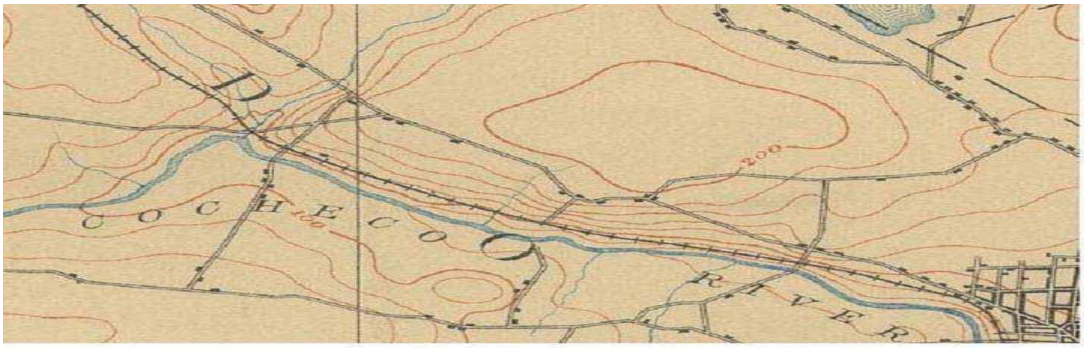

Cocheco River Watershed Monitoring Plan 2006 and 2007

Prepared for

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Dover, NH

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Cocheco River Watershed Monitoring Plan
2006 and 2007

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The sampling that has been conducted for the past seven years on the Cocheco River could not have been accomplished without the efforts of the many Cocheco River Watershed Coalition (CRWC) volunteers. This data has contributed to the refinement of this new monitoring plan.

Development of this plan was made possible by a grant from the New Hampshire Department of Environmental Services (DES) through the USEPA Clean Water Act Section 319 Grant Program. Natalie Landry, of the Watershed Assistance Bureau, supported and encouraged the restoration and implementation planning process on the Cocheco since 2003 and has provided significant background information and references for development of the plan, in particular the *Hodgson Brook Watershed Monitoring Plan*.

The NHDES also plays a pivotal role in initiating and supporting sampling efforts on the Cocheco River each year. Through the Volunteer River Assessment Program (VRAP) CRWC volunteers and staff have been trained to collect, report and analyze information and help form a framework for water quality monitoring. VRAP provides equipment and supplies and quality assurance and quality control review for the sampling program. A similar program, the Volunteer Biological Assessment Program (VBAP) also at DES, has helped the CRWC initiate a pilot program in biomonitoring that will be continued throughout the restoration process. Their continued involvement in these volunteer monitoring programs will assure that the data collected is accurate and valuable to the restoration of the Cocheco and other rivers throughout New Hampshire.

Cover illustration: United States Geological Survey, 1898, topographic quadrangle, Dover, NH.

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Appendices

Section 1 – Environmental Quality of the Cocheco River Watershed

1.1 Introduction

The Cocheco River Watershed Monitoring Program is a comprehensive, volunteer-based environmental monitoring effort designed to answer specific questions about the quality of the river and the surrounding watershed area. The Cocheco River is located in the Piscataqua River basin that is shared by the States of New Hampshire and Maine. The Cocheco River and its tributary streams flow through 13 New Hampshire communities. The river converges with the Salmon Falls River to form the Piscataqua River that flows through Portsmouth Harbor into the Atlantic Ocean.

The Cocheco River watershed is comprised of 10 rural towns and three cities. Rapid development is sweeping upward from metro Boston and is pressuring natural resources within the Cocheco River area. The Cocheco River Watershed Coalition is a grassroots organization that works to protect the river from the threats of development and existing uses through effective partnerships with municipal and state governments as well as other nongovernmental organizations. The CRWC is dedicated to protecting the natural watershed resources and restoring the degraded portions of the river. This monitoring plan will help the organization identify pollution sources and track progress in restoring the river as they implement the Cocheco River Watershed Restoration and Implementation Plan (Truslow, 2006).

1.2 Background

Since 1998, the Cocheco River Watershed Coalition (CRWC) has been working with the NH Department of Environmental Services (DES) to monitor the water quality of the river. In 1999, the Cocheco River Watch was established with three monitoring teams under the direction of the DES Volunteer River Assessment Program (VRAP). In an effort to better understand and document the broad range of technical issues relating to the health of the watershed, the CWRC applied for a grant from the DES funded through the Section 319 Clean Water Act grants program. In 2003 the DES awarded the CRWC funds to support a project titled, *Environmental Quality Characterization and Recommended Monitoring and Restoration for the Cocheco River*. According to the DES:

This project aims to establish a baseline of existing conditions, identify sources of contaminants and determine impacts on the Cocheco River ecosystem as a whole. This will be accomplished through the compilation and analysis of existing information, creation of watershed and site descriptions and land use cover maps, to determine recommendations for future monitoring programs and restoration activities within the Cocheco River Watershed.

Two documents have been prepared to date as part of this program.

Cocheco River Watershed Environmental Quality Report (EQR) – February 2005. This document describes the pollution issues, pollution sources and the resulting human and biological impacts on the Cocheco River Watershed. The report also identifies gaps in monitoring information for both spatial coverage and measured parameters.

Cocheco River Watershed Restoration and Implementation Plan (CRWRIP), June 2006. This document presents goals, objectives, and actions developed to address environmental pollution and associated watershed conditions identified in the EQR. The plan also includes the organizational steps needed to complete the restoration actions, measures of success, community involvement, an estimated budget for years one and two of implementation, and an organizational structure for implementation. The CRWRIP states four goals for the Cocheco River Watershed study area:

> *Public Perception and Education Goal - Change the negative public perception of and behavior toward the Cocheco River so that the assets and benefits of the Cocheco River can be realized.*
>
> *Water Quality Restoration Goal - Improve the water quality of the Cocheco River to meet New Hampshire Class B water quality standards by 2015.*
>
> *Habitat Improvement Goal - Understand and improve the instream and riparian habitat of the River to assure the ecological well being of the Cocheco River.*
>
> *Development and Stormwater Impact Goal - Minimize the impact of current and future development and infrastructure and associated stormwater impacts on the Cocheco River watershed.*

Multiple objectives were developed for each goal, and in total, over 80 actions were developed to achieve these objectives.

The following document, the Cocheco River Monitoring Plan 2006 – 2007, includes a summary of the impacts and pollutants that have been identified as important in the EQR and CRWRIP and provides guidance for collecting chemical, physical, and biological information to fill data gaps, understand long-term trends, and to quantify the impact of the restoration efforts described in the *Watershed Restoration and Implementation Plan for the Cocheco River*. As much of the data collected each year will be used to modify and plan following years sampling efforts, this plan was developed to specifically address year one and year two of sampling coinciding with initial restoration implementation – specifically 2006 and 2007. The plan can be used as a guide for the development of revised sampling programs for following years.

1.3 Current Environmental Conditions

From 1999 to 2003, volunteers and staff of CRWC collected and tested over 750 samples for water quality along the length of the Cocheco River. The 2005 *Cocheco River Environmental Quality Report* (EQR) (Fargo and Truslow, 2005) reviewed and analyzed the data collected from 1999 to 2003. The focus of study of the EQR was the analyses of dissolved oxygen, pH, bacteria, metals and nutrients data from a variety of reports and monitoring programs. These are overall indicators of water quality related to State water quality standards and were the analyses most often completed by CRWC volunteers during the five year water quality sampling history.

The following summary of water quality is excerpted from the EQR and the *Watershed Restoration and Implementation Plan for the Cocheco River*. The summary is based on the findings of the EQR, which includes information about the State's assessment of water bodies. A summary table of this information is included in Appendix A.

State of New Hampshire Water Quality Standards

The State of New Hampshire has water quality standards that provide the baseline quality that all surface waters of the State must meet in order to protect their intended uses. These standards are the "yardstick" for identifying where water quality violations exist. They also help determine the effectiveness of restoration and pollution prevention programs (NHDES, 2005). The standards are divided into three parts, which are

- designated uses,
- water quality criteria, and
- anti-degradation.

(1) Designated uses represent the desired uses that a water body should support. As shown in Table 1, there are seven designated uses that the water quality standards are intended to protect. These designated uses are: aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (e.g., swimming), secondary contact recreation (e.g., boating), and wildlife.
(2) Water quality criteria are designed to protect the designated uses of all surface waters and are expressed in either numeric or narrative form. A water body that meets the criteria for its assigned classification is considered to have attained its intended use (NHDES, 2005).
(3) The third and final component of the water quality standards is anti-degradation which includes the provisions designed to preserve and protect the existing beneficial uses and to minimize degradation of the State's surface waters. For example, anti-degradation applies to any proposed new or increased activity that would lower water quality or affect the existing or designated uses.

DES defines each designated use in the *2005 New Hampshire Consolidated Assessment and Listing Methodology (CALM)*. The following table was taken from that publication. It lists each use, definitions and the applicable surface waters for which assessments are completed.

Table 1 - Designated Uses of State Surface Waters

Designated Use (Applicable surface waters)	Department of Environmental Services' Definition
1. Aquatic Life (All surface waters)	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.
2. Fish Consumption (All surface waters)	Waters that support fish free from contamination at levels that pose a human health risk to consumers.
3. Shellfish Consumption (All tidal surface waters)	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.
4. Drinking Water Supply (All freshwater surface waters)	Waters that with conventional treatment will be suitable for human intake and meet state/federal drinking water regulations.
5. Primary contact Recreation (All surface waters)	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water (such as swimming).
6. Secondary contact recreation (All surface waters)	Waters that support recreational uses that involve minor contact with the water (such as boating or fishing).
7. Wildlife (All surface waters)	Waters that provide suitable physical and chemical conditions in the water and riparian corridor to support wildlife as well as aquatic life.

The New Hampshire Department of Environmental Services (DES) determines if surface waters of the State meet certain uses based on available data from DES monitoring efforts and other organizations' data. These determinations are made for what DES calls "assessment units or AUs." Each water body type in the State (river, stream, lake, pond, estuary, ocean) was divided into smaller segments, which are the AUs. AUs are the basic unit of record for conducting and reporting the results of all water quality assessments (NHDES, 2005). Each of the designated uses, with the exception of wildlife, has a methodology that is used to make an assessment decision. An assessment methodology for wildlife has not yet been developed.

When this study was initiated, it was agreed that the focus of work would be on the non-tidal main stem of the Cocheco River. The upper Isinglass River subwatershed was not included in the study as a Local Advisory Committee is now working on assessment and oversight of this area. The portion of the Isinglass River from the outflow of Bow Lake Dam in Strafford to its confluence with the Cocheco River in Rochester is now a "designated" river as defined by the New Hampshire Rivers Protection and Management Program (NHDES, 2006). The five subwatersheds covered in this report include the Upper Cocheco, Middle Cocheco, Axe Handle Brook, Lower Isinglass, and Lower Cocheco to the Cocheco Falls in Dover.

These subwatersheds contain 68 assessment units ranging from six in the Lower Isinglass to 21 in the Lower Cocheco. Each assessment unit (AU) is evaluated to determine if the designated uses are met for the River. Two of the seven uses were not assessed. The shellfish consumption use is not relevant in freshwater bodies. And, as mentioned

previously, an assessment methodology has yet to be developed for wildlife uses. The drinking water use was assessed for only one AU, which is the Rochester Reservoir in the Axe Handle Brook subwatershed. As is the case for all of the state's freshwater water bodies, the fish consumption use is impaired based on mercury contamination from atmospheric deposition. The three remaining uses were assessed for each AU, if data existed for the indicators needed to assess each use. The uses that are assessed for all subwatersheds include primary contact recreation, secondary contact recreation, and aquatic life. A complete listing of the AU's is included in Appendix A. The discussion and tables are divided by the subwatersheds included in the Cocheco Restoration Study Area. The locations of these subwatersheds are illustrated in Figure 1 and are shown in more detail in Figures 2 through 6. Figures are included at the end of the report after the References section.

Upper Cocheco

The Upper Cocheco does not meet the standards for aquatic life use in five of its nineteen AUs. The causes of this problem include low pH levels in four of the AUs (main stem of Cocheco and Mad River) and the presence of nonnative aquatic plants in Sunrise Lake. DES lists the sources of these impacts as unknown. Also, the standard for swimming (primary contact recreation) is not met for two AUs in the main stem of the river. DES lists the source of the bacteria as unknown. The EQR notes that failing septic systems are suspected in the area between Central and Spring Street as well as other areas in town.

Threats to water quality include sprawl and increasing residential and commercial development in outlying portions of Farmington, especially from inadequate on-site waste disposal systems. These factors, especially housing developments that encroach into sensitive riparian areas are also mentioned as threats to other natural resources.

Impairment	Causes	Sources
Aquatic life	pH & nonnative aquatic plants	unknown
Primary Contact Recreation	Bacteria	Failing septic systems

Axe Handle Brook

Axe Handle Brook does not meet the standards for aquatic life use in two of its nine AUs. The cause of the problem is low pH levels in Howard Brook and Baxter Lake. The reason for these low pH levels is currently unknown. The assessment unit for Howard Brook does not meet the standards for either primary or secondary recreation based on bacteria levels. The source of the bacteria is listed as livestock and indicates that livestock wastes are directly deposited or are carried to the brook by stormwater runoff. The threat to this subwatershed is the increase in residential development including the impacts from increased stormwater runoff and septic systems.

Impairment	Causes	Sources
Aquatic life	pH	Unknown
Primary Contact Recreation	Elevated bacteria	Livestock
Secondary Contact Recreation	Elevated bacteria	Livestock

Middle Cocheco

The Middle Cocheco does not meet the standards for aquatic life use in six of its thirteen AUs. These six AUs include parts of the Cocheco River main stem, Pokamoonshine Brook, Rattlesnake River, and the 50-acre AU at the City Dam. The causes vary but all have low pH values. Other causes include low dissolved oxygen, elevated aluminum levels, and poor results from habitat and biological surveys, in addition to nonnative aquatic plants present at the City Dam. The EQR notes that the elevated aluminum levels may derive from a combination of natural causes and analytical technique. These aluminum levels may also be a result of sedimentation from stormwater runoff.

The upper most assessment unit in this subwatershed is impacted by the groundwater discharge to the river in the vicinity of the Farmington and Cardinal landfills. DES is in the process of conducting a total maximum daily load (TMDL) analysis for the Farmington wastewater treatment facility and is also investigating the infiltration of contaminated groundwater into the Cocheco River down gradient of the Cardinal and Farmington landfills. Groundwater monitoring has shown elevated nitrate and biological oxygen demand (BOD) down gradient of the septage lagoons at the Farmington landfill. Concentrations of these contaminants have been observed to increase during dryer seasons and decrease during wetter seasons.

The EQR illustrates that changes in pH and dissolved oxygen appear to be linked. This relationship suggests that correcting the problems manifested in impaired dissolved oxygen levels may also improve what appears to be a problem with pH levels in the Cocheco River.

The EQR also described degraded stream and riparian habitat based on a survey conducted by EPA in 2001. The surveyed section of the River at Little Falls Bridge

reportedly had a good number and diversity of macro-invertebrate organisms, but received low scores overall due to a degraded riparian buffer, namely poor riparian vegetative cover, poor bank stability, and excess sedimentation.

Primary contact recreation is impaired in four of the assessment units, which include the upper main stem, Pokamoonshine Brook and two middle portions along the Middle Cocheco subwatershed. Boating, or secondary contact recreation, is not supported in the upper main stem of this portion of the Cocheco River. The recreation uses are not supported based on elevated bacteria levels. The source is currently listed as unknown.

The EQR notes that illicit discharges into the storm drainage system and cross connections of storm and sanitary sewers are suspected to exist in the older downtown sections where infrastructure is aging. Another persistent site for elevated bacteria levels is 23-Cch. While various sources are suspected more investigation is needed to identify the sources. The EQR states that the seasonal camps at the Rochester Fairgrounds are not serviced by a properly constructed septic system or by the City sewer system. Efforts are underway to remedy the situation. In addition, manure storage at the fairgrounds is not adequate. Fairgrounds management has also sought funds to construct functional manure storage facilities.

Impairment	Causes	Sources
Aquatic life	Low pH, low dissolved oxygen,	pH & DO = suspected to be landfills & WWTF/lagoon discharges
	Elevated aluminum,	Al=natural causes, stormwater sedimentation
	Poor results from habitat & biological surveys, non-native aquatic plants	Habitat & biological surveys=poor riparian vegetative cover, poor bank stability and sedimentation
Primary Contact Recreation	Elevated bacteria	Possible illicit discharges and cross connections Failing septic systems Animal waste
Secondary Contact Recreation	Elevated bacteria	Same as above

Lower Isinglass

The Lower Isinglass does not meet aquatic life uses in one of its six AUs. The cause of the problem is low dissolved oxygen levels in the main stem of the Cocheco River. The source of the impact is listed as municipal point source. The AU of the Cocheco River at the Gonic Pond dam also does not meet the standards for primary contact recreation based on bacteria levels exceeding the standard and the source are listed as unknown.

Impairment	Causes	Sources
Aquatic life	Low dissolved oxygen	Municipal point source
Primary Contact Recreation	Elevated bacteria	Unknown

Lower Cocheco

The Lower Cocheco contains twenty-one assessment units and four do not meet the aquatic life use. The cause of the problem is low pH levels in the main stem including the areas behind the Waldron Dam and the Central Avenue Dam and the source is listed as not known.

The EQR states that the largest uncontrolled landfill in Dover is the former municipal landfill on Tolend Road. Groundwater seeps along the bank of the River, associated with the so-called eastern plume (subsurface contamination) is impacting the river's quality. On the positive side, the EQR notes that the fish diversity and population represented at the Cocheco Falls fish ladder in Central Dover is superior to that found at other fish ladders in coastal New Hampshire. The greatest threat to spawning habitat is low water levels. Dissolved oxygen and temperature, which can be related to water depth, are also major factors in fish habitat quality.

Primary contact recreation is not being met in two of the twenty-one assessment units based on elevated bacteria levels. One of the two AUs is located in the upper portion of the subwatershed on the main stem and the other is a 20- acre AU above the Central Avenue Dam. The source of the elevated levels in the AU near sampling site 10-Cch is unknown but illicit discharges into storm drain systems are listed as the source for the Central Ave Dam AU. The EQR also notes that there are known septic system failures in the Reyners Brook drainage area. The City of Dover is pursuing funds to extend sewer to this area.

