STATE OF CONNECTICUT
DEPARTMENT OF
ENVIRONMENTAL PROTECTION
Bureau of Water Management
79 Elm Street
Hartford, CT 06106-5127
http://dep.state.ct.us
Arthur J. Rocque, Jr., Commissioner

Ambient Monitoring Strategy for Rivers and Streams
Rotating Basin Approach

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For further information contact:

Planning & Standards Division
Bureau of Water Management
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Phone: 860-424-3020
Fax: 860-424-4055

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I. Purpose

The purpose of this multi-year strategy is to describe the objectives, scope and plans for implementation of ambient surface water monitoring activities conducted by the Connecticut Department of Environmental Protection (CTDEP), Bureau of Water Management (BWM), as required under Section 106 of the Federal Clean Water Act (CWA). It also serves to identify the ambient water quality monitoring strategy which has a goal of achieving statewide assessment of water quality as required by Sec. 305(b) of the CWA (USEPA 1997).

II. Objectives

Ambient monitoring is the acquisition of data to characterize the physical, chemical or biological integrity of surface waters. It is conducted to meet the following objectives:

- Evaluation of pollution control program effectiveness
- Baseline characterization and identification of reference conditions
- Assessment of water quality trends
- Evaluation ecological damage due to emergency pollution events
- Identification of existing and emerging pollution problems
- Investigation of nuisance complaints
- Meet reporting commitments required by State and Federal regulations.

Short-term goals and objectives are described in annual monitoring workplans. Annual workplans are prepared prior to initiation of the respective data collection period and are incorporated by reference into the biannual State/EPA Performance Partnership Agreement. Annual monitoring workplans identify projects to be accomplished by the various program elements within an annual monitoring and assessment cycle. Sampling locations, parameters, methods, and time frame are included in the annual work plans. The work plans are circulated for comment to relevant management and technical staff.

III. Geographical Coverage

The Connecticut DEP has organized the hydrography of the State into a hierarchical system of natural drainage basins comprised of four basic levels of magnitude (CTDEP 1981). Major basins represent the greatest level of magnitude and are roughly equivalent, but not identical to USGS eight digit cataloging units. Major basins are comprised of three categories of sub basins. In order of decreasing magnitude these are regional, sub regional, and local basins. The distribution of drainage basin units at each level of magnitude is listed below.

Major basins	-	8
Regional basins	-	45
Subregional basins	-	336
Local basins	-	2,893

The State contains a total of approximately 5,830 miles of rivers and streams (USEPA 1993). Section 305 (b) of the CWA requires that states monitor, assess, and report water quality status to Congress and to the public at two year intervals. In previous 305(b) assessment cycles (through 1996) we have assessed 893 major river miles which comprise approximately fifteen percent of the state total. Slightly fewer miles (ten percent) were actually monitored (CTDEP 1996).

Beginning with the 1998 305(b) assessment cycle, the BWM initiated a rotating basin approach to monitoring and assessment. This approach is consistent with the current 305(b) guidelines and the overall goal of a more comprehensive statewide assessment, by ultimately increasing the number of river miles monitored.

To accomplish this plan the State was divided into five hydrologic assessment units comprised of one or two CTDEP major basins, or USGS cataloging units. The assessment units and assessment schedule are listed in Table 1 and shown in Figure 1. Monitoring and assessment efforts will be concentrated on one unit each year for a five year period. Implementation began during the fall of 1997. Sample collection is currently in progress in the third rotating assessment unit.

Table 1. Rotating Basin Assessment Units

Monitoring Year	CT DEP Major Basin		USGS Cataloging Unit
1996-1997	Housatonic	6000	01100005
1997-1998	Southwest Coastal Southcentral Coastal	7000 5000	01100006 01100004
1998-1999	Connecticut	4000	01080205 01080207
1999-2000	Upper Thames	3000 (3100-3800)	01100002 01100001
2000-2001	Lower Thames Southeast Coastal Pawcatuck	3000 (3900) 2000 1000	01100003 01100003 01090005

IV. Program Elements

The Bureau of Water Management relies on a variety of program elements which employ different methodologies to acquire environmental data for the assessment of water quality. The various program elements and their relationship to the overall rotating basin strategy are described below.

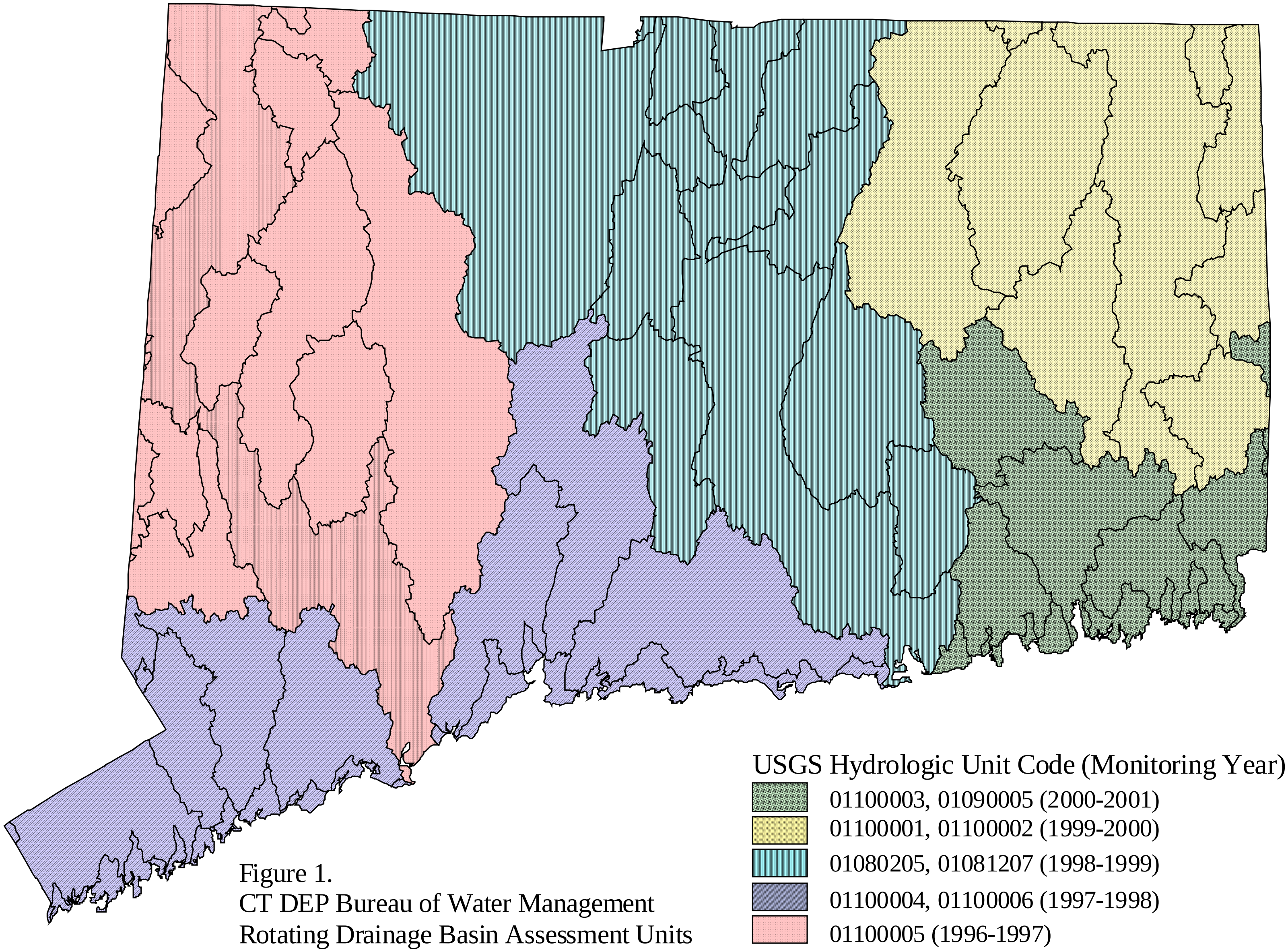

Figure 1.
CT DEP Bureau of Water Management
Rotating Drainage Basin Assessment Units

