

DRAFT

WATER RESOURCES MANAGEMENT PLAN
AND
ENVIRONMENTAL ASSESSMENT

DELAWARE WATER GAP NATIONAL RECREATION AREA
New Jersey / Pennsylvania

(Part III A: Water Quality Protection Only)

STAFF REPORT OF THE DRBC/NPS PLANNING TEAM

March 1990 WORKING DRAFT

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III.A. Water Quality Protection

III.A.1. STATEMENT OF PROBLEM

The natural and recreational resources, the local amenities, and the economic opportunities provided by the Delaware Water Gap National Recreation Area are intimately linked to its water resources. The quality of this water resource and the recreational experiences associated with it are, in turn, intimately associated with the chemical, physical and biological water quality properties of the water resource. A trend in water quality deterioration can be anticipated if the level of water quality protection is not increased. This deterioration could profoundly impact the value of the recreation area and the amenities and opportunities it provides locally, regionally and nationally.

Three major water quality protection issues have been identified:

WATER QUALITY ISSUES

- A. Existing Water Quality Standards and Associated Policies Do Not Protect Existing High Water Quality Standards;
- B. Point and Non-point Pollution from Growth and Development Threaten the Existing High Quality Waters;
- C. The Use of DWGNRA Waters and Lands for Wastewater Assimilation Conflicts with Its Purposes.

Intimately intertwined with these major issues are various concerns which must be taken into consideration:

RELATED ISSUES

- Local municipalities want and have the legal right to control their own destinies including the amount of growth they receive and whether sewerage service is provided for their present and future citizens;
- Local development and other interests want to pursue their business interests including their rights under state and national law;
- the Pennsylvania Department of Environmental Resources is faced with an increasing number of petitions for Exceptional Value status for various Pocono tributaries, an increasing number of wastewater treatment plant proposals, and dilemmas regarding how an area's high quality streams and national scenic rivers can be preserved amidst rapid growth and development;
- The U.S. Congress, through the Wild and Scenic Rivers Act, requires the National Park Service to manage the Middle Delaware Scenic and Recreational River so that water quality is maintained or enhanced for future generations.



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- The general public believes that wastewater treatment plants are part of the problem and not a solution, that the applicable regulatory agencies approve projects too quickly without due regard for all environmental concerns, and that the compliance record of the region's wastewater treatment plants (and the regulatory response) is inadequate. Environmentalists would also like to see creative solutions to the region's wastewater problems
- The NPS/DRBC planning team believe that major increases in wastewater treatment flows and particularly non-point source loadings are imminent and pose a real threat to water quality. Programs addressing the latter are not in-place to any great extent.

The following paragraphs discuss each of the three major issues. Section III.A.2 examines the various management alternatives which address the issues. A recommended action plan is then presented in Section III.A.3.

III.A.1.a. EXISTING WATER QUALITY STANDARDS DO NOT PROTECT EXISTING HIGH WATER QUALITY

Water quality standards present numeric criteria for the water quality parameters of most concern. Current water quality standards for the Middle Delaware Scenic and Recreational River were adopted in 1967 by the Delaware River Basin Commission, followed by adoption by the states (DRBC, 1986). At the time of the adoption, it was assumed that Tocks Island Reservoir would be built in the area and that a five county regional sewerage system would be transporting wastewater to the southern end of the area for treatment (Albert, 1987a). In the intervening years, the reservoir and large regional conveyance and treatment system have not been built nor are they likely to be built in the foreseeable years.

Instead, the National recreation area has become very much river-oriented with the river itself becoming a nationally-designated scenic and recreational river. Wastewater treatment has not regionalized on a municipal level to any great extent although this pattern is changing quickly. Instead, wastewater treatment has generally followed a development by development pattern with small plants being built in some places and on-lot systems employed elsewhere. Exceptions to this pattern exist in the older established towns such as Delaware Water Gap, Stroudsburg, East Stroudsburg, and Port Jervis which are served by municipal plants (see Table 7).

The 1967 standards were based on the protection of so-called "designated uses". Designated uses for the Middle Delaware of most interest are "maintenance and propagation of resident game fish and other aquatic life", "passage of anadromous fish", and "recreation". Others refer to public, industrial and agricultural water supplies.

Numeric criteria adopted as water quality standards are the minimum needed to maintain the designated use. Existing water quality where higher than the adopted water quality standards, is allowed to degrade until the lower threshold represented by the standards is reached. In addition, the quality of the designated uses can also be legally impaired (i.e., fishing as a designated use is still maintained but it is not as good as it once was because of less game fish or smaller fish; the risk of illness from swimming is somewhat increased because bacterial levels

are higher; canoeing can still be done but the experience is lessened because water clarity is diminished and so forth).

How existing water quality standards can lead to further degradation of the existing water quality of the Middle Delaware can be illustrated by several key water quality parameters (see Figure 14). For example, current treatment levels are predicated on the adopted dissolved oxygen standard of a minimum of 4.0 mg/l and a minimum 24-hour average of 5.0 mg/l. Statistical analyses of state, U.S. Geological Survey and Commission/National Park Service water quality data, however, indicate that existing water quality is best defined as a minimum of 6.0 mg/l and a 24-hour average of 8.0 mg/l. Thus, current dissolved oxygen standards allows a 33 to 37 percent reduction in existing water quality based on dissolved oxygen.

In fisheries terms, the change in dissolved oxygen from today's levels to the level reflected in the adopted water quality standard equates to a fishery that is currently unimpaired to one that is moderately to severely impaired (U.S. EPA, 1986). Fishing as a designated use is still maintained, but less numbers or diversity of fish species might occur.

Although generally considered a public health indicator, fecal coliform bacteria are also good indicators of general pollution (Albert, 1986a). Current standards for the Middle Delaware call for fecal coliform levels to be maintained at levels not to exceed 200 per 100 milliliters as a geometric average (an average calculated from the logarithms of the values). As a result of this standard, effluent permits generally allow fecal coliform levels in wastewater treatment plant effluents to reach 200/100 ml.

Analyses of data from 445 fecal coliform samples taken in the Delaware River from Port Jervis to the Delaware Water Gap during the summers of 1984 to 1989 indicate a geometric average of less than 50 colonies per 100 milliliters with only about 10 percent of the total values exceeding 250/100 ml. The analyses included data from both rainy and dry-weather periods. As indicated in Figure 15, the shift from today's water quality to the level of water quality represented by the existing fecal coliform standard is a major change in water quality. Accompanying this shift would likely be changes to other parameters as well resulting in a general, overall deterioration in water quality.

Currently, water quality standards for the Middle Delaware have been adopted for only nine separate parameters: dissolved oxygen, temperature, pH, phenols, threshold odor number, detergents, radioactivity, fecal coliform and total dissolved solids. Limited as it is, this mix of parameters does not present an adequate description of the water quality condition which is to be protected.

For example, ammonia nitrogen can impact water quality in three ways: as ammonia toxicity, as nitrogenous oxygen demand which reduces dissolved oxygen levels, and as a nutrient source which stimulates aquatic plant growths (which in turn could result in violations of dissolved oxygen and pH criteria and result in other undesirable conditions). Ammonia concentrations in the Middle Delaware are allowed to increase unless a standard is adopted to control these increases. Similarly, standards for other parameters would be desirable for a more complete description of the level of water quality to be maintained, preserved or allowed.

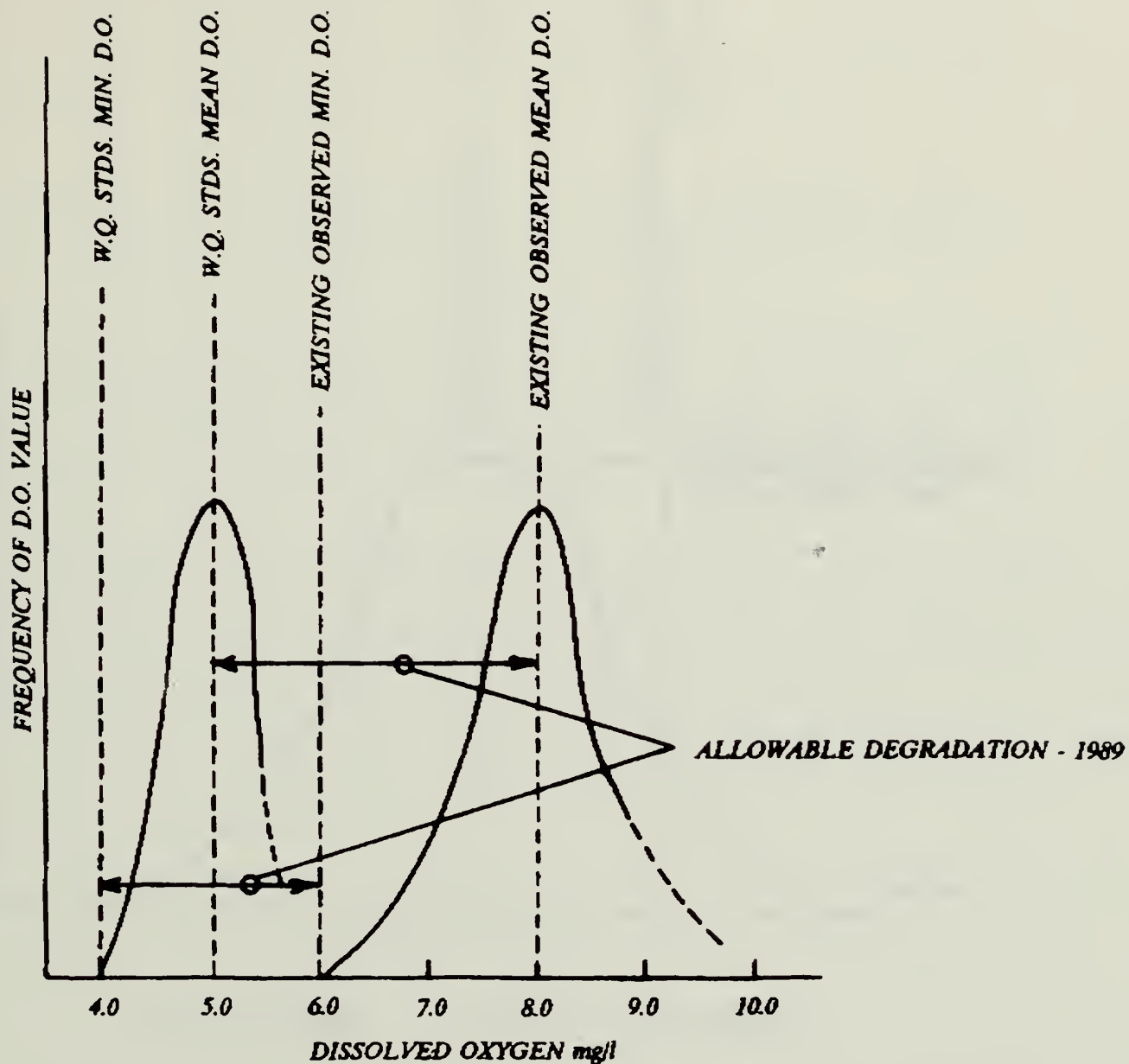


FIGURE 14: ALLOWABLE DISSOLVED OXYGEN DEGRADATION UNDER CURRENT WATER QUALITY STANDARDS

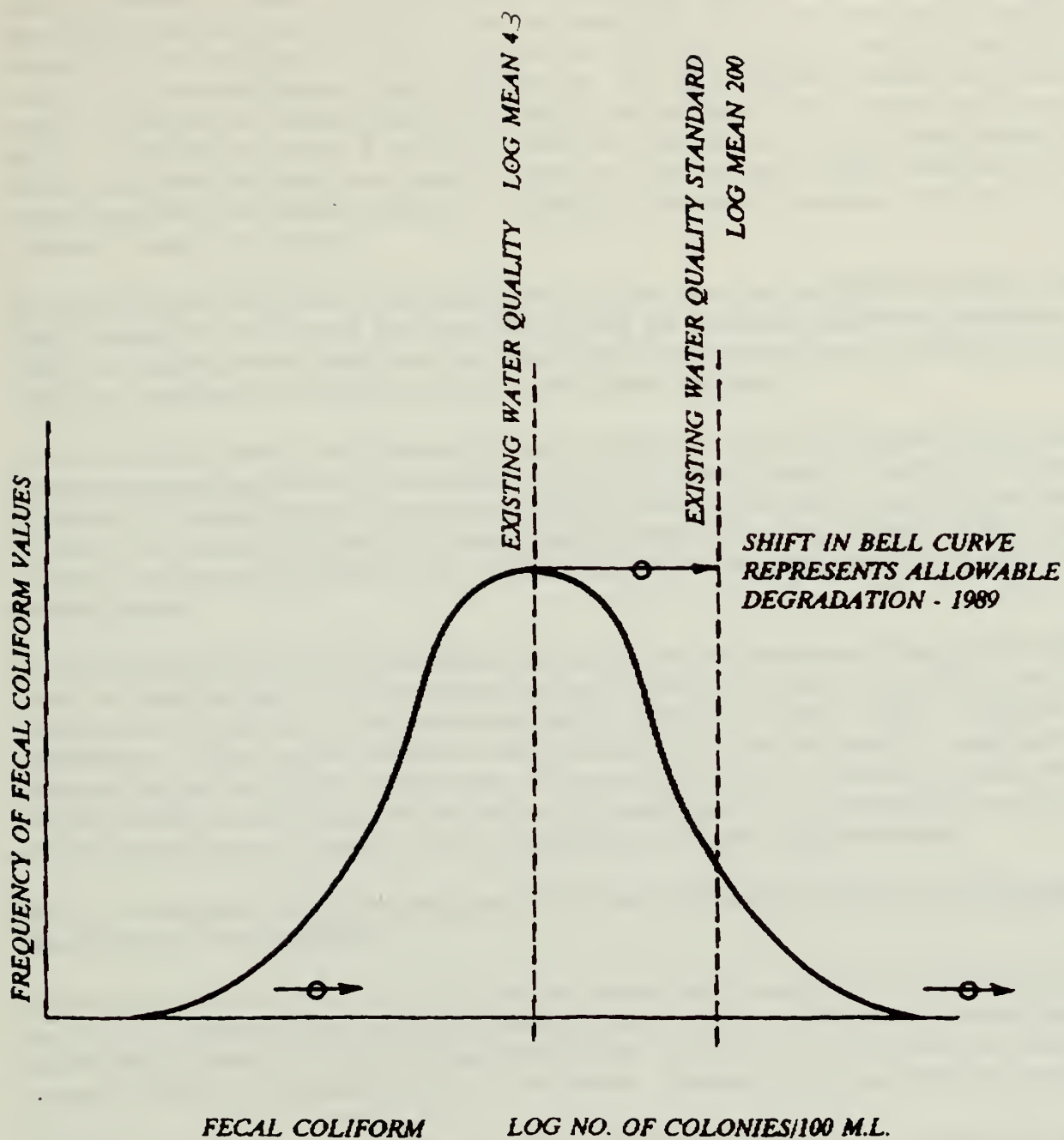


FIGURE 15: ALLOWABLE INCREASE IN FECAL COLIFORM LEVELS UNDER CURRENT WATER QUALITY STANDARDS

Table 18 presents a listing of 24 water quality values which represents today's water quality in the Middle Delaware and the reach of the Delaware River from Port Jervis to the northern boundary of the DWGNRA. The basis for these potential criteria was the statistical analyses of almost 6000 individual pieces of water quality data. The 25 parameters describe water quality from four perspectives: chemical, physical, bacterial, and biological. These criteria are potential water quality standards which, if adopted as described in subsequent sections, would resolve the issues surrounding existing water quality versus the level of water quality reflected by the currently-adopted water quality standards. Appendix C presents information about how these potential criteria were derived.

As discussed previously in Part I, anti-degradation policies have been adopted to augment water quality standards. The current anti-degradation policy for the Middle Delaware promulgates a policy that existing water quality is to be maintained in those areas where it is currently higher than that called for by the existing adopted water quality standards.

A caveat exists, however, which makes this policy ineffectual. This caveat states that the anti-degradation considerations can be waived if the change in water quality is "justifiable as a result of necessary economic or social development" (DRBC, 1986). In practice, no test for "justifiable" is used. As a result, the level of water quality represented by the adopted water quality standards, and not anti-degradation considerations, govern the wastewater management decision-making process.

The Middle Delaware Scenic and Recreational River and the various streams within the DWGNRA meet the qualifications for "Outstanding National Resource Waters" as defined by U.S. Environmental Protection Agency anti-degradation policies (U.S. EPA, 1983). This type of classification, unlike current standards and policies, make anti-degradation considerations paramount in the wastewater management decision-making process. As a result, waiver of the anti-degradation considerations can not occur. EPA regulations do not require the provision of an Outstanding National Resource Waters classification in water quality standards.

III.A.1.b. Point and Non-Point Sources from Growth and Development Threaten the Existing High Quality Waters of the DWGNRA

As described in Section III.A.1.a., currently-adopted water quality standards and related regulations do not protect existing water quality from being degraded. Water quality, from a practical sense, can be legally degraded by growth and development. Growth and development increases the amount of pollutants entering the system from sewage treatment plants and from land runoff.

The impacts of urbanization are already observed in the DWGNRA waters. Information obtained from the six year old Commission/National Park Service cooperative monitoring program clearly demonstrates that water and sediment quality differs in the urban or urbanizing areas from that in an undeveloped area (Albert, various years). Typically, these areas have higher fecal coliform, specific conductivity, aquatic plant growths, and other characteristics that suggest diminished water quality. These characteristics can also be seen in the DWGNRA by comparing the water quality of undeveloped tributaries with developed or developing tributaries and by comparing water quality data from the Port Jervis to Milford or Delaware Water Gap reaches of the Delaware with intervening, non-urbanized reaches.