Impairment	Causes	Sources
Aquatic life	pH	Unknown, Tolend Rd landfill discharge suspected Low water levels
Primary Contact Recreation	Elevated bacteria	Illicit discharges and possible cross connections Failed septic systems

Watershed-wide Water Quality Issues

Toxic metals

Although impairments caused by toxic metals are not documented, with the exception of the aluminum impairment in the Middle Cocheco, the EQR shows that copper and lead are potentially toxic metals that appear to occur at elevated concentrations at various sampling locations along the river. Sources are suggested to include discharges from wastewater treatment facilities, usually attributed to corrosion of household plumbing fixtures**.** Fish tissue samples collected statewide by the USEPA and DES show elevated mercury levels. This is thought to be largely a result of air pollution from power plants and incinerators. Air pollution reaches the ground during precipitation events, which is ingested by fish through their gills and mouth.

Threat	Causes	Sources
Aquatic life	Toxic metals	Wastewater treatment plant effluent
Fish Consumption	Elevated mercury levels	Atmospheric pollution

Nutrients

Nitrogen and phosphorus compounds are considered to be nutrients. When dissolved in surface water, these compounds provide aquatic plants with the food (nutrients) to thrive, and sometimes overtake ponds, wetlands, streams and rivers. Similar to land application of these compounds on crops and gardens (fertilizer), some nutrients are absolutely necessary to healthy plants, but too much can damage surface water environments. Excess nutrients can lead to vegetative blooms that damage riparian (stream and river) ecosystems and can eventually deplete dissolved oxygen from surface waters. Excessive concentrations of certain nutrient compounds (in particular, nitrite) can also cause harm to humans if ingested.

Phosphorus is often the limiting nutrient in freshwater aquatic systems. That is it is often in short supply compared to other nutrients and therefore surface waters are often more sensitive to excess phosphorus than excess nitrogen. The source of excess nutrients can be from wastewater treatment plant discharge, failed septic systems or direct discharge of septage to surface water. In addition, sediment erosion, pet and livestock animal waste runoff, excess fertilizer runoff from agriculture and landscaping can also be a cause of increased nutrients. Along the Cocheco, it was phosphorus that exceeded DES standards in over 60% of samples taken. Nitrogen exceeded limits in only 11% of samples. Future sampling and analysis of these excess nutrients requires more attention to pinpoint and reduce sources of this contaminant.

Threat	Causes	Sources
Aquatic Life	Phosphorus concentrations increase and result in algae blooms and low dissolved oxygen	Removal of riparian buffers Wastewater treatment plant discharges. Agricultural and pet waste runoff. Fertilizers from households and agricultural uses.
Primary & Secondary Recreation	Phosphorus concentrations increase and drive algae blooms and increases in aquatic weeds	Same as above

Riparian and Aquatic Wildlife

As mentioned previously, DES does not conduct an assessment for wildlife use at this time**.** The habitat of the Cocheco River corridor and its tributaries has not been widely studied, but it is beginning to receive more attention. New Hampshire Fish and Game Department (NHFG) keeps records of fur bearing mammals trapped and deer hunt totals each year. This survey indicates a healthy population of mammals ranging in size from mink to deer. NHFG also tracks the amount of fish returning to the ladder at Cocheco Falls in Dover. Of these species, river herring (alewives and blue back herring) were the most abundant. In 2004, over 70,000 fish were counted on their return upstream. Challenging upstream habitat can limit the success of these fish, especially shallow waters and areas of the river containing low dissolved oxygen.

The EQR mentions that the NHFG conducted a habitat quality mapping project recently and once available, these maps will provide much needed information about terrestrial habitat. Fragmentation of habitat is a rapidly growing problem. The Society for the Protection of New Hampshire Forests (2005) reports that substantial land conversion from forest and farmland to developed uses is now occurring along and between the State's major transportation corridors including Route 16 (Spaulding Turnpike). SPNHF also reports that New Hampshire is gradually losing the values provided by extensive forests, including their contribution to wildlife habitat, losing about 17,500 acres per year largely to development. Forest blocks big enough to support significant wildlife habitat are already sparse in the Seacoast (SPNHF 2005), meaning preservation of the remaining forests is critical for protecting habitat and wildlife.

A study conducted by USEPA at the Little Falls Bridge in Rochester showed several factors to be compromising the health of the river in this location. Of these factors, lack of protective plants along the rivers edge, erosion of the stream bank and sediment deposition in the water affected the health of that section of river the most. Based on knowledge of stream condition in other areas, this is a common problem on the Cocheco. Recent studies have shown that valuable habitats and biological communities occur along

the Cocheco River. Special protection measures will likely be required to safeguard these and surrounding areas of the river.

Threat	Causes	Sources
Wildlife	Habitat fragmentation Loss of riparian vegetation Erosion of stream banks Sedimentation	Development along transportation corridors Conversion of forest lands to developed uses Removal of buffers along headwater streams and the main stem of the river.

Solid Waste Dumping

The banks of the Cocheco have been a dumping place for some time. Historically, landfills were located along the river's edge in Dover, Rochester, and Farmington and contributed to contamination of the River. All of these areas, but the municipal landfill in Farmington, have now been closed. Dumping of household debris and other refuse along small tributary streams and the Cocheco River corridor has also long been a problem. This is especially true in areas where stream banks are steep and the river is generally out of sight of everyday automobile and pedestrian traffic. CRWC has engaged citizens and towns in several cleanups since 1997, collecting a total of approximately 5,745 pounds of materials. This problem will continue to receive attention as part of restoration as it is a visible sign of stewardship of the river.

Impairment	Causes	Sources
Wildlife	Riparian habitat destruction	Dumping of household debris on banks Dumping of debris from businesses

Stormwater Runoff

The population of the Cocheco River watershed is expected to increase by over 20% in the next 20 years. Populations are projected to increase by twelve percent (12%) in Dover and up to fifty-eight percent (58%) in New Durham from 2000 to 2020 (Fargo and Truslow, 2005). As development increases along the river, the amount of paved area and building covering the ground will increase correspondingly.

These hard surfaces where water cannot easily absorb into the ground are referred to as *impervious surfaces*. As impervious surface area increases, stream water quality and habitat impacts are observed (USGS, 2005). Impervious cover as low as seven percent (7%) of total land area can affect the quality of the receiving water and aquatic habitats (USGS, 2005). The EPA states that excessive polluted stormwater runoff is one of the most difficult impacts of urbanization to control and correct (EPA, 2005). And, DES lists stormwater as the State's number one priority nonpoint source (NHDES, 1999).

Water quality impairments in the watershed do not explicitly mention stormwater as a source; however several of the sources for aquatic life and recreational use impairments are listed as "unknown." There has not been a study or monitoring program done to measure the impacts of stormwater on the water or habitat quality in the watershed.

The subwatersheds have varying degrees of impervious cover. Truslow and Fargo (2005) state that the amount of developed land could double in the next twenty years, based on regional planning estimates. Development, particularly the creation of impervious surfaces, increases the rapidity with which precipitation or stormwater runs off the developed areas. As impervious surfaces approach the seven to 14 percent coverage of these watersheds, water quality and habitat impacts are very likely.

Current stormwater pollutant load estimates for each subwatershed are listed below. Estimates were calculated based on the Simple Method (CWP, 2000). More information about how the pollutant loads were calculated is provided *Watershed Restoration and Implementation Plan for the Cocheco River* (Truslow, 2006). The Simple Method was used to calculate stormwater pollutant load estimates for bacteria, total suspended solids (TSS) and total phosphorus. The information needed to use the Simple Method includes subwatershed drainage area, impervious cover area, stormwater runoff pollutant concentration and annual precipitation. Pollutant loads are estimated as a product of annual runoff volume and pollutant concentration. In the Simple Method, the runoff coefficient is calculated based on the percentage of impervious cover in the subwatershed. As such, the subwatersheds with the higher percentage of impervious cover yielded greater pollutant loads.

Table 2
Estimated Annual Bacterial, Total Suspended Solids and Phosphorus Load

Subwatershed Name	Area (Acres)	Approximate % of Impervious Surface, 2000	Estimated Annual Load of Bacteria (billions of colonies)	Estimated Annual Load of TSS (lbs)	Estimated Annual Load of Phosphorus (lbs)
Upper Cocheco	27,616	1.5	141,415	20,319	108
Axe Handle Brook	7,396	1.0	37,045	5,242	25
Middle Cocheco	31,905	4.7	636,333	88,703	517
Lower Isinglass	14,593	3.1	250,120	34,280	147
Lower Cocheco	16,146	12.0	1,049,605	148,799	790

Based on these calculations, the Lower Cocheco subwatershed contributes the greatest pollutant load for all three parameters. In addition, the Lower Cocheco watershed area contributes almost double the load for bacteria and TSS when compared to the Middle Cocheco, the subwatershed with the next highest pollutant load. The percentage of impervious cover is estimated at 12% in the Lower Cocheco, which exceeds the percentage at which water quality impacts to streams are typically observed (10%). The Middle Cocheco impervious cover percentage approaches the threshold range of 10% where research indicates that the most sensitive functional stream elements are lost from the system (USGS, 2005 and Zielinski, 2002).

The USEPA began to focus on stormwater contamination as part of the Federal Water Quality Act of 1987. In 2003, municipalities of a certain size (called MS4s) were

required to address reduction of stormwater runoff and improvement of stormwater quality. Both Rochester and Dover are considered MS4 communities by the USEPA, based on the size of their separate storm sewer systems. Farmington is not considered an MS4 community and is therefore not required to initiate these activities by law at this time. Dover and Rochester are required to reduce the discharge of pollutants to the maximum extent practicable in the urban centers, protect water quality and meet the requirements of the Clean Water Act. This means that the best management practices used by the community must not create an impairment of use or further degrade an impaired water body.

Threat	Causes	Sources
Aquatic life	Polluted stormwater and increased stormwater volume. Decreased base flows. Scouring and incision of streambed. Unstable banks.	Uncontrolled and untreated stormwater from development (existing and new).
Primary Contact Recreation	Elevated bacteria	Untreated stormwater from development (existing and new.)
Secondary Contact Recreation	Elevated bacteria	Same as above

Additional work will be required to design low impact developments and stormwater systems and to retrofit systems for existing development. Low impact development (LID) methods and innovative stormwater treatment designs are being tested and implemented in the U.S. and other countries. The efforts within the Cocheco watershed can incorporate good stormwater management practices, LID and other innovative practices in order to limit the impact of this growing source of contamination to surface water.

1.4 Gaps in Water Quality Data

While past water quality monitoring has evaluated water quality along the main stem of the River in over 27 locations, many waters have not been assessed by the State based on a lack of data or in the case of use by wildlife, a lack of an assessment method. For example, only four of the twenty-one AUs in the Lower Cocheco have been assessed for aquatic life use. This means that there is a large gap in our understanding of how healthy the river is in this subwatershed, especially in terms of it ability to support aquatic organisms. The monitoring plan recommends new and enhanced environmental monitoring to fill data gaps with the goal of assessing all the water bodies for the designated uses. Because of the amount of work required to assess all of the AU's, there will be a deliberate effort to incrementally increase the sampling to eventually sample all of the assessment units. A complete list of the AUs and the associated impairments is located in Appendix A.

Section 2 – Development of the New Cocheco River Monitoring Program

2.1 Current Monitoring Program

The Cocheco River Watershed Coalition (CRWC) has been conducting regular monitoring along the Cocheco River since 1999. Table 3 lists the 27 points that have been monitored to date and Figure 1 shows the locations of these monitoring points. The CRWC Project Coordinator, Lorie Chase, directs the monitoring. Sampling and monitoring is primarily carried out by CRWC volunteers according to DES Volunteer River Assessment Program (VRAP) guidelines. Each May, new volunteer monitors are trained and veteran monitors receive refresher training. The sampling season includes the months of June, July, August, September, and October.

Samples are taken every two weeks (bi-weekly) at the baseline sites during the sampling season. At each monitoring location the basic field parameters, pH, specific conductance (SC), water and air temperature, dissolved oxygen (DO) and turbidity are measured at during each sampling episode. In addition, monthly samples are collected for laboratory analysis of *E. coli*. Samples are also analyzed for nutrients and metals as funding allows. Other monitoring activities that have been conducted by CRWC include biological assessments, solid waste surveys and buffer assessments.

2.2 Questions to be Answered by Cocheco Monitoring Program

In order to accomplish the goals and objectives developed as part of Cocheco River restoration planning, many monitoring actions were developed to enhance the existing data and to answer questions about pollutant trends and sources. Answering questions about sources of water quality degradation, determining how current land use effects water quality, and determining the current condition of the habitat and riparian buffers of the Cocheco watershed is essential to successful restoration. Monitoring will also document the changes in water quality due to restoration activities. The questions that were asked in the development of the *Cocheco River Watershed Restoration and Implementation Plan* (CRWRIP) are as follows:

- What is the source of bacterial contamination detected in the urban Farmington portion of the Upper Cocheco River subwatershed?
- What are the causes of depressed pH in the Upper Cocheco, Axe Handle Brook, and Middle and Lower Cocheco River subwatersheds? Is the depressed pH linked to fluctuations in dissolved oxygen levels (DO) or increased biological oxygen demand (BOD) in these areas?
- What is the best method of removing and thereafter preventing the invasion of non-native aquatic plants in Sunrise Lake, other Upper Cocheco lakes and ponds, and the Middle Cocheco River?
- What other areas in the river watershed are affected by nuisance aquatic species?
- What is the extent of bacterial contamination in the Axe Handle Brook subwatershed and what is the best approach for the cleanup of the source areas?

Table 3
2005 Cocheco River Sampling Locations and Descriptions -
Cocheco River Watershed

Sample Location	Sampling Point Decription	Municipality	Sampling Frequency and Organization	Distance from Estuary (miles)	Sample Point Elevation (ft. above mean sea level)
07-CCH	Central Avenue Bridge	Dover	Regular - CRWC	0.41	37
07'-CCH	Chestnut Street Bridge	Dover	Occasional-CRWC	0.55	37
09-CCH	Fourth Street Bridge	Dover	Occasional-CRWC	1.01	38
10-CCH	Whittier Street Bridge	Dover	Regular - CRWC	tbd	tbd
10A-CCH	Upper Factory Road	Dover	Occasional-CRWC	2.78	70
11-CCH	Watson Bridge Road	Dover	Regular - CRWC	3.85	108
12-CCH	Strafford County Farm	Dover	Regular - CRWC	6.31	112
13-CCH	Below Confluence with Isinglas River	Rochester	Occasional-CRWC	8.24	118
15-CCH	England Road at Waste Management Landfill	Rochester	Occasional-CRWC	10.10	122
16-CCH	Rochester Waste Water Treatment Plant (Gonic)	Rochester	Occasional-CRWC	12.10	135
18-CCH	Maple Street Bridge (Gonic)	Rochester	Occasional-CRWC	13.02	175
19-CCH	Route 125 Bridge	Rochester	Regular - CRWC	14.68	178
21-CCH	North Main Strett Bridge (202A)	Rochester	Regular - CRWC	16.96	220
22-CCH	Little Falls Bridge	Rochester	Regular - CRWC	21.33	225
22J-CCH	Abanonded Bridge Behind CMC	Farmington	DES only	23.87	232
22S-CCH	Downstream of Confluence with Rattlesnake River	Farmington	DES only	25.65	238
22U-CCH	Pike Industries Bridge	Farmington	Regular - CRWC	25.93	243
23-CCH	Watson Corner Road Bridge (Now called Cocheco Road)	Farmington	Regular - CRWC	26.69	250
01-POK	Pokamoonshine Brook at Confluence	Farmington	DES only	27.05	255
23D-CCH	Upstream of Confluence with Pokamoonshine Brook	Farmington	DES only	27.05	257
23S-CCH	Upstream of Farmington Wastewater Treatment Plant outfall	Farmington	DES only	27.96	258
25-CCH	South Main Street Bridge	Farmington	Occasional-CRWC	28.53	260
00-MAR	Mad River at Confluence with Cocheco	Farmington	Occasional-CRWC	28.98	273
26-CCH	Central Street Bridge (Route 25)	Farmington	Regular - CRWC	29.13	275
04-ELA	Ela River at Confluence	Farmington	Occasional-CRWC	29.21	278
27-CCH	Spring Street Bridge	Farmington	Occasional-CRWC	29.85	310
28-CCH	Main Street/Old Bay Road Bridge	Farmington	Occasional-CRWC	30.99	395
29-CCH	Middleton Road Bridge	Farmington	Occasional-CRWC	35.10	695

CRWC - Cocheco River Watershed Coalition
DES - New Hampshire Department of Environmental Services
Occasional - Sampled for special projects or infrequently

- What is the condition of the riparian buffer and aquatic habitat along the main stem and tributaries to the Cocheco River. What buffer areas should be restored?
- Where are the exemplary natural communities in the watershed and are they impacted by land use or water quality?
- What is the extent and source of anomalous BOD, pH and temperature along the main stem of the Cocheco?
- What is the extent and source of aluminum, copper and lead contamination in the Middle Cocheco subwatershed?
- Where are nitrogen and phosphorus levels elevated and what is the source? What negative impacts do elevated nutrients have on the aquatic ecosystem of the Cocheco?
- What is the extent of illicit sewer discharge to the river and its tributaries?
- How are stormwater runoff and increased impervious surface cover impacting the quality of the Cocheco River Watershed? What are the major sources of this contamination type?
- Are active and closed landfills affecting water quality in the Cocheco River?
- What is the extent of dumping along the Cocheco River? How can CRWC help to clean up and limit future dumping?
- What positive and negative impacts are generated from agricultural land use along the Cocheco River?
- How are biological and chemical changes and aquatic system health linked along the Cocheco River?
- How have improved waste disposal and commercial/industrial land use practices harmed or improved the water quality of the Cocheco River Watershed?
- What is the water quality of the Cocheco River tributaries and sections of the river that have not yet been assessed according to DES guidance?

Appendix B lists the monitoring-related actions developed as part of the CRWRIP that will be carried out as part of the new monitoring program. The existing monitoring program emphasizes evaluation of water quality, riparian buffer and stream habitat. The emphasis of the program will still be ultimately based on routine monitoring of water quality; however a variety of factors besides water quality will be surveyed or sampled in order to understand the river environment as a whole. The modified 2006/2007sampling program will include the following:

- Water Quality Monitoring
- Biological Monitoring
- Solid Waste Surveys
- Habitat Assessment Surveys
- Septic System Failure and Illicit Discharge Detection Surveys
- Land Use Change Monitoring
- Stormwater Structure Surveys
- Road Crossing/Obstacle Surveys
- Pre- and post- restoration project monitoring and documentation

2.3 New Assessment Unit Sampling Points

One purpose of the revised monitoring program is to increase sampling in areas that have not yet been assessed for designated use support, e.g., swimming and boating. As part of the new monitoring program development, supplemental monitoring points were chosen along the main stem of the Cocheco River and many of its tributaries. The portion of the Cocheco River Watershed addressed in this plan is nearly 102 square miles. To date much of the main stem of the Cocheco River has been monitored and several tributaries have also been intermittently sampled. A long-term objective of the restoration plan is to evaluate the water quality and attainment of designated uses for each assessment unit (Action WQR-23).

