TECHNICAL MEMOS

PINELANDS COMMISSION

SURFACE WATER QUALITY

BETZ ▪ CONVERSE * MURDOCH * INC,

CONSULTING ENGINEERS, PLANNERS, AND COMPUTER SCIENTISTS

TECHNICAL MEMORANDUM SW IV-1

SUMMARY OF PINELANDS WATER QUALITY

PINELANDS COMMISSION

FEBRUARY 1980

BETZ•CONVERSE•MURODHC•INC.
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PLYMOUTH MEETING, PENNSYLVANIA 19462

TECHNICAL MEMORANDUMS
SURFACE WATER QUALITY

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SUMMARY OF PINELANDS WATER QUALITY

INTROCUCTION

The water quality of the Pinelands was assessed by reviewing existing monitoring data, the needs of water consumers and the relationship between pollution sources and water quality. General pollution control measures were reviewed and management techniques were recommended. Six technical memorandum were produced which detail the methods, findings and recommendations of this study.

Technical Memorandum SW IV-1	Summary of Pinelands Water Quality
Technical Memorandum SW IV-2	Surface Water Uses
Technical Memorandum SW IV-3	Criteria and Needs for Surface Water Uses
Technical Memorandum SW IV-4	Water Quality Index
Technical Memorandum SW IV-5	Drainage Basin Assessments
Technical Memorandum SW IV-6	Land Use/Water Quality Effects
Technical Memorandum SW IV-7	Controls for Nonpoint Pollution Sources

In addition to providing a general description of the six technical memorandums, this summary interprets the study findings and presents the consultants' overall view cf the critical issues in protecting Pinelands water quality. Management alternatives and recommendations presented in this summary are not found in individiual technical memorandums. Ideas for future study are also provided.

DESCRIPTION OF PROJECT TASKS

In this section, each technical memorandum is summarized in terms of its purpose, the methodology applied and the findings of the study. The reader should refer to the specific technical memorandum for more detailed information.

Technical Memorandum SW IV-2 Surface Water Uses

General: Technical Memorandum SW IV-2 describes the existing Pinelands environment in terms of surface water uses and relates these uses to those permitted by the New Jersey Department of Environmental Protection's proposed surface water classifications.

The uses addressed were potable water supply, cranberry and blueberry agriculture, other agricultural uses, fish and wildlife habitat maintenance, primary contact and secondary contact recreation, and other significant uses. The proposed classifications for Pineland surface waters are FW-1, FW-2 Trout Maintenance, FW-2 Non-Trout, FW-Central Pine Barrens, FW-Lower Mullica and Wading Rivers, Central Pine Barrens, and TW-1.

Findings: There is one municipal water department and several private industries that use Pinelands surface waters for water supply. Eighty percent of the cranberries produced in New Jersey are harvested in the Wading River drainage sub-basin, as are 40% of New Jersey's blueberries. The estuaries from Barnegat Bay to Great Bay are the major supplier of hard clams in New Jersey and upstream degradation could adversely affect this industry. In terms of recreation, the Pinelands contain four state forest and park campgrounds, five state parks, forests and natural areas for day use, and seventeen wildlife management areas.

All uses identified were consistent with those permitted under the proposed classification system.

Technical Memorandum SW IV-3 Criteria and Needs for Water Uses

General: In Technical Memorandum SW IV-3, the emphasis is placed on water quantity and quality requirements for major activities and user groups associated with the surface waters of the Pinelands. The major concern is with the needs of cranberry and blueberry cultivation.

Major activities discussed, in addition to cranberry and blueberry cultivation, are other fruit and vegetable cultivation, wetland and aquatic habitat maintenance, and recreation. Cranberries require sandy, peaty soils and large quantities of water for irrigation and frost control. Blueberries require dry, sandy, high organic acid soils and more fertilization than do cranberry plants. Other tree fruit, primarily peaches and apples, require light, loamy soils.

No species of fish is restricted to the Pinelands, but there are 16 species indigenous to the acidic waters. The downstream areas of the Pinelands National Reserve encompass a major portion of New Jersey's estuarine systems.

Recreation in the Pinelands includes both primary contact and secondary contact activities. Primary contact recreation requires higher quality water than does secondary contact recreation.

Findings: The bog cultivation of cranberries has apparently not degraded Pinelands surface water quality because the Wading River drain-e sub-basin, where 80% of New Jersey's cranberries are harvested, is relatively pristine. Changes in the area's hydrology would have a major affect on the vegetation in the cedar bogs and swamps.

It is important to maintain the present stream velocities to preserve fish habitat. Upstream water quantity and quality must be maintained to preserve the estuaries. Extension of saline waters upriver would force the white perch and other fish out of their present habitat; existing estuarine nursery and spawning areas would be disrupted. There is some relationship between bathing water quality and bathers' illness.

Technical Memorandum SW IV-4 Water Quality Index

General: A water quality index was developed as an assessment tool. By combining a number of water quality parameters into one index, a generalized water quality map was produced and a general assessment of Pinelands water quality was made.

A water quality index was produced based on New Jersey Water Quality Standards. The five parameters used in the index were biochemical oxygen demand (BOD), total nitrogen, fecal coliform, suspended solids and total dissolved solids (TDS). Standards or cutoff limits were established and compared to frequency distributions developed for 80 water quality monitoring stations within the Pinelands National Reserve.

The following water quality classifications were established:

- Pristine
- Good
- Slightly Disturbed
- More Disturbed
- Most Disturbed

Findings: Of the 80 stations subjected to the water quality index, 2 were judged pristine, 15 good, 46 slightly disturbed, 10 more disturb-ed, and 7 most disturbed (see Figure 1). Each of the five parameters exhibited a high statistical correlation with the water quality index.

Technical Memorandum SW IV-5 Drainage Basin Assessment

General: The purpose of this technical memorandum was to summarize existing water quality, land use and potential pollution sources by drainage basin.

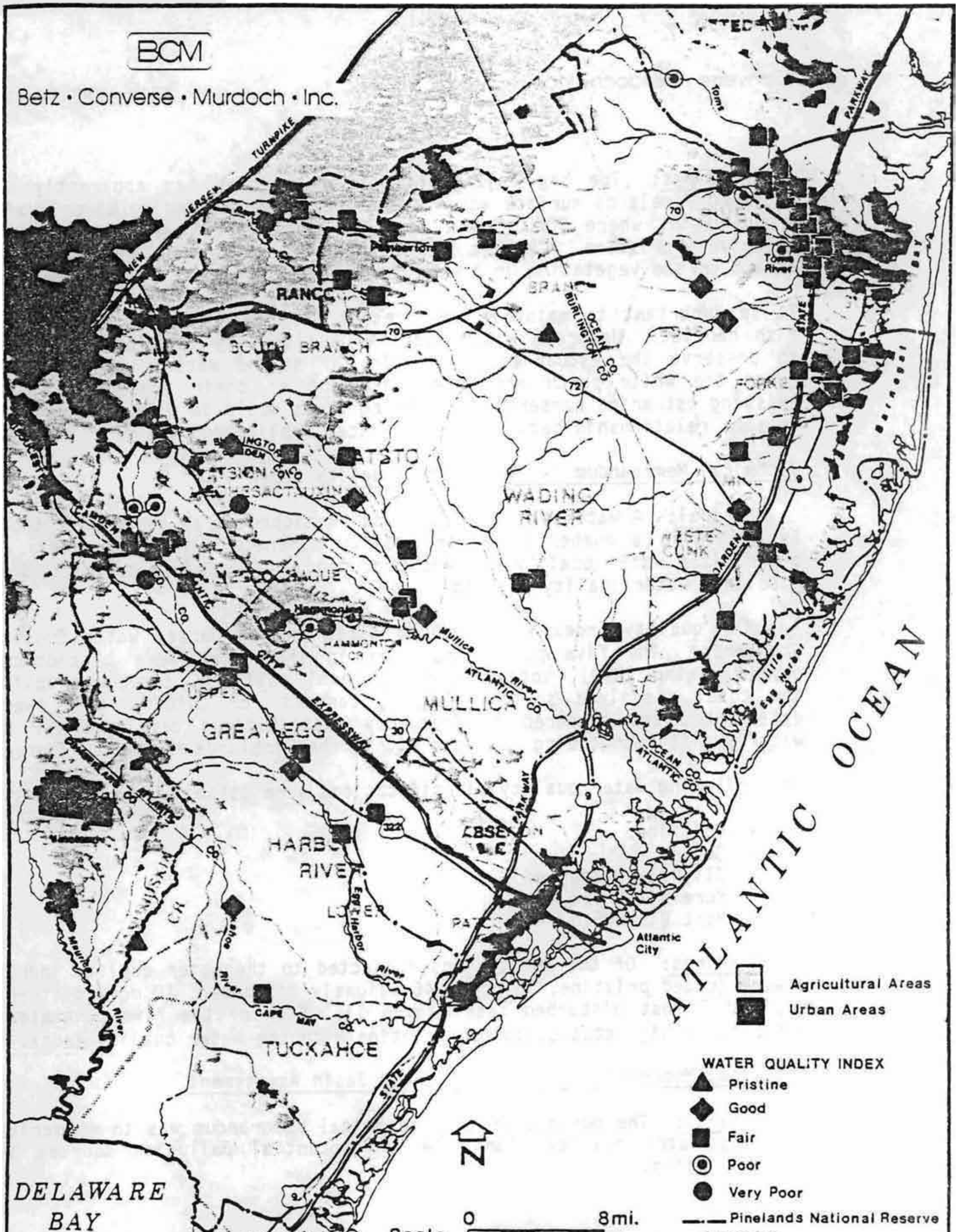

Figure 1. **WATER QUALITY** INDEX

The following major drainage basins and sub-basins were assessed (see Figure 2).

Drainage Basin	Sub-basins
1. Toms River	1.1 Toms River
2. Rancocas Creek	2.1 Rancocas North Branch
	2.2 Rancocas South Branch
3. Cedar Creek	3.1 Cedar Creek
4. Forked River	4.1 Forked River
	4.2 Oyster Creek
	4.3 Mill Creek
	4.4 Westecunk Creek
5. Mullica River	5.1 Bass River
	5.2 Wading River
	5.3 Batsto River
	5.4 Atsion-Mechesactzuxin Creeks
	5.5 Nescochaque Creek
	5.6 Hammonton Creek
	5.7 Mullica River
6. Great Egg Harbor River	6.1 Great Egg Harbor River (Upper)
	6.2 Great Egg Harbor River (tower)
7. Maurice River	7.1 Manumuskin Creek
	7.2 Lower Maurice
8. Absecon Creek	8.1 Absecon Creek
9. Tuckahoe River	9.1 Tuckahoe River
10. Dennis Creek	10.1 Dennis Creek
11. Patcong Creek	11.1 Patcong Creek

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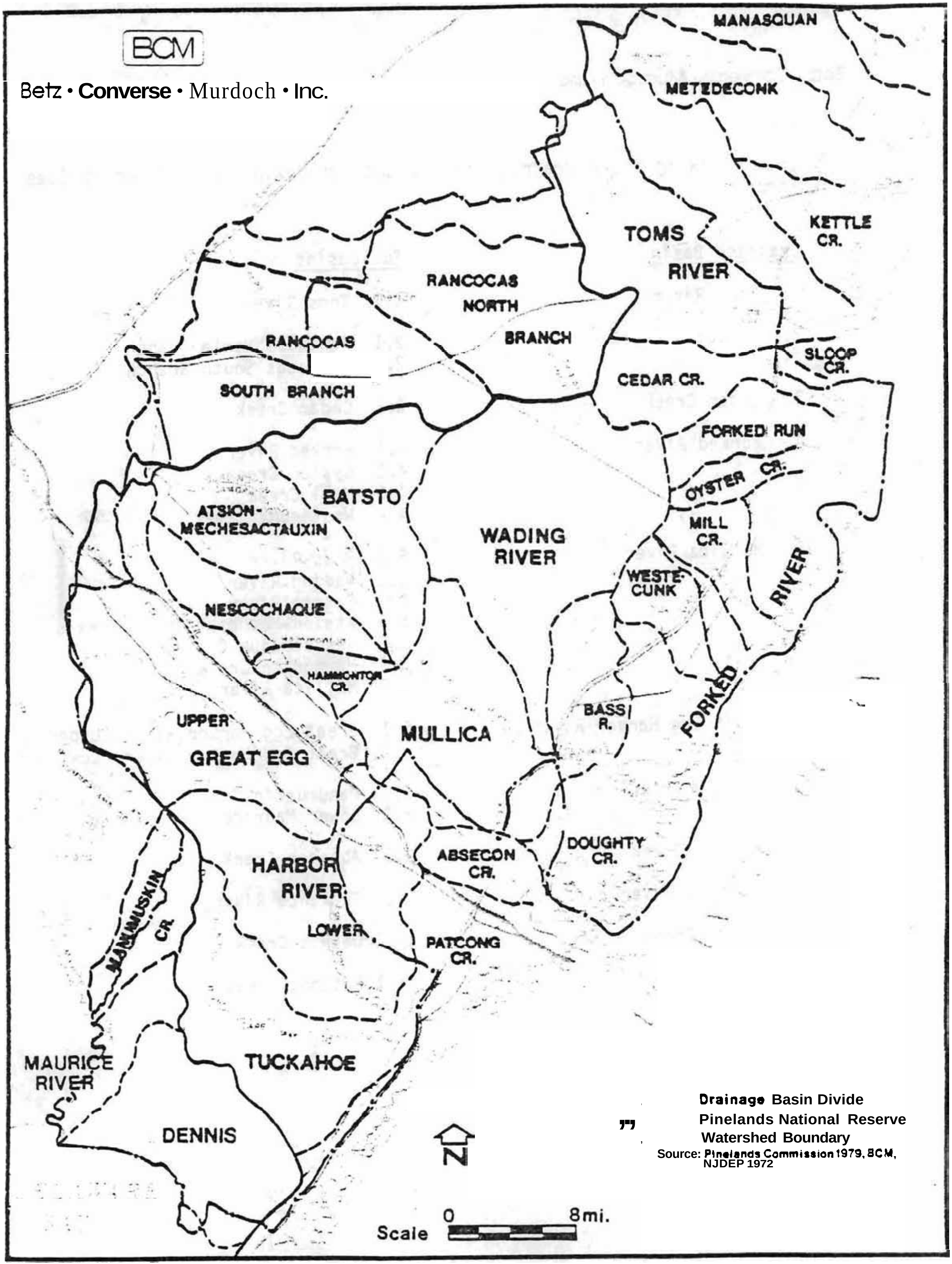

Figure 2. PINELANDS DRAINAGE BASINS

For each basin:

- The major tributaries, lakes and towns were listed
- Percentages of land use types were calculated
- Locations of point and site-specific nonpoint pollution sources (pipe discharge, landfills, spray irrigation sites, etc.) were mapped
- The quantity of domestic effluent expected at each water quality monitoring site was calculated
- The water quality index and median pH levels for all water quality monitoring stations within the basin were discussed
- A general assessment related the water quality conditions to probable pollution sources
- Recommendations for future studies within the basin were given

Some of the basins, such as Toms River and the Great Egg Harbor River, had substantial data sources, but other small basins, such as Absecon Creek and Patcong Creek, had minimal data.

Findings: Table 1 summarizes the major findings by basin.

Technical Memorandum SW IV-6 Land Use/Water Quality Effects

General: This technical memorandum contains the assessment of the effects of agricultural practices and urban development on Pinelands water quality.

Fifteen sub-basins were selected for a detailed study of land use effects on Pinelands water quality. The basins varied in geographic area, water quality level and percentage of agricultural and developed land. Water quality parameters for each sub-basin were compared graphically and statistically to land use.

Findings: The results indicated that agricultural land was associated with elevated levels of total dissolved solids, nitrogen and pH; developed areas were associated with elevated levels of total dissolved solids, suspended solids, biochemical oxygen demand, nitrogen and pH. Agricultural effects are due to fertilization and liming practices.

TABLE 1

DRAINAGE BASIN ASSESSMENT SUMMARY

Drainage Basin	Drainage Area (sq.mi.)	Number of Water Quality Stations	Water Quality	Land Use	Pollution Sources	Major Issues
1.0 Toms River	191 (55% in Pinelands National Reserve)	19	Good - upper Davenport Branch Slightly disturbed: main stem Ridgeway Branch Wrangle Brook Jakes Brook More disturbed: Union Branch Lower Davenport Branch Most Disturbed: Manapaqua Branch	Upper - relatively undeveloped Lower - generally developed	Domestic discharge Industrial discharge Landfills Urban runoff	• Point source discharge on Manapaqua Branch • Protection of Davenport Branch and Wrangle Brook segments outside of state landholdings • Protection of upper reaches and lakes • Impact on Barnegat Bay
2.0 Rancocas Creek						
North Branch	167	6	Pristine: McDonalds Branch Slightly disturbed: North Branch, upper South Branch	Upper-undeveloped (state land holdings) Lower-more developed	Domestic discharge Landfills Urban runoff	• Effects of landfills • Protection of lakes
South Branch	144	4	Most disturbed: lower South Branch	Upper-forested and agriculture Lower-more developed	Agricultural runoff	
3.0 Cedar Creek	56	3	Good to slightly disturbed	Forested Cranberry bogs Minor development	Downstream domestic discharge Minor urban runoff	Maint ... of good water qu... ity especially in basin segments outside of government land
4.0 Forked River						
Forked River	20	4	Good to slightly disturbed	Mostly undeveloped (forest) west of Route 9; developed east of Route 9	Landfills in upper reaches Point sources and urban runoff in lower reaches of several of the streams	• Protection of headwaters, cranberry bogs and lakes
Mill Creek	21	5	Good to slightly disturbed			
Oyster Creek	11	3	Slightly disturbed			
Westecunk Creek	21	2	Slightly disturbed			

TABLE 1 (Continued)

Drainage Basin	Drainage Area (sq.mi.)	Number of Water Quality Stations	Water Quality	Land Use	Pollution Sources	Major Issues
5.0 Mullica River						
Bass River East Branch West Branch	20	 1 0	Slightly disturbed	Undeveloped forest (1/3 state forest) Cranberry Bogs	Landfill	Protection of head-waters outside state-owned lands
Wading River West Branch Oswego River	176	 1 1	Slightly disturbed	Undeveloped forest Cranberry Bogs Blueberries		•Protection of headwaters outside state owned lands •Protection of cranberry bogs and lakes •Lack of water quality sampling stations
Batsto River	74	3	Good - downstream Batsto R. Slightly disturbed -upstream Batsto River, Springers Brook	Undeveloped; 75% in state park Cranberry bogs Agriculture in upper reaches	Agriculture runoff Landfills	•Effects of landfills •Pollution of Springers Brook
Atsion-Mechesactauxin Creeks	89	5	Good/Slightly disturbed Main stem - Mullica R. Most Disturbed - Wildcat Br.	Upper reaches: developed and agriculture Lower reaches: undeveloped; 67% in Wharton Tract	Industrial discharge Landfills Urban runoff Agricultural runoff	•Pollution of headwater from development •Effects of landfills •Industrial discharge
Neschochaque Creek	42	1	Slightly disturbed (most pollutant sources are upstream where there are no sampling stations)	Upper reaches: developed and agricultural Lower reaches: forest 25% in Wharton Forest	Industrial discharge Domestic discharge Urban runoff Agricultural runoff Landfill	•Pollution of upper reaches •Point source discharge •Effects of landfill •Lack of water quality stations near pollutant sources
Hammonton Creek	18	3	More disturbed/most disturbed	Agriculture Developed	Domestic point source Industrial point source Urban runoff Agricultural runoff Landfill	•Hammonton Creek is the most polluted major stream in the Mullica River basin •Effects of future growth and further degradation of water quality
Lower Mullica River	98	0 (only water quality station under tidal influence)	---	Mainly undeveloped forest Some agriculture and development	All pollutants from major tributaries Domestic discharge Industrial discharge	•Development in Atlantic County •Lack of water quality stations •Protect Great Bay

TABLE 1 (Continued)

Drainage Basin	Dralnage Area (sq.mi.)	Number of Water Quality Stations	Water Quality	Land Use	Pollution Sources	Major Issues
6.0 Great Egg Harbor River						
Upper Lower	205 99	13 11	Good - Deep Run Slight disturbed: Main stem below Sicklers-ville, Fourmile Branch Hospitality Branch Babcock Creek More disturbed: Mainstem above Sicklersville Host disturbed: main stem near Berlin Squankum Branch	Agriculture Developed: heaviest in upper reaches Undeveloped, forest	Domestic point discharge Industrfal polnt dis-charge Landfills Urban runoff Agricultural runoff	•Effects of development in upper reaches •Effects of agriculture on pH •Point source control •Pollution of Lake Lenape •Effects of coastal de-velopment on Babcock Creek and Gravely Run
7.0 Maurice River						
Manumuskin Creek	32	1	Pristine	Undeveloped, forest Minor development and agriculture	Industrial point dis-charge	-Protection of pristine water quality •Need for more water quality sampling stations
8.0 Absecon Creek	19	0	---	50%urbanized	Urban runoff	•Effects of Atlantic City developcent measure •Protection of Atlantic City Reservoir •Protection of Absecon Bay •Need for water quality sampling stations
9.0 Tuckahoe River	70	2	Good/Slightly disturbed	Undisturbed. forest State fish and game land Development Agriculture	Industrial discharge Landflll	•Protection of tribu-taries upstream of state lands
10. Dennis Creek	72	0	---	Undisturbed, forest includes state land	Domestic point discharge Landfills	•Need for water quality sampling statlons on Dennis Creek and West Creek
11.0 Patcong Creek	26	0	---	Oeveloped along coast	Domestic point discharge Urban runoff	•Protection of Patcong Lake •Need lor water quality sampling statlons

Elevated parameters in developed areas are due to stormwater runoff, malfunctioning septic systems, leachate from site-specific nonpoint sources and point source discharge.

Although there were too few data points to incorporate domestic discharge into the statistical analysis, the preliminary analysis indicated that point source domestic discharge may be responsible for elevated phosphorus levels. Separate calculations were made to estimate the water quality effects of typical secondary treated domestic effluent.

If the relaticnship between land use and water quality is verified by additional data, the analysis may be useful in estimating water quality in unmonitored basins.

Technical Memorandum SW IV-7 Controls for Nonpoint Pollution Sources

General: Technical Memorandum SW I\(-7 summarizes the "best management practices" (BMPs) available for control of nonpoint sources of pollution and directs the reader to additional sources of data.

Management practices recommended on a national scale by the U.S. Environmental Protection Agency (EPA), and on a local level in New Jersey 208 areas were reviewed. A general data base was provided from which to choose the methods best suited to the Pinelands.

Findings: Three 208 studies which include portions of the Pinelands in their study area concluded that point sources are the primary critical problem. The strategy for point sources is to rectify existing water quality problems, whereas nonpoint source control stratecjy must emphasize the prevention of potential future problems. A wide variety of management practices can be used to reduce the effects of nonpoint pollution and ensure that established performance standards are met.

MAJOR CONCLUSIONS

Description of a Pristine Pinelands Stream

A typical, high quality Pinelands stream such as McDonalds Branch in the North Branch Rancocas Creek watershed is slow moving, brown but clear, has a sandy substrate and is overhung by dense vegetation. The water is soft and pH is low. It generally has a high level of dissolved humic matter, especially in the summer months, and may have fluctuating oxygen levels due to bog and swamp drainage and organic demands. There are low levels of nutrients, suspended and total dissolved solids. It can be classified as dystrophic.

The following tabulation summarizes the average water quality levels of McDonalds Branch and of Pineland streams in general and compares them to the proposed New Jersey Water Quality Standards for the Central Pine Barrens. The figures in the tabulation represent mean water quality levels in mg/l unless otherwise stated.

	mg/l		
	McDonalds Branch	All Pineland Streams	New Jersey Standards
pH (median)	4.1	4.5	3.5 - 5.5
Suspended Solids	1.4	12.5	40
Total Dissolved Solids	25.8	20	100
Dissolved Oxygen	4.7	8.3	85% saturation
Biochemical Oxygen Demand	0.8	2	5
Fecal Coliform (median)(MPN/100 ml)	2	33	200
Nitrate - N	0.01	0.63	2.00
Total Nitrogen	0.27	1.4	---
Total Phosphorus-PO4	0.035	0.46	0.7
Turbidity (JTU)	1.9	4.6	20
Total Organic Carbon	8.1	8.5	---
Arsenic, total (ug/l)	0.83	6.2	50
Cadmium, total (ug/l)	0.083	1.3	10
Chromium, total (ug/l)	11.67	19.0	50 (hexavalent)
Copper, total (ug/l)	2.75	18.3	
Iron, total (mg/l)	0.363	1.1	
Lead, total (ug/l)	4.5	16.7	50
Nickel, total (ug/l)	1.5	13.7	
Zinc, total (ug/l)	30.0	40.6	
Aluminum, total (ug/l)	166.7	220.4	
Mercury, total (ug/l)	0.37	0.65	5
Dieldrin (ug/l)	0.0000	0.0009	
Toxphene (ug/l)	0.0000	0.0000	
Malathion (ug/l)	0.0000	0.0000	
Silvex (ug/l)	0.0000	0.0172	

Inert Soils will Affect Surface Water Quality

The majority of upland soils in the Pinelands has a high percentage of sand and is relatively inert. Water entering the soil column through precipitation, stormwater runoff or leachate passes through relatively unchanged; little pollutant renovation is accomplished through the soil layer. This concept has a substantial impact on surface water quality predictions and management recommendations.

Streams with Low Average Flows are Sensitive to Pollution

Streams with catchment areas, usually less than 20 square miles, have low average flows and do not have the capability of assimilating large waste loads. From the water quality index results it can be seen that small tributary streams have a very good water quality or very disturbed water quality, depending on the upstream land uses. Streams with higher average flow values (e.g., main stems, 4th and 5th order streams) can better assimilate organic wastes.

Water Quality Index Shows Strong Relationship to pH Levels

There is a relatively consistent inverse relationship between pH and general water quality conditions (see Figures 1 and 3). Areas exhibiting higher pHs generally have lower water quality. This conclusion is supported by statistical analysis in Technical Memorandum SW IV-6.

Land Use has a Sianificant Impact on Surface Water Quality

Stream stretches with pristine or good water quality generally drain areas of natural vegetation which have few point sources or site-specific nonpoint sources of pollution. Stream stretches draining areas in row crop agriculture generally have higher pH levels, higher nitrogen levels, and higher total dissolved solids levels due to fertilization and liming practices.

Streams draining areas of suburban and urban development generally contain elevated pH, suspended solids, total dissolved oxygen demand (BOO) and nitrogen. The high levels are due to malfunctioning septic systems, stormwater runoff, point source discharge and leachate from site-specific nonpoint pollution.

Point versus Nonpoint Sources of Pollution

A common question in any assessment of water quality is which has the greater effect, point or nonpoint sources. This is a very difficult question to answer in the Pinelands. Our data have shown that both are capable of degrading water quality. Hammonton Creek is an example of a watershed degraded by point sources. Squankum Branch in the Upper Great Egg Harbor basin is one small agricultural area with very poor water quality, yet has no known point discharge. Nonpoint sources are more pervasive; every stream draining a developed or agricultural area will be affected. Point sources affect only stream segments downstream of discharge, but very often can discharge greater amounts of pollutants

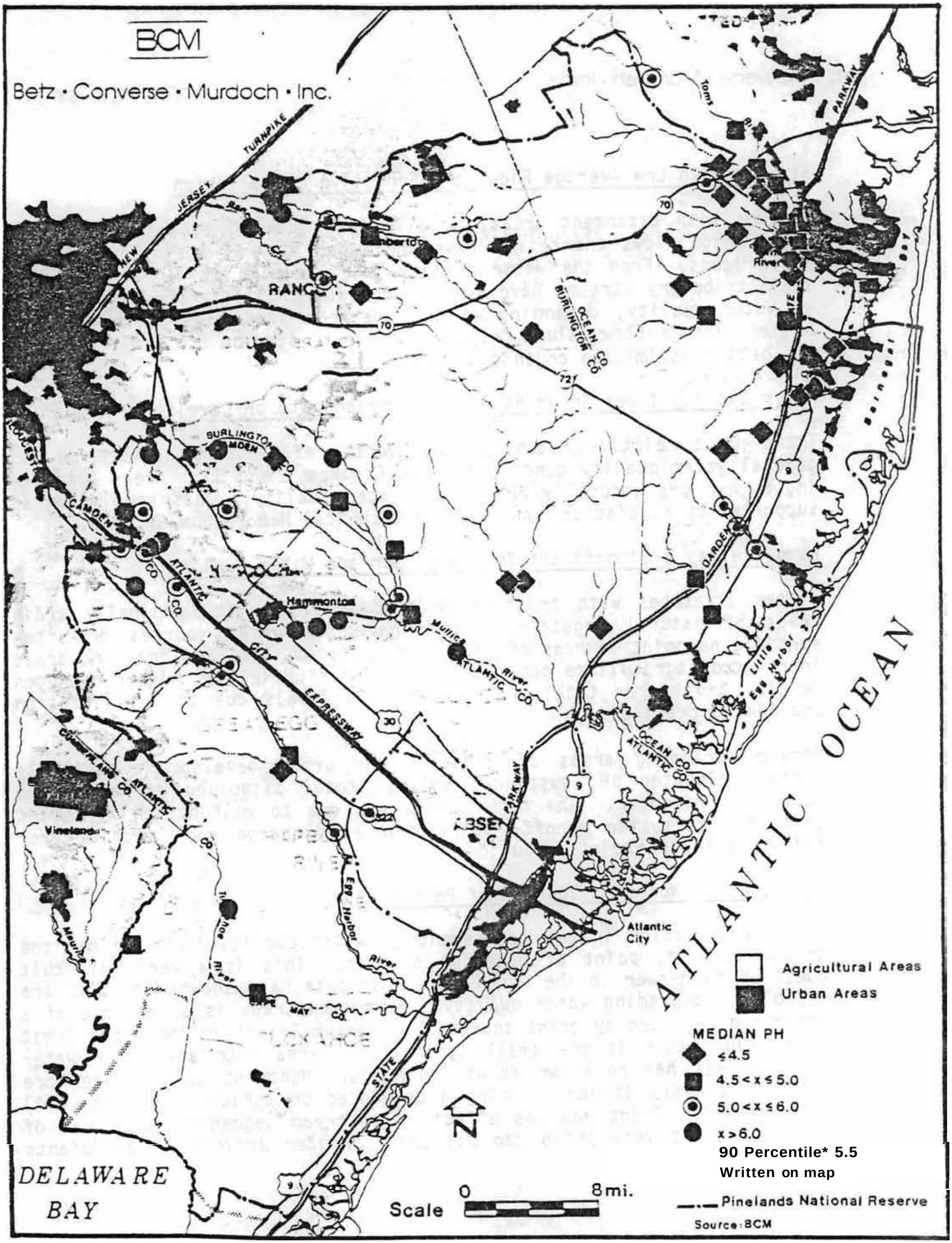
BCM
Betz · Converse · Murdoch · Inc.
NEW JERSEY TURNPIKE
Hammonton
ATLANTIC CITY EXPRESSWAY
GARDEN STATE PARKWAY
Atlantic City
Vineland
DELAWARE BAY
ATLANTIC OCEAN
Agricultural Areas
Urban Areas
MEDIAN PH
≤4.5
4.5 < x ≤ 5.0
5.0 < x ≤ 6.0
x > 6.0
90 Percentile* 5.5
Written on map
Pinelands National Reserve
Scale 0 8mi.
Source: BCM

Figure 3. pH

than nonpoint sources. Nonpoint sources will always be more important in terms of the linear miles of stream affected. What is most important at a downstream point on the main stem depends on many factors.

Various areawide water quality management plzns (208) have emphasized the degrading effects of point sources:

- "Nonpoint sources are very often not the dominant contributor to poor stream quality." (DVRPC's Tri-County 208 Study)
- "Nonpoint source pollution in the Ocean County area does not represent a serious problem." (Ocean County 208)
- "Pollution resulting from point source discharges caused most of the observed water quality problems in streams of Atlantic County." (Atlantic County 208)

The analysis in Technical Memorandum SW IV-6 of 15 watersheds showed water quality to be degraded by development of the basin regardless of whether point sources were present. The Pinelands, not being heavily developed, have fewer and smaller point sources than more developed areas of the state. Because there are fewer point sources, nonpoint sources play a greater role. It is difficult to determine which pollutant source--point or nonpoint--will have the greater impact on the Pinelands in the future. As the ares. develops and point source discharges to streams are used for waste disposal, point sources will become increasingly important as pollutant sources. However, because many point source loads are being reduced because of treatment plant upgrading and industrial pre-treatment requirements, the relative effect of each point source may diminish.

A common method of assessing the relative importance of point and nonpoint sources for a watershed is to estimate the total annual poundage produced by each source using previous studies and measured effluent chzracteristics. Total poundage may be a misleading unit of comparison between point and nonpoint sources because it does not consider the timing and "slug" concentrations of pollutant loadings. Point source pollutants usually enter streams continuously; nonpoint sources release pollutants as a result of storm events. The ecological effects from point and nonpoint sources may differ significantly.

Sensitivity of the Pinelands System to Water Quality Changes

The major water quality parameters associated with development which may alter stream ecosystems and Pinelands vegetation are pH, suspended solids, total dissolved solids, and nutrients.

pH: The Pinelands ecosystem is adjusted to a low pH. Some species prefer low pH, others tolerate it and non-Pineland species which cannot function at low pHs cannot compete. If the pH is elevated, the species pool will change.

Land uses affecting pH include liming of row crops for soil improvement, domestic discharge (point and nonpoint) and final discharge of water treated in a municipal water treatment plant (pH of water supply must be 6.0 - 8.5).

Suspended Solids: Suspended solids loads are normally very low in the Pinelands. resulting in clear streams. Increased sediment loads can smother bog vegetation and fish eggs, clog the gills of filter feeders, change the stream bottom substrate, interfere with fish behavior and transport toxins and nutrients. Although periodically high suspended solids loads are common in any system, continually elevated levels will have a deleterious effect on a system.

Land uses that could increase suspended solids loads in Pineland streams include vegetation clearing and soil disruption during construction, street runoff and poor agricultural practices. Increased flooding resulting from development can cause bank erosion.

Total Dissolved Solids (TDS): TDS values are low in the Pinelands. Many indigenous Pineland species, including cranberries, are calciphobic (prefers an acid mediam poor in calcareous matter) and have adjusted to low ionic strength waters. An increase in TDS wil cause a shift in the species pool.

Factors which affect total dissolved solids include row crop agriculture (fertilizer and lime additions), domestic waste discharge, leachate from site-specific nonpoint sources, and street runoff.

Nutrients: Nitrogen and phosphorous levels are low in typical Pineland waters. Technical Memorandum SW IV-3 illustrates the significance of low nutrient levels on stream macrophytes and algal populations, cranberry and blueberry production, endemic Pinelands vegetation (including cedar bogs), and downstream estuaries.

Nitrogen levels are increased in Pineland streams by fertilizer used on row crop agriculture, and from domestic waste discharge (point and nonpoint) and runoff from lawns and streets.

The detailed basin analysis in Technical Memorandum SW IV-6 suggested that phosphorous may be a pollutant closely associated with domestic point source discharge. A phosphorus level below 0.05 parts per million (ppm) is recommended by the the U.S. Environmental Protection Agency (EPA) as necessary to protect impoundments; 0.23 ppm-P is the state standard for Central Pine Barren streams. An expected concentration in effluent from secondary treatment of domestic waste is 5 ppm.

Estuaries May be Impacted by Water Quality Changes in Pinelands Streams

Many of the Pinelands rivers drain to small, semi-enclosed estuaries whose water exchange with the ocean is minimal. Affected bays include Barnegat Bay, Manahawkin Bay, Great Bay, Great Egg Bay, Absecon Bay and Little Egg Harbor. Because of their minimal flushing capabilities, they will be impacted by increased nutrient loadings.

If stream flows are reduced in the Pinelands due to groundwater withdrawals, or become flashy due to the reduction in recharge areas, the estuaries will be deleteriously affected, The isohalines (salt concentration delineation) will shift upstream, altering the brackish water ecosystem. Freshwater marshes will shift to brackish marshes, aquatic nursery and spawning areas will be altered, the sediment deposition zones at the freshwater-saltwater interface will shift upstream, and estuarine circulation patterns may be altered.

Pinelands Agriculture is Sensitive to Water Quality/Water Quantity Conditions

Cranberry and blueberry agriculture is indigenous to the Pinelands and is encouraged in the Pinelands Act. The literature indicates that both crops are sensitive to changes in nutrient loads, pH, depth to water table and water availability. Increases in pH and/or nutrient loads or changes in the N:P ratio will cause increased vegetative growth, a subsequent loss of berry production and encourage competitive species. The water table must be adjusted by drainage and irrigation to maximize production. (Blueberries prefer a greater depth to water table than cranberries.) Adequate water supplies are required in cranberry production for irrigation, protection from frost and winter kill, harvesting and pest control. A rule of thumb is a 10:1 ratio for area of water supply to area of cranberry bog.

MAJOR ISSUES AND RECOMMENDATIONS

An analysis was performed to determine what major issues and management recommendations should be considered in the development of a Pinelands Plan. Two major groups of factors were considered: land use (agricultural use and development land) and geographic factors (bogs, pristine streams, estuaries, etc.).

The following matrix (Table 2) presents the major factors that are relevant to the management of the Pinelands, the related major issues, and recommendations.

Three issues are significant:

1. Effects of row crop agriculture on Pinelands water quality

2. Appropriate and adequate disposal of wastes

3. Protection of sensitive geographic areas:

   Cranberry bogs
   Lakes and impoundments
   State and federal landholdings/Pinelands Preservation Area
   Estuaries

These issues are discussed below, along with a discussion on suitability for development and appropriate recommendations aimed at mitigating water quality problems. A brief summary of potential water quality management strategies is also included.

Effects of Row Crop Agriculture on Pinelands Water Quality

Concern: A review of the literature and the results of Betz•Converse•Murdoch•Inc.'s (BCM) land use/water quality studies show that row crop agriculture can and is having a significant impact on Pinelands water quality (e.g., Hammonton Creek and the Upper Great Egg Harbor River tributaries). Agriculture, however, is encouraged in the Pinelands Act.

Because soils suitable for row crop agriculture are limited in the Pinelands, agriculture will probably not expand further into the Pines. Nevertheless, the Commission must decide a policy for areas already being farmed. To require streams in these agricultural zones to meet standards similar to those set for naturally vegetated areas of the Pinelands would essentially halt row crop agriculture in these areas.

Recommendations: Several recommendations are offered to mitigate the effects of row crop agriculture on Pinelands water quality.

1. Require strict best management practices (BMPs) on land in row crop agriculture. With the aid of the Soil Conservation Service and the soil conservation districts, determine the fertilization and liming methods that will least affect stream quality.

TABLE 2

WATER QUALITY ISSUES AND RECOMMENDATIONS
SUMMARY MATRIX

Plan Development Factors	Major Issues	Recommendations
<u>Agricultural Use</u>		
Row Crops and Orchards	• Elevated pH due to liming practices (except blueberry cultivation) • Nutrient increase due to fertilization • Potential suspended solids loads due to erosion TDS increase due to liming and fertilization • Potential toxic problem due to use of pesticides	Develop BMPs for liming, fertilization and pesticide use in cooperation with SCS and Soil Conservation Districts • Minimize spread of row crop agriculture to sensitive area
Livestock	• Increase in nutrient and organic loading • Increase in bacteria concentration	• Limit access of livestock to streams • Control runoff from feedlots ▪ Prohibit feed lots on highly pervious soils without adequate treatment of wastewater
Cranberry Production	▪ High nutrient loads or elevated pH in receiving water will cause vegetative growth at expense of berry production and encourage competitor species ▪ Potential impact of siltation on cranberries ▪ Pesticide use on cranberries is minimal • Dependent on adequate water supply	• Discourage upstream development which will increase pH, nutrients or suspended solids • Maintain water supplies above bog rreas • Strict protection required in areas of major cranberry production (e.g., Wading River)
<u>Developed</u>		
Percent Land Cover	• As percentage of cover increases, recharge areas decrease, runoff increases ▪ Increased runoff from lawns, roads. parking lots, etc. carries contaminents Including: Nutrients Hydrocarbons Heavy metals Bacteria Toxins	• Encourage groundwater recharge Maintain natural vegetation, discourage lawns • Control quality and quantity of stormwater runoff • Land uses expected to produce contaminants should: • Be prohibited from inert, pervious soil ▪ Require a set back from any waterways ▪ Discouraged from areas upstream of critical zones
Wastewater Systems	▪ There Is a large chance of septic system failure due to inert soils Systems will impact: pH bacteria levels nutrient loads TDS Toxic concentration (system cleaners) • Illegal connections will degrade water quality • Regional sewage treatment plants may impact: pH nutrients TDS Chlorine ▪ Impact of recharge loss due to sewers must be determined • Regional system will encourage future growth	▪ Establish septic system policy (adequate soils. density) Establish septic system management districts ▪ Enforce state and Federal anti-degradation acts ▪ Discourage large regional STPs ▪ Discourage stream discharge especially above critical areas Establish regulations concerning dilution and degree of treatment for STPs (especially nitrogen. phosphorus and pH) Investigate small STPs with high nutrient removal capabilities and grond discharge for clustered settlements Require upgrading and/or removal of major existing dischargers (e.g., Hammonton Creek) ▪ Prohibit use of phosphate detergents

TABLE 2 (Continued)

Plan Development Factors	Major Issues	Recommendations
<u>Developed Areas</u> (Continued)		
Water Supply	• Municipal and industrial water supply require neutral pH • Discharge of waters with elevated pH will impact Pineland streams	• Discourage municipal water supplies unless pH can be adjusted • Encourage the use of plastic pipes in home to minimize corrosion from acid waters
<u>Industrial Use</u>		
Wastewater and Cooling Water	• Potential source of contaminants including: toxins metals heat organic waste elevated pH • Discharge of industrial waste to municipal STP may impact treatment method and effect sludge disposal	• Encourage alternatives to stream discharge • Cooperate with DEP for stricter discharge and pretreatment requirements • Discourage stream discharge above critical areas
Lagoons and Materials storage areas	• Improperly located, designed and/or maintained lagoons or storage areas will impact ground and surface water	• NJDEP has a statewide lagoon study underway. The Pinelands Commission should provide input and request management suggestions
Illegal Discharge	• Will impact ground and surface water quality	• Coordinate with appropriate DEP agency
<u>Solid Wastes</u>	• Solid waste may include: household rubbish industrial wastes sewage sludge septic wastes construction debris • Land fill leachate can impact ground and surface water	• Discourage wastes from outside of Pinelands • Determine availability of solid waste handling facilities before development is approved • Establish solid waste handling facilities for wastes generated within the Pinelands. Regional centers can be established based on current technology (recycling, reclamation, proper landfilling, etc.) • Establish collection districts and managment agencies • Coordinate with NJDEP sludge management program for STPs • Septic waste control should be addressed in septic system management plan
<u>Geographic Factors</u>		
Small Tributary Streams (draining less than 20 sq.mi.)	• Low waste assimilative capacity • Different aquatic communities than in main stems of river • Small streams in the upper reaches of a watershed (upper 1/3 of basin) will have significant effect on quality and quantity of lower reaches of a stream system	• Set strict performance standards for development • Discourage commercial and industrial development with associated road and parking lot runoff • Minimize percent cover • Use discharge regulations and enforcement of state and federal anti-degradation policies • Determine assimilative capacity of low flow streams and use as a basic for permitted levels of development upstream

TABLE 2 **(Continued)**

Plan Development Factors	Major Issues	**Recommendations**
Geographic Factors (continued)		
State and Federal Landholdings Pinelands National Reserve	• Areas will be kept natural and/or used for recreation • Water quality should be maximized	• Protect streams entering state and federal landholdings and the Preservation area • Set strict performance standards for sections of the watershed above the critical areas. especially for control of bacterial contamination, pH levels, nutrient levels and suspended solids loads • Discourage use of motor boats to minimize bank erosion
Cranberry Bogs	• Sensitive to water quality/quantity changes • Cranberry agriculture encouraged in Pinelmds Act	• Encourage cranberry production • High priority protection for areas upstream of cranberry bog acquistion strict performance standards lowest density zoning enforcement of anti-degradation policies water quality management districts
High Quality Streams	• Exhibit Pinelands character • Maintain Pinelands aquatic communities • Sensltive to pollution - easily altered	• High priority protection for watersheds of known pristine streams
Estuaries	• Receive Pinelands drainage • Bays with low flushing rates and minimal exchange with ocean will be most impacted by water quality changes	Set stricter water quality standards for rivers flowing to small. enclosed estuaries: Toms River Cedar Creek Forked River Basin Mullica River Great Egg Harbor River Tuckahoe River Absecon Creek Patcong Creek

2. Discourage row crop agriculture from spreading to other areas of the Pinelands, especially areas draining into the National Reserve area or upstream from cranberry bogs or lakes.

3. If nonfarmable land is available in watersheds with row crop agriculture, encourage uses that will not further increase pH or nutrient loads,

4. Establish water quality management areas and provide farmers with incentives for minimizing the use of fertilizer and lime.

Appropriate and Adequate Disposal of Wastes

Concern: A number of major sources of water pollution associated with development result from improper handling of domestic and industrial wastes. This mishandling of waste is reflected in pollution from improperly managed or located septic tanks, landfills, waste lagoons and point source discharges of industrial and domestic wastes. Part of the control strategy is to correct existing problems., But, in addition, because the Pinelands is relatively undeveloped, there is an opportunity to anticipate the demand for handling waste from future development. The size and location of the expected population, as we11 as the quantity and types of waste generated, may be estimated. Careful planning should be done to ensure that appropriate institutions and physical plants are available to handle the anticipated wastes.

Recommendations: Three recommendations are offered to ensure that waste disposal will not adversely the water quality of the Pinelands streams.

1. Landfills

- Existing landfills should be surveyed to determine if they are causing water quality problems. If so, appropriate corrective steps should be taken,

  Transfer of wastes into the Pinelands from outside should be discouraged to limit the number and extent of required landfills in order to protect the integrity of the Pinelands ecosystem.

  Regional solid waste recycling and disposal centers should be established to handle waste from existing and future development in the Pinelands. The establishment of these centers should coincide with anticipated growth. The current technology should be used to ensure environmentally safe disposal and reuse.

2. Domestic Wastes

- Steps should be taken to ensure proper location, design and maintenance of septic tanks, as we11 as the application of innovative environmentally acceptable methods of septage disposal. This would' require regulations for septic tank location and density and a system of regional management of septic tanks.

- Upgrade or eliminate point source discharges where they cause significant stream degradation, e.g., Hammonton Creek.

- Discourage new point source discharges, especially above stream segments requiring special protection.

- Encourage strict enforcement of federal and state anti-degradation policies in the Pinelands.

- Establish regulations to control dilution levels, and degree of treament, including nutrient removal and methods of disinfection of any new, approved point source discharge.

- Discourage large regional plants which transfer water out of basins and that may attract unplsnned develcpment.

- Encourage the use of innovative wastewater systems to ensure the protection of groundwater. If found feasible, these generally smaller systems would encourage development clustering, reduce stream discharge, and recharge groundwater.

- Coordinate with the Office of Sludge Management and Industrial Pretreatment, New Jersey Department of Environmental Protection, to ensure that sewage sludge in the Pinelands is disposed of in an environmental ly acceptable manner.

3. Industrial Wastes

- Upgrade or eliminate industrial point source discharges where they have been identified as causing significant water quality degradation.

- Coordinate with the Off ice of Sludge Management and Industrial Pretreatment to ensure that industrial wastes entering municipal sewage treatment plants are controlled.

Coordinate, with the Division of Water Resources, on their state-wide survey of industrial lagoons to ascertain lagoon effects on the water quality in the Pinelands.

Protection of Sensitive Geographic Areas

Concern: The major findings illustrate the sensitivity of cranberry bogs, pristine Pineland stream communities, lakes and impoundments to changes in water quality and quantity. Even if these areas are included in state and federal landholdings or within the Pinelands Preservation Area, they will not be protected if land uses deleterious to water quality are permitted upstream. The coastal bays which are the ultimate receivers of Pineland drainage must also be protected.

Recommendations: Sensitive geographic areas can be protected by applying the recommendations described below.

1. Areas upstream of cranberry bogs should be regulated by strict land use controls. Any use potentially raising pH, nutrients or suspended solids should be restricted.

2. Areas above impoundments (especially in the upper reaches of a drainage basin) should be regulated to minimize levels of nutrients and suspended solids.

3. Sections of drainage basins outside and upstream of federal or state landholdings and the Pinelands Preservation Area should be carefully managed. Strict controls of bacterial contamination, pH, nutrients, and suspended solids are most critical.

4. River system nutrient budgets should be developed which can be used to establish nutrient limits for the protection of estuaries areas.

Suitability for Development

In addition to the previous three major issues and their associated recommendations, some general statements can be made on the suitability of various Pinelands areas for development. The following sections discuss areas that will be least impacted by development, areas where development should be prohibited and areas requiring careful management in order to protect Pinelands water quality.

1. Areas where development will have the least impact on water quality

Lands draining to main stems of rivers (especially 4th and 5th order streams)

Reason: River stretches with high average flows can better assimilate wastes due to dilution and biological activity.

Soils with a significant clay content that will absorb pollutants, but are still pervious enough to allow adequate recharge. (The soils consultant can better identify the pertinent soil groups.)

Reason: To reduce groundwater and surface water pollution, development should be planned for areas with soils having the greatest renovation capabilities. The small-sized, negatively-charged clay particles best absorb pollutants such as phosphate, metals and organic compounds. If, however, the clay content of a soil is too high, soil porosity will be reduced and overland runoff during storm events will become a major problem.

- Land with depth to seasonally high water table at least six feet from the surface

Reason: The water table should be deep enough to allow adequate drainage and reduce overland runoff. A water table at least six feet from the surface will limit problems for homes with basements and/or septic fields. The New Jersey DEP Standards for the Construction of Individual Sub-surface Sewage Dispcsal Systems state that the seasonally high water table should be at least four feet below the bed of the septic drainage field. The pipes are usually laid two feet below the surface.

2. Areas which should be prohibited from development

- Land with depth to seasonally high water table less than two feet from the surface and in natural lowland or wetland vegetation

Reason: Areas containing natural lowland or wetland vegetation should be protected due to their water quality renovation potential. The plants themselves and the organically rich soils will absorb many pollutants before they enter the main stream systems. If development is allowed in areas of high water table, pollutants will enter the hydrologic system directly with no renovation. Development types which would have the most deleterious effects are high density residential and commercial and industrial with large areas of parking lots and roads.

- All D hydrologic group soils and C hydrologic groups soils having a direct hydrologic connection with Pinelands streams (see Technical Memorandum SW I for details)

  Reason: These soils will have a high water table and a high runoff potential. Pollutants will be transported to the stream systems with little renovation.

3. Areas requiring strict land use management controls

- Upland areas with sandy, inert soils

  Reason: Any pollutant entering these soils will reach the groundwater which is directly connected to surface water bodies relatively unchanged. These soils have minimal renovation ability.

  Four mitigative measures can be applied to ensure the integrity of these areas:

  a. Domestic wastes must be sufficiently treated before it is discharged

  b. Natural vegetation should be maximized; lawn maintenance requiring liming and fertilization should be discouraged

  c. Groundwater recharge of pollutant-free water should be encouraged

  d. Development types with anticipated high levels of pollutants (parking lot runoff, high density development, etc.) should be discouraged

- Lands bordering wetland areas

  Reason: These lands will probably contribute direct runoff to the wetlands. Wetland areas provide waste renovation, improving water quality. They are also sensitive to water quality changes and should be protected.

  Four mitigative measures can be applied to control runoff and protect wetland areas:

  a. Domestic wastes must be sufficiently treated

b. Stormwater runoff which has been routed through a settling basin to adequately reduce suspended solids loads can be discharged to wetlands (if nutrient and pH levels are approved)

c. Nutrients should be minimized and pH levels stabilized

d. Strict sediment control measures should be enforced

Potential Water Quality Management Alternatives

Four potential water quality management alternatives are discussed in this section. All four alternatives should be used to preserve Pinelands water quality.

1. Acquisition of Critical Areas

This is the most effective method of ensuring that water quality is protected.

2. Zoning, Subdivision and Site Plan Ordinances

This alternative requires coordination among municipalities and relies on standard land use management methods.

3. Performance Standards

Performance standards offer an effective management tool for specific pollution problems. Different performance standards can be established for different basins of the Pinelands. Performance standards can be based on known best management practices for nonpoint sources and the particular soil and water conditions in the Pinelands.

4. Pollutant Allotment System

A pollutant allotment system is based on a drainage basin approach to water quality management. It assumes that one of the ultimate aims of the Pinelands Plan is to protect water quality and ensure water quality levels which will preserve sensitive areas. Instead of protecting water quality on a site-by-site basis (as with performance standards), the allotment system is based on a desired water quality level at the bottom of a drainage basin and requires that only land uses and activities which will maintain water quality at the desired level will be allowed in the drainage basin. The precedent for a pollutant allotment system is found in the offset policy (trade-offs) used for air quality control, waste load allocations for point source discharges, and water rights legislation in the western states.

Water quality management districts should be established based on watershed boundaries. The lower boundaries of a district can be established by considering the sensitivity of downstream uses to changes in water quality. For instance, one district could be established upstream of cranberry bogs. Another district, with slightly less stringent standards, would exist between the cranberry bogs and the receiving estuary.

Water quality standards would be set for each management district based on the requirements and critical limits of the downstream use needing protection. Based on the literature, the pollution potential of land uses would be rated and control techniques would be rated for their ability to reduce pollutants. Additional pollutant levels allowed in the district could be calculated by subtracting existing pollutant levels from maximum levels specified in the district standards. No new land uses would be allowed in a basin (after application of the best control method) which would cause the standard of the management district to be exceeded.

A simplified example of how a water quality management district would function is described in the following paragraphs; many questions would require answers before a feasible pollution allotment plan could be established.

Assume that a watershed drains to an area devoted to cranberry production. To protect the cranberry industry, nitrogen levels in the water entering the bogs should be less than 1 mg/l, suspended solids less that 10 mg/l, and pH between 3.5 and 5.5. (Additional research may be required to establish the actual standards.) The first step would be to determine existing conditions in the watershed. Assume that under average conditions, total nitrogen is 0.4 mg/l, suspended solids are 5 mg/l and median pH is 4.2. The difference between the established standards and the existing conditions can be allocated to allow new land uses in the basin, i.e., land uses contributing 0.6 mg/l of nitrogen would be allowed in the basin.

Assume that a landowner submits a development application to the Pinelands Commission to build four houses in the management district above the cranberry bog. He must show proof that the proposed domestic waste disposal methods, use of fertilizer, and stormwater runoff will not contribute more than 0.6 mg/l of total nitrogen to the system. The applicsnt can meet this limit by incorporating appropriate control measures into his development plan or opt to plan his subdivision in another management district which has less strict standards (downstream of the cranberry bogs).

In drainage basins with minimal existing development, only a portion of the allotment would be given to any particular development by the Pinelands Commission. These percentages can be based on a Pinelands land use plan.

RECOMMENDATIONS FOR FUTURE STUDY

Based on the findings and conclusions of this study, BCM has identified nine critical aspects of the Pinelands that should be considered for future study.

1. Develop additional water quality indices and refine existing index (see Technical Memorandum SW IV-4 for details)
   - Toxins index
   - Indices based on aquatic comminity requirements, water use, or recreation requirements
2. Develop critical area map for water quality
   - Map cranberry production areas, state and federal landholdings and Pinelands National Reserve areas

     Map watersheds of streams draining into these critical areas to define those requiring strict land use controls
3. Conduct research on the water quality/quantity needs of cranberries and blueberries
4. Test and refine the regression analysis to allow water auality predictions on unmonitored streams (see Technical Memorandum SW IV-6).
5. Determine waste assimilative capabilities of small low flow streams and use as a basis for upstream development levels.

6. Develop pollutant allotment system

   - Define management districts
   - Develop standards
   - Develop water quality predictive models for the management districts
   - Determine pollution potential of Pinelands land uses
   - Develop management plan

7. Conduct detailed study of key watersheds or suspected problem areas

   - Localized impact of point and nonpoint pollution sources
   - Renovation capability of wetland areas
   - Analysis of pollutant source management

8. Survey landfills, especially those in upper reaches of watersheds

   - Site survey
   - Groundwater testing
   - Surface water testing

9. Establish additional water quality monitoring stations (see Technical Memorandum SW IV-5 for recommendations)

10. Refer to the technical memorandums for additionai recommendations.

TECHNICAL MEMORANDUM SW IV-2
SURFACE WATER USES

PINELANDS COMMISSION

FEBRUARY 1980

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
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SURFACE WATER USES

GENERAL

This technical memo discusses, by watershed, New Jersey Department of Environmental Protection surface water classifications (NJDEP, 1979), designated uses, and actual uses. The classifications and designated uses referred to in this report are the proposed revisions to the existing standards and have not yet been adopted.

Data on existing uses are intended to address potable water supply, cranberry and blueberry agriculture, fish and wildlife habitat maintenance, primary contact and secondary contact recreation and other significant uses of Pinelands surface waters. Some of this information, particularly concerning agriculture and habitat maintenance, has been reported in depth by other consultants to the Pinelands Commission and is discussed briefly in this technical memorandum.

Only one municipal water department obtains water from Pinelands surface water, the Atlantic City Water Department. Its source, Dougherty Pond, is partially located in the Absecon Creek Drainage Basin. It is possible that individual industries in the Pinelands have surface water intakes, but such information has not been delineated for the Pinelands (Webster, 1980). However, two users of surface water were identified in the Ocean County Areawide Water Quality Management Plan (208): Oyster Creek Power Plant (Forked River drainage sub-basin) and Toms River Chemical Company (Toms River drainage sub-basin).

Eighty percent of the cranberries produced in New Jersey are harvested in the Wading River drainage sub-basin. Production of the remaining 20% is divided evenly among the Batsto, Mullica, South Branch Rancocas, and North Brank Rancocas sub-basins (Lee, 1979; Thompson, 1980). In 1977, 93% of the state's blueberries were produced in Burlington and Atlantic counties, which contained 92% of the state's harvested acres (NJ Department of Agriculture, 1978). Forty percent of New Jersey's blueberries are produced in the Wading River drainage sub-basin (Lee, 1979).

Commercially important shellfish are found in the estuaries with the furthest inland habitat being in the Mullica River east of the Garden State Parkway. The estuaries from Barnegat Bay to Great Bay are the major supplier of hard clams in New Jersey, and upstream degradation could adversely affect this industry. Commercially important shellfish in the study area include hard clams (all estuaries within the study area), oysters (Mullica and Great Bay estuaries; some in Barnegat Bay and in Delaware Bay beyond the mouth of the Maurice River), and blue crab (all estuaries within the study area). Other commercially important shellfish are soft clams (presence varies along the coast), blue mussel (presence varies along the coast), and bay scallops (presence varies in Little Egg Harbor and Barnegat Bay) (McCloy, 1980).

Anadromous fish, which migrate from the sea into brackish and fresh water to spawn, travel up most of the tidal rivers within the study area, although they rarely go west of the Garden State Parkway. Species include alewife, blueback herring, white perch and, in the Great Egg Harbor River and the Mullica River, striped bass (Figley, 1980). Freshwater fish in the Pinelands are discussed in the report of another consultant.

There are four state forest and park campgrounds in the Pinelands. Bass River Forest, located in the Bass River and Wading River drainage sub-basins, contains 178 trailer and tent sites, 6 closed lean-tos, flush toilets, hot showers, laundry, sewage dump station, fireplaces, picnic tables, bathing, boating, fishing, hiking, children's playground, nature area and snack bar. Belleplain Forest, located in the Dennis Creek drainage basin, contains 93 trailer and tent sites, 12 closed lean-tos, flush toilets, hot showers, laundry, sewage dumping station, fireplaces, picnic tables, bathing, boating, fishing, hiking, children's playground, nature area and snack bar. Lebanon Forest, located in the North Branch Rancocas River and Wading River drainage sub-basins, contains 93 trailer and tent sites, flush toilets, hot showers, laundry, sewage dumping station, fireplaces, picnic tables, bathing, and hiking. Wharton Forest, located in the Wading River, Batsto River, Atsion-Mechesactauxin Creeks, Nescochaque Creek and Mullica River drainage sub-basins, contains 74 trailer and tent sites, picnic tables, fireplaces, bathing, boating (motor boat launching ramp), canoeing (three canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village (NJDEP, 1977).

In addition to these parks which accommodate overnight use, the Pinelands contain five state parks, forests and natural areas for day use. These are Barnegat Lighthouse Park and Island Beach Park, across the bay from the mouth of the Forked River; Hammonton Lake Natural Area, in the Hammonton Creek drainage sub-basin; North Brigantine Natural Area, below the mouth of the Mullica River; and Penn Forest, in the Wading River drainage sub-basin (NJDEP, 1977).

Seventeen Wildlife Management Areas are located in the Pinelands. Activities in these areas primarily involve hunting and fishing. The Wildlife Management Areas are Beaver Swamp, Dennis Creek and Heislervillo, in the Dennis Creek drainage sub-basin; Colliers Mills, Manchester and Whiting, in the Toms River drainage sub-basin; Port Republic and Swan Bay, in the Mullica River drainage sub-basin; Great Bay Boulevard, below the mouth of the Mullica River; Greenwood Forest, in the Cedar Creek, Wading River and North Branch Rancocas River drainage sub-basins; Manahawkin, north of the mouth of Mill Creek; Marmora, below the mouth of the Great Egg Harbor River; Pasadena, in the North Branch Rancocas River drainage sub-basin: Peaslee, in the Manumuskin Creek, Lower Maurice River and Tuckahoe River drainage sub-basins; Stafford Forge, in the Westecunk Creek drainage sub-basin; Lester G. MacNamara, in the Great Egg Harbor River (lower) and Tuckahoe River drainage sub-basins; and Winslow, in the Great Egg Harbor River (upper) drainage sub-basin (NJDEP, 1977).)

The designated uses for the proposed classifications (NJDEP, 1979) of Pinelands waters are:

FW-1

Fresh waters, including rivers, streams, lakes or other bodies of water which, because of their clarity, color, scenic setting, or other characteristic of aesthetic value or unique special interest, have been designated by authorized state agencies in conformance with laws pertaining to the use of private lands, to be set aside for posterity to represent the natural aquatic environment and its associated biota.

FW-2 Trout Yaintenance, FW-2 Non-Trout

Fresh surface waters, including fresh tidal waters, approved as sources of public water supply. These waters shall be suitable for public potable water supply after such treatment as shall be required by law or regulation.

These waters shall also be suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation; industrial and agricultural water supply and any other reasonable uses.

FW-Central Pine Barrens

These waters shall be suitable for cranberry bog water supply and other agricultural uses; the maintenance, migration and propagation of the natural established biota indigenous to this unique ecological system; public potable water supply after such treatment as shall be required by law or regulation; swimming; and other reasonable uses.

FW-Lower Mullica and Wading Rivers - Central Pine Barrens

These waters shall be suitable for cranberry bog water supply and other agricultural uses; the maintenance, migration and propagation of the natural established biota indigenous to this unique ecological system; public potable water supply after such treatment as shall be required by law or regulation; swimming; and other reasonable uses.

TW-1

These waters shall be suitable for shellfish harvesting where permitted.

These waters shall also be suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation; industrial and agricultural water supply and any other reasonable uses.

Table 1 and Figure 1 show the proposed classification of Pinelands surface waters. Subsequent pages summarize the water classifications and actual uses in each drainage sub-basin.

SUMMARY OF WATER CLASSIFICATIONS AND ACTUAL USES IN EACH DRAINAGE SUB-BASIN

SUB-BASIN 1.1 TOMS RIVER

NJDEP Classification: FW-Central Pine Barrens

- Davenport Branch and tributaries upstream from Route 530
- Unnamed tributary to Michaels Branch through Keswick Grove and tributaries upstream from the east crossing of the Penn Central Railroad to source

NJDEP Classification: FW-2 Trout Maintenance

- Toms River and tributaries from Route 528 bridge downstream to Route 547 bridge in Whitesville

TABLE 1

PROPOSED SURFACE WATER CLASSIFICATIONS

Watershed	Drainage Sub-basins	Classification*					
		(1)	(2)	(3)	(4)	(5)	(6)
Toms River	Toms River	-	X	-	X	-	
Rancocas River	Rancocas North Branch	X	-	-	X	-	
	Rancocas South Branch	-	-	-	X	-	
Cedar Creek	Cedar Creek	X	-	-	X	-	
Forked River	Forked River	-	-	-	X	-	X
	Oyster Creek	-	-	-	X	-	X
	Mill Creek	-	-	-	X	-	X
	Westecunk Creek	-	-	-	X	-	X
Mullica River	Bass River	X	-	-	X	-	X
	Wading River	X	-	-	X	X	X
	Batsto River	X	-	-	X	-	
	Atsion-Mechesactauxin Creeks	-	-	-	X		
	Nescochaaue Creek	X	-	-	X	-	
	Hammonton Creek	-	-	-	X	-	-
	Mullica River	X	-	-	X	X	X
Great Egg Harbor River	Grest Egg Harbor River (Upper)	-	-	X	-	-	-
	Great Egg Harbor River (Lower)	X	-	-	-	-	X
Maurice River	Manumuskin Creek	X	-	X	-	-	
	Lower Maurice	X	-	-	-	-	
Absecon Creek	Absecon Creek	-	-	X	-	-	X
Tuckahoe River	Tuckahoe River	-	-	X	-	-	X
Dennis Creek	Dennis Creek	X		X	-	-	-
Patcong Creek	Patcong Creek	-		X			X

*Legend

1 FW-1
(2) FW-2 Trout Maintenance
(3) FW-2 Non-Trout
(4) FW-Central Pine Sarrens
(5) FW-Cower Mullica and Wading Rivers-Central Pine Sarrens
(6) TW-1

burce: New Jersey Department of Environmental Protection, 1979

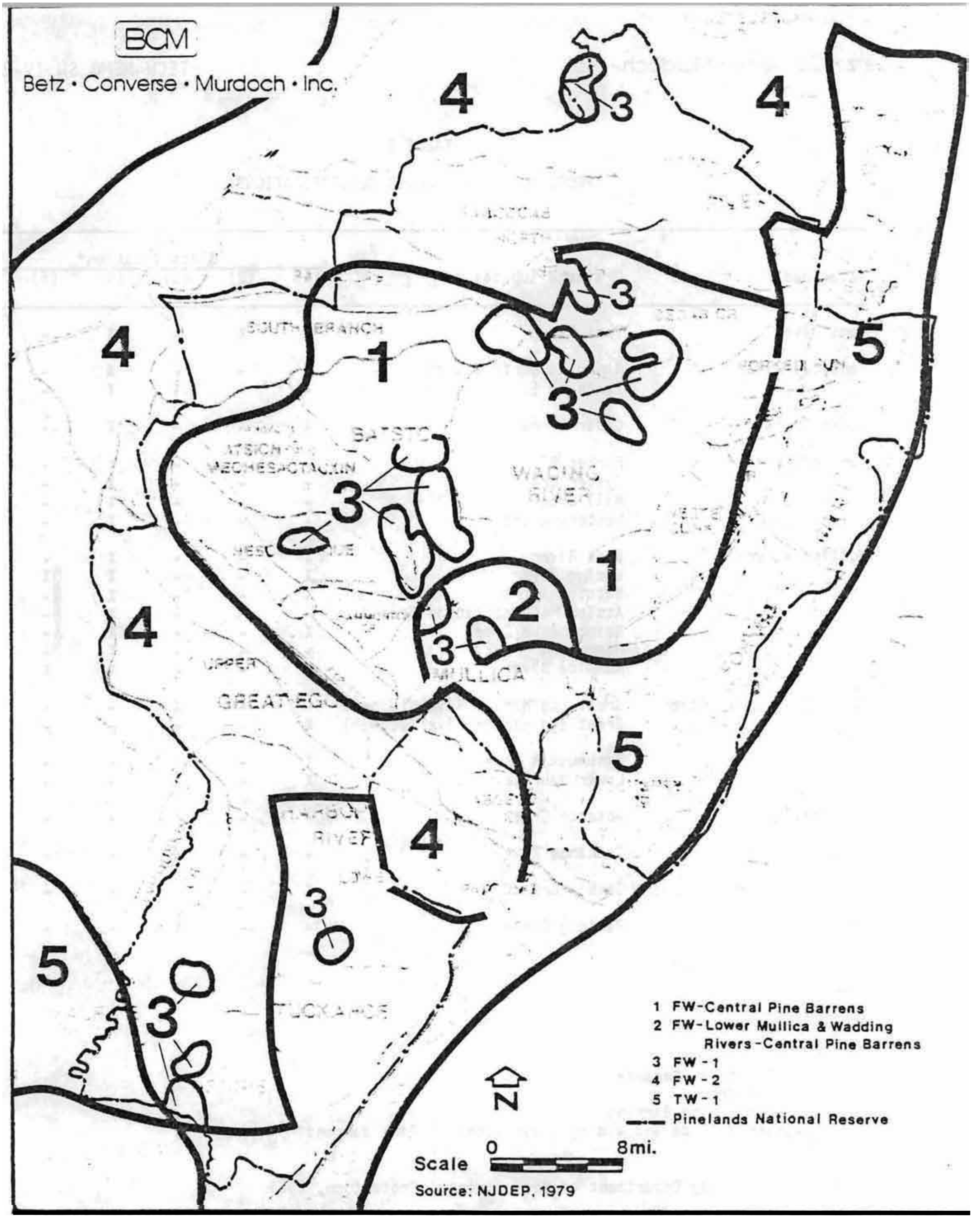

Figure 1. PROPOSED CLASSIFICATIONS

Actual Uses

1. Colliers Mills Wildlife Management Area - hunting, freshwater fishing (a portion is classified FW-1)

2. Manchester Wildlife Management Area - hunting

3. Whiting Wildlife Management Area - hunting

NJDEP Classification: TW-1

- Eastern portion of sub-basin not within other classifications (as viewed on the official surface water proposed classification map located in the offices of the Division of Water Resources, MJDEP)

Actual Use

1. Toms River Chemical Company - withdrawal and discharge

SUB-BASIN 2.1 RANCOCAS CREEK NORTH BRANCH

NJDEP Classification: FW-1

- Deer Park Branch and tributaries near Buckingham downstream to its confluence with Pole Bridge Branch
- Tributaries to the South Branch of Mount Misery Brook situated wholly within Lebanon State Forest boundaries*
- Cooper Branch and tributaries downstream to Pakim Pond, and tributaries to Cooper Branch downstream of Pakim Pond situated wholly within the boundaries of Lebanon State Forest*
- Shinns Branch and tributaries situated wholly within the Lebanon State Forest boundaries*
- Jade Run situated within the Lebanon State Forest boundaries*
- McDonalds Branch and tributaries situated within the Lebanon State Forest boundaries*
- The two easterly branches of the South Branch of Mt Misery Brook situated wholly within the Pasadena Tract boundaries*

* Potable water supply

Actual Uses

1. Lebanon Forest (also in the Wading River drainage sub-basin) - 93 trailer and tent sites, flush toilets, hot showers, laundry, sewage dumping station, fireplaces, picnic tables, bathing and hiking (a portion is classified FW-Central Pine Barrens)

2. Greenwood Forest Wildlife Management Area (also in the Cedar Creek and Wading River drainage sub-basins) - hunting, fresh-water fishing (a portion is classified FW-Central Pine Barrens)

3. Pasadena Wildlife Management Area - hunting

NJDEP Classification: FW-Central Pine Barrens

- Greenwood Branch and tributaries within the boundaries of Greenwood Rancocas Reserve and Lebanon State Forest
- Tributaries to Country Lake, Mirror Lake and Hanover Lake within the boundaries of the Whitesbog Fish and Wildlife Management Area and Lebanon State Forest
- Mt. Misery Brook and tributaries upstream of the western intersection of the Lebanon State Forest boundary at Mt. Misery, except those designated FW-1
- Tributaries to Pole Bridge Branch upstream of the Penn Central Railroad

SUB-BASIN 2.2 RANCOCAS CREEK SOUTH BRANCH

NJDEP Classification: FW-Central Pine Barrens

- South Branch Rancocas Creek and tributaries upstream from Route 206 to source, except those designated FW-1
- Jade Run and tributaries upstream from Route 206, except those designated FW-1

SUB-BASIN 3.1 CEDAR CREEK

NJDEP Classification: FW-1

- Webbs Mill Branch and tributaries situated wholly within the Greenwood Forest Track boundaries; Chamberlain's Branch and five tributaries originating in and situated wholly within the Greenwood Forest Tract boundaries upstream from the blueberry farm exception; also other tributaries to Chamberlain's Branch situated wholly within the Greenwood Forest Tract boundaries

Actual Use

1. Greenwood Forest Wildlife Management Area (also in Wading River and North Branch Rancocas River drainage sub-basins) - hunting, freshwater fishing (a portion is classified as FW-Central Pine Barrens)

NJDEP Classification: FW-Central Pine Barrens

- Cedar Creek (Lacey Township) and tributaries upstream of Route 9 (head of tide) surrounded by the northern ridgeline; and the southern ridgeline west of the Garden State Pzrkway and the southern ridgeline (between the Garden State Parkway and Route 9) as defined by Lacey Road, Manchester Avenue, and Haines Road)

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

SUB-BASIN 4.1 FORKED RIVER

NJDEP Classification: FW-Central Pine Barrens

- All fresh waters west of the Garden State Parkway bounded by the Mullica River and Cedar Creek (Lacey Township) watersheds, except those designated FW-1

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Sarrens

Actual Uses

1. Barnegat Lighthouse Park (day use) across bay from river's mouth - picnicking, bathing, fishing

2. Island Beach Park (day use) across bay from river's mouth - picnicking, bathing, fishing, nature trails

SUB-BASIN 4.2 OYSTER CREEK

NJDEP Classification: FW-Central Pine Barrens

- All fresh waters west of the Garden State Parkway

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Actual Use

1. Oyster Creek Power Plant (withdrawal)

SUB-BASIN 4.3 MILL CREEK

NJDEP Classification: FW-Central Pine Barrens

- All fresh waters west of the Garden State Parkway

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head cf tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Actual Use

1. Manahawkin Wildlife Management Area (north of the mouth of Mill Creek) - hunting, saltwater fishing

SUB-BASIN 4.4 WESTECUNK CREEK

NJDEP Classification: FW-Central Pine Barrens

- All fresh waters west of the Garden State Parkway

Actual Use

1. Stafford Forge Wildlife Management Area - hunting, freshwater fishing (a portion is classified TW-1)

NJDEP Classification: TW-1

All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

SUB-BASIN 5.1 BASS RIVER

NJDEP Classification: FW-1

Tommy's Branch from its headwaters downstream to Bass River State Forest Recreation Area service road

- Falkenburg Branch of Lake Absegami from its headwaters downstream to the lake

NJDEP Classification: FW-Central Pine Barrens

All surfece waters within that portion of Bass River State Forest, located on the New Gretna and Oswego Lake USGS Quadrangle Maps, wnich is uninterrupted by private lands and contiguous to the Ives Branch and Bartletts Branch watersheds lying both north and south of Stage Road

- West Branch Bass River and tributaries upstream from the Bass River State Forest boundary (where it crosses the West Branch Bass River, downstream of Stage Road), except those designated FW-1

East Branch Bass River and tributaries upstream from the Bass River State Forest boundary (where it crosses the East Branch Bass River, downstream of Stage Road), except those designated FW-1

- That portion located on the New Gretna and Oswego Lake USGS Quadrangle Maps which is uninterrupted by private lands and contiguous to and lying to the southeast of the Garden State Parkway

Actual Use

1. Bass River Forest (also in Wading River drainage sub-basin) - 178 trailer and tent sites, 6 closed lean-tos, flush toilets, hot showers, laundry, sewage dump station, fireplaces, picnic tables, bathing, boating, fishing, hiking, children's playground, nature area and snack bar (a portion is classified TW-1)

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

SUB-BASIN 5.2 WADING RIVER

NJDEP Classification: FW-1

Westerly tributary to the Howardsville Cranberry Bog Reservoir and tributaries situated wholly within the Greenwood Forest Tract boundaries

- Tulpehocken Creek and tributaries from its origin downstream to its confluence with Featherbed Branch

The westerly tributaries to Tulpehocken Creek and those natural ponds within the lands bounded by Hawkins Road, Hampton Gate Road, and Sandy Ridge Road

Actual Uses

1. Lebanon Forest (also in the North Branch Rancocas River drainage sub-basin) - 93 trailer and tent sites, flush toilets, hot showers, laundry, sewage dump station, fireplaces, picnic tables, bathing, and hiking (a portion is classified FW-Central Pine Barrens)
2. Greenwood Forest Wildlife Management Area (also in the Cedar Creek and North Branch Rancocas River drainage sub-basins) - hunting, freshwater fishing (a portion is classified FW-Central Pine Barrens)

NJDEP Classification': FW-Central Pine Barrens

- Wading River and tributaries upstream from Charcoal Landing, Burlington County (head of tide), except those designated FW-1

  a. Freshwater segments of tributaries to the Wading River between head of tide and Route 542 bridge

  b. Freshwater segment of Ives Branch and its tributaries from the 10-foot contour

  All surface waters within the Wharton Tract State Forest

  All surface waters within the following portions of the Bass River State Forest:

  a. That portion located on the New Gretna and Oswego Lake USGS Quadrangle Maps which is uninterrupted by private lands and contiguous to the Ives Branch and Bartletts Branch watersheds lying both north and south of Stage Road

  b. That portion located on the New Gretna USGS Quadrangle Map which is uninterrupted by private lands and contiguous to and lying to the south of Stage Road

- All fresh waters west of the Garden State Parkway bounded by the Mullica and Cedar Creek watersheds, except those designated FW-1

Actual Uses

1. The Wading River Basin produces 80% of the cranberries harvested in New Jersey. It produces 40% of New Jersey's blueberries (Stephen Lee grower) (a portion is classified FW-Lower Mullica and Wading Rivers - Central Pine Barrens)

2. Bass River Forest (also in the Bass River drainage sub-basin) - 178 trailer and tent sites, 6 closed lean-tos, flush toilets, hot showers, laundry, sewage dump station, fireplaces, picnic tables, bathing, boating, fishing, hiking, children's playground, nature area and snack bar (a portion is classified TW-1)

3. Wharton Forest (also in the Batsto River, Atsion-Mechesactauxin Creeks, Nescochaque Creek and Mullica River drainage sub-basins) - 74 trailer and tent sites, fireplaces, picnic tables, bathing, boating (motor boat launching ramp), canoeing (thres canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village.