A. Physical/Chemical Monitoring

1. Cooperative DEP/USGS Primary Physical/Chemical Monitoring Network
   This network is a long-term cooperative venture between the CT DEP and the United States Geological Survey (USGS). The network is maintained by the USGS, Hartford office under a 50/50 funding arrangement with the DEP that dates back to the early 1970's. Currently, water quality data are collected at 33 sites on 15 rivers. Over 30 physical and chemical parameters are monitored at an average frequency of eight times per year. Sampling sites are located primarily on the State=s largest rivers, interstate rivers, waste receiving streams, and selected unimpaired reference sites. Sampling site locations and parametric coverage are presented in tables 2 and 3 respectively. Over the past decade coverage has been reduced by approximately 50% due to increasing costs and diminished funding. This project provides reliable, high quality data that describes the physical and chemical characteristics of the rivers monitored. Many of the sampling sites also include continuous streamflow measurement, which is conducted under an associated cooperative project. The data are used to support trend assessment, to determine compliance with water quality standards, estimate loading, and establish reference conditions on minimally impaired waters. Many of these sites have been monitored for an extended time period and represent a considerable investment in support of trend monitoring. These sites will continue to be monitored at an optimum frequency to take advantage of their extended period of record. A small subset of primary network sites will be rotated in an effort to expand coverage and support the rotating basin approach. However, due to the need for a multi-year period of record at monitoring sites by the USGS, the rotation will not be entirely consistent with the secondary sites described below.

   Additionally, a new component was added to the network in 1998, which continuously monitors field parameters over extended time periods. This is accomplished by deployment of self-contained monitoring instruments, which store data internally (Yellow Springs Instruments, model 6000). These instruments measure temperature, specific conductance, pH, dissolved oxygen and turbidity. They were deployed for up to 10-day intervals at selected network sites on a trial basis in 1998. The units will continue to be used at selected sites with an emphasis on the rotating basin schedule and other high priority issues.

2. Rotating Secondary Physical/Chemical Monitoring Network
   This network is intended to supplement the primary network sites by providing physical/chemical (p/c) data on selected rivers. Sampling frequency is quarterly for one year consistent with the rotating basin schedule. Third quarter sampling events are coincident with critical stress periods characterized by low streamflow and elevated water temperature. Sampling site selection is based on a targeted approach considering sub basin size, location of wastewater discharges, land use, and resource value. Sampling site locations are listed in Appendix A and shown in Figure 2. Conventional water quality parameters, toxic metals, and indicator bacteria are measured by means of grab samples. Sample collection and field measurements are performed by personnel from the DEP, Bureau of Water Management. Laboratory analyses are conducted by the CT Department of Public Health (CTDPH), Laboratory Division.

Table 2
CTDEP/USGS COOPERATIVE PHYSICAL-CHEMICAL MONITORING NETWORK SITES

USGS Site #	
	PAWCATUCK BASIN (1000)
01118500	PAWCATUCK RIVER NEAR WESTERLY, RI.
	THAMES BASIN (3000)
01119375	WILLIMANTIC RIVER AT MERROW, CT
01120800	NATCHAUG RIVRE AT CHAPLIN, CT
01122610	SHETUCKET RIVER AT SOUTH WINDHAM, CT
01124000	QUINEBAUG RIVER AT QUINEBAUG, CT
01125100	FRENCH RIVER AT N. GROSVENDORALE, CT
01125520	QUINEBAUG RIVER AT COTTON BRIDGE ROAD NR POMFRET, CT
01127000	QUINEBAUG RIVER AT JEWETT CITY, CT
	CONNECTICUT BASIN (4000)
01184000	CONNECTICUT RIVER AT THOMPSONVILLE, CT
01184490	BROAD BROOK AT BROAD BROOK, CT
01188000	BURLINGTON BROOK NEAR BURLINGTON, CT
01188090	FARMINGTON RIVER NEAR UNIONVILLE, CT
01189030	PEQUABUCK RIVER AT FARMINGTON, CT
01189995	FARMINGTON RIVER AT TARIFFVILLE, CT
01190070	CONNECTICUT RIVER AT HARTFORD, CT
01192050	HOCKANUM RIVER AT ROCKVILLE, CT
01192500	HOCKANUM RIVER NEAR EAST HARTFORD, CT
01192704	MATTABESSET RIVER AT ROUTE 372 AT EAST BERLIN
01193050	CONNECTICUT RIVER AT MIDDLE HADDAM, CT
01193500	SALMON RIVER NEAR EAST HAMPTON, CT
01193750	CONNECTICUT RIVER AT EAST HADDAM, CT
	SOUTHCENTRAL COASTAL BASIN (5000)
01196222	QUINNIPIAC RIVER NR MERIDEN, CT
01196500	QUINNIPIAC RIVER AT WALLINGFORD, CT
01196530	QUINNIPIAC RIVER AT NORTH HAVEN, CT
	HOUSATONIC BASIN (6000)
01198125	HOUSATONIC RIVER NEAR ASHLEY FALLS, MA
01200600	HOUSATONIC RIVER NR NEW MILFORD, CT
01201487	STILL RIVER AT RT 7 AT BROOKFIELD CENTER, CT
01203000	SHEPAUG RIVER NEAR ROXBURY, CT
01205500	HOUSATONIC RIVER AT STEVENSON, CT
01208049	NAUGATUCK RIVER NR WATERVILLE, CT
01208500	NAUGATUCK RIVER AT BEACON FALLS, CT
01208736	NAUGATUCK RIVER AT ANSONIA, CT
	SOUTHWEST COASTAL BASIN (7000)
01208990	SAUGATUCK RIVER AT REDDING, CT
01209710	NORWALK RIVER AT WINNIPAUK, CT