There are a total of 68 assessment units in the watershed study area, and currently less than 14 of these are being sampled on a regular basis. In addition to the work being conducted by CRWC, the Volunteer Lakes Assessment Program through DES is currently involved with monitoring of Sunrise Lake in Middleton and Baxter Lake in Farmington and Rochester. Most of the regular monitoring is on the main stem of the Cocheco. In the summer of 2005, the CRWC project coordinator, the DES VRAP coordinator, and the authors of the EQR and *Restoration and Implementation Plan* designated additional sampling locations especially on tributary streams in the upper watershed and in urban areas that had not been previously monitored. Over 30 new points were established to provide a monitoring point within each AU at a location that could be easily accessed for sampling. Figures 2 through 7 show the existing and new monitoring locations within each subwatershed. Appendix B includes the names and locations of all the existing and new monitoring points in the Cocheco River watershed and the AU for each point. Some AU's have not yet been given an AU number as noted in the appendix table.

2.4 Cocheco Focus Areas 2006 & 2007

Since the Cocheco River Watershed Study area is over 102 square miles and less than 40% of that area has been regularly monitored or studied, expansion of the monitoring program will proceed incrementally and focus on certain areas where the priorities are greatest or where recent data collection has suggested that further study is warranted. This section contains descriptions of these focus areas, previous work and findings and the work that will be completed in these areas. The focus areas for the first two years of monitoring include the following:

- Mad River in Farmington and New Durham;
- Cocheco River main stem and tributaries in downtown Farmington;
- Cocheco River main stem, Lower Isinglass River, and Willow Brook in Rochester, and
- Berry Brook in Dover.

Mad River –Farmington

The Mad River is within the Upper Cocheco River subwatershed and is within the NHRIV600030601-08 Assessment Unit. It is one of the most pristine tributaries of the Cocheco River watershed and changes character from a headwater stream with a steep gradient in New Durham and upper Farmington to a more moderate gradient stream as it approaches downtown Farmington. Two sampling points were monitored for water quality on the Mad River in 2005. In addition, biomonitoring with rock baskets was completed at one of the sampling locations in 2005 by DES and CRWC.

In 2006 and 2007 the following actions from the *Watershed Restoration & Implementation Plan* will be implemented on the Mad River. Monitoring to evaluate the historic anomalous DO, pH, and BOD levels (**WQR-1), e**stablishment of monitoring stations to provide information about the links between physical, chemical and biological changes (**HI-6)**, and surveys to identify failed septic systems (**WQR-4)**.

In order to look at the tributary as a whole, the physical characteristics of the Mad River watershed will be monitored and the changes that have taken place along the river in the suburban and urban areas will be evaluated. With the help of VBAP (NHDES-VBAP,2006), two stream reaches will be surveyed using the habitat assessment parameters provided by DES (Appendix D). A location will be chosen for flow monitoring and a stage-rating curve will be established for that location. This station may also be equipped with an instream water quality data logger by the DES ambient water quality team to better understand temporal changes in water quality in May or June and again in September. This evaluation will be especially helpful in determining optimum sampling times and relationships for DO and pH. DES plans to re-sample the biological community in the Mad River using rock baskets as well in 2006.

A total of 4 locations – 00-MAR, 01-MAR, 02-MAR, and 03-MAR will be sampled for field parameters, *E. coli*, and BOD. Field measurements and samples for E. *coli* analysis will be collected three times and samples for BOD analysis will be collected twice. Bacteria samples will be collected three times at each location to allow for a geometric mean to be calculated as required in the 2005 CALM.

Cocheco Main Stem – Farmington

Water quality in the Farmington portion of the main stem has been affected by failed septic systems, illicit discharges and untreated stormwater. Like the Mad River described above, Actions **WQR-1, WQR-3** and **WQR-4** will all be implemented in this area. In addition, nutrient levels will be monitoring to provide an understanding of nutrient concentrations at various locations (**WQR-9**) will also be emphasized in this area. Considerable attention is being focused on Farmington due to its aging infrastructure. Projects to identify failed septic systems and illicit discharges is now underway by DES and the town. Also, work is being done in several areas to correct stormwater runoff and

erosion problems. Additional routine sampling will add considerably to the existing water quality database and help determine source areas of pollutants.

Nine new monitoring points along the main stem, in addition to the baseline sampling locations in Farmington, will be added in 2006 and 2007 as shown in Table 6. Analyses will include *E. coli*, BOD, and nutrients and field parameters will be measured. Kick net biomonitoring will also be completed at one location on the Ela River. The *E. coli* sampling will be completed three times to allow for a geometric mean as per the CALM (NHDES, 2005).

Cocheco Main Stem, Lower Isinglass River, and Willow Brook – Rochester

CRWC and the City of Rochester will work closely to accomplish evaluation and cleanup work along the Cocheco and its tributaries in Rochester. In addition to the Water Quality Actions listed above, the projects in this area will also include the Survey of nuisance aquatic species (**HI-7)**, Solid waste surveys (**HI-10)**, and Surveying and removing obstacles to flow (**HI-10**).

In this area, seven additional stations will be added in addition to the baseline sampling locations. On the Lower Isinglass River attention will be focused on understanding the BOD, pH, and DO relationships where unusually low DO has been previously detected. The instream data loggers will be used at one sampling location in the Lower Isinglass in May or June and September to determined temporal relationships as on the Mad River. In addition rock baskets will be placed by DES in this location to further establish the quality of the aquatic ecosystem.

On the main stem, metals will be analyzed to determine source areas and to better establish a baseline in this area. Aluminum, copper and lead analyses will be conducted in four locations. Two stations will be sampled on Willow Brook, in an urbanized section of Rochester, to establish a water quality baseline in this location. All stations will be sampled for *E.coli* three times to establish a geometric mean for assessment. A flow monitoring station may also be established on Willow Brook if conditions allow.

Berry's Brook – Dover

Two sampling stations will be added on Berry Brook in Dover. This urban stream will be sampled for field parameters, *E. coli* and BOD. The physical parameter suite will also be assessed and a stream gauging station may be established. Restoration of certain sections of Berry Brook will be initiated in 2006 and 2007 by the City of Dover, CRWC, DES and the UNH Stormwater Center. This sampling will provide excellent information on water quality changes as a result of these efforts. Biomonitoring with kicknets may also be continued at this location in 2007.

Lower Cocheco River - Dover

In the Lower Cocheco River in Dover, kick net biomonitoring will be conducted near the Whittier Street Bridge upstream of the downtown area. Rock basket sampling may also be added in future years if funding allows.

Section 3 – Cocheco River Monitoring Plan

3.1 Introduction

This plan describes the baseline monitoring suggested for long-term trend analysis, designated use assessments and pollution source identification. While many monitoring activities are considered routine, some will involve limited sampling in select areas. The CRWC should review this plan and the data following the first two years of monitoring to determine what areas of the watershed need more attention and identify the resources that can be shifted to support the collection of new information.

The routine water monitoring activities that have occurred since 1999 will continue with the addition of an increase in the number of sampling locations and sample collection frequency plus additional types of monitoring such as benthic macroinvertebrate sampling and biological oxygen demand analysis (Appendix C). The plan will allow for more watershed wide analysis of environmental conditions. In addition, the frequency of monitoring will be increased at certain stations to provide more statistical strength to the data analysis while providing enough data for designated use assessments to be made in accordance with State methods described in the DES CALM document (NHDES, 2005).

Water quality sampling will be carried out under the DES Volunteer River Assessment Program described below. CRWC volunteers in association with other governmental and non-governmental organizations will carry out the remaining monitoring tasks. Locations of monitoring points referred to in the text are illustrated in Figure 2 through 7 and listed in Appendix C.

3.2 Volunteer River Assessment Program (VRAP)

The Cocheco River Watershed Coalition has been part of the VRAP program since 1999. The DES Watershed Management Bureau administers this program. DES supplies the training, sampling protocol, equipment and guidance to organizations and their volunteers to measure water quality. VRAP also provides quality assurance and quality control guidance through training and assessment of the collected data. The additional monitoring tasks outlined in the section below will be in addition to the current baseline VRAP monitoring conducted by CRWC.

The data collected under the auspices of VRAP are incorporated into the DES Environmental Monitoring Database. This information is ultimately uploaded to the Environmental Protection Agency's (EPA) database, STORET. These data are used in DES reports to EPA every two years required as part of the Clean Water Act Section 305(b). The DES recently issued a summary of the 2005 monitoring data for the Cocheco River (DES, 2006). This report and the Environmental Quality Report (EQR) (Fargo & Truslow, 2005) that summarizes data collected from 1998 to 2003 are referenced throughout the following sections.

3.3 VRAP Water Quality Monitoring in the Cocheco River Watershed

The VRAP program for the Cocheco River Watershed will include collection of samples for the field parameters suite as well as bacterial indicator species (*E. coli)* and biological oxygen demand (BOD), the dissolved metals aluminum, copper, and lead, and the nutrients phosphorus and nitrogen. The VRAP program will also include evaluation of physical characteristics including stream morphology, stream bank characteristics, and stream flow in selected locations.

CRWC will continue to provide volunteer VRAP monitors and coordination for all sampling activities. Volunteer monitors will go through VRAP training each May (in 2006 on May 11) with training updates as the season progresses, and will complete sampling in accordance VRAP protocols as per the EPA-approved VRAP Quality Assurance Project Plan. Sampling will begin in late May and continue through September.

CRWC will assemble all data for submittal to DES. This information will be used in the biennial reports to the EPA and will be evaluated using the DES Consolidated Assessment and Listing Methodology (CALM).

3.4 Monitoring Suites

Table 4 illustrates the monitoring activities as organized by Monitoring Suite. A suite is a collection of analyses that either evaluates the same class of pollutant (e.g., bacterial suite) or is collected similarly (e.g. field parameter suite). The analyses will be used to understand several facets of river environmental quality. The table also lists which activities will be completed during years one and two of monitoring plan implementation – 2006 and 2007. The monitoring activities are described below according to their program type and suite designation. Also included in this section is the method of analysis, laboratory and approximate schedule for 2006 sampling. Table 5 lists proposed sampling points for 2006 and 2007. The baseline sampling points are those that have been sampled regularly since 1999. Supplemental sampling points are those that have been added since 2005 or will be added in 2006 and 2007.

Field Parameter Suite

Description: Field measurement of dissolved oxygen, pH, specific conductance, temperature, and turbidity will be completed at each water quality sampling location each time a sample is taken. These basic water quality characteristics reveal a great deal about the overall quality of the water and aquatic habitat at a given location and apply to all water quality restoration actions.
Analysis: Measurements will be made using equipment initially calibrated by DES and maintained and further calibrated by VRAP volunteers. This year a set of instrumentation will be purchased by CRWC through a grant from the New Hampshire Coastal Program. Another set of field parameter instruments will be loaned to CRWC through the VRAP program and will be shared with the Isinglass River sampling team.

Table 4
Summary of Monitoring Program -2006 and 2007

Monitoring Suite	Indicator	Coordinating Agency	Related Action Plan(s)	Baseline Stations (See Table 6)	AU Supplemental Stations (see Table 6)	Other Sampling Locations	Frequency
Bacterial	Biological Oxygen Demand	VRAP	WQR-1	All stations	All supplemental stations		2x per season - baseline and supplemental sites
Bacterial	*E. coli*	VRAP	WQR-3, WQR-4	All stations	All supplemental stations		4x - baseline 3x supplemental
Bacterial	Failed Septic System Survey	CRWC	WQR-4			Mad and Ela River traverse	1x per season
Bacterial	Illicit Discharge Surveys	DES	WQR-5 & WQR-6			Farmington - 2006: Rochester 2007	1x per season
Bacterial	Water Quality Improvement Monitoring	DES	WQR-8			Areas of corrected infrastructure	
Biological	Buffer Data Review and Surveys	DES	HI-4			Main Stem	2006
Biological	Rock Basket/ Kick Net Aquatic Invertebrate Survey	DES	HI-6			Rock baskets - 2 locations, Kick nets up to 10 stations	1x per season
Biological	Shoreline Protection Violation Survey	CRWC	DSI-7				to be determined
Biological	Nuisance Aquatic Survey	Weedwatchers	HI-7			Rochester	2006
Biological	Wildlife Obstacle Survey	CRWC	HI-11				2006
Biological	Identify Exemplary Natural Communities	NH Audubon	HI-3				to be determined
Biological	Historic Fish Species Survey	NHFG	HI-21			Watershed wide	to be determined
Field	Dissolved Oxygen	VRAP	WQR-1	*	All		All
Field	pH	VRAP	WQR-1	*	All		All
Field	Specific Conductance	VRAP	All WQR actions	*	All		All
Field	Temperature	VRAP	WQR-1	*	All		All
Field	Turbidity	VRAP	WQR-12	*	All		All
Metals	Aluminum	VRAP	WQR-14	*			2x per season
Metals	Copper	VRAP	WQR-14	*			2x per season
Metals	Lead	VRAP	WQR-14	*	13-CCH, 15-CCH, 16-CCH, 18-CCH		2x per season
Nutrients	Nitrate	VRAP	WQR-9	*			2x per season
Nutrients	Total Phosphorus	VRAP	WQR-9	*	00-MAR, 04-ELA, 01-POK, 01-AXE, 03-AXE, 00-AXE, 23U-CCH, 25-CCH, 26-CCH, 27-CCH, 28-CCH, 29-CCH		2x per season

Table 4
Summary of Monitoring Program -2006 and 2007

Monitoring Suite	Indicator	Coordinating Agency	Related Action Plan(s)	Baseline Stations (See Table 6)	AU Supplemental Stations (see Table 6)	Other Sampling Locations	Frequency
Physical	Culvert and Obstruction Surveys	DES	HI-11		Farmington - 2006; Rochester 2007		To be determined
Physical	Flow measurements	CRWC	HI-6	To be determined	To be determined		1x per season
Physical	Stream morphology and bank Characteristics	VBAP, CRWC	HI-6	All	All		1x per season
Physical	Solid Waste Survey	CRWC	HI-10	All	All	Main Stem and tributary traverse Rochester 2006; Farmington 2007; Dover 2008	Repeat every 3 years
Physical	Research permitted withdrawls	CRWC	WQR-15			All Subwatersheds	
Stormwater	Data Review	UNH Stormwater Center	WQR-12	All		All Subwatersheds	
Stormwater	Stormwater Structure Survey	UNH Stormwater Center	DSI-10			Farmington - 2006: Rochester 2007	1x per season
Stormwater	Impervious Surface Survey	NHEP	DSI-1			All Subwatersheds	to be determined
Stormwater	Road Crossings Survey	UNH Stormwater Center	DSI-12			Farmington - 2006: Rochester 2007	1x per season

Table 5
Proposed VRAP Sampling Locations and Frequency
Cocheco River Restoration Project

Sample Point Abbreviation	Sampling Point Description	Municipality	Subwatershed	Sampling Frequency	Analysis or Suite of Analyses ##
Baseline Locations					
07-CCH	Central Ave Bridge	Dover	Lower Cocheco	monthly (1)	Fields, *E.coli*, BOD
10-CCH	Whittier Street Bridge	Dover	Lower Cocheco	monthly (1)	Fields, *E.coli*, BOD
11-CCH	Watson Road Bridge	Dover	Lower Cocheco	monthly (1)	Fields, *E.coli*, BOD
12-CCH	County Farm; Former Covered Bridge Location	Dover	Lower Cocheco	monthly (1)	Fields, *E.coli*, BOD
19-CCH	Route 125 Bridge	Rochester	Middle Cocheco	monthly (1)	Fields, *E.coli*, BOD
21-CCH	North Main Street Bridge (202A)	Rochester	Middle Cocheco	monthly (1)	Fields, *E.coli*, BOD
22-CCH	Little Falls Bridge	Rochester	Middle Cocheco	monthly (1)	Fields, *E.coli*, BOD
22U-CCH	Pike Industries Bridge	Farmington	Middle Cocheco	monthly (1)	Fields, *E.coli*, BOD
23-CCH	Watson Corner Road Bridge (Now called Cocheco Road)	Farmington	Middle Cocheco	monthly (1)	Fields, *E.coli*, BOD
26-CCH	Central Street Bridge (Route 25)	Farmington	Upper Cocheco	monthly (1)	Nutrients, *E. coli*, BOD, Fields
AU-Supplemental Stations**					
01-BRR	Berry Brook; 6th St. Bridge	Dover	Lower Cocheco	Limited (2)	Fields, *E.coli*, BOD
06-BRR	Berry Brook; Roosevelt St. Bridge	Dover	Lower Cocheco	Limited (2)	Fields, *E.coli*, BOD
13-CCH	Glen Hill Rd/ Rochester Neck Road; DS of Confluence w/ Isinglass	Rochester	Lower Cocheco	Limited (2)	Metals, *E. coli*, BOD, Fields
01-WOR	Willow Brook; Old Dover Road Bridge	Rochester	Middle Cocheco	Limited (2)	Fields, *E.coli*, BOD
07-WOR	Willow Brook; Franklin Street Bridge	Rochester	Middle Cocheco	Limited (2)	Fields, *E.coli*, BOD
01-RAT	Rattlesnake River, Behind Auto Shop	Farmington	Middle Cocheco	Limited (2)	Fields, *E.coli*, BOD
00-ISN	Isinglass River just above confluence with Cocheco	Rochester	Lower Isinglass	Limited (2)	Nutrients, E. coli, BOD, Fields
15-CCH	England Road at Waste Management Landfill	Rochester	Lower Isinglass	Limited (2)	Metals, *E. coli*, BOD, Fields
16-CCH	Rochester Waste Water Treatment Plant (Gonic)	Rochester	Lower Isinglass	Limited (2)	Metals, *E. coli*, BOD, Fields
18-CCH	Maple Street Bridge (Gonic)	Rochester	Lower Isinglass	Limited (2)	Fields

Table 5
Proposed VRAP Sampling Locations and Frequency
Cocheco River Restoration Project

Sample Point Abbreviation	Sampling Point Description	Municipality	Subwatershed	Sampling Frequency	Analysis or Suite of Analyses ##
AU-Supplemental Stations (continued)**					
01-POK	Pokamoonshine Brook at Confluence	Farmington	Middle Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
23U-CCH	Upstream of Farmington Wastewater Treatment Plant outfall	Farmington	Middle Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
25-CCH	South Main Street Bridge	Farmington	Middle Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
01-AXE	Axe Handle Brook, Rte. 125 Bridge	Rochester	Axe Handle Brook	Limited (2)	Fields, E.coli, BOD
03-AXE	Chesley Hill Road Bridge	Farmington	Axe Handle Brook	Limited (2)	Fields, *E.coli*, BOD
00-MAR	Mad River at Confluence with Cocheco	Farmington	Upper Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
01-MAR	Mad River; Tappan Street Bridge	Farmington	Upper Cocheco	Limited (2)	Fields, *E.coli*, BOD
02-MAR	Mad River - Old Route 11 Bridge	Farmington	Upper Cocheco	Limited (2)	Fields, *E.coli*, BOD
03-MAR	Mad River - River Street Bridge	Farmington	Upper Cocheco	Limited (2)	
04-ELA	Ela River at Spring Street Bridge	Farmington	Upper Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
27-CCH	Spring Street Bridge	Farmington	Upper Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
28-CCH	Main Street/Old Bay Road Bridge	Farmington	Upper Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
29-CCH	Middleton Road Bridge	Farmington	Upper Cocheco	Limited (2)	Nutrients, *E. coli*, BOD, Fields
(1) *E. coli* will be sampled monthly. BOD, nutrients, and metals samples will be taken 2 times during the sampling season to coordinate with the other limited sampling points					
(2) Sampling locations to be added in 2006 sampling round, may be modified for 2007, depending on results. *E.coli* will be sampled 3 times in these locations. BOD, metals and nutrients will be sampled 2 times during the season at selected locations.					
## Suite descriptions listed in Table 4					

Field parameter data will be recorded on the revised VRAP field data sheet included in Appendix C. This information will be used to more accurately interpret laboratory results of bacterial, nutrient, and metals parameters.