4. Penn Forest (day use) - picnicking, small boat launch, fishing, hiking, bridle paths, hunting

NJDEP Classification: FW-Lower Mullica and Wading Rivers - Central Pine Barrens

- Wading River and tidal portions of its tributaries, from head of tide to Route **542** Bridge

NJDEP Classification: TW-1

- All tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers

SUB-BASIN 5.3 BATSTO RIVER

NJDEP Classification: FW-1

Deep Run and tributaries from its headwaters downstream to Springer's Brook

- Skit Branch and tributaries from its headwaters downstream to confluence with Robert's Branch
- Brooks and tributaries to Batsto River between and immediately to the west of Tylertown and Crowleytown from its headwaters downstream to the head of tide at mean high water
- The easterly branches of the Batsto River from Batsto Village upstream to the confluence of Skits Branch

NJDEP Classification: FW-Central Pine Barrens

- All surface waters within the Wharton Tract State Forest

Actual Use

1. Wharton Forest (also in the Wading River, Atsion-Mechesactauxin Creeks, Nescochaque Creek and Mullica River drainage sub-basins) - **74** trailer and tent sites, fireplaces, picnic tables, bathing, boating (motor boat launching ramp), canoeing (three canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village

SUB-BASIN 5.4 ATSION-MECHESACTAUXIN CREEKS

NJDEP Classification: FW-Central Pine Barrens

- All surface waters within the Wharton Tract State Forest

Actual Use

1. Wharton Forest (also in the Wading River, Batsto River, Nescochaque Creek and Mullica River drainage sub-basins) - 74 trailer and tent sites, fireplaces, picnic tables, bathing, boating (motor boat launching ramp), canoeing (three canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village

SUB-BASIN 5.5 NESCOCHAQUE CREEK

NJDEP Classification: FW-1

- Gun Branch from its headwaters downstream to U.S. Route 206

NJDEP Classification: FW-Central Pine Barrens

- All surface waters within the Wharton Tract State Forest

Actual Use

1. Wharton Forest (also in the Wading River, Batsto River, Atsion-Mechesactauxin Creeks and Mullica River drainage sub-basins) - 74 trailer and tent sites,. fireplaces, picnic tables, bathing, boating (motor boat launching ramp), canoeing (three canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village

SUB-BASIN 5.6 HAMMONTON CREEK

NJDEP Classification: FW-Central Pine Barrens

- Mullica River and tributaries upstream from Seventh Avenue, Sweetwater, Atlantic County (head of tide), except those designated FW-1

Actual Use

1. Hammonton Lake Natural Area (day use) - hiking

SUB-BASIN 5.7 MULLICA RIVER

NJDEP Classification: FW-I

- Stream in the southeasterly corner of the Wharton Tract lying between Ridge Road and Seaf Weeks Road down to the Wharton Tract State Forest boundaries

NJDEP Classification: FW-Central Pine Barrens

Mullica River and tributaries upstream from Seventh Avenue, Sweetwater, Atlantic County (head of tide), except those designated FW-1

Freshwater segments of tributaries to the Mullica River between head of tide and Lower Bank Road Bridge at Lower Bank, except those designated FW-1

Indian Cabin Creek and tributaries upstream from Egg Harbor City Lake

- All surface waters within the Wharton Tract State Forest boundaries

Actual Use

1. Wharton Forest (also in the Wading River, Batsto River, Atsion-Mechesactauxin Creeks and Nescochaque Creek drainage sub-basins) - 74 trailer and tent sites, fireplaces, picnic tables, bathing, boating (motor boat launching ramp), canoeing (three canoe rivers), fishing, hiking, children's playground, nature area and historic Batsto Village

NJDEP Classification: FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Mullica River and tidal portions of its tributaries, from head of tide to Lower Bank Road Bridge at Lower Bank

NJDEP Classification: TW-1

All tidal waters situated wholly within Port Republic Fish and Wildlife Management Area

- All tidal waters situated wholly within Brigantine. Wildlife Refuge

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Actual Use

1. North Brigantine Natural Area (day use) (below the mouth of the Mullica River) - fishing, hiking
2. Port Republic Wildlife Management Area - saltwater fishing
3. Swan Bay Wildlife Management Area - saltwater fishing, car-top boats
4. Great Bay Boulevard Wildlife Management Area (below the mouth of the Mullica River) - hunting, saltwater fishing

SUB-BASIN 6.1 GREAT EGG HARBOR RIVER (UPPER)

NJDEP Classification: FW-2 Non-Trout

- Upstream from head of tide of all freshwater basin tributaries to mainstem, Delaware River, south of Big Timber Creek to Cape May County

Actual Use

1. Winslow Wildlife Management Area - hunting, freshwater fishing

SUB-BASIN 6.2 GREAT EGG HARBOR RIVER (LOWER)

NJDEP Classification: FW-1

- Hawkin's Creek and the next adjacent tributary to the Great Egg Harbor River lying to the north from their origin downstream to where the influence of impounding occurs

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Actual Uses

1. Marmora Wildlife Management Area (below the mouth of the Great Egg Harbor River) - hunting, saltwater fishing

2. Lester G. MacNamara (also in the Tuckahoe River drainage sub-basin) - hunting, freshwater fishing, saltwater fishing, boat launch

SUB-BASIN 7.1 MANUMUSKIN CREEK

NJDEP Classification: FW-1

- Cedar Branch of the Manumuskin River from its origin to the Peaslee Track boundaries

Actual Use

I. Peaslee Wildlife Management Area (also in the Lower Maurice River and Tuckahoe River drainage sub-basins) - hunting, freshwater fishing (a portion is classified FW-2 Non-Trout)

NJDEP Classification: FW-2 Non-Trout

- Upstream from head of tide of all freshwater basin tributaries to main stem, Delaware River, south of Big Timber Creek to Cape May County

SUB-BASIN 7.2 LOWER MAURICE RIVER

NJDEP Classification: FW-1

- That tributary to the Branch of Little East Run having its confluence just south of Stangor Avenue; first and second easterly tributaries to Little East Run north of Academy Avenue

- Middle Branch of Muskee Creek from its origin to the Peaslee Tract boundaries

- Those portions of tributaries to Slab Branch situated wholly within the Peaslee Fish and Same Tract boundaries

Actual Use

I. Peaslee Wildlife Management Area (also in the Manumuskin Creek and Tuckahoe River drainage sub-basins) - hunting and fresh-water fishing (a portion is classified FW-2 Non-Trout)

NJDEP Classification: FW-2 Non-Trout

- Upstream from head of tide of all freshwater basin tributaries to main stem, Delaware River, south of Big Timber Creek to Cape May County

SUB-BASIN 8.1 ABSECON CREEK

NJDEP Classification: FW-2 Non-Trout

- Absecon Creek and tributaries upstream from Atlantic City Reservoir Dam in the City of Absecon*

  * Potable water supply

Actual Use

1. Dougherty Pond provides water for the Atlantic City Water Department.

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

SUB-BASIN 9.1 TUCKAHOE RIVER

NJDEP Classification: FW-2 Non-Trout

- All streams in Cape May County upstream from head of tide or tidal barriers thereon*
- Upstream from head of tide of all freshwater basin tributaries to main stem, Delaware River, south of Big Timber Creek to Cape May County

  * Potable water supply

Actual Use

1. Peaslee Wildlife Management Area (also in the Manumuskin Creek and Lower Maurice River drainage sub-basins) - hunting, fresh-water fishing (a portion is classified FW-1)

NJDEP Classification: TW-1

- All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-Lower Mullica and Wading Rivers - Central Pine Barrens

Actual Use

1. Lester G. MacNamara (also in the Lower Great Egg Harbor River drainage sub-basin) - hunting, freshwater fishing, saltwater fishing, boat launch

SUB-BASIN 10.1 DENNIS CREEK

NJDEP Classification: FW-1

- The portion of that tributary to West Creek originating about 0.9 miles southeast from Hoffman's Mill and situated wholly within the Belleplain State Forest boundaries
- Eastern Branch of the easterly tributary to Pickle Factory Pond from its origin to its confluence with the western branch
- Those tributaries to West Creek which originate approximately 0.5 miles upstream of Hoffman's Mill and which are located wholly within the Belleplain State Forest boundaries

All tributaries to Lake Nummi from their origin downstream to Lake Nummi

- Those two tributaries to Savages Run and portions thereof downstream of Lake Nummi that are situated wholly within the Belleplain State Forest boundaries
- A stream and tributaries thereto originating just south of East Creek Mill Road, NNE of Eldora 1.2+ miles and situated wholly within the Belleplain State Forest boundaries

Actual Uses

1. Belleplain Forest - 93 trailer and tent sites, 12 closed lean-tos, flush toilets, hot showers, laundry, sewage dumping station, fireplaces, picnic tables, bathing, boating, fishing, hiking, children's playground, nature area and snack bar.

2. Dennis Creek Wildlife Management Area - hunting, saltwater fishing, boat launch

MJDEP Classification: FW-2 Non-Trout

- All streams in Cape May County upstream from the head or' tide or tidal barriers thereon*

  * Potable water supply

Actual Use

1. Beaver Swamp Wildlife Management Area - hunting, freshwater fishing

NJDEP Classification: TW-1

Eastern portion of sub-basin not within other classifications (as viewed on the official surface water proposed classification map located in the offices of the Division of Water Resources, NJDEP)

Actual Use

1. Heislerville Wildlife Management Area - hunting, saltwater fishing

SUB-BASIN 11.1 PATCONG CREEK

NJDEP Classification: FW-2 Non-Trout

- All other freshwater basins or portions thereof in the Coastal Plain upstream from head of saline influence except those designated FW-1, FW-Central Pine Barrens, and FW-2 Trout Maintenance

NJDEP Classification: TW-1

All other tidal waters of the Plain downstream from the head of tide to surf waters except those designated FW-tower Mullica and Wading Rivers - Central Pine Barrens

REFERENCES

Figley, Bill. Nacote Creek Research Laboratory, Division of Fish, Game and Shellfisheries, New Jersey Department of Environmental Protection, Absecon, personal communication, 1980.

Lee, Stephen. Grower, personal communication, 1979.

McCloy, Tom. Division of Fish, Game and Shellfisheries, New Jersey Department of Environmental Protection, Trenton, personal communication, 1980.

New Jersey Department of Agriculture. New Jersey Agriculture Statistics, 1978.

New Jersey Department of Environmental Protection. brochure, Division of Parks and Forestry, Trenton, 1977.

New Jersey Department of Environmental Protection. Guide to Wildlife Management Areas, Division of Fish, Game and Shell- fisheries, Trenton, undated.

New Jersey Department of Environmental Protection. Proposed Revisions to Water Quality Standards (draft), Trenton, 1979.

Thompson, Charles, Grower. personal communication, 1980.

Webster, Ray. Division of Water Resources, New Jersey Department of Environmental Protection, Trenton, personal communication, 1980.

TECHNICAL MEMORANDUM SW IV-3

CRITERIA AND NEEDS FOR WATER USES

PINELANDS COMMISSION

FEBRUARY 1980

BETZ-CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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TECHNICAL MEMO SW IV-3

CRITERIA AND NEEDS FOR WATER USES

INTRODUCTION

This technical memorandum discusses the water quality and quantity requirements for major activities and user groups associated with the surface waters of the Pinelands. The majority of the study time was expended in evaluating the water needs of cranberry and blaeberry cultivation because of their economic importance and their unique relationship with the core area of the Pinelands. The water quality requirements of the aquatic communities of the Pinelands streams and the estuaries downstream were also included in the examination, as were the needs of the cedar swamp community.

There is a lack of available research data concerning many of these topics. The unique environment of the Pinelands makes it difficult to apply data from other areas to the region under study. Information was obtained by personal interviews and by accessing previously accumulated data. The following text, therefore, incorporates a mixture of opinion, hypothesis, and research. The need for farther field study is evident, although some of the topics are covered in greater detail in the reports of other consultants.

AGRICULTURE

Cranberry Cultivation

General: Cranberries have been cultivated in the Pinelands for generations. The earliest efforts to cultivate *Vaccinium macrocarpon* were made in 1825 (McCormick, 1972). This perennial, evergreen heath thrives in sandy, peaty soils with pH values from 3.5 to 4.7. It also requires a wet, well-drained soil and a water table located close to the surface (Marucci, 1972). This makes it suitable for cultivation in an environment like the Pinelands, of which it is a native.

Cranberries are cultivated commercially in low-lying bogs which are supplied with water via a ditch and floodgates or by a spray system. Large quantities of water are required, and large areas are maintained as reservoirs or kept in their natural state to ensure an adequate water supply. A 10-acre:1-acre ratio is often cited as the requirement of land held for water supply purposes and land in production. One-tenth of the land held for water supply purposes is usually reservoirs and the rest is maintained as undeveloped lowland and forested upland (McCormick, 1972). These ratios, however, are only guidelines and vary with the hydrology of a particular area (Haines and Haines, 1979).

V. macrocarpon cultivation methods are more compatible with the surrounding environment than are other forms of agriculture. Fertilization levels are low, roughly a total of 200 lbs. per acre of 10-10-10 fertilizer applied in two broadcast applications, one in early spring and one after harvest. Over-fertilization favors vegetative growth and decreases berry yields. Insecticides (primarily Guthion and Parathion), herbicides (especially Casoron, Eevital, and Dalopon), and fungicides (commonly Ferbam and Difolitan) are used; however, the applications must be carefully controlled so as not to adversely affect production (Marucci, 1979; Haines and Haines, 1979; Thompson, 1980). Such treatments are required because New Jersey is near the southern limit of V. macrocarpon. The warmer climate and longer growing season enhance weed, insect, and fungal disease problems. The application of these chemicals is, to an extent, self-regulating because improper use will decrease production by affecting bee pollination or by being deleterious to the plant itself.

All of New Jersey's cranberry production is located in the Pinelands. Much of it (roughly 80% or more) is found in the Wading River watershed (Lee, 1979; Thompson, 1980), which is one of the more pristine areas in the study region. Because this area is typified by high water quality, the bog type cultivation of cranberries has apparently not degraded the surface waters. This is also indicated by the work of Gray (1972), Deubert (undated), Konrad and Bryans (1974), and Eck (1977). These studies were done in different areas and varied in their degree of rigorousness; however, their findings corroborate, at least with respect to nutrients, the contention that cranberry culture does not adversely affect water quality downstream.

Water Quantity Requirements: Water is used for a number of purposes:

1. Irrigation
2. Frost protection in the spring and fall
3. Winterkill protection, i.e., winter flood (late December to May)

4. Insect and weed control

5. Harvest (mid-September to mid-October)

The specific water quantity required to produce cranberries will vary with location and year. Soil type, bog shape, bog size, frost severity, frost frequency, evaporation rate, transpiration rate, and other factors will cause this variation. Methods of irrigation (spray vs. ditch) and the extent in which they are employed also contribute to the differences.

No reliable data were obtained on the specific water quantities required. McCormick (1972) cites a figure of 300,000 gal.$\cdot$acre$^{-1}\cdot$year^{-1} for irrigation and frost protection, but its validity is unknown. The lack of data stems from the employment of a variety of water supply types (i.e., wells, surface reservoirs, streams, etc.) and an attitude by growers which focuses on availability rather than consumption rates. The growers are only concerned that they have sufficient water stocks. They are not particularly interested in quantifying its use. In relative terms, Thompson (1980) indicated that winter flood represented the single largest water requirement, but that harvest was the most intensive use. Cognizant of the annual variation which can occur, he roughly estimated for one of his bog systems a need for water in frost protection during three 1- to 3-day periods in the spring and four 3- to 5-day periods between August and harvest. Additional data sources include the New Jersey Water Policy and Supply Council and Pinelands Commissioner Tom Darlington who uses spray irrigation systems for cranberry cultivation.

<u>Water Quality Requirements</u>: There is again a lack of numerical data on the specific water quality requirements needed for *V. macrocarpon* production. None of the people interviewed were aware of any work being done in this field. It is, however, possible to indicate some factors which are considered important.

Cranberries require a high quality water. The pH of the water is critical. Applications of lime and other activities which lead to pH shifts have been associated with decreased production (Thompson, 1980) or death of the plants (Lipman, 1980). Cranberries, unlike other crop plants, can tolerate and prefer acidic conditions. pH less than 6.5 is required; pH less than 5.5 is preferred (Esser, 1980). Apparently, this stems from an increased tolerance to iron, aluminum and manganese which solubilize under acid conditions (Medappa and Dana, 1970). Nutrients such as nitrogen in the form of ammonium (Greidanus *et al*, 1972) and phosphorus (Greidanus and Dana, 1972) are also required. Nitrate

(NO_3-N) needs to be less than 10 mg/l (Esser, 1980). Whether these nutrients are received by fertilization or via stream input is not critical; however, the level will determine if vegetative growth is favored. Such growth at the expense of berry production is undesirable from the grower's viewpoint, and it is much easier to compensate nutrient levels if the natural background levels are low initially. Nitrate control, however, is not as critical in areas above bogs where spray irrigation, rather than flooding, is used for management. High sediment load can also be a problem for cranberry plants because rotting can result (Thompson, 1980).

Blueberry Cultivation

General: The growing of high-bush blueberries began in 1916 in New Jersey, and the industry has grown to the point where the annual gross value of the New Jersey crop is 8 to 14 million .dollars. Developed from the indigenous *Vaccinium australe* and *V. corymbosum*, the current varieties used commercially are (1) Bluecrop, (2) Weymouth, and (3) Jersey (Applegate *et al*, 1979; Marucci, 1979). Blueberries do best on dry, sandy, high organic, acid soils and have a cold requirement of 650 to 850 hours below 45°F. They are subject to both frost and drought damage. Optimum growth is at a pH between 4.3 and 4.8 and a water table 18 to 24 inches below the surface. The soil must be well aerated and capable of rapidly removing any standing water or precipitation (Kenaer and Brightwell, 1966).

Blueberries require more fertilization than cranberry plants. In New Jersey, application rates are 300 $lbs. \cdot acres^{-1} \cdot year^{-1}$ of 10-10-10 fertilizer. The blueberry plants are strip-fertilized in early and late spring, and depending on rainfall levels, a fall dressing may be applied. The pesticides currently used include (Marucci, 1973; Haines and Haines, 1979; Lee, 1979):

1. Insecticides: Guthion, Malathion, and Parathion
2. Fungicides: Difolitan and Captan
3. Herbicides: Casoron, Karmex, Sinbar, and Paraquat
4. Dormant sprays: superior oil and lime sulfur

As in the case of the cranberry plants, the application of these chemicals is to an extent self-regulating because improper use will decrease production by affecting bee pollination or by being deleterious to the plant itself.

Water Quantity Reauirements: Ballinger (1966) indicates irrigation should be frequent enough to prevent soil dessication and that the water should be in sufficient-quantity to penetrate to the bottom of the root zone but no further. The rate of application should not be faster than the rate of absorption by the soil. Soil composition will affect the requirement for water as will soil structure, evapotranspiration, and other factors.

No data were found on the requirement for water in volumetric terms. Alderfer (unpublished) described a procedure for estimating irrigation needs which accounted for soil type, crop, and evapotranspiration. This might provide a measure of the water needed.

In relative terms, blueberry culture is probably less reliant on surface water supplies than cranberry culture because there is neither a winter flood requirment nor a need for water during harvest. If the Pinelands Commission requires numerical data, the Water Policy and Supply Council data might be of use. Robert Hanna of the Extension Service at Cook College might also have pertinent data.

Water Quality Reauirernents: Ballinger (1966) found nitrogen to be very important to growth and fruit auality in the blueberry plant. However, excessive amounts of nutrients in the water supplies are detrimental to production because, like the cranberry plant, the blueberry plant is sensitive to too much fertilizer. The Pinelands Commission is referred to Dr. Paul Eck, who is knowledgeable about the blueberry (and cranberry), for additional data.

Tree Fruit and Vegetable Cultivation

General: Most of the tree fruit culture occurs on light, loamy soils that are relatively level. Peaches are the primary one-tree fruit crop ($18.7 million in 1977), followed by apples ($12.8 million in 1977), according to the data of the New Jersey Crop Reporting Service (1978). Much of the state's production is centered in the Camden, Gloucester, and Atlantic counties area external to the Pinelands Preservation Area but within the Protection Area boundaries. Fertilization varies with age but is fairly intensive. Apples receive the most fertilizer--1,000 pounds of 5-10-15 prior to April 1 and 200 pounds of 16-8-8 around June 1. Irrigaticn requirrnents average 5 acre-inches of water per year (Esser, 1980).

The primary vegetable crops on a statewide basis are tomatoes ($20.2 million in 1977), peppers ($9.1 million in 1977), and sweet corn ($5.9 million in 1977) according to the New Jersey Crop Reporting Service (1978). Brown (1980) indicated that peppers, tomatoes, and cucumbers are particularly important in South Jersey. Most of the production areas .extend from the fringe of the protection area outwards.

Water Quantity and Quality Reauirements: Miller (1979) had no data on water quality and quantity requirements for the tree fruit species. He referred to the Water Policy and Supply Council for the well reports or the Alderfer report to derive an estimate. His own rough estimate for peaches and apples was 1.5-acre-inches per week, but this again would vary because of a number of factors. He felt that the well data might be useful because most orchard operators use subsurface water drawn by wells to irrigate.

Brown (1980) similarly had no data for the vegetable crops. He also cited the well reports as a potential source of volumetric water use data. Brown felt the requirements could be calculated, and he indicated that they might already have been worked out by Robert Hanna of the Extension Service. The Crops Department of Cook College might also be able to provide data.

Runoff problems are potentially greater for these types of agriculture than for blueberry and cranberry cultures. This is particularly true for nutrients because of the higher amounts utilized. The county agents did not expect this to be a serious problem, but its actual magnitude is unknown.

AQUATIC WETLAND COMMUNITIES

Cedar Bogs or Swamps

General: Robichaud and Buell (1973) detailed the vegetation typical of southern New Jersey bogs. Their listing is shown below.

Trees

Southern white cedar - the dominant tree and the seedlings of red maple (variety three-lobed), black gum, and sweet bay

Shrubs

Typically heath shrubs: Leatherleaf, Laurel, Swamp azalea, Cranberry, Blueberry, Huckleberry, other heaths
Wax myrtles

Herbs

Sphagnum moss; Sedges; Swamp loosestrife; Pitcher plant; Sundews; Marsh, chain, and other ferns; Curly grass fern; Bog asphodel; many other herbs

Note that shrub and forest vegetation may or may not be associated with a sedge and sphagnum mat.

According to Robichaud and Buell (1973), a bog area is typically poorly drained, resulting in the presence of standing water at times during the spring and early summer. Bog waters are quite acidic and of low fertility. Large quantities of peat (partially decomposed organic matter) are present. Bogs form where the water table intersects the surface. Near the water's edge, sphagnum and sedges are generally present. Also present are acid-tolerant shrubs such as leatherleaf, sheep laurel, swamp azalea, and sweet pepperbush. Blueberry, cranberry, and huckleberry plants are common. These same shrubs are also distributed in the areas further inland. Sphagnum hummocks occur in this inland region and are associated with a variety of ferns, carnivorous plants, and wild orchids. Many of the unusual or rarer plants, such as the curly grass fern, the bog asphodel, and the Carolina club moss, are present here also. Trees are found on the hummocks and C. thyoides is the dominant species.

Water Quantity Requirements: The cedar bogs or swamps are characterized by their saturated condition. The plants which are present often require a saturated root zone for growth. The occurrence of a bog is initially determined by the intersection of the water table with the surface. Clearly, changes in the area's hydrology would affect the plants. If the water table were lowered, many species of plants would be eliminated. The fire frequency would probably increase and could lead to the devastation of the cedar bog site. Little (1979) reports that the cedar and swamp hardwoods are subject to severe damage by even light fires because of their relatively thin bark. Also, C. thyoides does not sprout after its stem has been killed by fire, unlike the pitch and shcrtleaf pines. Root systems may also suffer damage from fire if the organic peat burns.

Water Quality Requirements: Many Pinelands plants can tolerate low pH values and low ionic strength waters. The environment is oligotrophic (has low nutrient levels], an important factor in determining the composition of the vegetation present. Altering these conditions will produce changes in the species observed. For example, sphagnum is known to be calciphobic and would be eliminated if the calcium levels were raised.

Lowland Swamps

General: According to Robichaud and Buell (1973), the lowland swamp is less acidic and more fertile than the cedar bogs. It is also drier and probably represents the successional stage beyond the cedar bog.

C. thyoides seedlings do not tolerate shade. Consequently, more shade-tolerant species such as the sweet bay, the black gum, and the red maple take over, resulting in a lowland swamp.

Water Quantity and Quality Reauirements: Although lowland swamps are not as wet as cedar bogs and contain increased levels of nutrients, their water quality and quantity requirements are fairly consistent with them.

Pinelands Fish

General: Hastings (1979) describes the Pinelands fish fauna as depauperate. No one species is restricted to the Pinelands but there are 16 species indigenous to the acidic waters. Some of the more common species are the blackbanded sunfish (Enneacanthus chaetodon), the banded sunfish (E. obesus), the bluespotted sunfish (E. gloriosus), the mud sunfish (Acantharchus pomotis), the yellow bullhead (Ictalurus natalis), the piratc perch (Aphredoderus sayanus), the ironcolor shiner (Notropis chalybaeus), and the swamp darter (Etheostoma fusiforme). The 16 species are tolerant of low pH but their presence may also be due to the slow current speeds, the availability of food, and-the reduced competition which exist in the Pinelands streams.

Graham (1978) studied the effect of pH, food mechanisms, and competition on the distribution of sunfish (Centrarchidae) in the Pinelands. He found pumpkinseed (Lepomis gibbosus) and bluegill (L. macrochirus) absent from most acid, dystrophic waters and E. chaetodon and E. obesus commonly present. E. gloriosus exhibited a distribution throughout the state, but seemed more prevalent in the more neutral pH waters outside the Pinelands. Graham concluded that pH was largely responsible for the distribution he observed; however, he also added that it did so through direct and indirect means. The direct means would be by pH toxicity. Indirectly, pH, along with low nutrient levels, combined to preclude high planktonic productivity. This placed the Lepomis spp. at a disadvantage because their young are planktivorous. Enneacanthus, on the other hand, is well-suited to the consumption of the iron floc which is the main production form observed. Consequently, Lepomis does not occupy Pinelands sites because it is not capable of outcompeting the Enneacanthus for the limited habitat available. Graham also cited the importance of other factors associated with low pH (i.e., low Ca concentrations, high dissolved CO_2 levels, and high heavy metal values).

Water Quantity Requirements: The current regime determines to a large extent the nature of the habitat, and the habitat favors the existing species. It would seem important to maintain the present current velocities if the status quo is the desired goal. The present hydrologic regime would also ensure the continued effects of tidal forces, and maintain the existing location of the fresh/saltwater interface at the head of the estuaries.

Water Quality Requirements: Maintenance of the existing pH levels would seem the most critical factor. If buffering/neutralization were to occur, due to agricultural practices and/or development, downstream fish populations like the pumpkinseed (L. gibbosus) would invade the stream. Stocked species such as the pumpkinseed, bluegill, and large-mouth bass would also be favored (Hastings, 1980).

Estuaries

General: Estauries are defined as semi-enclosed bodies of water with an open access to the sea in which seawater is measurably diluted by freshwater drainage. As this implies, the estuarine environment is a dynamic one because the mixing process is complicated by the effects of tides, currents, etc. The lower or downstream areas of the Pinelands National Reserve encompass a major portion of New Jersey's estuarine systems.

In the estuary, the water draining the Pinelands mixes with seawater. The nature and chemical composition of the water changes progressively and gradients are established. Two of the major changes involve increases in pH and salinity as the ocean is approached. The following text will deal primarily with salinity and its implications for some of the major species or groups of organisms.

Water Quantity and Quality Requirements: If the maintenance of the ecosystem in its present state is desired in the undeveloped areas, the current levels of water quantity and quality must be maintained. In the developed areas, some estuarine systems have already been degraded and are contaminated by heavy metals, microorganisms, chemicals, organic material, etc. The water quality in these areas will have to be improved to reverse the damage.

Mollusks

Mollusks such as Modiolus demissus (the ribbed mussel), Mercenaria mercenaria (the hard clam), Mya arenara (the soft clam), and (Crassostrea virginica (the oyster), exhibit fairly wide tolerances to salinity (Lent, 1969; Wells, 1957; Matthiessen, 1960; Galtsoff, 1964). However, they do have optimal levels. Gunter (n.d.) indicates that sessile or slightly motile organisms are stunted when conditions vary either upward or downward from the optima. Wells (1957) points out that in relatively saline waters a change in isohaline position will cause a shifting in the density and/or location of the hard clam population.

Other factors in combination with organism salinity tolerance often determine whether the organism will survive. Crassotrea is a typical example. Given the proper substrates, the oyster requires a salinity level within its tolerance, but beyond that of its predators. such as Urosalbinx, Eupleura, and Cliona. Generally, this salinity is between 10 and 15 parts per thousand (ppt). Otherwise, these organisms will degrade the' oyster's habitat and/or debilitate the oyster {in the case of Cliona) or devastate the young oyster population (in the case of the oyster drills) (Galtsoff, 1964; Durand and Nadeau, 1972).

Fish

The estuaries function as nurseries for many species. Out of a total of 195 species collected from mid-New Jersey to the Chesapeake Bay, Wang and Kernehan (1979) report that 40 species spawn in, and 136 species use as nursery areas, the estuaries between Cape May and Manasquan. The species utilizing the estuary include all important.forage species and the main sport fish sought by inshore fishermen. A characteristic of these nursery areas is a salinity gradient which serves to separate the young and larvae from the predator and adult stages. It also separates them from some organisms like the ctenophores (comb jellyfish) which, in addition to preying on fish larvae, can devastate planktonic Crustacea populations which post-larval stages feed upon.

If there is a sudden upstream displacement of the isohaline, the nursery areas may be moved out of the salt marsh and the sheltered areas which they provide into less favorable habitats. Alternatively, the habitat area could be reduced (Durand and Nadeau, 1972). Other fish such as the white perch, an important sport fish, are year-round residents of the estuaries. White perch are found in salinities of 15 ppt or less. The extension of saline water upriver would force the white perch out of its present habitat (Durand and Nadeau, 1972).

Crustaceans

Callinectes sapidus (the blue crab) is a commercially and recreationally important species. It. like fish, has a life cycle/nursery requirement of' low salinity conditions (Hoese, 1967). Consequently, changes in salinity would alter the habitat area of the crab.

RECREATION

Water-related recreation is classified as being either primary contact or secondary contact, based on the probability of significant water ingestion risks. Primary contact activities include wading, swimming, diving, surfing, water-skiing and similar activities. Secondary contact recreation includes boating, fishing and other limited-contact activities. The quantity of water is not critical to recreation, except that anticipated conditions, such as flood or drought, should be known in advance, so that recreationists can plan accordingly.

Water quality requirements for secondary contact recreation relate to aesthetic considerations. Waters should be virtually free from substances producing objectionable color. Dissolved oxygen should be sufficient to maintain aerobic conditions in the water column and, except as affected by natural phenomena, at the sediment-water interface (EPA, 1976). Insufficient dissolved oxygen results in the onset of septic ccnditions with its attendant malodorous emissions.

Evidence suggests that some relationship exists between bathing water quality and bathers' illnesses (National Academy of Sciences, 1974). The human body is capable of tolerating greater concentrations of most chemicals upcn occasional contact with, or ingestion of, small quantities of water than are most forms of aquatic life. Therefore, recommendaticns for the support of various forms of desirable aquatic life would probably be sufficient for the protection of human life (National Academy of Sciences, 1974).

A geometric mean of 200 fecal coliform organisms per 100 ml has been recommended previously as a limiting value that, under normal circumstances, should not be exceeded in water intended for bathing and swimming (U.S. Department of the Interior, 1968), nor should more than 10% of the tctal samples taken during any 30-day period exceed 400 per 100 ml (EPA, 1976). The principal value of this index is as an indicator of possible fecal contamination from man or other warm-blooded animals. The measure should be used only in conjunction with other evaluative parameters of water quality, such as sanitary surveys, other biological indices of pollution, and chemical analyses of water.

The most comfortable temperature range for instructional and general recreational swimming where the metabolic rate of heat production is not high, i.e., about 250 kilo calories/hour (1,000 BTU/hour), appears to be about 29 to 30°C (84 to 86°F) (Bullard and Rapp, 1970). One hour of continuous immersion in waters colder than 15°C (59°F) may cause death to some swimmers and extreme stress to all swimmers not wearing protective clothing. Prolonged immersion in water warmer that 34 to 35°C (93 to 94°F) is hazardous (National Academy of Sciences, 1974). Median lethal immersion time in water at or near freezing is less than 30 minutes for children and most adults (Molnar, 1946).

Ideally, the pH of swimming water should be approximately the same as that of the lacrimal fluid of the eyes, that is, 7.4. However, because the lacrimal fluid has a high buffering capacity, a range of pH values from 6.5 to 8.3 can be tolerated ,under average conditions. If the water is relatively free of dissolved solids and has a very low buffering capacity, pH values from 5.0 to 9.0 may be acceptable to most swimmers (National Academy of Sciences, 1974).

Water at bathing and swimming areas should be clear enough for users to estimate depth, to see subsurface hazards easily and clearly, and to detect the submerged bodies of swimmers or divers who may be in difficulty. If the water is naturally turbid, subsurface hazards should be removed and depth should be indicated by signs (National Academy of Sciences, 1974).

REFERENCES

Alderfer, R. B. Information Needed for Determining Irrigation Water Requirements In Compliance with N.J. Water Laws, 181 and 375, unpublished.

Applegate, J.E., S. Little and P. E. Marucci. "Plant and Animal Products of the Pine Barrens," Pine Barrens Ecosystem and Landscape, edited by R. T. T. Forman, Academic, pp. 25-38, 1979.

Ballinger, W. E. "Soil Management, Nutrition, and Fertilizer Practices," Blueberry Culture, edited by P. Eck and N. F. Childers, R.V. Press, p. 378, 1966.

Brown, Arthur. Personal communication, 1980.

Bullard and Rapp. "Problems of Body Heat Loss in Water Immersion," Aerospace Medicine 41:1269-1277, 1970.

Deubert, K. H. "Cranberry Production and Water Quality," Cranberries, n. d.

Durand, J. B., Nadeau, R. J. "Biological Evaluation of the Mullica River - Great Bay Estuary," New Jersey Water Resources Research Institute, Rutgers University, p. 138, 1972.

Eck, P. Effect of Cranberry Bog Operations on the Water Quality of the Oswego River, unpublished, 1977.

Environmental Protection Agency. Quality Criteria for Water, 1976.

Esser, Anthony. New Jersey Pinelands Commission, personal communication, 1980.

Galtsoff, Paul S. "The American Oyster Crossostrea Virginica Ginelin," U.S. Dept. of the Interior, Fish & Wildlife Service, Bureau of Commercial Fisheries, Fishery Bulletin U64, 1964.

Graham, J. H. "Factors Affecting the Distribution of Sunfishes (centrarchidae) in Southern New Jersey," M.S. Thesis, p. 119, 1978.

Gray, R. "Surface Water Quality in Drainage Areas of Cranberry Bogs," Cranberries 37 (3), pp. 8-9, 1972.

Greidanus, T., and M. N. Dana. "Cranberry Growth Related to Tissue Concentration and Soil Test Phosphorus," J. Am. Soc. Hort. Sci. 97 (3), pp. 326-328, 1972.

Greidanus, T., L. A. Peterson, L. E. Schraeder and M. N. Dana. "Essentiality of Ammonium For Cranberry Nutrition," J. Am. Soc. Hort. Sci. 97 (2), pp. 272-277, 1972.

Gunter, G. "Some Relations of Estuarine Organisms to Salinity," Limnol, & Oceanog., pp. 182-190, n.d.

Haines, W., Sr. and W. Haines, Jr. Personal communication, 1979.

Hastings, R. W. "Fish of the Pine Barrens," Pine Barrens Ecosystem and Landscape, edited by R. T. T. Forman, Academic, p. 601, 1979.

Hastings, R. W. Personal Communication, 1980.

Hoese, H. D. "Effect of Higher than Normal Salinities' on Salt Marshes," Marine Science 12, pp. 249-261, 1967.

Kender, W. J. and W. T. Brightwell. "Environmental Relationships," Blueberry Culture, edited- by P. Eck and N. F. Childers, Rutgers Press, pp. 75-93, 378, 1966.

Konrad, J. G, and M. A. Bryans. "Analyses of Cranberry Marsh Discharge Waters," .(Progress Report), Cranberries, 1974.

Lee, S. Personal communication, 1979.

Lent, Charles M. "Adaptations of the Ribbed Mussel, Modiolus Demissus (Dillwyn), to the Intertidal Habitat," Am. Zoologist 9, pp. 283-292, 1969.

Lipman, E., Personal communication, 1980.

Little, S. "Fire and Plant Succession in the New Jersey Pine Barrens," Pine Barrens Ecosystem and Landscape, edited by R. T. T. Forman, Academic, p. 601, 1979.

Marucci, P. "New Jersey Cranberry Bogs: Good for the Goose and Good for the Environment," The Green Scene, pp. 12-15, Nov. 1972.

Marucci, P. Personal communication, 1979.

Matthiessen, George. "Observations on the Ecology of the Soft Clam, Mya Arenaria, in a Salt Pond," Limnol. and Oceanog. 5, pp. 291-300, 1960.

McCormick, J. "The Cranberry Industry in the New Jersey Pine Barrens," submitted to the National Park Service, p. 40, 1972.

Medappa, K. C. and M. N. Dana. "Tolerance of Cranberry Plants to Manganese, Iron, and Aluminum," J. Am. Soc. Hort. Sci. 95 (1), pp. 107-110, 1970.

Miller, L. A. Personal communication, 1980.

Molnar, G. W. "Survival of Hypothermia by Man Immersed in the Ocean," Journal of the American Medical Association 131:1046-1050, 1946.

National Academy of Sciences, National Academy of Engineering. Water Quality Criteria, 1972, 1974.

New Jersey Department of Agriculture, New Jersey Crop Reporting Service. New Jersey Agricultural Statistics, p. 76, 1978.

Robichaud, B. and M. F. Buell. Vegetation of New Jersey", R. V. Press, p. 340, 1973.

Thompson, C., Personal communication, 1980.

U.S. Department of the Interior. Water Quality Criteria: Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, 1968.

Wang, J. and R. Kernehan. "Fishes of the Delaware Estuaries, A Guide to the Early Life Histories," Ecological Analysts, Towson, Maryland, p. 410, 1979.

Wells, Harry W. "Abundance of the Hard Clam, Mercenaria mercenaria, in Relation to Environmental Factors," Ecology, 38 (1), pp. 123-128, 1953.

TECHNICAL MEMORANDUM SW IV-4

WATER QUALITY INDEX

PINELANDS COMMISSION

FEBRUARY 1380

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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WATER QUALITY INDEX

GENERAL DISCUSSION

There are eleven major drainage basins in the Pinelands National Reserve and hundreds of streams. There are many chemicals in water which reflect water "quality." The United States Geological Survey (USGS) has hundreds of different compounds listed in the STORET water quality data base. It is difficult to simultaneously consider all these compounds in order to develop an overall picture of general water quality conditions throughout the Pinelands. Therefore, it is necessary to aggregate measurements of a variety of compounds, each measured a number of times, into a single number. This number is an index.

In designing an index, it is necessary to select which compounds are to be used and the relative importance of each to the index. This selection depends on what the index is supposed to measure. The term "water quality" is, in itself, inadequate to define the index. A water quality index based on recreational use of water would emphasize bacterial levels, turbidity and nutrient-stimulated algal growth. A water quality index based on protecting a particular ecologicai community may emphasize toxics, pH, and dissolved oxygen. A water quality index based on public perception may emphasize water clarity. To design an index incorporating a71 aspects is difficult; it requires value judgments such as weighting the importance of public recreation against ecological integrity.

The water quality index developed for this study is based on a standard accepted base, the New Jersey State Water Quality Standards. Every compound listed in the Water Quality Standards was considered for inclusion in the index. A number were ruled out for various reasons. Toxics were sampled too infrequently and were too poorly defined. Phosphorus also had an inadequate data base. Oxygen was eliminated because of its diurnal variability. The parameters were thus narrowed down to five: Biochemical oxygen demand (BOD), suspended solids (SS), total dissolved solids (TDS), total nitrogen (TN), and fecal coliforms (FC).

pH, which is one of the most important parameters regulating the character of the Pinelands (Patrick et al, 1979) was purposely excluded so that its relationship to the water quality index could be studied. Incorporating it in the index would preclude the use of the index in studying the correlation between pH and water quality.

To create a reliable index, water quality sampling stations were considered only if at least five samples had been an'alyzed since 1970 for the majority of the five parameters. STORET data, made available through the New Jersey Department of Environmental Protection, was used as a data base. Only 80 of the more than 150 water quality stations within the Pinelands National Reserve boundary listed on STORET met the above criteria. These qualifying stations are monitored by the USGS and Ocean County officials.

Frequency distributions were used to compare the levels of each parameter to the appropriate state Water Quality Standard.* Frequency distribution analysis was preferred to the use of a mean because a mean or average of a small data base can be biased more easily by one or two extraordinary values. Such values may be likely if samples are taken during extreme flow conditions. All index parameters are assumed to be equally important in describing water quality and thus the index gives equal weigh ach parameter.

This index was developed solely to present a rough estimation of water quality levels in the Pinelands. The index is primarily an indicator of nutrient and organic enrichment and can be used to illustrate gross differences among drainage basins and, in combination with land use data, to show relative effects of man-made disturbances. The index alone should not be used to designate area boundaries of pristine, good and disturbed water quality because there are not enough data points. If additional reliable data sources are found or more monitoring stations are established, the water quality 'index file can be expanded. With greater refinement, the water quality index may be used in conjunction with current land use data and statistical regression analyses to predict the general water quality level of unmonitored streams (see Technical Memorandum SW IV-6).

The following sections describe the selected parameters, the selected concentration levels and the construction of the index.

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* A frequency distribution tabulates the frequency that a certain value is likely to be observed.

SELECTED PARAMETERS

The parameters selected for the water quality index were:

Biochemical Oxygen Demand (BOD_5)
Fecal Coliform (FC)
Total Nitrogen (TN)
Suspended Solids (SS)
Total Dissolved Solids (TDS)

The selection was based on a review of the existing data base, a survey of the Pinelands water quality literature and the New Jersey Water Quality Standards.

The five parameters were selected from a large pool of possible chemical constituents. BOD_5 was chosen instead of dissolved oxygen saturation and total organic carbon because of the standard testing method, availability of data and acceptance as a standard test by the informed public. Total nitrogen was chosen as the representative plant nutrient. Total phosphorus, which is probably the limiting nutrient in the area, was not used because the data availability is poor and the levels are often negligible. in undisturbed streams. The variability of phosphorus solubility with pH also limits the use of the parameter as an index for the Pinelands.

Fecal coliform is an indicator of waste from warm blooded animals and is often associated with septic system failures. High suspended solids loads are associated with erosion and land disturbance. Total dissolved solids (TDS) concentration which are normally very low in the Pinelands, were used to assess the ionic strength of the streams. High TDS readings are related to point source pollution, malfunctioning septic systems, changes in soils and geology or the influence of salt water.

BOD_5 (Biochemical Oxygen Demand)

Definition: BOD is a measure of the oxygen demand or organic pollution. The BOD_5 is measured in a laboratory test; a duration of 5 days is used to assess the relative oxygen requirements in water bodies and wastewater.

Values: The New Jersey DEP (1979) proposes a maximum of 5 mg/l BOD5 as the standard for the central Pine Barrens. A review of USGS water quality data for 1969 to 1979 for Pineland streams shows an average BOD5 of 2.0 mg/l and a range of the means from 0.2 mg/l to 13.29 mg/l. Velz (1970) states that a stream draining virgin territory normally carries a residual organic load of 0.5 to 1.0 ppm of 5-day standard BOD during dry periods. During storm events, the load may increase to 1.0 to 2.0 ppm or higher. An average BOD_5 of .200 mg/l can be expected for domestic raw sewage and 10 to 20 mg/l for secondary treated sewage (Fair, Geyer and Okun, 1968)..

.Significance: BOD_5 is an indicator of organic . The BOD_5 values of pristine Pineland streams are low. .There are slight increases during the' summer months due to leached organic acids and detritus from bog and swamp areas. 4 constantly high BOD_5 is most likely the result of human activity,

Three parameters could be used as indicators of organic enrichment: BOD_5, total organic carbon (TOC) and percent oxygen saturation. BOD_5 was selected for the water quality index because of the relative reliability of test methods, extensive available literature, acceptance by the informed public, and use in NJDEP v quality standards.

Fecal Coliform

Definition: The c n group comprises all of the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35°C. Elevated temperature tests separate organisms of the coliform group into those of fecal origin and those derived from nonfecal sources.

Values: The New Jersey DEP (1979) proposes a criterion that fecal coliform levels should not exceed a geometric average of 200/100 ml in the central Pine Barrens. The U.S. Environmental Protection Agency recommends that in shellfish harvesting waters a median fecal coliform concentration not exceed 14 MPN (most probable number)/100 ml (EPA, 1976)

Significance: Fecal coliform bacteria indicate fecal waste contamination by warm-blooded animals and/or man and may indicate the possible presence of pathogens. Elevated fecal coliform counts often result from malfunctioning septic fields, urban runoff and lapses in disinfection of wastewater before discharge.

Total Nitrogen

Definition: The sum of ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), organic nitrogen and particulate nitrogen in the water column at one specific time.

Values: The New Jersey DEP (1979) has established a nitrate nitrogen level not to exceed 2 mg/l in the Central Pinelands and 3 mg/l in the Lower Mullica and Wading rivers. An un-ionized ammonia level of 0.02 mg/l has been set for all streams. Concentrations of un-ionized ammonia are directly dependent on pH and temperature. Un-ionized ammonia is not a significant problem in the Pinelands because water samples with a pH of 6 and a temperature of 20°C would require a total ammonia (NH_3 + NH_4) concentration of 25 mg/l to contain an un-ionized ammonia concentration of 0.02 mg/l.

McCarty et al (1970) indicate that the total nitrogen concentration in streams ranges between 0.1 and 3.0 mg/l N. Total nitrogen levels in the Pinelands average 1.4 mg/l as N; nitrate nitrogen averages 45% of total nitrogen in the Pinelands. Higher discharge streams tend to have a higher nitrogen concentration than those with lower flow rates (Feth, 1966). Higher nitrogen values are generally found in the winter months (December to April) due to biological inactivity (Martin and Goff, 1972). Nitrogen reserves in the soil build up during the winter due to reduced terrestrial uptake after crop harvesting and metabolic shutdown of the forested areas. Leaching of the nitrates formed in the soil by nitrifying bacteria leads to its increased concentrations in streams (Durand, 1980).

Significance: Nitrogen compounds are important in the assessment of water quality for the following reascns:

- Nitrogen is a major plant nutrient (ammonia and nitrate are the most usable forms)
- Un-ionized ammonia is toxic to aquatic organisms and man
- Excessive levels of nitrate can cause methemoglobinema (Blue Baby disease) when it is converted to nitrites in the gastrointestinal tract. The New Jersey potable water standard for nitrate is 10.0 mg/l NO_3-N.
- Nitrification of ammonia to nitrates requires oxygen, reducing natural dissolved oxygen levels. Most nitrification activity occurs in the soil, however, so the effect on stream oxygen levels will be minimal.

If inorganic nitrogen and phosphorus compounds are readily available, excessive macrophyte and algal growth will occur (assuming other environmental requirements are met). Sawyer (1974) reports that inorganic nitrogen levels above 0.3 mg/l may cause noxious algae blooms. High nitrogen levels in the Pinelands will most likely cause excess macrophyte growth in the streams and lakes and alter the nutrient balance of the receiving estuaries.

Nitrogen levels are naturally low in the Pinelands; elevated readings are most likely due to man's activities. High nitrate levels are often associated with agricultural runoff and high ammonia levels usually signify sewage input.

Total nitrogen is used in the Pinelands water quality index because of the continual conversion among nitrogen compounds. Under aerobic conditions, ammonia is readily converted to nitrate by nitrification, while under anaerobic conditions, nitrogen gas is created by denitrification. The specific nitrogen compound dominant at a water quality sampling station will depend partially on the distance from the pollutant source, the nitrogen compound dominant at the pollutant source, and the oxygen context of the stream.

Total nitrogen is an especially important component of the water quality index because it is the only measure of nutrient loads. The data base on total phosphate and orthophosphate is not sufficient to be included in the index.

Suspended Solids

Definition: Suspended solids (total nonfiltrable residue) is the retained material on a standard glass fiber filter disc after filtration of a well-mixed water sample. The residue is dried at 103 to 105°C (APHA, AWWA, WPCF, 1975).

Values: The New Jersey DEP (1979) has proposed a suspended solids limit not to exceed 40 mg/l in the central Pine Barrens and not to exceed 25 mg/l in trout waters. The mean suspended solids level for Pinelands streams [illegible] on USGS data collected between 1967 and 1979 is 12.5 mg/l.

Significance: Increased suspended solids values indicate that river banks and/or nearby lands are eroding. High suspended solid loads are usually associated,.with construction (land clearing) and/or agriculture (Wolman, 1967).

High levels of suspended sediment in water bodies can deleteriously affect the aquatic community by clogging the gills of filter feeders, reducing light penetration and photosynthesis, and interfering with behavioral movements of fish. Oxygen levels usually decrease with increasing suspended sediment concentrations. Contact and non-contact recreation is negatively affected. Suspended particles may also serve as transport mechanisms for nutrients and pesticides.

Total Dissolved Solids (TDS)

Definition: Total dissolved solids (filterable residue) is material that passes through a standard glass fiber filter disk and remains after evaporation and drying to constant weight at 180°C (APHA, AWWA, WPCF, 1975). Dissolved solids are the difference between total solids and suspended solids.

Values: The New Jersey DEP (1979) has proposed a TDS limit not to exceed 100 mg/l in the Central Pinelands and Lower Mullica and Wading River basins and not to exceed 500 mg/l or 133% of background in FW2 streams. The average TDS value for Pineland streams is 20 ppm and the world average TDS level in natural waters is 105 ppm (Means et al, 1980).

Significance: The total dissolved solids level is used in the Pinelands water quality index for the following reasons:

- Pinelands aquatic biota have adjusted to a low TDS level. Significant increases will alter osmotic regulation.
- Human activities can be traced by significant increases in TDS.

WATER QUALITY INDEX CRITERIA

Water Quality Data

USGS and Ocean County water quality data collected since 1970 were used for the Pinelands assessment. The index was applied to 80 stations which were sampled a minimum of five times for a majority of the five parameters. With the help of the NJDEP Division of Water Resources, frequency distributions were established for the five parameters for each of the 80 stations. The 10-, 50-, 90- and 100-percentile levels* were used as divisions between quality groupings (see Appendix 1 for percentile levels).

Frequency distribution analysis was used to reduce the effects of extreme or aberrant data. An assumption was made that the data at each station reflect a valid sample of stream flows. If this assumption were not made and cutoff limits were established for flow levels, the already sparse data base would be further reduced.

There is a potential bias in the index due to the seasonal distribution of sampling. It is possible that the water quality stations are under-sampled during the winter months. To the extent that this seasonal bias occurs more or less uniformly over all our water quality stations, it will not affect the relative water quality estimation among stations.

If sampling varies greatly with respect to season among the stations, a significant bias may occur. For the purposes of this general water quality index, seasonal bias does not need to be considered. If a more rigorous index is created in the future, the potential bias can be investigated by creating a table showing the seasonal distribution of sampling for each station. The index can be adjusted for seasonal effect by multiplying each measurement used for the index by a seasonal adjustment factor and then recalculating the percentiles and index.

Water Quality Groupings

The follawing "base concentration limits" were established for use in the water quality index:

Biochemical Oxygen Demand	5 mg/l
Total Nitrogen	3 mg/l
Suspended Solids	12.5 mg/l
Total Dissolved Solids	100 mg/l
Fecal Coliform	200/100 ml

It was first proposed that the concentration limits be based on the NJDEP Proposed Revisions to the Water Quality Standards (NJDEP, 1979) for all five parzmeters. These limits produced a good distribution for BOD, TDS and fecal coliform, but were too high for suspended solids.

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* The X percentile level is the concentration exceeded 100-X percent of the time. If the 90th percentile for BOD_5 is 4.5 mg/l, 90% of the time BOD values are less than 4.5 mg/l and 10% of the time they exceed 4.5 mg/l.

All but one or two stations had 90 percentile levels less than the proposed standard af 40 mg/l. The concentration limit of 12.5 mg/l which is the average suspended solids level for Pineland streams was used in the index instead of the NJOEP proposed standard.

The NJOEP propo[illegible]ater quality standards have a nitrate (NO_3-N) limit of 2 mg/l i[illegible] central Pinelends and 3 mg/l in the lower Mullica and Wading River area. There is no proposed standard for total nitrogen. A total nitrogen level of 4.4 mg-N/l was first used as the index limit based on the fact that nitrate levels averaged 45% of the total nitrogen level in the Pinelands (2 mg/l is 45% of 4.4 mg/l). The 4.4 mg-N/l limit proved to be too high, however, so it was dropped to 3 mg/l which is the upper limit of total nitrogen levels in natural streams (McCarty et al, 1970).

These levels were compared with the frequency distributions for the water quality stations. The following additive ranking system was established:

Value Determination

- If the concentration limit for a particular parameter was better or equal to the "base concentration limits" 90 percent of the time (i.e., 90th percentile), it is given a "1."
- If the concentration limit for a particular parameter falls in the 50 to 90 percentile bracket, it is given a "2."
- If the concentration limit for a particular parameter falls below the 50 percentile level, it is given a "3."

Factor Combination

- Good Quality - The added values for the five parameters equals 5
- Slightly Disturbed - The added values for the five parameters equals 6 or 7
- More Disturbed - The added value for the five parameters equals 8 or 9
- Most Disturbed - The added values for the five parameters is greater than 9

The Ocean County water quality stations did not have a recorded value for total nitrogen. Instead of eliminating all of these stations from the data bank, the percentile levels of Total Kjeldahl Nitrogen and Nitrate and Nitrate Nitrogen ($NO_3 + NO_2$) were added together to approximate the total nitrogen percentiles. In future refinements of this index, total nitrogen frequency distribution should be developed from the raw data. Appendix 2 lists the water auality index values and number of observations for each of the five parameters and the median pH level at the 80 sampling locations.

Pristine Quality Group

The stream stretches rated as good quality in the above analysis were subjected to a more stringent test to determine pristine streams of the Pinelands. The following concentration limits were established:

Biochemical Oxygen Demand	<3.0
Total Nitrogen	≤1.0
Suspended Solids	≤10.0
Total Dissolved Solids	≤50.0
Fecal Coliform	≤100.0

Any stream stretch that meets these criteria at least 90% of the time is considered pristine. These concentration limits were based on a review of the frequency distribution in the twelve "good quality" streams, water quality data from a known pristine stream (McDonalds Branch), and the general literature.

RESULTS

Of the 80 stations, the index rated 2 as pristine, 15 as good, 46 as slightly disturbed, 10 as more disturbed and 7 as most disturbed. Appendix 1 shows the frequency distribution plots and data tables and Appendix 2 tabulates the water quality index ratings. The water quality index results are illustrated on Figure 1. Figure 2 is a map of the median pH values for comparison.

A plot of the water quality index against median pH in Figure 3 shows a positive relationship. This relationship is discussed in greater detail in Technical Memorandum SW IV-6.

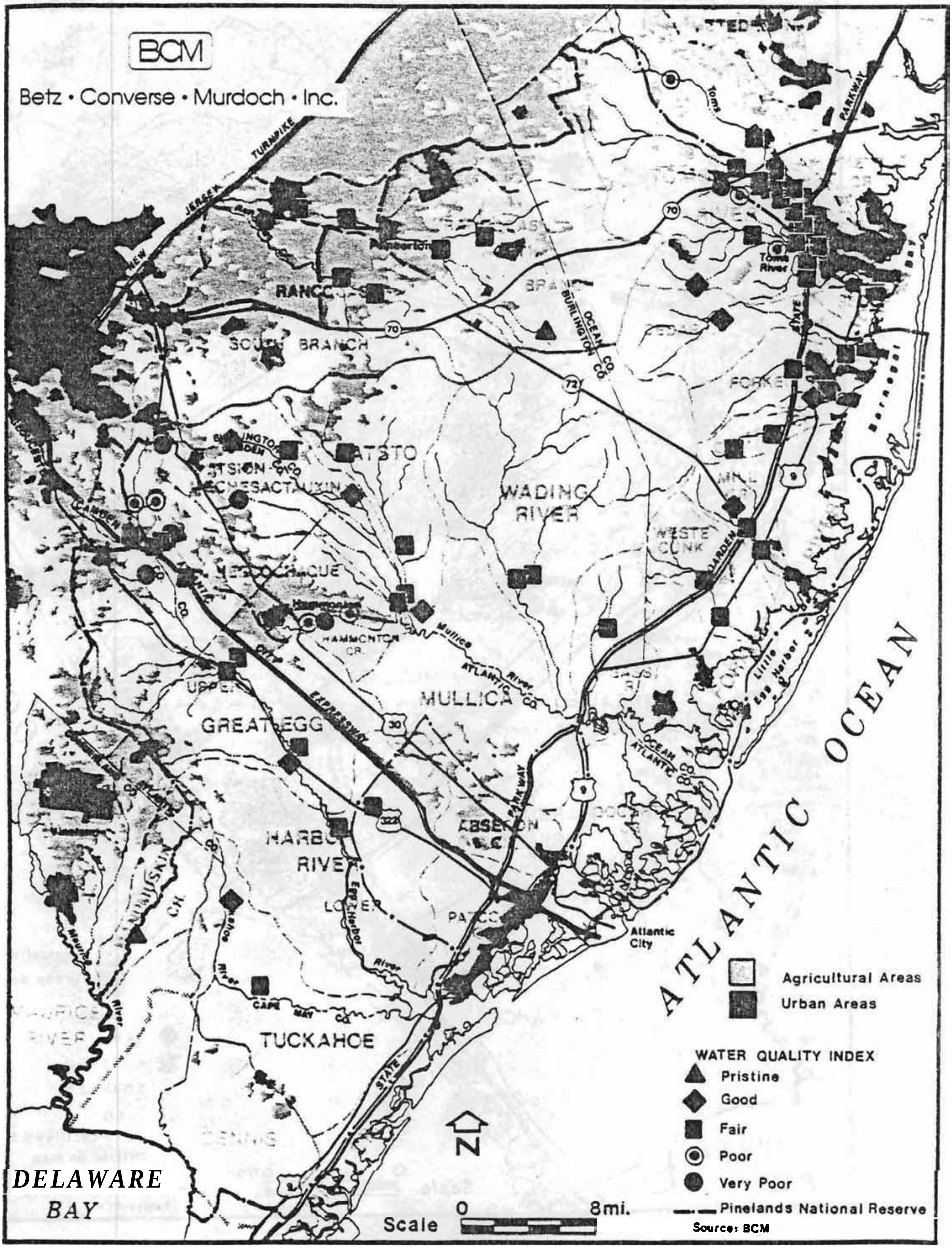

Figure I - WATER QUALITY INDEX

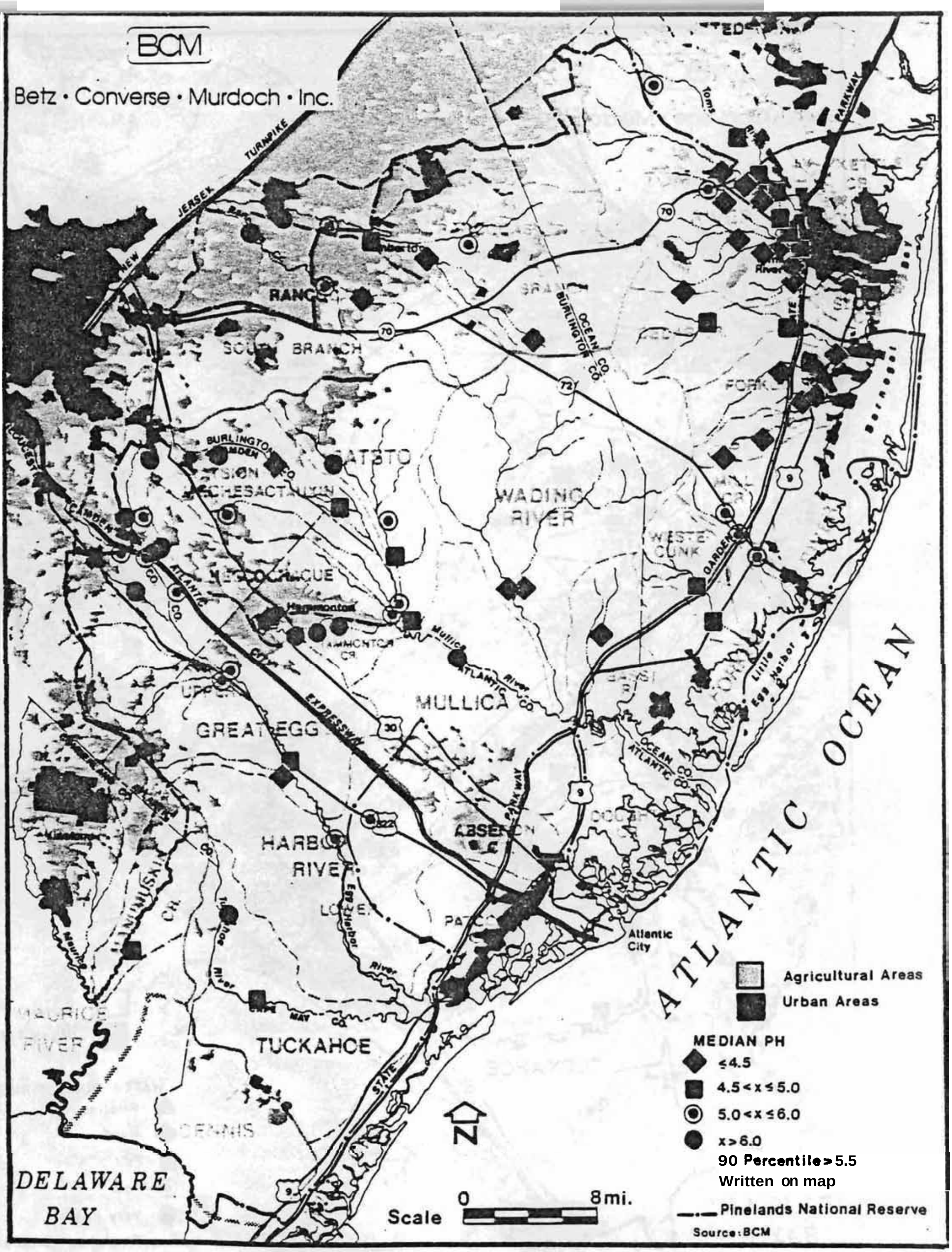
BCM
Betz · Converse · Murdoch · Inc.
ATLANTIC OCEAN
DELAWARE BAY
WADING RIVER
MULLICA
GREAT EGG
HARBOR RIVER
TUCKAHOE
SOUTH BRANCH
Atlantic City
Agricultural Areas
Urban Areas
MEDIAN PH
≤4.5
4.5<x≤5.0
5.0<x≤6.0
x>6.0
90 Percentile>5.5
Written on map
Pinelands National Reserve
Source: BCM
Scale
0
8 mi.
N

Figure 2. pH

Source: BCM

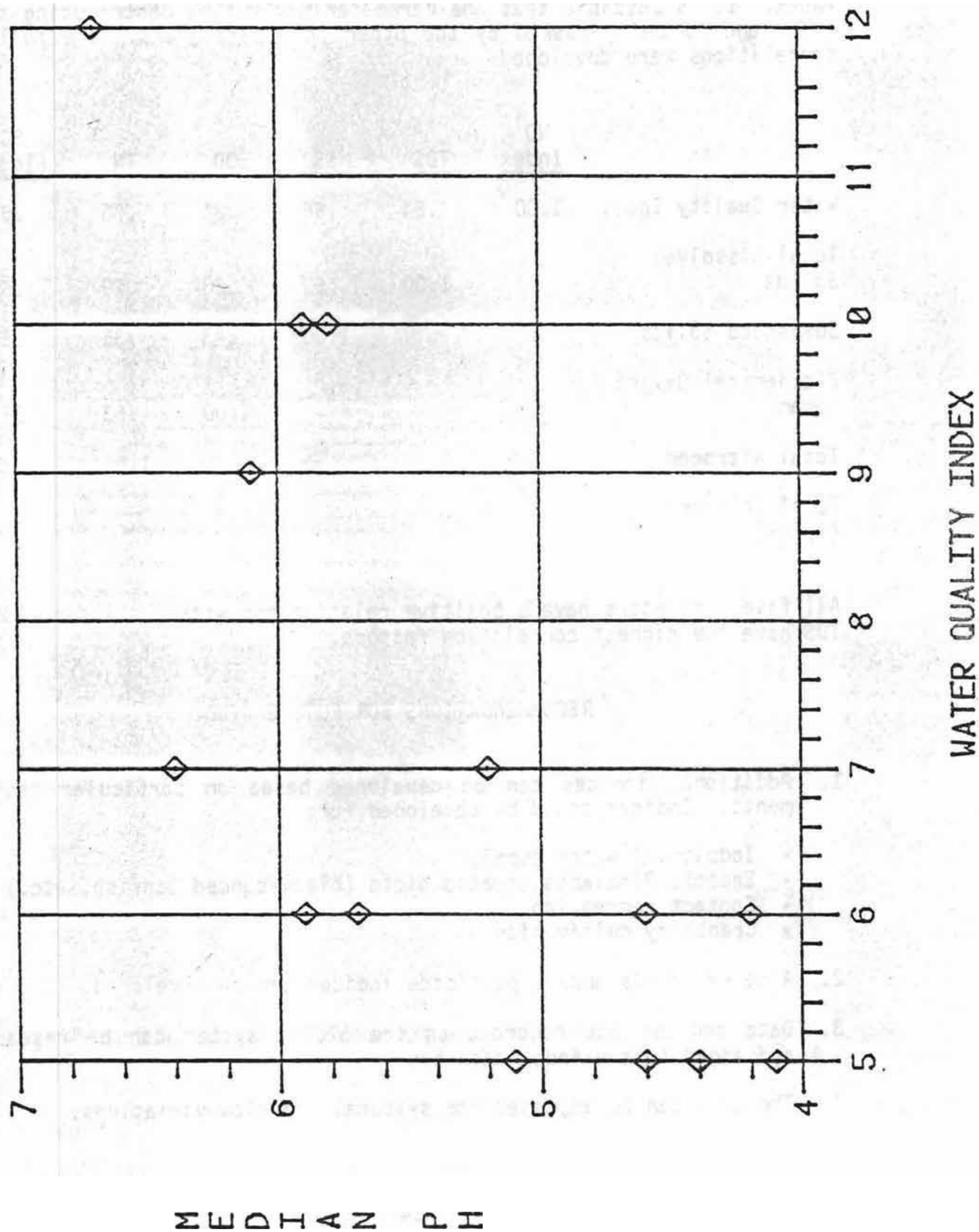

FIGURE 3
PH VS. WATER QUALITY

A correlation matrix was developed to determine if each of the five parameters exhibited a positive relationship with the water quality index. It is possible that one parameter may not be contributing to the index and is being masked by the other four parameters. The following correlations were developed:

	WQ Index	TDS	SS	BOD	TN	FC (log10)
Water Quality Index	1.00	.84	.66	.91	.76	.63
Total Dissolved Solids		1.00	.62	.68	.79	.61
Suspended Solids			1.00	.43	.35	.85
Biochemical Oxygen Demand				1.00	.63	.54
Total Nitrogen					1.00	.28
Fecal Coliform (log10)						1.00

All five parameters have a positive relationship with the index; BOD and TDS have the highest correlation factors.

RECOMMENDATIONS FOR FUTURE STUDY

1. Additional indices can be developed based on particular requirements. Indices could be developed for:
   - Industrial water supply
   - Endemic Pinelands aquatic biota (black-banded sunfish, etc.)
   - Contact recreation
   - Cranberry cultivation
2. A heavy metals and/or pesticide indices can be developed.
3. Data sources not recorded on the STORET system can be researched and added to the index data bank.
4. The data can be adjusted for seasonal and flow variations.

REFERENCES

American Public Health Association (APHA), American Water Works Association (AWWA), Water Pollution Control Federation (WPCF). Standard Methods for the Examination of Water and Wastewater, 14th ed., 1975.

Durand, James. B. Written communication, January 21, 1980.

Durand, James B. and Bonnie Zimmer. Pinelands Study - Surface Water Quality, Rutgers University, Camden, New Jersey, 1979.

Fair, Gordan M., John C. Geyer, and Daniel A. Okun. Water and Wastewater Engineering, Vol. 2: Water Purification and Wastewater Treatment and Disposal, John Wiley & Sons, Inc., New York, New York, 1968.

Feth, I. S. Nitrogen Compounds in Natural Water - A Review, Journal Water Resources Research 2: 41-58, 1966.

Martin, Donald M. and David R. Goff. The Role of Nitrogen in the Aquatic Environment, Academy of Natural Sciences of Philadephia, 1972.

McCarty, P., et al. Chemistry of Nitrogen and Phosphorus in Water, Journal American Water Works Association, 62: pp. 127-140, February, 1970.

McKee, J. E. and M. W. Wolf. Water Quality Criteria, 2nd ed., State of California, State Water Resources Control Board, 1971.

Means, J. L., R. F. Yuretich, D. A. Creror, D. J. Kinsman and M. P. Borcsik. Hydrogeochemistry of the New Jersey Pine Barrens, Princeton University, (in press).

New Jersey Department of Environmental Protection. Proposed Revisions to Water Quality Standards (draft), September 1979.

Patrick, Ruth, Barbara Matson and Lee Anderson. Streams and Lakes in the pine Barrens, In: Pine Barrens - Ecosystem and Landscape, Academic Press, Inc., New York, 1979.

Sawyer, C. N. Fertilization of Lakes by Agricultural and Urban Drainage, Journal New England Water Works Association, 61: 109-127, 1947.

U.S. Environmental Protection Agency, Quality Criteria for Water, EPA-440/9-76-023, Washington, D.C., 1976.

Velz, Clarence J. Applied Stream Sanitation, Wiley - Interscience, New York, New York, 1970.

Wetzel, Robert G. Limnology, W. B. Saunders Co., Philadephia, Pennsylvania, 1975.

Wolman, M.G. A Cycle of Sedimentation and Erosion in Urban River Channels, Geografisha Annalen, 49A: 385-395, 1967.

APPENDIX 1

WATER QUALITY DATA

FREQUENCY DISTRIBUTION PLOTS*

* The proposed NJDEP Water. Quality Standards for the Central Pine Barrens is shown on each graph

Source: Betz•Converse•Murdoch•Inc.
STORET

1.0 TOMS RIVER DRAINAGE BASIN

Station	Station No.	Station Location
1	OCN032	Jakes Brook Double Trouble Road
2	OCN030	Toms River New Egypt-Cassville Road
3	OCN029	Toms River Lakehurst-Whitesville Road
4	OCN028	Toms River at Route 70
5	OCN040	Ridgeway Branch Route 70
6	OCN027	Toms River Route 571
7	OCN026	Toms River above Toms River Chemical
8	OCN025	Toms River Oakridge Parkway Route 5
9	OCN024	Toms River Lakehurst Road Route 527
10	OCN035	Wrangle Brook St Thomas Dr
11	OCN034	Wrangle Brook $ Barbadoes Drive
12	OCN037	Davenport Branch Whiting-Lacey Road
13	OCN036	Davenport Branch Road Between Holiday City Dover Road
14	OCN033	Wrangle Brook Gem Ave
15	OCN032	Jakes Brook Double Trouble Road
16	OCN042	Manapaqua Branch Lakehurst-Ridgeway Road
17	OCN039	Union Branch Route 37
18	OCN038	Union Branch Brookline Road
19	OCN041	Ridgeway Branch Lakehurst-Ridgeway Road

TABLE 2-1 (Continued)

Water Quality Station		BOD5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
OCN 024	Toms River Lakehurst Rd.	1	16	2	3	1	51	2	8	1	42	7	4.60
OCN 035	Wrangle Br. off Fort de France Avs.	1	15	1	4	1	48	2	6	1	46	6	4.20
OCN 034	Wrangle Branch S. Barbados Dr.	1	16	2	4	1	50	2	6	1	44	7	4.40
OCN 037	Davenport Branch Whiting - Lacey Rd.	1	17	1	3	1	50	1	7	1	44	5	4.37
OCN 036	Davenport Branch between Holiday City and Dover Rd.	2	14	1	4	2	49	2	6	1	44	8	4.49
OCN 033	Wrangle Brook end of Gem Ave.	1	15	2	4	1	46	2	5	1	43	7	4.40
OCN 032	Jakes Branch Double Trouble Rd.	1	16	1	5	1	47	2	6	1	44	6	4.19

* Water quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

STORET SYSTEM 01/31/85

MULTIPLE STATION PLOT (MSP)
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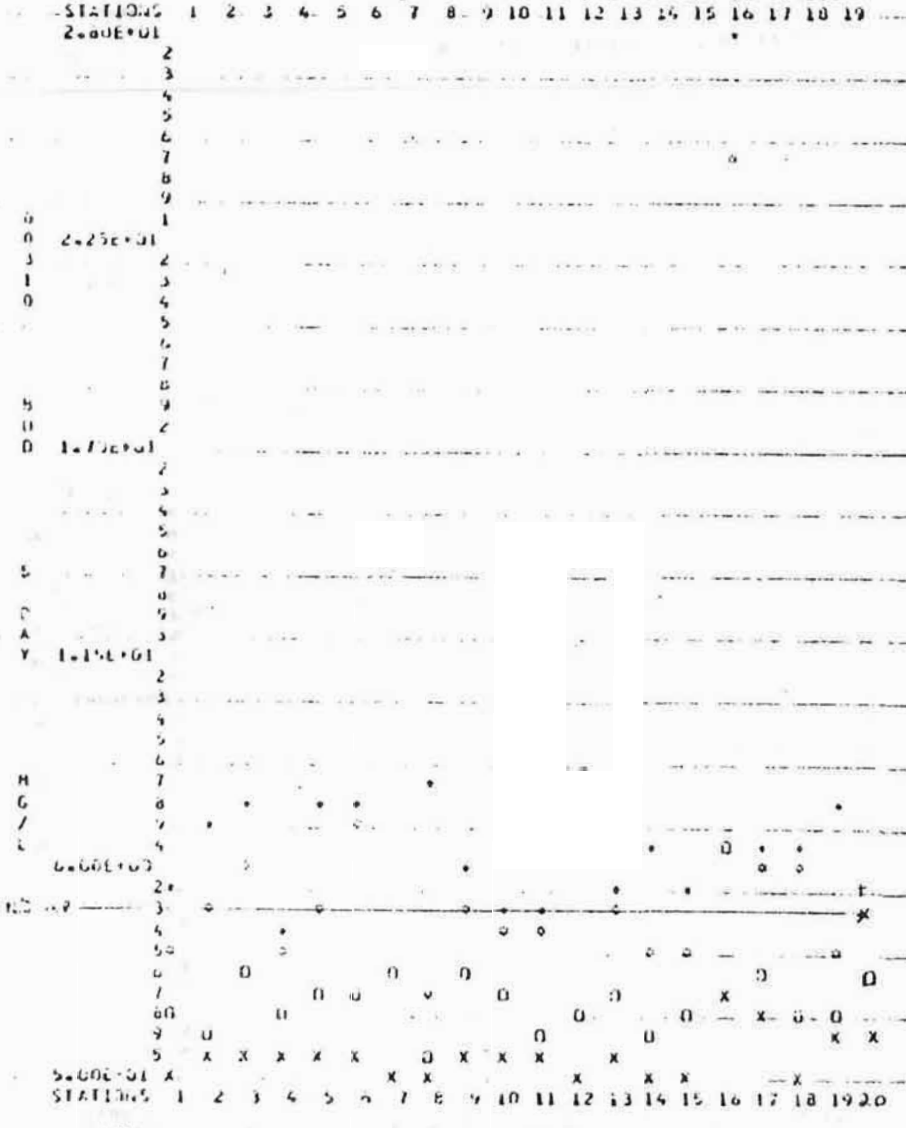
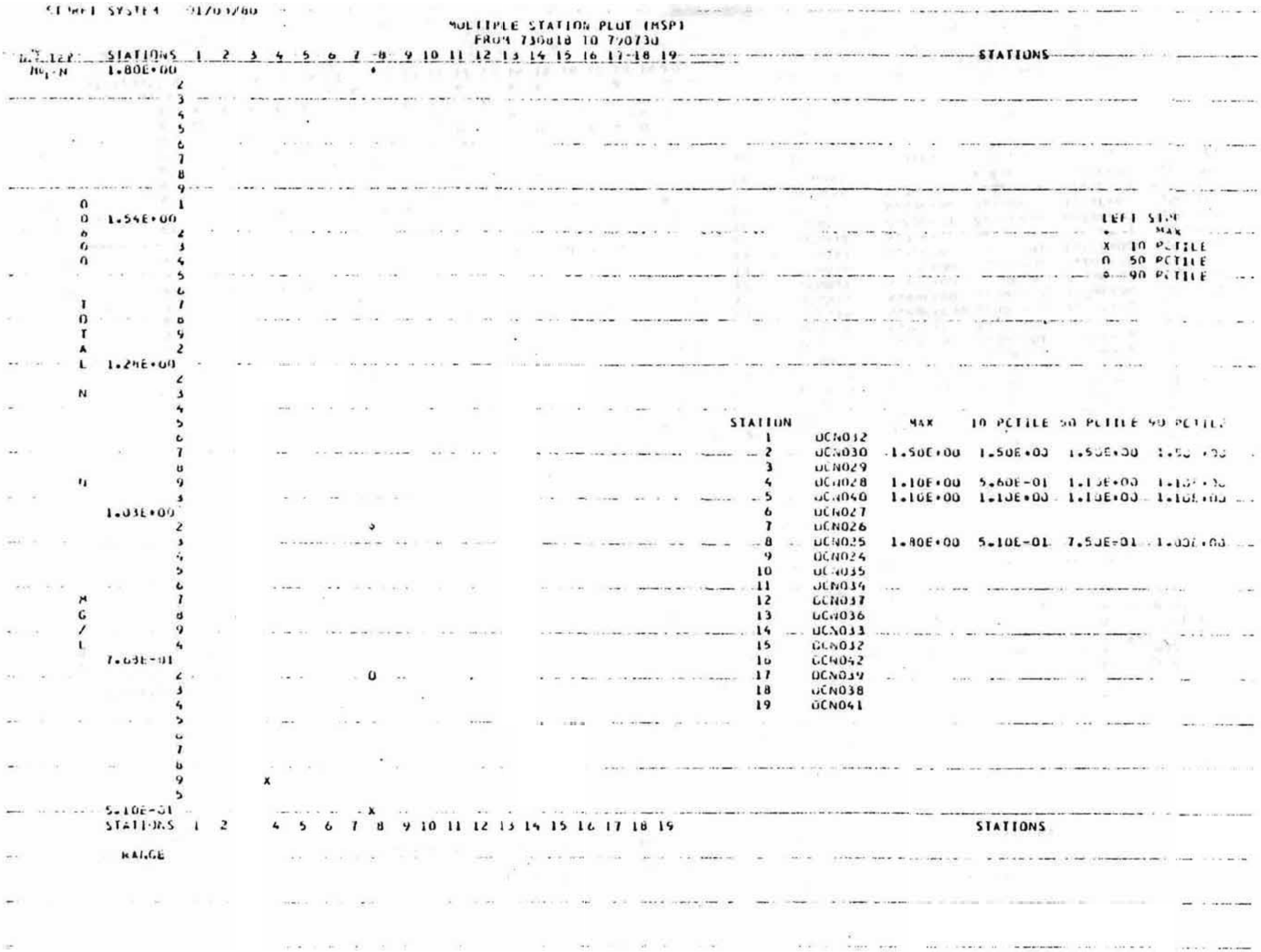


LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
9 90 PCTILE

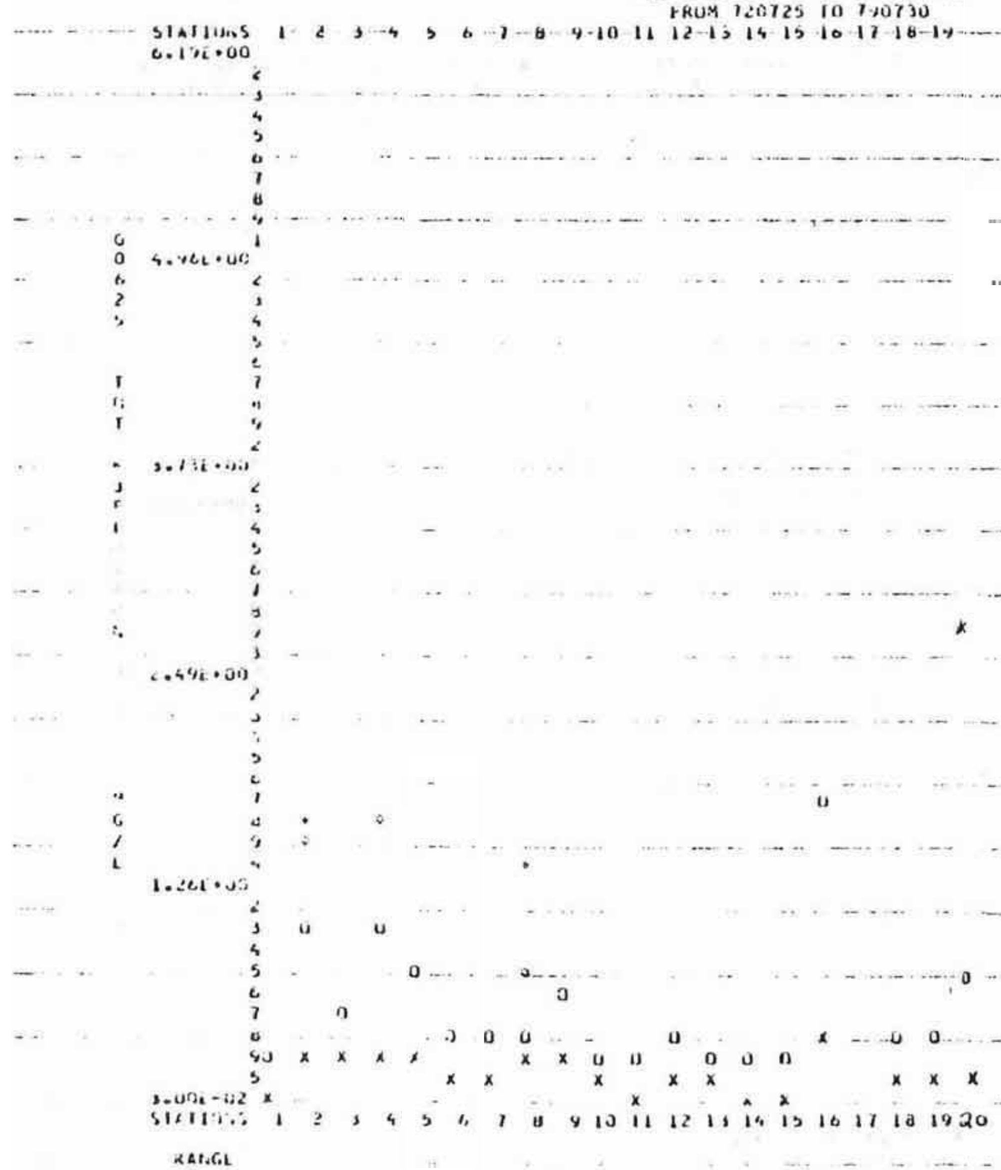
STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	OCN032	5.70E+00	6.00E-01	2.40E+00	[illegible]
2	OCN030	7.00E+00	1.00E+00	1.50E+00	[illegible]
3	OCN029	7.50E+00	9.00E-01	3.00E+00	[illegible]
4	OCN028	4.50E+00	1.00E+00	2.30E+00	[illegible]
5	OCN040	7.50E+00	1.00E+00	2.70E+00	[illegible]
6	OCN027	7.50E+00	1.30E+00	2.70E+00	[illegible]
7	OCN026	4.80E+00	6.00E-01	3.00E+00	[illegible]
8	OCN025	8.00E+00	6.00E-01	1.20E+00	[illegible]
9	OCN024	6.00E+00	1.20E+00	[illegible]	[illegible]
10	OCN035	4.80E+00	1.00E+00	2.70E+00	[illegible]
11	OCN034	4.80E+00	1.00E+00	1.50E+00	[illegible]
12	OCN037	5.10E+00	5.00E-01	2.40E+00	[illegible]
13	OCN036	5.40E+00	1.20E+00	2.70E+00	[illegible]
14	OCN033	6.30E+00	6.00E-01	1.50E+00	[illegible]
15	OCN032	5.70E+00	6.00E-01	2.40E+00	[illegible]
16	OCN042	2.80E+01	2.70E+00	6.70E+00	[illegible]
17	OCN039	6.60E+00	2.10E+00	3.00E+00	[illegible]
18	OCN038	6.30E+00	5.00E-01	2.40E+00	[illegible]
19	OCN041	7.50E+00	1.80E+00	2.40E+00	[illegible]
20	OCN031	6.30E+00	1.32E+00	[illegible]	[illegible]



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032				
2	UCN030	1.50E+00	1.50E+00	1.50E+00	1.50E+00
3	UCN029				
4	UCN028	1.10E+00	5.60E-01	1.10E+00	1.10E+00
5	UCN040	1.10E+00	1.10E+00	1.10E+00	1.10E+00
6	UCN027				
7	UCN026				
8	UCN025	1.80E+00	5.10E-01	7.50E-01	1.00E+00
9	UCN024				
10	UCN035				
11	UCN034				
12	UCN037				
13	UCN036				
14	UCN033				
15	UCN032				
16	UCN042				
17	UCN039				
18	UCN038				
19	UCN041				

STORET SYSTEM 01/03/90

MULTIPLE STATION PLOT (MSP)
FROM 720725 TO 790730



LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
* 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032	1.76E+00	3.00E-02	3.10E-01	[illegible]
2	UCN030	1.60E+00	1.50E-01	1.00E+00	[illegible]
3	UCN029	1.39E+00	2.40E-01	4.80E-01	[illegible]
4	UCN028	3.92E+00	2.40E-01	1.00E+00	[illegible]
5	UCN040	2.00E+00	2.40E-01	7.50E-01	[illegible]
6	UCN027	1.39E+00	1.50E-01	4.20E-01	[illegible]
7	UCN026	1.39E+00	1.30E-01	3.70E-01	[illegible]
8	UCN025	1.37E+00	2.60E-01	3.80E-01	[illegible]
9	UCN024	4.17E+00	2.70E-01	[illegible]	[illegible]
10	UCN035	5.40E-01	1.50E-01	3.20E-01	[illegible]
11	UCN034	5.10E-01	9.00E-02	2.45E-01	[illegible]
12	UCN037	1.90E+00	1.70E-01	3.00E-01	[illegible]
13	UCN036	1.11E+00	1.00E-01	3.05E-01	[illegible]
14	UCN033	2.30E+00	9.00E-02	2.20E-01	[illegible]
15	UCN012	1.26E+00	3.00E-02	4.10E-01	[illegible]
16	UCN042	6.19E+00	4.00E-01	1.75E+00	[illegible]
17	UCN039	4.75E+00	2.20E-01	3.20E-01	[illegible]
18	UCN038	1.39E+00	1.30E-01	3.95E-01	[illegible]
19	UCN041	1.39E+00	1.30E-01	4.00E-01	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STORET SYSTEM 01/03/8?