Table 3
CTDEP/USGS COOPERATIVE PHYSICAL-CHEMICAL MONITORING NETWORK
PARAMETER LIST

Parameter Code	Description
00010	WATER TEMPERATURE (DEGREES C)
00020	AIR TEMPERATURE (DEGREES C)
00025	AIR PRESSURE (MM OF HG)
00061	DISCHARGE, INST. CFS
00065	GAGE HEIGHT (FEET)
00076	TURBIDITY (NTU)
00095	SPECIFIC CONDUCT (US/CM @ 25C)
00300	OXYGEN DISSOLVED (MG/L)
00301	OXYGEN DISSOLVED (PERCENT OF SATURATION)
00400	PH, WH, FIELD (STANDARD UNITS)
00452	CARBONATE, DISSOLVED, IT (MG/L AS CO3)
00453	BICARBONATE, DISSOLVED, (MG/L AS HCO3)
00500	RESIDUE SOLIDS (MG/L)
00600	NITROGEN TOTAL (MG/L AS N)
00605	NITROGEN ORGANIC (MG/L AS N)
00608	NITROGEN AMMONIA (MG/L AS N)
00613	NITROGEN, NITRITE (MG/L AS N)
00623	NITROGEN AMMONIA + ORGANIC, DISSOLVED (MG/L AS N)
00625	NITROGEN AMMONIA + ORGANIC (MG/L AS N)
00631	NO2 + NO3 DISSOLVED (MG/L AS N)
00665	PHOSPHORUS TOTAL (MG/L AS P)
00666	PHOSPHORUS DISSOLVED (MG/L AS P)
00671	PHOSPHORUS ORTHO (MG/L AS P)
00680	CARBON ORGANIC TOTAL (MG/L AS C)
00900	HARDNESS TOTAL (MG/L AS CAO3)
00915	CALCIUM DISSOLVED (MG/L AS CA)
00925	MAGNESIUM DISSOLVED (MG/L AS MG)
00930	SODIUM DISSOLVED (MG/L AS NA)
00935	POTASSIUM DISSOLVED (MG/L AS K)
00940	CHLORIDE DISSOLVED (MG/L AS CL)
00945	SULFATE DISSOLVED (MG/L AS SO4)
00950	FLUORIDE DISSOLVED (MG/L AS F)
00955	SILICA DISSOLVED (MG/L AS SIO2)
01005	BARIUM DISSOLVED (UG/L AS BA)
01010	BERYLLIUM DISSOLVED (UG/L AS BE)
01025	CADMIUM DISSOLVED (UG/L AS CD)
01030	CHROMIUM DISSOLVED (UG/L AS CR)
01035	COBALT DISSOLVED (UG/L AS CO)
01040	COPPER DISSOLVED (UG/L AS CU)
01046	IRON DISSOLVED (UG/L AS FE)
01049	LEAD DISSOLVED (UG/L AS PB)
01056	MANGANESE DISSOLVED (UG/L AS MN)
01060	MOLYBDENUM DISSOLVED (UG/L AS MO)
01065	NICKEL DISSOLVED (UG/L AS NI)
01075	SILVER DISSOLVED (UG/L AS AG)
01090	ZINC DISSOLVED (UG/L AS ZN)
01095	ANTIMONY DISSOLVED (UG/L AS SB)
01106	ALUMINUM DISSOLVED (UG/L AS AL)
22703	URANIUM, NATURAL, (UG/L AS U)
31616	COLIFORM, FECAL (COLS/100 ML)
31649	ENTEROCCOCI, ME, M (COL/100 ML)
39086	ALKALINITY, DISSOLVED, I (MG/L AS CACO3)
70300	RESIDUE DISSOLVED 180C (MG/L)

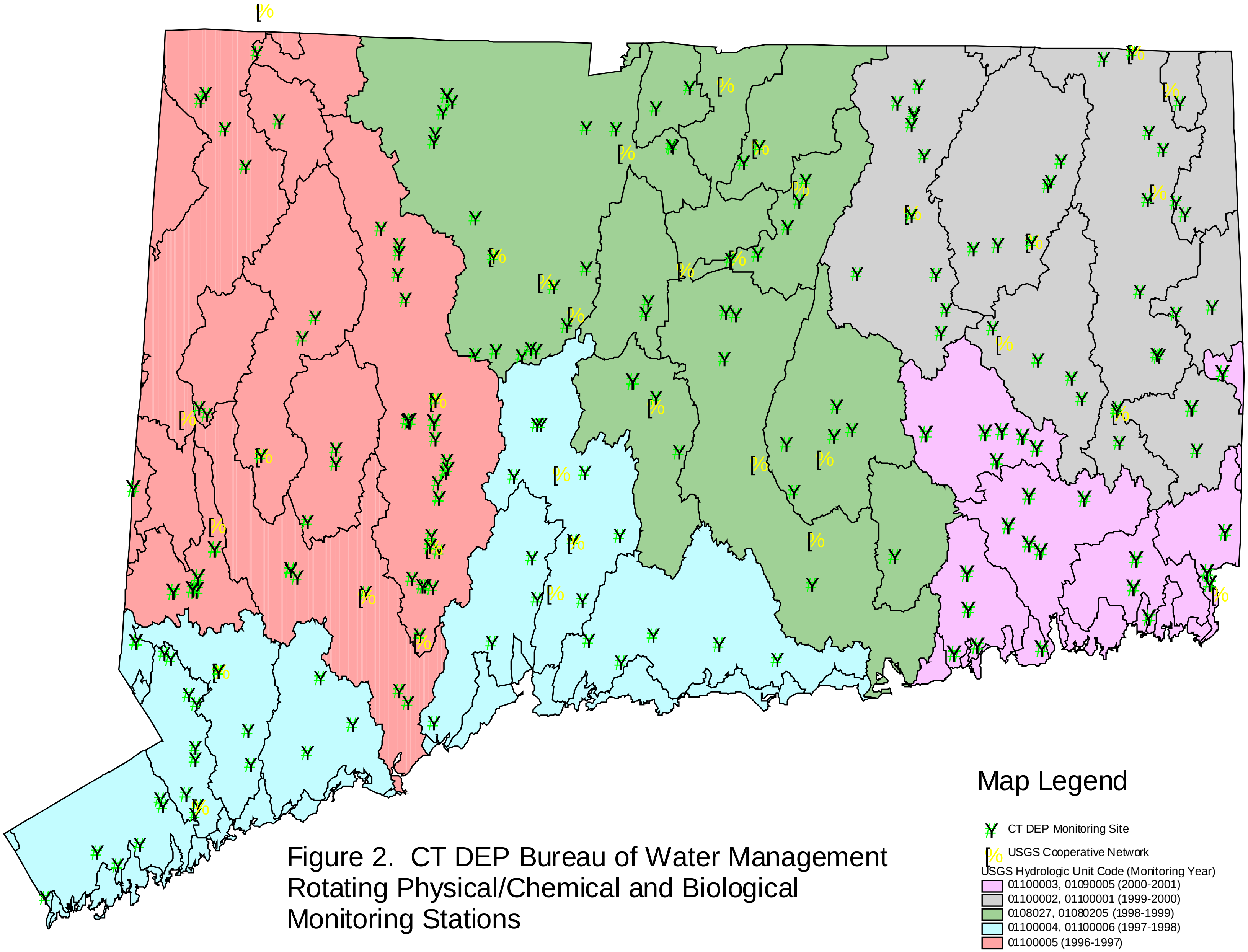

Figure 2. CT DEP Bureau of Water Management Rotating Physical/Chemical and Biological Monitoring Stations

B. Biological Monitoring

1. Ambient Biological Monitoring
Ambient biological monitoring characterizes water quality by evaluating the biological integrity of resident communities of aquatic organisms. Biological monitoring has been conducted by the DEP Bureau of Water Management since the early 1970's and has focused primarily on the benthic invertebrate community of wadeable stream segments. Approximately 329 sites on 140 rivers have been monitored to date. Assessments are based on community structure characteristics using techniques which are intended to minimize the influence of variables such as habitat, seasonality and sampling method. Methodology has followed a modified version of the USEPA Rapid Bioassessment Protocol (RBP) III since 1989 (Plafkin 1989). Pursuant to the rotating basin strategy benthic invertebrate monitoring will be conducted at approximately fifty sites each year corresponding to the rotation schedule described in Section III. Since biological monitoring integrates environmental conditions over an extended time period each site is sampled only one time which primarily takes place during the fall. Spring sampling is conducted on a limited basis for special studies or to supplement fall sampling. Site selection corresponds to and is coordinated with the rotating secondary physical/chemical sites described in Section A, provided habitat conditions are suitable. Biological monitoring is conducted at primary p/c sites during years when they fall within the rotational assessment unit. In addition to the rotating basin schedule, approximately ten regional reference sites located across the State are sampled annually.

