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Oyster River Watershed Nonpoint Pollution Control Project

NH Coastal Program
Office of State Planning
Written in Cooperation with
The Strafford Regional Planning Commission
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EXECUTIVE SUMMARY

Nonpoint sources of pollution are a major cause of water quality problems in New Hampshire. It is important to evaluate nonpoint pollution on a watershed scale since the whole drainage area affects the water quality of an outlet or surface water. To address nonpoint pollution in the Oyster River Watershed the New Hampshire Coastal Program (NHCP), Strafford Regional Planning Commission (SRPC) and the University of New Hampshire (UNH) initiated a project to evaluate the potential nonpoint pollution sources in the watershed, public perceptions of the problem, and current management strategies to control nonpoint pollution sources.

Involvement of representatives from communities in the watershed was a key component of the project. To maximize local involvement, the NHCP worked with the SRPC to form a steering committee with members from municipal boards, UNH, and other interest groups. The Steering Committee provided community members an opportunity to contribute to the development of the program, direct specific project activities such as site selection for water quality monitoring and development of the public attitude survey, and develop final recommendations.

This report focuses on project activities that reviewed the ability of local land use regulations to control and prevent nonpoint pollution, and assessed the water quality impacts of existing sources of nonpoint pollution.

Land use activities in the watershed are potential sources of nonpoint pollution. In New Hampshire municipalities have the authority to enact local regulations that can help prevent or reduce pollution sources. A review of local regulations revealed there are many ordinances in place to control nonpoint pollution. The summary matrix of the review provides the towns in the watershed an opportunity to examine what regulations are important for reducing nonpoint pollution, how many towns in the watershed incorporate these measures into their regulations, and gaps that towns may want to focus on in the future when updating regulations. In particular, towns should adopt the performance standards detailed in the Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH, review the amount of impervious surface, (a key component in reducing polluted runoff), that is allowed in developments, consider soil-based lot sizing and possible programs for the regular inspection of septic systems.

Recent sources of water quality data were reviewed to assess existing sources of nonpoint pollution in the watershed and aid in developing site-specific monitoring. The major findings were:

- Great Bay Watch (GBW) and New Hampshire Department of Environmental Services (NHDES) have observed variable but elevated bacteria and nutrient levels in the watershed.

- Jackson Estuarine Laboratory (JEL) at the University of New Hampshire completed two projects in the watershed and found:

- Bacterial and nutrient levels were elevated in the watershed and as high or higher than recent measurements in other tidal rivers in the Great Bay Watershed.
- Bacterial levels in the tidal river were consistent with a restricted or conditionally approved shellfish harvest classification.
- Higher bacteria levels were observed following rainfall events of greater than .25" for most sample dates (except during one unusually dry spring).
- The bacteria contamination is dominated by nonpoint sources such as septic systems, urban and agricultural runoff, and other undetermined sources. The wastewater treatment plant is a relatively constant source of nutrients and intermittent source of bacterial contamination.
- Loading estimates indicated the greatest source of fecal coliform and enterococci bacteria is the main stem of the Oyster River (freshwater), followed by Johnson Creek and Beards Creek.
- Impounded areas and marshes appear to have a positive impact on water quality.

The project team chose additional sample sites to monitor and focused on freshwater sites in the watershed. In particular this sampling found:

- The major sources of pollutants are in the lower part of the watershed, still intermittent sources in the upper part of the watershed should not be disregarded.

- Suspended sediment levels frequently exceeded levels for generally clean freshwaters throughout the watershed.

- Some of the highest bacteria, nutrient, and suspended sediment levels were observed from catch basin pipe outfalls.

- The highest bacteria levels of all the samples collected were observed in College Brook.

- A limited number of samples were tested for lead, zinc, and copper. Although a number of samples exceeded conservative standards set for aquatic life, none exceeded limits set for public health.

The Steering Committee discussed project results and developed recommendations for education initiatives, future monitoring, and improved maintenance of control structures.

INTRODUCTION

New Hampshire has solved many water pollution problems in the past twenty years. However, pollution sources still threaten the water quality of our lakes, rivers, and coastal waters. This is evident in New Hampshire's seacoast region where the majority of the shellfish beds are closed to harvesting due to bacterial pollution (DES, 1994). Previous attempts to control pollution focused on point sources and recent water quality studies suggest that nonpoint sources (NPS) of pollution are the major cause of current water quality problems.

To address nonpoint pollution in the Oyster River Watershed the New Hampshire Coastal Program (NHCP), Strafford Regional Planning Commission (SRPC) and the University of New Hampshire (UNH) initiated a project to evaluate the potential nonpoint pollution sources in the watershed, public perceptions of the problem, and current management strategies to control nonpoint pollution sources. Involvement of representatives from communities in the watershed was a key component of the project. To maximize local involvement, the NHCP worked with the SRPC to form a steering committee with members from municipal boards, UNH, and other interest groups. The Steering Committee provided community members an opportunity to contribute to the development of the program, direct specific project activities such as site selection for water quality monitoring and development of the public attitude survey, and develop final recommendations.

Nonpoint source pollution is the hidden pollution of our waterways. Unlike point sources of pollution that are relatively easy to identify because they come from the end of a pipe, nonpoint pollution arises from a variety of diffuse sources that can be hard to pin down. Industrial discharges and the outfall from a wastewater treatment plant are point sources. Nonpoint pollution, also referred to as polluted runoff, is generated from many scattered sources. It develops when water washes over lawns, parking lots, city streets, farm fields, construction sites, and picks up pollutants such as bacteria , oil, sediments or fertilizers. Polluted runoff may then travel to waterways by natural drainage or through a storm drain system and degrade water quality.

Watershed initiatives are critical to managing for nonpoint pollution sources. A watershed is basically a drainage basin. It is the geographic area in which water, sediments, and dissolved materials drain to a common outlet. Since nonpoint sources of pollution are difficult to locate, problems in a drainage basin may go unnoticed until the cumulative impacts are seen at the downstream outlet. The whole drainage area affects the water quality of the outlet, therefore it is important to evaluate nonpoint pollution on a watershed scale.

PROJECT OBJECTIVES

The following were the overall objectives of the project:

- Assess the water quality impacts of existing nonpoint sources of pollution in the watershed through a review of existing water quality data augmented with additional site specific monitoring.

- Review ability of local land use regulations to control and prevent nonpoint pollution.

- Develop a survey tool to measure watershed residents' knowledge and perception of nonpoint pollution.

- Work with a local steering committee to identify sites for water quality monitoring, develop a survey tool to measure perceptions of nonpoint pollution issues in the watershed, review information sources gathered, and develop recommendations to manage for nonpoint pollution.

- Help the NHCP define a process to involve local governments and interest groups in the development and implementation of the Coastal Nonpoint Pollution Control Project.

This report summarizes methods and results for the review of local land use regulations and water quality monitoring. A second report details methods, results and recommendations for the survey of residents in the watershed (see Hanratty et al., 1996, report attached). Survey results that relate to components of this report are noted.

LOCAL LAND USE REGULATIONS

Land use activities in the watershed are potential sources of nonpoint pollution. Fertilizers and pesticides used on agricultural land and residential areas can wash off into surface waters if applied in excessive amounts or close to water bodies. Stormwater runoff from urban areas often contains high concentrations of toxic metals, bacteria, nutrients and sediments. If stormwater is transported directly to surface waters, and bypasses the natural filtering capacity of soils and vegetation, it can seriously degrade water quality. Although parking lots, roads, driveways, and other impervious surfaces are normal results of development, preventing the direct transport of runoff from impervious surfaces to waterways is critical to protect water quality.

In New Hampshire, municipalities have the authority to enact local land use regulations that can help reduce nonpoint sources of pollution. Requiring erosion and sediment controls during construction activities can help retain soil particles on site and lessen the chance they wash away in a rainstorm and enter a local stream. Grass swales, vegetated buffer strips, and detention basins are examples of techniques that can be required to slow runoff from impervious areas and allow pollutants to filter out before water enters an important water body.

NHCP staff reviewed local ordinances and regulations for their ability to address sources of nonpoint pollution. The list of municipal regulations to review was based on federal recommendations that define several nonpoint management measures that state Coastal Nonpoint Pollution Control Program should address. The review included the towns that cover the major part of the watershed, Durham, Lee, Madbury, and Barrington. A summary matrix of the review is located in appendix A. For categories where state regulations may apply, the matrix will be blank unless a town has referenced these state regulations or adopted a local regulation. The review was completed from January to March 1995.

This review was an attempt to summarize key nonpoint regulations for towns in the watershed. Local regulations are continuously changing and developing and any summary has the potential to be quickly outdated. Still, this summary matrix provides the towns in the watershed an opportunity to examine what regulations are important for reducing nonpoint sources of pollution, how many towns in the watershed incorporate these measures in their regulations, and gaps that towns may want to focus on in the future when updating regulations.

The following summary highlights some important regulatory gaps in the watershed that towns should focus on in the future.

Soil Type Lot Size Regulations

No towns in the watershed require soil-based lot sizes. In the 1970's the Rockingham County Conservation District developed a system for determining building lot sizes based on the land's capacity to handle the effluent from septic systems. This model has been adopted by many communities throughout the state. In early 1990's, a group called the Ad Hoc Committee for Soil-based Lot Size Regulations conducted an extensive review of the soil type lot size regulations and made revisions to make the regulations even more scientifically defensible. The result was the "Model Subdivision regulations for Soil-Based Lot Size", published in June, 1991. All communities with soil type lot size regulations should bring their local regulations into conformance with the standards set forth in the model. Adoption of this model will reduce the likelihood of nonpoint pollution from septic systems placed on inadequate soils types.

Impervious Limits

A twenty percent impervious limit generally allows for house coverage, necessary walkways and driveways, and maintains the natural capability of a site to control NPS (pers. convs. F. Latawiec, OSP, Arnold and Gibbons, 1996). Some advocate impervious limits of 10-15 percent to maintain the quality of sensitive or unique stream areas such as cold-water trout habitat (Schueler, 1991). Impervious areas are basically all the areas that are not vegetated, such as rooftops and driveways, or compacted soils. Constructed impervious surfaces can reduce the potential for infiltration of precipitation and result in increased runoff, erosion, and greater pollutant loads to surface waters. Vegetated areas control nonpoint pollution by preserving the natural storage capacity and filtering ability of soils and vegetation. Towns in the watershed have lot impervious limits ranging from ten to seventy-five percent.

Septic Systems

Septic systems are believed to be a major source of bacteria and nutrients in surface waters. Soil-based lot size, discussed previously, reduces some NPS concerns related to septic systems. NHDES regulates the design and installation of new systems. All towns in the watershed reinforce these regulations by inspecting new systems prior to backfilling.

Septic systems require regular inspection and maintenance. No town in the watershed requires owners to inspect tanks annually. All septic tanks need periodic inspections to determine if they are functioning properly or need to be pumped. If homeowners wait until a system shows complete signs of failure, such as surface breakout of wastewater, expensive repairs are required and nonpoint sources of pollution may result. Towns should consider establishing a program focusing on education for septic system owners and creating a septic tank inspection program. Informational brochures about septic system maintenance are available from DES. Also, Granite State Designers and Installers is updating the publication "Septic Systems - How They Work and How to Keep Them Working" and free copies will be available this fall (Contact Granite State Designers and Installers 603-228-1231).

Subdivision and Site Plan Review Regulations

Subdivision regulations apply to the subdivision of land, while site plan review regulations apply to nonresidential and multi-family development. Both types of regulations are important in the effort to provide for the proper treatment of stormwater runoff and the control of nonpoint pollution that may result as land is developed. Various versions of model subdivisions and site plan review regulations have been prepared by a variety of groups. These models cover everything from application procedures to surety agreements. The provisions that specifically address nonpoint pollution include erosion and sediment control, stormwater management, and control of hazardous materials.

All towns in the watershed have some type of subdivision and site plan review regulations. For these regulations to be effective it is important they specify design standards. To ensure these standards are met and implemented may require independent review by a qualified consultant, on-site inspections, and performance bonding. An excellent guidance manual is the "Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas of New Hampshire" (RCCD, 1992). It is recommended that towns require applicants to meet the established standards in this guide. (The handbook is available from Strafford County Conservation District, 749-3037.)

Actions to consider

Based on the review of local regulations, towns in the watershed should consider the following actions. For the complete regulation review see appendix A.

Abbreviations used: E&SC-erosion and sediment controls, SDR-subdivision regulations, SPR-site plan review, SPA-shoreland protection act, Green book = Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire, P&VPD soils-poorly and very poorly drained soils.

Durham	**Lee**	**Madbury**	**Barrington**
consider soil-based lot sizing in unsewered areas	consider soil-based lot sizing	consider soil-based lot sizing	consider soil-based lot sizing
septic systems- town inspects new systems-consider program for older systems (educ/compliance)	septic systems-town inspects new systems-consider program for older systems (educ/compliance) -require inspection and upgrade if necessary for expans./conversion.	septic systems-town inspects new systems-consider program for older systems.(educ/compliance) -require inspection and upgrade if necessary for expans./conversion.	town references 155-E-should consider periodic inpsecion/permit renewal
E&SC will be addressed **if new SPA approved** -covers down to 75' from all perennial brooks	reference “Green book”* for design stds. for E&SC and stormwater treatment in SPR and SDR	reference “Green book”* for design stds. for E&SC and stormwater treatment in SPR and SDR	reference “Green book”* for design stds. for E&SC and stormwater treatment in SPR and SDR
consider designating important wetlands for 100' buffer** (current requir. - 75' for surface water or VPDsoil/50' PDsoil)	buffer for wetlands-75'-consider designating prime areas** with buffer 100'.	consider maint. 100' vegetated buffer for important surface waters and wetlands** current require.-50' for tidal wetlands and P&VPD soils.	consider maint. 100' vegetated buffer for important surface waters and wetlands** current require-100' in industr. Park for prime wl, 50' all others

		consider greater impervious limits in sensitive areas-SPA, Aquifer Protec. Z.	consider aquifer protection zone

****note****-recommendation on considering buffers of 100' is based on the most recent guidelines (see ref. Chase et al. 1995) for wetland and surface waters for New Hampshire, but should be **applied to areas that are determined to warrant protection** through a comprehensive planning strategy.
*"Green Book" refers to the Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire, Rockingham County Conservation District. 1992.

WATER QUALITY INFORMATION

See appendix B for information on water quality parameters and state standards.

The following recent sources of water quality data were reviewed to assess existing sources of nonpoint pollution in the watershed and aid in developing a site-specific monitoring program. The most recent data sources were reviewed to assess the current state of the watershed. Other data sources prior to 1990 exist (NHDES, water quality study for the town of Lee, Durham Urban Runoff Study), but were not included in this review.

Point Sources

Most studies suggest recent reductions in point sources of pollution in NH leave nonpoint sources as the leading cause of water quality problems. Available information for the Durham wastewater treatment plant is reviewed to assess how this theory holds in the Oyster River Watershed. A study completed by Jackson Estuarine Lab (JEL, 1995) concluded the Durham wastewater treatment plant is a relatively constant source of nutrients and an intermittent source of bacterial contamination to the Oyster River. When they estimated loads from point versus nonpoint sources they concluded the treatment plant was the major source of inorganic phosphorus, contributed about 48% of the inorganic nitrogen, but the bacterial loading from the treatment plant was insignificant compared to nonpoint sources.