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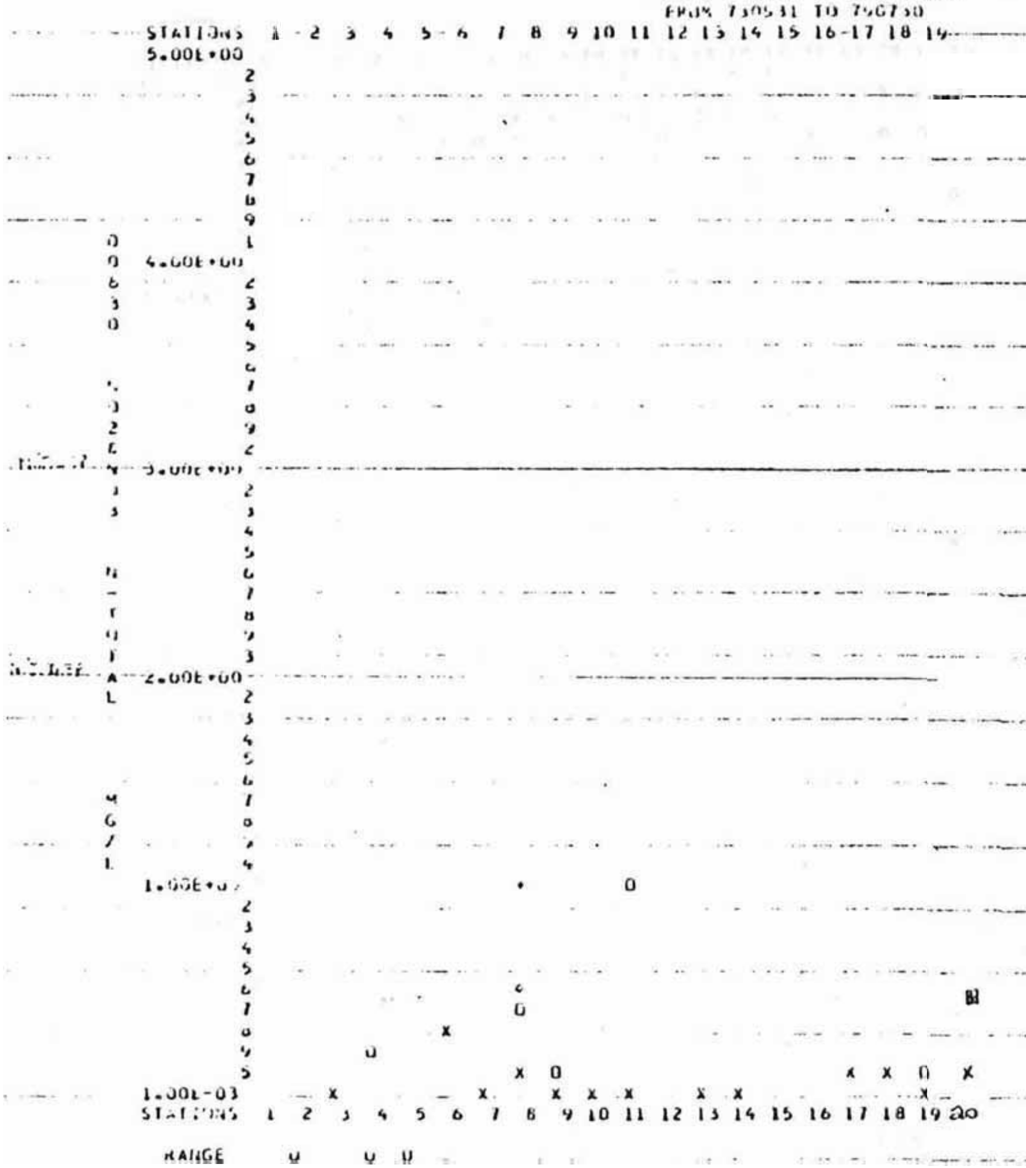

LEFT SIDE
• MAX
x 10 PCTILE
O 50 PCTILE
Δ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032	1.00E+00	1.00E-03	2.00E-02	[illegible]
2	UCN030	1.00E+00	0.00E+00	1.00E+00	[illegible]
3	UCN029	2.30E-01	5.00E-02	2.00E-01	[illegible]
4	UCN028	1.00E+00	0.00E+00	2.00E-01	[illegible]
5	UCN040	1.00E+00	0.00E+00	1.00E+00	[illegible]
6	UCN027	3.70E-01	3.30E-01	3.60E-01	3.70E-01
7	UCN026	1.40E-01	4.00E-02	1.40E-01	1.40E-01
8	UCN025	1.00E+00	1.50E-01	3.60E-01	[illegible]
9	UCN024	1.00E+00	3.00E-02	1.20E-01	[illegible]
10	UCN035	1.00E+00	2.00E-02	1.00E+00	[illegible]
11	UCN034	5.00E+00	4.00E-02	1.00E+00	5.00E+00
12	UCN037	1.00E+00	6.00E-03	1.00E-02	[illegible]
13	UCN036	1.00E+00	1.00E-02	1.00E+00	[illegible]
14	UCN033	1.00E+00	4.00E-02	1.00E+00	[illegible]
15	UCN032	1.00E+00	1.00E-03	2.00E-02	[illegible]
16	UCN042	1.00E+00	1.30E-01	1.50E-01	[illegible]
17	UCN039	1.00E+00	7.00E-02	1.00E+00	[illegible]
18	UCN038	2.20E-01	1.20E-01	1.80E-01	2.20E-01
19	UCN041	1.90E-01	1.00E-03	8.00E-02	1.90E-01
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
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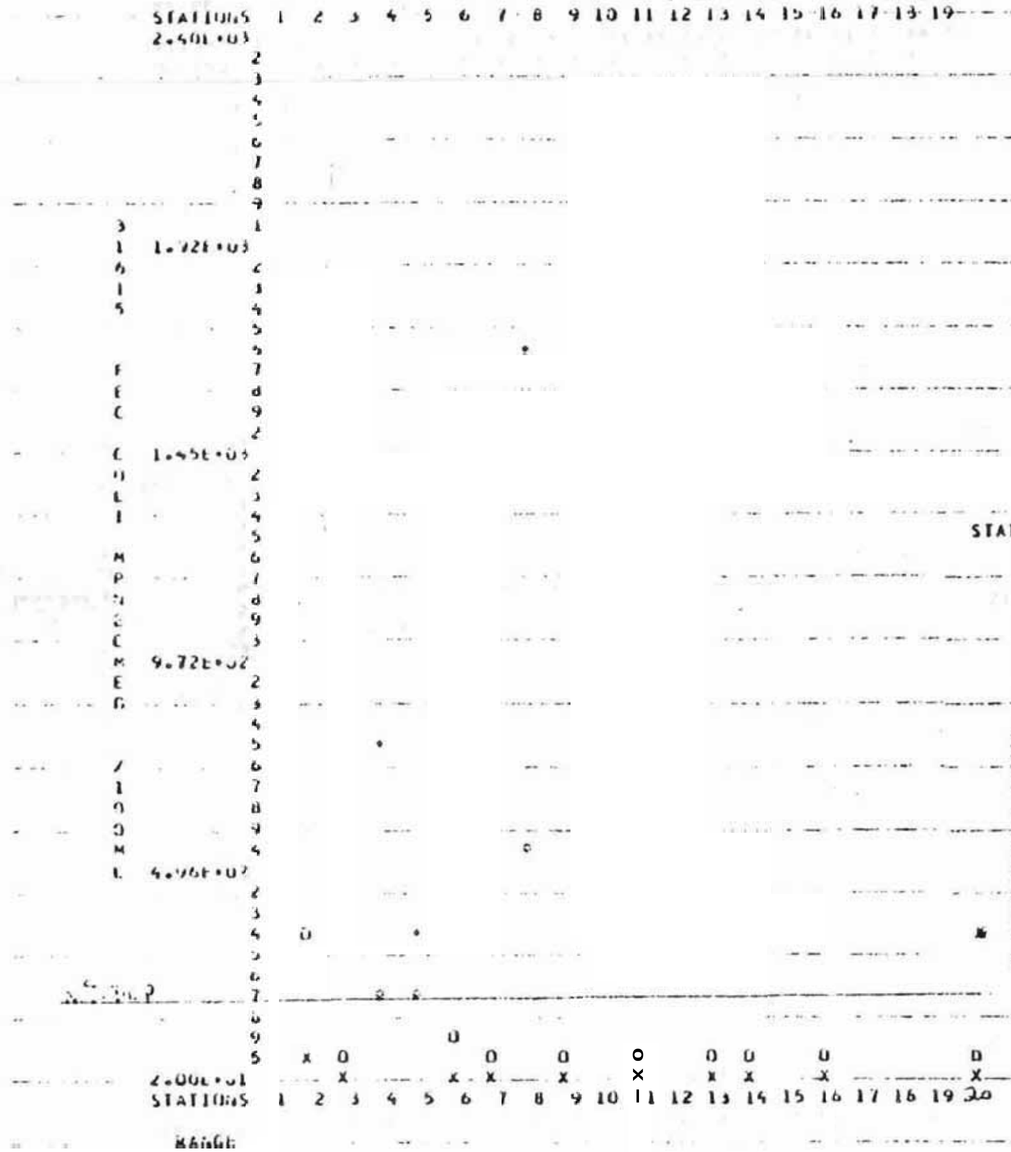

LEFT SIDE
\+ MAX
X 10 PCTILE
O 50 PCTILE
\- 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032	2.40E+03	2.00E+01	2.00E+01	[illegible]
2	UCN030	1.30E+03	5.00E+01	3.30E+02	[illegible]
3	UCN029	1.70E+02	2.00E+01	4.00E+01	1.70E+02
4	UCN028	7.90E+02	2.00E+01	2.80E+01	[illegible]
5	UCN040	3.30E+02	2.00E+01	2.00E+01	3.30E+02
6	UCN027	2.30E+02	2.00E+01	1.10E+02	2.30E+02
7	UCN026	1.10E+03	2.00E+01	8.00E+01	1.10E+03
8	UCN025	1.70E+03	2.00E+01	3.30E+01	5.40E+02
9	UCN024	2.40E+03	2.00E+01	8.00E+01	[illegible]
10	UCN035	7.90E+02	2.00E+01	2.00E+01	[illegible]
11	UCN034	4.90E+02	2.00E+01	9.00E+01	[illegible]
12	UCN037	5.00E+01	2.00E+01	2.00E+01	5.00E+01
13	UCN036	2.30E+02	2.00E+01	8.00E+01	2.30E+02
14	UCN033	1.30E+03	2.00E+01	8.00E+01	[illegible]
15	UCN032	2.40E+03	2.00E+01	2.00E+01	[illegible]
16	UCN042	3.30E+02	2.00E+01	5.30E+01	[illegible]
17	UCN039	3.30E+02	2.00E+01	2.00E+01	3.30E+02
18	UCN038	8.00E+01	2.00E+01	2.00E+01	[illegible]
19	UCN041	2.40E+03	2.00E+01	2.00E+01	[illegible]
20	OCN031	[illegible]	[illegible]	[illegible]	[illegible]

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
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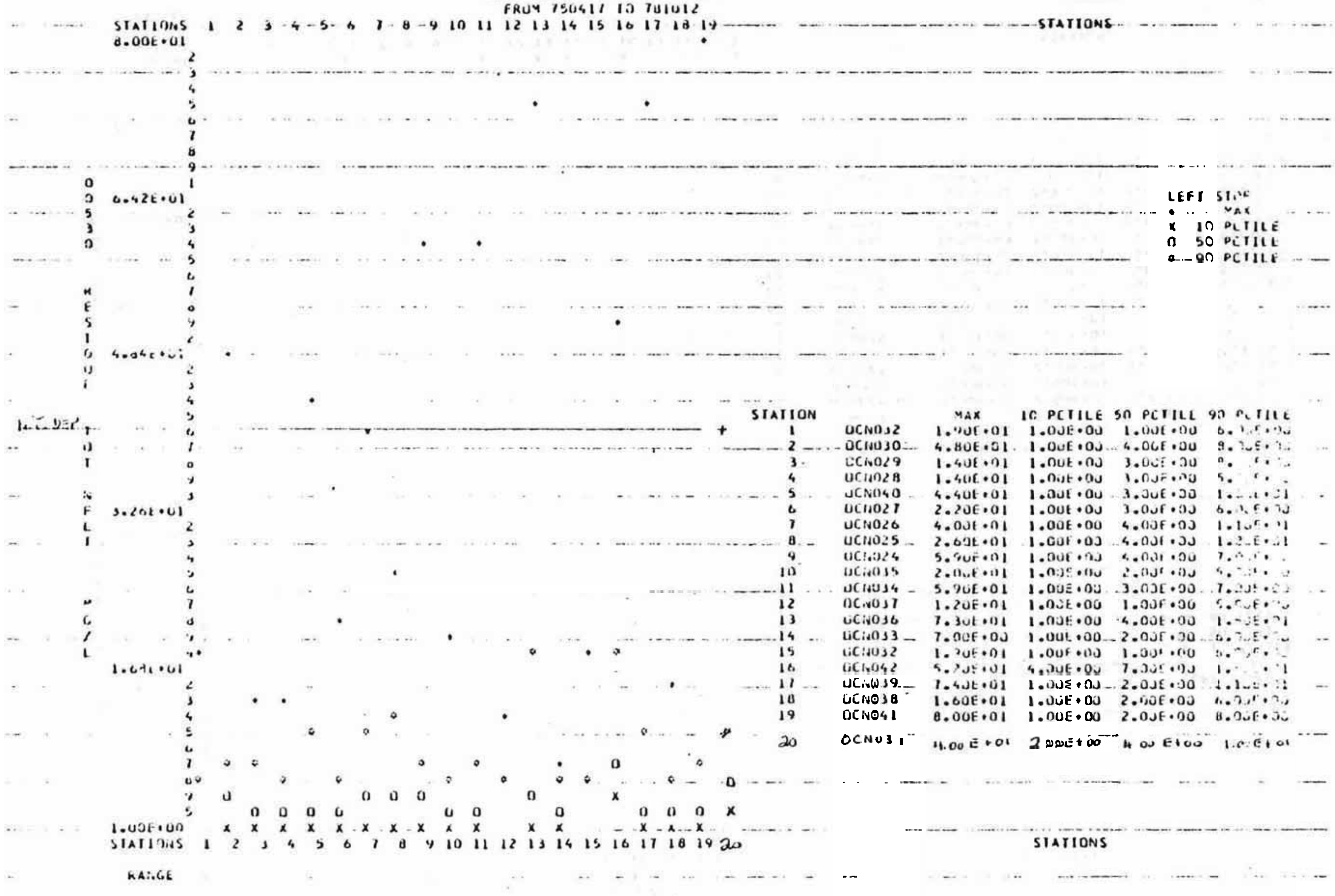

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
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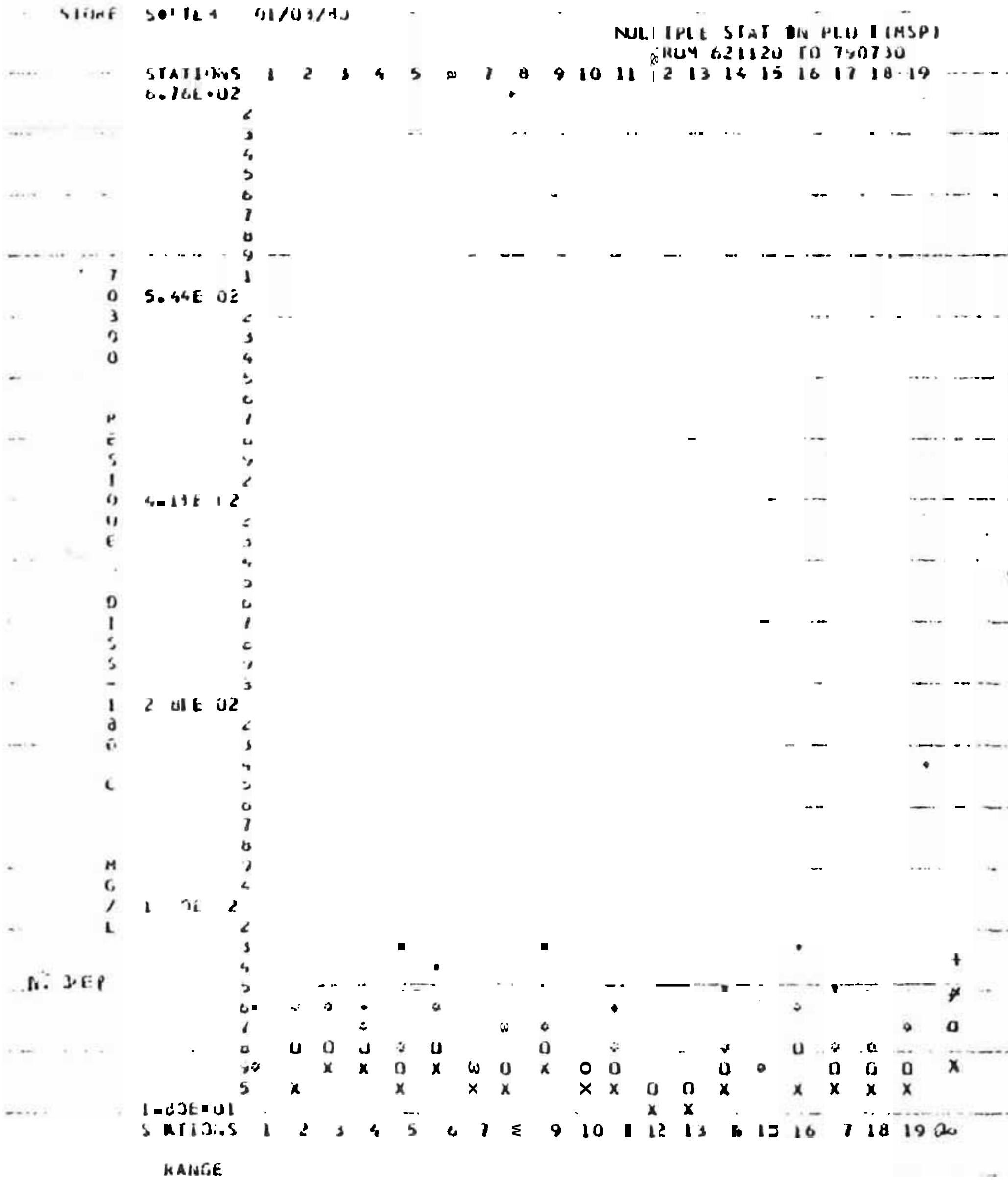
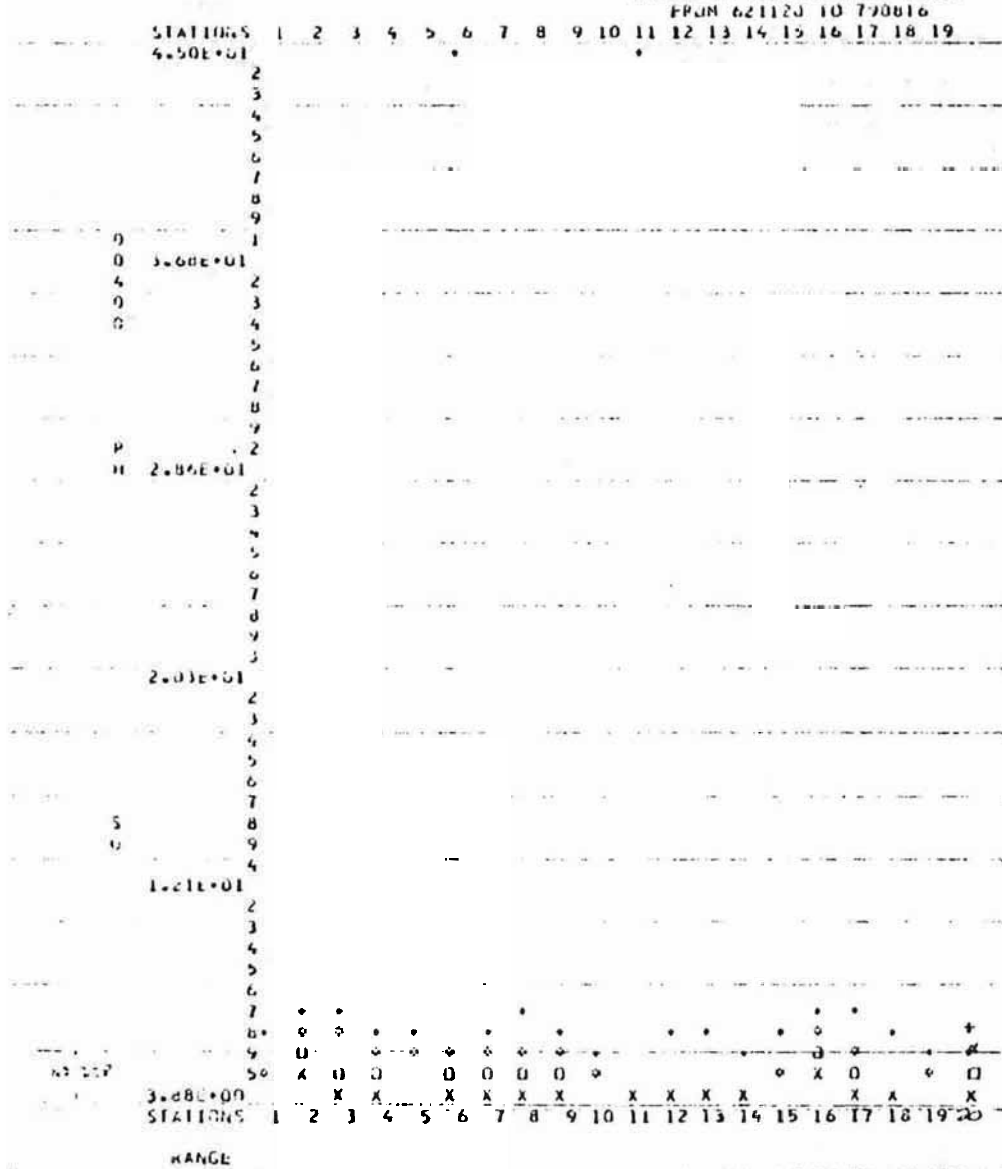
3	OCN029	1.40E+01	1.00E+00	3.00E+00	[illegible]
4	OCN028	1.40E+01	1.00E+00	3.00E+00	[illegible]
5	OCN040	4.40E+01	1.00E+00	3.00E+00	[illegible]
6	OCN027	2.20E+01	1.00E+00	3.00E+00	[illegible]
7	OCN026	4.00E+01	1.00E+00	4.00E+00	[illegible]
8	OCN025	2.60E+01	1.00E+00	4.00E+00	[illegible]
9	OCN024	5.90E+01	1.00E+00	4.00E+00	[illegible]
10	OCN035	2.00E+01	1.00E+00	2.00E+00	[illegible]
11	OCN034	5.90E+01	1.00E+00	3.00E+00	[illegible]
12	OCN037	1.20E+01	1.00E+00	1.00E+00	[illegible]
13	OCN036	7.30E+01	1.00E+00	4.00E+00	[illegible]
14	OCN033	7.00E+00	1.00E+00	2.00E+00	[illegible]
15	OCN032	1.20E+01	1.00E+00	1.00E+00	[illegible]
16	OCN042	5.20E+01	4.00E+00	7.00E+00	[illegible]
17	OCN039	7.40E+01	1.00E+00	2.00E+00	[illegible]
18	OCN038	1.60E+01	1.00E+00	2.00E+00	[illegible]
19	OCN041	8.00E+01	1.00E+00	2.00E+00	8.00E+00
20	OCN031	4.00E+01	2.00E+00	4.00E+00	[illegible]



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032	8.90 E+01	2.50E+01	3.60E+01	[illegible]
2	UCN030	1.47 E+02	3.70E+01	5.70E+01	7.9[illegible]
3	UCN029	4.43 E+02	3.80E+01	5.90E+01	7.[illegible]
4	UCN028	9.00 E+01	4.00E+01	5.50E+01	[illegible]
5	UCN040	1.26 E+02	3.20E+01	4.80E+01	6.[illegible]
6	UCN027	1.10 E+02	3.30E+01	5.30E+01	8.[illegible]
7	UCN026	6.40 E+01	3.60E+01	4.80E+01	5.[illegible]
8	UCN025	6.76 E+02	3.60E+01	5.00E+01	7.[illegible]
9	UCN024	1.37 E+02	4.10E+01	5.6[illegible]	[illegible]
10	UCN035	6.30 E+01	2.70E+01	4.10E+01	5.[illegible]
1[illegible]	UCN034	8.50 E+01	3.10E+01	4.20E+01	5.[illegible]
1[illegible]	UCN037	4.90 E+01	2.10E+01	3.0[illegible]	3.[illegible]
1[illegible]	UCN036	4.50 E+01	1.80E+01	3.10E+01	4.[illegible]
1[illegible]	UCN033	1.90 E+02	2.80E+01	3.80E+01	5.[illegible]
1[illegible]	UCN032	8.40 E+01	2.50E+01	3.6[illegible]	4.[illegible]
1[illegible]	UCN042	1.17 E+02	3.50E+01	6.20E+01	[illegible]
1[illegible]	UCN039	9.10 E+01	3.10E+01	4.60E+01	6.[illegible]
1[illegible]	UCN038	1.36 E+02	3.00E+01	4.70E+01	6.[illegible]
1[illegible]	UCN041	2.40 E+02	3.40E+01	4.70E+01	6.[illegible]
20	[illegible]	1.7[illegible]	[illegible]	[illegible]	[illegible]

STORET SYSTEM 01/03/P3

MULTIPLE STATION PLOT (MSP)
FROM 621120 TO 790816



STATIONS

LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
◊ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN032	6.20E+00	3.88E+00	4.19E+00	[illegible]
2	UCN030	7.10E+00	4.45E+00	5.40E+00	[illegible]
3	UCN029	6.80E+00	4.19E+00	4.80E+00	[illegible]
4	UCN028	6.70E+00	4.17E+00	4.49E+00	[illegible]
5	UCN040	6.20E+00	3.94E+00	4.25E+00	[illegible]
6	UCN027	4.50E+01	4.26E+00	4.72E+00	[illegible]
7	UCN026	6.50E+00	4.12E+00	4.47E+00	5.75E+00
8	UCN025	7.20E+00	4.20E+00	4.70E+00	5.70E+00
9	UCN024	6.60E+00	4.23E+00	[illegible]	[illegible]
10	UCN035	5.70E+00	4.50E+00	4.20E+00	[illegible]
11	UCN034	4.50E+01	4.16E+00	4.43E+00	[illegible]
12	UCN037	6.10E+00	4.01E+00	4.37E+00	[illegible]
13	UCN036	6.64E+00	4.19E+00	4.49E+00	4.94E+00
14	UCN033	5.70E+00	4.24E+00	4.40E+00	4.70E+00
15	UCN032	6.20E+00	3.98E+00	4.19E+00	[illegible]
16	UCN042	6.80E+00	5.10E+00	5.75E+00	[illegible]
17	UCN039	6.89E+00	4.05E+00	4.33E+00	[illegible]
18	UCN038	6.00E+00	4.10E+00	4.36E+00	[illegible]
19	UCN041	5.50E+00	3.91E+00	4.21E+00	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

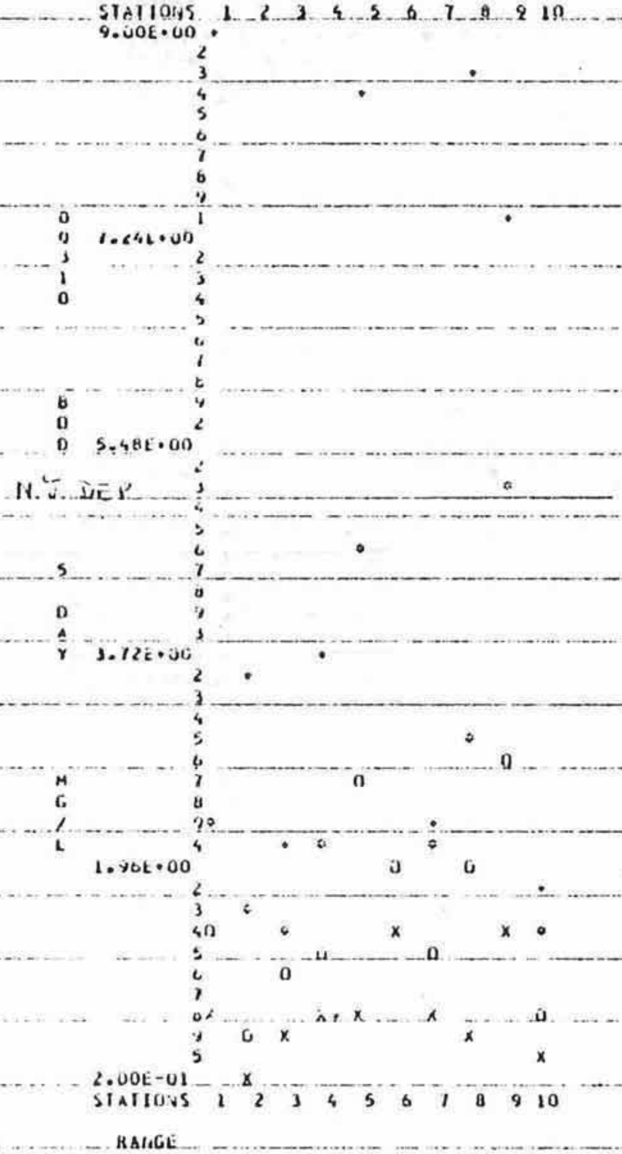
2.0 RANCOCAS CREEK DRAINAGE BASIN

7.0 MAURICE RIVER DRAINAGE BASIN

Station	Station No.	Station Location
1	01465970	North Branch Rancocas Creek at Browns Mills
2	01466500	McDonalds Branch in Lebanon State Forest
3	01466900	Greenwood Branch at New Lisbon
4	01467000	North Branch Rancocas Creek at Pemberton
5	01467003	North Branch Rancocas Creek at Ewanville
6	01467006	North Branch Rancocas Creek at Pine Street at Mt. Holly
7	01465835	South Branch Rancocas Creek at Retreat
8	01465850	South Branch Rancocas Creek at Vincentown
9	01465915	South Branch Rancocas Creek at Hainesport
10	01412100	Manumuskin River near Manumuskin

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
FROM 690320 TO 790830

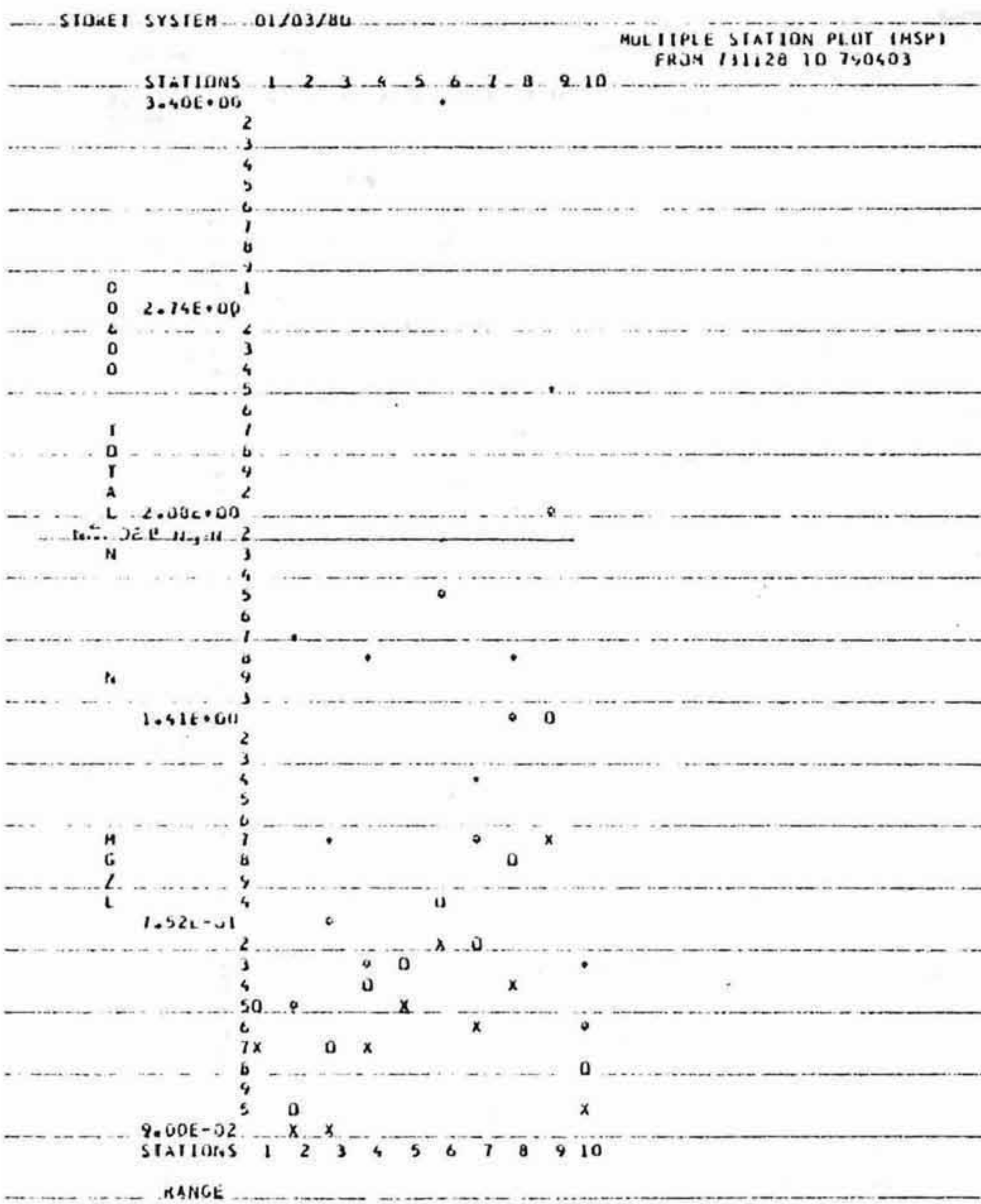


STATIONS

LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
@ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	9.00E+00	8.00E-01	1.50E+00	2.30E+00
2	01465500	3.60E+00	2.00E-01	6.00E-01	1.60E+00
3	01466900	2.10E+00	6.00E-01	1.10E+00	1.50E+00
4	01467000	3.80E+00	8.00E-01	1.30E+00	2.20E+00
5	01467003	8.50E+00	8.00E-01	2.60E+00	4.60E+00
6	01467006	3.80E+00	1.40E+00	2.00E+00	3.70E+00
7	01465835	2.40E+00	7.00E-01	1.30E+00	2.20E+00
8	01465850	9.60E+00	6.00E-01	2.00E+00	3.10E+00
9	01465915	7.40E+00	1.50E+00	2.90E+00	5.10E+00
10	01412100	1.70E+00	4.00E-01	8.00E-01	1.50E+00

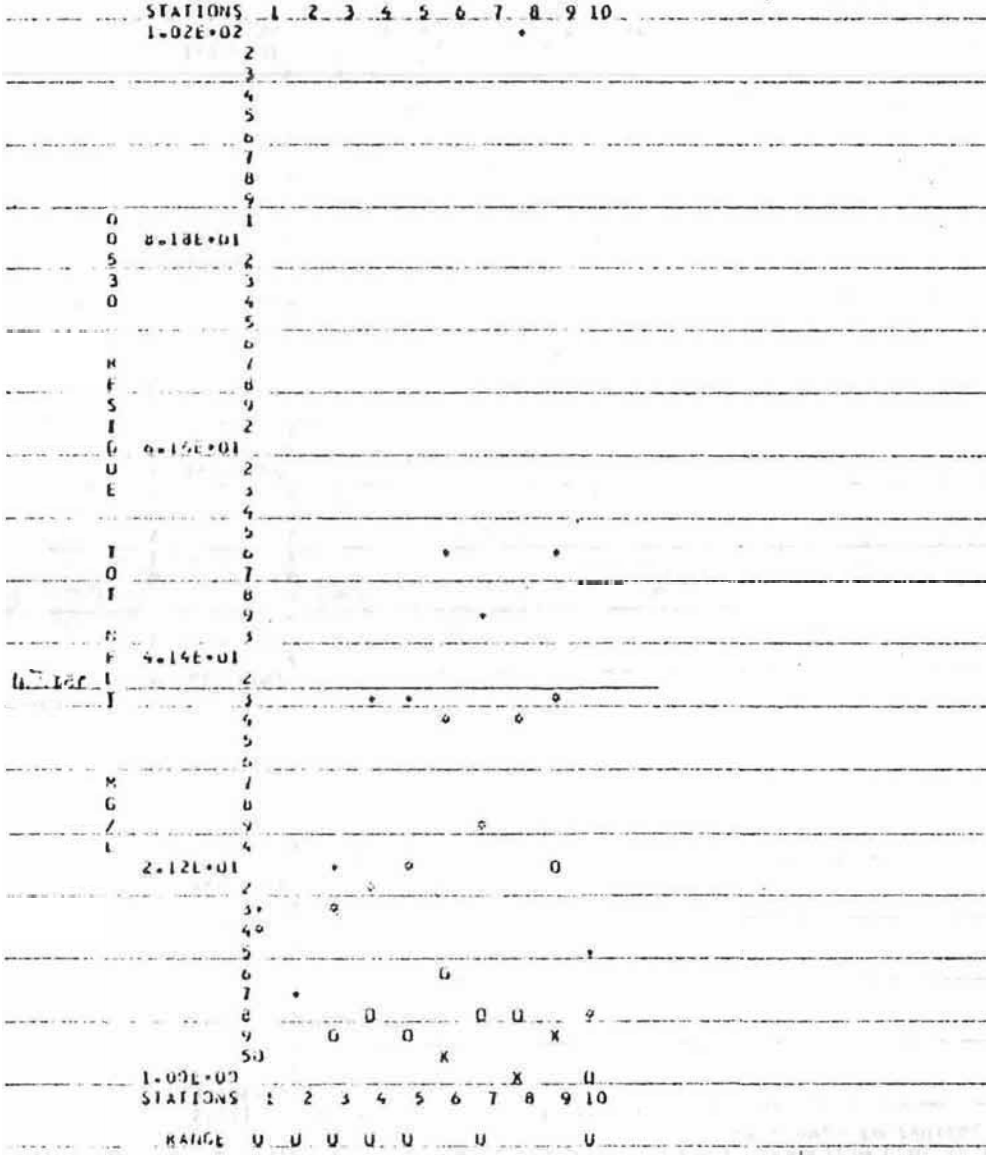
STATIONS



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	1.20E+00	3.40E-01	5.60E-01	1.20E+00
2	01466500	1.70E+00	9.00E-02	1.50E-01	4.80E-01
3	01465900	9.90E-01	1.10E-01	3.80E-01	7.50E-01
4	01467000	1.60E+00	3.50E-01	5.50E-01	6.40E-01
5	01467003	1.30E+00	5.10E-01	6.50E-01	1.33E+00
6	01467006	3.40E+00	6.90E-01	8.30E-01	1.80E+00
7	01465835	1.20E+00	4.50E-01	6.80E-01	1.00E+00
8	01465850	1.60E+00	5.70E-01	9.50E-01	1.40E+00
9	01465915	2.50E+00	1.00E+00	1.40E+00	2.10E+00
10	01412160	6.10E-01	1.30E-01	2.70E-01	4.20E-01

STORET SYSTEM 01/03/80

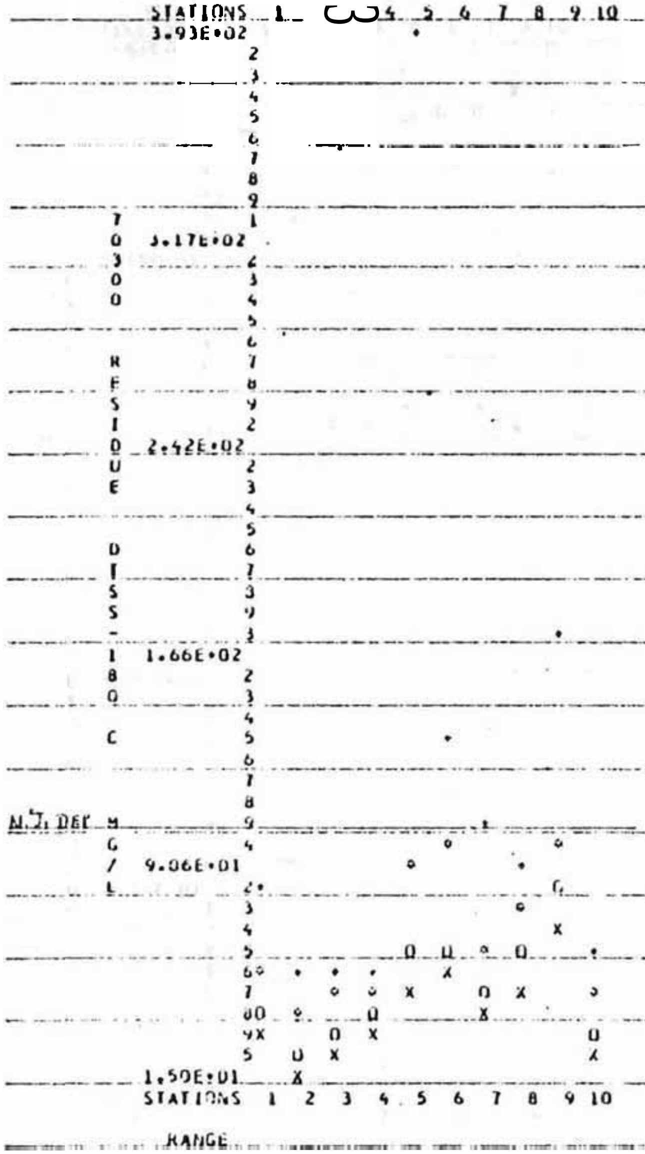
MULTIPLE STATION PLOT (MSP)
FROM 671020 TO 780810



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	1.80E+01	0.00E+00	4.00E+00	1.50E+01
2	01466500	9.00E+00	0.00E+00	1.00E+00	2.00E+00
3	01466900	2.70E+01	0.00E+00	5.00E+00	1.70E+01
4	01467000	3.80E+01	0.00E+00	7.00E+00	2.00E+01
5	01467003	3.70E+01	0.00E+00	6.00E+00	2.10E+01
6	01467006	5.20E+01	4.00E+00	1.20E+01	3.50E+01
7	01465835	4.60E+01	0.00E+00	7.00E+00	2.60E+01
8	01465850	1.02E+02	2.00E+00	8.00E+00	3.60E+01
9	01465915	5.10E+01	6.00E+00	2.20E+01	3.90E+01
10	01412100	1.30E+01	0.00E+00	2.00E+00	7.00E+00

STORET SYSTEM 04/03/80

MULTIPLE STATION PLOT (MSP)
FR 230926 TO 790726



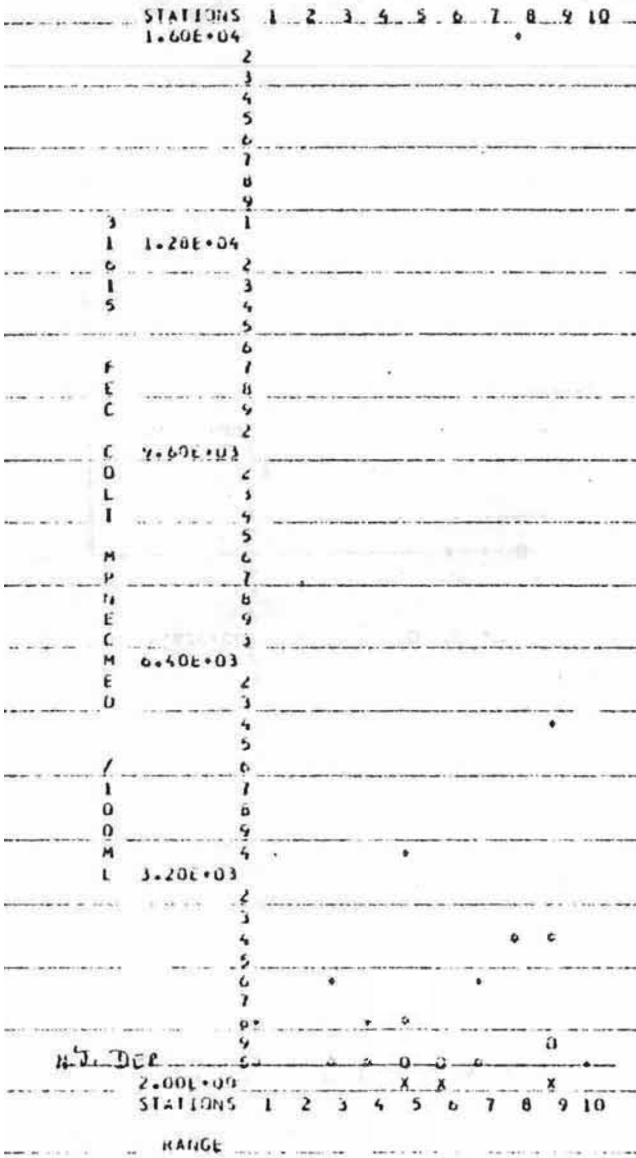
STATIONS

LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
+ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	8.00E+01	3.00E+01	3.90E+01	5.00E+01
2	01465500	5.20E+01	1.50E+01	2.60E+01	3.80E+01
3	01465900	5.50E+01	2.50E+01	3.20E+01	4.20E+01
4	01467000	5.60E+01	2.90E+01	3.50E+01	4.20E+01
5	01467003	3.93E+02	4.80E+01	5.70E+01	9.15E+01
6	01467006	1.39E+02	5.40E+01	6.40E+01	9.75E+01
7	01465835	1.04E+02	3.40E+01	4.30E+01	6.00E+01
8	01465850	9.10E+01	4.60E+01	6.00E+01	7.80E+01
9	01465915	1.73E+02	6.80E+01	8.10E+01	9.60E+01
10	01412100	5.80E+01	2.40E+01	3.20E+01	4.80E+01

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
FROM 750314 TO 790403



STATIONS

LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
• 90 PCTILE

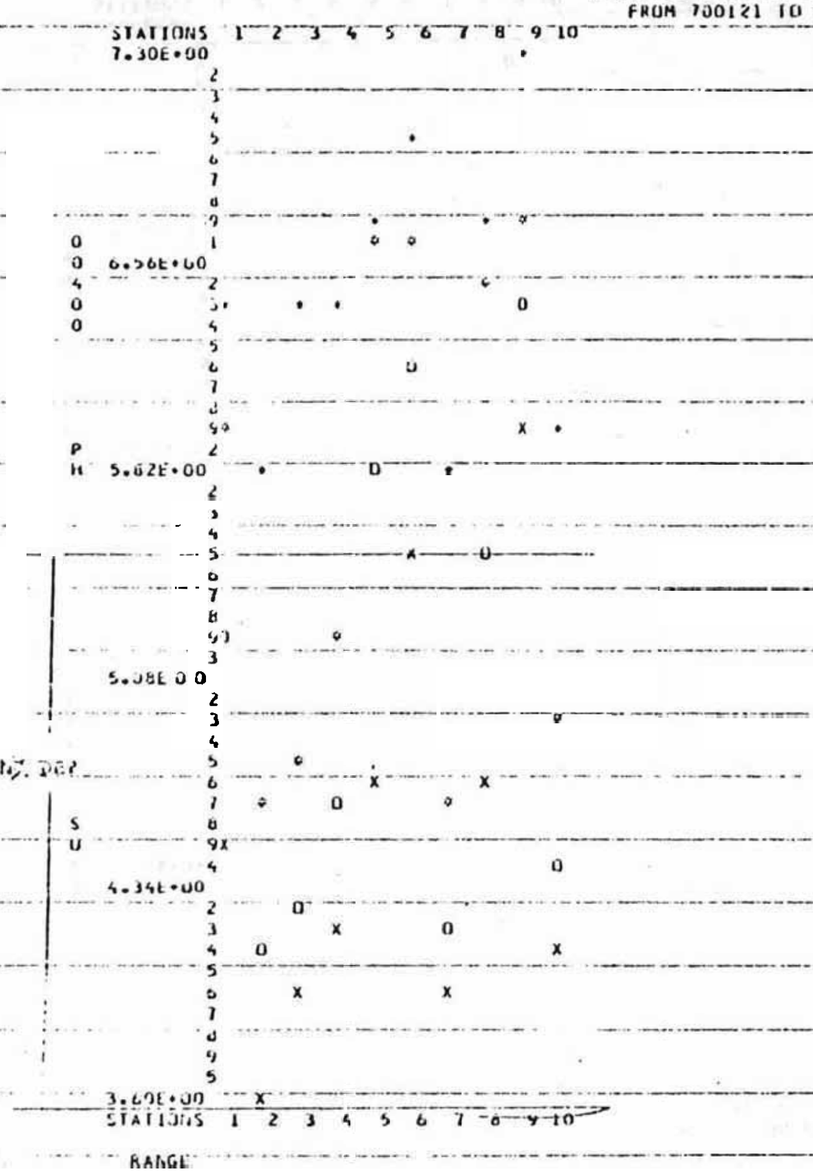
STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	9.20E+02	2.00E+00	1.30E+01	3.50E+02
2	01466500	2.30E+01	2.00E+00	2.00E+00	2.30E+01
3	01466900	1.50E+03	2.00E+00	3.30E+01	2.40E+02
4	01467000	9.20E+02	2.00E+00	4.70E+01	3.30E+02
5	01467003	3.50E+03	4.00E+00	2.20E+02	9.20E+02
6	01467006	2.40E+03	5.00E+00	1.80E+02	2.40E+03
7	01465835	1.60E+03	2.00E+00	3.30E+01	3.50E+02
8	01465850	1.60E+04	5.00E+00	1.30E+02	2.40E+03
9	01465915	5.40E+03	3.30E+01	4.90E+02	2.20E+03
10	01412100	2.40E+02	5.00E+00	2.30E+01	7.90E+01

STATIONS

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
FROM 700121 TO 790630

STATIONS



LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
• 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01465970	6.40E+00	4.50E+00	5.20E+00	6.00E+00
2	01466500	5.80E+00	3.60E+00	4.10E+00	4.60E+00
3	01466900	5.40E+00	4.00E+00	4.30E+00	4.80E+00
4	01467000	6.40E+00	4.20E+00	4.60E+00	5.20E+00
5	01467003	6.70E+00	4.70E+00	5.80E+00	6.60E+00
6	01467006	7.00E+00	5.50E+00	6.20E+00	6.60E+00
7	01465835	5.90E+00	4.00E+00	4.20E+00	4.60E+00
8	01465850	6.70E+00	4.70E+00	5.50E+00	6.50E+00
9	01465915	7.30E+00	6.00E+00	6.40E+00	6.70E+00
10	01412100	6.00E+00	4.10E+00	4.40E+00	4.90E+00

STATIONS

3.0 CEDAR CREEK DRAINAGE BASIN

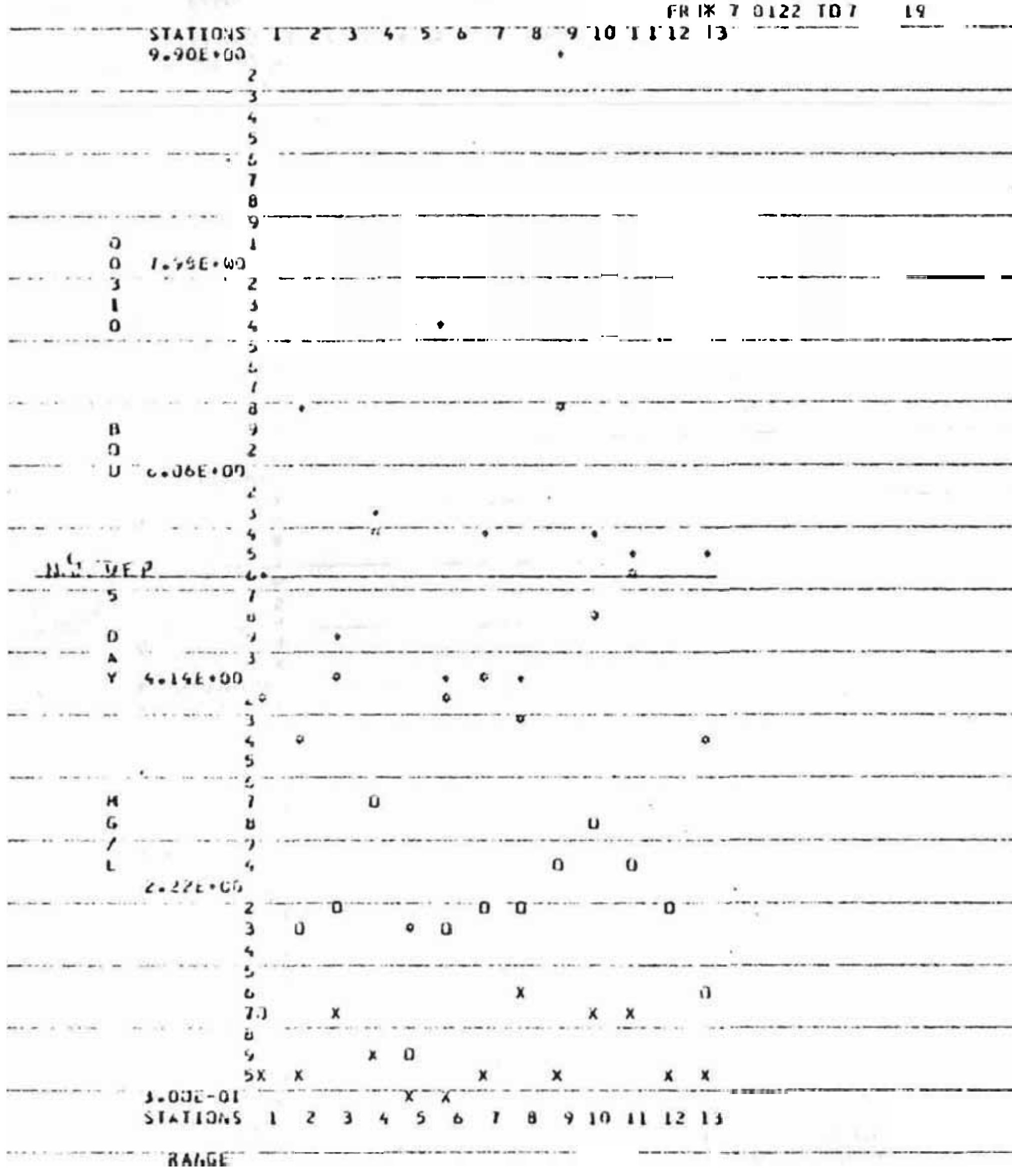
4.0 FORKED RIVER DRAINAGE BASIN

Station	Station No.	Station Location
1	OCN045	Cedar Creek Whiting-Lacey Road
2	01408870	Cedar Creek at Double Trouble Road
3	OCN043	Cedar Creek Route 9 Lanoka Harbor
4	OCN052	Oyster Creek Road east of Brookville
5	OCN051	Oyster Creek Wells Mills Road
6	OCN047	North Branch Forked River JCP&L Lines
7	OCN046	North Branch Forked River Parker Avenue
8	OCN048	Mid Branch Forked River at Route 9
9	OCN054	Mill Creek Route 72
10	OCN055	Fourmile Branch Mill Creek Oxycocus-Littleville Mill Road
11	OCN053	Mill Creek Route 180
12	OCN059	Westecunk Creek Martha Road
13	OCN058	Westecunk Creek Route 9

STORET SYSTEM 01/04/83

MULTIPLE STATION PLOT FROM 7 0122 TO 7 19

S • IONI



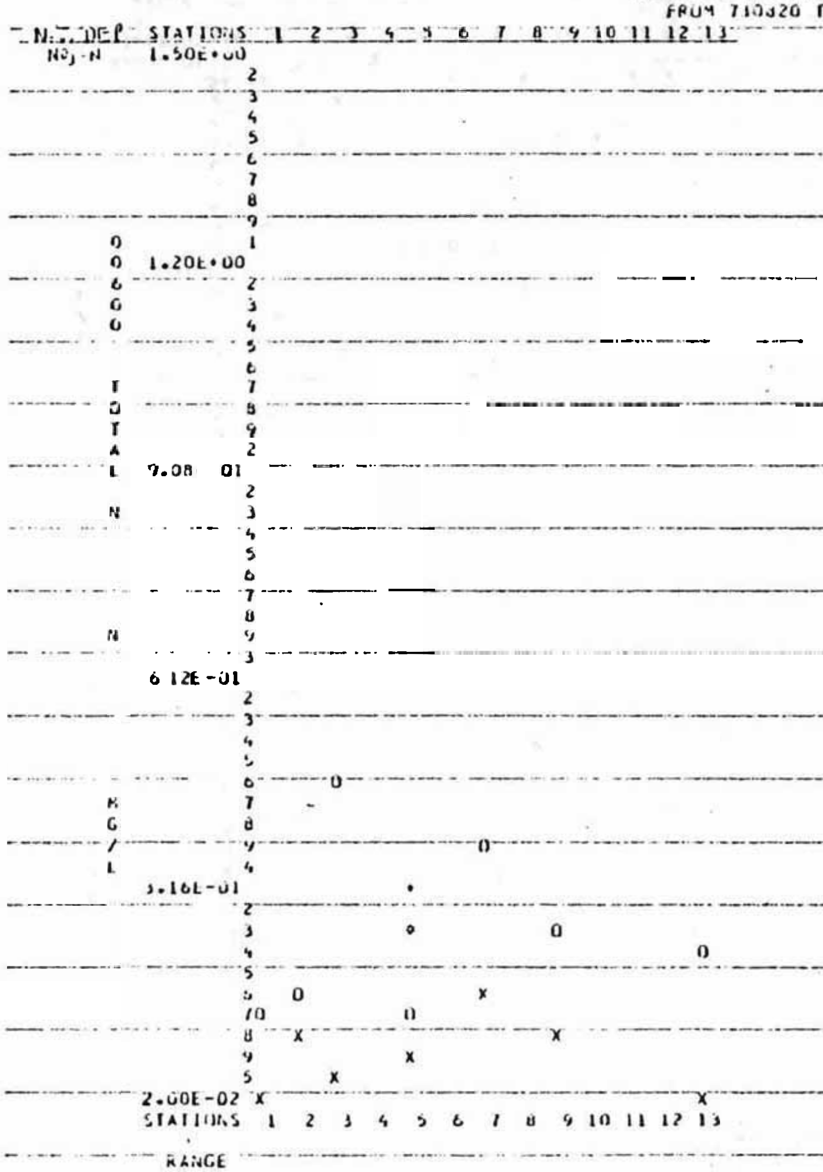
L I SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
⊕ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN045	5.10E+00	5.00E-01	1.00E+00	3.[illegible]
2	G1403870	6.60E+00	5.00E-01	1.63E+00	3.[illegible]
3	UCN043	4.50E+00	1.00E+00	2.12E+00	4.20E+00
4	UCN052	5.70E+00	6.00E-01	3.00E+00	5.40E+00
5	UCN051	7.50E+00	3.00E-01	7.00E-01	1.90E+00
6	UCN047	4.20E+00	3.00E-01	1.90E+00	3.90E+00
7	UCN046	5.40E+00	5.00E-01	2.00E+00	4.20E+00
8	UCN048	4.20E+00	1.20E+00	2.00E+00	3.70E+00
9	UCN054	9.90E+00	5.00E-01	2.40E+00	6.60E+00
10	UCN055	5.50E+00	1.00E+00	2.70E+00	4.70E+00
11	UCN053	5.30E+00	1.00E+00	2.50E+00	5.10E+00
12	UCN059	4.80E+00	5.00E-01	2.10E+00	4.80E+00
13	UCN058	5.30E+00	5.00E-01	1.20E+00	3.50E+00

STAT S

STORET SYSTEM 01/04/90

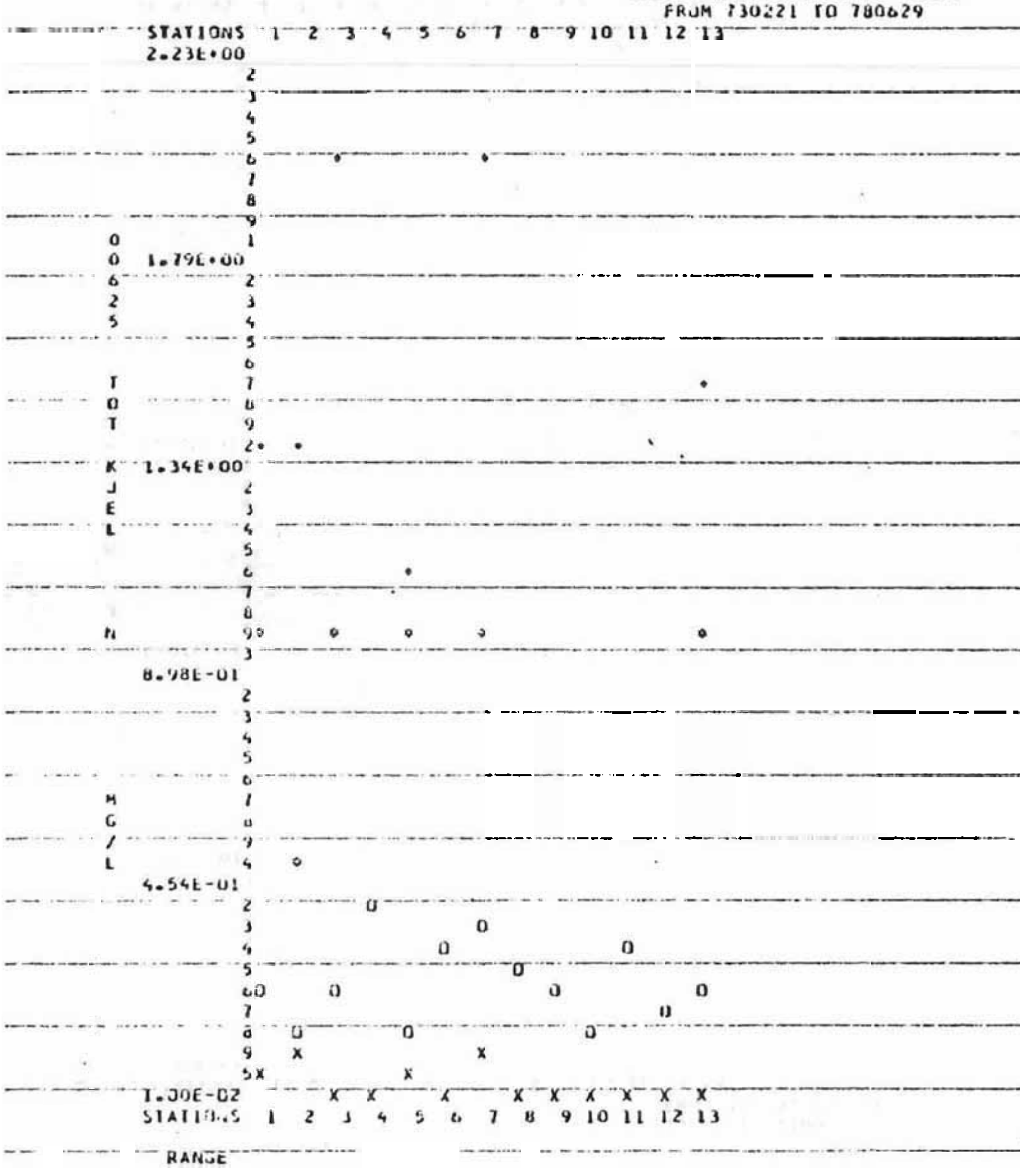
MULTIPLE STATION PLOT (MSP)
FROM 710820 TO 780629



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	DCN045	4.00E-01	2.00E-02	1.40E-01	4.00E-01
2	01403870	2.40E-01	1.20E-01	1.70E-01	2.40E-01
3	DCN043	8.00E-01	4.00E-02	4.70E-01	8.00E-01
4	DCN052				
5	DCN051	3.30E-01	9.00E 2	1.50E-01	2.60E-01
6	DCN047				
7	DCN046	5.40E-01	1.60E0 1	3.70E-01	5.40E-01
8	DCN048				
9	DCN054	1.40E+00	1.00E0 1	2.60E-01	1.40E+00
10	DCN055				
11	DCN053				
12	DCN059				
13	DCN058	1.50E+00	3.00E0 2	2.20E-01	1.50E+00

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT (MSP)
FROM 730221 TO 780629

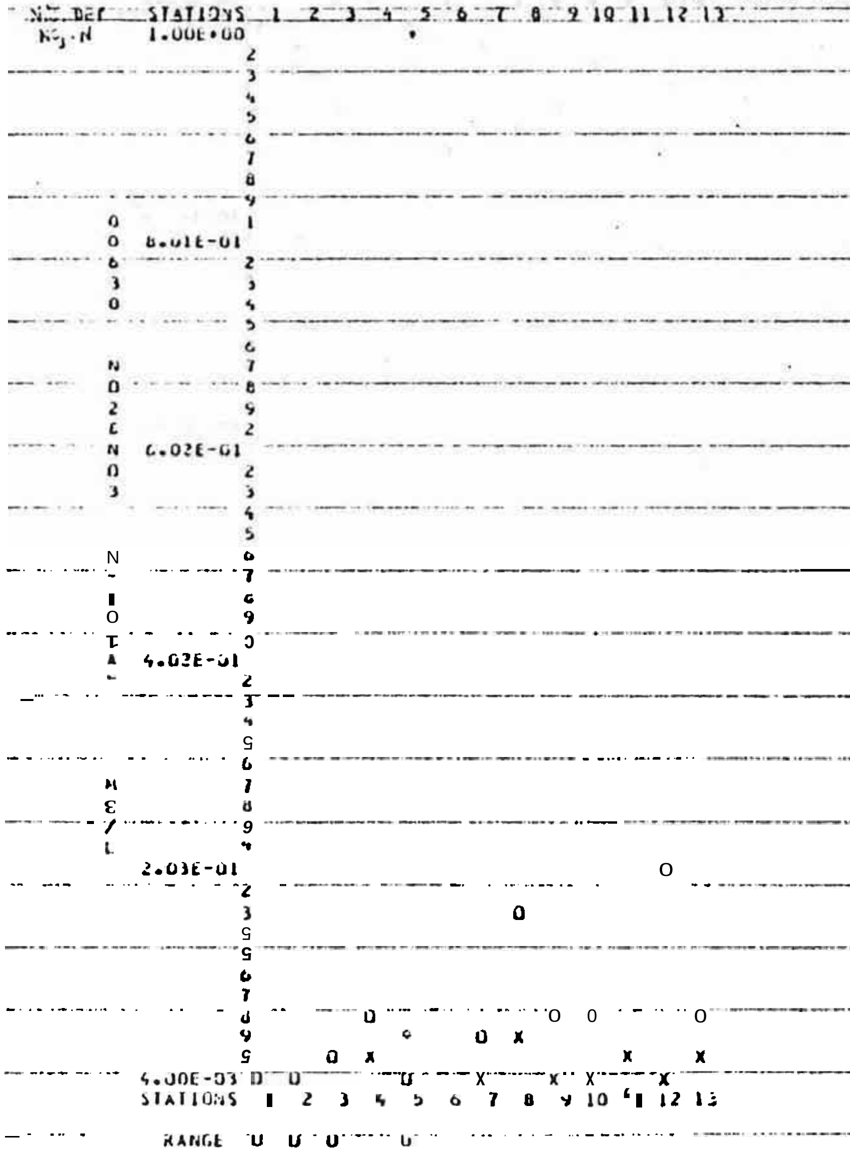


LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
* 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN045	1.39E+00	7.00E-02	2.50E-01	9.[illegible]E-01
2	01400870	1.39E+00	1.20E-01	1.[illegible]E-01	5.10E 01
3	UCN043	2.00E+00	2.00E-02	2.40E-01	1.03E 00
4	UCN052	1.40E+00	1.00E-02	4.20E-01	1.40E 00
5	UCN051	1.12E+00	5.00E-02	1.50E-01	1.[illegible] 00
6	UCN047	2.23E+00	1.00E-02	3.40E-01	2.23E 00
7	UCN046	2.00E+00	1.20E-01	3.60E-01	1.03E 00
8	UCN0[illegible]	8.40E-01	1.00E-02	2.60E-01	[illegible]E 01
9	UCN054	1.40E+00	1.00E-02	2.40E-01	1.39E 00
10	UCN055	1.60E+00	1.00E-02	1.40E-01	1.60E 00
11	UCN053	1.40E+00	1.00E-02	3.20E-01	1.39E 00
2	WCN059	8.00E-01	1.00E-02	1.80E-01	8.00E 01
3	UCN058	1.50E+00	1.00E-02	2.20E-01	1.03E 00

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT INSPI
FROM 730531 TO 790705

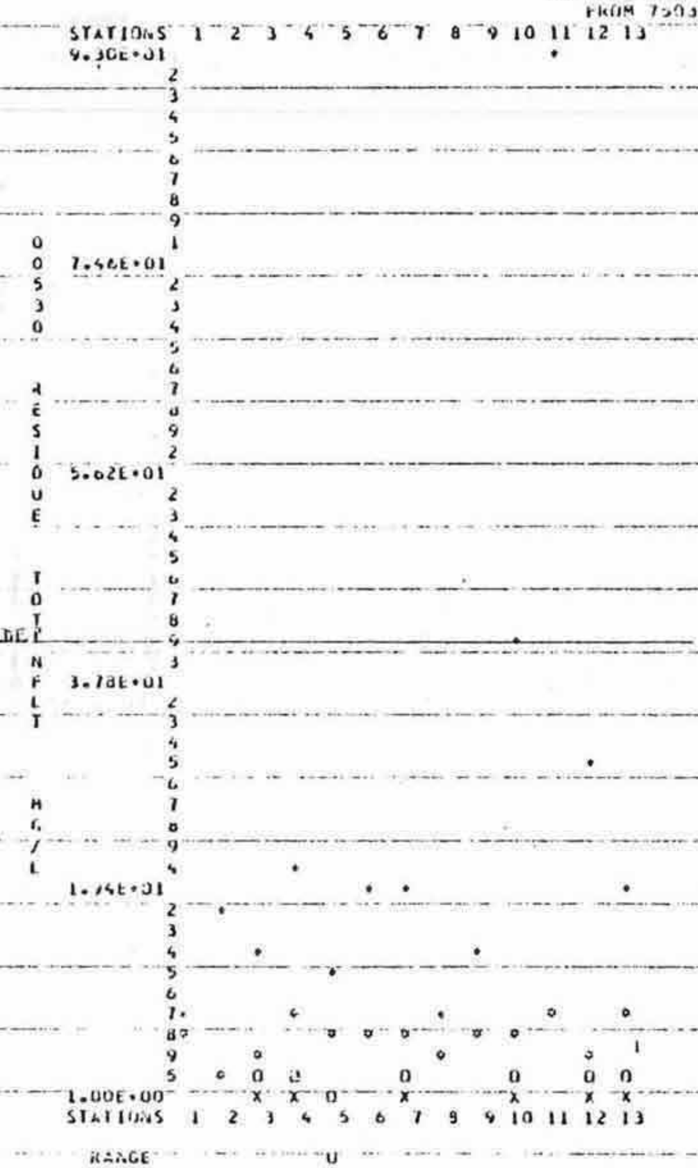


LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
• 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN045	3.00E-02	[illegible]	[illegible]	3.00E-02
2	01408370	1.00E+00	0.00E+00	[illegible]	[illegible]
3	UCN043	1.00E+00	0.00E+00	3.00E-02	[illegible]
4	UCN052	1.00E+00	3.00E-02	7.00E-02	[illegible]
5	UCN051	1.00E+00	0.00E+00	1.00E-02	4.00E-0[illegible]
6	UCN047	2.00E-02	4.00E-03	1.00E-02	2.00E-02
7	UCN046	1.00E+00	1.00E-02	4.00E-02	1.00E+00
8	UCN048	1.00E+00	5.00E-02	1.70E-01	1.00E+00
9	UCN054	1.00E+00	1.00E-02	6.00E-02	1.00E+00
10	UCN055	1.70E-01	8.00E-03	6.00E-02	1.70E-01
11	UCN053	1.00E+00	2.00E-02	1.00E+00	1.00E+00
12	UCN059	1.00E+00	4.00E-03	2.00E-01	1.00E+00
13	UCN058	1.00E+00	1.40E-02	6.00E-02	1.00E+00

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT (MSP)
FROM 750314 TO 780629

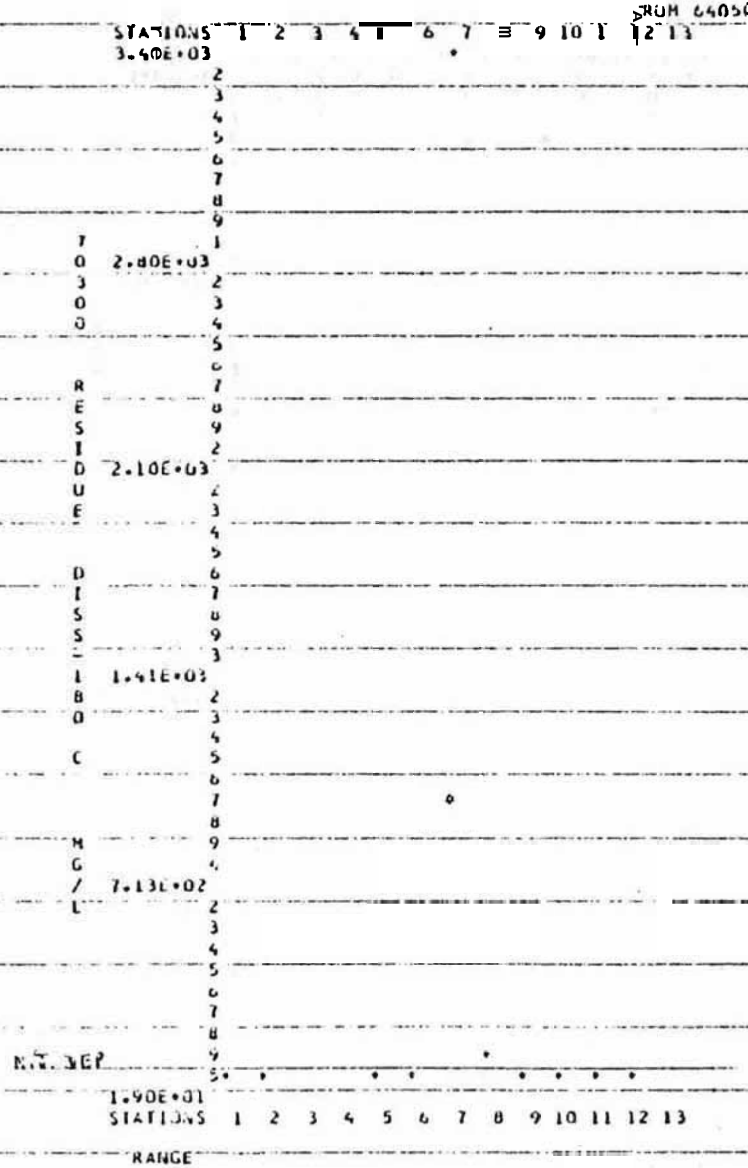


LEFT SIDE
• MAX
x 10 PCTILE
O 50 PCTILE
◦ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	OCN045	9.00E+00	1.00E+00	1.00E+00	6.00E+00
2	01408870	1.70E+01	1.00E+00	1.00E+00	3.00E+00
3	OCN043	1.40E+01	1.00E+00	2.00E+00	5.00E+00
4	OCN052	2.20E+01	1.00E+00	3.00E+00	9.00E+00
5	OCN051	1.20E+01	0.00E+00	1.00E+00	6.00E+00
6	OCN047	2.00E+01	1.00E+00	1.00E+00	7.00E+00
7	OCN046	2.00E+01	1.00E+00	2.00E+00	7.00E+00
8	OCN048	9.00E+00	1.00E+00	1.00E+00	4.00E+00
9	OCN054	1.30E+01	1.00E+00	1.00E+00	7.00E+00
10	OCN055	4.10E+01	1.00E+00	3.00E+00	7.00E+00
11	OCN053	9.30E+01	2.00E+00	3.00E+00	9.00E+00
12	OCN059	3.00E+01	1.00E+00	2.00E+00	5.00E+00
13	OCN058	2.00E+01	1.00E+00	2.00E+00	9.00E+00

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT (MSP)
FROM 640507 TO 780629



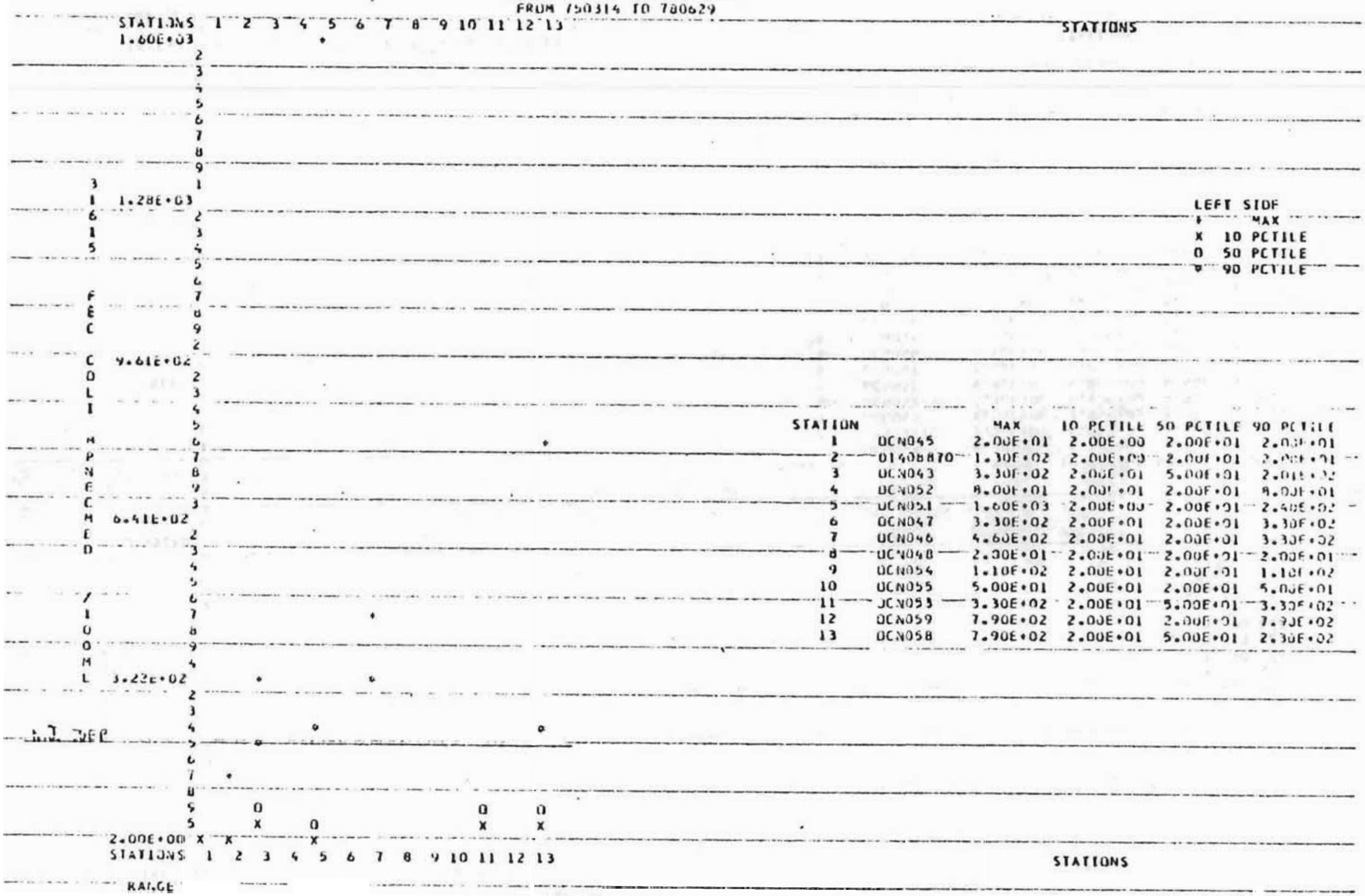
LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
+ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	OCN045	8.30E+01	1.90E+01	3.00E+01	5.00E+01
2	01408870	7.30E+01	2.30E+01	3.10E+01	4.50E+01
3	OCN043	5.20E+01	2.40E+01	3.40E+01	4.60E+01
4	OCN052	1.06E+02	2.60E+01	4.20E+01	5.70E+01
5	OCN051	7.50E+01	2.20E+01	3.00E+01	4.13E+01
6	OCN047	8.10E+01	2.40E+01	3.30E+01	4.90E+01
7	OCN046	3.49E+03	2.60E+01	3.90E+01	1.01E+03
8	OCN048	1.74E+02	2.50E+01	3.90E+01	4.70E+01
9	OCN054	6.30E+01	2.70E+01	3.60E+01	4.40E+01
10	OCN055	6.20E+01	3.00E+01	3.80E+01	4.30E+01
11	OCN053	6.20E+01	3.20E+01	4.00E+01	5.10E+01
12	OCN059	8.20E+01	2.00E+01	2.90E+01	4.10E+01
13	OCN058	1.11E+02	2.40E+01	3.70E+01	6.10E+01

