstone River corridor high priority area is the focus of this report
In a relatively unique partnership effort, the Corps of Engineers and the NRCS agreed that the Corps would conduct a Flood Control Feasibility Study for Manville while NRCS would conduct a study of flooding and potential solutions in the upstream municipalities.

The Steering Committee and its Technical Advisory Committee identified a number of flood mitigation measures to be studied by NRCS. NRCS analyzed flood water storage at 26 sites throughout the watershed and levees at four locations in the Lower Millstone River high priority area. These locations were in Hillsborough Township, Millstone Borough, East Millstone and Griggstown in Franklin Township. Both the flood water storage and levee measures were found not to meet the benefit cost test required of all Federally-assisted flood damage reduction projects. Other alternatives -- structure elevation, relocation, floodproofing and buyouts --were evaluated in

Millstone Borough where the greatest density of potentially benefiting structures exist in the high priority flood area. Those measures were not found to be cost effective.

Proposed alternatives were found to be too costly for the benefits that would be achieved in terms of reduced flood damages to residential and commercial structures. Federal agencies, including NRCS, are required to show that benefits exceed costs for a recommended alternative for flood mitigation. In summary, the NRCS discontinued watershed planning for flood mitigation measures in the watershed since the benefits of implementing change to reduce flood losses did not exceed the costs for any of the implementation strategies.

The following recommendations were made by the Steering Committee to further pursue the opportunities for potential flood damage reduction:

The affected municipalities should apply for assistance under the Federal Emergency Management Agency (FEMA) Flood Mitigation Assistance (FMA) Program available through the New Jersey State Office of Emergency Management. The FEMA FMA is designed to reduce the number of repetitive flood loss claims in the National Flood Insurance Program (NFIP). Following completion of a Flood Mitigation Plan, the municipality becomes eligible to receive project funding to elevate, relocate or remove (buyout) structures that have repetitive flood loss claims. NRCS assisted Franklin Township in completing a Flood Mitigation Plan in 2003. Montgomery and Princeton Townships are currently being assisted by NRCS in developing Flood Mitigation Plans. Millstone Borough is considering a proposal from NRCS to develop a Flood Mitigation Plan.

The US Army Corps of Engineers (US ACOE) is currently conducting the Millstone River Basin Flood Damage Reduction Study. In lieu of following the above recommendation, the Corps Study could be expanded to include other municipalities above recommendations regard assistance available through Federal agencies including NRCS, FEMA and USACOE.

In addition to the above recommendations, the municipalities uld explore alternative approaches to use funding available from State, county or local sources. A recently approved state bond issue may provide funding for flood control activities. Also, the State of New Jersey Environmental Trust Fund may be able to provide low interest loans to assist in this endeavor.

It is recommended that, individually or collectively, the seven municipalities participate and implement activities under the Community Rating System (CRS). Currently none of the Millstone River valley municipalities of Franklin, Hillsborough, Montgomery, Princeton, and South Brunswick Townships and Millstone and Rocky Hill Boroughs participate in the CRS. The Community Rating System, similar to fire hazard rating that impacts homeowner insurance rates, promotes activities including public information, mapping and regulation, flood damage reduction and flood preparedness. These activities increase public safety, reduce flood losses and the cost of flood insurance and avoid economic disruption. Discounts on flood insurance due to these activities range from 5-25% for property owners in flood-prone areas.

INTRODUCTION

The Millstone River Watershed has been the scene of chronic flooding over the last 100 years or more of record keeping. Following Hurricane Floyd (September 16-17, 1999) and its associated flooding, the Natural Resources Conservation Service (NRCS) was contacted by then-Congressman Robert Franks and Congressman Rush Holt regarding the use of the PL83-566 Program to develop a watershed plan to reduce future flood losses in the Millstone River watershed.

WATERSHED SETTING

The Millstone River Watershed is located in central New Jersey and drains approximately 184,300 acres or 288 square miles (Figure 1). The watershed includes portions of five counties: Hunterdon, Mercer, Middlesex, Monmouth and Somerset. It also includes all or portions of 26 municipalities (Figure 2). Trenton, New Jersey is located approximately five miles southwest of the watershed and New Brunswick, New Jersey is located adjacent to the northeastern portion of the watershed.

The Millstone River watershed is part of the Raritan River Basin. It includes Hydrologic Units 02030105090, 02030105100 and 02030105110, as defined by the U.S. Water Resources Council. The watershed is y-shaped and drains to the Raritan River.

The Millstone River originates in Millstone Township, Monmouth County. The major tributaries of the Millstone River include Stony Brook, Beden Brook, Rocky Brook, Cranbury Brook, Shallow Brook, Cedar Brook, Devils Brook, Heathcote Brook, Simonson Brook, Ten Mile Run, and Six Mile Run. Stream elevations vary from 400 feet at the headwaters to 20 feet at the confluence of the Millstone and Raritan Rivers.

The general topography of the watershed ranges from steep in the along the northwestern portions (Sourland Mountains) and in the southeastern portions to relatively gently rolling in the mid-portion.

The watershed lies in the Piedmont and Coastal Plain physiographic provinces of New Jersey (Figure 3). The northwestern portion of the watershed is in the Piedmont and the southeastern portion of the watershed is in the Coastal Plain. The Millstone River rises in and flows through the Coastal Plain area which is characterized in this region by level to gently rolling topography. The underlying geological formations (Figure 4) in the Coastal Plain are chiefly unconsolidated and nearly horizontal beds of sand, silt, clays, and glauconite accumulated by sedimentation in water. The Piedmont Plateau has topography that is rolling to hilly, resulting in streams of high gradients that in places have narrow, steep-sided rock controlled channels. Narrow trap rock and sandstone ridges alternate with broader shale valleys generally extending northeast-southwest. The underlying rock formations of the Piedmont Plateau are soft red shales, sandy shales, red or gray massive argillite, thicker bedded harder shale, deeply weathered sandstone, and moderately coarse intrusive diabase with metamorphosed shale borders (SCS, 1952).

The headwaters of the Millstone River lie in the Coastal Plain and are dominated by deep, permeable, sandy loam or fine sandy loam soils (Figure 5) derived from unconsolidated sands, silts and clays. The largest part of the drainage area below the headwaters is composed of similarly textured soils that are underlain by more sandy materials. The sandy nature of the soils permits rapid infiltration of water. This factor, plus other favorable conditions for water retention, results in low surface runoff. A majority of the soils in the Stony Brook and other Piedmont Plateau streams have silt loam surfaces, with heavier silt loam or silty clay loam subsoils. A considerable portion of the soils are only 10-20 inches deep over bedrock. Most of the deep soils are compact in the substratum. In general, the result is a moist, cold land, crossed at varied intervals by narrow, shallow, shaly ridges. Runoff is notably high, sheet erosion is intensive and soil wetness is a general problem.

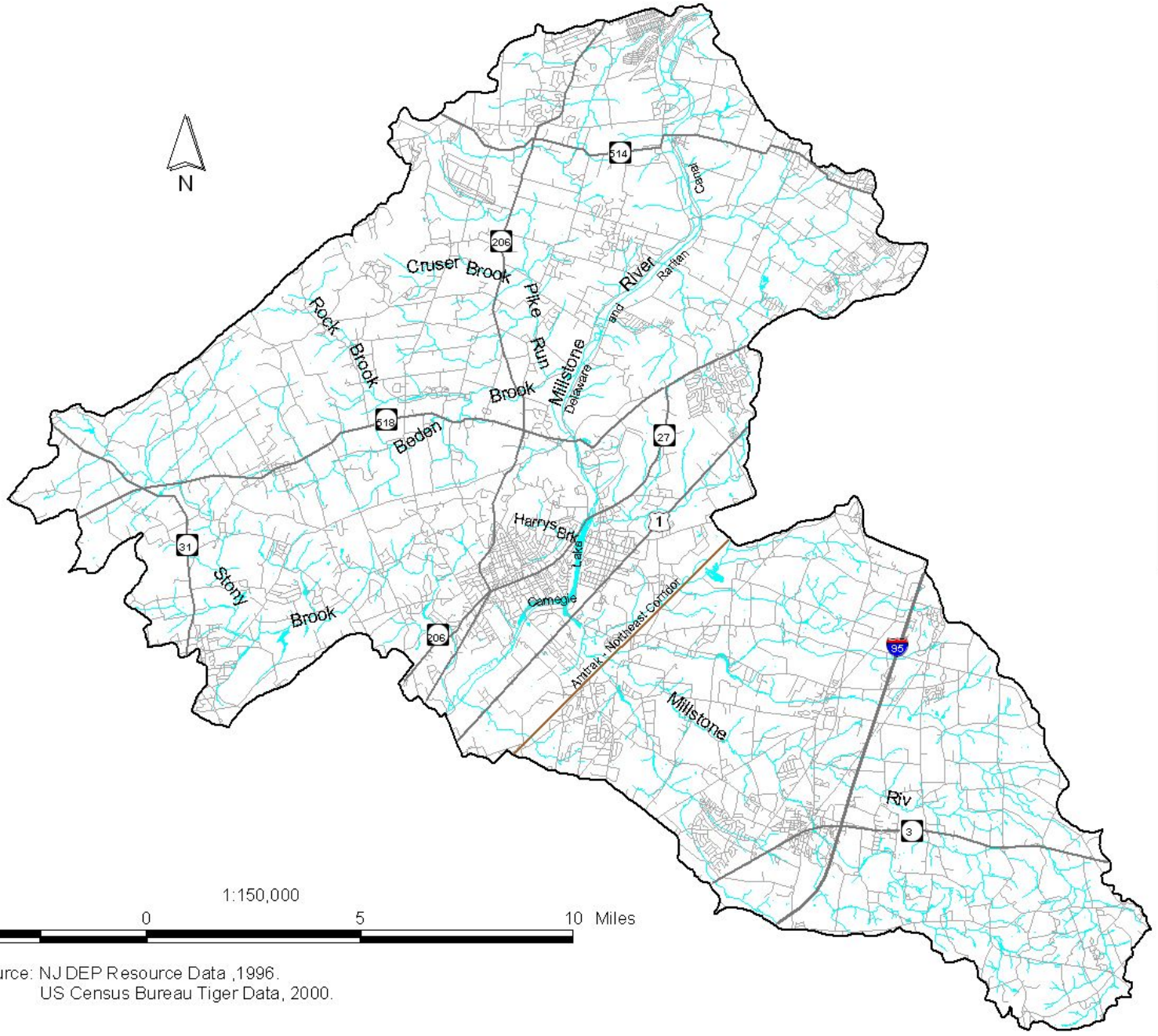
The climate is humid, temperate; and influenced considerably by the ocean. Summers are hot and humid while winters are cool. In winter the average temperature is 33 degrees F. In summer the average temperature is 73 degrees F. The average annual precipitation is about 45 inches, distributed evenly throughout the year. Mean monthly temperatures range from 31 degrees F in January to 85 degrees F in July. The frost-free period averages 166 days from April to October. The watershed is subject to periodic coastal storms, including tropical hurricanes that move up the Atlantic Coast.

There are a number of water bodies within the watershed. Many of these water bodies were originally developed for water power in association with a mill. Water bodies (with their surface areas in parentheses) include: Carnegie Lake (222 acres), Curlis Lake (125 acres), Rosedale Lake (38 acres), Grovers Mill Pond (30 acres), Honey Lake (28 acres), Etra Lake (19 acres), Plainsboro Pond (18 acres), Peddie and Perrineville Lakes (16 acres), Anderson Pond and Brainard Lake(15 acres), Bridgepoint Pond (12 acres) and Sylvan Lake (6 acres). Additionally, a major portion of the 58 mile long Delaware and Raritan Canal traverses the watershed from south to north. Carnegie Lake, built in 1907, is used for recreation and Princeton University crew racing. Rosedale, Honey and Curlis Lakes, constructed as part of the NRCS Stony Brook Watershed Plan, are used for sediment control, public recreation and fish and wildlife. Grovers Mill Pond, Etra Lake, Plainsboro Pond, Peddie Lake, Perrineville Lake, Brainard Lake, Bridgepoint Pond and Sylvan Lake are publicly accessible through adjacent parks.

Land use within the watershed has and continues to undergo significant change. Agricultural and forestland is being rapidly converted to residential, commercial, industrial and transportation uses (Table 1). The Route 1 Corridor, part of the Boston-Washington axis, and the Northeast Corridor Railway cut through the watershed in a northeast-southwest alignment.

Figure 1

Millstone River Watershed Map



KEY

- watershed boundary
- roads
- major roads
- railroads
- lakes and reservoirs
- streams

Data Source: NJ DEP Resource Data ,1996.
US Census Bureau Tiger Data, 2000.

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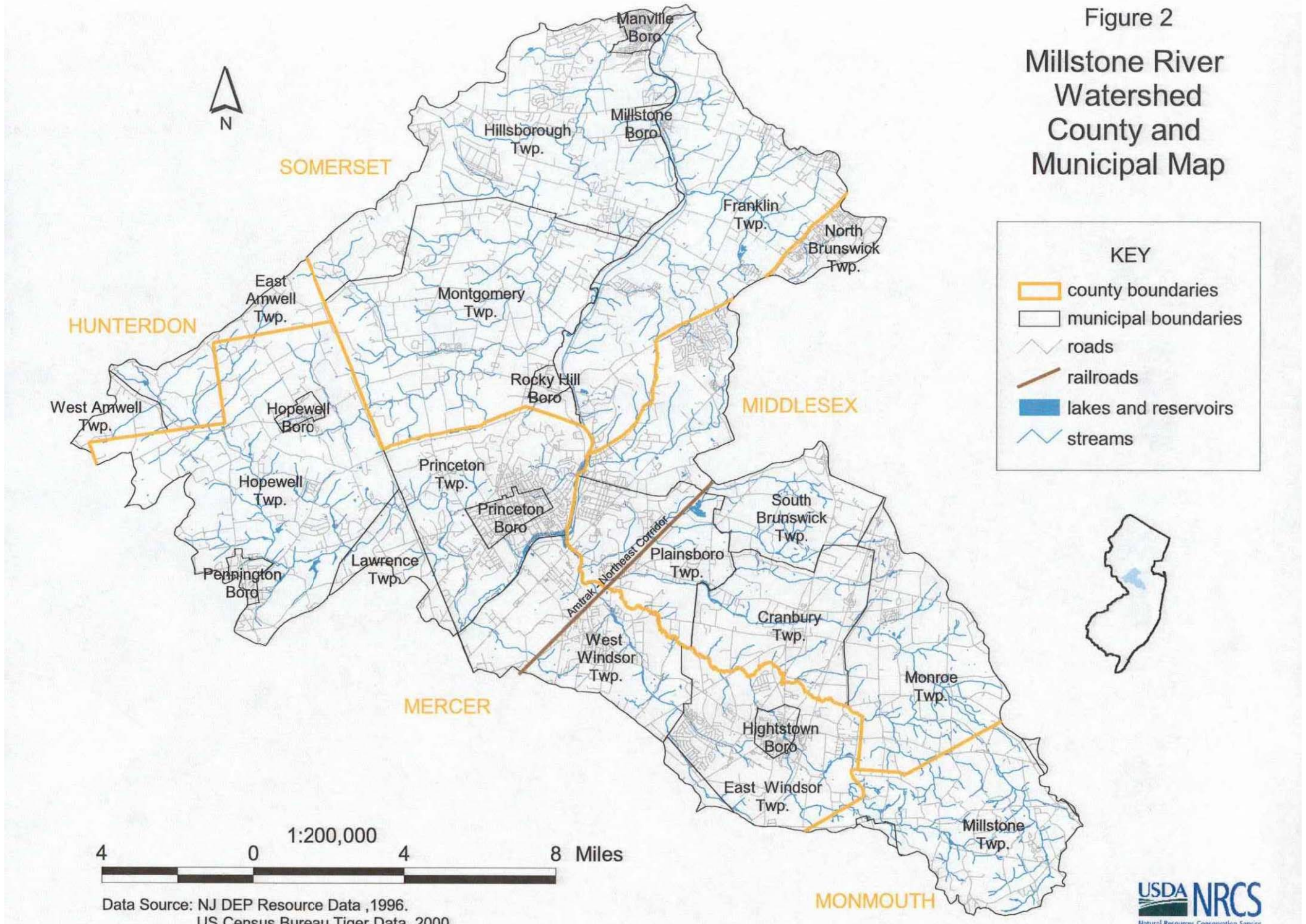
Figure 2

Millstone River Watershed County and Municipal Map



Data Source: NJ DEP Resource Data ,1996.
US Census Bureau Tiger Data, 2000.

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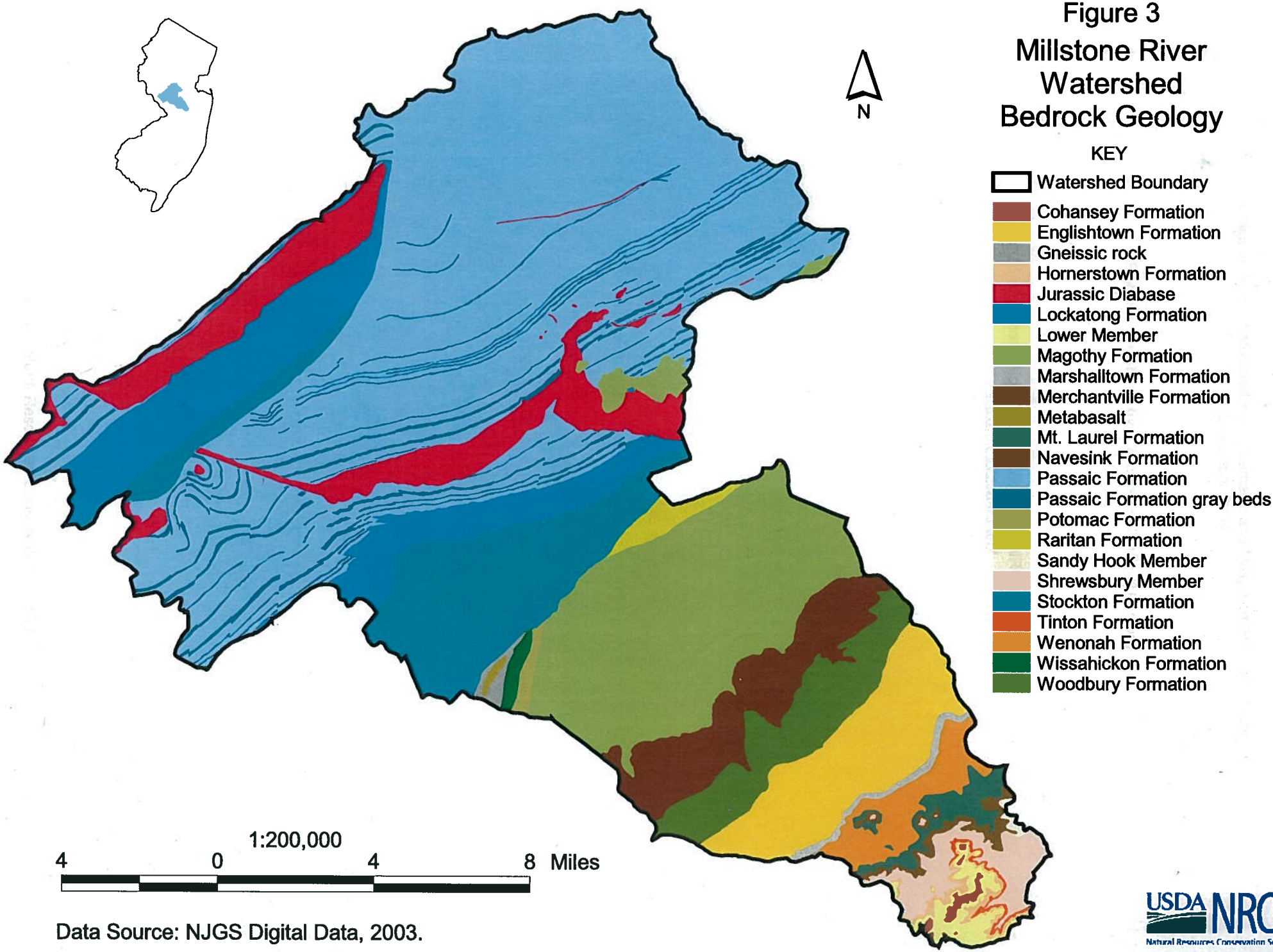
Figure 3
Millstone River Watershed Bedrock Geology



Data Source: NJGS Digital Data, 2003.

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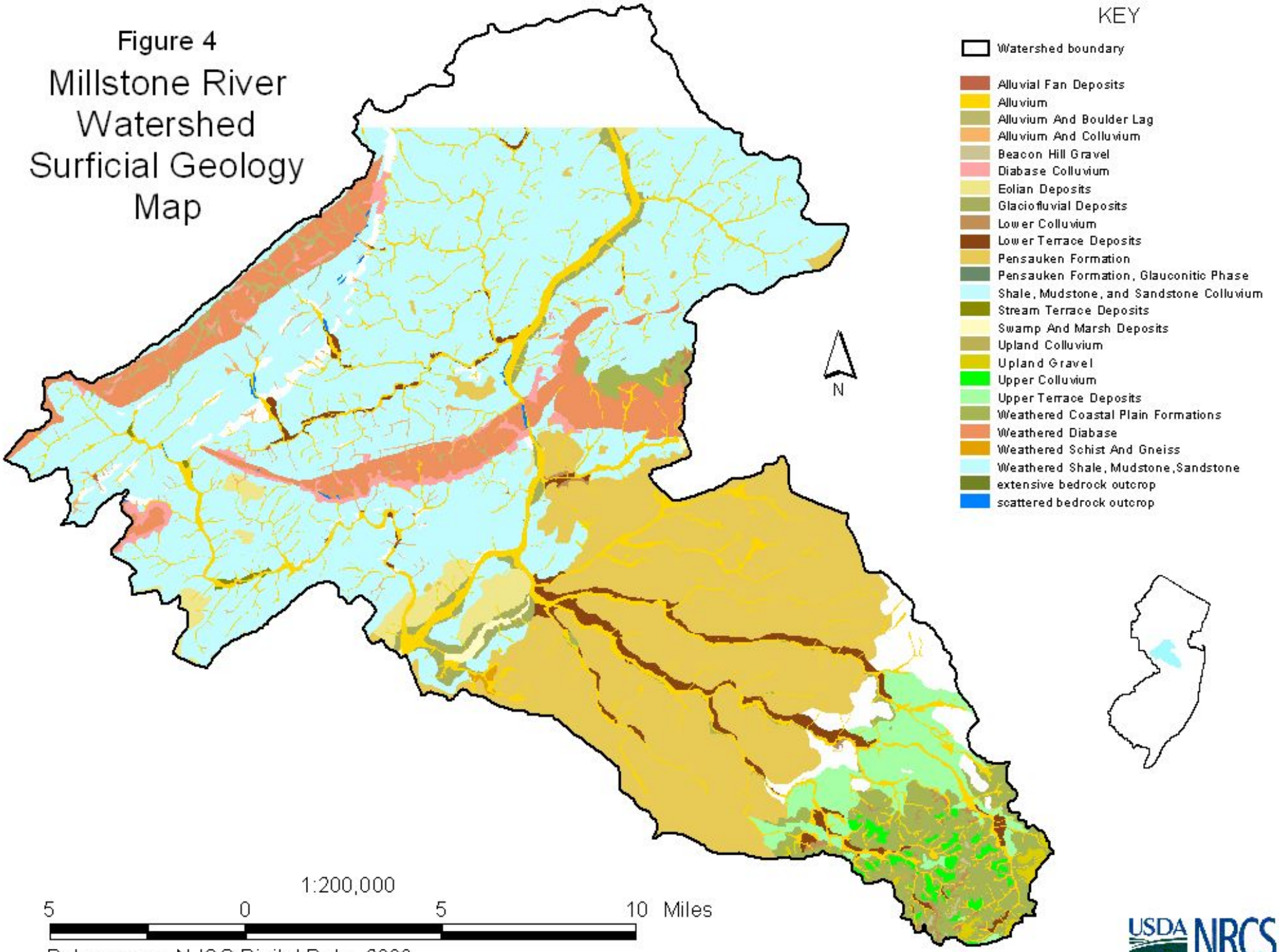
Figure 4

Millstone River Watershed Surficial Geology Map



Data source: NJGS Digital Data, 2003.