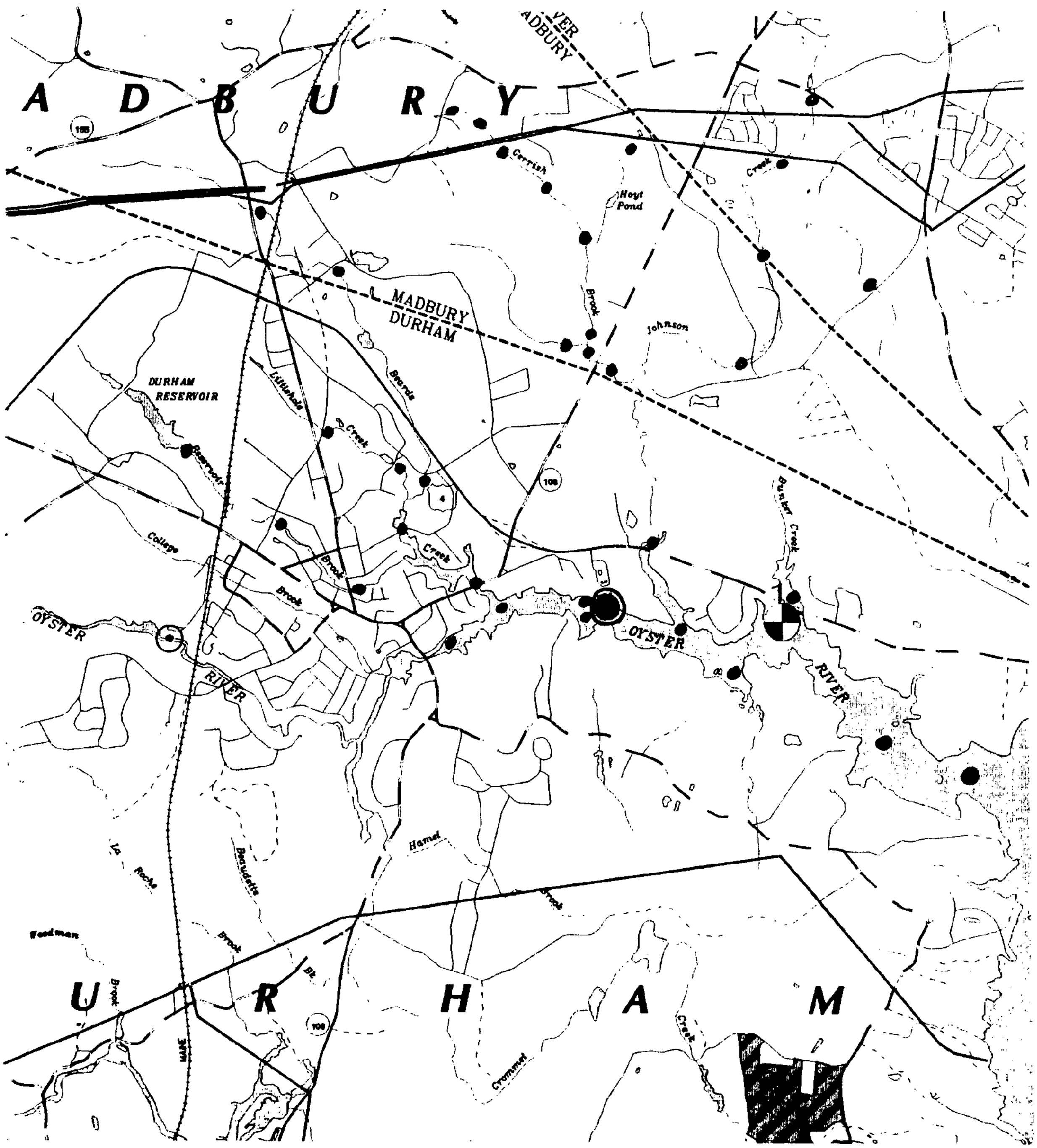
Great Bay Watch

Great Bay Watch (GBW) is a volunteer water quality monitoring group sponsored by Sea Grant Extension at the University of New Hampshire. The watch has been sampling at Smith's dock, just upstream of Bunker Creek and downstream of the Durham Wastewater Treatment Facility, since 1990. The site is sampled twice a month from April to November at both high and low tide. The Watch has observed higher fecal coliform levels at low tide (mean = 40 colonies) than at high tide (mean = 3 colonies) suggesting bacteria sources are located upstream of the site. Yearly means for the site from 1990-1995 show a decreasing trend at both tidal stages. Recurring low tide oxygen depletion was also noted for this site. (GBW, 1995).

Jackson Estuarine Laboratory

Jackson Estuarine Laboratory (JEL) at the University of New Hampshire completed two projects assessing nonpoint pollution sources in the Oyster River Watershed from 7/92 to 6/94. The projects

Sampling Sites
JEL
GBW
Durham WWTP



focused on the tidal portion of the river and the tributaries that empty directly in to the tidal river. Samples were collected at 12 sites along a transect in the tidal river, as well as, a number of sites in sub watersheds. The following conclusions were reached:

- Bacterial and nutrient levels were elevated in the watershed and as high or higher than recent measurements in other tidal rivers in the Great Bay Watershed.
- Bacterial levels in the tidal river were consistent with a restricted or conditionally approved shellfish harvest classification.
- Higher bacteria levels were observed following rainfall events of greater than .25" for most sample dates (except during one unusually dry spring).
- The bacteria contamination is dominated by nonpoint sources such as septic systems, urban and agricultural runoff, and other undetermined sources. The wastewater treatment plant is a relatively constant source of nutrients and intermittent source of bacterial contamination (see also discussion above for point sources).
- Loading estimates indicated the greatest source of fecal coliform and bacteria is the main stem of the Oyster River (freshwater), followed by Johnson Creek and Beards Creek.
- Impounded areas and marshes appear to have a positive impact on water quality.

NH Department of Environmental Services

Data collected from the Oyster River Watershed for the state ambient water quality monitoring program were reviewed. A network of eleven sites in the watershed have been sample since 1974; some sites being sampled more frequently than others. Recent water quality concerns were observed at site 8-Oys (Rte 155a crossing). Variable but elevated fecal coliform and nitrate levels, and occasionally depressed oxygen levels were evident. College Brook was recently sampled. Elevated bacteria levels were observed (fecal coliform range=250-1550cts/100 ml) but no sources were identified.

Durham Conservation Commission

Durham Conservation Commission recently required nitrogen monitoring for drainage tiles from one of UNH's agricultural fields. Data collected from 4/1/94 to 10/9/95 were made available for review. Nitrate values ranged from <.1 mg/L to 11.3 mg/L at the upper end of the ditch and from .1 to .8 mg/L at the downstream location. The one date when nitrate levels exceeded the standard of 10mg/l in the drainage ditch, the downstream location levels decreased to .4mg/L. Ammonium levels ranged from <1mg/l to 3mg/L, with over 90% of the samples reported at less than 1mg/L. These levels are well below the State standard for ammonia based on acute toxicity for aquatic life of 29 mg/L. Ammonia levels for most unpolluted surface waters is usually less than .1 mg/L. All but two of the 17 sample dates were dry weather sample periods. The Steering Committee expressed interest in this site and decided to include this site in the wet-weather sampling.

Site Specific Sampling

Available water quality data for the watershed was summarized and presented to the Steering Committee to help focus supplemental monitoring. The Committee discussed what parameters to focus on and the number of samples that could be collected with the available sampling budget. Twenty sample sites were selected as follows:

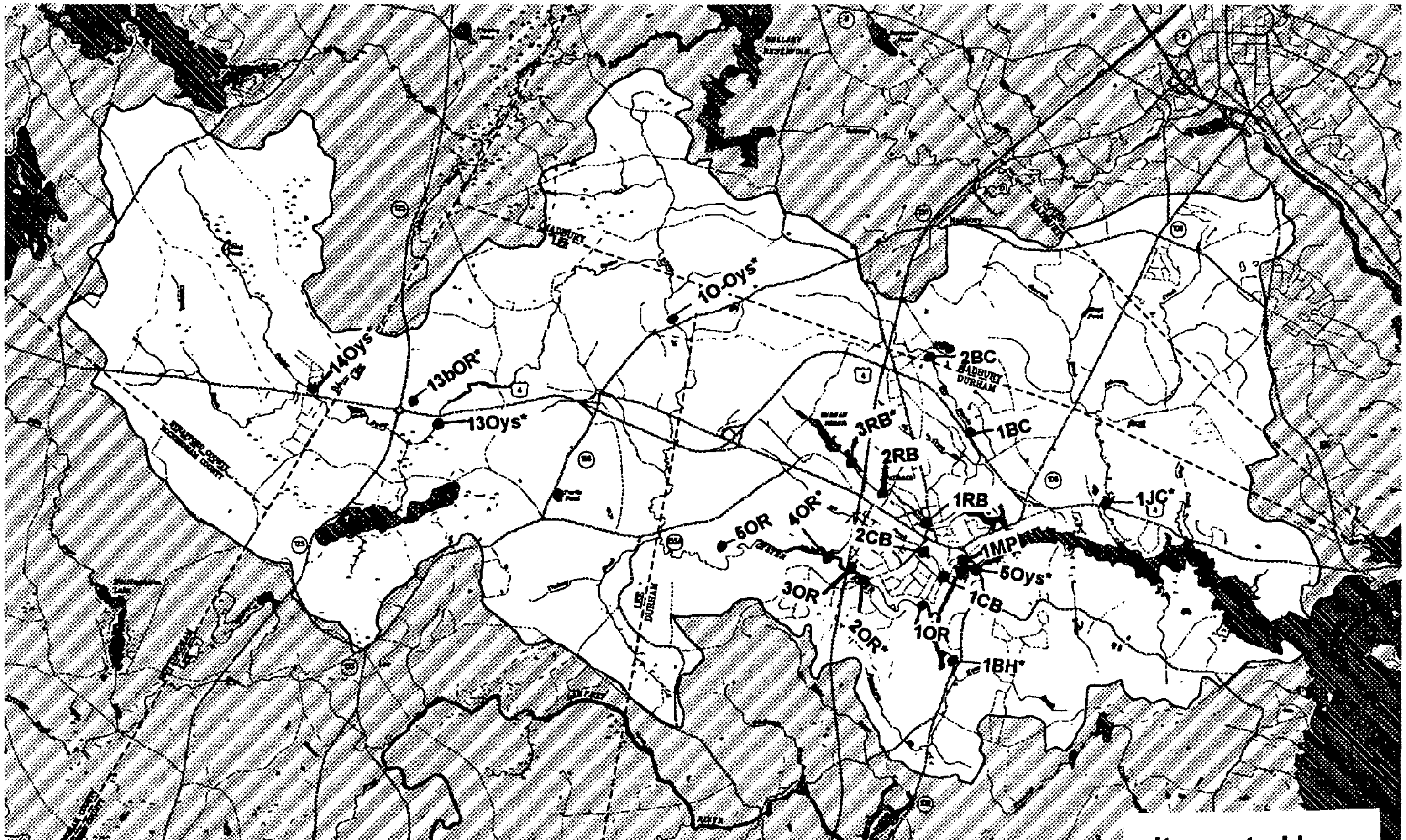
site	objective
1JC*	Measure downstream impact of sources identified by Jackson Estuarine Lab (JEL). Results were variable but suspected impacts could be significant during high flows-attributed bacteria and nutrients to on-site septic and agr. runoff. in upper part of watershed-measure below wetlands.
1&2BC	Follow up on high bacteria and NH_4 measured by JEL ,noted unidentified pipes in area, use 2 "flexible sites" to bracket area.
1RB	Downtown Durham, possible flex site- attempt to identify sources, (JEL sampled culvert outfall at Madbury road crossing with variable but high fecal coliform range=10-757, n=3 GM=97).
2RB	Designate sample site to follow up on high bacteria and NO_3 levels measured by JEL (fecal coliform geo ave=281, range 81-656, n=4).
3RB*	Bracket brook, see how much is coming from upper part of watershed.
1&2CB	Bracket college brook, has been identified in past as significant source, see what is from campus vs. downtown resid./commercial district.
5Oys*	Measure at tidal dam for freshwater endpoint reference.
1MP	Drainage swale that collects parking lot runoff from bank, apartment complex, and drains into Mill Pond.
1BH*	Sample from resid./agric. area around Beaudette and Hamel Brooks.
1&2OR*	Bracket and measure potential residential contribution to Mill Pond.
3OR	End of culvert drains into Oyster River-measure runoff from UNH-collects large parking lot area and dorm complex.
4OR*	Measure what is coming over dam.
5OR	End of drainage from UNH Moore fields, testing for Durham CC did not include bacteria and covered mostly dry events. Site recommended by Steering Committee members.
1O-Oys* 13Oys* 13bOR* 14Oys*	Sites to collect baseline data on the upper part of watershed, site 13oys and 13bOR are to split out Lee traffic circle and Wheelright Pond.

Sites noted by an asterisks (*) did not vary. Other locations had variable sites in an attempt to identify possible pollution sources. See the more detailed site description and maps that follows for the exact sample location on a particular date. Sites designated by "Oys" correspond to established NHDES sample sites. Samples sites included outlets from storm drains, drainage swales, detention basins, along with stream sites in the main branch of the Oyster River. Since stormwater was documented to negatively impact the water quality in the watershed, sampling focused on wet weather sampling.

OYSTER RIVER WATERSHED – BASE MAP

Map produced at NH Office of State Planning, September 09, 1996

SCALE: 1 inch to 2000 feet



DATA SOURCES:

NEW HAMPSHIRE GRANIT

sites noted by an asterisks (*) did not vary

Sample Collection and Analyses
Samples were grab samples collected in polyethylene bottles that were acid-washed and prepared at NHDES and Jackson Lab at UNH. Bottles used for nutrient and metal analyses contained an acid preservative. For all sites except 5-Oys, a sample was collected directly in the sample bottle. Due to access limitations at site 5-Oys, a clean bucket rinsed twice with sample water was used to collect a sample and then transferred into sample bottles.

All samples were held on ice and transported to the appropriate lab for analysis. Nutrients, metals, and bacteria tests were conducted at NHDES. Metals analysis for total recoverable metals was done on a limited number of samples to provide baseline data. Total suspended solids and percent organic matter analyses were completed at JEL. Field instruments were used to measure pH, dissolved oxygen, conductivity, and temperature and results were recorded on field data sheets.

For all samples, concentrations were measured and not loads. This needs to be kept in mind when considering the overall importance of detected contaminants. For example, bacteria concentrations could be high but perhaps the volume of flow at this sample site is low, so the relative impact of contaminants for the watershed is insignificant.

In the watershed, waters above the Mill Road crossing are class A, and below this class B. This is the state classification system for water quality standards. Waters that meet class A standards are considered the highest quality and potentially usuable as a water supply after adequate treatment. Discharge of sewage or waste is prohibited to waters of this classification. Waters that meet class B standards are considered acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies. No disposal of sewage or wastes, unless adequately treated, is allowed.