   The WMB has long recognized the need to obtain a broader perspective of biological integrity by incorporation of fish community assessment data into the biological monitoring process. This has been accomplished to a limited degree by a cooperative working relationship with the CTDEP Division of Inland Fisheries. Fish sampling information obtained by fisheries biologists for purposes consistent with the fisheries management program has been utilized in the form of best professional judgement assessments which we consider to be generally equivalent to USEPA RBP IV (Plafkin 1989). In an effort to develop a more quantitative approach directed at specific water quality issues, funds obtained through an EPA 104(b)(3) grant will support part of a Fisheries Division staff position beginning in 1999. This will allow for approximately 24 fish community surveys equivalent in effort to RBP V during the 1999 sampling season. We intend for this project to support development of fish community structure metrics that will provide a more quantitative approach to our assessment process.

2. Aquatic Toxicity Testing
The toxicity laboratory began operation in 1984 as part of the Aquatic Toxicity Program, and support of this program remains its primary function. This laboratory routinely tests wastewater effluents and surface waters for toxicity to aquatic organisms by exposing test organisms to water or effluent samples under controlled laboratory conditions. Currently, three species of test organisms are cultured. These include two invertebrate species: *Daphnia pulex*, and *Ceriodaphnia dubia* (water fleas), and one fish species: *Pimephales promelas* (fathead minnow). In general, two types of toxicity tests are conducted. Acute tests are of relatively short duration and measure mortality of the test organisms as the test endpoint.

Chronic tests are of longer duration and measure growth rate or production of offspring as test endpoints in addition to mortality.

Effluent toxicity data are used to evaluate permit compliance and in some cases to support enforcement actions. Toxicity testing data are also used to quantify the assimilative capacity of surface waters to toxic compounds. This is a necessary step in establishing water quality criteria and waste load allocations.

The toxicity laboratory also provides quality assurance oversight for toxicity data provided by contract laboratories. All private toxicity laboratories who provide discharge toxicity monitoring services to Connecticut industries and municipalities in fulfillment of permit requirements participate in the toxicity laboratory=s QA/QC program, and follow approved protocols for testing.

Toxicity testing will be conducted in support of the rotating basin assessment strategy. The initial goal is to conduct effluent testing on all National Pollutant Discharge Elimination System (NPDES) major discharges in the hydrological assessment unit consistent with the schedule of rotation described in Section III. Ambient toxicity testing will be conducted on selected stream reaches within the subject assessment unit as the need is indicated by the results of biological monitoring, and the nature, location, and compliance history of toxic pollution sources. These sampling sites are described in the annual monitoring work plans. Since the aquatic toxicity laboratory is primarily tasked to support the aquatic toxicity program, testing will also be conducted as needed outside of the rotation schedule.

3. Tissue Contaminant Monitoring

Monitoring of toxic contaminants in tissues of fish and invertebrates has been conducted since the late 1970's in cooperation with the CTDEP Fisheries Division, and CTDPH Environmental Epidemiology Section. Chemical analyses are conducted under contract with the CTDPH Laboratory Division, or the University of Connecticut, Environmental Research Institute. The primary purpose of this monitoring has been screening for human health risk, or more intensive assessment for development of fish tissue consumption advisories for individual water bodies. Since 1985, methodologies for fish tissue samples prepared for human health risk assessment have followed Federal Department of Agriculture (FDA) guidelines for edible portion. In situations where ecological risk was the primary issue, whole fish or aquatic invertebrates have been analyzed. Current methodology generally follows recent EPA guidance (USEPA 1995). Tissue contaminant data has also been obtained by means of State or private contractors.

Typical contaminants monitored include PCBs, pesticides, and toxic metals. Monitoring data is available for the State=s major rivers and many smaller streams. Much of the data was collected in reaction to known or suspected contamination problems. During the period 1988 through 1994 fish tissue samples from wadeable streams across the State were obtained in cooperation with the CTDEP Fisheries Division, Stream Survey Project. In 1987 monitoring of dioxin and dibenzofuran was initiated in fish tissue as well as water, sediment, and soil near resource recovery facilities pursuant to Section 22a-240 of the Connecticut General

Statutes. A multi-state fish tissue contaminant survey is planned for the mainstem of the Connecticut River beginning in 1999.

C. Intensive Water Quality Surveys

Intensive surveys are conducted to obtain data which provide a greater degree of spacial or temporal resolution than is generally obtained by routine fixed network monitoring sites. These surveys can include physical/chemical or biological monitoring and are sometimes program specific, providing support to section 319, 314, or Total Maximum Daily Load (TMDL) projects. Intensive surveys will be carried out in concert with the rotational assessment strategy to the greatest extent possible. However, given the origin and nature of these projects it is anticipated that a significant portion will occur outside of the general rotation schedule. Details of specific intensive surveys are provided in the annual workplans.

Intensive physical/chemical water quality surveys are conducted by the BWM to obtain chemical and physical data on selected water bodies during specific environmental conditions. These surveys are conducted to determine compliance with water quality classifications, to verify or calibrate mathematical water quality models used for the establishment of wasteload allocations, and to evaluate the effects of pollution control measures. Often survey design calls for collecting a series of samples from multiple locations on a river segment, its tributaries, and wastewater discharges over a 24 or 48-hour period. Most intensive surveys are conducted on rivers which contain a relatively high percentage of treated wastewater, and take place during critical stress periods of minimal streamflow and elevated water temperatures.

Intensive biological surveys can be described as biological monitoring activities outside of the fixed or rotating network of sampling sites. This work can include assessment of resident aquatic communities, tissue contaminants, or toxicity testing of surface waters, effluents, or aquatic sediments.

D. State Park Beach Monitoring

This program is conducted in cooperation with the CTDEP Parks Division and CTDPH Environmental Health Section to evaluate health risks and make beach closure decisions at state-owned and managed swimming areas. Beach monitoring for indicator bacteria is conducted by BWM personnel weekly at the 22 State beaches shown in Figure 3. Four are located along the coast of Long Island Sound, and 18 are located at inland State Parks. Sampling begins one week before Memorial Day and ends Labor Day week. Enterococci group bacteria are used as the indicator of sanitary quality. Analyses are performed by the CTDPH Laboratory Division.