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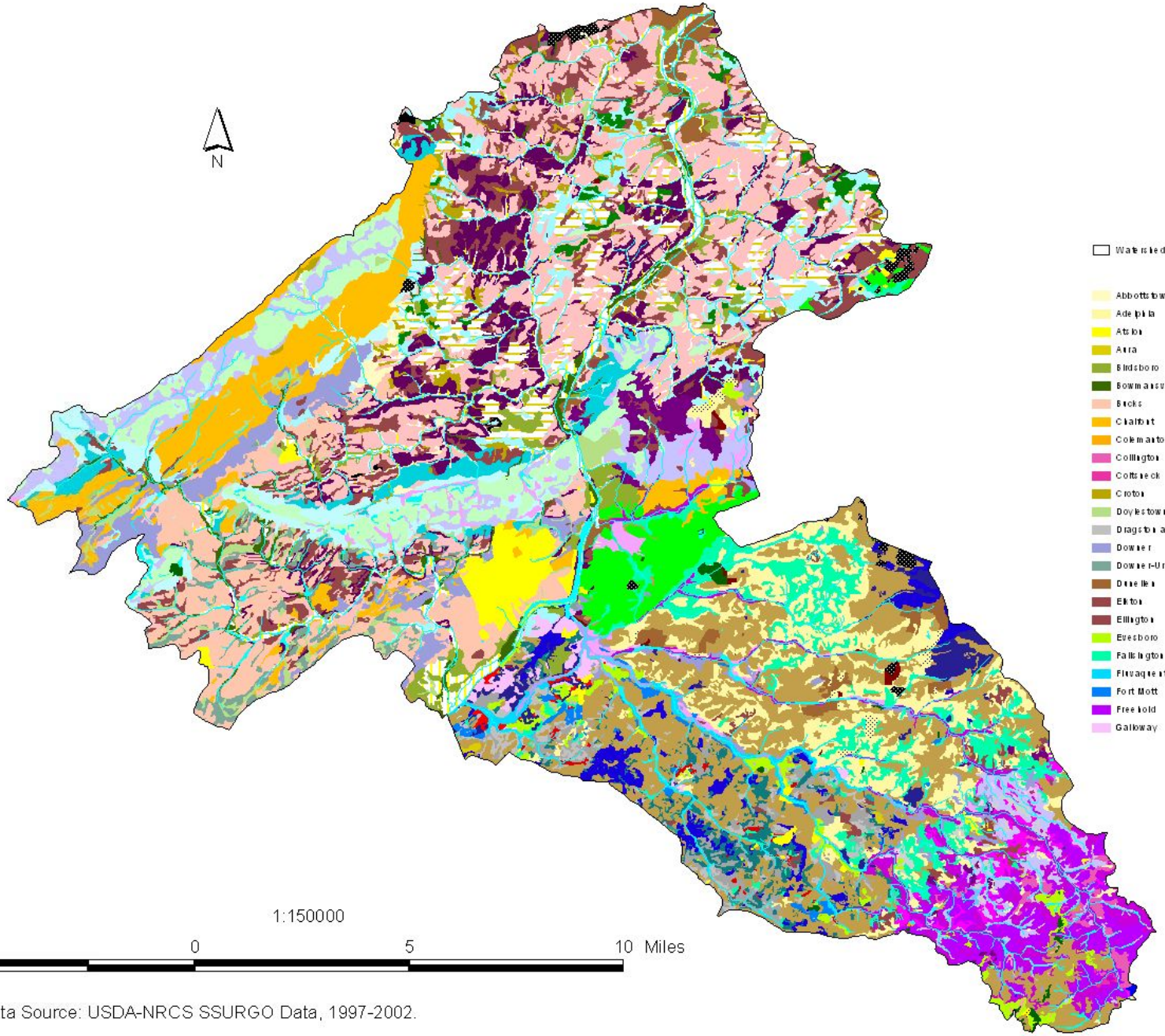
Figure 5

Millstone River Watershed Soils Map



Data Source: USDA-NRCS SSURGO Data, 1997-2002.

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June 2004

Table 1 - Present Land Use

LAND USE	ACRES	PERCENT
Agricultural	22,355 (45,154)	12.34 (24.5)
Urban	66,632 (57,133)	36.79 (31.0)
Forest	19,680 (40,546)	10.87 (22.0)
Barren Land	2,160 (2,949)	1.19 (1.6)
Wetland	16,901 (36,676)	9.33 (19.9)
Water	53,393 (1842)	29.48 (1.0)
Watershed Total	181,121 (184,300)	100.00

Data Source: NJDEP 1995-1997 Land Cover

The population of the watershed in 2000 was approximately 434,601 people.
This is expected to increase to 489,953 by 2020. The New Jersey Office of State Planning provided these population estimates.

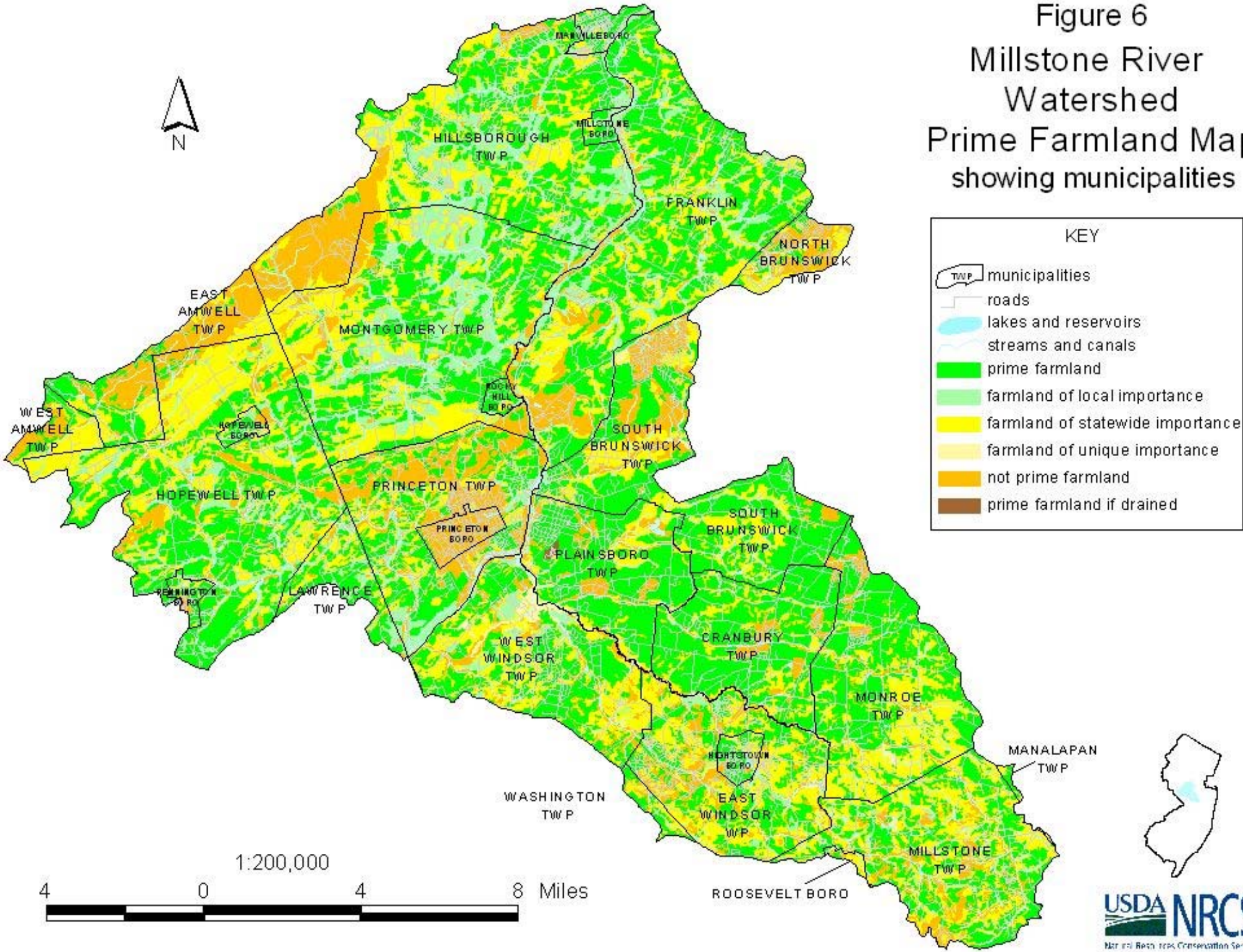
Table 2 – Past, Present and Projected Population*

County and Municipality	1980	1990	2000	2020
Hunterdon County				
East Amwell	3,468	4,332	4,455	5,990
West Amwell	2,299	2,251	2,383	2,544
Mercer County				
East Windsor	21,041	22,353	24,919	24,296
Hightstown	4,581	5,126	5,216	5,058
Hopewell B.	2,001	1,968	2,035	1,954
Hopewell T.	10,893	11,590	16,105	17,624
Lawrence	19,724	25,787	29,159	30,218
Pennington	2,109	2,537	2,696	2,450
Princeton B.	12,035	12,016	14,203	11,804
Princeton T.	13,683	13,199	16,027	14,723
Washington	3,487	5,815	10,275	12,614
West Windsor	8,542	16,021	21,907	22,627
Middlesex County				
Cranbury	1,927	2,500	3,227	3,056
Monroe	15,858	22,255	27,999	35,260
North Brunswick	22,220	31,287	36,287	40,736
Plainsboro	5,605	14,213	20,215	19,979
South Brunswick	17,127	25,792	37,734	45,134
Monmouth County				
Manalapan	19,914	26,716	33,423	35,588
Millstone	3,926	5,069	8,970	9,130
Roosevelt	835	884	933	959
Somerset County				
Franklin	31,358	42,780	50,903	66,590
Hillsborough	19,061	28,808	36,634	48,032
Manville	11,278	10,567	10,343	11,697
Millstone B.	530	450	410	442
Montgomery	7,360	9,612	17,481	20,723
Rocky Hill	717	693	662	725
Total	261,579	344,621	434,601	489,953

Source: US Bureau of Census (Actual Population)
NJ Office of State Planning (Projected Population)

* Population represents the entire municipality including areas outside of the watershed.

Figure 6
Millstone River Watershed Prime Farmland Map
showing municipalities



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HISTORY OF FLOODING

The Millstone River and several of its tributaries have had a long history of flooding. According to Gurin (1962), the Rocky Brook subwatershed at Hightstown has seen recorded floods that occurred in the following years (ranked from worst first): 1906, 1934, 1944, 1938-1915, 1923, 1955, 1882, 1960, 1962, 1948. Additional flooding in 1966 and 1967 was identified by Farlekas (1969). Since that time flooding has occurred in 1971 (Hurricane Doria) and 1999 (Hurricane Floyd).

According to Bettendorf (1966), flood records for floods on the Stony Brook and the Millstone River immediately above Carnegie Lake are very sparse. Prior to Hurricane Floyd, the greatest flood during the period of record (Water Year 1921- 2003) at Lake Carnegie in Princeton and at Millstone River near Kingston occurred September 21, 1938 (Bettendorf, 1966). Figure 6 and Table 3 show the peak streamflow for each year at Blackwells Mills on the Millstone River. The Blackwells Mills streamgage has a drainage area of (258 sq. mi.) 165,120 acres or approximately 90 percent of the Millstone River Watershed.

USGS hydrologic data indicate that major floods occurred in 1936, 1938, 1948, 1955, 1960, 1961,1971, January 1996, October 1996, September 1999 for the lower Millstone River valley, from Princeton and South Brunswick Townships and Rocky Hill Borough through Franklin, Montgomery and Hillsborough Townships including Millstone and Manville Boroughs. The three largest floods on the Millstone River prior to 1921, when the Blackwell Mills gage station records begin, were 1810, 1882 and 1896 (Ross, 1969). Historical accounts (1896 State Geologist Annual Report) show that the flood of 1882 was the largest known flood to have occurred prior to 1962 (Thomas, 1962). The USGS stream gage station located at Blackwells Mills shows that the top ten recorded flows since 1921 have occurred in 1938, 1946, 1949, 1971, 1978, 1979, 1994, 1996, 1997, and 1999.

The storm of record occurred in 1999 (Hurricane Floyd) and was considered to be larger than a 100 year frequency flood event. Flood depths around houses and businesses in the lower Millstone River watershed were in excess of eight feet on the first floor during the event.

Table 3 – Peak Stream Flow for Millstone River at Blackwells Mills

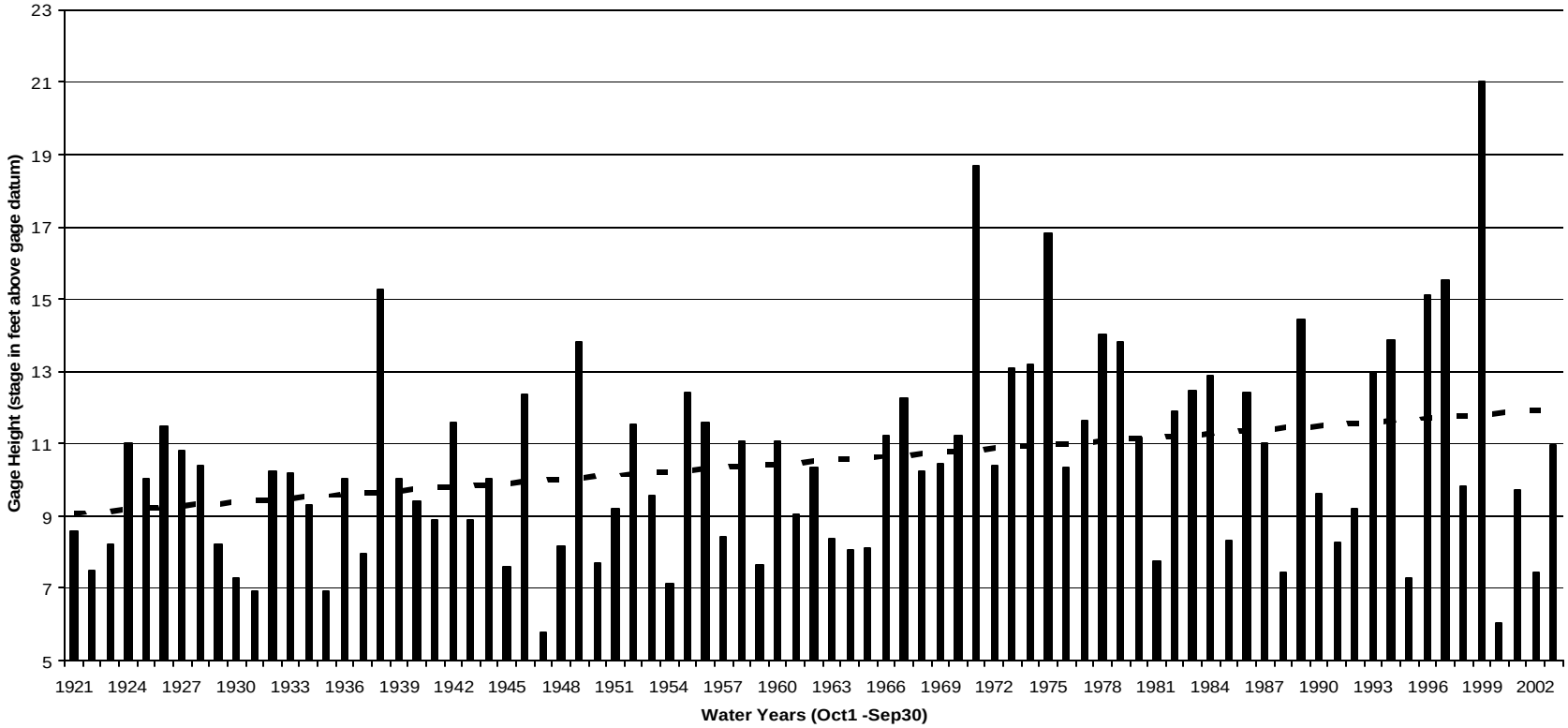
Water Year 1921 to 2003

Water* Year	Date	Gage Height (feet)	Flow (cfs)	Water Year	Date	Gage Height (feet)	Flow (cfs)
1921	August 8, 1921	8.55	4,190				
1922	March 8, 1922	7.50	3,420	1963	March 7, 1963	8.38	4,190
1923	March 17, 1923	8.20	3,840	1964	January 10, 1964	8.05	3,850
1924	April 7, 1924	11.00	7,900	1965	February 9, 1965	8.09	3,890
1925	February 12, 1925	10.05	6,340	1966	February 14, 1966	11.21	8,330
1926	September 7, 1926	11.50	7,900	1967	March 7, 1967	12.24	9,820
1927	July 23, 1927	10.80	7,540	1968	May 30, 1968	10.26	6,290
1928	October 18, 1927	10.40	7,000	1969	July 29, 1969	10.43	6,540
1929	February 27, 1929	8.22	4,000	1970	April 3, 1970	11.23	7,860
1930	March 8, 1930	7.30	3,140	1971	August 28, 1971	18.68	22,200
1931	June 17, 1931	6.94	2,810	1972	June 23, 1972	10.40	4,790
1932	March 28, 1932	10.25	6,650	1973	February 3, 1973	13.09	8,860
1933	November 19, 1932	10.21	6,650	1974	December 21, 1973	13.21	9,080
1934	March 5, 1934	9.32	5,300	1975	July 15, 1975	16.84	17,100
1935	February 16, 1935	6.91	2,810	1976	January 28, 1976	10.35	4,810
1936	January 3, 1936	10.05	6,270	1977	March 23, 1977	11.62	6,350
1937	December 20, 1936	7.97	3,800	1978	January 27, 1978	14.02	10,700
1938	September 21, 1938	15.29	18,300	1979	January 22, 1979	13.84	10,300
1939	February 4, 1939	10.04	6,270	1980	March 22, 1980	11.15	5,600
1940	March 15, 1940	9.41	5,440	1981	May 12, 1981	7.75	2,820
1941	February 8, 1941	8.88	4,760	1982	January 5, 1982	11.87	6,740
1942	August 9, 1942	11.57	8,940	1983	April 17, 1983	12.46	7,730
1943	December 30, 1942	8.90	4,780	1984	May 30, 1984	12.87	8,460
1944	January 6, 1944	10.05	6,340	1985	September 28, 1985	8.31	3,140
1945	November 28, 1944	7.61	3,420	1986	April 17, 1986	12.41	7,650
1946	June 3, 1946	12.37	10,500	1987	April 5, 1987	11.02	5,460
1947	April 6, 1947	5.79	2,130	1988	July 22, 1988	7.46	2,670
1948	November 12, 1947	8.17	3,970	1989	September 21, 1989	14.42	11,400
1949	December 31, 1948	13.84	14,000	1990	October 21, 1989	9.61	4,950
1950	February 15, 1950	7.70	3,500	1991	March 4, 1991	8.26	3,700
1951	November 26, 1950	9.21	5,180	1992	June 6, 1992	9.19	4,530
1952	December 21, 1951	11.53	8,870	1993	December 12, 1992	12.97	9,160
1953	March 13, 1953	9.56	5,650	1994	January 29, 1994	13.88	10,500
1954	December 15, 1953	7.12	2,980	1995	March 9, 1995	7.28	2,910
1955	August 14, 1955	12.42	8,000	1996	January 20, 1996	15.09	12,600
1956	October 15, 1955	11.57	7,500	1997	October 20, 1996	15.53	13,400
1957	April 6, 1957	8.43	4,240	1998	January 24, 1998	9.83	5,180
1958	February 28, 1958	11.05	7,990	1999	September 17, 1999	21.01	26,200
1959	August 9, 1959	7.67	3,460	2000	March 17, 2000	6.02	2,110
1960	September 13, 1960	11.07	8,030	2001	March 31, 2001	9.71	5,050
1961	March 24, 1961	9.07	4,670	2002	May 19, 2002	7.42	3,020
1962	March 13, 1962	10.34	6,770	2003	June 5, 2003	10.98	5,950

Source: U.S. Geological Survey, West Trenton, NJ

* Water Year is the period October 1 through September 30

Figure 7 - Peak Streamgage Height per year at Blackwells Mills Gage 1921 - 2003



Note: Flood stage is 9 feet as set by the National Weather Service. The heavy dashed line represents the trend line of the peaks. Trends in the peak stage data may be affected by climatic trends, development, flood detention basin and pond construction, loss of farmland, reforestation of the floodplain, and other factors.

PREVIOUS STUDIES

Planning and implementation of water and related land resource projects have occurred in several areas of the (288 sq. mi.)184,300 acre watershed. The Soil Conservation Service, (SCS, now the Natural Resources Conservation Service), assisting Hunterdon and Mercer County Soil Conservation Districts and the Stony Brook Millstone Watershed Association, developed a watershed plan in 1956 to reduce erosion and sedimentation in the Stony Brook (47.8 sq. mi.) 30,604-acre subwatershed. This plan resulted in the installation of several water retention structures with the purpose of reducing sedimentation to Carnegie Lake.

The Soil Conservation Service, following a 1961 request from Mercer, Middlesex and Monmouth Counties and the Freehold and Mercer County Soil Conservation Districts and Hightstown Borough and West Windsor Township, studied the 62,000-acre Upper Millstone River subwatershed. Identified problems included significant flood damage to stores and a rug factory in Hightstown and lack of adequate drainage outlets and irrigation water for agriculture in the Rocky Brook subwatershed. In 1973, SCS determined that flood damage reduction and irrigation water development would not be economically feasible. The reasons given for this determination were the recent completion of a State Flood Hazard Analysis that would likely decrease the future unwise use of the flood plain as well as no feasible reservoir site, sufficient to control enough area to be effective in reducing downstream flooding.

