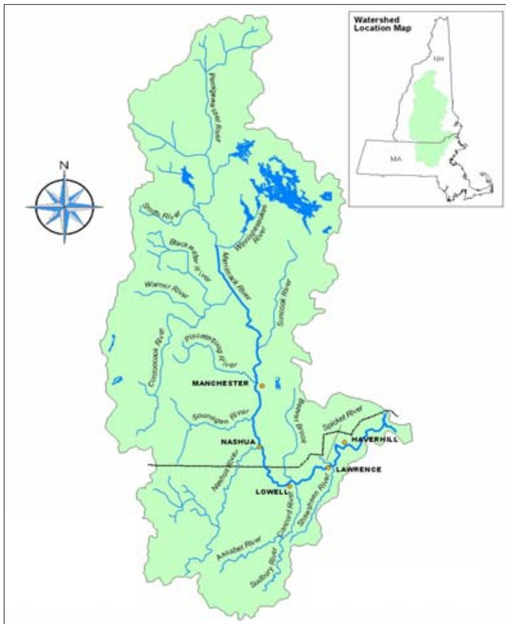

Merrimack River Watershed Assessment Study

Quality Assurance Project Plan (QAPP)

Prepared for:

New England District
U.S. Army Corps of Engineers

Sponsor Communities:
Manchester, NH
Nashua, NH
Lowell, MA
GLSD, MA
Haverhill, MA

May 2003

The River Basin Community Coalition concept was conceived in June 1998 in response to regulatory requirements to mitigate Combined Sewer Overflows (CSO) discharges. Because the coalition communities faced an aggregate financial commitment of 0.5 to 1.0 billion dollars, the five founding technical managers and administrators from each community believed that such an investment should be made wisely. They believed that this wise investment should be founded on good science that holistically embraces the needs of the watershed. Generally speaking the mission is to "spend smart" by making wise science based investments in activities related to water quality improvements that are not solely focused on CSO mitigation.

QUALITY ASSURANCE PROJECT PLAN

for

Merrimack River Watershed Assessment Study

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Date Prepared: May 13, 2003

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Acronyms and Abbreviations

ASTM	American Society of Testing and Materials
BOD	Biochemical Oxygen Demand
cfs	Cubic feet per second
CMR	Code of Massachusetts Regulations
COC	Chain-of-Custody
CSO	Combined Sewer Overflow
DO	Dissolved Oxygen
DQO	Data Quality Objectives
Dup	Duplicate
D/S	Downstream
FSP	Field Sampling Plan
FPC	Field Program Coordinator
GIS	Geographic Information System
GLPs	Good laboratory procedures
GLSD	Greater Lawrence Sanitary District
GPS	Global Positioning System
IDW	Investigation-derived waste
L	Liter
LCSDs	Laboratory Control Standard Duplicates
LCS	Laboratory Control Samples
MADEP	Massachusetts Department of Environmental Protection
MDLs	Method detection limits
MF	Membrane filtration (for fecal coliform analysis in freshwater)
mL	Milliliter
MPN	Most Probable Number (for fecal coliform analysis in marine waters)
MS	Matrix spikes
MSDs	Matrix spike duplicates
NAI	Normandeau Associates, Inc.
NEA	Northern Ecological Associates, Inc.
NHDES	New Hampshire Department of Environmental Services

PCB	Polychlorinated biphenyls
PIBS	Portable-Invertebrate-Box Sampler
PM	Project Manager
Poly	Polyethylene
QA	Quality assurance
QA/QC	Quality assurance/ quality control
QAPP	Quality Assurance Project Plan
QC	Quality control
%R	Percent Recovery
RL	Reporting Limit
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
TBD	To be determined
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
U/S	Upstream
WRDA	Water Resource Development Act
WWTP	Wastewater Treatment Plant

Preface

This Quality Assurance Project Plan (QAPP) has been developed for the Merrimack River Watershed Assessment Study. The Study is funded by the United States Army Corps of Engineers (USACE) and a coalition of five communities located along the Merrimack River: Manchester and Nashua, New Hampshire; Lowell, Greater Lawrence Sanitary District (GLSD), and Haverhill, Massachusetts. The USACE New England District acts as the study manager and primary authority for this project. Although this project is not funded by the United States Environmental Protection Agency (USEPA), the USACE has requested that this QAPP be developed in accordance with USEPA guidelines. As such, the document is based on EPA's *QA/R-5: EPA Requirements for Quality Assurance Project Plans* (March 2001). This submittal is comprised of the following three components:

- Quality Assurance Project Plan (QAPP): Provides a summary of the project scope and objectives, defines the project quality objectives, and provides an overview of the field, analytical, and quality assurance/ quality control (QA/QC) activities

- Field Sampling Plan: Describes the specific sampling locations, frequency, and methods for water quality and flow measurements

- Standard Operating Procedure (SOP) Compendium: Compilation of SOPs detailing the specific sampling and laboratory procedures

Approval of this QAPP by USEPA and the USACE is required before the sampling program can begin. Copies of this QAPP will be provided to the Massachusetts Department of Environmental Protection (MADEP) and the New Hampshire Department of Environmental Services (NHDES) for review and comment prior to initiation of the sampling program.