Table 18 Water Quality Values Representing the Existing Water Quality,

Parameter	Proposed Criteria
D.O. (mg/l)	Minimum of 6.0 mg/l and 24-hour average of 8.0 mg/l with minimum representing nighttime low value.
BOD (mg/l)	Mean of less than 1.6 mg/l.
Total Phosphorus (ug/l)	Less than 100 ug/l 90% of the time maximum value not to exceed 200.
Dissolved Ortho Phosphorus (ug/l)	Less than 15 ug/l 92% of time.
Total Nitrogen (mg/l)	Mean of 1.0 mg/l with no more than 15% of values greater than 1.35 mg/l.
Ammonia Nitrogen* (mg/l)	Not to exceed 0.67 mg/l.
Fecal coliform (colonies/100ml.)	"Ambient fecal coliform:" not to exceed 50 colonies per 100 ml as a reach-wide geometric average over May through September period with 90 percent of values not to exceed 250 colonies per per 100 milliliters.
Specific conductivity umhos/cm	Not to exceed an average of 90 at any one location or 80 reach-wide, 85 percent of values not to exceed 100.
pH	pH of 6.5 to 9.0.
Total Suspended Solids	Not to exceed an average of 9 mg/l at any one location nor a reach-wide average of 6.0 mg/l, 86 percent of values not to exceed 15 mg/l.
Total Dissolved Solids (mg/l)	60 mg/l.
Biocriteria	Existing water quality defined by a reach-wide mean Shannon-Wiener index value of 3.6 with no more than 10% of the values below 3.0; mean equitability index value of 0.8 with no more than 15% of the values below 0.6; and, a mean EPT value of 13 with no more than 15 percent of the values below 10. As a guideline, the values at any one location after sufficient sampling should be at least 3.0; 0.6 and 10 respectively for the Shannon-Wiener, equitability and EPT indices.
Turbidity	a. maximum 30-day average 20 units. b. maximum 150 units.
Manganese (ug/l)	Not to exceed 110 ug/l.
Iron (ug/l)	Not to exceed 1 mg/l.
Hardness**	No hardness standard is proposed. Based on hardness of 18 mg/l and EPA criteria formulae, the following toxic heavy metal criteria are proposed (as ug/l): Cd 0.30; Cr III 50.82; CrVI to be developed; Cu 2.73; Pb 0.36; Ni 25.96; Ag 0.21; and Zn 77.4.

* Ammonia proposed criteria based on toxicity implications inherent in existing water quality as defined by pH and water temperature

** Metals criteria based on toxicity implications inherent in existing data as defined by hardness minimums

River bottom sediment toxics data acquired in 1987 (Albert, 1989) also support these findings. For example, of the 17 locations examined from Hancock, New York to the Delaware Water Gap, the Milford area stations were highest in chlordane and phenols while the Port Jervis, Delaware Water Gap and Brodhead Creek stations had a greater frequency of higher values than almost all other locations (exceptions were a toxic landfill and a site being influenced by unknown sources of metals). Local sources of the contaminants in the urban sediments are indicated by comparing data from each location.

If urbanization has resulted in a diminishing of water quality, a reasonable assumption is that increased urbanization will lead to further declines in water quality including reaches which currently are relatively unimpacted. This is true because the conversion of land from forest and open fields to suburban and urban uses increases dramatically the amount of pollutants coming off the land surface (non-point sources). If, in addition, a sewage treatment plant is built or expanded as a result of the growth, a new load exists that has not been seen before.

The following example illustrates the dramatic increase in pollutant loading that might occur from converting forest land to residential uses without any controls other than those currently in force. The example assumes that (1) the hypothetical watershed is 100 acres and initially contains no houses; (2) the watershed is then sub-divided into 200 half acre lots with houses built on the lots and sewer service provided; (3) families of 2.5 persons each occupy the houses and use 100 gallons sewage per person per day; (4) secondary treatment (equivalent to a 30 mg BOD/l and 5 mg P/l) is required at the development's treatment plant; and (5) non-point source contributions from the land before and after development are 4 and 40 lbs BOD and 0.1 and 1 lb phosphorus per acre per year respectively (based on literature values for the conversion of forest to urban/suburban uses).

A. Changes in Land Use, Population, and Sewage Flows

	<u>Before</u>	<u>After</u>	
Forest	100	0	acres
Residential	0	100	acres
Population	0	500	persons
Sewage Flows	0	50,000	gpd

B. Changes in Pollutant Loadings (lbs/yr as represented by BOD and Phosphorus)

<u>Point Sources</u>	<u>Before</u>	<u>After</u>
BOD	0	4600
Phosphorus	0	760

Non-Point Sources

BOD	400	4000
Phosphorus	10	100

C. Total Annual Increase in Pollutants (lbs/yr.)

	<u>Net Increase</u>	
	<u>Loading</u>	<u>Percent</u>
BOD	8200	2150
Phosphorus	850	8600

The above illustration indicates that growth and development can cause major increases in the net amount of pollutants entering a stream or watershed unless the increase in loads are controlled. While the above analyses were limited to two parameters, many more water quality constituents would also increase. These include oxygen-demanding materials, various herbicides and pesticides, heavy metals, and other nutrients. The absolute magnitude of the increase would depend upon the amount or scale of the growth and development that is occurring. The greater the scale of development, the greater likelihood that central sewerage facilities will be provided and that stream hydrology will be permanently modified.

All factors being equal, the potential impact of growth and development is largely a function of how much land is going to be converted from forest and fields to other, more intense uses. As part of this planning activity, an inventory of current and potential land uses was made. The study area for the inventory was the eleven townships which are immediately adjacent to the DWGNRA. It should be recognized that municipalities upstream of these townships also affect water quality in the DWGNRA. Time and resources did not allow their evaluation.

Land use information was obtained from a variety of sources including county tax assessment offices, county planning commissions, township zoning ordinances and maps, township municipal offices, local sewage enforcement and zoning officers, local comprehensive and wastewater treatment plans, conservation district offices, and others. This information was compiled on an individual land parcel basis using computer spreadsheets and delineated on base maps with transparent overlays. The land use data base contains over 3000 records concerning acreage, dwelling units, sewerage service, parcel ownership, named developments, land use, and other information.

Seventeen land use categories were used to characterize and quantify land use. The information is currently being converted into a Geographic Information System and a report entitled "Inventory and Characterization of the Land Use Surrounding the Delaware Water Gap National Recreation Area" is being prepared as part of the DRBC/NPS water resources planning program. This detailed report is scheduled for completion in 1990.

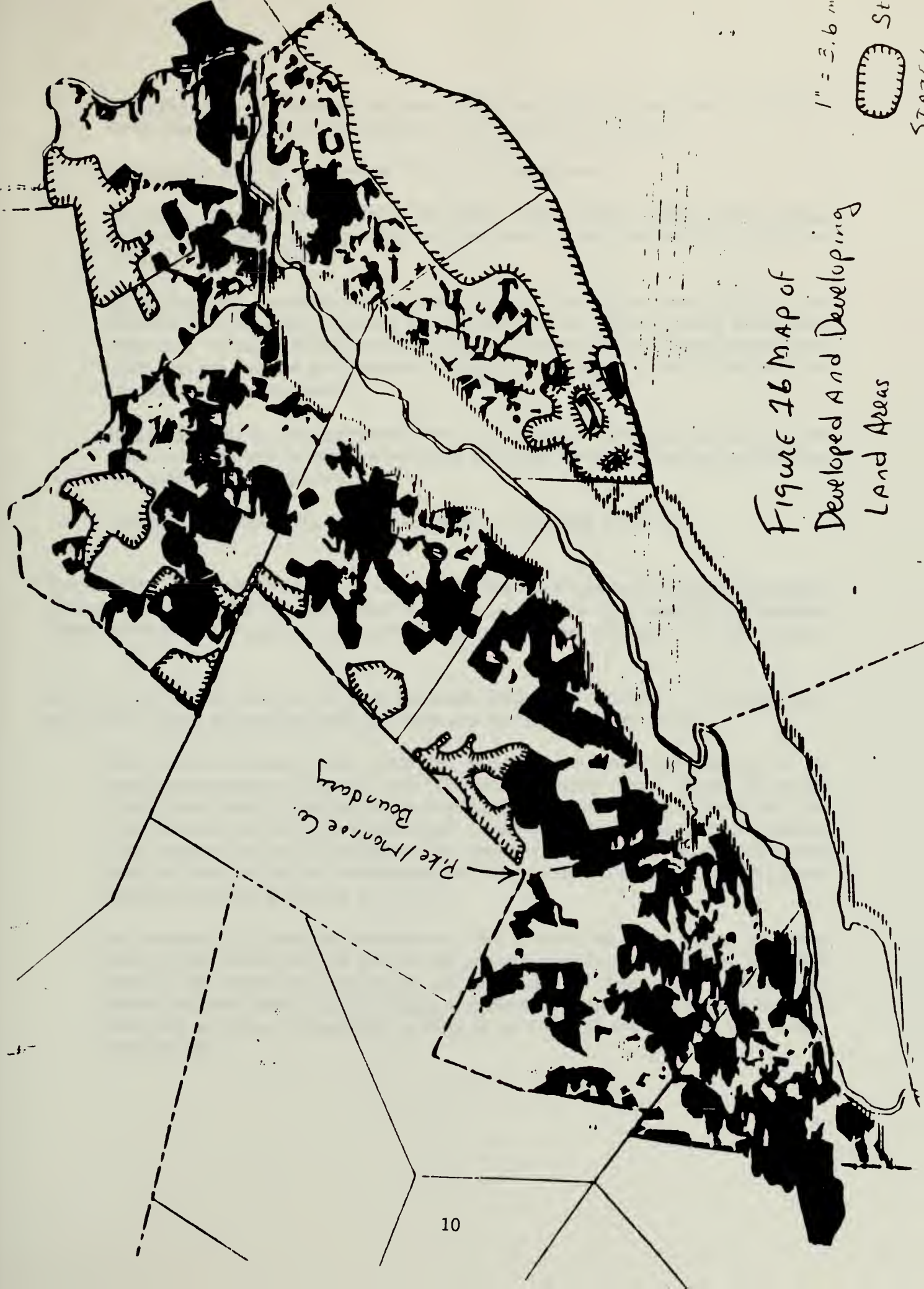
Figure 16 presents a general depiction of the land surrounding the DWGNRA which has been developed, or is currently being developed. Included are lands which are owned by active, adjacent developments, but not yet sub-divided. The map indicates that a lot of the available private land in the townships surrounding the DWGNRA, as of 1989, was subject to conversion to more intense land uses. Over time, it is conceivable that this land will be fully developed (ie. all developments built out) and that a portion of the currently undeveloped land will also have been acquired by developers.

Appendix D contains a series of pie graphs depicting the current land use by municipality. Warren County, New Jersey townships were excluded from the analyses because they are wholly within the DWGNRA or state forests. The graphs present acreage figures for seven groups of land uses. These are defined as follows:

Total Acres represent township or watershed totals including the Boroughs of Matamoras, Milford, Delaware Water Gap, Stroudsburg, and East Stroudsburg.

1" = 3.6 mi
St
STANDARD

Figure 16 Map of
Developed And Developing
Land Areas



DWGNRA Acres are most of the acres within the DWGNRA boundaries exclusive of ownership (ie. includes all in-holdings except for one 500 acre tract)

Other Public Land are predominantly acreage in state forests

Developer Acres represent acreage in named developments (existing and proposed residential and resort developments) and land owned by adjacent developers which has not yet been sub-divided.

Acres Developed are existing residential, commercial, industrial and quasi-public (schools, churches, cemeteries etc.) land uses. This grouping does not include existing development in partially completed subdivisions (see "Developer Acres"). The five boroughs within the study area are included and considered 100 percent developed. Land use data for these boroughs were not gathered.

Remaining Acres are acreage currently vacant or devoted to farms, hunting/fishing clubs, camps, campgrounds (private), golf courses, and major reserved open areas within resort and residential developments.

Unknown are acres which can not be classified or grouped at this time.

The extensive data base developed on land use for the townships and boroughs immediately surrounding the DWGNRA is summarized in Tables 19 through 23. Subsequent discussions present estimates of the point and non-point source loads that are inherent in this development.

Based on the summary land use data, the following findings are obtained. The findings apply only to the portion of counties within the study area and not the entire county.

1. Of the 234,009 total acres in the study area, 34 percent are state or federally-owned. The remaining 66 percent of the study area (153,396) is privately owned. Almost 30 percent of this private land is developed while 34 percent is currently owned by developers. Full development of the latter will result in over a doubling of the amount of land developed in the drainage area to the DWGNRA. The impact of this new development will depend upon the density of the new development and other factors. The density of development is likely to increase if the area is sewered.
2. The remaining 36 percent of privately-held land is owned by farms, camps, sportsmen clubs, summer camps, and the like. It can be envisioned that some of these large land holdings will eventually be purchased and sub-divided for development as well. Any impacts predicted herein could be grossly understated because of the uncertain future of these lands as well as the unassessed portions of the DWGNRA drainage area lying outside the study area.

Table 19: Summary of Study Area Land Use (acres)

	Pike townships	Monroe townships	Sussex townships	Total
Total Acres	125,504	53,075	55,430	234,009
Acres Developed	24,501	15,276	5,900	45,677
Developer Acres	36,964	14,231	1,482	52,677
Remaining Acres	28,186	14,087	12,769	55,042
DWGNRA	16,796	6,076	8,587	31,459
Other Public	18,990	3,305	26,561	48,856
Unknown	67	100	131	298

Note: Includes Boroughs of Matamoras, Milford, Delaware Water Gap, Stroudsburg, and East Stroudsburg which are assumed above to be totally developed although this is not totally correct.

Table 20: Summary of Developments

	Pike townships	Monroe townships	Sussex townships	Total
No. named developments	114	117	7	238
no. subdivided lots	31,183	13,261	1,476	45,920
no. lots built upon	9,500	4,910	835	15,245

Note: Table does not include boroughs and does includes some developer-owned land which has not yet sub-divided (ie. large acreage with only one lot).

Table 21: 1988 Average Lot Size for Lots 10 Acres and Under

<u>Township</u>	<u>Acres</u>
Sussex County:	
Montague	0.9
Sandyston	2.1
Pike County:	
Westfall	1.3
Milford	---
Dingmans	1.1
Delaware	0.8
Lehman	0.9
Monroe County:	
Middle Smithfield	0.7
Smithfield	1.4

Table 22: Summary of the 15 Largest Developments

Name	(county)	Acres	Lots	% Built
Sunrise Lake	(Pike)	3255	1189	51
Pocono Mtn. Lake Ests.	(Pike)	3204	2626	17
Wild Acres	(Pike)	2991	4872	21
Pocono Mtn. Woodland Lks.	(Pike)	2543	1676	18
Saw Creek Estates	(Pike)	2437	2741	61
Tamiment Resort	(Pike)	2300	452	18
Pocono Ranchlands	(Pike)	1900	2000	13
Conashaugh Lakes	(Pike)	1700	964	18
Shawnee Development Co.	(Monroe)	1296	64	n/a
Altamonte	(Sussex)	1228	999	55
Gold Key Lake	(Pike)	1200	2046	32
Pine Ridge	(Pike)	1100	1524	24
Pocono Mtn. Lake Forest	(Pike)	1088	1085	13
Birchwood Lakes	(Pike)	1000	2517	30
Big Ridge	(Monroe)	970	3300	2

Notes:

- (1). The 15 largest developments represent 53 percent of the "Developer Acres" shown in Table 19 and 50 percent of the "No. Sub-divided Lots" shown in Table 20.
- (2). In the case of resorts, lots size etc. may reflect development which is condominiums rather than lots owned or for sale to individual purchasers.
- (3). The percent built was derived by dividing the number of dwelling units by the number of sub-divided lots. The resulting number may not reflect true development potential where large adjacent land parcels have not yet been sub-divided.
- (4). The number of acres divided by the number of lots do not yield average lot size of land dedicated to internal facilities (lakes, golf courses, roads etc.) and land which is undevelopable due to steep slopes etc.
- (5). The data presented are only for the 15 largest developments. Land use data were collected on 223 other named developments including developments of ten acres and less. These range in size from 781 acres (the 16th largest development) to 2 acres (the smallest development with known acreage).

Table 23: Ranking of Townships

Township	Amount of Developer Acres	Percentage of Developer to Private Acres	Amount of Remaining Acreage
Westfall	6	6	5
Milford	8	7	8
Dingmans	1	2	2
Delaware	3	3	6
Lehman	2	1	4
Middle Smith.	4	5	1
Smithfield	5	4	9
Montague	7	8	3
Sandyston	9	9	5

3. The amount of privately-owned land that is developed or currently developing in Monroe and Pike Counties (study area only) is 68 percent for both counties with Pike County having the highest ratio of developing land to already developed land. Monroe County, however, also has a high ratio. In terms of immediate development, the New Jersey portion of the study area currently has less development going on than the Pennsylvania portion.
4. Over 50 percent of the developing land area is contained in 15 (6.3 percent) of the named developments operating in the townships adjacent to the DWGNRA (Table 22). Twelve of the 15 largest developments are in the Pike County portion of the study area and 14 are in the Pennsylvania portion of the study area. When all developing lands are included, 70 percent of the total land currently being developed is located in Pike County and 97 percent are in the Pennsylvania portion of the study area. Figure 17 shows the location of the 15 largest developments.
5. Table 23 presents a ranking by township of the amount of developer acres, the percentage of the developer acres to the total privately-owned acreage, and the amount of remaining acreage. When townships are ranked in this manner, four townships stand out: Dingmans, Delaware, Lehman, and Middle Smithfield. The first three townships, all adjacent to each other and located in Pike County, have the greatest amount and percentage of land currently undergoing development.

The fourth township, Middle Smithfield Township in Monroe County, is adjacent to the these three Pike County townships. While it is only 4th or 5th in terms of development activity, it has the largest amount of undeveloped land owned by non-developers. However, when the level of development in the adjacent Pike County townships is considered, Middle Smithfield is considered to have a significant development potential.

In summary, major growth and development is occurring in the townships surrounding the DWGNRA particularly those in Pike County and, to a lesser extent, Monroe County. The Pennsylvania townships adjacent to the middle section of the DWGNRA appear to be developing the most rapidly at this time. In water quality terms, non-point and point source loads from the Pennsylvania portion of the study area are likely to pose a much greater threat to DWGNRA water quality than those from the New Jersey portion - at least in the foreseeable future.

Land use, growth and development can also be examined on a watershed basis instead of a township/municipality basis. Watersheds are, to some degree, easily developed into "sewersheds" via gravity sewer lines. In addition, watersheds will be the geographical unit which "delivers" non-point source pollution to the DWGNRA and the Middle Delaware Scenic and Recreational River.

Based on an analysis of sub-division acreages and other considerations, the following 10 watersheds have the greatest amount of acreage currently undergoing development: (1) Raymondskill (Pike County); (2) Marshalls (Monroe County); (3) Dingmans (Pike County); (4) Toms Creek (Pike County); (5) Saw Creek (Pike County); (6) Big Bushkill (Monroe County); (7) Little Bushkill (Pike County); (8) Hornbecks (Pike County); (9) Brodhead (Monroe County); and (10) Sawkill (Pike County). This ranking confirms the findings of the township analyses.