SAMPLING RESULTS

Samples were collected for five rain dates, focusing on days when rainfall was insignificant 2-3 days prior to sampling. Spring snowmelt was occurring before the first sample date. The twenty initial sites were sampled on 3/20/96. (See map page 12). This was a rain on snowmelt event. Rain began early in the morning and a total of .56 inches of rain was recorded for the day at the Durham observation station. For the second storm sample (4/23/96), rain began late the evening before and sampling was conducted the next morning. Rainfall was measured at .53 inches. Smaller sample collections at variable sites took place on three subsequent dates: 4/29/96, 6/3/96, and 6/21/96. On 4/29/96 sampling began at 3:00 p.m. Rainfall measured .21 inches for that day (recorded at 5 p.m.). Sampling on 6/3/96 was a false start and total rainfall accumulation was only .09 inches. Steady rain was observed during the last sample event and total rainfall measured .30 inches.

Reading the Graphs
A few things should be kept in mind when reviewing the following graphs. The graphs focus on the results for bacteria, nutrients, suspended sediments and metals analysis. Metals data were collected on a limited number of samples and are summarized following the graphs and site

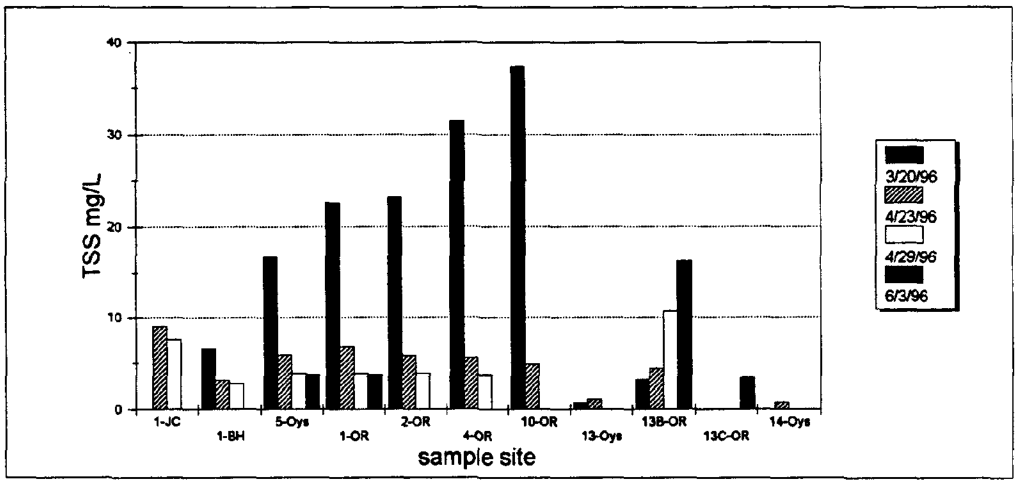
descriptions. Sample sites were grouped between variable an nonvariable sites, as well as, subwatershed locations. Sites included river locations, catch basin drains, and drainage swales. A complete database for all lab and field tests completed for each sample is in appendix C. Note, when making comparisons between graphs, axis scales may vary. Only parameters that were detected will show on the graph. This accounts for variability between graph legends. If a sample is listed in the legend but not visible on the graph, it may be due to a low value that is not visible on the scale utilized. The database included should be referenced for exact values (see appendix C).

Nonvariable sites

The following sample site locations did not vary for different sample dates. Most were sampled on the first two dates and then selected ones were subsequently sampled. Sites 1-JC, 1-BH, 5-Oys, and 1-OR are located in the lower part of the watershed that is classified as class B waters and are stream sites. The remaining nonvariable sample sites are located in class A waters. All are stream sites in the main stem of the Oyster River, except 13B-OR is located on a feeder stream that receives runoff from the Lee traffic circle. (See locator map page 12).

The only bacteria levels that exceed state standards for this data set were at site 1-BH. Bacteria levels at this site exceeded the one time limit of 406 E. coli/100 ml on 6/21/96. (E. Coli =730cts/100 ml). Levels were variable at this site and the geomean for 3 samples was just below the state standard at 119 cts/100ml (standard limit for a geomean is 126/100ml). This site was selected to examine if there were any pollutant inputs to Mill Pond from the surrounding residential/agricultural section of the watershed. Site 1-JC was selected to examine if high bacteria and nutrients observed by JEL in the upper watershed of Johnson Creek made it down stream during highflow conditions. Bacteria levels were not greatly elevated. At the tidal dam E. coli levels are comparable to JEL results. Although E. coli is not the indicator for shellfishing waters, it is evidence bacteria are reaching the dam and the sehlfish areas in the tidal portion of the river.

For nutrients, levels in the upper part of the watershed are generally less than the lower sites. 13-B stands out as having some of the higher nutrient levels for the sites in the upper part of the watershed. This was the only site in the upper watershed to exceed the general ammonia value for clean surfaces waters of .1 mg/L. Suspended sediments, which may be a source of nutrients, were also high at this site. A number of sites in this group had total phosphorous levels greater than those for generally clean waters. Suspended sediment levels frequently exceeded 10mg/L, particularly for the early spring sample date.


TSS mg/L
0
10
20
30
40
1-JC
1-BH
5-Oys
1-OR
2-OR
4-OR
10-OR
13-Oys
13B-OR
13C-OR
14-Oys
sample site
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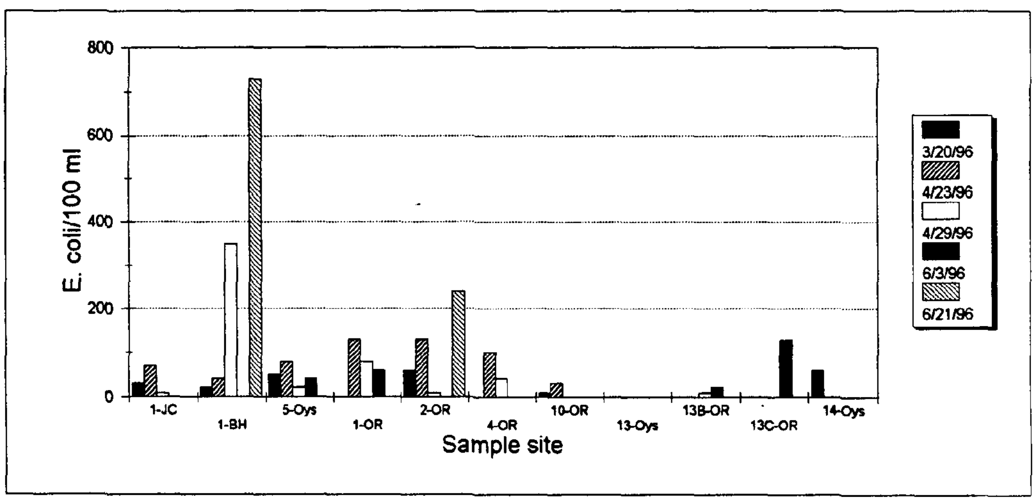
4/29/96
6/3/96


E. coli/100 ml
0
200
400
600
800
1-JC
1-BH
5-Oys
1-OR
2-OR
4-OR
10-OR
13-Oys
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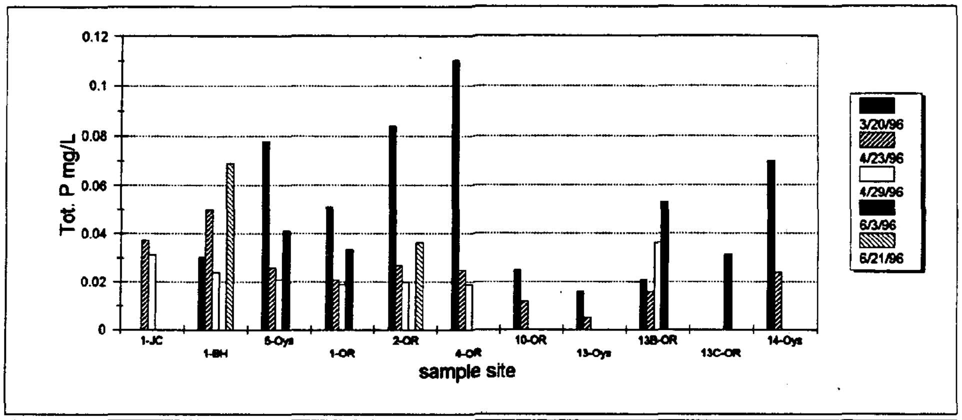
6/3/96
6/21/96


0.12
0.1
0.08
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0.04
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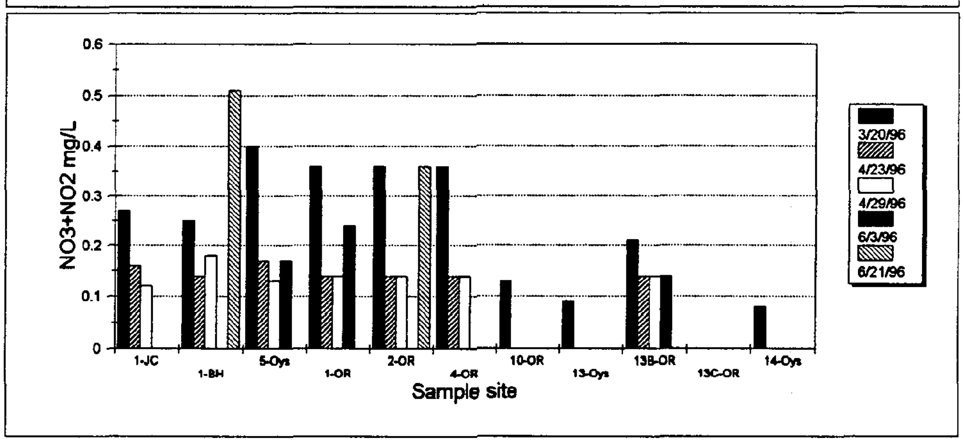
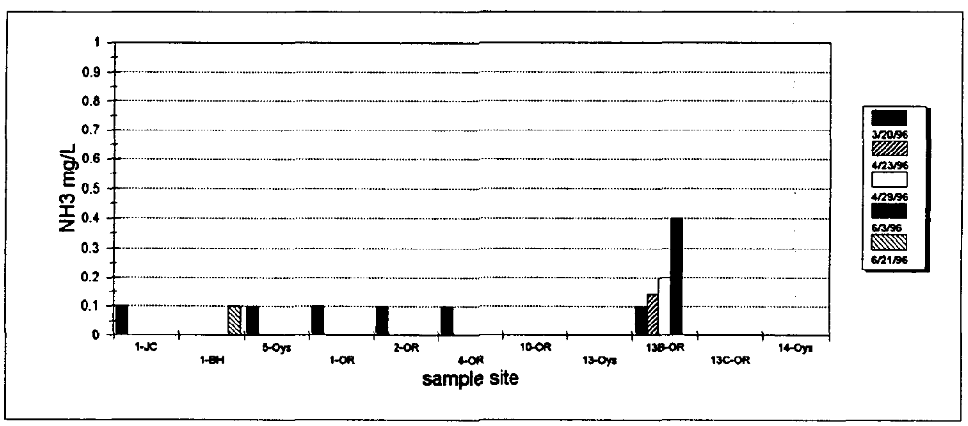
Tot. P mg/L
1-JC
1-BH
5-Oys
1-OR
2-OR
4-OR
10-OR
13-Oys
13B-OR
13C-OR
14-Oys
sample site
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96


0.6
0.5
0.4
0.3
0.2
0.1
0
NO3+NO2 mg/L
1-JC
1-BH
5-Oys
1-OR
2-OR
4-OR
10-OR
13-Oys
13B-OR
13C-OR
14-Oys
Sample site
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96

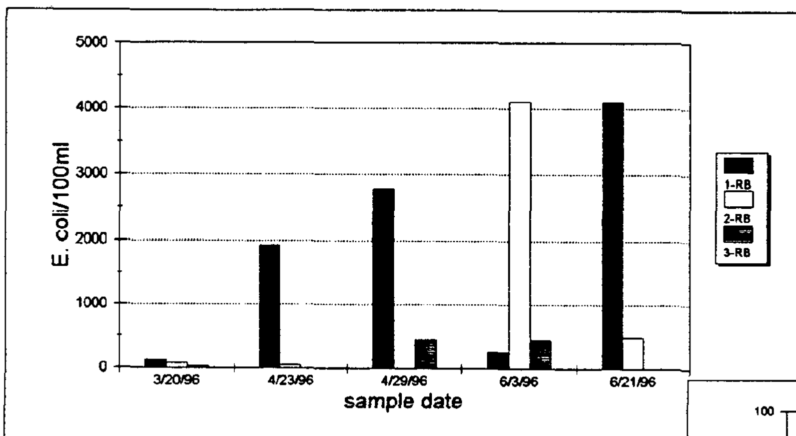

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
NH3 mg/L
1-JC
1-BH
5-Oys
1-OR
2-OR
4-OR
10-OR
13-Oys
13B-OR
13C-OR
14-Oys
sample site
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96