The DES ambient water quality group will also provide several water quality data loggers for use during the 2006 and 2007 sampling seasons. This instrumentation is self-contained and can be placed in a stream for continuous collection of pH, dissolved oxygen, specific conductance, and temperature data. The instrument is typically left in place for 48 to 72 hours. This instrumentation will be used for the DO, pH, temperature, and BOD study in particular. The data loggers will be placed by DES in the Mad River near the location of the VBAP rock baskets, near the confluence of the Isinglass and Cocheco rivers, and just downstream of the Farmington Landfill early in the sampling season to determine temporal variations in these parameters. This will help to optimize the timing of BOD, DO and pH data for other sampling locations and aid in the overall evaluation of stream conditions in impacted sections of the Cocheco. If still available, the data loggers will also be placed in one or more of the earlier sampled locations to collect data during low flow periods. CRWC will assist DES with placement of the instruments and provide the data to CRWC upon retrieval.

Applications: This sampling suite will help to provide basic water quality information for regular sampling efforts and for interpretation of results for Action WQR-1. WQR-3, WQR-4, WQR-5, WQR-6, WQR-9, WQR-12 and HI-6. As an example, Action WQR-1 is planned to better define and understand causes of anomalous dissolved oxygen, biological oxygen demand, and temperature fluctuations, will employ these parameters, coupled with measurement of biological oxygen demand to understand the organic contaminant impacts to the river. Particular attention will be focused on the confluence of the Isinglass and Cocheco Rivers, in the vicinity of existing and closed landfills, and near aggregate industries that may be affecting water quality. Some baseline sampling to establish levels along the profile of the Cocheco will be completed to provide a point of comparison with specific study areas.

Schedule/Reporting: Whenever possible, field parameter data will be collected each time a water sample is taken for analysis. This will result in no less than four measurements per baseline station and at least two measurements for each supplemental station each sampling season. The instream water quality data logger will be place in several locations in late May or early June and again in late August or early September to obtain data during low flow periods. Results will be reported to VRAP and VBAP as it is collected and included in the annual VLAP summary report.

Bacterial Suite

As part of the VRAP program, samples for analysis of *E.coli* and BOD will be taken to better understand the sources and concentration of bacteria in the river and its tributaries. Action WQR-3 that involves the modification of the bacterial sampling program to further identify sources of bacterial loading will be implemented as part of the bacterial sampling suite. Known problem areas include areas of downtown Farmington, Farmington Landfill, and tributary and main stem locations in the heavily settled areas of Rochester and Dover. Other monitoring program tasks that will be completed outside of

the VRAP program include failed septic system surveys and illicit discharge surveys as described in Section 4.

E. coli

Description: The bacteria *E. coli* is a core indicator for water quality attainment and is used as an indication that fecal-borne bacteria (e.g., untreated sewage) is reaching surface water. Results of this analysis are used as the primary decision making tool for determining if surface waters meet Class A or Class B water quality in New Hampshire and two designed uses which are primary and secondary recreation (e.g., swimming and boating).

***Analysis*:** Once collected by VRAP volunteers, samples will be taken to the Rochester Wastewater Treatment Plant for analysis. Laboratory grade sample containers will be provided by CRWC for sample collection.

Application: In addition to regular water quality sampling, bacterial analysis and sampling will be used to complete Actions WQR-3 & WQR-4. As restoration work is completed sampling will also be conducted for WQR-8.

Schedule/Reporting*:* Samples will be collected at each baseline sampling location at least once per month or approximately 4 times over the course of a sampling season. Assessment of AU's using the DES standards for *E. coli* requires calculation of a geometric mean of sample results. In order to calculate a geometric mean it is important that at least three independent *E.coli* samples be collected within 60 days at the same station, but not on the same day, or at least three independent samples are collected within the same Assessment Unit provided that at least two of the samples are separated by a period of at least two days (NHDES, 2005). As part of the effort to further identify sources of bacterial pollutants and to expand the sampling program into tributary Assessment Units, sampling locations will be added on the following tributaries - Kicking Horse Brook, Dames Brook, Pokamoonshine Brook and the Rattlesnake River in Farmington. Two additional sampling stations will also be added on both Willow Brook in Rochester and Berry Brook in Dover to assist in identifying areas of bacterial loading. Samples will be taken at three times per season at these locations within 60 days.

In addition to regular sampling, *E. coli* sampling will also be conducted during storm flow and at low flow conditions on the river. This temporal information will provide insight into changes in water quality due to weather conditions. High bacteria levels are often associated with storm flow as material washed from land and impervious surfaces collects in stormwater and is quickly transported to drainage channels and storm drains which then discharge to streams. This flush can result in high bacterial concentrations in surface waters. If high *E.coli* is detected during low flow conditions it suggests that illicit discharges may be affecting water quality. This analysis can help with identification of illicit discharge of sewage to storm sewer drains and surface waters.

Results will be reported to VRAP and VBAP and included in the annual VRAP summary report.

Biological Oxygen Demand (BOD)

Description: Biological oxygen demand (BOD) is an indicator of the organic pollutant load to surface water. It is an indirect measure of sources such as sanitary wastewater loading and can provide valuable information in assessing pollutant sources.
Analysis: VRAP volunteers will collect water samples and transport them to the DES laboratory in Concord within 24 hours of sample collection.
Application: As stated in Action Plan WQR-1, supplemental monitoring will be completed to determine the causes and relationship of anomalous dissolved oxygen, biological oxygen demand, and temperature changes along the Cocheco River. Particular attention will be focused on the confluence of the Isinglass and Cocheco Rivers, in the vicinity of existing and closed landfills and aggregate (sand and gravel) industries that may be affecting water quality. Some baseline sampling to establish levels along the profile of the Cocheco will be completed to provide a baseline for comparison with specific study areas. This will include addition of established sampling points in the Upper Cocheco subwatershed and in upper reaches of tributary streams.
Schedule/Reporting: Sampling will be conducted for BOD at all baseline stations at least two times over the sampling season in 2006. Two locations will also be added on the Mad River and on the main stem of the Cocheco within the Lower Isinglass subwatershed In order to obtain data over a number of hydrologic conditions, samples will also be taken during early morning hours and late afternoon for one of the sampling events and during storm flow and low flow conditions. Biological respiration is generally low overnight and in the early morning as fauna are largely inactive at these times. As the day progresses, activity (and respiration) increases. CRWC wishes to document this range of conditions to better understand fluctuating and anomalous BOD, dissolved oxygen (DO), and pH levels noted in past sampling seasons. This information will help guide future sampling and help to answer questions about parameter fluctuation. For the 2007 sampling season, sample locations may be modified but the number of samples will remain the same, if funding allows. Results will be reported to VRAP and VBAP and included in the annual VRAP summary report.

Metals Suite

Description: The presence of metals in surface water can be a result of both natural and manmade influences. The elevated concentrations of aluminum, copper, and lead might be an indication of discharge from household and commercial plumbing systems. Suspended sediments may also be partially responsible for elevated aluminum levels. Care must be taken in sample collection and analysis to filter suspended sediments before preservation so that only dissolved metals are analyzed.
Analysis: VRAP volunteers will collect these samples for analysis for dissolved aluminum, copper, and lead and deliver them to the NHDES laboratory in Concord.
Application: Action Plan WQR-14 was developed to determine the source and concentrations of these metals in the Cocheco River.
Schedule/Reporting: Samples will be collected for analysis of dissolved aluminum, copper, and lead at all baseline stations at least twice over the sampling season. Focus areas will include aggregate (sand and gravel) industries and near wastewater treatment

plant outfalls. Additional sampling may be conducted at 23-Cch, 22U-Cch, and 21-Cch; in the areas of previously elevated metals results if interim results suggest additional sampling would be beneficial. Results will be reported to VRAP and included in the annual summary report.

Nutrients Suite

Description: Both phosphorus and nitrogen are nutrients for aquatic plants and animals. These elements are essential to healthy aquatic populations. An excess of nutrients can be deleterious to a waterway. Algal blooms and proliferation of nuisance aquatic species can result if too much nutrient is present. This in turn leads to depressed dissolved oxygen and pH due to the increase in biological respiration. Focus areas will include areas of possible diffuse discharge from golf courses, residential development, wastewater treatment plants and other areas of septic discharge.
Analysis: VRAP volunteers will collect samples and transport them to the DES laboratory in Concord for analysis.
Application: Action Plan WQR-14 was developed to address the need for understanding the source and concentration of elevated nutrients in the Cocheco River.
Schedule/Reporting: In the 2007 sampling season, nutrient analyses will be completed at least two times at sample sites 18-Cch, 16-Cch, 15-Cch, 13-Cch, 12-Cch, and 11-Cch. Nutrient analysis will also be completed at baseline stations as the budget allows. Results will be reported to VRAP and VBAP and included in the annual summary report.

Stream Morphology and Bank Characteristics

Description: As part of the revised sampling protocol, development of a stream morphology and bank characteristics monitoring program will be initiated in 2007. Implementation will begin in 2007. These characteristics will include available cover, pool substrate characteristics (sediment type and distribution), pool variability, observed sediment deposition, channel flow characteristics (how full is the channel?), manmade alteration of the channel, channel sinuosity, bank stability, bank vegetative cover, riparian vegetation zone width, and evidence of solid waste dumping, etc. Several locations will also be selected on key tributaries for stream flow measurement. This discharge (volume per time) will be approximated using stage-rating curves, which equate stream depth to discharge at that location. This information will be used in conjunction with the USGS gauging station 01072800 near the Rochester Wastewater Treatment Plant to better understand the flow regime and evaluate samples with respect to a variety of stream flow conditions.
Analysis: A protocol, checklist and field description sheet will be prepared for use by samplers. The stream characteristics data collected will be based on the DES habitat assessment field data collected for low gradient streams included in Appendix C. Photographs will also be taken at each site to document stream conditions.
Application: Like the field parameter data collection, physical parameter information will have broad application to the restoration efforts on the Cocheco River. This specifically addresses the needs identified in HI-6, but will also be important to WQR-1, WQR-12, HI-4, HI-10, and DSI-7.

Schedule/Reporting: Stream morphology and characteristic information will be collected throughout the sampling season. By the end of the sampling season in 2006, each baseline and supplemental sampling point will have been evaluated. Stream discharge measurement points will be chosen for the Mad, Ela, and Willow Brook in 2006. Stage/discharge relationships will be established at these points so that in 2007 and following years, discharge can be estimated using stage height alone. Results will be reported to VRAP and VBAP and included in the annual summary report.

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Section 4 – Monitoring Surveys and Special Studies

In addition to water quality testing, a range of special studies and surveys will be carried out to answer the remaining questions about the quality of the Cocheco River Watershed. The following sections are organized by monitoring suite as defined in Table 5 and outlined in Section 3.

4.1 Bacterial Suite

Part of the bacterial suite sampling program, *E. coli and* BOD, will be completed as part of the VRAP sampling program as described above. The following additional special surveys or studies will also be completed as part of restoration plan implementation.

Septic System Surveys

Description: There are several locations in heavily settled areas where septic systems may have failed based on age and proximity to surface water. These failures contribute to bacterial and related contamination in tributary streams and along the river. In order to identify these potential sources, DES has proposed a system of screening for these areas. This work will directly apply to Action Plan WQR-4.
Methodology: Water samples are evaluated for specific conductance (SC) and bacterial indicator (*E. coli*) concentration along a reach of a stream where failed septic systems may be discharging. SC indicates the presence of dissociated ionic compounds and septic system discharge may contain elevated ionic compounds and raise natural stream SC above background levels. The presence of *E. coli* bacteria indicates fecal-borne bacterial sources. This preliminary assessment tool may assist in identification of these septic system failures. Where needed, additional bacterial sampling coupled with microbial source tracking (e.g., ribotyping) can be used in order to further identify the sources of bacteria.
Schedule/Reporting: This method is being undertaken in Farmington on the Ela River in early 2006 and will be used on the Mad River in Farmington and on other urban streams as needed in 2006. Other areas in Farmington and areas not serviced by sewer in Rochester and Dover could also be evaluated using this methodology in 2007. Results will be reported to DES and municipalities and included in the annual summary report.

Illicit Discharge Surveys

Description: When untreated sewage is discharged anywhere but to a septic system or sanitary sewer, it is considered an illicit discharge. The exception is a combined sewer overflow (CSO); however there are no permitted CSOs in the watershed. Illicit discharges may be a result of old infrastructure or improper hookup to a storm sewer. These illicit connections direct bacterial and other contaminants directly to surface water outfalls and can result in surface water contamination. Also called a dry weather discharge, these discharges occur largely in older urban and suburban settings that have not been recently upgraded. Action Plans WQR-5 and WQR-6 directly address collection of this information.

Methodology: New England Interstate Water Pollution Control Commission has developed a method for conducting these surveys entitled "Illicit Discharge Detection and Elimination Manual", dated January 2003. In addition, several municipalities in the Cocheco River Watershed are conducting these surveys as part of their stormwater Phase II programs. CRWC will assemble a team of volunteers to assist with the surveys. They will then coordinate with the municipalities to determine if and where additional surveys are required, where problem areas are, obtain a map of storm sewers, and survey storm systems according to the manual to see if dry weather discharge is occurring. If discharge is detected, results will be reported and sampling conducted, if warranted. CRWC will then work with the municipality to see that the dry discharge is eliminated. ***Schedule/Reporting***: Surveys will be carried out as time and budget allows. In 2007 CRWC will assist with the Rochester illicit discharge detection survey. Results of these surveys will be included in annual summary reports as described in Section 6.

Water Quality Improvement Monitoring

Description: DES will work with CRWC to monitor areas where restoration actions have been implemented to reduce bacterial contamination. This will be especially important where septic systems have been replaced and illicit discharges have been corrected. Action Plan WQR-8 includes the justification and steps for implementation of this action. ***Schedule/Reporting***: Areas and frequency of monitoring will be determined when restoration is implemented. Results will be reported to VRAP and included in the annual summary report.

4.2 Biological Suite

Biomonitoring with Kick Nets and Rock Baskets

Description: Monitoring of **invertebrate populations** will be completed using kick nets and rock baskets in order to better understand links between chemical, physical and biological changes along the river. The results of this sampling and analysis will be used to gather information about the number and abundance of benthic macroinvertebrate species in the river that can be directly tied to biological health of the river or its tributaries. The results will also be provided to DES and could be used to assess Aquatic Life Use as per the CALM. This work will be closely coordinated with the water quality-monitoring program described above. Like VRAP, the DES Volunteer Biological Assessment Program (VBAP) staff will work closely with CRWC volunteers, providing training, oversight, data analysis and annual reports.

Methodology: **Kick netting**. In 2005 CRWC volunteers were trained for "screening" investigations of stream and river aquatic communities. The volunteers, with intensive assistance from VBAP staff, initiated a pilot biomonitoring project using kick netting protocols and equipment. This program included training a corps of biomonitoring volunteers, testing and evaluating the utility of the VBAP protocol and the associated biotic index, and determining the level of volunteer interest and ability to collect biological data. The biomonitoring corps completed screening at nine sites on the main

stem and tributaries of the Cocheco. VBAP staff published their report of the project (NHDES, 2005a) stating that the results obtained from the VBAP protocol "are not intended to represent formal water quality 'assessments', but rather, a basic indicator of aquatic community condition."

Beginning in 2006, CRWC volunteers, using the kick netting equipment being purchased with NHCP funding will continue and expand the biomonitoring program on the Cocheco River. Sample locations will be evaluated to determine if appropriate conditions are present for the kick net methodology. The stream must be wadeable and the stream bottom must have gravel or cobbles that will support benthic macroinvertebrate species. Physical and chemical characteristics at the sites are measured as part of the VBAP protocol, but do not exactly match the parameters included in the water quality sampling program described above. Those water quality parameters not common to both programs will be measured so that data obtained can be used for both VRAP and VBAP databases and links can be made between physical, chemical and biological results. More information about each of these characteristics is available at www.des.state.nh.us/WMB/biomonitoring/habitat.htm.(NHDES, VBAP, 2001) VBAP staff will oversee the project, train volunteers, provide QAQC and report on results.

Rock baskets are made of bank run gravel (1.5 -3 inches diameter) contained within cylindrical plastic coated wire baskets. Three connected baskets are laid on the stream bottom and anchored to the streambed. These baskets are then left in place for six to eight weeks, prior to recovery and harvesting. Organisms harvested from the baskets are preserved and sent to a biological laboratory for analysis (NHDES, 2006).

The use of rock baskets requires substantial effort on the part of professional staff and produces a more detailed database of biological indicators. It is complementary to the kick netting survey. Identification of organisms is performed in a taxonomic laboratory and the results can be used for a semi-quantitative stream assessment. In 2005, CRWC volunteers assisted staff with identification of potential study sites, obtaining access and installation and recovery of the rock baskets at four sites on the main stem of the Cocheco and one site on the Mad River.

Because this method of biomonitoring requires substantial time, advanced training, and funding for analysis, CRWC volunteers will assist DES with the placement and processing of the rock basket samples only as staffing and funding permit in the 2006 and 2007 seasons. A long-term objective of this work will be to assess a site in each subwatershed in the Cocheco River watershed and continue baseline sampling of one or more sites. The remaining untested subwatersheds are the Lower Isinglass and Axe Handle Brook subwatersheds. Physical characteristics will be studied and documented prior to placement of the rock baskets.
Schedule/Reporting: Rock basket sampling will be completed in two locations in 2006. The Mad River location completed in 2005 will be repeated in 2006 and one additional location will be selected by the DES VBAP for 2006. Site selection and placement will take place in July for recovery in September. Kick net screenings will be implemented at 10 sites in 2006. Several of the 2005 sites will be repeated to establish a baseline and

other stations not yet evaluated will be added to coincide with water quality sampling locations. It is expected that two more rock basket samplings and an additional 10 kick net sample locations will be completed in 2007 as well, as funding allows.