The Soil Conservation Service, following a 1963 request from the New Jersey Neuro-Psychiatric Institute and Montgomery Township, studied sedimentation in the Rock Creek subwatershed. The objective was to reduce sedimentation to the Institute's Skillman or Sylvan Lake. There was an apparent lack of interest by the PL83-566 local sponsors and their application for assistance was withdrawn. Due to the high hazard designation of the dam here, the State recently opened a valve but has not yet breached the dam. Montgomery Township is expected to purchase the North Princeton Developmental Center and, when this occurs, will become responsible for the breaching and removal of the dam.

The U.S. Army Corps of Engineers in August 1982 completed a Survey Report for Flood Control which, in part, covered the lower part of the Millstone River watershed. A levee was proposed to protect Zarephath (Alma White College) in Franklin Township, Hillsborough Township along Route 533 and the Millstone River and Millstone Borough along an alignment parallel to North and South River Street. The report noted that at that time, following hydrologic, hydraulic and economic analyses, the proposed levees could not be economically justified.

A stormwater management study was performed by Killam Associates and Middlesex County Planning Board in April 1991 in the 14,525-acre Devils Brook-Shallow Brook-Cedar Brook subwatershed. The purpose of the study was to evaluate the impacts of future land development on existing drainage facilities and flood problem areas and devise a land development strategy that would prevent adverse impacts. The municipalities at the time were not willing to take a regional or watershed approach to management of stormwater. A key recommendation was that each land development project should by regulation be required to control the peak rate of site runoff from the 2, 10 and 100-year frequency storm to 40, 60 and 60 percent, respectively of the existing peak flows from the site. There were other recommendations for intermunicipal coordination of stormwater control and facilities maintenance. There was no interest in implementation at that time. A Regional Stormwater Management Plan (expanded to include the Cranbury Brook) pursuant to the new Stormwater Rules (NJAC 7:8) using 319 funding is currently being

pursued. The towns have agreed to participate and it is hoped that they will follow through and implement the results of the most recent planning process.

In September 2000, the U.S. Army Corps of Engineers completed a reconnaissance study recommended that a Millstone River Basin Feasibility Study be developed for the purpose of flood damage reduction in the Lost Valley section of Manville Borough and ecosystem restoration occur in several locations in the Basin. This study has begun, with the State of New Jersey as the local sponsor.

HISTORY OF THIS STUDY

Tropical Storm Floyd included precipitation of up to 11 inches of rainfall during an 18 hour period (Robinson, 1999). It caused the largest flood event on record for the Central New Jersey area. Tropical Storm Floyd flooding caused $170 million in damage to public and private buildings and structures with 2,550 single family homes and 70 multifamily units damaged in Manville Borough alone. Several million dollars of flood damages occurred in Zarephath in Franklin Township and Millstone Borough. In Millstone Borough approximately 25 structures were flood damaged with approximately 15 of these structures being individual homes or businesses. Millstone Borough has the distinction of being the municipality with the highest per structure flood insurance claims among the 26 municipalities, including Manville, within the watershed. The flooding associated with Tropical Storm Floyd was the third major flood to occur in these municipalities in a three year period. Tropical Storm Floyd (September 16 - 17, 1999) precipitated interest by former Congressman Bob Franks and Congressman Rush Holt in the NRCS PL83-566 Program for the Millstone River Watershed as well as the Raritan River Basin. As a result of their request, this study was initiated.

In January 2000 an initial meeting was held by NRCS to determine the level of local interest in pursuing a PL83-566 Watershed Plan Development Project. In February 2000, representatives of Hunterdon, Mercer, Middlesex, Monmouth and Somerset Counties and numerous municipalities met and formed a Steering Committee. The project received formal letters of endorsement from all five county boards of freeholders (Hunterdon, Mercer, Middlesex, Morris, Monmouth and Somerset) as well as over a dozen of the 26 municipalities in the watershed.

Photo 1 - Millstone River Watershed Steering Committee

In June 2000, the Steering Committee identified seven objectives as follows:

- Flood Damage Reduction
- Agricultural Enhancement
- Open Space Protection
- Water Quality Protection
- Ground Water Recharge Protection
- Increase Recreational Opportunities
- Enhance Fish and Wildlife Habitat

While flood damage reduction was identified as the top priority, other objectives were not prioritized.
Division of Work for Flood Damage Mitigation Planning

In 2001, the Army Corps of Engineers and the Natural Resources Conservation Service agreed the Corps would focus on the Manville vicinity while the Natural Resources Conservation Service would focus on upstream municipalities including Franklin, Hillsborough, Millstone, Montgomery, Rocky Hill, South Brunswick and Princeton. In addition, the two agencies agreed to share data, models and expertise to benefit both projects.

Public Participation

The Steering Committee approved a Public Participation Plan and delegated the Public Participation Coordinator role to the New Jersey Water Supply Authority. A copy of the final Public Participation Plan is in Appendix A.

The Steering Committee has a project website that includes a discussion forum. Minutes of meetings, findings and maps are posted on the website which is hosted by the Raritan Basin Watershed Project of the New Jersey Water Supply Authority. The website can be viewed at:

http://www.raritanbasin.org/nrcs_millstone.htm

Steering Committee meetings were generally held on a monthly basis and are open to the public and include the opportunity for public comments at every meeting.

The "Basin Bulletin", a newsletter of the Raritan Basin Watershed Management Project, has included articles on the project.

A public meeting was held in South Brunswick Township by the Steering Committee on December 6, 2000 to receive public concerns, issues, alternatives and effects that should be considered during the initial assessment of the project. The meeting notice was sent to Mayors, Municipal Clerks, Environmental Commissions and Municipal Emergency Management Coordinators in all 26 municipalities, municipal utility authorities, County Freeholders and State and Federal legislators. Approximately 35 people attended this meeting. A summary of that meeting is in Appendix B.

A March 22, 2001 public meeting was held in Montgomery Township where an overview of the NRCS project was given. Over 50 people were in attendance. The meeting summary is in Appendix C.

Another public meeting to review project planning progress, particularly as it related to the individual structure elevation survey, was held in Griggstown on September 18, 2001 with approximately 20 people attending.

A public meeting was held in Millstone Borough on November 12, 2002 to give property owners an idea of the costs, benefits and appearance of various flood mitigation measures (nonstructural) for their properties. Approximately 20 people attended the meeting. Two separate paths toward flood mitigation solutions, one the NRCS PL83-566 approach and the other the FEMA/State OEM Flood Mitigation Assistance Program which targets assistance to repetitive loss structures. Property owners requested that NRCS do flood audits of individual properties to develop individual flood information sheets. These sheets would show the elevation of the first floor and/or low opening relative to the stage height at the Blackwells Mills gaging station providing property owners time to evacuate and/or move contents above the predicted flood crest.

Another public meeting was held May 15, 2003 in Millstone Borough to discuss the findings of the NRCS analysis of nonstructural alternative measures including elevation, relocation and acquisition of structures.

Methodology of Study

This study was carried out in three phases with each succeeding phase narrowing the scope of the study. Phase I was a watershed-wide inventory to determine the history, location and severity of the flood problems. It was done by interviewing municipal officials and reviewing the FEMA National Flood Insurance Program claims database. While neither of these methods provided a complete determination of the history of flooding they were both useful in scoping of the flood problem. As a result of this information, the scope of the study was narrowed in Phase 2. This phase was an in-depth flood study of the main stem of the Millstone River from above Manville to just downstream of Carnegie Lake in Princeton and South Brunswick Townships. As mentioned earlier, Manville was excluded from the NRCS study since the Corps of Engineers is conducting a study there. The results of both Phase 1 and 2 resulted in Phase 3. Under this phase, a rigorous, intensive flood study of Millstone Borough was conducted.

PHASE 1 – WATERSHED – WIDE ANALYSIS

Municipal Interviews

During August to October 2000 the Natural Resources Conservation Service (NRCS) Watershed Planning Staff interviewed officials from all 26 municipalities in the watershed regarding historic flood damages. The recent and historic flood damages were located on municipal maps. Figure 8 shows the location, type of damage and frequency in each of the municipalities in the watershed. Accuracy depended on the memories and records of municipal officials interviewed. The purpose of the interviews was to determine the kinds, location and frequency of flood damage. The dollar amounts of flood damage were not determined. Nearly 70 locations throughout the watershed were identified as having had flood damages. Flooding at these locations was lumped into one of eight categories of flood damage with some locations having more than one type. A total of 85 incidents of flood damage were reported (not individual structures). A summary is shown in Table 4. The results for each individual municipality reporting are shown in Appendix D.

Tropical Storm Floyd flooding at several locations in the watershed is shown in the photos in the following pages.

Photo 2 - Looking Upstream Toward Kingston Mill and Carnegie Lake from "New" Route 27 bridge (Old bridge parapets in foreground), September 17, 1999

Photo 3 - Looking West across "New" Route 27 Bridge, September 17, 1999

Photo 4 – Looking toward Princeton Church of Christ from Parking Lot, September 17, 1999

Photo 5 - Kingston Locktenders House, September 17, 1999

Photo 6 - 1076 Canal Road, Griggstown, September 17, 1999

Photo 7 - Canal Road and Griggstown Causeway Looking at 1079 Canal Road, Griggstown, September 17, 1999

Photo 8 - East Millstone First Aid Squad Building, Franklin Inn and Onka Building, September 17, 1999

Photo 9 - East Millstone Bridgetender's House, September 17, 1999

Photo 10 - Pillar of Fire Chapel at Zarephath, September 17, 1999

Photo 11 - View of Millstone River (background) and Pillar of Fire at Zarephath, September 17, 1999

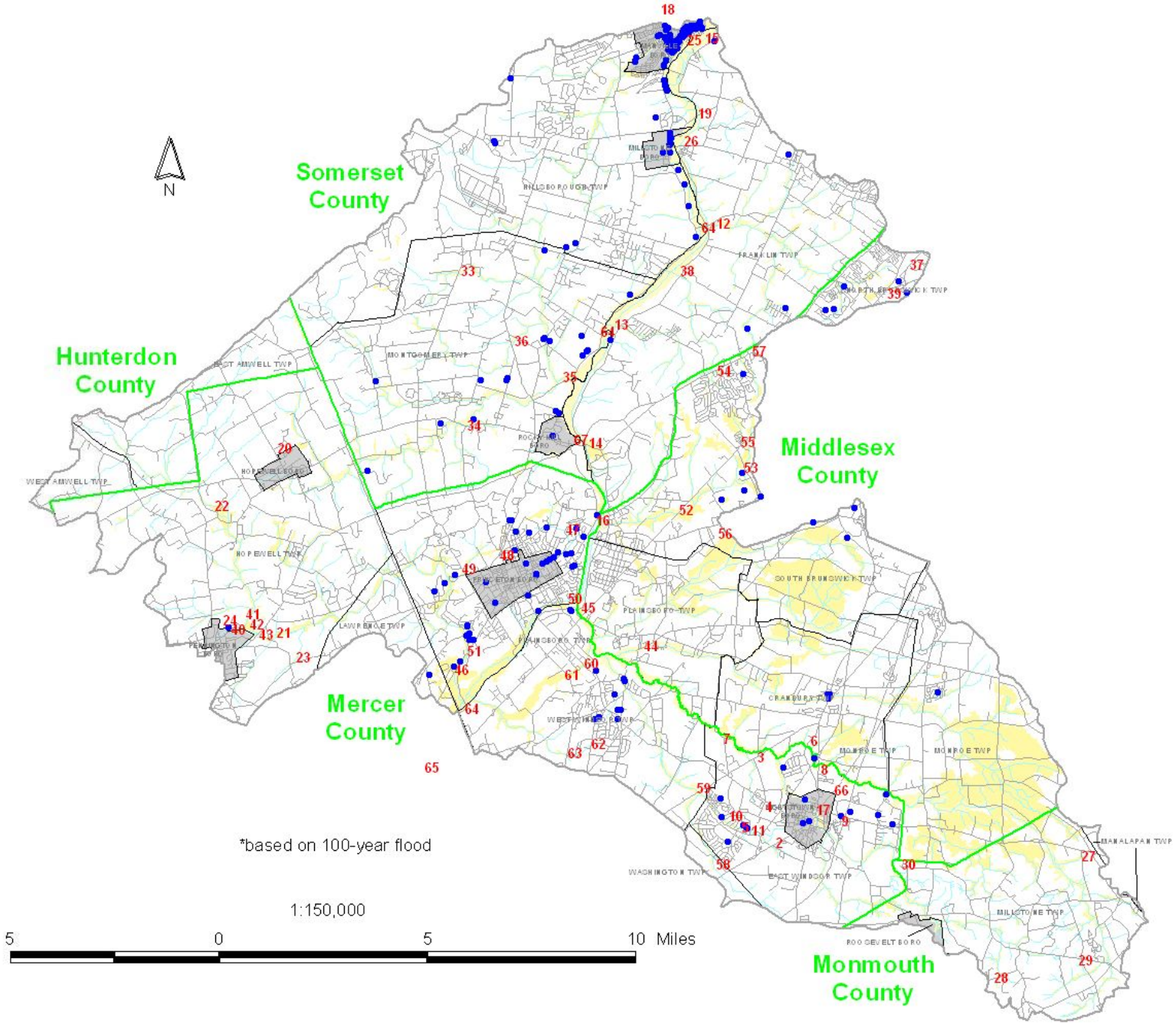


Figure 8

Millstone River Watershed Historical Flood Damage Locations

Legend

- watershed boundary
- county boundaries
- municipal boundaries
- streams
- roads
- flood prone areas*
- 38 municipal interview site (see appendix E)
- FEMA National Flood Insurance claim sites

USDA NRCS
Natural Resources Conservation Service

Table 4 - Types of Historic and Recent Flood Damages Reported During Municipal Interviews

Flood Damage Type	Percent of Total Occurrences
Roads and Bridges	63
Residential	12
Commercial	8
Recreation	5
Water and Sewer Treatment Plants	4
Industrial	1
Educational	1
Other	6
TOTAL	100
Source: Millstone River Watershed Municipality Interviews Conducted during August –October, 2000	

Damage from Hurricane Floyd (September 16 - 17, 1999) was concentrated in three areas. Manville Borough was hardest hit with estimates over $100 million in damage (Economic Development Administration, 2000). Zarephath in Franklin Township received damage in the millions of dollars. Many residential and commercial properties in Millstone Borough were damaged. In summary, historical as well as recent flooding indicates that severe flood damages take place in the lower watershed – Manville Borough, Zarephath and Millstone Borough. Upstream flooding is more isolated, less severe and includes some residential and commercial and many roads and bridges.

Federal Emergency Management Agency National Flood Insurance Claims

An analysis of the FEMA National Flood Insurance Program Claims (NFIP) database containing over 700 flooding incidences for the municipalities in the watershed was performed. Figure 4 shows the location and dates of these flood claims in the watershed. It is generally agreed that the FEMA National Flood Insurance Claims data serve as a valuable indicator of the location, frequency and dollar value (Table 5) of flood damage in an area. These data were used, along with the municipal interview data, to characterize flood damages in the watershed.

NFIP data covering the period 1977-1999 was analyzed. Data were sorted by community name (municipality), date of loss and address of claim. Dollar values were adjusted to 1999 values. The total dollar loss by municipality was developed (Table 5). The number of participants in the National Flood Insurance Program were identified, by municipality , as well as the number of properties vulnerable to flooding. These data were used to compute an estimated participation rate (Table 6). The dollar value of flood claims for the ten largest (dollar value) storm events (Table 7) was also developed. These ten storm events during the 1977 to 1999 period accounted for 84 percent of all flood insurance claims. The number of repetitive losses, those properties making two or more claims, was identified for each municipality (Table 8).

Nationally, participation in the National Flood Insurance Program is approximately 6 percent of the estimated flood damaged properties. Table 6 shows the number of National Flood Insurance participants, number of flood vulnerable properties and an estimated participation rate by municipality. The number of National Flood Insurance participants and estimated participation rates were provided by FEMA. The number of flood vulnerable properties were provided by the watershed municipalities.

Table 5 - FEMA National Flood Insurance Program Flood Damage Claims by Municipality for the Period 1977-1999

Municipality	Dollar Damages (Indexed to 1999 Values)
Cranbury Township	$12,886.
East Amwell Township	745.
East Windsor Township	$41,528.
Franklin Township	$677,696.
Hightstown Borough	$1,984.
Hillsborough Township	$452,496.
Hopewell Borough	-0-
Hopewell Township	$111,062.
Lawrence Township	-0-
Manalapan Township	-0-
Manville Borough	$12,151,701.
Millstone Borough	$1,101,649.
Millstone Township	$7,482.
Monroe Township	$118,837.
Montgomery Township	$551,491.
North Brunswick Township	$19,724.
Pennington Borough	$26,778.
Plainsboro Township	$758.
Princeton Borough	$85,182.
Princeton Township	$407,461.
Rocky Hill Borough	$63,858.
Roosevelt Borough	-0-
South Brunswick Township	$119,332.
Washington Township	$6075.
West Amwell Township	$2135.
West Windsor Township	$92,236.
TOTAL	$16,053,095.

Source: Federal Emergency Management Agency

NOTE: The above dollar values are not the total flood damages but represent only the claims submitted to FEMA. Past dollar damages were adjusted to1999 values.

Table 6 - National Flood Insurance Program (NFIP) Participation Rates by Municipality

Municipality	NFIP Participants[1]	Flood Vulnerable Properties[2]	NFIP Participation Rate (Percent)[3]
Cranbury Township	19	17 Res/15 Com	59
East Amwell Township	9	4 Res	100
East Windsor Township	81	24 Res/3 Com	33
Franklin Township	85	75 Res/15 Com	94
Hightstown Borough	14	8 Res/7 Com	100
Hillsborough Township	177	38 Res	100
Hopewell Borough	2	20 Res	10
Hopewell Township	57	15 Res	26
Lawrence Township	170	75 Res/40 Com	100
Manalapan Township	59	1 Res	100
Manville Borough	625	424 Res	100
Millstone Borough	18	10 Res/3 Com	100
Millstone Township	10	25 Res/50 Com	13
Monroe Township	103	25 Res/10 Com	34
Montgomery Township	60	15 Res/5 Com	100
North Brunswick Township	22	40 Res/1 Com	54
Pennington Borough	3	11 Res/1 Com	21
Plainsboro Township	13	10 Res	77
Princeton Borough	21	37 Res	57
Princeton Township	71	135 Res/6 Com	50
Rocky Hill Borough	8	2 Res	100
Roosevelt Borough	1	-0-	100
South Brunswick Township	133	64 Res/4 Com	52
Washington Township	10	17 Res	59
West Amwell Township	6	13 Res	46
West Windsor Township	73	150 Res/10 Com	46
TOTALS	1,850	1,255 Res/170C	62.7

[1] Federal Emergency Management Agency

2 Millstone River Watershed Municipality Flood Vulnerable Properties Report

3Rate of participation was derived by dividing the number of policies in force by the number of residential and commercial structures reported as being located in the Special Flood Hazard Area (SFHA) of the municipality. Where the number of policies exceeds the number of SFHA structures, the rate was considered to be 100%. In those cases, policies may be written on properties that are not identified as flood-prone – or the municipality may have inadvertently underreported the number of flood-prone structures.

Table 7 - FEMA National Flood Insurance Program Claims by Top Ten Storm Events (1977-1999)

Storm Event Date	Dollar Value (1999)
January 26, 1978	$71,337.
January 21/25, 1979	$34,816.
July 7, 1984	$8,266.
July 5, 1989	$38,437.
September 20, 1989	$95,994.
December 11, 1992	$46,072.
January 28, 1994	$27,267.
January 19/20, 1996	$325,879.
October 18/20,1996	$1,404,878.
September 16, 1999	$13,551,207.

Source: Federal Emergency Management Agency

NOTE: The above dollar values are not the total flood damages.

Table 8 - FEMA National Flood Insurance Claim Repetitive Losses by Municipality

Municipality	Number of Repetitive Losses[1]
Cranbury Township	1
East Amwell Township	1
East Windsor Township	3
Franklin Township	1
Hightstown Borough	0
Hillsborough Township	8
Hopewell Borough	0
Hopewell Township	2
Lawrence Township	0
Manalapan Township	0
Manville Borough	134
Millstone Borough	6
Millstone Township	0
Monroe Township	4
Montgomery Township	6
North Brunswick Township	0
Pennington Borough	1
Plainsboro Township	0
Princeton Borough	1
Princeton Township	8
Rocky Hill Borough	0
Roosevelt Borough	0
South Brunswick Township	4
Washington Township	0
West Amwell Township	0
West Windsor Township	3
TOTAL	183

[1] Repetitive losses are those where two or more flood insurance claims have been made for the same property during the 1977-1999 period.

Flood Damage Priority Study Areas

In early 2001, the Millstone Watershed Steering Committee, based upon the above data, prioritized the areas in the watershed to be studied into high, medium and low priority areas for further study based on damage frequency, number of damaged structures, dollars of flood damage, applicability of the PL566 Program to provide solutions, benefits of potential solutions versus the costs and local support for possible implementation. The purpose of prioritizing was to permit the limited NRCS technical assistance to be focused in those areas with the highest priority. Figure 9 shows the priority study areas in the watershed. There are two high priority areas. One area is the lower Millstone River corridor affecting Franklin, Hillsborough, Millstone, Montgomery, Rocky Hill, South Brunswick and Princeton. The other area is the Harrys Brook watershed in Princeton Township.

Agricultural Issues

During this phase of the investigation a group of local agricultural experts was formed to analyze the agriculture situation and identify any resource issues and concerns. Despite the fact that the watershed is heavily populated, over 22,000 acres of farmland still exist. Figure 6 shows the extent and location of the watershed prime farmland (both developed and undeveloped for non-agricultural uses). It also identifies those farmlands that have been permanently preserved under the state/county farmland preservation program.

An analysis of the Farmland Assessment data is shown on Table 9. It lists by municipality the acres of cropland and the various number and kinds of farm animals. Nearly 1,500 landowners have enrolled their land into the Farmland Assessment program.