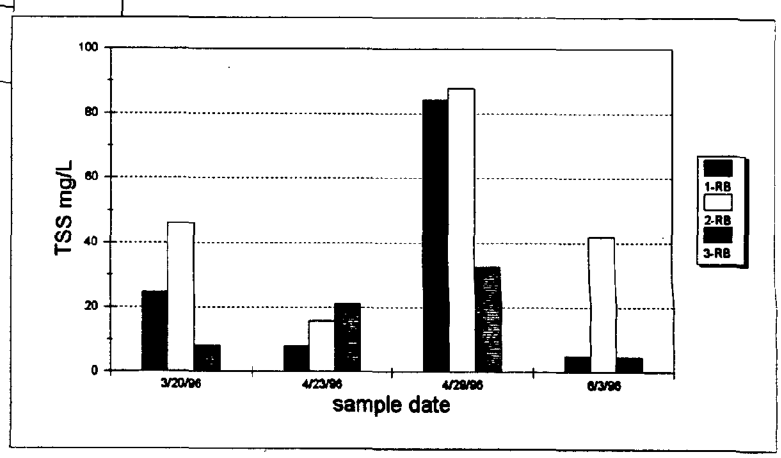
Variable Sites

Pettee (Reservoir) Brook

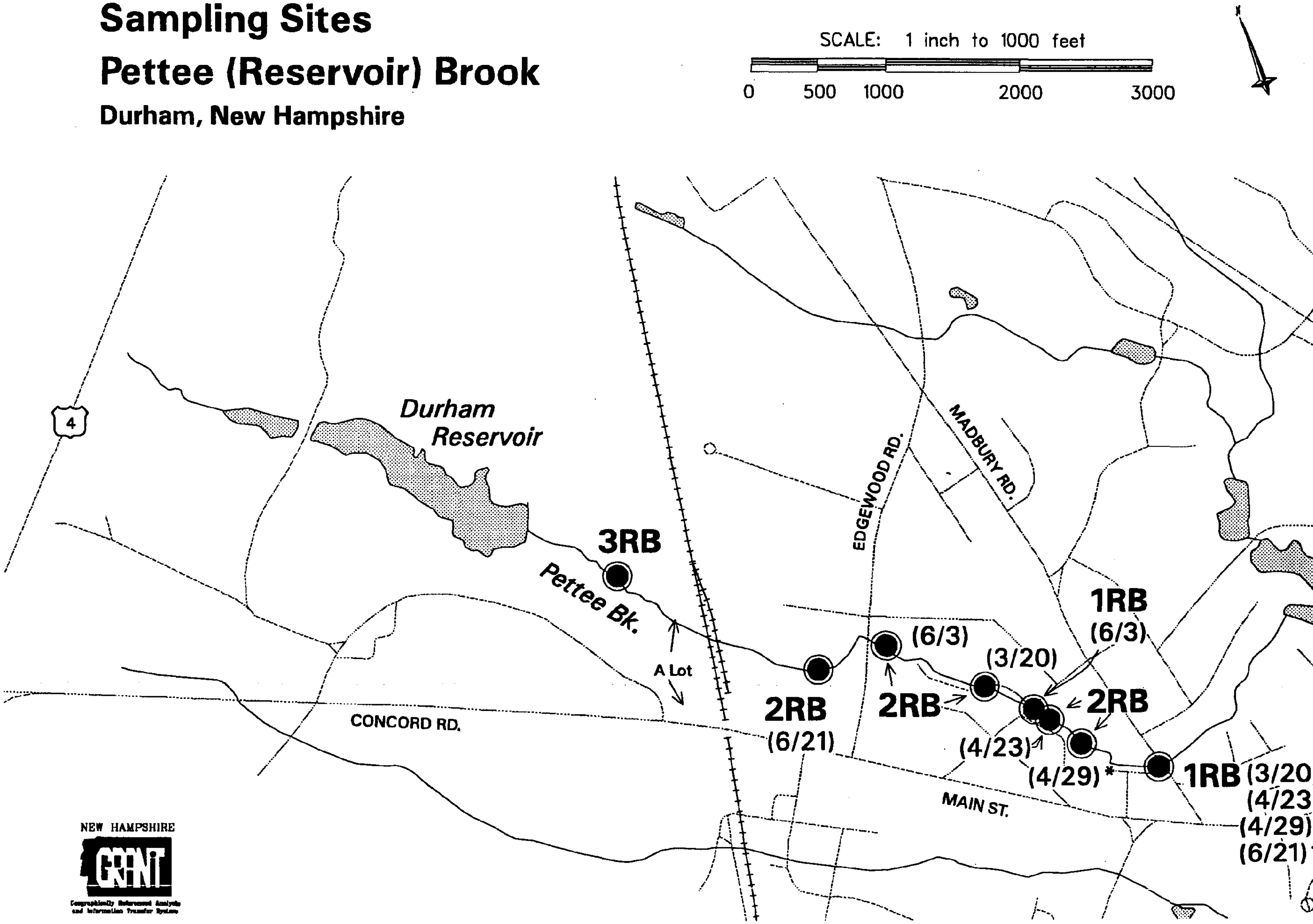
Downtown Durham was identified as an area of potential runoff concerns by the Steering Committee. Previous work by JEL found variable but occasionally high levels of nutrients and bacteria along Pettee Brook that runs through a section of downtown Durham and the UNH campus. Three variable sites were sampled along this brook in attempt to identify potential sources. Sites 1-RB and 2-RB were variable with 1-RB always the furthest downstream on any sample date. Site 3-RB was a fixed site and the furthest upstream. Most samples were from stream sites. Sites noted on the map by an asterisk were catch basin outfall pipes (see site map that follows).

There are a number of samples for this stream that had high bacteria counts. Levels that greatly exceed the state standard were observed from stream samples in the lower part of the stream on 4/23/96 (E. coli=2780cts/100ml) and mid way in the stream on 6/3/96 (E. coli=4100cts/100ml). The levels found at 2-RB on 6/3/96 are similar to levels observed by JEL. No potential sources were confirmed through this sampling. Subsequent sampling of a catch basin discharge in the lower section of the stream identify this as a potential source of bacteria. This discharge was sampled on two events and bacteria levels greatly exceeded state standards (4/29/96 E. coli=2780cts/100ml, 6/21/96 E.coli=4100cts/100 ml). Other pipes obviously discharging from catch basins into the stream in this area were also sampled but did not have elevated bacteria counts. The highest TSS levels were observed from these pipe discharges, suggesting the sediment traps for these basins are not working or need to be cleaned. TSS levels from in stream samples were also elevated. Erosion occurring at the Whittemore Center construction site is one obvious source of sediments. Some of the highest nutrient levels related to catch basin pipe discharges. Background levels of bacteria at the upstream sample site (3-RB) were much lower but still elevated compared to state standards . No specific sources were determined for this sample site.

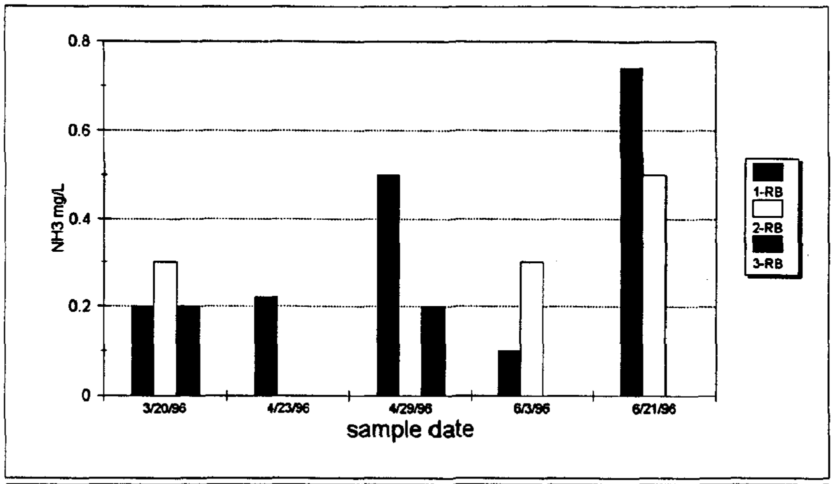


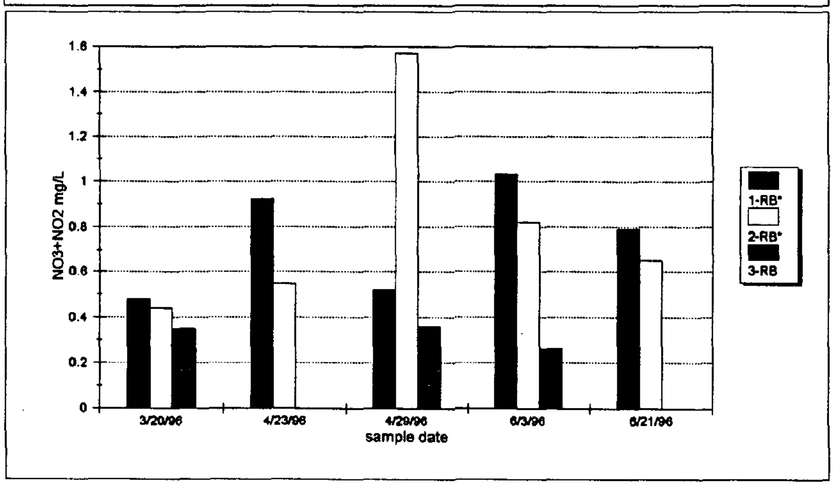


Sampling Sites
Pettee (Reservoir) Brook
Durham, New Hampshire



Map produced at NH Office of State Planning, September 09, 1996 * indicates catch basin outfall pipe.


0.8
0.6
0.4
0.2
0
NH3 mg/L
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-RB
2-RB
3-RB


1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
NO3+NO2 mg/L
3/20/96
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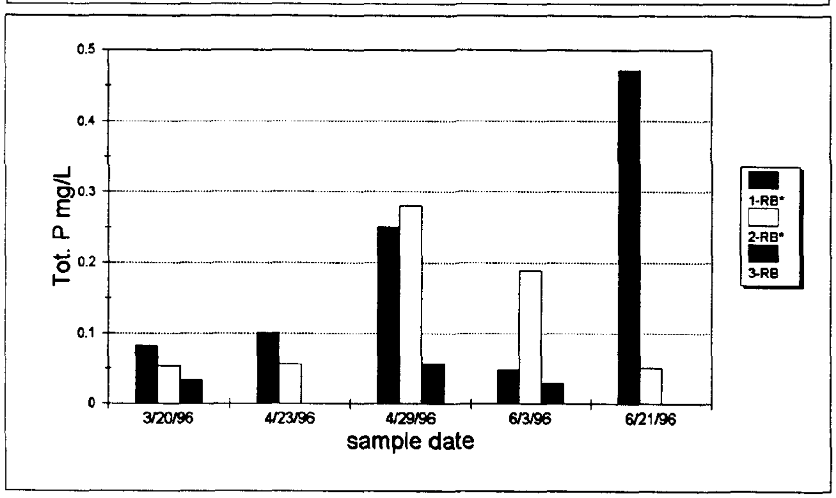
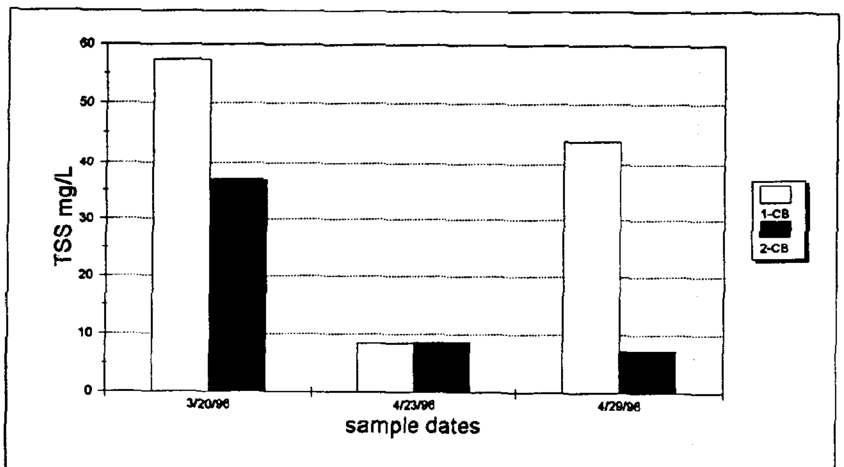
6/21/96
sample date
1-RB*
2-RB*
3-RB

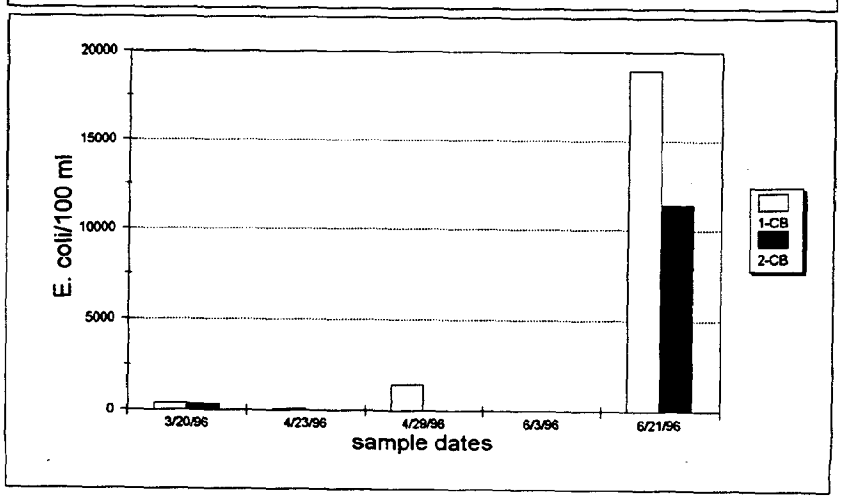

0.5
0.4
0.3
0.2
0.1
0
Tot. P mg/L
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-RB*
2-RB*
3-RB

College Brook

Two flexible sites were sampled on College Brook. This stream was identified in previous studies as a significant source of bacteria and nutrients. The stream passes through the UNH campus, as well as, commercial and residential sections of Durham. Samples were collected from stream locations in the main brook and on one occasion, (1CB on 4/29), from a drainage swale that runs along the railroad track (see locator map).

The highest bacteria levels for all samples collected for this study were observed in College Brook samples. On 6/21/96 a sample collected just below Mill Road (1-CB) had E. Coli levels of 19,000cts/100 ml, and further upstream (2-CB) counts were 11,400/100 ml. Earlier sampling at the Mill Road site (2-CB on 3/20/96) had elevated levels of bacteria (E. Coli =360 cts/100 ml) but did not exceed the one-time standard limit. The sample site furthest downstream on this date had similar levels of bacteria (1-CB on 3/20/96, E. Coli =370 cts/100 ml)and may suggests bacterial sources are reaching the Mill Pond from the UNH campus. One potential source from the UNH campus is runoff from livestock barns along this tributary (see 1-CB on 4/29/96). The highest nutrient levels relate to this drainage swale suggesting runoff from the livestock barns is a pollution source to the stream. Other sources above and below this runoff swale site probably contribute to the pollutant levels observed on 6/21/96 and should be investigated further.





