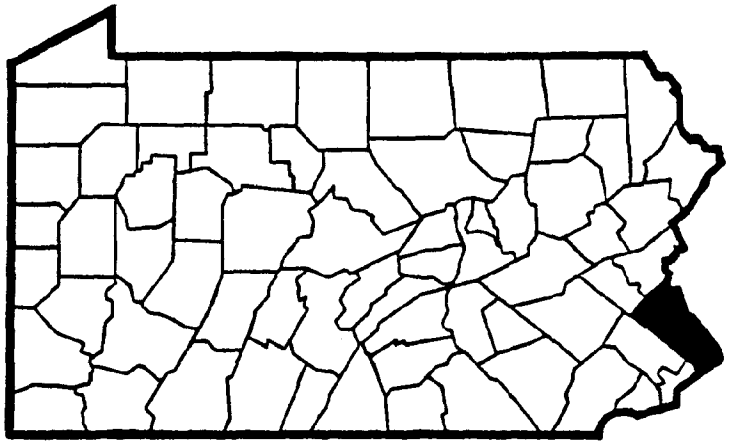
Neshaminy Creek Nonpoint Pollution and Wetlands Study

Volume 2—Technical Supplement



September 1994

Prepared by:

Bucks County Planning Commission
The Almshouse
Neshaminy Manor Center
Doylestown, PA 18901
(215) 345-3400

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Acknowledgments

Bucks County Conservation District
CZM Steering Committee of DVRPC
PaDER Coastal Zone Management Program
National Oceanic and Atmospheric Administration
Study Area Municipalities

TD899.N42 N44 1994 v.2

Pennsylvania Coastal Zone Management Program

Neshaminy Creek Nonpoint Pollution and Wetlands Study

September 1994

DER Grant/Contract No. CZ1: 93. 04PD
Grant Task No. 93264

A REPORT OF THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES TO THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION PURSUANT TO NOAA AWARD NO. NA37070351

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COUNTY COMISSIONERS:
Andrew L. Warren, *chairman*
Mark S. Schweiker
Sandra A. Miller

Credits

Project Management/Coordination

Robert E. Moore	Executive Director
Vitor A. Vicente	Director, County-wide Planning
George F. Spotts	Director, Community Planning
Dennis P. Livrone	Senior Environmental Planner, Project Manager
Timothy A. Koehler	Senior Comprehensive Planner

Planning Staff

Theresa M. Bentley	Environmental Planner
Suzanne Ravenscroft	Environmental Planner
Mary A. Marano	Environmental Planner
Richard G. Brahler	Comprehensive Planner
David A. Sabastian	Comprehensive Planner
Robert H. Keough	GIS Planner

Drafting Staff

Roberta L. Wilburn	Project Director
Ernest F. Hoferica	Graphics Coordinator
Susan L. Stewart	Illustrator
Kay Schulberger	Draftsperson

Administrative Staff

Margaret A. Creeden	Office Supervisor
Katherine R. Connery	Clerical Supervisor
Dolores J. Diamond	Clerical Researcher
Janet A. Moore	Clerk Stenographer
Mary J. Witzell	Clerk Stenographer
Cheryl D. Zabinski	Library Technician/Editor
Michelle D. Clements	Billing Clerk
Gail L. Gioia	Receptionist

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Appendix G	Species Location Information — Morris Arboretum
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Glossary

Bibliography

APPENDIX A

Agency Directory

Appendix A

AGENCY DIRECTORY

For more information related to coastal zone management, the Delaware Estuary, stormwater management, and wetlands protection and acquisition, contact the following agencies:

Coastal Zone:

Pennsylvania Department of Environmental Resources
Bureau of Land and Water Conservation
400 Market Street, 11th Floor
P.O. Box 8555
Harrisburg, PA 17105-8555
(717) 787-2529

Delaware Estuary:

The Delaware Estuary Program
c/o U.S. Environmental Protection Agency
841 Chestnut Street
Philadelphia, PA 19107
1-800-445-4935
(215) 597-9977

Stormwater Management:

Pennsylvania Department of Environmental Resources
Bureau of Land and Water Conservation
400 Market Street, 11th Floor
P. O. Box 8555
Harrisburg, PA 17105-8555
(717) 783-7577

Bucks County Planning Commission
The Almshouse, Neshaminy Manor Center
Doylestown, PA 18901
(215) 345-3400

Bucks County Conservation District
924 Town Center
New Britain, PA 18901-5182
(215) 345-7577

Wetlands Protection:

U. S. Army Corps of Engineers
Regulatory Branch
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107
(215) 656-6734

U. S. Fish and Wildlife Service
Tobyhanna Army Depot
111 Midway Road, Building 1015
Tobyhanna, PA 18466-5031
(717) 894-1275

U. S. Environmental Protection Agency
Region III, Environmental Services Division
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9301

Pennsylvania Department of Environmental Resources
Water Management Program
Soils and Waterway Section
555 North Lane
Lee Park, Suite 6010
Conshohocken, PA 19428
(610) 832-6131

Pennsylvania Fish and Boat Commission
Education and Information Office
P. O. 67000
Harrisburg, PA 17106-7000
(717) 657-4518

The Nature Conservancy
1211 Chestnut Street
12th Floor
Philadelphia, PA 19107
(215) 963-1400

APPENDIX B

Excerpts from Bucks County Continuum

Excerpts from

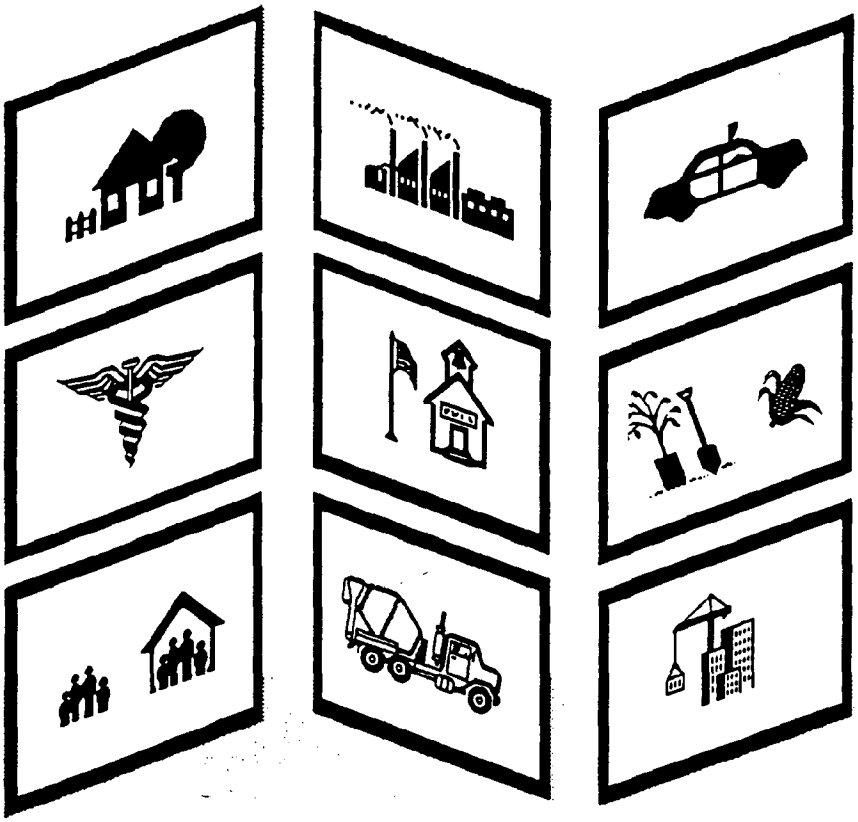
Bucks County Continuum

Land Use

Demographics

Socio-Economics

Community Facilities



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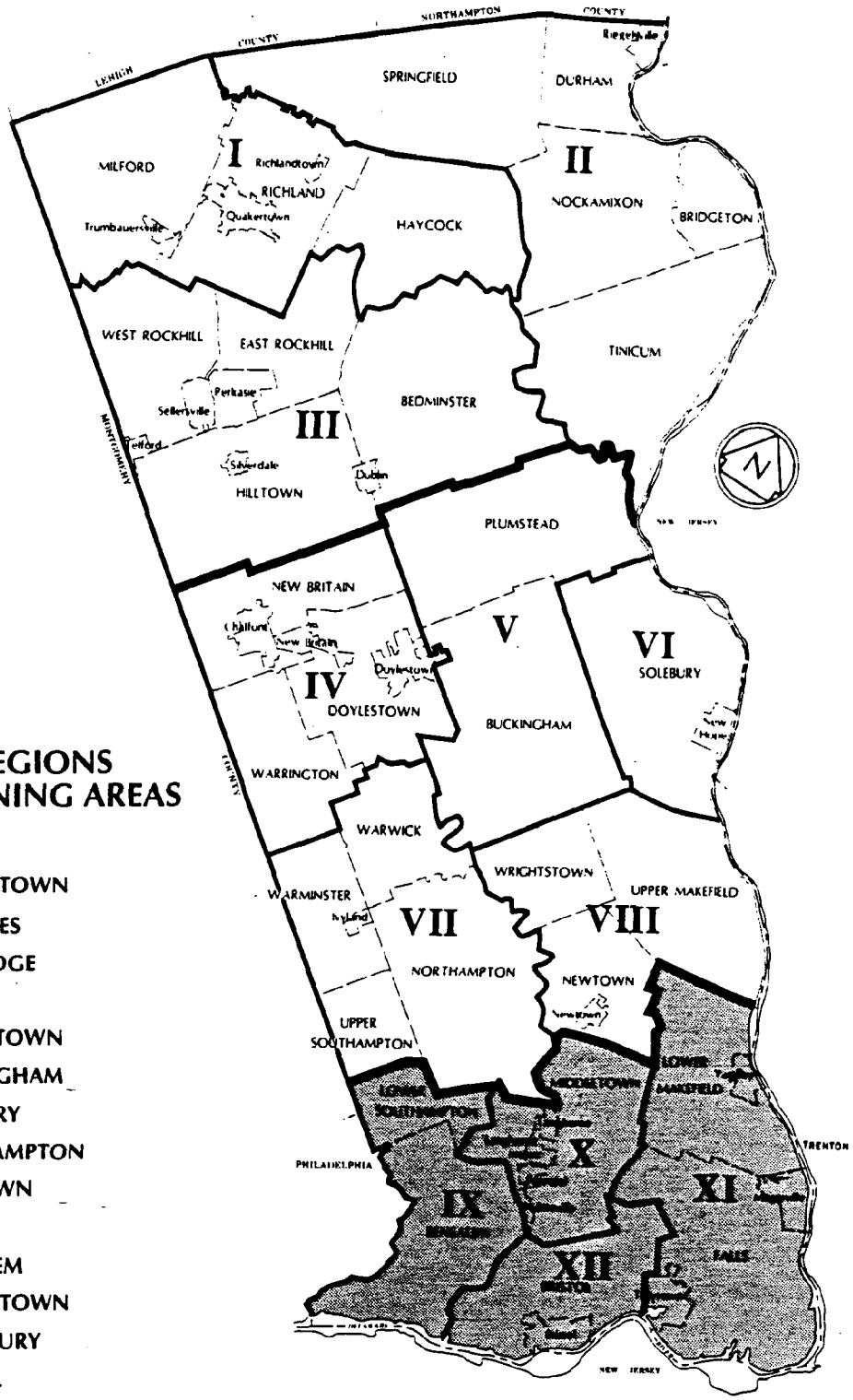


COUNTY REGIONS AND PLANNING AREAS

UPPER

- I QUAKERTOWN
- II PALISADES
- III PENNRIDGE

CENTRAL

- IV DOYLESTOWN
- V BUCKINGHAM
- VI SOLEBURY
- VII NORTHAMPTON
- VIII NEWTOWN

LOWER

- IX BENSALEM
- X MIDDLETOWN
- XI PENNSBURY
- XII BRISTOL

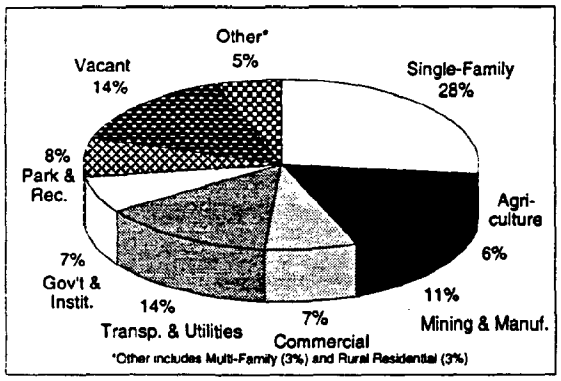
Lower Bucks is the most urbanized region in the county. This condition can be attributed to several factors including concentrations of industry in the region, the construction of the Levittown and Fairless Hills subdivisions in the late 1950s and development pressures spilling over from the Philadelphia and Trenton areas. The land area for the region is 109 square miles or about 18 percent of the total land area of the county. While the overall population density is higher than the rest of the county, there are still numerous natural resources and critical plant and wildlife habitats throughout the region. Most of the critical habitats are associated with the Delaware River and Neshaminy Creek. The region contains a vast number of riverine, estuary, and upland wetlands. There are two state and eight county parks throughout this region, including a portion of the Delaware Canal State Park. With mounting growth pressures, especially in the 1950s and 1960s, adequate infrastructure and services have been provided to serve local communities. With an extensive transportation network, as well as public water and sewer facilities both residential and non-residential development has thrived. Public transportation includes SEPTA commuter rail service on the Trenton and West Trenton lines, SEPTA bus service, Bucks County Transit service and various privately-owned bus companies. The Delaware River also provides shipping access for raw materials and goods movement. The school districts located in this region include Neshaminy, Pennsbury, Morrisville, Bristol Borough, Bristol Township, and Bensalem.

Land Use Characteristics/Development Trends

1990 Land Use Characteristics (in acres)

Planning Area	Single-family	Multi-family	Rural Res.	Ag.	Mining & Manu.	Commer-cial	Trans & Util.	Gov't & Instit.	Park & Rec.	Vacant	Total
Bensalem Area	5,301	851	583	302	1,071	1,760	2,329	1,980	1,024	1,843	17,044
Middletown Area	3,945	297	340	961	235	1,300	1,117	1,158	2,195	1,911	13,459
Pennsbury Area	6,427	380	928	2,902	5,253	1,231	4,131	864	1,462	4,896	28,474
Bristol Area	3,418	276	48	0	1,227	815	2,559	824	658	1,537	11,362
Regional Total	**19,091**	**1,804**	**1,899**	**4,165**	**7,786**	**5,106**	**10,136**	**4,826**	**5,339**	**10,187**	**70,339**

1990 Land Use Percentages



Development Trends

Lower Bucks contains the largest overall percentage of mining and manufacturing acreage in the county, which is a testament to its industrial-based origin. Over 70 percent of the region is intensely developed leaving less than one-quarter of the region in either agricultural, rural residential, or vacant land uses; and a substantial portion of this land is either restrictive natural resource areas or idle/vacant lands left over from manufacturing operations. With extensive transportation and infrastructure, development is expected to continue throughout this region although at a lower rate than in the past. As open space for development becomes more scarce and various areas reach build-out capacity, growth will decrease significantly. With minimal land left for development, potential future growth will be linked to infill, adaptive reuse, and redevelopment in urbanizing areas, along with improvements and upgrades in infrastructure.

1970-1990 Land Use Comparison Percentage

Planning Area	Residential			Agriculture/Vacant			Non-Residential			Park & Recreation		
	1970	1980	1990	1970	1980	1990	1970	1980	1990	1970	1980	1990
Bensalem Area	40%	39%	38%	36%	23%	14%	21%	32%	42%	2%	6%	6%
Middletown Area	33%	28%	33%	29%	34%	22%	16%	26%	28%	21%	12%	16%
Pennsbury Area	23%	23%	25%	59%	35%	29%	15%	34%	40%	2%	8%	5%
Bristol Area	41%	34%	33%	32%	17%	14%	25%	41%	48%	2%	8%	6%
Lower Region Total	**32%**	**30%**	**31%**	**44%**	**29%**	**22%**	**18%**	**33%**	**40%**	**6%**	**8%**	**8%**

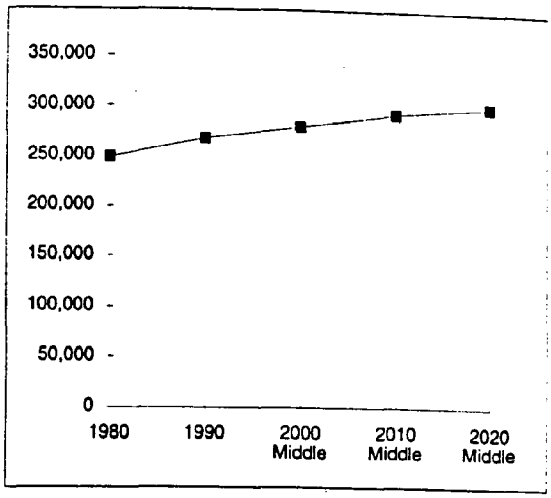
1980-1990 Population and Housing Comparison

Characteristics	1980	1990	Amount Change	Percent Change
Population	249,156	267,504	18,348	7.36%
Population Density	2,288/sq.mi.	2,427/sq.mi.	139/sq.mi.	6.08%
Housing Units	87,979	99,609	11,630	13.22%
Total Households	83,033	94,830	11,797	14.21%
Average Household Size	2.97	2.79	-0.18	-6.06%
Owner Vacancy Rate	1.3 %	1.2 %	-0.1 %	
Renter Vacancy Rate	11.1 %	9.6 %	-1.5 %	

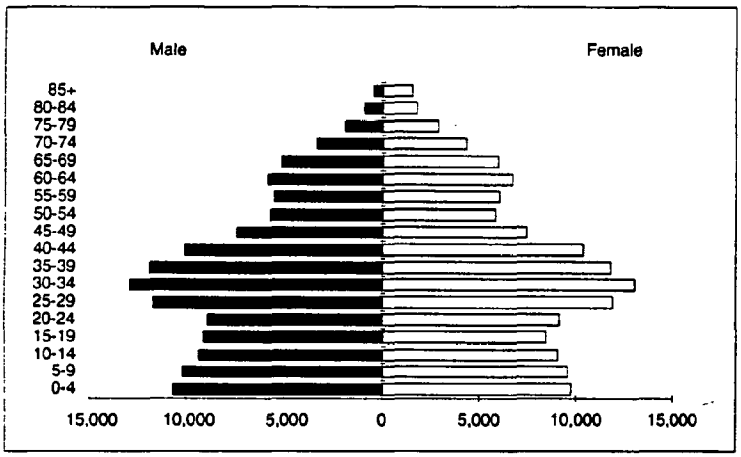
Origin of New Residents (1985-1990)

Total New Residents 1985-1990	Origin of New Residents: Within Bucks	Phila-delphia	Other Areas w/in PA	Other States
89,284	51,080	12,221	6,971	25,983

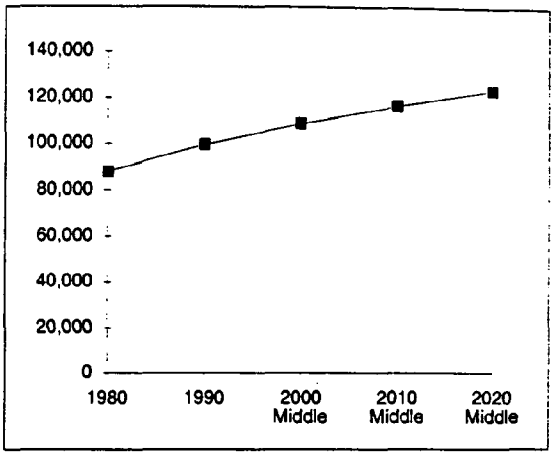
Population Trend



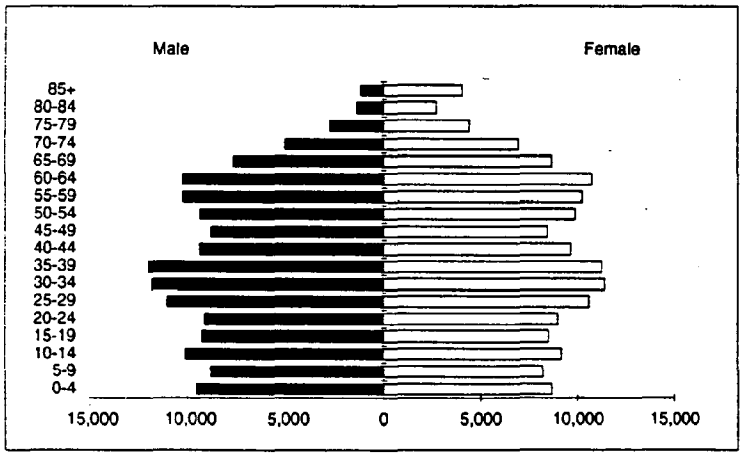
1990 Population Pyramid (by age group)



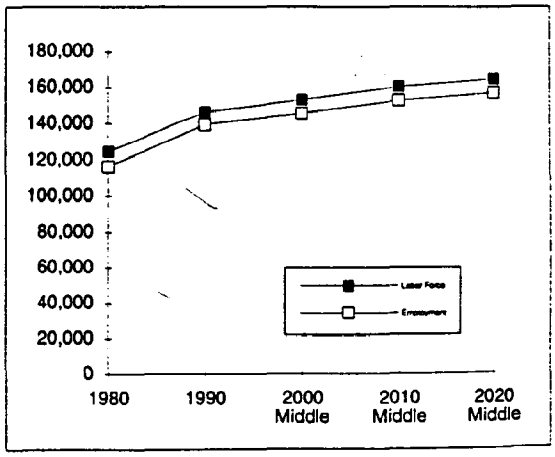
Dwelling Units Trend



2020 Population Pyramid (by age group)



Labor Force/Employment Trends



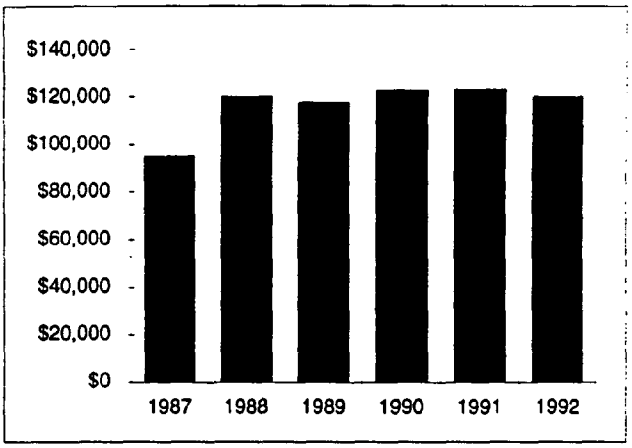
Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	267,504	270,930	279,690	284,400	279,380	293,060	307,810	271,670	300,780	341,250
Housing	99,609	106,170	108,800	109,960	112,350	116,650	120,520	113,980	123,460	128,860
Labor Force	146,124	148,050	152,840	155,420	152,840	160,290	168,330	148,550	164,460	186,680
Employment	139,370	141,140	145,690	148,150	145,700	152,750	160,470	141,590	156,740	177,840

Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	1,284	$95,000
1988	1,054	$120,000
1989	1,042	$117,930
1990	963	$123,000
1991	912	$123,100
1992	896	$120,000

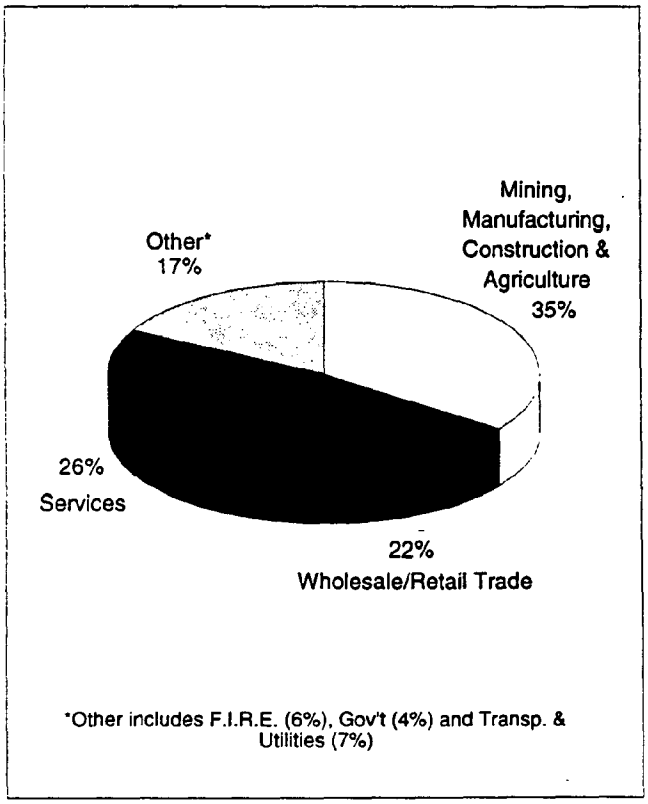
Median Home Sale Price



1980 - 1990 Educational Attainment

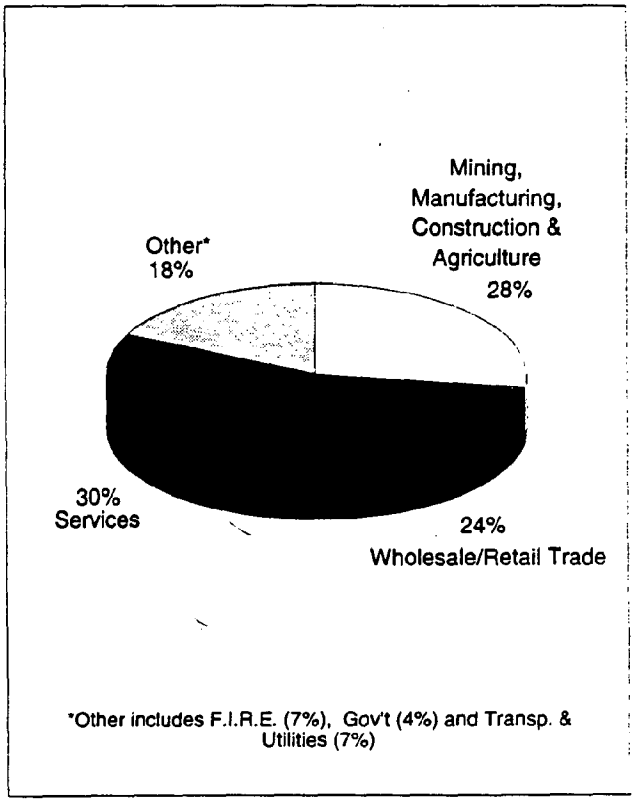
Characteristics	1980	1990
Persons 25 Years Old and Over	143,693	173,208
Percent High School Graduates	73%	81%
Percent 4 or more years of College	16%	21%

1980 Resident Employment by Type

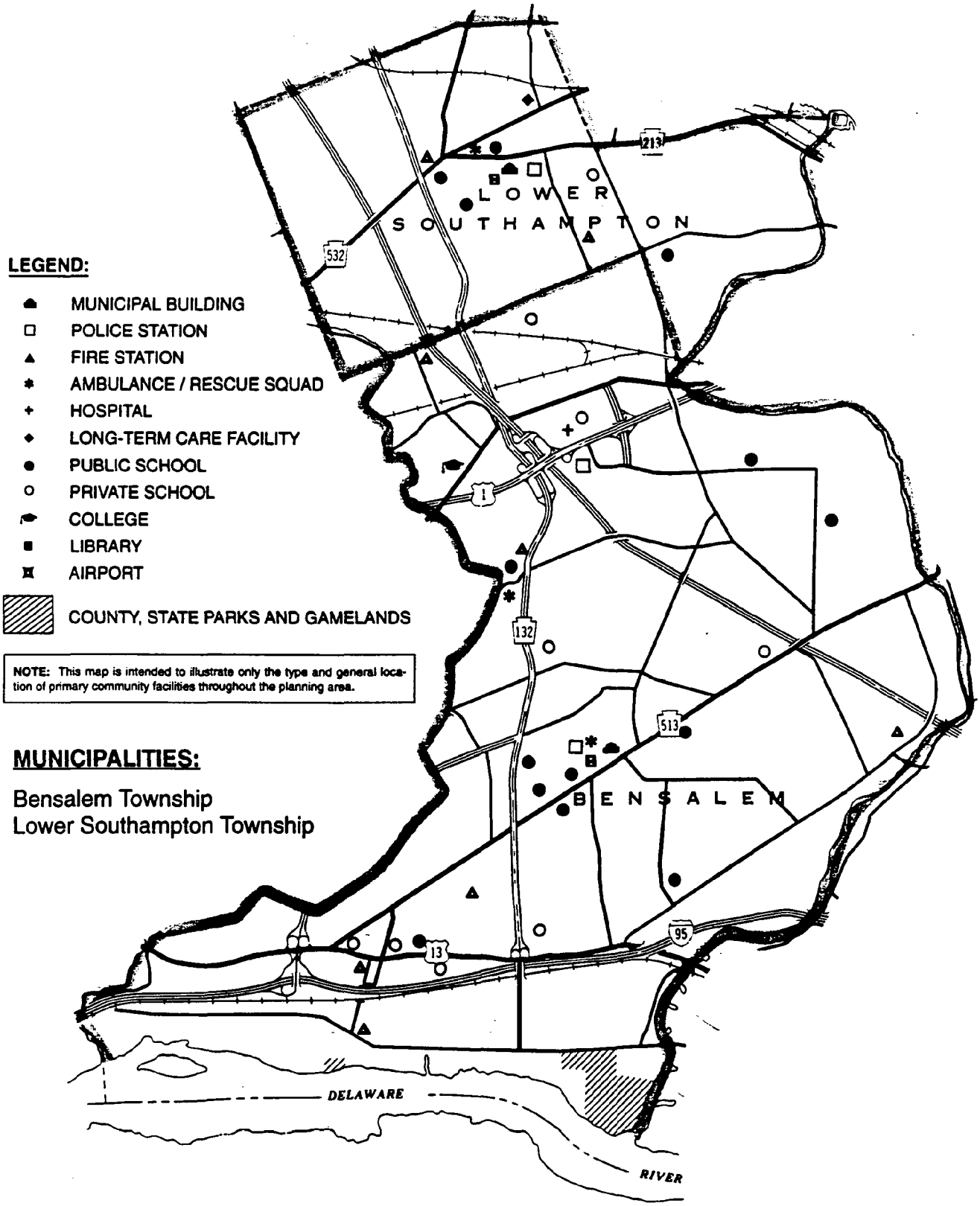


*Other includes F.I.R.E. (6%), Gov't (4%) and Transp. & Utilities (7%)

1990 Resident Employment by Type



*Other includes F.I.R.E. (7%), Gov't (4%) and Transp. & Utilities (7%)



LEGEND:

- MUNICIPAL BUILDING
- POLICE STATION
- FIRE STATION
- AMBULANCE / RESCUE SQUAD
- HOSPITAL
- LONG-TERM CARE FACILITY
- PUBLIC SCHOOL
- PRIVATE SCHOOL
- COLLEGE
- LIBRARY
- AIRPORT
- COUNTY, STATE PARKS AND GAMELANDS

NOTE: This map is intended to illustrate only the type and general location of primary community facilities throughout the planning area.

