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State of New Jersey  
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GOVERNOR

**New Jersey's Modernized Ambient Chemical Monitoring Network**



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**January 1998**

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## **New Jersey's Modernized Ambient Chemical Monitoring Network**

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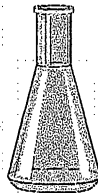
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**New Jersey Department of Environmental Protection  
Division of Science and Research  
Water Monitoring Management**



**NEW JERSEY'S MODERNIZED AMBIENT CHEMICAL MONITORING NETWORK**

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**Abstract**

The New Jersey Department of Environmental Protection (NJDEP) and the United States Geological Survey (USGS) have jointly operated an Ambient Surface Water Monitoring Network since 1976. On June 26, 1996, the agencies agreed that due to expanding water quality data needs, resulting in part from the NJDEP's new watershed approach to improving the State's water quality, the network would be redesigned.

Relying heavily on Geographical Information System (GIS) land use data and the Ambient Biomonitoring Network (AMNET), a redesigned network has been developed. Where possible, historical water quality stations have been retained to preserve valuable long term databases. Stations were selected in each of the newly created Watershed Management Areas (WMA's) to address a variety of water quality issues. Additionally, the Redesign Committee was interested in enhancing the network's quality assurance documentation. This was accomplished through an agreement with the Environmental Protection Agency (EPA), Edison office, which provides for the analysis of replicate and duplicate samples from the network.

Specific improvements resulting from the redesign include: (1) an expansion of the number of active stations from 78 to 115; (2) alignment of the chemical and biological databases; (3) WMA specific monitoring; (4) station selection based on land use; (5) expanded network coverage into tidally impacted areas; (6) network flexibility to respond to site specific issues; and (7) the enhancement of network Quality Assurance (QA) documentation.

**Background/Historical**

The Ambient Stream Monitoring Program (ASMP) was established by the NJDEP and the USGS in the mid-1970's as a cooperative stream monitoring network. The goals of the network were: (1) to provide data on the status of water quality; (2) to assess trends over time, and; (3) to correlate status and trends with land use and water quality management measures. Stations were selected based on the following site selection criteria: (1) segments with known exceedances of water quality criteria; (2) inlets and outlets of major lakes and reservoirs; (3) urban and industrial areas; (4) drinking water supplies; (5) mouths of major tributaries; and (6) segments in protected/rural areas. Stations were located in freshwater and tidal stream segments.



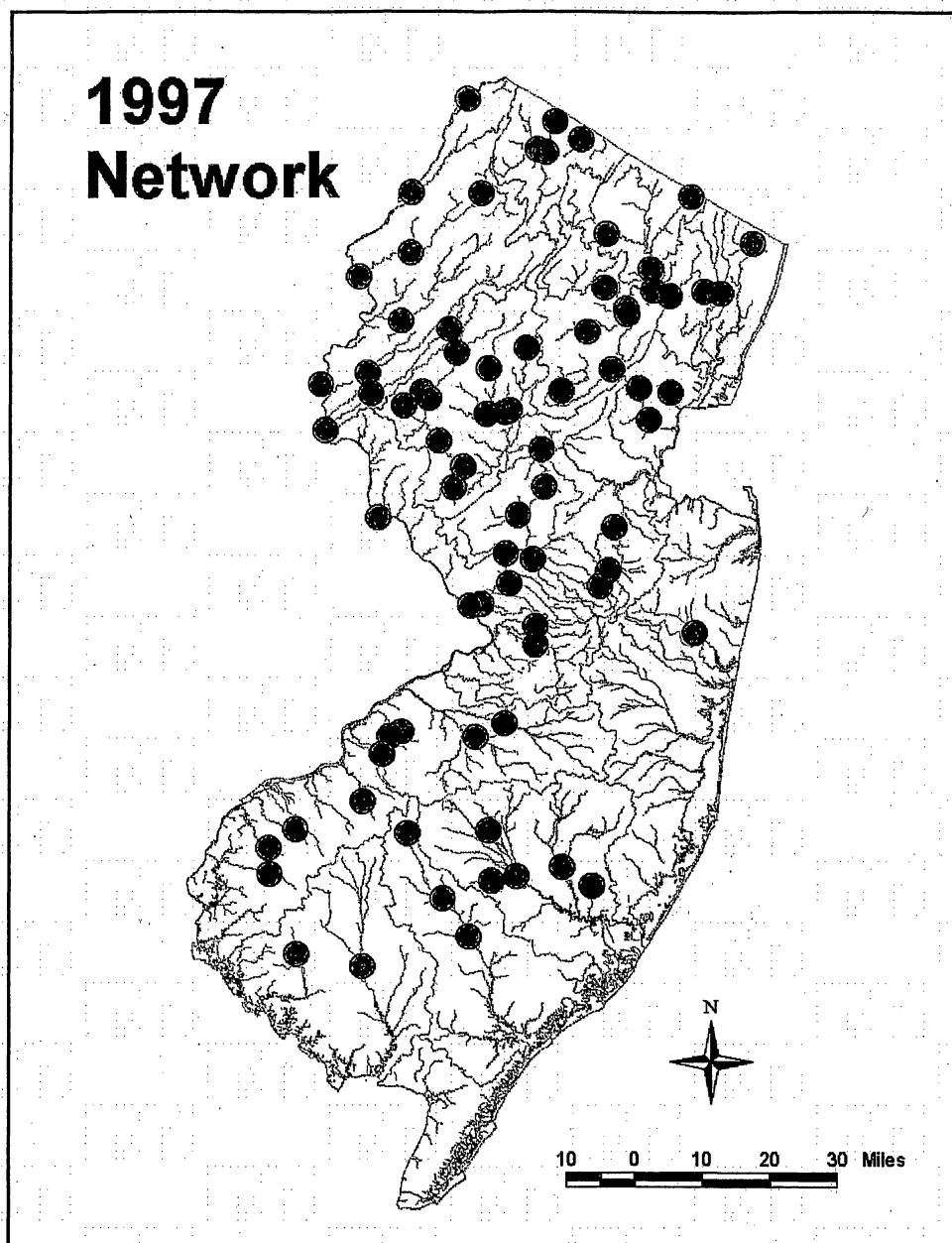


Figure 1

Flow and tide stage were directly monitored or calculated from nearby stations to provide data for load calculations.

Water samples were collected from over 200 stations 9 times per year by NJDEP and USGS, and analyzed for major ions, nutrients, bacteria, biochemical oxygen demand (BOD), and field parameters. Total metals data were collected from 60% of the stations twice per year. Metals samples were collected on a rotating schedule so that data was collected at all stations over a 2 year period. Sediment samples were collected annually and analyzed for nutrients, carbon, metals, pesticides, PCBs, and sediment characteristics at a subset of the water quality