Sampling Sites

College Brook

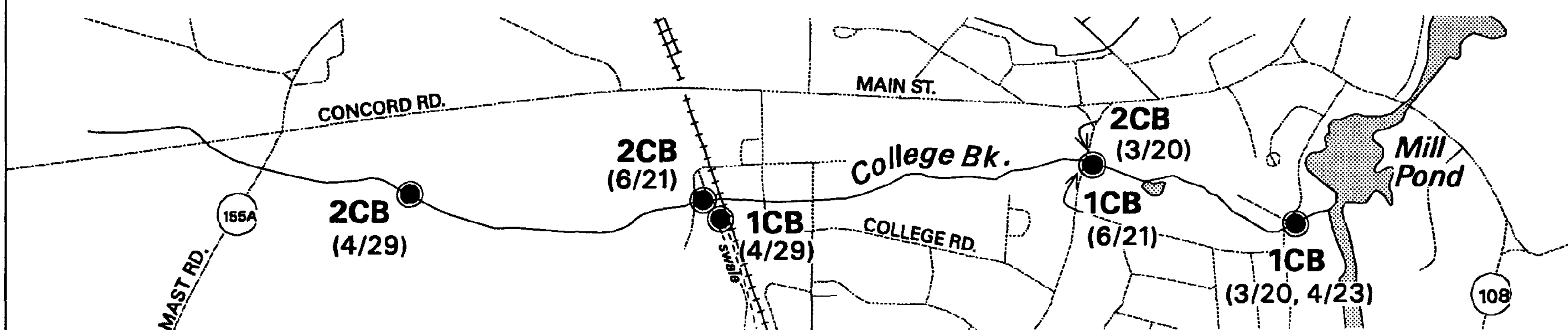
Durham, New Hampshire

SCALE: 1 inch to 1200 feet

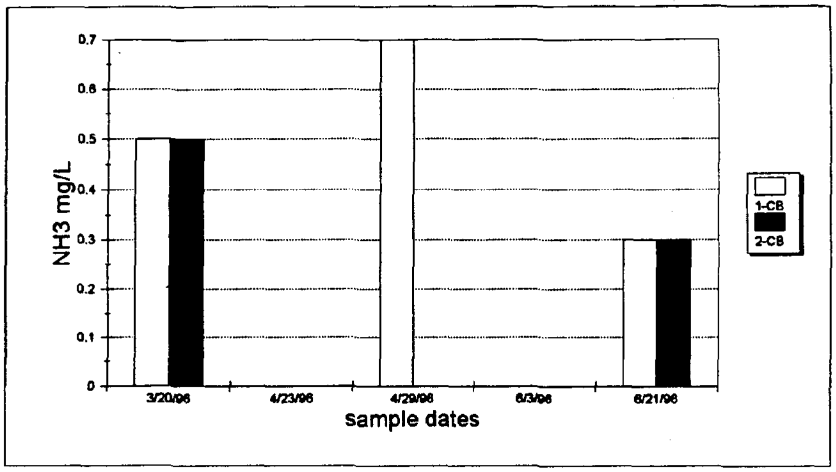
0 500 1000 2000 3000

NEW HAMPSHIRE GRANIT

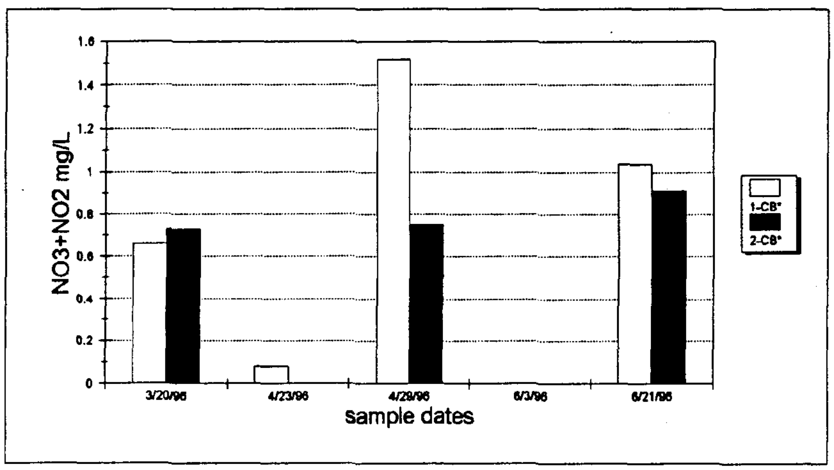
Geographically Referenced Analysis and Information Transfer System



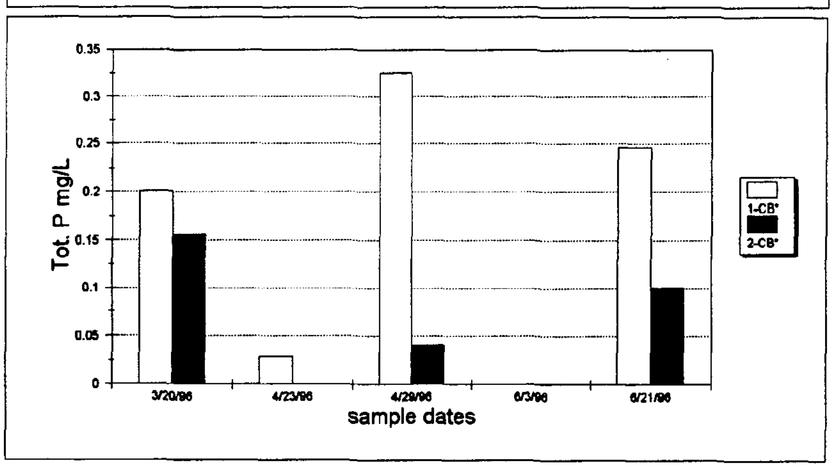
Map produced at NH Office of State Planning, September 10, 1996



NH3 mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample dates
1-CB
2-CB



NO3+NO2 mg/L
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample dates
1-CB*
2-CB*

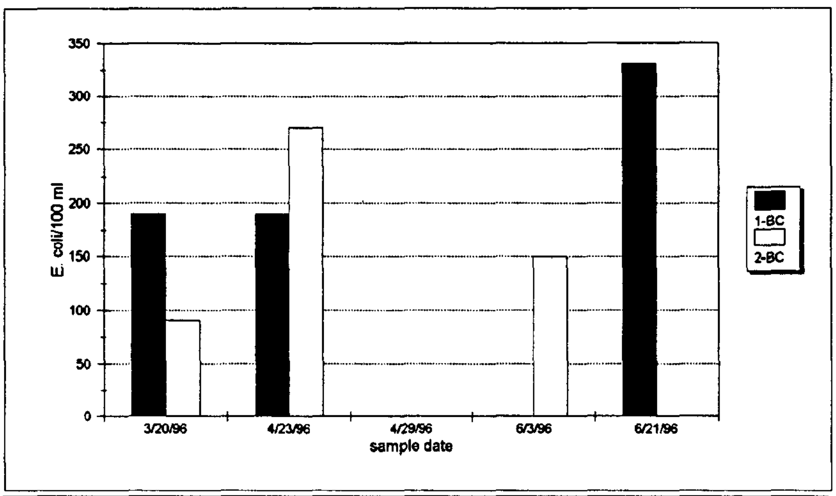


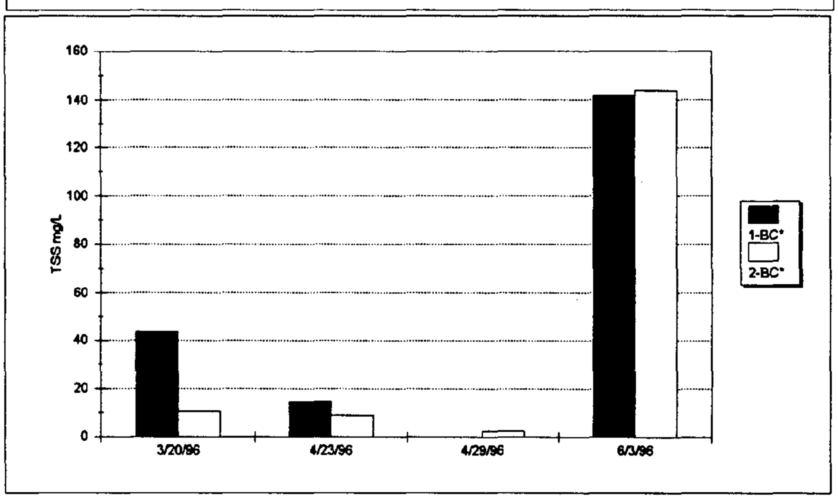
Tot. P mg/L
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample dates
1-CB*
2-CB*

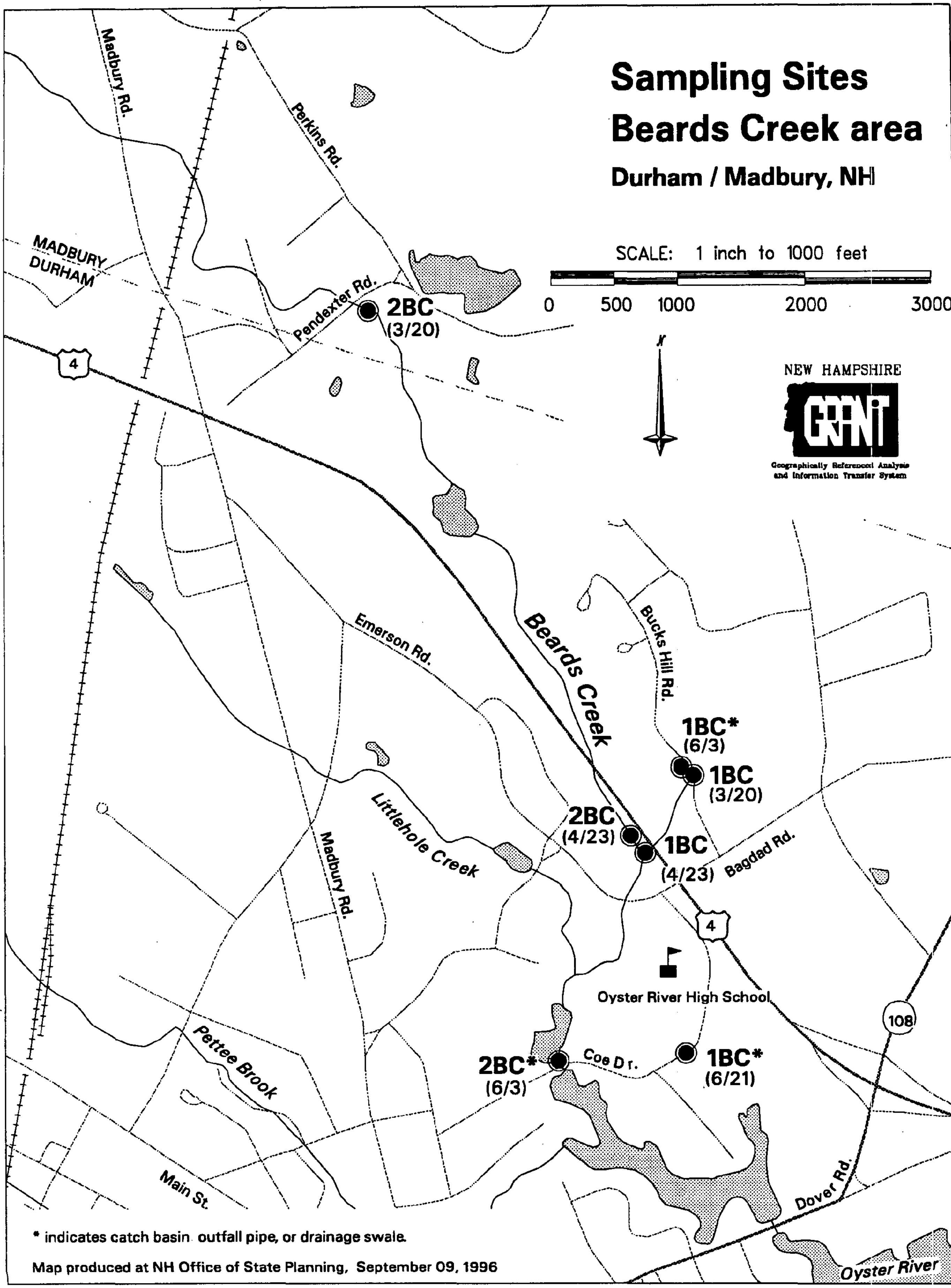
Beards Creek

Two variable sites were sampled in Beards Creek. Along witht stream locations, sample sites included a detention pond outlet, drainage swale, and catch basin outfall pipes (see locator map).

No bacteria samples exceeded the one time standard of 406/100 ml but certainly a number of ubiquitous sources that cumulatively could affect the overall health of the watershed were evident. The highest bacteria levels for this section were observed from a pipe that drains two catch basins receiving road runoff near the Oyster River high school (site 1BC, 6/21/96). Some of the highest suspended sediment levels observed were from this section of the watershed; at levels much greater than 10 mg/L and from areas receiving road runoff via catch basins and drainage swales (sites 1BC on 3/20/96, 1BC and 2BC on 6/3/96). High nutrients levels also related to these sources.

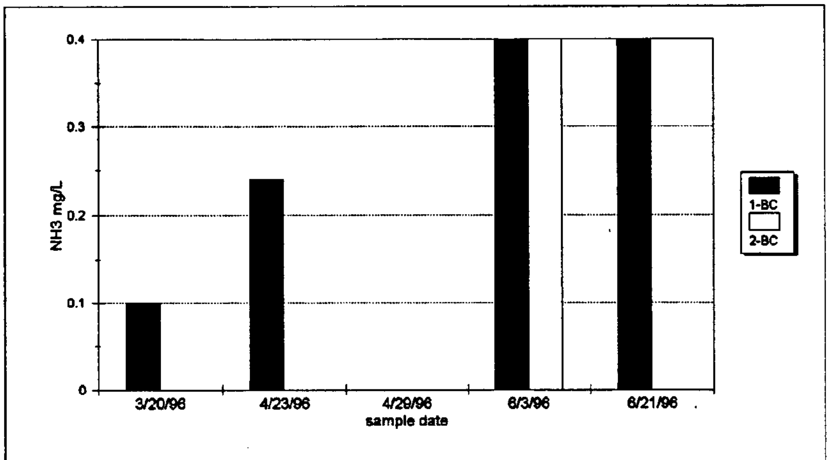


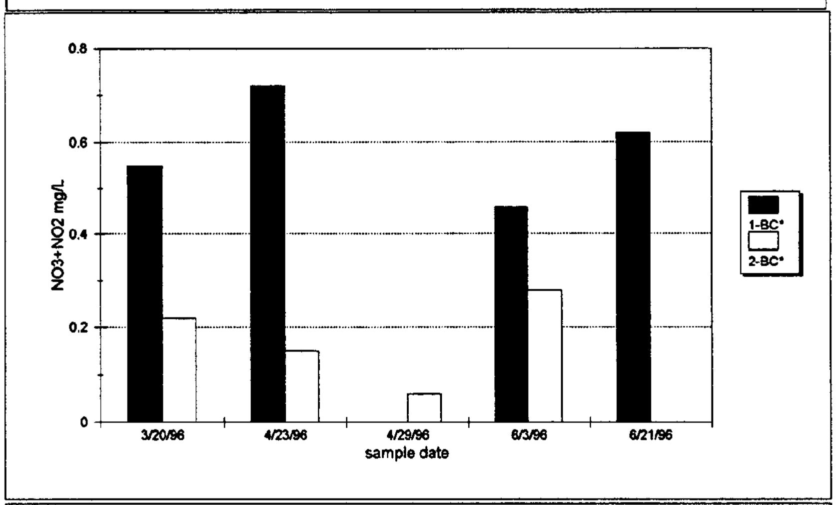


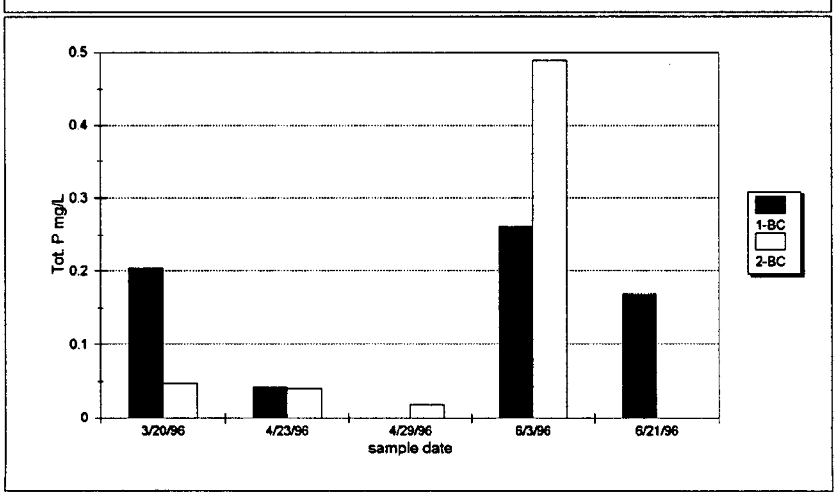


* indicates catch basin outfall pipe, or drainage swale.