The group came up with a list of issues and concerns as follows:

- Integrated Crop Management (ICM) could be expanded to vegetable growers
- Riparian buffers are needed
- Stream bank stabilization on agricultural lands is a major problem
- More farmland needs to be preserved under the farmland preservation program
- Groundwater recharge is needed in the Hopewell area
- Irrigation water management is a concern
- Improved pasture management is needed for horse farms
- Development of farmland/conversion to non-agriculture uses is a concern

Figure 9

Millstone River Watershed Priority Flood Damage Study Area map*

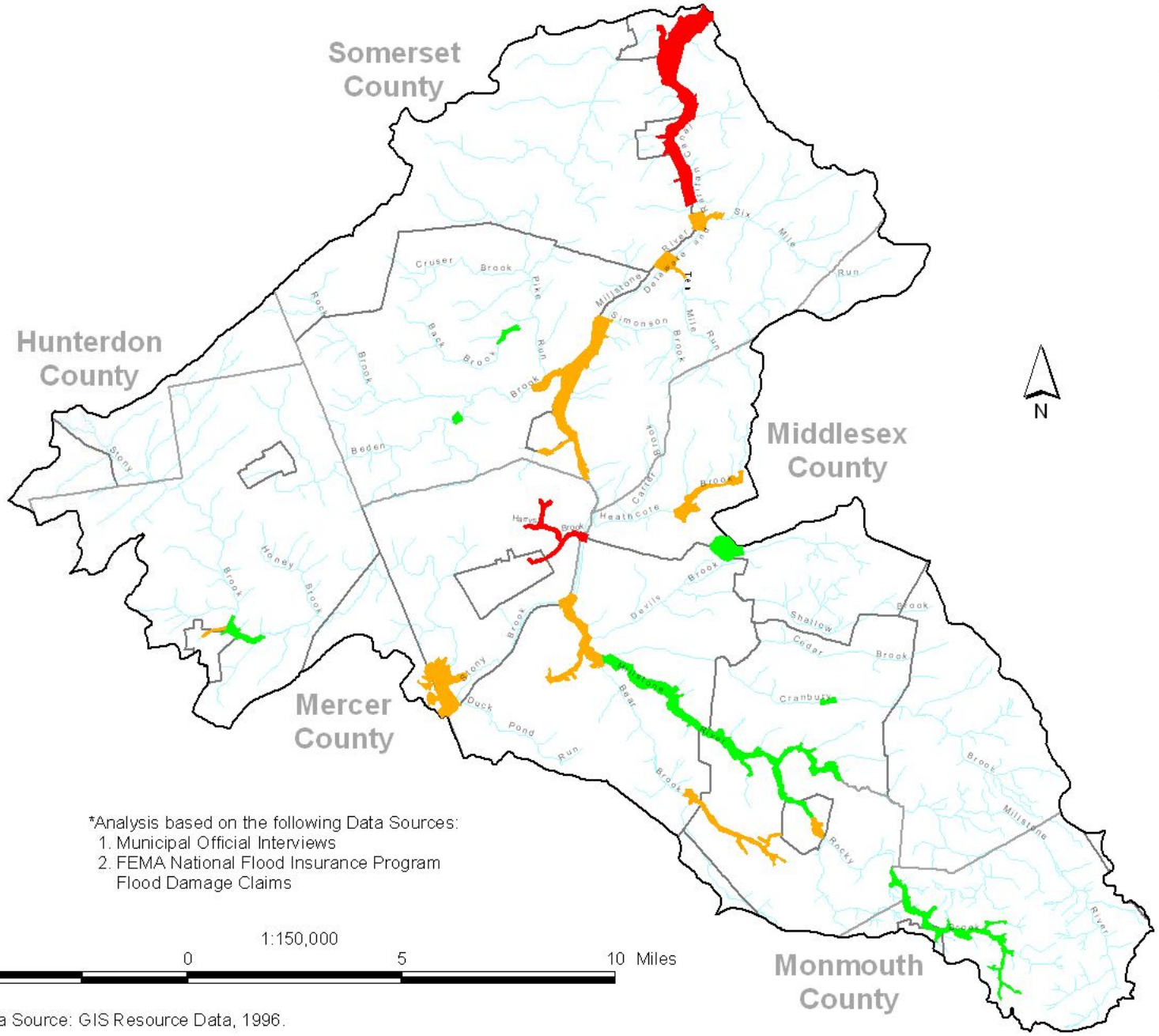


Table 9 - Agriculture Information

Source: NJ Farmland Assessment Data 1998 - Tax Year 1999 (Data is for only municipal lands within the watershed)

	Area		Cropland & Woodland Data (Acres)													Animals					No. of forms
	Sq. Mile	% in W/S	Crop Harv	Crop Past	Perm Past	Ttl Wood	Equine Ac	Ttl Ag Use	Ttl Hyld	Ttl Fld Crp	Ttl Berry	Ttl Frt	Ttl Nurs	Ttl Veg	Ttl Irrg	Beef Ctle	Dairy Ctle	Equine	Sheep	Swine	filed
Hunterdon																					
East Amwell	29	24	1587	246	299	799	29	2909	413	1297	2	1	34	38	3	94	63	102	73	11	65
West Amwell	22	10	356	46	122	373	1	951	143	302	1	1	23	1	1	37	46	13	12	3	16
Totals			1943	292	421	1173	30	3860	556	1599	3	2	57	40	5	130	109	115	85	14	81
Mercer																					
East Windsor	16	95	3020	22	16	755	27	3840		2225	1	12	242	327	33			16	52	1	89
Hightstown	1	100	6					6		6											
Hopewell B.	1	100	47		19	5		71	5	18				8					63		
Hopewell T.	59	56	4274	732	1722	3504	19	10252	1738	3575	1	10	213	117	26	199	5	249	287	76	219
Lawrence	22	18	248	14	40	120		423	29	158	1	26	33	25	8	10	23	4	15		13
Pennington	1	82	7					7					7								
Princeton B.	2	100																			
Princeton T.	17	100	420	58	60	752	3	1293	123	422		1	2			24		19			
Washington	21	5	228	3	4	118	1	318	7	192	1	1	20	14	1	1		4	1	1	7
West Windsor	26	63	1986	44	61	987	7	3085	82	1875	8	2	33	93	5	74	38	29		256	71
Totals			10236	873	1922	6241	57	19295	1984	8471	12	53	550	583	73	308	66	320	418	334	398
Middlesex																					
Cranbury	13	100	4607	44	134	1141	40	5966	127	4033		2	311	357	130	33		82	38		
Monroe	42	43	3117	80	247	1542	15	5000	184	2500	21	25	291	207	58	14	3	153	37	141	186
N. Brunswick	12	26	63	3	1	10		85	36	51	1	1	2	10		1		2			4
Plainsboro	12	100	1980	41	92	1428	8	3549	151	1734		2	170	60	25	56		6			
S. Brunswick	41	49	2120	27	106	1427	5	3660	167	1522	3	83	359	156	17	25	1	61	65	302	157
Totals			11886	194	580	5548	68	18260	664	9840	24	112	1133	791	230	128	4	303	139	443	348

Table 9 – Agriculture Information (Continued)

Data is for only municipal lands within the watershed

	Area		Cropland & Woodland Data (Acres)													Animals					Form Filed forms
	Sq. Mile	% in W/S	Crop Harv	Crop Past	Perm Past	Ttl Wood	Equine Ac	Ttl Ag Use	Ttl Hyld	Ttl Fld Crp	Ttl Berry	Ttl Frt	Ttl Nurs	Ttl Veg	Ttl Irrg	Beef Ctle	Dairy Ctle	Equine	Sheep	Swine	filed
Monmouth																					
Manalapan	31	1	25	1	6	12	1	44	1	16	1	1	4	3	1	1		3	2	1	1
Millstone T.	38	49	2929	103	357	1692	30	5111	357	1690	9	8	321	521	149	32	1	449	138	28	225
Roosevelt	2	16	63		3	34	25	100		33				25	3			4			2
Totals			3017	105	366	1737	55	5255	358	1740	10	9	325	549	154	33	1	455	139	29	228
Somerset																					
Franklin	47	70	2821	307	387	1494	15	5023	821	2197	4	7	393	57		128		87	70	31	161
Hillsborough	55	58	4473	427	1214	2607	8	8729	1792	3967	6	5	239	97	9	210	297	168	158	41	217
Manville	2	54	27					27					27								1
Millstone B.	1	100	113			21		134		102											
Montgomery	33	100	3664	741	453	2074	28	6960	1518	3111		15	206	18	2	354	8	148	129	37	37
Rocky Hill	1	100	30					30		26			2	2							
Totals			11128	1474	2054	6196	51	20902	4131	9403	10	27	867	174	11	691	305	403	357	110	416
Grand Totals			**38210**	**2938**	**5342**	**20895**	**262**	**67572**	**7693**	**31052**	**59**	**203**	**2932**	**2136**	**472**	**1291**	**485**	**1596**	**1139**	**931**	**1471**
W/S total area = 184,300 Ac																					

Note: Totals were estimated by multiplying the number of acres, animals and forms filed in each municipality by the percentage of their land area in the watershed.

PHASE 2 – MILLSTONE MAINSTEM ANALYSIS

Study Area

The primary study area for the purpose of examination of various flood mitigation measures includes those parts of Franklin, Hillsborough, Montgomery, Princeton, and South Brunswick Townships and Millstone and Rocky Hill Boroughs adjacent to the Millstone River corridor. The study area does not include Zarephath in Franklin Township or Manville Borough. The Corps of Engineers is currently conducting a Feasibility Study of the flooding in the Manville Borough and Zarephath vicinity.

Methodology for Flood Damage Evaluation

Hydrology and Hydraulics

The modeling effort on the Millstone River Watershed consisted of using the Natural Resources Conservation Service SITES model to determine the size and costs of 26 dams at strategic locations throughout the 184,300 acre Millstone River watershed. Once costs were generated, a benefit to cost analysis was performed to determine the cost-effectiveness of the proposed structures.

Hydrology was limited to evaluation of United States Geological Survey gage data using the Log Pearson Type III analysis and a Transfer Equation to generate discharges at various locations throughout the Millstone River Watershed. This transfer equation approach set a proportionality factor based on tributary drainage area related to known gage data. The storm frequencies analyzed included: the 2-year, 10-year, 50-year, 100-year, and New Jersey Flood Hazard Area Design Flood (125% of the 100-year storm frequency). On July 8, 2002, concurrence on the watershed hydrology was received from Robert Schopp, Hydrologist, of the United States Geological Survey.

These were the discharges used to evaluate the hydraulics. This hydrologic evaluation used the current land use condition and there was no hydrologic evaluation using the future land use condition of the watershed. A review of the hydrology and hydraulics evaluation is shown in Appendix F.

Structure Elevation Survey

During April to October 2001 NRCS conducted a structure-by-structure elevation survey of over 170 structures in the Steering Committee high priority flood damage area 11-mile lower Millstone River corridor through Franklin, Hillsborough, Montgomery, Princeton and South Brunswick Townships and Millstone and Rocky Hill Boroughs. The purpose of the survey was to determine elevations of all the structures and their vulnerability to various flood events. Individual structures were chosen to be surveyed based on the FEMA 100 year flood zone. Information obtained included first floor, low opening (basement window or door) and adjacent ground elevations. The survey also included Zarephath in Franklin Township. The survey did not include Manville Borough as the U.S. Army Corps of Engineers Study includes that location.

The survey was tied into known elevation benchmarks. Elevations were developed using Somerset County, New Jersey Water Supply Authority, U.S. Geological Survey and New Jersey Coastal and Geodetic Survey existing benchmarks. The survey was based on the 1929 datum. During the process of the survey it was determined that a benchmark shown on the Millstone Borough Flood Insurance Study map was in error by approximately eight feet lower than the actual elevation. The elevation had been used to develop Elevation Certificates for National Flood Insurance Program rating for several structures there. As a result, the survey will assist those property owners who have flood insurance to verify their elevation and perhaps lower their annual flood insurance premium.

Table 10 shows the results of the survey and the type and number of structures which are affected by flooding under various types of storm events. The table also shows the flood damages (structure and contents) caused by different frequency storms. These damages are from the URB-1 analysis which will be described in the following section. A total of 87 structures, including 45 homes and 13 businesses are affected by the 100-year frequency flood.

Table 10 – Properties Flooded by Predicted Frequency

Total Damage and Number of Structures Flooded by Storm Frequency						
Storm Frequency	Storm Event			# Buildings flooded		Total Damages
1.0	100 yr.			87		2,671,221
2.0	50 yr.			63		1,668,231
10.0	10 yr.			15		280,436
50.0	2 yr.			4		93,782

Note: This table shows the damages that would be expected to occur from a flood of a particular frequency, and the number of structures flooded.

Economic

Flood damage was analyzed in the high priority study area using a computer program called URB1. This is a fairly simple, flood damage analysis program developed by NRCS. The following input data was used for the main stem analysis, but was later modified for the Millstone Borough, Phase III study:

Data	Source
Storm Frequencies Evaluated	2, 10, 50 and 100 year
Water Surface Profiles	2, 10, 50 and 100 year
Structure Elevations	Above-mentioned elevation study
Structure Value	Current (2001) assessed values obtained from the local tax assessors
Structure Content Value	Assumed to equal 50% of the structure value
Depth vs. Damage functions	These relate the percent damage to the structure and content based on their values caused by one foot increments of floodwater depth. The higher the floodwater depth, the greater the damage. These functions are specific to the type of structure evaluated and were obtained from various government agencies.

As part of the analysis, only flood damage to the structures and their contents was evaluated. It was recognized that other forms of flood damage occur, however, these two categories of damage are generally by far the greatest.

URB 1 computes what are termed average annual damages (structural and content). This dollar figure is the average annual damage of all buildings per year expanded over the evaluation period for the storm frequencies chosen. It also computes the average annual damage per structure and the storm frequency at which damage begins. For this study, damages were computed for only the present conditions, thus the effects of future development and land use patterns were not considered.

Table 11 shows a summary of the average annual flood damages for the vicinity.

A benefit-cost ratio was calculated by comparing average annual damages (benefits) against the average annual costs of reducing flood damage.

Road and bridge damages were evaluated based on road closure and traffic count information obtained from Somerset County Engineering and municipal public works departments.

All the alternatives were evaluated using the same property values and flood damage inundation relationships. This gave values at the same level of comparison for each alternative.

While evaluating the nonstructural alternatives in Millstone Borough, historic values, approved by the State Historic Preservation Office, were used to add twenty (20) percent to the values developed using the standard stage damage charts. The twenty percent reflects the 20 percent tax credit given by the Internal Revenue Service when a structure is historically restored according to the Secretary of the Interior standards and to reflect the cost of workmanship and materials to make restoration historically correct.

In addition to flooded structures, there are a number of other categories of flood damages which occur in the watershed. These categories include historic structure flooding, lost recreational user days in the D&R Canal State Park, lost time due to closed businesses, and road and bridge flooding. Road and bridge flooding can cause major changes in emergency fire and ambulance routes, lengthen worker commutes and add further congestion to other already congested roads. Other flood damage categories include clean up, traffic, basement pumpouts and fire and police costs. During Hurricane Floyd flooding all Millstone River crossings at Manville Borough upstream to and including Route 27 at Kingston were closed. Those wishing to cross the River had to cross at Princeton. These closings included Route 610 (Wihousky Street) in Manville Borough, Route 514 (Amwell Road) at Millstone Borough, Blackwells Mills Road, Griggstown Road and Route 518 (Washington Street) at Rocky Hill. Table 12 shows the road and bridges closed and the frequency of flooding under the current land use/cover conditions in the watershed.

Table 11 - Summary of Average Annual Flood Damages (Structural & Content) Millstone River from Weston Canal Causeway to Carnegie Lake

	Residential Dwellings		Residential Outbuildings, etc		Commercial Enterprises		Other (historical, etc.)		Total for Town	
Municipality	Total Flooded	Total Average Annual Damages	Total Flooded	Total Avg Annual Damages	Total Flooded	Total Avg Annual Damages	Total Flooded	Total Avg Annual Damages	Strucs flooded	Average Annual Damages
Franklin	15	28,080	7	778	4	804	2	28,455	28	58,117
Hillsborough	9	11,385	7	631	1	2,731	2	2,729	19	17,476
Millstone Boro	15	35,339	8	4,555	7	7,800			30	47,694
Montgomery	3	2,154	1	247					4	2,401
Rocky Hill	2	1,236	1	84	1	391			4	1,711
So. Brunswick	1	37,365					1	288	2	37,653
Total	45	115,559	24	6,295	13	11,726	5	31,472	87	165,052

Note: Average annual damage is the average damage per year from all floods (statistically speaking). It can be used as an Indicator of the severity of the flooding problem, and in benefit-cost analysis.

Table 12 shows the impact of flooding on various Millstone River crossings over time.

Table 12 - Flooding Impacts on River and Stream Road Crossings

	Vehicle Trips			Number of Road Closures					
Name of River or Stream Crossing	Peak Hourly Weekday Morning Traffic	Peak Hourly Weekday Afternoon Traffic	Average Daily Weekday Traffic	1971-1996	1999	2000	2001	2002	2003
Weston Canal Road	1314	1145	7635	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Millstone (Route 514) Causeway	1051	1294	7958	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Blackwells Mill Road	485	343	3133	59	3	1	3	1	8
Griggstown Causeway	514	430	2891	59	7	4	6	5	13
South Middlebush Road at Six Mile Run and Middlebush Creek crossings			16,162	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Vehicle Trip Source: Somerset County Engineering Office
Vehicle Trips – Weston Canal Road and Millstone (Route 514) Causeway, March 2001
Vehicle Trips – Blackwells Mills and Griggstown, January 2001
Road Closings data from Somerset County Flood Information System
N.A. – There is no road closing data is for the Weston Canal Road or Millstone (Route 514) crossings. These roadways appear to be higher in elevation and are able to pass more commonly occurring flood events.
Also there are no road closing data for South Middlebush Road crossings of Six Mile Run and Middlebush Creek which carry 16,162 vehicle trips on an average weekday

Minimum Standards to be Met for Flood Protection

Preliminary cost data were developed for each option. The technical advisory committee held a formulation meeting to develop an initial list of alternatives. Each option was considered alone and then in various combinations in an effort to meet the Steering Committee's objectives. Alternatives were developed to maximize flood damage reduction through the 100-year flood.

The 100-year flood was selected because it is consistent with the Steering Committee's objectives. A 100-year evaluation period was used because this is the planned life expectancy and minimum engineering standards for many of the improvements being considered, it complements the criteria used in the National Flood Insurance Program, FEMA programs and local floodplain management ordinances. These ordinances require that buildings to be floodproofed, elevated or moved must be protected, elevated or moved above the base flood elevation. The base flood, as designated by FEMA is the 100-year (1% frequency or 1% chance of occurrence) flood.

The analysis, particularly the flood water storage option, was complicated by a number of factors including:

Lack of any hydrology and hydraulics to show the impact of these sites individually and collectively on downstream flooding
Multipurpose nature of most sites (flood damage reduction and water–based recreation and water supply at two sites)
Lack of data on what proportion of flooding at downstream areas including Zarephath in Franklin Township is due to the Millstone River vs. backwater effects from the Raritan River

A January 2002 Planning Team meeting resulted in an agreement that NRCS would initially analyze the benefits and costs of various flood damage reduction alternatives. If we found that these alternatives did not meet the benefits vs. costs screening then these would be discarded. On the other hand, if alternatives successfully completed this screening process, then further analysis would be necessary.

Flood Damage Reduction Alternatives Considered

Federal planning of water and related land resource projects is governed by the document "Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies" (P&G)(U.S. Water Resources Council, 1983). The document is intended to ensure proper and consistent planning by all federal agencies in the formulation and evaluation of water and related land resource implementation studies.

All alternatives were evaluated in consideration of the following criteria: completeness, effectiveness, efficiency and acceptability.

Completeness - provides the opportunity to reduce flood damages for the entire high priority flood damage area.

Effectiveness - measures the extent to which an alternative reduces identified problems or achieves specified opportunities.

Efficiency - the alternative is cost-efficient in reducing flood damages relative to other alternatives and, if possible, provides for net economic benefits.

Acceptable - does not have insurmountable adverse effects on the human environment that cannot be mitigated and has the potential to be supported by the public, receive federal, state and local financial assistance or be affordable without financial assistance, receive all necessary permits required by local, state and federal agencies. local government, and the public, and compatibility with existing laws, regulations and policies.

Table 13 displays the flood damage reduction alternatives considered. Floodwater storage structures and levees were considered on a watershed-wide basis. Floodwater storage structures were evaluated for 26 locations throughout the watershed. Dikes and levees were evaluated for four locations in the Lower Millstone River high priority area, namely, Hillsborough Township, Millstone Borough, East Millstone and Griggstown. The remaining alternatives - structure elevation, relocation, floodproofing and buyouts - were evaluated only in Millstone Borough where the greatest density of potentially benefited structures exist in the high priority flood area.

Table 13 - Flood Damage Reduction Alternatives Considered

Flood Mitigation Measure Studied	Watershed Location
Flood Water Storage	Watershed - wide
Levees	Watershed - wide
Elevation of Structures	Millstone Borough
Floodwalls	Millstone Borough
Relocation of Structures	Millstone Borough
Acquisition of Properties (Buyouts)	Millstone Borough
Enhancement and Expansion of Existing Flood Warning System	Millstone Borough
No Action	Watershed - Wide

Potential Flood Water Storage Sites Evaluated

The NRCS SITES model was used to analyze 26 sites (Figure 10) from a topographic and water storage perspective and to develop a total construction cost. The SITES software is a descendent of the DAMS2 program. DAMS2 was a full-featured rainfall-runoff routing program developed for watershed dam design and analysis. In developing the SITES software, DAMS2 was recoded and the auxiliary (emergency) spillway analysis portion of the program was rewritten and expanded to include new technology for spillway performance evaluation. This technology was developed through the joint efforts of the Agricultural Research Service (ARS) and the NRCS. The Integrated Development Environment (IDE) for the SITES software was developed cooperatively by NRCS, ARS, and Kansas State University.

The 26 sites included both existing dam sites (many requiring State Dam Safety Act upgrading) and new sites where there is no existing dam but the site is largely undeveloped and is in an apparently good location for water detention. Table 14 shows the estimated costs and benefits associated with each of the 26 sites that were evaluated. Columns C through E show the costs of each of the structures including land rights, but not road or utility relocations. Most of these sites would require the purchase of large tracts of land to temporarily store the large volumes of floodwater. As a result, real estate costs represented 2/3 to 3/4 of the overall installation costs. Columns F through H list the costs associated with developing a water based recreation facility at each site. Columns I through M compare the benefits and costs with column L showing the benefit to cost ratio. Each site was assigned flood control benefits (Table 14) in proportion to the amount of the total watershed which drained to that site. The last column indicates the proportion of the site's total benefits that are derived from the proposed recreation facility. The proportion of total benefits that would be allocated to recreation and not flood damage reduction was far greater than permitted under the PL83-566 Program.

This methodology did not consider subsurface conditions and associated costs. In order to proportion the needed flood storage in flood control dams the NRCS allots a storage volume for sediment, both submerged and aerated. The storage allotted is based on the life of the structure (100 years). If increased sedimentation should occur the excess should exit through the outlet control structure, thus ensuring no decrease in available flood storage. Likewise for multiple purpose flood control structures, proportioning of water supply and/or recreation storage is set below the required flood storage.