STATIONS

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT (MSP)
FROM 750314 TO 780629



STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	OCN045	2.00E+01	2.00E+00	2.00E+01	2.00E+01
2	01408870	1.30E+02	2.00E+00	2.00E+01	2.00E+01
3	OCN043	3.30E+02	2.00E+01	5.00E+01	2.01E+02
4	OCN052	8.00E+01	2.00E+01	2.00E+01	8.00E+01
5	OCN051	1.60E+03	2.00E+00	2.00E+01	2.40E+02
6	OCN047	3.30E+02	2.00E+01	2.00E+01	3.30E+02
7	OCN046	4.60E+02	2.00E+01	2.00E+01	3.30E+02
8	OCN048	2.00E+01	2.00E+01	2.00E+01	2.00E+01
9	OCN054	1.10E+02	2.00E+01	2.00E+01	1.10E+02
10	OCN055	5.00E+01	2.00E+01	2.00E+01	5.00E+01
11	OCN053	3.30E+02	2.00E+01	5.00E+01	3.30E+02
12	OCN059	7.90E+02	2.00E+01	2.00E+01	7.90E+02
13	OCN058	7.90E+02	2.00E+01	5.00E+01	2.30E+02

STORET SYSTEM 01/04/80

MULTIPLE STATION PLOT (MSP)
FROM 610602 TO 790231

STATIONS 1 2 3 4 5 6 7 8 9 10 11 12 13 — STATIONS

LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
+ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	UCN045	6.70E+00	4.14E+00	4.60E+00	5.41E+00
2	U1404870	2.30E+01*	4.03E+00	4.52E+00	5.13E+00
3	UCN043	7.69E+00	3.95E+00	4.31E+00	[illegible]
4	UCN052	5.70E+00	4.10E+00	4.16E+00	[illegible]
5	UCN051	5.80E+00	4.00E+00	4.40E+00	4.70E+00
6	UCN047	7.63E+00	3.80E+00	4.15E+00	4.55E+00
7	UCN046	8.10E+00	4.00E+00	4.26E+00	[illegible]
8	UCN048	4.74E+00	3.70E+00	4.10E+00	4.42E+00
9	UCN054	6.40E+00	4.53E+00	5.23E+00	5.95E+00
10	UCN055	7.50E+00	4.75E+00	5.09E+00	6.90E+00
11	UCN053	6.50E+00	4.60E+00	5.34E+00	6.25E+00
12	UCN059	1.16E+03*	4.30E+00	4.63E+00	5.35E+00
13	UCN058	6.50E+00	4.21E+00	4.74E+00	5.65E+00

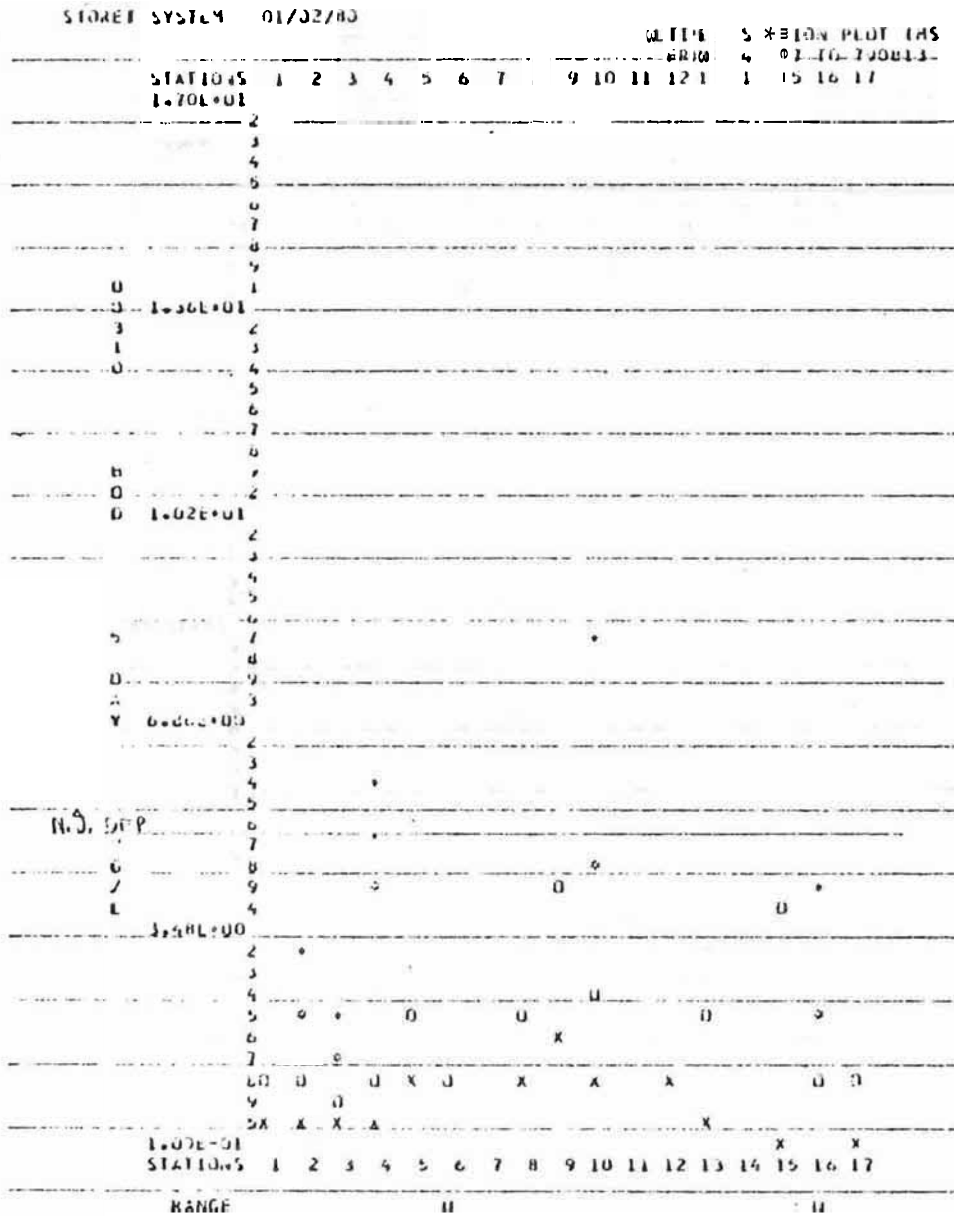
* Aberrant Data

STATIONS 1 2 3 4 5 6 7 8 9 10 11 12 13 — STATIONS

RANGE

5.0 MULLICA RIVER DRAINAGE BASIN

Station	Station No.	Station Location
1	01409411	Nescochaque Creek at Pleasant Mills
2	01410150	East Branch Bass River near New Gretna
3	01409815	West Branch Wading River at Maxwell
4	01410000	Oswego River at Harrisville
5	01409450	Springers Brook near Indian Mills
6	01409470	Batsto River at Quaker Bridge
7	01409500	Batsto River at Batsto
8	01409412	Hammonton Creek at Route 30 at Hammonton
9	01409414	Hammonton Creek at Hammonton
10	01409416	Hammonton Creek at Westcoatville
11	01409375	Mullica River near Atco
12	01409383	Mullica River at Jackson Road
13	01409387	Mullica River at Outlet of Atsion Lake
14	01409400	Mullica River near Batsto
15	01409403	Wildcat Branch at Chesilhurst
16	393825074393500	Mullica River at Pleasant Mills
17	01409535	Mullica River at Green Bank



STATIONS

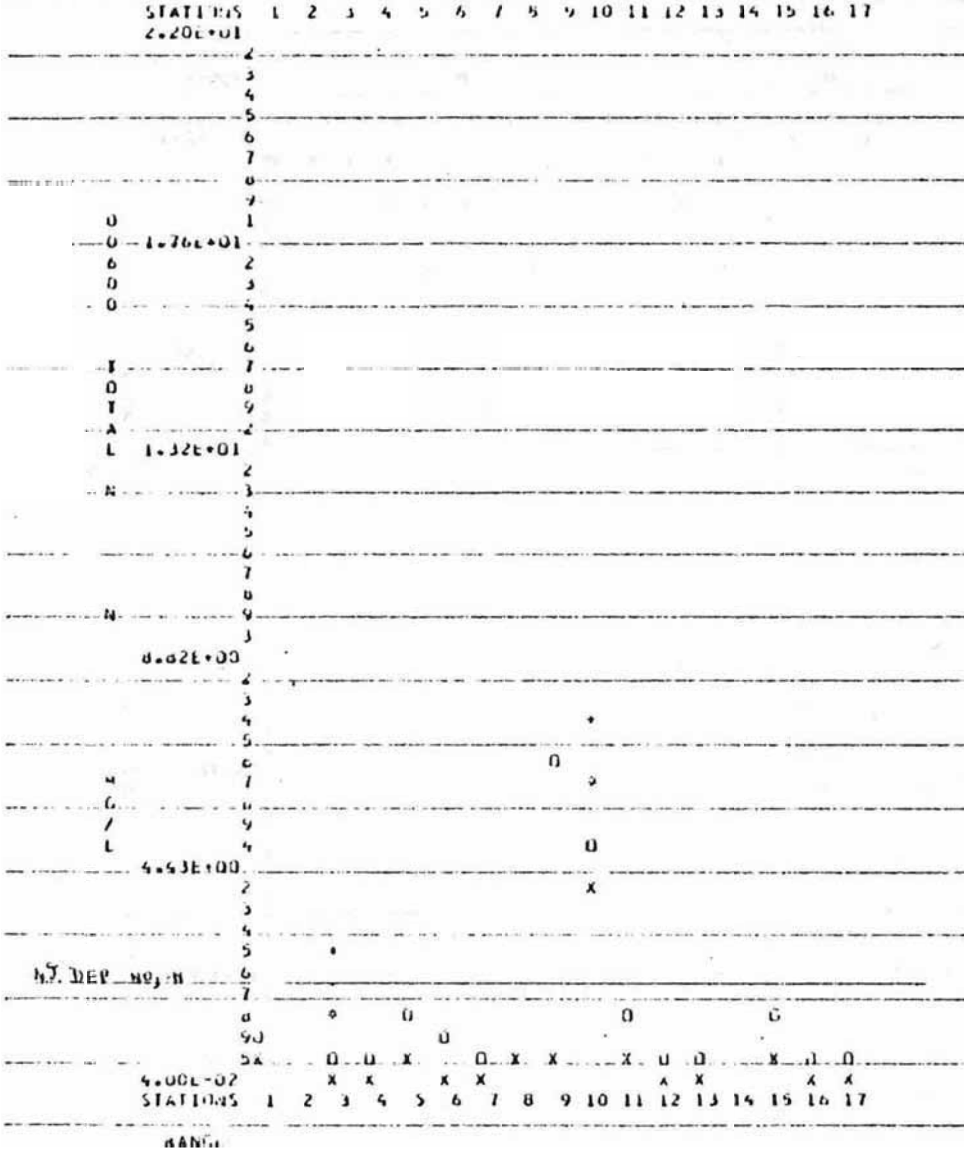
LEFT SIDE
- * MAX
- X 10 PCTILE
- O 50 PCTILE
- 9 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01407411	2.10E+00	6.00E-01	1.20E+00	[illegible]
2	01413150	3.00E+00	5.00E-01	1.90E+00	[illegible]
3	01407815	2.00E+00	3.00E-01	9.00E-01	[illegible]
4	01410000	6.00E+00	5.00E-01	1.20E+00	[illegible]
5	01407450	3.10E+00	1.00E+00	2.00E+00	[illegible]
6	01407470	2.90E+00	0.00E+00	1.00E+00	[illegible]
7	01409500	3.00E+00	1.00E+00	1.00E+00	[illegible]
8	01409412	7.30E+00	1.10E+00	2.10E+00	[illegible]
9	01409414	9.40E+00	1.90E+00	4.30E+00	9.40E+00
10	01407416	8.20E+00	1.00E+00	2.60E+00	[illegible]
11	01407375	2.90E+00	1.00E+00	1.00E+00	[illegible]
12	01407383	2.30E+00	1.00E+00	2.00E+00	[illegible]
13	01409337	3.00E+00	5.00E-01	2.00E+00	[illegible]
14	01409400				
15	01409403	1.70E+01	1.00E-01	3.90E+00	1.70E+01
16	393825074323500	5.00E+00	0.00E+00	1.00E+00	[illegible]
17	01407535	2.60E+00	2.00E-01	1.00E+00	[illegible]

STATIONS

STORET SYSTEM 01/02/80

MULTIPLE STATION PLOT (MSP)
FROM 740717 TO 790726



STATIONS

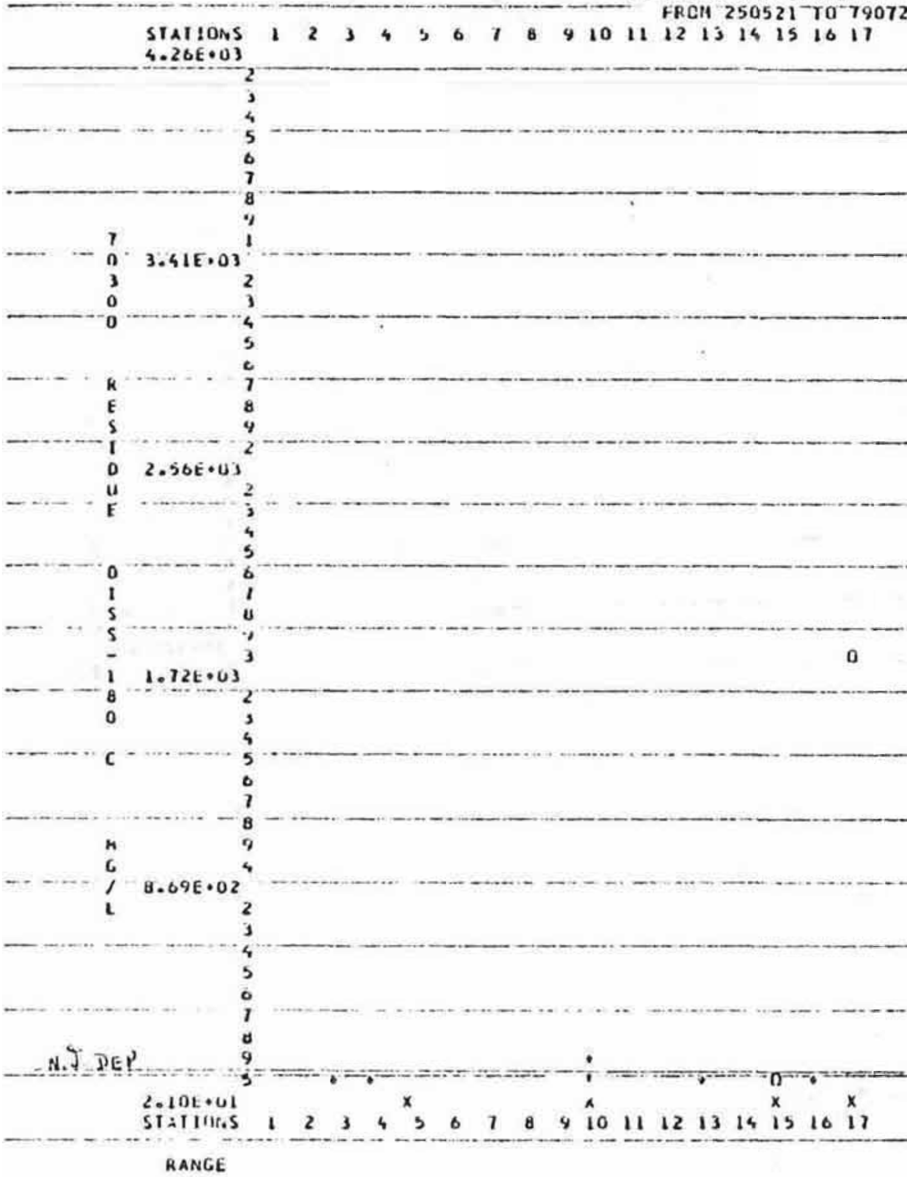
LEFT SIDE
- MAX
x 10 PCTILE
O 50 PCTILE
o 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01409411	1.20E+00	4.60E-01	9.70E-01	1.20E+00
2	01410150	1.40E+00	1.70E-01	2.40E-01	1.40E+00
3	01409815	2.50E+00	1.20E-01	3.50E-01	1.40E+00
4	01410000	1.40E+00	1.40E-01	5.50E-01	1.40E+00
5	01409450	2.80E+00	5.10E-01	1.40E+00	[illegible]
6	01409470	2.90E+00	1.80E-01	9.50E-01	[illegible]
7	01409500	1.40E+00	4.00E-02	4.30E-01	[illegible]
8	01409412	9.00E-01	2.60E-01	7.30E-01	[illegible]
9	01409414	2.00E+01	5.20E-01	6.70E+00	2.00E+01
10	01409416	7.50E+00	3.90E+00	4.90E+00	[illegible]
11	01409375	2.90E+00	5.30E-01	1.30E+00	[illegible]
12	01409383	8.90E-01	2.40E-01	4.00E-01	[illegible]
13	01409387	2.60E+00	2.30E-01	5.10E-01	[illegible]
14	01409400				
15	01409403	2.70E+01	4.80E-01	1.20E+00	2.20E+01
16	393825074323500	1.40E+00	2.40E-01	5.20E-01	1.30E+00
17	01409535	7.30E-01	1.50E-01	6.00E-01	7.30E-01

STATIONS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 STATIONS

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
FROM 250521 TO 790726



STATIONS

LEFT SIDE
* MAX
X 10 PCTILE
O 50 PCTILE
+ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01409411	5.60E+01	3.90E+01	4.70E+01	5.60E+01
2	01410150	4.70E+01	2.50E+01	3.10E+01	4.60E+01
3	01407815	1.17E+02	2.20E+01	2.70E+01	4.12E+01
4	01410000	8.60E+01	2.40E+01	3.00E+01	4.23E+01
5	01409450	1.14E+02	5.70E+01	9.30E+01	1.03E+02
6	01409470	1.10E+02	2.10E+01	3.70E+01	7.40E+01
7	01409500	5.20E+01	2.20E+01	3.20E+01	4.90E+01
8	01409412	5.10E+01	3.00E+01	4.90E+01	5.10E+01
9	01409414	1.80E+02	7.80E+01	1.23E+02	1.35E+02
10	01409416	1.80E+02	4.80E+01	8.80E+01	1.41E+02
11	01409375	1.18E+02	3.30E+01	5.80E+01	7.50E+01
12	01409383	9.40E+01	3.40E+01	4.00E+01	9.40E+01
13	01409387	7.90E+01	2.10E+01	3.50E+01	6.90E+01
14	01409400	4.30E+01	2.40E+01	3.10E+01	4.20E+01
15	01409403	1.55E+02	4.90E+01	8.90E+01	1.55E+02
16	393825074393500	9.70E+01	3.30E+01	4.00E+01	5.10E+01
17	01409535	4.26E+03	4.50E+01	1.81E+03	4.26E+03

STATIONS

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
FROM 750806 TO 781011

STATIONS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 — STATIONS

8.70E+02
6.96E+02
5.22E+02
3.49E+02
1.75E+02
1.00E+00

O O S 5 O R E S I D U E T O T A L F L T M G / L

N.J. DEP

STATIONS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 — STATIONS

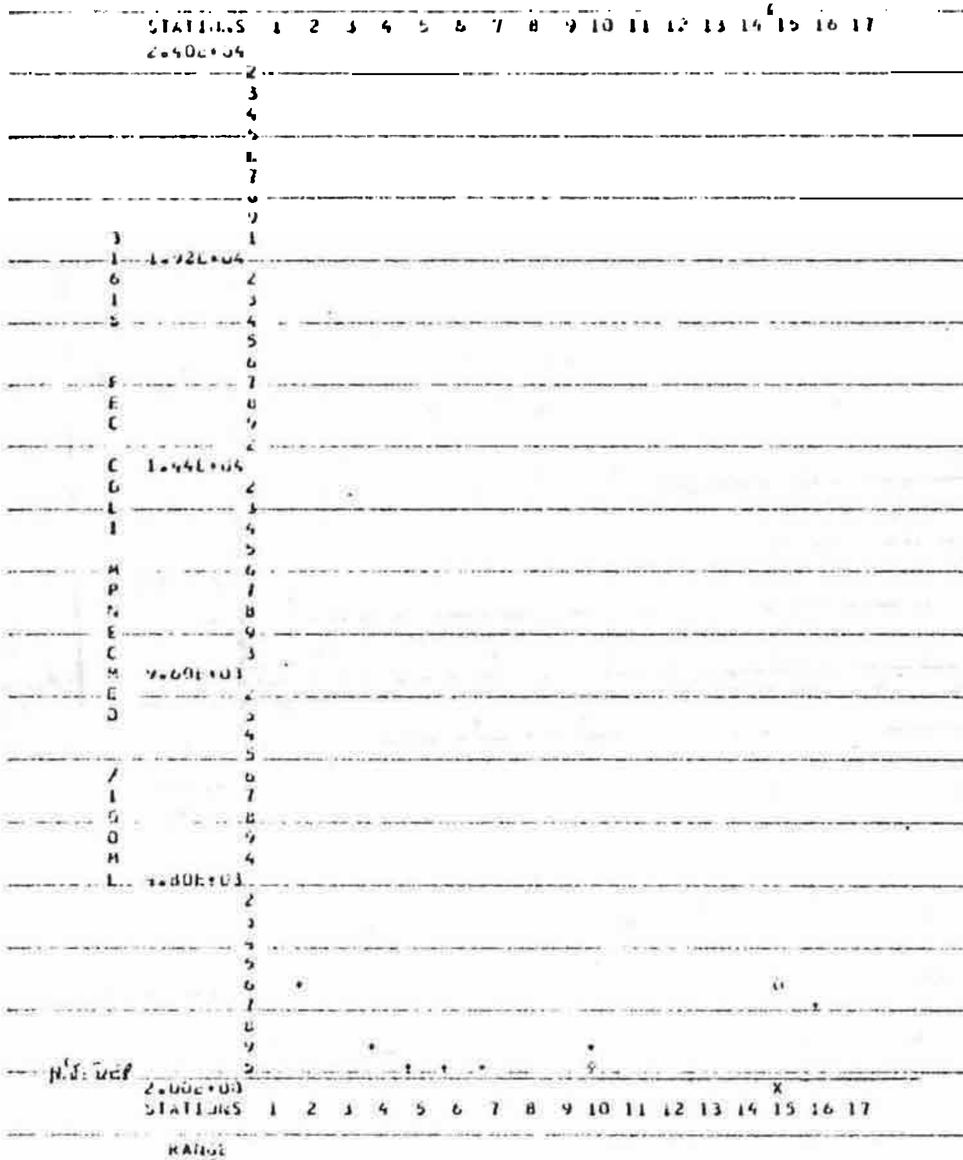
RANGE U U U U U U U

LEFT SIDE
+ MAX
x 10 PCTILE
O 50 PCTILE
90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01409411	5.00E+00	0.00E 00	4.00E+00	5.00E+00
2	01413150	1.40E+01	0.00E 00	3.03E+00	1.30E+01
3	01409815	1.70E+01	0.00E 00	7.00E+00	1.63E+01
4	01410000	1.10E+01	0.00E 00	4.00E+00	9.00E+00
5	01409450	9.00E+00	1.00E 00	6.00E+00	9.00E+00
6	01409470	1.40E+01	0.00E 00	2.00E+00	1.10E+01
7	01409500	1.20E+01	0.00E 00	3.00E+00	7.00E+00
8	01409412	1.80E+01	4.00E 00	6.00E+00	1.40E+01
9	01409414	6.00E+01	9.00E 00	1.90E+01	[illegible]
10	01409416	1.10E+01	4.00E 00	9.00E+00	1.10E+01
11	01409375	1.70E+01	1.00E 00	2.00E+00	9.00E+00
12	01409383	1.80E+01	1.00E 00	3.00E+00	1.80E+01
13	01409387	1.70E+01	0.00E 00	5.00E+00	1.10E+01
14	01409400				
15	01409403	8.70E+02	4.00E+00	2.10E+01	8.70E+02
16	393825074393500	1.50E+01	3.00E+00	7.00E+00	1.30E+01
17	01409535	4.20E+01	4.00E+00	2.10E+01	4.20E+01

STORET SYSTEM 01/02/80

MULTIPLE STATION PLOTS

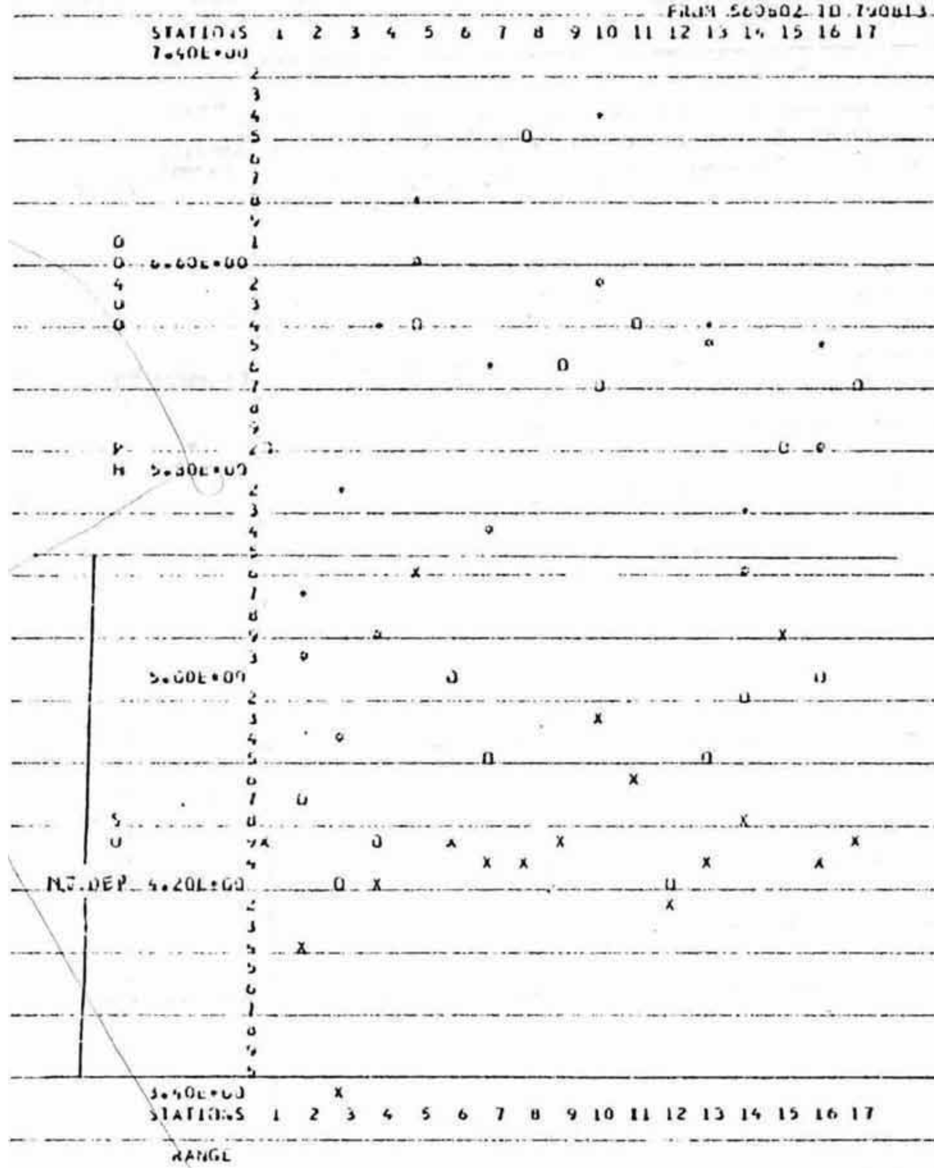


LEFT SIDE
• MAX
x 10 PCTILE
0 50 PCTILE
• 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01402411	3.30E+02	2.00E+01	5.00E+01	3.3[illegible]
2	01410150	2.40E+03	2.00E+01	2.00E+01	[illegible]
3	01409815	9.00E+01	2.00E+01	2.00E+01	[illegible]
4	01410000	7.90E+02	2.00E+01	2.00E+01	[illegible]
5	01409450	4.90E+02	2.00E+01	2.00E+01	[illegible]
6	01409470	3.30E+02	2.00E+01	2.00E+01	[illegible]
7	01409500	4.90E+02	2.00E+01	2.00E+01	[illegible]
8	01409412	1.30E+03	2.00E+01	2.00E+01	1.30E+03
9	01409414	5.40E+03	2.00E+01	2.00E+01	5.40E+03
10	01402416	7.90E+02	1.10E+01	2.00E+01	3.50E+02
11	01409375	2.00E+01	2.00E+01	2.00E+01	2.00E+01
12	01409383	1.10E+02	2.00E+01	2.00E+01	1.10E+02
13	01409387	8.90E+01	2.00E+01	2.00E+01	2.0[illegible]
14	01409400				
15	01409403	2.40E+04	2.00E+00	2.40E+03	2.40E+04
16	393825074393500	1.70E+01	2.00E+01	2.20E+01	1.30E+[illegible]
17	01409535	1.60E+03	2.00E+00	1.70E+02	1.[illegible]

STORET SYSTEM 01/02/83

MULTIPLE STATION PLOT (MSP)
FROM 560602 TO 790813



STATIONS

LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
ø 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01409411	6.50E+00	4.40E+00	5.90E+00	[illegible]
2	01410150	5.30E+00	4.00E+00	4.50E+00	5.1[illegible]
3	01407815	5.70E+00	3.40E+00	4.20E+00	4.[illegible]
4	01410000	6.40E+00	4.20E+00	4.45E+00	5.2[illegible]
5	01409450	6.80E+00	5.40E+00	6.40E+00	[illegible]
6	01409470	6.40E+00	4.40E+00	5.30E+00	[illegible]
7	01407500	6.20E+00	4.30E+00	4.70E+00	5.[illegible]
8	01409412	7.40E+00	4.30E+00	7.10E+00	7.4[illegible]
9	01409414	6.90E+00	4.40E+00	6.20E+00	6.3[illegible]
10	01409416	7.20E+00	4.95E+00	6.10E+00	6.5[illegible]
11	01409375	7.40E+00	4.60E+00	6.40E+00	7.4[illegible]
12	01407383	7.20E+00	4.10E+00	4.20E+00	7.[illegible]
13	01409387	6.40E+00	4.30E+00	4.55E+00	[illegible]
14	01409400	5.60E+00	4.40E+00	4.90E+00	5.4[illegible]
15	01409403	5.50E+00	5.20E+00	5.30E+00	6.50E+00
16	394825074393500	6.30E+00	4.30E+00	5.00E+00	5.8[illegible]
17	01409535	6.56E+00	4.40E+00	6.10E+00	6.5[illegible]

STATIONS

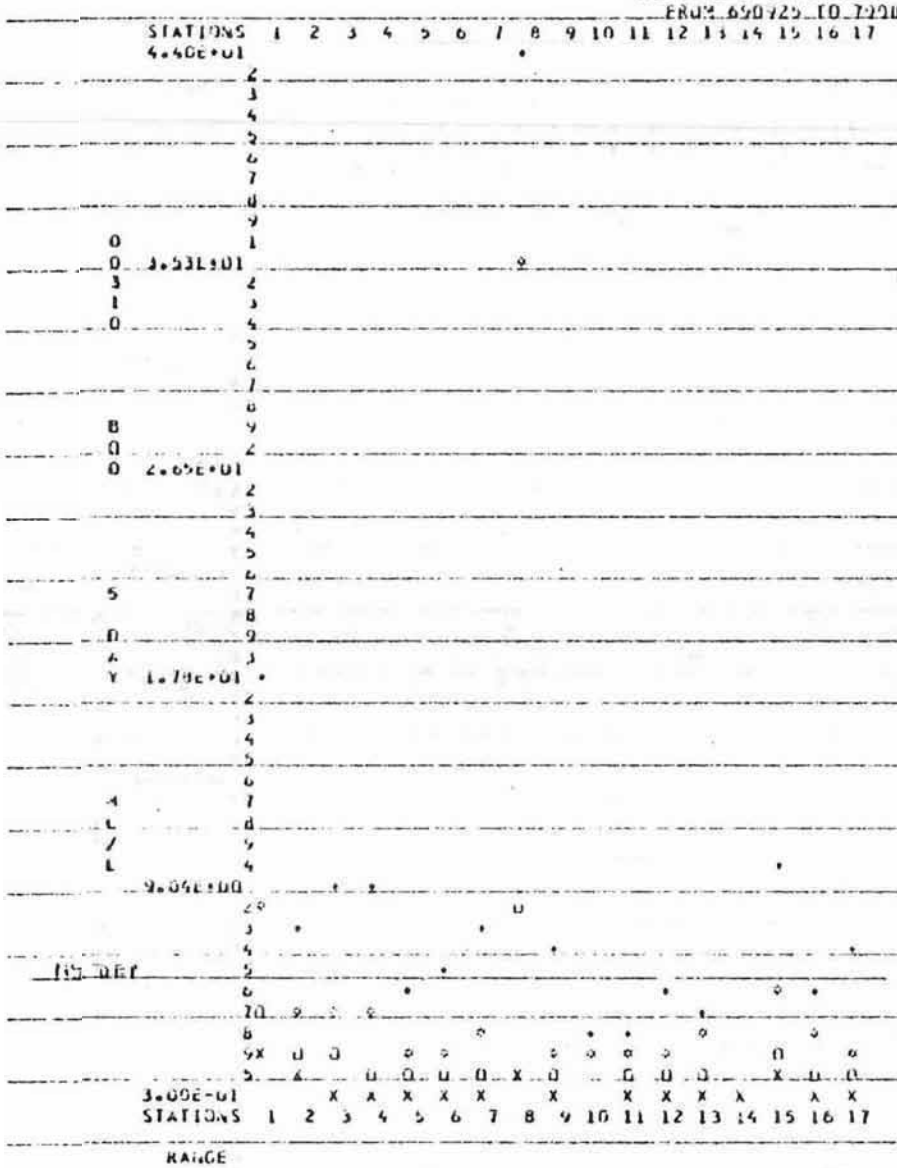
6.0 GREAT EGG HARBOR RIVER DRAINAGE BASIN

9.0 TUCKAHOE DRAINAGE BASIN

Station	Station No.	Station Location
1	01410775	Great Egg Harbor River at Berlin
2	01410784	Great Egg Harbor River near Sicklersville
3	01410787	Great Egg Harbor River Tributary at Sicklersville
4	01410789	Great Egg Harbor River Tributary 2 at Winslow Crossing
5	01410803	Fourmile Branch at Winslow Crossing
6	01410810	Fourmile Branch at New Brooklyn
7	01410820	Great Egg Harbor River near Blue Anchor
8	01410865	Squankum Branch at Malago Road
9	01411000	Great Egg Harbor River at Folsom
10	01411053	Hospitality Branch at Berryland
11	01411110	Great Egg Harbor River at Weymouth
12	01411140	Deep Run at Weymouth
13	01411170	Great Egg Harbor River at Mays Landing
14	01411196	Babcock Creek near Mays Landing
15	394203074562901	West Outlet New Brooklyn Lake at Winslow Crossing
16	01411290	Tuckahoe River near Estell Manor
17	01411300	Tuckahoe River at Head of River

STORET SYSTEM 01/02/80

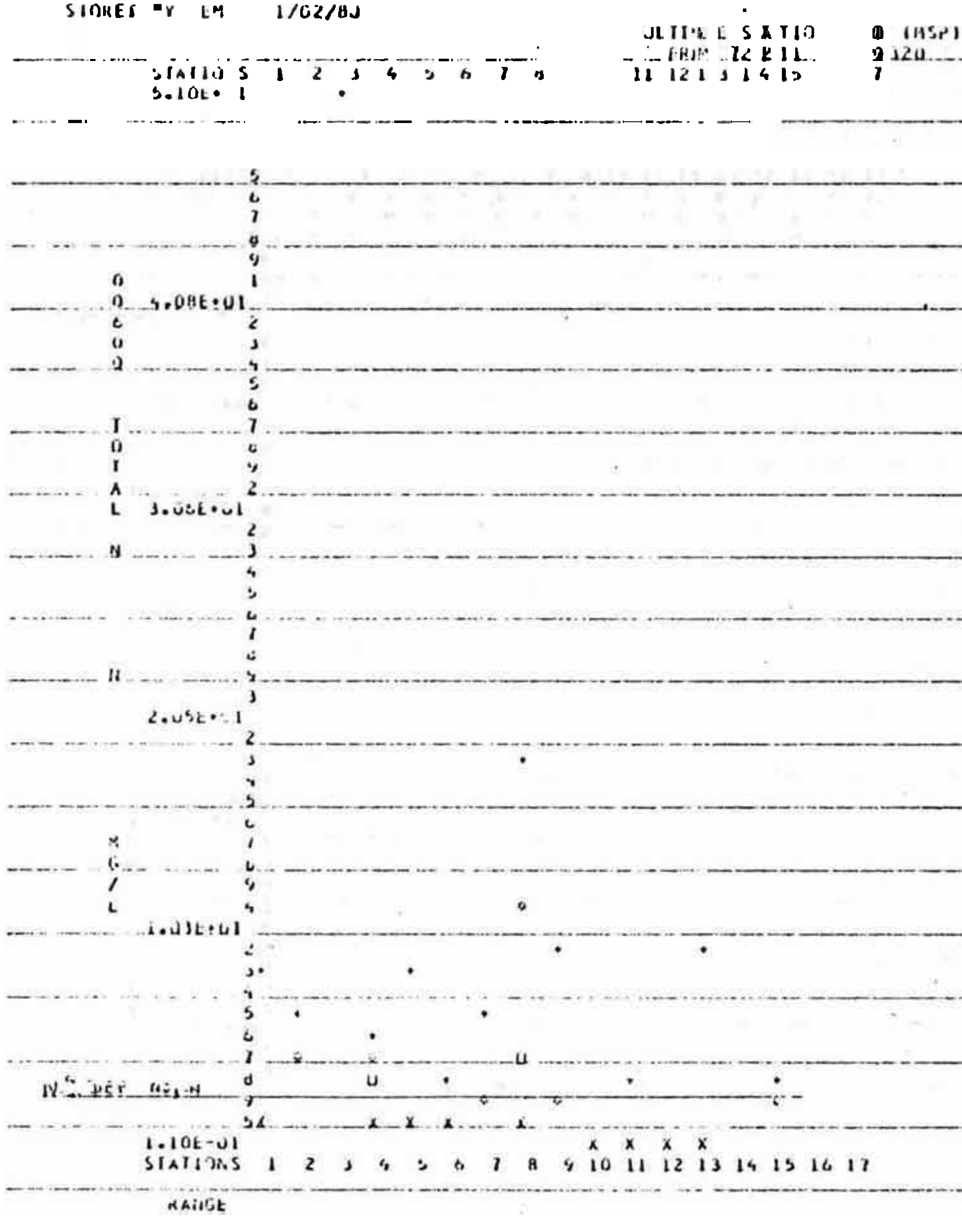
MULTIPLE STATION PLOT (MSP)
FROM 650925 TO 790815



LEFT SIDE
- • MAX
- x 10 PCTILE
- □ 50 PCTILE
- ◇ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01410775	1.90E+01	2.00E+00	4.10E+00	[illegible]
2	01410784	7.10E+00	9.00E-01	1.90E+00	3.70E+00
3	01410787	8.80E+00	6.00E-01	1.90E+00	4.20E+00
4	01410789	9.00E+00	6.00E-01	1.60E+00	3.70E+00
5	01410803	4.30E+00	3.00E-01	8.00E-01	1.70E+00
6	01410810	5.40E+00	5.00E-01	1.00E+00	2.10E+00
7	01410820	7.00E+00	5.30E-01	1.10E+00	2.60E+00
8	01410965	4.40E+01	1.00E+00	7.40E+00	3.50E+01
9	01411000	6.50E+00	4.00E-01	1.30E+00	2.30E+00
10	01411053	2.50E+00	8.00E-01	1.40E+00	2.30E+00
11	01411110	2.65E+00	5.00E-01	1.10E+00	2.00E+00
12	01411140	5.90E+00	3.00E-01	9.70E-01	[illegible]
13	01411170	3.60E+00	4.00E-01	1.30E+00	3.30E+00
14	01411196	1.60E+00	6.00E-01	9.00E-01	1.40E+00
15	394230074562901	9.80E+00	1.10E+00	1.90E+00	4.60E+00
16	01411290	4.80E+00	7.00E-01	1.40E+00	3.50E+00
17	01411300	6.00E+00	6.00E-01	1.00E+00	2.20E+00

STORET BY LM 1/02/80



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2	01410784	6.30E+00	1.03E+00	1.[illegible]E+00	3.[illegible]
3	01410787	5.10E+01	6.20E-01	1.10E+00	1.[illegible]
4	01410789	5.50E+00	1.60E+00	2.53E+00	3.[illegible]
5	01410803	7.90E+00	1.20E+00	1.70E+00	7.1[illegible]
6	01410910	2.90E+00	1.30E+00	1.90E+00	2.5[illegible]
7	01410820	5.90E+00	9.60E-01	1.50E+00	2.[illegible]
8	01410865	1.80E+01	1.60E+00	3.90E+00	1.1[illegible]E+01
9	01411000	9.30E+00	7.70E-01	1.30E+00	1.7[illegible]E+00
10	01411053	1.20E+00	3.70E-01	6.20E-01	1.1[illegible]
11	01411110	3.60E+00	5.60E-01	7.60E-01	1.1[illegible]
12	01411140	8.40E-01	3.90E-01	6.20E-01	8.[illegible]E-01
13	01411170	9.40E+00	5.90E-01	7.20E-01	7.5[illegible]E-01
14	01411176	9.10E-01	3.60E-01	4.50E-01	7.60E-01
15	394230074562901	2.80E+00	9.40E-01	1.50E+00	2.20E+00
16	01411270	8.90E-01	2.40E-01	4.50E-01	8.60E-01
17	01411300	9.40E-01	1.10E-01	4.00E-01	9.20E-01

STORET SYSTEM 01/03/83

MULTIPLE STATION PLOT (MSP)
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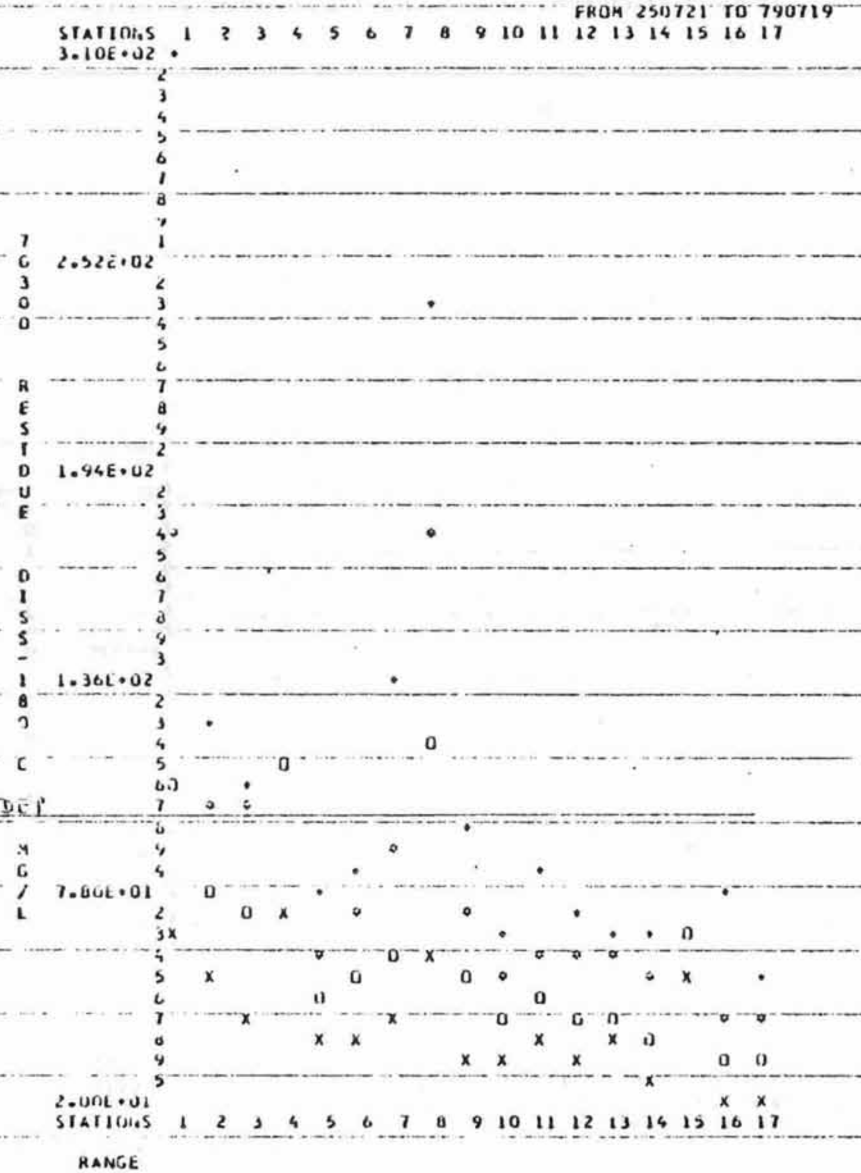

STATIONS

LEFT SIDE
• MAX
X 10 PCTILE
O 50 PCTILE
◦ 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
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2	01410784	1.25E+02	5.60E+01	8.00E+01	[illegible]
3	01410787	1.08E+02	4.10E+01	7.40E+01	[illegible]
4	01410789	1.43E+02	7.00E+01	1.13E+02	1.41E+02
5	01410803	7.60E+01	3.70E+01	4.70E+01	6.20E+01
6	01410810	8.60E+01	3.50E+01	5.50E+01	7.30E+01
7	01410820	1.35E+02	4.60E+01	5.90E+01	9.40E+01
8	01410865	2.41E+02	6.20E+01	1.20E+02	1.79E+02
9	01411000	9.30E+01	3.10E+01	5.60E+01	[illegible]
10	01411053	6.50E+01	2.90E+01	4.20E+01	5.30E+01
11	01411110	8.10E+01	4.00E+01	4.80E+01	5.90E+01
12	01411140	7.40E+01	3.40E+01	4.20E+01	[illegible]
13	01411170	6.70E+01	3.60E+01	4.60E+01	6.13E+01
14	01411196	6.70E+01	2.70E+01	3.90E+01	5.73E+01
15	394203074562901	7.90E+01	5.20E+01	6.60E+01	7.70E+01
16	01411290	8.00E+01	2.00E+01	3.20E+01	4.30E+01
17	01411300	5.20E+01	2.10E+01	3.30E+01	4.20E+01

STATIONS

STORET SYSTEM 01/03/80

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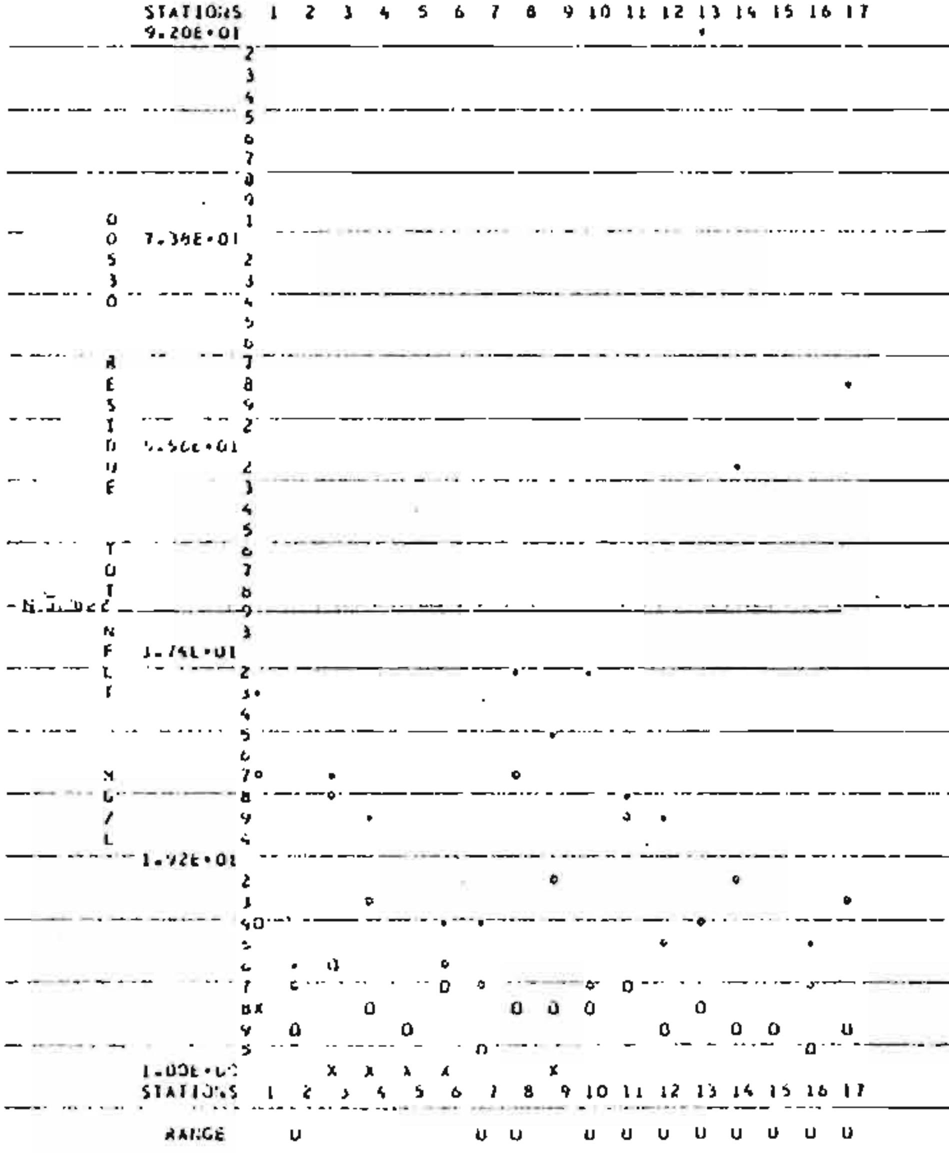

STATIONS

LEFT SIDE
- MAX
X 10 PCTILE
O 50 PCTILE
* 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
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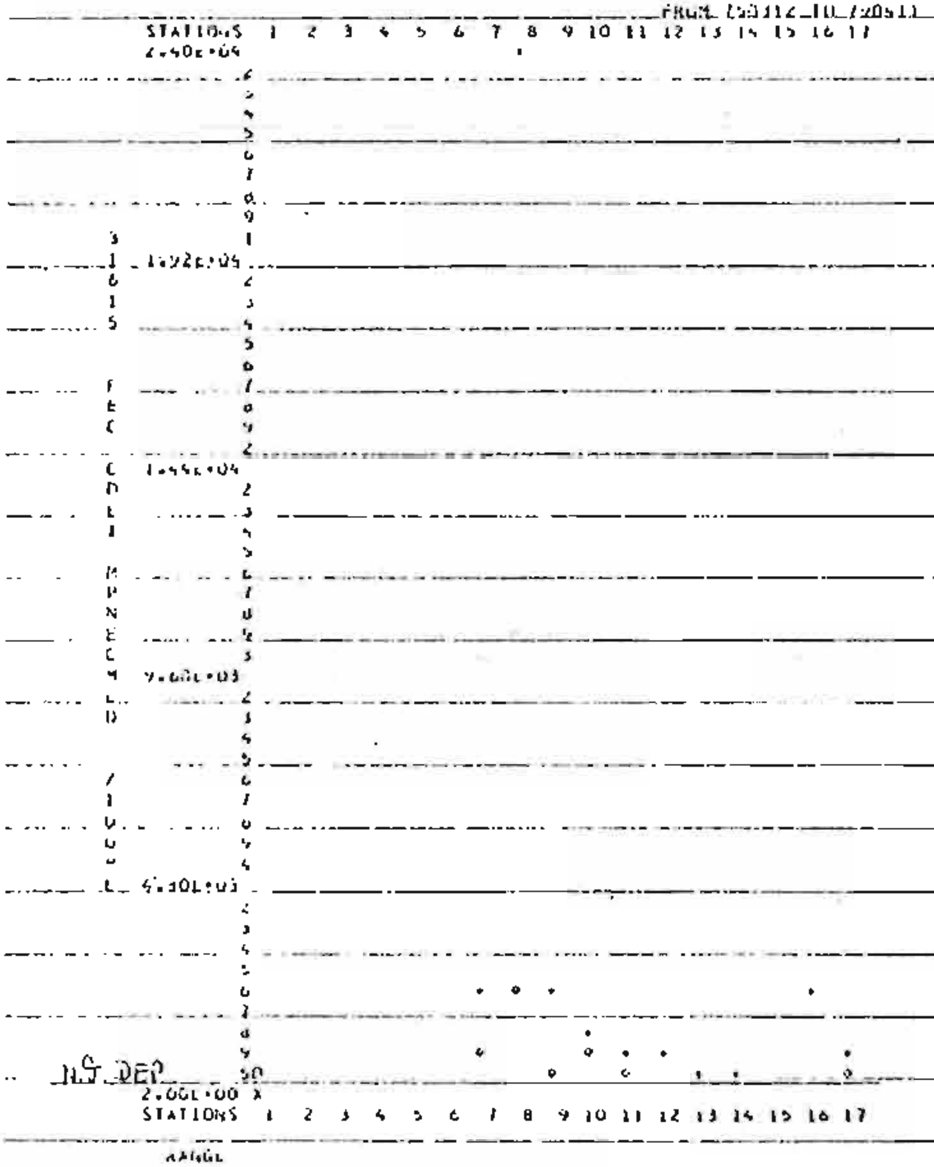
2	01410784	1.00E+01	0.00E+00	5.[illegible]	9.[illegible]
3	01410787	2.60E+01	1.00E+00	1.10E+01	[illegible]
4	01410709	2.30E+01	1.00E+00	7.00E+00	1.63E+01
5	01410803	1.10E+01	1.00E+00	5.00E+00	1.1[illegible]
6	01410810	1.30E+01	1.00E+00	8.00E+00	1.1[illegible]
7	01410820	1.30E+01	0.00E+00	3.00E+00	8.0[illegible]
8	01410865	3.90E+01	0.00E+00	2.00E+00	2.7[illegible]
9	01411000	3.00E+01	1.00E+00	7.00E+00	1.33E+01
10	01411055	3.60E+01	0.00E+00	6.00E+00	9.00E+00
11	01411110	2.40E+01	0.00E+00	9.00E+00	2.20E+01
12	01411140	2.20E+01	0.00E+00	5.00E+00	1.20E+01
13	01411170	9.20E+01	0.00E+00	7.00E+00	1.40E+01
14	01411196	5.40E+01	0.00E+00	4.00E+00	1.70E+01
15	394203074562901	1.80E+01	0.00E+00	4.00E+00	1.80E+01
16	01411290	1.20E+01	0.00E+00	3.00E+00	9.00E+00
17	01411300	6.10E+01	0.00E+00	4.00E+00	1.50E+01

STORET SYSTEM 01/02/80

MULTIPLE STATION PLOT INSPT
FROM 750312 TO 720511



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0 50 PCTILE
o 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
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2	01410784	5.40E+02	1.10E+01	[illegible]	[illegible]
3	01410787	9.70E+02	2.00E+01	[illegible]	[illegible]
4	01410789	9.20E+02	5.00E+02	[illegible]	[illegible]
5	01410903	5.40E+02	9.00E+00	[illegible]	[illegible]
6	01410810	5.60E+02	2.00E+00	[illegible]	[illegible]
7	01410820	2.40E+03	2.00E+01	[illegible]	[illegible]
8	01410855	2.40E+04	2.00E+01	2.30E+02	[illegible]
9	01411000	2.40E+03	2.00E+00	[illegible]	[illegible]
10	01411053	1.60E+03	[illegible]	[illegible]	[illegible]
11	01411110	9.20E+02	1.30E+01	[illegible]	[illegible]
12	01411150	7.10E+02	[illegible]	[illegible]	[illegible]
13	01411170	5.40E+02	7.00E+00	3.20E+01	2.40E+02
14	01411196	4.90E+02	7.00E+00	3.40E+01	[illegible]
15	394233074562901	4.90E+02	2.00E+01	4.90E+01	[illegible]
16	01411270	2.40E+03	2.00E+00	[illegible]	[illegible]
17	01411300	9.20E+02	2.00E+00	1.30E+01	[illegible]

STATIONS

STORET SYSTEM 01/03/80

MULTIPLE STATION PLOT (MSP)
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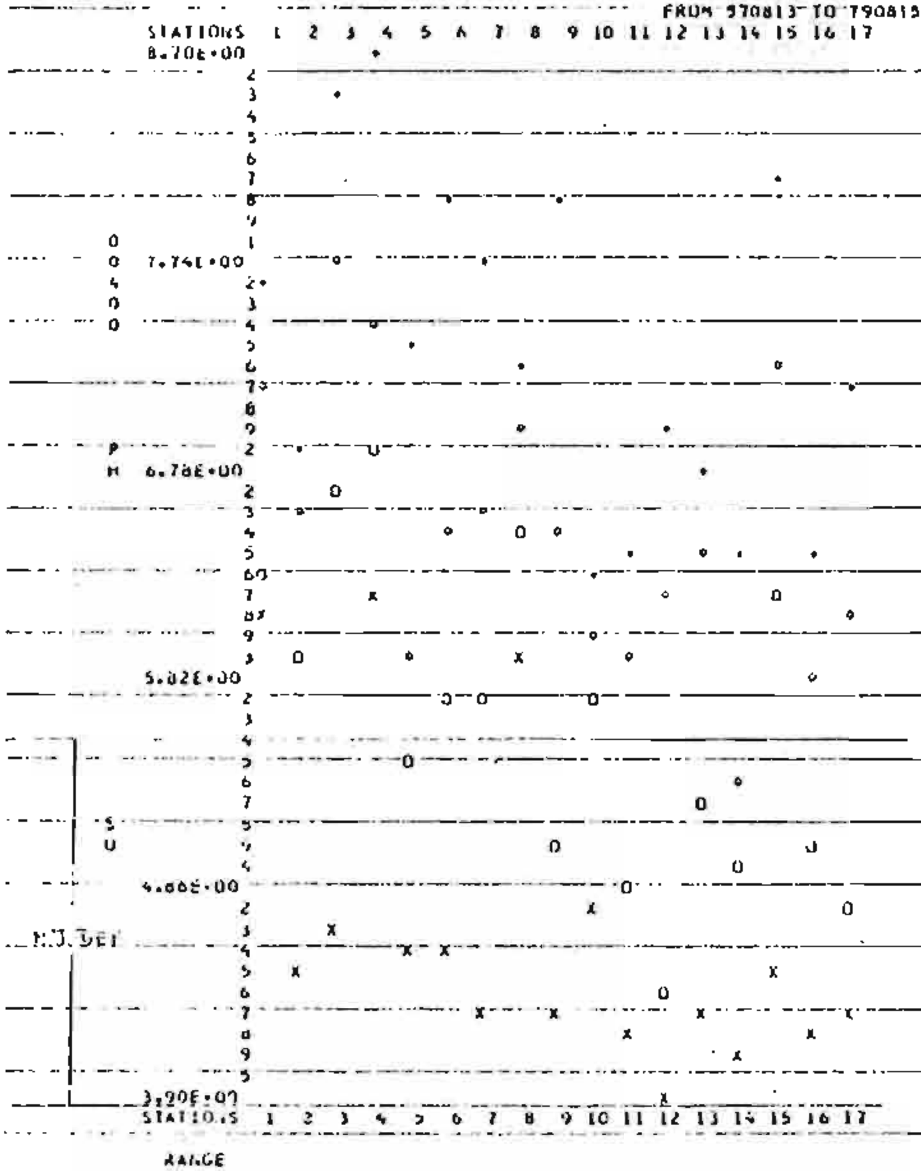

LEFT SIDE
- • MAX
- X 10 PCTILE
- O 50 PCTILE
- • 90 PCTILE

STATION		MAX	10 PCTILE	50 PCTILE	90 PCTILE
1	01410775	7.60E+00	6.10E+00	6.30E+00	7.20E+00
2	01410784	6.90E+00	4.50E+00	5.90E+00	[illegible]
3	01410787	8.50E+00	4.70E+00	6.70E+00	7.70E+00
4	01410789	8.70E+00	6.20E+00	6.90E+00	7.50E+00
5	01410003	7.40E+00	4.60E+00	5.40E+00	[illegible]
6	01410810	8.00E+00	4.60E+00	5.70E+00	6.90E+00
7	01410820	7.70E+00	4.30E+00	[illegible]	[illegible]
8	01410855	7.30E+00	5.70E+00	6.50E+00	[illegible]
9	01411000	8.00E+00	4.30E+00	5.10E+00	[illegible]
10	01411053	6.30E+00	4.80E+00	5.70E+00	6.30E+00
11	01411110	6.40E+00	4.20E+00	4.90E+00	5.30E+00
12	01411140	7.00E+00	3.90E+00	4.40E+00	6.20E+00
13	01411170	6.00E+00	4.30E+00	5.20E+00	[illegible]
14	01411196	6.40E+00	4.10E+00	5.00E+00	5.30E+00
15	394203074562901	8.10E+00	4.50E+00	6.20E+00	7.30E+00
16	01411290	6.40E+00	4.20E+00	5.10E+00	[illegible]
17	01411300	7.20E+00	4.30E+00	4.80E+00	6.10E+00

APPENDIX 2

WATER QUALITY INDEX

TABLE 2-1

WATER QUALITY INDEX
1.0 - TOMS RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
OCN 031	Toms River Trenton-Cassville Rd.	1	12	2	2	1	51	2	7	1	45	7	4.96
OCN 030 (01408260)	Toms River near Van Hiseville	2	17	1	6	1	56	3	12	1	49	8	5.40
OCN 029	Toms River Lakehurst-Whitesville Rd.	2	16	1	3	1	53	1	7	1	48	6	4.80
OCN 028 01408310	Toms River near Lakehurst	1	19	1	26	1	68	2	15	1	52	6	4.69
OCN 041	Ridgeway Br. Lakehurst-Whitesville Rd.	1	13	1	3	1	54	2	7	1	48	6	4.21
OCN 040 01408492	Ridgeway Branch Rt. 70 near Lakehurst	2	16	1	7	1	55	2	14	1	50	7	4.25
OCN 027	Toms River, Rt. 571 Manchester-Dover Border	2	15	1	3	1	54	2	7	1	50	7	4.92
OCN 042	Kanapaqua Branch Lakehurst-Ridgeway Road, Tributary to Union Branch	3	15	2	3	2	53	2	7	1	49	10	5.75
OCN 039	Union Branch Colonial Drive	2	13	2	7	1	57	2	9	1	52	8	4.33
OCN 038	Union Branch Brookville Rd.	2	15	1	3	1	55	1	8	1	50	6	4.36
OCN 026	Toms River below confluence of Union and Ridgeway	1	14	1	2	1	45	2	7	1	39	6	4.47
OCN 025 01408500	Toms River near Toms River	1	95	1	69	1	94	2	16	1	129	6	4.70

TABLE 2-2

WATER QUALITY INDEX
2.0 - RANCOCAS RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
2.1 North Rancocas													
01465970	North Branch at Browns Mills	1	30	1	18	2	25	2	25	1	29	7	5.20
01466500	McDonalds Branch in Lebanon State Forest	1	66	1	24	1	31	1	4	1	86	5 (pristine)	4.10
01466900	Greenwood Branch at New Lisbon	1	24	1	17	2	25	2	24	1	33	7	4.30
01467000	North Branch at Pemberton	1	30	1	18	2	27	2	29	1	54	7	4.60
01467003	North Branch at Evanville	1	24	1	17	2	25	3	35	1	25	8	5.80
001467006	North Branch on Pine St. at Mt. Holly	1	27	1	18	2	27	2	28	1	27	7	6.20
2.2 South Rancocas													
01465835	South Branch at Retreat	1	29	1	19	2	25	2	26	1	29	7	4.20
01465850	South Branch at Vincentown	1	27	1	17	2	27	2	27	1	31	7	5.50
01465915	South Branch Hainesport	2	28	1	18	3	27	3	28	1	28	10	6.40

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-3

WATER QUALITY INDEX
3.0 CEDAR CREEK

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
3.1 Cedar Creek													
OCN045 01408930	Cedar Creek Whiting-Lacey Road	1	22	1	6	1	55	1	12	1	51	5	4.60
OCN044 01408870	Cedar Creek Double Trouble Road	1	23	1	6	1	55	1	12	1	50	5	4.52
OCN043	Cedar Creek Lanoka Harbor	1	18	1	4	1	57	2	16	1	50	6	4.31

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-4

WATER QUALITY INDEX
4.0 FORKED RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
4.1 Forked River													
OCN047	North Branch Forked River dirt road along JCP&L ROW	1	16	1	3	1	48	2	8	1	44	6	4.15
OCN046	North Branch Forked River at Forked River	1	24	1	10	1	58	2	16	2	49	7	4.28
OCN048	Middle Branch Forked River at Rt. 9	1	12	1	6	1	44	1	7	1	43	5	4.16
4.2 Oyster Creek													
OCN052	Oyster Cr. outflow of Brookville Bog	2	13	1	5	1	48	1	9	1	44	6	4.36
OCN051	Oyster Creek at Rt. 532	1	55	1	32	1	74	2	34	1	83	6	4.40
4.3 Mill Creek													
OCN054 01409150	Mill Creek at Rt. 72	2	15	1	11	1	59	1	16	1	49	6	4.23
OCN055	Fourmile Branch at Oxycocus-Littleville Mill Rd.	1	11	1	3	1	53	1	8	1	46	5	5.09
OCN053 (01409210)	Mill Creek at Rt. 180	2	13	1	6	1	53	2	10	1	43	7	5.34
4.4 Westecunk Creek													
OCN059	Westecunk Creek at Martha's Rd.	1	14	1	5	1	48	2	7	1	43	6	4.03
OCN058	Westcunk Creek Rt. 9 near West Creek	1	18	1	11	1	59	2	15	1	48	6	4.74

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-5

WATER QUALITY INDEX
5.0 - MULLICA RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
5.1 Bass River													
01410150	E. Branch Bass River near New Gretna	1	12	1	5	2	14	1	16	1	16	6	4.50
5.2 Wading River													
01409815	W. Branch Wading River near Maxwell	1	26	1	22	2	20	1	10	1	28	6	4.20
01410000	Oswego Creek East Branch Wading River at Harrisville	1	13	1	8	1	15	2	18	1	23	6	4.40
5.3 Batsto River													
01409450	Springers Brook near Indian Mills	1	10	1	9	1	16	2	16	2	17	7	6.40
01409470	Batsto River at Quaker Bridge	1	8	1	7	1	13	2	14	1	12	6	5.00
01409500	Batsto River at Batsto River	1	14	1	8	1	16	1	18	1	22	5	4.70
5.4 Atsion/Mechesactauxin Creeks													
01409375	Mullica River near Atco	1	6	1	9	1	11	1	11	1	11	5	6.40
01409383	Mullica River at Jackson Rd. near Indian Mills	1	4	1	6	2	10	1	8	1	10	6	4.20
01409387	Mullica River at outlet of Atsion Lk.	1	10	1	9	1	16	1	15	1	18	5	4.65
01409403	Wildcat Branch Chesilhurst	1	6	1	6	3	6	3	6	2	6	10	5.90
03938250 4393560	Mullica River at Pleasant Mills	1	11	1	7	2	14	1	16	1	16	6	5.00

TABLE 2-5 (Continued)

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
5.5 Nescochaque Creek													
01409411	Nescochaque at Pleasant Mills	1	4	1	6	1	6	2	6	1	6	6	5.90
5.6 Hammonton Creek													
01409412	Hammonton Creek Rt. 30 at Hammonton	2	6	1	8	2	6	2	6	1	8	8	7.10
01409414	Hammonton Creek at Hammonton	2	5	1	8	3	6	2	6	3	10	11	6.20
01409416	Hammonton Creek at Westcoatville	1	17	3	11	1	11	2	14	2	14	9	6.10
5.7 Mullica River													
01409535	Mullica River at Green Bank (tidal)												6.10

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-6

WATER QUALITY INDEX
6.0 - UPPER GREAT EGG HARBOR RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
6.1 Upper Great Egg Harbor River (GEHR)													
01410775	GEHR at Berlin	2	26	1	18	3	26	3	26	3	27	12	6.30
01410784	GEHR near Sicklersville	1	58	2	41	1	12	2	17	2	27	8	5.90
01410787	GEHR tributary on Blackwood-New Brooklyn Rd.	1	64	1	42	2	17	3	6	2	27	9	6.70
3942030 4562901	GEHR West outlet - Brooklyn Lake	1	34	1	31	2	8	2	6	1	13	7	6.20
01410789	Trib N. 2 on Sicklerville Rd.	1	63	2	64	2	17	2	5	3	27	10	6.90
01410803	Fourmile Branch at Winslow Crossing	1	54	1	55	1	8	2	6	1	18	6	5.40
01410810	Fourmile Branch at New Brooklyn	1	72	1	66	1	17	3	6	1	28	7	5.70
01410820	GEHR near Broad Lane (near Blue Anchor NJ)	1	71	1	56	1	21	2	17	1	35	6	5.70
01410865	Squankum Br. at Malaga Rd.	3	25	3	21	2	26	3	24	3	30	14	5.60
01411000	Squankum Br. at Folsom	1	62	1	31	2	30	2	30	1	65	7	5.10
01411053	Hospitality Branch at Berryland	1	25	1	17	1	25	2	24	1	25	6	5.70
01411110	Hospitality Branch at Weymouth	1	30	1	18	2	26	2	26	1	30	7	4.90
01411140	Deep Run Branch at Weymouth	1	28	1	18	1	27	1	26	1	28	5	4.40
6.2 Lower Great Egg Harbor River													
01411196	Babcock Creek at Rt. 322 near Mays Landing	1	24	1	17	2	25	2	23	1	25	7	5.00
0141170	GEHR at Mays Landing	1	28	1	20	2	28	2	27	1	29	8	5.20

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-7

WATER QUALITY INDEX
7.0 - MAURICE RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
7.1 Manumuskin River													
01412100	Manumuskin River near Manumuskin	1	26	1	19	1	27	1	24	1	27	5 (pristine)	4.40

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-8

WATER QUALITY INDEX
9.0 - TUCKAHOE RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
9.1 Tuckahoe River													
1411290	Tuckahoe River near Estell Manor	1	26	1	19	1	27	1	25	1	27	5	5.10
1411300	Tuckahoe River at Head of River, St. Rt. 49	1	33	1	19	2	29	2	29	1	33	7	4.80

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TECHNICAL MEMORANDUM SW IV-5

DRAINAGE BASIN ASSESSMENT

PINELANDS COMMISSION

FEBRUARY 1980

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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DRAINAGE BASIN ASSESSMENT

INTRODUCTION

The purpose of this technical memorandum is to document the existing water quality in the major drainage basins of the Pinelands. Water quality, land use and pollutant source information is summarized to provide:

- An overview of water quality and potential pollution sources by drainage basin
- Documentation of severely impacted areas
- Documentation of areas with high water quality
- A basis for determining critical areas in need of management by the Pinelands Commission

This report is organized by the major drainage basins and sub-basins of the Pinelands listed in Table 1 and illustrated in Figure 1. For each basin, the following topics are addressed:

General Description

Land Use

Pollution Sources

Water Quality

Drainage Basins Assessment

General
Critical Issues
Recommendations for Future Study

TABLE I

PINELANDS MAJOR DRAINAGE BASINS AND SUB-BASINS

Drainage Basin	Sub-basins
1. Toms River	1.1 Toms River
2. Rancocas Creek	2.1 Rancocas North Branch 2.2 Rancocas South Branch
3. Cedar Creek	3.1 Cedar Creek
4. Forked River	4.1 Forked River 4.2 Oyster Creek 4.3 Mill Creek 4.4 Westecunk Creek
5. Mullica River	5.1 Bass River 5.2 Wading River 5.3 Batsto River 5.4 Atsion-Mechesactauxin Creeks 5.5 Nescochaque Creek 5.6 Hammonton Creek 5.7 Mullica River
6. Great Egg Harbor River	6.1 Great Egg Harbor River (Upper) 6.2 Great Egg Harbor River (Lower)
7. Maurice River	7.1 Manumuskin Creek 7.2 Lower Maurice
8. Absecon Creek	8.1 Absecon Creek
9. Tuckahoe River	9.1 Tuckahoe River
10. Dennis Creek	10.1 Dennis Creek
11. Patcong Creek	11.1 Patcong Creek

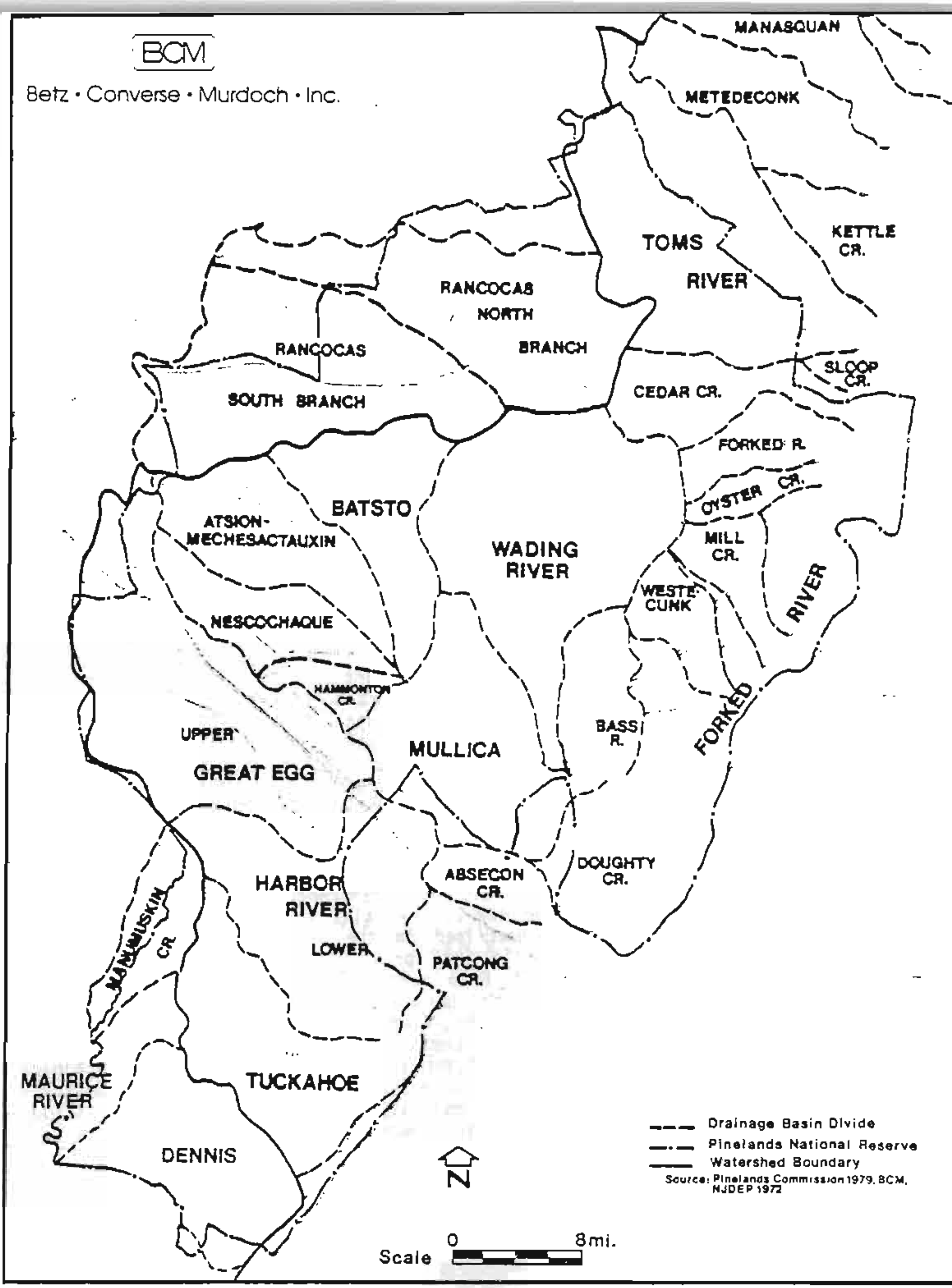

Figure 1. PINELANDS DRAINAGE BASINS

A matrix which summarizes the information in each drainage basin section contains the following data:

River Mile
Drainage Area
Water Quality Index

Point Source Data

Quantity of Discharge (cumulative at monitoring station)
Number of Domestic and Industrial Dischargers

Nonpoint Source Data

Number of Landfills
Number of Land Disposal Sites

Land Use

Percent Developed
Percent Agricultural

The information presented in this report is supported by a series of appendices containing detailed data tabulations. The Water Quality Index referred to in the following discussions is described in Technical Memorandum SW IV-4 and the results are tabulated in Appendix 2. Figures 2 and 3 map the water quality index results and median pH levels, respectively. For stream stretches within the FW-Central Pine Barrens Water Quality Standards Area (see Figure 4), the number of standard violations which would have occurred during the period of record are discussed.

Land use data used in the technical memorandum are based on the 1972 land use overlays for the New Jersey Atlas sheet series. The nonpoint pollution source data summarized in the basin discussions are site-specific, such as landfills and spray irrigation sites, not general categories such as runoff from agricultural land. The point source data were compiled from the New Jersey Department of Environmental Protection (NJDEP) records. To determine the relative impact of point sources on water quality at a sampling station, the quantity of domestic discharge released upstream of the station was divided by the drainage area defined by the station to give a concentration in gallons/day/square mile. This calculation could not be done for industrial discharges because of incomplete flow records and sporadic discharges.