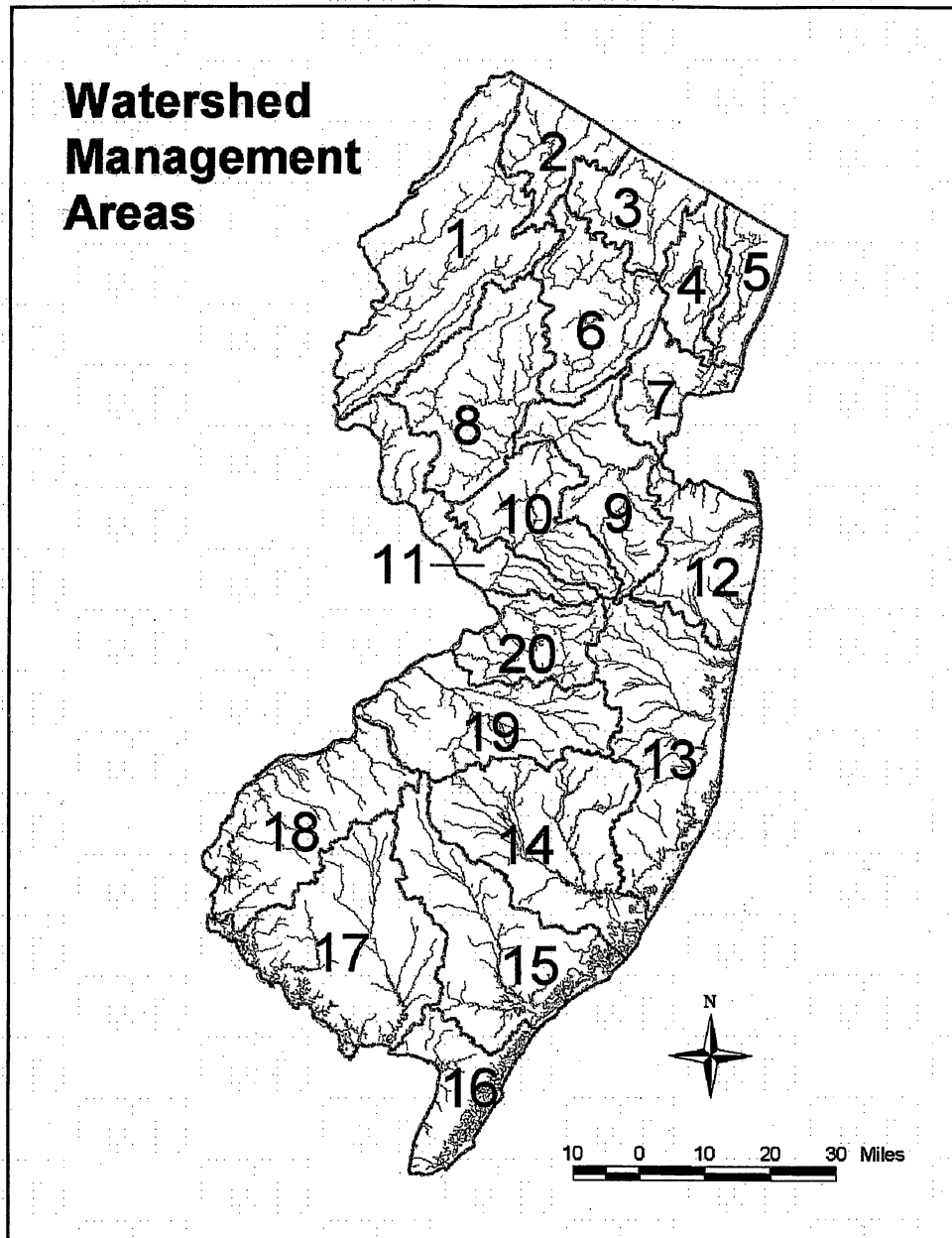
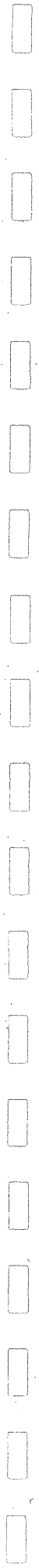


Figure 2

stations because sampling was not technically feasible at all 200 stations. Samples were collected at 40% of the stations using a rotating schedule so that all sediment stations were sampled once every 3 years.

Monitoring results are reported annually by USGS in Water Year Reports and are maintained in USGS's Water Data Storage and Retrieval (WATSTORE) and EPA's Storage and Retrieval (STORET) systems. NJDEP assesses the data to evaluate attainment of designated uses and reports this information every two years in the Statewide Water Quality Inventory Report as required in Section 305(b) of the Clean Water Act.



Over the past 20 years, the number of stations dropped from 200 to 78 for a number of reasons. Generally, stations were eliminated to increase efficiency or reduce network costs. Concern had developed, however, that the 78 station network did not provide proper spatial coverage.

## **Redesign**

The DEP/USGS Redesign Committee brought a wide range of water resources program experience to this project. Committee members have working experience with: (1) the existing network; (2) indicator selection; (3) the National Environmental Performance Partnership System (NEPPS) agreement; (4) watershed characterization; (5) USGS's National Water-Quality Assessment Program (NAWQA); and (6) the Clean Water Act [specifically sections 303(d) and 305(b)]. Additionally, input was solicited from water quality data using programs within NJDEP. The Department's watershed initiative and the newly created WMA's were the major focus of the redesign committee (See Figure 2).

Because a major objective of the redesign was to align NJDEP's chemical and biological databases, the decision was made to use the existing AMNET station set (771 stations statewide) as the universe of stations for the revised network wherever possible. The advantages of using this stratified random station set are: (1) biological data is available at each station; (2) sites have been located through the Global Positioning System (GPS) and are in the GIS system; and (3) site access has been confirmed. To answer a range of water quality questions, 5 types of stations were included in the redesign of the ambient network and sampled quarterly; they are as follows:

- (1) **Reference/Background Stations** (Figure 3) - An assessment of our existing network recently revealed a lack of stations which would provide background water quality in different regions of the state. This information is important for setting water quality standards and planning and evaluating water quality control initiatives. In the revised network, 6 stations within New Jersey's 4 physiographic provinces (Valley and Ridge, New Jersey Highlands, Piedmont, and Coastal Plain) will address this need. These sites are almost exclusively within county, state or federally controlled lands (FW1 or C1 waters) and are expected to provide permanent baseline data sources.
- (2) **Watershed Integrator Stations** (Figure 4) - These stations are located near the discharge end of each WMA and are selected to measure the combined water quality impacts of activities within the WMA. This data will be useful in defining the parameters of concern for intensive watershed monitoring projects and defining downstream boundary conditions. Each WMA will receive one (1) Watershed Integrator Station.
- (3) **Land Use/Indicator Stations** (Figure 5) - Each of the 20 WMA's will have 2 Land Use/Indicator Stations to monitor the dominant land uses within the WMA. This data will provide non-point loading information specific to each WMA throughout the state. This data will support dynamic model development where appropriate and provide direction for



nonpoint pollution control strategies. To select these stations, the Redesign Committee relied on a GIS land use database developed by USGS. With this database, we were able to quantify the percentages of forest, urban areas, and agriculture, and the drainage area for each potential station within the WMA. The following table (Table 1) illustrates how this process was used to select Land Use/Indicator Stations in WMA 19. The table shows the land use data associated with all the AMNET stations in WMA 19.