Recreational Considerations

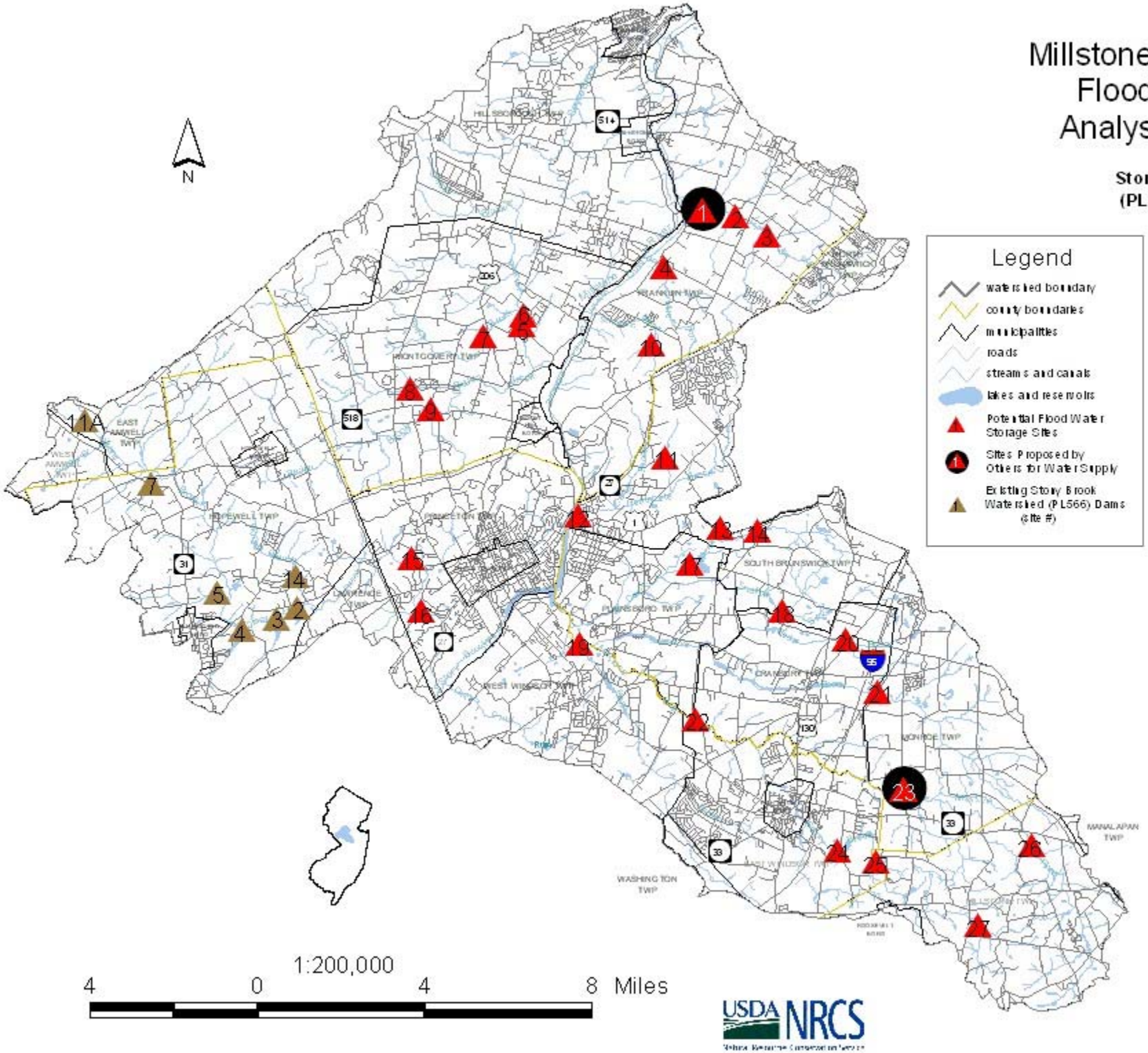
Recreational costs and benefits were developed in December 2001 as a result of the Steering Committee objective to improve water-based recreational opportunities. The minutes of a meeting held with County and local recreation interests on September 26, 2001 are in Appendix G. The State Comprehensive Outdoor Recreation Plan identifies this region as a region lacking water-based outdoor recreation facilities. As a result, water-based recreation facilities were planned for each of the 26 sites. Typical components of a recreational development include public access, boat ramps, picnic, recreation and sanitary facilities. The size of each facility was in direct proportion to the size of the lake that would be constructed in conjunction with each flood control dam. Cost could be shared and each dam site could provide multiple benefits by planning each dam as a multi-purpose flood control and recreation site.

Benefits at each site were computed by assigning a dollar value to each projected user day. User days were calculated based on the size of the facility, the general population and the demand for a particular type of recreation activity. Table 15 shows the costs and benefits associated with each recreational development (USDA NRCS, Ready Reference). Each site had a favorable cost-benefit ratio when comparing the recreation benefits to the costs of providing them.

Water Supply Considerations

Water supply was a potential benefit associated with at least two of the 26 sites (Six Mile Run and Applegarth Road), which are planned as future water supply reservoirs by the New Jersey Water Supply Authority and Monroe Township Utilities Authority, respectively. Water supply, while not a cost-shared item under PL83-566, is considered to be a project purpose.

Figure 10
Millstone River Watershed Floodwater Storage Analysis Location Map
with Existing Stony Brook Watershed (PL566) Dam Locations



1 Six Mile Run, site 1
2 Six Mile Run, site 2
3 Six Mile Run, site 3
4 Ten Mile Run site
5 Bridgepoint Lake, site 1
6 Bridgepoint Lake, site 2
7 Bridgepoint Lake, site 3
8 Sylvan Lake site
9 Beden Brook, site 1
10 Simonson Brook site
11 Heathcote Brook Branch site
12 Carnegie Lake site
13 site adjacent to Sourdek Park
14 Devils Brook site
15 Stony Brook, site 2
16 Stony Brook, site 1
17 McCormack Lake site
18 Shallow Brook site
19 Penns Neck site
20 Cedar Brook site
21 Cranbury Brook site
22 Cranbury Neck site
23 Applegarth Road site
24 Etra Lake site
25 Mercer-Monmouth site
26 Smith site
27 Perrineville Lake site
2 Willow Lake
3 Rosedale Lake
4 Curtis Lake
5 Baldwin Lake
7 Hunt Lake
11A Amwell Lake
14 Honey Lake

Table 14 - Flood Water Storage Structure Benefits and Costs (Recreation & Flood Control)

A	B	C	D	E	F	G	H	I	J	K	L	M
Site Information		Flood Control Costs			Recreation Development Costs			Benefit - Cost Comparison				
Site Name	Drain-age area as % of Watershed	Installation Cost Not Including Roads or Utility Relocations	Annual Operation & Maintennce Costs	Average Annual Cost	Total Recreational Development Cost	Ann'l Operation & Maintenance Costs ($2.65) x Total Recreational User Days)	Ave Ann Cost incl O&M (100 yrs @6.125%)	Ave Ann flood cntrl Benefits per site $170,000 X % W/S	Ave Ann recreation benefits / site	Total Ave Ann Flood control & recreation benefits	Benefit to Cost Ratio	% Recreation benefits
Applegarth Road	5.09	11,364,611	5,700	701,782	5,092,000	1,425,721	1,737,606	8,648	2,205,833	2,214,481	0.91	99.6%
Beden Brook	4.26	7,124,630	7,100	443,484	2,090,500	529,926	657,969	7,250	819,885	827,135	0.75	99.1%
Bridgepoint 1	7.18	9,467,104	5,300	585,160	3,002,500	793,039	976,942	12,202	1,226,966	1,239,168	0.79	99.0%
Bridgepoint 2	7.04	9,920,878	7,200	614,854	3,002,500	791,979	975,882	11,965	1,225,326	1,237,291	0.78	99.0%
Bridgepoint 3	1.39	3,077,154	3,500	191,976	1,172,000	211,014	282,799	2,357	326,475	328,832	0.69	99.3%
Cedar Brook	0.82	3,314,477	4,700	207,712	1,578,000	325,611	422,263	1,392	503,775	505,167	0.80	99.7%
Cranbury Brook	4.09	9,813,851	3,800	604,898	6,803,500	1,877,748	2,294,462	6,954	2,905,194	2,912,148	1.00	99.8%
Cranbury Neck	14.28	16,589,549	14,100	1,030,210	6,684,500	1,892,439	2,301,865	24,280	2,927,925	2,952,205	0.89	99.2%
Devils Brook	1.39	11,977,079	29,400	762,996	1,315,500	261,746	342,320	2,369	404,965	407,335	0.37	99.4%
Etra Lake	3.01	5,380,364	7,400	336,947	2,323,500	579,990	722,304	5,124	897,342	902,466	0.85	99.4%
Heathcote Brook	0.28	2,895,217	7,900	185,232	175,500	45,347	56,096	480	70,159	70,639	0.29	99.3%
McCormack Lake	2.06	6,504,518	13,900	412,302	2,190,500	513,496	647,664	3,495	794,465	797,960	0.75	99.6%
Mercer-Monmouth	2.16	8,767,401	18,600	555,603	2,021,500	567,672	691,489	3,672	878,286	881,958	0.71	99.6%
Penns Neck Upper Bear Swamp	36.56	52,301,431	18,900	3,222,363	10,422,000	3,380,944	4,019,292	62,154	5,230,895	5,293,048	0.73	98.8%
Perrineville Lake	0.95	2,910,073	6,700	184,942	618,000	157,760	195,612	1,617	244,081	245,698	0.65	99.3%
Sondek Park (Adjacent)	0.56	2,763,847	2,000	171,286	955,000	169,918	228,412	948	262,892	263,840	0.66	99.6%
Shallow Brook	1.24	6,416,641	8,800	401,819	1,616,500	368,074	467,085	2,115	569,474	571,588	0.66	99.6%
Simonson Brook	0.34	1,331,351	3,100	84,645	109,000	27,337	34,014	586	42,296	42,882	0.36	98.6%
Six Mile Run Site 1a	5.57	11,020,778	5,400	680,423	6,698,500	1,859,675	2,269,958	9,477	2,877,232	2,886,710	0.98	99.7%
Six Mile Run Site 2	3.66	4,700,974	1,700	289,635	2,901,000	744,449	922,135	6,220	1,151,788	1,158,008	0.96	99.5%
Six Mile Run Site 3	2.23	3,207,898	1,400	197,884	2,218,500	525,612	661,495	3,791	813,210	817,001	0.95	99.5%
Stonybrook Site 1	14.46	9,412,752	9,800	586,331	2,925,500	768,267	947,454	24,582	1,188,639	1,213,221	0.79	98.0%
Stonybrook Site 2	12.72	11,615,605	20,800	732,256	2,019,000	496,228	619,892	21,620	767,750	789,370	0.58	97.3%
Smith Site	2.10	5,588,733	8,300	350,610	1,882,500	426,067	541,370	3,572	659,198	662,770	0.74	99.5%
Sylvan Lake (Skillman Dam)	3.20	5,190,473	13,900	331,816	1,606,000	351,507	449,874	5,438	543,840	549,278	0.70	99.0%
Ten Mile Run	1.37	4,207,705	8,500	266,222	567,500	167,798	202,557	2,334	259,612	261,946	0.56	99.1%

Table 15 - Potential Recreational Benefits and Costs Per Site

Site Name	Permanent Pool (Acres)	Flood Pool (Acres)	Total Recreational Development Cost	Average Annual Recreational Development Costs	Annual Operation and Maintenance Costs	Total Average Annual Recreational Costs	Total Average Annual Recreational Benefits	Recreational Annual Benefits vs. Annual Costs
Applegarth Road	342	1312	5,092,000	311,885	1,425,721	1,737,606	2,205,833	1.27
Beden Brook	145	483	2,090,500	128,043	529,926	657,969	819,885	1.25
Bridgepoint 1	247	715	3,002,500	183,903	793,039	976,942	1,226,966	1.26
Bridgepoint 2	243	715	3,002,500	183,903	791,979	975,882	1,225,326	1.26
Bridgepoint 3	59	192	1,172,000	71,785	211,014	282,799	326,475	1.15
Cedar Brook	46	308	1,578,000	96,653	325,611	422,263	503,775	1.19
Cranbury Brook	170	1801	6,803,500	416,714	1,877,748	2,294,462	2,905,194	1.27
Cranbury Neck	356	1767	6,684,500	409,426	1,892,439	2,301,865	2,927,925	1.27
Devils Brook	93	233	1,315,500	80,574	261,746	342,320	404,965	1.18
Etra Lake	188	521	2,323,500	142,314	579,990	722,304	897,342	1.24
Heathcote Brook	6	43	175,500	10,749	45,347	56,096	70,159	1.25
McCormack Lake	83	483	2,190,500	134,168	513,496	647,664	794,465	1.23
Mercer-Monmouth	34	549	2,021,500	123,817	567,672	691,489	878,286	1.27
Penns Neck Upper Bear Swamp	2,421	2692	10,422,000	638,348	3,380,944	4,019,292	5,230,895	1.30
Perrineville Lake	27	148	618,000	37,853	157,760	195,612	244,081	1.25
Sondek Park (Adjacent)	142	130	955,000	58,494	169,918	228,412	262,892	1.15
Shallow Brook	184	319	1,616,500	99,011	368,074	467,085	569,474	1.22
Simonson Brook	11	24	109,000	6,676	27,337	34,014	42,296	1.24
Six Mile Run Site 1a	217	1771	6,698,500	410,283	1,859,675	2,269,958	2,877,232	1.27
Six Mile Run Site 2	175	686	2,901,000	177,686	744,449	922,135	1,151,788	1.25
Six Mile Run Site 3	98	491	2,218,500	135,883	525,612	661,495	813,210	1.23
Stony Brook Site 1	238	693	2,925,500	179,187	768,267	947,454	1,188,639	1.25
Stony Brook Site 2	206	434	2,019,000	123,664	496,228	619,892	767,750	1.24
Smith Site	91	395	1,882,500	115,303	426,067	541,370	659,198	1.22
Sylvan Lake (Skillman Dam)	113	316	1,606,000	98,368	351,507	449,874	543,840	1.21

Reasons for Not Developing Flood Water Storage Further

The option of building flood water storage would not meet Steering Committee's objectives in terms of flood damage mitigation as well as other more cost-effective alternatives. Although the impact of any one structure or combination of structures on those flood damages not caused by Raritan River backwater could be significant, flood mitigation benefits are relatively small versus the cost associated with dam construction. The significant cost of real estate, whether already publicly owned or not, for the construction or retrofitting of an existing dam resulted in this alternative not meeting Federal program benefit cost guidelines. The flood water storage alternatives all had costs that greatly exceeded benefits, and could not be studied further. In terms of the four Water Resources Council Principles and Guidelines (P&G):

1. Complete - no, it would not account for Raritan River backwater flooding due to runoff from the South Branch and Upper Raritan subwatersheds.
2. Effective - yes, it would provide protection of downstream properties exclusive of the Raritan River backwater area.
3. Efficient - no, other alternatives are more cost-efficient for similar benefits.
4. Acceptable - maybe, high sponsor costs for acquisition of necessary land rights, may be difficult to satisfactorily obtain permits to impact any wetlands, potential multi-purpose uses including public water supply and water-based recreation in a known deficit area.

Levees

Four locations in Hillsborough Township, Millstone Borough, East Millstone (Franklin Township), and Griggstown (Franklin Township) were the sites chosen for potential levees (Figure 13). NRCS used the unit costs of earthen levees, flood walls and road closures developed by the US Army Corps of Engineers for the Green Brook Flood Control Project. Earthen levees, the lowest cost levee option, were planned wherever there was sufficient room for construction without affecting homes or businesses or encroachment on the Millstone River. Costs associated with interior drainage such as pumps and floodgates, utility relocation, permits, land rights acquisition and armoring of the levee were not included. Benefits included prevented structure damage only and did not include income lost, emergency costs and road closures. None of the four locations had a positive benefit cost ratio for levee construction.

Reasons for Not Developing Levees Further

This option of building levees could meet the Steering Committee's objective for reducing flood damages, except it is not a cost effective approach relative to other alternatives being developed. Costs for all dike locations are much greater than the actual flood damage benefits received and relative to other possible alternatives. Operation and maintenance (O&M) for dikes would be mowing, control of woody vegetation,

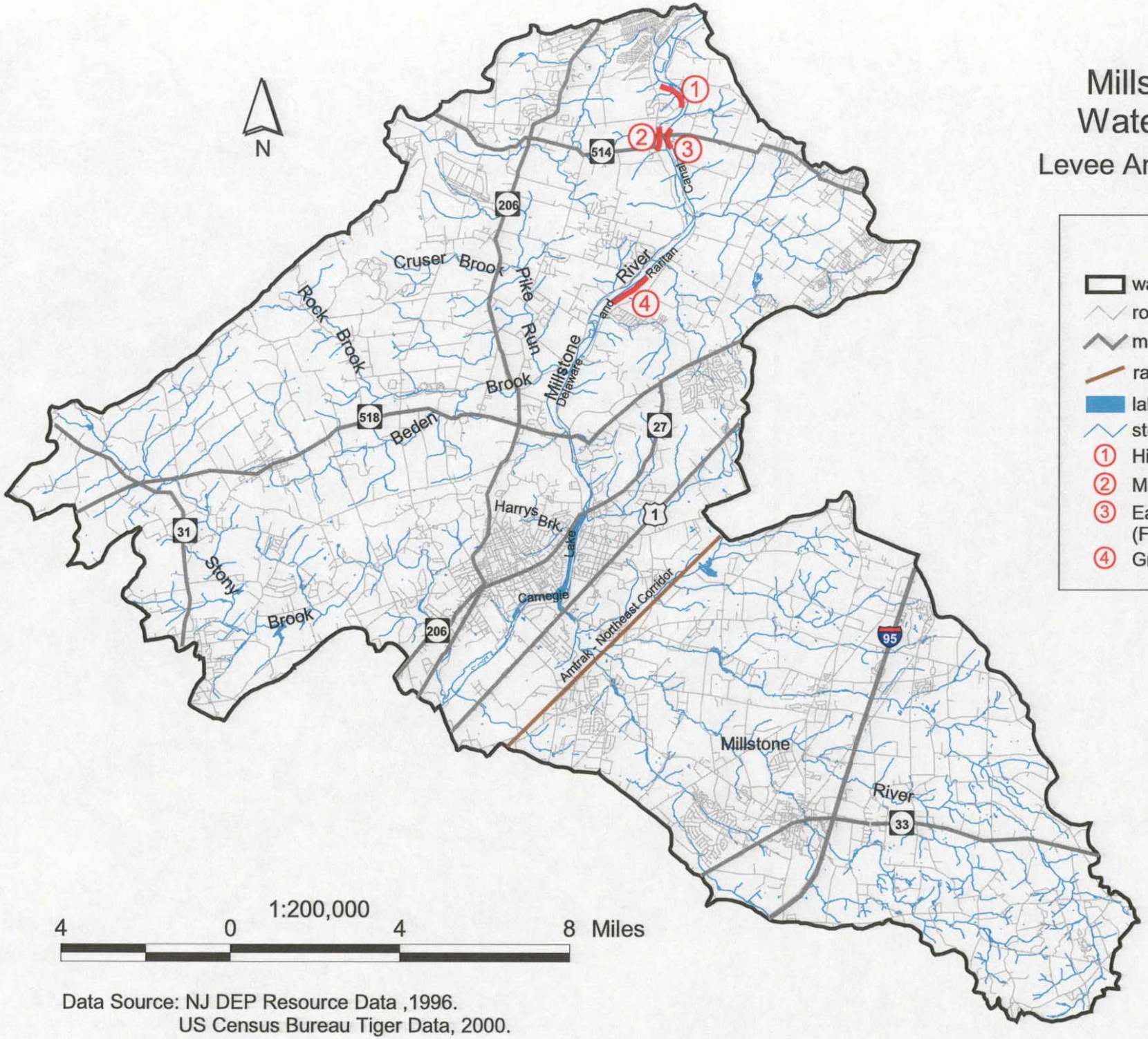
replacement of rock riprap and the filling in and seeding of rills after large flood events. In terms of the four Water Resources Council Principles and Guidelines (P&G):

1. Complete - yes, if combined with nonstructural measures for non-dike areas
2. Effective - yes, complete protection of buildings behind each dike/floodwall for floods up to the 100 year frequency flood
3. Efficient - no, other alternatives are much more cost-efficient for similar benefits
4. Acceptable - unlikely, due to the impact to the viewshed of the River in National and State Historic Districts such as Millstone Borough (dikes would be over 15 feet high in some locations).

Figure 11

Millstone River Watershed Map

Levee Analysis Locations



KEY

- watershed boundary
- roads
- major roads
- railroads
- lakes and reservoirs
- streams
- ① Hillsborough Township
- ② Millstone Borough
- ③ East Millstone (Franklin Township)
- ④ Griggstown

Data Source: NJ DEP Resource Data ,1996.
US Census Bureau Tiger Data, 2000.

USDA NRCS
Natural Resources Conservation Service
March 2004

PHASE 3 – MILLSTONE BOROUGH ANALYSIS

An intensive investigation of flood damages and alternative solutions was conducted in Millstone Borough. As previously mentioned, this area was chosen for a detailed investigation due both to its long history of flooding as well as the concentration of damages in a relatively compact area. Millstone Borough has the greatest historical damages of any municipality on a per structure basis. Because of these factors it was felt that one or more feasible solutions might be found. Figure 14 shows the flood vulnerability of the first floor of Millstone Borough structures. Several flood damage reduction alternatives were analyzed with the hope of reducing flood damages in the Borough of Millstone.