Map produced at NH Office of State Planning, September 09, 1996


NH3 mg/L
0.4
0.3
0.2
0.1
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-BC
2-BC

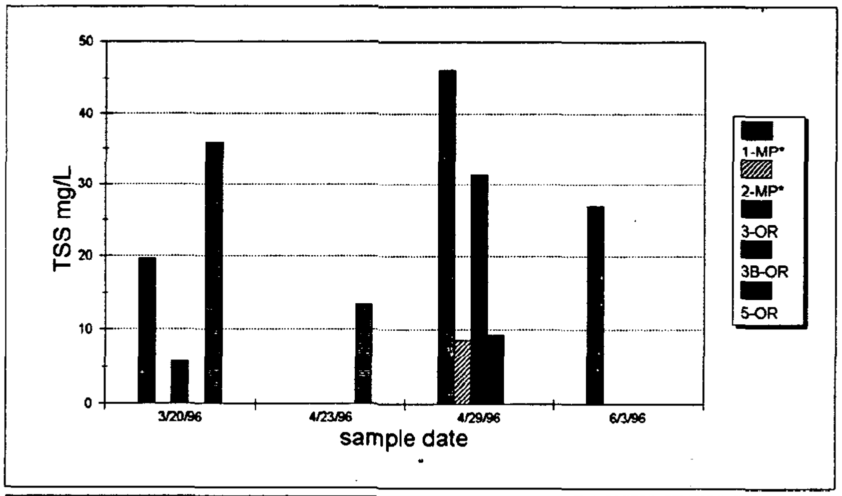

NO3+NO2 mg/L
0.8
0.6
0.4
0.2
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-BC*
2-BC*

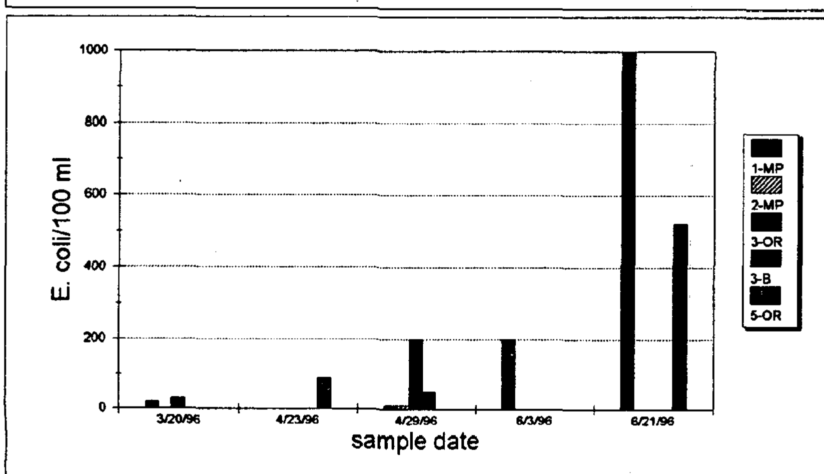

Tot. P mg/L
0.5
0.4
0.3
0.2
0.1
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-BC
2-BC

Mill Pond and Lower Oyster River

These sites were mostly drainage swales or catch basin outlets that fed into the Oyster River or Mill Pond (see locator map). Sample sites 1MP and 2MP, collected between 3/20 and 6/3 were from a drainge swale and pipes that drain into it (located between the bank parking lot and the road to an apartment complex). 1MP on 3/20 and 2MP on 4/29 were collected from the swale. 1MP on subsequent dates corresponds to the following pipe outfalls: 4/29 the lowest pipe on the east side of the swale, 6/3 the second pipe in on the same side, and 6/21 the catch basin outfall for road runoff on the west side of the swale.

A catch basin that receives road runoff and drains into Mill Pond had the highest E. coli levels (1000 cts/100 ml) 1MP on 6/21/96. The drainage swale leading from the UNH agricultural fields (5OR) had low to undetectable bacteria levels but relatively high nutrient levels. In particular, nitrate was elevated but did not exceed standards set for drinking water. Suspended sediment levels were high for a number of these samples. At sites 3-OR and 5-OR, in-stream samples were taken once at each site where the drainage swales discharge (3B-OR on 4/29/96 and 5-OR on 6/21/96), to see if any sources were attenuated after passing through the drainage swale. Although very limited data, reduced levels were oberved for nutrients at both sites and bacteria at site 3B-OR. The in-stream sample on 6/21/96 for 5-OR had higher bacteria levels than previous samples from the drainage swale. These levels may relate to other upstream sources or the intensity of the storm event.





Sampling Sites

Lower Oyster River and Mill Pond

Durham, New Hampshire

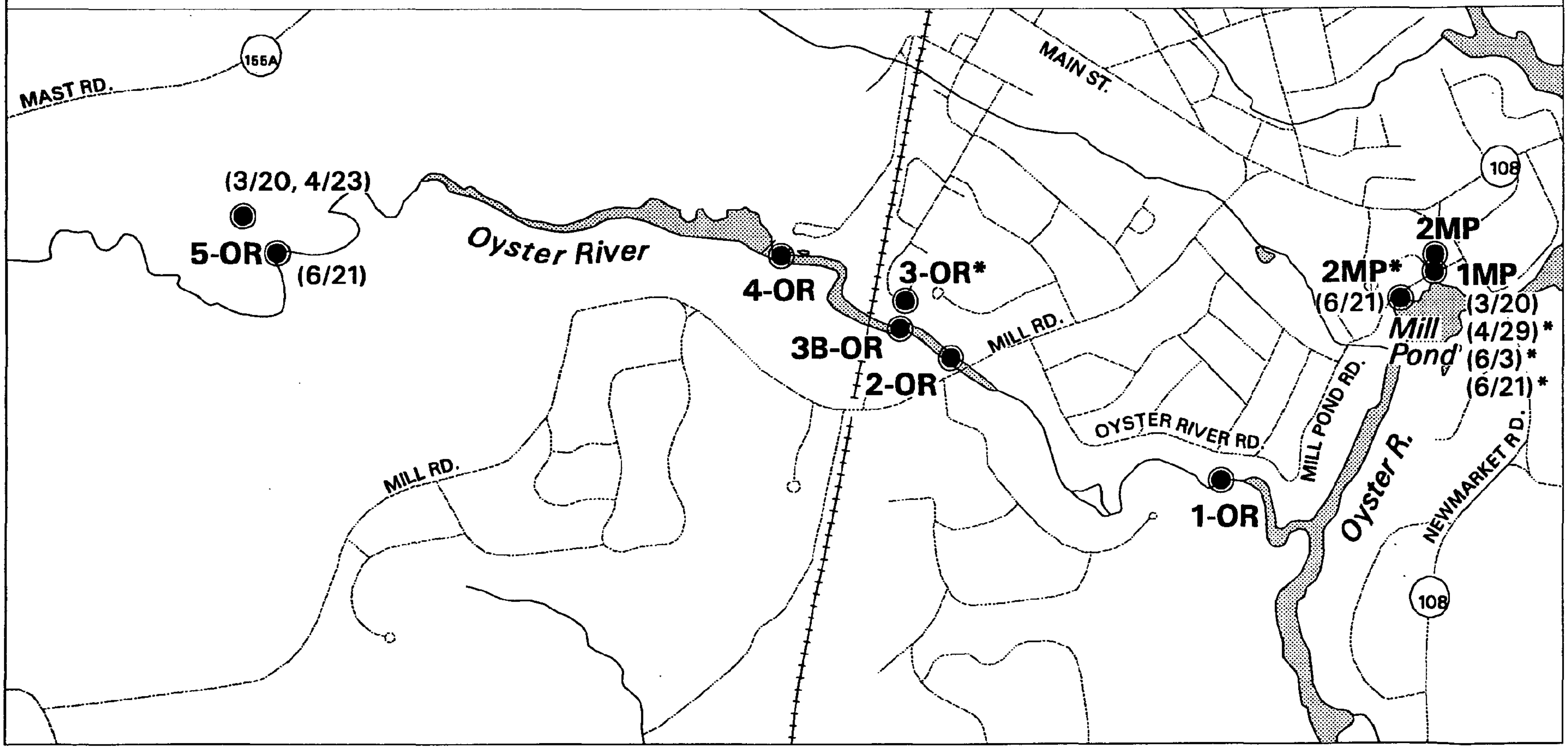
Map produced at NH Office of State Planning, September 10, 1996

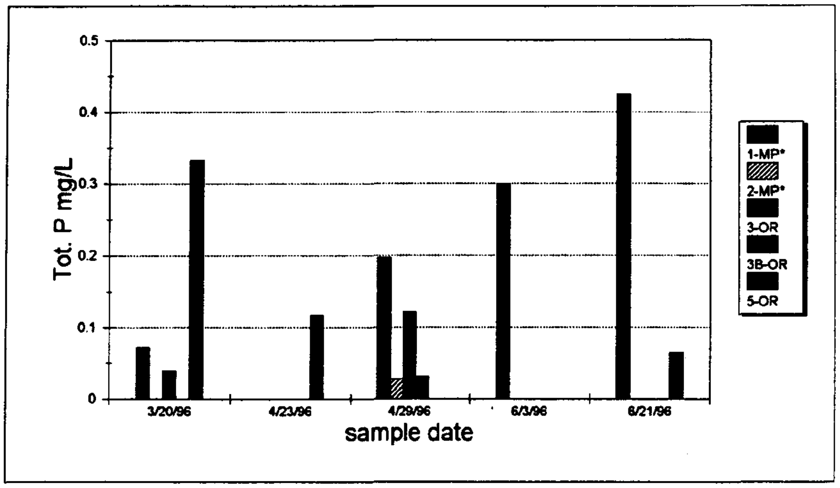
SCALE: 1 inch to 1300 feet

0 500 1000 2000 3000

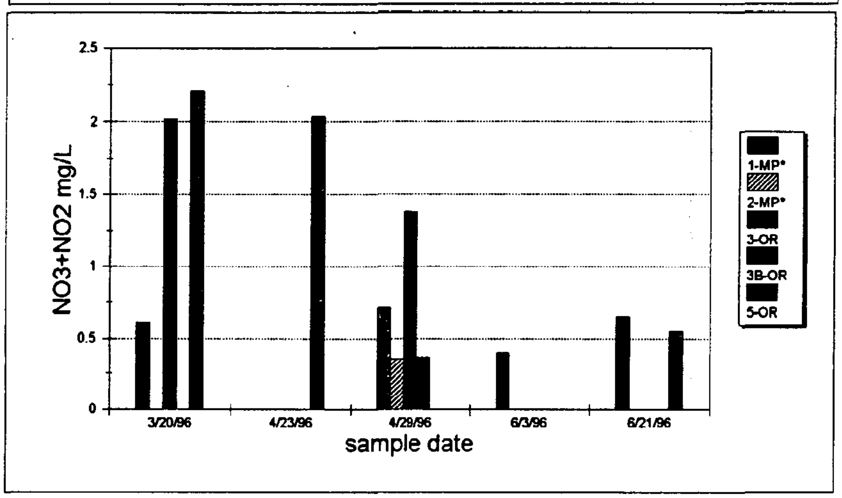
NEW HAMPSHIRE GRANIT

NOTE: * indicates catch basin outfall.

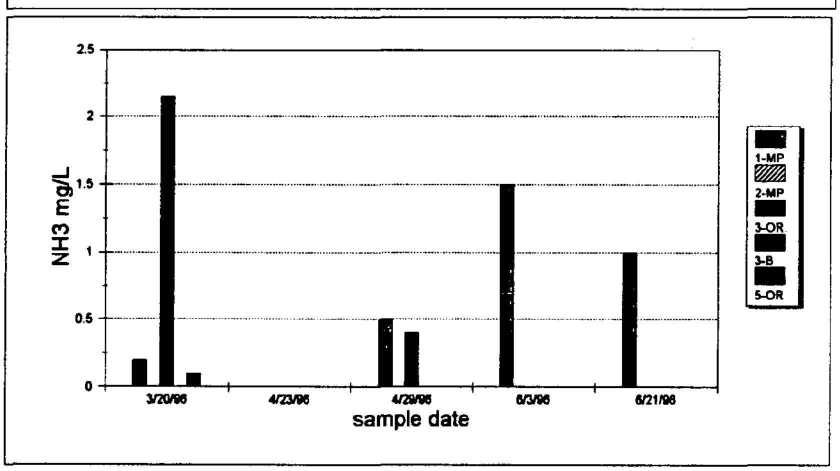




Tot. P mg/L
0.5
0.4
0.3
0.2
0.1
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-MP*
2-MP*
3-OR
3B-OR
5-OR



NO3+NO2 mg/L
2.5
2
1.5
1
0.5
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-MP*
2-MP*
3-OR
3B-OR
5-OR



NH3 mg/L
2.5
2
1.5
1
0.5
0
3/20/96
4/23/96
4/29/96
6/3/96
6/21/96
sample date
1-MP
2-MP
3-OR
3-B
5-OR

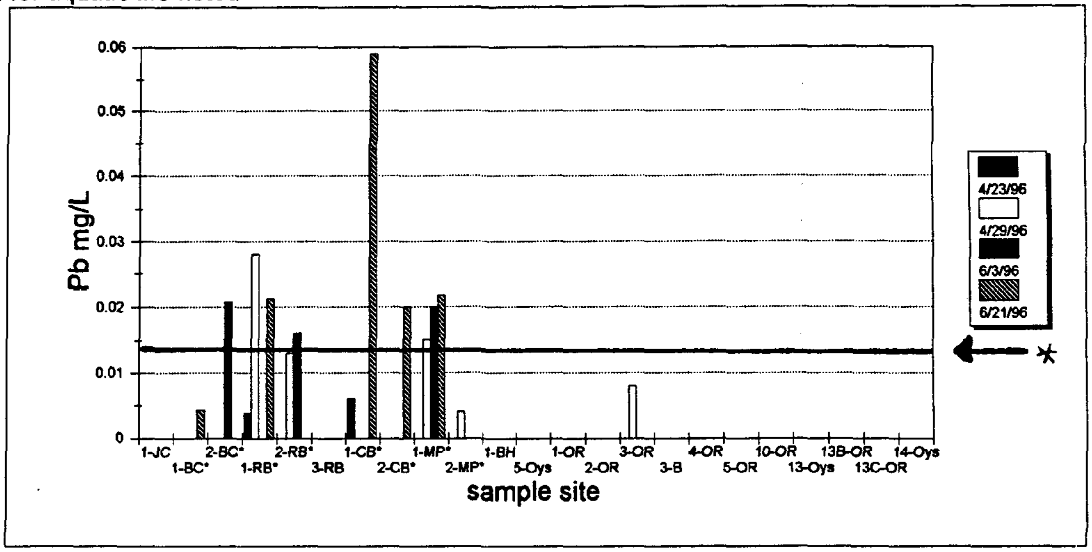
Data for Metals

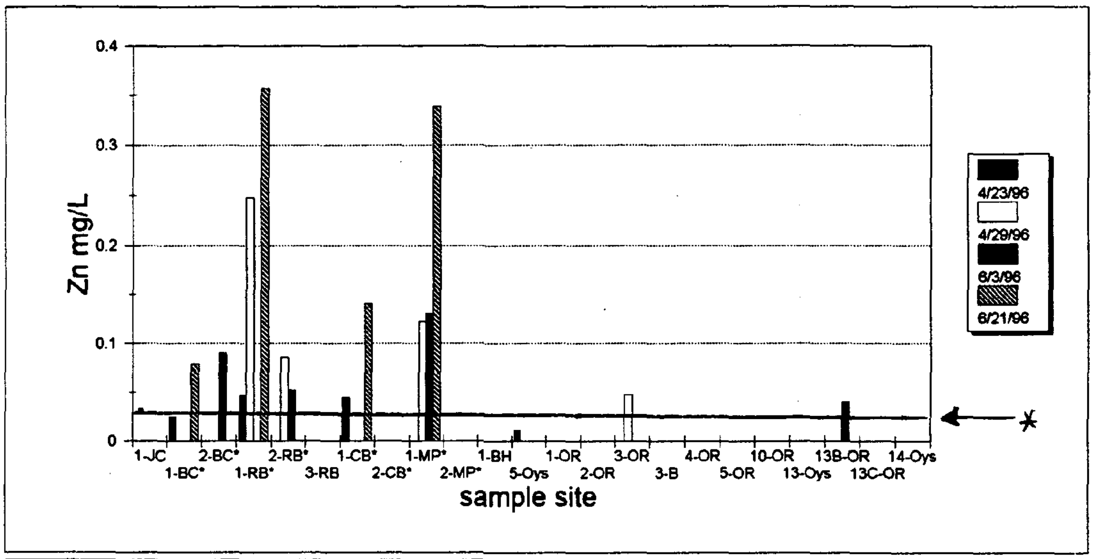
The Steering Committee expressed interest in testing for metals. As previously mentioned, metals are commonly contained in urban runoff, can be toxic to aquatic life, and have the potential to bioaccumulate in the food chain.