MUNICIPALITIES:

Bensalem Township
Lower Southampton Township

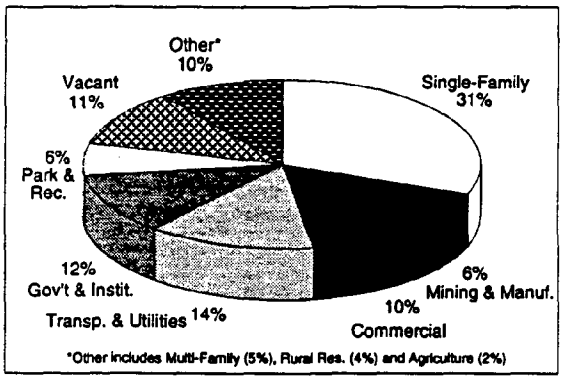
The Bensalem planning area is intensely developed with about one third of the area composed of single-family detached residential land use. The planning area is about 27 square miles which constitutes about 24 percent of the region and four percent of the county. The planning area has limited natural resources remaining. However, within the Neshaminy State Park there are numerous wetlands plant species of concern located in an inter-tidal freshwater mudflat. The Franklin Limestone, a special geologic formation is also located in the eastern portion of Lower Southampton Township. Parks, other than municipal parks, are limited to the Neshaminy State Park, the county's Delaware River Access Area which has boat launching facilities. Transportation routes are extensive and include major arterials such as U.S. Route 1 and state routes 132, 513, 532, 213, and 232 and access to both Interstate 95 and the Pennsylvania Turnpike. Commuter rail (SEPTA's Trenton and West Trenton lines) and bus service are also available along with shipping access through the Delaware River. Water and sewer service is almost entirely public and the area is served by the Bensalem and Neshaminy school districts.

Land Use Characteristics/Development Trends

1990 Land Use Characteristics (in acres)

Municipality	Single-family	Multi-family	Rural Res.	Ag.	Mining & Manu.	Commer-cial	Trans. & Util.	Gov't & Instit.	Parks & Rec.	Vacant	Total
Bensalem Township	3,245	753	313	192	885	1,503	1,758	1,678	815	1,633	12,775
Lower Southampton Twp.	2,056	98	270	110	186	257	571	302	209	210	4,269
Planning Area Total	**5,301**	**851**	**583**	**302**	**1,071**	**1,760**	**2,329**	**1,980**	**1,024**	**1,843**	**17,044**

1990 Land Use Percentages



Development Trends

Most of the intense growth in the Bensalem planning area occurred from the early 1950s through the 1970s. Many of the factors that would encourage growth are found in the Bensalem planning area, namely proximity to Philadelphia, great transportation access, and its strong economic presence in the region. Currently, only about one sixth of the planning area is composed of either agricultural, rural residential, or vacant lands. The area is diversified with a full range of residential and non-residential uses. Bensalem Township has a similar proportion of residential and non-residential uses with several concentration areas of commercial and industrial development (e.g., shopping centers, industrial/business parks). Lower Southampton Township, however, is more residential in overall character. Although the area is anticipated to continue to grow, limited developable land will curtail growth opportunities. Infill, adaptive reuse and redevelopment projects may play an increasing more important role in future growth.

1970-1990 Land Use Comparison Percentage

Municipality	Residential			Agriculture/Vacant			Non-Residential			Park & Recreation		
	1970	1980	1990	1970	1980	1990	1970	1980	1990	1970	1980	1990
Bensalem Township	35%	34%	32%	39%	25%	16%	23%	34%	46%	2%	6%	6%
Lower Southampton Twp.	56%	52%	53%	26%	18%	11%	16%	25%	31%	2%	5%	5%
Planning Area Total	**40%**	**39%**	**38%**	**36%**	**23%**	**14%**	**21%**	**32%**	**42%**	**2%**	**6%**	**6%**

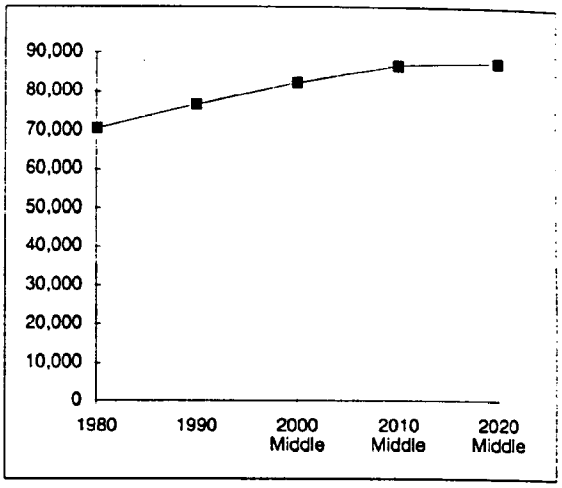
1980-1990 Population and Housing Comparison

Characteristics	1980	1990	Amount Change	Percent Change
Population	70,704	76,648	5,944	8.41%
Population Density	2,648/sq.mi.	2,870/sq.mi.	222/sq.mi.	8.38%
Housing Units	26,951	29,976	3,025	11.22%
Total Households	24,989	28,025	3,036	12.15%
Average Household Size	2.80	2.71	-0.09	-3.21%
Owner Vacancy Rate	1.3%	1.3%	0.0%	
Renter Vacancy Rate	12.6%	12.0%	-0.6%	

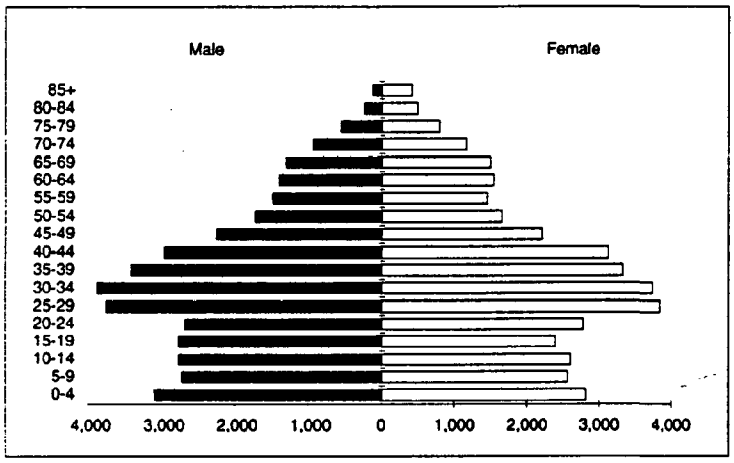
Origin of New Residents (1985-1990)

Total New Residents 1985-1990	Origin of New Residents: Within Bucks	Phila-delphia	Other Areas w/in PA	Other States
28,015	13,611	8,031	2,821	6,373

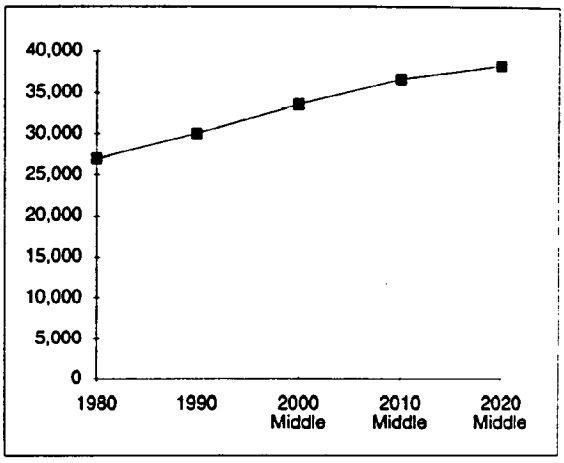
Population Trend



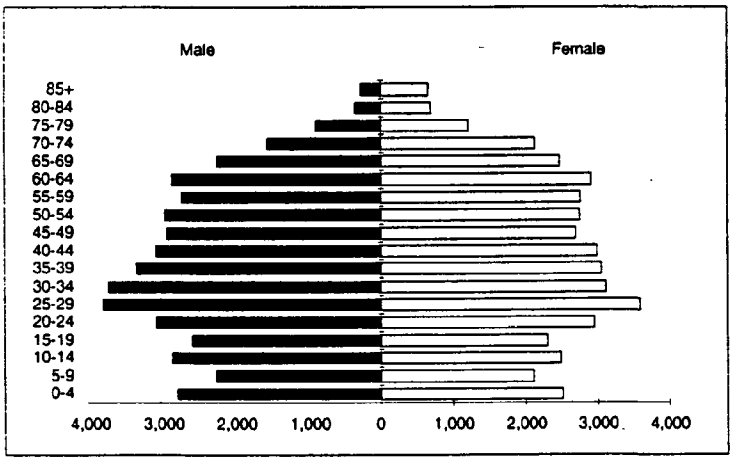
1990 Population Pyramid (by age group)



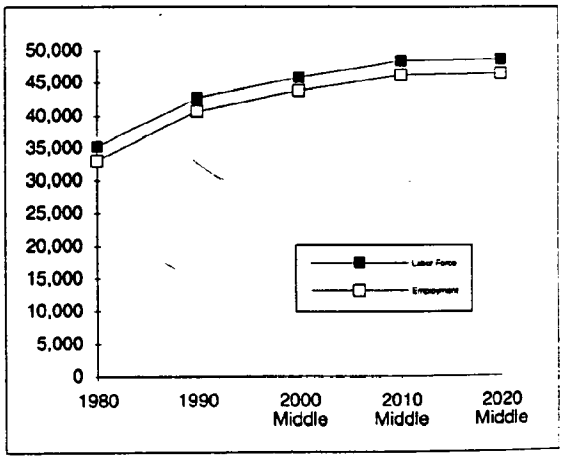
Dwelling Units Trend



2020 Population Pyramid (by age group)



Labor Force/Employment Trends



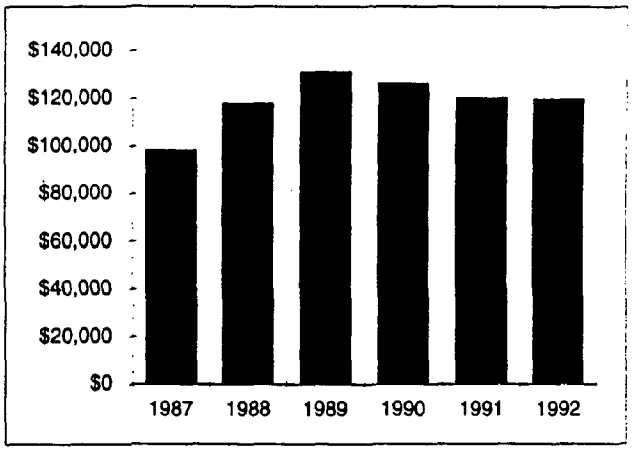
Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	76,648	79,800	82,380	83,760	82,900	86,930	91,300	79,100	87,580	99,360
Housing	29,976	32,740	33,560	33,910	35,230	36,580	37,800	35,390	38,330	40,010
Labor Force	42,654	44,410	45,840	46,620	46,160	48,420	50,840	44,040	48,760	55,410
Employment	40,742	42,370	43,730	44,480	44,030	46,150	48,490	41,980	46,480	52,730

Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	326	$98,250
1988	313	$117,900
1989	291	$131,500
1990	276	$126,450
1991	206	$120,500
1992	177	$119,900

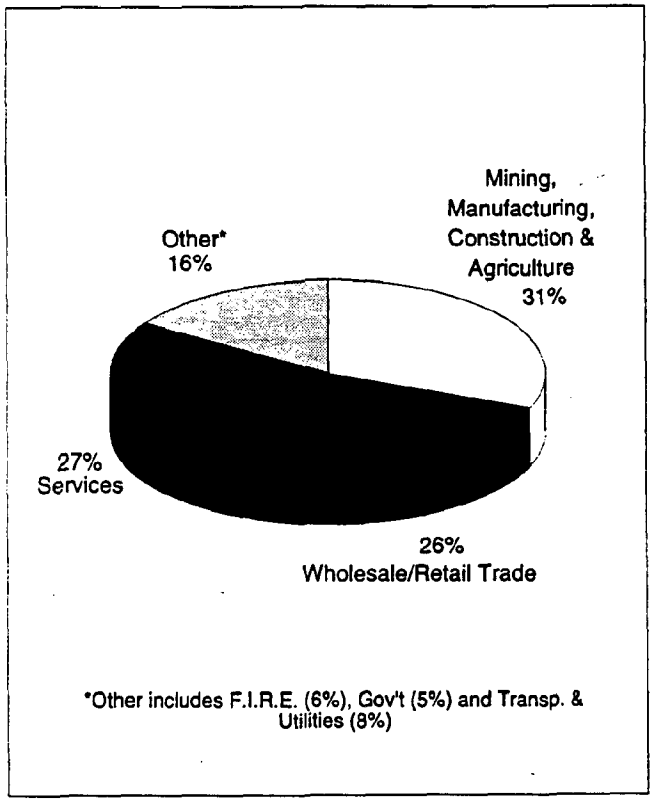
Median Home Sale Price



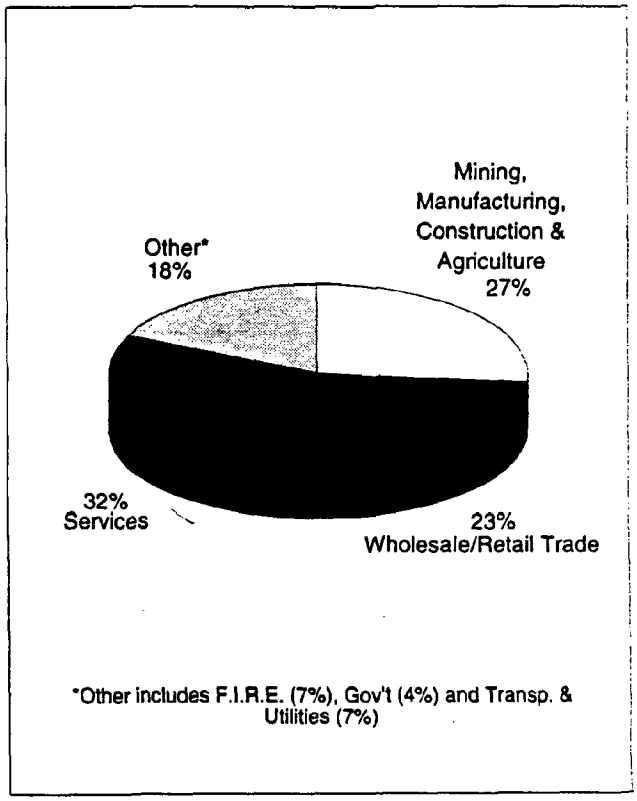
1980 - 1990 Educational Attainment

Characteristics	1980	1990
Persons 25 Years Old and Over	41,306	49,353
Percent High School Graduates	73%	80%
Percent 4 or more years of College	17%	21%

1980 Resident Employment by Type



1990 Resident Employment by Type



Municipal Profile

Date of Incorporation:		1692	
Type of Government:		Board of Supervisors	
School District:		Bensalem	
Land Area/Water Area:		Land: 19.96 sq. mi.	Water: 0.99 sq. mi.
Utilities:			
	Water	Public: 98.6%	Well: 1.4%
	Sewer	Public: 98.9%	On-Site: 1.1%

Land Use Characteristics/Development Trends

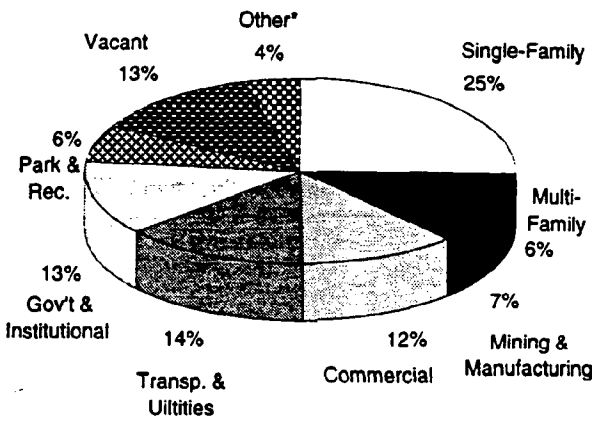
1990 Land Use Characteristics (in acres)

Land Use	Acres
Single-Family Residential	3,245
Multi-Family Residential	753
Rural Residential	313
Agricultural	192
Mining and Manufacturing	885
Commercial	1,503
Transportation and Utilities	1,758
Government and Institution	1,678
Park and Recreation	815
Vacant	1,633
Total	**12,775**

1970-1990 Land Use Comparison (by Percentage)

General Land Use	1970	1980	1990
Residential	35%	34%	32%
Agricultural/Vacant	39%	25%	16%
Non-Residential	23%	34%	46%
Park and Recreation	2%	6%	6%

1990 Land Use Percentage



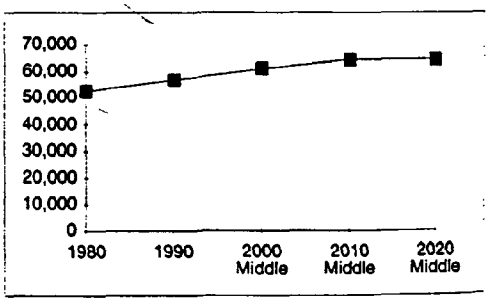
*Other includes Rural Residential (3%) and Agriculture (2%)

Demographics

1980-1990 Population and Housing Comparision

Characteristics	1980	1990	Amount Change	Percent Change
Population	52,399	56,788	4,389	8.38%
Population Density	2,653/sq.mi.	2,839/sq.mi.	186/sq.mi.	7.01%
Housing Units	20,766	22,713	1,947	9.38%
Total Households	18,930	20,964	2,034	10.74%
Avg. Household Size	2.73	2.68	-0.05	-1.83%
Owner Vacancy Rate	1.4%	1.5%	0.1%	
Renter Vacancy Rate	13.5%	12.9%	-0.6%	

Population Trend



Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	56,788	59,050	60,960	61,980	61,560	64,550	67,790	58,320	64,580	73,260
Housing	22,713	24,830	25,460	25,720	26,910	27,940	28,870	26,980	29,220	30,500
Labor Force	31,532	32,790	33,850	34,420	34,210	35,880	37,670	32,410	35,880	40,800
Employment	29,965	31,120	32,120	32,670	32,460	34,020	35,750	30,730	34,020	38,590

Socio-Economics

1980 - 1990 Household Comparison

Characteristics	1980	1990
Median Household Income	$19,356	$38,488
Median Home Value	$52,700	$117,400
Median Gross Rent	$260	$538

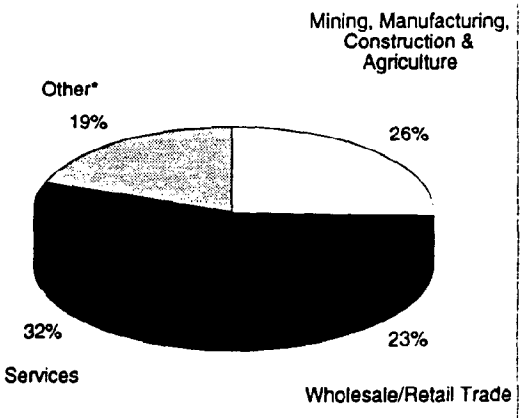
Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	223	$86,900
1988	231	$110,000
1989	226	$128,200
1990	226	$125,250
1991	162	$115,000
1992	128	$113,900

1980 - 1990 Educational Attainment

Characteristics	1980	1990
Percent High School Graduates	72.8%	79.9%
Percent 4 or more years of College	17.8%	21.8%

1990 Resident Employment by Type



*Other includes F.I.R.E. (8%), Gov't (5%) and Transp. & Utilities (7%)

Community Facilities

Name of Facility	Address
Bensalem Municipal Building	3800 Hulmeville Road
Bensalem Township Police	3800 Hulmeville Road
Pennsylvania State Police	3970 New Street
Cornwells Fire Company No. 16	2049 Bristol Pike
Eddington Fire Company No. 28	1444 Brown Avenue
Newport Fire Company No. 44	5961 Bensalem Boulevard
Newport Fire Company No. 88	2900 Pasqualone Boulevard
Nottingham Fire Company No. 65	3420 Street Road
Trevose Fire Company No. 4	4900 Street Road
Cornwells Union Fire Company No. 37	2067 State Road
Bensalem Rescue Squad No. 185	3800 Hulmeville Road
Bensalem Rescue Squad No. 186	Street Road and Richlieu Road
Eastern State Hospital and School	3740 Lincoln Highway
Neil A. Armstrong Middle School	2201 Street Road
Belmont Hills Elementry School	Neshaminy Boulevard & Grandview Avenue
Benjamin Rush Elementary School	3400 Hulmeville Road
Bensalem High School	4319 Hulmeville Road

Name of Facility	Address
Cecelia Snyder Middle School	3333 Hulmeville Road
Cornwells Elementary School	2400 Bristol Pike
Samuel K. Faust Elem School	2901 Bellview Drive
Robert K. Schaefer Middle School	3333 Hulmeville Road
Russell C. Struble Elem School	4300 Bensalem Boulevard
Valley Elementary School	3100 Don Allen Drive
St Charles Borromeo School	1704 Bristol Pike
De LaSalle Vocational School	Street Road and Bristol Pike
Holy Ghost Preparatory School	2429 Bristol Pike
Our Lady of Fatima School	Mechanicsville Road and Murray Ave.
Saint Ephrem School	5340 Hulmeville Road
Cornwells Christian Day School	2284 Bristol Pike
Trevose Day School	4951 Central Avenue
Phila College of Textile & Science	2655 Interplex Drive
Bensalem Free Library	3700 Hulmeville Road
Delaware River Access Area	Station Avenue
Neshaminy State Park	State Road and Dunksferry Road

Municipal Profile

Date of Incorporation:	1928	
Type of Government:	Board of Supervisors	
School District:	Neshaminy	
Land Area/Water Area:	Land: 6.67 sq. mi.	Water: 0.0 sq. mi.
Utilities:		
Water	Public: 77.2%	Well: 22.8%
Sewer	Public: 97.6%	On-Site: 2.4%

Land Use Characteristics/Development Trends

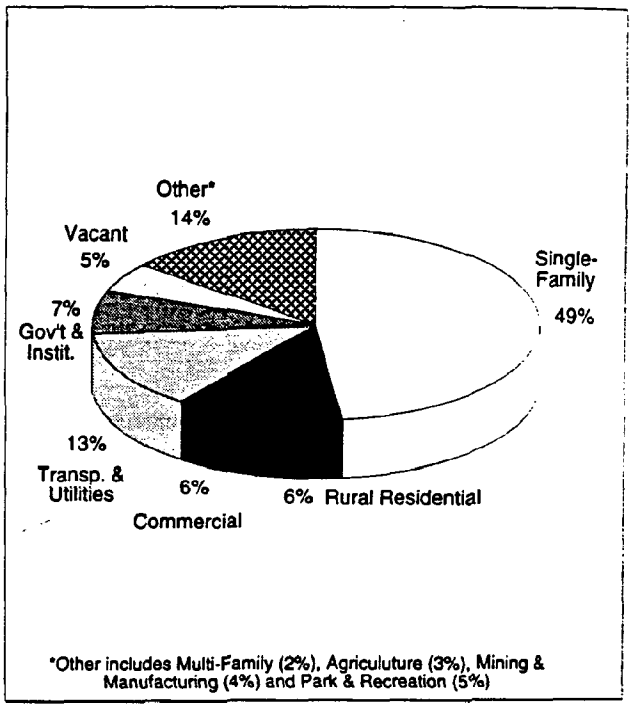
1990 Land Use Characteristics (in acres)

Land Use	Acres
Single-Family Residential	2,056
Multi-Family Residential	98
Rural Residential	270
Agricultural	110
Mining and Manufacturing	186
Commercial	257
Transportation and Utilities	571
Government and Institution	302
Park and Recreation	209
Vacant	210
Total	**4,269**

1970-1990 Land Use Comparison (by Percentage)

General Land Use	1970	1980	1990
Residential	56%	52%	53%
Agricultural/Vacant	26%	18%	11%
Non-Residential	16%	25%	31%
Park and Recreation	2%	5%	5%