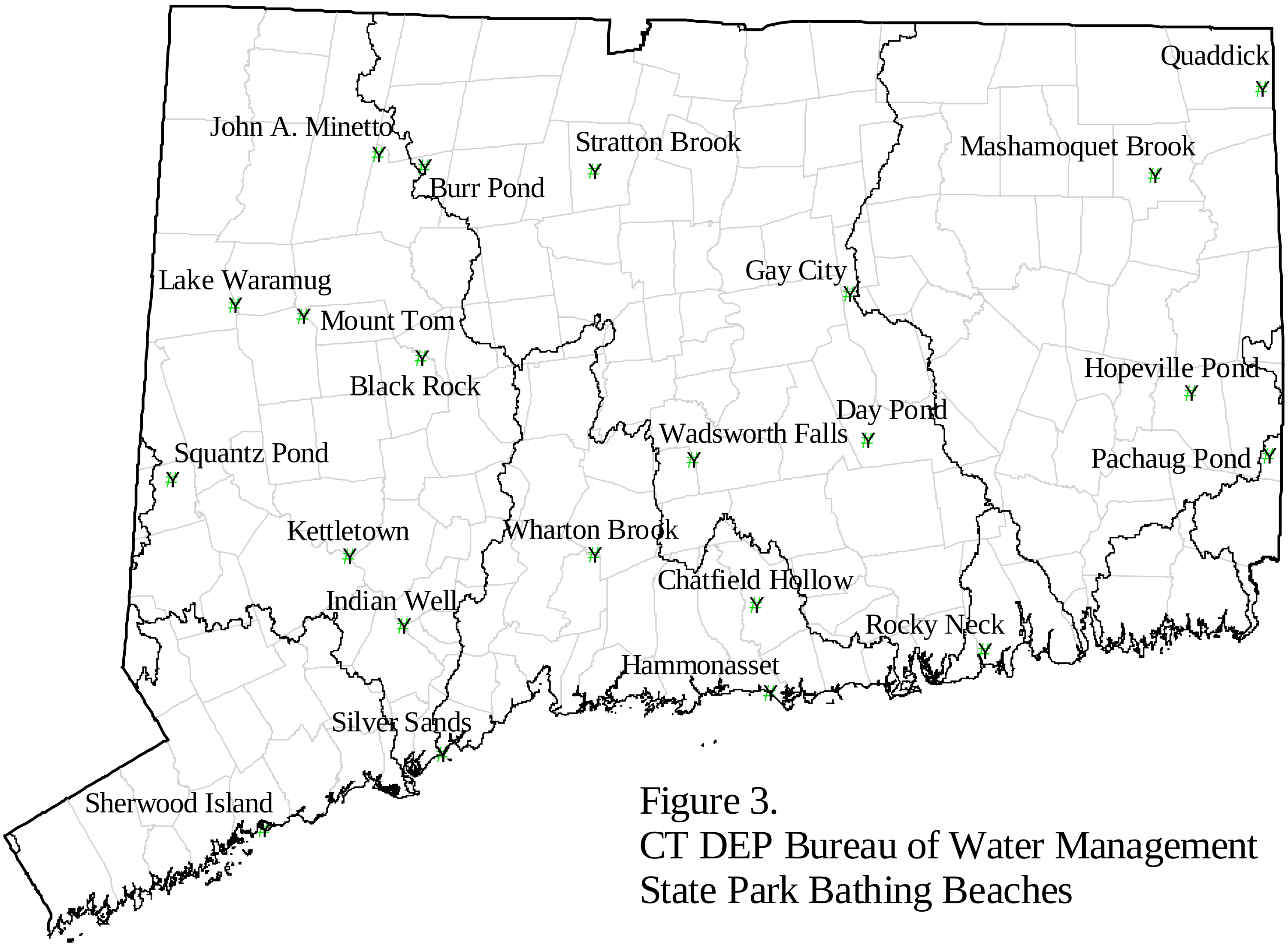

Figure 3.
CT DEP Bureau of Water Management
State Park Bathing Beaches

E. Volunteer Monitoring

The Bureau of Water Management encourages volunteer monitoring by administration of Sec. 319 funded monitoring projects, and by providing technical assistance and QA/QC support to volunteer monitoring projects. The Bureau has incorporated quality assured volunteer monitoring data into the 305(b) assessment process since 1996. Monitoring staff have provided support to approximately five specific volunteer monitoring projects since 1995. A new staff position was recently added to the BWM, Ambient Monitoring and Assessment Section to provide increased technical support to volunteer monitoring projects. A volunteer stream monitoring guidance document is currently in draft form. This document is directed at persons or groups interested in becoming involved in citizens monitoring activities and is intended to encourage them to adopt a tiered approach. The tiered approach is designed to channel their activities in a way that will optimize the value to DEP of the information collected, while maintaining interest and enthusiasm on the part of the volunteers.

F. Technical Assistance and Review

In addition to actual monitoring activities the Ambient Monitoring Section provides technical support to NPDES permitting functions related to powerplant thermal discharges and intake structures subject to section 316 of the Clean Water Act. This includes coordination of technical reviews with the DEP Fisheries Division. Support is also provided to the BWM, Permits, Enforcement, and Remediation Division by assisting with writing orders and permits, and subsequent review of monitoring proposals and reports. The Ambient Monitoring Section also provides coordination with Massachusetts DEP, USEPA, local government, and private industry on management of interstate pollution problems on the Connecticut, French, Quinebaug, Pawcatuck, and Housatonic Rivers.

V. Data Management

Efficient data management is essential to an effective monitoring program and has major implications for assessment, reporting, tracking, sharing data, and meeting data quality objectives. Electronic data management technology has greatly expanded our ability to manage, present, and share water quality information. It also represents a cost in terms of dedicated support staff with the specialized skills needed to obtain an optimum return on the significant investment in data management infrastructure. At current staffing levels the BWM is still unable to fully utilize and benefit from available monitoring and assessment software such as the EPA waterbody system, modernized STORET, and the DEP Geographic Information System (GIS). Full utilization of these assets would enhance our ability to aggregate monitoring and assessment information on a watershed basis and conduct spatial analysis, it would also help to meet reporting commitments to EPA on time, and facilitate sharing data with the public, and other secondary users. However, the BWM has made significant progress in the last eighteen months, initially by prioritization and effective use of qualified seasonal employees and student interns. Within the last six months addition of one full-time analyst has accelerated this progress.

Major issues related to data management are discussed below.

Infrastructure - Currently all seven staff level employees are personally assigned Pentium PCS which run Microsoft Windows NT software. Additionally, there is one non-assigned NT workstation available with ARCVIEW software. Two PCS have Internet access. All PCS are linked by a LAN and have access to MS word processing, spreadsheet, database and presentation software.

Locational Data - Since 1981 all tables and/or spreadsheets containing sampling site locations have included the DEP four digit basin code to facilitate aggregation, sorting or retrieval of data by drainage basin unit. Since implementation of the rotating basin strategy in 1997, all existing and proposed monitoring locations (as well as numerous historical sites) have been located on GIS for display purposes using various methods. Beginning in 1999, our goal is to include collection of locational data using differential global positioning system (DGPS) equipment at all monitoring sites as part of our routine data collection procedures. Sites sampled in 1997 and 1998, and all reference sites will also be located with DGPS during 1999. Locations of sites sampled prior to 1997 will be upgraded by DGPS on a priority basis during subsequent years.

Parametric Results - For several years Bureau staff have participated in the STORET modernization process with the intent of utilizing the final product as a comprehensive monitoring database. We expect to receive a working copy in early 1999. Meanwhile, an interim ACCESS database application has been developed in-house and we recently evaluated an EPA funded ACCESS application (EDAS) which is currently being used to manage the quarterly p/c data. Regardless of what final system or combination is adopted for general use, all data collected under the rotating strategy (1997 and beyond) will reside in an electronic database with STORET used as the ultimate repository. We plan to install STORET on the DEP LAN which will facilitate access to monitoring information throughout the Department, including linkage to the GIS system. Periodic STORET uploads to EPA will ultimately provide read access to any Internet user.

Previously collected data have been stored in paper files, or in some instances using Statistical Analysis System (SAS), or LOTUS spreadsheet software. Data migration into the new system will be done in a prioritized sequence not yet fully established, but will probably begin with ambient biological and tissue contaminant data.