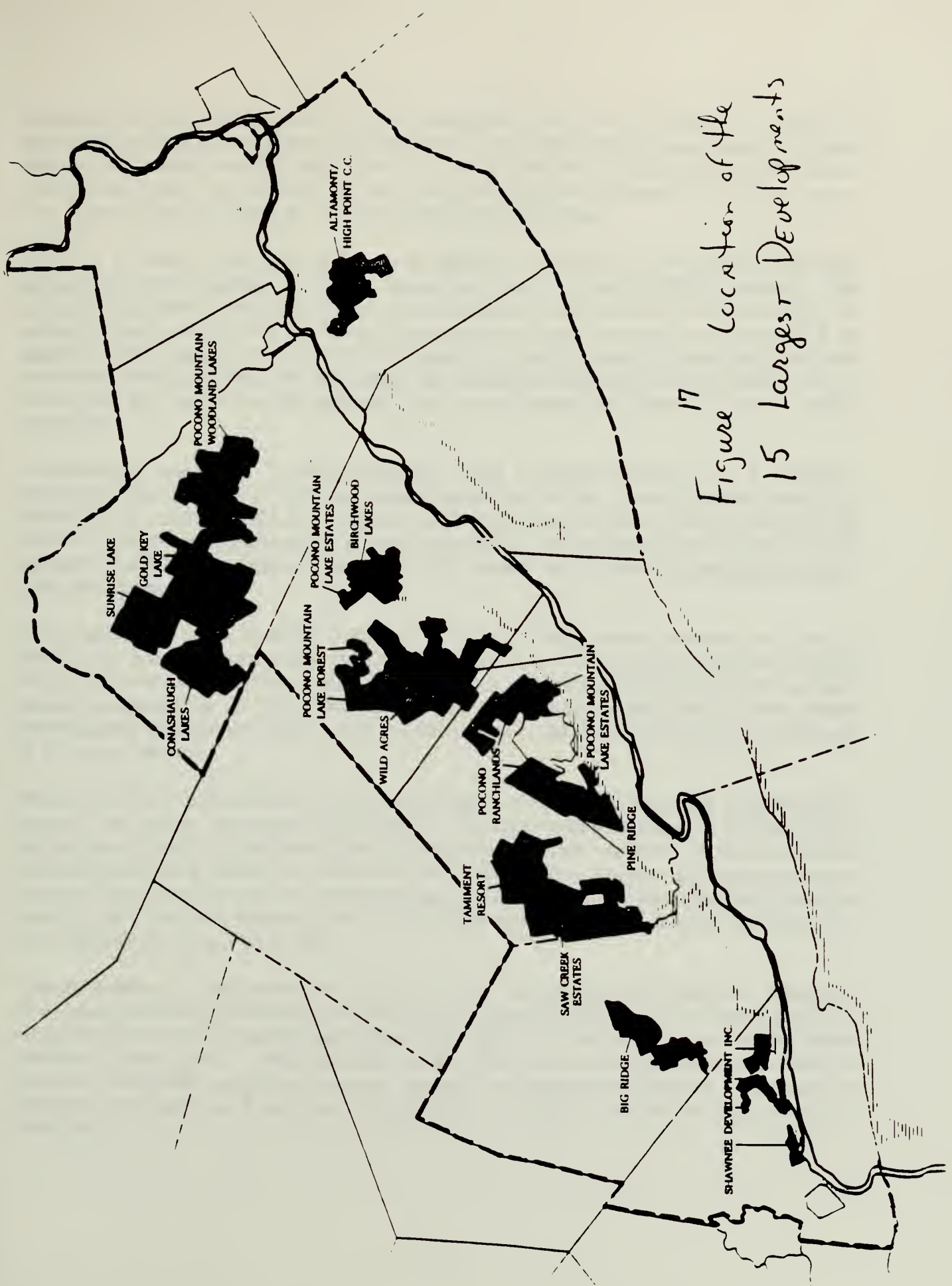


Figure 17 Location of the
15 Largest Developments

Although some watersheds nearer the older established towns are still subject to growth, the open areas draining to the center of the DWGNRA, particularly in Pike County, have the greatest potential for changing water quality. The center of the DWGNRA from Dingmans Ferry to above the Delaware Water Gap currently has water quality which is least affected by pollution sources. This appears likely to change in the near future if trends continue.

Estimates of sewage generation in the municipalities surrounding the DWGNRA indicate that major point source loadings are on the immediate horizon. The NPS/DRBC planning effort estimates that current sewage generation in the study area is approximately 2.8 to as high as 5.7 million gallons per day with the former figure probably closer to reality (see Appendix E for analyses). This compares to 0.7 to 1.0 MGD which is currently treated at the various study area wastewater treatment plants and discharged. The remainder is treated via on-lot systems. Due to the shallow soils and other site problems, these on-lot systems are thought to have a limited useful life.

In addition to the 0.7 to 1.0 MGD currently treated in plants located in the 8 immediate townships, approximately 4.1 MGD is currently treated at the Port Jervis, Delaware Water Gap (borough), Stroudsburg, and East Stroudsburg wastewater treatment plants. When these flows are included, total sewage generation in the area surrounding the recreation area is almost 7 MGD (using the 2.8 MGD low estimate from above) with about 5 MGD treated in existing wastewater treatment plants.

In the foreseeable future (possibly within 10 to 20 years) the sewage generation of 10 to 18 MGD in the townships surrounding the DWGNRA is estimated. This figures compares to almost 15 MGD in wastewater treatment plant capacity which is currently being proposed in the eight townships surrounding the DWGNRA. As these figures suggest, the provision of sewer service and treatment facilities will likely reduce the percentage of the total of sewage that is disposed of via on-lot systems.

When Port Jervis, Delaware Water Gap, Stroudsburg, and East Stroudsburg are included in the analyses, total sewage generated and treated at wastewater treatment plants in the near future will be over 21 MGD. This latter figure includes some proposed expansion to the Stroudsburg and East Stroudsburg plants, but, due to the lack of information, not the other two plants. Not included in any of these totals is wastewater generated and/or treated outside the study area, but within in the DWGNRA drainage area eg. the upper Brodhead, upper Bushkill and Delaware River watersheds above Port Jervis.

Ultimate build out of the private land in the study area (surrounding townships only) could lead to an estimated sewage generation of 45 MGD plus at least 6 MGD from the Port Jervis and other established towns plus possibly more depending upon the development and redevelopment potential of these towns. With full build out, it is likely that most of this wastewater will be delivered to regional wastewater sewerage systems for treatment and disposal. Although the timing of total build out is extremely unpredictable, it certainly is within the life span of the DWGNRA.

It must be emphasized again that these ultimate build out estimates do not include townships which are outside the study area, but upstream of the DWGNRA. Water quality impacts from these areas are expected as well.

Increases in non-point sources are also anticipated although they have only been partially assessed. Using literature values from several sources (particularly Lake Wallenpaupack), the additional non-point source load entering the DWGNRA watershed after build out of current development occurs could be over 200,000 lbs. BOD/year; almost 20,000 lbs. phosphorus/year; and up to 35,000 lbs. nitrogen/year.

Additional analyses were made using the USDA AGNPS model (USDA, 1990). Non-point nutrient levels were determined for a 1 and 1/2 inch rain event, two slope conditions (3% and 15%), and three soil types. The soil and slope conditions are representative of the Pocono region. This analysis indicated that nitrogen runoff (lbs./acre) would increase up to 2700 percent and phosphorus runoff up to 850 percent after the land was converted from forest to suburban uses. Considering that development is underway on 53,000 acres with an additional 55,000 acres not yet acquired by developers, the potential for water quality changes in the future are immense.

Peak runoff from the modeled rain event increased over 600 percent. The increased runoff will change channel characteristics, increase sediment loadings to the river, and impact benthic and other aquatic life. In addition, this extra runoff would not be available to ground water aquifers. As a result, summer low flows in tributaries could be much less in the future than they are today. Appendix F presents the details of the non-point source analyses.

III.A.1.c. The Use of DWGNRA Waters for Wastewater Assimilation is Contrary to its Purposes

The establishment of the Delaware Water Gap National Recreation Area reflects a National interest in outdoor recreation and a long term commitment by the U.S. Government to provide this recreation in the highly urbanized Northeast portion of the country. The recreation area has existed for 25 years and it can be expected that the area will be in existence far into the future. The uniqueness and value of the recreation area as an outdoor and natural resource will increase over time proportionally with population increases and the loss of outdoor opportunities elsewhere due to the conversion of open space to urban uses.

Added to this interest is the inclusion of the Delaware River within the recreation area into the National Wild and Scenic Rivers System. This inclusion means that the river is considered by the U.S. Government as something Nationally unique and special.

The waters of the DWGNRA are, without doubt, nationally important. This means that a citizen of California or Maine has as much vested interest in the DWGNRA future as a resident of New Jersey or Pennsylvania or one of their surrounding counties.

The Delaware Water Gap National Recreation Area is, of course, a locally important resource as well. The existence of a large federal park facility and dedicated open space provides a major amenity for existing residents of the region and future residents who might be attracted to live in the region due to its perceived environmental values. The presence of a national park also stimulates the local economy in many ways. The river and the DWGNRA stimulate sales and

rentals of everything from canoes and canoe trips to gifts and sporting equipment to campground space, resort condominiums and primary houses. The local economy also benefits from the wages and salaries which are directly and indirectly paid out each year through the National Park Service itself. The economic benefits of the DWGNRA is measured in millions of dollars.

About two dozen tributaries including the Delaware River upstream of the DWGNRA boundary flow into the recreation area. These streams and river reach are currently used, among other things, for the assimilation of effluents from wastewater treatment plants. Since these discharges enter the system upstream of the DWGNRA, in some cases wastewater assimilation is completed after the water has passed into the recreation area.

In recent years, the National Park Service has been beset by requests for right of ways across their lands for discharge outfalls which would discharge into the Middle Delaware Scenic and Recreational River. The main reason for these requests is that the Middle Delaware has a greater assimilation capacity than do the tributaries draining into the park. The reasons the Delaware has this greater capacity is due (1) to its size in comparison to a tributary, and (2) the fact that current water quality standards are much lower for the Delaware than on the tributaries. At least two existing wastewater treatment plants currently discharge directly to DWGNRA waters.

Also of concern are dischargers which discharge directly upstream from DWGNRA waters. These discharges and potential, future discharges like them, also use DWGNRA waters for waste assimilation.

A major issue in terms of protecting existing water quality of the DWGNRA is whether or not the water within the recreation area should be used for wastewater assimilation. The use of DWGNRA waters in this manner is contrary to the national interest in them. An analogous situation would be to allow a municipal landfill to be located in the recreation area to handle local solid wastes.

III.A.2. MANAGEMENT ALTERNATIVES

Four basic management alternatives are presented for protecting the waters in and around the DWGNRA:

ALTERNATIVE A: THE PASSIVE APPROACH calls for no changes to the existing management system;

ALTERNATIVE B: THE ACTIVE APPROACH increases the level of protection to higher levels although these levels are less than existing water quality;

ALTERNATIVE C: THE AGGRESSIVE APPROACH has as its overriding premise the preservation of existing water quality;

ALTERNATIVE D: USE OF OUTSTANDING NATIONAL RESOURCE WATERS has as its premise the preservation of existing water quality by restricting wastewater treatment options to non-discharging technologies in the DWGNRA drainage area.

Selection of any of these alternatives is a major policy decision with certain technical and political ramifications. Each of these alternatives, however, is attainable by employing various combinations of technical and policy "tools".

The following sections describe each alternative, discuss its advantages and disadvantages, and presents various examples of how the alternative could be attained.

ALTERNATIVE A - PASSIVE APPROACH: NO ADDITIONAL MAJOR MANAGEMENT ACTIONS; ALLOW WATER QUALITY TO DEGRADE TO LEVELS INHERENT IN THE EXISTING ADOPTED WATER QUALITY STANDARDS

The philosophy of Alternative A is that water quality protection is currently adequate and therefore no changes to the existing management structure and programs are necessary. Under this alternative, water quality would be allowed to degrade over time to a level similar to the level of water quality reflected in the existing water quality standards. In general, this would mean a low level of "fishable" and "swimmable" water quality. It can be presumed, however, that current management actions will maintain the existing designated uses of the Delaware River and its tributaries within the DWGNRA, particularly those pertaining to fishing, boating and bathing. It is likely that these uses will be impaired in comparison to the quality of today's uses, but not necessarily precluded by the changes in water quality.

The development of this plan and the information presented in the Section 3.A.1: STATEMENT OF PROBLEM support the contention that additional management actions are warranted to protect the water quality of the DWGNRA. Indeed, the current level of protection plus on-going growth and development will likely lead to or is already resulting in water quality which is degraded in comparison to the water quality of today or the recent past. Whether or not this degradation occurs over ten years or fifty years is problematic.

The likelihood that water quality problems will arise which prevent full recreational uses is fairly certain if a "business as usual" attitude prevails. These problems could be manifested by periodic observable wastewater treatment plant upsets, beach closings, aquatic plant growths which interfere with boating and fishing, and others. The institutional response will be to limit the extent of the problem and to ultimately correct it to the extent possible. In other words, Alternative A legally sanctions lower water quality levels in the DWGNRA and the Middle Delaware Scenic and Recreational River with the presumption that major water quality problems will be addressed as or after they occur.

This alternative is the easiest to implement from a water quality management viewpoint. Since it maintains the status quo, programs, regulations and other state and DRBC management activities which are already in place continue. In actuality, it could be anticipated that these activities would be periodically reviewed and adjustments made when warranted. The development of new programs would not be precluded. For example, renewed interest in non-point sources as a result of the 1987 federal Clean Water Act is likely to occur regardless whether or not this alternative is selected. Similarly, if a water quality problem arises, it can be anticipated that the applicable management agency (ies) will address the problem by taking whatever actions are deemed necessary.

Although water quality management agencies and local governments would have no additional implementation responsibilities, the National Park Service would be faced with a dilemma. Under the legal mandates of its enabling legislation and the National Wild and Scenic Rivers Act, the NPS is required to preserve the existing water quality of its waters. Without assistance from the states and Commission, the National Park Service will be forced to use its own powers and regulatory authority.

At a minimum, the NPS has the power to purchase land within the recreation area where treatment plants or sewer line right of ways are proposed and under New Jersey law, the National Park Service also owns the river bed on the New Jersey side of the Delaware and in the New Jersey tributaries adjacent to Federally-owned land. (The Commonwealth of Pennsylvania maintains ownership of the streambeds in its state.) The powers of the NPS outside the recreation area boundary are less certain under its enabling laws.

Whether or not "fishable or swimmable water quality uses are ever jeopardized if this alternative is adopted is not known. However, the intrinsic environmental value of the recreation area/Middle Delaware experience will certainly diminish over time under this alternative.

The selection of the "no additional management actions" alternative favors local growth and development and makes it paramount over the national interest in the DWGNRA. The lower level of water quality protection given to the Delaware River will mean that proposals for larger and larger wastewater treatment plants will be acceptable regardless of accumulative impacts. These plants, under current regulations, would be required to perform secondary treatment with no additional requirements (eg. for nutrient removal etc.).

The applicable technical and policy management tools for Alternative A are presented in Table 24.

ALTERNATIVE B - ACTIVE APPROACH: INCREASE MANAGEMENT ACTIONS; RAISE WATER QUALITY STANDARDS AND IMPLEMENT OTHER MANAGEMENT ACTIONS TO INCREASE THE LEVEL OF PROTECTION PROVIDED

A management alternative that would be tighter than Alternative A is one that provides for a higher level of water quality protection than currently given to the Middle Delaware and related waters. This increased level of protection, however, would still be less than existing water quality as described under Alternatives C and D.

Water quality protection under Alternative B would be based on the philosophy that water quality protection will be increased, but that it is not possible to prevent some degradation to the existing water quality. Using some rationale to select water quality criteria and parameters of concern, water quality standards would be raised to some desired level. For example, if current water quality is represented by a minimum dissolved oxygen of 6.0 mg/l and the existing standard is 4.0 mg/l, a decision could be made to increase the standard to 5.0 mg/l. This decision would eventually result in dissolved oxygen levels less than today's levels, but better than the level that might be anticipated under current requirements.

Table 24: Applicable Technical and Policy Tools for Alternative A

- Maintain existing water quality standards
- Maintain existing non-degradation policy
- Maintain wastewater treatment requirements based on universal secondary treatment except where higher levels might be required on tributaries
- Continue the existing, but limited, non-point source control programs in the DWGNRA region and wait for new programs to evolve at the state and federal level
- Maintain existing monitoring programs
- Continue existing management system consisting of mixed private and municipal treatment plant ownership

The development of alternative criteria for other parameters would not be as simplistic as the dissolved oxygen example. One approach, however, would be to adopt the most stringent criteria representing fishable and swimmable water quality that is contained in the latest edition of the U.S. Environmental Protection Agency document, Quality Criteria for Water (U.S. EPA, 1986). In some cases, the selected criteria would not differ substantially from existing water quality. For some other parameters, EPA has no recommended criteria.

Another issue which would require resolution would be the phraseology of potential non-degradation policies. For example, would socio-economic impacts be allowed to override water quality protection in Alternative B.

A decision would have to be made concerning what river and tributary reaches would subject to higher water quality standards. Since existing tributary standards are generally higher than the Delaware River, it is likely that there would be no need to raise standards on them. For the Delaware River, standards should be raised not only for the Middle Delaware Scenic and Recreational River but also upstream to and including the Port Jervis/Matamoras area. A stream classification analogous to Pennsylvania's "High Quality" classification could also be considered implementing Alternative B.

Once new water quality standards are in place, they would dictate the level of treatment which area wastewater treatment plants would have to attain both singularly and in combination. A second treatment option would be to require a specific level of treatment for all dischargers upstream of the DWGNRA. Under this option, a level of treatment reflecting best available treatment technology with some caveat that it should be reasonably cost efficient is selected. The level of treatment (which is greater than secondary treatment), is not necessarily the attainment of some particular set of water quality standards.

The major advantage of Alternative B is that it raises the level of water quality protection by making the Delaware River relatively equal with the protection currently provided to its tributaries. Implementation may be easier than Alternative C because the strategies employed do not deviate drastically from traditional water quality management practices employed elsewhere. Unlike Alternative A, Alternative B recognizes that the area's high water quality is a legitimate concern which is worthy of consideration along with local growth and development concerns.

Major disadvantages with Alternative B exist. If the goal is to preserve the high quality of the DWGNRA and the Middle Delaware Scenic and Recreational River, Alternative B will likely fall short. Unlike Alternative C, Alternative B is not based on preserving water quality, but rather, in preventing it from degrading as much as Alternative A would allow. The amount of degradation will depend upon the standards which are set, the level of treatment provided, the aggressiveness of non-point source control programs, and the willingness of water quality regulatory agencies and local government to adequately manage the situation via comprehensive monitoring, tighter regulatory programs, comprehensive planning and project approval processes.