1990 Land Use Percentage

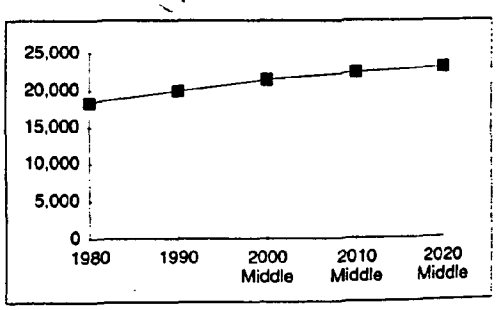


Demographics

1980-1990 Population and Housing Comparision

Characteristics	1980	1990	Amount Change	Percent Change
Population	18,305	19,860	1,555	8.49%
Population Density	2,803/sq.mi.	2,964/sq.mi.	161/sq.mi.	5.74%
Housing Units	6,185	7,263	1,078	17.43%
Total Households	6,059	7,061	1,002	16.54%
Avg. Household Size	3.00	2.80	-0.2	-6.67%
Owner Vacancy Rate	0.4%	0.9%	0.5%	
Renter Vacancy Rate	4.8%	5.9%	1.1%	

Population Trend



Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	19,860	20,750	21,420	21,780	21,340	22,380	23,510	20,780	23,000	26,100
Housing	7,263	7,910	8,100	8,190	8,320	8,640	8,930	8,410	9,110	9,510
Labor Force	11,122	11,620	11,990	12,200	11,950	12,540	13,170	11,630	12,800	14,610
Employment	10,777	11,250	11,610	11,810	11,570	12,130	12,740	11,250	12,460	14,140

Socio-Economics

1980 - 1990 Household Comparison

Characteristics	1980	1990
Median Household Income	$21,994	$42,984
Median Home Value	$58,600	$139,600
Median Gross Rent	$271	$561

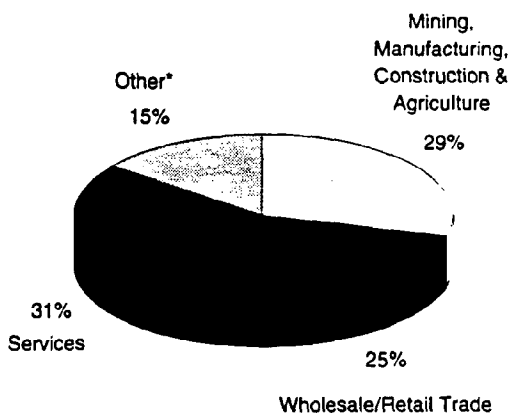
Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	103	$114,875
1988	82	$129,000
1989	65	$135,000
1990	50	$136,100
1991	44	$130,000
1992	49	$131,000

1980 - 1990 Educational Attainment

Characteristics	1980	1990
Percent High School Graduates	73.1%	81.8%
Percent 4 or more years of College	14.1%	20.5%

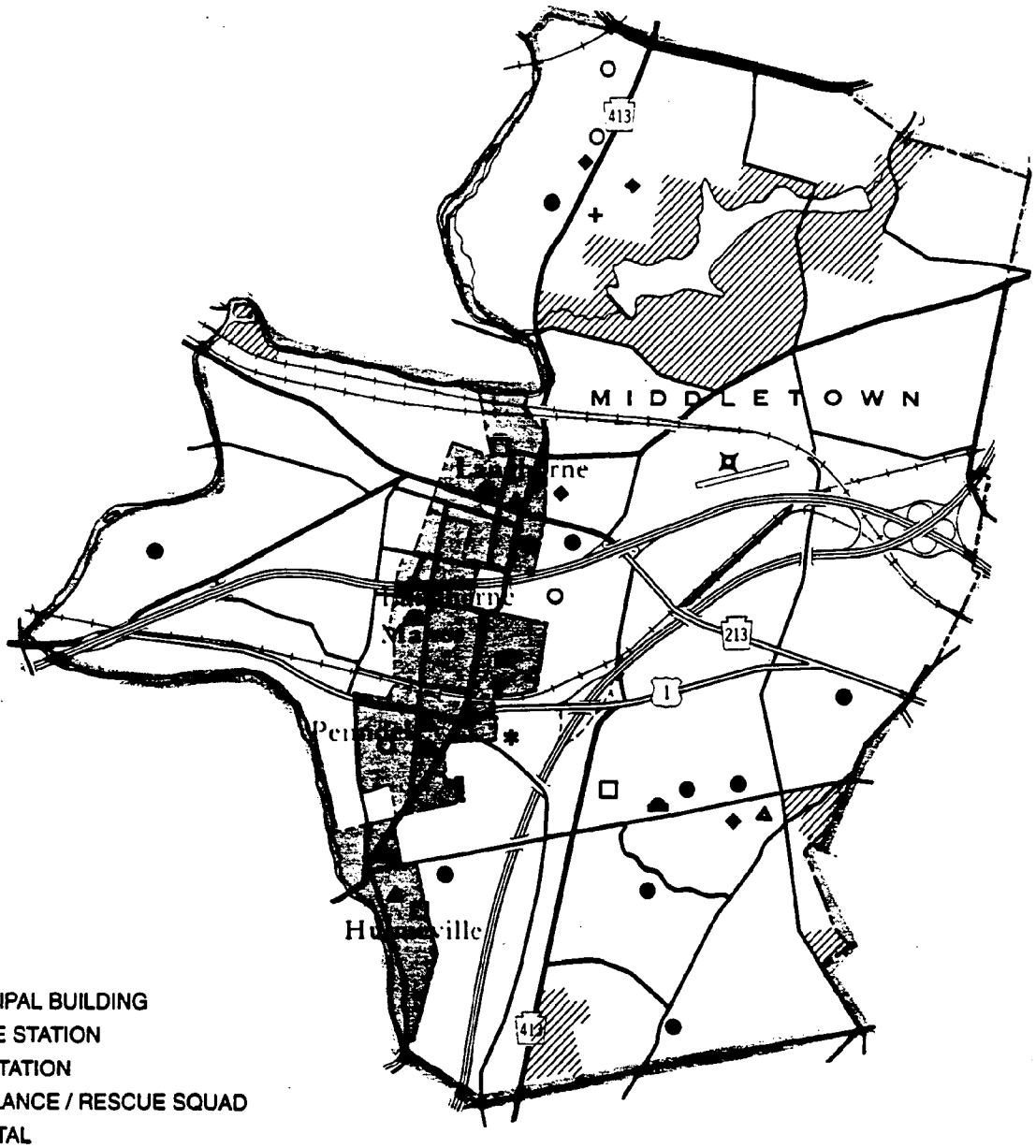
1990 Resident Employment by Type



*Other includes F.I.R.E. (6%), Gov't (3%) and Transp. & Utilities (6%)

Community Facilities

Name of Facility	Address
Lower Southampton Township Municipal Building	1500 North Desire Avenue
Lower Southampton Township Police	1500 North Desire Avenue
Feasterville Fire Company No. 1	20 Irving Place
Lower Southampton Fire Company No. 6	466 Elmwood Avenue
Tri-Hampton, Feasterville Rescue Squad No. 114	1440 Bridgetown Pike
Ridge Crest Convalescent Home	1730 North Buck Road
Poquessing Junior High School	Heights Lane and Bridgetown Pike
Poquessing Elementary School	Hieghts Lane and Poquessing Way
Tawanka Elementary School	2055 Brownsville Road
Lower Southampton Elementary School	7 School Lane
Assumption BVM School	55 Bristol Road
Lower Southampton Township Library	1500 North Desire Avenue



LEGEND:

- MUNICIPAL BUILDING
- POLICE STATION
- FIRE STATION
- AMBULANCE / RESCUE SQUAD
- HOSPITAL
- LONG-TERM CARE FACILITY
- PUBLIC SCHOOL
- PRIVATE SCHOOL
- COLLEGE
- LIBRARY
- AIRPORT
- COUNTY, STATE PARKS AND GAMELANDS

NOTE: This map is intended to illustrate only the type and general location of primary community facilities throughout the planning area.

MUNICIPALITIES:

Hulmeville Borough
Langhorne Borough
Langhorne Manor Borough
Middletown Township
Penndel Borough

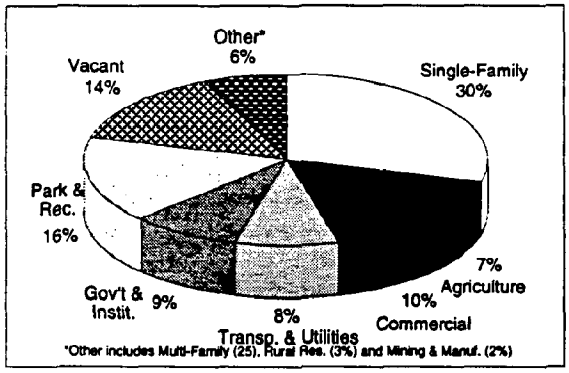
The Middletown planning area is urban to suburban in character, containing Middletown Township and four contiguous boroughs (Langhorne, Langhorne Manor, Penndel, and Hulmeville). The total land area for the planning area is 21 square miles or about 19 percent of the region and three percent of the county. The natural resources in the area are limited to Neshaminy Creek, other various streams and wetlands, and small woodlands. However, one sixth of the area consists of park and recreational lands. The majority of the county's 1,185 acre Core Creek Park (including Lake Luxembourg) in addition to Playwicki Park lies within Middletown Township. Transportation to the area is very good including U.S. Route 1 and state routes 413 and 213. In the eastern portion of Middletown Township, a cloverleaf ramp provides access to Interstate 95. Commuter rail (SEPTA's Trenton and West Trenton lines) and bus service are available. The Buehl airport is also located in Middletown Township. Public water and sewer service exists throughout much of the area. In addition, the area is serviced by the Neshaminy School District.

Land Use Characteristics/Development Trends

1990 Land Use Characteristics (in acres)

Municipality	Single-family	Multi-family	Rural Res.	Ag.	Mining & Manu.	Commer-cial	Trans. & Util.	Gov't & Instit.	Park & Rec.	Vacant	Total
Hulmeville Borough	104	0	16	0	14	18	22	8	1	60	243
Langhorne Borough	153	8	6	0	0	14	37	48	21	26	313
Langhorne Manor Borough	151	13	0	0	0	1	104	39	0	70	378
Middletown Township	3,419	268	318	961	205	1,238	891	1,051	2,167	1,732	12,250
Penndel Borough	118	8	0	0	16	29	63	12	6	23	275
Planning Area Total	**3,945**	**297**	**340**	**961**	**235**	**1,300**	**1,117**	**1,158**	**2,195**	**1,911**	**13,459**

1990 Land Use Percentages



Development Trends

Like other planning areas in the lower Bucks region, the Middletown planning area received a majority of its growth during the county's industrial and housing boom starting in the 1950s. A large portion of the Levittown housing development is contained at the southern end of the Middletown Township. The four boroughs are mainly residential in character with some concentrations of non-residential land uses. Consequently, one third of the planning area is currently single-family housing. A high concentration of commercial and business enterprises are situated within Middletown Township. Nevertheless, approximately one quarter of the area is still agricultural, rural residential, or vacant land. Growth pressures in the Middletown planning area are likely to continue for the next 10 years and possibly beyond due to good transportation access, adequate infrastructure, and land still available for development besides the fact the area is a major employment area in the county.

1970-1990 Land Use Comparison Percentage

Municipality	Residential			Agriculture/Vacant			Non-Residential			Park & Recreation		
	1970	1980	1990	1970	1980	1990	1970	1980	1990	1970	1980	1990
Hulmeville Borough	45%	45%	45%	36%	31%	29%	13%	21%	25%	5%	3%	0%
Langhorne Borough	55%	50%	53%	15%	8%	9%	25%	33%	32%	6%	9%	7%
Langhorne Manor Borough	47%	37%	43%	19%	20%	19%	34%	38%	38%	0%	5%	0%
Middletown Township	31%	26%	32%	30%	36%	23%	15%	25%	28%	23%	13%	18%
Penndel Borough	62%	51%	46%	8%	9%	8%	26%	37%	44%	4%	2%	2%
Planning Area Total	**33%**	**28%**	**33%**	**29%**	**34%**	**22%**	**16%**	**26%**	**28%**	**21%**	**12%**	**16%**

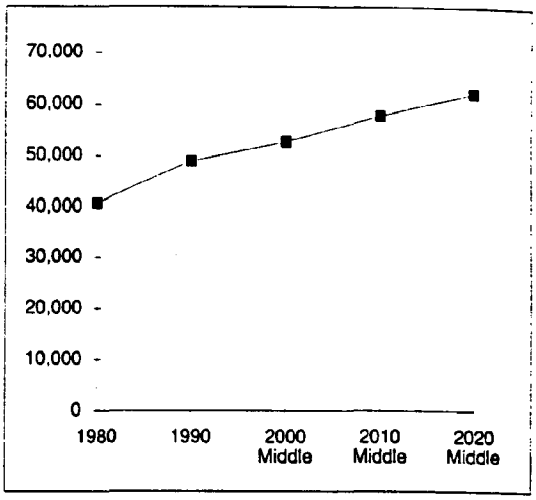
1980-1990 Population and Housing Comparison

Characteristics	1980	1990	Amount Change	Percent Change
Population	40,763	48,850	8,087	19.84%
Population Density	1,914/sq.mi.	2,293/sq.mi.	379/sq.mi.	19.80%
Housing Units	13,915	17,112	3,197	22.98%
Total Households	13,034	16,573	3,539	27.15%
Average Household Size	3.05	2.85	-0.2	-6.56%
Owner Vacancy Rate	1.4 %	0.8 %	-0.6 %	
Renter Vacancy Rate	12.6 %	6.0 %	-6.6 %	

Origin of New Residents (1985-1990)

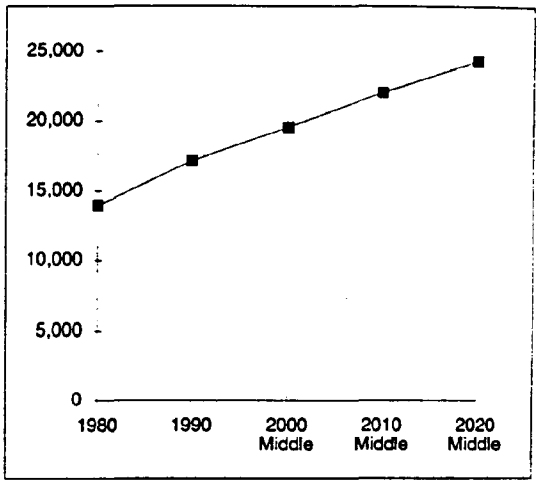
Total New Residents 1985-1990	Origin of New Residents			
	Within Bucks	Phila-delphia	Other Areas w/in PA	Other States
16,212	10,321	1,417	1,503	4,474

Population Trend

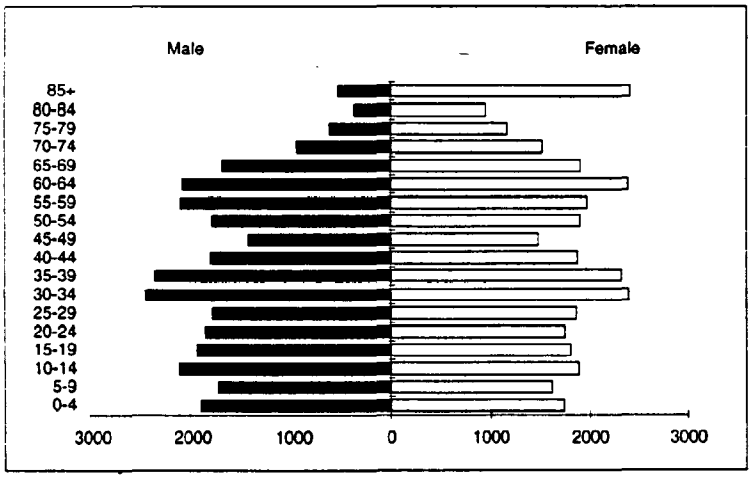


1990 Population Pyramid (by age group)

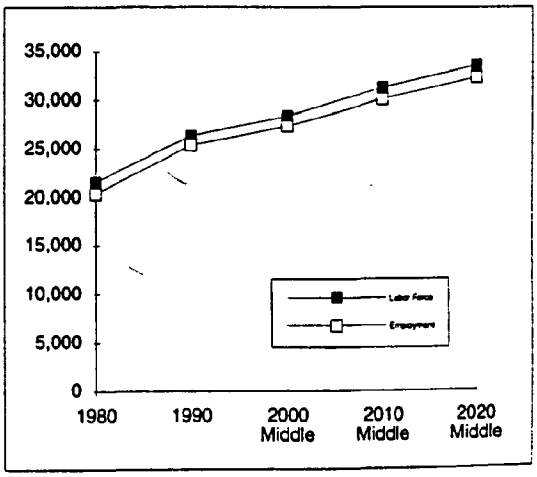
Dwelling Units Trend



2020 Population Pyramid (by age group)



Labor Force/Employment Trends



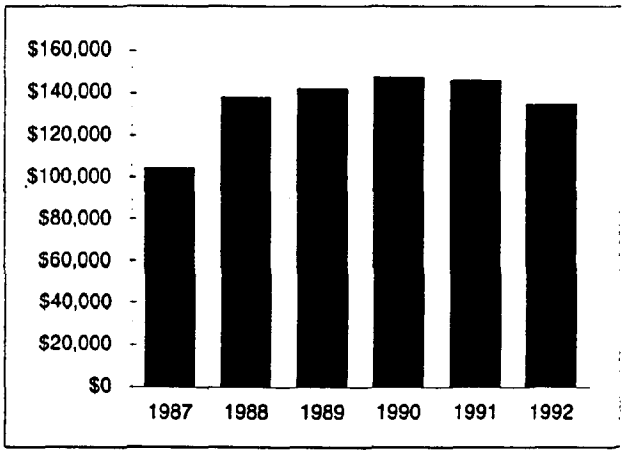
Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	48,850	51,040	52,690	53,580	55,320	58,010	60,930	56,320	62,350	70,740
Housing	17,112	19,040	19,510	19,720	21,250	22,060	22,790	22,460	24,330	25,390
Labor Force	26,375	27,530	28,420	28,900	29,830	31,280	32,850	30,360	33,610	38,130
Employment	25,405	26,500	27,350	27,810	28,700	30,100	31,610	29,200	32,320	36,680

Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	303	$104,500
1988	192	$137,900
1989	180	$142,000
1990	186	$147,200
1991	195	$146,000
1992	156	$135,000

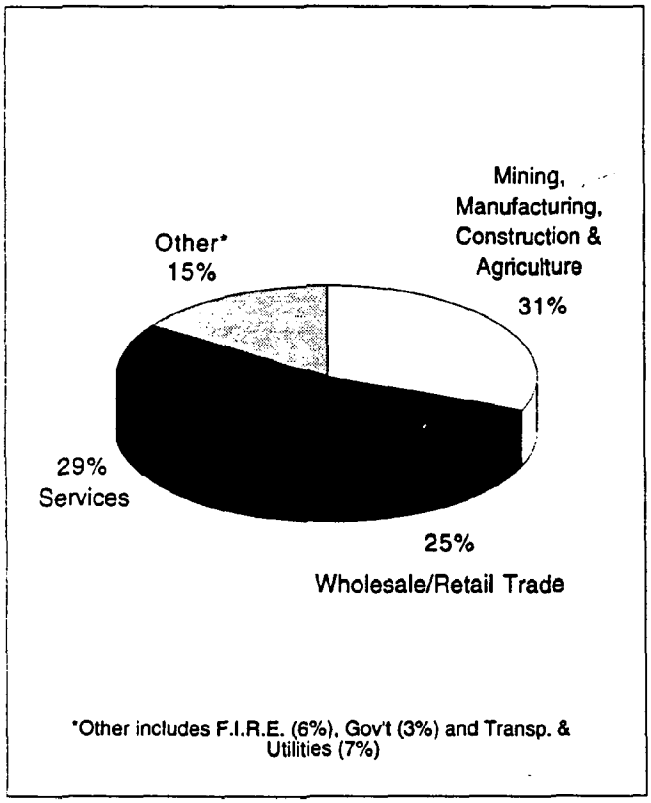
Median Home Sale Price



1980 - 1990 Educational Attainment

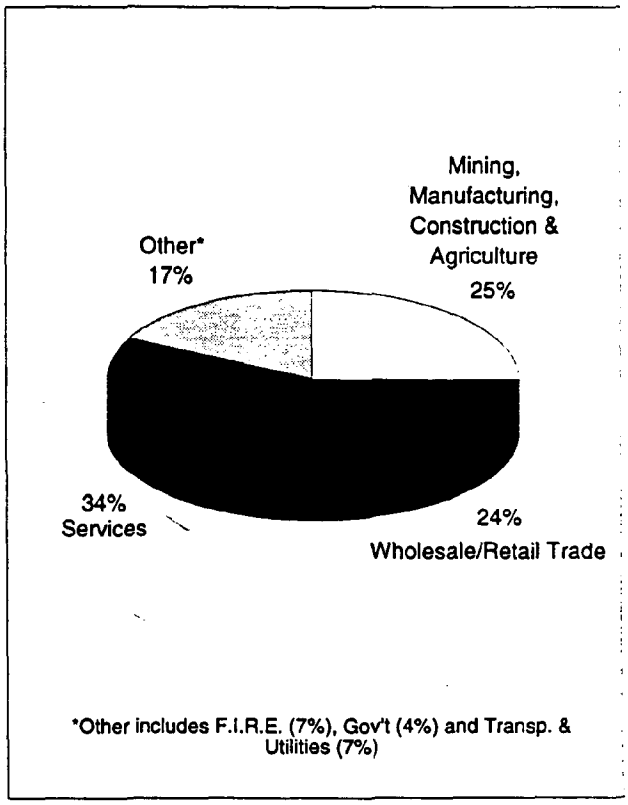
Characteristics	1980	1990
Persons 25 Years Old and Over	23,237	31,522
Percent High School Graduates	79%	85%
Percent 4 or more years of College	19%	25%

1980 Resident Employment by Type



*Other includes F.I.R.E. (6%), Gov't (3%) and Transp. & Utilities (7%)

1990 Resident Employment by Type



*Other includes F.I.R.E. (7%), Gov't (4%) and Transp. & Utilities (7%)

Municipal Profile

Date of Incorporation:	1872	
Type of Government:	Borough Council	
School District:	Neshaminy	
Land Area/Water Area:	Land: 0.38 sq. mi.	Water: 0.0 sq. mi.
Utilities:		
Water	Public: 21.9%	Well: 78.1%
Sewer	Public: 91.0%	On-Site: 9.0%

Land Use Characteristics/Development Trends

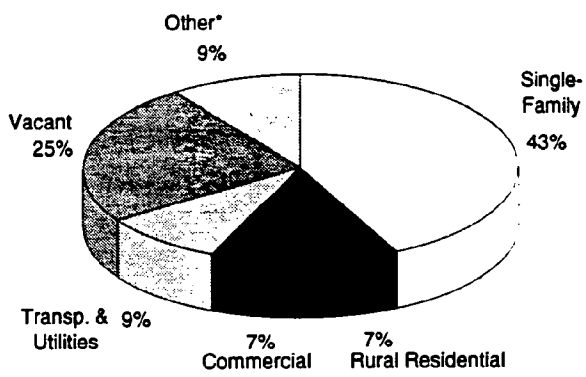
1990 Land Use Characteristics (in acres)

Land Use	Acres
Single-Family Residential	104
Multi-Family Residential	0
Rural Residential	16
Agricultural	0
Mining and Manufacturing	14
Commercial	18
Transportation and Utilities	22
Government and Institution	8
Park and Recreation	1
Vacant	60
Total	**243**

1970-1990 Land Use Comparison (by Percentage)

General Land Use	1970	1980	1990
Residential	45%	45%	45%
Agricultural/Vacant	36%	31%	29%
Non-Residential	13%	21%	26%
Park and Recreation	5%	3%	0%

1990 Land Use Percentage



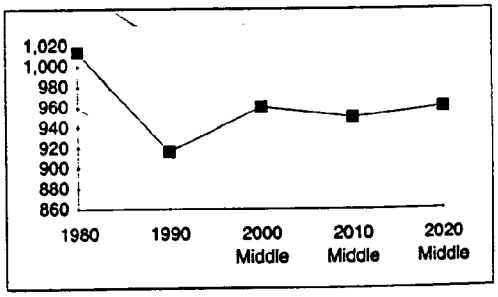
*Other includes Mining & Manuf. (6%), Gov't & Instit. (3%) and Park & Recreation (0.4%)

Demographics

1980-1990 Population and Housing Comparision

Characteristics	1980	1990	Amount Change	Percent Change
Population	1,014	916	-98	-9.66%
Population Density	2,740/sq.mi.	2,290/sq.mi.	-450/sq.mi.	-16.42%
Housing Units	348	333	-15	-4.31%
Total Households	337	319	-18	-5.34%
Avg. Household Size	3.01	2.87	-0.14	-4.65%
Owner Vacancy Rate	0.7%	0.0%	-0.7%	
Renter Vacancy Rate	4.2%	4.6%	0.4%	

Population Trend



Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	916	930	960	970	910	950	1,000	860	960	1,090
Housing	333	330	340	340	320	330	340	310	330	350
Labor Force	518	520	540	550	510	540	570	490	540	610
Employment	498	500	520	530	490	520	540	470	520	590

Socio-Economics

1980 - 1990 Household Comparison

Characteristics	1980	1990
Median Household Income	$20,257	$37,381
Median Home Value	$49,400	$121,300
Median Gross Rent	$178	$478

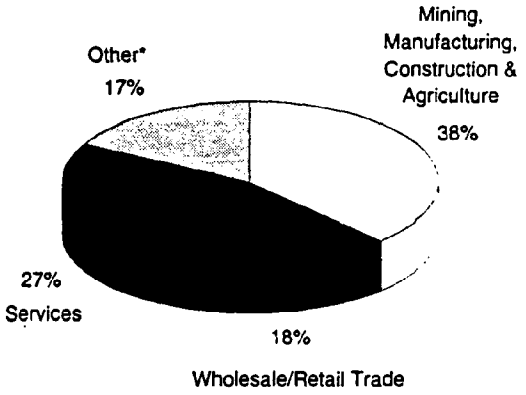
Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	7	$80,000
1988	4	$153,750
1989	1	$93,500
1990	3	$93,000
1991	4	$102,950
1992	1	$107,000

1980 - 1990 Educational Attainment

Characteristics	1980	1990
Percent High School Graduates	65.3%	82.6%
Percent 4 or more years of College	9.0%	16.6%

1990 Resident Employment by Type



*Other includes F.I.R.E. (5%), Gov't (6%) and Transp. & Utilities (6%)

Community Facilities

Name of Facility	Address
Hulmeville Borough Municipal Building	114 Trenton Avenue
Hulmeville Borough Police	1009 Pennsylvania Avenue
William Penn Fire Company No. 7	Main Street and Trenton Avenue

Municipal Profile

Date of Incorporation:	1876	
Type of Government:	Borough Council	
School District:	Neshaminy	
Land Area/Water Area:	Land: 0.49 sq.mi.	Water: 0.0 sq. mi.
Utilities:		
Water	Public: 98.5%	Well: 1.5%
Sewer	Public: 99.6%	On-Site: 0.4%

Land Use Characteristics/Development Trends

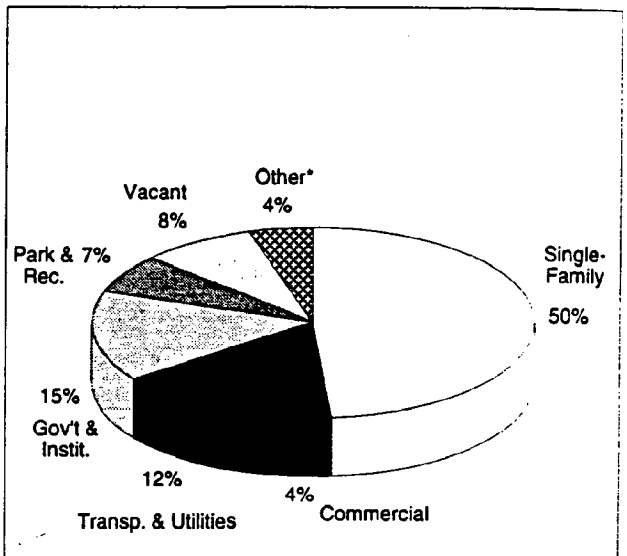
1990 Land Use Characteristics (in acres)

Land Use	Acres
Single-Family Residential	153
Multi-Family Residential	8
Rural Residential	6
Agricultural	0
Mining and Manufacturing	0
Commercial	14
Transportation and Utilities	37
Government and Institution	48
Park and Recreation	21
Vacant	26
Total	**313**

1970-1990 Land Use Comparison (by Percentage)

General Land Use	1970	1980	1990
Residential	55%	50%	53%
Agricultural/Vacant	15%	8%	9%
Non-Residential	25%	33%	32%
Park and Recreation	6%	9%	7%

1990 Land Use Percentage



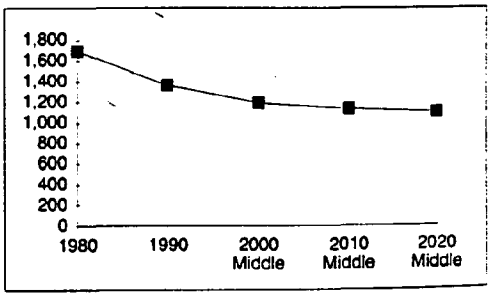
*Other includes Multi-Family (3%) and Rural Residential (2%).