Results of biomonitoring will be provided to the DES VBAP program and to will be included in the annual summary report as described in Section 6.

Nuisance Aquatic Species Surveys

Description: Rivers, streams, ponds and lakes are all susceptible to invasion by non-native aquatic plants. These plants displace native vegetation, affect recreation and degrade native fish and aquatic invertebrates populations. Some examples of these species are variable milfoil, water chestnut, fanwort, purple loosestrife and common reed (also known as phragmites). In the Cocheco River, these species are known to be a problem in areas like Sunrise Lake and above impoundments in Farmington, Rochester and Dover.
Methodology: CRWC will work with the DES Weed Watcher Program to train volunteers to identify and assess areas for invasive plants.
Schedule/Reporting: In 2006, several areas in Rochester will be surveyed. In 2007, other areas in Rochester and areas in Middleton and Dover will also be surveyed. Results of these surveys will be summarized in the annual summary report described in Section 6. These results are reported to the DES Biology Section for inclusion in the 305(b) Reporting to Congress. The presence of exotic macrophytes can impair water bodies for aquatic life use support.

Stream Buffer Data Review

Description: Water quality protection can be aided by maintaining a vegetated buffer area along tributaries and adjacent to rivers. The vegetation helps to trap sediment, trash and other solid waste that might enter streams and also provides habitat for animals and native plants. Emphasis will be placed on improving buffer areas especially in urbanized or growing areas. In order to identify areas that need restoration, information regarding buffers must be collected and reviewed.
Methodology: Sources for this information includes reports submitted to conservation commissions and to conservation and land protection organizations. Field observations and field surveys by citizens and landowners will also be used in evaluations.
Schedule/Reporting: In 2006, work will be focused on assessing the buffers along the urbanized main stem of the Cocheco River. Work in following years will focus on headwaters locations and implementing buffer restoration programs. For 2006, buffer data will be summarized in the annual report. Recommendations for buffer field surveys in 2007 will be included in that report. In 2007 and following years, buffer surveys will be completed and the results of buffer surveys will be included in annual reports.

Wildlife Obstacle Survey

Description: Obstacles to wildlife passage will be surveyed using a program developed by DES in association with The Nature Conservancy. Similar work was recently completed by TNC and DES in the Ashuelot River Watershed in southwestern New Hampshire. Examples of obstacles include dams or impoundment structures, undersized or elevated culverts that "maroon" upstream tributaries and curbing berm obstacles at road crossings.
Methodology: CRWC will work with DES and TNC using the methodology developed for the Ashuelot River. An understanding of how this method might be applied to the Cocheco River will be undertaken in 2006 and implementation may begin in 2007, depending on funding and applicability to the Cocheco. These obstacles will then be ranked to determine ability and cost to repair the obstruction. Municipalities, DES, NHFG and other cooperating organizations will be involved in the evaluation and in determining how repairs might proceed.
Schedule/Reporting: This work will likely begin in 2007. Results will be included in the annual summary report described in Section 6.

Exemplary Natural Community Surveys

Description: The New Hampshire Natural Heritage Inventory program is administered by the Department of Resources and Economic Development in cooperation with TNC. They have developed a guide to natural communities and have ranked natural communities according to their importance and quality within the state.
Methodology: CRWC will notify local and regional land protection organizations and NHNHI about the ongoing restoration work and encourage their participation in identifying these natural communities. If an exemplary natural community is present within or close to a wetlands or shoreline buffer particular emphasis will be placed on protection of these communities.
Schedule: Project development will begin in 2007 and will be implemented in following years.

Historic Fish Species Survey

Description: The Cocheco River and its tributaries support a variety of native anadromous (migrating) and resident fish populations. Some historic fish species have been lost, but there is interest in restoring species if environmental conditions are improved. The species targeted for restoration will be identified at the completion of the survey.
Methodology: CRWC volunteers will work with NHFG and related interest group to survey the type and historic distribution of fish species that may no longer be present and determine if restoration of these species is feasible.
Schedule: Project development will begin in 2007 and implementation will proceed in following years.

4.3 Physical Parameters Suite

Solid Waste Surveys

Description: Dumping has long been an issue along the Cocheco. Cleanups have been conducted over the years, but a comprehensive survey has not yet been completed. A Survey of current status of solid waste dumping along the river will be made as part of the monitoring effort. This will be coordinated with periodic cleanups and follow up monitoring to determine impacts of regular cleanup and education. Focus areas will be in urban areas and in suspected areas of dumping in rural neighborhoods.
Methodology: The California Regional Water Quality Control Board, Surface Water Ambient Monitoring Program developed an assessment method for wadeable streams. The parameters include:
Qualitative level of trash (high, medium, low), number of items found, threat to aquatic life, threat to human health, illegal dumping and littering, and accumulation of trash. This methodology is described in detail in the assessment publication (CRWQCB, 2002).
Schedule/Reporting: In 2006 and 2007, CRWC will work with Rochester Department of Public Works to survey the main stem and tributaries in Rochester. A summary of the trash survey will be included in annual reports using the methodology suggested in the CRWQCB publication.

Researching Permitted Withdrawals

Description: Withdrawals of flow from a stream or river can affect the biological community and can impact the degree to which river flow can dilute and mitigate pollutant discharges.
Methodology: The CRWC volunteers will contact DES and determine the number, location and volume of water permitted for withdrawal. Investigation of smaller withdrawals that do not need registration will also be identified, if possible as per http://www.des.state.nh.us/factsheets/ws/ws-1-17.htm.
Schedule/Reporting: This information will be collected over the next two years and updated every three years thereafter. Results will be included in the annual summary report to guide future work. This information will be used in combination with habitat assessments to determine if withdrawals might affect existing aquatic habitat.

4.4 Stormwater Impact Evaluation Suite

Review of Water Quality Data to Determine Stormwater Impacts

Description: Stormwater runoff can flush sediment, bacteria, nutrients, metals, oil and grease, and solid waste into streams and rivers. As described in previous sections, significant effort will be placed on sampling and analysis for many of these chemicals or waste types. Evaluating which contributions are from a stormwater source will be largely based on data review and site-specific information. The Action Plan WQR-12 specifically addresses this need.

Methodology: Information collected during water quality sampling and surveys of physical conditions and structures will all be used to evaluate the impact of stormwater runoff and specifically locate sources of stormwater runoff pollution. Analytical results may indicate areas of stormwater impact that might not be apparent from visual surveys and visual surveys will help to determine if land or road/bridge management is adding to stormwater pollution. CRWC will evaluate the collected data as part of the data review tasks described in Section 6.
Schedule/Reporting: Data analysis will begin in 2006 and continue as long as data collection continues. Results will be discussed with and reported to DES and municipalities. The results will be included in annual reporting as presented in Section 6. Additional parameters and analyses may be added in the future if analysis suggests the additional data would be valuable. The results of a previous year's sampling will help to guide any modifications to sampling in following years.

Impervious Surface Monitoring

Description: The Complex Systems Research Group at University of New Hampshire has collected impervious surface measurements on a watershed scale. After analysis of aerial photographs for land use changes, impervious surface data is transferred to Geographic Information System format and percent of impervious cover is estimated. This has been completed on 1990, 2000, and most recently, 2005 aerial photograph data in part with New Hampshire Estuaries Project funding. This information will help CRWC to understand the change in and impact of stormwater runoff from impervious surfaces and can be passed on to municipalities to make them aware of the connection between impervious surfaces and stormwater pollution.
Schedule/Reporting: CRWC will work with NHEP to obtain this information on municipalities within the Cocheco River watershed. The 2005 data may be available in late 2006 or early 2007. These results will be incorporated into the final report for 2007 and may be used to direct future sampling efforts and to work with municipalities on understanding impacts and further limiting impervious surfaces in impacted areas. The coordinator will also work closely with the UNH Stormwater Center on findings to encourage incorporation of the best stormwater treatment technologies for minimizing impacts of impervious surface cover in the watershed.

Road Crossing Survey

Description: Road crossings can be places where sediments and contaminants build up from auto traffic and from winter road treatment. If excess sand, gravel and salt are not removed in spring after winter storms have ceased, this material will wash directly into rivers and stream. A survey of these areas will provide CRWC and municipalities with information on where stormwater impacts may be greatest so that remedial measures can be taken.
Schedule: This work is not currently schedule for 2006 or 2007, but will be completed as funding or cooperation allows.

Section 5 – Monitoring Plan Implementation

5.1 Monitoring Schedule

As part of Restoration Planning, actions were prioritized in order to help determine an implementation schedule. Those actions that were deemed most important are planned for completion early in the restoration process. The emphasis of regular sampling is to gather data to evaluate the attainment of primary and secondary recreational use and aquatic life support.

The monitoring schedule was determined based on the financial and volunteer resources available to CRWC. There are 68 assessment units on the Cocheco River and tributaries. The volunteer effort involved is great and is the limiting factor for most of the work that can be accomplished each year. In order to maximize these resources, sampling was divided into three sections – baseline stations, supplemental sampling points on the main stem and supplemental sampling points on the tributaries. Baseline stations, which have the most sampling history, will be sampled approximately once per month. Stations added in order to better evaluate the entire watershed have been titled "supplemental stations". These stations will be sampled two times per year and possibly one additional time if results suggest additional sampling is important. Table 6 exhibits the water quality sampling schedule and also includes biomonitoring and some of the special studies and surveys.

5.2 Personnel Resources

Role of Coordinator

The CRWRIP outlines the role of CRWC in the implementation of the restoration plan and provides for creation of a Restoration Technical Advisory Committee (RTAC) that will oversee completion of the plan. It was determined that a coordinator be hired to administer implementation of the restoration plan. The coordinator will be responsible for recruiting volunteers, organizing training opportunities, procuring resources for completion of sampling tasks and coordinating sampling schedules. Permission for access to certain sampling sites and coordination with municipalities and agencies will also be required in some cases. The coordinator will also assure that Quality Assurance and Quality Control measures are being followed as required by the overseer of the applicable quality assurance project plan.

As data are collected in a sampling season, the coordinator will assemble the data and transmit it to DES for internal use, reporting to EPA, and for generating reports about the watershed for use in watershed communities.

Table 6
Proposed Cocheco River Monitoring Schedule

January-April 2006	May-06		Jun-06		Jul-06	
Description	**Date**	**Description**	**Date**	**Description**	**Date**	**Description**
Seek funding and cooperation for 2006 sampling season	11-May	VRAP Volunteer training	05-Jun	Supplemental Sampling sites - main stem	03-Jul	Baseline sampling event
				Bacteria		Bacteria
Continue data analysis of 2005 data and submit to NHDES	22-May	Baseline sampling event		field parameters		field parameters
		Bacteria		BOD, nutrients		Metals
Recruit volunteers for sampling and data collection		field parameters		physical parameter evaluation begins		physical parameter evaluation continues
		metals	19-Jun	Baseline sampling event	17-Jul	Supplemental Sampling sites - tributaries
		physical parameter evaluation begins		Bacteria		Bacteria
				field parameters		field parameters
				BOD		BOD, nutrients, metals
				physical parameter evaluation continues		physical parameter evaluation begins
					31-Jul	Supplemental Sampling sites - main stem
						Bacteria
						field parameters
						physical parameter evaluation continues

Table 6
Proposed Cocheco River Monitoring Schedule

Aug-06		Sep-06		October to December 2006
Date	**Description**	**Date**	**Description**	**Description**
14-Aug	Baseline sampling event	11-Sep	Baseline sampling event	Data compilation and delivery to NHDES
	Bacteria		Bacteria	Evaluation of sampling points and scheduling for 2007
	field parameters		field parameters	Evaluation of data to determine stormwater impacts.
	physical parameter evaluation continues		physical parameter evaluation continues	Evaluation of pH, BOD, and DO results
	Kick net surveys of selected areas		BOD, nutrients	Work with municipalities and agencies on obstacles surveys and stormwater structure surveys.
28-Aug	Supplemental Sampling sites - main stem	25-Sep	Supplemental Sampling sites - tributaries	Complete Solid waste surveys (after October 2006)
	Bacteria		Bacteria	
	field parameters		field parameters	
	BOD, nutrients, metals		BOD, nutrients, metals	
	physical parameter evaluation continues		physical parameter evaluation continues	
	Biomonitoring		Biomonitoring	

Volunteer Resources

CRWC has successfully attracted many loyal volunteers for sampling and special studies. At this time 12 volunteers will be working on 2006 sampling events and will be trained on May 11, 2006 for VRAP sampling. Additional volunteers will be recruited for special surveys and sampling tasks. One group that will be recruited this year is young adults associated with civic organizations and youth groups. CRWC feels that their involvement is vital to the continued stewardship of the Cocheco River. As many as 20 volunteers will likely be required for the 2006 and 2007 sampling seasons. The coordinator will track volunteer hours for grant reporting and to promote additional volunteer efforts in following years.

Coordination with State and Local Agencies

The state and local agencies involved with CRWC work on the Cocheco include the municipalities of Dover, Rochester, and Farmington, DES, NRCS, NHEP, NHFG and NHCP. Coordination will be required with several departments within these organizations as well. Table 4 illustrates the agencies and departments that CRWC will be working with. For water quality sampling, coordination will be required with DES VRAP group as well as the Rochester Wastewater Treatment Plant who provides analysis for *E.coli* samples.

5.3 Quality Control and Quality Assurance

All water quality and biological sampling will be completed under the guidance of DES VRAP and VBAP program staff and under the Quality Assurance Project Plans (QAPP's) specific to each program. This will cover sampling, QA/QC (Quality Assurance/Quality Control) of data, and reporting. CRWC will prepare a QAPP to be submitted and approved when necessary for all other components of the monitoring plan as part of procedure development. Examples provided by DES such as *Generic Quality Assurance Project Plan for Stream Morphology Data Collection* (Provan and Lorber, 2003) will be used to guide the development of additional QAPP's. Standard operating procedures (SOP's) will be developed for special studies and surveys where a QAPP is not required. In this case, CRWC will work closely with contacts at DES to make sure that the SOP's are acceptable to funding agencies and to assure quality data collection and analysis.

5.4 Estimated Costs of Monitoring Program

Monitoring costs have been estimated for 2006 and 2007 sampling seasons. A grant request has been submitted to New Hampshire Coastal Program (NHCP) and is awaiting NH Governor and Executive Council approval. The City of Rochester is also working with CRWC on several tasks. All the tasks covered in 2006 and 2007 are shown in Table 8.

Table 7
Monitoring Tasks to be Completed – 2006 and 2007

2006	2007
Stormwater infrastructure survey development	Buffer/habitat surveys
DO, pH, and BOD monitoring	Failed septic surveys
Bacterial monitoring	DO, pH, and BOD monitoring
Nutrient monitoring	Bacterial monitoring
Metals monitoring	Nutrient monitoring
Increased AU monitoring	Metals monitoring
Biomonitoring	Biomonitoring
Nuisance species survey, Rochester	Nuisance species survey - Rochester
Solid waste survey, Rochester	Solid waste survey- Rochester
Obstacle removal, Rochester	Stormwater infrastructure survey

Costs of Monitoring

The total cost of monitoring for 2006 is estimated at $18,740. This will include biomonitoring and water quality sampling. In particular it includes funding for coordination of sampling efforts, and purchase of a complete set of field parameter meters for pH, specific conductance, dissolved oxygen, temperature, and turbidity. This also includes the cost of sample bottles, sample analysis, and transportation to laboratory for sample analysis. The cost for 2007 is estimated to be the same assuming laboratory costs remain constant. Other surveys listed above will be carried out in association with that municipality and will be funded through their budgets for these items. The stormwater infrastructure survey is not yet funded, but funding will be pursued for completion of this effort as scheduled.

Sources of Funding

For 2006, funding for monitoring plan implementation is being provided through a grant from the New Hampshire Coastal Program and the New Hampshire Department of Environmental Services. Other services and support are being provided through the VRAP and VBAP programs at DES, the City of Rochester, the UNH Stormwater Center, the Town of Farmington, and the UNH Cooperative Extension in Dover. In 2007, assistance will again be sought from these sources as well as from additional municipalities.

Section 6 – Data Analysis and Reporting

Each year, as part of the CRWRIP process, data will be reviewed and analyzed to determine the progress of the program with respect to the goals and objectives. Reporting to supporting agencies, municipalities, and the public is an important component of the restoration process.

6.1 Agency Reporting

As water quality data and analytical results throughout the sampling season have been received, the VRAP, VBAP results will be provided to DES for QA/QC, analysis, and inclusion in annual reports for CALM assessment and for submittal to the EPA. The DES will then complete all necessary evaluation for data quality and summarize the results of sampling in a report, similar to that prepared for 2005 data (NHDES, 2005a). Data collected and tasks completed as part of any grant program will also be summarized and reported as required to the appropriate agencies.

6.2 Reporting to Restoration Technical Advisory Committee (RTAC) and CRWC Community

Quarterly reporting

The Coordinator will meet quarterly with the RTAC to provide updates on the progress of the restoration plan. At this time, data collected or surveys completed will be summarized and provided to the RTAC for review and comment.

Annual reporting

As part of annual plan review, monitoring data will be summarized and presented for discussion with the RTAC. At this time, the committee may recommend modification of the sampling plan to accommodate new findings and to continue expansion of the sampling program as funding and manpower allows. At a minimum this report will contain the following section – Work Completed, QA/QC, data maintenance and storage, Summary Results of Water Quality Monitoring, Summary Results of Surveys and Special Studies, Evaluation with respect to the CRWRIP, and Recommendations for Future Monitoring Efforts. Where possible, all data compilation and reporting will be completed as part of this report to satisfy all parties and components of the report will be crafted to provide summaries to the appropriate agencies. Abbreviated summaries will also be prepared for presentation to the general public. This information will be provided to CRWC membership and will be distributed at outreach events and functions. The local press will also be provided with results on an annual basis. These outreach materials should translate the scientific information and promote the environmental successes and partnerships that developed as a result of the restoration activities.

In the past CRWC has invited members and the public to an annual CRWC meeting where results of sampling for that year are presented and discussed. This practice should

be continued in order to keep the public involved in the restoration and monitoring process.

Five Year Data Review

The EQR completed in 2005 provided a summary and analysis of data collected over a five-year period from 1998 to 2003. After completion of the 2008 sampling season, a review of the data collected in the 2004 to 2008 sampling periods will be made so that significant trends can be identified. At this time, a comprehensive report is not anticipated unless a funding source is available for the work.