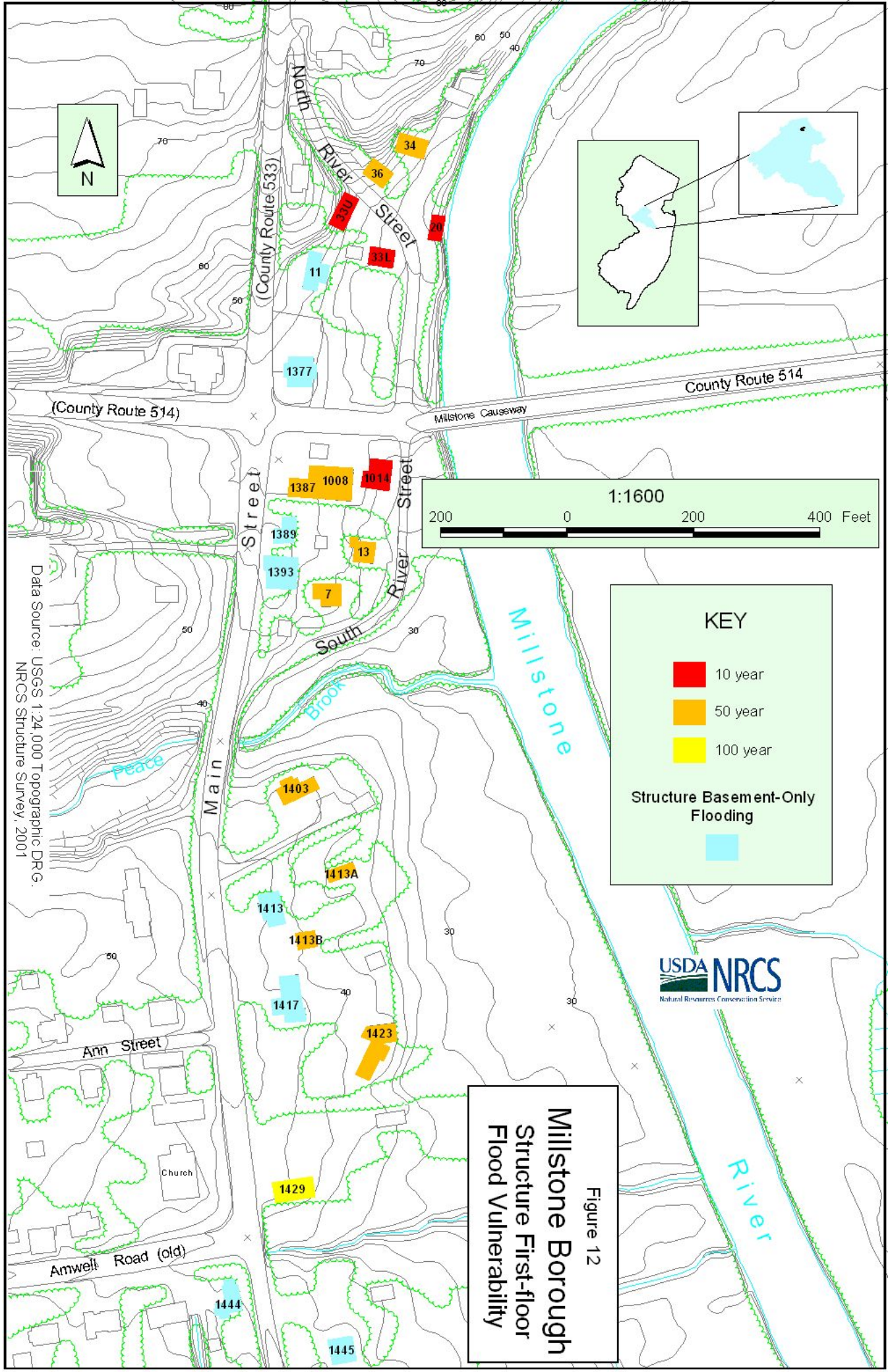
The URB1 model that was used reflected several input changes from the previous watershed main stem model used in Phase II. First, the assessed values were updated using the more current values from the latest assessment. Secondly, those structures with historic significance had their values increased by an additional twenty percent. This increase reflected the increased cost of restoring a historic structure, and was in keeping with the Internal Revenue Service twenty percent tax credit allowed for restoration of historic structures. FEMA has used this previously in a Flood Mitigation Assistance Program project in Pennsylvania. These increases resulted in a revised average annual damage computation of $61,700. Twenty three structures, most of which were residential dwellings, are subject to these damages. An additional category of benefits was evaluated which consisted of reduced flood insurance premiums. Under FEMA guidelines, structures protected from flooding can qualify for a reduced or eliminated premium.

Structural Measure

Floodwall

Earlier in the analysis, a levee located away from protected structures was considered, however, it was thought that to bring some type of “low level” levee/floodwall more closely located adjacent to the structures needing protection might be more economically feasible. This alternative was found to not meet the benefit cost test and, in general, was not publicly acceptable.

1. Complete – yes, this would protect the contents of the structure and emergency escape route from structures.
2. Effective – yes, complete protection of structures and their contents up to the 100 year flood without the need for major interior drainage costs.
3. Efficient – no, other alternatives are more cost-efficient for similar benefits
4. Acceptable – no, this alternative is generally unacceptable by property owners due to the impact to viewshed of the River in National and State Historic Districts such as Millstone Borough.


N
North River
(County Route 533)
Street
34
36
33U
20
33L
11
1377
(County Route 514)
County Route 514
Millstone Causeway
1387
1008
1014
Main Street
South River
1389
1393
13
7
1:1600
200 0 200 400 Feet
Data Source: USGS 1:24,000 Topographic DRG.
NRCS Structure Survey, 2001
KEY
10 year
50 year
100 year
Structure Basement-Only Flooding
Millstone
Brook
Peace
1403
1413A
1413
1413B
1417
1423
Ann Street
Church
1429
Amwell Road (old)
1444
1445
River
USDA NRCS
Natural Resources Conservation Service
Figure 12
Millstone Borough
Structure First-floor
Flood Vulnerability

Nonstructural Measures

The focus of the nonstructural measures analysis was in Millstone Borough where, due to the relatively large group of flooded structures and the history of repetitive flood loss claims under the National Flood Insurance Program, it was felt there was the best chance for showing a positive benefit cost ratio under the P&G guidelines.

Nonstructural measures specifically analyzed including elevation of individual structures, installation of a flood wall and/or floodproofing. Other nonstructural measures considered but not specifically analyzed included voluntary relocation and buyout options.

Elevation

Information from the costs for elevation of structures at the nearby and on-going State OEM/FEMA-funded North Branch village project was used to develop the cost estimates. A certain amount of cost is associated with the actual lifting of a structure, however, the greater portion of the cost is related to the labor and materials to reconstruct a foundation through which water can flow during a flood event and still provide an adequate structure foundation. The amount of lift required was based on the 2001 structure survey plus one foot of freeboard. It was determined that this alternative had greater costs than benefits.

Complete – partly, this would protect the contents of the structure but would not specifically allow an emergency escape route should the flood water rise above the 100 year frequency flood plus one foot freeboard elevation.
Effective – yes, complete protection of buildings and their contents up to the 100 year frequency flood
Efficient - yes, no other alternatives are as cost-efficient for similar benefits
Acceptable – yes, most acceptable alternative, in terms of the impact to viewshed of the River in National and State Historic Districts such as Millstone Borough.

Flood Proofing

Flood proofing was analyzed, particularly for those structures where flood water would be three feet or less above the ground (at the structure) in a 100 year frequency flood event. Specifically targeted in the analysis were commercial structures on Amwell Road. This alternative was also determined to not meet the benefit cost test.

Complete – no, this alternative would provide protection of the contents of structure, however, it would not permit an emergency escape route.
Effective – partly, protection of structure contents would be accomplished but no protection of the structure itself.
Efficient – no, other alternatives are more cost-efficient for similar benefits
Acceptable – yes, this alternative would minimally impact the visual appearance of treated structures.

Relocation

Some of the costs associated with the elevation alternative would be part of the relocation option. This alternative was not analyzed in detail due to the lack of a positive benefit cost analysis for the elevation alternative. It was thought, due to the need to account for the costs associated with moving the structure as well as land acquisition (even where already

government-owned), the relocation option would similarly not meet the benefit cost test. On the other hand, the government-owned land may be eligible as a local sponsor cost if made available free of charge to the structure owners.

Complete – yes, this alternative would be the best of any alternative considered thus far in terms of removal of the structure and its contents from the flood plain.
Effective – yes, protection of the structure and its contents would be accomplished
Efficient – no, other alternatives may be more cost-efficient for similar benefits
Acceptable – partly, this alternative would change the visual appearance of the River corridor and the National and State Historic District.

Buyout

The buyout option was not analyzed in any great detail due to the cost of buyouts, the cost of finding replacement housing for displaced property owners and the likelihood of property owner and public acceptance of this option in the National and State Historic District-designated Millstone Borough.

Complete – yes, this alternative would be the best of any alternative considered, except the relocation alternative, in terms of removal of the structure and its contents from the flood plain.
Effective – yes, structure and its contents would be removed from the flood plain.
Efficient – no, the relocation alternative may be more cost-efficient for similar benefits.
Acceptable – no, this alternative would change the visual appearance of the River corridor and remove historic structures from the National and State Historic District.

Enhancement and Expansion of Existing Flood Warning System

Somerset County Engineering currently maintains a Flood Information System tied to U.S. Weather Service and U.S.G.S. real time streamflow data. As the stage height increases, information is provided to local leaders (via Fax) including the Millstone Borough Mayor and the local Emergency Management Coordinator. Since this information can be accessed from the Somerset County Flood Information website, it was felt that individual property owners could benefit. Until the NRCS structure-by-structure survey in 2001, this was not possible. Following the survey completion, first floor, low opening (basement/crawl space) and adjacent ground elevations became available for each individual structure in the Borough.

Considerable time and effort was spent with individual property owners in the flood zone area on this option. Meetings were held with most of the property owners to identify specific needs of each structure in terms of an individual flood action plan. The Individual Flood Information Sheet (Figure 15) shows the Blackwells Mills stream gage stage height relative to the first floor for a 100 year frequency flood event. Recommendations are given for how high to elevate contents of the first floor at various stage heights. Also, recommendations to consider taking in advance of the next flood are given.

Complete – no, this alternative would not provide for the protection of the structure and its contents. However, if provided in a timely manner, it could provide the opportunity for the safe evacuation of structure occupants, vehicles and, perhaps some easily removed structure contents.
Effective – no, structure and its contents would be damaged by flood.
Efficient – yes, the cost of this option is minimal as it is part of the on-going effort by Somerset County to provide information, available from other sources, in a form that will prove useful during a flood event.
Acceptable – no, this alternative, while providing for emergency evacuation, would not resolve the ongoing flood damage problem in Millstone Borough.

Figure 13 - Individual Property Flood Information Sheet

Each Individual Property Flood Information Sheet includes a photo of the property indicating the flood height based on local stream gage data with recommendations for reducing flood damages.

For further information, contact Greg Westfall.

gregory.westfall@nj.usda.gov

No Action Alternative

This alternative was not acceptable to the Steering Committee.

Several alternative solutions, singly and in combination, were evaluated. These included flood walls, levees or dikes, elevation (raising the structure's first floor above the 100 year frequency flood elevation), and flood proofing. While some alternatives for some structures came close to being economically justified, no combination of alternatives was able to provide flood protection to all 23 structures in a cost-efficient manner. The study was terminated as a result of this determination.

HARRYS BROOK

The Natural Resources Conservation Service surveyed the first floor, low opening and adjacent ground elevations for 10 residential properties in the Randall Drive and Meadowbrook Lane on Branch 2 of Harrys Brook as well as 5 residential properties on Locust Lane on the main stem of Harrys Brook in Princeton Township.

Table 5 presents a summary of the number and types of property that are vulnerable to flooding as defined by the 500, 100, 50, 10 and 2 year flood events under the flood depths as determined for Harrys Brook Branch 2 (FEMA FIS, 1984). Table 6 presents a summary of the number and types of property that are vulnerable to flooding as defined by the 500, 100, 50, 10 and 2 year flood events under the flood depths determined for Harrys Brook mainstem (FEMA FIS, 1984).

Comparing the elevations of the first floors and low openings (basement doors or windows) of the 10 homes in the Branch 2 vicinity (Meadowbrook and Braeburn)to the projected elevation of 5 different flood frequencies gave a good indication of their vulnerability to flooding. Table 5 below displays this information. In summary, 2 of the 10 homes studied were very flood prone in that they sustained flood damage that was frequent and substantial. Six of the remaining 8 homes were damaged less frequently, and two were not flooded. Not coincidently, the 2 homes found to be the most flood prone were those that had the most flood insurance claims in the FEMA database.

Similarly, the elevations of the first floor and low openings were compared with the 5 different flood for five homes in the Harrys Brook mainstem vicinity (Locust Lane). There was no structure which was identified as having first floor flooding, however, up to three structures, one of them under nearly every flood frequency, can have flood waters moving into their basements.

An economic analysis was done to compute the average annual flood damages for the ten (10) homes in Harrys Brook Branch 2. While in some cases the projected damages were significant, the small number of homes affected precluded further analysis as a PL83-566 Project.

Table 16 – Summary of Number of Flood Vulnerable Residential Properties in Harrys Brook Branch 2 (Meadowbrook Road) Vicinity

	Flood Frequency				
Flooding Location within Structure	2 Year (50%)	10 Year (10%)	50 Year (2%)	100 Year (1%)	500 Year (0.2%)
First Floor	1	2	2	3	4
Low Opening/ Basement	1	3	3	4	4

Note: For example a 2 year flood occurs (statistically speaking) every other year, and has a 50% (one in two) chance of occurring in any one year.

Data Sources: FEMA, 1984
USDA NRCS Structure Elevation Survey

Table 17 – Summary of Number of Flood Vulnerable Residential Properties in Harrys Brook Mainstem (Locust Lane) Vicinity

	Flood Frequency				
Flooding Location within Structure	2 Year (50%)	10 Year (10%)	50 Year (2%)	100 Year (1%)	500 Year (0.2%)
First Floor	-	-	-	-	-
Low Opening/ Basement	-	1	1	1	3

Note: For example a 2 year flood occurs (statistically speaking) every other year, and has a 50% (one in two) chance of occurring in any one year.

Data Sources: FEMA, 1984
USDA NRCS Structure Elevation Survey

Conclusions and Recommendations

Conclusions

A three phase investigation was made to determine the extent, location and frequency of flood problems in the Millstone River Watershed. A Steering Committee, made up of representatives of five counties and numerous municipalities, identified seven objectives for the watershed planning effort with flood damage reduction being the top priority. The Committee directed NRCS to identify the location, type and extent of flood damages from the Tropical Storm Floyd event and other historical flood events. Interviews were conducted and further study/analysis was conducted where appropriate. Based on interviews of municipal officials and data from the National Flood Insurance Program flood claims, the Committee identified two priority study areas in the watershed. These areas were the Lower Millstone River corridor including Manville, Franklin, Hillsborough, Millstone, Montgomery, Princeton, Rocky Hill and South Brunswick and the Harrys Brook watershed in Princeton Township. NRCS is conducting a study on the Harrys Brook watershed. The Lower Millstone River corridor high priority area is the focus of this report.

The Corps of Engineers is studying Manville Borough and NRCS studied upstream municipalities. NRCS intensively studied Millstone Borough since the per-structure flood losses are the greatest of any municipality in the watershed.

Several alternatives were studied to solve the flood problems. The alternatives were evaluated in terms of whether they were complete, effective, cost-effective and publicly acceptable. They ranged from large floodwater storage dams with multipurpose recreation facilities to the raising or elevation of individual homes and businesses. Large dams were ruled out due to their tremendous costs (due primarily to the cost of land for floodwater storage) as well as the fact that they were all located too far upstream from the flood prone areas to have a significant impact on downstream flooding. Each planned floodwater impoundment was designed with an associated water-based recreation facility. While these recreation components had a positive benefit-cost ratio, the flood control component did not. As a result, all 26 structures were dropped from further consideration as an alternative for effective flood control.

Additional alternatives were evaluated during the intensive flood study in the Borough of Millstone. These alternatives included floodwalls, buyouts/relocations, and floodproofing. While some of the alternatives came close to being cost effective, no single alternative or combination of alternatives could have a positive benefit cost ratio while at the same time protecting all the structures. Additionally some of the alternatives were deemed unacceptable to the residents. Planning efforts were halted as a result of the negative benefit-cost ratio.

In summary, with the exception of Manville and, to some extent, Millstone Borough, flooding is not a major problem throughout the watershed. Only 87 structures in the watershed are flooded by the large, infrequent 100 year frequency flood as noted in Table 10. The more frequent 2 year frequency flood that happens, on average, every other year, floods only 4 structures. Flooding, when it does occur, is confined mainly to those municipalities on the main stem of the Millstone River upstream to Carnegie Lake. One exception to this is Harrys Brook in Princeton Township where several residences suffer fairly frequent flooding. Other more frequently flooded areas are low lying roads such as South Middlebush Road (County Route 615), Griggstown Causeway and Blackwells Mills Causeway. The frequent flooding of these roadways causes major traffic problems several times a year.

Agricultural issues and concerns were investigated during the study. While several issues were found, without a viable flood control component these concerns cannot be addressed under the PL83-566 Program.

The issue of whether flooding will become worse in the future was not evaluated.
Increased flooding has been a problem for several municipalities. Since the PL83-566 Program was unable to solve the flood problem, there are several recommendations given below for municipalities and counties to consider to reduce their flood losses.

Recommendations

1. It is recommended that the municipalities and Somerset County consider the use of the Federal Emergency Management Agency (FEMA) Flood Mitigation Assistance (FMA) Program available through the New Jersey State Office of Emergency Management. The FEMA FMA is designed to reduce the number of repetitive flood loss claims in the National Flood Insurance Program (NFIP). A structure which has made two or more flood loss claims to the NFIP may be eligible to receive funding to reduce or eliminate flood losses. The FMA Program provides funding to municipalities that are participating in the National Flood Insurance Program to develop Flood Mitigation Plans. Following completion of a Flood Mitigation Plan, the municipality is eligible to receive project funding to elevate, relocate or remove (buyout) structures that have repetitive flood loss claims. Franklin Township completed a Flood Mitigation Plan and Millstone Borough, Montgomery and Princeton Townships are currently developing Flood Mitigation Plans with NRCS assistance.

2. Another recommendation is to consider the expansion of the Corps of Engineers Feasibility Study area to include other areas upstream of Manville. Early in the NRCS project, the US Army Corps of Engineers began a Millstone River Reconnaissance Study. The Corps and NRCS agreed that Manville would not be part of the NRCS project but that the NRCS would focus on the upstream communities and the Corps would focus on the Manville vicinity. As a result, the US Army Corps of Engineers (US ACOE) is currently doing a Manville Flood Control Feasibility Study. The USACOE uses the same Principles and Standards guidelines as NRCS which require a positive benefit cost ratio.

The above recommendations regard assistance available through Federal agencies including NRCS, FEMA and USACOE. An alternative approach would be to use funding available from State, county or local sources. A 2003 approved state bond issue may provide funding for flood control activities. Federal guidelines on cost-effectiveness would not affect such a project.

4. Since 1968 the National Flood Insurance Program (NFIP) has provided federally backed flood insurance to encourage communities to enact and enforce flood plain regulations (FIA, 1990). The program has been very successful in helping flood victims get back on their feet. In order to be covered by a flood insurance policy, a property must be in a community that participates in the NFIP. To qualify, a community adopts and enforces a flood plain management ordinance to regulate proposed development in flood hazard areas. The objective of the ordinance is to ensure that such

development will not aggravate existing flooding condition and that new buildings will be protected from future flood damage.

In 1990 the Federal Insurance Administration has implemented the Community Rating System (CRS). The purpose of CRS is to recognize or encourage community activities to reduce flood damages to existing buildings, to manage development in areas not mapped by the NFIP, to protect new buildings beyond the minimum NFIP protection level, to help insurance agents obtain flood data, or to help people obtain flood insurance. Community application for CRS classification is voluntary. Nationally, there are 994 communities receiving flood insurance premium discounts based on their implementation of local mitigation, outreach, and educational activities that go well beyond minimum NFIP requirements. While premium discounts are one of the benefits of participation in CRS, it is more important that these communities are carrying out activities that save lives and reduce property damage. Communities receiving premium discounts through the CRS cover a full range of sizes from small to large, and a broad mixture of flood risks including coastal and riverine. Any community in full compliance with the rules and regulations of the NFIP may apply for a CRS classification. The applicant community submits documentation that it is implementing one or more of the activities recognized in the CRS. Eighteen creditable activities are organized under four categories that include Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness.

Public information activities which receive credit under CRS include:

- Elevation certificate
- Map determinations
- Outreach projects
- Hazard disclosure
- Flood protection library
- Flood protection assistance

Mapping and regulatory activities include:

- Additional flood data
- Open space preservation
- Higher regulatory standards
- Flood data maintenance
- Stormwater management

Flood damage reduction activities include:

- Repetitive loss projects
- Acquisition and relocation
- Retrofitting

- Drainage system maintenance

Flood preparedness activities include:

- Flood warning program
- Levee safety
- Dam safety

As a result of participation in the CRS activities, communities receive benefits including reduced flood insurance rates, increased public safety, reduction of damages to property and public infrastructure, avoidance of economic disruption and losses, reduction of human suffering, and protection of the environment. Currently 42 of New Jersey's 566 municipalities participate in the Community Rating System. None of the eight municipalities (including Manville) in the study area participate in the Community Rating System. It is recommended that the Steering Committee encourage municipalities to use the Community Rating System.

Table 18 – List of Preparers

Name	Title	Education	Experience
Carl DuPoldt	Planning Engineer	B.A. Biology/Math M.S. Environmental Engineering	19 years Water/Wastewater Planning/ Engineering 6 years Water Quality Coordinator 5 years Urban Conservation Engineer
Kent Hardmeyer	Economist	B.S. Economics M.S. Economics	9 years Economist 6 years RC&D Coordinator 20 years District Conservationist
David T. Lamm	State Conservation Engineer		
Phillip Renn	Water Resources Coordinator, Connecticut		
ShayMaria Silvestri	GIS Specialist	B.S. Geology M.S. Geology	7 years GIS Specialist
David L. Smart	State Resource Conservationist		
Robert Snieckus	National Landscape Architect		
Gregory Westfall	Water Resource Planner/ Planning Staff Leader	B.S. Agriculture and Natural Resources M.S. Water Resources	7 years Soil Conservationist 11 years District Conservationist 12 years Water Resource Staff Leader/Planner

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APPENDICES

APPENDIX A - Millstone River Watershed (PL 566) Public Participation Plan

Millstone River Watershed (PL 566)
Public Participation Plan

Definitions

The Steering Committee is comprised of local sponsors to the Millstone River watershed project and of additional interests as agreed to by the Steering Committee. Each co-sponsor having jurisdiction within the Millstone River watershed shall designate a specific individual (with alternate if desired) to serve as a member of the Steering Committee to make decisions and take actions for that entity as a sponsor of the project. Additional representatives of the sponsor may attend and participate as ex officio members without decision-making authority. It is the responsibility of each co-sponsor to establish an internal process for guiding the votes of its Steering Committee member.

The Technical Team is made up of representatives of all agencies and organizations that would provide technical inputs during project planning.

The Raritan Basin Watershed Management Project (Raritan Project) is an initiative of the NJ Department of Environmental Protection (NJDEP), managed by the NJ Water Supply Authority (NJWSA), for development of a comprehensive management plan for the entire Raritan Basin, including the Millstone River watershed.

Goal

This Public Participation Plan is designed to provide open access and encourage public participation throughout the course of the various planning activities for the Millstone River Watershed as conducted by the Natural Resources Conservation Service pursuant to PL 566 (Small Watersheds Program). To the maximum extent possible, public participation for this initiative should be integrated with the public participation process for the Raritan Basin Watershed Management Project, to reduce demands on the time and resources of participating entities and to encourage integration of the two initiatives.

Identifying the Public

New Jersey Water Supply Authority, (NJWSA) will maintain a database of every individual and organization who contacts the Steering Committee or who registers at a Steering Committee meeting or public event. This database may be integrated with but will remain distinguishable from the Raritan Basin Watershed Management Project database.