In summary, there are some major advantages to Alternative B which would, in fact, provide better water quality protection to the DWGNRA than is now available. Alternative B, however, does not answer all the issues prevalent in the study area nor does it necessarily lead to the tight management control which may be necessary to resolve all issues to all parties' satisfaction.

Table 25 presents the technical and policy tools which appear applicable to Alternative B. The degree of aggressiveness in Alternative B can be increased or decreased by selecting optional management tools.

ALTERNATIVE C - AGGRESSIVE APPROACH: IMPLEMENT SUFFICIENT MANAGEMENT ACTIONS TO PRESERVE EXISTING WATER QUALITY

Under this management alternative, the definition of existing water quality discussed previously and shown in Table 18 would be adopted as water quality standards. Adoption of these standards would provide a high level of protection to the Middle Delaware Scenic and Recreational River and the DWGNRA because all major water quality management decisions would be based on an aggressive attainment of these standards.

The adoption of water quality standards which reflect existing water quality changes the basis of standards from the protection of designated uses (ie. fishable, swimmable and drinkable) to one that protects water quality (ie. the preservation of existing water quality levels is the overriding designated use). This is an important policy distinction.

Another major difference between water quality management decisions based on preserving existing water quality versus traditional water quality management approaches concerns the terms: "dilution" and "assimilation" capacities. Dilution, of course, occurs when a small volume of water containing various constituents is mixed with a much larger body of water containing less quantities of the constituent. The smaller waters are "diluted" by the larger water body.

Assimilation capacity, on the other hand, refers to the so-called natural purification capabilities of water bodies to reduce non-conservative substances via biological, chemical and/or physical processes. Examples of non-conservative parameters include biochemical oxygen demand and fecal coliform which will decline with time in the natural environment due to bacterial action (BOD), bacterial die-off (fecal coliform), and other processes.

Conservative substances, on the other hand, are ones which are not naturally removed from the water body although they may change chemical form or location. Nutrients: phosphorus and nitrogen for example, stay in the aquatic system even though they might change chemical form (eg. ammonia being converted to nitrates) or location (eg. from the water column to sediments to plant tissue and back to the water column). Other conservative substances pass through the aquatic system with little or no change (eg. dissolved solids). In the natural environment, conservative substances are reduced only through dilution.

The importance of dilution and assimilation capacities is the following: If water quality standards are based on existing water quality, technically no such thing as dilution or assimilation capacity exists in the receiving water body. In other words, dilution and assimilation capacity are somewhat artificial water quality management concepts. Both terms reflect the difference between a water quality standard and ambient water quality or, said another way, the amount of legal water quality degradation that is allowed. When ambient water quality and water quality standards are the same, dilution and assimilation capacity do not exist because no legal degradation is allowed.

Table 25: Applicable Technical and Policy Tools for Alternative B

- Adopt higher water quality standards
- Predicate water quality standards on a selected design flow for the Delaware River at Montague;
- Adopt and apply a stricter non-degradation policy which allows water quality to be degraded only when certain socio-economic tests are met
or
Adopt and apply a stricter non-degradation policy which allows water quality to be degraded only when certain public interest tests are met
- Adopt wastewater treatment requirements based on treatment technology such as "Best Available-Economically Achievable or some specific application of advanced wastewater treatment technology
or
Adopt wastewater treatment requirements based on meeting the new, higher water quality standards
- Continue the existing, but minimal non-point source control and planning programs in the DWGNRA region and allow new non-point source programs and strategies to evolve at the state and federal level
and/or
Actively encourage the expansion of local voluntary non-point source control programs
- Expand ambient water quality monitoring activities including additional compliance monitoring
- Modify existing management system to make all municipal government entities co-permittees in private wastewater treatment works

It is important to note that no matter how large the water body is in comparison to a discharge, if that discharge has a concentration of a substance which is greater than the concentration found in the receiving water body, the in-stream concentration after mixing will be greater than the standard. Whether measurable or not by current scientific instruments, the change in water quality will violate the standard.

This concept is proven mathematically. Assume that a standard is "not greater than 1.5 mg/l" for some substance and that 1.5 mg/l reflects existing water quality. A 1 MGD (1.55 cubic foot per second) treatment plant proposes to discharge 20 mg/l of this substance into a river which has, for example purposes, a flow of 1750 cfs. The dilution ratio is extremely high: 1 to 1129. By flow weighing the contributions of the river and discharge, it is determined that 1751.55 cfs ($1750 + 1.55$) has, after mixing, 2656 mg/l/ per 1751.55 cfs ($(1750 \times 1.5) + (1.55 \times 20)$) or 1.516 mg/l of the substance. Since the resulting concentration is greater than the standard of 1.5 mg/l, the standard is violated (ie. existing water quality is degraded). In fact, the only way a violation of the standard can be avoided is to have the effluent concentration of 1.5 mg/l or less.

The lack of dilution and assimilation capacity in this situation has important ramifications concerning new wastewater treatment plant discharges and other sources of pollution. Existing pollution loads are not affected since they are inherently part of the existing water quality already.

One option for non-conservative substances is to address them similarly to conservative substances (see discussion which follows). A second alternative is to allow a mixing zone in which river processes are allowed to reduce the initial concentration to the level required by the standard. The initial concentration of the substance in the effluent would be determined from mixing zone calculations using appropriate mixing zone policies, stream modeling, plume modeling, and so forth. For BOD, dissolved oxygen deficits caused by the discharge would also be a critical determination to insure that the D.O. standard was not violated.

If applied to the DWGNRA situation, mixing zones policies should require as small a mixing zone as physically possible. In no case should the discharge be visible to recreationists (eg. cloudy water, foam, un-submerged outfall pipes etc.). Since effluent plumes in the Delaware River are known to hug the shoreline for long distances, in-stream diffuser outfalls may have to be employed to assure immediate and complete mixing. Finally, mixing zones should not be allowed to cross the DWGNRA boundary. In other words, all wastewater assimilation should occur upstream of DWGNRA boundary control points. This would mean that discharges proposed at or near the boundary may have to be relocated.

The basic philosophy of mixing zones for non-conservative substances is that it creates assimilation capacity. Assimilation capacity does not inherently exist in a situation where water quality standards reflect existing water quality. Mixing zones describe an area in the stream where some standards are contravened temporarily to allow in-stream purification process to work. Mixing zones for conservative substances are not valid since these substances are not removed by in-stream processes. Conservative substances, therefore, require a different strategy.

Two broad strategies exist for conservative substances. The first is to recognize that there is no dilution capacity and to then require the appropriate level of treatment. The second strategy is to "create" dilution capacity where it theoretically does not exist.

Five options for handling conservative substances exist. These are:

1. the "concentration-based option" whereby effluent requirements are identical to the water quality standards;
2. the "load-based option" where pollutant loads are restricted from increasing above today's loads;
3. the so-called "Five Percent Rule" whereas the net contribution of a substance from all point sources is not allowed to increase any water quality criteria by more than 5 %;
4. the "comprehensive monitoring" option where sophisticated, continuously-operated monitoring equipment is used to "search" for dilution capacity/discharging opportunities;
5. the "comprehensive control" option which combines the comprehensive monitoring option with a state or other regional authority which has responsibility for final effluent polishing and discharge.

These five options are discussed in greater detail in the following paragraphs.

The concentration-based option is the most absolute of the six options. As discussed previously, mathematically a discharge with a higher concentration than the receiving water will degrade "existing water quality" no matter how what size it is. The concentration option recognizes that the reverse is true: Any discharge, no matter how large, will not degrade water quality as long as the concentration in the effluent equals or is less than existing water quality. In other words, if the water quality standards are used as effluent standards, existing water quality will not degrade. These effluent standards would have to be applied to tributaries as well. As such, they could present the overall goals of watershed non-point source control programs.

A major advantage of the concentration-based option is its ease of administrating. Effluent standards are set ahead of time and an unlimited number of new dischargers are allowed regardless of size.

The load-based option ignores effluent and tributary concentrations, but regulates so that the pollutant loads to the system do not increase above existing loads. For example, suppose a 100,000 gallon per day plant (0.1 million gallons per day) currently discharges an effluent with a concentration of 20 mg/l of a conservative substance. Since the plant currently discharges 16.68 pounds per day of the substance ($0.1 \text{ MGD} \times 8.34 \times 20 \text{ mg/l}$), water quality will not degrade if an expansion of the plant discharges the same load. In order to do this, the expanded plant must have an effluent concentration of 2.0 mg/l of the substance if it is expanded to one million gallons per day (ie. $1 \text{ MGD} \times 8.34 \times 2.0 \text{ mg/l} = 16.68 \text{ lbs/d}$).

A major problem with the implementation of this option is determining existing loads particularly for constituents which are not normally sampled in area treatment plant effluents, and determining loads for watershed non-point sources in general. In addition, the option does not allow new discharges to occur unless they can acquire the load of an existing discharge.

The Five Percent Rule basically "buys" dilution capacity at the expense of some very minor changes in existing water quality. The rationale for applying such a rule is:

1. The Five Percent Rule accounts for the uncertainty inherent in water quality standards based on available water quality data. In other words, a certain degree of error is inherent in all water quality measurements and statistical analyses.
2. The water quality/aquatic life impact of a minor (5 percent) change in ambient water quality is extremely uncertain and probably insignificant. In other words, with a maximum change of five percent, existing water quality is essentially the same as it was.
3. Effluent requirements under the Five Percent Rule will result in a five percent change when total effluent flow equals the effluent flow used to allocate the five percent dilution capacity. In other words, the difference in water quality will be less than five percent most of the time.
4. Since the control point for the Five Percent Rule is the southern boundary of the DWGNRA, changes in water quality throughout the recreation area will average less than five percent with decreasing amounts of change in a northern direction.
5. Water quality criteria proposed for the parameters subject to the Five Percent Rule were developed from frequency analyses of the existing water quality data. This means that approximately 85 to 90 percent of the time, ambient water quality will actually be better than "existing" water quality as defined by the criteria.

The five percent rule would require an effluent quality that does not result in a theoretical violation of water quality standards by more than five percent for conservative substances and zero percent for non-conservative substances after mixing. (A recommended mixing zone policy is presented in Section 3.A.3.) The Five Percent Rule would be applied to all dischargers together. In addition, the Five Percent Rule when applied to total nitrogen would not override ammonia toxicity considerations.

Because all dischargers are addressed simultaneously, the Five Percent Rule is a wasteload allocation system. An allowance for non-point sources is not believed to be applicable because the Five Percent Rule as used herein is dry-weather/low flow based.

The equation for calculating effluent requirements under the Five Percent Rule is the following:

$$\text{Conc.} = ((Q1 * WQ * 0.05) + (Q2 * WQ * 1.05))/Q2 \quad \text{where:}$$

Conc. = effluent concentration (mg/l);

Q1 = Delaware River flow (as MGD) used as design flow;

WQ = applicable water quality standard (mg/l);

Q2 = total effluent flow (MGD) tributary to the Delaware River control point
(ie. the southern boundary of the DWGNRA);

An option to the above formula is to delete the $(Q2 * WQ * 1.05)$ portion of the equation. This portion of the equation allows dilution credit for the wastewater stream. If this dilution credit is not allowed, "Conc." will equal "WQ" when Q2 is 5 percent of Q1. In other words, effluent requirements would be the identical to water quality standards when total effluent flow is 50 MGD assuming a Q1 of 1550 cfs. (1000 MGD) was selected.

Figure 18 presents an example of the use of the Five Percent Rule using Total Nitrogen as the example parameter. A design flow for the Delaware River of 1550 cfs. is assumed since this flow is near the estimated 7Q10 flow of the Delaware River at the southern boundary of the DWGNRA and is written into Delaware River Basin drought management policies. Within the framework of possible design flows ranging from 1500 cfs. to 1650 cfs., potential effluent criteria varies less than 9 percent. This percent difference would not influence the design or cost of treatment systems.

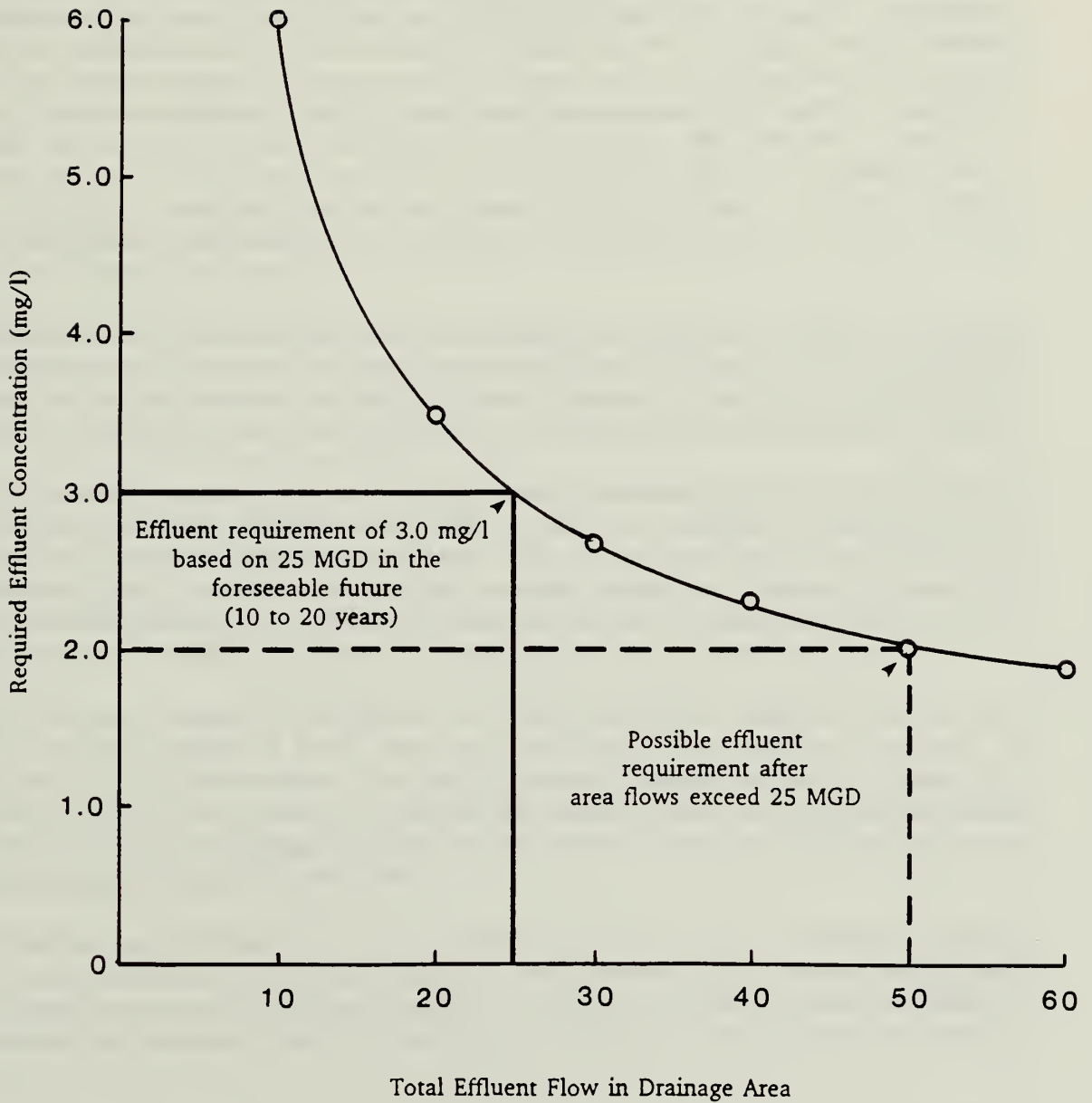
Implementation of the Five Percent Rule entails the selection of the initial total effluent flow to be allocated (ie. Q2). This flow should logically reflect a planning horizon of at least 10 to 20 years. All effluent flows tributary to the control point should be considered. Dischargers above reservoirs and those which discharge to tributaries at considerable distance from the tributary's confluence with the Delaware River could be excluded from the allocation system. This would entail a policy decision based on various technical considerations.

The fourth option under Alternative C, the Comprehensive Monitoring option, takes advantage of the statistical analyses used to develop the proposed water quality criteria that represents existing water quality. As discussed previously, these criteria were developed by statistically analyzing all the available water quality data for the Delaware River within the study area. In many cases, criteria were selected which generally reflect an 85 or some greater percent of the time attainment. This means that generally speaking, at least 85 percent of the time water quality will be better than the "existing water quality" as defined by the criteria. The remaining 15 percent of the time represents natural variations inherent in any water quality variable and historical problems which have either been already been corrected or should be corrected.

The Comprehensive Monitoring option takes advantage of the above through the use of continuous, automatic, electronic monitoring equipment which becomes an intrinsic part of wastewater treatment plant operations. The monitoring equipment is used to monitor the quality of the Delaware River and the quality of potential effluent and, via computer models, searches for discharging opportunities. Discharging opportunities occur when the quality of the river is running better than the standards, the effluent is better than the standards, and other situations. As stated above, this should occur relatively frequently.

Figure 18

Example of the Five Percent Rule using
a Total Nitrogen Standard of 1.0 mg/l
(based on Delaware River low flow of 1550 cfs)



The option is best described by illustration. Previously the example was presented of a 1 million gallon per day (1.55 cfs) plant which discharged 20 mg/l of a substance into a 1750 cfs. river with a standard of 1.5 mg/l for the substance. Flow weighing the discharge with the river showed that the new river concentration would be 1.516 mg/l. The standard, which was assumed to represent existing water quality, was therefore violated. In order to meet the standard, the treatment plant would have to treat its wastes to meet a concentration of 1.5 mg/l or less.

The Comprehensive Monitoring option takes advantage of the fact that the actual concentration of the substance in the river on any given day will likely be less than 1.5 mg/l. For example, assume that the concentration was not 1.5 mg/l on a given day, but 1.2 mg/l. With monitoring data constantly being entered, a computer could calculate what concentration the discharge would have to have in its effluent in order to not violate the standard of 1.5 mg/l. In order that the standard of 1.5 mg/l was not violated, the discharge plus the river must result in a concentration per flow of 2625 mg/l per 1751.55 cfs or 1.5 mg/l ($1750 \times 1.5 = 2625$; $1750 + 1.55 \text{ cfs.} = 1751.55$). On the day that the river concentration is 1.2 mg/l, a 1.55 cfs. treatment plant could discharge a concentration of the substance of 338 mg/l since $(1.55 \times 339) + (1750 \times 1.2) \text{ per } 1751.55 \text{ cfs.} = 1.5 \text{ mg/l}$.

Similar calculations show that until the time that river has a concentration of at least 1.48 mg/l, the example treatment plant could discharge its normal effluent of 20 mg/l. However, when the concentration in the river exceeds 1.48 mg/l additional treatment is required or conversely the effluent needs to be held until such time that in-stream concentrations decrease below 1.48 mg/l.