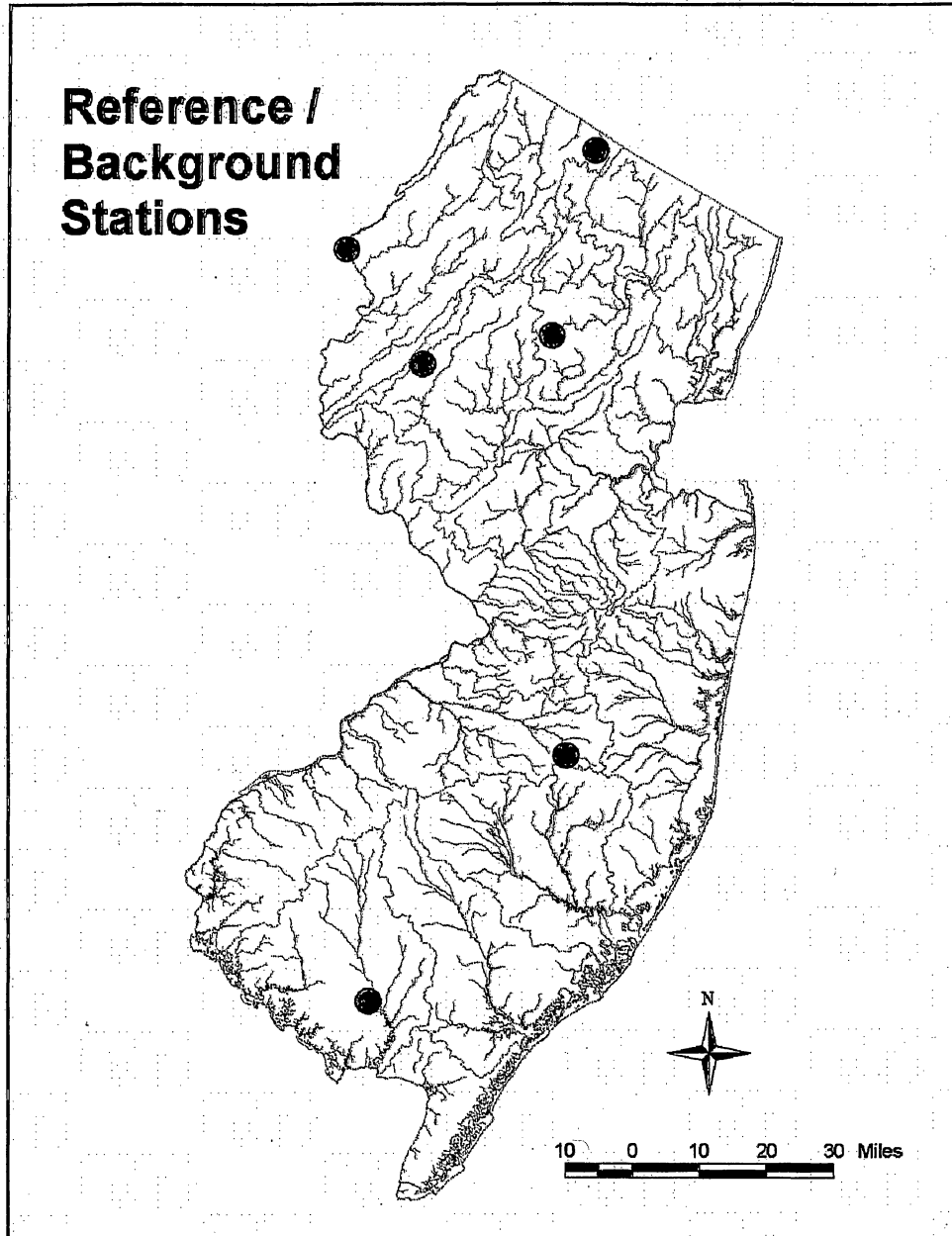
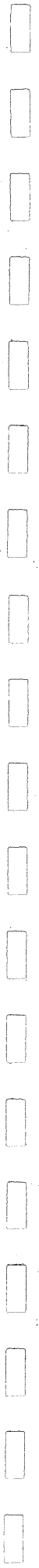


Figure 3



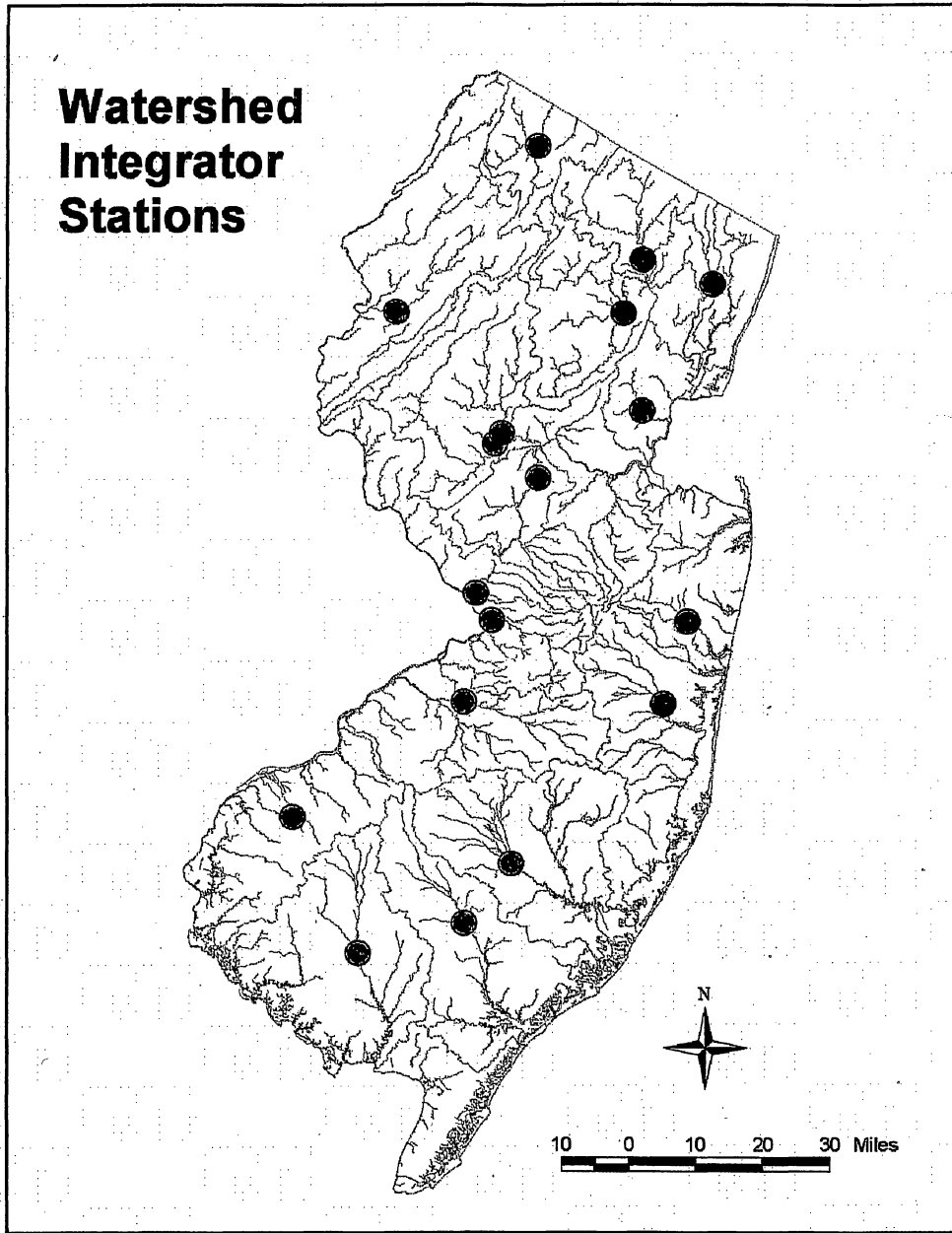


Figure 4

This WMA includes parts of Burlington and Camden Counties. The Redesign Committee projected that the major land uses in WMA 19 were agriculture and urban. From the chart, AMNET station 172 can be seen to have a high percentage of agricultural land use (79.8%) and was therefore selected as our Agriculture Land Use/Indicator Station. Similarly, AMNET station 191 had a high percentage of urban land use (66.6%) and was selected as the urban Land Use/Indicator Station. This land use data was useful for station selection, but will also be significant for data evaluation.