Demographics

1980-1990 Population and Housing Comparision

Characteristics	1980	1990	Amount Change	Percent Change
Population	1,697	1,361	-336	-19.80%
Population Density	3,327/sq.mi.	2,722/sq.mi.	-605/sq.mi.	-18.18%
Housing Units	559	545	-14	-2.50%
Total Households	542	528	-14	-2.58%
Avg. Household Size	2.68	2.55	-0.13	-4.85%
Owner Vacancy Rate	0.0%	0.3%	0.3%	
Renter Vacancy Rate	1.0%	5.0%	4.0%	

Population Trend



Population, Housing, Labor Force, Employment Projections

Characteristics	1990 Census	2000 Low	2000 Middle	2000 High	2010 Low	2010 Middle	2010 High	2020 Low	2020 Middle	2020 High
Population	1,361	1,150	1,190	1,210	1,080	1,130	1,190	990	1,100	1,250
Housing	545	490	500	510	470	490	510	480	520	540
Labor Force	755	640	660	670	600	630	660	550	610	690
Employment	741	630	650	660	580	610	640	540	600	680

Socio-Economics

1980 - 1990 Household Comparison

Characteristics	1980	1990
Median Household Income	$20,443	$36,000
Median Home Value	$55,100	$139,900
Median Gross Rent	$214	$463

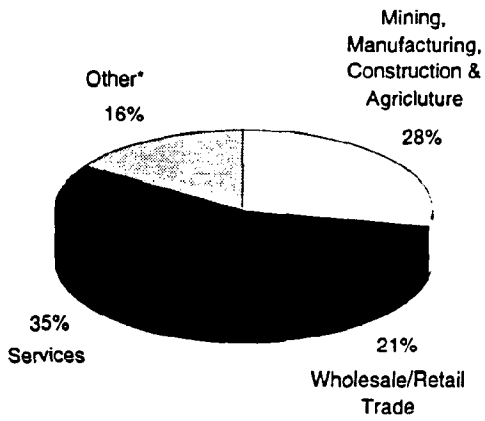
Home Sales and Median Home Prices (2nd Quarter) 1987-1992

Year	Home Sales	Median Price
1987	7	$143,500
1988	4	$164,500
1989	4	$104,950
1990	4	$134,500
1991	4	$116,500
1992	5	$145,275

1980 - 1990 Educational Attainment

Characteristics	1980	1990
Percent High School Graduates	74.1%	83.6%
Percent 4 or more years of College	21.9%	24.4%

1990 Resident Employment by Type



*Other includes F.I.R.E. (6%), Gov't (4%) and Transp. & Utilities (6%)

Community Facilities

Name of Facility	Address
Langhorne Borough Municipal Building	114 East Maple Avenue
Langhorne Borough Police	114 East Maple Avenue
Langhorne-Middletown Fire Company No. 21	114 East Maple Avenue
Pennwood Library	Pine and Flowers avenues

Municipal Profile

Date of Incorporation:		1890	
Type of Government:		Borough Council	
School District:		Neshaminy	
Land Area/Water Area:		Land: 0.59 sq.mi.	Water: 0.0 sq. mi.
Utilities:			
	Water	Public: 97.3%	Well: 2.7%
	Sewer	Public: 17.3%	On-Site: 82.7%

Land Use Characteristics/Development Trends

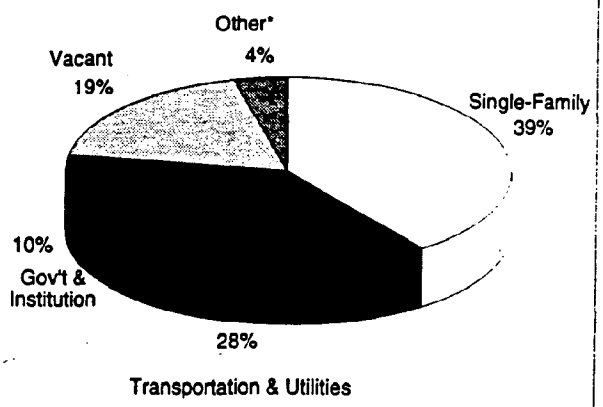
1990 Land Use Characteristics (in acres)

Land Use	Acres
Single-Family Residential	151
Multi-Family Residential	13
Rural Residential	0
Agricultural	0
Mining and Manufacturing	0
Commercial	1
Transportation and Utilities	104
Government and Institution	39
Park and Recreation	0
Vacant	70
Total	**378**

1970-1990 Land Use Comparison (by Percentage)

General Land Use	1970	1980	1990
Residential	47%	37%	43%
Agricultural/Vacant	19%	20%	19%
Non-Residential	34%	38%	38%
Park and Recreation	0%	5%	0%

1990 Land Use Percentage



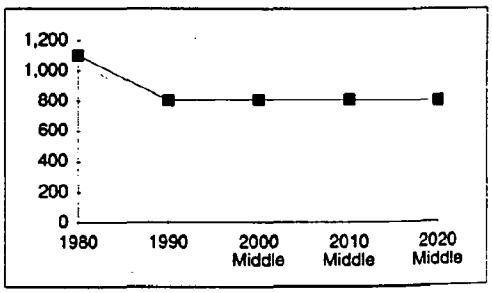
*Other includes Multi-Family (3%) and Commercial (0.3%)

Demographics

1980-1990 Population and Housing Comparision

Characteristics	1980	1990	Amount Change	Percent Change
Population	1,103	807	-296	-26.84%
Population Density	1,697/sq.mi.	1,345/sq.mi.	-352/sq.mi.	-20.74%
Housing Units	360	304	-56	-15.56%
Total Households	353	297	-56	-15.86%
Avg. Household Size	2.90	2.72	-0.18	-6.21%
Owner Vacancy Rate	0.3%	0.0%	-0.3%	
Renter Vacancy Rate	4.0%	3.8%	-0.2%	

Population Trend



APPENDIX C

Bucks County Wetlands Plant List

Bucks County Wetlands Plant List

SCIENTIFIC NAME	COMMON NAME
1. *Acer negundo* L.	Box Elder
2. *Acer saccharinum* L.	Silver Maple
3. *Acorus calamus* L.	Sweetflag
4. *Agrostis alba* L.	Redtop
5. *Alisma subcordatum* Raf.	Subcordate Waterplantain
6. *Alnus serrulata* (Ait.) Willd.	Hazel Alder
7. *Amaranthus cannabinus* (L.) Sauer	Tidemarsh Waterhemp
8. *Amorpha fruticosa* L.	Dull-Leaf Indigo
9. *Andropogon gerardii* Vitman	Big Bluestem
10. *Andropogon glomeratus* (Walt.) B.S.P.	Bushybeard Bluestem
11. *Andropogon virginicus* L.	Broomsedge Bluestem
12. *Arisaema triphyllum* (L.) Schott	Indian Jack-in-the-Pulpit
13. *Aronia arbutifolia* (L.) Ell.	Red Chokecherry
14. *Aronia melanocarpa* (Michx.) Ell.	Black Chokecherry
15. *Asclepias incarnata* L.	Swamp Milkweed
16. *Aster umbellatus* Mill.	Flattop Aster
17. *Betula nigra* L.	River Birch
18. *Bidens* (all species)	Beggarticks
19. *Boehmeria cylindrica* (L.) SW.	Smallspike False-Nettle
20. *Calamagrostis canadensis* (Michx.) Beauv.	Bluejoint Reedgrass
21. *Calamagrostis cinnoides* (Muhl.) Barton	Hairyseed Reedgrass
22. *Caltha palustris* L.	Marsh Marigold
23. *Cardamine bulbosa* (Schreb.) B.S.P.	Bulb Bittercress
24. *Cardamine pensylvanica* Muhl. ex Willd.	Pennsylvania Bittercress
25. *Carex* (all species)	Sedge
26. *Cephalanthus occidentalis* L.	Common Buttonbush
27. *Chelone glabra* L.	White Turtlehead
28. *Chrysosplenium americanum* Schweinitz	Golden Saxifrage
29. *Cicuta bulbifera* L.	Poison Waterhemlock
30. *Cicuta maculata* L.	Common Waterhemlock
31. *Cinna arundinacea* L.	Stout Woodreed
32. *Clethra alnifolia* L.	Summersweet Clethra
33. *Conium maculatum* L.	Poison Hemlock
34. *Cornus amomum* Mill.	Silky Dogwood
35. *Cyperus* (all species)	Flatsedge
36. *Decodon verticillatus* (L.) Ell.	Water Willow
37. *Dulichium arundinaceum* (L.) Britt.	Three-Way-Sedge
38. *Echinochloa walteri* (Pursh) A. Heller	Walter Millet
39. *Eleocharis* (all species)	Spikerush
40. *Epilobium coloratum* Biehler	Purpleleaf Willowweed
41. *Equisetum fluviatile* L.	Water Horsetail
42. *Equisetum hyemale* L.	Scouringrush Horsetail
43. *Eragrostis hypnoides* (Lam.) B.S.P.	Teal Lovegrass
44. *Eragrostis pectinacea* (Michx.) Nees	Carolina Lovegrass
45. *Eupatoriadelphus dubius* (all species)	Joe-Pye Weed
46. *Eupatorium perfoliatum* L.	Boneset
47. *Eupatorium pilosum* Walter	Hairy Thoroughwort
48. *Euthamia graminifolia* (L.) Nutt.	Grass-Leaved Goldenrod
49. *Fraxinus nigra* Marshall	Black Ash

50. *Fraxinus pennsylvanica* Marshall	Green Ash
51. *Galium obtusum* Bigel.	Bluntleaf Bedstraw
52. *Galium parisiense* L.	Wall Bedstraw
53. *Galium tinctorium* L.	Dye Bedstraw
54. *Glyceria* (all species)	Mannagrass
55. *Helenium autumnale* L.	Common Sneezeweed
56. *Heteranthera reniformis* R. & P.	Roundleaf Mudplantain
57. *Hibiscus mosocheutos* L.	Rose Mallow
58. *Hydrophyllum virginianum* L.	Virginia Waterleaf
59. *Hypericum mutilum* L.	Dwarf St. Johnswort
60. *Ilex verticillata* (L.) A. Gray	Winterberry
61. *Impatiens capensis* Meerb.	Spotted Touch-Me-Not
62. *Impatiens pallida* Nutt.	Pale Touch-Me-Not
63. *Iris pseudacorus* L.	Yellow Iris
64. *Iris versicolor* L.	Blueflag Iris
65. *Juncus* (all species)	Rush
66. *Laportea canadensis* (L.) Wedd.	Canada Woodnettle
67. *Leersia oryzoides* (L.) Swartz	Rice Cutgrass
68. *Leersia virginica* Willd.	Whitegrass
69. *Leucothoe racemosa* (L.) Gray	Swamp Leucothoe
70. *Lindera benzoin* (L.) Blume	Spicebush
71. *Liquidambar styraciflua* L.	Sweetgum
72. *Ludwigia* (all species)	Seed-Box
73. *Lycopus* (all species	Bugleweed
74. *Lyonia ligustrina* (L.) DC.	Male-Berry
75. *Lysimachia* (all species)	Loosestrife
76. *Lythrum salicaria* L.	Purple Loosestrife
77. *Magnolia virginiana* L.	Sweetbay
78. *Mentha X piperita* L.	Peppermint
79. *Mertensia virginica* (L.) Pers.	Virginia Bluebells
80. *Mimulus ringens* L.	Monkey-Flower
81. *Myosotis scorpioides* L.	True Forget-Me-Not
82. *Nasturtium officinale* R. Br.	Watercress
83. *Nuphar luteum* (L.) Sibth. & J.E. Smith	European Cowlily
84. *Onoclea sensibilis* L.	Sensitive Fern
85. *Osmunda* (all species)	Fern
86. *Panicum longifolium* Torr.	Long-Leaved Panic-Grass
87. *Panicum rigidulum* Bosc. ex Nees.	Redtop Panicum
88. *Peltandra virginica* (L.) Kunth.	Arrow-Arum
89. *Phalaris arundinacea* L.	Reed Canarygrass
90. *Phragmites australis* (Cav.) Trin. ex Steud.	Giant Cane
91. *Polygonum amphibium* L.	Water Knotweed
92. *Polygonum arifolium* L.	Halberdleaf Tearthumb
93. *Polygonum hydropiper* L.	Marshpepper Knotweed
94. *Polygonum hydropiperoides* Michx.	Swamp Knotweed
95. *Polygonum pensylvanicum* L.	Pennsylvania Smartweed
96. *Polygonum punctatum* Ell.	Dotted Smartweed
97. *Polygonum sagittatum* L.	Arrow-Leaved Tearthumb
98. *Polygonum scandens* L.	Hedge Cornbind
99. *Pontederia cordata* L.	Pickerelweed
100. *Quercus bicolor* Willd.	Swamp White Oak
101. *Quercus palustris* Muench.	Pin Oak
102. *Quercus phellos* L.	Willow Oak

103. *Ranunculus sceleratus* L.	Celeryleaf Buttercup
104. *Ranunculus septentrionalis* Poir.	Swamp Buttercup
105. *Rhododendron viscosum* (L.) Torr.	Swamp Azalea
106. *Rhynchospora capitellata* (Michx.) Vahl	False Bog Rush
107. *Rorippa palustris* (L.) Besser	Marsh Yellowgrass
108. *Rorippa sylvestris* (L.) Besser	Creeping Yellowgrass
109. *Rosa palustris* Marshall	Swamp Rose
110. *Sagittaria* (all species)	Arrowhead
111. *Salix* (all species)	Willow
112. *Saururus cernuus* L.	Lizard's Tail
113. *Scirpus* (all species)	Bulrush
114. *Scutellaria integrifolia* L.	Rough Skullcap
115. *Scutellaria lateriflora* L.	Blue Skullcap
116. *Sium suave* Walt.	Common Waterparsnip
117. *Smilax hispida* Muhl.	Bristly Greenbriar
118. *Sparganium* (all species)	Burreed
119. *Spiraea latifolia* (Ait.) Borkh.	Broadleaf Meadowsweet Spiraea
120. *Spiraea tomentosa* L.	Hardhack
121. *Symplocarpus foetidus* (L.) Nutt.	Common Skunkcabbage
122. *Thelypteris thelypteroides* (Michx.) J. Holub	Marsh Fern
123. *Triadenum virginicum* (L.) Raf.	Marsh St. Johnswort
124. *Typha angustifolia* L.	Narrow-Leaved Cattail
125. *Typha latifolia* L.	Common Cattail
126. *Ulmus americana* L.	American Elm
127. *Ulmus rubra* Muhl.	Slippery Elm
128. *Vaccinium corymbosum* L.	Highbush Blueberry
129. *Vaccinium macrocarpon* Ait.	Large Cranberry
130. *Verbena hastata* L.	Blue Verbena
131. *Viburnum dentatum* L.	Arrow-Wood
132. *Viburnum recognitum* Fernald	Arrow-Wood
133. *Woodwardia areolata* (L.) T. Moore	Netted Chainfern
134. *Zizania aquatica* L.	Annual Wildrice

APPENDIX D

Field Observations and Notes

APPENDIX D

Field Observations And Notes
Czm Nonpoint Pollution And Wetlands Study
July 1994

During the months from April to July 1994, the Bucks County Planning Commission staff visited most of the wetlands identified on the U. S. G. S. National Wetlands Inventory (NWI) maps in the CZM study area. The purpose of this was to observe the condition of the wetlands in the CZM study area. By observing the state of the wetlands, staff could determine where wetlands may be in distress or where pollutants like trash were affecting them. By doing this, local municipal officials will know where wetlands are located in the municipality. It may also help them establish zones or areas of concern within the municipality protecting all remaining wetlands.

Several of the wetlands delineated on the NWI maps could not be located. Others could not be observed due to lack of access roads or other entry to the area. The physical condition of these wetlands is uncertain. At this time, any protection policies or recommendations for wetland protection found in chapter six of volume I of the report can be applied to unobserved wetlands. Future studies may be able to access these areas, so that protection policies or actions can be more firmly established.

The following observations are intended as descriptive measures only. No field sampling was performed for specific pollutants, although obvious distress characteristics such as a lack of vegetation, widespread presence of debris or trash, off color water or surface residues (oil, greases or other) were noted. Where possible, existing species were identified and recorded.

The numerical sequence of the following information is intended to be used with the study area map, Figure 7 of the report, to locate the wetlands described. The numbers correspond to the numbers shown on Figure 7 and are not intended as a priority listing.

1. **Neshaminy State Park, Bensalem Township.: Wetlands Area (PFOIC on NWI maps)**
   - Obvious standing water
   - Wetland associated vegetation observed (Fragmities).
   - An 8' to 10' high earthen berm separating the wetland area from the main stem of the Neshaminy Creek.
   - Severe impact on creek bank from industrial and residential debris. 55 gallon oil drums, plastic garbage bags, tires and residential refuse observed on the creek.
   - A black, thick residue material was observed on the creek bank and floating the water's edge in the same area.
   - Residential houses observed on the opposing bank of the creek.

At the time of the site visit on April 11, 1994, an interview was held with Richard Eberle, Park Manager.

- Mr. Eberle suggested that problems have existed with the Park's marina. Evidence has been found suggesting boat operators are dumping sewage holding tanks into the marina. The park did have a functioning sewage pumping area and holding tanks at one time, but the system is in extreme disrepair and no longer functioning.
- Mr. Eberle reported that recently DER inspected the integrity of the system. The pumping lines and holding tank are no longer stable and are disintegrating, rendering them unusable.

- Mr. Eberle acknowledged that there were occasional accidents where fuel or oil was spilled into the marina, but it did not constitute a major problem.
- He suggested that much greater problems were being created by Jack's Marine (Bristol Township). The owner is pursuing an arrangement with the state whereby he can dredge existing wetlands to create more dock space within his existing marina operation. He also pointed out that there was a restaurant, engine repair and overhaul and boat rental operations happening on the site. To date, DER has denied Jack's requests to dredge the wetland area.

2. **State Rd., Bensalem Township. (Industrial Park) : Wetland Area**
   - Various types of industrial, semi-commercial and freight uses are present in the area of the wetland. Development abutting the wetland site.
     -Rollins Truck Rentals
     -B F Goodrich
     -Integrity Textiles
     -American Furniture Rentals and Sales
     -Bombardier Transportation Group
     -Railroad Siding
   - Heavy vehicular traffic, comprised mainly of tractor trailers. Constant stream of receiving and shipping trucks. Hydrocarbon residues from vehicles may enter wetland.

3. **Expressway @ I-95 area, Bensalem Township. (Industrial Park): Wetland Area**
   - Large area of impervious surface.
   - Heavy vehicular traffic, comprised mainly of tractor trailers. Constant stream of receiving and shipping trucks. Hydrocarbon residues from vehicles may enter wetland.
   - Due to activities in the industrial park such as trucking, there is the potential for pollution by oils, greases, hydrocarbons, chemicals spills from industrial manufacturing processes, manufacturing or assembly/production byproducts such as paint or degreasers, CFC's (Styrofoam), refuse/trash.

4. **Industrial Park, Bensalem Township. (Railroad tracks): Wetland Area**
   - Opportunity for various types of pollutants associated with railroad operations, such as chemical spills, oils and refuse to enter the wetland in the event of an accident or mishandling by personnel.

5. **Expressway @ I-95, Bensalem Township.: Wetland Area**
   - Large area of impervious surface.
   - Heavy vehicular traffic, comprised mainly of tractor trailers. Constant stream of receiving and shipping trucks. Hydrocarbon residues from vehicles may enter wetland.
   - Due to activities in the industrial park such as trucking, there is the potential for pollution by oils, greases, hydrocarbons, chemicals spills from industrial manufacturing processes, manufacturing or assembly/production byproducts such as paint or degreasers, CFC's (Styrofoam), refuse/trash.
   - Opportunity for various types of pollutants associated with railroad operations, such as chemical spills, oils and refuse to enter the wetland in the event of an accident or mishandling by personnel.

6. **Route 13, Bensalem Township.: Wetland areas (PSSI/EM and PFOI on NWI map)**
   - Heavy commercial area
     -Gas Stations
     -Business Offices
     -Food Establishments

-Convenience Stores

- Heavy vehicular traffic because it is a commercial area. Constant stream of vehicles. Hydrocarbon residues from vehicles may enter wetland.
- Sewage pump station present at wetland area.

7. Route 13, Bensalem Township.: Wetland Areas (PSSI/EM and PFOI on NWI map)

- Heavy commercial area
  - -Gas Stations
  - -Business Offices
  - -Food Establishments
  - -Convenience Stores
- Heavy vehicular traffic because it is a commercial area. Constant stream of vehicles. Hydrocarbon residues from vehicles may enter wetland.

8. Route 13, Bensalem Township.: Seven Eleven Store

- Dredge/spoils area behind the store in commercial district. Berm at least 13' above existing ground level, center is depressed/settled (bowl shaped).
- Five foot wire mesh fence at top of berm preventing access. Outlet structure placed inside basin (12" CMP) discharging directly into a swale 30' from the main stem of the Neshaminy Creek.
- Extremely poor condition surrounding the swale structure. Bare earth, trash, tires, abandoned boats, plastic containers, residential refuse located at bank near the outlet.
- Low tide conditions revealed that the bed of the creek along the banks was a dark grayish color.
- Richard Eberle, Park Manager of Neshaminy State Park informed staff that the dredge material came from the Neshaminy Creek and the Delaware River. The use of this material as a storage basin for stormwater management purposes is questionable.
- Potential use as study area for future grant purposes. Remediation may include removal of outlet structure from dredge pile or installation of water quality outlet, rehabilitation of the creek banks at the swale outlet point, removal of large abandoned marina and boat materials, etc.

9. Spencer St., Bristol Township.: Wetland Area (PFOI on NWI map)

- Obvious residential impacts: trash and debris scattered throughout.
- Dump site for construction debris; chunks of concrete and asphalt roadway present.
- Low lying, marshy, wooded; very little species diversity.

10. Garfield St., Bristol Township.: Wetland area (PFOI on NWI map)

- Relatively trash and refuse free.
- Very little species diversity.
- Light residential area surrounding the entire site.

11. Newport Rd. and Park Ave., Bristol Township.: Wetland area (PFOI on NWI map)

- Relatively free of trash and refuse .
- Very little species diversity.
- Medium residential area surrounding the entire site.

12. Newport Rd. and Route 13, Bristol Township.: Wetland Area

- Adjacent to new commercial development, with fresh earth disturbance, relatively poor E&S controls because silt running off into roadway.
- Possible loss of wetland area?

13. **State Rd. and Totem Rd., Bensalem Township. Wetland Area (PEMIR on NWI map (2 identified))**
   - Very poor condition; residential refuse, trash, vermin present.
   - Occurs along major truck transport route: State Rd.
   - Mostly commercial land uses, some scattered residential dwellings among buildings.
   - Has active marina in area.

14. **Jack's Marine, Bensalem Township.: Wetland Area (RIUBVx on NWI maps)**
   - Potential on this site for serious impacts to the waterway and wetland areas in the event of improper management of marina, repair business or restaurant.
   - Fuel pumps observed in closed proximity to the Neshaminy Creek.
   - Dredging equipment visible, possible dredge site observed at back entrance to marina.

15. **Neshaminy State Park Marina, Bristol Township.: Confluence of the Neshaminy Creek and the Delaware River**
   - Fairly well kept, but may be causing sewage pollution problem through holding tank dumping in the marina.

16. **Brownsville Rd., Lower Southampton Township.: Wetland Area (PUBZh on NWI maps)**
   - Situated in a trailer park; extreme residential impact potential.
   - Low quality wetlands.
   - Relatively clear of debris at this time.

17. **King David Cemetery and Rosedale Cemetery, Neshaminy Ave. and Bristol Rd., Bensalem Township.: Wetland Area.**
   - Could not identify wetland area on site.

18. **Timber Lane & Bensalem Blvd.: Wetland Area (PFOI on NWI map)**
   - Large area, large single family residential development, unfinished (bankrupt).
   - Obvious wetland conditions. Stands of Red Maple, cattails. Extreme disturbance to the perimeter of the wetland by unfinished development. Some foundations set and overgrown. Large piles of residential debris scattered, and lawn clippings, many in plastic bags.

19 **Beverly/Forest and Forest/Lavender, Bensalem Township.: Wetland area (PFOI on NWI map)**
   - Wetlands surrounded by 1/4 medium acre residential built in the 1950's or 60's. Wetland has healthy established vegetation, but little diversity.
   - Woodland consists of Maple, Oak, Beach, Dutchman's breeches.
   - Little trash/debris, high organic layer. Residential lawns have surface water present (has not rained for 3 days)

20. **Bridgewater Road, Bensalem Township.: Wetland (PFOI on NWI map)**
   - Area is medium residential. Dead ends 200' from I-95 expressway.
   - Vegetation seems to be primarily Red Maples and Ash, jewel weed.
   - Driveway on I-95 edge of site lead to some type of industrial site. Driveway is posted & blocked. Some trees have been removed for access purposes (trucks).
   - Looks generally good, no obvious residential debris or trash.
   - Observed a large mulch pile & some scrap metal behind fence on driveway.

21. **N. Gillam Avenue, Langhorne Borough : Wetland Area**

- White Ash, Red Maple, White Oak, poison ivy, sugar maple (no debris), sweet gum, sumac, jewel weed (indicator), Beech, chestnut, apparent old stand growth, May Apple, black cherry (wet species), ferns, wild rose.
- Stream running through center, homes around west side of site, north perimeter (light residential), West Richardson Ave side (light residential).
- Robinwood Dr. (north of the wetland) has new residential houses.

22. S. of Gillam, Langhorne Borough: Wetland Area
- Roadside dumping (some), skunk cabbage, dense understory growth, yellow birch, seems wetter. House on northwest corner.
- This area abuts Route 281 which has new development called the Woods of Lincoln II at Hulmeville and Henry. Has a stormwater detention basin in fair condition.

23. South of Route 1, Middletown Township.: Wetland area (R3UBH on NWI map)
- Appears to be wet area, however not labeled a wetland.
- College Ave. probably built on fill through wetland area, light density residential.

24. Poplar Street and Walsh Avenue, Langhorne Manor Borough: Wetland area (R3UBH on NWI map)
- Low density residential/ large homes.
- White ash, red maple, beech on site.

25. Virginia Street (PUBZH on NWI map))
- Tributary continues through the wetland.
- Low species diversity, not very dense, sweet gum, Northern Jack in the Pulpit.
- Clean area, homes abut wetland.
- Some residential trash dumping along tracks on Comley Avenue South.
- Stream runs through cast in place concrete pipe under railroad tracks.