The public includes but is not limited to: all who contact Steering Committee or the public participation liaison; attendees at Steering Committee meetings or events; Federal and State legislators, elected and appointed municipal officials; government agencies; media representatives; property owners; residents; community and environmental groups; businesses and others who express an interest in the study.

As a minimum, the database would contain the current names and addresses of at least two representatives from each municipality, such as municipal mayors, council persons, borough/township administrators, engineers, planners and environmental commissioners. Further, the database would contain the current names and addresses of all County Freeholders, County

Administrators, Engineers, Planning Board Directors and Emergency Management Directors, as provided to NJWSA by county co-sponsors.

The Steering Committee, with assistance from New Jersey Water Supply Authority, shall rely primarily on county and municipal government officials with regard to individuals with "special needs." To the extent possible, information will be provided to organizations and agencies with "special needs" members or clientele for dissemination to such individuals.

Steering Committee Meetings

All meetings of the Steering Committee are open to the public and will be announced through the Raritan Project Web site. Steering Committee meetings are working meetings and not designed as public forums. Opportunities for public input will be reserved for specific times, such as at the end of each meeting.

The New Jersey Water Supply Authority will coordinate with the chair of the Steering Committee to provide agendas and meeting notices for Steering Committee meetings and will provide minutes. Provision of meeting notices, agendas and minutes will be made to all interested parties through e-mail or the Raritan Project Web site. However, one representative of all municipalities and counties in the watershed as identified for municipalities and counties under "Identifying the Public" may request hard copy of minutes and meeting notices if they lack access to e-mail or the Internet.

Public Meetings

The Steering Committee, with the assistance of the New Jersey Water Supply Authority, will host a series of three types of public meetings. Wherever possible these meetings will be held as part of the Raritan Basin Watershed Management Project and may address issues in addition to the PL 566 project issues. All counties, municipalities, soil conservation districts and environmental and other organizations in the Millstone River watershed would be notified regarding the following meetings:

- **Public Meetings to Gather Baseline Information.** Public meetings, hosted by the Steering Committee and assisted by the New Jersey Water Supply Authority, would be held in December 2000 to present a preliminary listing of flood-related issues in the Millstone River Watershed and potential management tools to be examined in each problem area. The public will be invited to provide data, photos, stories and other information. Meetings would also be held by NRCS with municipalities for the purposes of scoping as the project develops. Also, scoping meetings would be held with other agencies (FSA, RD, Corps, FWS, EPA, Fish and Wildlife Service, State Parks, etc). Meetings with individual municipalities, organizations and/or agencies may be conducted as the need arises.

- **Alternatives Meetings.** A series of meetings, hosted by the Steering Committee, assisted by the New Jersey Water Supply Authority and attended by the Technical Team, will be to update interested parties on the progress of the plan and present a set of recommended alternatives that address the flooding issues identified previously. These meetings will provide the public with an opportunity to comment on the recommendations both during and after the meeting.

- **Public Hearing.** At least one public hearing will be held according to guidelines of the National Environmental Policy Act. This hearing will be scheduled in the late fall, 2001. If an Environmental Impact Statement (EIS) is to be prepared by NRCS, notice must be published in the Federal Register and local newspapers of Notice of Intent to prepare an EIS.

Communications

Communication will be in the appropriate format reflecting the characteristics of the group that is to receive the communication. Communication should be language and educational level appropriate. Also, if there are those with "special needs," communication should reflect the needs of this individual and/or group.

New Jersey Water Supply Authority will distribute information about the project through a periodic newsletter to all in the database. The newsletter can be part of a Raritan Basin Watershed Management Project newsletter. This written communication would summarize current activities, list upcoming meetings and studies, and provide contact name (s) for additional information. First issue would be concurrent with the first major public meeting (December 2000). It would be distributed periodically, in concert with key decision points wherever possible.

New Jersey Water Supply Authority will post all Steering Committee member and Technical Team contact information, meeting notices, agendas, meeting minutes and other communication on a web site for widespread distribution.

The Chair of the Steering Committee would also be available on a daily basis to field questions from the public via phone, fax and e-mail. All media contacts would be directed to the Chair of the Steering Committee. All letters of comment would be directed to the Steering Committee who, through coordination with members of the Technical Team, would respond to each. Correspondence would be signed by the Chair of either the Steering Committee or the Technical Team. The Chair of the Steering Committee will insure that all publics receive the same information relating to a specific topic. (Multiple people answering the phone, responding to fax or e-mail can result in publics getting "mixed messages.") All mailings of meeting notices, agendas, and minutes would be made with an agency-less letterhead, or using the Raritan Basin Watershed Management Project letterhead. Unless the latter approach is used, the letterhead would identify the name of the project (Millstone River Watershed Plan/Steering Committee or Millstone River Watershed Plan/Technical Team) and list the Steering Committee or Technical Team members.

The Chair of the Steering Committee would provide a monthly report of contacts and topics to Steering Committee.

Reviewable File

Copies of all materials submitted by interested parties at public meetings or by mail would be available for public review at the USDA Natural Resources Conservation Service office in Somerset, New Jersey. Materials would include Steering Committee and Technical Team minutes, signup sheets from meetings and other records of participation; notes and highlights of activity, Public Participation Plan; copies of newspaper and other notices; copies of materials provided to the public; and comments received and copies of written responses.

Materials in any form that residents, organizations and others may submit to the Steering Committee would be accepted at any time. The Steering Committee would consider all concerns.

APPENDIX B - Summary of Millstone River Watershed Public Meeting December 6, 2000

Attendees to the public meeting were as follows:

Name	Affiliation/Township
A. Gallagher	Johnson & Johnson, Skillman Montgomery
Zoya Pugh	South Brunswick
Richard Pollard	Chr. Env. Comm, South Brunswick
Bill Bauder	Cranbury
Michael Rogers	Monroe MUA, Monroe
Diane Leonard	Kendall Park, South Brunswick
Al Bodnar	Millstone Township
Ernest Thurlow	Somerset-Union SCD
Robert von Zumbusch	Kingston Mill, Princeton
Ron Trust, Sr.	Perrineville, Millstone Twp
Anne Zeman	Kingston, South Brunswick
Anna Drago	Cranbury
Matt Watkins	Monmouth Jct., South Brunswick Twp Administrator
Katrina Flagel	Mercer County Planning Division
Joe Skupien	Somerset County Engineering Division
William Kruse	Middlesex County Planning
Nancy Grbelja	Env. Comm. & Watershed Council, Millstone Twp.
Amanda Bok	Princeton Packet, South Brunswick
Alfred Meiss	Cranbury
Fenton Purcell	Manville Representative
Jerry Milden	Millstone Twp.
Bryan Bidlack	South Brunswick
Andrea Kahn	New Brunswick
Frank Minch	Freehold Soil Conservation District
Janice Reid	NRCS – Freehold F.O.
Craig Marshall	Monmouth Jct., South Brunswick
Dan Van Abs	New Jersey Water Supply Authority
David Southard	Monmouth Jct., South Brunswick
Regina Gallagher	Cranbury
Harriet Honigfeld	Monmouth County Planning Board
Steven Cook	Representing Senator Inverso, Hamilton Township
John McConnell	Representing Rush Holt
Kent Hardmeyer	NRCS
Greg Westfall	NRCS
Carl DuPoldt	NRCS

The first hour of the meeting (6-7pm) was devoted to informal discussion and review of maps developed by the Natural Resources Conservation Service(NRCS). Watershed maps on display included a general watershed map showing the stream network with municipal and county boundaries, present land use/land cover map, hydrologic soil group, agricultural lands, municipal flood damages survey, FEMA National Flood Insurance Claims, and FEMA Flood Insurance Studies.

Daniel Van Abs, Project Public Participation Coordinator, opened the meeting and asked for introductions of the Steering Committee and Natural Resources Conservation Service (NRCS) watershed planning staff.

A copy of the Power Point presentation given by Daniel Van Abs,
Joseph Skupien, Steering Committee Chairperson; Greg Westfall, Water Resource Planner; and Kent Hardmeyer, Economist is attached.

Dan Van Abs reviewed the agenda and purposes of the meeting. The primary purposes of the meeting were to inform the public of the project and its objectives and to receive public comments on flood damage problem areas and on other water resource concerns. He noted that Carl DuPoldt, NRCS, would be gathering the response forms, provided at the meeting registration, for presentation of written public comments later in the meeting.

Joe Skupien discussed how the project started, the makeup and purposes of the Steering Committee. Steering Committee is made up of representatives of five counties, Hunterdon, Mercer, Monmouth, Middlesex and Somerset; four soil conservation districts, New Jersey Water Supply Authority, New Jersey Department of Environmental Protection and several municipalities including Manville Borough, Millstone Township and South Brunswick Township. There are several other municipalities which have provided resolutions of support to the project including Franklin Township, Hightstown Borough, Hillsborough Township, Millstone Borough, Monroe Township and several others who are considering giving this support. Steering Committee members attending the meeting were introduced: Fenton Purcell (Manville), Katrina Flagel (Mercer County), Harriet Honigfeld (Monmouth County), Frank Minch (Freehold Soil Conservation District), Clark Gilman (New Jersey Department of Environmental Protection – Flood Plain Management), Nancy Grbelja (Millstone Township), Matt Watkins (South Brunswick Township), Ernie Thurlow (Somerset-Union Soil Conservation District) and William Kruse (Middlesex County).

Joe noted the purposes of the Steering Committee, namely, assure adequate public participation throughout the watershed planning process, provide locally led direction and coordination for two federal agencies, the NRCS and the Corps of Engineers. Joe noted that we are fortunate to have two Federal agencies, the NRCS and the Corps of Engineers, both interested in working in this watershed. He noted that the Corps will be focusing on flood damage reduction in the major flood damage areas from Millstone Borough downstream through Manville Borough. NRCS will be working in the upstream areas to enhance the Corps flood damage reduction activities in the lower watershed and to address other water and related land resource objectives. The third purpose of the Steering Committee is to provide information during the watershed planning process, ideas on alternatives, problems, policy, economics and engineering. We hope to bring the public's ideas to bear on the results of this effort. When this study is done, we will have identified alternative measures to address the problems we have identified. The Steering Committee will have the job of selecting the alternative (s) for implementation.

Greg Westfall provided an overview of the PL83-566 Program and how it relates to this project. He was asked what type of projects can be funded for planning and implementation assistance under this program. He noted that purposes can include flood damage reduction, agricultural enhancement, water quality protection, public water-based recreational development, fish and wildlife habitat enhancement, ground water recharge protection and municipal water supply development. While municipal water supply development can be one of the project purposes, its implementation is not currently cost shared.

He noted that total project benefits must exceed total project costs in order to have a viable project. He noted that while flood damage reduction is the primary reason why this project started and that there are many other purposes which would improve overall project benefits including control of agricultural runoff and sediment and nutrient contributions to watershed water bodies which can be addressed and may provide greater overall project benefits. He also was asked whether PL83-566 will cost share farm ponds. He indicated that this is not normally a cost shareable practice but that it had been and may

be covered under ongoing soil and water conservation programs. Janice Reid, District Conservationist for NRCS, responded that under certain cost share programs this could be an eligible practice.

A question was raised on the types of flood damage reduction alternatives that NRCS would consider in this watershed. Greg noted that there are a range of alternatives including but not limited to buyouts, wetland easement purchases, floodwater retarding structures or small dams, levees and others. Small dams could have other water resource benefits including public water-based recreation, fish and wildlife habitat and municipal water supply. Mercer County Park's Mercer Lake, used for public recreation, was built under this program with multiple purposes including flood damage reduction to the City of Trenton and Hamilton Township as well as public water-based recreation and fish and wildlife habitat.

PL83-566 Projects can be either structural or land treatment. Generally speaking, flood damage reduction needs to be a part of any structural project but within that there are many opportunities for the program to provide technical and financial assistance for such objectives as public water-based recreation, fish and wildlife habitat, municipal/rural water supply and others.

Kent Hardmeyer reviewed the results of the municipal flood damage survey. A question was raised regarding whether flood damage reduction would include not building in vacant areas or new building. It was agreed that building in the existing flood plain would not be prudent. It was noted that this study intends to determine what the effect of future development would be on flooding.

A questioner asked why buyouts are not being considered as an alternative. It was noted that this will be among those being considered. Clark Gilman, NJDEP, noted that at Manville there have been offers to 42 homeowners but only 5 have accepted the offer for a buyout.

There was some discussion regarding the approximately 50 year old dike at Zarephath. Clark Gilman, DEP, noted that Zarephath is hoping to raise this dike another foot and half. There were comments on whether this activity would be moving the problem further downstream.

There was a question regarding whether retention/detention basins recharge the ground water. Dan Van Abs noted that there are very few basins that actually managed to recharge groundwater. He noted that soils and geology do not permit this in every area of the state. He noted that the costs can often preclude actual implementation of this idea.

Dan Van Abs noted that project information is posted on the following website:

http://www.raritanbasin.org/nrcs_millstone.htm

Dan Van Abs requested public comments that were recorded on a flipchart. He noted that these comments may be useful for not only this project but also the Raritan Basin Watershed Management Project. These comments follow:

Monroe Township - interested in working with this project to develop reservoir(s) for flood damage reduction, municipal water supply, fish and wildlife habitat and public water-based recreation. Township would be willing to provide funding.

Cranbury Township vicinity development impacts from poor State Erosion and Sediment Control Act enforcement - damaged streams. Municipalities have no ability to enforce erosion and sediment control measures, construction severely impacts streams - mostly siltation. Sediment damage to streams. Restoration?

Open space programs - Streams should be primary focus of land purchases. How to use for stream buffers? Improved land management?

Use of existing lakes (e.g. Brainard Lake at Cranbury) for floodwater storage and other water resource purposes of the project

Correct problems caused by previous channelization on Cranbury Brook

Nonpoint source pollution controls

Lawn/turf management "Source Controls"

Kendall Park storm sewer pollutants go into streams

Back-up behind bridges causing flooding of existing and often historic structures (e.g. Route 27 at Millstone River)

Reducing impervious cover (e.g. Parking garages instead of lots) and improving site recharge

Ten Mile Run/Heathcote Brook - preserve tributaries to these streams

Sustain/retain capacity of Upper Millstone to protect the lower River

Farm ponds for retention in Upper Millstone

Restoring stream corridors replanting

Additional public comments included:

How exactly do the detention basins work? Do they recharge and shouldn't they be managed for recharge?

Steven Cook, Senator Inverso's office, asked how NRCS did collect damage data from Townships. He noted that the Senator's office gets flooded with complaints regarding stormwater especially as it relates to State routes. He offered to provide NRCS with a contact at the NJDOT to follow-up.

A question was raised regarding whether stream-side wetlands are zones of ground water recharge. Dan Van Abs indicated that these are more often zones of discharge.

Response card comments included:

Zoya Pugh, South Brunswick Township - Concern about the 350 foot wide by 6.5 mile long Route 92 project that will cover up a lot of porous soils and wetlands and cause flooding in other areas with construction activity further compacting many acres of land.

Richard Pollard, South Brunswick Environmental Commission Chairman, expressed his concern regarding nonpoint source pollution controls and the need to protect the headwaters of Devils Brook and Ten Mile Brook. In addition, Heathcote Brook Watershed area - flood retention projects.

Bill Bauder, Cranbury Township (Stream Watch) expressed his concern regarding soil erosion reduction, particularly concerning sediment controls and enforcement on construction sites. He also asked what can be done to insure agriculturally preserved/deed restricted land adhere to best management practices with regard to stabilization of soils, use of buffers to streambanks, etc.

Michael Rogers, Director, Monroe MUA, noted that water supply in the Upper Millstone and flood protection were concerns. He would like to see the Millstone River watershed protected for its value for passive recreation and water supply.

A South Brunswick Township resident had concerns regarding nonpoint source pollution and runoff/erosion as well as sprawl and degradation of critical habitat. They felt that Heathcote Brook, Devils Brook, Ten Mile Run and Millstone River should be protected.

Diane Leonard of South Brunswick (Kendall Park) was concerned that protection of stream corridor preservation in the Ten Mile Run, Heathcote Brook areas was needed to prevent stream scouring, provide habitat for wildlife and low impact recreation, walking, birding, etc. She also asked about changing codes so runoff from roofs recharge from underground

tanks under driveways instead of running to storm drains which scour our little creeks. She suggested a more permeable surface material for parking lots, roads and also require parking lots to add levels going up instead of spreading out.

Other written comments concerns about ground water recharge enhancement (protection of aquifer recharge areas). Also, protection of as many local streams and brooks to control sedimentation was cited as important. Also, concern was expressed regarding the purity and quality of water and the need to protect open space.

APPENDIX C - Notes from March 22, 200l Public Meeting in Montgomery Township

Notes from March 22, 200l Public Meeting in Montgomery Township

Compiled by Greg Westfall
USDA Natural Resources Conservation Service

This public meeting was originally scheduled for February 5th (cancelled due to snow) and then rescheduled for February 22nd (again cancelled due to snow). Donald Matthews, Deputy Mayor and Montgomery Township Steering Committee representative, had organized the meeting. Presenters at the meeting were:

Daniel Van Abs, New Jersey Water Supply Authority;
Greg Westfall, Natural Resources Conservation Service;
Noelle Mackay and Steve Yergeau, Stony Brook Watershed Association.

There were over 50 people in attendence (see attached partial list). The major group represented was the River Road Association which is led by Elizabeth Palius. She also is a leader in the Millstone Valley Preservation Committee. Members of these groups come from several municipalities including Franklin Township, Hillsborough Township, Millstone Borough and Montgomery Township.

Don Matthews opened the meeting at 7:15 pm and introduced "Liz" Palius. She spoke of the group's interest in the flood issue. Dan Van Abs covered the overall Raritan Basin Watershed Management Project. Greg Westfall gave an overview of the Millstone River PL566 Watershed Project. Noelle Mackay and Steve Yergeau reviewed the draft Beden Brook Characterization and Assessment study. Questions were held until the end of the last presentation starting at about 8:45 pm.

Questions included:

Do you know what the Corps is proposing for Manville?

Why is the Water Supply Authority, with its newly installed weir, a part of the PL566 Project to reduce flood damages?

We continue to feel that Millstone Borough's flood damage concerns as they relate to the proposed (and now apparently in the construction phase) Green Brook project are not being addressed. What can be done about this?

What can be done about development and unused stormwater detention basins (before I came here tonight the River at Griggstown was at road elevation and all the upstream detention basins I checked were empty)?

Are you looking at measures for education of the public to address flooding issues in their own backyards?

Why can't Somerset County improve infiltration, through tree planting, in its detention basins rather than requiring that the whole detention basin be mowed/maintained?

What can be done about the trees that are laying in the River and the tributaries?

If you protect Manville with some type of structure such as levees, how can you say that Millstone Borough or somewhere upstream of Manville is not affected by induced flooding?

Will the PL566 project take into consideration historic and cultural resources?

Millstone Borough has repeatedly approached the SHPO regarding the impact of the Green Brook Corps project on its historic district, what will NRCS be doing?

What type of flood damage reduction alternatives are being considered?

What are the nonstructural alternatives?

What do you mean by floodproofing?

Why do we have to consider benefits and costs, why can't we just get what's needed done?

Why do you have to gather further economic damage information if you have the FEMA Flood Insurance claims data, municipal interviews and the SBA and FEMA reports from Hurricane Floyd?

Attendance List

Name	Address	Affiliation/Interest
Bob Tucker	385 George Road, Dayton, NJ	SBMWA
Sid & Liz Palius	492 River Road, Belle Mead Phone 908-874-3820	River Road Assn. Millstone Valley Preservation Comm.
Shirley Eberle	29 Chaplain Way, Franklin Park	
Theodore Chase Jr.	59 Old Georgetown Rd, Princeton	Franklin Plng Bd, etc.
Dan Ten Broeke	2346 Amwell Road, Somerset	Millstone Valley Preservation Coalition Meadows Fdtn.
Bill Pauley	554 Griggstown Rd. Belle Mead	D&R Canal Commiss.
Lois Pauley	same	
Clem Fiori	P.O. Box 161, Blawenburg	Montgomery Twp
Joanne Kaise	134 Skipton Place, Somerset	Meadows Fdtn. Historic Comm.
Jean Gray	739 River Road, Belle Mead 08502 Montgomery Twp. Phone - 908-874-4811 jeanmgray@juno.com	SBMWA Volunteer Shade Tree Comm River Road Assoc.
Dick Letard	12 MeadowRun Dr., Skillman	Montgomery Twp Planning Board
Kent Youngberg	(had to leave at 8)	
Greg Kaganowicz	293 Griggstown Road, Belle Mead	Montgomery Twp Environmental Comm
Portia Orton	1500 Main Street, Millstone	Historic District Comm.
Ava Herbert	530 River Road, Belle Mead	River Road Assn.