6.3 Monitoring Plan Review

A process for evaluation the progress of restoration implementation is detailed in the CRWRIP (Truslow, 2006). An important function of the RTAC will be to review the monitoring data and survey information collected each year with the Coordinator. This analysis will provide direction in planning the following year's monitoring plan and seeking the necessary funding for its implementation. Specific questions to answer as part of review include:

- Were QA/QC standards met? What changes should be made to operating procedures to correct any problems?
- Have newly sampled AU's met attainment? If not are they included for additional sampling for the upcoming year? When should these AU's be sampled for re-evaluation?
- Are additional parameters required to determine water quality impacts?
- Should sampling frequency be increased or decreased?
- Do survey (illicit discharge surveys for instance) results indicate the need for adding new sample points?
- Was analysis and reporting sufficient? If not, how could this be improved?
- Can municipalities share in cost of sampling and analysis?
- Are businesses financially involved in the monitoring effort? If not, how could they be encouraged to participate?

Section 7 – References

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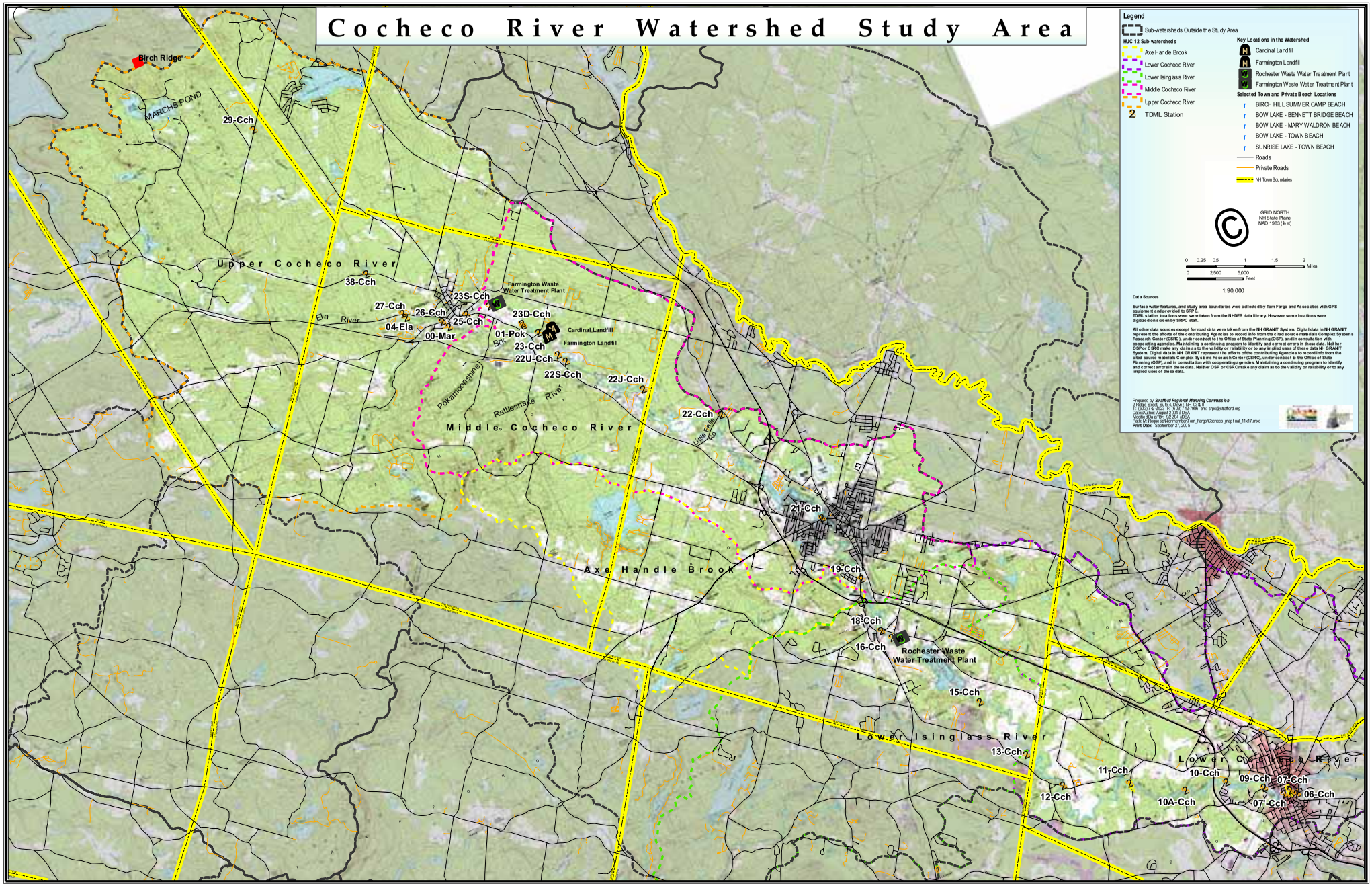
Monitoring Plan Figures


Cocheco River Watershed Study Area
Birch Ridge
MARCH'S POND
29-Cch
Upper Cocheco River
38-Cch
27-Cch
26-Cch
25-Cch
04-Ela
00-Mar
Ela River
23S-Cch
Farmington Waste Water Treatment Plant
23D-Cch
01-Pok
Pok Brk
Cardinal Landfill
Farmington Landfill
23-Cch
22U-Cch
22S-Cch
22J-Cch
22-Cch
Pokamoonshine
Rattlesnake River
Middle Cocheco River
Little Pine Rd
21-Cch
Axe Handle Brook
19-Cch
18-Cch
16-Cch
Rochester Waste Water Treatment Plant
15-Cch
Lower Isinglass River
13-Cch
12-Cch
11-Cch
10-Cch
10A-Cch
09-Cch
07-Cch
07'-Cch
06-Cch
Lower Cocheco River
Legend
Sub-watersheds Outside the Study Area
HUC 12 Sub-watersheds
Axe Handle Brook
Lower Cocheco River
Lower Isinglass River
Middle Cocheco River
Upper Cocheco River
TDML Station
Key Locations in the Watershed
Cardinal Landfill
Farmington Landfill
Rochester Waste Water Treatment Plant
Farmington Waste Water Treatment Plant
Selected Town and Private Beach Locations
BIRCH HILL SUMMER CAMP BEACH
BOW LAKE - BENNETT BRIDGE BEACH
BOW LAKE - MARY WALDRON BEACH
BOW LAKE - TOWN BEACH
SUNRISE LAKE - TOWN BEACH
Roads
Private Roads
NH Town Boundaries
GRID NORTH
NH State Plane
NAD 1983 (feet)
0 0.25 0.5 1 1.5 2 Miles
0 2,500 5,000 Feet
1:90,000
Data Sources
Surface water features, and study area boundaries were collected by Tom Fargo and Associates with GPS equipment and provided to SRPC.
TDML station locations were taken from the NHDES data library. However some locations were digitized on screen by SRPC staff.
All other data sources except for road data were taken from the NH GRANIT System. Digital data in NH GRANIT represent the efforts of the contributing Agencies to record info from the cited source materials Complex Systems Research Center (CSRC), under contract to the Office of State Planning (OSP), and in consultation with cooperating agencies. Maintaining a continuing program to identify and correct errors in these data. Neither OSP or CSRC make any claim as to the validity or reliability or to any implied uses of these data NH GRANIT System. Digital data in NH GRANIT represent the efforts of the contributing Agencies to record info from the cited source materials Complex Systems Research Center (CSRC), under contract to the Office of State Planning (OSP), and in consultation with cooperating agencies. Maintaining a continuing program to identify and correct errors in these data. Neither OSP or CSRC make any claim as to the validity or reliability or to any implied uses of these data.
Prepared by Strafford Regional Planning Commission
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T: (603) 742-2523 F: (603) 742-7666 email: srpc@strafford.org
Date/Author: August 2004 / DEA
Modified Date/By: 9/2004 / DEA
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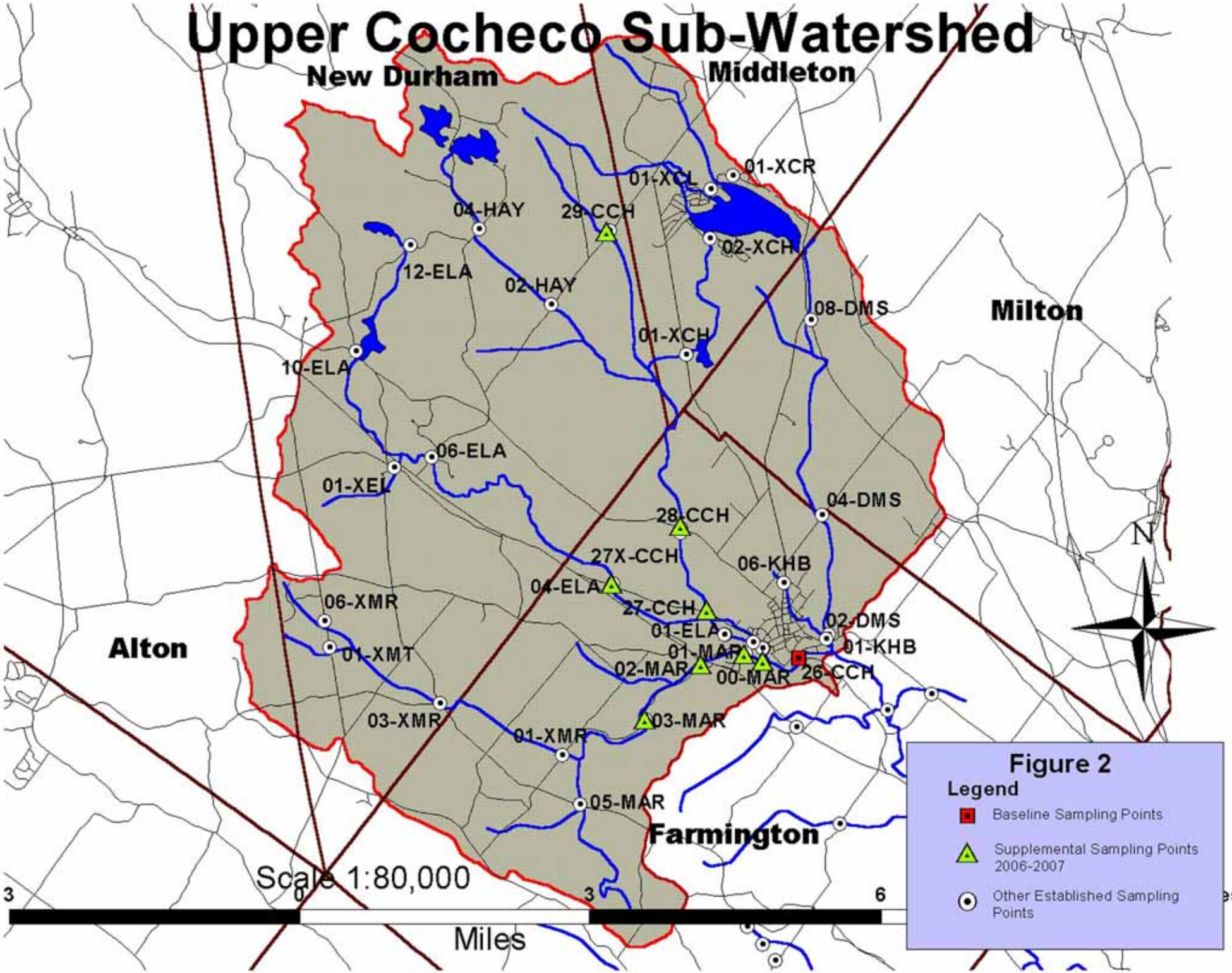
Print Date: September 27, 2005