Section 1 Project Management

1.1 Project/Task Organization

1.1.1 Study Authority

The Merrimack River Watershed Assessment Study is a jointly funded effort by the federal government, through the United States Army Corps of Engineers (USACE), and the following five local community sponsors within the Merrimack Basin: the cities of Manchester and Nashua, New Hampshire, the City of Lowell, the Greater Lawrence Sanitary District (GLSD), and the City of Haverhill, Massachusetts- collectively the "Merrimack River Basin Community Coalition". The USACE Study Manager is responsible for overall study management, control, coordination, and implementation/completion.

The USACE is providing 50-percent of the cost share for the assessment study, as well as technical assistance. Involvement of the USACE is authorized under Section 729 of the Water Resources Development Act (WRDA) of 1986 entitled "Study of Water Resources Needs of River Basins and Regions" as amended by Section 202 of WRDA 2000. This project was initiated in response to specific language contained in Section 437 of WRDA 2000 that directed the USACE to conduct a comprehensive study of the water resource needs of the Merrimack River basin in Massachusetts and New Hampshire.

Directed funds for this effort were provided to the USACE by Congress in the fiscal year 2001 and 2002 Energy and Water Development Appropriation Bill. The City of Lowell, Massachusetts, serving as the local sponsor of this project, entered into a Memorandum of Understanding with the four other parties (Manchester and Nashua, New Hampshire; GLSD and Haverhill, Massachusetts) in the watershed to provide the remaining financial support for the study.

1.1.2 Team Organization

The USACE Study Manager, Ms. Barbara Blumeris, serves as the primary point of contact between CDM and its subcontractors (hereafter referred to as the CDM Project Team) and the five sponsor communities. The five communities, in conjunction with the USACE, serve as the overall Study Management Team for the watershed study. The role of this Team is to provide general project guidance and ensure that work performed under this contract meets the prescribed project scope. The Study Management Team will review proposed sampling locations and water quality constituents associated with the field sampling plan. All project deliverables will be reviewed by both an Independent Technical Review Team of USACE staff and by the Study Management Team. Approximately monthly meetings of the Study Management Team and the CDM Project Team will be convened during the development and implementation of the field sampling program. The Study Management Team will ultimately use the results of this monitoring program to support decisions for recommended investments in the watershed.

The CDM Project Team is comprised of CDM and its subcontractors:

- Normandeau Associates Inc. (NAI) of Bedford, New Hampshire
- Northern Ecological Associates (NEA) of Portland, Maine
- Aquatec Biological Sciences of Williston, Vermont
- AMRO Environmental Laboratories Corporation of Merrimack, New Hampshire

Mr. Gary Mercer of CDM will serve as the Technical Project Manager for this field sampling program. Mr. Mercer will ensure that the work completed by the CDM Project Team meets the prescribed scope of work; he will be the primary point of contact between the CDM Project Team and the Study Management Team. Mr. Mercer will work closely with the Study Management Team to develop an effective sampling plan and solicit feedback regarding the proposed design. Mr. Mercer will also be responsible for coordinating the specific details of the data collection and review effort, such as:

- Making final go/no go decisions for sampling events
- Oversight of CDM Project Team mobilization during sampling events, including sampling crews from CDM, Normandeau, and NEA
- Oversight of data reviews and preparation of technical memorandums

Ms. Beth Rudolph will serve as the Field Program Coordinator for CDM. She will be responsible for mobilizing, coordinating, and managing sampling teams from CDM in the field. Ms. Rudolph will also be responsible for daily tracking of weather events, and will report directly to the Technical Project Manager. Ms. Jeniffer Oxford will serve as CDM's Quality Assurance Officer; she will be responsible for ensuring that the data collected during the sampling program meets the quality objectives set forth in this QAPP. Ms. Oxford is independent of the CDM Team members that will be working on the field sampling effort. Mr. Timothy Wall will serve as the Contract Manager for CDM.

Mr. Don Kretchmer and Ms. Sarah Watts will serve as the respective Field Program Coordinators for Normandeau Associates and NEA; they will be the primary points of contact for CDM. Mr. Kretchmer and Ms. Watts will be responsible for mobilizing, coordinating, and managing their respective project teams during the field sampling effort.