26. Park Ave., Langhorne Manor Borough (Industrial Site): Wetland area (PSSIA on NWI map)
- Auto body truck terminals. Wetland following stream down site.
- Detention Basin present on site.
- Located in the area of U.S. Route 1.

27. No Information Available

28. Parker Ave. along U.S. Route 1, Penndel Borough: Wetland (R3UBH on NWI map)
- Medium density residential along Parker Ave.
- Junk yard (Autos) in the areas of Parker Ave and Spring Street.
- Penndel Body Works on U. S. Route 1.

29. N. River Drive, Middletown Township.: Wetland area (PFOIA on NWI map)
- Extensive area, right on banks of the creek.
- Cherry, beech, catalpa, red maple, white ash.
- Evidence of wildlife habitat (mallards present).

30. **Highland Ave. and Route 281, Middletown Township:(PUBZx on NWI map))**
- Dense area, species seen include white ash, red maple.
- Surrounded by paved road, cross streets,
- Building supply business located in area (sand, gravel supply)
- North section of site is location of residential sewage pump station near Old Lincoln Highway

31. **Middletown Township, Idlewood on the Neshaminy: Wetland area**
- Looks like construction will begin soon (construction trailer on site).
- Close to creek, impacts to hydrology.

32 **Old Lincoln Highway, Middletown Township: (BUBHx on NWI map))**
- Couldn't get on site because road ends and is adjacent to private property.
- Large single family lots
- Abandoned quarry, woodlands and High school surrounding the area.
- In close proximity to railroad tracks

33. **Middletown Township: (BUBHx on NWI map)**
- Appears to be storage tanks in the immediate area, although could not observe clearly. If tanks are present, may cause threat from accidental spills depending on contents of tanks.

34 **Old Lincoln Highway, Bensalem Township: (R2UBH on NWI map))**
- Significant (large) wetland system, upstream from industrial park
- Bisected by Old Lincoln Highway
- Ash, white oak, white ash, poplar, wild lily, cherry present on site.
- Very clean, little debris, residential area.
- Trailer park located in the area.
- Auto parts store, other commercial businesses in area.

35. **Industrial Center, Bensalem Township: (PEMSC, PFOIC, PFOIA on NWI map)**
- Dumping , trash on site. Impacts from surrounding land uses.
- Sweet gum , white oak, white ash, Poplar, Cherry, wild rose, willow (bushes), jewel weed, Virginia creeper, witch hazel, Rose of Sharon, horse chestnut present on site.
- Residential house abutting site.
- Erosion evident in wetland vegetation behind site, also evidence of All Terrain Vehicles using the area for recreational purposes which could be causing the soil disturbances. These vehicles have damaged the natural flora of the site.
- Small basin on site.

36. **Jefferson Avenue, Bristol Township: Wetland area (PFOIC on NWI map)**
- Small, but very wet at Jefferson and Madison.
- mallards, maple, ash, Virginia creeper, white oak.
- Light residential area, a little debris from surrounding land uses.

37. **Washington St., Bristol Township: Wetland area (PFOIC on NWI map)**
- Wetland has significant, healthy understory. Other vegetation consists of beech and cherry.
- Residential development is low density. Space between homes.

38 **Longview Avenue/Lime Avenue, Bristol Township: Wetland area**
- Wild rose, maple, ash, Virginia creeper, white oak
- Residential development is low density. Space between homes.

39. **Longview/Cyprus/Fernwood, Penndel Borough and Bristol Township: (PUBZx on NWI map)**
- Swale runs through the area, looks almost riverine.
- Wild rose, maple, ash, Virginia creeper, white oak.

40. **Bristol road, Bensalem Township.: Wetland area**
- Trailer park impacts directly on the remaining wetland.
- Looks good, but potential runoff impacts from amount of impervious surfaces due to high residential density.
- White ash and swamp or red maple are primary species, and wetland fringe indicators.

41. **Bristol road, Bensalem Township.: Wetland area**
- A small trailer park area on the other side of site # 40 above. Evidence of earth moving.
- Black Cherry, sumac, red maple present in wet areas.

42. **Bensalem Township: Wetland area**
- Jewel weed, honeysuckle, maple. Small area, private prop (poster). Gravel access road. Looks to be in good condition. Willow, sumac, cherry, white ash.

43. **Wetland-Industrial Park. Bensalem**
- Very well maintained. Wetlands seem to be fenced off from parking areas.
- Vegetation includes maples, cherry, honeysuckle, may apples, tilia and witch hazel.
- Large open space at end of the park leaves potential for new or more development.
- Several basins present-very well maintained, grassed, vegetated.

44. **Bartram Road, Bristol Township, Industrial Park (Keystone); Wetland area**
- Well maintained area, although some refuse lying in parking lot, and also spilling over into the wetland fringe.

45. **Route 413, Bristol Township: Wetland area**
- Wetland-abuts shopping center on 413.
- Good shape, fairly well protected from parking lot.
- Potential road impact from 413.
- Vegetation includes willow (bush), arrowwood (bush), sumac, maple, white oak, white ash, fragmities.

46. **Industrial Commercial area, Bristol Township: Wetland area**
- Light industrial/commercial section of township.
- Very rundown, trash and debris as well as scrap and junk visible.

47. **Bristol Township: Wetland area**
- Some residential type trash (litter and papers, household items).
- Exposed junk cars lying directly in the wetland fringe vegetation, and scattered along the wetland perimeter.
- Vegetation includes arrowwood (bush), sweet gum, maple, oak, white ash.

48. **Bristol Township.: Wetland area**
- PNDI indicates there are protected species within this site.
- The area is posted as "No Hunting" and as a preservation and study area by the County of Bucks.
- Large industrial zoned parcels for sale abutting the site. Some trucking operations were evident on the day of observation.
- Looks very healthy. Vegetation is full, and there seems to be a great deal of species diversity in the interior of the wetland.
- A Waste Automation facility (private residential trash disposal company) is located directly across the road from the posted wetland area. Normal operations by trash trucks were occurring on the observation day. The potential for impacts from this facility.

49. **Bristol Township.: Wetland area**
- Small strip of wetland vegetation observed abutting I-95. As this is a buffer for I-95, it is doubtful that it is of high quality or will be further impacted in the future. Possibly already degraded through vehicular pollutants.

50 **Bristol Township.: Wetland area**
- Light/medium residential development. Apparently maintained wetland vegetation, because site is wooded and some trees are intact. Age of trees approximated to be between 30 and 40 years.
- Mature vegetation seems unusual due to normal clear cutting operations that occur prior to construction. Lots of natural vegetation; species include: maple, oak, hickory, sweet gum, cottonwood.

51. **Bristol Township.: Wetland area**
- Medium (1/2 acre lot) residential.
- Heavily wooded, mature trees. Yellow poplar, red maple, striped maple, sassafras, jewel weed. Wetland vegetation present but not sure of species. Oaks, white ash.
- No trash or other debris. Looks good. Definitely wet.
- Evidence of hiking trails, so human impact is evident. May suffer future pollution through the possibility of trash dumping or littering.

52. **Newportville Rd., Bristol Township.: Wetland area**
- Abuts Newportville Rd. right before reaching the Hulmeville Borough limits.
- Privately owned area.
- Looks good, vegetation appears healthy although not much diversity. Light residential surrounding.

53. **Bristol Township.: Wetland area**
- Small areas of wetland along I-95 creating a buffer for the expressway.
- Looks okay, but can't get close enough to really observe.

54. **Middletown Township./Hulmeville Borough: Wetland area**
- Middletown Trace townhouses. See #69 for stormwater management questions.
- Well maintained lawn areas, fairly new development(10 to 20 yrs?).
- Wetland vegetation abuts edges of the site. The parking areas for the development are graded towards wetland w/curb cut at low spot that channels stormwater runoff into the wetland. At end of channel there is a lot of debris & rubble.
- Steep slope by channel shows signs of severe erosion from lawn area of site.
- Next to Hoover School on Trenton Road.
- Vegetation: Raspberry, blackberry, jewel weed, cherry, ash, maple, sumac, chestnut.

55. **Fernwood & Bensalem Blvd., Bristol Township. : Wetland area**
- Looks good; lot of vegetation. Honeysuckle, yellow locust, cherry, maple mature trees, sumac.
- Surrounded by residential development (medium density).

56. **Leonard Ave., Bristol Township.: Wetland area**
- Looks good, fairly healthy. Vegetation includes: multiflora rose, maple, cherry, sassafras, jewel weed.
- Some residential development next to the wetland; junk cars other debris abut the wetland area at the bottom of Leonard Avenue.

57. **Bristol Township.: Wetland area**
- Fairly new residential area. Wetland weaves through subdivision.
- Large area impacted by roadways abutting and cutting through subdivision.
- Vegetation includes yellow locust, oak, elm.
- Trails in wetland and other evidence of human impact (paper litter).

58. **Bensalem Township.: Wetland area**
- Looks good, vegetation appears healthy although not much diversity. Light residential surrounding.

59. **Glenn Avenue, Bensalem Township.: Wetland area**
- Located on Glenn Avenue off Hulmeville (Route 513).
- Large wetlands split into two areas by Hulmeville Rd..
- Back part is large lot residential with very large expanses of lawn.
- Opposite side is very heavy residential (guessing 1/4 acre lots or less).

60. **Hulmeville Rd., Bensalem Township.: Wetland area**
- Off Hulmeville Rd. at the Korean Methodist Church. Wetland area among intermittent development behind church buildings and parking lot.
- A local resident was interviewed as to the impacts to the wetland by surrounding neighbors. Informed staff that the wetland area is owned by Bensalem Township. Reported that there have been numerous complaints from neighbors and church caretaker regarding trash fires and other disturbances in the wetland. Also reported that there have been several instances of local residents using the wetland as a dumping spot for furniture, large appliances, tires and other various refuse items. Have been complaints from surrounding neighbors. All this suggests that pollutants are entering this wetland regularly, some dangerous such as gasoline used to set fires.
- On the day of observation, there was residential trash and litter present in the area.

61. **Byberry Rd., Bensalem Township.: Wetland area**
- Small commercial area abutting small wetland.
- Fairly good, low quality wetland probable. Not much species diversity.

62. **Richelieu Road, Bensalem Township., Country Common Apts.: Wetland area**
- Wetland completely wooded.
- Adjacent to parking lot for apartment units.
- Construction and apartment maintenance operations being performed at time of visit.
- Parking areas had heavy evidence of gasoline/grease spills. Fairly fresh.
- Observed employee spraying herbicide on weeds along entire outer boundary of complex, areas that abutted wetland from parking lot.
- Heavy residential area abutting wetland.

63. Richelieu Rd., Bensalem Township., Philadelphia Park Racetrack

- Area directly in front and to the left the of main entrance to park, maintained as grassy field. Indicated on NWI maps that wetlands were once in this area. Adjacent to this field are several acres of parking lot.
- Grassy field has evidence of low spot drainage area adjacent to the parking area. Edge of lot had been secured with several large hay bales directly beside a mature growth of cattails. Ground looked marshy and wet even thought it was a dry day.
- Opportunity for prolonged contact between marshy spot on field area and runoff from the parking area. Due to the size of the lot, potential for great amount of vehicle pollutants to degrade area.

64. Richelieu Rd, Bensalem Township, Philadelphia Park Racetrack (main entrance)

- Wooded area adjacent to main entranceway from Street Road into Philadelphia Park.
- No debris or other impacts observed.
- Vegetation looks fairly healthy.

65. Mechanicsville Road, Bensalem Township.: Wetland (PFOI on NWI map)

- Small wetland area abutting Mechanicsville Road across the street from Philadelphia park.
- Seems to be in good condition, no debris or trash.
- Medium/low residential area.
- Mechanicsville Rd. heavy vehicular traffic area.

66. Grace Ave., Bensalem Township.: Wetland

- Very secluded area off of Grace Ave., which is a dead-end street.
- Very healthy, flora and fauna abundant.
- Low density residential area (2 - 3 acre lots?)

Stormwater Detention Basin Field Location Notes

One of the objectives for the study of nonpoint pollutants and wetlands in the coastal zone area project was to note the condition of stormwater management detention basins in the study area. Many times stormwater management detention basins are improperly maintained. This means that they collect trash, litter, sediments or debris like broken tree limbs in their outlet pipes. They may also be improperly designed, and cause pollution through erosion of soil on their sides or bottom. By noting the location of stormwater detention basins, especially if they need repair, future studies can determine the feasibility of fixing them.

69. Trenton Rd., Middletown Township., Middletown Trace Apts.

- Fairly new (20 yrs?) townhouse complex.
- Lawn areas well maintained, probably herbicide used in operations/care.
- Drainage graded towards large wetland area abutting property.
- Entire complex is situated on high spot. Grading is a gradual downslope towards wetlands. Wetlands appear fairly healthy with dense vegetation (trees and shrubs).
- Observed a parking area for set of townhouses (maybe 20 residences?) that had a curb cut a the low point to outlet stormwater runoff. Entire parking area was graded down to the curb cut. On opposite side of cut was lawn area with a concrete flow channel leading directly downslope into the wetland. No filtering or flow reduction method.
- Observation of wetland where stormwater flow was directed from parking lot showed areas of extreme erosion, debris and potential pollutants. Construction rubble and landscaping debris visible. Within 50 feet of each side of the inlet the banks of the wetland slope (steep 15%-20%?) severe erosion was observed. Tree roots were

completely exposed and no vegetation was remaining on these spots. Assumption of detrimental flows every time it rains. Recommend remediation of this area specifically.

70. Trevose Rd., Bensalem Township., Neshaminy Square Shopping Center : Detention Basin

- Originally observed on April 11.
- Detention basin located in cemetery behind center, draining large commercial area and associated parking.
- Poor maintenance conditions at the time of initial observation: overgrown grass, bare soil, wet spots.
- Wetland vegetation was present; cattails, fragmities. Visible marshy conditions.
- Very good potential for future remediation practices (water quality outlets or other upgrades).

71. Route 1, Middletown Township., The Commons at Middletown: Detention Basin

- Newer residential townhouse/Apt complex.
- Well maintained lawn and parking areas. Area around dumpsters was cleaner than most.
- Stormwater basin was well maintained and clean. Potential for use as future study upgrade for water quality purposes. Basin has two sides with relatively steep slopes. Outlet from basin drains into a culvert under parking area to a small tributary protected by a vegetated berm. The tributary was only roughly one-half mile from the main stem of the Little Neshaminy.
- Grassy, well landscaped and maintained.
- Apple, oak, weeping cherry, pines surrounding basin.

72. Highland Ave., Middletown Township.: Detention Basin

- Very poor condition
- Neighbors report that during times of rainfall, basin discharges high amounts of sediment
- Also some problems with volume and direction of runoff
- Deep , not fully grassed yet.
- Hulmeville Road north of railroad tracks on Highland Avenue

73. Timber Lane & Bensalem Blvd.: Stormwater Detention Basin

- Basin is very marshy, wet area. Spongy underfoot, but fairly dry on outer edges.
- Very subtle slope (ratio is 4 or 5 to 1).
- Three inlets coming under street from residential side.
- Concrete wing wall w/2 elliptical openings roughly 32" wide by 18" high: separation distance 28", T=3'. Adjacent to this are 2 separate concrete projection pipe inlets coming in from under the street. Same size as each other; approx. 16" x 12".
- Low flow concrete pad to outlet, 0 degrees from pipe to outlet.
- Surface water on right of outlet with cattails.
- Tributary on the other side of the berm from outlet.

74. S. of Gillam, Langhorne Borough: Detention Basin

- New development called the Woods of Lincoln II at Hulmeville and Henry
- Lot number 6043, subdivided into 8 lots (West) Hulmeville/Henry is next to a basin
- Basin has rip/rap and is heavily silted.

75. **Old Lincoln Highway, Bensalem Township, Northbrook Office Park.: Detention Basin**
- Detention and retention basins on site.
- Northbrook Drive/Old Lincoln Highway abutting Neshaminy Mall property.
- Area looks fairly well maintained.

76. **Old Lincoln Highway near Reading Railroad, Bensalem Township.: Detention Basin**
- Very small Basin in an Industrial Park. Does not look too bad. No future use.

77. **Bensalem Township.: Detention Basin**
- Basin in industrial park
- Question arose as to vegetation planted in basin, although well maintained.
- Composed of dogwoods & oaks, relatively young (5 yrs.?) and healthy.
- Question whether they should be planted on actual basin side slopes.

78. **Pearl Buck & Bartram Rd., Bensalem Township.: Detention Basin**
- Basin located on corner of streets.
- Basin is in very poor condition probably because of steep sides (can't mow well), not mowed in quite some time on the day observed.

79. **Bridgetown Pike, Lower Southampton Township., Sweetwater Farms: Detention Basin**
- Specific location in development: Norfolk Lane, off of Fox Hollow Rd.
- Retention pond draining residential development (very large homes, 1/2 to full acre lots).
- Located at the bottom of a deep slope base.
- Residential drainage apt to contain serious amounts of lawn care products (herbicides, pesticides, fertilizer).
- Construction activity still under way on Norfolk Lane.

80. **Haunted Lane, Bensalem Township.: Detention Basin**
- Snyders Manufacturing Company
- Front of building right on street (20' separation).
- Irregular shape, on steep slope
- Basin planted with ornamentals (red twig dogwoods)
- Slopes covered in wood chips
- Outlet crosses under driveway to adjoining site. Runoff appears to flow to a "wet" pond (wetland) on the adjoining site. Also combines w/road drainage. Standing water in basin (2"). Heavy rip-rap from inlet. Also, appears to be breaching berm along street because of rip rap channel there.

81. **Haunted Lane; Bensalem Township: Retention Basin @ Water's Edge Office Park**
- Retention pond - Turtles, minnows, frogs!
- Fenced (6' barb wire)
- Municipality reports complaints by local residents regarding odors
- Side slopes on basin are roughly 2:1 with 4' vertical.
- Water is green, with thin scum on top; bare banks.
- Some bare soil spots on basin slopes.
- Concrete overflow pad at left corner of basin cuts out approximately 70 degree angle to Haunted Lane.
- Wet area, possible wetland vegetation apparent at roadside. May drain into storm sewer system. Follows same path as site #78 down into wetland area.

Wetland Classifications

Wetlands are classified as on the National Wetlands Inventory (NWI) maps by characteristic wetness, soils, plants or other physical traits. This classification appears as a series of letters, both upper and lower case, and occasionally including a number. Each wetland on the maps is designated according to this classification system by the U. S. Geological Survey department of the federal government.

NWI maps used in the study to locate and identify wetlands shown on Figure 7 in the report, contained these classifications. No attempts were made to field verify or confirm these classifications by staff. The classifications listed below represent the types of wetlands found within the study area . For further explanation or detail on specific classification information, please refer to the NWI maps for a full description and definition.

The specific NWI maps used to define the study area were: the Bristol quadrant, the Beverly quadrant, the Trenton West quadrant and the Langhorne quadrant.

BUBHx
Saturated-Unconsolidated Bottom, Permanently Flooded, Excavated

PEM
Palustrine- Emergent

PEMIR
Palustrine- Emergent, Persistent, Seasonal-Tidal

PEM5A
Palustrine- Emergent, Mesohaline, Temporarily Flooded

PEMSC
Palustrine- Emergent, Temporary Tidal, Seasonally Flooded

PFOI
Palustrine- Forested, Broad-leaved Deciduous

PFOIA
Palustrine- Forested, Broad-leaved Deciduous, Temporarily Flooded

PFOIAd
Palusrtine- Forested, Broad-leaved Deciduous, Temporarily Flooded, Partially Drained/Ditched

PFOIC
Palustrine- Forested, Broad-leaved Deciduous, Seasonally Flooded

PSSI
Palustrine- Scrub-Shrub, Broad-leaved Deciduous

PSSIA
Palustrine- Scrub-Shrub, Broad-leaved Deciduous,Temporarily Flooded

PUBHx
Palustrine- Unconsolidated Bottom, Permanently Flooded, Excavated

PUBHKx
Palustrine- Unconsolidated Bottom, Permanently Flooded, Artificially Flooded, Excavated

PUBZh
Palustrine- Unconsolidated Bottom, Intermittently Exposed/Permanent, Diked/Impounded

PUBZH
Palustrine- Unconsolidated Bottom, Intermittently Exposed/Permanent, Permanently Flooded

PUBZx
Palustrine- Unconsolidated Bottom, Intermittently Exposed/Permanent, Excavated

R1UBVx
Riverine-Tidal, Unconsolidated Bottom, Permanent Tidal, Excavated

R2UBH
Riverine -Lower Perennial, Unconsolidated Bottom, Permanently Flooded

R3UBH
Riverine-Upper Perennial, Unconsolidated Bottom, Permanently Flooded

APPENDIX E

Role and Management of Stormwater in NPS Transport

APPENDIX E

INTRODUCTION

Stormwater management must be addressed in the control and reduction of nonpoint source pollutants. Uncontrolled stormwater runoff causes extreme damage to the land. This damage can be seen as eroded stream banks, gullies in farm fields and hillsides with bare, exposed patches of soil. All of these situations create nonpoint source pollutants. Runoff picks up tiny pieces of the soil and carries them into stormwater control basins and into the streams themselves the stream. Runoff carries everything in its path towards the water.

In order to control runoff and capture many of the pollutants it carries, the use of Best Management Practices (BMPs) is essential. BMPs are stormwater management facilities which work to remove or reduce the negative effects of stormwater runoff. This may be by slowing down fast moving runoff, or removing some of the soil particles it carries.

The following discussions address how stormwater runoff moves pollutants, and some of the recommended practices which may reduce the impacts of runoff.

Role and Management of Stormwater in NPS Transport

Overland flow

Stormwater management plays a critical part in the transport of many non-point source pollutants. If no water is available to transport many pollutants they accumulate at the source of origin. Rainwater that falls from the atmosphere and reaches the earth normally moves along the surface of the ground. As the water moves, it collects substances in its path and carries them along. Surface runoff from storms moves pollutants and carries them through the landscape. Water always seeks the least resistant or lowest path to travel due to gravity; this could be down a hillside, across a lawn, through a pipe or simply from one end of a parking lot to another. The lowest point in any drainage system is normally a waterbody: stream, lake river or ocean.

As rain falls, it strikes the ground with some force. This force is often great enough to dislodge exposed soil particles. The runoff then carries the particles as it travels. These soil particles eventually end up in the stream (streams that look very muddy or brown after a rainfall have a large amount of soil or "sediment" within them), on the shoulder of the road, or in the bottom of a stormwater detention basin. Sediments will move along in the water until they meet an obstacle to settle out against, or the flow of the water slows down enough so that the soil particles can sink down to the bottom. Construction areas are particularly vulnerable to this type of runoff movement. Sites that have been stripped of all vegetation and trees no longer have any protective covering from the force of the rain. Runoff travels across the surface of the bare soil, picking up loose particles and eroding weak or vulnerable areas. This type of erosion and sediment movement can cause disastrous results to stream biology, and creates serious drainage problems on the remaining land.

Stormwater runoff moving randomly downgrade over the surface of the land is considered "overland" or sheet flow. Other types of flow associated with the movement of stormwater runoff include channel flow (whereby contained in some type of structure or natural channel) or rill and gully flow (where the water starts as overland flow and through erosive action creates small rills and gullies). Flow is usually measured in some type of velocity, or volumetric measurement per time, (i.e., cubic feet per second). The faster the flow, the more potential damage the runoff may cause by virtue of the force of the moving water. Soil particles or other objects on the surface of the land that may ordinarily resist movement can be dislodged by fast moving water.

Infiltration

Considerations for using this practice:

Soils

- Use soil survey to determine soils on site. Determine soil hydrologic groups (A, B, C or D) from the survey. Group D soils are very limited by slow drainage and are not acceptable for infiltration, also, Group C soils may need modifications.

Look for:

- Limiting zones- These are found as a soil with a seasonal high water table or shallow depth to bedrock. Soil body must contain at least 24" between bottom of the facility and a limiting zone for adequate pollutant removal.
- Texture of soil is important for Cation Exchange Capacity (CEC) evaluation. The higher the clay fraction of a particular soil, the better CEC it is likely to have.
- Minimum infiltration rate of the soil for use with an infiltration facility is 0.20 in/hr. Soils with a lesser rate drain too slowly and should not be used with this type of facility.

Site Evaluation

- Designer should place the infiltration facility in natural drainageway if possible.
- Soil testing- A soil infiltration, percolation and deep pit test can be done on site. These types of tests indicate whether or not the soil can accommodate an infiltration facility. It is always a good idea to double check the soil characteristics regardless of the information given in the soil survey.
- Gradients- no facility should be used in areas where slopes are steep Cut and fill operations destroy the integrity of the slope and can result in slope slippage or general failure.

Design

- Ponding time within an infiltration facility is 72 hours. maximum. This maintains aerobic conditions in facility, and allows it to drain before the next storm.
- Inlets- Properly designed inlets are very important to avoid sedimentation of facility and shorten its life span. Water quality, oil/grit traps or sediment forebays are critical in maintaining the useful lie of the facility. Sediment forebays at the inlet to reduce sediments flowing into the facility can prevent clogging.
- Vegetation- Vegetation is a key element very to protect infiltration facilities. Grass filter or buffer areas around the facility can collect sediments prior to entering it. Must be dense healthy turf that is maintained.
- Partial vs. full infiltration- infiltration can be used as a partial method on site in a small area to assist in the overall drainage of the site. It can be used in conjunction with any other method.
- It is also critical to schedule construction of the site around construction of the facility. No heavy machinery can be used on the soils designated for the facility. Heavy machinery can crush delicate soil pores and ruin the infiltration property of the area.

Devices for Infiltration:

Infiltration Basins

- Larger, aboveground facility, which makes inspection relatively easy as opposed to underground systems. Appropriate for drainage areas of roughly 5 through 50 acres.
- Infiltration should occur through the bottom and sides of the facility, which makes it somewhat more tolerant to sediment and easier to maintain.
- Bottom is flat or gently sloping and should have dense turf covering as should the sides.

- Can be used for sediment control during construction, but no heavy machinery can be used in the facility. Must be cleaned out and floor tilled prior to establishing vegetation if used for this purpose.
- Maintenance- Checked twice a year or more for erosion, and to make sure the facility is draining properly. Must be mowed several times a year to maintain the vegetation on the filter strip, basin bottom and sides.

Infiltration Trenches

- Smaller, underground facilities, appropriate for drainage areas of up to 5 acres.
- A trench is a linear device, which allows different site configurations for flexibility in placement. Several can be used in sequence or at different locations on one site.
- Must be protected from sediment during construction from runoff containing sediments. Sediments must be diverted. Should not use until grass filter is established to protect it.
- To check for drainage during maintenance operations, an observation well should be put in the facility. Should be checked twice a year or more, 3 to 4 days following a storm.
- Grassed filter strip needs mowed to keep turf short. Inlet must be checked regularly for sediments and debris build up.

Vegetated Swales-

- Vegetated swales are shallow surface depressions along a site. They are mainly a conveyance facility, best used with trenches or basins. The recommended design calls for check dams at periodic points in the swale to slow water velocities, and allow infiltration to occur at ponding spots.
- Must have dense turf covering. Helps control erosion.
- Best if follows natural drainageway, very gentle slope- no more than 5%.
- Must be mowed frequently to maintain short, dense turf. Occasional sediment removal at check dam points will be necessary to remove build ups..

Porous Paving-

- This technique uses a porous asphalt system in conjunction with underground infiltration beds.
- It is best used in parking areas, or cul-de-sac's. Because of the porous nature of the asphalt, it does not have the shear stress capabilities of normal paving materials.
- Cannot accommodate pervious surface runoff due to sediments or grit clogging the pores. Should be protected by a stone and turf buffer area surrounding perimeter of pavement.
- Observation well into the underground recharge beds allows evaluation of drainage during maintenance inspections.
- Sweeping or vacuuming twice per year and pressure washing should keep pores clear. Maintenance must be done regularly to prevent clogging.