Upper Cocheco Sub-Watershed
New Durham
Middleton
Milton
Alton
Farmington
01-XCR
01-XCL
04-HAY
29-CCH
02-XCH
12-ELA
02-HAY
08-DMS
01-XCH
10-ELA
06-ELA
01-XEL
04-DMS
28-CCH
27X-CCH
06-KHB
04-ELA
06-XMR
27-CCH
02-DMS
01-ELA
01-KHB
01-XMT
01-MAR
02-MAR
00-MAR
26-CCH
03-XMR
03-MAR
01-XMR
05-MAR
N
Scale 1:80,000
3
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3
6
Miles
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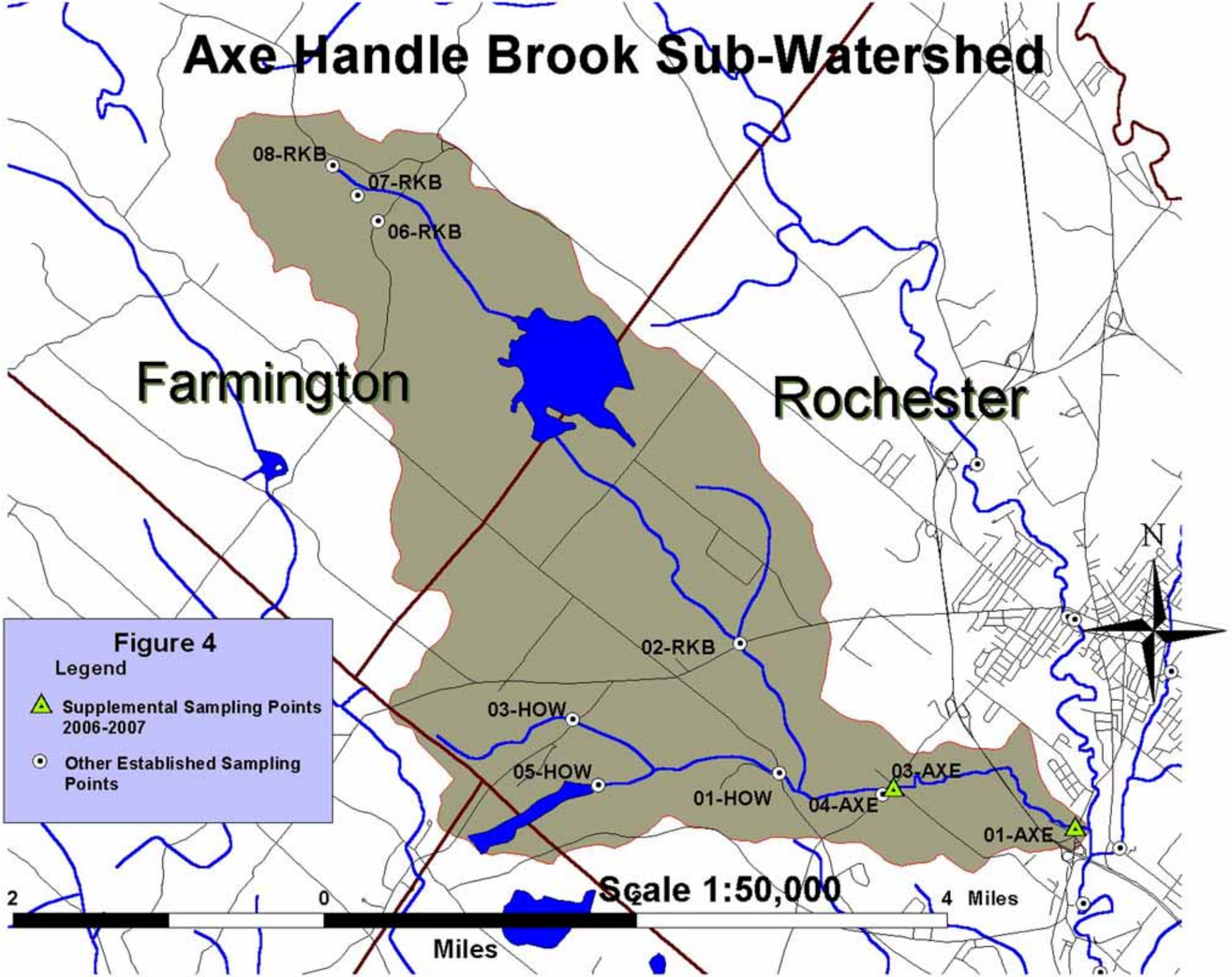
Supplemental Sampling Points 2006-2007
Other Established Sampling Points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08-RKB
07-RKB
06-RKB
Farmington
Rochester
02-RKB
03-HOW
05-HOW
01-HOW
03-AXE
04-AXE
01-AXE
N
Figure 4
Legend
Supplemental Sampling Points 2006-2007
Other Established Sampling Points
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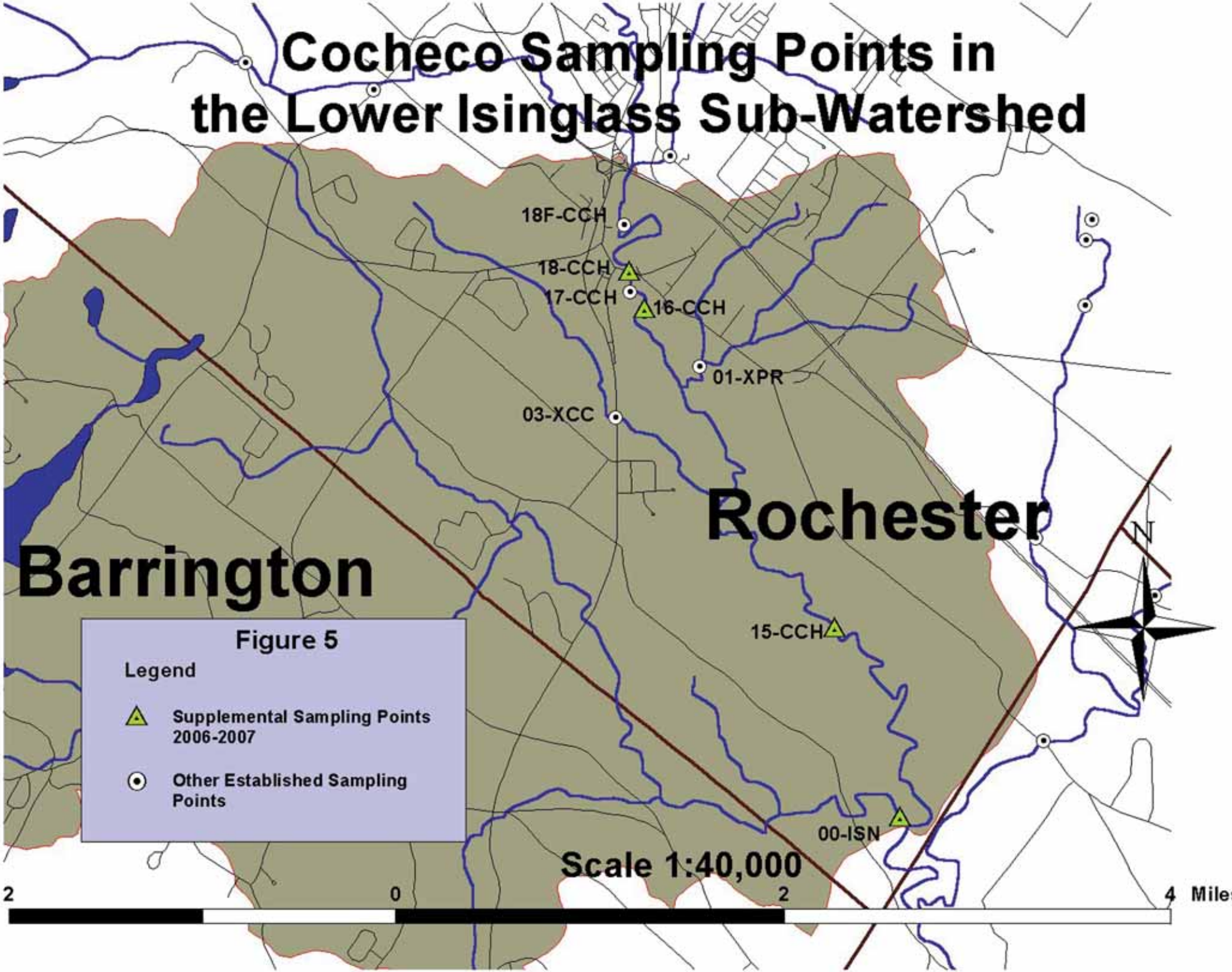
0
2
4 Miles
Miles
Scale 1:50,000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the Lower Isinglass Sub-Watershed
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18-CCH
17-CCH
16-CCH
01-XPR
03-XCC
Rochester
Barrington
15-CCH
00-ISN
N
Figure 5
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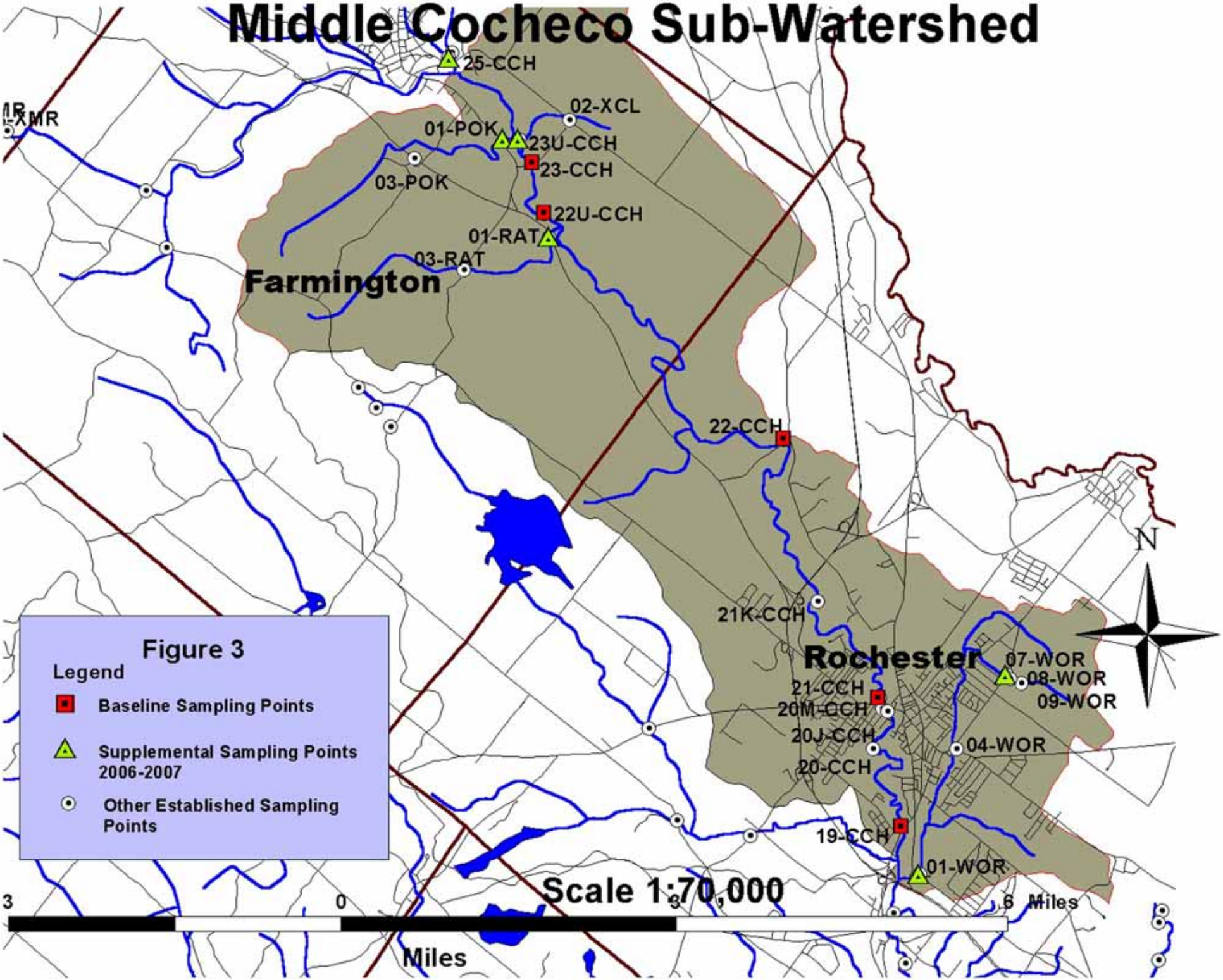
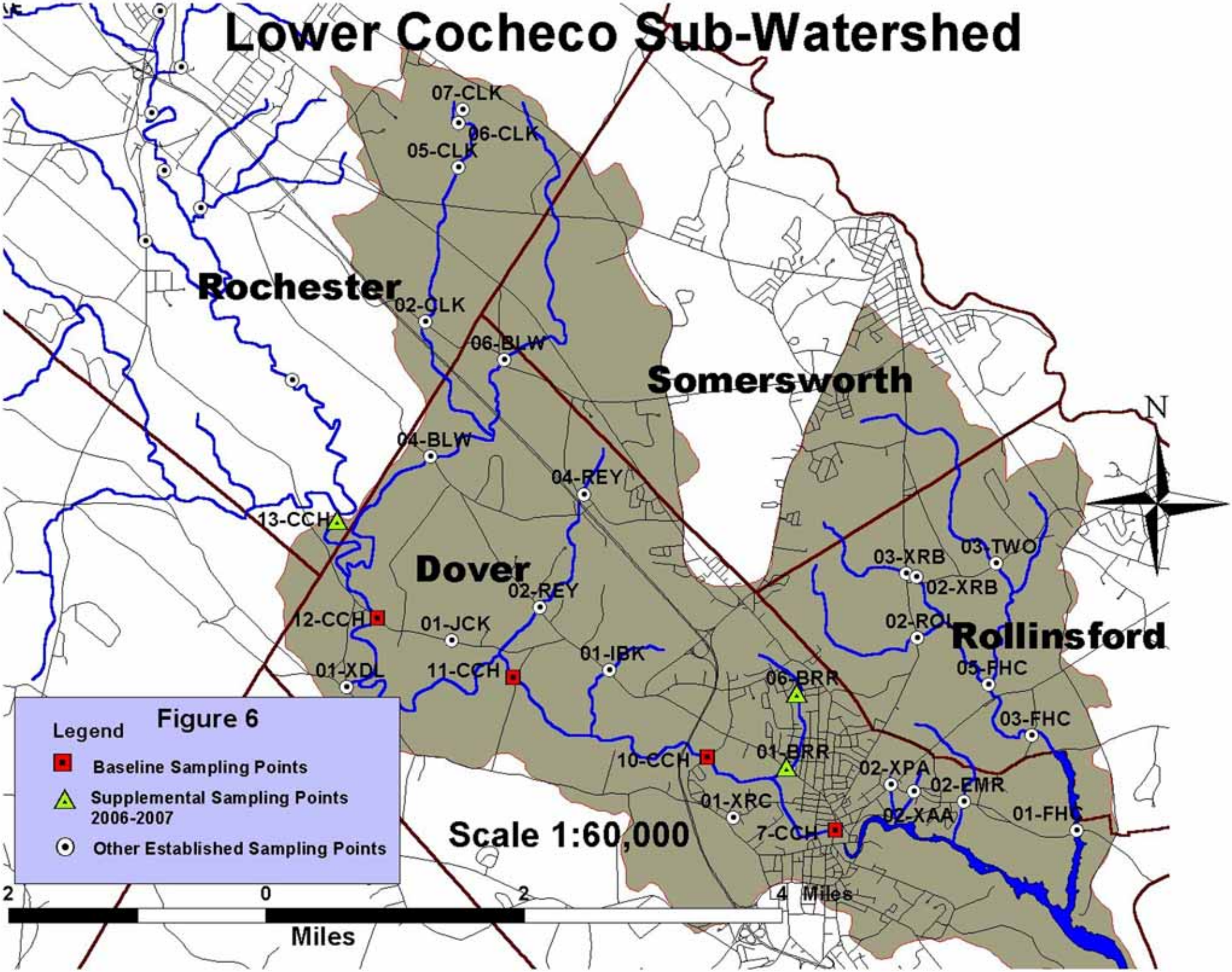
Supplemental Sampling Points 2006-2007
Other Established Sampling Points
Scale 1:40,000
2
0
2
4 Miles


Middle Cocheco Sub-Watershed
25-CCH
02-XCL
01-POK
23U-CCH
23-CCH
03-POK
22U-CCH
01-RAT
03-RAT
Farmington
22-CCH
21K-CCH
Rochester
07-WOR
08-WOR
09-WOR
21-CCH
20M-CCH
20J-CCH
20-CCH
04-WOR
19-CCH
01-WOR
N
Figure 3
Legend
Baseline Sampling Points
Supplemental Sampling Points 2006-2007
Other Established Sampling Points
Scale 1:70,000
3 0 3 6 Miles
Miles


Lower Cocheco Sub-Watershed
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06-CLK
05-CLK
Rochester
02-CLK
06-BLW
Somersworth
04-BLW
04-REY
13-CCH
Dover
02-REY
12-CCH
01-JCK
01-XDL
11-CCH
01-IBK
10-CCH
06-BRR
01-BRR
01-XRC
7-CCH
03-XRB
03-TWO
02-XRB
02-ROL
Rollinsford
05-FHC
03-FHC
02-XPA
02-EMR
02-XAA
01-FHC
N
Figure 6
Legend
Baseline Sampling Points
Supplemental Sampling Points 2006-2007
Other Established Sampling Points
Scale 1:60,000
2 0 2 4 Miles
Miles

APPENDIX A – COCHECO RIVER WATERSHED ASSESSMENT UNITS, DESIGNATED USES, AND IMPAIRMENTS

Appendix A. Assessment Units, Designated Uses and Impairments

Assessment Unit	Designated Use	Is the Use Supported?	Cause of Impairment
Upper Cocheco (19 assessment units)	Aquatic Life	Not Supporting for five assessment units Fully Supporting for none Not assessed eight assessment units Insufficient Information six assessment units	Low pH for four AUs Non-native aquatic plants present in one AU
	Primary Contact Recreation	Not Supporting for two assessment units Fully Supporting for two assessment units Not assessed for ten assessment units Insufficient information for five assessment units	Elevated *E.coli* (bacteria)
	Secondary Contact Recreation	Not Supporting for zero assessment units Fully Supporting for four assessment units Not assessed for ten assessment units Insufficient information for five assessment units	--
	Fish Consumption	Not Supporting for all nineteen assessment units	Mercury in fish tissue
Axe Handle Brook (9 assessment units)	Aquatic Life	Not Supporting for two assessment units Fully Supporting for zero assessment units Not assessed for six assessment units Insufficient information for one assessment unit	Low pH
	Primary Contact Recreation	Not Supporting for one assessment units Fully Supporting for one assessment units Not assessed for six assessment units Insufficient information for one assessment unit	Elevated *E. coli* (bacteria)

Assessment Unit	Designated Use	Is the Use Supported?	Cause of Impairment
	Secondary Contact Recreation	Not Supporting for one assessment unit Fully Supporting for zero assessment units Not assessed for six assessment units Insufficient information for two assessment units	Elevated *E. coli* (bacteria)
	Fish Consumption	Not Supporting for all nine assessment units	Mercury in fish tissue
	Drinking Water After Adequate Treatment	Fully Supporting for the one assessment unit that was assessed (Rochester Reservoir)	--
Middle Cocheco (13 assessment units)	Aquatic Life	Not Supporting for six assessment units Fully Supporting for zero assessment units Not assessed for seven assessment units Insufficient information for zero assessment units	Elevated Al, low DO, low pH, Benthic macroinvertebrates monitoring results, Bioassessment and Habitat survey results, presence of nonnative aquatic plants
	Primary Contact Recreation	Not Supporting for four assessment units Fully Supporting for one assessment units Not assessed for seven assessment units Insufficient information for one assessment units	Elevated *E. coli* (bacteria)
	Secondary Contact Recreation	Not Supporting for one assessment units Fully Supporting for four assessment units Not assessed for seven assessment units Insufficient information for one assessment unit	Elevated *E. coli* (bacteria)
	Fish Consumption	Not Supporting	Mercury in fish tissue

Assessment Unit	Designated Use	Is the Use Supported?	Cause of Impairment
Lower Isinglass (6 assessment units)	Aquatic Life	Not Supporting for one assessment unit Fully Supporting for zero assessment units Not assessed for four assessment units Insufficient information for one assessment unit	Low dissolved oxygen
	Primary Contact Recreation	Not Supporting for one assessment unit Fully Supporting for one assessment unit Not assessed for four assessment units Insufficient information for zero assessment units	Elevated *E. coli* (bacteria)
	Secondary Contact Recreation	Not Supporting for zero assessment units Fully Supporting for two assessment units Not assessed for five assessment units Insufficient information for zero assessment units	--
	Fish Consumption	Not Supporting	Mercury in fish tissue
Lower Cocheco (21 assessment units)	Aquatic Life	Not Supporting for four assessment units Fully Supporting for zero assessment units Not assessed for seventeen assessment units Insufficient information for zero assessment units	Low pH
	Primary Contact Recreation	Not Supporting for two assessment units Fully Supporting for three assessment units Not assessed for sixteen assessment units Insufficient information for zero assessment units	Elevated *E. coli* (bacteria)

Assessment Unit	Designated Use	Is the Use Supported?	Cause of Impairment
Lower Cocheco Continued	Secondary Contact Recreation	Not Supporting for zero assessment units Fully Supporting for four assessment units Not assessed for seventeen assessment units Insufficient information for zero assessment units	--
	Fish Consumption	Not Supporting	Mercury in fish tissue

APPENDIX B – MATRIX OF MONITORING ACTIONS

Appendix B
Matrix of Monitoring Actions
Cocheco River Restoration Project

Action Number	Description	Area of Interest	Related Objective(s)	Lead Organization	Communities	Other	Near Term - 1 to 3 Years	Mid Term 4 to 5 years	Long Term 6 to 10 years
DSI-10	Identify and correct flawed or outdated stormwater infrastructure along Cocheco River.	All subwatersheds	DSI Objectives 1, 4, & 5	Watershed Public Works Departments	primarily Rochester, Farmington, Dover	NHDES, NHDOT, CRWC	highest	highest	highest
HI-4	Review collected data and determine additional areas needed buffer/habitat surveys and complete surveys as needed.	All subwatersheds	HI Objective 1	CRWC	Conservation Commissions	Conservation organizations, UNHCE, UNH, NHNHI	highest	highest	highest
HI-6	Establish chemical, physical, and biological monitoring stations to determine links between biological and chemical changes along River	All subwatersheds	HI Objective 2	CRWC	Conservation Commissions	NHDES, NHCP	highest	highest	highest
HI-10	Conduct a solid waste survey along the Cocheco corridor and tributaries with the assistance of neighbors and volunteers	All subwatersheds	HI Objective 3	CRWC	Public Works departments	Volunteers, Residents, United Way	highest	highest	highest
WQR-1	Modify sampling plan to better define and understand causes of anamolous dissolved oxygen, biological oxygen demand, and temperature fluctuations in the Cocheco River Watershed	All Subwatersheds	WQR Objective 1	CRWC	All communities	VRAP, UNH, consultants, Waste Management, riparian landowners, volunteers	highest	highest	highest
WQR-3	Modify bacterial sampling program to further identify sources of bacterial loading	Upper, Middle and Lower Cocheco	WQR Objective 2	CRWC		VRAP, UNH, consultants, volunteers	highest	highest	highest
WQR-4	Evaluate extent of failed septic systems in heavily settled areas.	Farmington, Rochester, Dover	WQR Objective 2	Farmington, Rochester, Dover	Farmington Health Officer, Public Works	Residents, NHDES	highest	highest	highest

Appendix B
Matrix of Monitoring Actions
Cocheco River Restoration Project

Action Number	Description	Area of Interest	Related Objective(s)	Lead Organization	Communities	Other	Near Term - 1 to 3 Years	Mid Term 4 to 5 years	Long Term 6 to 10 years
WQR-9	Review existing data to identify areas of elevated phosphorus and nitrogen and modify sampling plan to assess source areas.	Upper, Middle and Lower Cocheco	WQR Objective 3	CRWC	Municipalities	VRAP, UNH, consultants	highest	highest	highest
WQR- 12	Analyze sampling data, identify existing impacts of stormwater runoff on Cocheco River water quality	All Subwatersheds	WQR Objective 4	CRWC	Public works departments	VRAP, volunteers, NHDES	highest	highest	highest
DSI-1	Reduce or minimize proliferation of impervious surfaces.	All subwatersheds	DSI Objectives 1 & 6	Municipalities	All Municipalities	NHDES, SRPC, NHEP, UNHCE, CRWC	high	high	high
DSI-7	Work with citizens and municipalities to reduce shoreline protection violations and stream bank modification	All subwatersheds	DSI Objectives 2 & 6	NHDES	Cons. Commissions., All communities	CRWC	high	high	high
DSI-12	Evaluate road crossings and lessen stormwater impairment at these Cocheco River discharge points.	All subwatersheds	DSI Objectives 4 & 5	CRWC	Public works departments	NHDOT, UNH, NRCS	high	high	high
HI-7	Survey distribution and determine causes of terrestrial and aquatic nuisance species.	All subwatersheds	HI Objective 2	CRWC	Conservation Commissions	Volunteers, NHFG, UNH, NHDES	high	high	high
HI-11	Survey road crossings to identify obstacles to stream flow and wildlife passage.	All subwatersheds	HI Objective 3	CRWC	Public works departments	NHDOT, UNH, NHFG, TNC	high	high	high
WQR-5	Begin volunteer program to help identify illicit discharges.	Upper, Middle and Lower Cocheco	WQR Objective 2	CRWC	Public works departments	Volunteers, NHDES	high	high	high
WQR-6	Evaluate and correct illicit discharges and cross connections near Cocheco River and its tributaries.	Upper, Middle and Lower Cocheco	WQR Objective 2	Public works departments	Farmington, Rochester, Dover	CRWC, NHDES, property owners	high	high	high