During sampling events, the Field Program Coordinators, Ms. Rudolph (CDM), Mr. Kretchmer (NAI), and Ms. Watts (NEA), will be responsible for:

- Coordinating sampling efforts and equipment requirements within the CDM Project Team
- Identifying problems at the field team level
- Resolving difficulties in coordination with the Technical Project Manager
- Implementing and documenting corrective actions

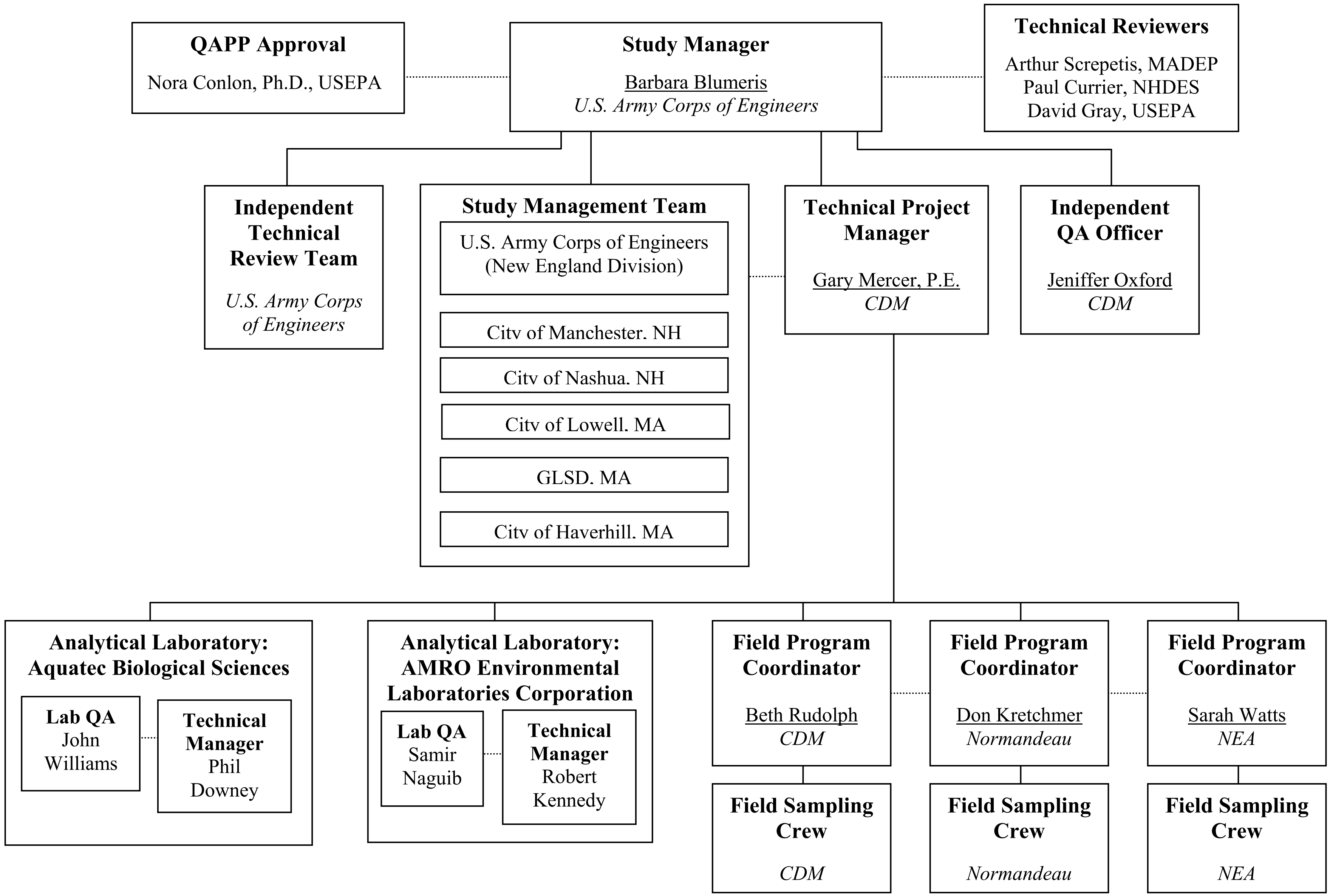
Field technical staff from CDM, NAI, and NEA will be responsible for gathering and analyzing data in the field. They will report directly to their respective Field Program Coordinators.

Aquatec Biological Sciences and AMRO Environmental Laboratories Corporation will analyze water quality samples collected during this investigation. The contacts at Aquatec and AMRO are Mr. Phil Downey and Ms. Marianne Steen, respectively. Each laboratory has an assigned Quality Assurance Officer that is responsible for assuring that the Quality Assurance Plan for their respective laboratories is adhered to and that the quality assurance and quality control criteria stipulated in this QAPP is achieved and documented for all analyzed samples. Laboratory technical staff are responsible for sample analysis and identification of corrective action. Analytical results and quality assurance and control reports will be sent to CDM's Technical Project Manager. A summary of the parameters to be analyzed by each laboratory is provided in Table 2-9.

Nora Conlon, Ph.D. serves as the approving authority for this QAPP from the U.S. Environmental Protection Agency (USEPA). Dave Gray of the USEPA, Arthur Screpetis of the Massachusetts Department of Environmental Protection (MADEP), and Paul Currier of the New Hampshire Department of Environmental Services (NHDES) serve as the respective technical reviewers from each agency. Following the approval of this QAPP, Ms. Conlon and the technical reviewers will be kept abreast of the Study progress once the sampling program begins.