Retention, Artificial Wetlands, Detention

Retention (Wet) Ponds

- Retention facilities operate on the same detaining principal as detention facilities. The difference lies in the permanent pool or wet area. These types of facilities should have persistent water source.
- The larger the facility is, the better pollutant removal capacity it will have. All facilities should incorporate a sediment forebay to catch sediments.
- The permanent pool of water encourages settling of particulates and sediments. Plants and algae remove soluble nutrients from the runoff. Vegetation must be healthy.

- Seventy five percent of facility is in deep water (over 5 feet). A 10 foot shallow aquatic bench designed around the perimeter of the pool will allow emergent plant growth and adds a strong measure of safety against persons falling into the facility. This shallow area should be no more than six inches deep and slope gradually upland from the pool.
- A grassy meadow area surrounding the pond will protect against surface flow runoff and provide habitat. This area will need to be mowed occasionally. Periodic sediment removal is essential.
- Predator fish species can be used to control mosquitoes.

Artificial Wetlands-

- These facilities are not the same as a retention pond; only 25 percent of the wetland facility is in deep water (over three feet deep). Mostly composed of marshy, emergent wetland vegetation.
- The site needs to be fairly level for placement, these facilities are best managed as shallow marshes.
- Wetlands also need a sediment forebay to catch particulates and reduce smothering vegetation due to high sediment loading..
- The vegetation used in the facility is important as it does most pollutant removal. Healthy stock should only be used.
- Vegetation also encourages insects which will eat mosquito larvae.
- Dead vegetation and organic matter from the bottom of the facility may need to be removed occasionally to remove from system.

Dual Purpose Detention-

- Dual purpose detention combines a standard detention basin designed with a second lower section intended to hold the 1 year/24 hour storm. The lower floor of the facility holds the runoff for a period of 24 hours to encourage settling of pollutants.
- This second bottom creates a two stage design, lower stage for first flush storm, the upper stage for detaining and releasing the larger runoff volumes.
- A multiple stage outlet releases both the smaller and the larger storms.
- Vegetation in the basin must kept mowed, and occasional sediment removal must be performed to maintain volumetric storage areas.

Non-Structural BMPs

Minimum Disturbance/Minimum Maintenance Practices

- This is a non-structural management practice. It is best used at the site development stage. Developed sites can be revegetated with native vegetation, but grading and fill operations cannot be undone.
- Careful planning at the site planning stage should include leaving natural vegetation in place, and thereby reduce lawns or other impervious or semi-pervious areas..
- Must be implemented with zoning and subdivision regulations.

Table E-1

Table E-1 Advantages and Disadvantages of Management Practices

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Infiltration Basin	• Provides ground-water recharge • Can serve large developments • High removal capability for particulate pollutants and moderate removal for soluble pollutants • When basin works, it can replicate predevelopment hydrology more closely than other BMP options • Basins provide more habitat value than other infiltration systems	• Possible risk of contaminating ground water • Only feasible where soil is permeable and there is sufficient depth to rock and water table • Fairly high failure rate • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors • Regular maintenance activities cannot prevent rapid clogging of infiltration basins	Construction cost moderate but rehabilitation cost high
Infiltration Trench	• Provides ground-water recharge • Can serve small drainage areas • Can fit into medians, perimeters, and other unused areas of a development site • Helps replicate predevelopment hydrology, increases dry weather baseflow, and reduces bankfull flooding frequency	• Possible risk of contaminating ground water • Only feasible where soil is permeable and there is sufficient depth to rock and water table • Since not as visible as other BMPs, less likely to be maintained by residents • Requires significant maintenance	Cost-effective on smaller sites. Rehabilitation costs can be considerable.
Vegetated Filter Strip (VFS)	• Low maintenance requirements • Can be used as part of the runoff conveyance system to provide pretreatment • Can effectively reduce particulate pollutant levels in areas where runoff velocity is low to moderate • Provides excellent urban wildlife habitat • Economical	• Often concentrates water, which significantly reduces effectiveness • Ability to remove soluble pollutants highly variable • Limited feasibility in highly urbanized areas where runoff velocities are high and flow is concentrated • Requires periodic repair, regrading, and sediment removal to prevent channelization	Low

Source: US EPA, Section 6217 Guidance Document, EPA-840-B-92-002

Table E-1 (Continued)

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Grassed Swale	• Requires minimal land area • Can be used as part of the runoff conveyance system to provide pretreatment • Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians • Economical	• Low pollutant removal rates • Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	Low compared to curb and gutter
Porous Pavement	• Provides ground-water recharge • Provides water quality control without additional consumption of land • Can provide peak flow control • High removal rates for sediment, nutrients, organic matter, and trace metals • When operating properly can replicate predevelopment hydrology • Eliminates the need for stormwater drainage, conveyance, and treatment systems off-site	• Requires regular maintenance • Possible risk of contaminating ground water • Only feasible where soil is permeable, there is sufficient depth to rock and water table, and there are gentle slopes • Not suitable for areas with high traffic volume • Need extensive feasibility tests, inspections, and very high level of construction workmanship (Schueler, 1987) • High failure rate due to clogging • Not suitable to serve large off-site pervious areas	Cost-effective compared to conventional asphalt when working properly
Concrete Grid Pavement	• Can provide peak flow control • Provides ground-water recharge • Provides water quality control without additional consumption of land	• Requires regular maintenance • Not suitable for area with high traffic volume • Possible risk of contaminating ground water • Only feasible where soil is permeable, there is sufficient depth to rock and water table, and there are gentle slopes	Information not available

Table E-1 (Continued)

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Filtration Basin	• Ability to accommodate medium-size development (3-80 acres) • Flexibility to provide or not provide ground-water recharge • Can provide peak volume control	• Requires pretreatment of storm water through sedimentation to prevent filter media from prematurely clogging	Information not available
Water Quality Inlets Catch Basins	• Provide high degree of removal efficiencies for larger particles and debris as pretreatment • Require minimal land area • Flexibility to retrofit existing small drainage areas and applicable to most urban areas	• Not feasible for drainage area greater than 1 acre • Marginal removal of small particles, heavy metals, and organic pollutants • Not effective as water quality control for intense storms • Minimal nutrient removal	Information not available
Water Quality Inlet Catch Basins with Sand Filter	• Provide high removal efficiencies of particulates • Require minimal land area • Flexibility to retrofit existing small drainage areas • Higher removal of nutrient as compared to catch basins and oil/grid separator	• Not feasible for drainage area greater than 5 acres • Only feasible for areas that are stabilized and highly impervious • Not effective as water quality control for intense storms	Information not available
Water Quality Inlet Oil/Grit Separator	• Captures coarse-grained sediments and some hydrocarbons • Requires minimal land area • Flexibility to retrofit existing small drainage areas and applicable to most urban areas • Shows some capacity to trap trash, debris, and other floatables • Can be adapted to all regions of the country	• Not feasible for drainage area greater than 1 acre • Minimal nutrient and organic matter removal • Not effective as water quality control for intense storms • Concern exists over the pollutant toxicity of trapped residuals • Require high maintenance	High, compared to trenches and sand filters

Table E-1 (Continued)

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Extended Detention Dry Pond	• Can provide peak flow control • Possible to provide good particulate removal • Can serve large development • Requires less capital cost and land area when compared to wet pond • Does not generally release warm or anoxic water downstream • Provides excellent protection for downstream channel erosion • Can create valuable wetland and meadow habitat when properly landscaped	• Removal rates for soluble pollutants are quite low • Not economical for drainage area less than 10 acres • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors	Lowest cost alternative in size range
Wet Pond	• Can provide peak flow control • Can serve large developments; most cost-effective for larger, more intensively developed sites • Enhances aesthetics and provides recreational benefits • Little ground-water discharge • Permanent pool in wet ponds helps to prevent scour and resuspension of sediments • Provides moderate to high removal of both particulate and soluble urban stormwater pollutants	• Not economical for drainage area less than 10 acres • Potential safety hazards if not properly maintained • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors • Requires considerable space, which limits use in densely urbanized areas with expensive land and property values • Not suitable for hydrologic soil groups "A" and "B" (SCS classification) • With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life	Moderate to high compared to conventional storm water detention

Table E-1 (Continued)

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Extended Detention Wet Pond	• Can provide peak flow control • Can serve large developments; most cost-effective for larger, more intensively developed sites • Enhances aesthetic and provide recreational benefits • Permanent pool in wet ponds helps to prevent scour and resuspension of sediments • Provides better nutrient removal when compared to wet pond	• Not economical for drainage area less than 10 acres • Potential safety hazards if not properly maintained • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors • Requires considerable space, which limits use in densely urbanized areas with expensive land and property values • Not suitable for hydrologic soil groups "A" and "B"(SCS classification) • With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life	

Table E-1 (Continued)

Management Practice	Advantages	Disadvantages	Comparative Cost (Schueler, Kumble, and Heraty, 1992)
Constructed Stormwater Wetland	• Can serve large developments; most cost-effective for larger, more intensively developed sites • Provides peak flow control • Enhances aesthetics and provides recreational benefits • The marsh fringe also protects shoreline from erosion • Permanent pool in wet ponds helps to prevent scour and resuspension of sediments • Has high pollutant removal capability	• Not economical for drainage area less than 10 acres • Potential safety hazards if not properly maintained • If not adequately maintained can be an eyesore, breed mosquitoes, and create undesirable odors • Requires considerable space, which limits use in densely urbanized areas with expensive land and property values • With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life • May contribute to nutrient loadings during die-down periods of vegetation	Marginally higher than wet ponds

Table E-2

TableE-2 Cost of Management Practices for Control of Runoff from Newly Developed Areas

Practice	Land requirement	Construction cost	Useful life	Annual O&M	Total annual cost	References
Infiltration Basin	High	Average: $0.5/ ft^3 storage Probable Cost: $0.4 - $0.7/ft^3 Reported Range: $0.2 - $1.2/ ft^3	25[a]	Average: 7% of capital cost Reported Range: 3% - 13% of capital cost	$0.03 - $0.05/ ft^3	Wiegand, et al, 1986; SWRPC, 1991
Infiltration Trench	Low	Average: $4.0/ ft^3 storage Probable Cost: $2.5 - $7.5/ft^3 Reported Range: $0.9 - $9.2/ ft^3	10[a]	Average: 9% of capital cost Reported Range: 5% - 15% of capital cost	$0.3 - $0.9/ft^3	Wiegand, et al, 1986; Macal, et al, 1987; SWRPC, 1991; Kuo, et al, 1988
Vegetative Filter Strip	Varies	Established from existing vegetation- Average: $0 Reported Range: $0 Established from seed- Average: $400/ acre Reported Range: $200 - $1,000/ acre Established from seed and mulch- Average: $1,500/ acre Reported Range: $800 - $3,500/ acre Established from sod- Average: $11,300/ acre Reported Range: $4,500 - $48,000/ acre	50[b]	Natural succession allowed to occur- Average: $100/ acre Reported Range: $50 - $200/ acre Natural succession not allowed to occur- Average: $800/ acre Reported Range: $700 - $900/ acre	Natural succession allowed to occur- Established from- Natural vegetation: $100/ acre Seed: $125/ acre Seed & mulch: $200/ acre Sod: $700/ acre Natural succession not allowed to occur- Established from: natural vegetation: $800/acre Seed: $825/acre Seed & mulch: $900/acre Sod: $1,400/acre	Schueler, 1987; SWRPC, 1991

Source: US EPA, Section 6217 Guidance Document, EPA-840-B-92-002

Table E-2(continued)

Practice	Land requirement	Construction cost	Useful life	Annual O&M	Total annual cost	References
Grass Swales	Low	Established from seed: Average: $6.5/ lin ft Reported Range: $4.5 - $8.5/ lin ft Established from sod: Average: $20/ lin ft Reported Range: $8 - $50/ lin ft	50[b]	Established from seed or sod- Average: $0.75/ lin ft Reported Range: $0.5 - $1.0/ lin ft	Established from seed: $1/lin ft Established from sod: $2/lin ft	Schueler, 1987; SWRPC, 1991
Porous Pavement	None	Average: $1.5/ ft^2 [c] Reported Range: $1 - $2/ ft^2 [c]	10[d]	Average: $0.01/ ft^2 [c] Reported Range: $0.01/ ft^2 [c]	0.15/ ft^2 [c]	SWRPC, 1991; Schueler, 1987
Concrete Grid Pavement	None	Average: $1/ ft^2 [c] Reported Range: $1 - $2/ ft^2 [c]	20	Average: (-$0.04)/ft^2 [c] Reported Range: (-$0.04)/ ft^2 [c]	0.05/ ft^2 [c]	Smith, 1981
Sand Filter/ Filtration Basin	High	Average: $5/ ft^3 Probable Cost: $2 - $9/ft^3 Reported Range: $1 - $11/ft^3	25[d]	Average: Not Available Probable Cost: 7% of construction cost Reported Range: Not Available	$0.1 - $0.8/ft^3	Tull, 1990
Water Quality Inlet	None	Average: $2,000/ each Reported Range: $1,100 - $3,000/ each	50	Average: $30/each[f] Reported Range: $20-40/each[f]	$150/ each	SWRPC, 1991
Water Quality Inlet with Sand Filters	None	Average: $10,000/ drainage acre Reported Range: $10,000/ drainage acre	50	Average: Not Available Probable Cost: $100/ drainage acre Reported Range: Not Available	$700/ drainage acre	Shaver, 1991
Oil/Grit Separator	None	Average: $18,000/ drainage acre Reported Range: $15,000 - $20,000/ drainage acre	50	Average: $20/ drainage acre[f] Reported Range: $5 - $40/ drainage acre[f]	$1,000/ drainage acre	Schueler, 1987

Table E-2 (continued)

Practice	Land requirement	Construction cost	Useful life	Annual O&M	Total annual cost	References
Extended Detention Dry Pond	High	Average $0.5/ ft³ storage Probable Cost: $0.09 - $5/ft³ Reported Range: $0.05 - $3.2/ ft³	50	Average: 4% of capital cost Reported Range: 3% - 5% of capital cost	$0.007 - $0.3/ft³	APWA Res. Foundation
Wet Pond and Extended Detention Wet Pond	High	Storage Volume < 1,000,000 ft³: Average: $0.5/ ft³ storage Probable Cost: $0.5 - $1/ft³ Reported Range: $0.05 - $1.0/ ft³ Storage Volume > 1,000,000 ft³: Average: $0.25/ ft³ storage Probable Cost: $0.1 - $0.5/ft³ Reported Range: $0.05 - $0.5/ft³	50	Average: 3% of capital cost Probable Cost: <100,000 ft³ = 5% of capital cost >100,000 & <1,000,000 ft³ = 3% of capital cost >1,000,000 ft³ = 1% of capital cost Reported Range: 0.1% - 5% of capital cost	$0.008 - $0.07/ft³	APWA Res. Foundation; Wiegand, et al, 1986; Schueler, 1987; SWRPC, 1991
Stormwater Wetlands	High	Average: Not available Reported Range: Not available	50[b]	Average: Not Available Reported Range: Not Available	Not available	

[a] References indicate the useful life for infiltration basins and infiltration trenches at 25-50 and 10-15 years, respectively. Because of the high failure rate, infiltration basins are assumed to have useful life span of 25 years and infiltration trenches are assumed to have useful life span of 10 years.
[b] Useful life taken as life of project, assumed to be 50 years.
[c] Incremental cost, i.e., cost beyond that required for conventional asphalt pavement.
[d] Since no information was available for useful life of porous pavement, it was assumed to be similar to that of infiltration trenches.
[e] Since no information was available for useful life of filtration basins it was assumed to be similar to that of infiltration basins.
[f] Frequency of cleaning assumed 2 times per year.

Table E-3

Table E-3 Effectiveness of Management Practices for Control of Runoff From Newly Developed Areas

Management Practice		Removal Efficiency (%) TSS	TP	TN	COD	Pb	Zn	Factors	References
INFILTRATION BASIN	Average:	75	65	60	65	65	65	• Soil percolation rates • Basin surface area • Storage volume	NVPDC, 1979; EPA, 1977; Schueler, 1987; Griffin, et al, 1980; EPA, 1983; Woodward-Clyde, 1986
	Reported Range:	45-100	45-100	45-100	45-100	45-100	45-100		
	Probable Range:[a]								
	SCS Soil Group A	60-100	60-100	60-100	60-100	60-100	60-100		
	SCS Soil Group B	50-80	50-80	50-80	50-80	50-80	50-80		
	No. Values Considered:	7	7	7	4	4	4		
INFILTRATION TRENCH	Average:	75	60	55	65	65	65	• Soil percolation rates • Trench surface area • Storage volume	NVPDC, 1979; EPA, 1977; Schueler, 1987; Griffin, et al, 1980; EPA, 1983; Woodward-Clyde, 1986; Kuo et al., 1988; Lugbill, 1990
	Reported Range:	45-100	40-100	(-10)-100	45-100	45-100	45-100		
	Probable Range:[b]								
	SCS Soil Group A	60-100	60-100	60-100	60-100	60-100	60-100		
	SCS Soil Group B	50-90	50-90	50-90	50-90	50-90	50-90		
	No. Values Considered:	9	9	9	4	4	4		
VEGETATED FILTER STRIP	Average:	65	40	40	40	45	60	• Runoff volume • Slope • Soil infiltration rates • Vegetative cover • Buffer length	IEP, 1991; Casman, 1990; Glick et al., 1991; VADC, 1987; Minnesota PCA, 1989; Schueler, 1987; Hartigan et al., 1989
	Reported Range:	20-80	0-95	0-70	0-80	20-90[H]	30-90[I]		
	Probable Range:[c]	40-90	30-80	20-60	--	30-80	20-50		
	No. Values Considered:	7	4	3	2	3	3		
GRASS SWALE	Average:	60	20	10	25	70	60	• Runoff volume • Slope • Soil infiltration rates • Vegetative cover • Swale length • Swale geometry	Yousef et al., 1985; Dupuis, 1985; Washington State, 1988; Schueler, 1987; British Columbia Res. Corp., 1991; EPA, 1983; Whalen, et al., 1988; Pitt, 1986; Casman, 1990
	Reported Range:	0-100	0-100	0-40	25	3-100[H]	50-60[H]		
	Probable Range:[d]	20-40	20-40	10-30	--	10-20	10-20		
	No. Values Considered:	10	8	4	1	10	7		

Source: US EPA, Section 6217 Guidance Document, EPA-840-B-92-002

Table E-3 (Continued)

Management Practice		Removal Efficiency (%) TSS	TP	TN	COD	Pb	Zn	Factors	References
POROUS PAVEMENT	Average:	90	65	85	80	100	100	• Percolation rates • Storage volume	Schueler, 1987
	Reported Range:	80-95	65	80-85	80	100	100		
	Probable Range:	60-90	60-90	60-90	60-90	60-90	60-90		
	No. Values Considered:	2	2	2	2	2	2		
CONCRETE GRID PAVEMENT	Average:	90	90	90	90	90	90	• Percolation rates	Day, 1981; Smith, et al, 1981; Schueler, 1987
	Reported Range:	65-100	65-100	65-100	65-100	65-100	65-100		
	Probable Range:	60-90	60-90	60-90	60-90	60-90	60-90		
	No. Values Considered:	2	2	2	2	2	2		
SAND FILTER/FILTRATION BASIN	Average:	80	50	35	55	60	65	• Treatment volume • Filtration media	City of Austin, 1988; Environmental and Conservation Service Department, 1990
	Reported Range:	60-95	0-90	20-40	45-70	30-90	50-80		
	Probable Range:	60-90	0-80	20-40	40-70	40-80	40-80		
	No. Values Considered:	10	6	7	3	5	5		
WATER QUALITY INLET[a]	Average:	35	5	20	5	15	5	• Maintenance • Sedimentation storage volume	Pitt, 1896; Field, 1985; Schueler, 1987
	Reported Range:	0-95	5-10	5-55	5-10	10-25	5-10		
	Probable Range:	10-25	5-10	5-10	5-10	10-25	5-10		
	No. Values Considered:	3	1	2	1	2	1		

Table E-3 (Continued)

Management Practice		Removal Efficiency (%) TSS	TP	TN	COD	Pb	Zn	Factors	References
WATER QUALITY INLET WITH SAND FILTER[9]	Average:	80	NA	35	55	80	65	• Sedimentation storage volume • Depth of filter media	Shaver, 1991
	Reported Range:	75-85	NA	30-45	45-70	70-90	50-80		
	Probable Range:	70-90	--	30-40	40-70	70-90	50-80		
	No. Values Considered:	1	0	1	1	1	1		
OIL/GRIT SEPARATOR[9]	Average:	15	5	5	5	15	5	• Sedimentation storage volume • Outlet configurations	Pitt, 1985; Schueler, 1987
	Reported Range:	0-25	5-10	5-10	5-10	10-25	5-10		
	Probable Range:	10-25	5-10	5-10	5-10	10-25	5-10		
	Number of References	2	1	1	1	1	1		
EXTENDED DETENTION DRY POND	Average:	45	25	30	20	50	20	• Storage volume • Detention time • Pond shape	MWCOG, 1983; City of Austin, 1990; Schueler and Helfrich, 1988; Pope and Hess, 1989; OWML, 1987; Wolinski and Stack, 1990
	Reported Range:	5-90	10-55	20-60	0-40	25-65	(-40)-65		
	Probable Range:[e]	70-90	10-60	20-60	30-40	20-60	40-60		
	No. Values Considered:	6	6	4	5	4	5		
WET POND	Average:	60	45	35	40	75	60	• Pool volume • Pond shape	Wotzka and Oberta, 1988; Yousef et al., 1986; Cullum, 1985; Driscoll, 1983; Driscoll, 1986; MWCOG, 1983; OWML, 1983; Yu and Benemouflok, 1988; Holler, 1989; Martin, 1988; Dorman et al., 1989; OWML, 1982; City of Austin, 1990
	Reported Range:	(-30)-91	10-85	5-85	5-90	10-95	10-95		
	Probable Range:	50-90	20-90	10-90	10-90	10-95	20-95		
	No. Values Considered:	18	18	9	7	13	13		

Table E-3 (Continued)

Management Practice		Removal Efficiency (%) TSS	TP	TN	COD	Pb	Zn	Factors	References
EXTENDED DETENTION WET POND	Average:	80	65	55	NA	40	20	• Pool volume • Pond shape • Detention time	Ontario Ministry of the Environment, 1991, cited in Schueler et al., 1992
	Reported Range:	50-100	50-80	55	NA	40	20		
	Probable Range:	50-95	50-90	10-90	10-90	10-95	20-95		
	No. Values Considered:	3	3	1	0	1	1		
CONSTRUCTED STORMWATER WETLANDS	Average:	65	25	20	50	65	35	• Storage volume • Detention time • Pool shape • Wetland's biota • Seasonal variation	Harper et al., 1986; Brown, 1985; Wotzka and Obert, 1988; Hickock et al., 1977; Barten, 1987; Melorin, 1986; Morris et al., 1981; Sherberger and Davis, 1982; ABAG, 1979; Oberts et al., 1989; Rushton and Dye, 1990; Hey and Barrett, 1991; Martin and Smoot, 1986, Reinelt et al., 1990, cited in Woodward-Clyde, 1991
	Reported Range:	(-20)-100	(-120)-100	(-15)-40	20-80	30-95	(-30)-80		
	Probable Range[f]:	50-90	(-5)-80	0-40	---	30-95	---		
	No. Values Considered:	23	24	8	2	10	8		

NA - Not available.
[a] Design criteria: storage volume equals 90% avg runoff volume, which completely drains in 72 hours; maximum depth = 8 ft; minimum depth = 2 ft.
[b] Design criteria: storage volume equals 90% avg runoff volume, which completely drains in 72 hours; maximum depth = 8 ft; minimum depth = 3 ft; storage volume = 40% excavated trench volume.
[c] Design criteria: flow depth < 0.3 ft, travel time > 5 min.
[d] Design criteria: low slope and adequate length.
[e] Design criteria: min. ED time 12 hours.
[f] Design criteria: minimum area of wetland equal 1% of drainage area.
[g] No information was available on the effectiveness of removing grease or oil.
[h] Also reported as 90% TSS removed.
[i] Also reported as 50% TSS removed.

APPENDIX F

Species Location Information—PNDI

APPENDIX F

INTRODUCTION

Appendix F has been compiled from site specific data collected by the Pennsylvania Natural Diversity Inventory (PNDI). PNDI is a department within the Pennsylvania State Bureau of Forestry, which delineates, observes, records and tracks the location and condition of the natural resources such as endangered species in Pennsylvania.

In October of 1993, planning commission staff contacted the PNDI offices in Harrisburg requesting information available through their database record files. These files contain the location of endangered species and habitats. The information requested was in regards specifically to the CZM study area in Bucks County. A GIS map of the study area was sent to PNDI with a letter requesting any data they could provide.

The data received from PNDI appears on the following three pages of this appendix. The code number preceding each entry refers to a location on the CZM study area map, Figure 7 in the report, and appears on tFigure 7 within a square symbol. These locations are approximate; the study area shows the general location of past PNDI observations of the species in its habitat. The species identified may occur in several areas outside of the PNDI location. Staff did not confirm or verify the presence of any of these species during the study process.

The PNDI data is significant information for local officials and agencies. The species on the PNDI list are all protected under federal and state endangered species laws. This means that their habitats are also protected. It is the responsibility of local government, both county and municipal, to enact ordinances and other management measures which will preserve and protect the environment of these species. The map also assists local authorities in determining where in their jurisdiction theses areas are located.

Appendix F - Pennsylvania Natural Diversity Inventory

Map Code *	Species Name	Common Name	Location	Environmental Observations	Penn. Status
101	Echinochloa Walteri	Walter's Barnyard Grass	Neshaminy State Park, Bensalem	Several 100 mature specimens observed along creek banks (7/25/86). Well distributed in observation area.	Endangered
102	Sagittaria calycina var. spongiosa	Long-lobed arrowhead	Neshaminy State Park, Bensalem	First recorded 1982. Observed again in 1993. 25 individuals seen, no flowering or fruiting plants, observation uncertain. Reported to be okay.	Endangered
103	Eupatorium Rotundifolium	A. Eupatorium	Neshaminy State Park, Bensalem	First recorded in1991. Has not been recorded since. 50 - 100 genets in flower with normal vigor. Dry habitat. Threats to site include human impacts and exotic species invasion.	Undetermined
104	Chasmanthium Laxum	Slender Sea-Oats	Del Haas Woods, Bristol Twp.	One highly localized population observed (7/24/86). Artificially maintained habitat created by overhead powerlines.	Endangered
105	Juncus Dichotomus	Forked Rush	Delhaas Woods, Bristol Twp.	Several 100 specimens observed in non-contiguous distribution (7/24/86). Under threat of bio-succession vegetation.	Endangered
106	Rhexia Mariana	Maryland Meadow Beauty	Delhaas Woods, Bristol Twp.	Thousands observed over several acre area (7/24/92). Thriving attributed to powerline clearing.	Endangered
107	Andropogon Glomeratus	Bushy Bluestem	Delhaas Woods, Bristol Twp.	Several 100 plants observed (8/24/93). Powerline creates good habitat area. Some disturbances due to ATVs in the area.	Undetermined
108	Carex Bullata	Bull Sedge	Delhaas Woods, Bristol Twp.	Approximately 20 mature plants over several square meters observed in 1982. None observed in 1993.	Endangered
109	Eupatorium Rotundifolium	A Eupatorium	Delhaas Woods, Bristol Twp.	Several 100 mature plants observed (9/21/89). Good quality site.	Undetermined
110	Paspalum Setaceum	Slender Paspalum (Beadgrass)	Delhaas Woods, Bristol Twp.	Several 100 plants estimated, potentially over many acres (8/19/87). Very vigorous along powerline cut.	Undetermined
111	COASTAL PLAIN FOREST	COASTAL PLAIN FOREST	Delhaas Woods, Bristol Twp.	Disturbed area, but largest remaining type (4/2/92). Has greatest diversity of forest type in area.	