The obvious method of implementing the Comprehensive Monitoring option is to continuously-monitor both the river and effluent quality and to base the discharge of the effluent on computerized calculations of allowable discharge. The concept can be extended to include computer-directed plant operations whereas the computer makes the decision to release the effluent (or portions thereof) or to send it to holding basins and/or additional treatment units. Downstream monitors would monitor the effectiveness of the system plus compliance.

The option also favors seasonal discharges. For some parameters, ambient levels are not important for certain periods of time. Nutrients and fecal coliform are two examples of parameters with seasonal implications. This could be written into any computer program. For other parameters, levels at some portion of the year are naturally better than the proposed water quality criteria eg. dissolved oxygen). Variations in river flow would allow flexibility with some flows allowing higher effluent concentrations.

A natural systems approach using a series of "effluent polishing" units employing artificial wetlands, ponds, aquaculture, etc. would appear to be favored by this option plus provide additional treatment removals and fail-safe capacity. A series of continuously-monitored effluent release locations along a series of "bio" units would allow decisions concerning when to discharge from where.

Some major, not so readily-apparent advantages to this type of arrangement exist. Compliance would be easily monitored by state regulatory agencies through communication with each treatment plant's monitoring/computer system. Response could be triggered by "alerts" received

at the state office. In addition, if a major compliance problem threatens recreationists, National Park Service officials could also be automatically alerted. It is anticipated that this level of alert would be different than the alert given to state agencies since the latter would include more routine compliance problems.

The series of effluent polishing units result in fail-safe advantages. When compliance problems did occur, the system would not allow the discharge to enter the river unless it was overridden. Instead, the effluent would be held in storage for additional treatment or sent to the next unit in the series for treatment. A storage requirement of 30 to 90 days capacity would be selected for implementation. Presumably, the permission of regulatory authorities would be required to override the computer and that this permission would be granted only when the capacity of the system to hold effluent is exceeded. Due to the automatic warning designed into the system, it is assumed that state officials would already be involved in the treatment plant's operations by the time an illegal discharge was authorized. As this implies, an aggressive role for the regulatory agencies is envisioned.

By its very nature, this option encourages non-point source control and the maintenance of existing water quality. The flexibility inherent in this option exists only if ambient water quality is not degraded by background pollutant loads such as non-point sources. Increasing treatment levels would be required if the background levels began rising or if various treatment plants were chronically out of compliance.

In other words, the philosophy of the monitoring/seasonal option is based on the premise that a decision has been made to preserve existing water quality. Allowing a system which reduces area treatment requirements while allowing local growth and development to occur places a responsibility on local government to control all possible sources of pollution which is under its jurisdiction. If the background is changing due to loads originating outside the local government's area, the onus is on the region and the state to insure that corrective measures are taken.

The only major disadvantage of the Comprehensive Monitoring option is its reliance on electronic, continuous monitors. The state-of-the-art of this technology, however, has increased in recent years to the point where such an option is potentially feasible.

The Comprehensive Control option is a variation of the Comprehensive Monitoring option. It conceptually could also be employed in the other options as well since it is institutionally different and technically different. Under the Comprehensive Control option, local wastewater treatment plants would be owned and operated (or otherwise controlled) by local municipalities. Secondary or somewhat better treatment would be required at all treatment plants and the number and location of treatment plants would be unrestricted.

The option would require, however, that no local treatment plant results in a direct discharge to a receiving stream. Instead, all local treatment plants would be required to discharge to one or more regional "effluent polishing/discharging" systems which are operated as described in the Comprehensive Monitoring option. These systems would be owned and operated by a state, interstate or state/regional authority. Development of regional "natural systems effluent polishing/discharging" units would have various advantages including aesthetics, increased storage capacity, better effluent discharge control, better operational capabilities and others.

Local municipalities would be required to negotiate and contract with the supra-authority for effluent polishing and discharging services, treatment capacity, and the costs associated with construction and operation. In addition, entry into the supra-authority's system would be predicated on performance requirements for the local secondary treatment plant(s), the establishment of effective non-point source control programs, and growth controls correlated to the negotiated capacity of the regional plant(s).

The major difficulties with the Comprehensive Control option are institutional. Legal and financial feasibility studies would be necessary and all applicable parties would have to be able to effectively work out the system and its many aspects. The major advantage of the option is the comprehensiveness of its approach, its total control of the water quality situation, and its possible cost-effectiveness. In addition, the option satisfies all the major and minor issues surrounding water quality protection in the scenic rivers area.

As an "aggressive approach," Alternative C should also address disinfection concerns. Since the waters of the DWGNRA are important recreationally and from an aquatic life viewpoint, disinfection should protect public health while not harming aquatic life. Chlorination does not favor either of these concerns because the process does not kill viral pathogens of human concerns (Cabelli, 1990) and can be toxic to aquatic life. Alternative disinfection processes (i.e., ultraviolet light, ozonation or equivalent) should be employed instead.

Table 26 presents a summary of the technical and policy tools which appear applicable to Alternative C. Under Alternative C, the preservation of existing water quality becomes the overriding concern and the existing management system is tightened up in numerous ways to insure success. The alternative can be more, or less aggressive depending upon which of several management options are chosen.

ALTERNATIVE D - VERY AGGRESSIVE APPROACH: USE OUTSTANDING NATIONAL RESOURCE WATERS CLASSIFICATION TO PRESERVE EXISTING WATER QUALITY

Alternative D preserves existing water quality via legislative action. The Outstanding National Resource Waters classification, as defined in U.S. Environmental Protection Agency regulations are placed on the Delaware River and its tributaries. Inherent in this policy action is the institution of a no discharge policy for new wastewater treatment plants. New plants would have to use no-discharge technologies such as land treatment and several others, or be able to assume the pollutant load of a pre-existing plant. Because this alternative is a very aggressive alternative, it is assumed that non-point control sources would be mandatory.

Use of ONRW is a relatively simple solution that offers several advantages. First, it reduces the amount of management effort required since regulation of discharges is greatly reduced. Permitting is relatively easy. Secondly, it offers a fairly good certainty of success if the alternative is applied to tributaries as well as the river. Disadvantages of the alternative includes its controversial nature and its inflexibility in regards to wastewater treatment options.

Table 26: Applicable Technical and Policy Tools for Alternative C

- Adopt water quality standards based on existing water quality
- Predicated standards attainment on a design flow of 1390 cfs. at Montague (7Q10 flow)
or
Predicate attainment standards on a design flow of 1550 or 1650 cfs. at Montague (adopted drought warning flows)
or
Predicated standards attainment of a design flow of 1750 cfs. at Montague (U.S. Supreme Court requirement)
- Adopt and apply a stricter non-degradation policy which includes a classification where preserving existing water quality supercedes socio-economic and other considerations (eg. Outstanding Basin Waters)
- Adopt wastewater treatment requirements based on preserving existing water quality using the concentration-based option, load-based option, the five percent rule, of the comprehensive monitoring option
- Require wastewater treatment plants to be fail-safe by providing adequate treatment unit redundancy, adequate emergency effluent storage, extra power sources, adequate chemical stores, and monitoring early warning systems
- Require wastewater de-chlorination or chlorine substitute
or
Require chlorine substitute (uv, ozone)
- Mandate strict mixing zone policies for non-conservative substances
- Require outfalls to obtain quick, complete mixing
- Establish no-discharge zones or reaches
or
Use National Park Service powers to prevent wastewater treatment plants from being built in the DWGNRA
- Establish a partially-voluntary/partially-mandatory non-point source control program
or
Require mandatory non-point source control programs
- Expand ambient monitoring activities including increased compliance monitoring and non-point source monitoring
or
Expand ambient monitoring activities including increased compliance monitoring, non-point source monitoring, and use of continuous monitors

Table 26: Applicable Technical and Policy Tools for Alternative C (contd.)

- Expand wastewater treatment plant discharge self-monitoring requirements to daily during the recreation season (via fax)
or
Expand monitoring programs to include wastewater treatment plants "wired" into state-operated continuous compliance monitoring system
Complete development of a regional water quality model which includes the generation of non-point source impacts
- Expand DRBC project review functions to include wastewater treatment projects less than 50,000 gallons per day but greater than 10,000 gallons per day
- Modify existing management systems to make all municipal government entities co-permittees in private wastewater treatment plants
or
Require municipal ownership or co-ownership of all wastewater treatment works
- Require municipal wastewater treatment authorities to include on-lot/septic tank and other non-point source management responsibilities;
- Create State, State/federal, Interstate or state/regional authority to construct, own and operate regional wastewater treatment systems or plants;
- Create State, State/federal, Interstate, or state/regional authority to construct, own and operate regional wastewater effluent polishing/discharging systems;
- Expand regulatory functions to include non-point source compliance requirements

ONRW classification would not prevent local growth and development from occurring because no-discharge opportunities (eg. land treatment) do exist in the area (Sopper and Kardos, 1972). Conceivably, however, some site-specific situations (ie. a specific development) could be constrained. These constraints can be overcome through the use of regional solutions.

Because of its blanket approach, Alternative D employs the fewest management tools. The management tools directly applicable to Alternative D are presented in Table 27.

III.A.3 RECOMMENDED COURSE OF ACTION

The recommended course of action is Alternative C - Aggressive Approach which has the objective of preserving existing water quality. The recommended elements of this course of action are the following:

NON-DEGRADATION POLICY AND WATER QUALITY STANDARDS:

1. Adopt a stringent non-degradation policy which includes among other elements an "Outstanding Basin Waters" class where, because of special considerations, water quality preservation supersedes socio-economic and other considerations. A proposed definition of "Outstanding Basin Waters" is presented in Table 28;
2. Classify the waters of the Delaware Water Gap National Recreation Area including the Middle Delaware Scenic and Recreational River as "Outstanding Basin Waters."
3. Raise water quality standards in the Delaware River from Port Jervis to the Delaware Water Gap to reflect existing water quality. The criteria presented in Table 29 are recommended for adoption;

POINT SOURCE REGULATION:

1. Adopt a minimum treatment requirement as follows:
 - a. Advanced secondary treatment or Best Available Treatment for non-conservative substances as determined by the application of mixing zone policies.
 - b. Total Nitrogen, phosphorus. Suspended solids and dissolved solids as determined by the application of the Five Percent Rule.
 - c. Effluent polishing by use of recirculating sand filters or equivalent.
 - d. Wastewater disinfection by ultra violet light, ozonation or equivalent non-chlorination technology.
2. Adopt a mixing zone policy which provides for quick complete mixing and rapid assimilation within a short (downstream) time frame with no wastewater assimilation occurring within the boundaries of the DWGNRA. The recommended mixing zone policy is:

Table 27: Applicable Technical and Policy Management Tools for Alternative D

- Adopt and apply EPA's Outstanding National Resource Waters classification
- Adopt wastewater treatment requirements based on preserving existing water quality by prohibiting new wastewater discharges and increases in discharge loads
- Require plants to be reasonably fail-safe with adequate treatment unit redundancy, adequate emergency storage, and other design features
- Require mandatory non-point source control programs
- Maintain existing monitoring programs
- Complete the development of a regional water quality model which includes the generation of non-point source estimates
- Continue existing, de-centralized management system consisting of mixed private and municipal treatment plants with states and DRBC in current oversight roles
- Expand regulatory functions to include non-point source compliance requirements

Table 28: Description of the "Outstanding Basin Waters" Classification

Definition: Outstanding Basin Waters are those waters which have high quality and significant recreational, ecological, or water supply uses. In general, waters which could be considered for the Outstanding Basin Waters classification have already been incorporated into (1) national or state parks, (2) national or state wild, scenic and recreational rivers systems, (3) national or state wildlife refuges, and (4) streams designated as "critical habitat" under Federal or state endangered species programs.

Water Quality Standards. Water quality standards will be based on historical and existing water quality data for parameters of concern including consideration of spatial, seasonal, diurnal, and hydrological variations. In developing water quality standards, the Commission will consider standard statistical procedures, information from scientific documents, the advice of experts, and comments from the public.

Non-Degradation. Water quality degradation is not allowed in Outstanding Basin Waters outside of designated mixing zones. Water quality variations resulting from the application of the Five Percent Rule are allowable and considered consistent with non-degradation.

Wastewater Discharges. Outstanding Basin Waters classification means that existing water quality forms the basis for water quality management decisions. In preserving existing water quality, the Commission will develop wasteload allocations, effluent limitations, mixing zone policies, special monitoring requirements and other requirements as necessary to prevent water quality degradation. These regulations will be directed at all point sources of pollution including sources in tributary areas which potentially impact water quality in the Outstanding Basin Waters.

No Discharge. Direct discharges to Outstanding Basin Waters may be prohibited if the lands surrounding the Outstanding Basin Waters are substantially owned, controlled and managed by agencies of the signatory parties to the Delaware River Basin Compact.

Non-Point Sources. Non-point source pollution emanating from land areas draining to water bodies classified as Outstanding Basin Waters must be controlled to preserve water quality in the Outstanding Basin Waters. The Commission will require mandatory non-point source control programs as deemed necessary and promote voluntary programs where appropriate.

Table 29: Proposed Criteria for the Delaware River^{1/}

Parameter	Proposed Criteria	Basis and Proposed Point Source Regulation Mechanism
D.O. (mg/l)	Minimum of 6.0 mg/l and 24-hour average of 8.0 mg/l with minimum representing nighttime low value.	Statistical analyses; regulated via mixing zone policies.
BOD (mg/l)	Mean of less than 1.6 mg/l.	Statistical analyses; regulated via mixing zone policies.
Total Phosphorus (ug/l)	Less than 100 ug/l 90% of the time maximum value not to exceed 200.	Statistical analyses and EPA criteria document; regulated by Five Percent Rule.
Dissolved Ortho Phosphorus (ug/l)	Less than 15 ug/l 92% of time.	Statistical analyses. Recommended as guideline and not standard.
Total Nitrogen (mg/l)	Mean of 1.0 mg/l with no more than 15% of values greater than 1.35 mg/l.	Statistical analyses; regulated via Five Percent Rule.
Ammonia Nitrogen ^{2/} (mg/l)	Not to exceed 0.67 mg/l.	Based on maximum pH and water temperature and EPA criteria document; regulated by mixing zone policies.
Fecal coliform (colonies/100ml)	"Ambient fecal coliform:" not to exceed 50 colonies per 100 ml as a reach-wide geometric average over May through September period with 90 percent of values not to exceed 250 colonies per per 100 milliliters.	Statistical analyses; regulated via mixing zone policies; the existing standard of a geometric mean of 200 colonies/100ml. is to be retained as the standard for "Public Health Fecal Coliform."
Specific conductivity umhos/cm	Not to exceed an average of 90 at any one location or 80 reach-wide, 85 percent of values not to exceed 100.	Statistical analyses; point source regulation not applicable.
pH	pH of 6.5 to 9.0.	Based on data observations; supported by EPA criteria document.
Total Suspended Solids	Not to exceed an average of 9 mg/l at any one location nor a reach-wide average of 6.0 mg/l, 86 percent of values not to exceed 15 mg/l.	Statistical analyses; regulated by Five Percent Rule.
Total Dissolved Solids (mg/l)	60 mg/l.	Regulated by Five Percent Rule; standard based on existing standard which calls for 133% of background, statistical analyses defines background as 45 mg/l.

Table 29 Proposed Criteria of the Delaware River

Parameter	Proposed Criteria	Basis and Proposed Point Source Regulation Mechanism
Biocriteria	Existing water quality defined by a reach-wide mean Shannon-Wiener index value of 3.6 with no more than 10% of the values below 3.0; mean equitability index value of 0.8 with no more than 15% of the values below 0.6; and, a mean EPT value of 13 with no more than 15 percent of the values below 10. As a guideline, the values at any one location after sufficient sampling should be at least 3.0; 0.6 and 10 respectively for the Shannon-Wiener, equitability and EPT indices.	Based on statistical analyses plus review of UDSRR data; point source regulation not applicable.
Turbidity	a. maximum 30-day average 20 units. b. maximum 150 units.	Based on data observations. Same as existing standard except "unless exceeded due to natural conditions" qualifier is removed. Point-source regulation not applicable.
Manganese (ug/l)	Not to exceed 110 ug/l.	Based on data observations and EPA criteria document.
Iron (ug/l)	Not to exceed 1 mg/l.	Based on data observations and EPA criteria document; regulated by mixing zone policies.
Hardness/ ^{3/} Heavy Metals	No hardness standard is proposed. Based on hardness of 18 mg/l and EPA criteria formulae, the following toxic heavy metal criteria are proposed (as ug/l): Cd 0.30; Cr III 50.82; CrVI to be developed; Cu 2.73; Pb 0.36; Ni 25.96; Ag 0.21; Zn 77.4.	See description under proposed criteria, hardness derived from statistical analyses.
1/ Criteria based on monitoring data for locations between river miles 251 and 207 (Matamoras/Port Jervis to Portland respectively). Proposed for application between River Miles 258 and 210 (downstream boundaries of the Upper Delaware Scenic and Recreational River and the Delaware Water Gap National Recreation Area respectively).		
2/ Proposed Ammonia criteria is a function of pH and water temperature data. Most ammonia data are less than the suggested criteria. Criteria is toxics-related.		
3/ Proposed heavy metals criteria is a function of ambient hardness as CaCO ₃ . Available (but limited) metals data indicate concentrations less than the proposed criteria. Criteria is toxics-related.		

- a. Complete mixing and assimilation of all wastewaters discharged to the Delaware River and its tributaries to the DWGNRA are to occur in a Mixing and Assimilation Zone defined by a maximum length of 3/4ths of the distance between the point of discharge of the furthest downstream discharger and the nearest upstream point where the boundary of the Delaware Water Gap National Recreation Area crosses the receiving stream. Mixing and Assimilation Zones will be established for each tributary having a discharge and for the Delaware River upstream of the northern boundary of the DWGNRA.

Complete mixing and assimilation is defined as the point when all values along a transect of the receiving stream at the downstream edge of the mixing zone are within 10 percent of each other and all water quality standards are met except for those subject to the Five Percent Rule.

Within the Mixing and Assimilation Zone, standards for minimum dissolved oxygen, fecal coliform (the public health criteria of a geometric mean of 20/100 ml. but not the water quality-based standard of 50/100ml.), ammonia and other toxics, and biocriteria shall be met.