Assessment Data - The Bureau has utilized the EPA Waterbody System (WBS) for managing and reporting 305(b) assessment information since 1988. We have participated in the ongoing redesign project and expect to begin using the modernized system beginning in 1999. In 1996 we participated in an EPA grant to georeference our 305(b) assessment units (waterbodies). This project was not entirely successful due to differences in scale between the EPA base map (RF3) and the CTDEP GIS coverage. However, in 1999 a revised EPA/USGS national hydrography database (NHD) will become available. This new tool in combination with the ability of the redesigned WBS database to accommodate waterbody segmentation should facilitate indexing all current and future 305(b) assessments including 303(d) listed segments.

VI. Assessment and Reporting

CWA Reporting - Annual assessments will be conducted for each hydrologic assessment unit on all data collected under this program and by cooperating organizations. Additionally, reasonable efforts will be made to incorporate data from outside sources such as other State agencies, the US Army COE, municipalities, academia, and volunteer monitoring groups. Assessment data will be organized by 305(b) Awaterbody≅ and stored electronically in the EPA WBS database. Electronic updates will be made to EPA annually, and an abbreviated written report will be submitted every two years as required by the 1998 Sec. 305(b) guidance (USEPA 1997). Assessment information will also be used to support preparation of impaired waters lists required by CWA, Sec. 303(d), and other needs as determined by Bureau management.

General Reporting - The goal is to produce a written summary of all ambient monitoring projects soon after the raw data becomes available. Use of the STORET database as a data repository will also ensure that sufficient documentation is associated with all sampling results to maximize utility of monitoring data to secondary users within the DEP and outside. STORET also provides Internet access to all resident data at the discretion of the data collecting agency.

A preliminary assessment of aquatic invertebrate sampling results will be prepared soon after sample collection is completed, usually by late winter following the previous fall sampling period. This preliminary assessment will be based on field observations and is considered to be equivalent to RBP I. These results will be circulated within the Planning Division and used to adjust the annual workplan for the remainder of the assessment cycle. A final assessment (RBP III) of the aquatic invertebrate data will be conducted when laboratory analyses are completed, usually within one year of sample collection.

VII. Problem Areas and Data Gaps

Development of a comprehensive monitoring strategy requires that problem areas and data gaps be identified and addressed. Problem areas and deficiencies related to the ambient monitoring program are primarily dependent on two basic issues: available personnel resources; and the priorities that determine how those resources are applied to a wide variety of monitoring needs. Fortunately, a high degree of staff experience and expertise has somewhat compensated for limited resources in past years, and has carried the program through difficult periods. We realize that this is not an acceptable alternative to adequate resources and sound planning. Some of the problem areas are addressed below.

Resources - The ambient monitoring section is currently staffed by seven full-time employees, comprised of five environmental analysts, one engineering aide and one supervising environmental analyst. Full time staff are augmented seasonally by up to six temporary student employees. Two analysts are dedicated full-time to operating the aquatic toxicity laboratory, two are primarily occupied in aquatic invertebrate sampling and analysis with some time dedicated to intensive surveys and special monitoring projects. One analyst is assigned to electronic data management, quarterly p/c sampling and providing technical assistance to volunteer monitoring programs. The engineering aid provides support for field and laboratory activities, and health and safety issues. An analyst assigned to the Permitting, Enforcement and Remediation Division (PERD) provides part-time support for review of Sec. 319 QA/QC plans and some 305(b) reporting functions. One supervising environmental analyst performs 305(b) reporting and data management functions as well as administrative duties, and supervision of six full-time and six seasonal employees. The lack of a dedicated staff person assigned to 305(b) reporting, and management of related assessment data is currently the most serious resource constraint and often results in delays in meeting 305(b) and other reporting deadlines.

Priorities - The rotating basin monitoring strategy has been instrumental in development of a more proactive approach to data acquisition and reporting. In previous years ambient monitoring activities have often been driven by the need to obtain data on short notice in response to real or perceived crises, or high profile issues. Acting in concert with limited staff resources, this condition resulted in reporting backlogs and the inability to adequately address long-term issues such as biocriteria development; refinement of sampling and assessment methodologies, and quality assurance practices. The rotating basin strategy and increased staff resources have provided the foundation for a more robust planning and prioritization process. This process should accommodate long-term issues on a prioritized basis while responding to crisis situations as needed.

Data Management - As discussed in Section V above, data management is a key component of an affective monitoring program. The WMB has made significant progress in this area for the reasons stated in Section V. We expect the improvements in data management to provide the necessary tools to support development of numerical biocriteria, refinement of assessment methodologies and reporting efficiency. However, at our existing staff level we are still not fully able to utilize and benefit from the available data management resources.

Coverage - The percentage of total stream miles in Connecticut that are monitored is approximately 10%. This is significantly lower than the national average of 19% (USEPA 1998). One of the goals of the rotating basin monitoring strategy is to increase the percentage of stream miles monitored. The 1998 305(b) reporting cycle was the first completed under the new plan. The number of monitored waterbodies in the Housatonic Basin assessment unit increased from 9 to 33. River miles monitored in the basin increased from 184 (12 %) to 308 (20 %). At present staffing levels, this trend in increased miles monitored is expected to continue with future assessment cycles. The traditional emphasis on Amajor≅ rivers and waste receiving streams has resulted in disproportionately fewer miles of low order streams being assessed and these low order streams make up a significant portion of the State=s river mileage. It is clear that in order to assess these waters the use of a probabilistic monitoring design is necessary. However, this type of design introduces new issues in terms of how to interpret and report this data and what implications are at stake in terms of 303(d) listing. Also, based on preliminary information (Larson, personal communication) it appears that a minimum sample size would represent the equivalent of our annual workload for aquatic invertebrate monitoring (~50 samples).

The Bureau needs to work with EPA to develop a plan which will ultimately provide the necessary data. One other data gap we are aware of is the need to develop biological methods for assessment of low gradient streams, this includes both large and small rivers.

Quality Assurance - Documentation of quality assurance practices is an area that needs attention. An audit of the Aquatic Toxicity Laboratory was conducted by the USEPA, Region I, Environmental Services Division at our request in August 1997. As a result of the audit numerous QA/QC procedures were modified or implemented. We also completed a laboratory SOP with the assistance of the ESD personnel. A related QA/QC measure includes assignment of an experienced Environmental Analyst from the Aquatic Toxicity Section as an outside QA/QC coordinator for the toxicity laboratory. Recent QA/QC changes which affect monitoring in general include two full-time employees that were recently hired. An engineering aid is involved with instrument maintenance and calibration as well as ensuring that more attention is given to details associated with QA/QC. A new environmental analyst is providing more oversight and review of QA/QC related to volunteer monitoring activities.

Database enhancements will also greatly improve the quality of our data. We have implemented a new computerized sample logging database for all ambient samples collected. Electronic data management capabilities will also facilitate the examination and use of QA samples such as duplicates and blanks. Outstanding issues related to quality assurance include the need to develop Quality Assurance Project Plans (QAPPs) that reflect all program elements covered under the new rotating basin strategy.

VIII. Program Evaluation

The final component of the rotating basin monitoring strategy is the proposal to conduct an annual evaluation for the purpose of determining if the objectives have been met. This evaluation should focus on specific commitments identified in the annual work plan, and what the completion status of each commitment is. The evaluation should also include assessment of available resources to support each of the program elements. Changing priorities and emerging problems should also be addressed. If deficiencies or new priorities are identified, they should be addressed by changes in the program.

This evaluation should occur at several levels. Consideration should be given to whether the data collected identify a need for additional monitoring or other follow-up work. Laboratory audits conducted by EPA will also be considered in the evaluation, as well as a general review of all QA/QC sample performance.