* Code number corresponds with locations on the study area map included.

Penn.

Map Code *	Species Name	Common Name	Location	Environmental Observations	Penn. Status
113	Viburnum Nudum	Possum Haw Viburnum	Delhaas Woods, Bristol Twp.	Last observed on 8/19/90. Mature with normal vigor. Obvious competition for habitat, poor survival prediction.	Endangered
114	Leucothoe Racemosa	Swamp Dog-Hobble	Delhaas Woods, Bristol Twp.	First observed in 1987. Last observation on 4/2/92. Appeared very vigorous in 1987.	Undertermined
115	Polygonum Robustius	Robust Smartweed	Delhaas Woods, Bristol Twp.	Observation date 8/19/87. 50 - 100 plants sighted.	Threatened
116	Magnolia Virginiana	Sweet Bay Magnolia	Delhaas Woods, Bristol Twp.	Several 100 individuals sighted, from seedlings to mature trees (4/2/92). May not be native to area.	Threatened
117	Gratiola Aurea	Golden Hedge-Hyssop	Delhaas Woods, Bristol Twp.	Thousands of plants observed (7/24/92). Normal vigor, good viability.	Undertermined
118	Magnolia Triplala	Umbrella Magnolia	Bristol Township	Sighting is as yet unconfirmed by PNDI, although they have entered the location into their database of species.	Threatened
119	Amaranthus Cannabinus	Waterhemp Ragweed	Croyden Marsh	Last observation in 1993. 1000's of plants observed at that time. No threats noted at that time.	Rare
120	Bidens Bidentoides	Swamp Beggar Ticks	Croyden Marsh	Originally observed on 8/11/83. Plants could not be located in 1993 field survey.	Threatened
121	Eleocharis Obtusa var. Peasei	Wright's Spike Rush	Neshaminy Creek (macrosite)	One clump found above high tide line in 1984, poor quality, good viability. No recent observations.	Endangered
122	Eleocharis parvula	Little-spike Spikerush	Neshaminy Creek (macrosite)	First observed in 1984. Habitat in alluvial sand at upper limit of intertidal zone. Last observation in 1986 recorded that the colony was increasing.	Endangered
123	Scirpus Fluviatilis	River Bullrush	Neshaminy Creek (macrosite)	Several 100 plants seen in quarter acre area. Mature with normal vigor, but no reproduction activity observed.	Rare
124	Zizania Aquatica	Indian Wild Rice	Croyden Acres Mudflat, Bristol Twp.	First and last observed 9/19/84. 10 individuals were seen bearing fruit. Individuals appeared healthy, but habitat is very small. Encroaching human activities, boat docks.	Rare
125	Leucothoe Racemosa	Swamp Dog-Hobble	Croyden Height's Woods	First observed 1991. Woods surrounding habitat have been impacted by human activities. Quality of population not assessed at that time.	Undetermined

* Code number corresponds with locations on the study area map included.

Map Code *	Species Name	Common Name	Location	Environmental Observations	Penn. Status
126	Quercus Phellos	Willow Oak	Croyden Height's Woods	First and last observations in 1991. Growing vigorously on flat, dry habitat.	Endangered
127	Amaranthus Cannabinus	Waterhemp Ragweed	State Road Marsh, Bensalem Twp.	First observed in 1912. Last observation 8/9/93. 20+ flowering individuals scattered over marsh. Excellent habitat, good viability.	Rare
128	Magnolia Triplala	Umbrella Magnolia	Bristol Township	Sighting is as yet unconfirmed by PNDI, although they have entered the location into their database of species.	Threatened

*** Code number corresponds with locations on the study area map included.**

APPENDIX G

Species Location Information—Morris Arboretum

APPENDIX G

INTRODUCTION

Appendix G has been compiled from site specific data collected by the Morris Arboretum. The Morris Arboretum is a branch within the University of Pennsylvania, which delineates, observes, records and tracks the location and condition of the natural resources such as endangered species in Pennsylvania.

In October of 1993, planning commission staff contacted the Dr. Ann Rhodes office in Philadelphia requesting information available through the Arboretum's species record files. The information requested was in regards specifically to the CZM study area in Bucks County. A general map of the study area was sent to Dr. Rhodes with a letter requesting any data they could provide.

The data received from the Morris Arboretum appears on the following three pages of this appendix. The code number preceding each entry refers to a location on the CZM study area map, and appears on the map with a triangular symbol. These locations are approximate; the study area shows the general location of past observations of the species in its habitat. The species identified may occur in several areas outside of the indicated location. Staff did not confirm or verify the presence of any of these species during the study process.

The Morris Arboretum data is significant information for local officials and agencies. The species on the following list are all protected under federal and state endangered species laws. This means that their habitats are also protected. It is the responsibility of local government, both county and municipal, to enact ordinances and other management measures which will preserve and protect the environment of these species. The map also assists local authorities in determining where in their jurisdiction theses areas are located.

Appendix G - Morris Arboretum Inventory

Map Code *	Species Name	Common Name	Location	Penn. Status
201	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bristol	Rare
202	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bensalem	Rare
203	Echinochloa Walteri	Walter's Barnyard Grass	Neshaminy Creek banks, Bensalem	Endangered
204	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bristol	Rare
205	Echinochloa Walteri	Walter's Barnyard Grass	Neshaminy Creek banks, Bristol	Endangered
206	Zizania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bristol	Rare
207	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bensalem	Rare
208	Echinochloa Walteri	Walter's Barnyard Grass	Neshaminy Creek banks, Bensalem	Endangered
209	Zinzania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bristol	Rare
210	Sagittaria Sublata	Subulate Arrowhead	Neshaminy Creek banks, Bensalem	Rare
211	Zinzania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bristol	Rare
212	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bristol	Rare
213	Bidens Bidentoides	Swamp Beggar-Ticks	Neshaminy Creek banks, Bristol	Threatened
214	Scirpus Fluviatilis	River Bullrush	Neshaminy Creek banks, Bristol	Rare
215	Zizania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bristol	Rare
216	Zizania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bensalem	Rare
217	Eupatorium Rotundifolium	A. Eupatorium	Neshaminy Creek banks (upland), Bristol	Undetermined
218	Polygonella Articulata	Eastern Jointweed	Neshaminy Creek banks (upland), Bristol	Undetermined
219	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks (tidal marsh), Bristol	Rare

*** Code number corresponds with locations on the study area map included.**

Map Code *	Species Name	Common Name	Location	Penn. Status
220	Bidens Bidentoides	Swamp Beggar-Ticks	Neshaminy Creek banks (tidal marsh), Bristol	Threatened
221	Sagittaria Sublata	Subulate Arrowhead	Neshaminy Creek banks (tidal marsh), Bristol	Rare
222	Sagittaria calycina var. spongiosa	Long-lobed arrowhead	Neshaminy Creek banks (tidal marsh), Bristol	Endangered
223	Amaranthus Cannabinus	Waterhemp Ragweed	Neshaminy Creek banks, Bristol	Rare
224	Echinochloa Walteri	Walter's Barnyard Grass	Neshaminy Creek banks, Bristol	Endangered
225	Eleocharis Obtusa var. peasii	Wright's Spikerush	Neshaminy Creek banks, Bristol	Endangered
226	Eleocharis Parvula	Little-spike Spikerush	Neshaminy Creek banks, Bristol	Endangered
227	Sagittaria Sublata	Subulate Arrowhead	Neshaminy Creek banks, Bristol	Rare
228	Scirpus Fluviatilis	River Bullrush	Neshaminy Creek banks, Bristol	Rare
229	Scirpus Smithii	Smith's Bullrush	Neshaminy Creek banks, Bristol	Endangered
230	Zizania Aquatica	Indian Wild Rice	Neshaminy Creek banks, Bristol	Rare
231	Eleocharis Parvula	Little-spike Spikerush	Neshaminy Creek banks, Bristol	Endangered
232	Sagittaria Sublata	Subulate Arrowhead	Neshaminy Creek banks, Bristol	Rare
233	Digitaria Cognatum	Fall Witch Grass	Neshaminy Creek banks, Bristol	Threatened
234	Quercus phellos	Willow oak	Neshaminy Creek banks, Bristol	Endangered
235	Triplasis purpurea	Purple sandgrass	Neshaminy Creek banks, Bristol	Endangered
236	Amaranthus Cannabinus	Waterhemp Ragweed	Delaware River banks, Bensalem	Rare
237	Heteranthera multiflora	Multiflowered mudplantain	Delaware River banks, Bensalem	Endangered
238	Sagittaria Sublata	Subulate Arrowhead	Delaware River banks, Bensalem	Rare
239	Zinzania Aquatica	Indian Wild Rice	Delaware River banks, Bensalem	Rare
240	Amaranthus Cannabinus	Waterhemp Ragweed	Delaware River banks (tidal marsh), Bensalem	Rare
241	Sagittaria calycina var. spongiosa	Long-lobed arrowhead	Delaware River banks (tidal marsh), Bensalem	Endangered

*** Code number corresponds with locations on the study area map included.**

Map Code *	Species Name	Common Name	Location	Penn. Status
242	Sagittaria Sublata	Subulate Arrowhead	Delaware River banks (tidal marsh), Bensalem	Rare
243	Scirpus Smithii	Smith's Bullrush	Delaware River banks (tidal marsh), Bensalem	Endangered
244	Zizania Aquatica	Indian Wild Rice	Delaware River banks (tidal marsh), Bensalem	Rare
245	Quercus phellos	Willow oak	Delaware River banks (upland), Bensalem	Endangered
246	Eupatorium Rotundifolium	A. Eupatorium	Delaware River banks (upland), Bensalem	Undetermined
247	Ilex opaca	American Holly	Bristol	Threatened
248	Magnolia virginiana	Sweetbay Magnolia	Bristol	Threatened

*** Code number corresponds with locations on the study area map included.**

APPENDIX H

Information from EPA Section 6217 Guidance Document

APPENDIX H

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APPENDIX H

Introduction

The following information highlights and delineates federal guidelines for the management of nonpoint source pollutants. This information was produced through the U.S. Environmental Protection Agency (USEPA) as a document entitled, *Guidelines Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993). Production of document was completed under the authority of Section 6217 (g) of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990.

All states are required to enforce the guidelines through coastal management programs. Any protection planning for local coastal areas financed with state funds must recommend and support management measures found in the Section 6217 guidelines.

Management Measures

The management measures are required and may be accomplished in many ways. The practices highlighted are offered as management options and techniques for those entities required to, or voluntarily choose to, reduce nonpoint source pollutants in surface waters. For further discussion on the topic of management practices, refer to Appendix E. For the complete discussions of each required management measure, please refer to the EPA document.

The management measures are mandatory for states to incorporate into coastal zone management programs and regulations. Applicable measures to the study area of the Neshaminy Creek watershed have been summarized from the CZARA Section 6217 guidelines. A brief discussion of measures has been included. The full discussion of each measure can be found in detail in the guideline document.

The management measures in this section are applied to specific areas of concern within the Neshaminy creek coastal zone management study; namely issues dealing with urbanization (i.e., development, roads and access areas, pollution prevention), and marinas and recreational boating.

Management Measures for the Control of Urban Runoff

1. Management Measure - Removal and Reduction of sediments

This measure is intended to reduce and encourage the removal of sediment pollutants that are generated by the site preparation process associated with new development.

Standard by design or performance:

- After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solids (TSS) loading by 80 percent. For the purposes of this measure, an 80 percent TSS reduction is determined on an average annual basis*; or
- Reduce post development loading of TSS so that the average annual TSS loading are no greater than pre development loading.
- To the extent practicable, maintain post development peak runoff rate and average volume at levels that are similar to pre development levels in combination with either of the above standards.

a. **Benefits**

- Decrease the erosive potential of increased runoff volumes and velocities associated with development induced changes in hydrology
- Remove suspended solids and associated pollutants entrained in runoff that result from activities occurring during and after development
- Retain hydrologic conditions which closely resemble those of the pre disturbance condition
- Preserve natural systems including in-stream habitat.

b. **Basis of Selection**

- Removal of 80 percent of total suspended solids (TSS) is assumed to control heavy metals, phosphorous, and other pollutants as well as sediment.
- A number of other coastal States, including Delaware and Florida, have implemented a TSS
- Analysis has shown that properly constructed wetlands, wet ponds, and infiltration facilities can remove 80 percent of TSS, provided they are designed and maintained properly.
- Control of the post development volume and peak runoff rates can reduce or prevent streambank erosion and stream scouring and maintain pre-development hydrological conditions. At minimum the 2-year/24 hour storm should be controlled, although in Bucks County, the standard has been established which will control the 1 year/24 hour storm for water quality purposes.

c. **Recommended Actions and Practices**

- **Training Programs**
  Develop training and education programs and materials for public officials, contractors, and others involved with the design, installation, operation, inspection and maintenance of urban runoff facilities.

*** Based on the average annual TSS loading from all storms less than or equal to the 2-year/24 hour storm. TSS loading from storms greater than the 2 year/24 hour storm are not expected to be included in the calculation of the average annual TSS loading.**

- **Require Regular Operation and Maintenance Practices**
  Ensure that all urban runoff facilities are operated and maintained properly.
  Maintenance is necessary to for the facility to function properly and not pose a health or safety threat. Maintenance should occur at regular intervals by trained individuals, and be performed in accordance with the adopted standards of the State or local government. It is more effective and efficient to perform preventative maintenance on a regular basis than provide remedial or corrective action.
- **Infiltration basins**
  Infiltration basins are impoundments in which incoming urban runoff is temporarily stored until it gradually infiltrates into the soil surrounding the basin. These basins in pollutant removal, and to ensure that the basin is ready to receive the next storm. The runoff entering the basin is pretreated to remove coarse sediment that may clog the surface soil on the basin floor. Concentrated runoff should flow through a sediment trap, or a vegetated filter strip may be used for sheet flow.
- **Infiltration trenches**
  Infiltration trenches are shallow excavated ditches that have been backfilled with stone to form an underground reservoir. Urban runoff diverted into the trench gradually infiltrates from the bottom of the trench into the subsoil and eventually into the ground water. Depending on the quality of the runoff, pretreatment will generally be necessary to lower the failure rate of the trench. Design requirements necessitate a minimum of 24 inches of soil body without restriction for use of this practice.

- **Vegetated filter strips**
  Vegetated filter strips are areas of land with vegetative cover that are designed to accept runoff as over land sheet flow from upstream development. Dense vegetative cover facilitates sediment attenuation and pollutant removal. They do not effectively treat high-velocity flows and are therefore recommended for use in agriculture and low-density development. Vegetated filter strips are often used as pretreatment for other structural practices such as infiltration basins and infiltration basins.Filter strips are less effective on slopes over 15 percent. Periodic inspection, repair and regrading are required to prevent channelization.
- **Grassed swales**
  A grassed swale is an infiltration/filtration method that is usually used to provide pretreatment before runoff is discharged to treatment systems. Grassed swales are shallow, vegetated, man-made ditches designed so that the bottom of the elevation is above the water table to allow runoff to infiltrate into ground water. The vegetation or turf prevents erosion, filters sediment, and provides some nutrient uptake.
- **Porous pavement and permeable surfaces**
  Porous pavement reduces much of the need for urban and runoff drainage conveyance and treatment off-site. Runoff is diverted through a porous asphalt layer into an underground stone reservoir. The stored runoff gradually exfiltrates out of the stone reservoir into the subsoil. It tends to clog with fine sediment. A vacuum-type street sweeper should be used to maintain porous pavement.
  Permeable paving surfaces such as modular pavers, grassed parking areas and permeable pavements may also be used to reduce runoff volumes. Proper operation and maintenance must be guaranteed due to high failure rates without proper upkeep.
- **Concrete grid pavement**
  This pavement consists of concrete blocks with regularly interspersed void areas that are filled with pervious materials, such as gravel, sand or grass. The blocks are placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support vehicles, while allowing infiltration of surface water into the underlying soil.
- **Water quality inlets**
  Water quality inlets are underground retention systems designed to remove settleable solids. In their simplest form, catch basins are single-chambered urban runoff inlets in which the bottom has been lowered to provide 2 to 4 feet of additional space between the outlet pipe and the structure bottom for collection of sediment. Maintenance and disposal of trapped residuals and hydrocarbons must occur regularly for these devices to work. No acceptable clean-out and disposal techniques currently exist.
- **Extended detention basins**
  Extended detention basins, or "first flush" detention basins temporarily detain a portion of urban runoff for up to 24 hours after a storm. The extended detention basins are normally "dry" between storm events. These basins are typically composed of two stages: an upper stage, which remains dry except for larger storms, and a lower stage, which is designed for smaller, more frequent storms.
- **Wet ponds**
  Wet ponds, also known as retention basins, are basins designed to maintain a permanent pool of water and temporarily store urban runoff until it is released at a controlled rate. Enhanced designs include a forebay to trap incoming sediment where it can easily be removed. A fringe wetland can also be established around the perimeter of the pond.
- **Constructed wetlands**
  Constructed wetlands are engineered systems designed to simulate the water quality improvement functions of natural wetlands to treat and contain surface water runoff pollutants and decrease loading to surface waters.
- **Filtration basins and sand filters**

Filtration basins are impoundments lined with filter media, such as sand or gravel. Urban runoff drains through the filter media into perforated pipes in the subsoil. Detention time is typically 4 to 6 hours. Sediment-trapping structures are used to prevent premature clogging of the filter media.

Sand filters are a self-contained bed of sand to which the first flush of runoff water is diverted. The runoff percolates through the sand, where colloidal and particulate materials are strained out by the media. Water leaving the filter is collected in underground pipes and returned to the stream or channel. A layer of peat, limestone, and/or topsoil may be added to improve removal efficiency.

- **Public Education**
  Educate the public about the importance of runoff management facilities.

d. Effectiveness and Cost Information

A median TSS removal efficiency above 80 percent was reported for three practices; constructed wetlands, wet ponds and filtration basins. However, it has been reported that the other practices are capable of achieving 80 percent TSS removal efficiency when properly designed, sited, operated, and maintained.

A systems approach to best management practices (BMP) design and implementation may be more effective. By applying multiple practices, enhanced runoff attenuation, conveyance, pretreatment, and treatment may be attained. Also, regionalization of systems may prove more efficient and cost effective due to the economies of scale of operating one large system versus several smaller systems. Areas such as stream side buffers and wetland may also have the added benefit of providing long-term pollutant removal capabilities without the comparatively high costs usually associated with structural controls. Conservation and preservation of these areas is important to water quality protection.

2. Management Measure - Watershed Protection

This management measure is intended to be applied by states to new development or redevelopment including construction of new and relocated roads that generate nonpoint source pollutants.

Primary intent is to develop a watershed protection program which will:

- Avoid conversion , to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss;
- Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota; and
- Site development, including roads, highways, and bridges, to protect to the extent practicable the natural integrity of waterbodies and natural drainage systems.

a. Benefits

- Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal nonpoint source programs in conformity with this management measure and will have flexibility in doing so.
- General goals to use in developing comprehensive programs for guiding future development and land use in a manner that will prevent and mitigate nonpoint source pollution.
- Plan for the reduction in nonpoint source pollutants by locating stormwater structures and or other land areas which may be responsible for generating nonpoint source pollutants in areas of the watershed which are not vulnerable.
- Allow planning to protect all natural resources in the regional watershed area.

- Help preserve and protect the natural hydrology of the area.

b. Basis of Selection

- Watershed protection is a technique to provide long-term water quality benefits.
- Protection of environmentally sensitive areas and areas that provide water quality benefits allows states flexibility in the pursuit of widely differing water quality priorities and reduces potential conflicts that may arise due to existing State or local programs.
- Produces long-term water quality benefits and lacks the high operation and maintenance costs associated with structural controls.
- Includes other natural resources such as individual stream quality designations, wetlands, woodlands and significant natural areas in the planning process.

c. Recommended Actions and Practices

- **Comprehensive Planning**
  Develop a comprehensive program that incorporates protection of surface waters programs and plans for guiding growth and development. Incorporate policies into existing land planning, zoning and site plan review.

- **Resource Inventory and Information Analysis**
  Define the watershed boundaries, target areas, and pollutants of concern, and conduct resource inventory and information analysis. Activities include: assessment of ground and surface water hydrology; soil type and ground cover; identification of environmentally sensitive areas, and unique geologic formations. Once environmentally sensitive areas are identified, areas that are integral to the protection of surface waters and the prevention of nonpoint source pollution can be protected.
  Suggested from; *Watershed Management: A Step by Step Guide*, Livingston and McCarron, 1992:
  1. Delineate and map watershed boundary and sub-basins within the watershed.
  2. Inventory and map natural storm water conveyance and storage system.
  3. Inventory and map man-made storm water conveyance and storage system.
  4. Inventory and map land use by sub-basin.
  5. Inventory and map detailed soils by sub-basin.
  6. Establish a clear understanding of water resources in the watershed.
  7. Inventory pollution sources in the watershed.
  8. Identify and map future land use by sub-basin.
  9. Identify planned infrastructure improvements; 5-year, 20-year.
  10. Analysis. Determine infrastructure and natural resources management needs within each watershed.
  11. Set resource management goals and objectives.
  12. Determine pollutant reduction (for existing and future land uses) needed to achieve water quality goals.
  13. Select appropriate management practices (point source, nonpoint source) that can be used to achieve the goal.
  14. Develop watershed management plan. All plans will include elements such as;
      -Existing and future land use plans
      -Master storm water management plan that addresses existing and future needs;
      -Wastewater management plan
      -Infrastructure and capital improvements plan.
- **Development of Watershed Management Plan**
  The resource inventory and information analysis component provides the basis for a watershed management plan. A watershed management plan is a comprehensive approach to addressing the needs of a watershed, including land use, urban runoff control practices, pollutant reduction strategies, and pollution prevention techniques.

To be effective, the plan should have goals describing desired outcomes and methods for achieving goals.

The following describes the steps for developing a watershed management plan.

- **Plan Implementation**
  Implementation tools that have been successful in controlling nonpoint source pollution:
  - Development of ordinances or regulations requiring NPS pollution controls for new development and redevelopment
  - Infrastructure planning which is the multi-year scheduling and implementation of public physical improvements.
  - Local ordinances- Zoning is a division of a municipality into districts for the purpose of regulating land use. Subdivision regulations give general site design standards. Farmland preservation ordinances are another measure that can be implemented to provide open space retention, habitat protection, and watershed protection.
  - Limits on impervious surfaces, encourages open space, and the promotion of cluster development.
  - Setback (buffer) standards- In coastal areas, setbacks or buffer zones adjacent to surface waterbodies, such as rivers, estuaries, or wetlands provide a transition between upland development waterbodies. Setbacks may prevent direct flow of urban runoff from impervious areas into adjoining surface waters and provide pollutant removal, sediment attenuation, and infiltration
  - Slope restrictions
  - Site plan reviews and approval
  - Designation of an entity or individual who is responsible for maintaining the infrastructure, including the urban runoff management systems.
  - Official mapping.
    Official maps can be used to designate and/or protect environmentally sensitive areas, zoning districts, identified land uses, or other areas that provide water quality benefits.
  - Environmental impact assessment statements
    To evaluate the impacts of proposed development may have on the natural resources of an area.
- **Cost of Planning Programs**
  Depends on a variety of factors including the level of effort needed to complete and implement a program.
- **Land or Development Acquisition Practices**
  An effective way to preserve land for protecting the environmental integrity of an area is to acquire it outright or to limit development rights.
  - **Fee Simple Acquisition Easements**
    Fee simple acquisition through either purchase or donation is the most direct way to protect land for preservation purposes and associated nonpoint source control functions.
    Conservation easements are restrictions put on property that legally restrict the present and future use of the land. The property owner gives up development rights within the easement while retaining fee ownership of the property.
  - **Transfer of Development Rights**
    Transfer of development rights (TDR) is based on the concept that ownership of real property includes the bundle of rights that go with it. The system is useful for the preservation of those areas thought necessary for maintaining the quality of surface waters in that development rights associated with the environmentally sensitive areas can be transferred to less sensitive areas.
  - **Purchase of Development Rights**

Rights of development are purchases while the remaining rights remain with the fee title holder. Restrictions on the deed make it clear that the land can not be developed based on the rights that have been purchased.

- **Land Trusts**
  May be established as publicly or privately sponsored nonprofit organizations with the goal of holding lands or conservation easements for the protection of habitat, water quality, recreation or scenic value or for agricultural preservation.
- **Agricultural and Forest Districts**
  Jurisdictions may allow landowners to apply for designation of land as an Agricultural or Forest district. Tax benefits are received in exchange for a commitment to maintain the land in agriculture, forest or open space.
- **Cost and Effectiveness of Land Acquisition Programs**
  The cost associated with land acquisition programs varies, depending on the desired outcome.

3. Management Measure - Site Development

Intended to provide states or local government with general guidance on nonpoint source pollution objectives that can be integrated into the site planning process.

Plan, design, and develop sites to:

- Protect areas that provide important water quality benefits and/or are particularly susceptible to erosion and sediment loss;
- Limit increases of impervious areas, except where necessary;
- Limit land disturbance activities such as clearing and grading, and cut and fill to reduce erosion and sediment loss;
- Limit disturbance of natural drainage features and vegetation.

a. Benefits

- Reduce the generation of nonpoint pollution and to mitigate the impacts of urban runoff and associated pollutants from all site development including roads.
- Preserve the natural amenities of the site.
- Reduce hydrologic impacts to the entire drainage area.

b. Basis of Selection

- Site plan review and conditional approval are used to ensure environmentally sensitive areas and areas necessary for maintaining surface water quality will not be lost;
- Requirements for erosion and sediment control plan review protect waters.
- Guidance on appropriate pollution prevention practices can be given.

c. Objectives to Incorporate into Site Development Reviews:

- During site development, disturb the smallest area necessary to reduce erosion and off-site transport of sediment
- Avoid disturbance of unstable soils
- Where appropriate, protect and retain indigenous vegetation to decrease concentrated flows and to maintain site hydrology;
- Minimize impervious surfaces
- Properly manage all maintained landscapes to avoid water quality impacts
- Avoid alteration, modification or destruction of natural drainage features on-site;
- Design sites so that natural buffers adjacent to coastal waterbodies are preserved.

d. Practices for Control of Erosion During Site Development
The following practices are representative of the types of practices that can be applied to achieve the measure described above.

- **Erosion and Sediment Control Plans and Programs**
  A well-thought out plan for urban runoff management on construction sites can control erosion, retain sediments on the sites, and reduce the environmental effects of runoff. In addition to a plan for BMP use, contractors should develop schedules that minimize the area of exposed soil at any given time, particularly during storms.
- **Phasing and Limiting Area of Disturbance**
  Reduces the potential for erosion and can be accomplished by clearing and grading from all post-development buffer zones, configuring the site plan to retain high amounts of open space, and using phased construction to limit the amount of disturbed area at any given time.
- **Require Vegetative Stabilization**
  Grass or mulch cover can reduce suspended sediment levels to surface waters by up to six fold.
- **Minimum Disturbance/Minimum Maintenance**
  An approach to site development in which clearing and site grading are allowed only within carefully prescribed building areas, preserving and protecting the existing natural vegetation.
  Minimum disturbance/minimum maintenance strategies help minimize nonpoint source impacts associated with the application of fertilizers, pesticides and herbicides that result from new land development.

e. Site Planning Practices

- **Clustering**
  Used to concentrate development and construction activity on a limited portion of the site, leaving the remaining portion undisturbed. Preserves environmentally sensitive areas, reduces road length and reduces impervious surfaces.
- **Performance Criteria**
  Contain built in safe-guards to protect natural features.
- **Site Fingerprinting**
  Places development away from environmentally sensitive areas, future open spaces, etc.
- **Preserving Natural Drainage Features and Natural Depression Storage Areas**
  Natural drainage features should be preserved as development occurs. Done at site and watershed planning stage. Desirable because of the ability of the natural drainage features to infiltrate and attenuate flows and filter pollutants.
- **Minimizing Imperviousness**
  Implemented at site planning level; reduced sidewalk widths
  - Use of permeable material for sidewalk construction
  - Mandatory open space requirements
  - Use of porous pavement where possible
  - Reduced building setbacks, which reduce the length of driveways and entry walks
  - Reduced street widths
- **Reducing the Hydraulic Connectivity of Impervious Surfaces**
  Pollutant loading from impervious surfaces may be reduced if the impervious area does not connect directly to an impervious conveyance system. This can be done in at least four ways;
  - Route runoff over lawn to increase infiltration
  - Discourage the direct connection of downspouts to storm sewers
  - Substitute pond and swale systems to increase infiltration

- Reduce the use of storm sewers to drain streets, parking lots, and back yards

- **Xeriscape Programs**
  Landscaping concept that maximizes the conservation of water by the use of site appropriate plants and an efficient watering system. Involves the use of plants that need minimal watering, fertilization and pesticide application.
- Reduce water loss and soil erosion through planning, design, and implementation
- Reduces mowing by limiting lawn areas
- Reduces fertilization through soil preparation

Management Measures for the Prevention of Pollution

1. Management Measure - Pollution Prevention

This management measure is intended to prevent and reduce nonpoint source pollutant loadings from activities normally occurring within an urban environment.