- b. For Delaware River dischargers only, a Zone of Immediate Impact will be allowed. A Zone of Immediate Impact is defined as a section of receiving stream where water quality standards may not be met during the mixing/assimilation process. The radial extent of the Zone of Immediate Impact will equal 25 percent of the width of the river at low flow. The Zone of Immediate Impact for a discharger cannot be larger than its Mixing and Assimilation Zone however, and all requirements of the latter must be met. In situations where the Zone of Immediate Impact for individual dischargers overlap, the Commission may require the relocation of discharge locations or higher treatment requirements based on allocation of the mixing zone.
 - c. Zones of Immediate Impact in tributaries may be established if desired, by applicable state regulations as long as the Mixing and Assimilation Zone requirements are met.
 - d. Parameters to be regulated by the mixing zone/assimilation zone policy are shown in Table 29.
 - e. In determining mixing zones for specific dischargers or groups of dischargers, the Commission may require the conduct of dye studies, water quality and hydrological studies, and plume modeling studies. For oxygen-demanding substances, both nitrogenous and carbonaceous biochemical oxygen demand will be assessed.
3. Apply a wasteload allocation policy based on the "Five Percent Rule" which is applied to the drainage area of the DWGNRA at its most downstream section for conservative substances and to the downstream boundary of mixing zones for non-conservative substances. The wasteload allocation policy is to consider all point sources of pollution projected in the reasonable near future.

The equation for calculating effluent requirements under the Five Percent Rule is the following:

$$\text{Conc.} = ((Q1 * WQ * 0.05) + (Q2 * WQ * 1.05))/Q2 \text{ where:}$$

Conc. = effluent concentration (mg/l);

Q1 = Delaware River flow (as MGD) used as design flow;

WQ = applicable water quality standard (mg/l);

Q2 = total effluent flow (MGD) tributary to the Delaware River control point (ie. the southern boundary of the DWGNRA);

The Delaware River design flow for wasteload allocations will be 1550 cubic feet per second. This flow approximates the 7-day 10-year flow in the DWGNRA at its Southern boundary and is manifested in Commission Drought Management regulations. The existence of drought management policies negates the need for basing allocations on a precise 7Q10 flow. The difference in flow through the DWGNRA is approximately 100 cfs from Montague to the Delaware Water Gap.

In determining Q2, the Commission will take into account all projected wastewater flow in the foreseeable future both in and outside the study area. Since potential study area flows are projected to be possibly over 21 MGD. 25 MGD is recommended as the basis for initial allocations under the Five Percent Rule. A design flow of 20 MGD could be used if existing flows are exempt from the allocation process.

Reallocation in accordance with the Five Percent Rule should occur when the total wastewater flow exceeds 90% of the design flow (22.5 MGD for 25 MGD design flow).

Parameters to be regulated under the Five Percent Rule are total nitrogen, total phosphorus, total suspended solids, and total dissolved solids. Effluent requirements (mg/l) for these parameters are as follows:

	Total Wastewater Flow (MGD)				
	20	25*	30	40	50
Total Nitrogen	3.5	3.0	2.7	2.3	2.0
Total Phosphorous	0.35	0.30	0.27	0.23	0.20
Total Suspended Solids	23.5	19.0	16.0	12.3	10.0
Total Dissolved Solids	151	121	101	76	61

* Recommended for initial implementation. If a design flow of 1500 cfs is selected, these numbers are reduced by 3.2 percent.

4. Require wastewater treatment plants to be reasonably failsafe through the provision of (1) emergency contingency plans; (2) redundancy of key units; (3) units and treatment processes capable of handling shock loadings; (4) facilities for containing or storing inadequately treated effluent for additional treatment instead of discharge; and (5) monitoring/early warning systems. Prior to implementing this recommendation, the Commission will develop guidelines for reviewing projects in accordance with this requirement.
5. Require all point sources to disinfect their wastewater using an appropriate substitute for chlorine (ultraviolet, ozonation or equivalent).
6. Require all river outfalls to not obstruct nor be readily visible to persons recreating on or near the Delaware River.
7. Require all treatment plants to submit daily discharge monitoring reports to the applicable state agency and the Delaware River Basin Commission within 24-hours of the date of the analyses. This requirement is applicable only during the May 1 to October 1 recreation season. Reports are to be submitted by facsimile or equivalent transmission.
8. Require local municipalities to be co-permittees with all wastewater treatment facilities approved under local land use and wastewater treatment ordinances.
9. Wastewater treatment and other requirements are to be effective within 18 months of the date of adoption for all wastewater treatment projects approved by the Commission on or after September 28, 1988. Permitted facilities construction before September 28, 1988, are to comply with these requirements as part of SPDES permit renewals or within 10 years, whichever is sooner. Requirements for the substitution of suitable disinfecting agents for chlorine are to be effective immediately for all facilities.
10. Require the reduction of pollutants, particularly fecal bacteria, from combined sewers in Port Jervis, NY and Stroudsburg, PA. Use of the excess treatment plant capacity in the former system should be explored.
11. Prohibit discharges to Outstanding Basin Waters within the DWGNRA boundaries because the lands in the recreation area are substantially owned, controlled and managed by agencies of the signatory parties to the Delaware River Basin Compact.

Non-Point Source Regulation:

1. Require all projects submitted to the Commission for approval of a wastewater treatment plant, ground and surface water withdrawal permit or other such action, to include a non-point source control plan covering the service area of the project. The plan shall address how the applicant intends to control and minimize stormwater runoff and related nonpoint sources based on storm events for 2.33-year, 10-year, 25-year, and 100-year return periods. The goal of the plan should be no net increase over pre-

project conditions. The resulting management program shall be designed to address, at a minimum, the following:

- a. Control of accelerated erosion and sedimentation problems from general earth disturbance activities including all clearing and excavation activities as well as potential post-development erosion and sedimentation problems;
 - b. Preservation of the existing natural drainage system, the flood-carrying capacity of the system, and base (low) flows. Addressed should be the attenuation of non-natural runoff flows and velocities through the design of stormwater control systems. These could include the construction of pervious or semi-pervious surfaces in lieu of non-porous pavement, detention/retention basins with or without groundwater recharge, stormwater infiltration systems, use of vegetative filter strips, buffer areas, and other best management practices;
 - c. Maintenance and protection of existing water quality from degradation due to increased non-point source runoff during and after construction via the application of best management practices integrated with the stormwater management control system. Sources of pollution to be controlled include, but are not limited to, the following: on-lot systems; fertilizer, pesticide and herbicide runoff; landscaping; storage and application of road de-icing agents and other transportation-related pollution; erosion from earth disturbance activities of any kind; and, all other water quality constituents carried by runoff.
 - d. The proper design, installation, and maintenance of all permanent stormwater management and nonpoint source control structures, vegetative cover, filter strips, and other best management practices which are utilized;
 - e. Design of appropriate strategies to protect or enhance fish and wildlife habitat, aesthetics and other natural resources through the establishment or preservation of wetlands, natural vegetative cover, and natural stream hydrology;
 - f. Development of institutional and financial arrangements which are accountable for non-point source controls in the post-development period.
2. Require that any project submittal to the Commission shall include a non-point source abatement plan. The project applicant shall demonstrate how the changes in stormwater runoff and non-point source pollutant loads from the project service area are to be mitigated so that the post-development load is equal to, or less than, pre-development loads. Allowable change, if any, will be predicated upon the continued maintenance of existing water quality in the Delaware River as described by the criteria recommended in item 1 above. Lastly, the Commission will consider, on a case by case basis, additional point source treatment as a non-point source Best Management Practice.

In developing the plan, the project applicant is to demonstrate understanding of the nature, magnitude, and extent of the potential non-point source pollution load and

stormwater runoff from the project service area. It is envisioned that water quality and hydrological modeling, water quality and other data collection, and various other assessment activities might be required prior to the development of the required plan.

3. Prior to implementing the requirement for a project service area non-point source control plan, the Commission should develop a framework with methodologies for guiding plans developed under this recommendations. An example of such a framework is the Framework for Critical Areas which was developed by the metropolitan Washington Council of Government for and use in Maryland (MWWCOG, 1988). This framework provides desktop methods for assessing non-point source removal requirements and for screening potential Best Management Practices for developing land areas. Analysis of the Maryland approach has shown it to be an effective tool for rapidly assessing non-point source loads and control strategies. In Maryland's critical areas, post-development non-point source loads are to be 10 percent less than pre-development loads.
4. If the project service area is addressed by a municipal or local non-point source plan which addresses all potential sources of non-point pollution and is undergoing implementation, the municipal or local plan can be submitted instead of a project service area plan. A statement from the municipality or state certifying that the applicant's proposed stormwater and non-point source control measures are in conformance with the approved plan will be required.
5. In situations where municipal and local plans address stormwater, but not non-point sources, the project applicant will use the stormwater plan as input for the project service area non-point source plan. Since stormwater controls could exacerbate non-point source problems, the applicant should assess the potential implementation impact of the stormwater plan on non-point source loadings.
6. In allowing municipal and local non-point source plans to be used to satisfy project service area plan requirements, the Commission's intentions are to encourage the development of local, regional and watershed solutions to non-point and stormwater problems.
7. All non-point source abatement plans developed in accordance with these recommendations are to be implemented during project development. Failure to comply with the plan subjects the applicant to a fine not to exceed \$1,000 per day in accordance with the provisions of the Delaware River Basin Compact.

Additional Recommendations:

1. Complete, maintain and enhance as applicable, the development of the a regionwide water quality model (with non-point and tributary inputs and toxic spill capabilities), and the regional land use data base, both initiated during the development of this plan. These planning tools should be made available to all interested parties.

2. After the adoption of a water quality protection strategy for the DWGNRA, the Commission should conduct an evaluation of the region's water quality monitoring activities to determine:
 - a. the ways and means of increasing overall efficiency and inter-agency coordination of all water quality monitoring activities;
 - b. needed resources at the local, county, state and interstate levels for water quality monitoring programs;
 - c. the methods and strategies needed to monitor and assess non-point source pollution;
 - d. additional biological and/or ecological information which is needed to assess and manage both water quality and aquatic life resources;
 - e. the methods and strategies needed to increase point-source compliance monitoring including the potential feasibility of automatic monitoring; and,
 - f. information needs relative to the maintenance of any new water quality standards and regulations adopted as a result of recommendations herein.

Discussion of Recommended Course of Action

The premise of the recommended plan is that reasonable alternatives exist for preserving water quality in the DWGNRA in spite of the rapid amount of growth and development which is occurring in the surrounding area. Treatment and other requirements will increase, but none are unreasonable from a technological or cost perspective. The benefits of maintaining high quality waters in the area will have economic benefits which should be considered as well.

The thrust of the recommended plan is to raise the level of water quality protection given to the DWGNRA by increasing the controls on point sources, by initiating certain non-point source control actions, and through other actions. The plan recognizes that local growth and development is a valid interest and water quality protection strategies were designed to minimize or prevent constraints to locally-sanctioned growth. Conceptually the plan recognizes that point sources are an immediate issue, while non-point source control issues will increase in importance as time goes by.

The recommended point source requirements are based on three different approaches depending upon parameter. Non-conservative substances, particularly oxygen-demanding substances and fecal bacteria, are controlled locally through mixing zone policies. Site specific calculations are used to determine needed treatment removals and outfall design.

The mixing zone policies were designed to prohibit wastewater assimilation in the DWGNRA, to effect mixing as quickly as possible, and to keep effluent plumes from hugging shorelines for long distances. Outfalls which are deep, sufficiently far from the DWGNRA boundary, located in high mix areas (eg. center channels) and employ diffuser systems are promoted by the policies. It is

believed that the proper design and placement of outfalls could, in many cases, reduce treatment requirements substantially.

The mixing zone policies also provide a Zone of Immediate Impact where water quality standards do not have to be met. This zone reduces treatment costs since in-stream processes are allowed instead of stringent end-of-the pipe requirements. The Zone of Immediate Impact, however, is contained within a small area so that existing water quality is maintained in river reaches adjacent to and downstream of the discharge. The design considerations of the Zone of Immediate Impact favors center channel, deep discharge outfalls.

Outside the Zone of Immediate Impact, but within the remaining portion of the mixing zone, certain water quality standards remain in force. These standards (minimum dissolved oxygen, the existing fecal coliform public health standard, toxics standards, and biocriteria) insure that important aquatic and recreational uses are not lost as the wastewater completes its mixing and assimilation process.

Conservative substances which are proposed for regulation are phosphorus, nitrogen, suspended solids, and dissolved solids. Under a strict interpretation of water quality preservation, treatment removals for these constituents would be extremely high. The recommended alternative, allocations based on the so-called Five Percent Rule, provide a reasonable compromise: very minor, (probably immeasurable) reductions in "existing" water quality for a major reduction in treatment removal requirements. These requirements will be greater than secondary treatment, but technically feasible and economically achievable.

The third part of the point source strategy is to implement the option in the proposed Outstanding Basin Waters classification in the DWGNRA to prohibit wastewater treatment plants within the boundaries of the National Recreation Area. This option states that the Commission could disallow treatment facilities adjacent to Outstanding Basin Waters where agencies of the signatory parties to the Delaware River Basin Compact have substantial land holdings. The DWGNRA and related public lands within the recreation area boundaries represent a major federal and state investment in recreation land and water with almost 62,000 acres under public ownership.

The plan also recommends the use of ultraviolet light, ozonation or equivalent disinfection process instead of chlorination. Chlorine compounds potentially harm aquatic life and do not kill harmful viral pathogens. Both are important considerations for a waterbody such as the Middle Delaware that is used intensely for primary-contact and sport fishing recreation.

In addition the plan recommends increased attention to treatment plant performance in terms of compliance problems due to plant upsets, shock loads etc. A 24-hour monitoring requirement is also recommended for the recreation season for the safety of recreationists.

Non-point source pollution looms as a major concern. The strategy of the recommended plan is a mix of mandatory and voluntary controls with the presumption that non-point source activities at the state and local level will be expanding over time. The plan proposes at this time that applicants for Commission project review develop a non-point source control plan for the service area of the project. This plan, subject to approval by the Commission, is to be implemented.

In recommending the above, the plan recognizes that non-point source planning is logically done also on municipal and watershed bases. The plan, therefore, recommends that the project service area plan requirement be waived where a municipal or state non-point source control plan is being implemented.

In summary, the plan promotes the idea that preservation of water quality in the DWGNRA is an attainable goal. This goal can be realized without constraining local growth and development using existing technologies for wastewater treatment and outfall design.

APPENDIX C

Description of how criteria based on existing water quality were developed

APPENDIX C: BASES FOR PROPOSED WATER QUALITY STANDARDS WHICH REFLECT EXISTING WATER QUALITY IN THE MIDDLE DELAWARE SCENIC AND RECREATIONAL RIVER

INTRODUCTION

This paper presents the recommended water criteria which define "existing water quality" for the reach of the Delaware River running from Port Jervis, New York to the Delaware Water Gap. The Commission/National Park Service planning team believes that the recommended criteria are reasonable and reflective of the existing quality of the Middle Delaware Scenic and Recreational River.

Many of the criteria were developed from existing water quality data from four sampling locations (Port Jervis, Montague, the Delaware Water Gap, and Portland) which were collected by the U.S.G.S. and the environmental departments of New York, Pennsylvania, and New Jersey. (The Delaware Water Gap location is called the Delaware River near Stroudsburg by PA DER and Kittatinny by the DRBC/NPS program.) These data varied as to their extent and statistical validity at any one location.

For several parameters, notably fecal coliform, dissolved oxygen, and benthic organisms, the extensive data base collected by the DRBC/NPS Scenic Rivers Monitoring Program at various locations from Port Jervis to the Delaware Water Gap was used.

State and U.S.G.S. data were presented and statistically analyzed in the report Statistical Analysis of Historical Water Quality Data from the Middle Delaware Scenic and Recreational River. This report was prepared for the planning team by F. Jay Breidt and Duane C. Boes, Department of Statistics, Colorado State University. Appendices A through D of the cited report contain other data summaries which assisted in the selection of criteria. Data used by Breidt and Boes were re-evaluated by Commission staff along with new data obtained from STORET. Data from the DRBC/NPS Scenic Rivers Monitoring Program were used to augment the above data where possible and provided the sole data base for the selection of some criteria. Wherever possible and relevant, information contained in the U.S. EPA "Gold Book" criteria document was used to guide the decision-making.

Although varying by parameter, the selection of criteria that best represents existing water quality was generally based on the philosophy that a reasonable criteria is one that will be met at least 85 percent of the time. In all data sets, data are distributed around a mean and median. If the distribution is "normal", data plots take the shape of a bell curve with the majority of the data (ie. approximately two standard deviations) defining the height of the curve and the outliers defining the extent of the two tails of the curve. The outliers do not describe existing water quality, but rather, rare events caused by localized pollution problems, extremes in natural parameter variability, sampling error, or spatial and temporal factors.

Determination of the 85th percentile was done in several ways. Breidt and Boes used statistical techniques which determined the 85th, 90th and 95th percentiles which had a 95 percent

confidence limit. The Breidt and Boes analyses also statistically determined trends in the data, seasonalities and whether or not data from different locations could be combined as one data set. Analyses conducted by DRBC staff generally utilized frequency analyses and standard deviations to determine potential criteria.

Where pertinent, factors such as the U.S.EPA recommended criteria, relationships between parameters, and other factors including common sense were considered along with the statistical analyses. Wherever possible it was the goal of the selection process to support the proposed standard with as many rationale as possible. In most cases, selection criteria is supported by at least two complementary factors.

Lastly, it was the goal of the selection process to develop a full range of chemical (inorganic and organic), bacterial, physical, and biological standards that describe existing water quality. It is believed that this mix of descriptors is absolutely necessary to present the total range of the water quality picture in the Middle Delaware Scenic and Recreational River.

The following sections present the proposed criteria and summarize the rationale behind its selection, on a parameter by parameter basis. Table C-1 presents a summary of the data used to define existing water quality.

PARAMETER BY PARAMETER DISCUSSION

DISSOLVED OXYGEN:

Proposed: The proposed standard is a minimum of 6.0 mg/l with a 24-hour average of 8.0 mg/l with the intent that minimum criteria applies to nighttime conditions between 3 and 6 AM.

Existing: The existing standard for D.O. is a minimum of 4.0 mg/l and a 24-hour average of 5.0 mg/l.

Bases: The recommended dissolved oxygen criteria is based on an analysis of 787 values obtained in the 1964 to 1989 period at over 20 locations. The data were obtained from routine monitoring programs plus two extensive diurnal (24-hour) studies conducted by the DRBC and the NPS. Of the 787 values, six or 0.7 percent were less than 6.0 mg/l. The recommended mean criteria is reflected in the means derived from the various data sets which were always greater than 8.0 mg/l. The criteria is also supported by information and recommendations contained in the U.S. Environmental Protection Agency dissolved oxygen criteria document which indicates that the full protection of aquatic life requires a D.O. level of 6.0 mg/l as a minimum.