A project organization chart is provided in Figure 1-1.

Figure 1-1: Project Organizational Chart



1.2 Problem Definition and Background

1.2.1 Study Background

The cities of Manchester and Nashua, New Hampshire, Lowell and Haverhill, Massachusetts, and the Greater Lawrence Sanitary District, Massachusetts are currently working separately to develop and implement long-term Combined Sewer Overflow (CSO) control plans in compliance with the Federal Clean Water Act. The collective cost of these potential CSO improvements may reach upwards of one billion dollars over the next 20 years. Given this sizable investment, the communities are concerned that decisions regarding the potential mitigation measures are being made without adequate understanding of the existing conditions in the Merrimack River, the pollution sources to the River, and the potential benefits of the proposed CSO improvements. The five sponsors, in conjunction with the USACE, are jointly funding the Merrimack River Watershed Assessment Study to develop a comprehensive assessment of the current River and watershed conditions.

1.2.2 Study Purpose

The overall purpose of the Merrimack River Watershed Assessment Study is to develop a comprehensive Watershed Management Plan for the Merrimack River watershed. The Plan will be used to guide investments in the environmental resources and infrastructure of the basin and will be aimed at achieving water quality and flow conditions that support designated uses, such as drinking water supply, recreation, and aquatic life support, in addition to other uses such as hydropower.

The assessment study is divided into two phases, only the first of which is currently funded. The water quality and flow-monitoring program for which this QAPP and the associated Field Sampling Plan have been developed is included in Phase I of the study. The general purpose of each phase is discussed below:

Phase I (Funded): The primary purpose of Phase I is to identify the relative causes and impacts of pollution problems in the Merrimack River basin as they pertain to designated uses. This will be accomplished through research, field monitoring, simulation modeling, and planning-level review of alternative pollution abatement and management strategies. Ultimately, the output from Phase I should help decisionmakers understand the relative contributions of pollutants from various sources and the basin-wide impacts of these pollutants as measured against water quality standards. This information will be used to guide decisions about how best to direct funding to yield the greatest overall benefits with respect to the designated uses of the river.

Phase II (Not Yet Funded): Phase II will build on the results from Phase I through additional field monitoring to investigate specific areas of interest or concern identified during Phase I. Additionally, a detailed cost-benefit analysis will be conducted for a wide array of possible abatement, control, and restoration initiatives. Ultimately, the output from Phase II will be a prioritized list of recommended investments throughout the Merrimack River watershed aimed at improving beneficial uses and restoring ecosystems. Additional data beyond that collected during Phase I (per this QAPP and associated Field Sampling Plan) may be required to perform the more detailed cost-benefit analysis. The collection of such data would be addressed in an amendment to this QAPP.

1.2.3 Description of Existing Conditions

Under the first Task Order of this Merrimack River Watershed Assessment Study contract, CDM developed a "*Description of Existing Conditions*" report that summarized the current state of the watershed to the project participants, sponsors, and interested stakeholders. Among other topics, this report presented a comprehensive summary of the current water quality conditions in the Merrimack River mainstem and significant tributaries based on water quality data collected since 1990 and the most recent assessment listings published by New Hampshire and Massachusetts, as follows:

- State of New Hampshire 2002 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology and Comprehensive Monitoring Strategy (December 2002)
- Massachusetts Year 2002 Integrated List of Waters. Part 1- Context and Rationale for Assessing and Reporting the Quality of Massachusetts Surface Waters and Part 2- Proposed Listing of Individual Categories of Waters (October 2002)

The review of available water quality data performed for the "*Description of Existing Conditions*" report indicated that numerous reaches in the Merrimack River mainstem and major tributaries do not currently meet designated use requirements based on violations of water quality standards for bacteria, nutrients, and metals. The results of this data review were used to identify potential water quality parameters to be considered during the specific field sampling portion of the Merrimack River Watershed Assessment Study. Additionally, the data presented therein is intended to serve as a baseline for comparison during the water quality sampling and data analysis task described in this QAPP and the associated Field Sampling Plan.

1.3 Task Description

A comprehensive water quality sampling and flow monitoring program will be completed under Phase I of the Merrimack River Watershed Assessment Study. The overall goal of the field sampling program is to provide an accurate and representative picture of the current water quality and streamflow conditions at specific sampling stations in the Merrimack River mainstem south of Hooksett, New Hampshire, as well as at the mouths of the major tributaries discharging south of this point. Additional wet-weather sampling will be performed upstream and downstream of Concord, New Hampshire to identify potential water quality impacts from stormwater runoff from an urban community with a completely separated stormdrain/sewer system. The environmental data collected under this task will be used as input to water quality and hydrologic/hydraulic models to be developed under subsequent tasks of the Merrimack River Watershed Assessment Study; a brief description of the modeling plan is provided in Section 1.3.6. These models will serve as the basis for future investment decisions in the basin.