Hazel Staak-Westover	38 Philye Drive, Princeton, NJ 08540	River Road Assn. B.D.
Lloyd Pietrak	20 Mosher Road, Griggstown, NJ 08540	Homeowner along Simonson Brook
Charlotte Fuller Huguette Castaneda	20 Mosher Rd., Griggstown, NJ 08540 762 Route 518, Skillman, NJ 08558	same
Staats, Lloyd & June	644 Millstone River Rd., B.M. 08522	will monitor our Stream
Henry Wierzbowski	1444 Main Street, Millstone 08844	
Don Johnson	Montgomery Township Special Projects Engineer	
Bill Buczek	1413 Main St., Millstone, NJ 08844 Phone – 908-281-5425	
Ed Murphy	565 Griggstown Road, Belle Mead, NJ 08502 Phone – 908-359-1568	
Barbara Ross	501 State Road, Princeton, NJ 08540	D & R Canal Watch
Edward Brown	1429 Main Street, Millstone	Planning Board Member
Bruce J. Allen	1097 Canal Road, Princeton (Griggstown) 08540	Flooded Homeowner
Marilyn Kulik	1079 Canal Road, Princeton (Griggstown) 08540 Phone - 908-359-9387	Flooded Homeowner Citizens to Preserve Griggstown
Sharon Tarantino	1423 Main Street, Millstone 08844 Phone – 908-359-2443	Flooded Homeowner
Joyce Mackay	65 River Road, Belle Mead 08502 Phone 908-874-7748	Flooded Homeowner flooded 5’ throughout
Barbara Gladstone	297 River Road, Belle Mead 08502 Phone – 908-281-6640	Flooded Homeowner

Mary Patrick	11 Alley-Millstone, Hillsborough 08844	Flooded Homeowner
Carl Kestner	13 South River Street, Millstone 08844	Flooded Homeowner
Anton Lemli	621 Canal Road, Somerset, NJ 08873 Phone – 732-873-2974	Flooded Historic Homeowner Blackwells Mills
Dorothy (Mrs. C.J.) Weingart	113 River Road, Belle Mead, NJ Phone - 908-359-4282	Flooded Homeowner

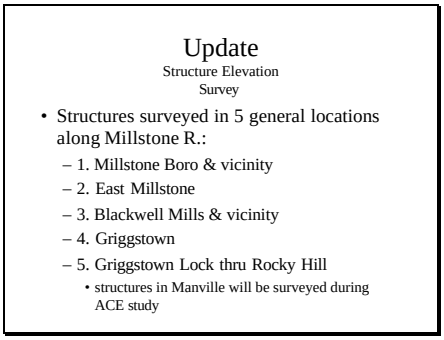
Historic structures on the D & R Canal

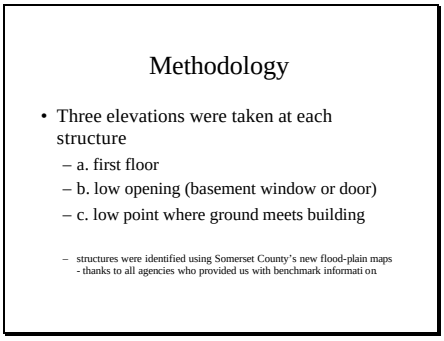
Van Wickle House (circa 1722)	Somerset	4 feet of water
John Lovel	Phone 732-545-1968	
Mark Else	732-846-7075	
Bonnie Sovinee	732-545-8984	
Franklin Inn (circa 1752)	East Millstone	4 feet + of water
Mark Else	Phone 732-846-7075	
Bonnie Sovinee	732-545-8984	

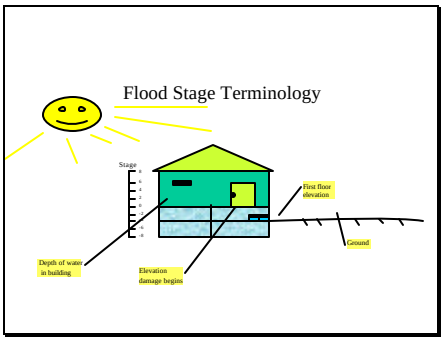
APPENDIX D - September 18, 2001 Public Meeting in Franklin Township

September 18, 2001 Public Meeting
Griggstown Reformed Church, Franklin Township

A Power Point presentation was provided by Kent Hardmeyer and Greg Westfall to an audience of approximately 20 people. The Power Point presentation is as follows:







Number of structures surveyed

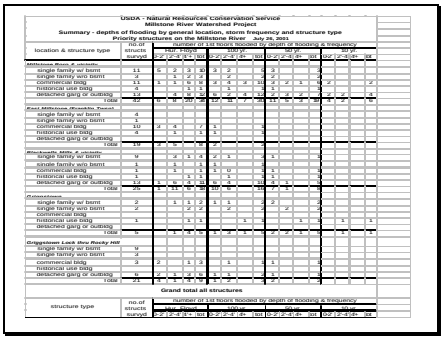
- Millstone Boro = 42
- East Millstone = 19
- Blackwell Mills = 25
- Griggstown = 5
- Griggstown Lock
  - thru Rocky Hill = 21
- **Total structures = 112**

Structure Categories

- Single family w/ bsmt = 35
- Single family w/o bsmt = 10
- commercial building = 25
- historical use building = 10
- detch garg or outbldg = 32
  - Total Structures = 112

Spreadsheet breakdown (handout)

- Breakdown of structures with 1st floors flooded
  - by structure type
  - by location
  - by flood event
  - by depth of flooding

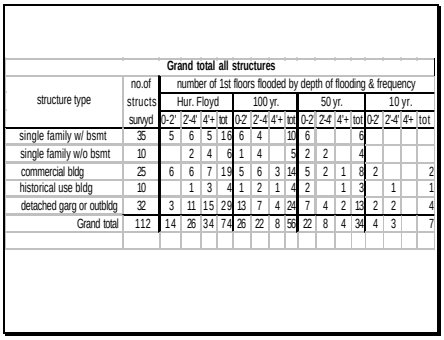


USDA - Natural Resources Conservation Service
Millstone River Watershed Project
Summary - depths of flooding by general location, storm frequency and structure type
Priority structures on the Millstone River July 29, 2001

location & structure type	no. of structs surveyd	number of 1st floors flooded by depth of flooding & frequency															
		Hur. Floyd				100 yr.				50 yr.				10 yr.			
		0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot
Millstone River & tributaries																	
single family w/ bsmt	11	5	2	3	10	3	2		5								
single family w/o bsmt	4		1	2	3		2		2								
commercial bldg	11	1	1	5	7	2	1	2	5	2	2	1	5	2			2
historical use bldg	3			1	1		1		1		1		1				
detached garg or outbldg	12		3	10	13	10	2	1	13	5	2	2	9	2	2		4
total	41	6	7	21	34	15	8	3	26	7	4	3	14	4	2	0	6
East Millstone (Rocky Hill)																	
single family w/ bsmt	6																
single family w/o bsmt	1																
commercial bldg	10	2	6		7	1			1								
historical use bldg	1		1		1	1			1								
detached garg or outbldg																	
total	18		7	1	8	2	1		3								
Rhododendron Acres & vicinity																	
single family w/ bsmt	9		2	1	3	2	1		3								
single family w/o bsmt	1		1		1	1			1								
commercial bldg	1		1		1	1	1		2								
historical use bldg	1																
detached garg or outbldg	12	1	5	3	9	5	3		8	3	1		4				
total	24	1	9	4	14	9	5		14	3	1		4				
Rossmoore																	
single family w/ bsmt	2		1	1	2	1	1		2								
single family w/o bsmt	2			2	2		2		2								
commercial bldg																	
historical use bldg	1			1	1			1	1			1	1		1		1
detached garg or outbldg																	
total	5		1	4	5	1	3	1	5	2	2	1	5		1		1
Griggstown Lock thru Rocky Hill																	
single family w/ bsmt	9																
single family w/o bsmt	2																
commercial bldg	3	2		1	3		1		1								
historical use bldg																	
detached garg or outbldg	1																
total	15	2	1	1	4	1	1		2								

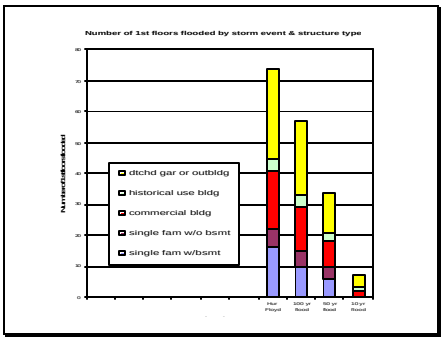
Grand total all structures

structure type	no.of structs surveyd	number of 1st floors flooded by depth of flooding & frequency															
		Hur. Floyd				100 yr.				50 yr.				10 yr.			
		0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot



Grand total all structures

structure type	no.of structs surveyd	number of 1st floors flooded by depth of flooding & frequency															
		Hur. Floyd				100 yr.				50 yr.				10 yr.			
		0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot	0-2'	2'-4'	4'+	tot
single family w/ bsmt	35	5	6	5	16	6	4		10	6			6				
single family w/o bsmt	10		2	4	6	1	4		5	2	2		4				
commercial bldg	25	6	6	7	19	5	6	3	14	5	2	1	8	2			2
historical use bldg	10		1	3	4	1	2	1	4	2		1	3		1		1
detached garg or outbldg	32	3	11	15	29	13	7	4	24	7	4	2	13	2	2		4
Grand total	112	14	26	34	74	26	22	8	56	22	8	4	34	4	3		7



Next Steps

- 1. Determine average annual structural flood damages of inventoried structures
  - Use existing computer program
  - program uses depth-to-damage ratios, i.e. dollar damage per foot of floodwater based on value & type of structure & contents
  - use existing water surface profiles, i.e., depth of floodwater at different frequency storms

Next Steps con't

- 1 Con't -
  - basically computes the damages from all projected floods over the life of the project (usually 50 to 100 yrs.)
  - then divides sum of damages by years of project life
  - result is average annual flood damages without project

Example (Simplified)
Computing Average Annual Damages
w/o project
100 yr flood protection/evaluation period

Storm Freq	flood stage	dollar damages	no. of floods	total damages	% of total
2 yr	40.4	75,000	50	3,750,000	30%
5 yr	41.8	115,000	20	2,300,000	18%
10 yr	43.9	135,000	10	1,350,000	11%
25 yr	44.6	575,000	4	2,300,000	18%
50 yr	45.4	845,000	2	1,690,000	14%
100 yr	46.5	1,100,000	1	1,100,000	9%
				12,490,000	100%

Ave Ann damage = $12,490,000 / 100 yrs =$124,900

Using current federal discount rate (6.375%) each $100,000 of ave ann damage reduction will buy about $1,565,000 of solution

Next Steps Con't

- 2. Use Ave Ann w/o project flood damages to determine amount available for a fix
  - similar to buying a home
  - bank uses ones income to determine how expensive home one can afford
- 3. Determine alternatives, costs and compare benefits to costs

APPENDIX E – Municipal Interview-Reported Flood Damages

Municipal Interview Reported Flood Damages

	Map No.	Location - Description	Flooding Frequency
Cranbury Township			
	1	Flooding of Main St. to Methodist church	3-5 yr intvl.
East Windsor Township			
	2	Airport Rd @ Rte 33	annually
	3	Old Trenton Rd @ Bear Brook	annually
	4	One-mile Rd Extension	annually
	5	East Windsor tennis courts	3 yr intvl
	6	Old Cranbury Rd @ Millstone R	annually
	7	Millstone Rd @ Millstone R	annually
	8	N of St James Vil on Rte 539 @ Millstone R	3-5 yr intvl
	9	Franklin St @ NJ Tnpk entrance ramp	heavy rain
	10	2-3 homes (Dutchneck Rd)	Hurr Flyd
	11	MUA Admin office	Hurr Flyd
Franklin Township			
	12	Blackwell Mills Causeway @ Millstone R	annually
	13	Griggstown Rd @ Millstone R	annually
	14	Rte 518 @ Millstone R	annually
	15	Zarepath (Alma White College)	Hurr Flyd, etc
	16	Rte 27 @ Millstone R (Kingston)	Hurr Flyd
Hightstown Borough			
	17	central business district, park and sewer plant	1938 Hurr
Hillsborough Township			
	18	Dukes Highway E @ Kimberly Dr. (Raritan R)	Hurr Flyd
	19	Millstone R Rd north of Millstone Boro	Hurr Flyd

Hopewell Township			
	20	Cemetary off Hopewell-Wertsville Rd	
	21	Old Mill/Federal City Rd	> 50 yr intvl
	22	Stony Brk Rd btwn Hopewell Rd & Pennington Hopewell Rd Blackwell Rd @ bridge downstream of Rosedale	> 100 yr intvl
	23	Lake	
	24	Hopewell Twp-Pennington Boro Main St and Hansen Place upstream of Pennington Furnace and Lewis Brook	
Manville Borough			
	25	Severe and somewhat frequent flood damages - primairly "Lost Valley" section. Flooding from Raritan and Royce Brk	major storms
Millstone Borough			
	26	residential & commercial areas adjacent to Millstone R	major storms
Millstone Township			
	27	Conover Rd & several backyards	
	28	Agress Rd & Lightfoot Rd	
	29	Rte 524 opposite Crest Cir Dr	
	30	Disbrow Hill Rd @ Monroe Twp.	
Montgomery Township			
	31	Griggstown Causeway	annually
	32	Sewer Plant	Hurr Flyd
	33	Cruser Brk @ Rte 601	
	34	Bedens Brk @ Rte 518	
	35	Pike Brk @ River Rd	
	36	Cruser Brk @ Rte 206	
North Brunswick			
	37	Jersey Ave	heavy rain
	38	N Brunswick Water Filtration Plant (in Franklin Twp)	Hurr Flyd
	39	Boyd Pond near Rte 1	

Pennington Borough		
40	Lewis Brook west of Delaware Av to main st	frequently
41	confluence of Lewis Brk & Stony Brk	annually
42	King George Rd & Pennington Rocky Hill Rd	Hurr Flyd
43	Mt Rose Rd @ Stony Brook	Hurr Flyd
Plainsboro Township		
44	Maple Ave @ Cranbury Brk	cont prob
45	Mapleton Rd at Millstone R	annually
Princeton Township		
46	Quaker Road	annually
47	Harry's Brk, 2 homes	frequently
48	Rte 206 several locations	annually
49	Great Rd @ Mtn Brk	2-3 yr intvl
50	River Rd several location plus Harrison & Washington Sts	Hurr Flyd
51	Mercer St @Stony Brk	5 yr intvl
67	Washington St. @ Millstone R, residential & commercial	Hurr Flyd
South Brunswick Township		
52	Heathcote Brk @ Rte 1	3-4 yr intvl
53	Upper Heathcote Brk @ New Road	3-4 yr intvl
54	Kendall Park in vicinity of New Road	3-4 yr intvl
55	New Road @ corner of Rte 1 near Red Roof Inn	3-4 yr intvl
56	low areas adjacent to Amtrack Northeast Corridor	3-4 yr intvl
57	Six Mile Run along Rte 27 (Pine Brk vicinity)	10 yr intvl
Washington Township		
58	Hankins Rd @ Bear Crk	1/2 yr intvl
West Windsor Township		
59	Old Trenton Rd @ Big Bear Brk	annually
60	Washington Rd @ Little Bear Brk	2 yr intvl
61	Alexander Rd @ Little Bear Brk	annually
62	Penn Lyle Rd @ Duck Pond Run	infrequent
63	North Post Rd @ Duck Pond Run	infrequent

Delaware and Raritan Canal State Park		
64	various locations along the canal at historic structures, etc, plus loss of recreational user days	frequently
Mercer County Engineer		
46	Quaker Road	
65	Rte 1, I-295 corridor, overlap flooding with Assunpink	
	River Rd, Rte 27, Rte 601 in Princeton	
50	Twp	
60	Princeton Jct, Wash St @ Little Bear Brk	
66	Cranbury Sta Rd @ Hightstown Bypass	

APPENDIX F – Summary of Hydraulics Analysis

SUMMARY OF HYDRAULICS ANALYSIS

Hydraulics analysis was accomplished using the Corps of Engineers model (HEC-2). This model is the predecessor of the Corps of Engineers model HEC-RAS. The reason for using HEC-2 is that all existing modeling efforts to date have been performed in HEC-2. The modeling was confined to the main stem of the Millstone River from the confluence with the Raritan River to the confluence with the Rocky Brook.

The hydraulic modeling combined several existing modeling efforts. These modeling efforts included:

(1) URS Greiner modeling in the area of the Island Farm Weir to Blackwells Mills, with modifications by Joe Skupien, formerly Somerset County Hydraulic Engineer and currently with SWM Consulting

(2)The United States Geological Survey Step Backwater modeling. The step backwater modeling did not include the bridges at Blackwells Mills Causeway, Griggstown Causeway, and Washington Street. To incorporate these bridges, as-built drawings were obtained from Somerset County Engineering. In addition, the Anderson-Nichols/New Jersey Department of Environmental Protection topography was used. This topography is based on 1929 datum base elevations.

(3) Upstream of Carnegie Lake to the confluence with Rocky Brook, modeling performed by Justin and Courtney for the New Jersey Department of Environmental Protection was used.

(4) During the modeling effort the Pillar of Fire facility through their consultant, Leonard Jackson Associates, requested a request for FEMA-FIS map change. The Leonard Jackson modeling information was incorporated into the latest version of the Main Stem of the Millstone River Modeling. The modeling was reviewed and refined in collaboration with Joe Skupien, SWM Consulting/Millstone Steering Committee Chairperson, John Scordato, New Jersey Department of Environmental Protection, Flood Plain Management, and Robert Schopp, United States Geological Survey, West Trenton, New Jersey. The Natural Resources Conservation Service, National Water Management Center in Little Rock, Arkansas, also provided assistance. Storm frequencies analyzed included the 2-year, 10-year, 50-year, 100-year, New Jersey Flood Hazard Determination Frequency (125% of the 100-year frequency), and the 500-year. In addition, the 100-year Federal Emergency Management Agency, Flood Insurance Study was incorporated for comparison purposes. Concurrence was received on August 21, 2002. This information was updated using current information from the Hurricane Floyd flooding.

APPENDIX G - Recreation Committee Meeting Minutes September 26, 2001

Millstone River Watershed PL83-566 Project

Recreation Committee Meeting Minutes

September 26, 2001

Attendees

Name	Affiliation
Kent Hardmeyer	USDA NRCS
Howard Jones	Millstone Borough
Dan Van Abs	New Jersey Water Supply Authority
William Van Nest	Middlesex County Parks Department
Bill Kruse	Middlesex County Planning Department
Harriet Honigfeld	Monmouth County Planning Board
Michael Rogers	Monroe Township Municipal Utility Authority
Katrina Flagel	Mercer County Planning
Tom Boccino	Somerset County Park Commission
Beth Sawickie	Watershed Ambassador WMA#9
Elizabeth Dowd	NJ State Park Service
Catherine Drake	Green Acres
George O'Carroll	Monroe Township MUA
Spence Wickham	Monmouth County Parks System
Brian Rappaport	Watershed Ambassador WMA#10
Greg Westfall	USDA NRCS
Shay Marie Silvestri	USDA NRCS

Welcome and Introductions

William Kruse, Middlesex County representative on the Millstone River Watershed Steering Committee, welcomed those attending and asked the group to introduce themselves. Those attending are on the attached signup sheet.

Overview of PL83-566 Project in Millstone River Watershed

Greg Westfall and Kent Hardmeyer of the Natural Resources Conservation Service (NRCS) gave an overview of the PL83-566 Project, Criteria for Water-Based Recreational facilities and cost sharing available for water-based recreational features. A copy of the power point presentation is attached.

ShayMaria Silvestri reviewed a draft Comprehensive Open Space Watershed Map which showed the locations of approximately 25 sites (new and existing dam sites) on which NRCS has developed a preliminary analysis. She asked that those present provide her with any paper or, preferably, electronic files of their open space maps.

Review of Existing Studies and County and Other Initiatives

William Kruse noted that Middlesex County had done a marina study approximately 15 years ago that covered the Lower Raritan and Arthur Kill. He also noted that the County had done a Recreational Plan in 1995 and that there is a need for active recreation (eg. Basketball, tennis, baseball (softball) and boat slips, marinas).

Spence Wickham, Monmouth County Parks System, and Harriet Honigfeld, Monmouth County Planning Board, noted that the County Parks System in Monmouth had over 3 million visitors last year. They have 110 wet slips on Raritan Bay and boating takes place at Turkey Swamp Park. He noted that the Manasquan Reservoir, developed for water supply by New Jersey Water Supply Authority, is another addition to county parks. The County Parks System manages the land around the Reservoir for hiking (5 mile trail), etc. Land is being preserved along the Metedeconk and Manasquan Rivers. In 1998 the Open Space Plan was amended and is now part of the County Growth Management Guide. Wickham noted that Upper Freehold Township has one of the most progressive Stream Valley Protection ordinances on the books. Wickham also noted that the County Parks System would be very interested in redevelopment of the Perrineville Lake for recreation as part of any flood mitigation effort. It was noted that Perrineville Lake is fairly high in the watershed and not likely to offer much in the way of flood control to the lower watershed, particularly Manville and Millstone Boroughs. It would likely be much more effective for the Hightstown vicinity.

Michael Rogers, Monroe Municipal Utilities Authority, asked how far down the River would the impacts of floodwater storage in the upper watershed be valuable. Greg Westfall noted that NRCS is currently developing a hydraulic model to answer questions like this but has no answer at this time. Mike noted that the Township has a Recreational Element in their Master Plan. He also noted that the Township has approximately 5000 acres of an Agricultural Development Area in its southern part. The Township has a small piece of property along the Millstone but would like to purchase approximately 600 acres where they could store water for water supply and recreational uses as well as for downstream flood reduction.

Katrina Flagel, Mercer County Planning Division, stated that the Mercer is currently preserving stream corridors and that there is a desperate need for active recreation but people don't want any fields near them.

Tom Boccino gave an update on Somerset County Parks planning activities. He noted that they are currently working on a north-south greenway with acquisition along stream corridors. These areas will be used for passive recreation with the goal to create a continuous trail system throughout the County. There is a plan for a similar trail system for along the Raritan River between the Confluence (where the North and South Branches of Raritan meet) area and the Millstone River. He noted that the County had recently purchased the Spieden Farm and adjoining lands on Canal Road in Franklin Township. Franklin Township is working to preserve land between Griggstown and 10 Mile Run while the County is focused on the area between Griggstown and Rocky Hill. He noted that the County has held public hearings on their proposal but have had minimum turnout and little public input.

Elizabeth Dowd, State Parks Service, noted that an Environmental Center will be on the Spieden Farm and that there is a need for an Environmental Center in the D&R Canal State Park. She noted that there is a meeting being held today regarding development of a General Management Plan for flooding and historic structures with specific reference to Blackwells Mills and Griggstown.

Howard Jones, Millstone Borough, spoke regarding the Borough's interest in development of water-base recreation along Peace Brook, a tributary to Millstone River. The Borough currently owns property in this vicinity.

Dan Van Abs noted that the Eastern Raritan Water Supply Study found three priorities for future water supply development. These are in order of priority first to last: Kingston Quarry, Confluence Pump Station and Six Mile Run. He noted that Six Mile Run was purchased with water bonds and that these must be repaid, especially if the use is changed. He wasn't sure whether the authorizing bonds would permit water-based recreation.

Dan VanAbs stated that the Water Supply Authority is putting automatic gaging stations at all the locks so that the lock gates can be automatically opened or closed in the event of a future Floyd-type event. The system has 17 locks.

Catherine Drake, State Green Acres, noted a priority of her agency is the Crossroads of the Revolution project. The project is being managed by the Delaware and Raritan Greenways, Inc. Westfall asked what constitutes a diversion of land purchased with Green Acres funds. Drake noted that when Green Acres acquires a property these lands are acquired in perpetuity. Examples of "diversions" include right of way widenings, utility easements, or other change of land use. Bill Van Nest, Middlesex County Parks, noted that whenever Green Acres funds are accepted for one park that the same rules and prohibition of diversions apply to any park within that municipality whether it was purchased with Green Acres funds or not. Spence Wickham, Monmouth County Parks, noted that diversion is any change of land use. He noted that land of equal acreage and/or value must be substituted for the land lost. He noted that the test for utility companies often is "show me this is the only route you can take." He noted that it was important to "be creative." He cited that example of the County giving NJ Water Supply Authority pipeline access across the county-owned Howell Golf Course in exchange for the County Parks system management of the area around the Manasquan Reservoir. Catherine Drake noted that any diversion must go before the State House Commission where a need to demonstrate public benefits is required. Wickham noted that creating or upgrading a dam would likely increase public benefits.

William Kruse asked about purchase of land for preservation of groundwater recharge areas on which Middlesex County has developed information. Greg noted that PL83-566 has not purchased land for this purpose in the past but this has been discussed as something to be considered by NRCS staff.
Dan Van Abs noted that his staff has developed a ground water recharge map by subwatershed and that this will be developed by parcel in the near future.

Next Meeting/Future Direction
It was agreed that the group would be called back together as the need arises.