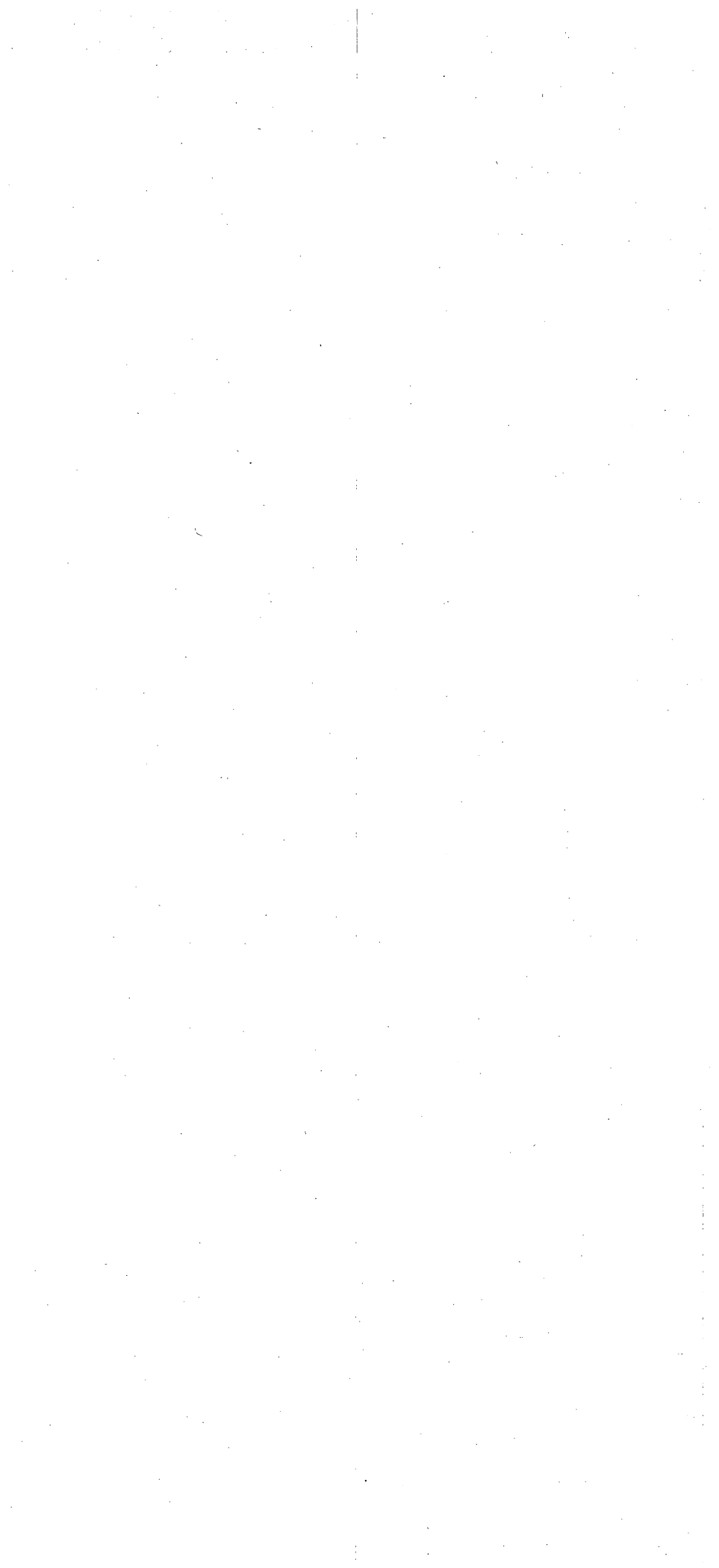


Table 1

WMA 19 Land Use

Station	Drainage Area	Urban%	Agriculture%	Forest%		Station	Drainage Area	Urban%	Agriculture%	Forest%
143	35.4	11.2	79.9	9		168	3.1	47.2	4.8	46.4
144	18.1	15	6.2	51.6		169	29	38.3	3.1	48.8
145	19.4	12.2	8.9	53.7		170	51.5	37.5	11.9	40.9
146	27.5	26	1.4	83.5		171	3.1	20.5	64.1	15.2
147	3.1	3.1	0	91.2		172	4.4	11.7	79.9	5.8
148	15.9	7	3.2	65.7		173	1.2	18.1	71.2	10
149	77.3	8	5.4	66		174	4.5	19.3	61.8	18.8
150	4.9	25	46.4	27.7		175	6.4	24.8	56.4	18.6
151	152.7	23.3	28.8	29.5	Integrator	176	12.6	51.1	35.1	12.8
152	149.6	19.2	13.3	50.7		177	5.1	49.3	45.2	5.4
153	7.3	19.2	14.3	50.7		178	3	67.9	25.5	5.5
154	3.9	9.7	5.9	51.4		179	6.4	47.1	37.1	15.2
155	21.2	12.1	3.2	63.9		180	12.2	53.9	30.2	15.6
156	35.9	17	6.5	52.2		181	12.8	54.2	29.8	15.7
157	46.8	14.8	11.4	44.5		182	16.7	60.1	26.5	12.9
158	8.6	5.9	77.8	2.8		183	1.6	72	15	10
159	6	21.1	34.7	8		184	7.7	78.5	13.2	7.6
160	11.3	18.2	32	6.7		185	8.4	80.4	12.2	7.2
161	13.5	16.5	39.7	5.6		186	12.5	86.2	8.1	5.4
162	81.1	15.4	29.6	27.9		187	1	47.1	27.7	22.4
163	24	52.7	31.1	14.4		188	9.5	62.9	18	18
164	3.9	58.5	4.4	29.4		189	27.2	69.8	11.5	15.8
165	1.6	15.6	7.5	51.2		190	1.1	51.1	0	40.7
166	0.9	35	5.4	43.9		191	8.1	66.6	7.6	20.7
167	16.7	34	17.8	35.8						

(4) **Statewide Status Stations** (Figure 6) - To assess statewide water quality status requires a randomly collected dataset reflecting the full range of water quality conditions. This will be developed by randomly selecting two AMNET stations from each WMA (total 40 stations) for chemical monitoring. Those random stations will be reselected annually, increasing spatial coverage. In addition to developing the statewide database, these stations will provide limited site specific data at an ever increasing number of locations.

(5) **Watershed Reconnaissance Stations** - The existing Ambient Surfacewater Network has not had the flexibility to adjust to additional water quality data needs within the NJDEP. The Redesign Committee addressed this situation by adding 10 Watershed Reconnaissance Stations to the revised network. These stations will be selected annually based on input from programs within NJDEP. Some examples of how these stations are expected to be used are: (1) investigate biologically impaired AMNET stations; (2) support preliminary watershed assessments; (3) investigate point source impacts; and (4) support the air deposition network. Figure 7 shows all of the stations for the new network, except for the watershed Reconnaissance Stations.