The field sampling program will be comprised of the following four major subtasks:

- Dry-weather water quality surveys
- Wet-weather water quality surveys
- In-stream flow measurement
- Continuous dissolved oxygen and temperature measurements

A brief description of each component of the sampling program is provided in the sections below, along with a description of the Study Area. Additional detail regarding the specific water quality parameters to be analyzed during the wet and dry-weather surveys, the expected streamflow sampling regimes, and the specific sampling locations are provide in Section 2.1.1 of the QAPP and in the Field Sampling Plan (submitted under separate cover). In addition to data collected directly by the CDM Project Team, water quality data collected by the wastewater treatment plants (WWTPs) along the mainstem Merrimack River and submitted to the USEPA on their monthly monitoring reports may also be used in subsequent tasks.

The water quality data collected during the sampling program will be compared to state regulatory standards (Massachusetts 314 CMR 4.00 and New Hampshire Env-Ws 1700), to the most recent water quality assessment reports developed for Massachusetts and New Hampshire, and to the numerical results of previous water quality sampling programs conducted since 1990, as described in the "*Description of Existing Conditions*" report. The results of this comparison will be used to identify segments of the mainstem Merrimack River that *may not* meet state water quality standards.

The formal deliverables of this sampling program will be a database of water quality and streamflow measurements collected during dry- and wet-weather and a Technical Memorandum summarizing the water quality and streamflow data.

1.3.1 Study Area

For the purposes of the field sampling program, the Study Area has been defined as the mainstem Merrimack River south of Hooksett, New Hampshire to the confluence of the River with the Atlantic Ocean. This area includes the sponsor communities of Manchester and Nashua, New Hampshire; Lowell and Haverhill, Massachusetts; and the Greater Lawrence Sanitary District, Massachusetts. Each of these five sponsors has combined sewage that is discharged directly into the River during storm events over a certain volume. The final 22 miles of the mainstem Merrimack River in the Study Area, downstream of Haverhill, Massachusetts are tidally influenced.

Four dams are located within the Study Area: the Hooksett Dam in Hooksett, New Hampshire, the Amoskeag Dam in Manchester, New Hampshire, the Pawtucket Dam in Lowell, Massachusetts, and the Essex Dam in Lawrence, Massachusetts. The Study Area also includes the confluence of 11 major tributaries with the mainstem, many of which contribute to the total pollutant load in the mainstem.

Figure 1-2 shows the entire watershed, along with the portion of the mainstem that is targeted by this sampling program. A more detailed explanation of the Study Area limits is included in Section 2.1 - Sampling Process Design. A detailed description of the physical setting of the entire Merrimack River Watershed, including geology, land use, climate, hydrology, and social/economic resources, is provided in the "*Description of Existing Conditions*" report.

Figure 1-2: Primary Study Area

CDM

6149-002-002-2BQAP
11/02

1.3.2 Dry-Weather Surveys

Three dry-weather surveys are scheduled as part of this sampling program; specific details regarding sampling stations and sampling matrices are provided in the Field Sampling Plan, submitted under separate cover. The surveys will be distributed between May and November 2003. Depending on weather conditions, it is anticipated that two surveys will occur between May and mid-September; the third event will be conducted in October or November. Samples will be collected at the mouth of the 11 major tributaries, downstream of WWTPs, at two recreational areas (public beach and boat launch), upstream and downstream of each CSO community, and at two shellfishing beds in the tidally influenced portion of the basin.

Samples will be analyzed for indicator organisms, nutrients, dissolved oxygen, and oxygen demand, since these pollutants are currently known to impede the designated uses of the river, as per the findings of the "*Description of Existing Conditions*" report. The program will include field measurements and the collection of water quality samples that will be transported to the subcontracted laboratories for analysis.

During dry-weather surveys, WWTP operators may be asked to collect additional samples for water quality parameters beyond the scope of their respective National Pollutant Discharge Elimination System (NPDES) permits. The CDM Project Team will analyze these samples so that the full suite of parameters sampled for in the mainstem Merrimack River is completed at each WWTP, as well. Additional information on the specific parameters of interest is provided in the Field Sampling Plan.

Additional information on the sampling locations and water quality parameters for the dry-weather sampling events is provided in Section 2.1.1 of the QAPP and in the Field Sampling Plan.

1.3.3 Wet-Weather Surveys

Three wet-weather surveys are scheduled as part of this sampling program. The specific details of the surveys, include sampling locations and frequencies, are included in the Field Sampling Plan. The timing of the surveys will be dependent on weather patterns and the occurrence of storm events with sufficient precipitation to cause overflows in the communities' combined sewer systems. However, it is anticipated that these events will be performed between May and November 2003. Specific event selection criteria are provided in the Field Sampling Plan. Efforts will be made to space the events out over the seven-month period, *i.e.* not all of the events will occur in the first month even if three events meeting the specified criteria occur.