Implement pollution prevention and education programs to reduce nonpoint source pollutants generated by the following activities:

- Improper storage, use and disposal of household hazardous chemicals, including; auto fluids, pesticides, paints, solvents etc.
- Lawn and garden activities, including the application and disposal of lawn care products, and leaves and yard trimmings.
- Turf management on golf courses, parks and recreational areas.
- Improper operation and maintenance of on-site disposal systems.
- Discharge of pollutants into storm drains.
- Commercial activities including parking lots, gas stations, and others not required to use the NPDES permitting system.
- Improper disposal of pet excrement.

a. Benefits

- Decrease nonpoint source pollutants in surface waters.
- Reduce potential contamination by e. coli and other pollutants associated with wastes (human and animal) in streams and other waterways.
- Increase the general quality of water within the region.

b. Basis of Selection

- Many states are currently using a combination of methods to change the behavior of the community with resulting reductions in nonpoint source pollutants.
- Communities may select the best option or method for control applicable to their area or specific problem.
- The controls and or practices outlined are flexible.
- Encourages community outreach and participation to achieve the desired effect. Can also determine the effectiveness of specific approaches and practices based on community response.

c. Recommended Actions and Practices

- **Promote Public Education**
  Public education is the key to promoting community problem solving. Information regarding the negative effects of household chemicals and wastes can result in long term behavior modifications which lead to reductions in contamination from these types of pollutants.

- **Establish Programs to Encourage Proper Disposal of Household Hazardous Wastes**
  Many communities have instituted programs, such as Amnesty Days, which highlight and recognize the impacts to the environment resulting from improper disposal of household hazardous chemicals and wastes. Bucks County has one day per year where, at three separate locations, residents can dispose of household hazardous wastes.
- **Develop used oil, antifreeze and hazardous chemical recycling programs and site collection centers in convenient locations**
  Establish specific days designated as drop off days and advertise through television, newspapers, flyers and radio. Encourage local service stations to provide used oil and antifreeze recycling locations for "do-it-yourselfers" to promote proper and easy disposal of these items.
- **Encourage Proper Lawn Management and Landscaping**
  Prepare and conduct educational programs on a regular basis with the assistance of the available media to educate homeowners regarding the proper care and landscaping techniques necessary to reduce nonpoint source pollutants. These techniques include:
  - Proper pesticide and herbicide use
  - Reduced fertilizer applications and proper timing of such applications
  - Limited lawn watering
  - Minimum maintenance and disturbance practices
  - xeriscaping (decreased water, energy and chemical inputs)
  - Reduced runoff techniques, such as reusing rooftop runoff
  - Training, certification and licensing programs for lawn care professionals
- **Encourage Proper On-Site Recycling of Yard Trimmings**
  Promoting of home composting programs can potentially result in municipal cost savings through reduced curb-side pick up and reduce landfill costs. Composting also promotes natural recycling of nutrients which reduces the need for synthetic chemical applications. Compost added to the soil can increase infiltration which reduces runoff, and decrease the need for watering.
- **Encourage the Use of Biodegradable Household Cleaners**
  The use of nonbiodegradable household cleaners and chemicals can potentially contaminate surface and ground waters. Public education can reduce this threat.
- **Management Pet Excrement to Minimize Runoff Into Surface Waters**
  Various studies have shown that animal excrement is a potentially hazardous pollutant in surface waters. The Nassau-Suffolk Regional Planning Board reported in 1978 that urban runoff containing pet excrement was responsible for numerous shellfish bed closures in New York State.
  Efforts must be made to promote the idea that pet owners should pick up pet droppings rather than leave them in yards or streets where they can combine with runoff and enter the surface waters. The removal of droppings includes not only those from dogs and cats, but also from larger animals such as horses and, or exotic animals.
- **Storm Drain Stenciling**
  Many municipalities have adopted programs that encourages civic groups to stencil a symbol or other specific mark on storm drains. These types of programs serve as a visible constant reminder to the public that storm drains discharge to surface water, which may be carrying several harmful components from nonpoint pollutants.
- **Encourage Alternative Design and Maintenance for Impervious Parking Lots**
  Parking lot runoff, particularly in commercial or industrial areas, normally accounts for a large percentage of nonpoint source pollutants. Alternatives range from dry sweeping, wet sweeping, grassed swales and vegetated buffer strips to polish runoff prior to leaving the area. Parking lots may also be good candidates for porous

pavement or other underground recharge beds, due to the lighter vehicular loads and decreased speeds.

- **Control Commercial Sources Of NPS Pollutants by Promoting Prevention Assessments and Developing NPS Reduction Strategies in the Workplace**
  Work with the local community businesses and establishments to develop programs and training procedures to reduce or eliminated nonpoint source pollutants. Each organization or workplace needs to determine what materials or byproducts are in a particular site that may generate nonpoint source pollutants. Sharing or information or procedures could be accomplished by a municipal clearinghouse or citizens action organization.

- **Promote Water Conservation**
  Encourage wise use of water in cleaning and maintenance operations. Encourage local citizens to reduce water usage through lawn care, car care and household fixtures. Promote aggressively through advertising and community organizations.
- **Encourage Litter Control**
  - Encourage local businesses to keep the areas in front of their establishments clear of debris.
  - Develop local ordinances restricting or prohibiting food establishments from using disposable food packaging, especially plastics, Styrofoam and other floatables.
  - Implement "bottle bills" and mandatory recycling laws.
  - Distribute public education materials on recycling.
  - Develop "user-friendly" ways of recycling such as curb side pick up, voluntary container buy backs and drop off recycling centers.
- **Promote Proper Operation and Maintenance of On-Lot Disposal Systems (OLDS)**
  Create laws which require homeowners or property owners to perform regular annual inspection and maintenance procedures if an on-lot septic system is present.

Management Measures for Roads, Highways and Bridges

1. Management Measure - Planning, Siting and Developing Roads and Highways

This management measure is intended for site development and, or land disturbance due to new, relocated or reconstructed roads and highways.

Plan, site and develop roads and highways to:

- Protect areas that provide important water quality benefits or are particularly susceptible to erosion.
- Limit land disturbance such as clearing and grading, and cut and fill to reduce erosion and sedimentation.
- Limit the disturbance of natural drainage features and vegetation.

a. Benefits

- Reduced erosion associated with roadways.
- Preserve natural drainageways.
- Reduce sedimentation associated with improper siting of roadways or highways.

b. Basis of Selection

- Approach recommended by the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA) guidance and other states (Virginia, Maryland, Washington, etc.)
- Minimize erosion and sediment damage to the highway and adjacent properties.
- Abate pollution of surface water and groundwater resources.

c. Recommended Actions and Practices

- **Site Planning**
  Consider the type and location of permanent erosion and sediment controls during the planning phase of projects.
- **Wetlands**
  All wetlands in the corridor that cannot be avoided must be mitigated per the Federal Clean Water Act and Pa DER regulations.
- **Setbacks**
  Assess and establish adequate setbacks near wetlands, waterbodies and riparian areas. Setback distances should be determined on a site by site basis, based on topography, soils, floodplains, cut and fill and geometry. General rule of thumb is to establish setbacks 50 to 100 feet from the edge of the wetland or waterbody and the ultimate right of way. Setbacks from major waters (i.e., oceans, rivers, lakes, estuaries) should be in excess of 100 to 1000 feet.
- **Cut and Fill Operations**
  Avoid excessive cut and fill operations to create as little disturbance as possible.,
- **Soils Consideration**
  Plan and avoid areas subject to subsidence, sink holes, landslides, rock outcroppings and highly erodible soils.
- **Planning for Runoff Controls**
  Size the right of way to include enough space for runoff pollution controls as appropriate.
- **Use Computer Models in Design**
  Use available computer models tom determine urban runoff from streets and highways when planning the area. Include design of any necessary stormwater or runoff control measures.
- **Plan Residential Roads and Streets**
  Local roads and streets should have minimum right-of-way widths. In larger subdivisions, grassed drainage swales can be used in lieu of curbs and gutters.
- **Mapping**
  Develop local official mapping to plan and reserve land where future public facilities will be necessary such as roads, highways, bridges, and runoff facilities. Sensitive areas of natural resources can be protected also.

2. Management Measure - Bridges

Intended for new, rehabilitated or relocated bridge structures to control erosion, streambed scouring and surface runoff.

Site design and maintain bridge structures so that:

- Sensitive and valuable aquatic ecosystems are protected.
- Areas providing water quality benefits are protected.
- Stream integrity is maintained.

a. Basis of Selection

- Documented effectiveness to protect against potential pollution impacts from siting bridges over sensitive areas and tributaries in the coastal zone.

b. Recommended Actions and Practices

- **Coordination Between Agencies**
  Coordinate with FHWA, USCG, COE and other appropriate state and federal agencies.
- **Review Appropriate Acts and Legislation**
  Review the National Environment;a policy Act requirements to ensure that environmental concerns are met
- **Site Structures Wisely**
  Avoid highway locations requiring numerous water crossings, or sensitive environmental systems.
- **Pollution Loadings**
  Design bridge decks to release runoff at a low velocity and reduce pollutant loading by directing it into adequate stormwater management areas. This nay be a detention basin, wetland which can accommodate the runoff or filter, grassed buffer strips. Conveyance must withstand peak velocities.
- **Restrict the Use of Scupper Drains**
  Scupper drains route runoff directly into the stream. Scupper drains should not be used on bridges less than 400 feet in length or crossing very sensitive ecosystems. On bridges where a scupper drain is used, reduce pollutant loading with treatment elsewhere to compensate for runoff discharged from the bridge.

3. Management Measure - Operation and Maintenance of Roads, Highways and Bridges

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways and bridges to reduce pollutant loadings to surface waters.

a. Benefits

- Reduce the amount of eroded and other pollutant materials from operations and maintenance procedures.
- Ensure pollutant loadings from roads, highways and bridges are minimized by the development and implementation of a program to control operation and maintenance activities.
- Protect sensitive areas.

b. Basis of Selection

- Recommended by the FHWA as a cost-effective practice,(FHWA, 1991).
- Protects the human environment.
- Effective for controlling erosion by revegetating bare slopes.
- minimizes polluted runoff from paved surfaces.

c. Recommended Actions and Practices

- **Slope and Vegetated Areas Care**
  Seed and fertilize slopes and vegetated areas, or seed and mulch areas as necessary. Sod may be a viable alternative to damaged areas.
- **Pesticides, Herbicides and Nutrients Management**
  Establish programs delineating appropriate management of pesticides and herbicides and nutrients.
- **Chemical Application Restrictions**

Limit the use of chemicals such as soil stabilizers, dust palliatives, sterilants and growth inhibitors to an educated estimation o f optimum application rates. Avoid over application or application directly to surface waters.

- **Road Debris**
  Periodic collection and removal of road debris will reduce the opportunity for pollutants to enter the waterway.

- **Care and use of Road Salts**
  Cover road salt supplies, as well as all deicing agents. Make sure stockpiles sit outside of the 100 year floodplain. Precautions should be taken to train personnel using these materials in proper application techniques and rates. This may include special trucks designed specifically for salt applications. Alternative deicing materials (e.g., sand) should be used in areas of sensitive ecology.
- **Snow Removal**
  Every effort should be made to prevent or discourage dumping accumulated snow into surface waters during removal or plowing operations.
- **Inspection Programs for Runoff Facilities and General maintenance**
  - Clean out sediment basins and traps.
  - Inspect silt fences and dispose of accumulated materials periodically.
  - Renew and replace riprap areas as necessary.
  - Repair or replace check dams and straw bales as necessary.
  - Regrade and reshape berms and swales to properly channel runoff.
  - Reseed and mulch bare spots immediately.
  - Protect culverts and inlets from siltation.
  - Inspect all permanent erosion and sediment controls on a regularly scheduled basis.
- **Training and Education**
  Develop and provide educational materials and opportunities to promote sound planning and programming.

4. Management Measure - Road, Highway and Bridge Runoff Systems

Develop and implement runoff management systems for existing roads, highways and bridges to reduce runoff pollutants concentrations and volumes entering surface waters.

Plan to:
- Identify priority and watershed pollutant reduction opportunities (e.g., existing structures improvements).
- Establish schedules for implementing appropriate runoff controls where necessary.

a. Benefits
- Establishes a retrofit system for existing runoff control problem areas.
- Mitigates severe problems with sensitive or fragile ecosystems.
- Protects and enhances water quality.

b. Basis of Selection
- Demonstrated effectiveness of retrofit systems for existing roads and highways constructed without or inadequate runoff control, systems.
- May reduce flooding in areas where runoff is not properly controlled.

c. Recommended Actions and Practices
- **Locate Potential Systems Placement**
  Inspect and locate those areas where runoff controls are most needed. Prioritize the severity of the problem areas and schedule implementation programs. The location of

runoff treatment facilities should occur within existing rights-of-way or in median or interchange loops.

- **Land Areas**
  Develop multiple use treatment facilities on adjacent lands (e.g., parks and golf courses) where possible. Acquire available additional; land areas for locating treatment facilities as possible. Where no land area is available or possible for the treatment of runoff, use underground storage or recharge facility options.
- **Buffer Strips**
  Use vegetated buffer or filter strips to maximize the travel time of sheet or overland flow to increase infiltration and reduce sedimentation.

Management Measures for Marinas and Recreational Boating

1. Management Measure - Marina Flushing

Site and design new or expanding marinas such that the tides and/or currents assist in flushing and renewing its water regularly.

a. Benefits

- Reduces concentrations of pollutants building up in the marina.
- Moves sediments and lessens the impacts they cause on benthic communities.

b. Basis of Selection

- Studies have shown that adequate flushing greatly reduces or eliminates potential for stagnation of water in the marina.
- Helps maintain biological productivity and aesthetics.

c. Recommended Actions and Practices

- **Site design**
  Siting and designing new marinas so that the bottom does not exceed the depth of the adjacent navigable waters will assist in supporting naturally occurring benthic communities.
- **Promote Circulation**
  Design or configure marinas so that there are as few segments as possible in order to assist and encourage circulation within the basin. Consider design alternatives which address poorly circulating waterbodies, such as wave attenuators and open marina basins.
- **Entrance Channels**
  Design and locate entrance channels to promote flushing by following the natural channel alignment. Any bends should be gradual. If the tidal range is small, widen the entrance as much as feasible.
- **Flow Through**
  Where possible, establish two openings at opposite ends of the marina to encourage and assist flow through currents. If this is not possible, a buried pipeline may promote flushing.

2. Management Measure - Shoreline Stabilization

Where shoreline erosion is a nonpoint source pollution problem, shorelines should be stabilized. Vegetative measures are preferred over structural methods unless cost effectiveness is a factor.

a. Benefits

- Reduces erosion of the shoreline in coastal areas.

- Vegetation stabilization reduces the potential for scouring.
- Promotes a healthy aquatic ecology.
- Protects fishing areas.

b. Basis of Selection

- Documented effectiveness of vegetation and structural methods to mitigate shoreline erosion and reduce turbidity and shoaling.

- Reduced dredging of marina basins and channels by reducing erosion along the shoreline.

c. Recommended Actions and Practices

- **Revegetating and Bulkheading**
  Where applicable, revegetate or install structural bulkheads to reduce erosion on the shoreline.

3. Management Measure - Stormwater Management

Reduce sediment loading from stormwater runoff by:

- Implement effective runoff control strategies which include the use of pollution prevention activities and proper design of hull maintenance areas.
- Reduce average annual loadings of TSS in runoff from hull maintenance areas by 80 percent. This reduction is determined on an average annual basis. Applies to hull maintenance areas only.

a. Benefits

- A reduction in pollutants associated with hull maintenance procedures. Hull maintenance includes bottom scraping, sanding, and/or painting.
- A reduction in organic (oils and greases).
- A reduction in contamination of the marina area.

b. Basis of Selection

- The 80 percent reduction of TSS can be achieved through BMPs operations procedures.
- By limiting control of TSS to hull maintenance areas, existing marina facilities can implement and sustain this measure.

c. Recommended Actions and Practices

- **Minimize Runoff Contacts**
  Hull maintenance areas should be designed to minimize runoff. These include maintenance areas with solid cement floors, coverings of a roof or tarp to block rainfall, trash and debris control, collection and proper disposal of chemicals, solvents and other materials used in hull maintenance processes.
- **Source Controls**
  Source control practices prevent runoff from coming into contact with pollutants. Items such as sanders with vacuum attachments to collect dust particles, vacuuming impervious areas periodically and tarp placed on the ground prior to placing the boat in a cradle to catch paint, dust and drippings are sources controls.
- **Sand Filters**
  Sand filters with an underlying gravel bed for infiltration can be used to strain out materials through a filter media. The water must be detained for a period of time to allow the straining process to be complete.
- **Structural Management facilities**

These include wet ponds, infiltration basins, constructed wetlands, swales and vegetated filter strips. As noted earlier, these types of practices, or BMPs, are highly effective ways of treating runoff that may be contaminated.

4. Management Measure -Sewage Facilities

Install pumpout, dump station and restroom facilities where needed at new and expanding marinas to reduce the release of sewage to surface waters. Design these facilities to allow ease of access of access and post signage to promote use by the boating public.

- Provide adequate and reasonably available pumpout facilities for all boaters.
- Conduct a comprehensive boater education project.

a. Benefits

- Reduced contamination of waters by bacteria, viruses and heavy metals.
- Reduced environmental stress on benthic and other aquatic communities.

b. Basis of Selection

- Need to reduce discharges of sanitary waste.
- Most coastal states already require pumpout facilities and restrooms at marinas.
- Preference for marina design which incorporates pollution prevention.
- Water quality benefits.

c. Recommended Actions and Practices

- **Fixed Point Systems**
  These systems include one or more centrally located sewage pumpout stations. Can be used to successfully meet the management measure, but states are not required to implement these practices.
- **Portable Systems**
  Portable or mobile systems are much like fixed point systems and can be used in there place. Portable units include a pump and a small storage unit. When the storage unit is full, it is pumped out into a municipal sewage system or holding tank. Portable units are strongly recommended for existing marinas which do not have any other type of facility, as they can be instituted immediately.
- **Dedicated Slipside Systems**
  These systems provide continuous slipside wastewater collection. Theses systems should be provided to live-aboard vessels. The remained of the marina can implement either of the other two systems.
- **Signage**
  Adequate and visible signage is strongly recommended prohibiting the discharge of sanitary waste from vessels into waters of the state. It should also fully explain the rules and procedures for sanitary waste disposal and the locations available for such facilitates.

5. Management Measure - Solid Waste Management

Properly dispose of solid wastes produced by the operation, cleaning, maintenance and repair of boats to limit entry of solid wastes into surface waters.

a. Benefits

- Reduction of pollutants and contaminants into surface waters.
- Reduced impacts to aquatic and benthic communities.

b. Basis of Selection

- Marinas have shown the ability to minimize entry of solid wastes into surface waters through implementation of many of the practices shown below.
- Inadequate disposal facilities and practices account for much of the contamination that occurs through these activities.

c. Recommended Actions and Practices

- **Boat Maintenance**
  Perform boat maintenance and cleaning above the waterline in such a way that no debris falls into the water.
- **Work Areas**
  Provide clearly marked work areas designated form boat repairs. No work can occur outside these areas.
- **Hull Areas**
  Clean hull maintenance areas frequently to remove trash, sand, paint chips and other contaminants.
- **Blasting**
  Provide spray booths for abrasive blasting or plastic tarp areas. Prevent residues from entering the waterway. When using tarps, windy days should be restricted.
- **Recycling**
  Provide adequate and appropriate disposal areas for recycling materials. Scrap metal, aluminum, glass, wood pallets, paper and cardboard should have designated and clearly marked areas for disposal. Used lead batteries should be stored on impervious surfaces under cover until picked up.

GLOSSARY

GLOSSARY

Benthic: Related to the bottom of a stream, lake, ocean or other body of water.

Best Management Practice: A structural facility designed to control stormwater runoff and thereby reduce the negative effects of runoff.

Bulkhead: A structure or partition to retain or prevent sliding of the land. A secondary purpose is to protect the upland against damage from wave action.

Channel: (1) A natural or artificial waterway or perceptible extent that either periodically or continuously contains moving water, or that forms a connecting link between two bodies of water. (2) The part of a body of water deep enough to be used for navigation through an area otherwise to shallow for navigation. (3) A large strait, as the English Channel. (4) The deepest part of a stream, bay, or strait through which the main volume or current of water flows.

Channelization and channel modification: River and stream channel engineering for the purpose of flood control, navigation, drainage improvement, and reduction of channel migration potential; activities include the straightening, widening, deepening, or relocation of existing stream channels, clearing or snagging operations, the evacuation of borrow pits, underwater mining, and other practices that change the depth, width, or location of waterways or embayments in coastal areas.

Coast: A strip of land of indefinite width (may be several kilometers) that extends from the shoreline inland to the first major change in terrain features.

Coastal area: The land and sea area bordering the shoreline.

Coastline: (1) Technically, the line that forms the boundary between the *coast* and the *shore*. (2) Commonly, the line that forms the boundary between the land and the water.

Constructed urban runoff wetlands: Those wetlands that are intentionally created on sites that are not wetlands for the primary purpose of wastewater or urban runoff treatment and are managed as such. Constructed wetlands are normally considered as part of the urban runoff collection and treatment system.

Erosion: The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

Estuary: (1) The part of the river that is affected by tides. (2) The region near a river mouth in which the fresh water in the river mixes with the salt water of the sea. (3) A semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage.

Forebay: An extra storage space provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond BMP.

Freshwater marsh: Wetland areas lining the shores of the upper portions of an estuary and the tributary streams along an estuary, dominated by water draining from upland creeks and rivers. Freshwater marshes may found in bowl-like depressions in the landscape and around lake fringes. They are extremely valuable wildlife habitats and natural pollutant filters.

Gabion: A rectangular basket or mattress made of galvanized, and sometimes PVC-coated, steel wire in a hexagonal mesh. Gabions are generally subdivided into equal-sized cells that are wired together and filled with 4- to 8-inch-diameter stone, forming a large, heavy mass that can be used as a shore-protection device.

Gradient (grade): See *slope*. With reference to winds or currents, the rate of increase or decrease in speed, usually in a vertical; or the curve that represents this rate.

Ground Water: Subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the water table.

Habitat: The place where an organism naturally lives or grows.

Heavy metals: Metallic elements with high atomic weights, e. g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

High tide, high water: The maximum elevation reached by each rising tide.

Hydrologic modification or Hydromodification: The alteration of the natural circulation or distribution of water by the placement of structures or other activities.

Impervious surface: A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development and/or a hard surface area that causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development.

Load: The quantity of sediment transported by a current. It includes the suspended load of small particles and the bedload of large particles that move along the bottom.

Low tide, low water: The minimum elevation reached by each falling *tide*. See tide.

Marsh: An area of soft, wet, or periodically inundated land, generally treeless and usually characterized by grasses and other low growth.

Marsh, salt: A marsh periodically flooded by salt water.

Marsh vegetation: Plants that grow naturally in a marsh.

Nonpoint source: Any source of water pollution that does not meet the legal definition of "point source" in Section 502(14) of the Clean Water Act. In general, they are diffuse sources of water pollution caused by rainfall or snowmelt moving over and through the ground. (See *point source.*)

Nourishment: The process of replenishing a beach. It may be brought about naturally by long shore transport or artificially by the deposition or dredged materials..

Percolation: The process by which water flows through the interstices of a sediment. Specifically, in wave phenomena, the process by which wave action forces water through the interstices of the bottom sediment and which tends to reduce wave heights.

Point Source: Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

Preexisting: Existing before a specified time or event.

Riparian: Pertaining to the banks of a body of water.

Riparian area: Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody. These systems encompass wetlands, uplands, or some combination of these two land forms; they will not in all cases have all of the characteristics necessary for them to be classified as wetlands.

Rip rap: A protective layer or facing of quarry stone, usually well graded within wide size limit, randomly placed to prevent erosion, scour, or sloughing of an embankment of bluss; also the stone so used. The quarry stone is placed in a layer at least twice the thickness of the 50 percent size, or 1.25 times the thickness of the largest size stone in the gradation.

Salt marsh: A marsh periodically flooded by salt water.

Scour: Removal of underwater material by waves and currents, especially at the base or toe of a shore structure.

Shoreline: The intersection of a specified plane of water with the shore or beach (e.g., the high water shoreline would be the intersection of the plane of mean high water with shore or beach). The line delineating the shoreline on National Ocean Servvice nautical charts and surveys approximates the mean high water line.

Sedimentation: The formation of earth, stones, and other matter deposited by water, wind, or ice.

Slip: A berthing space for boats, between two piers.

Slope: The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating 1 unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04); degrees (2° 18'), or percent (4 percent).

Soil classification **(size)**: An arbitrary division of a continuous scale of grain sizes such that each scale unit or grade may serve as a convenient class interval for conducting the analysis or for expressing the results of an analysis.

Species diversity: The variations between groups of related organisms that have certain characteristics in common.

Stream: (1) A course of water flowing along a bed in the earth. (2) A current in the sea formed by wind action, water density differences, etc.; e.g., the Gulf Stream. See also *current, stream.*

Tidal period: The interval of time between two consecutive, like phases of the tide.

Tidal range: The difference in height between consecutive high and low (or higher high and lower low) waters.

Tide: The periodic rising and falling of the water that results from gravitational attraction of the Moon and Sun and other astronomical bodies acting upon the rotating Earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as *tidal current*, reserving the name *tide* for the vertical movement.

Topography: The configuration of a surface, including its relief and the positions of its streams, roads, building, etc..

Upland: Ground elevated above the lowlands along rivers or between hills.

Vegetated buffer: Strips of vegetation separating a waterbody from a land use that could act as a nonpoint pollution source. Vegetated buffers (or simply buffers) are variable in width and can range in function from vegetated filter strips to wetlands or riparian areas.

Vegetated filter strip: Created areas of vegetation designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, adsorption, decomposition, and volatilization. A vegetated filter strip is an area that maintains soil aeration as opposed to a wetland, which at times exhibits anaerobic soils conditions.

Wetlands: Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration to support, and the under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions; wetlands generally include swamps, marshes, bogs, and similar areas. (This definition is consistent with the Federal definition at 40 CFR 230.3, promulgated December 24, 1980. As amendments are made to the wetland definition, they will be considered applicable to this guidance.)

Note: Most of the definitions in this glossary were taken from the EPA document, *Guidance Specifying Management Measures For Source of Nonpoint Pollution In Coastal Waters*, published by the EPA Office of Water, 1993.

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