Appendix B
Matrix of Monitoring Actions
Cocheco River Restoration Project

Action Number	Description	Area of Interest	Related Objective(s)	Lead Organization	Communities	Other	Near Term - 1 to 3 Years	Mid Term 4 to 5 years	Long Term 6 to 10 years
WQR-8	Conduct water quality monitoring to verify water quality improvement in areas of septic system repair and illicit discharge corrections.	Upper, Middle and Lower Cocheco	WQR Objective 2	CRWC	Public works departments	VRAP, volunteers, NHDES	high	high	high
WQR-14	Add regular metals analysis to sampling program to further define occurrence and sources of elevated metals	Middle and Lower Cocheco	WQR Objective 5	CRWC	Rochester and Farmington WWTP	VRAP, volunteers, NHDES	high	high	high
WQR-19	Modify sampling plan to track water quality changes in the vicinity of active and closed landfills along the Cocheco River.	Upper, Middle and Lower Cocheco	WQR Objective 7	CRWC	Public works departments	VRAP, UNH, consultants, landowners, NHTAG,NHDES Waste Management Division, EPA	high	high	high
HI-3	Work with New Hampshire Natural Heritage Inventory to identify exemplary natural communities.	All subwatersheds	HI Objective 1	NH Audubon	Conservation Commissions	TNC, NHDES, CRWC	priority	priority	priority
HI-21	Research historic fish species and their distribution within the Cocheco River watershed.	All subwatersheds	HI Objective 5	NHFG		CRWC, TU, UNH	priority	priority	priority
WQR-15	Research permitted withdrawals from the river	All subwatersheds	WQR Objective 6	CRWC	Public works departments, Cons. Commissions.	NHDES, consultants	priority	priority	priority

APPENDIX C – SUMMARY OF SAMPLING STATIONS AND ASSESSMENT UNITS – COCHECO RIVER WATERSHED STUDY AREA

Appendix C
Summary of Sampling Stations and Assessment Units - Cocheco River Watershed Study Area

Assessment Unit ID	Station ID	Proposed Station Location	Town
Upper Cocheco River: 600030601			
NHRIV600030601-01	12-ELA	Ela River; Birch Hill Road Bridge	New Durham
NHRIV600030601-02	10-ELA	Ela River; Outlet of Cold Rain Pond/Old Bay Road Bridge	New Durham
	01-XEL	Unnamed Trib; Valley Road Bridge/Branch south of Route 11	New Durham
	06-ELA	Ela River; Davis Cross Road Bridge	New Durham
	04-ELA	Ela River; Spring Street Bridge	Farmington
	02-ELA	Ela River; Behind Orchard Circle off Central Street	Farmington
	01-ELA	Ela River; 20 feet upstream from conf. w/ Cocheco	Farmington
	26-CCH	Cocheco River; Central Street Bridge	Farmington
NHRIV600030601-03	01-XCR	Unnamed; Pinkham Road Bridge; nouthern inlet of Sunrise Lake	Middleton
	01-XCL	Unnamed; Lakeshore Road Bridge; southern inlet of Sunrise Lake	Middleton
NHRIV600030601-04	02-XCH	Unnamed; Nicola Road Bridge; Outlet of Sunrise Lake	Middleton
NHRIV600030601-05	04-HAY	Hayes Brook; Miller Road Bridge	New Durham
note: Hayes Brook AU to be established	02-HAY	Hayes Brook; Middleton Road Bridge	New Durham
	29-CCH	Cocheco River; Middleton Road Bridge	New Durham
	01-XCH	Unnamed; Silver Street Bridge	Middleton
	28-CCH	Cocheco River; Old Bay Road Bridge	Farmington
NHIMP600030601-02	27X-CCH	Cocheco River; impoundment behind Cocheco Dam/Old Bay Road Br.	Farmington
NHRIV600030601-06	06-XMR	Unnamed; Ridge Road Bridge (North Branch)	New Durham
	01-XMT	Unnamed; Ridge Road Bridge (South Branch)	New Durham
NHIMP600030601-01	03-XMR	Unnamed; Road off Ten Rod Road just US of Libby's Pond Dam	Farmington
NHRIV600030601-08	05-MAR	Mad River; Ten Road Road Bridge	Farmington
	01-XMR	Unnamed; Hornetown Road Bridge	Farmington
	03-MAR	Mad River; River Street Bridge	Farmington
	02-MAR	Mad River - Old Route 111 Bridge	Farmington
	01-MAR	Mad River; Tappen Street Bridge	Farmington
	00-MAR	Confluence of Mad River and Cocheco	Farmington

Appendix C
Summary of Sampling Stations and Assessment Units - Cocheco River Watershed Study Area

Assessment Unit ID	Station ID	Proposed Station Location	Town
Upper Cocheco River: 600030601 (continued)			
NHRIV600030601-07	08-DMS	Dames Brook; Hare Road Bridge	Farmington
	04-DMS	Dames Brook; West Milton Road Bridge	Milton
	02-DMS	Dames Brook just US of Conf w/ Kicking Horse	Farmington
	01-DMS	Dames Brook; Route 75 Bridge	Farmington
NEW AU for Kicking Horse	06-KHB	Kicking Horse Brook; Charles St/Route 153 Bridge	Farmington
Note: Kicking Horse AU to be established	01-KHB	Kicking Horse Brook; Just above confl. w/ Dames Brook	Farmington
NHRIV600030601-09	25-CCH	Cocheco River; Main St./Rte. 153 Bridge	Farmington
LAKES			
NHLAK600030601-01		Chalk Pond	New Durham
NHLAK600030601-02		Club Pond	New Durham
NHLAK600030601-03		Coldrain Pond	New Durham
NHLAK600030601-04		Marchs Pond	New Durham
NHLAK600030601-05-01		Sunrise Lake	Middleton
NHLAK600030601-06		Currier Pond	Middleton
Axe Handle Brook Watershed: 600030602			
NHRIV600030602-01	08-RKB	Rickers Brook; Find access behind Ten Rod Road	Farmington
NHIMP600030602-01	07-RKB	ckers Brook; Bouchard Dam Impound./find acc, off Poor Farm R	Farmington
NHRIV600030602-02	06-RKB	Rickers; Poor Farm Road Bridge	Farmington
Note: Rickers Brook AU to be established			
NHRIV600030602-03	01-AXE	Axe Handle Brook; Rte. 125 Bridge Rochester	Rocheseter
	03-AXE	Axe Handle Brook;Chesley Hill Road Bridge	Rochester
	04-AXE	Axe Handle Brook; Route 202 Bridge	Rochester
	01-HOW	Howards Brook, Estes Road Bridge	Rochester
	02-RKB	Rickers Brook, Route 202A	Rochester

Appendix C
Summary of Sampling Stations and Assessment Units - Cocheco River Watershed Study Area

Assessment Unit ID	Station ID	Proposed Station Location	Town
Axe Handle Brook Watershed: 600030602 (continued)			
NHRIV600030602-04	?-HOW	Howards Brook; No obvious access; need to groundtruth	Rochester
NHIMP600030602-02	?-HOW	Howards Brook; No obvious access; need to groundtruth	Rochester
Howards Brook station numbers to be established			
LAKES			
NHLAK600030602-01	VLAP	Baxter Lake	Farm/Roch
NHLAK600030602-02		Nubble Pond	Farmington
NHLAK600030602-03		Rochester Reservoir	Rochester
Middle Cocheco River: 600030603			
NHRIV600030603-01	23-CCH	Watson Corner Road Bridge	Farmington
	23-U- CCH	Upstream of Farmington Waste Water Treatment Plant outfall	Farmington
	23-D CCH	Upstream of Confluence with Pokamoonshine Brook	Farmington
	22U-CCH	Pike Industries Bridge	Farmington
NHRIV600030603-02	03-POK	Pokamoonshine Brook; Route 11 Bridge	Farmington
	01-POK	Pokamoonshine Brook; Route 153 Bridge	Farmington
NHRIV600030603-03	02-XCL	Unnamed; Chestnut Hill Road Bridge	Farmington
	01-XCL	Unnamed; 50' US from confluence with Cocheco	Farmington
NHRIV600030603-04	03-RAT	Rattlesnake River; Meeting Hill Road Bridge	Farmington
	01-RAT	Rattlesnake River; Route 11 Bridge	Farmington
NHRIV600030603-05	None	Route 11 crossing; need to groundtruth	Farmington
NHRIV600030603-06	22-CCH	Little Falls Road Bridge	Rochester
	21K-CCH	Riverview Drive access to river	Rochester
NHIMP600030603-01	21-CCH	North Main St. Bridge (202A)	Rochester
NHRIV600030603-07	20M-CCH	Boat access needed….DS of dam…0.5 mi	Rochester
NHIMP600030603-02	20J-CCH	Bridge St. Bridge	Rochester
NHRIV600030603-08	19-CCH	Route 125 Bridge	Rochester
NHRIV600030603-09	09-WOR	Wordley Brook; ROW off of Franklin St. Rochester	Rochester
NHIMP600030603-03	08-WOR	Wordley Brook; Need to groundtruth to find access	

Appendix C
Summary of Sampling Stations and Assessment Units - Cocheco River Watershed Study Area

Assessment Unit ID	Station ID	Proposed Station Location	Town
Middle Cocheco River: 600030603 (continued)			
NHRIV600030603-10	07-WOR	Wordley Brook; Franklin Street Bridge	Rochester
	04-WOR	Wordley Brook; Route 108 Bridge	Rochester
	01-WOR	Wordley Brook; Old Dover Road Bridge	Rochester
Confluence with Isinglass: 600030607			
NHRIV600030607-12	01-XPR	Unnamed; Access fom WWTF access road	Rochester
NHRIV600030607-13	03-XCC	Unnamed; Route 125 Bridge	Rochester
NHRIV600030607-14	18F-CCH	Access from end of Shelby Lane	Rochester
NHIMP600030607-02	18-CCH	Gonic Dam Impoundment: Maple Street Bridge	Rochester
NHIMP600030607-03	17-CCH	Mill Dam Impoundment; access via trail off Maple St.	Rochester
NHRIV600030607-15	16-CCH	Rochester Wastewater Treatment Plant - Gonic	Rochester
	15-CCH	Old England Road Former Bridge	Rochester
Lower Cocheco River: 600030608			
NHIMP600030608-01	07-CLK	Clarks Brook; Find Access off Rte 108 near Skyhaven	Rochester
NHRIV600030608-01	06-CLK	Clarks Brook; Find Access off Rte 108 near Skyhaven	Rochester
NHIMP600030608-03	05-CLK	Clarks Brook; Find Access off Rte 108 near Skyhaven	Rochester
NHRIV600030608-02	02-CLK	Clarks Brook-Blackwater Road Bridge	Rochester
Note: Clark Brook AU may be established			
	06-BLW	Blackwater Brook - Blackwater Road Bridge	Dover
	04-BLW	Blackwater Brook - 6th St. Br. (Below conf w/ Clark)	Dover
NHRIV600030608-03	13-CCH	Glen Hill Road, Rochester Neck Road, DS of confluence with Isinglass River	Dover
	12-CCH	County Farm	Dover
NHRIV600030608-14	01-XDL	Swale from Dover Landfille; GlenHill Rd. Bridge	Dover
Note: Jackson Brook AU to be established	01-JCK	Jackson Brook; County Farm Road	Dover
NHIMP600030608-02	11-CCH	Watson Road Bridge	Dover
NHRIV600030608-04	04-REY	Reyners Brook; Varney Road Bridge	Dover
	02-REY	Reyners Brook; 6th Street Bridge	Dover
NHRIV600030608-05	10-CCH	Whittier Street Bridge	Dover

Appendix C
Summary of Sampling Stations and Assessment Units - Cocheco River Watershed Study Area

Assessment Unit ID	Station ID	Proposed Station Location	Town
Lower Cocheco River: 600030608 (continued)			
NHIMP600030608-04	07-CCH	Central Ave Bridge	Dover
NHRIV600030608-06	01-IBK	Indian Brook; 6th Street Bridge	Dover
Ruby Creek	01-XRC	Ruby Creek; 4th Street	Dover
Berry Brook	06-BRR	Berry Brook; Rosevelt St. Bridge	Dover
Note: Berry Brook and Ruby Creek AU's to be established	02-BRR	Berry Brook; 6th Street Bridge	Dover
NHRIV600030608-07	02-EMR	Emerson Brook; Gulf Road Bridge	Dover
NHRIV600030608-08	03-TWO	Twombly Brook; Rollins Road Bridge	Rollinsford
NHIMP600030608-06	05-FHC	Fresh Creek; Twomey Dam Impound; Access from Broadway	
NHRIV600030608-09	03-XRB	Unnamed off Robbins Brook; Broadway Bridge	Rollinsford
NHIMP600030608-05	02-XRB	Unnamed; Access from Rollins Road just behing Dam	Rollinsford
NHRIV600030608-10	02-ROL	Rollins Brook; Broadway Bridge	Rollinsford
NHRIV600030608-11	03-FHC	Fresh Creek; Old Mill Lane Bridge	Rollinsford
NHLAK600030608-01	01-FHC	Fresh Creek Pond; Gulf Road Bridge	Dover
NHRIV600030608-12	02-XPA	Unnamed Trib; Portland Ave. Bridge	Dover
NHRIV600030608-13	02-XAA	Unnamed Trib; Atlantic Ave. Bridge	Dover

APPENDIX D – EXAMPLES OF DATA COLLECTION FIELD SHEETS

NH Volunteer River Assessment Program
2006 Field Data Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

For Office Use Only

Data Entered: _____

Data QC: _____

Final Data: _____

Date: _____ Start Time: _____ End Time (All monitoring activities for the day complete): _____

River: _____ Kit #_____ Volunteer Monitors (First & Last Names): _____

Initial Turbidity Meter Check Value: _____

Initial Conductivity Meter Check Value (175-225µS): _____

Time Dissolved Oxygen Meter Turned On: _____

Time of 1st Dissolved Oxygen Calibration: _____

DES Station ID	Station Name Or Description	Time Sampled (HHMM) (Military Time)	Turbidity (NTU)	pH Calibration Slope (92-102%)	pH	Dissolved Oxygen Calibration Value	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)	Water Temp (ºC)	Air Temp (ºC)	Dissolved Oxygen (%sat in chamber)	Specific Conductance (µS)
_____R	**Replicate at** (Station ID) _____											

QA/QC Meter Check

Dissolved Oxygen Zero Oxygen Reading (mg/L): _____ (% Sat): _____ Station:_____ Time:_____

6.0 pH Buffer Reading (5.8 – 6.3): _____ Station: _____ Time: _____

DI Blank Turbidity Reading: _____ Station: _____ Time: _____

Important! Please complete the **VRAP Equipment & Supply Checklist** in your field kit ***before*** sampling!

All fields must be completed in order for this data sheet to be accepted by VRAP. **Scribe**:_____

Weather Conditions:

Current Weather (circle one): Clear Partly Cloudy Overcast Foggy Hazy Showers Downpour Snow Other:_____

Please describe the past three days' local weather. 1 Day Prior:_____ 2 Days Prior:_____ 3 Days Prior:_____

End of the Day Meter Check: (Record Value)

Conductivity (200 µS std.): _____

Turbidity (1.0 std.): _____

End of Day Checklist: (Check if completed)

All Meters:

- Dry and powered off: _____

DO:

- Rinse probe with DI water _____
- Return probe in chamber w/ wet sponge _____

pH:

- Rinse probe with DI water and blot dry _____
- Insert blue plug into probe and return probe to storage solution _____
- Store probe upright in storage solution _____

Turbidity:

- Rinse sample vial and fill with DI water _____

Conductivity:

- Rinse probe with DI water _____
- Return probe to chamber _____

VRAP Kit:

- Remove used Kimwipes _____
- Clean off dirt, dust and moisture _____

Comments: (Water level, Color, Odor, Observed Use) Please indicate site code.

Please return data sheets to:

NH Volunteer River Assessment Program
29 Hazen Drive – PO Box 95
Concord NH 03301
www.des.nh.gov/wmb/vrap

Habitat Assessment Field Data Sheet
Low Gradient Streams

Stream Name	
Station #_____ Rivermile _____	
Lat _____ Long _____	
Storet #	
Form Completed By	Date _____ Time _____ AM PM

Habit Parameter				
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	30 - 50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10 - 30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50%-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7.Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note-channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable: evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Habitat Assessment Field Data Sheet Mid Gradient Streams

Stream Name	**Location**
Station #_____ River mile _____	**Stream Class**
Lat _____ Long _____	**River Basin**
Storet #	**Agency**
Investigators	
Form Completed By **Date _____ Time _____ AM PM**	**Reason for Survey**

Habitat Parameter	***Condition Category*** **Optimal**	**Sub optimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30 - 50% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	10 - 30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Riffle substrate consists of gravel, cobble, and boulder particles that are 0-25% surrounded by fine sediment. Pool substrates are a mixture of substrate materials with little to no deposition of fines and gravel or cobble prevalent.	Riffle substrate consists of gravel, cobble, and boulder particles that are 25-50% surrounded by fine sediment. Pool substrates are a mixture of course to soft sand; some root mats and submerged vegetation may be present	Riffle substrate consists of gravel, cobble, and boulder particles that are 50-75% surrounded by fine sediment. Pool substrates are soft silts or mud; root mats and submerged vegetation may be common.	Riffle substrate consists of gravel, cobble, and boulder particles that are 75-100% surrounded by fine sediment. Pool substrate may be all mud with root mat and submerged vegetation abundant. Niche space severely limited.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <0.3 m/s, deep is >0.5 m.)	Only 3 of the 4 regimes present, and the majority of pools are large deep, with very few shallow.	Only 2 of the 4 habitat regimes present, with shallow pools much more prevalent than deep pools.	Dominated by 1 velocity/depth regime with a few shallow pools or no pools present (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 10% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 10-40% of the bottom affected; slight deposition in pools.	Moderate deposition f new gravel, sand or fine sediment on old and new bars; 40-70% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 70% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream rech channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; variety of habitat is key.	Occurrence of riffles relatively infrequent.	Occasional riffle; bottom contours provide some habitat.	Generally all flat water or shallow riffles; poor habitat.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable: evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, under story shrubs, or non woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally	70-90% of the stream bank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one half of the potential plant stubble height remaining	50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e.: parking lots, roadbeds, clear cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Habitat Assessment Field Data Sheet
High Gradient Streams

Stream Name	
Station #_____ Rivermile _____	
Lat _____ Long _____	
Storet #	
Form Completed By	Date _____ Time _____ AM PM

Habit Parameter				
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40 - 70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20 - 40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche species.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	
3. Velocity/Depth Ragime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is <0.3 m/s, deep is >0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of f new gravel, sand or fine sediment on old and new bars; 30-50% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable: evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e.: parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12018 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0