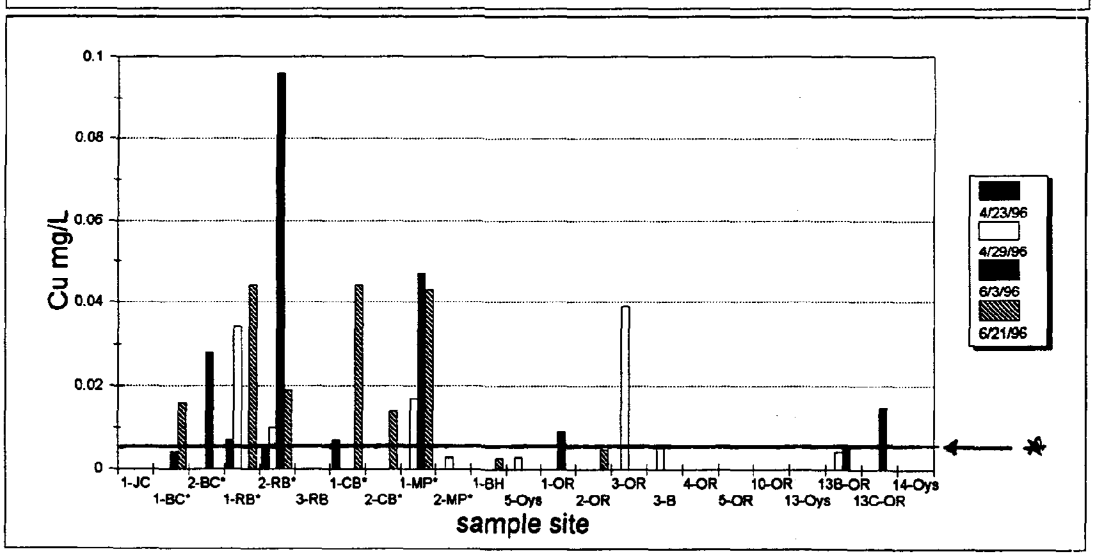
Due to cost and analytical limitations only a small portion of the sampling budget was appropriated for metals analysis. Results are compared to state standards which are based on USEPA standards designed to protect aquatic organism. DES and USEPA are currently reviewing metals standards and the toxicity standards for aquatic life are generally considered to be conservative limits. As well, the analytical method used measured total recoverable metals. This would include all metals in a sample including forms that may not be available for uptake by aquatic organisms. Although a number of samples exceeded conservative standards set for aquatic life, none exceeded limits set for public health.

Thirty-three samples were collected for metal analysis. Lead was detected in 15 of the 33 samples tested. Nine of these exceeded aquatic life standards. The highest level was detected in College Brook on 6/21/96. Zinc was detected in 16 samples, 14 of which exceeded standards for aquatic life. The highest level was detected at a catch basin outfall in Pettee Brook (1-RB on 6/21/96). Copper was detected the most of the three metals. Twenty-six samples had detectable levels of copper. The highest level was observed in Pettee Brook (2-RB on 6/3/96).

*Standard for aquatic life noted







CONCLUSIONS

Recent projects along with this sampling project demonstrate there are nonpoint sources of pollution in the watershed. Results suggest the major sources are in the lower part of the watershed, still, intermittent and ubiquitous sources in the upper part of the watershed should not be disregarded. In the lower part of the watershed, JEL identified septic systems and runoff from urban and agricultural areas as potential pollution sources. The site specific data from this study support these conclusions. Runoff from a drainage swale leading from UNH poultry barns had very high bacteria levels and contributes to the high levels observed in College Brook. Runoff from more urban areas also contributed to pollutant loading observed in this study. The lower part of the watershed had higher suspended sediments levels and often exceeded the average value for clean surface waters in NH (10mg/L). Some catch basins sampled contributed to the high suspended sediment values observed and cleaning and maintenance of these structures should be reviewed. Other suspected sources of suspended sediments to the river were road sand from winter applications and runoff from snow piles placed at the edge of stream banks. Erosion at construction sites was observed during sampling. Best mamagement practices to contol these sources should be promoted.

Potential sources from the University campus were a major concern of the Steering Committee. Although some of the higher pollutant levels were observed at University locations, other residential and commercial areas in the watershed contribute to the overall pollutant loading to the Oyster River. Attempts to reduce these existing sources should be considered. In the upper part of the watershed, the Lee traffic circle was an area of concern. Pollutant levels at the sample site did not frequently exceed acceptable levels, yet the higher suspended sediments and nutrient levels for the area were observed at this site. As development continues in this area it will be important to promote key preventative measures such as buffer strips and impervious surface limits to prevent the increase of nonpoint pollutant loading to the watershed.

It is interesting how the water quality data relate to some of the public perceptions measured in the watershed survey. Survey respondents are aware of some of the nonpoint pollution threats in the watershed. Respondents listed septic systems as one of the top contributors to nonpoint pollution in the Oyster River Watershed. Stormwater and urban runoff were also recognized as possible sources of nonpoint pollution. Other potential threats, such as agricultural activities, house construction activities, sediments due to erosion, and winter snow removal, were not perceived as major concerns. Regional and project specific data demonstrate these activities are significant sources of nonpoint pollution as well. This indicates watershed residents have an incomplete understanding of the nonpoint pollution issues in the watershed. These topics should be the focus of public education initiatives using watershed specific data for examples.

There are many regulations in place to prevent future sources but each town has areas where regulations could be strengthened. Towns should consider the adoption of performance standards detailed in the Stormwater management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH. Where regulations are in place, maintenance and inspection programs are critical to ensure control measures function properly. As well, education and awareness programs can play an important part in correcting existing sources such as faulty septic systems, sediments eroding from construction sites, and catch basins lacking maintenance.

STEERING COMMITTEE RECOMMENDATIONS

The Steering Committee made the following recommendations:

- Present project information to watershed towns in a report format. Summarize pertinent points in an executive summary.

- Areas with the most significant pollution sources should be brought to the attention of an appropriate town or university agent and DES for additional sampling. In particular the catch basin discharge on Pettee Brook that had high bacteria levels and the drainage swale near the livestock barns on College Brook.

- Education initiatives should be developed focusing on areas of need, (erosion control, agricultural best management practices, snow removal) and using watershed specific data for examples, coordinating available resources and working within established venues (e.g. distributing information at established town fair days, promoting information segments on radio and in newspapers). Initiatives should also work within schedules of the target audience.

- Workshop suggestions-promote septic system maintenance with a workshop demonstrating how to inspect your system. (See other suggestions in the survey report).

- Pursue distribution of septic system information via town halls, welcome wagons, real estate agencies, and banks.

- Promote regular inspection and maintenance of control structures in place, such as catch basins.

- Towns should consider the adoption of performance standards detailed in the Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH.

- As developement continues in the Lee traffic circle area, it will be important to promote key preventative measures such as buffer strips and limits on impervious surfaces to prevent the increase of nonpoint pollution loading to the watershed.

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ADDITIONAL REFERENCES

For towns that want to pursue any gaps in their regulations in regards to NPS control, the following references are helpful for additional information on NPS and techniques to prevent it:

- **A Guide to Controlling Nonpoint Pollution through Municipal Programs. Technical bulletin #11, N.H. Office of State Planning, 1995.**

This technical bulletin focuses on nonpoint sources of special concern to coastal waters. It provides guidance on improving the effectiveness of local ordinances and regulations and other municipal programs.

- **Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials. NHDES-WSPCD-94-2.**

This guide describes what causes NPS and best management practices (BMPs) to prevent it.

- **Local Land Use Management Techniques for Water Resource Protection and Geographic Inventory Procedures. NHOSP, 1992.**

Explains municipal regulatory and non-regulatory measures that can be use to protect water resources.

Appendix A

Checklist for evaluation of municipal ordinances & regulations - Oyster River Watershed, 1/96

Abbreviations used:
BMP-best management practicesE&SC-erosion and sediment controls
GB-Great Bay
LB-Little Bay
MHL-mean highwater line
PB-planning board
PD soil-poorly drained soil
VPD soil-very poorly drained soil
WL-wetland
WWDS-waste water disposal system

Zoning				
	Durham	Lee	Madbury	Barrington
lot sizes	10,000-120,000ft2min	21,250-85,000ft2min	20,000-180,000ft2min	80,000ft2 min
impervious limits	20-50%	10%-Aq z 25%-SPR	50%-Neigh./Comm.	25-75%(related to open space requir.)
building setbacks *surface water, wetlands*	see art. 10			
agriculture regulated *erosion/sedim./soil consv., run-off control/mgmt, nutrients,pesticides, grazing, State BMP Manual referenced?*				
Septic Systems - Zoning and Health Ordinance/Regulation				
setbacks from wetlands	see WL protec.	see WL protec.	100ft. wetland soils-see WL	in industr. park 100'from prime WL and 50' all other WL
setbacks from surface water	see shoreland protection	see shoreland protection	100'-public body water, permanent stream	
review of Design & construc. application			cluster regs.-at choice of PB by sant. eng.	
inspection of new systems	yes	yes-HO	yes-town eng.	
annual inspection				
operating guidelines				
inspection, upgrade required for expansion, conversion	yes			

Site Plan Review Regulations				
	Durham	Lee	Madbury	Barrington
minimize disturbance *avoid dev't of sensitive areas* *preserve riparian areas* *site roads etc. to preserve natural drainage features* *limit impervious area,* *limit land disturbance, cut & fill*	landscaping plan requir.	gen. requir.	gen.requir.-approp. buffers	gen. requir.
erosion/sediment control (E&SC) *1.ESC plans required pre-construction?* 2.what size areas? 3.outside review agency? *4.performance std. (80% TSS)* *5.design stds* *6.guidance manual*	(*proposed ammend. to SPA to require E&SC,adopt RCCD manual,, as guidance manual)		cluster-art. v-plan requir. SPR-art vi-"measures shall be taken"	yes-stds?
permanent stormwater treatment *1.performance stds (80% TSS, pre-dev't runoff rates)* *2.design stds.* *3.guidance manual*		requir. licensed eng. to design storm drainage-no stds. listed (runoff may not increase off the site or advers. effect abutting props.)	runoff-post shall not exceed pre. development	"storm drainage shall be provided for" PB may require performance bond
additional studies		discretion of PB	discretion of PB	
chemical control		no disch/dispos. tox/haz waste. storing-requires plan		
Subdivision Regulations				
minimize disturbance *avoid dev't of sensitive areas* *preserve riparian areas* *site roads etc. to preserve natural drainage features* *limit impervious area,* *limit land disturbance, cut & fill*	PB-can require plan for open space PB or approp. agent inspects during construct.	gen. requir. stripping topsoil not allowed unless in accord. w/ earth removal regs.	10+lot require impact statement	gen requir. may requir. tree planting
erosion/sed. control *1.ESC plans required pre-construction?* 2.what size areas? 3.outside review agency? *4.performance std. (80% TSS)* *5.design stds/guidance manual*	(proposed in SPA ammends.)	reference state requir.	10+ lots-requir. impact evaluation that includes ersosion	no guidance manual mulching requir. selectm. or appr.agent inspect streets
permanent stormwater treatment *performance stds (80% TSS, pre-dev't runoff rates)* *design stds* *guidance manual* *maint.-runs with*		storm drain plans requir.-lisce. eng. calc 10yr. storm.	runoff rates-post shall not exceed pre dev.	plan requir.-no g-man. some stds. listed
additional studies performance bonds	 yes	yes yes	yes	yes yes

Shoreland Protection				
	Durham	Lee	Madbury	Barrington
shorelands protected: which waters depth of shoreland	150'HWM of GB and LB, +tidal sec. of OyR, Lamp, Follet's Bk, and 75' all perennial brooks	100' from shore all rivers, Dube Brook,Chesley Brook, and Wheelright Pond(shore= MWL)	300'-Bellamy Reservoir 100'MHL of BelR &OyR, 50'MHL all other brooks streams,ponds, & public water supplies,150' shoreline or upland ext. tidal WL adj. LB	75' fromshore (MHL) any year round stream lake or pond>2ac.
salt storage, junk yards, solid waste prohibited	yes		prohib. w/in 75'	
land alteration requires E&SC	(proposed**)	no excav. or filling in zone unless approv. by PB		
septic setbacks > 75'	150' upgrade requir. upon transf. prop.	no WWDS in def. zone		
setback for primary structures	125'/75'	no perm or temp buildings in def. zone	prohib in protect distrs. defined	setback for structures other than docks or structures for recr. use of water.
vegetated buffer - depth	no fert/herb/pest within 75' of HWM 1acess pt/dev-max 10% of frontage		50'-from upland extent of tidal WL or edge of P&VPD soils	
50% tree cutting limit	no trees >6"DBH 50% limit	yes 50%(no time limit)	yes 50%/20yrs	
impervious limits				
non-sewered lot size				
density limit				
agriculture exemption requires BMP's	no animal feedlots no tilling-75' HWM		agr. allow-provide does not degrade surf/ground water or cause soil erosion	

	Durham	Lee	Madbury	Barrington
Wetland Protection area defined	PD and VPDsoils, surface waters	overlay-P&VP drained soils	soils id as P and VPDrained	PD &VPD soils & bodies of water.
septic setbacks	75' any WL failed syst.-requir. replace outside zone-unless HO det. otherwise	125'	100' stated in zoning	must comply state regs.
buffer protection	75' surf. water or VPDsoil 50' PD soil	75'-no structure (exception well or wellhousing, R.O.W. or use nonconflict)		in industr. park-100' from prime WL,50' all others w/50% basal area of natural veg.
Aquifer/Groundwater Protection				
overlay district	yes	yes		
impervious limits	25%	10%		
land use restrictions	min. use deicng agents list prohib. uses	list prohib. uses		
larger lots	hydrogeol study required for dev. 10+ lots-stds listed.			
Hazardous Materials storage regulated UST's regulated household hazmat	junkyards prohibited-all districts			
Roads, Parking Lots *deicing chemicals* *maintenance of stormwater structures*	requir. proper drainage offstreet parking-town maintains struct. in r.o.w -prop. owner maint. extensions lots>5-min 5% landscapped			
erosion & sediment controls	*y	dust controls	prevention requir.-no stds. listed	
exposure limit/phasing	*yes -5acres	yes		

reclamation requirements	*yes	incremental requirements stds. for seeding,debris	yes-planting plan requir., slope stds.	
equip. maintenance restricted on-site				
permit time limit	*3yrs.	24 mos.	1yr.-all oper. in exist. must comply time of renewal	
Miscellaneous pooper scooper law turf management cluster dev	landsc. article-plan required all commercial and commercial resid. guid. std. and bond requir.			