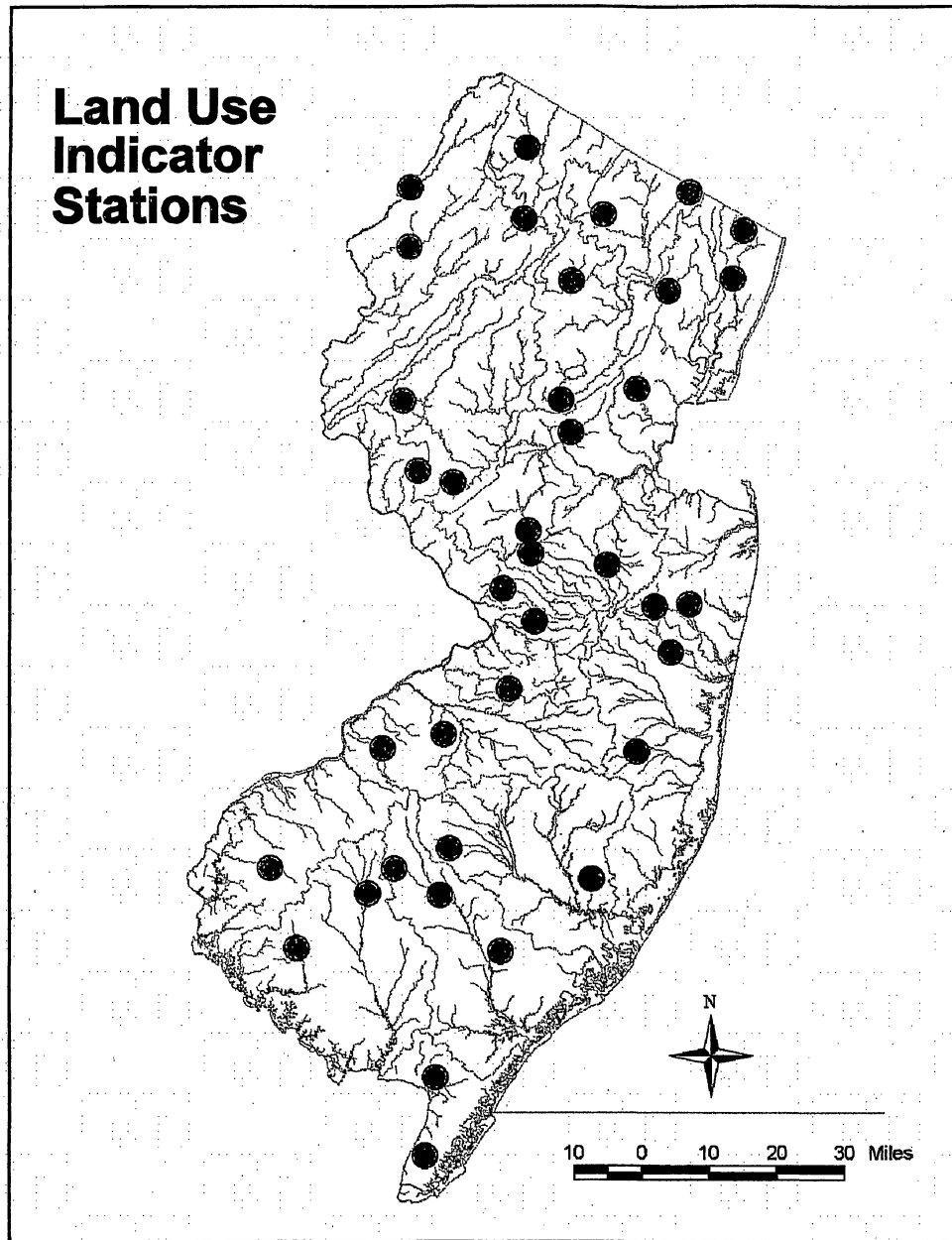
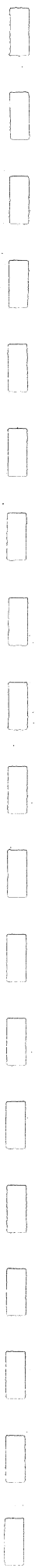


Figure 5

### Parameter Selection

A subcommittee of the Redesign Committee was assigned the task of reviewing and proposing changes, if needed, to the network's parameter list. Two NJDEP staff and one USGS staff person participated in this task. Several significant changes were proposed and will be incorporated into the redesign of the Ambient Surfacewater Network; they are:

- (1) **Bacterial Parameters** - The network will continue to monitor state waters for Fecal Coliform and Enterococcus; however, the timetable for sample collection will be altered. In the past,



samples were collected during each of the 5 sampling periods throughout the year. Because (1) environmental concentrations of bacterial parameters vary significantly, (2) analytical procedures are less precise, and (3) the Surface Water Quality Standards suggest collecting 5 samples over 30 days, the network will concentrate monitoring over the primary contact period (June, July, August). This will result in a higher degree of confidence in those databases.