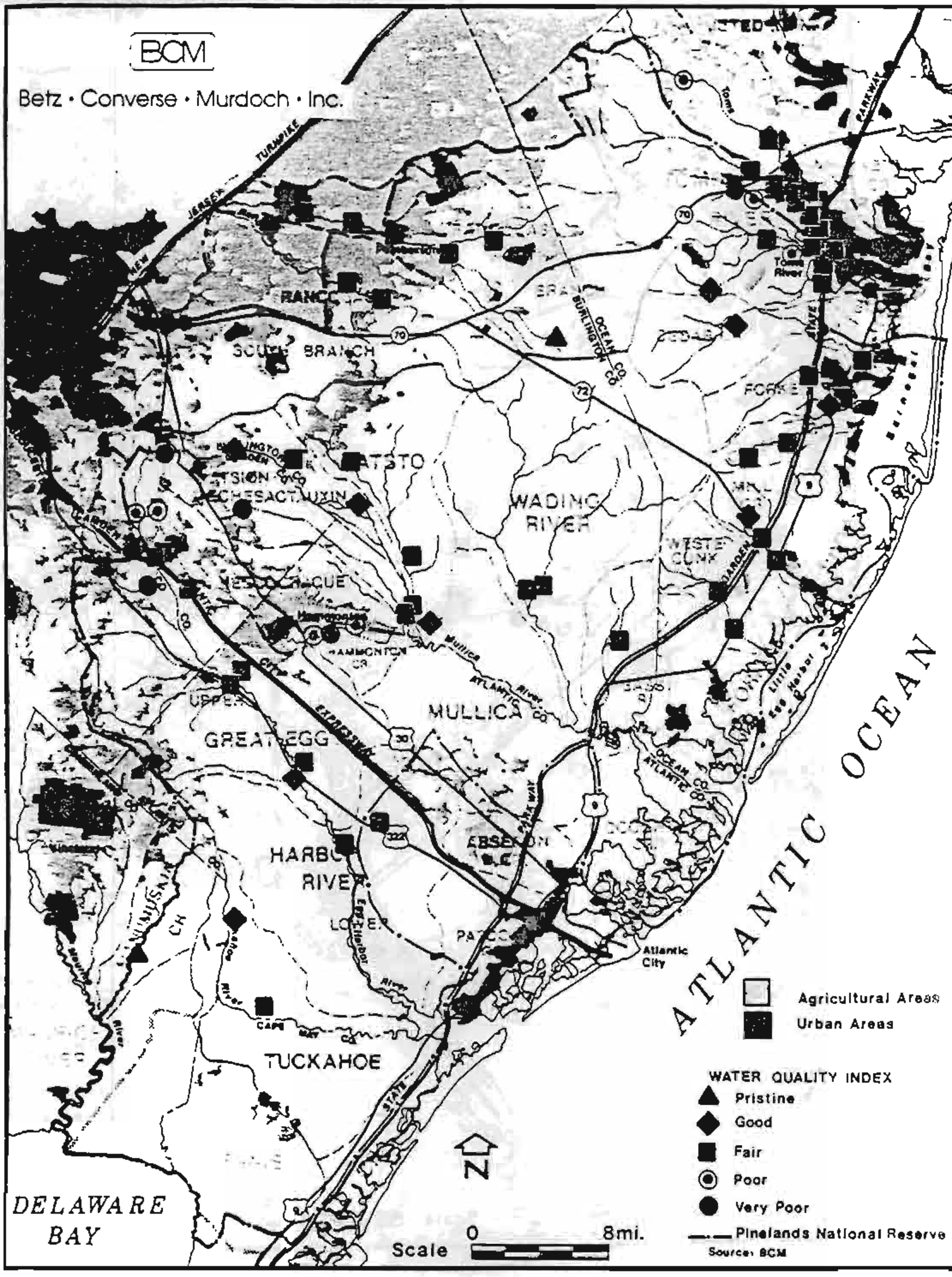

Figure 2. WATER QUALITY INDEX

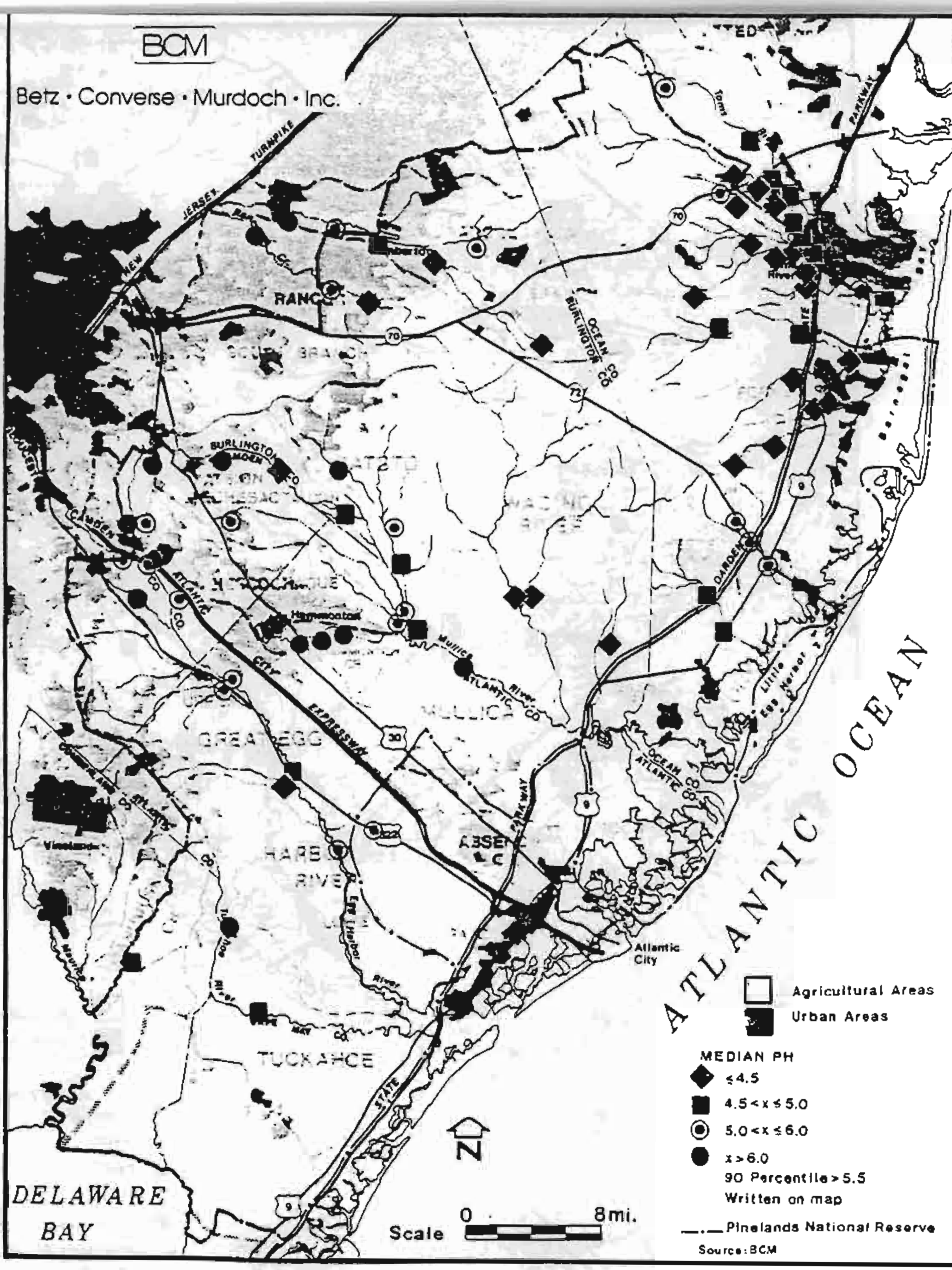
BCM
Betz · Converse · Murdoch · Inc.
NEW JERSEY TURNPIKE
RANCOCAS
SOUTH BRANCH
BURLINGTON CAMDEN CO
OCEAN CO BURLINGTON CO
GREAT EGG
MULLICA
ATLANTIC CO
HARBOR RIVER
TUCKAHOE
ATLANTIC CITY EXPRESSWAY
GARDEN STATE PARKWAY
Atlantic City
ATLANTIC OCEAN
DELAWARE BAY
Agricultural Areas
Urban Areas
MEDIAN PH
≤4.5
4.5<x≤5.0
5.0<x≤6.0
x>6.0
90 Percentile>5.5
Written on map
Pinelands National Reserve
Source: BCM
Scale
0
8mi.
N

Figure 3. pH

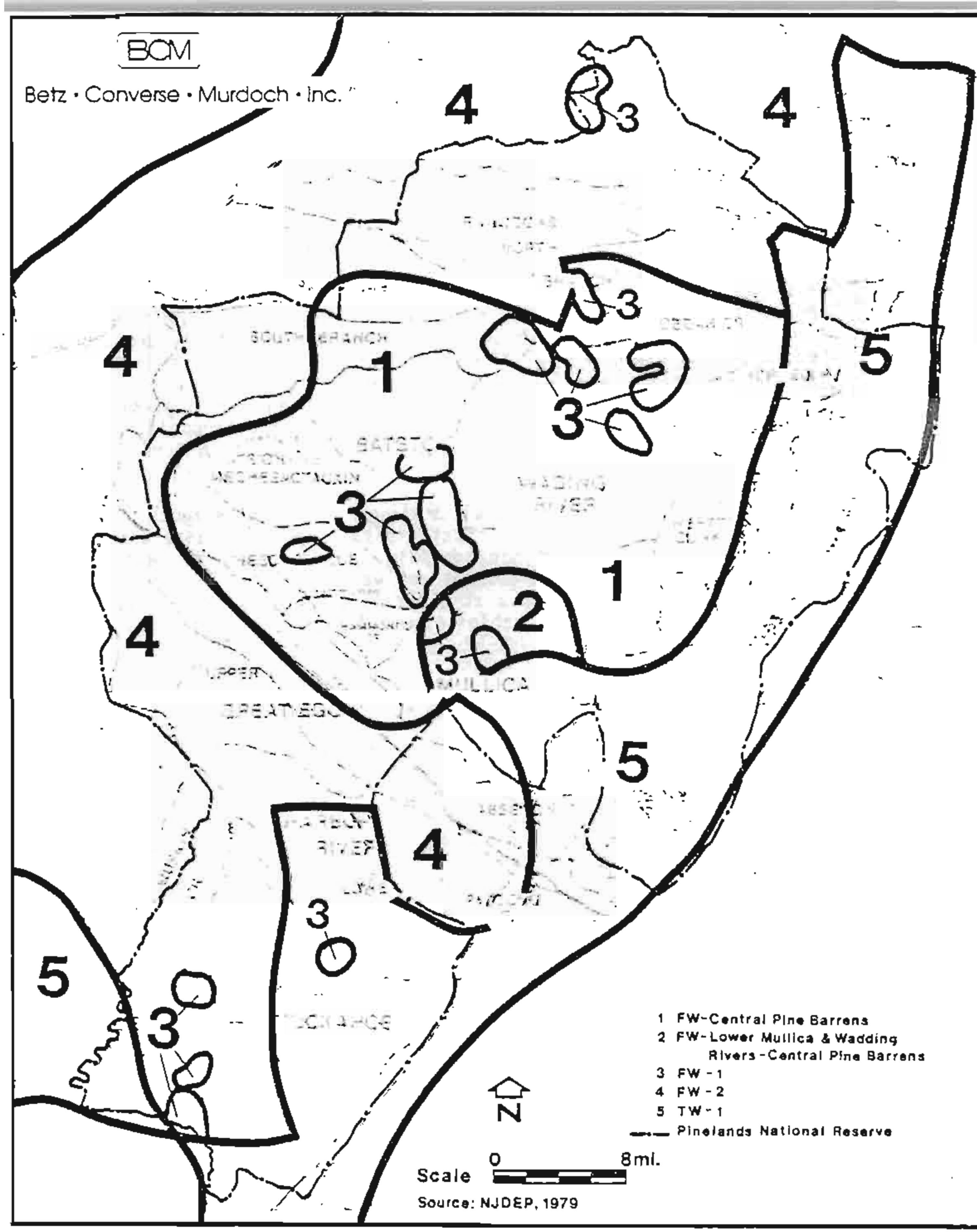

Figure 4. PROPOSED CLASSIFICATIONS

Toxic substances and heavy metals are being monitored in a statewide program conducted by the Office of Cancer and Toxic Substance Research, New Jersey Department of Environmental Protection. The sampling includes 25 sites within or near the Pinelands study area (see Table 2). Each site was sampled in 1978 and 1979, usually three times for surface water and once for the sediments. Five major groups of compounds were monitored: light organic toxics, heavy organic toxics (mostly pesticides), heavy metals, total organic carbon and aromatic hydrocarbons. Table 3 lists the chemical along with their limits of reportability. Because the data are still being reviewed, they cannot be released to the general public and they are not included in our analysis. The Office of Cancer and Toxics Research will make the data publicly available in its forthcoming report, scheduled for release in April of this year.

This memorandum presents general drainage basin assessments. Due to the location of the water quality stations, large basin size and mix of land uses upstream, it is not possible to show a direct relationship between land use, pollution sources and water quality. Technical Memorandum SW IV-6, however, looks at 15 small sub-basins in greater detail to better define the relationship between land use and water quality.

TABLE 2

PINELAND SITES SAMPLED FOR TOXICS

1.0 Toms River

Toms River near Lakehurst
Toms River near Toms River
Jakes Brook at Double Trouble Road

2.0 Rancocas Creek

Rancocas Creek at Mt. Holly

2.1 North Branch Rancocas
North Branch Rancocas near Pemberton
North Branch Rancocas at Mt. Holly

2.2 South Branch Rancocas
South Branch Rancocas at Hainesport

4.0 Forked River

4.1 Forked River
Forked River - Lake Barnegat - lower lake outfall

4.3 Mill Creek
Mill Creek at Manahawkin

4.4 Westecunk Creek
Westecunk Creek at West Creek

5.0 Mullica River

5.1 Bass River
East Branch Bass River at New Gretna

5.3 Batsto River
Batsto River at Quaker Bridge

5.4 Atsion-Mechesactauxin Creeks
Mullica River at Atsion
Mullica River at Mt. Pleasant Mills

5.6 Hammonton Creek
Hammonton Creek at Wescoatville

TABLE 2 (Continued)

6.0 <u>Great Egg Harbor River</u>

- 6.1 Great Egg Harbor River (Upper)
  - Hospitality Branch at Pennypot
  - Deep Run near Weymouth
  - Great Egg Harbor near Sicklersville
- 6.2 Great Egg Harbor River (Lower)
  - Great Egg Harbor River at Mays Landing

7.0 <u>Maurice River</u>

- 7.1 Manumuskin River
  - Manumuskin River near Manumuskin
- 7.2 Maurice River (Lower)
  - Maurice River at Norma
  - Maurice River at Millville
  - Maurice River at Mauricetown

8.0 <u>Absecon Creek</u>

Absecon Creek at Absecon

9.0 <u>Tuckahoe River</u>

Tuckahoe River near Estell Manor

Source: Office of Cancer and Toxic Substances Research, New Jersey Department of Environmental Protection (unpublished)

TABLE 3

SUBSTANCES INCLUDED IN SAMPLING FOR TOXICS IN SURFACE WATER

Parameter	Limit of Reportability	Parameter	Limit of Reportability
Group I (ug/l)		Group II (ug/l)	
Fluoroform	0.5	Aroclor 1016 (PCB'D)	0.06
Methyl chloride	6.0	Aroclor 1242 (PCB'A)	0.06
Methyl bromide	1.0	Aroclor 1248 (PCB'D)	0.06
Vinyl chloride	0.5	Aroclor 1254 (PCB'D)	0.06
Methylene chloride	90.0	BHC	0.01
Chloroform	0.8	BHC (Lindane)	0.01
1,2 dichloroethane	1.6	BHC	0.01
1,1,1 trichloroethane	2.0	Heptachlor	0.01
carbontetrachloride	0.1	Aldrin	0.01
1,1,2 trichloroethylene	0.3	heptachlor epoxide	0.01
Dichlorobromomethane	0.1	r chlordane	0.01
1,2 dibromoethane	0.1	p,p' - DDE	0.01
1,1,2,2 tetrachloroethylene	0.1	Dieldrin	0.01
Bromoform	1.0	Endrin	0.01
1,1,2,2 tetrachloroethane	0.3	o,p' - DDT	0.06
Diiodmethane	0.3	p,p' - DDD	0.02
m-dichlorobenzene	1.25	p,p' - DDT	0.04
p-dichlorobenzene	1.25	Mirex	0.02
o-dichlorobenzene	2.2	Methoxychlor	0.08
1,2,4 trichlorobenzene	2.0	Toxaphene	0.06
Dichloroethylene	10.0		
Dibromomethane	0.1		
t-dichlorethylene	10.0		
Group III (mg/l)		Group IV (mg/l)	
Arsenic	0.001	TOC	---
Beryllium	0.001		
Cadmium	0.001	Group V (mg/l)	
Chromium	0.001	Benzo (a) pyrene	---
Copper	0.001	Perylene	---
Lead	0.001	Chrysene	---
Nickel	0.005	Fluoranthene	---
Selenium	0.002		
Zinc	0.005		

Source: Office of Cancer and Toxic Substances Research, New Jersey Department of Environmental Protection

1.0 TOMS RIVER DRAINAGE BASIN

General Description

The Toms River drainage basin is the northern-most basin in the Pinelands National Reserve. Sixty-nine percent of the watershed (132 square miles) lies within the National Reserve; the remaining area (59 square miles) lies north and east of the National Reserve boundary. Major tributaries within the Toms River drainage basin include Davenport Branch, Wrangle Brook, Michaels Run, Old Hurricane Brook, Ruckels Branch, Manapaqua Brook, Ridgeway Branch, Jakes Brook and Maple Root Branch. Major lakes include Keswick Lake on Wrangle Brook, Lake Hurricane and Pine Lake on Union Branch and Lake Success on Ridgeway Branch. A number of unnamed lakes are associated with cranberry production. Toms River enters Barnegat Bay opposite Seaside Heights, 11 miles north of Barnegat Bay Inlet. The river is tidal up to the dam at the town of Toms River.

Major town centers include Toms River, Whiting, Lakehurst, Pleasant Plains, Whitesville and Keswick Grove. Toms River, Beechwood, Pleasant Plains and Whitesville are located outside the Pinelands National Reserve boundary. All but a very small section of the watershed lies within Ocean County.

Land Use

The upper reaches of the Toms River drainage basin are relatively undeveloped. The downstream areas, however, are more densely populated with commercial and industrial development (see Appendix 1). Major state landholdings include the Whitings and Manchester Fish and Wildlife Management areas and the Colliers Mills State Farm and Game Preserve. The U.S. Naval Air Station lies just north of the town of Lakehurst. Surface waters within the Toms River basin are utilized for agricultural, industrial, recreational shellfishing, fishing and swimming purposes.

Pollution Sources

Within the Toms River drainage basin there are four domestic dischargers, two industrial dischargers, four landfills and seven land disposal sites. Land disposal sites are primarily ground percolation areas. Five of the domestic dischargers are outside the Pinelands National Reserve boundary; two of these five are upstream of the boundary (see Appendices 3 and 4).

Water Quality

Nineteen Ocean County water quality sampling stations are located in the Toms River drainage basin (see Appendix 2). Four of these sites are also sampled by the United States Geological Survey (USGS). The two uppermost stations on the main branch of Toms River lie outside of the Pinelands National Reserve boundary.

See USGS Quad Sheets Cassville (3), Lakehurst (4), Whiting (9), Keswick Grove (10) and Toms River (11) for sampling station locations. One station (OCN037) on Davenport Branch is rated as good on the water quality index; 13 stations are rated as slightly disturbed, two as more disturbed and one as most disturbed. The station rated as most disturbed is OCN042 on the Manapaqua Branch at Lakehurst-Ridgeway Road.

The Toms River drainage basin streams are primarily classified as FW-2 and TW-1 based on the proposed revisions to the New Jersey Water Quality Standards (NJDEP, 1979). Only the headwaters of Davenport Branch and Jakes Brook are classified as FW-Central Pine Barrens streams. Since 1976, the FW-Central Pine Barrens' biochemical oxygen demand (BOD) standards (5 mg/l) would have been violated six percent of the time at the Davenport Branch Station (OCN037) and Jakes Brook Station (OCN032); the pH standard (3.5 - 5.5) would have been violated one percent of the time at these two stations. The Jakes Brook station would have violated the fecal coliform standard (200/100 ml) 17 percent of the time and the turbidity standard (20 JTU) 2 percent of the time (see Appendix 5). Both stations have pH values less than 4.8 ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: Table 4 summarizes the characteristics of the Toms River drainage basin. Although many of the upstream areas are relatively undisturbed and have good water quality as evidenced by the Davenport Branch station (OCN037), many of the downstream areas have been impacted by development pressure, and nonpoint and point sources. The station on Manapaqua Branch (OCN042), which is rated as most disturbed, is immediately downstream from a domestic point discharge and a landfill. The watershed at the station is only 5.9 square miles. The good water quality station on Davenport Branch (OCN037) drains 4.7 miles; there are no point or site-specific nonpoint pollution sources. The change from good to disturbed water quality from upper to lower Davenport Branch is not explainable by the land use data or pollution source data. Recent air photos should be inspected.

Critical Issues: The New Jersey Department of Environmental Protection (1978) states that major problems in the Toms River basin can be attributed to extremely rapid population growth and development. Inadequate septic systems, overloaded, antiquated waste treatment plants and substantial stormwater runoff contributions in downstream areas have combined with the natural slow flow of the river to degrade water quality with excessive solids, nutrient loadings, fecal coliform and BOD. Heavy power boat utilization of downstream portions have also degraded water quality.

Major issues within the Toms River Basin include protection of headwater areas and stream stretches above the cranberry bog lakes and impoundments. The domestic point discharge and landfill on Manapaqua Branch should be investigated. The headwaters of Davenport Branch and Wrangle Brook which lie outside state landholdings are most critical.

TABLE 4

I.O. TOMS RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
OCN 031	Toms River Trenton-Cassville Rd.	30.33	7.8	6*	0	0	0	0	0	11	0
OCN 030 (01408260)	Toms River near Van Hiseville	27.69	17.2	8**	2.60	1	0	0	0	21	0
OCN 029	Toms River Lakehurst-Whitesville Rd.	18.52	45.6	6*	1.67	2	1	0	1	8	1
OCN 028 (01408310)	Toms River near Lakehurst	14.60	52.0	6*	1.46	2	1	1	3	7	0
OCN 041	Ridgeway Branch Lakehurst-Whitesville Rd.	3.65	28.7	6*	11.49	1	0	1	0	3	2
OCN 040 (01408492)	Ridgeway Branch Rt. 70 near Lakehurst	---	---	7*	---	1	0	1	0	7	3
OCN 027	Toms River Rt. 571 Manchester-Dover Border	11.75	56.1	7*	1.194	2	1	1	3	20	3
OCN 042	Manapaqua Branch Lakehurst-Ridgeway Rd. Tributary to Union Branch	0.85	5.9	10***	25.40	1	0	1	0	4	1
OCN 039	Union Branch Colonial Drive	4.38	27.2	8**	5.60	1	0	1	1	8	1
OCN 038	Union Branch Brookville Rd.	0.36	---	6*	---	2	0	2	2	5	2

* = Slightly disturbed
** = More disturbed
*** = Most disturbed
**** = Good

TABLE 4 (Continued)

Water Quality Station					Point Source			Nonpoint Source		Land Use	
Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Number of Domestic Dischargers	Number of Industrial Dischargers	Number of Landfills	Number of Land Disposal Sites	Percent Developed	Percent Agricultural
OCN-026	Toms River below confluences of Union and Ridgeway	10.73	124.0	6*	4.41	4	1	3	5	9	1
OCN 025 01408500	Toms River near Toms River	9.58	124.0	6*	4.41	4	1	3	5	54	0
OCN 024	Toms River Lake-hurst Rd.	6.65	---	7*	---	4	1	3	5	60	0
OCN 035	Wrangle Brook off Fort de France Ave.	4.0	---	6*	0	0	1	0	2	9	1.4
OCN 034	Wrangle Brook S. Barbados Dr.	2.02	18.7	7*	0	0	1	1	2	2	0
OCN 037	Davenport Branch Whiting - Lacey Rd.	8.05	4.7	5****	0	0	0	0	0	4	0
OCN 036	Davenport Branch between Holiday City and Dover Rd.	1.26	8.09	8**	0	0	0	0	0	---	---
OCN 033	Wrangle Brook end of Gem Ave.	0.67	---	7*	0	0	1	1	2	2	0
OCN 032	Jakes Brook Double Trouble Rd.	1.42	8.63	6*	0	0	0	0	0	6	0
TOTAL - Toms River Basin			191		4.41	4	2	4	7	19	4

2.0 RANCOCAS RIVER DRAINAGE BASIN

General Description

The Rancocas Creek watershed, which drains 341 square miles entirely within Burlington County, consists of two major branches--the north and south. These originate from many small tributaries in the rural, eastern and central portions of the county. The north branch has a length of 25 miles and a drainage area of 167 square miles; the south branch is 23 miles long and drains an area of 144 square miles The confluence of the two branches is at Hainesport. Tidal influence extends up the main stem to the dam at Mount Holly on the north branch and to Vincentown on the south branch.

North Branch Rancocas: Major tributaries to North Branch Rancocas include McDonalds Branch, Mt. Misery Brook (Greenwood Branch), and Poll Bridge Branch. Major lakes include Mirror Lake, Hanover Lake, Big and Little Pine Lakes and Country Lakes. Town centers include Ewansville, Birmingham, Pemberton, New Lisbon, Browns Mills, Hanover Furnace and Whitesbog. Smithville and Mount Holly lie on the North Branch outside of the Pinelands National Reserve boundary.

South Branch Rancocas: Major tributaries to the South Branch Rancocas include Friendship Creek, Little Creek, Gum Spring, Bear Swamp River, Southwest Rancocas Creek and Masons Creek. Lakes include Centennial Lake, Taunton, Oliphant's Lake and the Medford Lakes. Major town centers include Lake Pine, Medford Lakes, Vincentown, Budd Town, Taunton and Marlton. Vincentown, Eayrestown, Lumberton and Hainesport lie outside the Pinelands National Reserve boundary.

Land Use

Agricultural lands are extensive in the middle portion of the basin. The eastern and southern portions of the basin are essentially forested and occupy 64% of the basin. The remaining 20% is characterized by development in the western and southern portions (see Appendix 1).

North Branch Rancocas: Seventy-eight percent of the North Branch Rancocas drainage basin is forested and contains extensive cranberry bogs. Fort Dix is located within the basin, north of Pemberton. Major state holdings include Lebanon State Forest and the Whitesbog Fish and Wildlife Management Area. A section of the Greenwood Forest Fish and Wildlife Management Area is also in the basin. The majority of the stream headwaters are within state landholdings; the major development belt lies between Pemberton and Hanover Furnace.

South Branch Rancocas: Fifty-six percent of the South Branch Rancocas drainage basin is upland forest; 22% is in agricultural use. The soils in this basin have a finer texture and are more suited to row crops than other Pineland areas. The only state holding within this basin is State Colony and a small section of Lebanon State Forest at Ongs Hat. Development has increased rapidly on the western section of the basin between Marlton, Medford, Medford Lakes and Taunton.

Pollution Sources

North Branch Rancocas: There are 14 domestic dischargers and 3 landfills within the Pinelands National Reserve boundary. Two of the landfills are in the upper headwater regions above Whitesbog; the remainder are concentrated downstream of Browns Mills (see Appendices 3 and 4).

South Branch Rancocas: Two domestic dischargers and two landfills are located upstream of Retreat on South Branch Rancocas Creek. One domestic discharger is located in the Little Creek drainage basin. Two landfills and five domestic dischargers are located in the Southwest Branch Rancocas Creek basin in the vicinity of Marlton, Taunton and Medford.

Water Quality

North Branch Rancocas: Five water quality sampling stations are located on the North Branch Rancocas Creek within the Pinelands National Reserve boundary. An additional station is found downstream at Mount Holly. McDonalds Branch in the headwaters areas of Lebanon State Forest is rated as pristine on the water quality index (see Appendix 2). The station at Ewansville is rated as more disturbed and the remaining three stations are rated as slightly disturbed.

The North Branch Rancocas Creek Basin includes FW-1, FW-2 and FW-Central Pine Barrens streams according to the proposed revisions to the New Jersey Water Quality Standards. The only station within the Central Pine Barrens Water Quality Standards Area is on Greenwood Branch at New Lisbon. Since 1972, the FW-Central Pine Barrens pH standard (3.5 - 5.5) would have been violated 4 percent of the time and fecal coliform (200/100 ml), 17 percent of the time (see Appendix 5). The station has pH values of less than 4.8 ninety percent of the time (see Appendix 6).

South Branch Rancocas: There is only one water quality station on the South Branch Rancocas within the Pinelands National Reserve boundary and three downstream of the boundary. Water quality at Retreat is slightly disturbed based on the water quality index and most disturbed at Hainesport.

The South Branch Rancocas includes FW-Central Pine Barrens streams and FW-2 streams. The water quality station at Retreat is within the FW-Central Pine Barrens Standards Area. Since 1975, pH standards (3.5 - 5.5) would have been violated three percent of the time; fecal coliform standards (200/100 ml), 15 percent; total phosphorus standards (0.23 mg/l-P), 4 percent; suspended solids (40 mg/l), 8 percent; and total dissolved solids (100 mg/l), 3 percent (see Appendix 5).

Drainage Basin Assessment

General: Table 5 summarizes the characteristics of the Rancocas River drainage basin. It can be assumed that the upper areas of the North Branch Rancocas basin have good water quality based on the pristine water quality at McDonalds Branch and the large amount of state-owned property within this basin. Below Browns Mills, however, water quality is degraded by the increase in point discharges and percent development.

The South Branch Rancocas Creek basin has a higher percentage of agricultural land and developed land than the North Branch drainage basin. High phosphorus and suspended solids loads were observed at the water quality station at Retreat; however, the information is not adequate enough to use to predict the exact cause of these violations. Insufficient data exist for the Southwest branch of the Rancocas to assess the development pressures of the Medford area and their impact on water quality. The New Jersey DEP (1970) states that high fecal coliform loads occur on the Southwest Branch just downstream of the Evesham Township, Medford Lakes Borough and the Medford Township municipal sewage treatment plants.

Excessive phosphorus and bacterial levels in the mid-stretches of the North Branch can be attributed to agricultural runoff, malfunctioning septic systems and sewage treatment plants. The two Mount Holly sewage treatment plants and the Pemberton Township Municipal Utility Authority (MUA) treatment plant, which have a combined flow of approximately 3.1 million gallons a day (MGD), are presently being upgraded (NJDEP, 1978). In the South Branch basin, excessive algal growth caused by high phosphorus loads discharged from the Medford Lakes Borough sewage treatment plant should be alleviated with treatment plant upgrading (NJDEP, 1978).

Critical Issues: The upper North Branch basin is well protected by state-owned land; however, the South Branch is more vulnerable. Development pressure from Philadelphia and Camden and the soil suitability for agriculture may have significant impacts on the South Branch basin. Stream stretches above recreational lakes and cranberry bogs should be give high priority.

Point sources, especially those discharging upstream of or into lakes, such as the Medford Lakes Borough plant, should be forced to upgrade and reduce the nutrient loadings.

Recommendations for Future Study: An investigation of the environmental effects on the North Branch basin of the two landfills drained by Poll Bridge Branch should receive high priority. In addition, potential development pressure upstream of Colonial Lake and Mirror Lake should be identified and the possibility of their degrading the lakes' water quality should be determined.

TABLE 5

2.0 - RANCOCAS CREEK DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
2.1 NORTH RANCOCAS											
01465970	North Branch at Browns Mills	---	19.5	7*	3.58	2	0	1	0	40	0
01466500	McDonalds Branch in Lebanon State Forest	--- ---	2.3	5 (pristine)	0	0	0	0	0	0	0
01466900	Greenwood Branch at New Lisbon	---	13.7	7*	0	0	0	2	0	---	---
01467000	North Branch at Pemberton	---	111.0	7*	4.41	8	0	3	0	---	---
01467003	North Branch at Ewansville	---	126.0	8**	24.40	13	1	3	0	17	0
01467006	North Branch on Pine St. at Mt. Holly	---	134.0	7*	22.60	14	1	3	0	---	---
Below station 01467006		---	---	---	---	15	1	3	0	---	---
2.2 SOUTH RANCOCAS											
01465835	South Branch at Retreat	---	44.4	7*	6.46	2	0	2	0	---	---
01465850	South Branch at Vincentown	---	53.3	7*	5.57	3	0	2	0	---	---
01465900	South Branch at Eayerstown	---	76.0	no data	3.91	3	0	2	1	---	---
01465915	South Branch Hainesport	---	156.0	10***	17.94	9	1	5	1	---	---
Below station 01465915		---	---	---	---	9	2	5	1	---	---
TOTAL Rancocas Creek Basin		---	341	---	---	---	---	---	---	28	10

* = Slightly disturbed
** = More disturbed
*** = Most disturbed
**** = Good

3.0 CEDAR CREEK DRAINAGE BASIN

General Description

Cedar Creek is a coastal stream draining directly to Barnegat Bay through Lanoka Harbor. The drainage basin occupies approximately 56 square miles. Major tributaries include Factory Branch, Newbolds Branch, Daniels Branch, Chamberlain Branch and Webbs Mill Branch. Bamber Lake lies just downstream from the confluence of Chamberlain and Webbs Mill branches.

Major town centers include Lanoka Harbor, Double-Trouble, Dover Forge, Camp Columbus, Pinewald and Cedar Crest. Pinewald is outside the Pinelands National Reserve boundary. The entire basin lies within Ocean County.

Land Use

The Cedar Creek drainage basin is relatively undisturbed. Seventy-one percent of the area is upland forest, and 20% is forested wetlands (see Appendix 1). The main agricultural crop is cranberries. The headwaters of Webbs Mill Branch and Chamberlain Branch drain the Greenwood Forest Fish and Wildlife Management area.

Pollution Sources

Two point source dischargers and three nonpoint pollution sources exist in the drainage basin (see Appendices 3 and 4). A landfill site is proposed for a location above Double Trouble Road.

Water Quality

Three Ocean County water quality sampling stations are located in the Cedar Creek drainage basin (see USGS Quad Sheets Keswick Grove (10), Toms River (11) and Forked River (19) for locations). The upper two stations, OCN044 and OCN045, are rated as good on the water quality index. The station furthest downstream (OCN043) is rated as slighly disturbed due to elevated fecal coliform levels. The two upstream sampling stations are not considered pristine due to slightly high BOD levels, which, however, could be due to natural oxygen demands (see Appendix 2).

Cedar Creek drainage basin includes FW-1, FW-Central Pine Barrens and TW-1 classified stream stretches based on the proposed revision to the New Jersey Water Quality Standards (NJDEP, 1979). Since 1976, the FW-Central Pine Barrens BOD and pH standards would have been violated six percent of the time at Water Quality Station OCN045, and pH violated one percent of the time at OCN-44 (see Appendix 5). All three stations have pH values less than 5.4, ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: The Cedar Creek drainage basin contains a large percentage of undisturbed land, a condition which is responsible for the basin's good water quality. Table 6 summarizes the drainage basin characteristics. The existing point and nonpoint sources do not have a major effect on the stream quality, at least at the sampling station locations. Localized impacts may exist.

Critical Issues: Based on the stream quality problems evident in the Toms River and Great Egg Harbor River basins, it will be most critical to protect the headwater areas (small streams in the upper watershed). The drainage basins of Factory Branch, Newbolds Branch, Daniels Branch and the unnamed tributary above Camp Columbus are not presently within federal and state landholdings. The drainage area above Bamber Lake should be protected to preserve the water quality of the lake.

Because Cedar Creek drains directly to Barnegat Bay which has a minimal flushing rate, it is critical to limit nutrient loading so as not to upset the ecological balance of the bay.

Recommendations for Future Study: A study should be conducted to compare the impact of Cedar Creek on Barnegat Bay to the other drainage basins.

TABLE 6

3.0 – CEDAR CREEK DRAINAGE BASIN ASSESSMENT

Water Quality Station					Point Source			Nonpoint Source		Land Use	
Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Number of Domestic Dischargers	Number of Industrial Dischargers	Number of Landfills	Number of Land Disposal Sites	Percent Developed	Percent Agricultural
OCM045 (01408830)	Cedar Creek Whiting-Lacey Road	13.72	20.1	5****	0	0	0	0	1	0.4	1.5
OCM044 (01408870)	Cedar Creek Double Trouble Road	7.26	46.4	5****	0	0	0	1	0	1.6	0.2
OCN043 (01409000)	Cedar Creek Lanoka Harbor	2.18	56.0	6*	0.5	2	0	2	1	11	0

* = Slightly disturbed
** = More disturbed
*** = Most disturbed
**** = Good

4.0 FORKED RIVER DRAINAGE BASIN

The Forked River drainage basin is comprised of four major streams: Forked River, Oyster Creek, Mill Creek and Westecunk Creek. Each of these will be considered as a separate basin.

4.1 Forked River

General Description

The Forked River drainage basin is approximately 20 square miles in size. It contains three major tributaries: North Branch Forked River, Middle Branch and South Branch. Three lakes are found on the North Branch Forked River below the Garden State Parkway: Deerhead Lake, Lake Barnegat and Lower Lake. The area drains directly to Barnegat Bay and is totally within Ocean County. The only major town is Forked River on Route 9.

Land Use

The majority of the watershed (83%) is forested and undeveloped (see Appendix 1). The developed area of the watershed lies east of the Garden State Parkway. Water is withdrawn from the South Branch Forked River for the Oyster Creek power plant.

Pollution Sources

There is one landfill site in the headwaters of the North Branch between Cave Cabin Branch and Long Branch. There is one domestic discharger on the North Branch at Route 9. There are no major pollution sources on the Middle or South branches of the Forked River (see Appendices 3 and 4).

Water Quality

Four Ocean County water quality stations are located in the Forked River drainage basin. A water quality index value was developed for the Middle Branch Forked River station and the two North Branch Forked River stations. The middle and north branches have good and slightly disturbed water quality, respectively (see Appendix 2). The high total dissolved solids reading at Station OCN046 is probably due to tidal influence. pH levels are less than 4.9 ninety percent of the time (see Appendix 6.) See USGS Quad Sheets Brookville (18) and Forked River (19) for station locations.

Drainage Basin Assessment

General: The Middle Branch Forked River basin is almost 100% forested and undisturbed. This condition is reflected in the good water quality monitored at Route 9. Water quality in the South Branch is also probably good. The North Branch water quality is slightly disturbed due to elevated fecal coliform levels. Due to the station locations, it is not possible to assess the relative impact of the upstream landfill, agricultural areas and developed areas (see Table 7 for summary).

Critical Issues: The upper basin west of the Garden State Parkway should be protected, especially because there are three lakes downstream on the North Branch. Development on the relatively steep slopes of the Forked River mountains should be discouraged. Because the Forked River drains directly to Barnegat Bay, an estuary with minimal flushing, nutrient levels should be monitored carefully.

Recommendations for Future Study: The impact of the Forked River system on Barnegat Bay should be compared to the other drainage systems and the localized impact of the landfill should be assessed.

4.2 Oyster Creek

General Description

Oyster Creek is an 11-square-mile area draining directly to Barnegat Bay. The basin is totally within Ocean County. The two major towns within the drainage basin are Brookville and Wells Mills. The mouth of Oyster Creek is located just opposite Barnegat inlet.

Land Use

The majority of the Oyster Creek basin is forested and undisturbed. Six percent of the area is in residential use and seven percent in agriculture (see Appendix 1). There are a few cranberry bogs upstream of Wells Mills Pond. The Oyster Creek power plant is located downstream of Route 9.

Pollution Sources

There are two industrial point sources within the Oyster Creek basin, both near Route 9 (see Appendices 3 and 4).

Water Quality

There are three Ocean County water quality stations and one USGS station within the Oyster Creek basin. See USGS Quad Sheets Brookville (18) and Forked River (19) for their locations. Water quality in areas outside of tidal influence is slightly disturbed based on the water quality index (see Appendix 2). High BOD values were found at Brookville Bog and high fecal coliform values at the Route 532 station. The elevated BOD and fecal coliform levels are probably due to runoff from livestock areas or malfunctioning septic systems. The elevated BOD levels could be due to natural conditions.

The headwaters of Oyster Creek (small streams in the upper area of the basin) are within the FW-Central Pine Barrens Water Quality Standards Area; the remaining creek is in a TW-2 area. Since 1976, the FW-Central Pine Barrens BOD standards (5 mg/l) would have been violated 15 percent of the time; the pH standard (3.5 - 5.5), 3 percent of the time; the turbidity standard (20 JTU), 6 percent of the time and the dissolved solids standard (100 mg/l), 2 percent of the time at Brookville Bog. The BOD and fecal coliform standards would have been violated at the Wells Mills Road station (see Appendix 5). The two uppermost stations in the basin have pH values of less than 4.8 ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: The Oyster Creek drainage basin has slightly disturbed water quality (see Table 7 for summary). High BOD levels are probably due to livestock, malfunctioning septic systems or natural conditions. High fecal coliform levels may be due to livestock or septic system failures.

Critical Issues: The small streams above Wells Mills Pond should be protected.

Recommendations for Future Study: Water quality data collected for the Oyster Creek generating plant should be reviewed and incorporated into the index. In addition, the impact of Oyster Creek on Barnegat Bay should be compared to the other drainage basins.

4.3 Mill Creek

General Description

Mill Creek is a 21-square-mile sub-basin draining directly to Manahawkin Bay. Major tributaries include Eightmile Branch and Fourmile Branch. Manahawkin Lake is at the confluence of Fourmile Branch and Mill Creek. The only major town is Manahawkin.

Land Use

The upper watershed of Mill Creek is forested and relatively undisturbed. Cranberry bogs are found upstream of Manahawkin Lake. Development has spread around the center of the watershed near Manahawkin; the lower watershed is primarily tidal wetlands. There is relatively little agriculture practiced in the watershed (see Appendix 1).

Pollution Sources

One landfill is located on the south side of Mill Creek above Manahawkin, and two domestic dischargers are located below Manahawkin (see Appendices 3 and 4).

Water Quality

Four Ocean County and two USGS water quality stations are located within the Mill Creek basin. The water quality index was developed for three of these stations. Fourmile branch has good quality, and Mill Creek at Route 72 and at Route 180 has slightly disturbed water quality due to elevated BOD and fecal coliform (see Appendix 2).

The headwater areas of Mill Creek are in the FW-Central Pine Barrens Water Quality Standards Area; the remaining sections of Mill Creek and Fourmile Creek are in the TW-2 area. Since 1976, the FW-Central Pine Barrens BOD standards (5 mg/l) would have been violated 21 percent of the time and the pH standard (3.5 - 5.5), 20 percent of the time at the Route 72 station (OCN054) (see Appendix 5). pH at this station is less than 5.8 ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: The major route from Philadelphia to Long Beach Island (Route 72) cuts through the Mill Creek basin. There is high development pressure along this road and in the area surrounding Manahawkin. Due to the lack of data for the area below Manahawkin, it is not possible to assess the impact of the two existing domestic dischargers (see Table 7 for summary).

Critical Issues: To protect the water quality of Manahawkin Lake and the existing cranberry bogs upstream, the small streams in the upper watersheds of Mill Creek, Eightmile Creek and Fourmile Creek should be protected. The wetlands area in the lower part of the basin is currently protected by state laws.

Recommendations for Future Study: The impact of the domestic dischargers should be assessed and the impact and potential impact of the Mill Creek basin on Manahawkin Bay water quality should be compared to the other drainage basins.

4.4 Westecunk Creek

General Description

Westecunk Creek is a 21-square-mile area draining to Little Egg Harbor. All but a very small portion of the basin is located in Ocean County. Major tributaries include Log Swamp Branch, Governors Branch, Uriah Branch and Rail Branch. Major towns include Stafford, Fords, West Creek and Parkerton.

Land Use

Fifty-four percent of the watershed is in upland forest and 14% is forested wetlands (see Appendix 1). Portions of the headwaters of Rail Branch and Log Swamp Branch are within the Bass River State Forest. Additional state landholdings include the Stafford Forge Wildlife Management area.

Pollution Sources

Two landfills are located in the basin below Stafford Forge (see Appendix 3).

Water Quality

There are two Ocean County water quality stations within the Westecunk Basin. The water quality index classifies the water quality at both stations as slightly disturbed because of high fecal coliform levels.

Approximately half of the Westecunk Basin is in the FW-Central Pine Barrens Standards Area. The remaining creek is in the TW-2 area. Since 1976, the water quality station at Martha Road would have had a six percent violation of the New Jersey pH standard (3.5 - 5.5) and a 14 percent violation of fecal coliform standards (200/100 ml). pH levels at the Martha Road station are less than 5.4 ninety percent of the time.

Drainage Basin Assessment

General: Table 7 summarizes the Westecunk Creek data. The elevated fecal coliform levels could be due to livestock areas or to septic system failures. The water quality index does not indicate degradation from the two landfill sites; however, localized impacts should be investigated.

Critical Issues: The small streams in the upper basin of Westecunk Creek should be protected, although protection is not as critical as other watersheds which have lakes downstream.

Recommendations for Future Study: Local water quality impacts downstream from the two landfill sites should be studied and the relative impact of Westecunk Creek on Little Egg Harbor should be studied.

TABLE 7

4.0 - FORKED RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
4.1 FORKED RIVER											
OCN047	North Branch Forked River; dirt road along JCP&L ROW	4.71		6*	0	0	0	1	0	---	---
OCN046	North Branch Forked River at Forked River	2.42	16.4	7*	0.39	1	0	1	0	---	---
OCN048	Middle Branch Forked River at Rt. 9	1.11	---	5****	0	0	0	0	0	---	---
OCN049	South Branch Forked River at Rt. 9	1.62	---	---	0	0	0	0	0	---	---
TOTAL Forked River Basin		---	20	---	---	1	0	1	0	11	7
4.2 OYSTER CREEK											
OCN052	Oyster Creek outflow of Brookville Bog	8.00	2.3	6*	0	0	0	0	0	---	---
OCN051 (01409095)	Oyster Creek at Rt. 532	5.03	7.4	6*	0	0	0	0	0	---	---
OCN050	Oyster Creek at Rt. 9	1.66	---	---	0	0	2	0	0	---	---
TOTAL Oyster Creek Basin		---	11	---	0	0	2	0	0	6	8
4.3 MILL CREEK											
OCN056	Eight Mile Branch at Rt. 72	1.60	---	---	0	0	0	0	0	---	---
OCN054 (01409150)	Mill Creek at Rt. 72	6.53	10.0	6*	0	0	0	1	0	---	---

* = Slightly disturbed
** = More disturbed
*** = Most disturbed
**** = Good

TABLE 7 (Continued)

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
4.3 MILL CREEK (Continued)											
OCN055	Fourmile Branch at Oxycocus-Littleville Mill Rd.	0.17	8.0	5****	0	0	0	0	0	---	---
OCN053	Mill Creek at Rt. 180	4.57	19.8	7*	0	0	0	1	0	---	---
01409210	Mill Creek at Manahawkin	---	20.4	---	0	0	0	1	0	---	---
Discharge Below Last WQS 01409210		---	---	---	---	2	0	1	0	---	---
TOTAL Mill Creek Basin		---	21	---	0	2	0	1	0	21.4	3.5
4.4 WESTECUNK CREEK											
OCN059	Westecunk Creek at Martha Rd.	5.23	15.6	6*	0	0	0	0	0	0.1	1.0
OCN058 (01409282)	Westcunk Creek; Rt. 9 near West Creek	2.89	20.6	6*	0	0	0	2	0	1.5	3.2
TOTAL Westecunk Creek Basin		---	21	---	---	---	---	---	---	1.5	3.2

5.0 MULLICA RIVER DRAINAGE BASIN

General Description

The Mullica River drainage basin is made up of 7 major sub-basins: Bass River, Wading River, Batsto River, Atsion-Mechesactauxin Creek, Nescochaque Creek, Hammonton Creek, and the Lower Mullica River. Each of these will be considered as a separate basin. Table 8 summarizes the data for all seven sub-basins.

5.1 Bass River

General Description

The Bass River basin is a 20-square-mile area draining to the Lower Mullica River. Major tributaries include the East Branch Bass River, West Branch Bass River, Tommy's Branch, Bartlett's Branch, and Job's Creek. The Bass River enters the Mullica at Moss Point. The only major lake in the watershed is Lake Absegami. New Gretna is the only major town. The majority of the basin lies in Burlington County; a small section lies in Ocean County.

Land Use

The Bass River Basin is relatively undisturbed, with over 90% of the area in forested land or nonforested wetland (see Appendix 1). Approximately 1/3 of the basin is included in the Bass River State Forest. The main agricultural crop is cranberries.

Pollution Sources

The only known pollution source within the basin is a landfill below the confluence of the East and West branches of the Bass River (see Appendix 3).

Water Quality

Two USGS water quality sampling stations are located within the Bass River Basin, one on the East Branch and the other on the West Branch near New Gretna. A water quality index was developed for the East Branch station. The East Branch has slightly disturbed water quality at this point due to elevated suspended solids loads. Because of the lack of upstream development, it is assumed that water quality in the West Branch is also good to slightly disturbed.

The Bass River drainage basin upstream of the confluence of the East and West branches is included within the FW-Central Pine Barrens Water Quality Standards Area. The lower section of the basin is classified as TW-1. At the East Branch sampling station, pH values are less than 5.1 ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: The Bass River Basin is a relatively undeveloped basin containing large state land holdings. The water quality index value of slightly disturbed at the East Branch station is probably conservative. The suspended solids 90 percentile concentration was only 0.5 mg/l higher than the 12.5 mg/l cutoff point. The slightly elevated solids load could be attributable to activities at the state recreation area immediately upstream from the sampling station.

Critical Issues: Although there are extensive state land holdings within the basin, the headwaters (small streams in the upper watershed) of the East Branch, West Branch, and Bartlett's Branch of Bass River are not protected. These areas should be given priority protection.

Recommendations for Future Study: This basin would be an ideal study area in which to assess the impacts of recreation on water quality.

5.2 Wading River

General Description

The Wading River Basin is a 176-square-mile area draining directly to the Mullica River. The Wading River enters the Mullica at Collins Point opposite the Port Republic Fish and Wildlife Management Area.

Major tributaries to the main stem Wading River include the West Branch, East Branch (Oswego River), Papoose Branch, Yellow Dam Branch, Plains Branch, Tulpehocken Creek, Shoal Branch, and Beaver Run. Major lakes include Chatsworth, Oswego Lake, Harrisville Pond, Simm Pond, and Decou Pond. A number of unnamed lakes are found upstream of cranberry bogs. Major town centers within the watershed include Chatsworth, Dukes Bridge, Paris Station, Friendship, Jenkins Neck, Martha, Leektown, Harrisville, and Wading River. Major land forms include Apple Pie Hill and Bear Swamp Hill.

Land Use

Seventy-five percent of the watershed is forested upland. Fifteen percent is forested wetland (see Appendix 1). Eighty percent of the Pinelands cranberries are grown within the Wading River Basin; 40% of the blueberry farms are within the basin.

Major landholdings within the basin include ten state forests, and portions of the Wharton Tract, Bass River State Forest, Lebanon State Forest, and the New Jersey Forest Fighters Service.

Pollution Sources

The Wading River Basin has no known point sources or site-specific nonpoint pollution sources.

Water Quality

There are four USGS stations within the Wading River Basin. Two of these stations, West Branch Wading River near Maxwell and the Oswego River at Harrisville, were used for the water quality index. Both of these stations were rated as having slightly disturbed water quality. The West Branch Wading River station exceeded the suspended solids level (40 mg/l) and the Oswego River station exceeded the established fecal coliform level (200/100 ml). Based on the fecal coliform/fecal streptococcus ratio, the bacteria contamination is probably due to livestock or poultry waste.

The Wading River Basin includes FW-1 streams, FW-Central Pine Barrens Water Quality Standards Area, and FW-Lower Mullica and Wading River Standard Streams. At the Oswego River station at Harrisville, the Central Pine Barren standards for BOD (5 mg/l) would have been violated 8% of the time, the fecal coliform standard 11% of the time, and the pH standard (3.5 - 5.5) 12% of the time since 1976.

Drainage Basin Assessment

General: The Wading River Basin has minimal developed land, however; it is used extensively for cranberry and blueberry production. Water quality levels on the West Branch Wading River and the Oswego River are slightly disturbed. The elevated suspended solids and fecal coliform levels are probably due to localized problems.

Critical Issues: It is most important that the water quality of the Wading River and its tributaries be maintained as high as possible. Tributaries in the upper basin which lie outside of state-owned lands are most critical. These headwater streams include Yellow Dam Branch, Plains Branch, Beaver Branch, Ives Branch, Pole Branch, Probst Branch, Goose Pond, and the sections of West Branch Wading River around Chatsworth. Streams above cranberry bogs and lakes must be protected.

Recommendations for Future Study: There are very few long-term water quality sampling stations within the Wading River Basin. Additional stations should be established on the upper basin and in the major lakes. The actual impact of cranberry production on water quality can also be studied in this basin.

5.3 Batsto River

General Description

The Batsto River basin, a major upper basin watershed tributary to the Mullica River, occupies 74 square miles in the Central Pinelands. Major tributaries to the Batsto River include Penn Swamp Branch, Roberts Branch, and Springers Creek. Lakes include Batsto Lake and Indian Mills Lake. Batsto, Pleasant Mills, Quaker Bridge, Hampton Furnace, Indian Mills, Tabernackle and Paisley are major towns.

Land Use

Approximately three-quarters of the Batsto Basin is included in the Wharton Tract. Cranberry production is extensive in the upper tributaries (see Appendix 1).

Pollution Sources

There are two landfill sites within the Batsto River Basin. One is located above the Springers Brook station and the second is located above the Batsto River at Quaker Bridge station. Both landfill sites are located near stream headwaters (see Appendix 3).

Water Quality

There are three USGS stations located within the Batsto River Basin. Based on the water quality index, the Batsto River at Batsto has good river quality. Slightly disturbed water quality is found on Springers Brook near Indian Mills and on the Batsto River at Quaker Bridge. The established fecal coliform level (200/100 ml) was exceeded at these two stations. The total dissolved solids level (100 mg/l) was also exceeded at Springers Brook (see Appendix 2).

According to the NJDEP Proposed Revisions to the State Water Quality Standards, the Batsto River Basin includes FW-1 and FW-Central Pine Barrens Water Quality Standards Area. The three USGS water quality stations are included within the FW-Central Pine Barrens Water Quality Standards Area. Since 1975, the pH standard (3.5 - 5.5) would have been violated 77% of the time at Springers Brook, 18% on the Batsto River at Quaker Bridge, and 22% on the Batsto River in Batsto. The fecal coliform standard (200/100 ml) would have been violated 13% of the time on Springers Brook, 14% on the Batsto River at Quaker Bridge, and 6% of the Batsto River at Batsto. Dissolved solids violations (100 mg/l) would have occurred on Springers Brook and on the Batsto River at Quaker Bridge; total alkalinity violations (10 mg/l) would have occurred on Springers Brook and at the Batsto River at Batsto.

Drainage Basin Assessment

General: The water quality within the Batsto Basin is good to slightly disturbed. An analysis of the fecal coliform/fecal streptococcus ratio shows that the bacterial contamination could be caused by human waste and/or livestock and poultry waste. This latter category includes wild game. The high total dissolved solids levels in Springers Brook could be due to the surrounding agricultural practices. pH and total alkalinity violations indicate the use of lime on field crops or septic systems contamination.

The Batsto River increases in quality downstream. Good quality is found at the Batsto River station at Batsto due to cleansing action as the river passes through bogs and swamp areas.

Critical Issues: The headwater areas (small streams in the upper watershed) of Springers Brook, Indian Mills Brook, and the Batsto River are not currently protected. These areas are particularly vulnerable due to development pressure from the Medford Lakes region. Because the Batsto River is a major tributary to the Mullica River and is often thought of as a "typical Pine Barrens stream," its water quality should be protected.

Recommendations for Future Study: The localized impacts of the two landfills and land disposal sites should be determined, especially because the landfills are upstream of cranberry production areas. The causes of the water quality problems on Springers Brook should also be determined.

5.4 Atsion-Mechesactauxin Creeks

General Description

This 89-square-mile watershed incorporates the headwaters of the Mullica River. Major tributaries to the Mullica include the Mechesactauxin Branch (Sleeper Branch), Clarks Branch, Wildcat Branch, Coopers Branch, and Wesickaman Creek. Atsion Lake and Beaver Dam Lake are the two major water bodies in the basin. Approximately two-thirds of the basin is included within the Wharton Tract.

Major towns include Atsion, Chesilhurst, and Atco. The basin is divided between Burlington, Camden and Atlantic counties.

Land Use

Fourteen percent of the watershed is in cropland and pasture. Eighty percent of the watershed is in upland forest and wetland forested areas (see Appendix 1).

Pollution Sources

There are three landfills, an industrial point source and a land disposal nonpoint source within the basin (see Appendices 3 and 4). The industrial point source is located in Chesilhurst. Three of the landfills are located in the upper section of the watershed.

Water Quality

There are six USGS water quality stations within the Atsion-Mechesactauxin Creek Basin. Water quality ranges from good on the Mullica River near Atco and at the outlet of Atsion Lake to most disturbed on the Wildcat Branch at Chesilhurst. The two other stations--Mullica River at Indian Mills and Mullica River at Pleasant Mills--have slightly disturbed water quality. The most disturbed water quality at Chesilhurst is due to violations of levels of suspended solids, fecal coliform and total dissolved solids (see Appendix 2).

The Atsion-Mechesactauxin watershed is completely contained within the FW-Central Pine Barrens Water Quality Standards Area. Between 1977 and 1978, water quality at the Mullica River station near Atco would have violated the pH (3.5 - 5.5), total phosphorus (0.23 mg/l-P), dissolved solids (100 mg/l), and nitrate nitrogen (2 mg/l-N) standards; the Mullica River station near Indian Mills would have violated the pH and total phosphorus standards (see Appendix 5). The pH, total alkalinity (10 mg/l) and nitrate nitrogen standards would have been violated on the

Mullica River at the outlet of Atsion Lake. Violations of pH, fecal coliform (200/100 ml) and total alkalinity would have occurred on the Mullica River at Pleasant Mills. Water quality on Wildcat Branch at Chesilhurst would have violated the following standards: BOD (5 mgl), pH, fecal coliform, turbidity (20 JTU), suspended solids (40 mg/l), dissolved solids and total alkalinity.

Drainage Basin Assessment

General: Water quality in the Atsion-Mechesactauxin Basin is quite variable. The most disturbed water quality on the Wildcat Branch is probably due to the industrial point source, urban development and surrounding agricultural land. This station is a good illustration of the fragile character of headwater areas. The normal low flows of the small streams are not adequate to assimilate the waste. Water quality at all other stations is either good or slightly disturbed due to elevated suspended solids loads. These loads could be due to natural conditions.

Critical Issues: This drainage basin probably has the greatest potential for being impacted by development. The small streams of the upper basin which are not within the Wharton Tract are very close to the developing centers of Berlin and Atco. These areas are expanding rapidly due to the convenient transportation to Philadelphia via the PATCO High Speed Line. Because the Mullica River is a primary component of the Pine Barrens character, it is imperative to protect the upper reaches.

Recommendations for Future Study: The localized impacts of the landfills and land disposal sites should be studied. The relative impact of the industrial point source, urban development and agricultural land at Chesilhurst should be determined. Water quality of the Mechesactauxin Branch at various distances downstream from Chesilhurst should be determined. This will also show the cleansing ability of swamp and bog areas. Many of the upper watershed stations were only sampled between 1977 and 1978. Additional long-term sampling stations should be established.

5.5 Nescochaque Creek

General Description

The Nescochaque Creek Basin is a 51-square-mile area draining to the Mullica River at Pleasant Mills. Major tributaries to the Nescochaque include Great Swamp Branch, Cedar Branch, Drivers Branch, Blue Anchor

Brook, Albertsons Brook, Gun Branch, Pump Branch, Clark Branch and Price Branch. The major lake within the basin is Nescochaque Lake. Major towns include Braddock, Winslow Junction, and sections of Hammonton.

Land Use

Approximately one-quarter of the basin is included within the Wharton Tract; 36 percent of the area is in agricultural use and 9 percent is residential (see Appendix 1). The basin is located entirely within Camden County.

Pollution Sources

Three industrial point dischargers, one domestic discharger, a landfill site and a land disposal site are located within the Nescochaque Basin (see Appendices 3 and 4).

Water Quality

One USGS water quality sampling station is located within the basin at Pleasant Mills. Water quality at this station is considered slightly disturbed due to elevated suspended solids loads (see Appendix 2). A significant fish kill occurred in Nescochaque Lake in July 1976, attributed to discharge from the Hammonton treatment plant. (Mikulka, 1976).

The total Nescochaque Basin is considered within the FW-Central Pine Barrens Water Quality Standards Area. The median pH value on Nescochaque Creek at Pleasant Mills is 5.9. pH values are less than 6.6 ninety percent of the time (see Appendix 6).

Drainage Basin Assessment

General: Because there is only one water quality station at the very base of the watershed, it is impossible to evaluate any local upstream water quality impact. Water quality at Pleasant Mills is slightly disturbed due to suspended solids concentrations; these elevated levels are probably due to natural conditions.

pH levels are slightly elevated at the Pleasant Mill station, probably because of the soil types within the basin and the percentage of land in agricultural use.

Critical Issues: The headwater areas of Pump Branch, Blue Anchor Branch and Great Swamp Branch are in agricultural areas. The impact to these headwater areas should be determined and appropriate management of nonpoint sources enforced.

The Nescochaque Basin is divided by Route 30 running from Philadelphia through Hammonton. Development pressure is high. Management of the headwater areas of the Nescochaque Basin is critical to the quality of the water in the Mullica River.

Recommendations for Future Study: Water quality stations should be established in the headwater areas to determine the effects of agricultural use on the streams there. The impact of the three industrial dischargers, the domestic discharger and the landfill site on water quality should also be investigated.

5.6 Hammonton Creek

General Description

The Hammonton Creek Basin is a 17-square-mile area draining the City of Hammonton. Hammonton Lake is found in the headwaters directly below the city. Major towns within the watershed include Hammonton, Wescoatville and Nesco. The Hammonton Creek Basin is located in Atlantic County. Hammonton Creek joins Nescochaque Creek at Lake Nescochaque.

Land Use

There are no state landholdings within the Hammonton Creek Basin. Twenty-four percent of the basin is in agricultural use and ten percent is developed land (see Appendix 1).

Pollution Sources

There is one domestic discharger, one industrial point source and a landfill within the Hammonton Creek Basin. The industrial point source is located upstream of Hammonton Lake; the domestic discharger is immediately downstream from the lake (see Appendices 3 and 4).

Water Quality

There are three USGS water quality sampling stations within the Hammonton Creek Basin. Two of the stations bracket the domestic point source, and the third is located downstream from Wescoatville. Water quality is disturbed at the upstream and downstream stations and most disturbed immediately below the domestic point source (see Appendix 2). The poor quality at the Route 30 station (01409412) is due to elevated levels of BOD, suspended solids and fecal coliform. The most disturbed quality at Station 01409414 is due to elevated levels of BOD, suspended solids, fecal coliform and total dissolved solids. More disturbed water quality at Wescoatville (01409416) is due to high levels of total nitrogen, fecal coliform and total dissolved solids. A major fish kill which occurred in Nescochaque Lake in July 1976 was attributed to high BOD loads originating from the Eastern Brewing Corporation and which passed through the Hammonton treatment plant (Mikulka, 1976).

Hammonton Creek is located within the FW-Central Pine Barrens Water Quality Standards Area. Violations of these standards have occurred at all three stations (see Appendix 5). The mean pH value at the upstream station is 7.1, 6.2 below the domestic discharge and 6.1 in the Wescoatville area (see Appendix 6).

Drainage Basin Assessment

General: The Hammonton Creek watershed has poor to very poor water quality because of point sources, urban runoff and agricultural practices. Based on the water quality index and pH values, Hammonton Creek has the worst water quality in the whole Pinelands area. The high nutrient loads can adversely impact Nescochaque Lake, the Mullica River and, finally, Great Bay. The high pH values will alter the acid water-dependent Pinelands aquatic communities.

Critical Issues: Hammonton Creek is a critical issue. A number of studies have been done on this creek that provide good background data (Durand and Zimmer, 1979). Management plans for point source dischargers must be established. The high nutrient levels and high pH levels are especially critical. A policy decision must be made as to whether Hammonton Creek should be restored to a "typical Pinelands stream" with low pH and low nutrient levels or whether higher ph and nutrient levels may be permitted. Management controls on the surrounding agricultural lands will have to be very strict if the pH and nutrient loads are to be significantly reduced.

Recommendations for Future Study: Rutgers University and the NJDEP have established extensive sampling programs on the Hammonton Creek. These programs should be continued. The impact of upstream land uses on Nescochaque Lake should be investigated. A study should be made to predict the water quality level of Hammonton Creek if the point sources are upgraded, but agricultural practices remain the same.

High nutrient loads originating in Hammonton Creek may be affecting the nutrient balance of Great Bay. If other tributaries of the Mullica (Atsion-Meschesactauxin Creeks and Nescochaque Creek) are modified by development and agricultural expansion similar to Hammonton Creek, Great Bay may be severely impacted.

5.7 Mullica River

General Description

This basin includes all land from Pleasant Mills to Great Bay that drain directly to the Mullica River. The land on the north side of the river is in Burlington County and primarily consists of the Wharton Tract. The land on the south side of the river is in Atlantic County and has minimal state landholdings. Extensive swamp lands exist on the south side of the Mullica River.

The only tributaries within this basin are Newton Creek, Landing Creek, Teal Creek and Indian Cabin Creek. Major towns include Egg Harbor City, Green Bank, Sweetwater, Crowleytown, Furman and Weekstown.

Land Use

This 97.5-square-mile basin is primarily an oakland forest and forest wetland. Five percent of the area is in agricultural use and two percent has been developed (see Appendix 1).

Pollution Sources

There are three point sources and seven site-specific nonpoint sources within the Lower Mullica Basin (see Appendices 3 and 4). Counting all of the upstream drainage area, there are four domestic dischargers, eight industrial dischargers, fourteen landfills and one land disposal site, all of which can potentially impact this section of the Mullica River.

Water Quality

One USGS water quality station is located within this basin at Green Bank. Due to tidal influence, a water quality index was not established.

This basin includes FW-1, FW-Central Pine Barrens Water Quality Standards Area, and FW-Lower Mullica and Wading Rivers Water Quality Standards Area. The Lower Mullica and Wading River Stream Standards Area includes the Mullica River and tidal portions of its tributaries from the head of tide to Lower Bank Road bridge at Lower Bank.

Drainage Basin Assessment

General: This area of the Mullica River Basin is affected by drainage from the upper tributaries and the tidal influence from Great Bay. Due to lack of data, the impact of direct drainage to this section of the Mullica cannot be determined.

Critical Issues: The Atlantic County portion of the basin is more critical than the Burlington County portion because there is more land area, more development and more agricultural land in the former. Within the total Mullica River Basin, the Lower Mullica is not as critical as the upper tributaries because the assimilative capacity of the Lower Mullica is greater than the upper tributaries and the impact will not be as significant.

The total Mullica River Basin should be a central issue in the Pinelands plan. The river drains a significant section of the National Preserve and is commonly considered as a "typical Pine Barrens river." If the upper reaches are altered by development and agricultural practices, the entire river and estuarine system will feel the impacts.

TABLE 8

6.0 - MULLICA RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
5.1 BASS RIVER											
01410150	East Branch Bass River near New Gretna	---	8.1	6*	0	0	0	0	0	---	---
01410200	West Branch Bass River near New Gretna	---	6.6	no data	0	0	0	0	0	---	---
Below Last WQS 01410200		---	---	---	---	0	0	1	0	---	---
TOTAL Bass River Basin		---	20.0	---	0	0	0	1	0	3.7	0.1
5.2 WADING RIVER											
01409810	West Branch Wading River near Jenkins	---	84.0	no data		0	0	0	0	---	---
01409815	West Branch Wading River near Maxwell	---	85.9	6*		0	0	0	0	---	---
01410000	Oswego River (East Branch Wading River) at Harrisville	---	64.0	6*		0	0	0	0	---	---
01410070	Wading River at Wading River	---	176.0	no data		0	0	0	0	---	---
TOTAL Wading River Basin		---	176.0	---	0	0	0	0	0	2.0	6.1

* = Slightly disturbed
** = More disturbed
*** = Most disturbed
**** = Good

TABLE 8 (Continued)

Water Quality Station Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
5.3 BATSTO RIVER											
01409450	Springers Brook near Indian Mills	---	12.6	7*	0	0	0	1	0	5.5	44.1
01409470	Batsto River at Quaker Bridge	---	55.7	6*	0	0	0	2	0	---	---
01409500	Batsto River at Batsto	---	70.5	5****	0	0	0	2	0	---	---
TOTAL Batsto River Basin		---	74.0	---	0	0	0	2	0	1.0	18.0
5.4 ATSION-MECHESACTAUXIN CREEKS											
01409375	Mullica River near Atco	---	3.2	5****	0	0	0	0	0	22.0	26.0
01409383	Mullica River at Jackson Rd. near Indian Mills	---	16.8	6*	0	0	0	0	0	---	---
01409387	Mullica River at outlet of Atsion Lake	---	26.7	5****	0	0	0	1	0	---	---
01409400	Mullica River near Batsto	---	64.4	no data	0	0	0	2	0	---	---
01409403	Wild Cat Branch at Chesilhurst	---	1.0	10***	0	0	1	1	1	22.0	23.0
3938250-4393500	Mullica River at Pleasant Mills	---	127.0	6*	0	0	1	3	1	4.0	15.0
TOTAL Atsion-Mechesactauxin Creeks Basin		---	89	---	0	0	1	3	1	4.0	5.0
5.5 NESCOCHAQUE CREEK											
01409411	Nescochaque at Pleasant Mills	---	43.8	6*	5.25	1	3	1	1	9.0	36.0
TOTAL Nescochaque Creek Basin		---	51	---	---	1	3	1	1	9.0	36.0

TABLE 8 (Continued)

Water Quality Station					Point Source			Nonpoint Source		Land Use	
Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Number of Domestic Dischargers	Number of Industrial Dischargers	Number of Landfills	Number of Land Disposal Sites	Percent Developed	Percent Agricultural
5.6 HAMMONTON CREEK											
01409412	Hammonton Creek Rt. 30 at Hammonton	---	2.5	8**	0	0	1	0	0	---	---
01409414	Hammonton Creek at Hammonton	---	2.7	11****	270.37	1	1	0	0	---	---
01409416	Hammonton Creek at Wescoatville	---	9.6	9**	76.04	1	1	0	0	13.0	48.0
Below Station 01409416		---	---	---	---	1	1	1	0	---	---
TOTAL Hammonton Creek Basin		---	17.0	---	---	1	1	1	0	10.0	24.0
5.7 MULLICA RIVER											
01409535	Mullica River at Green Bank (tidal)	---	243.0	tidal	6.66	3	7	10	0	---	---
Below station 01409535		---	---	---	---	4	8	14	1	---	---
TOTAL Mullica River Basin		---	517.0	---	---	4	8	14	1	3.0	13.0

6.0 GREAT EGG HARBOR RIVER DRAINAGE BASIN

The Great Egg Harbor River is divided into upper and lower sections at Mays Landing. These two areas will be considered as separate basins. Table 9 summarizes the data for the two sub-basins.

6.1 Great Egg Harbor River (Upper)

General Description

The Upper Great Egg Harbor River Basin covers 205 square miles. Major tributaries include Squankum Branch, Hospitality Branch, Whitehall Branch, White Oak Branch, Marsh Lake Branch, Deep Run, Mare Run, Penny Pot Stream, and Big Bridge Branch. Major lakes within the Upper Great Egg Harbor River Basin include Lake Lenape, Lake Peace, Collings Lake, Cedar Lake, Victory Lakes, Sunset Lake, Diamond Lake, Timber Lake, New Brooklyn Lake, Penbrin Lake, and New Freedom Lake.

Major towns include Weymouth, Buena, Williamstown, and sections of Hammonton. Berlin lies within the basin but outside of the Pinelands National Preserve boundary. The basin lies within Atlantic County, Gloucester County, and Camden County.

Land Use

Twenty-one percent of the Upper Great Egg Harbor River Basin is in cropland or pasture. There are extensive areas of row crops and orchards between Hammonton and Williamstown. Development pressure is strongest in the upper reaches of the basin near Berlin and around Hammonton. The Atlantic City Expressway, the White Horse Pike, and the Pennsylvania-Reading Seashore Railroad line run within the basin between Hammonton and Egg Harbor City. Fifty-two percent of the basin remains in forested land (see Appendix 1).

Pollution Sources

There are four domestic dischargers, two industrial dischargers, six landfills, and two land disposal sites within the Upper Great Egg Harbor River Basin. One domestic discharger and one landfill lie outside of the Pinelands boundary (see Appendices 3 and 4).

Water Quality

There are 13 USGS water quality sampling stations within the Upper Great Egg Harbor River Basin (see Appendix 2). Water quality varies from good to most disturbed. The three stations listed as most disturbed are located below Berlin Township, at the outlet of New Brooklyn Lake, and in the headwaters of Squankum Branch. Water Quality Station 01410775 at Berlin exhibited minor violations of BOD and total nitrogen and high violations of suspended solids, fecal coliform, and total dissolved solids, resulting in an index value of 12. The tributary at Sicklersville contained high levels of nitrogen, suspended solids, fecal coliform, and total dissolved solids, giving it an index value of 10. The Squankum Branch station exhibited elevated levels of all five parameters, resulting in a water quality index value of 14.

Median pH values are relatively high in the Upper Great Egg Harbor River Basin. Only Deep Run at Weymouth and the Great Egg Harbor River at Weymouth exhibited median pH values less than 5.0 (see Appendix 6).

Drainage Basin Assessment

General: Water quality in the Upper Great Egg Harbor River Basin is impacted by point sources, malfunctioning septic systems, and agricultural runoff. pH values are generally higher than other areas of the Pinelands due to agricultural liming practices and pollution sources. At this time, it is not possible to estimate the relative significance of the soil characteristics on pH levels. The Camden County Soil Survey lists all soils in the county having pH levels less than 5.0 (SCS, 1966). The water quality level improves and the pH level drops as one proceeds downstream in the Great Egg Harbor Basin. This is due to dilution effects, reduction of point sources, and less developed agricultural land in the area between Penny Pot and Mays Landing.

Critical Issues: Many sections of the Upper Great Egg Harbor River Basin have been impacted by development and agricultural practices. Water quality in these areas differs significantly from that of a "typical" Pinelands stream such as those found in the Wading River Basin. Strict control of agricultural liming and fertilization practices, rehabilitation of malfunctioning septic systems, and control of point sources may significantly improve the water quality of the Great Egg Harbor River Basin.

Because there is a major impoundment, Lake Lenape, at Mays Landing, nutrient levels in the upper reaches of the Great Egg Harbor Basin should be strictly controlled.

Recommendations for Future Study: A study should be conducted in the Upper Great Egg Harbor River Basin to determine the importance of soil type on pH levels. Deep Run--which has two point sources within its watershed, a lake, and significant areas of wetlands--would be an excellent area in which to study the renovation effects of wetlands on water quality.

6.2 Great Egg Harbor River (Lower)

General Description

The Lower Great Egg Harbor River Basin encompasses a 99-square-mile area between Mays Landing and Great Egg Bay. The Great Egg Harbor River is tidal for this entire stretch. Major tributaries include Babcock Creek, Jack Pudding Brook, Gravely Run, Miry Run, English Creek, Middle River, Gibson Creek, Stevens Creek, James Branch, and South River.

The entire lower basin of the Great Egg Harbor River is located within Atlantic County. Major towns include Mays Landing, Gravely Run, Estellville, and Oakville.

Land Use

The majority of the Lower Great Egg Harbor River Basin is in a natural state. Only six percent is in agriculture and five percent is developed (see Appendix 1). There is a state fish and game preserve along the lower south shore of the river.

Pollution Sources

There are three domestic dischargers, one industrial discharger, and three landfills within the Lower Great Egg Harbor River Basin. Three of the point sources are located in the Babcock Creek watershed and one is located on Gravely Run (see Appendices 3 and 4). The Atlantic City Racetrack is located within this basin.

Water Quality

There is one USGS water quality station on Babcock Creek at Route 322 and one station on Great Egg Harbor River at Mays Landing. The Mays Landing station is tidal so no water quality index was developed. Water quality on Babcock Creek is slightly disturbed due to elevated levels of suspended solids and fecal coliform (see Appendix 2). Median pH levels at these two stations range between 5.0 and 6.0 (see Appendix 6).

Drainage Basin Assessment

General: Because the Great Egg Harbor River is tidal in this basin and the two water quality stations are located in the upper sections of the basin, it is difficult to determine the actual water quality levels. Because water quality levels are only slightly disturbed at Mays Landing, it is assumed that the lower stretches of the river are also minimally disturbed.

Critical Issues: Future land use changes will probably have the most effect on Babcock Creek and Gravely Run due to their proximity to Egg Harbor City, the Pennsylvania-Reading Seashore Railroad line, and the Atlantic City Racetrack. Due to higher flow levels in the Lower Great Egg Harbor River, this basin will be less impacted by increased development than small tributaries located further upstream. The salt marshes should be protected and water quality maintained at a high enough level so as not to impact Great Egg Bay.

Recommendations for Future Study: Babcock Creek and Gravely Run have extensive areas of wetlands within their basin. These would also be good areas in which to study water quality renovation by wetlands.

TABLE 9

6.0 - UPPER GREAT EGG HARBOR RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
6.1 UPPER GREAT EGG HARBOR RIVER											
01410775	GEHR at Berlin	---	1.98	12***	0	0	0	0	0	---	---
01410784	GEHR near Sicklersville	---	15.1	8**	53.0	1	0	1	0	---	---
01410787	GEHR tributary on Blackwood-New Brooklyn Rd.	---	1.6	9**	0	0	0	0	0	0	45.0
3942030 4562901	GEHR, West outlet; Brooklyn Lake	---	22.8	7*	35.1	1	1	1	1	---	---
01410803	Fourmile Branch at Winslow Crossing	---	6.2	6*	0	0	0	0	0	---	---
01410810	Fourmile Branch at New Brooklyn	---	7.4	7*	0	0	0	0	0	---	---
01410820	GEHR near Broad Lane (near Blue Anchor)	---	37.3	6*	21.4	1	1	1	0	---	---
01410865	Squankum Br. at Malaga Rd.	---	3.0	12***	0	0	0	0	0	29.0	42.0
01411000	GEHR at Folsom	---	56.3	7*	14.2	1	1	2	1	3.0	9.6
01411053	Hospitality Branch at Berryland	---	20.0	6*	0	0	0	0	0	16.0	20.3
01411110	GEHR at Weymouth	---	154.0	7*	5.4	2	1	5	2	6.3	22.0
01411140	Deep Run Branch at Weymouth	---	20.0	5****	14.0	1	0	1	1	3.2	11.6

* = Slightly disturbed

** = More disturbed

*** = Most disturbed

**** = Good

TABLE 9 (Continued)

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
6.2 LOWER GREAT EGG HARBOR RIVER											
01411196	Babcock Creek at Rt. 322 near Mays Landing	---	16.3	7*	1.2	1	1	0	0	---	---
0141170	GEHR at Mays Landing	---	205.0	tidal	5.5	24	2	6	2	---	---
Below 0141170	GEHR at Mays Landing	---	---	---	---	7	3	9	2	---	---
TOTAL Great Egg Harbor River Basins		---	304.0	---	---	7	3	9	2	6.0	17.0

7.0 MAURICE RIVER DRAINAGE BASIN

General Description

Approximately two-thirds of the Manamuskin Creek watershed and approximately one-half of the Lower Maurice River Basin lie within the Pinelands boundary. Twenty-two square miles of the 32-square-mile Manumuskin Creek Basin lie within the Pinelands boundary, 28 square miles of the Lower Maurice River Basin are also contained within the boundary. Major tributaries to the Manamuskin Creek include Bearshead Branch, Lawrens Branch, and Cossa Boones Branch. Cumberland Lake is the only major impoundment. Muskee Creek is the only major tributary to the Lower Maurice River.

Major towns include East Vineland, Cumberland, Hesstown, Port Elizabeth, Bricks Borough, and Maurice Town. The majority of the basin lies within Cumberland County; only a small section of the Manamuskin Creek Basin lies in Atlantic County.

Land Use

A large percent of the Maurice Basin within the Pinelands boundary is in natural vegetation. State landholdings include the Peaslee Fish and Game Area and the Cadwald Fish and Game Area.

Pollution Sources

There is one industrial discharger in the Manamuskin River Basin and three landfill sites within the Lower Maurice River Basin (see Appendices 3 and 4).

Water Quality

USGS Water Quality Station 01412100 is located on the Manamuskin River near Manamuskin. This is one of the two stations rated as pristine by the water quality index within the Pinelands area (see Appendix 2). Median pH levels at this station range between 4.5 and 5.0 (see Appendix 6).

Drainage Basin Assessment

General: Table 10 summarizes the Maurice River data. Although there are little data on the water quality of the Maurice River Basin, the one station on the Manamuskin River is rated as pristine. Efforts should be made to protect the Manamuskin River Basin.

Critical Issues: The small streams tributary to Manamuskin Creek, which include Sharps Branch, Ingersall Branch, Big Neal Branch, Cedar Branch, Bearshead Branch, Cossa Boones Branch, Sweeten Water, Shincopin Branch, White Oak Branch, and Lawrens Branch, should be protected. These tributaries affect the water quality of Cumberland Lake and the Manamuskin River.

Recommendations for Future Study: The water quality of the Lower Maurice River should be determined. Additional sampling stations should be established on Manamuskin Creek and the Maurice River. Studies should be done to determine how soils in the Maurice River Basin compare with those of the Central Pinelands area of the Mullica or Rancocas basins. The relative impact of the Maurice Basin on the aquatic biota of Delaware Bay should be researched so that the effects of water quality changes can be predicted.

TABLE 10

7.0 - MAURICE RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
7.1 MANUMUSKIN RIVER											
01412100	Manumuskin River near Manumuskin	---	32.1	6 (pristine)	0	0	1	0	0	2.4	6.7
7.2 MAURICE RIVER											
Below Water Quality Station 0141200		---	---	---	0	0	0	3	0	---	---

* = Slightly disturbed

** = More disturbed

*** = Most disturbed

**** = Good

8.0 ABSECON CREEK DRAINAGE BASIN

General Description

The Absecon Creek watershed is an 18.5-square-mile area that drains to Absecon Bay. Absecon Creek has a north and south branch which join to form the Atlantic City Reservoir. The basin is located within Atlantic County.

Land Use

The NAFEC Atlantic City Airport is located within the Absecon Basin. Over 50% of the watershed is urbanized (see Appendix 1).

Pollution Sources

There are two landfills within the Absecon River Basin, both located in the North Branch drainage area (see Appendix 3).

Water Quality

There are no water quality stations with significant periods of record within the Absecon Creek basin. Water quality levels are unknown.

Drainage Basin Assessment

General: The Absecon Creek Basin currently has a high percentage of developed land and will be under increasing development pressure due to growth in and around Atlantic City. Table 11 summarizes the Absecon Creek data.

Critical Issues: The Atlantic City Reservoir is used as a public drinking water source. Water quality upstream of these reservoirs should be protected. Water quality levels should be maintained to protect Absecon Bay.

Recommendations for Future Study: Sampling stations should be established upstream of the Atlantic City Reservoir, in the reservoir, and in the coastal areas of the basin.

TABLE 11

8.0 - ABSECON CREEK DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
TOTAL	Absecon Creek Basin	---	19	---	0	0	0	2	0	61	2

9.0 TUCKAHOE RIVER DRAINAGE BASIN

General Description

The Tuckahoe River Basin is a 70-square-mile area draining to Great Egg Bay. It is a long, fairly narrow drainage basin running from Mill May to Beesley Point. Major towns include Mill May, Dorothy, Estell Manor, Buck Hill, Marshallville, Steelman Town, and Tuckahoe. The Tuckahoe River forms the boundary line between Atlantic and Cape May counties. Major tributaries to the Tuckahoe River include Sharps Branch, Greens Branch, Pole Bridge Branch, McNeals Branch, Warners Mill, Tar Kiln Brook, Cedar Swamp Creek, and Hughes Creek. A few lakes are located in the vicinity of Hunters Mill and in the stretch between Steelman Town and Marshallville.

Land Use

The watershed has only three percent developed land and five percent agricultural land; the remainder is undisturbed (see Appendix 1). A state fish and game preserve borders either side of the river below Tuckahoe.

Pollution Sources

There are two industrial dischargers and three landfills within the Tuckahoe River Basin. One landfill is located in the Pole Bridge Branch Basin, the other is located near Woodbine Borough in the headwaters of Cedar Swamp Creek. An industrial discharger is located on Tar Kiln Brook (see Appendices 3 and 4).