(1)- Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire, 1992, Rockingham County Conservation District.

APPENDIX B

Water quality parameters measured and state standards
Bacteria are measured as indicators of human and animal wastes and possible disease causing pathogens. Stormwater runoff is frequently contaminated with bacteria from animal wastes and failed septic systems. The National Urban Runoff Program study found urban runoff typically contains fecal coliform densities greater than 10,000 organism per 100 milliliters (U.S. EPA, 1983).

Fecal coliform is the State standard indicator for classifying shellfish waters. This is one parameter of many for classifying shellfish waters and would apply to tidal water. JEL and GBW measured fecal coliforms.

State standards

approved (for shellfishing)	restricted	prohibited
*mean <14/100 ml	mean<88/100 ml	mean>88/100 ml

(*mean of at least 30 samples for newly classified waters, 15 samples for reclassification)

E. coli is a particular species of fecal coliform that is specific to fecal material from humans and other warm blooded animals and is the State standard indicator for freshwater. Units used are number of coliform colonies counted/100 milliliters of sample water(ml)

State standards

	1x sample limit	geomean of 3 samples/60 days
class A waters	153/100ml	47/100ml
class B waters	406/100ml	126/100 ml
designated beach	88/100ml	47/100ml

Temperature, Conductivity, Dissolved Oxygen and pH
These are the parameters that are measured in the field. Extreme values can be quick indicators of pollution problems.

Temperature-Runoff from paved areas can increase stream temperatures. Temperature can affect other water quality characteristics such as dissolved oxygen. The state standard is "no increase that would appreciably interfere with the designated uses".

Specific Conductivity is a measure of the ability of water to conduct an electric current and is an indicator of the dissolved ionic matter present in water. High conductivity measurements may indicate pollution sources such as salt or nutrients from runoff. The unit of measure is micromhos (μmhos). There is no state standard for conductivity but most clean surface waters of New England have very low conductivity levels (Spang, 1988).

Dissolved Oxygen -Dissolved oxygen (DO) in water is required to support aquatic life. Stormwater runoff with high levels of organic matter can consume oxygen as it decays. The state standard is not less than 75% saturation or generally not less than 6.0 mg/L. Low DO is stressful to aquatic life.

pH- This is a measure of the acidity of water. The pH scale ranges from 1 to 14, seven being neutral with values below this indicating increasingly acidic conditions and values above indicating more basic conditions. Extreme values or changes may indicate biological activity or pollution sources. The state standard for class B waters is 6.5 to 8.0 or as naturally occurs.

Total Suspended Solids (TSS)- This is a measure of fine materials suspended in the water column. High levels of suspended sediments can reduce light penetration and may have attached nutrients and other adsorbed pollutants that affect stream life. High levels may indicate erosion or runoff problems. An average value for unpolluted surface waters in the Northeast is 10 mg/L.

Percent Organic Matter (% Org)-is the percentage of the TSS that is organic matter. In general, percent organic matter may be high but the overall amount of TSS is low. High TSS levels that are mostly organic matter (therefore the % organic matter is high), may indicate excess nutrient sources are stimulating algal growth.

Nutrients

Phosphorus and nitrogen are important plant and animal nutrients and generally found at very low concentrations in streams. Nutrients may enter streams from leaking septic systems, runoff from agricultural areas or fertilized lawns, or via sediments from eroding areas. Increased nutrient levels can stimulate algal production and are toxic to aquatic life at very high levels.

The state standard for phosphorus is "no phosporus in such concentrations that would impair any usage assigned to the specific class involved, unless naturally occuring". Naturally occuring levels of phosphorous in NH rivers are generally less than .035mg/L (NHDES, 1993). The state standard for nitrate is not to exceed 10 mg/L, based on protection of human health. In general unpolluted, well oxygenated surface water concentrations are less than 1 mg/L. USEPA also sets the drinking water standard at 10mg/L. The state standard for ammonia in freshwaters is 29 mg/L, based on acute toxicity for aquatic life. Levels for unpolluted surface waters are generally less than 0.1 mg/L.

Metals

Metals are a concern because they are commonly contained in urban runoff. The Nationwide Urban Runoff Program (EPA 1983) found elevated levels of Cu, Pb, Zn in at least 91% of the sample collected. Metals may be toxic to aquatic life and have the potential to bioaccumulate in the food chain.

The state uses the following USEPA acute toxicity standards designed to protect aquatic organisms. (DES and EPA are reviewing metals standards.)

Copper (Cu)	0.0048 mg/L
Zinc (Zn)	0.036 mg/L
Lead (Pb)	0.0139 mg/L

APPENDIX C

*note-nd- indicates no detect, blanks indicate no sample

LAB TESTS

	Tot. P					NH3-N					NO3+NO2-N					E. coli				
site	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96
1-JC	0.336	0.037	0.031			0.1	<.1	nd			0.27	0.16	0.12			30	70	10		
1-BC	0.204	0.041		0.26	0.168	0.1	0.24		0.4	0.4	0.55	0.72		0.46	0.62	190	190		<10	330
2-BC	0.047	0.04	0.018	0.489		<.1	nd	nd	0.4		0.22	0.15	0.06	0.28		90	270	<10	150	
1-RB	0.082	0.101	0.251	0.048	0.471	0.2	0.22	0.5	0.1	0.74	0.48	0.92	0.52	1.03	0.79	130	1920	2780	260	4100
2-RB	0.054	0.056	0.281	0.189	0.051	0.3	nd		0.3	0.5	0.44	0.55	1.57	0.82	0.65	80	50	<10	4100	480
3-RB	0.033		0.057	0.029		0.2		0.2	nd		0.35		0.36	0.26		30		440	430	
1-CB	0.201	0.029	0.326		0.246	0.5	nd	0.7		0.3	0.66	0.08	1.52		1.04	370	70	1420		19000
2-CB	0.156		0.04		0.101	0.5		nd		0.3	0.73		0.75		0.91	360		10		11400
1-MP	0.072		0.197	0.299	0.424	0.2		0.5	1.5	1	0.61		0.71	0.4	0.65	20		10	200	1000
2-MP			0.027					nd					0.35					10		
1-BH	0.03	0.05	0.024		0.069	<.1	nd	nd		0.1	0.25	0.14	0.18		0.51	20	40	350		730
5-Oys	0.078	0.026	0.021	0.041		0.1	nd	nd	nd		0.4	0.17	0.13	0.17		50	80	20	40	
1-OR	0.051	0.021	0.019	0.033		0.1	nd	nd	nd		0.36	0.14	0.14	0.24		<10	130	80	60	
2-OR	0.084	0.027	0.02		0.036	0.1	nd	nd		nd	0.36	0.14	0.14		0.36	60	130	10		240
3-OR	0.038		0.122			2.15		0.4			2.02		1.38			30		200		
3-B			0.03					nd					0.36					50		
4-OR	0.11	0.025	0.019			0.1	nd	nd			0.36	0.14	0.14			<10	100	40		
5-OR	0.333	0.118			0.064	0.1	nd			nd	2.21	2.04			0.55	<10	90			520
10-OR	0.025	0.012				<.1	nd				0.13	nd				10	30			
13-Oys	0.016	0.005				<.1	nd				0.09	nd				<10	<10			
13B-OR	0.021	0.016	0.036	0.053		0.1	0.14	0.2	0.4		0.21	0.14	0.14	0.14		<10	<10	10	20	
13C-OR				0.031					nd					nd					130	
14-Oys	0.07	0.024				<.1	nd				0.08	nd				60	<10			

	TSS				%org				Pb				Zn				Cu			
site	3/20/96	4/23/96	4/29/96	6/3/96	3/20/96	4/23/96	4/29/96	6/3/96	4/23/96	4/29/96	6/3/96	6/21/96	4/23/96	4/29/96	6/3/96	6/21/96	4/23/96	4/29/96	6/3/96	6/21/96
1-JC		9	7.56		14.25	20.83	20.59													
1-BC	43.5	14.5		142	14.94	13.79		21.13	nd		nd	0.0043	0.025		nd	0.079	nd		0.0041	0.016
2-BC	10.67	9.1	2.6	144	17.5	16.48	46.15	18.06			0.0207				0.09				0.028	
1-RB	24.33	8.11	84.33	5.12	10.96	20.55	23.32	34.15	0.0038	0.028		0.0213	0.047	0.248		0.357	0.007	0.034		0.044
2-RB	46	15.6	87.83	42	10.87	15.38	11.76	20.24	nd	0.013	0.0161	nd	nd	0.086	0.052	nd	0.0049	0.01	0.096	0.019
3-RB	8	21	32.6	4.75	15.63	17.46	12.88	28.95			nd				nd				nd	
1-CB	57.33	8.44	43.67		12.79	22.37	20.61		0.006			0.059	0.044			0.141	0.007			0.044
2-CB	36.8	8.67	7.3		11.96	25	19.18					0.02								0.014
1-MP	19.71		46.17	27	12.32		23.47	40.74		0.015	0.0199	0.0218		0.122	0.13	0.338		0.017	0.047	0.043
2-MP			8.6							0.004				nd				0.0027		
1-BH	6.57	3.14	2.8		21.74	45.45	35.71					nd				nd				0.0028
5-Oys	16.77	5.83	3.8	3.67	13.76	22.86	26.32	50	nd	nd	nd		0.011	nd	nd		nd	0.0029	nd	
1-OR	22.57	6.78	3.8	3.67	10.76	22.95	28.95	31.82			nd				nd				0.009	
2-OR	23.17	5.8	3.9		12.23	24.14	30.77					nd				nd				0.0048
3-OR	5.75		31.33		23.91		20.21			0.008				0.048				0.039		
3-B			9.33				19.64			nd				nd				0.006		
4-OR	31.4	5.56	3.67		13.38	24	24.24													
5-OR	36	13.5			12.7	18.52														
10-OR	37.35	4.9			6.33	22.45														
13-Oys	0.75	1.1			66.67	81.82														
13B-OR	3.25	4.4	10.67	16.33	46.15	54.55	43.75	40.82	nd	nd	nd		nd	nd	0.04		nd	0.0041	0.006	
13C-OR				3.4				58.82	ND		nd		nd		nd		nd		0.015	
14-Oys		0.8				87.5			nd				nd				nd			

site	Hardness 4/23/96	4/29/96	6/3/96	6/21/96
1-JC				
1-BC	58.8		85.2	9.73
2-BC			20.9	
1-RB	76.1	10.3		12.9
2-RB	48.6	99.4	79.1	249
3-RB			56.4	
1-CB	56.4			46.4
2-CB				257
1-MP		18.4	30.4	16.3
2-MP		154		
1-BH				101
5-Oys	27.5	30	42.7	
1-OR			38.1	
2-OR				49.3
3-OR		58		
3-B		41.2		
4-OR				
5-OR				
10-OR				
13-Oys				
13B-OR	14.8	16.5	24.7	
13C-OR	12.9		16.8	
14-Oys	5.69			

FIELD TESTS

	pH					temp					DO					Cond				
site	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96	3/20/96	4/23/96	4/29/96	6/3/96	6/21/96
1-JC	7.47	7.12	7.26			2.2	15.5	9.7			13.2	8.5	11.2			105	195	345		
1-BC	7.15	7.12		6.33	6.41	2.9	13.7		16.5	18.4	13.4	9		6.2	8.8	80	210		400	70
2-BC	7.31	7.43	7.6	6.4		2	14.7	10.8	20.7		13	8.8	11.2	8.2		75	195	220	155	
1-RB	6.9	6.92	6.51	7.26	5.9	2.7	13.3	11.3	16.7	19.4	12.8	9	10.2	8.5	8.2	170	210	50	380	65
2-RB	6.84	7.12	6.44	7.01	6.92	3	14.1	11	18.6	16.1	11.3	8.6	9	7.4	6	160	210	305	290	600
3-RB	6.73	7.02	6.89	7.05		2.5	15.7	11.4	18.4		11.6	8.4	9.9	6.8		145	115	125	245	
1-CB	7.33	7.25	6.76			2.8	12.7	9.3			12.8	9.2	10.2			180	350	330		
2-CB	7	7.16	6.97			2.7	12.2	9.2			13.8	9.2	10			185	330	405		
1-MP	6.92		6.47	6.45		3.8		12.7	19.5		12			8		410		80	190	
2-MP			7.02					9.6					9.8					450		
1-BH	7.47	6.54	6.82			2.2	14.1	11.2			11.4	7.7	9.6			80	130	145		
5-Oys	7.54	6.7	6.98	6.94		2.2	14	11.3	19.1		13	8.8	9.9	7.4		100	115	110	170	
1-OR	7.2	7.15	7.44	7.09		2.3	14.5	11	17.9		13.4	8.9	10.2	7.8		70	95	100	95	
2-OR	7.18	7.18	7.18			2	14.3	11.1			13.2	9	10.4			65	100	100		
3-OR	6.99		6.75			6.5		11.2			11.4		10.2			600		220		
3-B																				
4-OR	7.31	6.99	7			1.6	16	11			14.6	8.3	10.6				105	95		
5-OR	6.85	6.73				2.4	15.1				12	9.6				115	295			
10-OR	7.09	6.79				1.7	15				13.6	8				45	75			
13-Oys	6.96	6.43				2.2	18.3				12.2	6.7				45	75			
13B-OR	6.59	6.1	6.26	6.3		2.7	17.6	10.7	18.8		12.6	7.4	9.6	6		160	265	260	380	
13C-OR		6.24		6.23			19.4		18.3					5.9			80		120	
14-Oys	5.89	5.5				2.2	16.8				13.2	7.8				35	45			