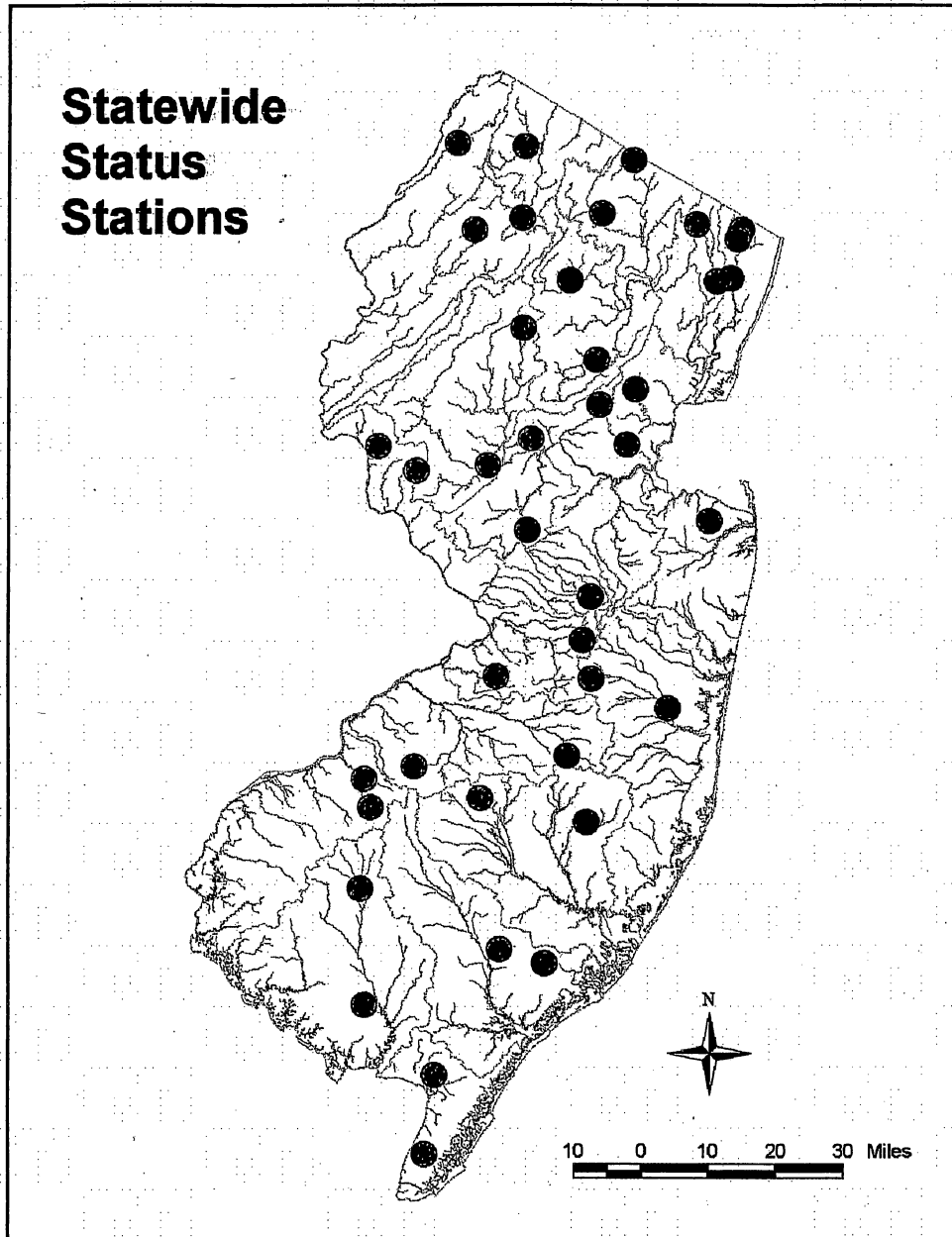


Figure 6



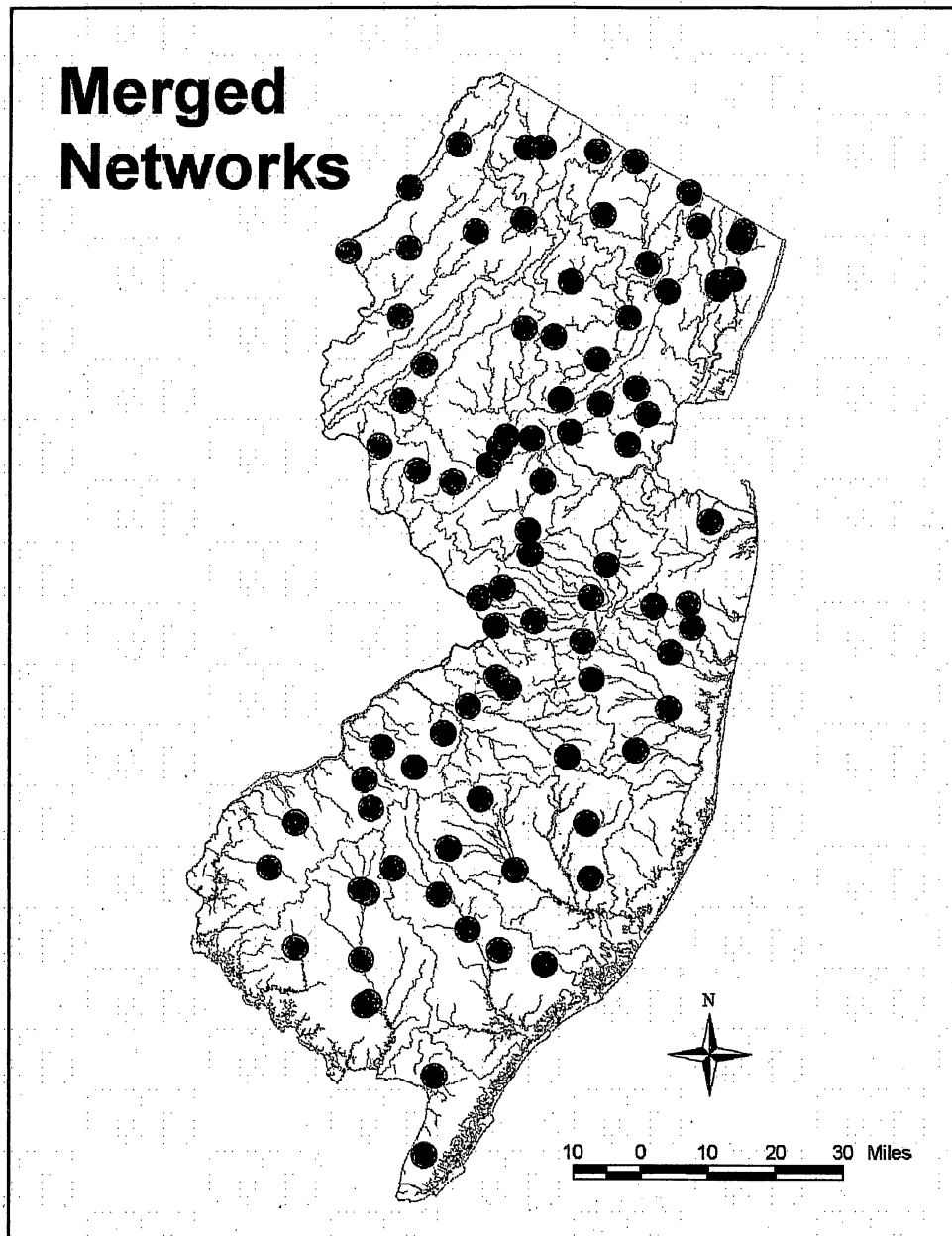


Figure 7

- (2) **D.O. Data** - A gradual change will be implemented in the collection of the network's D.O. data. Currently, D.O. readings are taken only at the time of sample collection. Since these samples are always collected between 0900 - 1400 hours, we never measure the lowest D.O. concentration of the 24 hour period. Because the Surface Water Quality Criteria for D.O. is stated as minimum concentration, the lack of diurnal D.O. data is a significant omission. With the purchase of recording D.O. meters, Network staff will begin to collect diurnal D.O. data which will allow accurate assessment against State Standards.
- (3) **Pesticides/Volatile Organic Compounds (VOC)** - As an expansion to the network database, 48 current "in use" pesticides and 30 volatile organic compounds will be collected from 6



## Reference/Background Stations and 40 Statewide Status Stations.

- (4) Sediments - The network has a sediment monitoring component. Two Reference/Background and 20 Statewide Status Stations will be monitored annually. The analysis of chlorinated pesticides (such as DDT) will be discontinued and the analysis of 28 polyaromatic hydrocarbons will be added.

A complete history of parameters, by station type and sampling frequency, can be found in Attachment I at the end of this report.

## Summary

The revised ambient monitoring network offers the following advantages over the previous network design:

- (1) At a time when biological indicators are playing an increasingly important role in environmental assessment, the new network will closely associate the chemical and biological databases.
- (2) The revised network is designed to individually characterize NJDEP's 20 WMAs, which are the units by which the department manages the State's water quality.
- (3) The number of actively monitored stations will increase from 78 to 115, reversing a trend of decreasing numbers of stations.
- (4) The land use information associated with each station will provide the basis for assessing non-point source impacts on water quality.
- (5) Expands QA Support Database.
- (6) The expansion of this network into tidally impacted water and a similar expansion of NJDEP's coastal monitoring network has finally resulted in a statewide ambient monitoring network.