Water Quality

There are two USGS water quality monitoring stations within the Tuckahoe River Basin. Station 1411290 near Estell Manor has good water quality and Station 1411300 at head of river on State Road 49 has slightly disturbed water quality due to elevated levels of suspended solids and fecal coliform (see Appendix 2).

Drainage Basin Assessment

General: Table 12 summarizes the Tuckahoe River data. The upper reaches of the Tuckahoe Basin have good water quality because of the large amount of natural vegetation remaining in the basin. The slightly degraded water quality at Head of River could be due to the nearby industrial discharger or to malfunctioning septic systems. Tuckahoe

River, below Head of River, is tidal and little is known of existing water quality levels. Due to the lack of development or agricultural land, it is assumed that water quality will be good to slightly disturbed.

Critical Issues: The small streams tributary to the Tuckahoe River that are not located within the Peaslee Fish and Game Area should be protected to maintain water quality at Estell Manor.

Recommendations for Future Study: Studies should be done to determine the existing water quality of Great Egg Bay and the relative influence of the Tuckahoe River and Great Egg Harbor River on the bay.

TABLE 12

9.0 - TUCKAHOE RIVER DRAINAGE BASIN ASSESSMENT

Water Quality Station					Point Source			Nonpoint Source		Land Use	
Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Number of Domestic Dischargers	Number of Industrial Dischargers	Number of Landfills	Number of Land Disposal Sites	Percent Developed	Percent Agricultural
1411290	Tuckahoe River near Estell Manor	---	8.8	5****	0	0	0	0	0	8.2	9.6
1411300	Tuckahoe River at Head of River, State Route 49	---	30.8	7*	0	0	1	1	0	---	---
Below Station 1411300		---	---	---	0	0	2	3	0	---	---
TOTAL Tuckahoe River Basin		---	70	---	---	---	---	---	---	3	5

* - Slightly disturbed

** - More disturbed

*** - Most disturbed

**** - Good

10.0 DENNIS CREEK DRAINAGE BASIN

General Description

Dennis Creek is a 72-square-mile area which includes the drainage of Dennis Creek, West Creek, Wiggens Ditch, and Goshen Creek. The basin is located in Cape May and Cumberland counties.

Land Use

Major state landholdings include the Belleplain State Forest, the Dennis Creek Fish and Game Area, and the Beaver Swamp Fish and Game Area. Woodbine Municipal Airport is included within the basin. Major towns include Belleplain, Woodbine, Mount Pleasant, Cedar Grove, Dennisville, South Dennis, North Dennis, Eldora, and Goshen. The majority of the watershed is in natural vegetation (see Appendix 1).

Pollution Sources

There is one domestic discharger and three landfills within the Dennis Creek River Basin. The domestic discharger is located upstream of Dennisville Lake (see Appendices 3 and 4).

Water Quality

No Dennis Creek water quality stations were included in the water quality index.

Drainage Basin Assessment

General: Table 13 summarizes the Dennis Creek data. Little is known of the water quality conditions within the Dennis Creek Basin. It is assumed that with the state landholdings and low percentage of development, water quality is fairly good. Because the creeks drain directly to the Delaware Bay instead of to smaller, more enclosed bays, water quality conditions are less critical to the estuary.

Critical Issues: No critical issues can be identified at this time due to lack of data.

Recommendations for Future Study: Minimally, water quality stations should be established on Dennis Creek and West Creek. The quality and renovation capabilities of the cedar swamps and salt marshes should be determined.

TABLE 13

10.0 - DENNIS CREEK DRAINAGE BASIN ASSESSMENT

Water Quality Station		River	Drainage	W.Q.	Point Source			Nonpoint Source		Land Use	
Number	Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Number of Domestic Dischargers	Number of Industrial Dischargers	Number of Landfills	Number of Land Disposal Sites	Percent Developed	Percent Agricultural
TOTAL	Dennis Creek Basin	---	72	---	0	1	0	3	0	3	13

11.0 PATCONG CREEK DRAINAGE BASIN

General Description

The Patcong Creek Basin is a 26-square-mile area located near the coast between Absecon Creek and Great Egg Harbor River. Patcong Creek drains to Great Egg Bay; major tributaries include Blackmans Branch and Little Meadow Run. Patcong Lake is located upstream of Northfield. Major towns include Northfield, Cardiff, and Pleasantville. The basin is located within Atlantic County.

Land Use

Forty-three percent of the watershed is developed and three percent is in agricultural use (see Appendix 1). The Northfield branch of the Pennsylvania-Reading Seashore Railroad line crosses the river basin as does the Black Horse Pike (Route 322), the Garden State Parkway, and Route 9. The majority of developed land lies along the coastal areas.

Pollution Sources

There is one domestic discharger located within the Patcong Creek Basin (see Appendix 3).

Water Quality

There are no water quality monitoring stations in the Patcong Creek Basin.

Drainage Basin Assessment

General: Table 14 summarizes the Patcong Creek data. Little is known of the water quality within the Patcong Creek Basin. Due to the high percentage of development in the basin, it is expected to be relatively disturbed. Development pressure within this basin will increase due to its proximity to Atlantic City and the major road intersections.

Critical Issues: The tributaries above Patcong Lake should be protected.

Recommendations for Future Study: Sampling stations should be established within this basin to determine the existing water quality of Patcong Lake and the impact of the domestic discharger on the water quality.

TABLE 14

11.0 - PATCONG CREEK DRAINAGE BASIN ASSESSMENT

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (sq.mi.)	W.Q. Index	Point Source: Quantity of Domestic Discharge (1000 gal/day/sq.mi.)	Point Source: Number of Domestic Dischargers	Point Source: Number of Industrial Dischargers	Nonpoint Source: Number of Landfills	Nonpoint Source: Number of Land Disposal Sites	Land Use: Percent Developed	Land Use: Percent Agricultural
TOTAL	Patcong Creek Basin	---	26	---	---	1	0	0	0	43	3

CONCLUSION

The following general conclusions can be drawn from the sub-basin water quality analysis:

1. The majority of monitored streams have good to slightly disturbed water quality.

2. The two streams rated as pristine on the water quality index are McDonalds Branch (North Branch Rancocas Creek) and Manumuskin Creek (Maurice River).

3. Stream stretches with pristine or good water quality generally drain natural areas that have few point sources or site-specific nonpoint sources.

4. Streams with the most disturbed water quality are:

   - Hammonton Creek at Hammonton
   - Wildcat Branch (Atsion-Mechesactauxin Creeks)
   - Manapaqua Branch (Toms River)
   - South Branch Rancocas-Hainesport (Rancocas Creek)
   - Great Egg Harbor River at Berlin
   - Tributary No. 2 at Sicklersville (Great Egg Harbor River)
   - Squankum Branch (Great Egg Harbor River)

5. Small tributary streams have either very good or very poor water quality, depending on surrounding land use. These streams with low flow levels cannot assimilate wastes as well as larger streams with higher flow levels.

6. The Great Egg Harbor River basin which could be characterized as having disturbed water quality separates two areas with good to pristine water quality--the Central Pines (Mullica River, upper North Rancocas) and the Lower Pines (Manumuskin, upper Tuckahoe).

7. There is a relatively consistent inverse relationship between pH and general water quality conditions (see Figures 1 and 2). Areas exhibiting higher pHs generally have lower water quality. In many cases, high pH waters

were found to be downstream from point sources or agricultural areas. This is an important conclusion because the pH of Pinelands surface waters is unique, being much lower than natural pHs found elsewhere in the country. Indigenous aquatic biota have adopted to these low pH levels; any man-made pH changes will have an adverse effect on these aquatic resources.

8. Estuaries with minimal flushing capabilities and small areas of exchange with the ocean will be affected most by upland drainage. Enclosed estuaries potentially impacted by Pinelands drainage areas are:

   - Barnegat Bay
   - Manahawkin Bay
   - Great Bay
   - Great Egg Harbor Bay
   - Little Egg Harbor
   - Absecon Bay

REFERENCES

Durand, James and Bonnie Zimmer. Pinelands Study - Surface Water Quality, Rutgers University, Camden Campus, 1979.

Mikulka, Joseph. A Report on the Fishkill in Lake Nescochaque and Hammonton Creek on or about July 17 and 18, 1976, New Jersey Department of Environmental Protection - Division of Water Resources, 1976.

New Jersey Department of Environmental Protection - Division of Water Resources. New Jersey 1977 State Water Quality Inventory - Report to Congress through U.S. EPA, 1978.

Soil Conservation Service. Soil Survey Camden County, New Jersey, U.S. Department of Agriculture, 1966.

APPENDIX 1

PERCENT LAND USE

TABLE 1-1

PERCENT LAND USE

Watershed	Size (sq miles)	Residential	Commercial/ Industrial	Mixed Urban	Agriculture: Cropland/ Pasture	Agriculture: Orchard/ Horticulture	Forested Land	Water	Wetlands: Forested	Wetlands: Non-Forested	Strip Mine Quarries Gravel Pits
Toms River*	132	6.0	15.0	2.0	2.0	0.6	62.0	0.6	17.0	0	4.0
Toms River**	159	2.0	0.5	8.0	8.0	0.7	74.0	0	6.0	0	2.0
N. Rancocas Creek	167	17.0	31.0	0	0	0	78.0	1.0	3.0	0	0
S. Rancocas Creek	144	8.0	0.6	1.0	20.0	2.0	56.0	2.0	10.0	0	0.3
Cedar Creek	56	4.0	1.0	0.3	0.4	0.5	71.0	1.0	20.0	0.6	2.0
Forked River	20	11.0	0	0	6.0	1.0	65.0	1.0	13.0	2.0	0.1
Oyster Creek	11	6.0	0	0	7.0	1.0	67.0	1.0	15.0	2.0	1.0
Mill Creek	21	7.0	0.4	14.0	3.0	0.5	54.0	0.2	14.0	4.0	3.0
Westecunk Creek	21	1.0	0.5	0	0.2	3.0	84.0	0	8.0	0	3.0
Bass River	20	3.0	0.7	0	0	0.1	63.0	2.0	0	31.0	0
Wading River	176	1.0	1.0	0	0.1	6.0	75.0	0.1	15.0	1.0	0.2
Batsto River	74	1.0	0	0	15.0	3.0	70.0	0.3	11.0	0	0
Atsion-Mechesactauxin Creeks	89	3.0	0.2	1.0	14.0	1.0	56.0	0.2	24.0	0	0
Nescochaque Creek	42	5.0	0.3	0	40	2.0	37.0	0.4	6.0	0	0.1
Hammonton Creek	18	8.0	2.0	0	22.0	2.0	52.0	1.0	15.0	0	0
Mullica River	98	1.0	0	0.7	5.0	0.6	68.0	3.0	15.0	5.0	0
Upper Great Egg Harbor River	205	4.0	0.3	2.0	21.0	1.0	52.0	1.0	18.0	0.1	1.0
Lower Great Egg Harbor River	99	3.0	1.0	1.0	5.0	1.0	64.0	3.0	10.0	12.0	0.1
Manumuskin Creek*	22	2.0	0	3.0	6.0	0	76.0	1.0	10.0	0.4	0.2
Manumuskin Creek***	32	1.0	0	2.0	12.0	0	73.0	1.0	9.0	1.0	1.0
Maurice River*	28	2.0	0	4.0	5.0	0	65.0	5.0	8.0	18.0	3.0
Absecon Creek	19	22.0	18.0	21.0	2.0	0	27.0	1.0	4.0	2.0	3.0
Tuckahoe River	70	2.0	0.1	1.0	5.0	0	56.0	2.0	18.0	12.0	3.0
Dennis Creek	72	1.0	2.0	0.2	4.0	9.0	35.0	0.3	20.0	31.0	0.6
Patcong Creek	26	32.0	3.0	8.0	3.0	0	44.0	0.8	3.0	5.0	1.0

* In study area
** Outside study area
*** Entire watershed (figures may not total 100% due to rounding error)

Source: Betz-Converse-Murdoch-Inc., using land use overlays to New Jersey Atlas Sheets (1" = 1 mile)

APPENDIX 2

WATER QUALITY INDEX

APPENDIX 2

WATER QUALITY INDEX

An index was developed to assess the water quality of the Pinelands National Reserve. The index is based on BOD_5, total nitrogen, suspended solids, fecal coliform, and total dissolved solids; all parameters are weighted equally. The following values were established:

BOD_5	- 5 mg/l
TN-N	- 3 mg/l
Suspended Solids	- 12.5 mg/l
Total Dissolved Solids	- 100 mg/l
Fecal Coliform	- 200/100 ml - MPN

Each parameter was assessed individually. If the established level was met in 90% of the samples at a particular station, it was given a rating of 1. If it was met 50% of the time it received a 2 and if less than 50%, a 3. The scores were then totaled and the following categories established:

Rating	Category
5	Good
6-7	Slightly disturbed
8-9	More disturbed
> 9	Most disturbed

The 17 water quality stations rated as good using the index were then subjected to a more stringent index to determine the most pristine streams of the Pinelands. If the following level was met 90% of the time at a station, it was considered pristine:

BOD_5	- < 3 mg/l
TN-N	- < 1.0 mg/l
Suspended Solids	- < 10 mg/l
Total Dissolved Solids	- < 50 mg/l
Fecal Coliform	- < 100/100 ml - MPN

The only two water quality stations meeting these standards are 01466500 on McDonalds Branch in the North Branch Rancocas watershed and 01412100 on the Manumuskin River in the Maurice watershed.

See Technical Memorandum SW IV-4 for more details on the construction of the water quality index.

TABLE 2-1

WATER QUALITY INDEX
1.0 - TOMS RIVER

Water Quality Station		BOD5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
OCN 031	Toms River Trenton-Cassville Rd.	1	12	2	2	1	51	2	7	1	45	7	4.96
OCN 030 (01408260)	Toms River near Van Hiseville	2	17	1	6	1	56	3	12	1	49	8	5.40
OCN 023	Toms River Lakehurst-Whitesville Rd.	2	16	1	3	1	53	1	7	1	48	6	4.80
OCN 024 01408310	Toms River near Lakehurst	1	19	1	26	1	58	2	15	1	52	6	4.69
OCN 041	Ridgeway Br. Lakehurst-Whitesville Rd.	1	13	1	3	1	54	2	7	1	48	6	4.21
OCN 040 01408432	Ridgeway Branch Rt. 70 near Lakehurst	2	16	1	7	1	55	2	14	1	50	7	4.25
OCN 027	Toms River, Rt. 571 Manchester-Dover Border	2	15	1	3	1	54	2	7	1	50	7	4.92
OCN 042	Manapaqua Branch Lakehurst-Ridgeway Road, Tributary to Union Branch	3	15	2	3	2	53	2	7	1	49	10	5.75
OCN 039	Union Branch Colonial Drive	2	13	2	7	1	57	2	9	1	52	8	4.33
OCN 038	Union Branch Brookville Rd.	2	15	1	3	1	55	1	8	1	56	6	4.36
OCN 026	Toms River below confluence of Union and Ridgeway	1	14	1	2	1	45	2	7	1	39	6	4.47
OCN 025 01408500	Toms River near Toms River	1	95	1	69	1	94	2	16	1	129	6	4.70

TABLE 2-1 (Continued)

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
OCN 024	Toms River Lakehurst Rd.	1	16	2	3	1	61	2	8	1	42	7	4.60
OCN 035	Wrangle Br. off Fort de France Ave.	1	15	1	4	1	48	2	6	1	46	6	4.20
OCN 034	Wrangle Branch S. Barbados Dr.	1	16	2	4	1	50	2	6	1	44	7	4.40
OCN 037	Davenport Branch Whiting - Lacey Rd.	1	17	1	3	1	50	1	7	1	44	5	4.37
OCN 036	Davenport Branch between Holiday City and Dover Rd.	2	14	1	4	2	49	2	6	1	44	8	4.49
OCN 033	Wrangle Brook end of Gem Ave.	1	15	2	4	1	46	2	5	1	43	7	4.40
OCN 032	Jakes Branch Double Trouble Rd.	1	16	1	5	1	47	2	6	1	44	6	4.19

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-2

WATER QUALITY INDEX
2.0 - RANCOCAS RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
2.1 North Rancocas													
01465970	North Branch at Browns Mills	1	30	1	18	2	25	2	25	1	29	7	5.20
01466500	McDonalds Branch in Lebanon State Forest	1	66	1	24	1	31	1	4	1	06	5 (pristine)	4.10
01466900	Greenwood Branch at New Lisbon	1	24	1	17	2	25	2	24	1	33	7	4.30
01467000	North Branch at Pemberton	1	30	1	18	2	27	2	29	1	54	7	4.60
01467003	North Branch at Evanville	1	24	1	17	2	25	3	35	1	25	8	5.80
001467006	North Branch on Pine St. at Mt. Holly	1	27	1	18	2	27	2	28	1	27	7	6.20
2.2 South Rancocas													
01465835	South Branch at Retreat	1	29	1	19	2	25	2	26	1	29	7	4.20
01465850	South Branch at Vincentown	1	27	1	17	2	27	2	27	1	31	7	5.50
01465915	South Branch Hainesport	2	28	1	16	3	27	3	28	1	28	10	6.40

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed.

TABLE 2-3

WATER QUALITY INDEX
3.0 CEDAR CREEK

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
3.1 Cedar Creek													
OCN045 01408830	Cedar Creek Whiting-Lacey Road	1	22	1	6	1	55	1	12	1	51	5	4.60
OCN044 01408870	Cedar Creek Double Trouble Road	1	23	1	6	1	65	1	12	1	50	5	4.52
OCN043	Cedar Creek Lanoka Harbor	1	18	1	4	1	57	2	15	1	50	6	4.31

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-4

WATER QUALITY INDEX
4.0 FORKED RIVER

Water Quality Station		BOD5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	Median pH
4.1 Forked River													
OCN047	North Branch Forked River dirt road along JCP&L ROW	1	16	1	3	1	48	2	8	1	44	6	4.15
OCN046	North Branch Forked River at Forked River	1	24	1	10	1	58	2	16	2	49	7	4.28
OCN048	Middle Branch Forked River at Rt. 9	1	12	1	6	1	44	1	7	1	43	5	4.16
4.2 Oyster Creek													
OCN052	Oyster Cr. outflow of Brookville Bog	2	13	1	5	1	48	1	9	1	44	6	4.36
OCN051	Oyster Creek at Rt. 532	1	55	1	32	1	74	2	34	1	83	6	4.40
4.3 Mill Creek													
OCN054 01409150	Mill Creek at Rt. 72	2	15	1	11	1	59	1	16	1	49	6	4.23
OCN055	Fourmile Branch at Oxycocus-Littleville Mill Rd.	1	11	1	3	1	53	1	8	1	46	5	5.09
OCN053 (01409210)	Mill Creek at Rt. 180	2	13	1	6	1	53	2	10	1	43	7	5.34
4.4 Westecunk Creek													
OCN059	Westecunk Creek at Martha's Rd.	1	14	1	5	1	48	2	7	1	43	6	4.03
OCN058	Westcunk Creek Rt. 9 near West Creek	1	18	1	11	1	59	2	15	1	48	6	4.74

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-5

WATER QUALITY INDEX
5.0 - MULLICA RIVER

Water Quality Station		BOD$_5$		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
5.1 Bass River													
01410150	E. Branch Bass River near New Gretna	1	12	1	5	2	14	1	16	1	16	6	4.50
5.2 Wading River													
01409615	W. Branch Wading River near Maxwell	1	26	1	22	2	20	1	10	1	28	6	4.20
01410000	Oswego Creek East Branch Wading River at Harrisville	1	13	1	8	1	15	2	18	1	23	6	4.40
5.3 Batsto River													
01409450	Springers Brook near Indian Mills	1	10	1	9	1	16	2	16	2	17	7	6.40
01409470	Batsto River at Quaker Bridge	1	8	1	7	1	13	2	14	1	12	6	5.00
01409500	Batsto River at Batsto River	1	14	1	8	1	16	1	18	1	22	5	4.70
5.4 Atsion/Mechesactauxin Creeks													
01409375	Mullica River near Atco	1	6	1	9	1	11	1	11	1	11	5	6.40
01409383	Mullica River at Jackson Rd. near Indian Hills	1	4	1	6	2	10	1	8	1	10	6	4.20
01409387	Mullica River at outlet of Atsion Lk.	1	10	1	9	1	16	1	15	1	18	5	4.65
01409403	Wildcat Branch Chesilhurst	1	6	1	6	3	6	3	6	2	6	10	5.90
03938250 4393500	Mullica River at Pleasant Hills	1	11	1	7	2	14	1	16	1	16	6	5.00

TABLE 2-5 (Continued)

Water Quality Station		BOD5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total Index Value*	Median pH
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples		
5.5 Nescochaque Creek													
01409411	Nescochaque at Pleasant Mills	1	4	1	6	1	6	2	6	1	6	6	5.90
5.6 Hammonton Creek													
01409412	Hammonton Creek Rt. 30 at Hammonton	2	6	1	8	2	6	2	6	1	8	8	7.10
01409414	Hammonton Creek at Hammonton	2	5	1	8	3	6	2	6	3	10	11	6.20
01409416	Hammonton Creek at Westcoatville	1	17	3	11	1	11	2	14	2	14	9	6.10
5.7 Mullica River													
01409535	Mullica River at Green Bank (tidal)												6.10

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-6

WATER QUALITY INDEX
6.0 - UPPER GREAT EGG HARBOR RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
6.1 Upper Great Egg Harbor River (GEHR)													
01410775	GEHR at Berlin	2	26	1	18	3	26	3	26	3	27	12	6.30
01410784	GEHR near Sicklersville	1	58	2	41	1	12	2	17	2	27	8	5.90
01410787	GEHR tributary on Blackwood-New Brooklyn Rd.	1	64	1	42	2	17	3	6	2	27	9	6.70
3942030 4562901	GEHR West outlet - Brooklyn Lake	1	34	1	31	2	8	2	6	1	13	7	6.20
01410789	Trib N. 2 on Sicklerville Rd.	1	69	2	64	2	17	2	6	3	27	10	6.90
01410803	Fourmile Branch at Winslow Crossing	1	54	1	55	1	8	2	6	1	18	6	5.40
01410910	Fourmile Branch at New Brooklyn	1	72	1	66	1	17	3	6	1	28	7	5.70
01410920	GEHR near Broad Lane (near Blue Anchor NJ)	1	71	1	55	1	21	2	17	1	35	6	5.70
01410865	Squankum Br. at Malaga Rd.	3	25	3	21	2	26	3	24	3	30	14	5.60
01411000	Squankum Br. at Folsom	1	62	1	31	2	30	2	30	1	65	7	5.10
01411053	Hospitality Branch at Berryland	1	25	1	17	1	25	2	24	1	25	6	5.70
01411110	Hospitality Branch at Weymouth	1	30	1	18	2	26	2	26	1	30	7	4.90
01411140	Deep Run Branch at Weymouth	1	28	1	18	1	27	1	26	1	28	5	4.40
6.2 Lower Great Egg Harbor River													
01411196	Babcock Creek at Rt. 322 near Mays Landing	1	24	1	17	2	25	2	23	1	25	7	5.00
0141170	GEHR at Mays Landing	1	28	1	20	2	28	2	27	1	29	8	5.20

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-7

WATER QUALITY INDEX
7.0 - MAURICE RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
7.1 Manumuskin River													
01412100	Manumuskin River near Manumuskin	1	26	1	19	1	27	1	24	1	27	5 (pristine)	4.40

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

TABLE 2-8

WATER QUALITY INDEX
9.0 - TUCKAHOE RIVER

Water Quality Station		BOD_5		Total Nitrogen		Suspended Solids		Fecal Coliform		Total Dissolved Solids		Total	Median
Number	Location	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value	No. of Samples	Index Value*	pH
9.1 Tuckahoe River													
1411290	Tuckahoe River near Estell Manor	1	26	1	19	1	27	1	25	1	27	5	5.10
1411300	Tuckahoe River at Head of River, St. Rt. 49	1	33	1	19	2	29	2	29	1	33	7	4.80

* Water Quality Index: 5 = good; 6-7 = slightly disturbed; 8-9 = more disturbed; 10 or more = most disturbed

APPENDIX 3

POLLUTION SOURCES

TABLE 3-1

POLLUTION SOURCE - 1.0 TOMS RIVER

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
OCN 031	Toms River Trenton-Cassville Road	30.33	7.8			
OCN 030 (01408260)	Toms River near Van Hiseville	27.69	17.2	P-D	Oak Tree Mobile Homes	0.036
OCN 029	Toms River Lakehurst-Whitesville Rd.	18.52	45.6	P-D NP-GP P-I	0029513 United Mobile Homes 0005169	0.031 --- ---
OCN 028 (01408310)	Toms River near Lakehurst	14.61	52.0	NP-LF NP-GP NP-GP	1518-B Maple Glen Mobile Homes Weider Estates	--- --- ---
OCN 041	Ridgeway Branch Lakehurst-Whitesville Rd.	3.65	28.7	P-D NP-LF	US Naval Air Station (Federal) 1511-A	0.330 ---
OCN 040 01408492	Ridgeway Branch Rt. 70 near Lakehurst	1.18	32.1			
OCN 027	Toms River Rt. 571 Manchester-Dover Border	11.75	66.1			
OCN 042	Manapaqua Branch Lakehurst-Ridgeway Rd. Tributary to Union Branch	0.85	5.9	P-D NP-LF	0027952 1513-A	0.150 ---
OCN 039	Union Branch Colonial Drive	4.301	27.2	NP-GP	Manchester Township Board of Education	
OCN 038	Union Branch Brookville Rd.	0.35	---	NP-GP	Leisure Village Comm. STP	

TABLE 3-1 (Continued)

Water Quality Station		River Mile	Drainage Area (Square Miles)	Pollution Source		
Number	Location			Type*	Permit No.	Discharge (mgd)
OCN 026	Toms River below conferences of Union and Ridgeway	10.73	124.0			
OCN 025 (01408500)	Toms River near Toms River	9.98	124.0	P-I	0004120	Direct to ocean
OCN 024	Toms River Lakehurst Rd.	6.65	---			
OCN 035	Wrangle Brook off Fort de France Ave.	4.0	---	P-I NP-GP NP-GP NP-LF	0005746 - Asargo Inc. Crestwood Village No. 2 Crestwood Village No. 1 1607-D	
OCN 034	Wrangle Brook S. Barbados Dr.	2.02	18.7			
OCN 037	Davenport Branch Whiting - Lacey Rd.	8.05	4.7			
OCN 036	Davenport Branch between Holiday City and Dover Rd.	1.26	8.9			
OCN 033	Wrangle Brook end of Gem Ave.	0.67	---			
OCN 032	Jakes Brook Double Trouble Rd.	1.42	8.6			
Below OCN 024				P-D P-D P-D	0025151 - Dover Township 0005657 - Toms River Water Co. 0022896 - Island Heights STP	

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-2

POLLUTION SOURCE - 2.0 - RANCOCAS RIVER

Water Quality Station		River Mile	Drainage Area (Square Miles)	Pollution Source		
Number	Location			Type*	Permit No.	Discharge (mgd)
2.1 NORTH RANCOCAS						
01465970	North Branch at Browns Mills		19.5	P-D	0023035 - Hilltop Trailer Court	0.020
				P-D	0022594 - Deborah Heart and Lung	0.060
01466500	McDonalds Branch in Lebanon State Forest		2.3			
01466900	Greenwood Branch at New Lisbon		13.7	NP-LF	1518-A	
				NP-LF	0329-A	
01467000	North Branch at Pemberton		111.0	P-D	0026778	0.010
				P-D	0028177	0.070
				P-D	0021555	0.020
				P-D	0021318	0.050
				P-D	0021733	0.200
				P-D	0027383	0.090
				NP-LF	0329-B	
01467003	North Branch at Ewansville		126.0	P-D	Pemberton Bd. of Ed.	.03
				P-D	0024821	2.5 (design)
				P-D	005509	1.40
				P-D	0028665	0.030
				P-D	0022438	0.020
				P-D	0022420	0.010
01467006	North Branch on Pine St. at Mt. Holly		134.0	P-I	0004731	
Below station 01467006				P-D	0024015	---

TABLE 3-2 (Continued)

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
2.2 SOUTH RANCOCAS						
01465835	South Branch at Retreat		44.4	NP-LF	0333-A	
				NP-LF	0339-B	
				P-D	0021768	0.150
				P-D	0023736	0.137
01465850	South Branch at Vincentown		53.3	P-D	0022268	0.010
01465900	South Branch at Eayerstown		76.0			
01465915	South Branch Hainesport		156.0	P-D	0029203	
				P-D	0024031	
				NP-GP	Pine Grove	
				P-D	King's Grant Sewage Company	
				P-D	0021326	0.560
				P-D	0026832	0.950
				P-I	0005258	
				P-D	0024601	
				NP-LF	0313-A	
				NP-LF	0320-A	
Below station 01465915				P-I	0020231	

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-4

POLLUTION SOURCE - 3.0 CEDAR CREEK

Water Quality Station Number	Water Quality Station Location	River Mile	Drainage Area (Square Miles)	Type*	Pollution Source Permit No.	Pollution Source Discharge (mgd)
3.1 CEDAR CREEK						
OCN045 (01408830)	Cedar Creek Whiting-Lacey Road	13.72	20.1	NP-GP	Timber Hill Corp.	
OCN044 (01408870)	Cedar Creek Double Trouble Road	7.25	46.4	NP-LF	Proposed	
OCN043	Cedar Creek Lanoka Harbor	2.18	56.0	P-D NP-LF P-D	Garden State Pkwy-STP 1512-A 0021130 - Lacey Township	0.026

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-5

POLLUTION SOURCE - 4.0 FORKED RIVER

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
4.1 FORKED RIVER						
OCN047	North Branch Forked River dirt road along JCP&L ROW	4.71		NP-LF	Southern Ocean Land-fill, Inc. 1520-A	
OCN046	North Branch Forked River at Forked River	2.42	15.4	P-0	0026808	0.006 design
OCN048	Middle Branch Forked River at Route 9	1.11				
OCN049	South Branch Forked River at Route 9	1.62				
4.2 OYSTER CREEK						
OCN052	Oyster Creek outflow of Brookville Bog	8.00	2.31			
OCN051	Oyster Creek at Route 532	5.03	7.43			
OCN050	Oyster Creek at Route 9	1.66		P-I P-I	0005500 0031097	
4.3 MILL CREEK						
OCN056	Eightmile Branch at Route 72	1.60				
OCN054 01409150	Mill Creek at Route 72	6.53	10.0	NP-LF	1530-A	.40
OCN055	Fourmile Branch at Oxycocus-Littleville Mill Road	0.17	8.0			

TABLE 3-5 (Continued)

Water Quality Station			Drainage Area	Pollution Source		
Number	Location	River Mile	(Square Miles)	Type*	Permit No.	Discharge (mgd)
4.3 MILL CREEK (Continued)						
OCN053	Mill Creek at Route 180	4.57	19.8			
01409210	Mill Creek at Manahawkin		20.4			
Below station 01409210				P-D P-D	0025810 0026221	
4.4 WESTECUNK CREEK						
OCN059	Westecunk Creek at Martha's Road	6.23	15.61			
OCN058	Westecunk Creek Rte. 9 near West Creek	2.89	20.6	NP-LF NP-LF	1516-A 1508-A	

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-6

POLLUTION SOURCE - 5.0 MULLICA RIVER

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
5.1 BASS RIVER						
01410150	East Branch Bass River near New Gretna		8.1			
01410200	West Branch Bass River near New Gretna		6.5			
Below station 01410200				NP-LF	0301-A	
5.2 WADING RIVER						
01409810	West Branch Wading River near Jenkins		84.1			
01409815	West Branch Wading River near Maxwell		85.9			
01410000	Oswego River East Branch Wading River at Harrisville		64.0			
01410070	Wading River at Wading River		176.0			
5.3 BATSTO RIVER						
01409450	Springers Brook near Indian Mills		12.6	NP-LF	0335-A	
01409470	Batsto River at Quaker Bridge		55.7	NP-LF	0339-B	
01409500	Batsto River at Batsto		70.5			

TABLE 3-5 (Continued)

Water Quality Station		River Mile	Drainage Area	Pollution Source		
Number	Location		(Square Miles)	Type*	Permit No.	Discharge (mgd)
5.4 ATSION-MECHESACTAUXIN CREEKS						
01409375	Mullica River near Atco		3.2			
01409383	Mullica River at Jackson Road near Indian Mills		16.8			
01409387	Mullica River at the outlet of Atsion Lake		26.70	NP-LF	Englewood Sand and Gravel	
01409400	Mullica River near Batsto		64.40	NP-LF NP-LF	0336-A 0332-A	
01409403	Wildcat Branch Chesilhurst		1.00	P-I NP-LD	0030066 Waterford Township	
03933250 43535000	Mullica River at Pleasant Mills		127.00			
5.5 NESCOCHAQUE CREEK						
01409411	Nescochaque at Pleasant Mills		43.80	NP-LF P-D P-I P-I P-I	0463-B 0021962 0029068 0028223 0004081	 0.230 3.000 0.015
5.6 HAMMONTON CREEK						
01409412	Hammonton Creek Rt. 30 at Hammonton		2.50	P-I	0024210	0.510
01409414	Hammonton Creek at Hammonton		2.70	P-D	0025160	0.730

5.0 - MULLICA RIVER (Continued)

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
5.6 HAMMONTON CREEK (Continued)						
01409416	Hammonton Creek at Wescoatville		9.6			
Below station 01409416				NP-LF	0117-B	
5.7 MULLICA RIVER						
Below station 01409535	Mullica River at Green Bank (tidal)		243.0	NP-LF	0117A	
				P-D	0024589	0.416
				P-I	0005126	
				NP-LF	0107-A	
				NP-LF	0111-C	
				NP-LF	0336-A	
				P-I	0005428	0.005
				NP-SI	Spray Irrigation	
				P-D	0027189	0.020
				NP-LF	0120-A	
				NP-LF	0111-F	

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-7

POLLUTION SOURCE - 6.0 - UPPER GREAT EGG HARBOR RIVER

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
6.1 UPPER GREAT EGG HARBOR RIVER						
01410775	GEHR at Berlin		1.90			
01410784	GEHR near Sicklersville		15.10	P-D NP-LF	0026972 0405-A	0.800
01410787	GEHR tributary on Blackwood-New Brooklyn Rd.		1.64			
3942030 4562901	GEHR West outlet - Brooklyn Lake		22.80	P-T NP-LD	0027839 Winslow Crossing	
01410789	Trib. No. 2 on Sicklersville Rd.		0.50			
01410803	Fourmile Branch at Winslow Crossing		6.22			
01410810	Fourmile Branch at New Brooklyn		7.74			
01410920	GEHR near Broad Lane (near Blue Anchor)		37.30			
01410865	Squankum Br. at Malaga Rd.		3.02			
01411000	GEHR at Folsom		56.30	NP-FL	0430-A	
01411053	Hospitality Branch at Berryland		20.00			
01411110	GEHR at Weymouth		154.00	NP-LF P-D NP-GP NP-LF	1113-A 0026522 Timberhill Corp. STP 0105-C	 0.030
01411140	Deep Run Branch at Weymouth		20.00	NP-SI P-D NP-LF	0004324 0021717 1112-A	0.007 0.280

TABLE 3-7 (Continued)

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
6.2 LOWER GREAT EGG HARBOR RIVER						
01411196	Babcock Creek at Rt. 322 near Hays Landing		16.3	P-D	0021211	0.020
				P-I	005177	0.022
Below station 01411170	GEHR at Hays Landing		205	P-D	0021393	0.470
				NP-LF	0123-A	
				NP-LF	0112-B	
				P-D	0020800	0.220
				NP-LF	0108-B	

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-8

POLLUTION SOURCE - 7.0 - MAURICE RIVER

Water Quality Station		River Mile	Drainage Area (Square Miles)	Pollution Source		
Number	Location			Type*	Permit No.	Discharge (mgd)
7.1 MANUMUSKIN RIVER						
01412100	Manumuskin River near Manumuskin			P-I	0004618	1.25

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

TABLE 3-9

POLLUTION SOURCE - 9.0 - TUCKAHOE RIVER

Water Quality Station				Pollution Source		
Number	Location	River Mile	Drainage Area (Square Miles)	Type*	Permit No.	Discharge (mgd)
9.1 TUCKAHOE RIVER						
1411290	Tuckahoe River near Estell Manor	8.8				
1411300	Tuckahoe River at Head of River, State Route 49	30.80	P-I	0030589		
Below station 1411300			P-I	0005644		
			P-I	0005461		
			NP-LF	0511-A		
			NP-LF	0516-C		
			NP-LF	0109-A		

* P-I - Point Source Industrial
P-D - Point Source Domestic
NP-LF - Nonpoint Source Landfill
NP-GP - Nonpoint Source Ground Percolation
NP-SI - Nonpoint Source Spray Irrigation
NP-LD - Nonpoint Source Land Disposal

APPENDIX 4

POINT SOURCE DATA

TABLE 4-1

POINT SOURCE DATA

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	FLOW (mgd) Design	FLOW (mgd) Actual	DATA SOURCE Source	DATA SOURCE Additional Data	DATA SOURCE Map
1.0 TOMS RIVER								
1.1 Toms River								
J. E. Clayton School STP	Domestic	Toms River			.031	Ocean Co. 208 p. 150	Yes p. 163	Ocean 19 p. 156
Lakehurst STP	Domestic	Manapaqua Brook	0027952	.03	.15	Ocean p. 151	Yes p. 164	Ocean 22 p. 156
Lakehurst Naval Air Sta. STP	Domestic	Ridgeway Branch	Federal	.60	.33	Ocean p. 151	Yes p. 164	Ocean 23 6 p. 156
Oak Creek (Tree) Mobile Homes STP	Domestic	Unnamed Trib.		.045	.036	Ocean p. 151	Yes p. 166	Ocean p. 156
ASARCO	Industrial	Green Brook (to Wrangle Brook)	0005746			Ocean p. 152	Permit p. 170	Ocean p. 156
SCM Corporation Jackson Mines	Industrial	Long Brook	0005169			Ocean p. 153	Permit p. 171	Ocean p. 156
Toms River Chemical	Industrial/ Cooling	Toms River	0004120			Ocean p. 154	Permit pp. 173-4	Ocean 51 & 64 p. 156
Atlantic Water Core Service	Water Treatment Bechurst	Jakes Brook	00235151			Ocean p. 153		Ocean p. 156
Toms River Water Co.	Water Treatment Bechurst	Baylor Brook	0005649			Ocean p. 154		
Toms River Water Co.	Water Treatment Bechurst	Toms River					Ocean p. 154	
2.0 RANCOCAS RIVER								
2.1 Rancocas River - North Branch								
Ionac Chemical Company Birmingham Road	Industrial Discharge	N. Rancocas	0005509	1.00	1.40	Tri-County 208 Table 3		502 Map 4-1 p. 4-3
Elizabeth Water Company 84 Mill Street	Industrial Discharge	N. Rancocas	0004731			Tri-County 208 Table 3		562 Map 4-1 p. 4-3

TABLE 4-1 (Continued)

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	Design	Actual	DATA SOURCE Source	Additional Data	Map
2.1 Rancocas River North Branch - Continued								
Hilltop Trailer Court Rt. 545	Non-municipal Discharge	N. Rancocas	0023035	0.02	0.010	Tri-County 208 Table 2		513 Map 4-1 p. 4-3
Deborah Heart & Lung Center, Browns Mills	Non-municipal Discharge	N. Rancocas	0022594	0.090	0.060	Tri-County 208 Table 2		516 Map 4-1 p. 4-3
Burlington County College Browns Mills	Non-municipal Discharge	N. Rancocas	0021555	0.380	0.020	Tri-County 208 Table 2		578 Map 4-1 p. 4-3
Pemberton Board of Education Ft. Dix Rd.	Non-municipal Discharge	N. Rancocas				Tri-County 208 Table 2		598 Map 4-1 p. 4-3
Pemberton Twp. Board of Education, Ft. Dix Rd.	Non-municipal Discharge	N. Rancocas	0022438	0.050	0.020	Tri-County 208 Table 2		519 Map 4-1 p. 4-3
Pemberton Twp. Board of Education, Browns Mills	Non-municipal Discharge	N. Rancocas	0022420	0.010	0.010	Tri-County 208 Table 2		518 Map 4-1 p. 4-3
Belair Trailer Park Browns Mills	Non-municipal Discharge	N. Rancocas	0028177	0.040	0.070	Tri-County 208 Table 2		515 Map 4-1 p. 4-3
Lakeshore Trailer Park Browns Mills	Non-municipal Discharge	N. Rancocas	0026778	0.020	0.010	Tri-County 208 Table 2		514 Map 4-1 p. 4-3
Burlington County Hospital Browns Mills	Non-municipal Discharge	N. Rancocas	0021318	0.050	0.050	Tri-County 208 Table 2		572 Map 4-1 p. 4-3
Mobile Estates Routes. 206 & 38	Non-municipal Discharge	N. Rancocas	0028665	0.060	0.030	Tri-County 208 Table 2		563 Map 4-1 p. 4-3
Sunbury Village Sewer Co. Browns Mills	Non-municipal Discharge	N. Rancocas	0027383	0.120	0.090	Tri-County 208 Table 2		579 Map 4-1 p. 4-3
Borough of Pemberton Antis Road	Municipal Discharge	N. Rancocas	0021733	0.180	0.200	Tri-County 208 Table 2		064 Map 4-3 Back Cover
Pemberton Township MUA Birmingham Road	Municipal Discharge	N. Rancocas	0024821	2.500		Tri-County 208 Table 1		051 Map 4-3 Back Cover
Mt. Holly Sewer Auth. Rancocas Road	Municipal Discharge	N. Rancocas	0024015	2.000	1.700	Tri-County 208 Table 1		069 Map 4-3 Back Cover

TABLE 4-1 (Continued)

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	Design	Actual	DATA SOURCE Source	Additional Data	Map
2.2 Rancocas River - South Branch								
Bermico Company Lumberton Road	Industrial Discharge	S. Rancocas	0005258			Tri-County 208 Table 3		549 Map 4-1 p. 4-3
Inmont Corporation Marina Hwy. & Del. Ave.	Industrial Discharge	S. Rancocas	0020231			Tri-County 208 Table 3		548 Map 4-1 p. 4-3
New Lisbon State Colony Rt. 72	Non-municipal Discharge	S. Rancocas	0021768	0.320	0.150	Tri-County 208 Table 2		573 Map 4-1 p. 4-3
Kings Grant Sewer Co. Tomlinson Mill Run	Non-municipal Discharge	S. Rancocas				Tri-County 208 Table 2		504 Map 4-1 p. 4-3
Fort Dix Nike Site Lumberton Road	Non-municipal Discharge	S. Rancocas	0024601	0.020	0.002	Tri-County 208 Table 2		550 Map 4-1 p. 4-3
Southampton Bd. of Education, Pleasant Ave.	Non-municipal Discharge	S. Rancocas	0022268	0.010	0.010	Tri-County 208 Table 2		592 Map 4-1 p. 4-3
Medford Lakes STP Rt. 541	Municipal Discharge	S. Rancocas	0021326	0.550	0.560	Tri-County 208 Table 1		050 Map 4-3 Back cover
Evesham Municipal Elmwood Road	Municipal Discharge	S. Rancocas	0024031	0.750	0.990	Tri-County 208 Table 1		062 Map 4-3 Back cover
Borough of Medford Lakes	Municipal Discharge	S. Rancocas	0026832	1.000	0.950	Tri-County 208 Table 1		065 Map 4-3 Back cover
Southampton Sewage Co. Vincentown Road	Municipal Discharge	S. Rancocas	0023736	0.500	0.137	Tri-County 208 Table 1		080 Map 4-3 Back cover
3.0 CEDAR CREEK								
3.1 Cedar Creek								
Garden State Parkway STP	Municipal Discharge	Cedar Creek		0.04	0.026	Ocean Co. 208 p. 150	Yes p. 161	Ocean 12 p. 156
4.0 FORKED RIVER								
4.1 Forked River								
Forked River State Marina STP	Domestic Discharge	N. Branch, Forked River		0.006		Ocean p. 169	Yes p. 161	Ocean 11 p. 156

TABLE 4-1 (Continued)

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	FLOW (mgd) Design	Actual	DATA SOURCE Source	DATA SOURCE Additional Data	DATA SOURCE Map
4.0 FORKED RIVER (Continued)								
4.2 Oyster Creek								
JCP&L Company STP Oyster Creek Generator Station	Domestic Discharge	Oyster Creek		0.004	0.002	Ocean p. 150	Yes p. 164	Ocean 20 p. 156
Oyster Creek Nuclear Plant	Industrial/ Cooling	Oyster Creek	0005550			Ocean p. 53	Permit pp. 171-2	Ocean 48, 63 p. 156
4.3 Mill Creek								
Stafford Township MUA STP	Domestic Discharge	Mill Creek		0.677	0.40	Ocean p. 152	Yes p. 165	Ocean 39 p. 156
5.0 MULLICA RIVER								
5.5 Nescochaque Creek								
Ancora State Hospital	Non-municipal Discharge	Nescochaque Creek	0021962	0.4	0.23	Tri-County 208 p. D-6		Tri-County 777 Map 4-1
Braddock Frosted Foods	Industrial Discharge	Nescochaque Creek	0004081			Tri-County 208 p. D-10		Tri-County 776 Map 4-1
5.6 HAMMONTON CREEK								
Hammonton	Domestic	Hammonton Creek	0025160	1.6	0.73	Atlantic Co. 208 p. II-101		
5.7 MULLICA RIVER								
Eastern Brewing Company	Sanitary Cooling	Cedar Br. Creek	0028223		0.015	Atlantic Co. 208 p. II-102		
Whitehall Coke	Cooling	Pond to lake	0024210		0.57	Atlantic p. II-102		
W. Skinner	Industrial Discharge		0029068	3.00	3.00	Atlantic p. II-102		
Pacemaker Corporation	Industrial Discharge		0005428		0.005	Tri-County 208 p. D-8		

TABLE 4-1 (Continued)

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	Design	Actual	DATA SOURCE Source	Additional Data	Map
6.0 GREAT EGG HARBOR RIVER								
6.1 Great Egg Harbor (Upper)								
Buena Borough	Domestic Discharge	Deep Run Brook	0021717	0.4	0.28	Atlantic Co. 208 p. II-101		
Scott Paper Company	Industrial Discharge	Deep Run Trib.	004324		0.007	Atlantic p. II-101		
6.2 Great Egg Harbor (Lower)								
Hamilton Township MUA	Domestic Discharge	Babcock Creek	0021393	0.625	0.47	Atlantic Co. 208 p. II-102		
A.C. Racing Association	Domestic Discharge	Adams Branch Babcock Creek	0021211	0.033	0.02	Atlantic p. II-102		
NAFEC		Gravely Run	0020800	0.22	0.22	Atlantic p. II-102		
Lenox China, Inc.	Industrial Discharge	Jack Pudding Br.	005177	0.035	0.022	Atlantic p. II-102		
A.C. Expressway	Domestic Discharge	Makepeace Creek	0026531	0.05	0.03	Atlantic p. II-102		
A.C. Expressway (Hammonton)	Domestic Discharge	Penny Pot Stream	0026522	0.004	0.001	Atlantic p. II-101		
7.0 MAURICE RIVER								
7.1 Manumuskin Creek								
N.J. Silica Sand Corp.	Industrial Discharge	Manumuskin Cr.	0004618		1.25	L. Delaware 208 p. V-4	Permit	L. Delaware p. III-24
7.2 Maurice (Lower)								
Pioneer Metal Finishing Colesmill Road		L. Maurice	0025658					Map 504
Nat Fruit Product Co. 50 S. Delsea Drive		L. Maurice	0004162					Map 505

TABLE 4-1 (Continued)

Name	Type	Stream	FLOW (mgd) NPDES Permit No.	Design	Actual	DATA SOURCE Source	Additional Data	Map
7.0 MAURICE RIVER (Continued)								
7.2 Maurice (Lower) (Continued)								
Owens Illinois Glass Div. 70 Sewell Street		L. Maurice	0065312					Map 506
Shield Alloy Corporation West Boulevard		L. Maurice	0004103	0.110				Map 518
9.0 TUCKAHOE RIVER								
9.1 Tuckahoe River								
Eatmor Cranberries, Inc.		Tuckahoe River	0030589			Cape May Co. 208 p. 11		Cape May 23 p. 7
Atlantic City Electric B.L. Generating Plant	Process/ Cooling	Great Egg Harbor Basin	0005444			Cape May p. 10		Cape May 19 p. 7
Atlantic City Electric B.L. Generating Plant	Process/ Cooling	Great Egg Harbor Basin	0005461			Cape May p. 10		Cape May 20 p. 7
10.0 DENNIS CREEK								
10.1 Dennis Creek								
Woodbine State School		Dennis Creek	0021172			Cape May p. 10		Cape May 18 p. 7

APPENDIX 5

STREAM STANDARD VIOLATIONS BASED ON FW-CENTRAL PINE BARREN STANDARDS

(for Water Quality Stations within FW-CP Designation)

TABLE 5-1

STREAM STANDARD VIOLATIONS BASED ON FW-CENTRAL PINE BARREN STANDARDS
(for Water Quality Stations within FW-CP Designation)

Station		Period of Record	BOD (5 mg/l)			Total Phosphorus (0.23 mg/l-P)			pH (3.5-5.5)		
			Number of Values	Percent Violation	Maximum Violation	Number of Values	Percent Violation	Maximum Violation	Number of Values	Percent Violation	Maximum Violation
OCN 037	Davenport Branch Whiting-Lacey Road	10/76-7/79	17	6	6.1	---	---	---	84	1	6.1
OCN 032	Jakes Brook Double Trouble Road	10/76-7/79	16	6	5.7	---	---	---	84	1	6.2
0146690	Greenwood Branch at New Lisbon	2/72-6/78	---	---	---	---	---	---	25	4	6.4
01465835	South Branch Rancocas at Retreat	7/75-8/79	---	---	---	24	4	0.2	29	3	5.8
OCN 045	Cedar Creek Whiting-Lacey Road	10/76-7/79	16	6	6.1	---	---	---	82	6	6.7
01408830	Cedar Creek at Cedar Crest	6/77-1/78	---	---	---	---	---	---	6	33	5.8
OCN 044	Cedar Creek Double Trouble Road	10/76-7/79	17	6	6.6	---	---	---	81	1	5.9
OCN 047	North Branch Forked River - JCP&L Lines	10/76-7/79	---	---	---	---	---	---	82	1	7.6
OCN 052	Oyster Creek Brookville Bog	10/76-7/79	13	15	5.7	---	---	---	73	3	5.7
OCN 051	Oyster Creek Wells Mills Road	10/76-7/79	14	7	7.5	---	---	---	---	---	---
01409095	Oyster Creek near Brookville	1/70-6/78	---	---	---	---	---	---	---	---	---
OCN 054	Mill Creek at Route 72	10/76-7/79	14	21	9.9	---	---	---	87	20	6.4
OCN 059	Westecunk Creek at Martha's Road	10/76-7/79	---	---	---	---	---	---	85	6	5.8
01410000	Oswego River at Harrisville	7/76-6/79	13	8	6.0	---	---	---	17	12	6.4
01409450	Springers Brook Indian Mills	8/75-5/78	---	---	---	---	---	---	13	77	6.6
01409470	Batsto River at Quaker Bridge	8/75-3/78	---	---	---	---	---	---	11	18	6.4
01409500	Batsto River at Batsto	8/75-5/79	---	---	---	---	---	---	18	22	6.2
01409375	Mullica River near Atco	2/77-5/78	---	---	---	11	9	0.3	9	89	7.4
01409383	Mullica River near Indian Mills	3/77-5/78	---	---	---	9	11	0.5	7	29	7.2
01409387	Mullica River at outlet of Atsion Lake	8/75-5/79	---	---	---	---	---	---	15	33	6.4
01409403	Wildcat Branch at Chesilhurst	6/77-1/78	6	33	17	---	---	---	6	83	6.5
393825074393500	Mullica River at Pleasant Mills	8/75-5/79	---	---	---	---	---	---	17	29	6.3
01409412	Hammonton Creek at Route 30	7/74-1/78	6	17	7.3	---	---	---	6	83	7.4
01409414	Hammonton Creek at Hammonton	7/74-1/78	6	40	9.4	2	100	2.3	8	88	6.9
01409416	Hammonton Creek at Wescoatville	7/74-8/79	17	6	8.2	10	80	4.5	20	75	7.2

TABLE 5-1 (Continued)

Station		Period of Record	Fecal Coliform (200/100 ml) Number of Values	Fecal Coliform Percent Violation	Fecal Coliform Maximum Violation	Turbidity (20 JTU) Number of Values	Turbidity Percent Violation	Turbidity Maximum Violation
OCN 037	Davenport Branch Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
OCN 032	Jakes Brook Double Trouble Road	10/76-7/79	6	17	2,400	81	2	25
0146690	Greenwood Branch at New Lisbon	2/72-6/78	24	17	1,600	---	---	---
01465835	South Branch Rancocas at Retreat	7/75-8/79	26	15	1,600	---	---	---
OCN 045	Cedar Creek Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
01408830	Cedar Creek at Cedar Crest	6/77-1/78	---	---	---	---	---	---
OCN 044	Cedar Creek Double Trouble Road	10/76-7/79	---	---	---	---	---	---
OCN 047	North Branch Forked River - JCP&L Lines	10/76-7/79	8	13	330	---	---	---
OCN 052	Oyster Creek Brookville Bog	10/76-7/79	---	---	---	69	6	50
OCN 051	Oyster Creek Wells Mills Road	10/76-7/79	---	---	---	---	---	---
01409095	Oyster Creek near Brookville	1/70-6/78	27	15	1,600	---	---	---
OCN 054	Mill Creek at Route 72	10/76-7/79	---	---	---	---	---	---
OCN 059	Westecunk Creek at Martha's Road	10/76-7/79	7	14	790	---	---	---
01410000	Oswego River at Harrisville	7/76-6/79	18	11	790	---	---	---
01409450	Springers Brook Indian Mills	8/75-5/78	16	13	490	---	---	---
01409470	Batsto River at Quaker Bridge	8/75-3/78	14	14	330	---	---	---
01409500	Batsto River at Batsto	8/75-5/79	18	6	490	---	---	---
01409375	Mullica River near Atco	2/77-5/78	---	---	---	---	---	---
01409383	Mullica River near Indian Mills	3/77-5/78	---	---	---	---	---	---
01409387	Mullica River at outlet of Atsion Lake	8/75-5/79	---	---	---	---	---	---
01409403	Wildcat Branch at Chesilhurst	6/77-1/78	6	67	24,000	6	17	30
393825074393500	Mullica River at Pleasant Mills	8/75-5/79	16	6	1,700	---	---	---
01409412	Hammonton Creek at Route 30	7/74-1/78	6	17	1,300	---	---	---
01409414	Hammonton Creek at Hammonton	7/74-1/78	6	17	5,400	10	10	55
01409416	Hammonton Creek at Wescoatville	7/74-8/79	14	14	790	---	---	---

TABLE 5-1 (Continued)

Station		Period of Record	Suspended Solids (40 mg/l) Number of Values	Suspended Solids (40 mg/l) Percent Violation	Suspended Solids (40 mg/l) Maximum Violation	Dissolved Solids (100 mg/l) Number of Values	Dissolved Solids (100 mg/l) Percent Violation	Dissolved Solids (100 mg/l) Maximum Violation
OCN 037	Davenport Branch Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
OCN 032	Jakes Brook Double Trouble Road	10/76-7/79	---	---	---	---	---	---
0146690	Greenwood Branch at New Lisbon	2/72-6/78	---	---	---	---	---	---
01465835	South Branch Rancocas at Retreat	7/75-8/79	26	8	46	29	3	104
OCN 045	Cedar Creek Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
01408830	Cedar Creek at Cedar Crest	6/77-1/78	---	---	---	---	---	---
OCN 044	Cedar Creek Double Trouble Road	10/76-7/79	---	---	---	---	---	---
OCN 047	North Branch Forked River - JCP&L Lines	10/76-7/79	---	---	---	---	---	---
OCN 052	Oyster Creek Brookville Bog	10/76-7/79	---	---	---	44	2	106
OCN 051	Oyster Creek Wells Mills Road	10/76-7/79	---	---	---	---	---	---
01409095	Oyster Creek near Brookville	1/70-6/78	---	---	---	---	---	---
OCN 054	Mill Creek at Route 72	10/76-7/79	---	---	---	---	---	---
OCN 059	Westecunk Creek at Martha's Road	10/76-7/79	---	---	---	---	---	---
01410000	Oswego River at Harrisville	7/76-6/79	---	---	---	---	---	---
01409450	Springers Brook Indian Mills	8/75-5/78	---	---	---	15	27	114
01409470	Batsto River at Quaker Bridge	8/75-3/78	---	---	---	12	8	110
01409500	Batsto River at Batsto	8/75-5/79	---	---	---	---	---	---
01409375	Mullica River near Atco	2/77-5/78	---	---	---	11	9	118
01409383	Mullica River near Indian Mills	3/77-5/78	---	---	---	---	---	---
01409387	Mullica River at outlet of Atsion Lake	8/75-5/79	---	---	---	---	---	---
01409403	Wildcat Branch at Chesilhurst	6/77-1/78	6	17	870	6	33	155
393825074393500	Mullica River at Pleasant Mills	8/75-5/79	---	---	---	---	---	---
01409412	Hammonton Creek at Route 30	7/74-1/78	---	---	---	---	---	---
01409414	Hammonton Creek at Hammonton	7/74-1/78	6	17	60	10	60	188
01409416	Hammonton Creek at Wescoatville	7/74-8/79	---	---	---	14	14	180

TABLE 5-1 (Continued)

Station		Period of Record	Total Alkalinity (10 mg/l) Number of Values	Percent Violation	Maximum Violation	Nitrate Nitrogen (2.0 mg/l-N) Number of Values	Percent Violation	Maximum Violation
OCN 037	Davenport Branch Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
OCN 032	Jakes Brook Double Trouble Road	10/76-7/79	---	---	---	---	---	---
0146690	Greenwood Branch at New Lisbon	2/72-6/78	---	---	---	---	---	---
01465835	South Branch Rancocas at Retreat	7/75-8/79	---	---	---	---	---	---
OCN 045	Cedar Creek Whiting-Lacey Road	10/76-7/79	---	---	---	---	---	---
01408830	Cedar Creek at Cedar Crest	6/77-1/78	---	---	---	---	---	---
OCN 044	Cedar Creek Double Trouble Road	10/76-7/79	---	---	---	---	---	---
OCN 047	North Branch Forked River - JCP&L Lines	10/76-7/79	---	---	---	---	---	---
OCN 052	Oyster Creek Brookville Bog	10/76-7/79	---	---	---	---	---	---
OCN 051	Oyster Creek Wells Mills Road	10/76-7/79	---	---	---	---	---	---
01409095	Oyster Creek near Brookville	1/70-6/78	---	---	---	---	---	---
OCN 054	Mill Creek at Route 72	10/76-7/79	---	---	---	---	---	---
OCN 059	Westecunk Creek at Martha's Road	10/76-7/79	---	---	---	---	---	---
01410000	Oswego River at Harrisville	7/76-6/79	---	---	---	---	---	---
01409450	Springers Brook Indian Mills	8/75-5/78	1	100	29	---	---	---
01409470	Batsto River at Quaker Bridge	8/75-3/78	---	---	---	---	---	---
01409500	Batsto River at Batsto	8/75-5/79	4	25	11	---	---	---
01409375	Mullica River near Atco	2/77-5/78	---	---	---	6	17	2.4
01409383	Mullica River near Indian Mills	3/77-5/78	---	---	---	---	---	---
01409387	Mullica River at outlet of Atsion Lake	8/75-5/79	3	33	18	8	13	2.3
01409403	Wildcat Branch at Chesilhurst	6/77-1/78	6	17	41	---	---	---
393825074393500	Mullica River at Pleasant Mills	8/75-5/79	4	25	16	---	---	---
01409412	Hammonton Creek at Route 30	7/74-1/78	2	100	16	---	---	---
01409414	Hammonton Creek at Hammonton	7/74-1/78	4	75	15	8	75	3.8
01409416	Hammonton Creek at Wescoatville	7/74-8/79	11	55	28	7	43	3.5

APPENDIX 6

pH VALUES

TABLE 6-1

pH VALUES

Station		Sample Size	Frequency Distribution 90%	50% (Median)	Maximum	Minimum
TOMS RIVER						
OCN 031		---	5.80	4.96	6.40	---
OCN 030		91	6.30	5.40	7.10	---
01408260		---	---	---	6.20	5.1
OCN 029		85	6.03	4.80	6.80	---
OCN 028		90	5.81	4.69	6.70	---
01408310		---	---	---	5.80	4.5
OCN 041	Ridgeway Branch	81	4.89	4.21	5.50	---
OCN 040 (01408492)	Ridgeway Branch	93	5.20	4.25	6.20	---
OCN 027		82	5.90	4.92	---	---
OCN 042	Manapaqua Branch	86	6.50	5.75	6.80	---
OCN 039	Union Branch	91	5.41	4.33	6.89	---
OCN 038	Union Branch	81	4.85	4.36	6.00	---
OCN 026		75	5.75	4.47	6.50	---
OCN 025 (01408500)		203	5.70	4.70	7.20	3.5
OCN 024		83	5.75	4.60	6.60	---
OCN 035	Wrangle Brook	79	4.70	4.20	5.70	---
OCN 034	Wrangle Brook	85	5.00	4.40	---	---
OCN 037	Davenport Branch	84	4.80	4.37	6.10	---
OCN 036	Davenport Branch	82	4.94	4.49	6.64	---
OCN 033	Wrangle Brook	76	4.90	4.40	5.70	---
OCN 032	Jakes Brook	84	4.65	4.19	6.20	---
NORTH RANCOCAS						
01465970		29	6.00	5.20	6.4	4.0
01466500	McDonalds Branch	75	4.60	4.10	6.0	3.2
01466900	Greenwood Branch	25	4.80	4.30	6.4	3.7
01467000		33	5.20	4.60	6.4	3.9
01467003		24	6.60	5.80	6.7	4.2
01467006		27	6.60	6.20	7.0	5.1
SOUTH RANCOCAS						
01465835		29	4.60	4.20	5.8	3.8
01465850		29	6.50	5.50	6.7	4.4
01465915		27	6.70	6.40	---	---

TABLE 6-1 (Continued)

Station		Sample Size	Frequency Distribution 90%	50% (Median)	Maximum	Minimum
CEDAR CREEK						
OCN 045 (01408830)		88	5.41	4.60	6.70	4.40
OCN 044 (01408870)		87	5.30	4.52	5.20	4.20
OCN 043		91	4.90	4.31	5.40	4.20
FORKED RIVER						
OCN 047	North Branch Forked River	82	4.55	4.15	7.60	---
OCN 046	North Branch Forked River	91	4.89	4.28	8.10	4.20
OCN 048	Middle Branch Forked River	79	4.42	4.16	4.74	---
OYSTER CREEK						
OCN 052		73	4.80	4.36	5.70	---
OCN 051		157	4.70	4.40	5.80	3.90
MILL CREEK						
OCN 054 (01409150)		102	5.80	5.23	6.40	5.00
OCN 055	Fourmile Branch	85	5.90	5.09	7.58	---
OCN 053 (01409210)		89	6.25	5.34	6.50	4.60
WESTECUNK CREEK						
OCN 059		85	5.35	4.03	---	---
OCN 058		94	5.65	4.74	6.5	4.90
MULLICA RIVER BASIN						
BASS RIVER						
01410150	East Branch Bass River	16	5.10	4.50	5.30	3.30
WADING RIVER						
01409815	West Branch Wading River	29	4.80	4.20	5.70	3.00
01410000	Oswego River	20	5.20	4.40	3.40	3.20

TABLE 6-1 (Continued)

Station		Sample Size	Frequency Distribution 90%	50% (Median)	Maximum	Minimum
BATSTO RIVER						
01409450	Springers Creek	20	6.60	6.40	6.60	4.70
01409470		11	6.40	5.00	6.40	4.30
01409500		22	5.60	4.70	6.20	3.50
ATSION/MECHESACTAUXIN CREEKS						
01409375	Mullica River	9	7.40	6.40	7.40	---
01409383	Mullica River	7	7.20	4.20	7.20	4.10
01409387	Mullica River	15	6.30	4.65	6.40	3.40
01409400	Mullica River	23	5.40	4.90	5.60	---
01409403	Wildcat Branch	6	6.50	5.90	6.50	5.20
039382504393500		17	5.90	5.00	6.30	---
NESCOCHAQUE CREEK						
01409411		5	6.6	5.90	6.60	4.40
HAMMONTON CREEK						
01409412		6	7.40	7.10	7.40	4.30
01409414		8	6.90	5.20	6.90	4.40
01409416		20	6.50	6.10	7.20	4.30
LOWER MULLICA RIVER						
01409535		7	6.50	6.10	8.10	3.40
GREAT EGG HARBOR RIVER						
UPPER GREAT EGG HARBOR RIVER						
01410775		29	7.20	6.30	7.50	5.70
01410784		60	6.60	5.90	6.90	4.30
01410787		63	7.70	6.70	8.50	3.70
01410789		110	7.50	6.90	8.70	5.20
01410803	Fourmile Branch	103	5.90	5.40	---	---
01410810	Fourmile Branch	116	6.50	5.70	8.00	3.00
01410820	Fourmile Branch	81	6.60	5.70	7.70	4.30

TABLE 6-1 (Continued)

Station		Sample Size	Frequency Distribution 90%	50% (Median)	Maximum	Minimum
01410865	Squankum Branch	30	7.00	6.50	7.30	5.70
01411000		98	6.50	5.10	7.10	4.50
01411053	Hospitality Brook	25	6.00	5.70	6.30	4.50
01411110		31	5.90	4.90	6.40	3.80
01411140	Deep Run	28	6.20	4.40	7.00	3.90
394203074562901	West outlet, New Brooklyn Lake	34	7.30	6.20	---	---
LOWER GREAT EGG HARBOR RIVER						
01411170		28	6.40	5.20	6.80	4.10
01411196	Babcock Creek	24	5.30	5.00	6.40	3.90
TUCKAHOE RIVER						
01411290		26	5.80	5.10	---	---
01411300		42	6.10	4.80	---	---
MANUMUSKIN RIVER						
01412100		26	4.90	4.40	6.00	3.90

TECHNICAL MEMORANDUM SW IV-6

LAND USE/WATER QUALITY EFFECTS

PINELANDS COMMISSION

FEBRUARY 1980

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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TABLES

FIGURES

TECHNICAL MEMORANDUM SW IV-6

LAND USE/WATER QUALITY EFFECTS

INTRODUCTION

A map of the water quality index superimposed on a generalized land use map shows a relationship between water quality at a particular site and the surrounding land use (see Figure 1). From this scale of presentation, it is apparent that sampling station sites with poor water quality tend to be found near developed areas and that stations with good quality tend to be found in undeveloped areas. A similar relationship occurs in mapping stream pH and land use (see Figure 2). The worst water quality is found in the developed western section of the Pinelands study area and in the Toms River watershed. Development in the western Pinelands affects the headwater of the Great Egg Harbor River, several tributaries of the Mullica River, and the lower segments of the North and South Branches of the Rancocas River. There are coastal development centers along the eastern boundary of the study area, but in most cases, these are not far enough inland to affect non-tidal water quality stations.

Stations with good water quality are on small tributary streams originating in Central Pinelands areas. This pattern of good quality streams occurs on the northern section of the study area--Cedar Creek, Westecunk Creek, McDonalds Branch--and in streams of the Tuckahoe Basin and Manumuskin Basin. Although existing data are sparse, one can expect water quality to be good in streams originating in the Central Pineland forests.

The extremes of both good and bad water quality are generally found in headwater areas (small streams in the upper sections of a watershed). These areas of low streamflow and small drainage basins do not have the assimilative capacity to handle concentrated waste loads. A point source discharge or high levels of development and agriculture will have a more deleterious effect on headwater streams than on downstream segments. Headwater areas are important in the study of land use/water quality effects because the small drainage area found in the headwaters allows a more accurate analysis of the land use impacts. Downstream river segments are usually influenced by a larger number of land uses and it is difficult to conclusively demonstrate that a particular land use is responsible for an observed water quality problem.

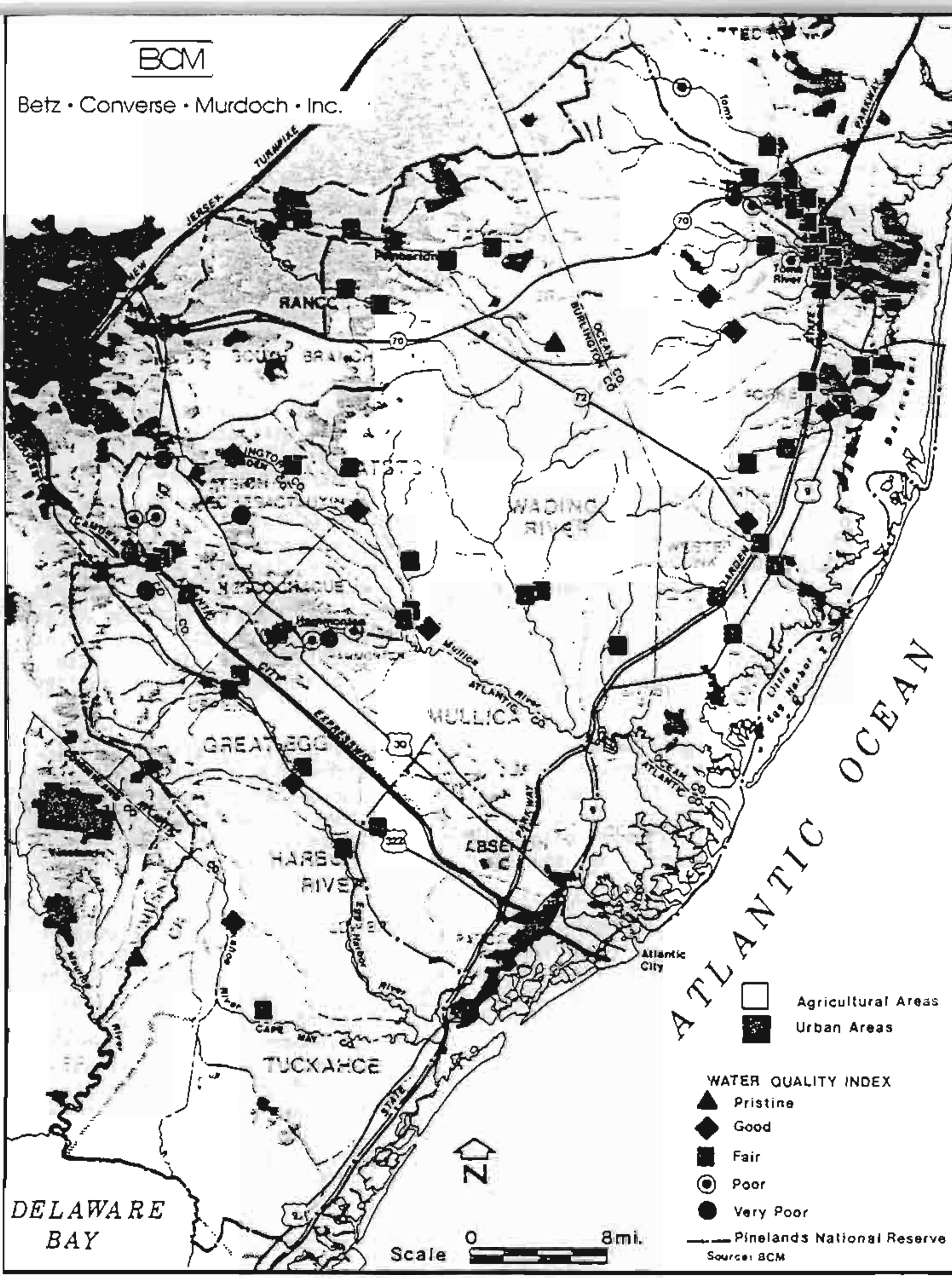

Figure 1. WATER QUALITY INDEX

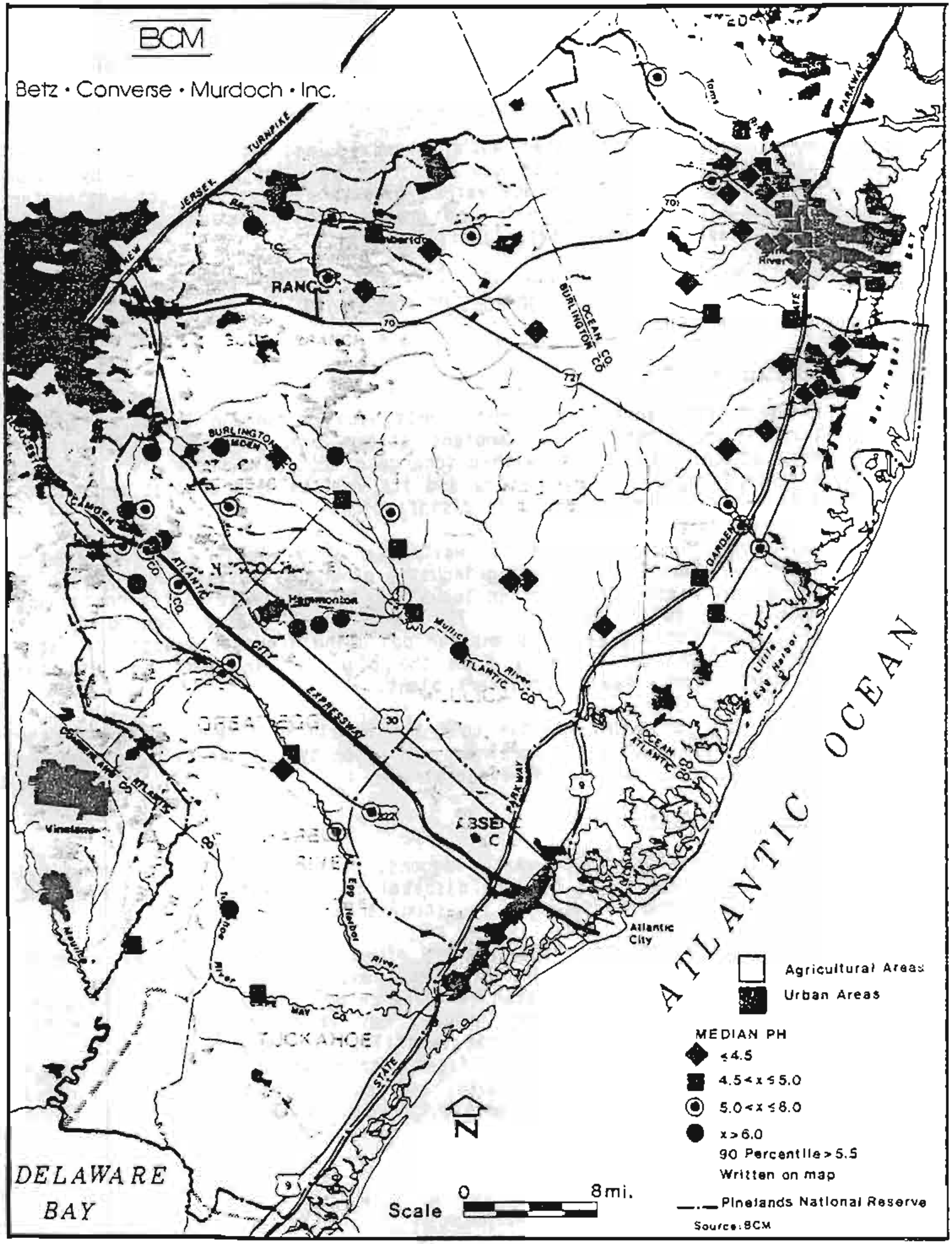
BCM
Betz · Converse · Murdoch · Inc.
NEW JERSEY TURNPIKE
ATLANTIC OCEAN
DELAWARE BAY
Hammonton
Vineland
Atlantic City
ATLANTIC CITY EXPRESSWAY
GARDEN STATE PARKWAY
OCEAN CO
BURLINGTON CO
Agricultural Areas
Urban Areas
MEDIAN PH
≤4.5
4.5<x≤5.0
5.0<x≤6.0
x>6.0
90 Percentile>5.5
Written on map
Pinelands National Reserve
Source: BCM
N
Scale
0
8mi.

Figure 2. pH

Human activity associated with urbanized and agricultural land can significantly affect water quality. The pollutants generated by urban activities may enter surface waters in several ways: direct wastewater discharge, stormwater runoff and groundwater contaminated from septic tanks, leaking pipes/tanks, landfills, etc.

SOURCES OF POLLUTANTS

Point Sources

Effluent from sewage treatment plants usually contain levels of pollutants significantly above ambient stream concentrations. Pollutants most commonly associated with discharge of domestic wastewater are BOD, nitrogen, phosphorous, chlorine and its various by-products, and pathogens released during lapses in disinfection.

Pollutants found in industrial wastewater vary widely according to the industry. The food processing industry generates wastes containing high BOD and nutrient levels; other industries may generate wastes containing metals and toxic chemicals. The temperature changes caused by the release of cooling water is another polluting effect. Industrial water may be discharged directly from the plant or incorporated into the discharge from a sewage treatment plant.

The effects of point sources upon the receiving streams depend on the type of wastes, level of treatment, dilution by the receiving stream and existing quality of the receiving stream.

Nonpoint Sources

Landfills, septic tanks, waste lagoons, construction sites, mining and extractions, and sites of land disposal of wastewater are all nonpoint sources which may be found in the study area.

Landfills can contain a wide variety of wastes. Many landfills, due to incorrect location, design, or operation, release leachate which is transported to streams by overland flow or by contaminated groundwater. The characteristics of the leachate may vary widely, reflecting the range of materials placed in the landfill. High concentrations of BOD, nutrients and bacteria are associated with domestic wastes, sludges from treatment plants and septic tanks, and food processing wastes. Various toxic substances and heavy metals can be associated with sludges and industrial wastes.

Lagoons are commonly used to hold wastes produced by manufacturing activities. These wastes can contain a wide range of toxic chemicals, or, in the case of food processing, heavy organic content and nutrients. Improper design, location or operation of a lagoon can cause these materials to enter waterways from leakage, overflow by stormwater, or stream flooding.

Although septic tanks may provide an economical and environmentally sound method of waste disposal, their improper location or operation may result in inadequate filtration of the wastes by the soil or surface overflow of the wastes. Because even properly operated septic tanks add nitrates to groundwater, high densities of septic tanks may cause excessive nitrate levels in groundwater, which in turn will affect stream concentrations.

Constructon activities are another nonpoint source of pollution. The main water pollution source associated with construction is sediments either from erosion as a result of removing cover vegetation or by exposing earth materials.

There are sand and gravel extraction sites in the study area which may be a source of sediment as earth materials are exposed during various stages of operation.

Land disposal, through ground percolation or spray irrigation, is an alternative means of disposing of domestic or food processing wastes. This method of waste disposal may be beneficial to water quality by substituting for direct stream discharge of wastewater. Nevertheless, because improper location and design of and inadequate operation or treatment at these sites may pollute ground and surface waters, they should be considered potential nonpoint sources.

Although these nonpoint sources--landfills, waste lagoons, septic tanks, sand and gravel extraction sites, and land disposal of effluent--represent specific identifiable sources of pollutants, all developed land has the capacity to be a source of water pollutants. The paving of previously vegetated area reduces the land's capacity for filtering and absorbing runoff; increased concentration of human activity results in increased deposition of a large number of pollutants on the land. As a result, urban land produces increased runoff which contains significant amounts of pollutants. Streets accumulate auto-related materials such as oil and grease, road salt and residual particulates from tires and brakes, as well as animal wastes, household and commercial refuse awaiting collection, and fertilizers and pesticides used in lawn care. Urban runoff enters waterways either by overland flow or through storm sewers.

Agricultural activities also generate pollutants--removal of vegetative cover during tillage leaves soil exposed to erosion. Nitrates, being readily soluble, can be leached out in runoff; sediment, itself considered to be a pollutant, is also a carrier for phosphates, organic matter, heavy metals and pesticides. In addition, materials such as pesticides, animal wastes, and chemical fertilizers can be transported to streams after they are applied to crops. Because of the acidic nature of the Pinelands soil, the addition of lime is a common agricultural practice. Runoff from limed fields can raise the pH of adjacent surface waters.

There have been many studies quantifying the polluting effects of various land uses upon surface waters. The U.S. Environmental Protection Agency (EPA) (Table 1) has summarized a number of these studies to provide estimates of the annual contribution through runoff per acre of particular land use. The table shows that the lowest pollution load originates from forested areas. Except for nitrogen, urban land produces a higher concentration of pollutants than agricultural land. Landfills and feedlots generate the highest concentrations of the measured pollutants.

Table 1 presents data accumulated from studies throughout the country. Data for parts of southern New Jersey, based upon studies by the Delaware Valley Regional Planning Commission (DVRPC) for seven watersheds in its 208 planning area (Table 2) show similar results as to the relative contributions of urban, agricultural and suburban land to water pollution.

POINT AND NONPOINT POLLUTION EFFECTS

It may be possible to calculate total annual poundage of various pollutants by using data in Table 1 for nonpoint sources and measured characteristics of effluent for point sources. These data would allow for a comparison of total annual poundage of pollutants between point and nonpoint sources. Comparing the environmental effects of pollutants is much more difficult because the various pollutants have different patterns of entering streams. Point sources and some nonpoint sources such as landfill leachate consist of regular flows; most nonpoint sources are highly irregular; a few storms a year may be responsible for the bulk of nonpoint pollutants entering streams.