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Appendix A. Rotating Physical/Chemical and Ambient Biological Monitoring Sites.

Housatonic Major Basin (1996-1997)
USGS HUC 01100005

Site ID/Basin Code	Stream Name	Proximity	Landmark
6000	Housatonic River	North 1.5 miles	Rte 128
6000	Housatonic River	upstream 0.25 miles	Housatonic Meadows SP
6005-	Factory Brook	upstream	R.R. Crossing
6005-	Factory Brook	downstream 50-350 ft	discharge POTW
6007-00-3.83	Salmon Creek	downstream	Rte. 112
6019	Deep Brook	upstream	RR bridge
6020	Pootatuck River	downstream	Mile Hill Rd.
6020-00-2.60	Pootatuck River	adjacent	Rocky Glen State Park
6020-00-3.73	Pootatuck River	downstream	Rte. 84 West overpass
6020-00-3.84	Pootatuck River	downstream	new WPCF outfall
6020-00-3.88	Pootatuck River	upstream	new WPCF outfall
6023	Eight Mile Brook	upstream	Loughlin Rd
6025	Trib to Farmill River	at	Route 8
6025-00-1.10	Farmill River	upstream	Rte. 110
6025-00-3.70	Farmill River	downstream	Rte 8 at old bridge
6100-00-2.05	Blackberry River	upstream	Rt.44 Bridge
6200-00-10.	Hollenbeck River	upstream	Cobble Rd
6300-00-00.44	Ten Mile River	upstream 0.25 miles	mouth
6301	Mudge Pond Brook	upstream	Rte. 361 (4)
6301	Mudge Pond Brook	downstream	Kings Hill Rd.
6500-00-3.75	West Aspetuck River	Upstream	Aspetuck Rd.
6502-00-02.08	East Aspetuck River	upstream	Wellsville Rd.
6502-00-3.0	East Aspetuck River		
6600-00-16.3	Still River	upstream	Gray's Bridge Rd
6604-00-0.10	Sympaug Brook	upstream	Cross St or Shelter Rock
6604-00-3.07	Sympaug Brook	upstream	South St
6606	Limekiln Brook	at	Mouth
6606-00-4.30	Limekiln Brook	upstream	Plumtrees Rd.
6700-00-11.75	Shepaug River	downstream	Wellers Bridge
6705	Bantam River	downstream	Smokey Hollow Rd.
6705	Bantam River	upstream	Stoddard Rd.
6800	Pomperaug River	upstream	Judson Ave
6800-00-4.30	Pomperaug River	upstream	Transylvania Brook
6802	Nonewaug River	downstream	Rte 47
6806-00-0.00	Transylvania Brook	upstream	East Flat Hill Rd
6900	Naugatuck River	behind	Fire Station
6900	Naugatuck River	off	Pershing Dr
6900	Naugatuck River		East Albert St
6900	Naugatuck River	upstream	Campville Rd.
6900	Naugatuck River	upstream	Frost Bridge Rte 263
6900	Naugatuck River	upstream	Eagle St.
6900	Naugatuck River	upstream	Maple St
6900	Hemp Swamp Brook	downstream	Emmissons testing Rd
6900-00-2.10	Naugatuck River	upstream	Division St
6900-00-24.	Naugatuck River	adjacent	Linden Park
6900-00-26.5	Naugatuck River	downstream	Bristol St
6900-00-28.6	Naugatuck River	upstream	S. Leonard St
6900-00-44.5	Naugatuck River	upstream	Reynolds Bridge

6900-00-60.2	Naugatuck River	upstream	Rte. 118
6900-00-63.7	Naugatuck River	upstream	Palmer Bridge
6900-22-00	Great Brook	adjacent	W. Dover St
6900-27-0.1	Spruce Brook	upstream	RR Bridge
6900-28-0.05	Hockanum Brook	between	Old Rte 8 & Rte 42
6900-28-0.90	Hockanum Brook	upstream	Bethany Rd.
6904-00-3.65	W Br Naugatuck River	downstream	Rte 4
6905-00-0.13	E. Br. Naugatuck River	downstream	Franklin St.
6908	Leadmine Brook	upstream	Leadmine Rd.
6910-00-0.25	Branch Brook	downstream	POTW near mouth
6911-00-0.05	Hancock Brook	near	Mouth upstream RR bridge
6911-00-01.04	Hancock Brook	downstream	Bridge in Waterville Park
6912-00-0.15	Steele Brook	near downstream	mouth Aroura St
6912-00-1.9	Steele Brook	adjacent	municipal stadium
6914	Mad River	near	mouth
6915-00-0.05	Fulling Mill Brook	upstream	N. Main St
6916-00-0.05	Hop Brook	upstream	RR bridge Naug Glass
6918-00-00	Beacon Valley Brook	upstream	Rte 8
6919	Bladdens River	downstream	North Rd
6919-00-0.00	Bladdens River	under	Rte. 8 & Rte. 67 jct
6920	Little River	downstream	Rte. 67
6920-00-0.05	Little River	adjacent	Wire company near mouth

Southwest/Southcentral Coastal Major Basin (1997-1998)

USGS HUC 01100004, 01100006

Site ID/Basin Code	**Stream Name**	**Proximity**	**Landmark**
5103-00-10.19	Menunketesuck River	upstream	Kelseytown Rd
5106-00-11.90	Hammonassett River	upstream	Summer Hill Rd
5106-00-19.96	Hammonasset River	upstream	Bunnell Rd
5110-00-11.06	West River	off Rte 77	South of Rte 80
5110-00-13.32	West River	downstream Rte 77	North of Rte 80
5111-00-8.12	Branford River	downstream	bridge off Valley Rd
5112-00-13.92	Farm River	downstream	Totoket Rd
5200-00-00.78	Ten Mile River	downstream	Rt.322
5200-00-26.52	Quinnipiac River	adjacent	Rt. 15 USGS gauge
5200-00-53.45	Quinnipiac River	upstream	W. Main St.
5201-00-00.69	Eightmile River	downstream	Marion Ave
5201-00-03.07	Eightmile River	downstream	Jude Lane
5201-00-6.90	Eightmile River	downstream	Welch Rd
5202-00-	Ten Mile River	upstream	Rte. 70
5206-00-0.98	Harbor Brook	upstream	Coe Rd.
5208-00-19.92	Muddy River	downstream	Liney Hill Rd
5208-00-7.05	Muddy River	upstream	Patten Rd. Hansen Park
5302-00-	Mill River	upstream	Tuttle Rd.
5302-00-18.43	Mill River	downstream	Dixwell Ave.
5305-00-7.67	West River	upstream	Valley Rd.
5307-00-01.59	Wepawaug River	upstream	Rte. 162
5307-00-3.37	Wepawaug River	downstream	Walnut St.