Sampling stations will be generally co-located with those used during the dry-weather surveys to understand the wet-weather impacts at each location. As noted above, additional samples will be collected at select combined sewer outfalls and stormdrains to quantify generalized loading from these point sources. Two stations will also be established upstream and downstream of Concord, New Hampshire to characterize the instream impacts of stormwater runoff from a large urban area with a separated stormwater/sewer system.

Samples will be analyzed for indicator organisms, nutrients, dissolved oxygen, and oxygen demand, since these pollutants are currently known to impede the designated uses of the Merrimack River. The program will include field measurements and the collection of spatial composite and grab samples that will be analyzed by the subcontracted laboratories. Multiple sweeps of each sampling station will be conducted during the wet-weather sampling events to characterize the temporal variation in pollutant concentrations and the duration of water quality exceedances.

Additional information on the sampling locations and water quality parameters for the wet-weather sampling events is provided in Section 2.1.1 of the QAPP and in the Field Sampling Plan.

1.3.4 In-stream Flow Measurements

The United States Geological Survey (USGS) currently operates two streamflow gaging stations along the mainstem within the Study Area. One station is located just south of Manchester, New Hampshire at Goffs Falls; the other is located downstream of the Concord River confluence in Lowell, Massachusetts. Additional flow measurements will be required beyond the USGS operated stations to account for pollutant mass loads discharging to the Merrimack River and within the River. Stage-discharge relationships will be developed at select stations along the mainstem and at the mouth of the major tributaries to quantify the variability of flow throughout the Study Area. Staff gages will be installed at each flow monitoring station so that the stage of the River or tributary can be determined during the wet- and dry-weather sampling events. These gages will be subject to periodic maintenance to confirm that the gage position has not changed. Additional information regarding installation and maintenance of the staff gages is provided in the Field Sampling Plan, as well as specific flow ranges over which the rating curves will be developed.

1.3.5 Continuous Dissolved Oxygen and Temperature Measurements

Continuous dissolved oxygen and temperature measurements (approximately one measurement per 15-minutes) will be made at two locations along the mainstem Merrimack River. These measurements will be taken over an approximately one-month period between mid-July and mid-September when dissolved oxygen concentrations are at critical levels for aquatic life support due to typical low-flow conditions. The exact timing of the continuous monitoring will be determined based on prevailing streamflow and climatic conditions. Routine maintenance will be performed on the dissolved oxygen and temperature probes to ensure that they are providing accurate measurements. Additional information on the type of equipment to be used and specific locations is provided in the Field Sampling Plan.

1.3.6 Modeling Methodology

The water quality and streamflow data collected as part of the field sampling program will be used as input into water quality and hydrologic/hydraulic models of the Merrimack River and its watershed in the Study Area, to be developed in a subsequent task. A technical memorandum summarizing the "Modeling Methodology" has been prepared under separate cover. The memorandum builds upon the outcomes of a modeling workshop conducted on November 8, 2002, at which a general consensus was achieved on the modeling plan. This section of the QAPP provides a brief description of the modeling plan; the reader is directed to the technical memorandum for additional details.

The underlying objective of the modeling effort is to develop a comprehensive set of models that are capable of:

- Simulating the water quality and hydraulic regimes in the mainstem Merrimack River under low-flow and baseflow conditions

- Simulating the dynamic nature of storm events and their effects on water quality and hydraulic conditions in the mainstem Merrimack River

Numerous models and combination of models are capable of meeting these objectives. Following an evaluation of several models, the USEPA's Stormwater Management Model (SWMM) and Water Quality Simulation Program (WASP) were identified as the best combination of models to simulate the hydrologic, hydraulic, and water quality conditions in the Merrimack River and its watershed. Both models are capable of simulating continuous and event-based scenarios at the fine timescales (*i.e.* on the order of minutes) required for this project.

SWMM will be used to simulate the hydrology and non-point source pollutant loading from the Merrimack River watershed, as well as the hydraulic routing in the mainstem River. SWMM was chosen for its ability to effectively model urban watersheds, which, based on a review of existing conditions, are expected to contribute the majority of pollution to the mainstem River. Additionally, CDM has already developed CSO models for each of the five sponsor communities using SWMM for the development of each city's Long-term CSO Control Plans. These existing models may be linked directly to the SWMM model to be developed as part of this Study.

WASP will be used to model the water quality in the mainstem Merrimack River. WASP is capable of effectively simulating the water quality parameters of concern in this study, including bacteria, nutrients, chlorophyll-a, dissolved oxygen, and BOD.

One SWMM model will be developed for the entire Merrimack River basin and will be linked directly to the WASP model developed for the mainstem. The existing CSO models for the five sponsor communities will remain separate to promote manageability of the new models. The existing models will be used to generate input files for the new models at matching timescales and in compatible formats.