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**ATTACHMENT 1**

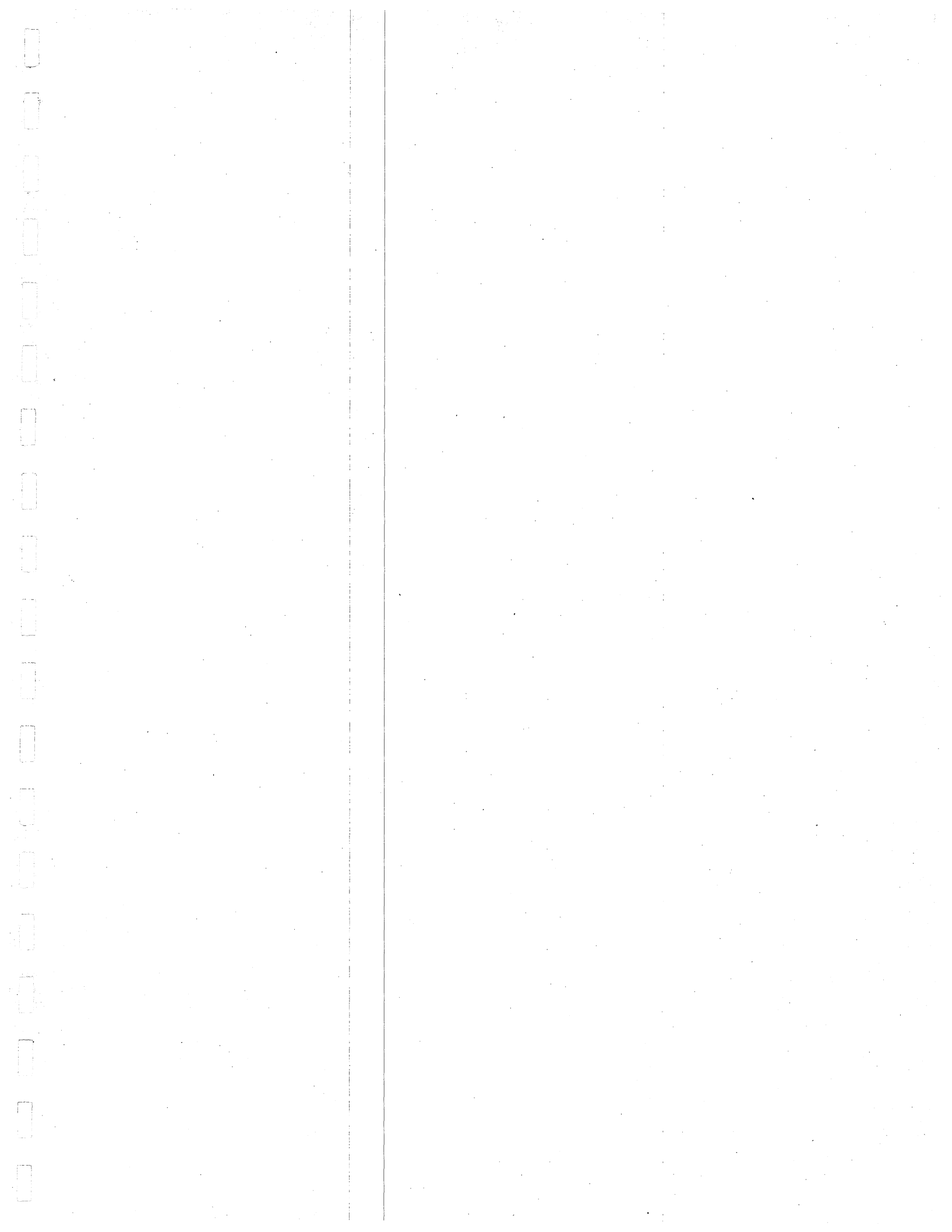


Table of Parameters by Station Type  
Monitoring Type and Frequency

<u>Station Type</u>	<u>Routine Water</u>	<u>Bottom Sediments</u>	<u>Supp. Water</u>	<u>Pest\ VOC</u>	<u>Stream Flow</u>
Reference	4x per yr	*	1x per yr	1x per yr	YES
Integrator	4x per yr	*			YES
Indicator	4x per yr	*			YES
Random	4x per yr		1x per yr	1x per yr	NO

\* Once per year at a total of 22 sites

Note: Parameters for Watershed Reconnaissance Stations will be determined on a case by case basis.

Routine Parameters

Specific conduct
pH
Water Temp
Dissolved Oxygen
BOD 5
Fecal Coliform
Enterococci
Hardness
Calcium Diss
Magnesium Diss

Sodium Diss
Potassium Diss
Alkalinity
Sulfate Diss
Chloride Diss
Fluoride Diss
Silicia Diss
Total Diss Solids
Total Residue Solids
Nitrite Diss
Nitrite and Nitrate Diss

Ammonia
Ammonia Diss
Total Kjeldahl Nitrogen
Total Kjeldahl Nitrogen (Diss)
Phosphorus
Phosphorus (Diss)
Organic Carbon Diss
Organic Carbon Suspended
Suspended Sediments
Boron Diss

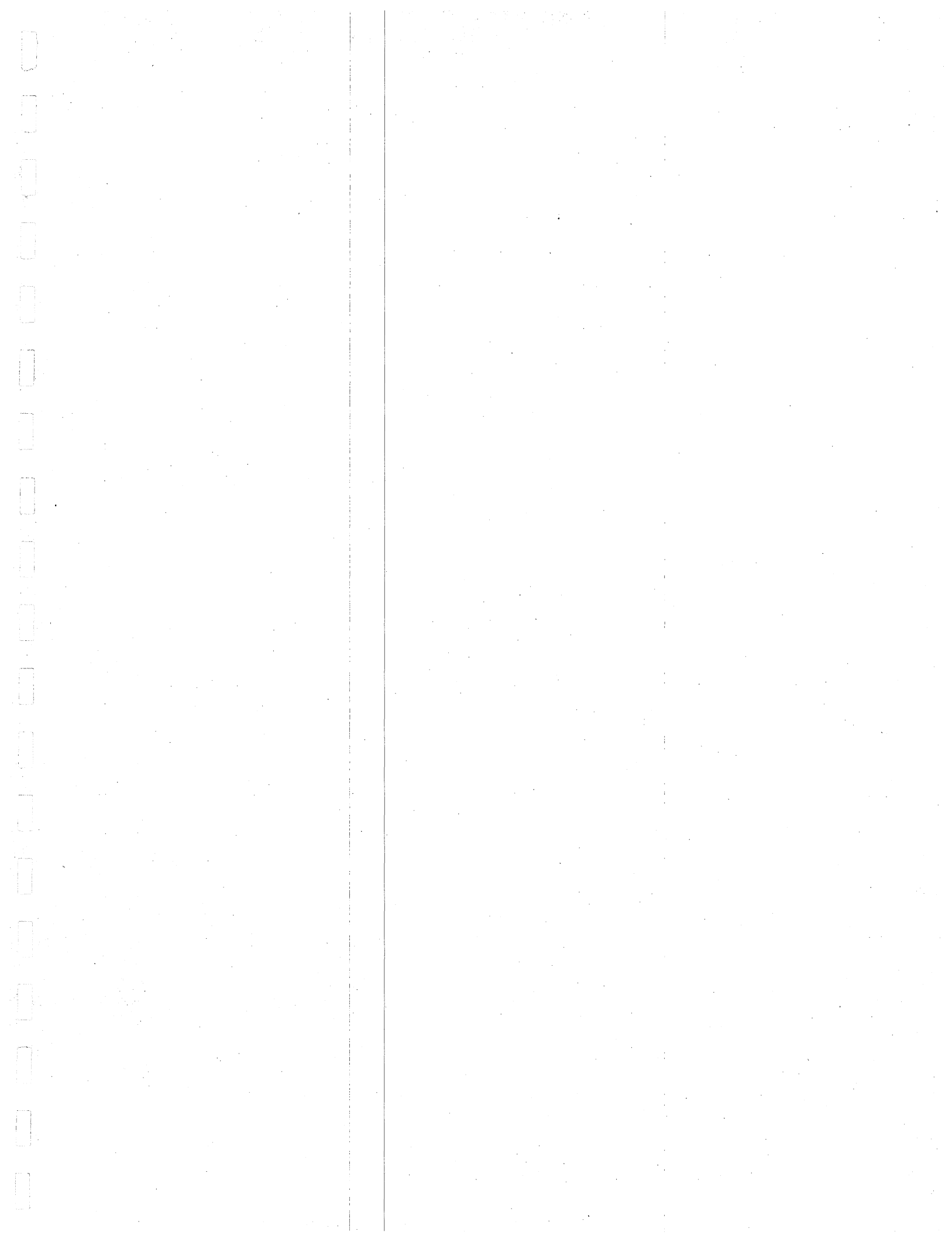
Supplemental Parameters \*

Arsenic
Beryllium
Boron
Cadmium
Chromium

Copper
Iron
Lead
Manganese
Mercury

Nickel
Selenium
Zinc
Barium
Silver

\* Note: All metals are total recoverable.