7105-00-16.52	Pequonnock River	downstream	Rte. 111 Bridge
7105-00-7.36	Pequonnock River	adjacent	Unity Park
7200	Saugatuck River	lower	Fly Area
7200-00-20.06	Saugatuck River	downstream	Jct. Rte 107 & Rte 53
7200-00-9.93	Saugatuck River	downstream	Davis Hill Rd
7202-00-2.65	Aspetuck River	downstream	Bayberry Lane
7300	Norwalk River	upstream	Old Mill Rd
7300-00-00.18	Comstock Brook	downstream	wooden br. In park
7300-00-05.93	Norwalk River	upstream	Perry Ave
7300-00-13.43	Norwalk River	downstream	Schenck's Island Park
7300-00-15.38	Norwalk River	downstream	School Road YMCA
7300-00-22.00	Norwalk River	downstream	Rte. 107 & Rte 57
7300-00-24.24	Norwalk River	downstream	Rte.7 & Rte 102 RR station
7300-00-29.55	Norwalk River	downstream	Rte. 7 & S. Stonehenge Rd
7300-00-4.50	Norwalk River	upstream	Rte. 123
7300-02-30.85	Norwalk River	upstream	Rte. 35
7300-07-00.13	Cooper Pond Brook	downstream	plaza bridge
7302-00-3.04	Silvermine River	end of	Alvin Rd., ds Perry ave
7401	Five Mile River	upstream	East St.(Rt.106)
7401-00-11.00	Five Mile River	under	Old Norwalk Rd.
7401-00-12.05	Five Mile River	downstream	Lakeview Ave.
7403-00-3.85	Noroton River	Behind	St. John's Cemetery
7404	Mill River	upstream	Burr Street
7404-00-8.31	Mill River	upstream	Lake Mohegan
7405-00-2.79	Rippowam River	downstream	Bridge St. Woodside Park
7407-00-6.30	Mianus River	upstream	Merrybrook lane
7411-00-4.6	Byram River	downstream	Comly Ave

Connecticut Major Basin (1998-1999)

USGS HUC 01080207, 01080205

Site ID/Basin Code	Stream Name	Proximity	Landmark
4000	Rainbow Brook	upstream 100 meters	Rainbow Rd
4000	Seymour Hollow Brook	Upstream	Rainbow Rd
4006	Salmon Brook	upstream	House Rd
4006	Salmon Brook	upstream	Research Rd
4006	Salmon Brook	downstream	Bell St
4009	Roaring Brook	upstream	Rte 17
4017	Pattaconk Brook	first crossing	Rte 148 downstream Rte 9
4100-00-14.92	Stony Brook	upstream	South Grand St
4101	Muddy Brook	downstream	Rte 168 (main st)
4200-00-10.46	Scantic River	adjacent	Wollum & Amellia
4206-00-01.09	Broad Brook	upstream	USGS gage at Rte 191
4300	Farmington River	adjacent	Rt.4 -Apricots
4300	Farmington River	upstream	Old Farms Rd
4302-00-00.28	Mad River	downstream	Old Rte 8 & Rte 44
4303	Still River	upstream 100 meters	Wallens St

4303	Still River	off	Rte. 8 behind VFW
4303	Still River	adjacent	USGS gage
4304	Sandy Brook	opposite	Grange Hall
4310	Nepaug River	upstream	Rte 202 & Steadman Rd
4311	Burlington Brook	upstream	USGS gage
4314-00-00.53	Coppermine Brook	upstream	W. Washington St.
4315	Pequabuck River	upstream	Canal St.
4315	Pequabuck River	upper end	Rockwell Park
4315	Pequabuck River	downstream 250 meters	Rte. 229
4315	Pequabuck River	adjacent	USGS Gage Central Ave
4315	Pequabuck River	downstream	Rte. 6 bridge
4319	W. Br. Salmon Brook	upstream 50 meters	Barndoor Rd.
4320	Salmon Brook	adjacent	Granbrook Park
4402	Piper Brook	upstream	Main St.
4403	Trout Brook	downstream	New Britain Ave
4500	Hockanum River	downstream	Walnut St.
4500	Hockanum River	upstream	Butcher Rd.
4500	Hockanum River	upstream	Dart Hill Rd.
4500	Hockanum River	downstream 100 meters	Rte 84 Vernon Cine 1
4500	Hockanum River	upstream	Adams St.
4503	Tankerhoosen River	upstream 100 m	mouth golf land
4600	Mattabesset River	downstream	ds Berlin St.
4607	Coginchaug River	downstream	Rte. 66
4700	Salmon River	downstream 0.7 miles	RR bridge
4705	Jeremy River	downstream	Rte. 149
4707-00-04.02	Blackledge River	upstream	Rte. 2
4707-12-00.09	Lyman Brook	upstream	conf. w/ Blackledge River
4709	Pocotopaug Creek	50 m upstream	Rte. 16
4709	Pine Brook	at old bridge	Pine Brook Rd
4800	Eight Mile River	downstream	Rte 156 upstream confluence
4802	E. Br. Eight Mile River	downstream	Rte 156 100 m upstream conf.

Thames Major Basin (1999-2000)
USGS HUC 01100002, 01100001

Site ID/Basin Code	Stream Name	Proximity	Landmark
3103	Furnace Brook	upstream	Orcuttville Road
3300	French River	adjacent	off Rt. 12
3800	Shetucket River	adjacent	Plains Rd.--USGS Gauge
3100	Willimantic River	upstream	old Rt.195
3100	Willimantic River	downstream	Stafford Springs POTW
3100	Willimantic River	upstream	UCONN POTW
3100	Willimantic River	downstream	UCONN POTW
3102	Middle River	upstream	Rtr. 32 bridge at mo
3104	Roaring Brook	downstream	Rt. 32
3106	Skungamaug River	adjacent	Times Farm Road
3200	Natchaug River	downstream	N. Bear Road
3200	Natchaug River	downstream	N. Bear Road
3202	Still River	downstream	Pilfershire Road
3203	Bigelow Brook	downstream	Route 198

3206	Mount Hope River	downstream	Atwoodville Road
3207-00-13.26	Fenton River	upstream	Daleville Road
3400-00-06.51	Fivemile River	downstream	Prym discharge
3500	Moosup River	downstream	POTW off rt. 14
3600	Pachaug River	n/a	at mouth
3700	Quinebaug River	upstream	Rt. 197 Br.
3700	Quinebaug River	behind	Firehouse
3700	Quinebaug River	adjacent	Rogers Corp
3700	Quinebaug River	upstream	Butts Bridge Road
3708-	Muddy Brook	100'-150' downst	dirt Rd off 171
3708-00-03.58	Little River	downstream	Nat. Chromium
3710	Mashamoquet Brook	adjacent	Rt. 101
3711	Blackwell Brook	downstream	Wauregan Road
3713	Mill Brook	downstream	RR tracks
3713	Mill Brook	downstream 20	200ft ds RR
3803	Merrick Brook	downstream	Station Road
3805	Little River	upstream	Bushell Hollow Road
3805-00-06.85	Little River	upstream	Potash Hill Rd.
3900	Kahn Brook	upstream	Kofkoff Farm
3900	Yantic River	Downstream	West Main Street
3903	Sherman Brook	downstream	road
3904	Deep River	upstream	Reservoir Road

Pawcatuck/Southeast Coastal Major Basin (2000-2001)
USGS HUC 01100003, 01090005

Site ID/Basin Code	Stream Name	Proximity	Landmark
1000	Pawcatuck River	under	old bridge
1001	Wyassup Brook	adjacent	Clarks Falls Road
1002	Green Fall River	downstream	Rt. 216 bridge
1004	Shunock River	upstream	Voluntown Road
1101	Wood River	downstream	road near Hazard Pond
2000-30	Fenger Brook	downstream	US-1
2102	Copps Brook	upstream	un-named road
2103	Williams Brook	upstream	dirt road
2104	Whitford Brook	downstream	Rt. 27
2202	Latimer Brook	adjacent	I-95
2205	Patagansett River	upstream	dirt road N. of 1-95
2206	Bride Brook	upstream	Rt. 156
3003	Poquetanuck Brook	upstream	Rt. 2a
3004	Oxoboxo Brook	downstream	Rt. 32