1.4 Quality Objectives and Criteria

Environmental data and streamflow measurements to be collected by the CDM Project Team in support of the Merrimack River Watershed Assessment Study will meet the quality objectives outlined in this section. The specific quality assurance objectives and the measurement performance criteria serve as the basis for the Field Sampling Plan (submitted under separate cover). This section provides overall guidelines as to the minimum requirements for quality control, whereas the Field Sampling Plan presents detailed information on locations, methods, and frequencies for environmental measurements and sample collection.

1.4.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support defensible decisions relating to specific environmental problems. DQOs are based on the end uses of the data to be collected; as such, different data uses may require different type and level of data quality. The data collection and analysis procedures will therefore be designed to meet the most stringent DQOs.

The following two overriding DQOs have been developed for the Merrimack River Watershed Assessment Study:

- Collect water quality and streamflow data sufficient for the calibration and validation of water quality and hydrologic/hydraulic models to be developed under subsequent tasks of this Study

- Collect water quality data to determine the relative likelihood that segments of the mainstem Merrimack River meet state water quality standards

These objectives were used to select sampling locations, as specified in the Field Sampling Plan, as well as suitable sampling methods, measurement techniques, and analytical protocols with the appropriate quality assurance and quality control guidelines.

State Water Quality Standards

Both Massachusetts and New Hampshire categorize waters according to their use class. Each class is associated with a series of designated uses; the ability of a waterbody to support these uses is assessed based on its ability to meet the applicable water quality standards. In New Hampshire, designated use categories include swimming (primary contact recreation), fish and shellfish consumption, drinking water, and aquatic life support. In Massachusetts, these uses include fish consumption, aquatic life support, drinking water, shellfishing, primary contact recreation (swimming), and secondary contact recreation (boating). Other uses of the River not specifically designated by the states include hydropower and navigation.

Table 2-10 provides a summary of the respective state's criteria for the water quality constituents to be sampled during this program. These standards will be used to assess the likely compliance/non-compliance status of the mainstem Merrimack River per the second DQO.

1.4.2 Measurement Performance Criteria

Measurement performance criteria, including the precision, accuracy, completeness, comparability, and representativeness of the data, will be used to assess the quality of all environmental measurements in relation to the Data Quality Objectives. In order to meet the quality assurance objectives, the data must be (1) of known quantitative statistical significance in terms of precision and accuracy; (2) representative of the actual site in terms of physical and chemical conditions; (3) complete to the extent that necessary conclusions may be reached; and (4) comparable to previous and subsequent data collected under this program. Both field and laboratory quality objectives are addressed in each section.

Precision

The precision of a measurement is the degree to which two or more measurements are in agreement. Precision is quantitative and is most often expressed in terms of Relative Percent Difference (RPD). RPD is calculated for each pair of duplicates as indicated below:

$$RPD = \frac{(S - D) * 100}{(S + D) \div 2}$$

where S= First sample value (original or matrix spike value)
D= Second sample value (duplicate or matrix spike duplicate value)

Field Precision Objectives. Field precision is assessed by the collection and analysis of duplicate samples in the field, which are not identified to the analytical laboratory.

The results of the duplicate analyses are used to assess the degree of precision in the field samples. Field precision for samples analyzed in the laboratories will be assessed at the rate of five percent, or one duplicate for every 20 samples collected. The RPD will be calculated per the above equation. Precision requirements for field duplicates are provided in Table 1-1.

The precision of *in situ* measurements conducted in the field will be assessed based on the reproducibility of multiple readings of a single sample.

Laboratory Precision Objectives. Precision in the laboratory is determined by the comparison of laboratory generated duplicate samples, where duplicates result from an original sample that has been split for identical purposes. The precision is evaluated by determining the RPD of duplicate (replicate) analyses, as provided in the equation above. Specific laboratory precision requirements are discussed in the applicable analytical Standard Operating Procedure (SOP) and/or laboratory Quality Assurance Plan. Precision goals for each water quality parameter, as well as the acceptance limits for applicable analytical methods are provided in Table 1-1.

For bacteria samples, Aquatec will develop field precision criteria for qualifying results if precision measurements are out of range. The first 15 samples of the project will be conducted in duplicate to generate an initial field control chart based on Standard Methods. For samples thereafter, duplicate analyses will be performed at a rate of one in 20 samples. The control chart will be updated after each field sampling event to include the new duplicate values.

Accuracy

Accuracy is defined as the extent of agreement between an observed value (*i.e.* sample result) and the accepted, or true, value of the parameter being measured. Accuracy is quantitative and is usually expressed as the percent recovery (%R) of a sample result as indicated below:

$$\%R = \frac{(A - B) * 100}{C}$$

where A= Analyte concentration determined experimentally with known quantity of reference material added
B= Background determined by separate analysis of sample or, in the field, a blank
C= True value of reference standard added

Field Accuracy Objectives. The accuracy of field measurements, including continuous dissolved oxygen/temperature measurements and in-stream flow measurements, will be assessed by using measurement equipment calibrated at a frequency interval set to maintain field accuracy goals. Accuracy of water quality sample collection activities will be assessed using field blanks and by adherence to all sample handling, preservation, and holding times. Field blanks consisting of distilled, deionized water will be submitted blindly to the analytical laboratories at a rate of five percent, or one blank per 20 samples collected. Field blank cleanliness requirements are provided in Table 1-1.