Bottom Sediment Parameters

pH
Carbon, Inorg.
Carbon Total
Phosphorus

Nitrogen, Ammonia
Nitrogen, Ammonia +Organic
PCB, Total Rec

Bottom Parameters: Metals

Zinc, Total Rec.
Selenium, Total Rec.
Nickel, Total Rec
Mercury, Total Rec

Managanese, Total Rec
Arsenic, Total Rec.
Cadmium, Total Rec.
Chromium, Total Rec.

Cobalt, Total Rec.
Copper, Total Rec.
Iron, Total Rec.
Lead Total Rec,

Bottom Parameters: PAH's

Acenaphthene, BTM
Anthracene, BTM
Benz(a)Anthracene, BTM
Benzo(ghi)Perylene, BTM
Benzo(a)Pyrene, BTM
Chrysene, BTM
Fluoranthene, BTM
Isophorone, BTM
9H-Fluorene, BTM
Acenaphthylene
Benzo(b)Fluoranthene, BTM
Benzo(k)Fluoranthene, BTM

Dibenzo(ah)Anthracene, BTM
Indeno(1,2,3-c,d)Pyrene, BTM
Naphthalene, BTM
Phenanthrene, BTM
Pyrene, BTM
2,6-Dimethylnaphthalene, BTM
1,2-Dimethylnaphthalene, BTM
1-Methyl-9H-Fluorene, BTM
Phenanthridine, BTM

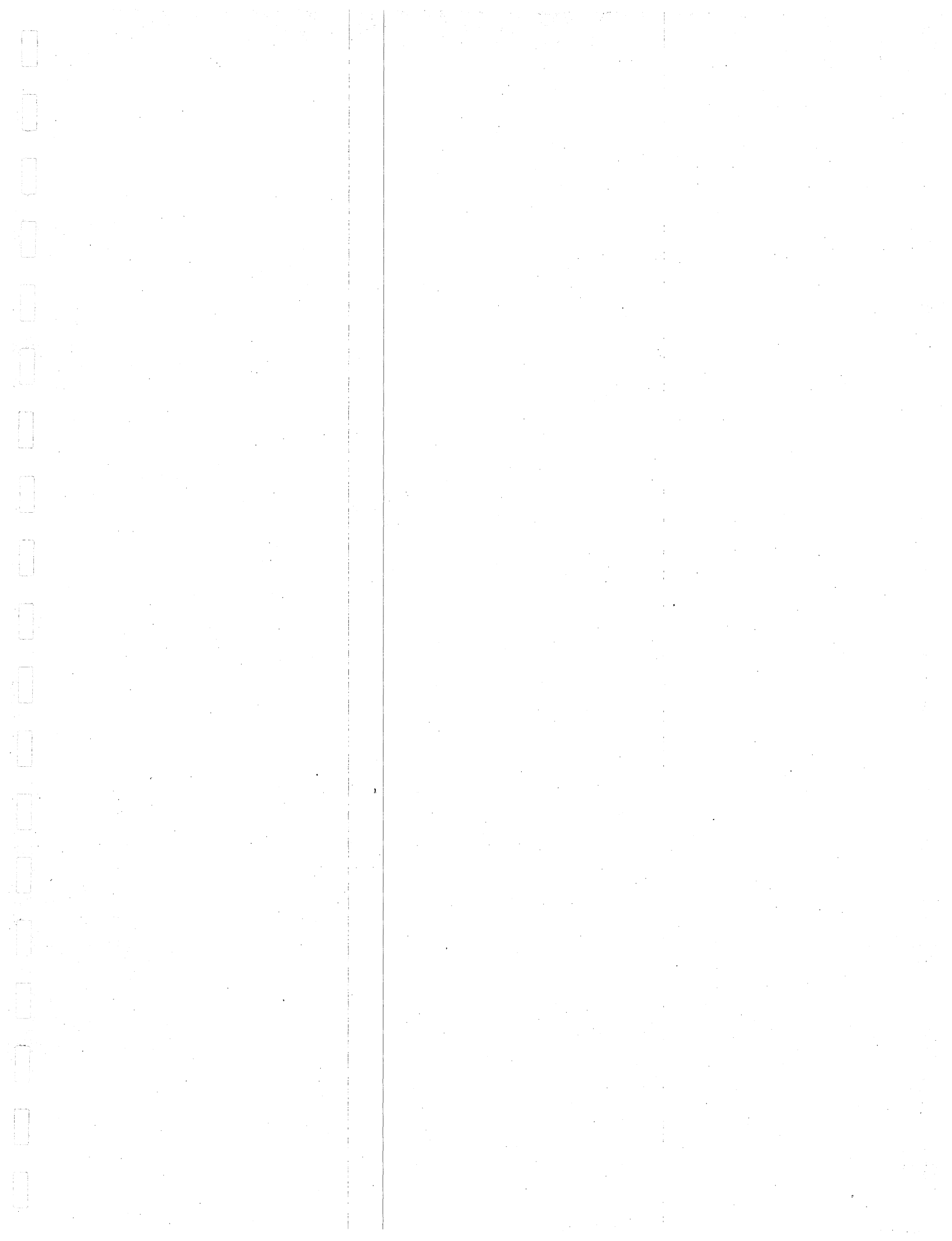
2-Methylantracene, BTM
4,5-Methylenephenanthrene, BTM
p-Cresol, BTM
2-Ethyl-naphthalene, BTM
1,6-Dimethylnaphthalene, BTM
2,3,6- Trimethylnaphthalene, BTM
1-Methylphenanthrene, BTM
1-Methylpyrene, BTM

Water Column Pesticides\Volatile Organic Compounds

Benzene
Carbon Tetrachloride
Dichlorobromomethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloropropane
Methylene Chloride
Toluene
Trichloroethylene
Vinyl Chloride

1,3-Dichlorobenzene
Styrene
1,4-Bromofluorobenzene
CIS-1,2-Dichloroethene
Bromoform
Chlorobenzene
Chloroform
Dichlorodifluoromethane
1,2-Dichloroethane
1,2-Transdichloroethene

Ethylbenzene
Tetrachloroethene
1,1,1-Trichloroethane, T
Trichlorofluoromethane T
1,2-Dichlorobenzene
1,4-Dichlorobenzene
Xylene
Methyltertbutylether
Trichlorotrifluoroethane



Continued.....

Acetochlor
Alachlor
Atrazine
Atrazine, Desethyl-
Benfluralin
Carbaryl (Sevin)
Carbofuran
Chlorpyrifos
Cyanazine
DCPA (Dacthal)
Diazinon
Dieldrin
Fonofos
Linuron
Malathion
Metolachlor

Metribuzin
Molinate
Napropamide
Parathion
Pendimethalin
Prometon
Simazine
Tebuthiuron
Terbufos
Trifluralin
2,6-Diethylaniline
Azinphos-Methyl
Butylate
Disulfoton
EPTC
Ethalfuralin

Ethoprofos
Lindane
Parathion-Methyl
Pebulate
Phorate
Propachlor
Propanil
Propargite
Propyzamide
Terbacil
Thiobencarb
Tri-Allate
Alpha-HCH
CIS-Permethrin
P.P-DDE