BIOCHEMICAL OXYGEN DEMAND:

Proposed: A standard of a mean of less than 1.6 mg/l is recommended.

Bases: The proposed criteria is based on the results of 152 BOD samples collected at 10 locations. The means of the various data sets were always less than 1.60 mg/l. The BOD

criteria suggests a background condition which is indicated by the literature to be generally reflective of water quality which is largely un-impacted by human activity.

TOTAL PHOSPHORUS:

Proposed: A total phosphorus standard of less than 100 ug/l 90 percent of the time with the maximum value not to exceed 200 ug/l is recommended.

Bases: The basis for the selection of this proposed standard are (1) the upper boundary 85th quantile estimate determined by Breidt and Boes for data from Port Jervis and Stroudsburg (the Delaware Water Gap) of 110 and 100 ug/l, respectively and (2) frequency analyses conducted on 247 data from 4 state/U.S.G.S. and 5 DRBC/NPS locations. A value of 100 ug/l is also supported by information contained in the U.S. EPA Quality Criteria for Water, particularly the reference from Mackenthun, 1973 to desired phosphorus levels in flowing waters that are not discharging into a lake or reservoir system. A phosphorus standard is believed necessary to prevent nuisance aquatic plant growths since evidence suggests that increases in aquatic plant beds in the DWGNRA may be influenced by human sources of nutrients.

DISSOLVED ORTHO PHOSPHORUS:

Proposed: A criteria of less than 15 ug/l 92 percent of the time was developed. The criteria is recommended as a guideline and not a standard.

Rationale: The recommendation is based on a frequency analysis of limited data: 84 values collected at Port Jervis. The data base at this time is not sufficient to derive statistically-based standard. However, dissolved ortho phosphorus criteria as a guideline to support the Total Phosphorus standard is recommended since this the dissolved ortho form of phosphorus is readily assimilated by aquatic plants.

TOTAL NITROGEN:

Proposed: A total nitrogen standard of a mean of 1.0 mg/l with no more than 15 percent of the values greater than 1.35 mg/l is recommended.

Bases: This value is derived from frequency analyses of nitrate + nitrite data and total kjeldahl nitrogen data collected from three locations (449 total values distributed approximately 51 and 49 percent respectively). The results of the two frequency analyses were then added.

The ammonia levels implicit in the proposed total nitrogen criteria are probably significantly less than the level suggested by the proposed ammonia criterion (see discussion which follows). This is because the total nitrogen criteria is defines existing water quality considerations while the proposed ammonia criteria is toxicity-based.

AMMONIA NITROGEN:

Proposed: An ammonia nitrogen standard of "not to exceed 0.67 mg/l" is being recommended.

Based: Data from four state and U.S.G.S. monitoring locations (264 values) and data from the DRBC/NPS monitoring program (5 locations, 14 values) were examined. Data analyzed by Breidt and Boes indicate that ammonia nitrogen concentrations are generally low. Recent DRBC/NPS data, however, suggests periodic ammonia concentrations that are significantly higher than indicated by the historical state and U.S.G.S. data. These values approach, or exceed, the U.S. EPA ammonia toxicity criteria when corollary pH and temperature are considered.

The recommended standard is derived from U.S. EPA's ammonia toxicity criteria for a one-hour concentration in a warmwater fishery that has a pH of 9.0 and a water temperature of 30 C. The pH and water temperature conditions are derived from monitoring data and reflect times when ammonia toxicity would have its greatest potential in the DWGNRA. The level of toxicity associated with this pH and temperature condition is the recommended criteria.

FECAL COLIFORM:

Proposed: The following is recommended as the "Water-Quality based" fecal coliform standard: "Not to exceed 50 colonies per 100 milliliters as a geometric average over the May through September recreation season with 90 percent of the values not to exceed 250 colonies per 100 milliliters. Samples shall be taken at such frequency and locations as to permit valid interpretation."

Existing: The existing fecal coliform standard is a geometric mean of 200 colonies/100 milliliters without a seasonal specification. It is being recommended that the existing standard be retained and delineated as the "Public Health Fecal Coliform" standard. The recommended standard is not a replacement for the existing standard, but additional fecal coliform criteria.

Bases: Fecal coliform is normally considered a public health parameter and the currently-adopted fecal coliform standard was adopted because of its public health significance. This standard should be retained until such time as it is replaced by a better bacterial or viral public health parameter.

Fecal coliform levels are also good indicators of existing water quality conditions because they reflect the degree of urbanization and other pollution impacts. The proposed standard is being recommended for its ability to define existing water quality conditions in the DWGNRA. The criteria would not be used for beach monitoring/closings since this is the purpose of retaining the existing 200/100 ml. criteria.

The recommended standard was derived from statistical analysis (by DRBC staff) of all available DRBC/NPS fecal coliform data. The data base consisted of 445 observations taken during both dry and wet weather conditions in the 1984-1989 period at 11

locations. At 9 of the 11 locations geometric mean fecal coliform values ranged from 24 to 42 colonies/100 ml. At the remaining two locations means were 71 and 89. These higher means, at Milford Beach and the Delaware Water Gap, respectively, reflect known problems and urbanization. The mean of all 11 locations was 43 colonies/100 ml and the standard would be applied as a reach-wide average condition.

SPECIFIC CONDUCTIVITY:

Proposed: Not to exceed an average of 90 at any one location or 80 reach-wide, 85 percent of the values not to exceed 100 umhos/cm.

Rationale: Data from the DRBC/NPS monitoring programs indicates that conductivity levels are sensitive to the degree of urbanization in a watershed (Albert, 1986a). The recommended criterion was derived based upon the statistical analyses of Breidt and Boes and frequency analyses by DRBC staff. Data for 22 locations (651) values were analyzed.

pH:

Proposed: A pH standard of 6.5 to 9.0 units is proposed.

Existing: Current pH standards calls for pH that ranges from 6.5 to 8.5 units.

Bases: DRBC/NPS data indicate that pH levels are affected by aquatic plant photosynthesis and respiration during the warmer months. As a result, the upper range of summertime pH is often 9.0 or greater for short periods of time in the afternoon. In addition, U.S. EPA criteria for freshwater aquatic life indicates that a pH range of 6.5 to 9.0 protects aquatic life. Since the current pH standard does not reflect either ambient water quality nor U.S. EPA's recommended criteria, adjustment of the upper range of the existing pH standard is warranted.

TOTAL SUSPENDED SOLIDS:

Proposed: Not to exceed an average of 9 mg/l at any one location nor a reach-wide average of 6.0 mg/l, 85 percent of the values not to exceed 15 mg/l

Bases: The recommended criteria was derived from data at three locations using 200 values. The mean criteria reflects the highest mean observed at any one location while the reach-wide criteria reflects the mean of all locations combined. The 85 percent criteria was derived from a frequency analysis.

TOTAL DISSOLVED SOLIDS:

Proposed: A standard of 60 mg/l is proposed

Existing: the existing standard is 133 percent of background or 500 mg/l whichever is less.

Rationale: Based on the statistical analysis of existing water quality data by Breidt and Boes for Port Jervis on a seasonal basis, the upper boundary, 85th quantile TDS values by season ranged from 43 to 47 mg/l. Three of the five seasonal statistical values equaled 45 mg/l and the means of all locations were equal to or less than 43.5. These values define background conditions. Since a value of around 45 mg/l defines the "background" for the DWGNRA, the current TDS standard can be interpreted as is 60 mg/l. It was decided to use this number for the proposed criteria.

BIOCRITERIA:

Proposed: a diverse and rich population of benthic macroinvertebrates represented by:

- a. a reach-wide mean Shannon-Wiener Species Diversity Index value of 3.6 with no more than 10 percent of the values below 3.0;
- b. a reach-wide mean Equitability index value of 0.8 or greater with no more than 15 percent of the values below 0.6; and,
- c. a reach-wide mean EPT Index value of 13 or greater based on genus level of identification with no more than 15 percent of the values below 10.

Bases: A standard based on benthic organisms complements standards for physical and chemical parameters because it represents the biological component of existing water quality. Aquatic organisms are particularly good water quality indicators since their presence and composition reflect not only existing water quality, but also pollution impacts which might have occurred in the recent past or pollutants which are not routinely monitored (eg. such as various toxicants). The Shannon-Wiener and Equitability indices have long been used by DRBC to summarize biological data in the annual summer reports of the DRBC/NPS Scenic Rivers Monitoring Program. Experience has shown that these indices can describe ambient water quality conditions very well.

Defining existing "biological" water quality conditions by using three separate indices is based on ecological principles. Ideal biological conditions are represented by a diverse, rich population with a suitable percentage of pollution-intolerant organisms present. The three proposed indices measure these factors when employed in combination.

The Shannon-Wiener Species Diversity Index is a measure of the diversity of species in a sampled population. Equitability is related since it is a comparison of the calculated SDI value with a theoretically ideal population. Experience with these indices in the DRBC/NPS Scenic Rivers Monitoring Program indicates that the two are complementary. Some researchers believe that Equitability may be more sensitive of the two (Weber, 1973).

The EPT Index is the total number of distinct taxa from the Ephemeroptera (may flies), Plecoptera (stone flies) and Trichoptera (caddis flies) groups. These groups contain many pollution-intolerant species. The EPT Index, therefore, is a good indicator of taxa richness among organisms of particular water quality concern. The range of the EPT Index varies according to the level of identification and is considered valid from the species level

through family level (Plafkin, 1989). The EPT values discussed herein are at the genus level of identification which is specified in the proposed criteria.

The proposed Shannon-Wiener Species Diversity Index biocriteria is derived from frequency analyses of all 1984 through 1989 data from the DRBC/NPS Scenic Rivers Monitoring Program. Data from 31 samples collected at 7 sites were analyzed. Samples for outside the DWGNRA study area were also analyzed to determine the validity of the proposed criteria. These data, however, were not used to develop the specific criteria presented herein.

The mean of all values from Port Jervis to the Delaware Water Gap was found to be 3.565 with 90 percent of the values being greater than 3.0. A Species Diversity Index value of 3.0 was selected because it represents a high frequency of occurrence and also the mean of all values minus one standard deviation ($3.565 - 0.476$ or 3.089). A value of 3.0 or greater is generally considered indicative of good water quality (Weber, 1973).

The mean Equitability value for all data was determined to be 0.787. The mean minus one standard deviation resulted in 0.6, the recommended Equitability criteria ($0.789 - 0.185$ or 0.604). A value of 0.6 or greater was observed from 85 percent of the samples based on frequency analyses of existing data. A value of 0.6 or greater is generally considered to be indicative of good water quality (Weber, 1973).

The mean EPT Index value for the available data was determined to be 13.15 with a standard deviation of 3.75. Although the mean minus one standard deviation equaled 9.4, the data when plotted normally was skewed towards values of 10 or greater. The frequency of an EPT value of 10 or greater in the data set was 85 percent. Regression correlation analyses between the EPT and Species Diversity Indices indicated that the two indices were roughly correlated and that an SDI value of 3.0 (recommended criteria) corresponded to an EPT value of 10.7. The selection of an EPT Index criteria of 10 or greater was based on the frequency of occurrence of the value in the existing data set. Based on the existing water quality and the SDI/EPT regression analysis and the literature (Lenat, 1988), a value greater than 10 reflects good water quality.

TURBIDITY:

Proposed: Retain existing standard but remove "natural conditions" qualifier

Existing: Unless exceeded due to natural conditions: a maximum 30-day average of 20 units with a maximum 150 units.

Rationale: Turbidity data for the DWGNRA indicates that values never exceed the current standard of a maximum 30-day average of 20 units with a maximum 150 units. The data, however, are insufficient to define a turbidity criteria that might be more stringent. Therefore, no change in the numeric criteria appears warranted.

The Commission's criteria contains a qualification that the turbidity criteria can be exceeded due to natural conditions. It is being recommended that this qualification be

removed from the DWGNRA standards since the current turbidity criteria is being met under all natural conditions.

MANGANESE:

Proposed: A standard of less than 100 ug/l is recommended.

Bases: Available manganese data indicate concentrations less than 100 ug/l. This concentration is considerably less than a level of concern for toxicity. A standard, however, is recommended due to the potential impact of manganese on water color and clarity. Discoloration is known to occur at levels of 150 ug/l.

IRON:

Proposed: A maximum of 1 mg/l is recommended.

Bases: Existing data for iron at various locations indicates that iron rarely exceeds the 1000 ug/l threshold presented in the U.S. EPA criteria document for iron toxicity. Although a more stringent standard could be derived via statistics from the iron data, the need for stringency in this case is not warranted since toxicity is the primary concern with the parameter. It is believed that an iron concentration of 1 mg/l as a maximum value adequately describes existing water quality and protects aquatic life.

HARDNESS AND CERTAIN HEAVY METALS:

Proposed: A hardness of 18 mg/l-CaCO₃ was selected from the statistical analyses of available data as representing a reasonable minimum hardness value. Hardness is the major parameter used for developing standards for heavy metals which have hardness-based toxicity. Based on the selected hardness value and formulae contained in the U.S. EPA criteria document, the following standards are recommended (all values as ug/l):

cadmium:	0.30
chromium III:	50.82
chromium VI:	to be based on EPA criteria when developed
copper:	2.73
lead:	0.36
nickel:	25.96
silver:	0.21
zinc:	77.40

Bases: Hardness is the significant factor affecting the toxicity of silver, lead, copper, nickel, chromium, cadmium, and zinc. The low hardness of the DWGNRA waters means that these heavy metals will be toxic to aquatic life at very low concentrations. Standards for these metals can be developed for the low hardness, existing water quality condition using formulae presented in the U.S. EPA criteria document. The resulting metals criteria reflect the existing hardness rather than existing levels of the various metal parameters.

The hardness criteria of 18 mg/l as CaCO₃ was selected for its conservativeness. Of the 551 total hardness data available in the study reach of the Delaware, 45 values (8 percent) were less than 20 mg/l and 16 values were less than 18 mg/l (3 percent). The latter was selected because of the additional protection provided. In addition, a value of 18 mg/l is the minimum value for Port Jervis which is considered a background station for study purposes.

Table C-1: Data used to Define Existing Water Quality

Parameter	Monitoring Locations	Period of Record	No. of Values	Range		
				Mean	Max	Min
D.O. (mg/l)	a) 4 locations combined	64-88	392	10.5	21	4.2*
	b) 15 DRBC/NPS	84-89	253	8.2	12	5.5*
	c) 7 diurnal #1	88	61	8.3	10.6	6.8
	d) 9 diurnal #2	88	81	8.1	13.1	6.0
BOD (mg/l)	a) Portland	76-89	72	<1.54	n/c	n/c
	b) Montague	79-89	52	<1.59	n/c	n/c
	c) Stroudsburg	88	1	<1.50	n/c	n/c
	d) 10 DRBC/NPS	87-89	27	<1.50	n/c	n/c
Total Ortho Phosphorus (ug/l)	a) DRBC/NPS	87-89	44	n/c	140	<10
Dissolved Ortho Phosphorus (ug/l)	a) Port Jervis	76-86	84	6.7	70	0
Total Nitrogen (mg/l)	a) Port Jervis TKN	75-86	90	0.70	13	0.08
	NO ₂ + NO ₃	75-86	86	0.34	1.8	0.05
	b) Montague TKN	79-89	61	0.56	2.0	0.06
	NO ₂ + NO ₃	79-89	62	0.43	1.1	0.10
	c) Portland TKN	76-89	78	0.60	2.6	0.05
	NO ₂ + NO ₃	76-89	72	0.35	1.03	0.05
Ammonia Nitrogen (mg/l)	a) 4 locations combined	64-88	264	n/c	0.34	n/c
	b) 5 DRBC/NPS	87-89	14	n/c	0.69	n/c
Fecal coliform (colonies/100ml)	a) 11 DRBC/NPS	84-89	445	43	n/c	n/c
Specific conductivity umhos/cm	a) 22 DRBC/NPS/USGS/STATE	75-89	651	79	87	68
pH	a) All DRBC/NPS locations	84-89	n/c	n/a	<9	n/a
Total Suspended Solids	a) Port Jervis	79-89	68	3	26	<1
	b) Montague	79-89	58	6	23	1
	c) Stroudsburg	82-89	74	9	124	0
Total Dissolved Solids (mg/l)	a) Port Jervis	64-76	91	37.5	47	30
	b) Montague	61-78	110	40.3	55	29
	c) Portland	78-86	24	43.5	51	33

* Of 787 values, 6 or 0.7% were less than 6.0 mg/l. These generally were associated with flows less than design flows.

** does not include macroinvertebrate samples from the Upper Delaware Scenic and Recreational River which were also analyzed to support criteria development. Stroudsburg (actually Delaware Water Gap monitored by PADER) and Portland (monitored by USGS). Listings of DRBC/NPS monitoring locations are found in the annual reports of the Scenic Rivers Monitoring Program, prepared by DRBC. Diurnal #1 and #2 refer to DRBC/NPS studies.

Table C-1: Data used to Define Existing Water Quality (cont.)