TABLE 1

RUNOFF AREAL LOADING RATE
(pounds/square mile/day)[a]

Land Use	Total Nitrogen	Total Phosphorus	BOD_5	TSS	Total Coliform
Agriculture	15 (1.9-58)	1.0 (0.05-3.9)	40 (6.3-57)	2,500 (449-6,595)	---
Forest	4 (1.3-16)	0.25 (0.01-1.4)	8 (6.3-11)	400 (71-620)	---
Pasture	8 (3.9-13.3)	0.5 (0.4-1.0)	17 (9.4-27)	670 (19-1,320)	---
Feedlots	1,700 (1,080-2,290)	370 (200-610)	---	---	---
Landfill	1,250 (50-2,500)	---	15,000 (80-33,100)	---	---
Urban	8 (3.3-28)	1.3 (0.4-7.9)	70 (20-129)	3,400 (306-7,526)	1,000[b] (1000-24,000)

(a) Average runoff concentration in mg/l; range presented in parentheses

(b) Runoff concentration in numbers/100 ml

Source: United States Environmental Protection Agency, 1976

TABLE 2

ANNUAL UNIT POLLUTANT LOADS RESULTING FROM STORM RUNOFF
(lbs/square mile/day)

Land Use	BOD	Total Phosphorus	Pb
Urban	36.8	1.10	0.12
Agriculture	4.2	0.50	0
Forest	2.6	0.09	0
Mixed	14.0	0.52	0.04

Source: Adapted from Delaware Valley 208 Joint Venture, 1977

SUB-BASIN ANALYSIS

In order to document the effects of developed and agricultural land on water quality, water quality was compared to land use in 15 sub-basins. These basins were defined on the basis of water quality station sites and were chosen to represent a range of water quality levels. The sub-basins were also selected to ensure an adequate representation of geographic areas and land use percentages.

Sub-basin Characteristics

Land use point source discharge and water quality information were combined for the 15 sub-basins (see Technical Memorandum SW IV-5, Appendices 2 and 3 for details). Land use data used in the sub-basin analysis were derived from 1980 Pinelands vegetation maps and 1978 aerial photographs. The vegetation maps identified the gross categories of developed land and agricultural land. The aerial photographs were used to classify developed land into four density categories and agricultural land into pasture land, grain crops and row crops. The areas of each land use were measured by planimeter and aggregated by sub-basin. Appendix 1 presents the land use data.

Municipal Treatment Plant Effects

The effect of a municipal treatment plant discharge on receiving stream water quality will depend on the quality and quantity of effluent, quality and flow levels of the receiving stream, the biological community and the distance between the treatment plant and water quality sampling station. However, the relative effects of point source discharge can be represented by the quantity of municipal treatment plant effluent discharged upstream of a water quality station divided by the drainage basin size at the sampling location. The relative contribution of domestic discharge effluent to total streamflow was calculated for 75 water quality sampling stations; results for the 15 sub-basins used in this study are presented in Table 3. Units are given in thousands of gallons of effluent per day per square mile of drainage area. A similar calculation was not possible for industrial discharge due to lack of data and the generally sporadic flow discharge.

Of all the 75 water quality stations in the study area, Hammonton Creek at Hammonton had the highest quality of domestic effluent, 270 thousand gallons per day per square mile of drainage area. Among the 15 sub-basins used in this analysis, Hammonton Creek at Westcoatville had the highest amount, 76 thousand gallons per day per square mile.

In addition to knowing the treatment plant contribution to streamflow, it is important to know the levels of pollutants added to the stream by point sources. Some simple calculations were made to estimate the effects of domestic point sources as nutrient concentrations in streams (Table 4). The calculations were based on an effluent level of 1,000 gallons per day per square mile of drainage area. The resulting pollutant concentrations presented in Table 4 can be multiplied by the quantity of domestic discharge at each sampling station (given in Table 3) to estimate the contribution of point sources to the nutrient levels recorded at the water quality station.

The assumption of effluent quality represents those of typical secondary treatment. Table 4 presents rough calculations and should only be used to show a relative comparison. Actual effects will depend upon degree of treatment, distance between dischargers and water quality measuring stations, and in-stream biological, chemical and physical conditions. Effects will vary among parameters also. Total dissolved solids (TDS) concentrations may vary less with distance below the discharger outfall than phosphorus. The effects of BOD, particularly, will decrease from the point of discharge to the point of measurement due to biodegradation and settling of the pollutant.

TABLE 3

SUB-BASIN WATER QUALITY AND LAND USE

	Water Quality Station			
	01466500 McDonalds Branch in Lebanon State Forest	01412100 Manumuskin River near Manumuskin	01408830 Cedar Creek Whiting-Lacey Road	01411290 Tuckahoe River near Estell Manor
Drainage Area	2.3	32.1 (21.2 within Pinelands)	20.1	8.8
Water Quality Index	5 (pristine)	5 (pristine)	6 (good)	5 (good)
Pollutant Sources				
Quantity of Domestic Discharge (1000 gal/day/sq. mi.)	0	0	0	0
Number of Domestic Dischargers	0	0	0	0
Number of Industrial Dischargers	0	1	0	0
Number of Landfills	0	0	0	0
Number of Land Disposal Sites	0	0	1	0
Land Use				
Percent Developed	0	3.0	0.5	8.0
Percent Agricultural	0	8.0	1.5	10.0
Water Quality				
Total Dissolved Solids 10%	15	24	19	20
50%	26	32	30	32
90%	38	40	50	43
Suspended Solids	0	0	1	0
	1	2	1	3
	2	7	6	9
Biochemical Oxygen Demand	0.2	0.4	0.5	0.7
	0.6	0.8	1.0	1.4
	1.6	1.5	3.9	2.5
Total Nitrogen	0.09	0.13	0.20	0.24
	0.15	0.27	0.14	0.45
	0.48	0.42	0.40	0.86
Fecal Coliform	2	5	2	2
	2	23	20	20
	23	79	20	130
Phosphorus	0.00	0.00	0.01	0.01
	0.01	0.01	0.01	0.01
	0.02	0.04	0.07	0.04
pH	3.60	4.10	4.14	4.20
	4.10	4.40	4.60	5.10
	4.60	4.90	5.41	5.80

TABLE 3 (Continued)

	Water Quality Station			
	01411140 Deep Run Branch at Weymouth	OCN059 Westecunk Creek at Martha's Rd.	OCN035 Wrangle Branch off Fort de France Ave.	01411053 Hospitality Branch at Berryland
Drainage Area	20.0	15.6	12.0	20.0
Water Quality Index	5 (good)	6 (slightly disturbed)	6 (slightly disturbed)	6 (slightly disturbed)
Pollutant Sources				
Quantity of Domestic Discharge (1000 gal/day/sq. mi.)	14.0	0	0	0
Number of Domestic Dischargers	1	0	0	0
Number of Industrial Dischargers	0	0	1	0
Number of Landfills	1	0	0	0
Number of Land Disposal Sites	1	0	2	0
Land Use				
Percent Developed	3.0	0.1	9.0	15.5
Percent Agricultural	12.0	0	0	26.3
Water Quality				
Total Dissolved Solids 10%	34	20	27	29
50%	42	29	41	42
90%	60	41	54	53
Suspended Solids	0	1	1	0
	5	2	2	6
	12	5	5	9
Biochemical Oxygen Demand	0.3	0.5	1.0	0.8
	0.9	2.1	2.7	1.4
	2.0	4.8	4.5	2.3
Total Nitrogen	0.38	--	--	0.37
	0.62	0.38	1.32	0.69
	0.80	1.80	1.54	1.1
Fecal Coliform	5	20	20	2
	49	20	20	46
	130	790	790	920
Phosphorus	0.03	0.01	0.01	0.01
	0.06	0.01	0.01	0.03
	0.13	0.01	0.08	0.05
pH	3.90	4.30	4.00	4.80
	4.40	4.63	4.20	5.70
	6.20	5.35	4.70	6.00

TABLE 3 (Continued)

	Water Quality Station		
	01409411 Nescochaque at Pleasant Mills	01409450 Springers Brook near Indian Hills	01465970 North Branch Rancocas Creek at Browns Hills
Drainage Area	43.8	12.6	19.5
Water Quality Index	6 (slightly disturbed)	7 (slightly disturbed)	7 (slightly disturbed)
Pollutant Source			
Quantity of Domestic Discharge (1000 gal/day/sq. mi.)	5.3	0	3.6
Number of Domestic Dischargers	1	0	2
Number of Industrial Dischargers	3	0	0
Number of Landfills	1	1	1
Number of Land Disposal Sites	1	0	0
Land Use			
Percent Developed	9.5	5.5	40.0
Percent Agricultural	36.0	41.0	0
Water Quality			
Total Dissolved Solids 10%	39	57	30
50%	69	93	39
90%	56	108	50
Suspended Solids	0	1	0
	4	6	4
	5	9	15
Biochemical Oxygen Demand	0.6	1.0	0.8
	1.2	2.0	1.5
	2.1	3.0	2.3
Total Nitrogen	0.46	0.53	0.34
	0.89	1.60	0.50
	1.20	2.00	1.20
Fecal Coliform	20	20	2
	50	20	13
	330	236	350
Phosphorus	--	0.01	0.01
	--	0.03	0.04
	--	0.04	0.14
pH	4.40	5.40	6.50
	5.90	6.40	5.20
	6.60	6.60	6.00

TABLE 3 (Continued)

	Water Quality Station			
	01409416 Hammonton Creek at Westcoatville	01409403 Wildcat Branch at Chesilhurst	OCN042 Manapaqua Branch Lakehurst-Ridgeway Road (Tributary to Union Branch)	01410865 Squankum Branch at Malaga Road
Drainage Area	9.6	1.0	5.9	3.0
Water Quality Index	9 (more disturbed)	10 (most disturbed)	10 (most disturbed)	12 (most disturbed)
Pollutant Source				
Quantity of Domestic Discharge (1000 gal/day/sq. mi.)	76.0	0	25.4	0
Number of Domestic Dischargers	1	0	1	0
Number of Industrial Dischargers	1	1	0	0
Number of Landfills	0	1	1	0
Number of Land Disposal Sites	0	0	0	0
Land Use				
Percent Developed	17.5	45.0	46.0	36.5
Percent Agricultural	41.5	10.0	0	23.0
Water Quality				
Total Dissolved Solids 10%	40	49	35	62
50%	88	89	62	120
90%	141	155	83	179
Suspended Solids	4	4	4	0
	0	21	7	7
	11	70	18	27
Biochemical Oxygen Demand	1.0	0.1	2.7	1.0
	2.6	3.9	6.7	7.8
	4.4	17.0	24.5	35.0
Total Nitrogen	3.90	0.48	--	1.60
	4.80	1.20	1.90	3.90
	6.40	22.00	7.19	11.00
Fecal Coliform	11	2	20	20
	20	2,400	50	230
	350	24,000	330	2,600
Phosphorus	1.10	--	0.06	0.01
	1.10	--	0.34	0.14
	3.00	--	0.55	4.20
pH	4.80	5.20	5.10	5.90
	6.10	5.90	5.75	6.70
	6.50	6.50	6.50	7.00

The impact of point source discharge will also vary with streamflow conditions. Table 4 presents point source nutrient contributions under several streamflow assumptions. The flow assumptions are based on low, medium, and high flows for the Mullica River. Low flow is defined as the flow which is exceeded 90% of the time, high flow as the flow which is exceeded only 10% of the time. A point source will have the most effect on water quality during low flow because it will make up a higher percentage of the total streamflow at any one point. At high flows, the point sources will have less effect, partly because of greater dilution and partly because nonpoint source pollutant contribution increases during storm-related high flow conditions. The effect of point sources on small streams with small drainage areas will be greater due to their relatively low flow volumes, compared to larger streams.

Land Use/Water Quality Relationships in the Pinelands

The investigation of the relationship of land use and water quality in the sub-basins used graphs and statistical analysis. Visual presentation through graphs presents the data more vividly than do statistics. Nevertheless, statistical analysis is able to separate the effects of development and agriculture more efficiently than graphic display.

In order to simplify this analysis, only one residential development category was used.* Cropland was the only agricultural category considered; pasture and meadows were expected to have minor effects on water quality and generally comprised negligible portions of the studied sub-basins.

Figure 3 provides a graphic summary of the land use data by plotting each watershed in the sub-basin study with respect to the percent of watershed that is developed and the percent that is agriculture. The graph shows that the selected sub-basins cover a wide range of conditions: intact, highly developed, highly agricultural and various combinations of agriculture and development.

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* Four categories would be too complex to present graphically and too few sub-basins were analyzed to use this level of detail in statistical analysis. Using density weighting factors in aggregating developed land was considered but discarded because it added little to the predictive ability of the statistical analysis.

TABLE 4

ESTIMATE OF EFFECTS OF MUNICIPAL TREATMENT PLANT
EFFLUENT ON MULLICA RIVER WATER QUALITY
(for each 1000 gallons of effluent/day/sq. mi. of drainage area)

Parameter	Assumed Effluent Concentration (ppm)	Low Flow (0.34 MGD) (ppm)	Medium Flow (0.97 MGD) (ppm)	High Flow 2.13 MGD) (ppm)
Phosphorus	5	.015	.005	.002
Nitrogen	30	.080	.031	.014
Biochemical Oxygen Demand (BOD)	25	.073	.025	.012
Total Dissolved Solids (TDS)	200	.586	.206	.093

See Appendix 2 for calculations

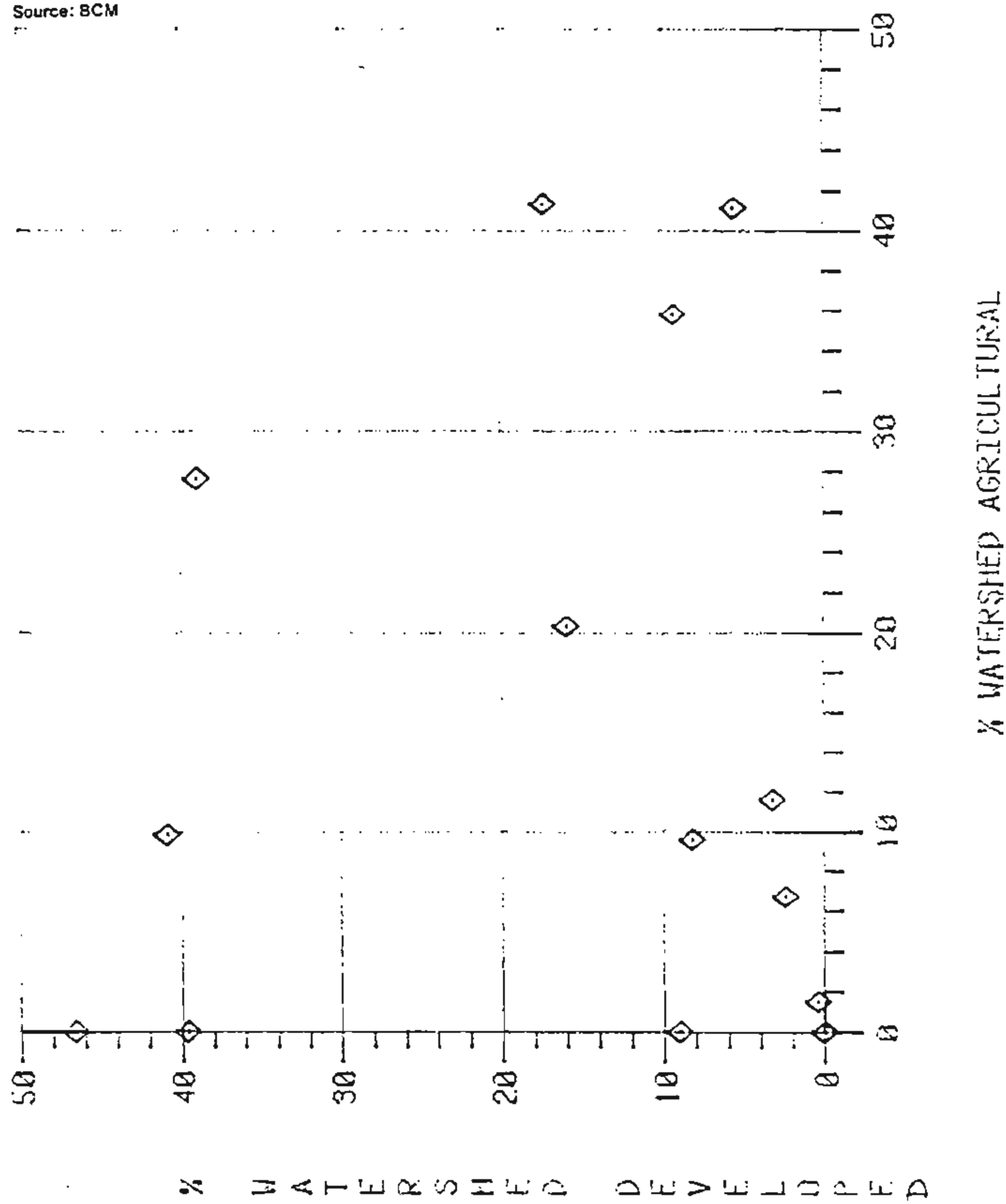
Major Assumptions:

- Treatment Plant Effluent = 0.001 mgd/sq. mi. of drainage area
- Water quality sampled immediately downstream from effluent outfall
- Secondary treatment of waste

Source: Betz•Converse•Murdoch•Inc.

FIGURE 3
DEVELOPED LAND VS. AGRICULTURAL LAND

Source: BCM



Graphs were plotted comparing each land use to various water quality indicators. Figure 4 shows the relationship between the water quality index and the percent of development in the basin. Figure 5 shows the relationship between the index and the percent of agricultural land of the basin. Figures 6 through 19 show similar relationships to land use for each of the five component parameters in the water quality index: BOD, total dissolved solids, total nitrogen, fecal coliform and suspended solids, as well as phosphate and pH.

Most of these graphs show that basins with greater proportions of developed and agricultural land had poorer water quality. The apparent strengths of this relationship varied among the parameters.

Because these basins represent various combinations of developed and agricultural land, it is difficult to determine the water quality effects of development and agriculture separately. Regression analysis was used for this purpose.

Least square regressions were performed for the water quality index, each of the five parameters composing the index, phosphate, and pH to examine the effect of development alone, agriculture alone, and development and agriculture together. Table 5 presents the results of the regression analysis. Because of inadequate data, domestic point source was excluded from the regression results. Only five of the sub-basins had any domestic discharges, with one particular basin having much greater domestic loads than the rest. The pollutant concentrations calcuated in Table 4 can be used in a manner similar to regression coefficients for point source contributions. However, these should be confirmed by additional sub-basin analysis.

The regression analysis indicates that both developed and agricultural land are associated with poor water quality. Developed land per areal unit has a greater effect on the water quality index than does agricultural land. The effects on individual water quality parameters vary. Agriculture tends to be associated with higher total dissolved solids, total nitrogen and pH than does developed land, but has little association with BOD or fecal coliform levels. The relationship between agriculture and elevated total dissolved solids and pH levels may results from liming of croplands. One must be careful interpreting these results because part of the relationship may be due to the characteristics of the soils which are most suitable for croplands. Development shows statistically significant effects on all indicators except phosphates.

FIGURE 4
WATER QUALITY VS. DEVELOPED LAND

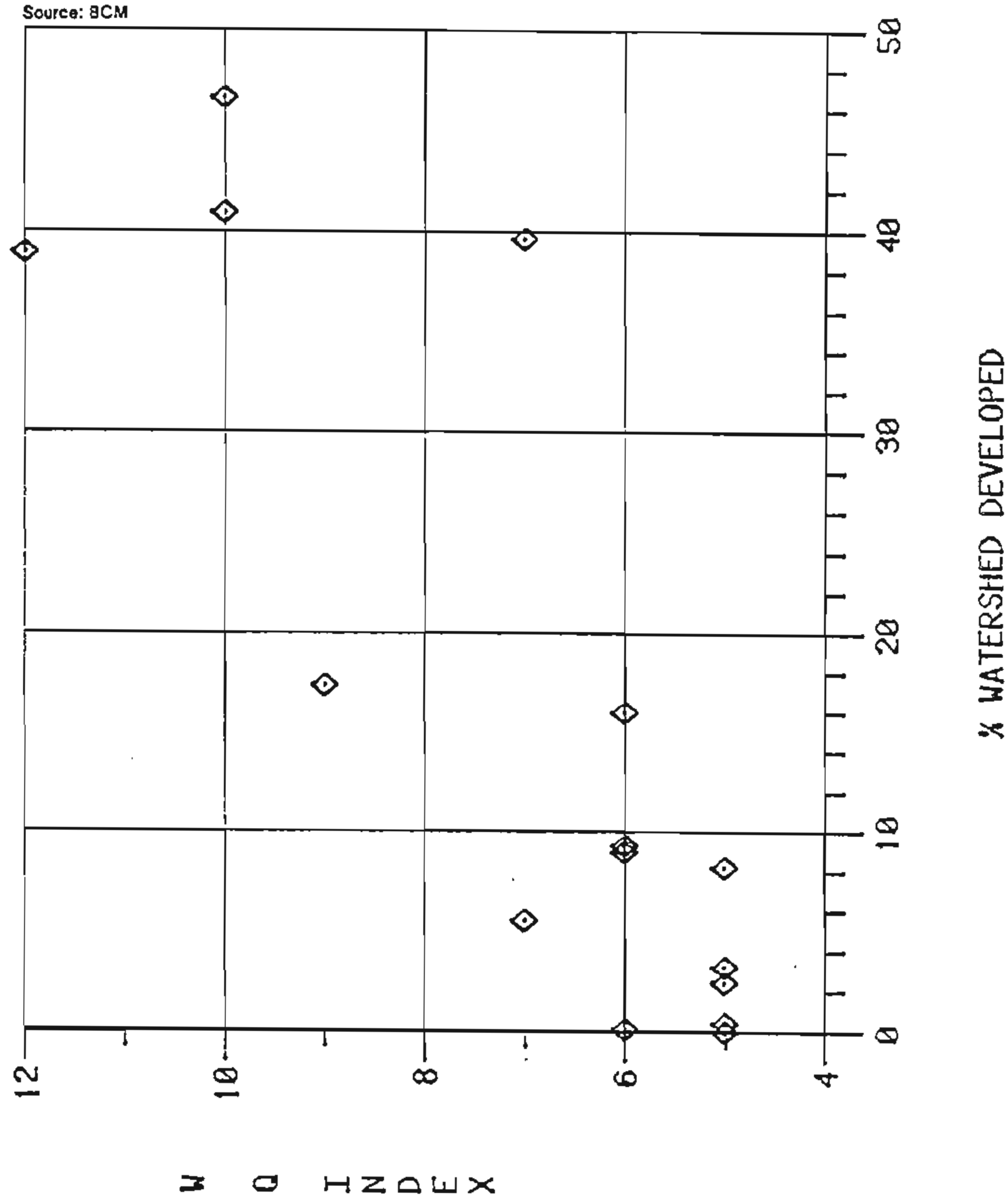


FIGURE 5
WATER QUALITY VS. AGRICULTURAL LAND

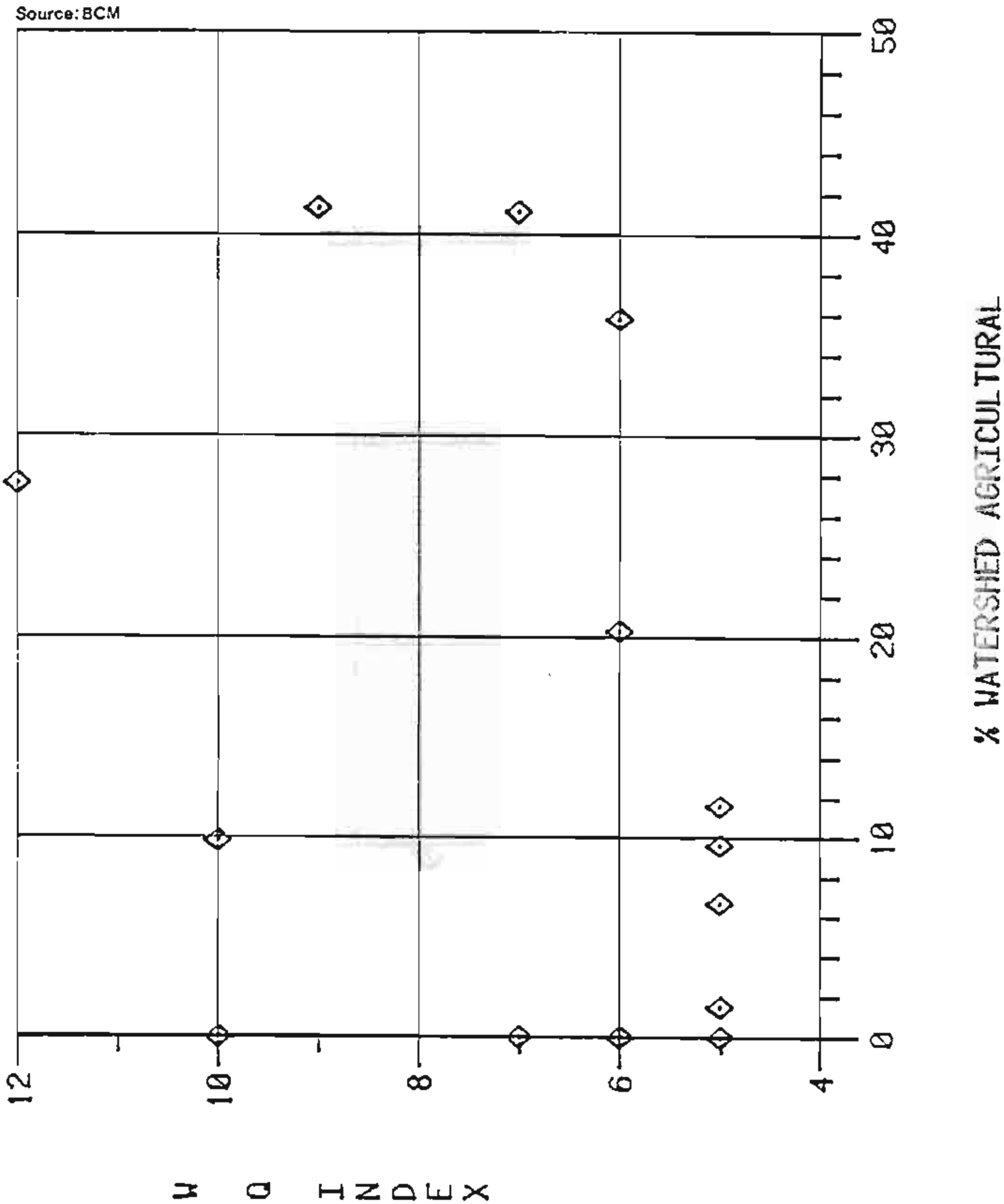


FIGURE 6
TDS VS. DEVELOPED LAND

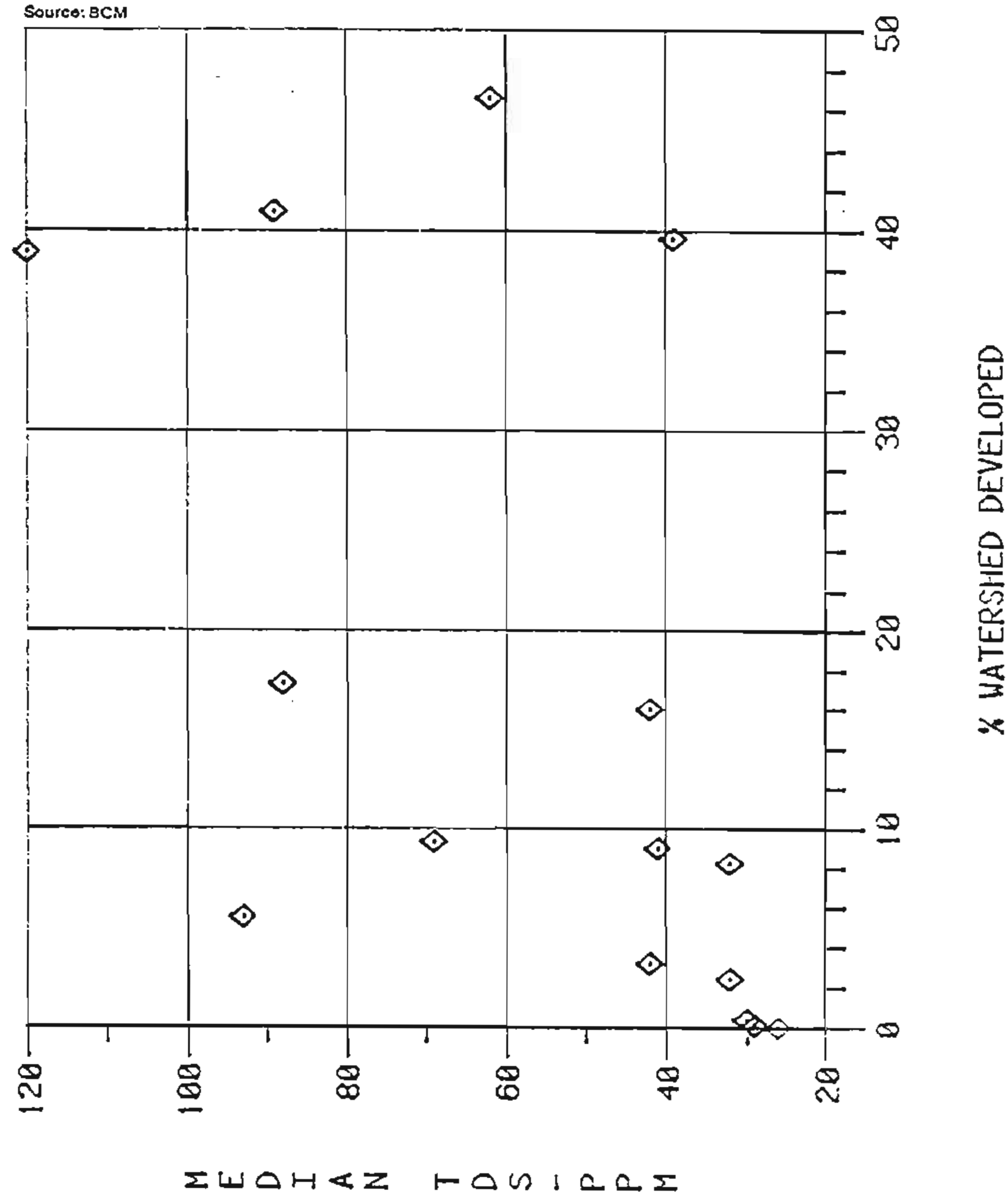
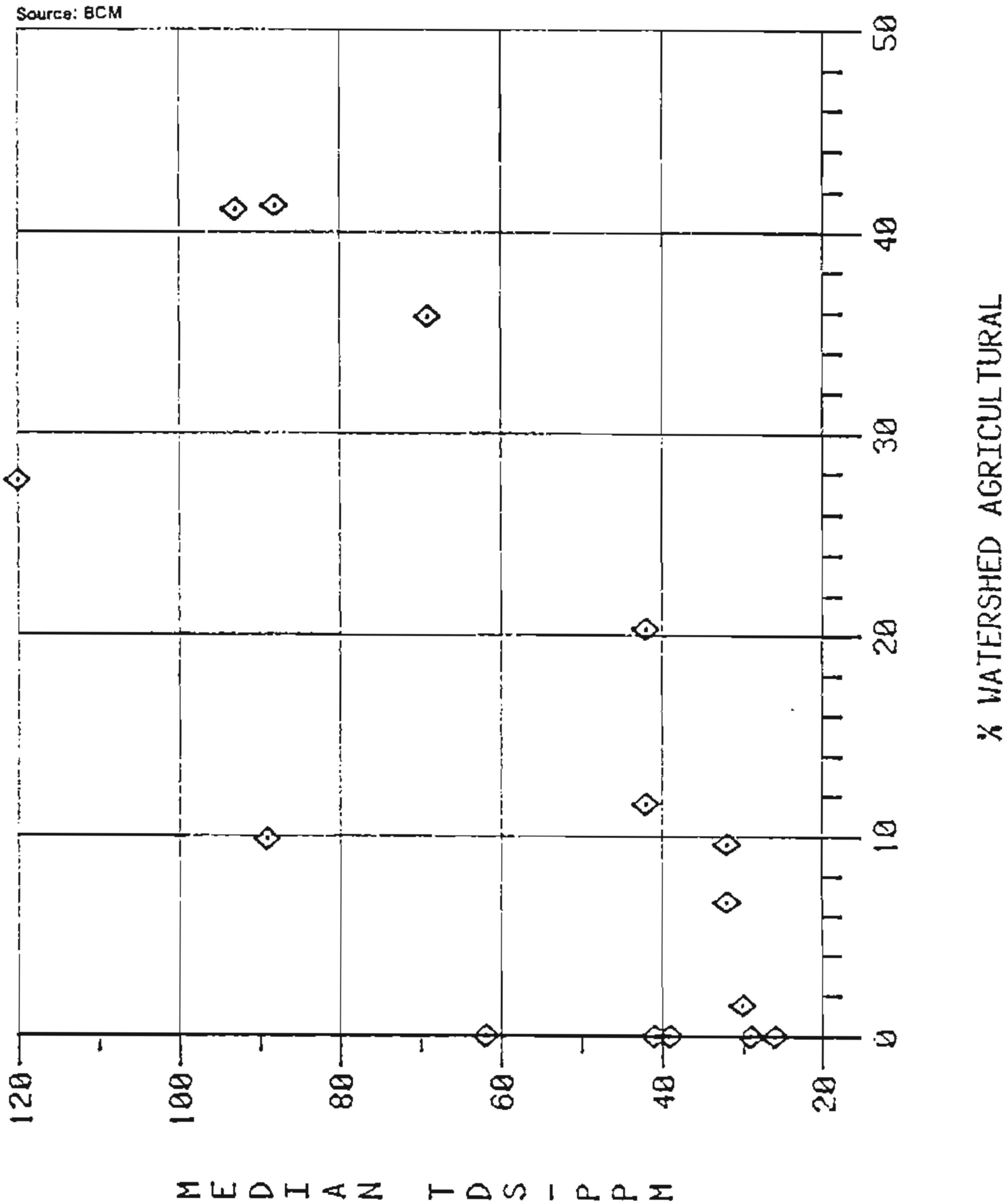


FIGURE 7
TDS VS. AGRICULTURAL LAND



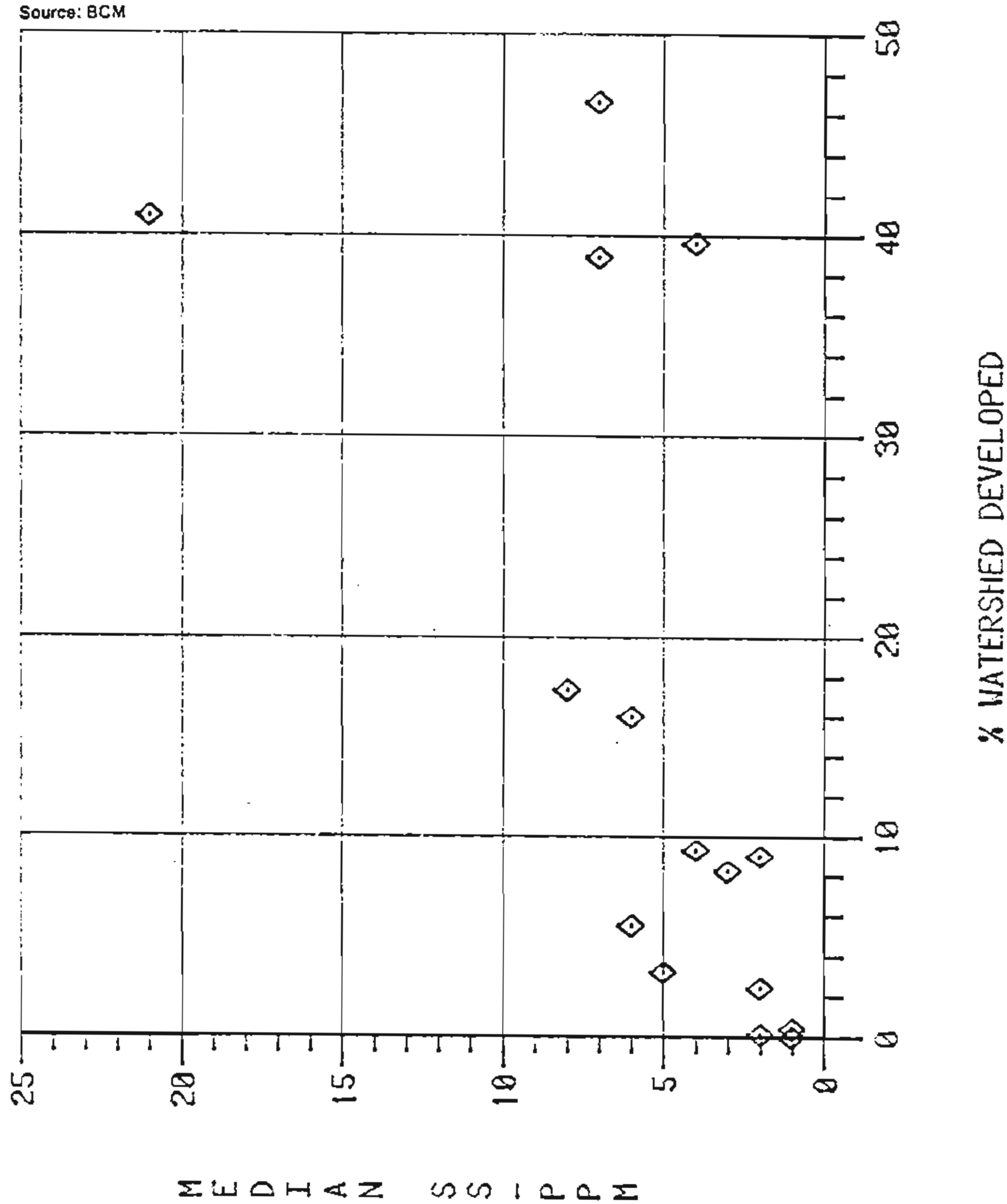
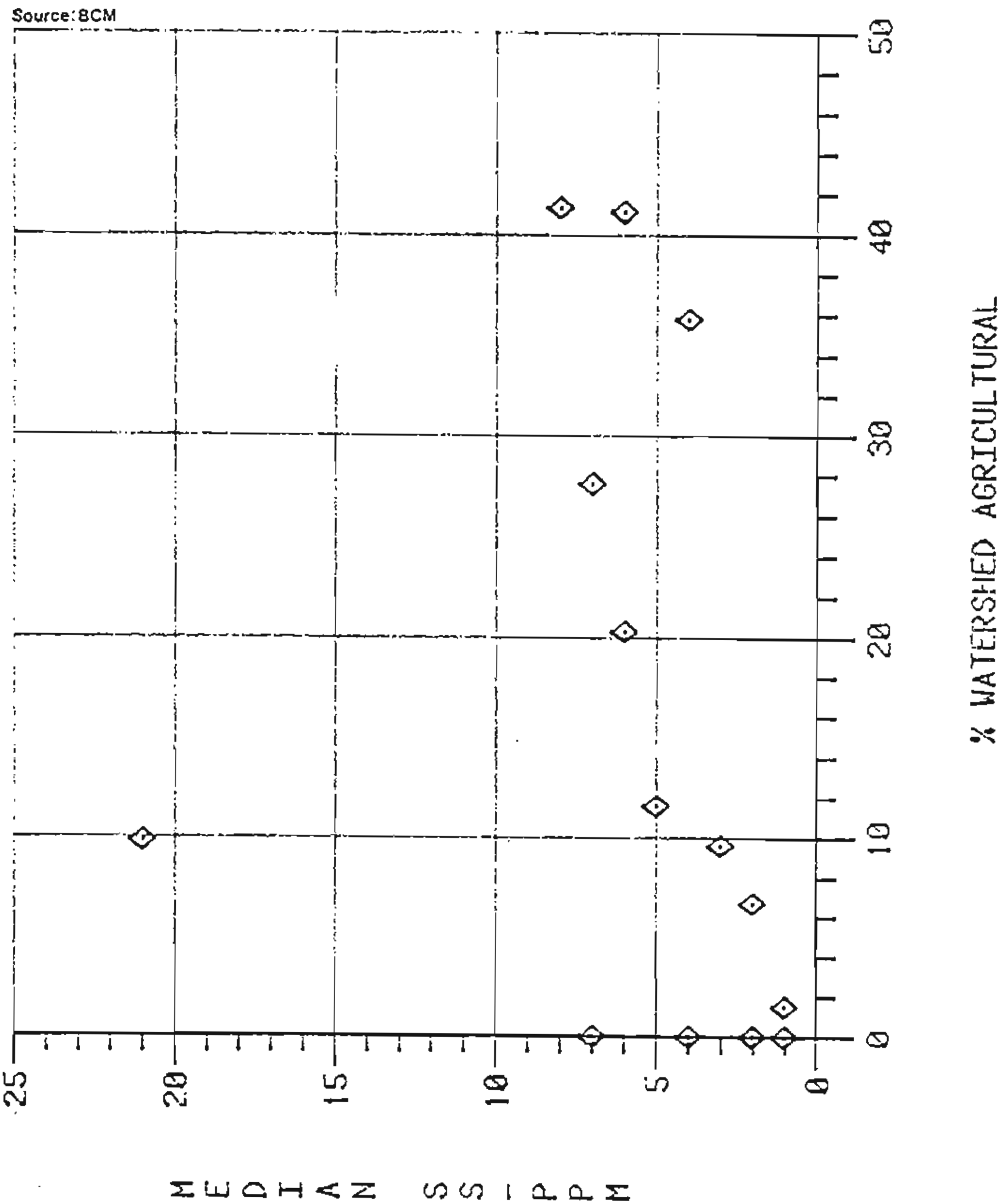


FIGURE 8
SS VS. DEVELOPED LAND

FIGURE 9
SS VS. AGRICULTURAL LAND



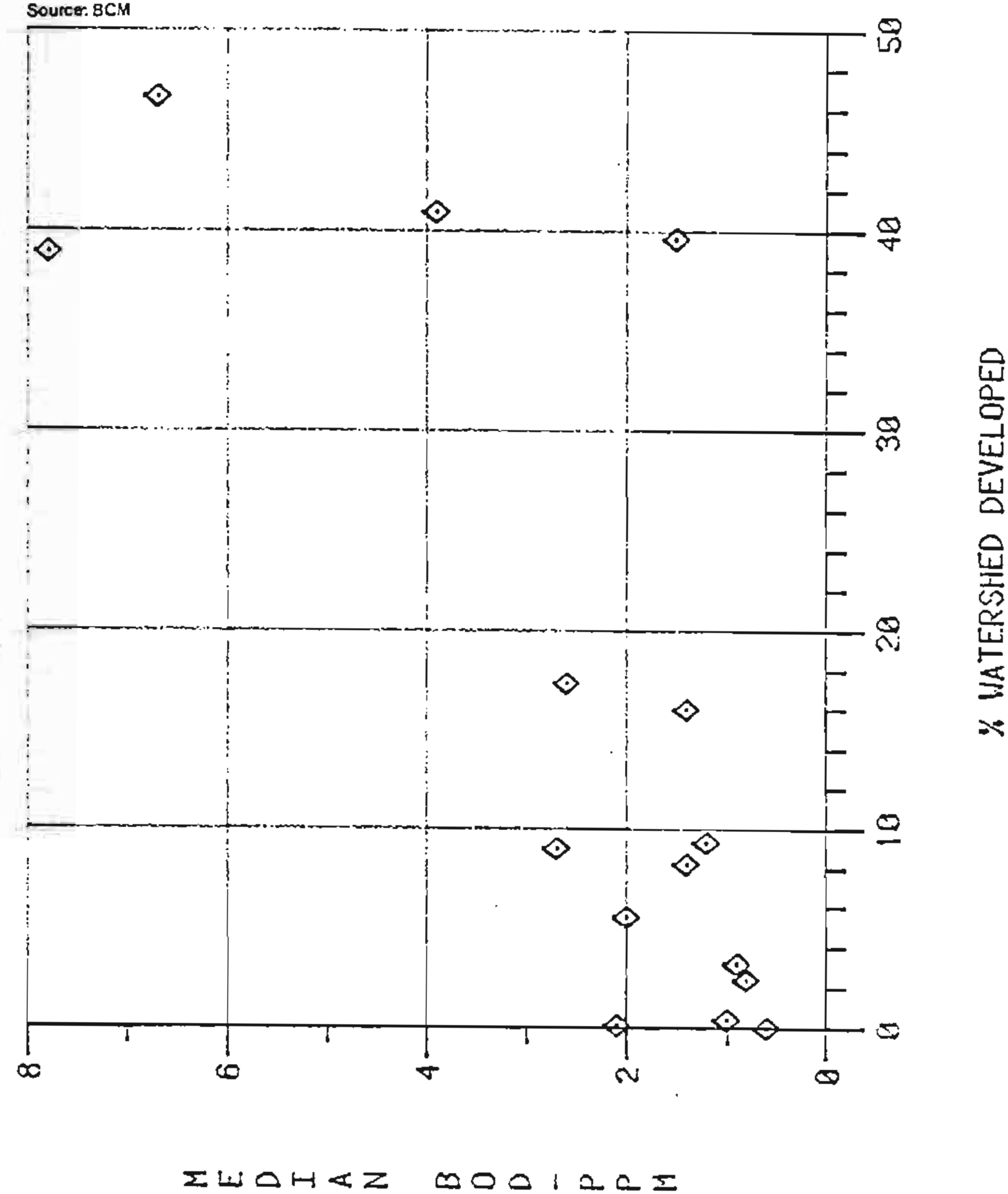


FIGURE 10
BOD VS. DEVELOPED LAND

FIGURE 11
BOD VS. AGRICULTURAL LAND

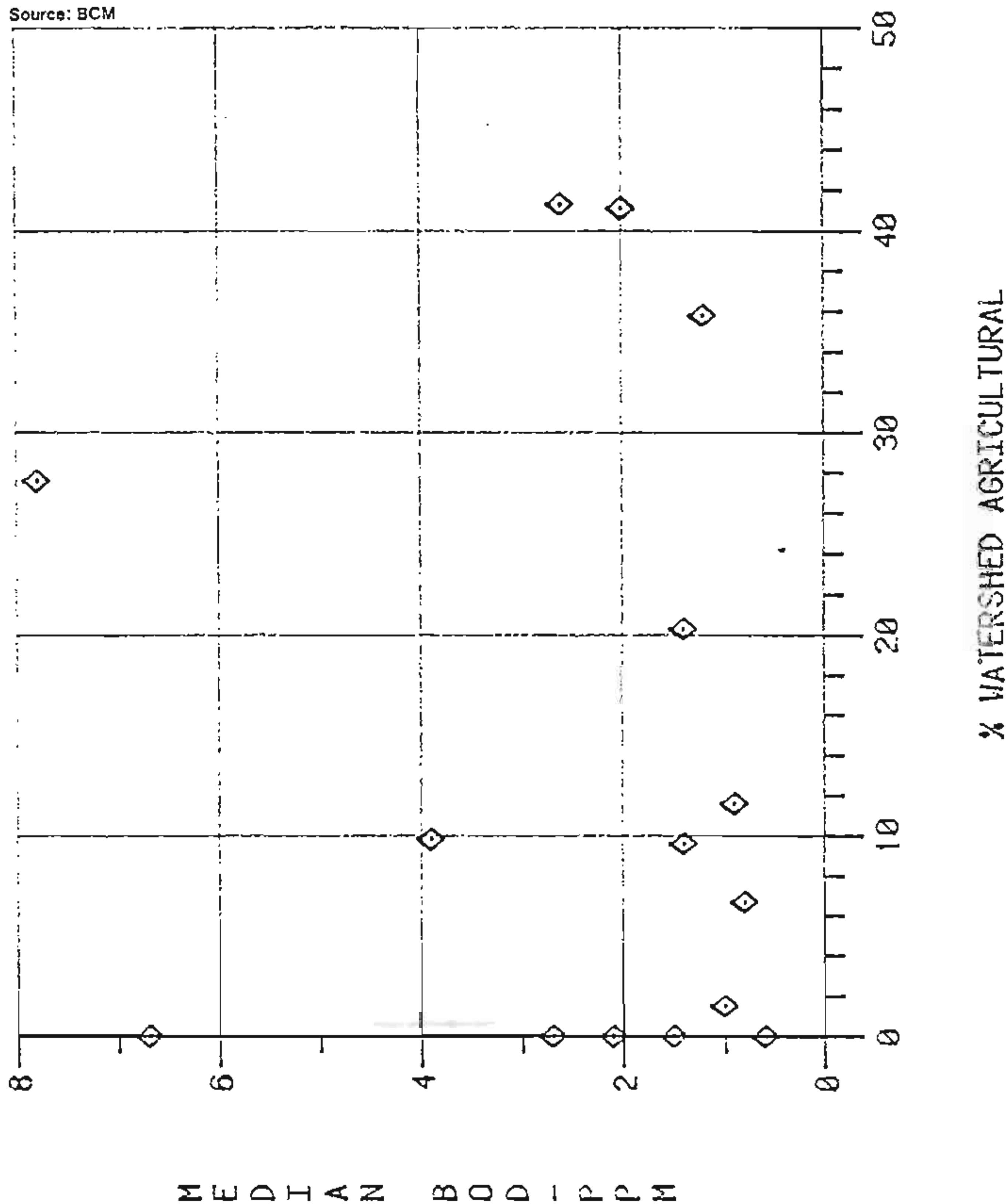


FIGURE 12
NITROGEN VS. DEVELOPED LAND

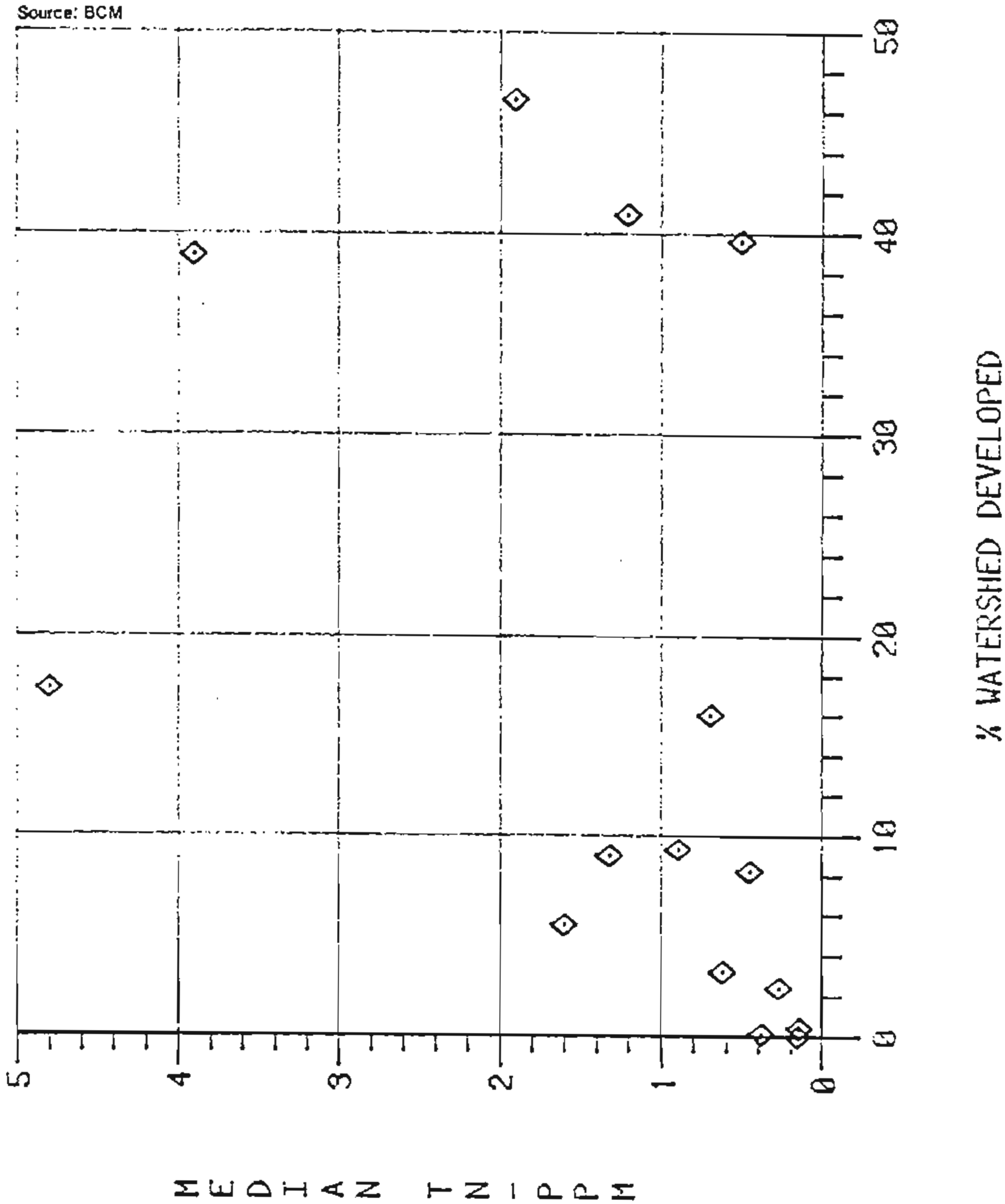


FIGURE 13
NITROGEN VS. AGRICULTURAL LAND

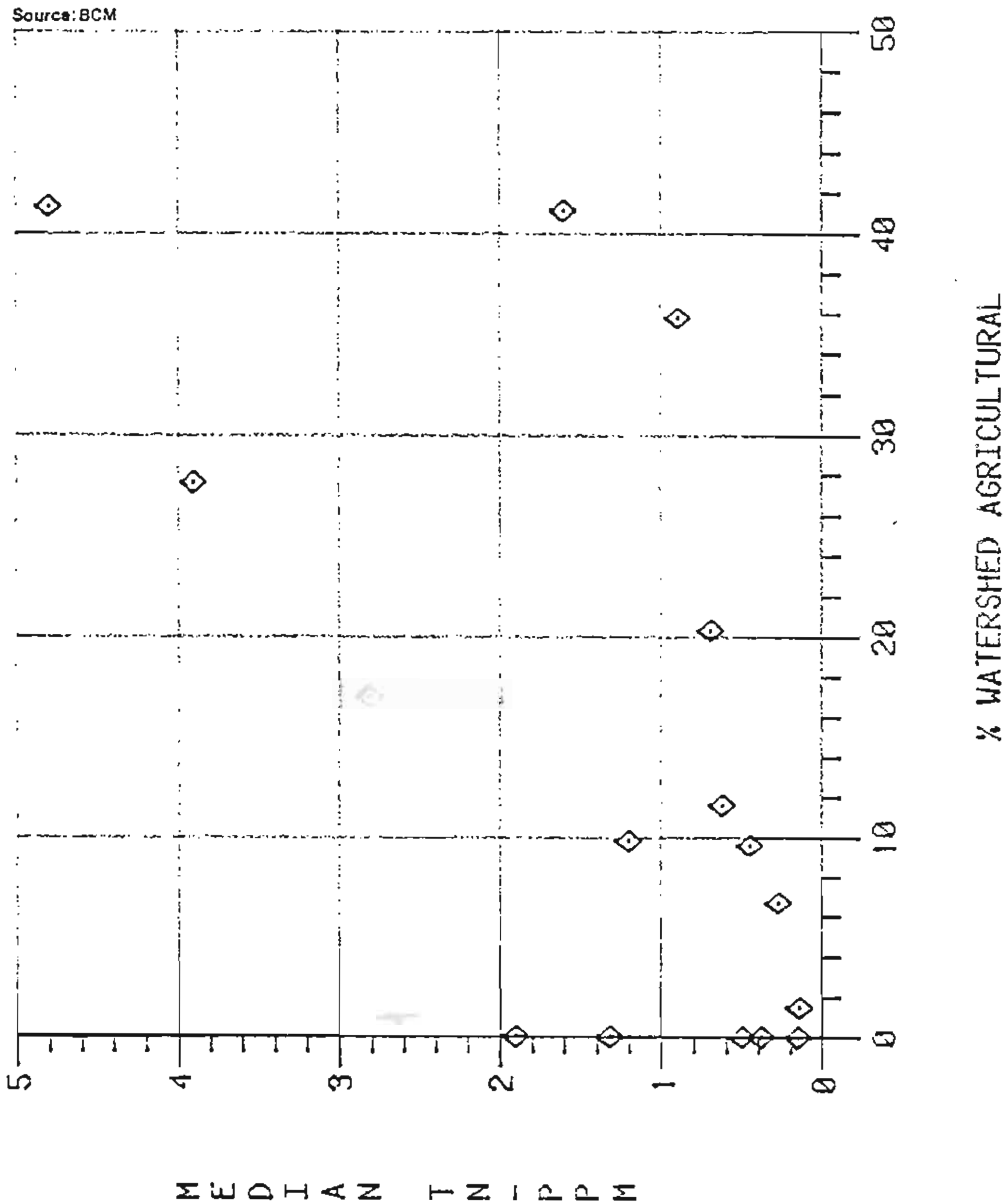


FIGURE 14
FECAL COLIFORM VS. DEVELOPED LAND

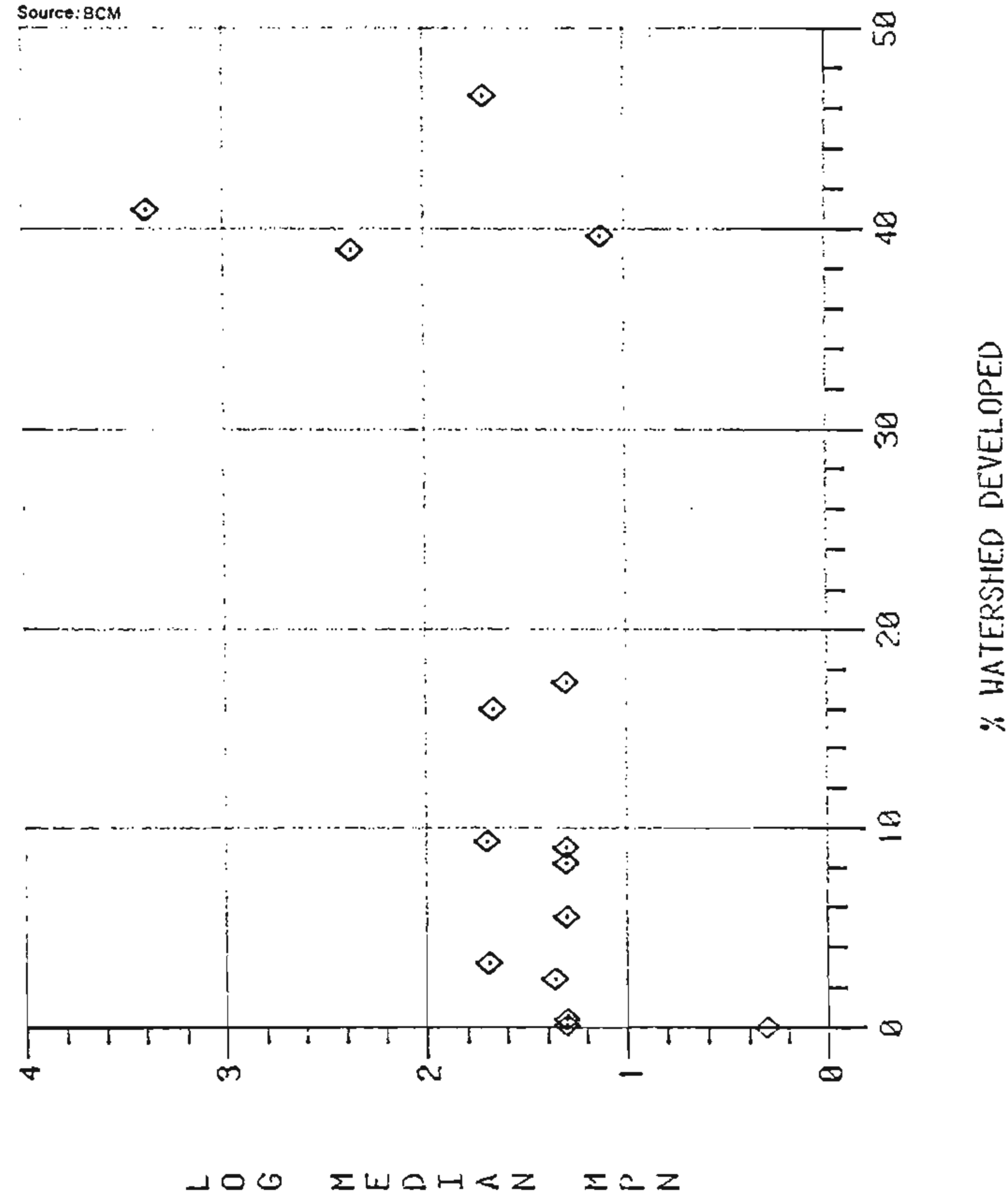


FIGURE 15
FECAL COLIFORM VS. AGRICULTURAL LAND

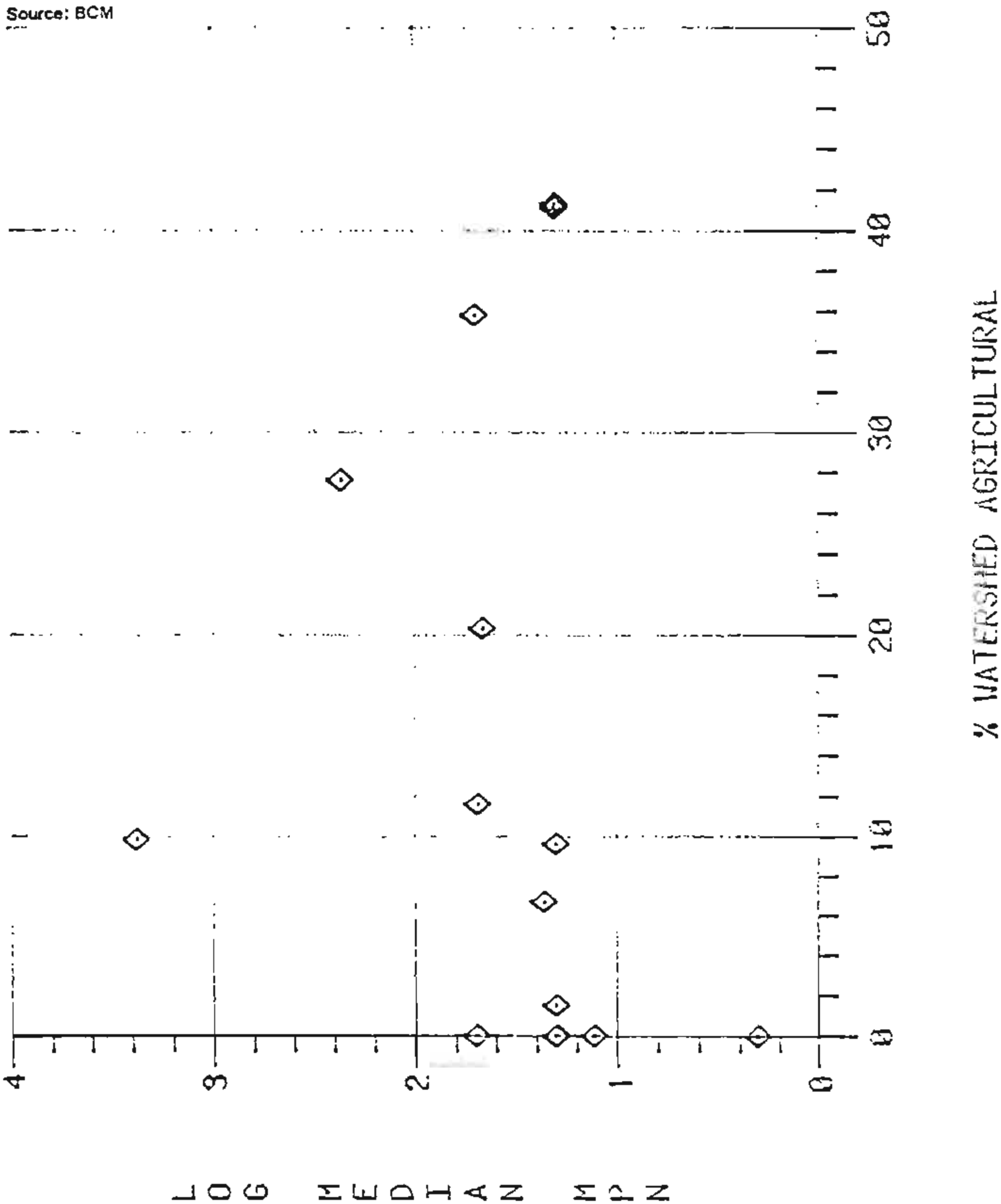


FIGURE 16
PHOSPHATE VS. DEVELOPED LAND

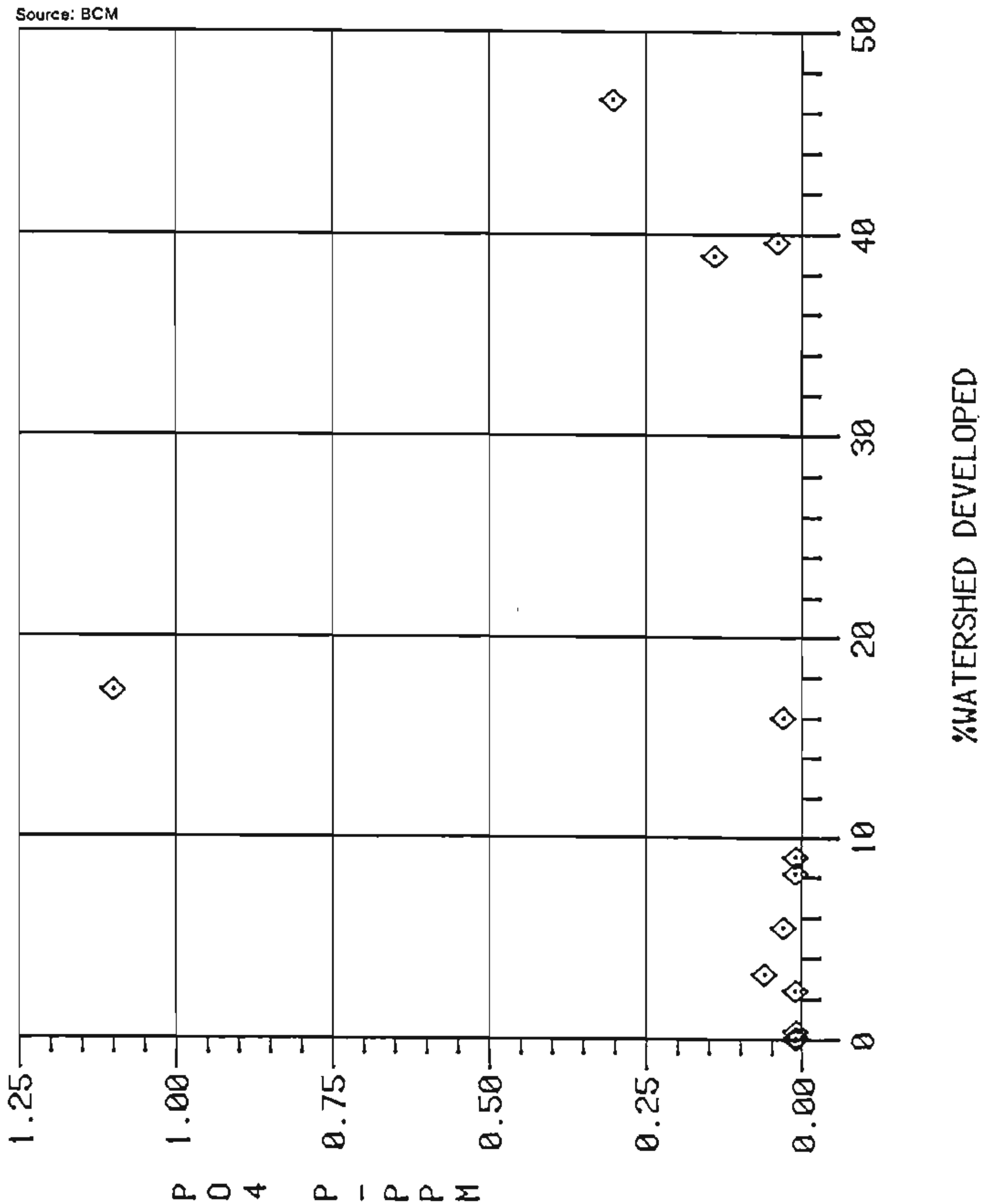


FIGURE 17
PHOSPHATE VS. AGRICULTURAL LAND

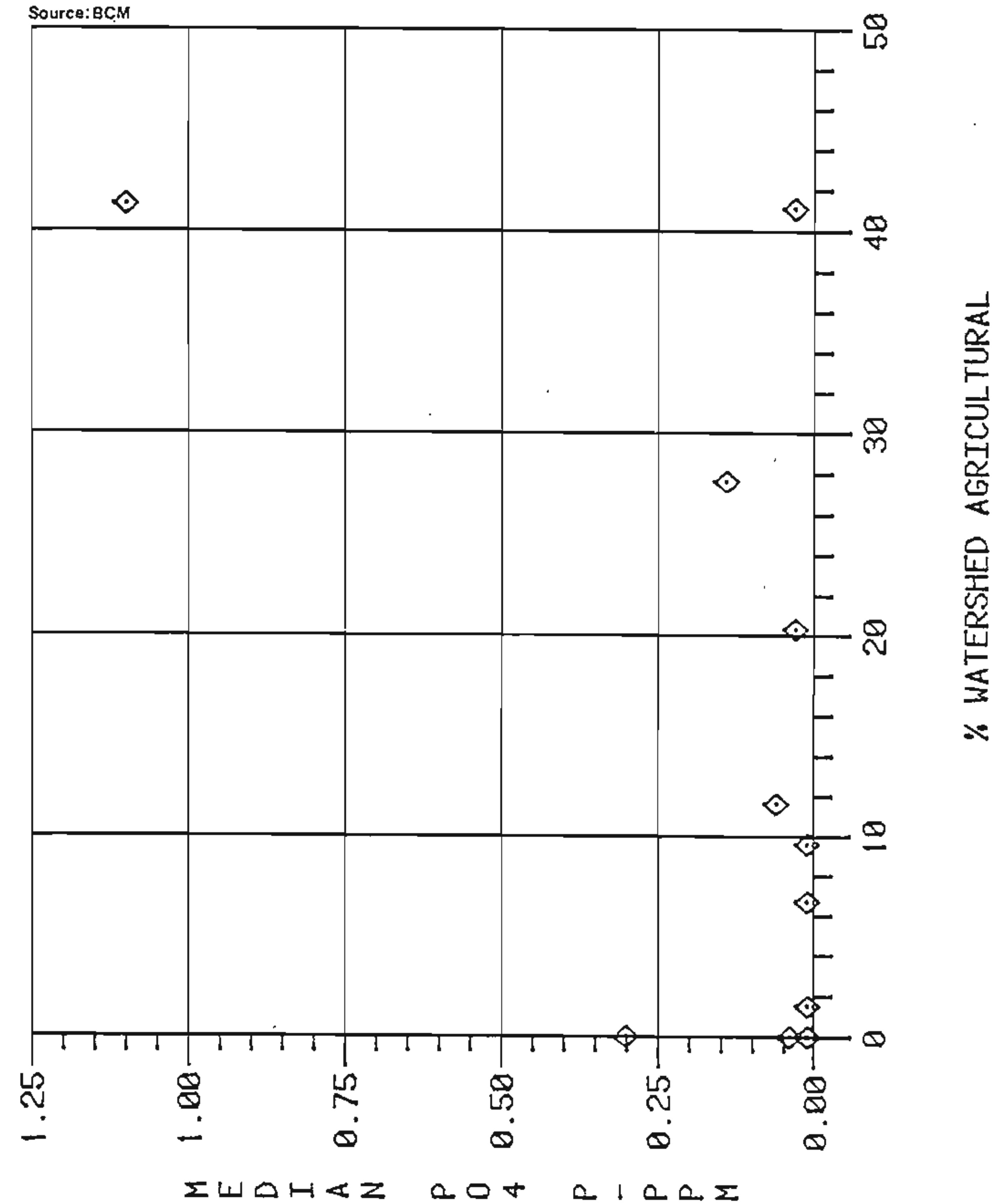


FIGURE 18
PH VS. DEVELOPED LAND

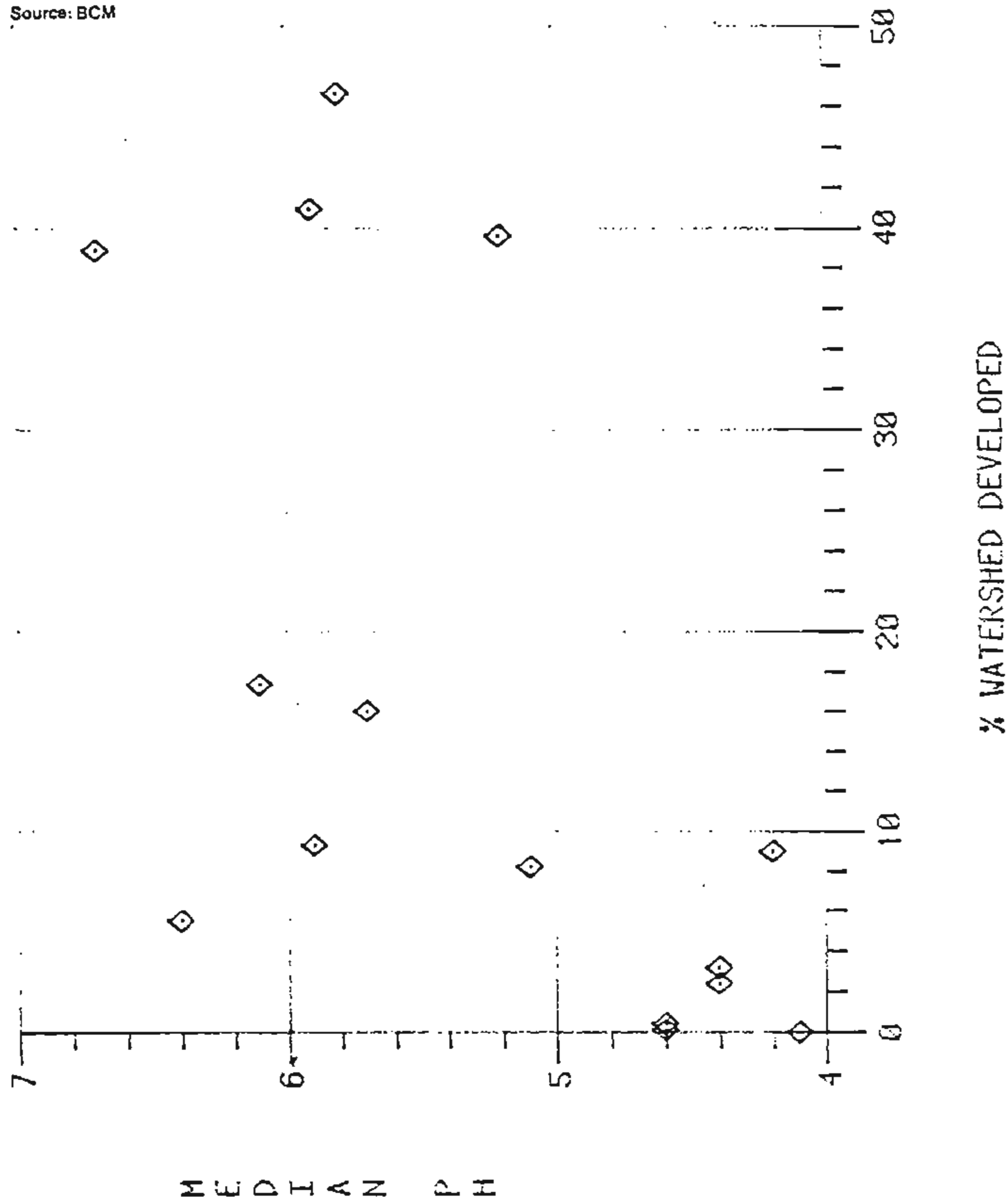


FIGURE 19
PH VS. AGRICULTURAL LAND

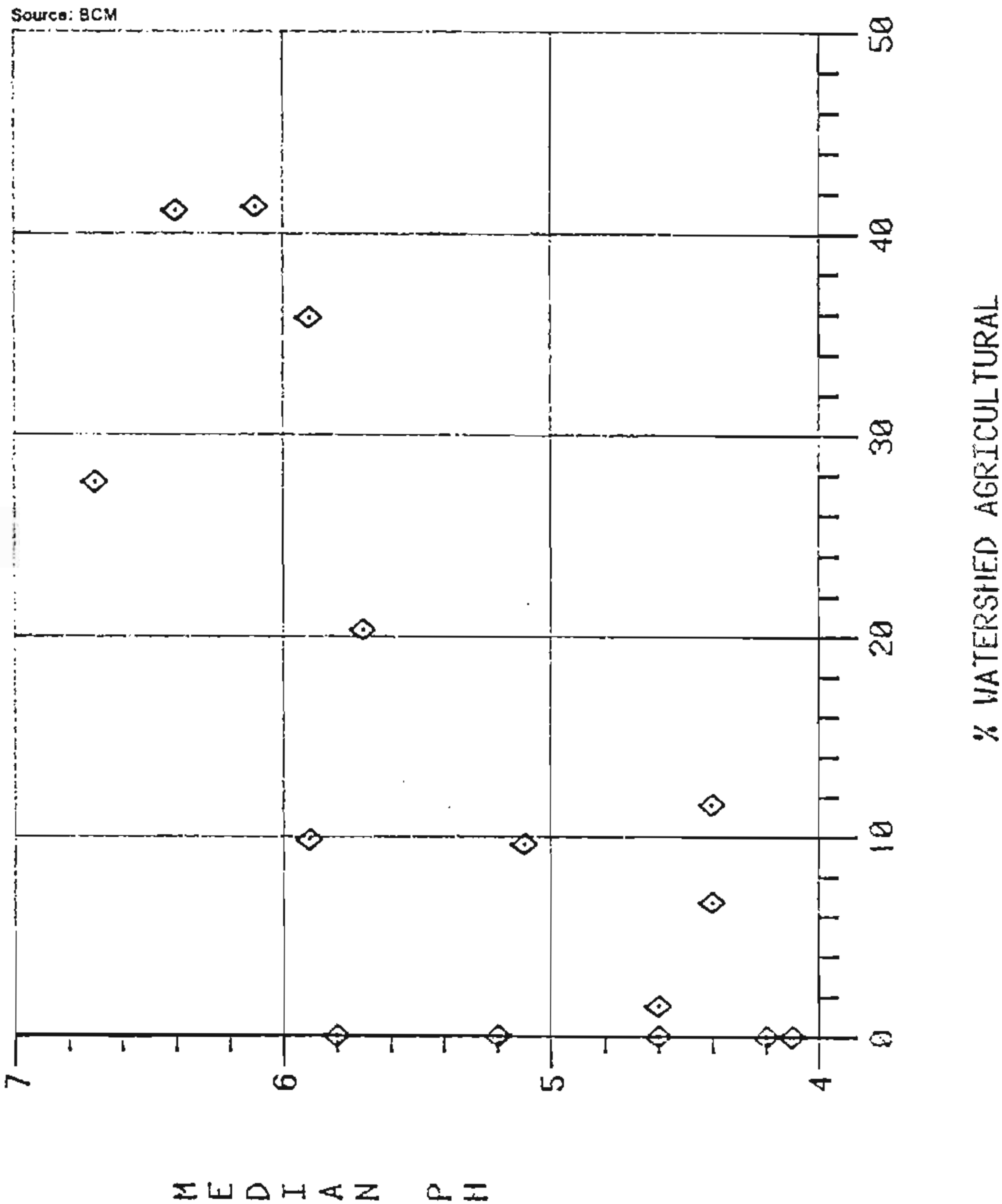


TABLE 5

REGRESSIONS OF WATER QUALITY INDICATORS ON LAND USE

Indicator	Equation (Standard Error)	Percent of Variance Explained
Water Quality Index	= 5.176 + 0.111*d (.020)	r^2 = .70
	= 6.336 + 0.044a (.038)	r^2 = .09
	= 4.552 + 0.112*d + 0.045*a (.017) (.019)	r^2 = .79
Total Dissolved Solids (ppm)	= 40.791 + 0.936*d (.407)	r^2 = .29
	= 37.128 + 1.350*a (.366)	r^2 = .51
	= 21.915 + 0.951*d + 1.362*a (.219) (.238)	r^2 = .79
Suspended Solids (ppm)	= 2.366 + 0.183*d (.063)	r^2 = .40
	= 0.422 + 0.077a (.085)	r^2 = .06
	+ 1.270 + 0.184*d + 0.079a (.062) (.069)	r^2 = .46
Biochemical Oxygen Demand (ppm)	= 0.914 + 0.096*d (.023)	r^2 = .58
	= 2.262 - 0.013a (.038)	r^2 = .01
	= 0.717 + 0.096*d + 0.014a (.024) (.026)	r^2 = .59

TABLE 5 (Continued)

Indicator	Equation (Standard Error)	Percent of Variance Explained
Total Nitrogen (ppm)	= 0.697 + 0.035d (.020)	r^2 = .19
	= 0.510 + 0.054*a (.019)	r^2 = .38
	= - 0.062 + 0.036*d + 0.055 (.015) (.016)	r^2 = .58
Fecal Coliform (log MPN)	= 1.175 + 0.023*d (.009)	r^2 = .33
	= 1.428 + 0.008a (.012)	r^2 = .03
	= 1.059 + 0.023*d + 0.008a (.009) (.010)	r^2 = .38
Phosphorus (ppm)	= - 0.069 + 0.005d (.005)	r^2 = .07
	= - 0.006 + 0.011a (.005)	r^2 = .30
	= - 0.052 + 0.004d + 0.010a (.005) (.005)	r^2 = .35
pH	= 4.801 + 0.030*d (.013)	r^2 = .35
	= 4.717 + 0.041*a (.010)	r^2 = .55
	= 4.232 + 0.030*d + 0.041*a (.004) (.005)	r^2 = .91

d = % watershed developed as residential, commercial or industrial use
a = % watershed in cropland
* = regression coefficient is significant at 95% confidence

The lack of a significant relationship between phosphate levels and land use is puzzling because the relationship is well documented in south Jersey and other areas of the country (see Tables 1 and 2). A close look at the data shows that domestic point source concentrations can best explain high phosphate levels. Figure 20 shows that two basins with high levels of domestic effluent share elevated phosphate levels. The data base of 15 sub-basins is inadequate to make a valid statistical connection because data are dominated by one or two points. Nevertheless, it does appear that phosphate concentrations may be affected by domestic effuent. Observations of phosphate levels in basins not affected by point sources show that land use changes affect phosphate levels, but not as much as do domestic point sources.