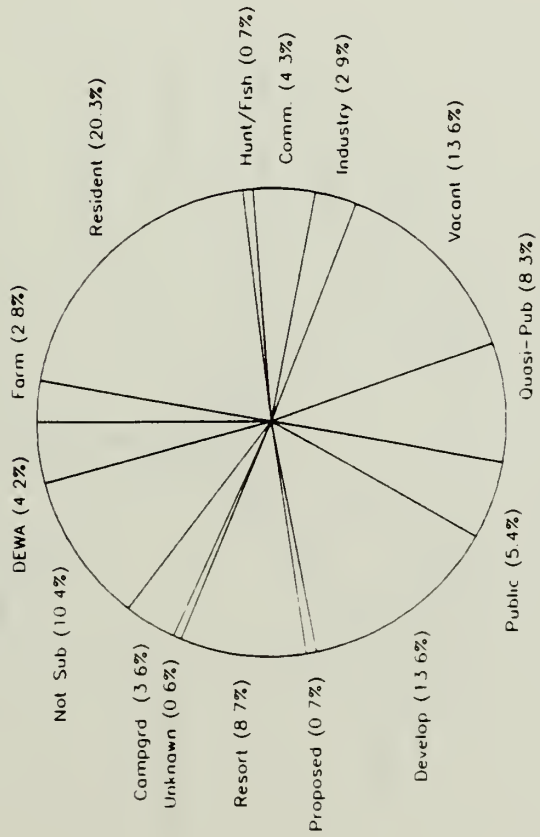
Parameter	Monitoring Locations	Period of Record	No. of Values	Range		
				Mean	Max	Min
Biocriteria	a) 7 DRBC/NPS	84-89	31**			
	Shannon-Wiener			3.6	4.3	2.1
	Equitability			0.8	1.2	0.4
	EPT			13.1	23	6
Turbidity	a) 3 locations combined	67-81	126	All values less than standard		
Manganese (ug/l)	a) 4 locations combined	64-89	148	all but 4 values less than 110 none since 1982 (drought)		
Iron (ug/l)	a) 4 locations combined	64-89	230	5 values or 2% (all DWG) exceed 1 mg/l		
Hardness	a) 5 locations combined	64-89	551	16 values (3%) were less than 18 mg/l		

APPENDIX D

Pie Charts showing land use by township

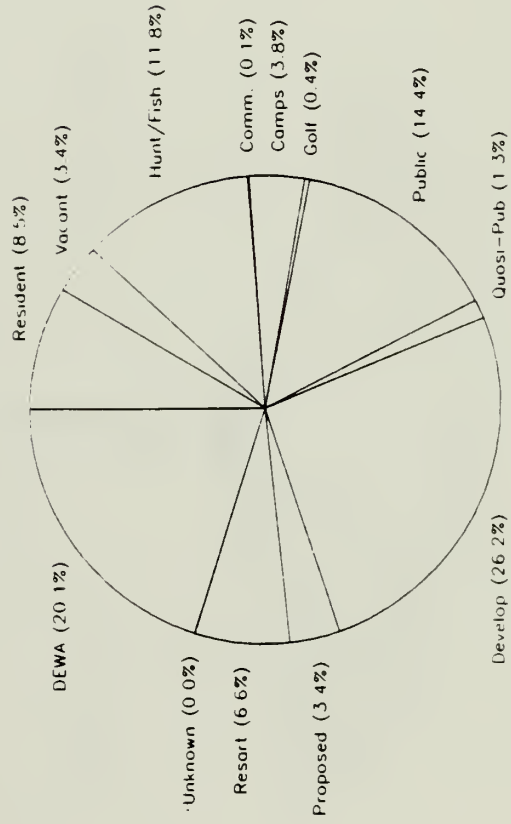
Summary of Land Use in Smithfield

(Total Acres 14,615)



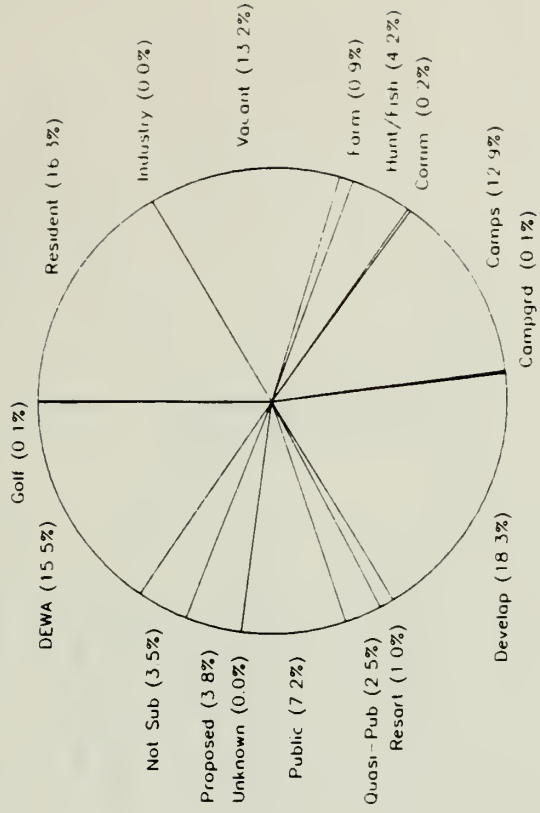
Summary of Land Use in Lebanon Twp

(Total Acres 30,848)



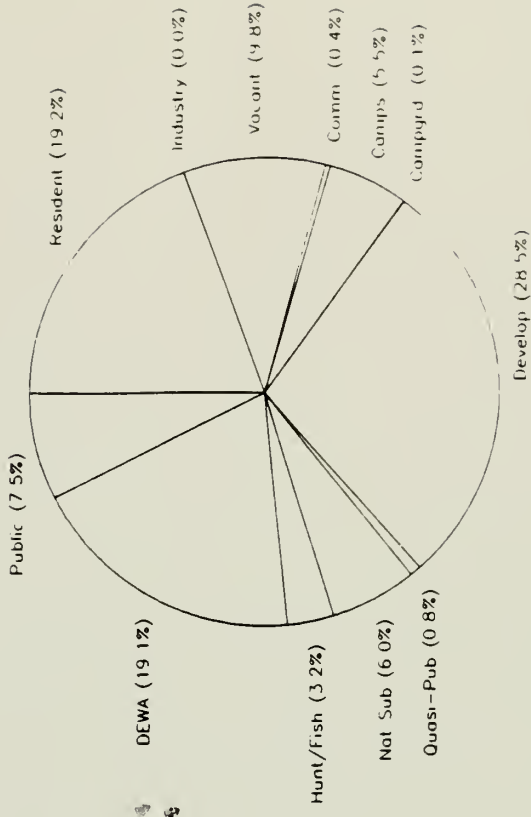
Summary of Land Use

Middle Smithfield Twp Total Ac 35,031



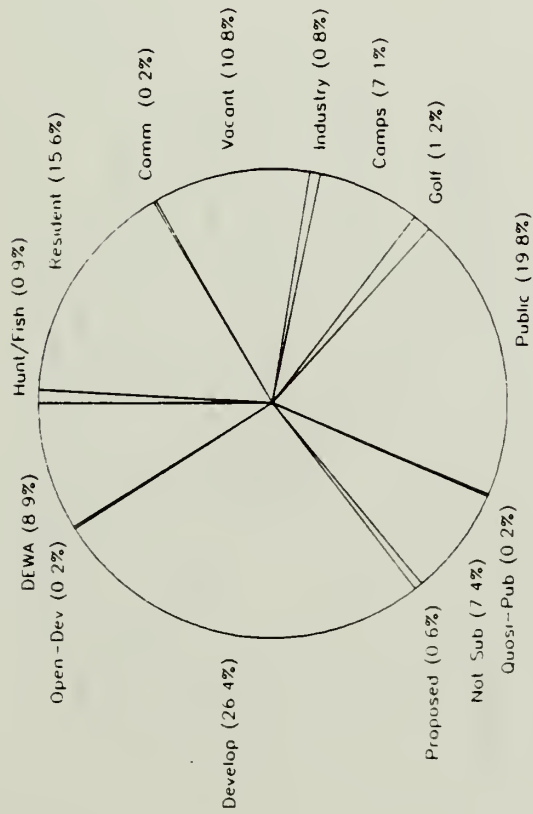
Summary of Land Use in Delaware Twp

(Total Acres 28,928)



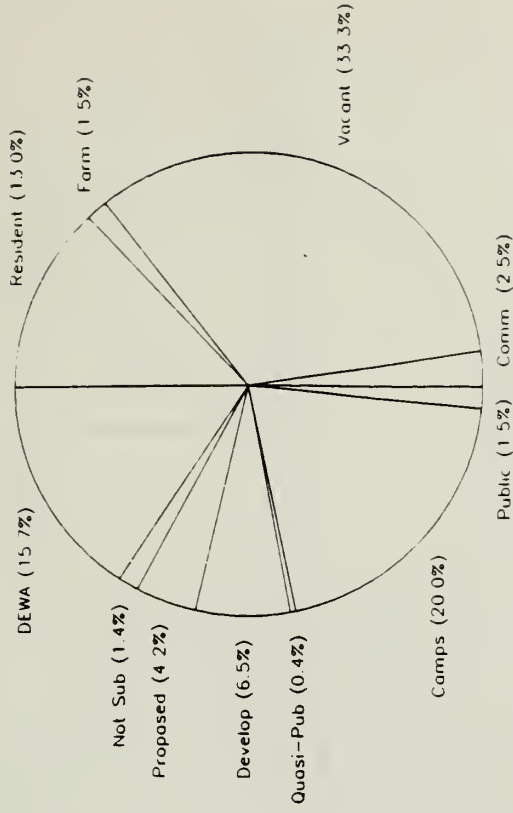
Summary of Land Use in Dingman Twp

(Total Acres 36,480)



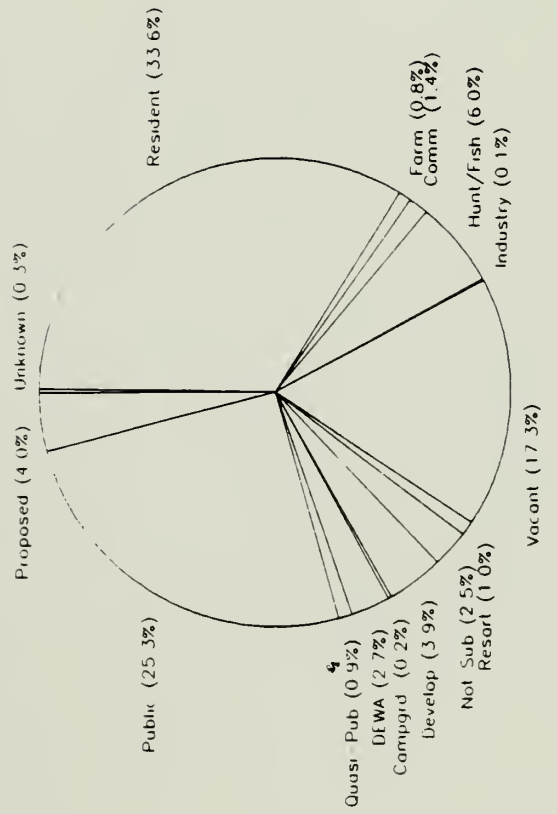
Summary of Land Use in Milford Twp

(Total Acres 8,320)



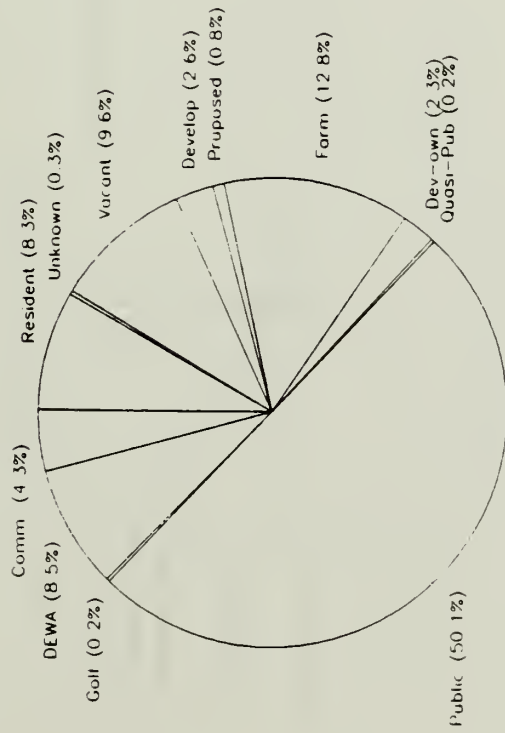
Summary of Land Use in Westfield Twp

(Total Acres 20,032)



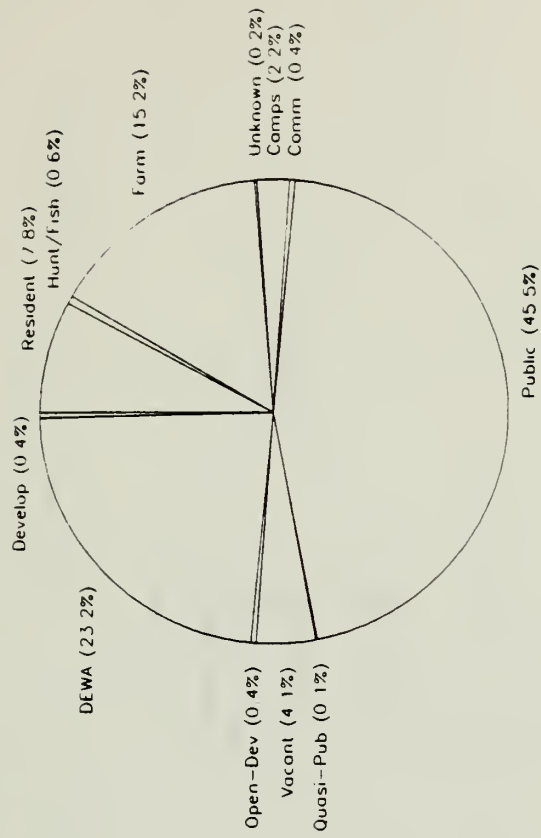
Summary of Land Use in Monticue Twp

(Total Acres 28,928)



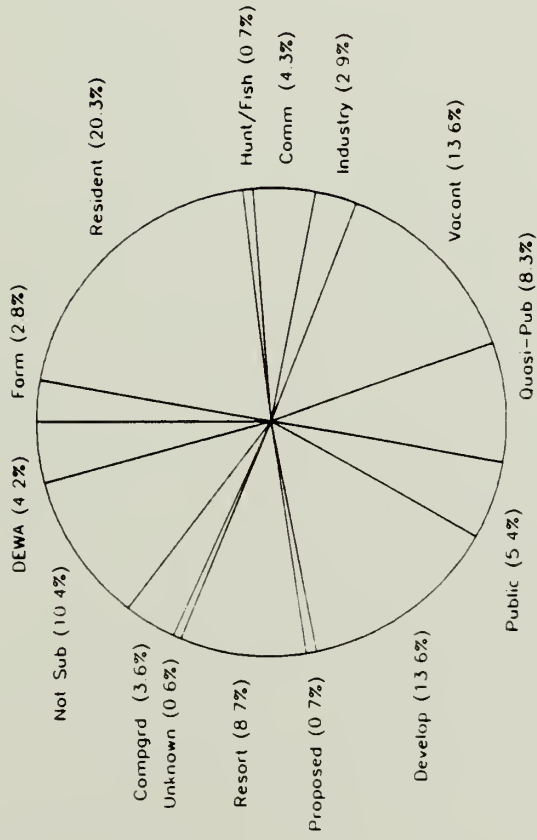
Summary of Land Use in Sandyston Twp

(Total Acres 26,496)



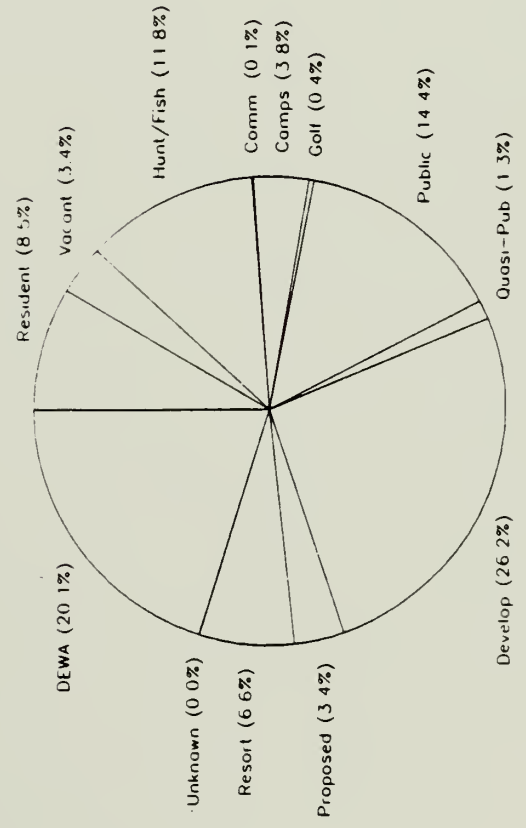
Summary of Land Use in Smithfield

(Total Acres 14,615)



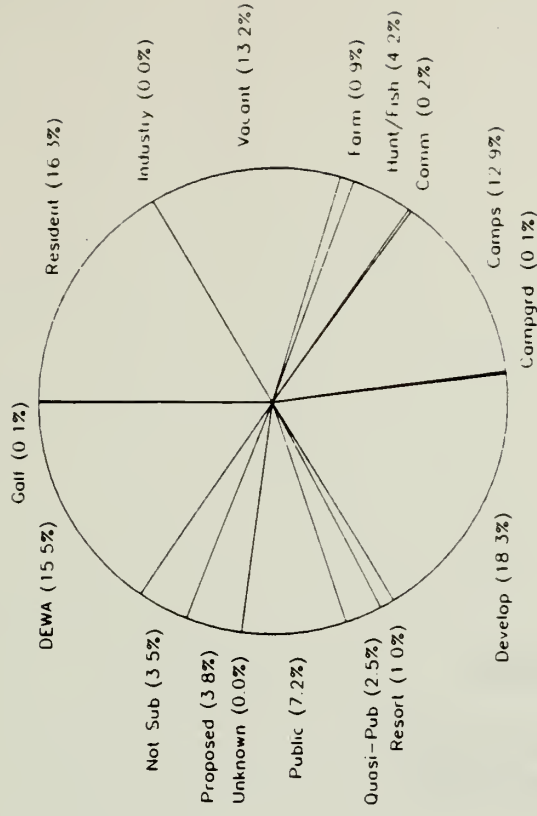
Summary of Land Use in Lebanon Twp

(Total Acres 30,848)



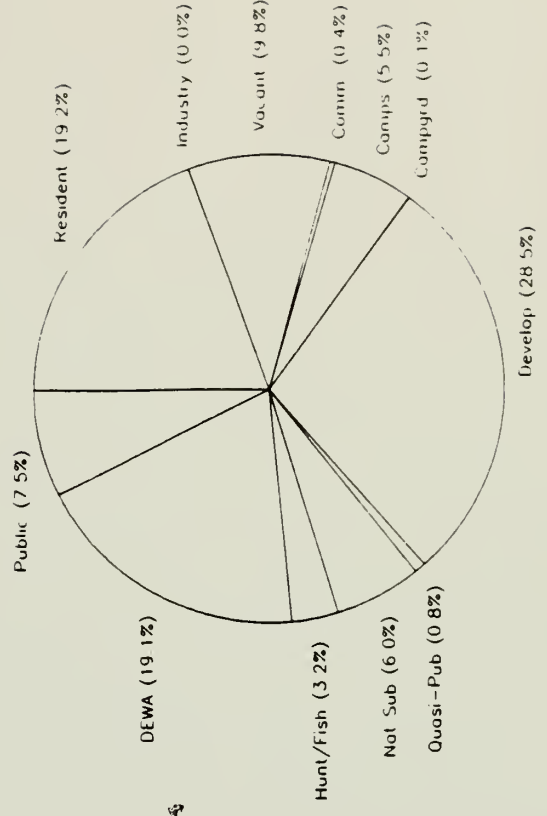
Summary of Land Use

Middle Smithfield Twp Total Acres 35,031



Summary of Land Use in Delaware Twp

(Total Acres 28,928)



APPENDIX E

Point Source Projections
(to be completed)

APPENDIX F

Non-point Source Analyses
(to be completed)