One of the major characteristics of Pinelands water is acidity. Because of the low buffering capacities of the water, the pH levels of these waters are very sensitive to disturbance. Durand and Zimmer (1979) note in their Pinelands studies that for stations in "disturbed areas" there is a shift in pH equivalent of one unit. The foregoing graph and regression analysis shows strong relationship between developed and agricultural land and pH levels. Figure 21 shows that there is a close association between the water quality index and pH. This evidence suggests that pH levels may be affected by pollution. To determine conclusively the actual effect, it is necessary to determine the variation of natural levels in soils.

The regression equations in Table 5 estimate the effects of agriculture and development on the water quality indicators. For undisturbed basins (those having no developed or agricultural land), the "d" and "a" terms are equal to zero. Thus, the constant term in these equations represents an estimate for the level of a particular indicator for a "pristine" watershed. A comparison of water quality levels on an actual undisturbed basin, McDonalds Branch, to the constant terms in the equations, shows a good correspondence for most indicators. Table 6 shows this comparison.

The regression equations may be useful for more than just assessing land use effects in existing data. If the predictive ability of the regression equations is verified, they may be used to predict water quality for basins which have no water quality sampling. The graph comparing predicted pH to actual pH for the 15 sub-basins (Figure 22) shows that the regression fits the data closely. Figure 23 similarly compares the predicted water quality index against the actual water quality index.

FIGURE 20
PHOSPHATE VS. DOMESTIC POINT SOURCES

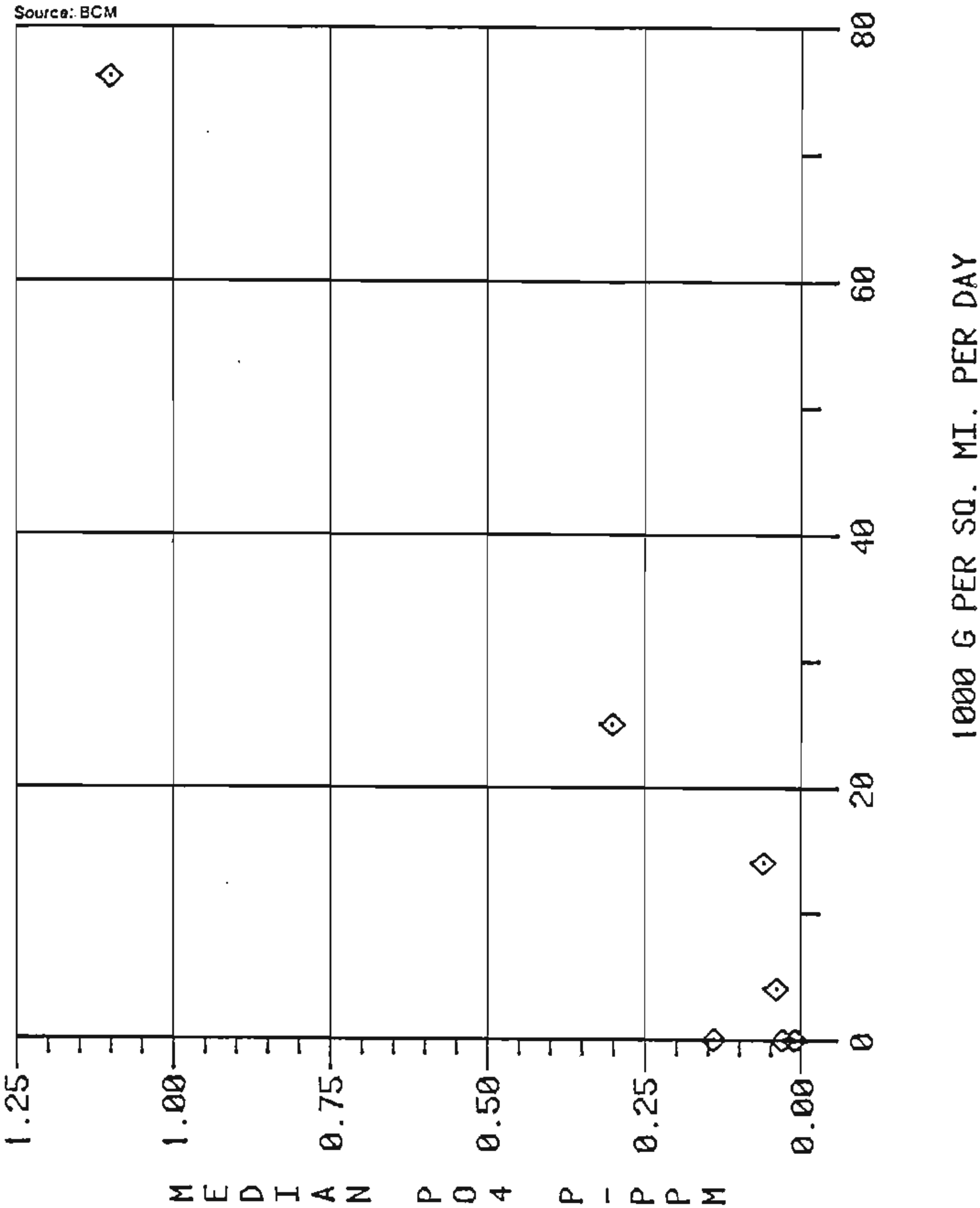
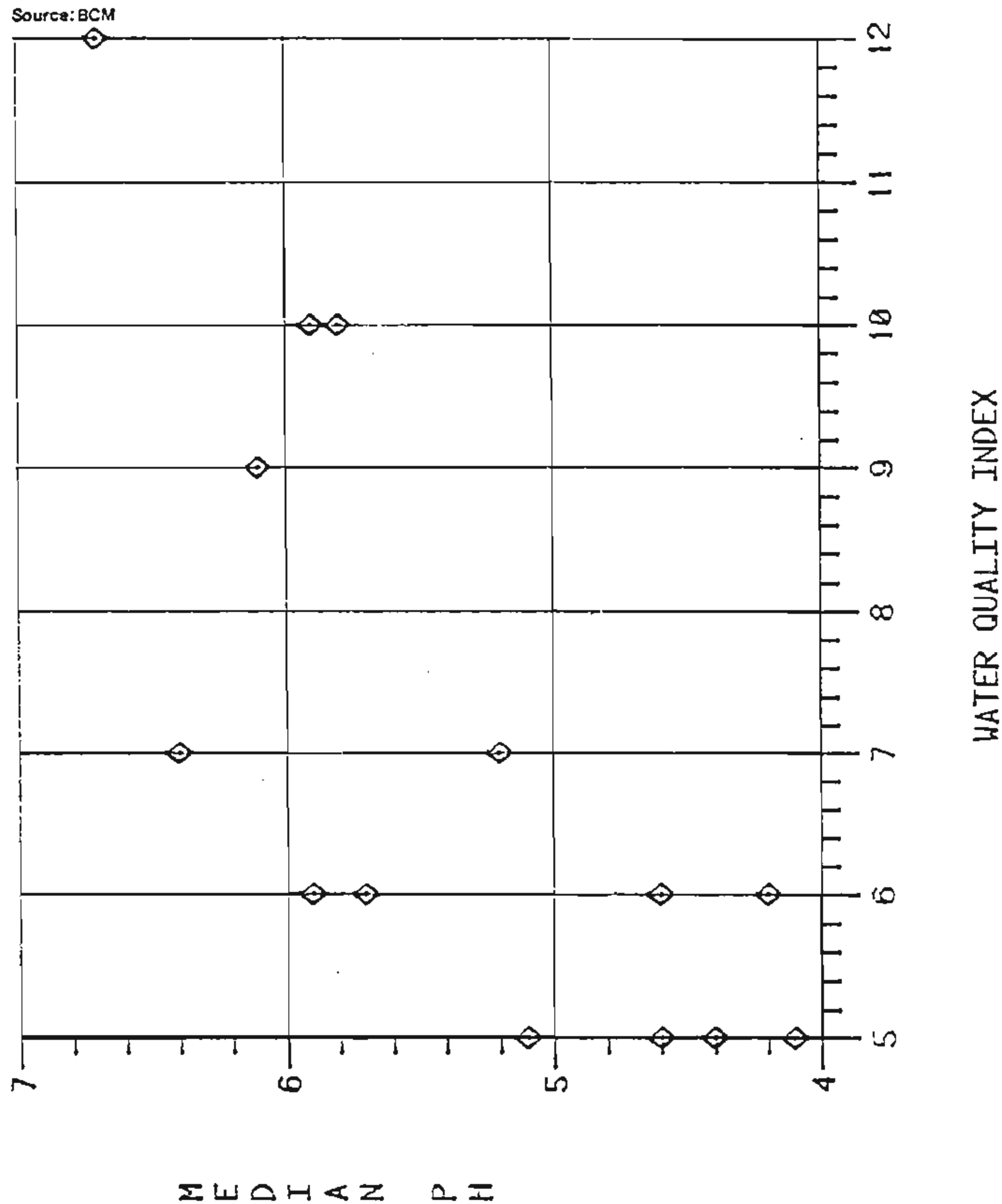


FIGURE 21
PH VS. WATER QUALITY



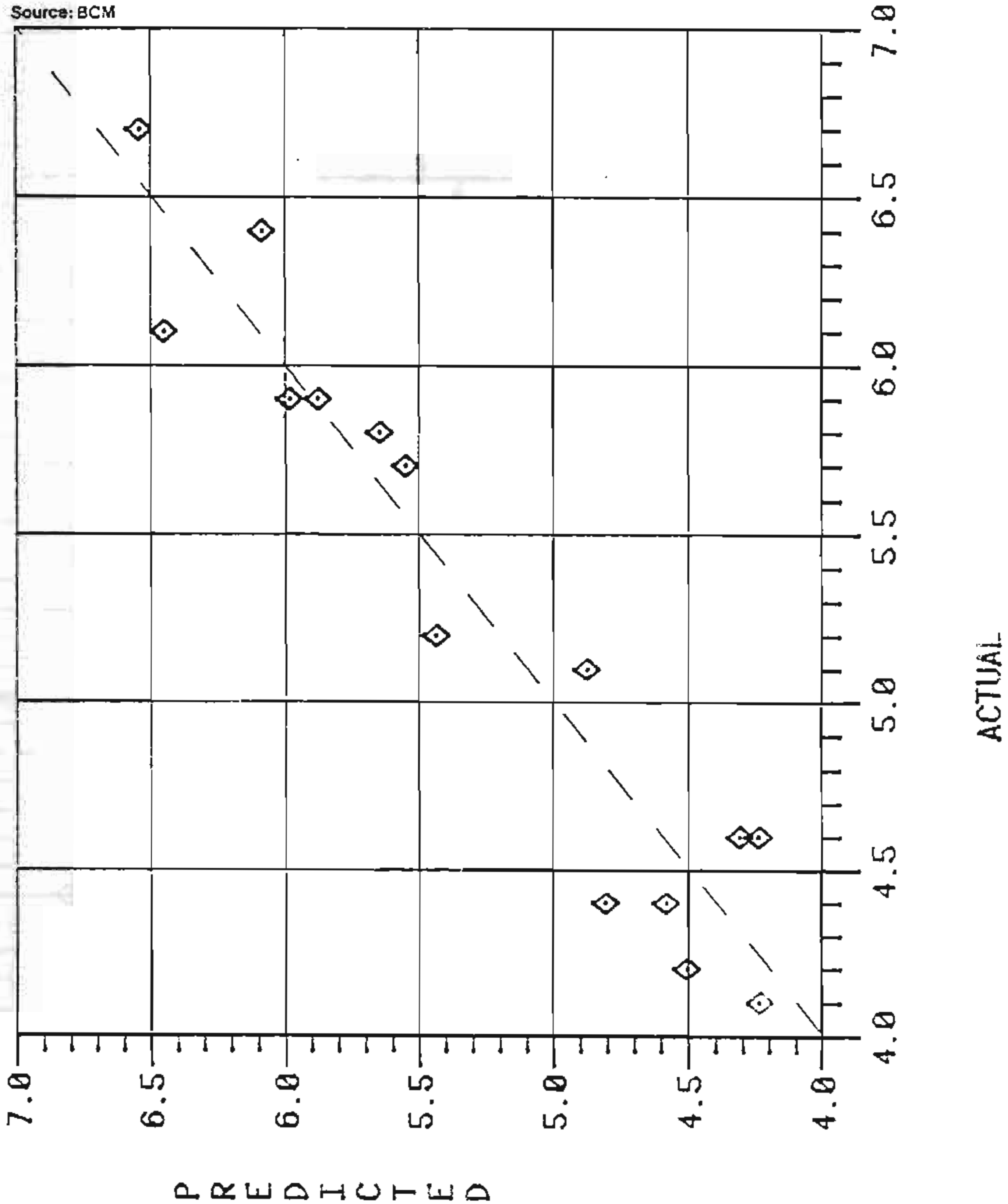


FIGURE 22
PH: PREDICTED VS. ACTUAL

FIGURE 23
W Q INDEX: PREDICTED VS. ACTUAL

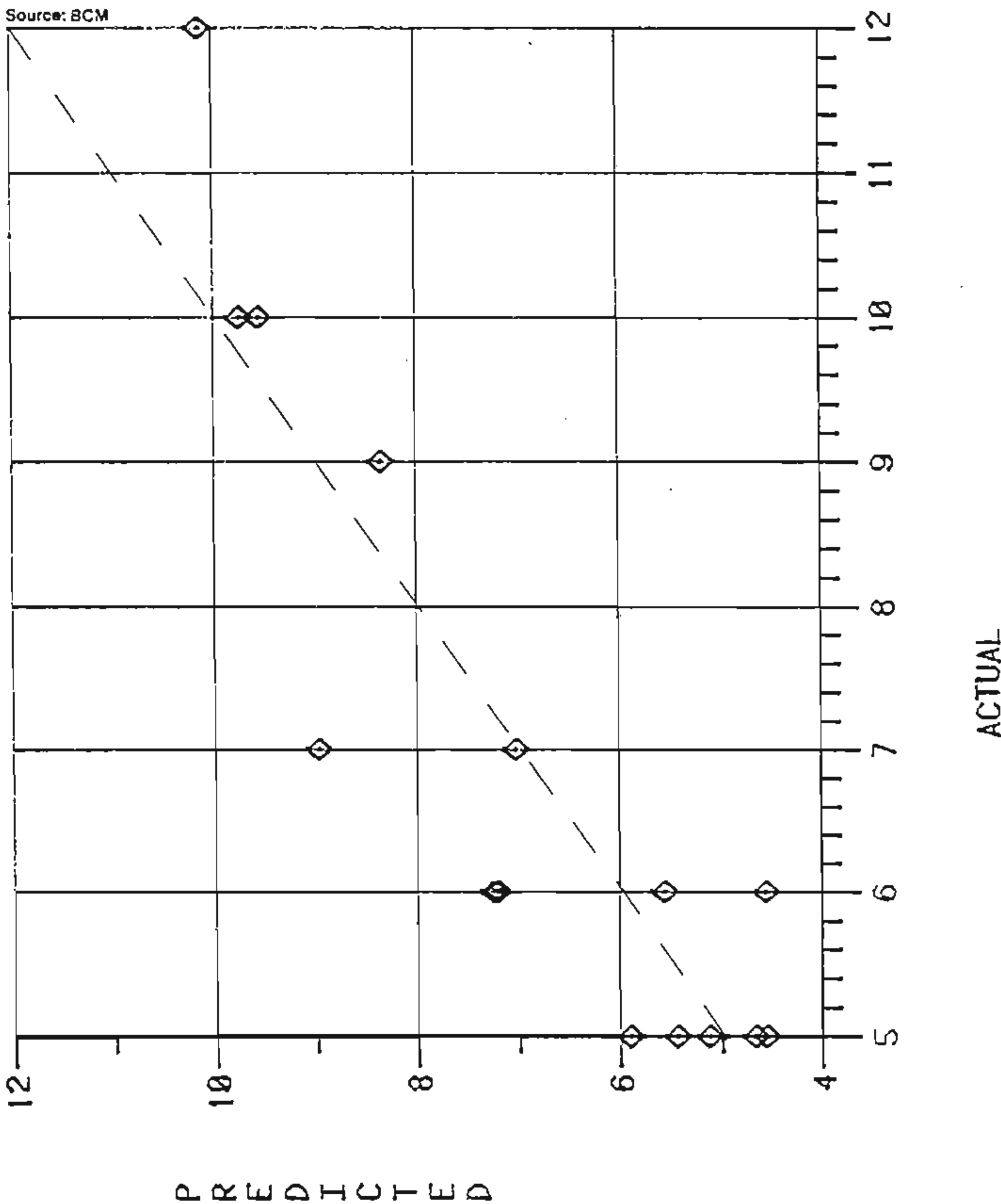


TABLE 6

COMPARISON OF PREDICTED AND ACTUAL INDICATOR LEVELS
FOR A PRISTINE WATERSHED

Indicator	McDonalds Branch	Predicted Value
Water Quality Index	5.00	4.60
Median Total Dissolved Solids (ppm)	26.00	22.00
Median Suspended Solids (ppm)	1.00	1.30
Median Biochemical Oxygen Demand (ppm)	0.60	0.70
Median Total Nitrates (ppm)	0.15	-0.10
Median fecal coliform (mpn)	2.00	11.00
Median pH	4.20	4.10

The best verification of the equations would be to test them on new data. This may be done by measuring land use in Pinelands watersheds which have water quality data but have not been included in the original analysis. If the predicted water quality indicator levels approximate measured levels, the equations may be used to predict levels in unmonitored watersheds. The water quality index for a basin would be best predicted not directly by the regression, but by running a regression for the 10, 50 and 90 percentile levels for each of the five parameters and then calculating the index from them (see Technical Memorandum SW IV-4 for a discussion of how the index is computed).

The foregoing analysis has substantiated the effects of overall land use upon stream quality. The information presented, however, represents land use in the aggregate. The data did not permit identification of which aspects of urban or agricultural activities contributed most to pollutants. The separation of various aspects would require more detailed data.

REFERENCES

Delaware Valley 208 Joint Venture. Exerpt of NPS Problems Working Paper 5.02-2, New York, 1977.

Durand, James B. and Bonnie Zimmer. Pinelands Study - Surface Water Quality, Rutgers University, 1979.

New Jersey Department of Environmental Protection. Water Quality Management Plan, Monmouth County, New Jersey (Draft), 1979.

U.S. Environmental Protection Agency. Areawide Assessment Procedures Manual, EPA-600/9-76-014, 1976.

APPENDIX 1

LAND USE DATA FOR STUDY SUB-BASINS

TABLE 1-1

LAND USE DATA FOR STUDY SUB-BASINS

Sub-basins, Station and Location	Drainage Area (square miles)	Developed Land Measured in Square Miles (%) <10% Cover	10% - 40% Cover	40% - 70% Cover	70% - 100% Cover	Total Developed
Great Egg Harbor River						
01410865 Squankum Branch at Malaga Road	3.0	0 (0%)	0.1 (3.5%)	1.0 (33%)	0 (0%)	1.1 (36.5%)
01411053 Hospitality Branch at Berryland	20.0	0 (0%)	0.8 (4%)	2.3 (11.5%)	0 (0%)	3.1 (15.5%)
01411140 Deep Run at Weymouth	20.0	0.5 (2.5%)	0.1 (0.5%)	0 (0%)	0 (0%)	0.6 (3%)
Tuckahoe River						
01411290 Tuckahoe River near Estell Manor	8.8	0.1 (1%)	0.2 (2.5%)	0.4 (4.5%)	0 (0%)	0.7 (8%)
Manumuskin River						
01412100 Manumuskin River near Manumuskin	32.1 21.2*	0 (0%)	0.6 (3%)	0 (0%)	0 (0%)	0.6 (3%)
Mullica River						
01409416 Hammonton Creek at Westcoatville	9.6	0 (0%)	0 (0%)	0.7 (7.5%)	1.0 (10.5%)	1.7 (17.5%)
01409411 Nescochaque Creek at Pleasant Mills	43.8	0 (0%)	1.8 (4.0%)	2.3 (5.5%)	0 (0%)	4.1 (9.5%)
01490450 Springers Brook near Indian Mills (Batsto River)	12.6	0 (0%)	0.5 (4%)	0.2 (1.5%)	0 (0%)	0.7 (5.5%)
01409403 Wildcat Branch at Chesilhurst	1.0	0 (0%)	0.1 (10%)	0.3 (30%)	0.1 (0.5%)	0.5 (45%)

TABLE 1-1 (Continued)

Sub-basins, Station and Location	Drainage Area (square miles)	Developed Land Measured in Square Miles (%) <10% Cover	10% - 40% Cover	40% - 70% Cover	70% - 100% Cover	Total Developed
Rancocas Creek						
01465970 North Branch at Browns Mills	19.5	0 (0%)	0.6 (3%)	7.2 (37%)	0 (0%)	7.8 (40%)
01466500 McDonalds Branch	2.3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Cedar Creek						
01408830 (OCN045) Cedar Creek at Cedar Crest	20.1	0 (0%)	0.1 (0.5%)	0 (0%)	0 (0%)	0.1 (0.5%)
Westecunk Creek						
OCN 059 Westecunk Creek at Martha Road	15.6	0 (0%)	0.02 (0.1%)	0 (0%)	0 (0%)	0.02 (0.1%)
Toms River						
OCN 035 Wrangle Branch off Fort de France Road	12.0	0 (0%)	0 (0%)	0 (0%)	1.1 (9%)	1.1 (9%)
OCN 042 Manapaqua Brook Lakehurst-Ridgeway Road	5.9	0 (0%)	0 (0%)	2.4 (40.6%)	0.3 (5%)	2.7 (46%)

TABLE 1-1 (Continued)

Sub-basins, Station and Location	Drainage Area (square miles)	Agricultural Land Measured in Square Miles (%): Grain Crop or Fallow	Pasture	Row Crop	Total Agricultural	Strip Mines Quarries Gravel Pits	Natural Vegetation	Water
Great Egg Harbor River								
01410865 Squankum Branch at Malaga Road	3.0	0 (0%)	0 (0%)	0.7 (23%)	0.7 (23%)	0 (0%)	1.2 (40%)	0 (0%)
01411053 Hospitality Branch at Berryland	20.0	0 (0%)	0.3 (1.5%)	3.8 (19%)	4.1 (20.5%)	0 (0%)	12.6 (63%)	0.2 (1%)
01411140 Deep Run at Weymouth	20.0	0.1 (0.5%)	0 (0%)	2.3 (11.5%)	2.4 (12%)	0 (0%)	17.0 (85%)	0 (0%)
Tuckahoe River								
01411290 Tuckahoe River near Estell Manor	8.8	0.1 (1%)	0 (0%)	0.8 (9%)	0.9 (10%)	0.3 (3.5%)	6.9(78.5%)	0 (0%)
Manumuskin River								
01412100 Manumuskin River near Manumuskin	32.1 21.2*	0 (0%)	0 (0%)	1.7 (8%)	1.7 (8%)	0.2 (1%)	18.6 (88%)	0.1 (0.5%)
Mullica River								
01409416 Hammonton Creek at Westcoatville	9.6	0 (0%)	0 (0%)	4.0 (41.5%)	4.0 (41.5%)	0 (0%)	3.8 (39.5%)	0.1 (1%)
01409411 Nescochaque Creek at Pleasant Mills	43.8	0 (0%)	0 (0%)	15.7 (36%)	15.7 (36%)	0 (0%)	23.9 (54.5%)	0.1 (0%)
01490450 Springers Brook near Indian Mills (Batsto River)	12.6	0 (0%)	0 (0%)	5.2 (41%)	5.2 (41%)	0 (0%)	6.7 (53%)	0 (0%)
01409403 Wildcat Branch at Chesilhurst	1.0	0 (0%)	0 (0%)	0.1 (10%)	0.1 (10%)	0 (0%)	0.5 (45%)	0 (0%)

TABLE 1-1 (Continued)

Sub-basins, Station and Location	Drainage Area (square miles)	Agricultural Land Measured in Square Miles (%) Grain Crop or Fallow	Pasture	Row Crop	Total Agricultural	Strip Mines Quarries Gravel Pits	Natural Vegetation	Water
Rancocas Creek								
01465970 North Branch at Browns Mills	19.5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11.5 (59%)	0.2 (1%)
01466500 McDonalds Branch	2.3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2.3 (100%)	0 (0%)
Cedar Creek								
01408830 (OCN045) Cedar Creek at Cedar Crest	20.1	0 (0%)	0 (0%)	0.3 (1.5%)	0.3 (1.5%)	0.2 (1%)	19.4 (96.5%)	0.1 (0.5%)
Westecunk Creek								
OCN 059 Westecunk Creek at Martha Road	15.6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15.6 (100%)	0 (0%)
Toms River								
OCN 035 Wrangle Branch off Fort de France Road	12.0	0.4 (3.5%)	0 (0%)	0 (0%)	0.4 (3.5%)	0 (0%)	10.4 (86.5%)	0.1 (1%)
OCN 042 Manapaqua Brook Lakehurst-Ridgeway Road	5.9	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3.1 (52.5%)	0.1 (1.5%)

* Area within Pinelands National Reserve boundary

APPENDIX 2

CALCULATION DETAILS FOR TABLE 4

TABLE 2-1

CALCULATION DETAILS FOR TABLE 4

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fp = effluent flow
cp = effluent concentration of pollutant
fu = stream flow above discharge plant
cu = in-stream pollutant concentration above discharge
fd = streamflow below discharge
cd = in-stream pollutant concentration below discharge

$$cd = \frac{(fu \times cu) + (fp \times cp)}{fd}$$

downstream concentration is assumed to be a weighted average of upstream concentration and discharge concentration

Assume:

fp = 1000 gallons per day (0.001 MGD) per square mile
fc = 5 ppm - P (Phosphorus concentration of effluent)
fu = 0.34 MGD (low flow conditions) per square mile
fd = fu + fp

$$cd = \frac{(0.34 \text{ MGD} \times cu) + (0.001 \text{ MGD} \times 5 \text{ ppm})}{0.34 \text{ MGD} + 0.001 \text{ MGD}}$$

$$= \frac{.34 \text{ MGD} \times cu}{.341 \text{ MGD}} + \frac{.005 \text{ ppm}}{.341}$$

$$\simeq cu + 0.015 \text{ ppm} \qquad \frac{.34}{.341} \simeq 1$$

$$cd - cu \simeq 0.015 \text{ ppm}$$

TECHNICAL MEMORANDUM SW IV-7

CONTROL TECHNIQUES FOR NONPOINT POLLUTION SOURCES

PINELANDS COMMISSION

FEBRUARY 1980

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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TABLES

TECHNICAL MEMORANDUM SW IV-7

CONTROL TECHNIQUES FOR NONPOINT POLLUTION SOURCES

INTRODUCTION

This technical memorandum identifies techniques, including management concepts, that can be used to reduce nonpoint sources of pollution. Literally thousands of documents have been prepared in the last several years concerning control techniques for these pollution sources. This technical memorandum summarizes the preventive "best management practices " (BMPs) that may significantly reduce the pollution potential of nonpoint sources and serves as a guide to the literature for readers who desire more detailed information.

Pollutant problems are of particular concern in the Pinelands because of the region's unique characteristics. Factors such as inert sandy soils (resulting in rapid mobility of pollutants), minimal buffering capabilities, and low pH levels (altering solubility factors), require specialized control resources.

Not all the nonpoint control techniques listed are applicable in the Pinelands. Many of these techniques were reviewed during the 208 planning activities recently completed for several 208 study areas, of which the Pinelands National Reserve is a part. The most extensively documented screening of techniques was prepared during the Tri-County 208 effort. Appendix 1 contains Tri-County 208's list of selected BMPs and should serve as a good starting point for further screening to determine those techniques most applicable to the Pinelands. The body of this technical memorandum presents nonpoint pollution sources, controls taken from the national literature, and a bibliography; the Appendix presents those controls which the Tri-County 208 agency felt were most appropriate for Burlington, Camden and Gloucester counties. The next step would be to further reduce the controls listed in Appendix 1 to those specifically suited to the Pinelands.

NONPOINT POLLUTION SOURCES

A nonpoint source of pollution is any area that may add pollutants to the system during storm events. The pollutant levels attributed to nonpoint sources generally increase during high flow periods. Discharges from storm sewers which are usually classified as point sources (pipe discharge) are, for the purposes of this technical memorandum, considered nonpoint sources; they are discussed in the urban runoff section of this technical memorandum. Nonpoint pollution sources include ubiquitous sources such as farmland or parking lot runoff, and site-specific sources such as landfills or spray irrigation sites.

A succession of U.S. Environmental Protection Agency (EPA) guidance documents have defined seven basic categories of nonpoint sources to which may be added an eighth category, miscellaneous sources. A brief description of the types of sources included in each of these categories follows.

1. Agriculture

   Livestock and crop production, manure disposal

2. Silviculture

   Forestry management, harvesting, recreation

3. Mining

   Sand and gravel, coal, other

4. Hydrographic Modification

   Channel enlargement, dams, reservoirs, artificial drainage, bank erosion

5. Urban Sources

   Runoff, storm sewers, combined sewer overflows, infiltration/inflow overflows

6. Construction

   Clearing, grading, building, site restoration

7. Land-Related Waste Disposal

   Septic tanks, landfills, sludge disposal sites, dredge spoil disposal sites

8. Miscellaneous

   Atmospheric sources, spills, benthic loads

The various chemical constituents normally associated with each class of nonpoint sources are represented in Table 1. The potential water quality importance of each source/constituent combination is given a relative rating in the table.

Note that storm sewers, combined sewer overflows and infiltration/inflow overflows are included as nonpoint sources even though they are legally classified as intermittent point sources. These dischargers are listed here due to their storm-activated nature, which is characteristic of most nonpoint sources. Saltwater intrusion, sometimes considered a non-point source, is beyond the scope of this technical memorandum. It is addressed as part of the groundwater portion of this project.

NONPOINT POLLUTION SOURCE CONTROLS

The following paragraphs present a checklist of control techniques for each of the eight nonpoint categories. Where appropriate, technical controls and regulatory controls are differentiated. The reader should refer to the bibliography in the back of this technical memorandum for references to more detailed discussions.

Agriculture

One of the most complete and useful sources of information currently available for the selection of agricultural pollution controls is the two-volume report jointly prepared by the EPA and the United States Department of Agriculture (USDA). This report points out controls for erosion, runoff, nutrients and pesticides. A methodology for selecting control practices, complete with flow charts and examples, is also presented. The two volumes are:

"Control of Water Pollution from Cropland, Volume I: A Manual for Guideline Development," EPA-600/2-75-026A (November 1975)

"Control of Water Pollution from Cropland, Volume II: An Overview," EPA-600/2-76-026B (1977)

Additional references are presented in the bibliography.

TABLE 1

SOURCE - POLLUTANT MATRIX

Non-Point Source Categories	Class(es)	Potential Surface Water Effects	Potential Ground Water Effects	Potential Non-Point Source Loading Contributions: Organic Matter	Sediment	Nutrients	Micro-Organisms	Trace Metals	Toxic Organics	Salts	Thermal	Acid Wastes	Others
Agriculture													
a. Livestock Production	SS,D	S	M	S	S	S	S	N	M	M	N	N	N
b. Crop Production	D	S	S	M	S	S	N	M	S	N	N	N	N
c. Manure Disposal	D	S	S	S	S	S	S	N	N	M	N	N	N
d. Windborne Loadings	D	M	N	N	M	N	M	M	M	N	N	N	N
e. Tile Drainage	D	S	S	S	M	S	M	N	S	M	M	N	N
Silviculture													
a. Forestry Management	D	S	N	M	N	S	N	N	M	N	N	N	N
b. Forest Harvesting	SS	S	N	S	S	S	N	N	M	N	S	N	N
c. Recreation	SS,D	S	M	M	S	N	M	N	N	N	M	N	N
Mining													
a. Surface	SS	S	M	N	S	N	N	S	N	N	N	S	M
b. Subsurface	SS	M	S	N	S	N	N	S	N	S	N	S	M
Hydrographic Modifications													
a. Dredging	D	S	N	S	S	M	N	S	S	N	N	N	M
b. Maintenance Facilities	SS	S	N	S	N	S	M	N	N	N	N	N	N
c. Channel Modification	SS	S	N	N	S	N	N	N	N	N	S	N	N
d. Dams	SS	S	S	M	M	M	N	N	N	N	S	N	M
Urban Sources													
a. Runoff	D	S	N	S	S	S	M	S	M	S	N	N	N
b. Storm Sewers	IP	S	N	S	S	S	M	S	M	S	N	N	N
c. Combined Sewer Overflows	IP	S	N	S	S	S	S	S	M	S	N	N	N
d. Separate Sanitary Sewer Overflows	IP	S	N	S	S	S	S	N	N	N	N	N	N
e. Deicing Salts	D	M	M	N	N	N	N	M	M	S	N	N	N
Construction	SS	S	N	N	S	M	M	M	M	N	N	N	M
Land Related Wastes Disposal													
a. Rural Sanitation	D	M	S	M	M	S	S	M	N	N	N	N	N
b. Landfills	SS	M	S	S	M	S	N	S	S	M	N	N	N
c. Sludge Disposal	SS	M	S	S	S	S	N	S	M	N	N	N	M
d. Dredge Spoils Disposal	SS	M	S	M	S	M	N	S	S	N	N	N	N
Miscellaneous													
a. Atmospheric	D	S	N	N	M	M	N	M	S	N	N	M	M
b. Spills	SS	S	S	S	M	M	N	S	S	M	N	S	M
c. Benthic Loads	D	S	N	S	S	S	M	M	S	N	N	N	N

Key: IP-Intermittent Point Source; SS-Site Specific Non-Point Source; D-Dispersed Non-Point Source; S-Severe; M-Moderate; N-Slight or None

Source: Chester-Betz Engineers, 1977

A brief checklist of representative control measures follows.

1. Methods for controlling pollutants caused by water erosion

    - Tillage alternatives
    - Terraces
    - Diversions
    - Strip cropping
    - Contouring
    - Grassed waterways
    - Crop rotations
    - Cover crops
    - Range and pasture management

2. Control of Pollutants Caused by Wind Erosion

    - Establish and maintain vegetative cover
    - Roughen land surface
    - Produce soil clods or aggregates
    - Reduce field width along prevailing wind direction
    - Level or bench land

3. Methods for Controlling Nutrients

    - Fertilization practices (timing, placement, use of slow release fertilizers)
    - Soil testing and plant analysis
    - Tillage
    - Crops and crop rotation
    - Contouring and terracing

4. Control of Pesticides

    - Biological control
    - Insect sterilization
    - Insect toxins and pathogens
    - Persistent crop varieties
    - Crop rotation
    - Control runoff and erosion
    - Application methods
    - Proper container disposal

5. Control of Animal Wastes

   - Runoff control
   - Pasture operations
   - Maintain adequate land-to-livestock ratio
   - Prevent overgrazing
   - Provide limited access to streams and ponds

Silviculture

Silviculture is not a major industry in the Pinelands, although some harvesting of wood is practiced. In the Pinelands, the focus must be directed toward preventing harmful effects caused by sediments and from thermal pollution caused by solar radiation. Prevention of pollution from pesticides, chemical fertilizers and fire-retardant chemicals generally is not a problem in the Pinelands because these items are generally not used in the Pinelands for silviculture activities.

A checklist of techniques effective in controlling the effects of sediment and thermal pollution follows.

1. Methods for Controlling Sediments

   - Erosion and sediment control practices
   - Careful road construction
   - Systematic layout of harvesting roads and system
   - Reforestation
   - Stabilization with grasses

2. Control Thermal Pollution Resulting from Solar Energy

- Buffer strips of vegetation along streams

Mining

Mining is a relatively small industry within the Pinelands, generally limited to sand and gravel mining. Nonpoint source pollution from this activity is generally low, and thus little emphasis is presented on control techniques for mining in this technical memorandum.

The most effective control techniques used in the Pinelands appear to be controlling water entering the mine area by water diversion, regrading, erosion control and revegetation.

Hydrographic Modifications

Hydrographic modifications include the following types of projects:

- Channel modification (stream clearing, channel realignment, construction of concrete channels for flood control, etc.)

- Dams and impoundments

Control practices to be followed during the construction phase of hydrologic modifications are the same as those for the general construction activity discussed later in this technical memorandum. Essentially, the best management practice for channel modifications is to reduce the erosive force of stream flow by reducing stream velocity (increase roughness, modify cross-section, etc.). Temperature increases can be controlled by the proper planting of vegetative cover. For problems resulting from impoundment construction, best management practices include proper site preparation, control of release waters and temporary algal and weed control.

Urban Sources

Control practices applied to nonpoint sources from urban areas can be divided into two categories: those most useful for already developed areas and those most applicable for new or developing areas. The problems of developed areas occur where structures or pavements are in place and where drainage is accomplished primarily through storm sewering. In densely populated commercial and industrial areas, management techniques, such as improved sanitation and sewer maintenance practices, are probably most effective. In addition, various storage/treatment techniques may be used. Examples of these techniques might be in-line storage, swirl concentrators for treatment of urban runoff, physical chemical treatment, etc. The difficulty with these practices is that they are extremely expensive and probably not applicable to the Pinelands situation. The preventive concept best applies to developing areas where man's encroachment is more subject to control and drainage is still essentially natural. These areas offer the greatest flexibility of approaches in preventing pollution.

The following tabulation outlines the technical approaches for dealing with urban nonpoint sources. Regulatory approaches are addressed later.

1. Measures to Reduce Runoff from Surface Contaminants

- Street litter
  - Public education to reduce litter
  - Ordinances for reducing litter
  - Ordinances directed at typical litter sources, such as garbage collection, open trucks, vacant lots, drive-in restaurants, etc.
  - Street cleaning
  - Catch basin cleaning
- Highway deicing
  - Greater use of sand
  - Greater use of mechanical snow removal
  - Careful metering of salt
  - Careful storage of salt
- Fertilizers and pesticides
  - Public education
  - Professional licensing for handlers and users of pesticides and fertilizers
  - Alternatives to fertilizers and pesticides
- Land disposal of wastes
- Infiltration/Inflow
  - Correction of defective joints and cracked pipes
  - Disconnection of roof leaders, cellar and yard drains
  - Correction of manhole cover and cross-connections

2. Measures to Reduce Runoff and Increase Infiltration

- Delay of runoff on-site
- Retention basins
- Temporary ponding on paved areas
- Temporary ponding on roofs
- Increased infiltration on-site
  - Dutch drains
  - Porous paving
  - Seepage or recharge basins
  - Dry wells
  - Grading

3. Erosion and Sedimentation Control Measures

- Vegetative measures (see Table 2)
- Diversion measures
- Slope stabilization techniques
- Stream bank stabilization measures
- Stabilization of surface drainage ways
- Other measures

These technical approaches can be implemented by the regulatory, fiscal and proprietary powers of state and local government. Eight specific regulatory approaches are summarized below. A detailed discussion of them can be found in "Preventative Approaches to Stormwater Management," EPA 440/9-77-001 (January 1977).

1. Purchase of interest in land to be preserved as open spaces or for non-intensive uses that will not interfere with the land's natural capacity to absorb and to purify stormwater or other effluents. This section covers a broad range of techniques, not all purely "regulatory."

2. Capital-investment programming for extension of sewers and other public services to such locations and at such rates over time as will serve to channel development into suitable areas, to discourage it in an area where it is likely to have adverse effects upon water quality, and to accommodate at all times whatever wasteflows it generates.

3. Designating sensitive, water-related lands on which development will be restricted or made subject to conditions for the purpose of protecting water quality.

4. Conditioning development permission upon environmental impact assessments that ensure minimization of water quality problems incident to development.

5. Requiring that development proceed along lines and in ways that preserve natural processes associated with the hydrological cycle.

6. Conditioning development permission upon compliance with technical standards for controlling runoff, erosion, and sedimentation.

7. Controls over land disposal of wastes for the purpose of protecting water quality, including controls over solid waste disposal and use of septic tanks.

8. Regulatory and administrative controls over in-place or accumulated sources.

TABLE 2

CONTROL MEASURES AND PROBLEM AREAS

● INDICATES APPLICABILITY OF A SPECIFIC CONTROL MEASURE TO ONE OR MORE OF THE SEVEN PROBLEM AREAS.

	Control Measure	Slopes	Streams and waterways	Surface drainageways	Enclosed drainage	Large flat surface areas	Borrow and stockpile areas	Adjacent properties
VEGETATIVE MEASURES	Minimization of stripped areas	●				●	●	
	Grubbing omitted	●				●		●
	Conservation of topsoil	●				●	●	
	Temporary mulching and/or seeding	●		●		●	●	●
	Seeding	●		●		●	●	●
	Mulches	●				●	●	
	Seeding with mulch and/or matting	●		●			●	●
	Hydroseeding	●				●	●	●
	Sodding	●		●		●	●	●
	Bio-technical protection of steep slopes	●						
DIVERSION MEASURES AND SLOPE DRAINS	Diversion berm	●					●	●
	Interceptor berm	●	●					●
	Diversion ditch	●					●	●
	Berm and ditch	●					●	●
	Slope drain	●						
MECHANICAL SLOPE STABILIZATION	Selective grading and shaping	●				●	●	●
	Roughened surface	●				●		
	Compaction	●				●		
	Benches or terraces	●					●	
	Retaining wall	●						●
	Seepage control	●						●
STREAM BANK STABILIZATION	Falls		●					
	Deflectors and jetties		●					
	Revetments		●					
	Bio-technical protection of stream banks		●					
	Checkdams		●					
	Weir		●					
SURFACE DRAINAGEWAYS	Bare channels			●				
	Grassed waterways			●				
	Lined channels			●				
	Grade control structures		●	●				
	Sediment trap		●	●				
	Sediment basin		●	●	●			
OTHER MEASURES	Filter inlet				●			●
	Aggregate cover					●		
	Curb and gutter					●		●
	Windbreak					●		
	Filter berm	●	●					●
	Traffic control on construction roads					●		

Source: Beckett Jackson Raeder Inc., *op. cit.*, Figure 2 In: Preventative Approaches to Stormwater Management, EPA 440/9-77-001, January 1977

The principal weakness of many regulatory schemes is that they fail to include adequate provisions for securing compliance on the part of those to whom they are addressed. In the case of many controls for urban non-point sources, these schemes apply to developers. A problem arises especially where compliance is not just a one-shot matter but consists of continuing activity. Regulations can address the problem by requiring developers to maintain retention basins in good working order, install monitoring devices, report operating data, etc. However, regulations, combined with permits to be issued on a case-by-case basis, are generally a superior type of control strategy.

Construction

The implementation of an effective erosion and sediment control plan based on current standards can prevent much of the sediment pollution generated on a construction site. Three elements make it more practical to control or reduce pollutants from construction activity than from other nonpoint source activities: (1) the relatively localized nature of activity, (2) the on-site concentration of men, facilities and equipment during the construction process, and (3) the ability to plan or modify specific activities in order to minimize the pollution potential.

The New Jersey Department of Environmental Protection (NJDEP) has established erosion and sediment control regulations for large construction projects; thus the mechanism for regulatory control of pollution from construction activities is already in place. Technical control techniques available for the control of construction-related pollution include measures for controlling erosion, sediment and stormwater runoff. A checklist of these techniques follows.

1. Erosion Control Techniques

   - Construction planning (minimizing disturbed land, scheduling of construction, proper planning of runoff control measures, etc.)
   - Runoff control (vegetative buffer strips, grading, diversion structures, grassed waterways, etc.)
   - Surface soil protection (straw, hay, woodchips, plants, etc.)

2. Sediment Control Techniques

   - Pre-pond techniques (sediment traps, such as straw bales, natural vegetative buffers, etc.)
   - Sediment ponds

3. Stormwater Management Methods

- Rooftop ponding and parking lot ponding
- Retention basins
- Diversion structures
- Porous pavement
- Holding tanks
- Infiltration systems
- Stream channel storage and control
- In-line sewer storage

Land-Related Waste Disposal Practices

Pollution from these sources, such as septic tanks and landfills, can be considered a nonpoint source. Pollutants enter streams through the inflow of groundwater which has been contaminated by these land-related disposal methods. Control techniques for these sources are included in the groundwater portion of this project.

Miscellaneous Sources

Miscellaneous pollution sources include atmospheric sources, spills and benthic loads. Control of atmospheric pollutant sources must rely primarily on air pollution control regulations. While air quality is generally improving, acid rainfall is of particular concern in the Pinelands. Prevention of spills has been addressed by recent federal and state regulations. The NJDEP currently requires industries to develop spill prevention programs. Benthic loads can be controlled primarily by ensuring implementation of erosion and sediment control measures, and by improving wastewater treatment plant discharges and dredging activity. Dredging is generally not cost-effective for controlling depressed dissolved oxygen problems caused by benthic deposits.

REFERENCES

The bibliography which follows was taken primarily from "Areawide Assessment Procedures Manual: Volume I, II and II," EPA-600/9-76-014 (July 1976).

In addition to the EPA bibliographical references, BCM used the following sources:

Chester-Betz Engineers. Non-Point Source Inventory, NPS Tech Memo No. 14, 1977.

U. S. Environmental Protection Agency. Preventative Approaches to Stormwater Management, EPA 440/9-77-001, January 1977.

References

1. "Predicting Rainfall Erosion Losses from Cropland East of the Rocky Mountains," Wischmeir, Smith, Department of Agriculture Publication Handbook 282 (1965).

2. "Control of Water Pollution From Cropland - Volume I: A Manual for Guideline Development," Stewart, Woolhiser, Wischmeir, Caro, Frere, Environmental Protection Agency Publication EPA-600/2-75-026a (November 1975).

3. "The Structure of Inputs and Outputs of Hydrologic Systems," Yevjevich, In: Systems Approach to Hydrology, Water Resources Publications, Colorado State University, Ft. Collins (1971).

4. "Control of Water Pollution From Cropland-Volume II: An Overview," Stewart, Woolhiser, Environmental Protection Agency Publication EPA-600/2-76-026b (1977, at press).

5. "Precipitation Network Requirements for Streamflow Estimation," Johanson, Technical Report No. 147, Department of Civil Engineering, Stanford University (August 1971).

6. "Area-Depth Rainfall Formulas," Court, Journal of Geophysical Research, Vol. 66, No. 6 (June 1961).

7. "Accuracy of Estimating Watershed Mean Rainfall," McGuinness, Journal of Geophysical Research, Vol. 68, No. 16 (August 1963).

8. "Sampling Errors in Measurement of Mean Precipitation," Huff, Journal of Applied Meterology, Vol. 9 (February 1970).

9. "On The Transformation of Point Rainfall to Areal Rainfall," Iturbe-Rodriguez, Mejia, Water Resources Research, Vol. 10, No. 4 (August 1974).

10. "Modeling Pesticides and Nutrients on Agricultural Lands," Donigian, Crawford, Environmental Protection Agency Publication EPA-600/2-76-043 (February 1976).

11. "ACTMO, An Agricultural Chemical Transport Model," Frere, Onstad, Holtan, Department of Agriculture, Agricultural Research Service Publication ARS-H-3 (June 1975).

12. "Handbook of Applied Hydrology," Chow (editor), McGraw-Hill (1964).

13. "The Influence of Land Use on Stream Nutrient Levels," Omernik, Environmental Protection Agency Publication EPA-600/3-76-014 (January 1976).

14. "Stochastic Approaches to Water Resources," Shen (editor), Colorado State University, Ft. Collins (1976).

15. "Loading Functions for Assessment of Water Pollution from Nonpoint Sources," McElroy, Chiu, Nebgen, Alleti, Bennett, Environmental Protection Agency Publication EPA-600/2-76-151 (May 1976).

16. "USDAHL-74 Revised Model of Watershed Hydrology," Holtan, Stiltner, Henson, Lopez, Department of Agriculture, Agricultural Research Service Tech. Bull. No. 1518 (December 1975).

17. "Use and Misuse of the Universal Soil Loss Equation," Wischmeier, Journal of Soil and Water Conservation (January/February 1976).

18. "Rainfall Energy and Its Relationship to Soil Loss," Wischmeir, Smith, Trans. Amer. Geophys. Union, Vol, 39, No. 2 (1958).

19. "Effect of Land Use on Sediment Delivery Ratios," Mutchler, Bowie, Proceedings of the Third Federal Inter-Agency Sedimentation Conference, Water Resources Council (May 1976).

20. "Modeling Nonpoint Pollution From the Land Surface," Donigian, Crawford, Environmental Protection Agency Publication, EPA-600/3-76-083 (July 1976).

21. "Urban Storm Water Runoff, "STORM"," Hydrologic Engineering Center, Army Corps of Engineers at Davis (August 1975).

22. "Draft Report on Nonpoint Source Assessment" Ohio River Basin Sanitation Commission, (1976).

23. "Nonpoint Source Pollution and the 208 Planning Process," Mulkey, Report to the Environmental Protection Agency's Water Planning Division, Athens (January 1976).

24. "Chemical Composition of Acid Precipitation in Central Texas," Cooper, Demo, Lopez, Proceedings of the First International Symposium on Acid Precipitation and Forest Ecosystem, Department of Agriculture, Forest Service General Tech. Report NE-23, pp. 281-291.

25. "Nutrient Content of Precipitation Over Iowa," Tabatabai, Laflen, Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem, Department of Agriculture, Forest Service General Tech. Report NE-23, pp. 293-308.

26. "The Chemical Composition of Atmospheric Precipitation From Selected Stations in Michigan," Richardson, Merva, Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem, Department of Agriculture, Forest Service General Tech. Report NE-23, pp. 321-332.

27. "Surface Runoff Losses of Soluble Nitrogen and Phosphorus Under Two Systems of Soil Management," Klausner, Zwerman, Ellis, Journal of Environmental Analysis, 3(1):42-46 (January/March 1974).

28. "The History and Character of Acid Precipitation in Eastern North America," Cogbill, Proceedings of the First International Symposium

on Acid Precipitation and the Forest Ecosystem, Department of Agriculture, Forest Service General Tech. Report NE-23, pp. 363-370.

29. "The Variability of pH in Convective Storms," Semonin, Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem, Department of Agriculture, Forest Service General Tech. Report NE-23, pp. 349-361.

30. "Losses of Fertilizers and Pesticides From Claypan Soils," Smith, Whitaker, Heineman, Environmental Protection Agency Publication EPA-660/2-74-068 (1974).

31. "Transport, Detoxification, Fate, and Effects of Pesticides in Soil and Water Environments," Leonard, Bailey, Swank, Land Application of Waste Materials, Soil Conservation Society of America, pp. 48-78 (1976).

32. "Quantification of Pollutants in Agricultural Runoff," Dornbush, Anderson, Harms, Environmental Protection Agency Publication EPA-600/2-74-005 (February 1974).

33. "Physical and Chemical Characteristics of Sediments Originating From Missouri Valley Loess," Schuman, Piest, Spomer, Proceedings of the Third Federal Inter-Agency Sedimentation Conference, pp. 3/28-3/40 (1976).

34. "Pesticide Concentration and Yields in Runoff and Sediment From a Mississippi Delta Watershed," Willis, McDowell, Parr, Murphree, Proceedings of the Third Federal Inter-Agency Sedimentation Conference, pp. 3/53-3/64 (1976).

35. "Agricultural Watershed Runoff Model for the Iowa-Cedar River Basins," Roesner, Report for Environmental Protection Agency's Systems Development Branch (November 1975).

36. "Oats and Oat Improvement," American Society of Agronomy Monograph 8 (1961).

37. "Wheat and Wheat Improvement," American Society of Agronomy Monograph 13,(1967).

38. "Alfalfa Science and Technology," American Society of Agronomy Monograph 15, (1972).

39. "Soybeans: Improvement, Production, and Uses," American Society of Agronomy Monograph 16, (1973).

40. "Pesticides in Soil and Water," American Society of Agronomy Monograph, 16, (1975).

41. "Changing Patterns in Fertilizer Use," Soil Science Society of America, Proceedings of a Symposium Sponsored by the Soil Science Society of America, (February 1968).

42. "Fertilizer Technology and Use," Olson, Army, Hanway, Kilmer (editors), Proceedings of the Symposium on "Fertilizer Technology and Use," Sponsored by the Soil Science Society of America, (December 1971).

43. "Usual Planting and Harvesting Dates," Burkhead, Max, Karnes, Reid, Department of Agriculture, Statistical Reporting Service, Agriculture Handbook No. 283 (March 1972).

14. "Animal Residue Utilization on Cropland and Pasture - A Manual for Evaluation and Guideline Development," Environmental Protection Agency and Department of Agriculture, Agricultural Research Service (In Preparation).

15. "Evaluation of the Environmental Impact Resulting from Unconfined Animal Production," Environmental Protection Agency (In preparation).

46. "Non-Point Water Quality Modeling in Wildland Management: A State-of-the-Art Assessment," U.S. Forest Service, U.S. Environmental Protection Agency, IAG No. DS-0660 (At press).

47. "Erosion and Sediment from Forest Land Uses, Management Practices, and Disturbances in the Southeastern United States," Dissmeyer, Proceedings of the Third Federal Inter-Agency Sedimentation Conference, 1976.

48. "Processes, Procedures, and Methods to Control Pollution Resulting from Silvicultural Activities," U.S. Environmental Protection Agency, Washington, D.C. EPA 430/9-73-010, (October 1973).

49. "Forest Harvest, Residue Treatment, Reforestation and Protection of Water Quality," U.S. Environmental Protection Agency, Region X, Seattle, Washington, EPA 910/9-76-020, (April 1976).

50. "Silvicultural Chemicals and Protection of Water Quality," (Draft) U.S. Environmental Protection Agency, Region X, Seattle, Washington.

51. "Logging Roads and Protection of Water Quality," U.S. Environmental Protection Agency, Region X, Seattle, Washington, EPA 910/9-75-007, (March 1975).

52. "Methods for Identifying and Evaluating the Nature and Extent of Non-point Source Pollution," Environmental Protection Agency Publication 430/9-73-014 (October 1973).

53. "Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," Environmental Protection Agency Publication 430/9-73-007 (October 1973).

54. "Nonpoint Source Pollution Control Guidance, Construction Activity," U.S. Environmental Protection Agency, (in progress).

55. "Comparative Costs for Erosion and Sediment Control, Construction Activities," Environmental Protection Agency Report 430/9-73-016 (1973).

56. "Standard and Specifications for Soil Erosion and Sediment Control in Developing Areas," U.S. Dept. of Agriculture, Soil Conservation Service.

57. "The Control of Pollution from Hydrographic Modifications," U.S. Environmental Protection Agency, EPA 430/9-73-017 (1973).

58. "Impact of Hydrologic Modifications on Water Quality," U.S. Environmental Protection Agency, EPA 600/2-75-007 (1975).

59. "EPA Nonpoint Pollution Control Guidance, Hydrologic Modifications," Environmental Protection Agency, Water Planning Division, (In preparation)

60. "Report on Channel Modifications," The President's Council on Environmental Quality, United States Government Printing Office, (March 1973).

61. "Planning and Design of Open Channels," United States Department of Agriculture, Soil Conservation Service, Technical Release No. 25 (December 1964, Revised March 1973).

62. "Water Quality Management Planning Methodology for Hydrographic Modification Activities," Texas Water Quality Board, (December 1976).

63. "Mathematical Simulation of the Turbidity Structure Within an Impoundment," U.S. Army Corps of Engineers, Research Report H-73-2.

64. "Selective Withdrawal from Man-Made Lakes," U.S. Army Corps of Engineers, Technical Report H-73-4.

65. "Ecological Evaluation of Proposed Discharge of Dredged or Fill Material Into Navigable Waters," U.S. Army Corps of Engineers, Miscellaneous Paper D-76-17.

66. "Techniques for Reducing Turbidity Associated With Present Dredging Procedures and Operations," U.S. Army Corps of Engineers, Contract Report D-76-4.

67. "B. Everett Jordan Lake Water Quality Study," U.S. Army Corps of Engineers, Technical Report H-76-3.

68. "Methods for Identifying and Evaluating the Nature and Extent of Non-point Sources of Pollutants," U.S. Environmental Protection Agency Publication 430/9-73-014, (October 1973).

69. "Processes, Procedures and Methods to Control Pollution from Mining Activities," U.S. Environmental Protection Agency Publication 430/9-73-011, (October 1973).

70. "Erosion and Sediment Control, Surface Mining in the Eastern U.S.," Volume I: Planning, Volume II: Design, EPA Technology Transfer Seminar Publication, EPA-625/3-76-006, (October 1976).

71. "EPA Guidance for Identification and Assessment of Mining Nonpoint Pollution Problems," (In progress).

72. Mine Drainage Abstracts, Bituminous Coal Research, Inc.

73. "Effects of Land Disposal of Solid Wastes on Water Quality," Department of Health, Education, and Welfare, SW-Z: Bureau of Solid Waste Management, Cincinnati (1968).

74. "Residual Management by Land Disposal," Proceedings of the Hazardous Waste Research Symposium, EPA Report No. 600/9-76-015 (July 1976).

75. Solid Waste Management, D. Joseph Hagerty, Joseph L. Pavoni, and John E. Heer, Jr., Van Nostrand Reinhold Environmental Engineering Series, (1973).

76. "Management of Hazardous and Toxic Wastes," Paul N. Cheremisinoff, William F. Holcomb, Pollution Engineering, 8:4, pp. 24-32, (April 1976).

77. "Stop Leachate Problems," Michael Dilaj, John F. Lenard, Water and Wastes Engineering, 12:10, pp. 27-40 (October 1975).

78. "The Report to Congress: Waste Disposal Practices and Their Effects on Groundwater," Executive Summary, U.S. Environmental Protection Agency, (April 22, 1976).

79. Solid Waste Disposal, Volume 1: Incineration and Landfill and Volume 2: Reuse/Recycle and Pyrolysis, Baum, B. and Parker, C., Ann Arbor Science Publishers Inc., Ann Arbor, Michigan, (Vol. 1, 1973; Vol. 2, 1974).

80. "Disposal of Sewage Sludge Into a Sanitary Landfill," U.S. Environmental Protection Agency, Report No. SW-71d, (1974).

81. "Residual Waste Best Management Practices: A Water Planner's Guide to Land Disposal," U.S. Environmental Protection Agency, EPA-440/9-76-022 (in progress).

APPENDIX 1

BEST MANAGEMENT PRACTICES FOR NONPOINT SOURCES OF POLLUTION (TRI-COUNTY 208)

APPENDIX 1

BEST MANAGEMENT PRACTICES FOR NONPOINT SOURCES OF POLLUTION (TRI-COUNTY 208)

The pages which follow were extracted from the Tri-County 208 Study. That project evaluated in detail many of the nonpoint source control techniques cited in the body of this technical memorandum. The 208 agency screened the techniques down to those which it felt were most appropriate for application in the tri-county study area (of which Pinelands is a part).

The nonpoint source control methods are categorized into two levels: management level A and management level B. Level A controls are applicable in areas where nonpoint source problems are not severe or cause-effect relationships cannot be adequately demonstrated. The 208 agency recommended that Level A practices be applied in most areas while Level B practices (more extensive nonpoint controls) be applied only when it is found that Level A practices still result in significant water quality deterioration. It is felt that these recommended Best Management Practices provide an excellent summary and starting point for evaluating nonpoint source control measures most applicable to the Pinelands. Recommendations from other 208 studies (for example, Ocean County and Atlantic County) have not been included herein because they did not address nonpoint sources as specifically as presented in the following tables.

Table 1-1 presents a summary of the best management practices as developed by the 208 agency. Land use and activities covered include the following:

1. Urban areas

   - Storm drainage (existing areas)
   - Storm drainage (new areas)
   - Construction sites
   - Existing pipelines and industrial storage areas
   - New pipelines and industrial storage areas
   - Suburban fertilizer and pesticide use
   - Deicing salt applications
   - Illegal discharges
   - Combined sewer overflow

2. Agricultural Areas

- Erosion from cultivated land
- Fertilizer, pesticides and animal wastes

3. Land-Related Waste Disposal Areas

- Landfills (existing facilities)
- Landfills (new facilities)
- Existing industrial liquid waste lagoons
- New industrial waste lagoons
- On-lot sewage disposal (existing areas)
- On-lot sewage disposal (new areas)

Following Table 1-1 is a more detailed explanation for each one of the land uses/activities (Table 1-2). For each of these areas, existing Level A and Level B controls are described. An indication is given as to where the control practice should be applied; costs, effectiveness and implementability are also explained.

TABLE 1-1

SUMMARY OF BEST MANAGEMENT PRACTICES FOR NON-POINT SOURCES OF POLLUTION

PROBLEM SOURCE	EXISTING MANAGEMENT	MANAGEMENT A	MANAGEMENT B
URBAN AREAS			
Storm Drainage-- Existing Areas	Some catch basin cleaning and street sweeping, but not in response to water quality problems.	Strengthened programs for maintenance of existing and new detention basins.	Extension of NPDES permit program to cover storm sewers. Intensive street sweeping with vacuum system in commercial/industrial areas. Selective installation of detention basins where streams being scoured by peak storm flows.
Storm Drainage-- New Areas	Municipal land development ordinances include drainage controls. Conservation District provides assistance on detention basins and storm water control. NJ DEP stream encroachment permit program includes review of proposed storm sewer outlets for flood impacts. State, county and local acquisition of open space.	Education program by county for officials and developers on improved storm management techniques. Develop model drainage ordinances, design standards for detention basins that add sedimentation and recharge features, and guidelines for site designs that reduce runoff generation. Use Green Acres and local funds to purchase sensitive areas with water quality benefits.	Anti-degradation concept applied to storm water disposed in Pineland; no change in storm runoff volume.
Construction Sites	Under Chapter 251, Soil Conservation District (or municipality, by petition) reviews sediment control plans for private construction activities over 5000 square feet.	Provisions of Chapter 251 extended to all government projects.	No further measures.
Existing Pipelines and Industrial Storage Areas	EPA and DEP have provisions for handling major spills of oil and hazardous materials. EPA requires contingency plans for handling spills at oil storage facilities near navigable waters.	Preventive regulatory controls for toxic and hazardous materials, including permitting of storage areas. Contingency plans for all storage facilities of oil or hazardous materials for control of all spills and leaks, major or minor. More strict surveillance and monitoring of industrial waste scavengers.	Structural changes to facilities as determined by site analysis (such as replacement, storage area liners, scavenger wells).

TABLE 1-1 (Continued)

PROBLEM SOURCE	EXISTING MANAGEMENT	MANAGEMENT A	MANAGEMENT B
New Pipelines and Industrial Storage Areas	Safety requirements issued by OSHA and insurance carriers. Standards for toxic pesticides set by EPA, and PUC has regulations for pipelines.	Standards developed for construction of storage areas (corrosion resistance, liners and dikes, and leakage detection systems). Prohibition of certain materials storage near public well fields.	No further measures.
Suburban Fertilizer and Pesticide Use	Cooperative Extension Service provides information upon request.	Cooperative Extension expands information program; makes information available at garden supply and department stores.	No further measures.
Deicing Salt Applications	No program; salt is applied without regard for water quality.	Areawide standards for application rates and proper storage	No further measures.
Illegal Discharges	NJ DEP has monitoring and enforcement program to identify illegal discharges and permit violations.	Expanded surveillance program to identify site-specific illegal dischargers.	
Combined Sewer Overflow	Studies underway to determine extent of problem and to devise possible solutions.	Extend NPDES permit program to all combined sewer outlets.	
AGRICULTURAL AREAS			
Erosion From Cultivated Land	Application of Soil Conservation District voluntary conservation agreements (plans).	Expand the system of voluntary conservation agreements. Use minimum cost control measures. Establishment of permanent cover in flood plains.	Mandatory conservation plans. Use of control measures requiring cost sharing. Selective acquisition of use rights to develop stream buffers.
Fertilizers, Pesticides and Animal Wastes	Recommended controls are provided by the Cooperative Extension Service and the Soil Conservation Service on a voluntary basis.	No further measures.	No further measures.
LAND-RELATED WASTE DISPOSAL AREAS			
Landfills--Existing Facilities	State has standards for operation and maintenance and issues permits specifying acceptable wastes; monitoring wells may be installed. State may close a grossly polluting landfill or may call for its takeover by a public agency.	Impermeable cover placed over fresh waste cells and old cells graded to minimize percolation. Install monitoring wells at all landfills. Site new water supply wells at safe distance from landfills.	Structural solutions to contaminated wells based on surveillance and analysis. (Scavenger wells, water supply well relocation, purification of water supply). Modify solid waste generation by resource recovery and public education; recycling of used crankcase oil is an example.

TABLE 1-1 (Continued)

PROBLEM SOURCE	EXISTING MANAGEMENT	MANAGEMENT A	MANAGEMENT B
Landfills--New Facilities	EPA and DEP standards for design and construction of landfills including mandatory impermeable liners. Requirements for monitoring wells at all new facilities.	State standards for siting landfills with respect to groundwater use and flow. Present controls continued, but related more closely to new groundwater concerns.	No further measures.
Existing Industrial Liquid Waste Lagoons	State issues permits for lagoons and may install monitoring wells if lagoons are suspected of causing pollution Pretreatment needed to meet effluent guidelines for surface discharges, but not for leachate.	State permit program requiring high level treatment and absence of toxics in leachate. Monitoring wells required at all sites. New water supply wells sited at safe distance from lagoon.	Structural controls applied to facilities shown by surveillance and analysis to be contaminating groundwater (e.g., scavenger wells, sewers, well relocation).
New Industrial Liquid Waste Lagoons	NJ DEP has no standards for design and construction of lagoons; permits required for new facilities allow some control over lagoon location.	State standards issued for design and siting of lagoons that reflect concern for groundwater use and flow. State discourages industrial location outside of sewer service areas.	No further measures.
On-lot Sewage Disposal--Existing Areas	Maintenance is responsibility of homeowner. State issues permits to landfills for sludge disposal.	Strengthen maintenance with county inspection and permit program. Education program to instruct on proper use and maintenance and on water conservation. Licensing of scavengers and inspection of landfills by DEP for permit violations.	Structural controls instituted where surveillance and analysis reveal groundwater contamination. (Sewers, alternative systems, replacement of system).
On-lot Sewage Disposal--New Areas	State standards (Chapter 199) for design and construction of on-lot disposal systems and for percolation tests (administered by county health departments.)	Site and density controls based on detailed analysis of soils and groundwater; standards set for use of alternative disposal systems.	No further measures.
OTHER GROUNDWATER POLLUTION SOURCES (No Management Alternatives)			
Spray Irrigation	An uncommon effluent disposal method thought not to cause groundwater contamination, except possibly at industrial facilities. Further study is needed before recommendations can be made.		
Induced Infiltration	Delaware River water may be contaminating water supplies along the riverfront, but further sampling is necessary. Several steps may be now taken to prevent pollution of drinking water.		
Salt Water Intrusion	Some observers feel that the Raritan-Magothy aquifer is threatened by contamination by migration of a salt front from the southeast toward public water supplies. However, present understanding of this is highly speculative.		

TABLE 1-2

DESCRIPTION OF BEST MANAGEMENT PRACTICES

CONSTRUCTION SITES

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Under provisions of Chapter 251, the Soil Conservation District (or the municipality, by petition) reviews sediment control plans for private construction activities.	Private construction sites over 5000 square feet in area.	Several hundred dollars per acre for cost of controls, over $100 fee charged developer for review and inspection by SCD.	Effective where plans implemented and where Soil Conservation District provides adequate inspection and enforcement. Government projects are not covered by this program.	Administrative and technical means generally available to effectively implement present program.
A	Extend provision of Chapter 251 to cover all government projects.	All developments throughout study area.	Low cost for extending scope of project review.	Significant sediment reduction especially during roadway construction and maintenance.	Interagency agreement would be needed through State Soil Conservation Committee and Soil Conservation District with State and local public works agencies. Legislative change required to include government project.
B	No further measures.				

STORM DRAINAGE--Existing Areas

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Some catch basin cleaning and street sweeping, but not in response to water quality problems.	Region-wide.	Not known; variable.	Present storm disposal aggravates stream quality by high storm flows and low base flows.	Existing municipal land development code covers storm disposal; use of ordinances inadequate in some areas; technical assistance available from Soil Conservation Districts (SCD) and County Planning Board.
A	Strengthen maintenance program for existing and new detention basins.	All detention basins.	Undetermined; borne by homeowners or municipalities.	Helps prevent gradual deterioration of water quality due to decline in effectiveness.	No institution clearly responsible; solution may be either public or private.
B	Extension of NPDES permit program to cover storm sewers.	Region-wide; may be appropriate more in commercial/industrial areas.	Moderate; administrative costs borne by public.	Undetermined; could help determine where treatment of storm water is needed.	New Jersey DEP would issue permits under general permit authority of NPDES.
	Intensive street sweeping with vacuum system.	Commercial-industrial areas.	High; $7-$14 per curb mile.	95% reduction of Biochemical Oxygen Demand (BOD) and suspended solids (SS).	Extension of present programs of street cleaning. May require federal financial assistance.
	Selective installation of detention basins.	Basins with streams being scoured by peak storm flows.	$500 per controlled storm sewer discharge.	30% reduction in BOD; 60% reduction in SS; Small improvements to urban stream quality; significant reduction in load to Estuary.	Unclear which institution would assume responsibility; technical assistance available from SCD.

TABLE 1-2 (Continued)

STORM DRAINAGE--New Areas

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Municipal land development ordinances include drainage controls; Soil Conservation District provides assistance on design of detention basins.	Region-wide in new developments.	Unknown.	Drainage controls inadequately applied in some areas. Often does not effectively prevent stream degradation; detention basins moderately effective.	Already implemented.
	NJ DEP stream encroachment permit program encompasses review of proposed storm sewer outlets for flood impacts.	Region-wide in new developments.	Unknown.	Although only flood impacts considered, water quality is protected to the degree that flooding controls reduce sediment-laden runoff.	Already implemented.
	State, county or local open space acquisition programs.	Selective locations with visual, ecological, recreational value.	High cost for acquisition, especially in developing areas.	Effective in controlling pollution from purchased lands; many lands purchased without consideration of water quality concerns.	Already implemented.
A	Education program by county for officials and developers on improved storm management techniques.	Region-wide; emphasis on newly developing areas.	Low cost.	Long-run benefit in reducing degree of degradation caused by development.	Information available; county planners and Soil Conservation District could jointly sponsor program.
	Develop (1) model drainage ordinances, (2) design standards for detention basins that add sedimentation and recharge features, and (3) guidelines for site designs that reduce runoff generation.	Region-wide; emphasis on newly developing areas.	Low cost; recharge basins cost about $100 per acre of controlled drainage.	Long-run benefit in reducing degree of degradation caused by development.	Sample ordinances already available; such advisory services already provided by county planners and Conservation District.
	Use Green Acres and local funds to purchase sensitive areas with water quality benefits.	In developing areas priority given to floodways and wetlands and to appropriate buffers.	High cost for fee simple purchase; moderately high for purchase of easements.	Buffer around streams and wetlands could trap sediment and related pollutants.	Acquisition programs already established; current State funds largely committed; local funds generally allotted to active recreational areas.
B	Anti-degradation concept applied to storm water disposal in Pinelands; no change in storm runoff volumes.	New developments in Pinelands.	Moderate increase in development costs borne by new residents.	Intensive recharge efforts highly effective in preventing degradation of stream quality.	Available publications give designs for recharge controls. Lack of local experience with such controls. Roles of local and county officials unchanged.

TABLE 1-2 (Continued)

EXISTING PIPELINES AND INDUSTRIAL STORAGE AREAS

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	EPA and DEP have provisions for handling major spills of oil and hazardous materials.	Applies to spills to surface waters.	$25 million fund created by 1¢ per barrel tax on hazardous material transfer.	Spill handling does not protect groundwater; not effective where spills are minor or undetected.	Already implemented.
	EPA requires contingency plans for oil storage facilities near navigable waters.	Only applies to oil storage near surface water.	Cost borne largely by storage operator; some small administrative cost.	Does not provide planning for upland spills of oil or hazardous materials; moderately effective for oil facilities.	Already implemented.
A	Preventive regulatory controls for toxic and hazardous materials, including permitting of storage areas.	All pipeline and storage facilities region-wide.	Moderate administrative cost.	Significant improvement over existing program which ignores hazardous materials and groundwater contamination.	Existing laws provide legal basis; would fit into existing DEP programs.
	Contingency plans developed for all pipelines and storage facilities of oil or hazardous materials and for control of all spills or leaks, major or minor.	All pipeline and storage facilities region-wide.	Low to moderate costs by storage operators; small administrative cost.	Significant improvement in reducing probability of spills and in increasing effectiveness of cleanup for surface and groundwater protection.	Existing laws provide legal basis; would be extension of existing DEP programs.
	More strict surveillance and monitoring of waste scavengers.	Region-wide.	Moderate administrative cost.	Long-run reduction in spills.	Extension of existing programs.
B	Structural changes to facilities as determined by site analysis (such as replacement, liners, scavenger wells).	Only facilities where extent of defect and contamination analyzed.	High cost borne by pipeline or storage operator; moderate administrative cost.	Highly effective at stopping pollution from specific sites.	Administrative and legal framework available; insufficient inspection and monitoring program.

NEW PIPELINE AND INDUSTRIAL STORAGE AREAS

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Safety requirements issued by OSHA and insurance carriers for new facilities. Standards for toxic pesticide storage issued by EPA and PUC has regulations for pipelines.	Region-wide.	Not known.	Not necessarily effective at reducing probability of many spills.	Already implemented.
A	Standards developed for construction of storage areas (corrosion resistance, liners and dikes, and leakage detection systems).	Region-wide for new storage facilities; priority given to oil and hazardous materials.	Moderate administrative costs.	Effective in reducing probability of spills and leaks at new facilities.	Legal and administrative structure is available. Major technical analysis required. May require federal financial assistance.
	Prohibition of certain material storage near public well fields.	Areas of high pumpage by public wells.	Moderate administrative costs.	Prevents possible contamination to existing public wells from new facilities.	Legal and administrative structure is available. Major technical analysis required. May require federal financial assistance.
B	No further measures.				

TABLE 1-2 (Continued)

SUBURBAN FERTILIZER AND PESTICIDE USE

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Cooperative Extension service offers information on request.	Region-wide in response to inquiries.	Not known.	Low; does not reach wide numbers of homeowners.	Already implemented.
A	Expanded information service by Cooperative Extension Service.	Region-wide; material made available through garden supply and department stores.	Low additional cost, borne by state.	Moderately effective at reaching public; no assurance that application practices are improved.	Expands existing programs.
B	No further measures.				

DEICING SALT APPLICATION

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	No programs; salt is applied without regard for water quality.	Region-wide; more salt is used in urban areas and along highways.	Cost of current deicing program not known.	Degrades water by increasing sodium and chloride concentrations in surface and groundwater.	Already implemented by local, county or state road maintenance crews.
A	Areawide standards for application rates and proper storage.	Region-wide.	Low cost; savings in raw material; some cost in improved equipment.	Effectiveness dependent on magnitude of current excesses.	Implementable by existing highway or public works departments.
B	No further measures.				

ILLEGAL DISCHARGES

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	NJ DEP has monitoring and enforcement programs to identify violations of discharge permits and major illegal discharges.	Region-wide.	Permit program and compliance monitoring and surveillance is $1 million per year statewide; surveillance for non-permitted discharges not known.	Only major illegal discharges are presently identified.	Already implemented.
A	Expanded surveillance to identify site-specific illegal discharges.	Region-wide; priority given to watersheds with unusually high levels of background pollution.	Expansion of water sampling likely to be costly.	Potentially very effective in improving water quality in tributaries degraded by one or more illegal discharges.	Legal and administrative framework already implemented; considerably expanded water sampling program needed.
B	No further measures.				

TABLE 1-2 (Continued)

EROSION FROM CROPLAND

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Soil Conservation District maintains voluntary conservation agreements; control measures are voluntary.	On farms where assistance is requested.	Ranges from $5/acre to over $200/acre.	Only effective if the farmer will install the control measures recommended. Effectiveness is only for small areas.	Administrative and technical means are presently available.
A	Expand the system of voluntary conservation agreements.	All farms possible; highest priority to farms along streams.	Moderate cost for additional staffing to begin a concentrated program.	Moderately effective compared to present system; could be highly effective in small watersheds.	Administrative and technical agencies are in existence; lack only funds and direction. May require financial assistance from water quality programs.
	Use minimum cost control measures.	All farms; highest priority to farms along streams.	Low	Moderately effective.	The agencies exist; should be implemented.
	Establishment of permanent cover in floodplains.	Croplands in the floodplains.	Moderate	Highly effective in reducing sediment pollution.	May be difficult to implement.
B	Mandatory conservation plans.	All farms.	High cost for additional staffing.	High—could have a tremendous impact on reducing sediment from croplands.	Low--may require legislation or preferential tax treatment. May require financial assistance to administer.
	Use of control measures requiring cost sharing.	All farms.	Could be high depending on severity of erosion problems or cropping patterns.	Could be very high.	Moderate--may require increased cost sharing or subsidies.
	Selective acquisition of use rights to develop stream buffers.	Croplands in the floodplain.	High	High--could reduce sediment loads.	Similar program exists--could be altered or a similar one developed.

FERTILIZERS, PESTICIDES AND ANIMAL WASTE

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Recommended controls are provided by the Cooperative Extension Service and the Soil Conservation Service on a voluntary basis.	Only on farms where assistance is requested.	Low costs for farmer and government agencies.	Moderate to high effectiveness in reducing pollution from these sources.	Agencies with the technical ability are in place and the present controls are effective.
A	No further measures.	---	---	---	---
B	No further measures.	---	---	---	---

TABLE 1-2 (Continued)

EXISTING INDUSTRIAL LIQUID WASTE LAGOONS

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	State issues permits for lagoons and may install monitoring wells if lagoons are suspected of causing pollution.	Region-wide.	Not known.	Provides information but has no effect on pollutants.	Already implemented.
	Pretreatment needed to meet effluent guidelines for only surface discharges of wastes from lagoons.	Region-wide.	Not known.	State has no program to control quality of leachate from unlined lagoons.	Already implemented.
A	State permit program would require that there be a high level of pretreatment and an absence of toxics.	Region-wide.	Moderate administrative costs.	Full compliance would effectively control most contamination.	Large expansion of program; would require cooperative agreements between Solid Waste Administration and Division of Water Resources and would require improved standards for leachate control. May require federal financial assistance.
	Monitoring wells required at all lagoon sites.	Region-wide.	Moderate costs borne by industry.	Provides information; no direct change in water quality.	Requires expansion of existing surveillance programs.
	Site new water supply wells at safe distance from lagoons.	Region-wide.	Low cost.	Prevents future health hazards.	Requires greater coordination among agencies responsible for wastes and water supply.
B	Structural controls applied to facilities shown by surveillance and analysis to be contaminating groundwater. (Such controls include scavenger wells, well relocation, and sewer service.)	Specific offending facilities.	High cost to lagoon operators; moderate administrative costs.	Highly effective at stopping specific pollution sources.	Expansion of existing surveillance, analysis and enforcement programs; would probably require more staff.

NEW:

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	NJ DEP has no standards for design of lagoons; permits required for new facilities allowing some control over lagoon location.	Region-wide.	Not known.	Groundwater quality may not be adequately protected by designs; standards are not well formulated.	Already implemented.
A	State standards issued for design and siting of lagoons that reflect concern for groundwater use and flow.	Region-wide.	Moderate administrative cost.	Primarily useful for protecting public water supply, but may also prevent discharge of contaminated groundwater to streams.	Extension of existing standards program; legal authority available; lagoon technology likely to be highly variable among industries, making standards hard to formulate.
	State discourages industrial location outside of areas served by sewers.	Outside of service areas.	Low administrative costs; unknown opportunity costs for landowners.	Effectiveness high assuming high degree of compliance.	Not a traditional control; full compliance difficult due to need to balance environmental goals with other community goals; concentration of control at municipal level prevents full state control.
B	No further measures.				

TABLE 1-2 (Continued)

ON-LOT SEWAGE DISPOSAL - Existing Areas

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Maintenance responsibility belongs to homeowners; state issues permits for sludge disposal at landfills.	Region-wide, outside sewer service areas.	Low cost for homeowners and low administrative costs.	Does not assure effective maintenance; ground and surface water pollution known to occur.	Already implemented.
A	Strengthen maintenance program, with county assuming a role through inspection and permit program.	Region-wide outside sewer service areas.	Moderate cost for county, offset by charges to homeowners ($35-$50 per year).	Could be very effective at reducing present pollution and preventing future contamination.	Debate as to which agency most appropriate for public maintenance program. Not readily implementable.
	Educational program to instruct on proper use and maintenance.	Region-wide outside sewer service areas.	Moderate cost.	Long-run benefits; no immediate water quality improvements.	New program, perhaps jointly sponsored by NJ DEP and County health departments.
	Licensing of scavengers and inspection by DEP of landfills for permit violations.	Region-wide outside sewer service areas.	Moderate administrative cost.	Might significantly reduce incidents of illegal disposal.	Expansion of existing waste hauler licensing programs.
B	Structural controls instituted where surveillance and analysis reveal groundwater contamination (such as sewers, alternative disposal systems, replacement of system).	Areas of high pollution due to septic tanks.	High cost for homeowner ($1000 to $4000); moderate administrative costs.	Highly effective for reducing documented pollution sources.	Significant expansion of existing surveillance and enforcement practices.

ON-LOT SEWAGE DISPOSAL - New Areas

LEVEL	SOLUTION DESCRIPTION	WHERE APPLIED	COST	EFFECTIVENESS	IMPLEMENTABILITY
Existing	Chapter 199 is state law setting standards for design and construction of on-lot disposal systems and for percolation test (administered by county health department).	Region-wide, outside sewer service areas.	Not known.	Moderately effective at avoiding sites conducive to system failures. Groundwater contamination still likely.	Already implemented.
A	Site and density controls applied, based on analysis of soil and groundwater, more detailed than presently available; standards set for alternative disposal systems.	Region-wide, outside sewer service areas.	Moderate cost to public.	Should be effective at reducing probability of future contamination.	Appropriate agency not designated; could be county health agency or planning department.
B	No further measures.				

The preparation of this document was financed in part through a planning grant from the National Park Service, Department of Interior, under the provisions of the Land and Water Conservation Fund Act of 1965 (Public Law 88-578, as amended).