Equipment blanks will be collected at all stations were bacteria spatial compositing is performed during the first wet-weather sampling event. Depending on the outcome of the first sampling round, a limited number of equipment blanks may be taken in subsequent events (*i.e.* one blank per 20 samples). The equipment blanks will consist of rinsate samples from the sample compositing equipment to determine if there is cross-contamination between sampling locations.

Laboratory Accuracy Objectives. Laboratory accuracy is assessed though the use of known standards, such as Laboratory Control Samples (LCS), and matrix and analytical spikes. Accuracy within the laboratory is expressed in terms of percent recovery (%R). Specific laboratory accuracy requirements are discussed in the applicable analytical Standard Operating Procedure and/or laboratory Quality Assurance Plan. Accuracy goals with acceptance limits for applicable analytical methods are provided in Table 1-1.

In addition, a limited number of Performance Evaluation (PE) samples will be used as a double-blind evaluation of the respective laboratory performances for the following parameters: fecal coliform, E. coli, total phosphorus, nitrate/nitrite, ammonia, Total Kjeldahl Nitrogen (TKN), and BOD. The samples will be purchased from an outside PE laboratory with a known quantity of analyte; samples will be incorporated into the first dry-weather field sampling batch. The PE laboratory will be supplied with bottles from the respective laboratories so that they are unaware of the nature of the sample when it is submitted. The PE laboratory will provide CDM with the known analyte concentration for comparison with the laboratory's results. For the fecal coliform and E. coli samples, members of the CDM project team will prepare the sample in the field from a pellet of known concentration supplied by the PE laboratory in order to meet the required six-hour holding time. All other samples will be shipped in their already prepared form by the PE laboratory.

Table 1-1: Quality Assurance Precision and Accuracy Objectives for Laboratory Analytical Analyses

Parameter	Field Precision (%RPD)[1]	Lab Precision (%RPD)[1]	Accuracy (%R)[2]	Field Blank Cleanliness[3]
Fecal Coliform	≤30%	N/A	N/A	<RL
E. Coli	≤30%	N/A	N/A	<RL
Enterococcus	≤30%	N/A	N/A	<RL
Total Phosphorus	≤30%	≤20%	80-120%	<RL
Nitrate/Nitrite	≤30%	≤20%	80-120%	<RL
Ammonia-N	≤30%	≤20%	80-120%	<RL
TKN	≤30%	≤20%	80-120%	<RL
Chlorophyll-a	≤30%	≤20%	80-120%	<RL
BOD_5	≤30%	≤20%	80-120%	<RL
BOD_{20}	≤30%	≤20%	80-120%	<RL
DO (Winkler titration)	N/A	10%	N/A	N/A

[1]%RPD= Relative Percent Difference, [2]%R= Percent Recovery, [3]RL= Reporting Limit, [4]N/A= Not Applicable

The accuracy of field measurements, such as temperature, dissolved oxygen, pH, conductivity, salinity, and turbidity will be assessed using instrument calibration in accordance with manufacturer's recommendations and calibration checks. The precisions of these estimates will be assessed on the basis of reproducibility by multiple readings of a single sample.

For in-stream flow measurements, each sampling team will be required to conduct flow monitoring at one of the real-time USGS gaging stations on the mainstem Merrimack River to assess the precision and accuracy of their measurements. Wherever possible, staff gages will be referenced to another fixed object at the time of installation (*i.e.* 21-feet below bridge railing on northwest pier). The location of the gage will be verified during each subsequent flow monitoring event prior to taking readings. Additionally, a quality assurance check of each gage will be performed approximately one-day prior to each wet and dry-weather sampling event to confirm that the gages have not been damaged or shifted.

As noted in Table 1-1, standard lab precision and accuracy objectives are not applicable to bacteria samples. Table 2-2 provides a summary of the positive and negative controls that will be implemented as part of the laboratory's quality assurance plan. Additional information on the quality assurance procedures is provided in the applicable Standard Operating Procedures (SOPs).

Table 1-2: Bacteria Quality Assurance Objectives

Parameter	Method	Frequency	Positive Control	Negative Control
Fecal Coliform	Membrane Filtration (MF)	Daily set of two controls	24-hour old culture of E. coli	Blank of consisting of sterile saline phosphorus buffer
	Most Probable Number (MPN)	Three control samples with the analytical run	E. coli	Enterobacter and a media blank of uninoculated EC media
E. coli	MTEC	Daily set of two controls	24-hour old culture of E. coli	Blank consisting of sterile phosphate buffer
	MPN	Two control samples with the analytical run	24-hour old culture of E. coli	Media blank consisting of uninoculated EC+MUG
Enterococcus	MPN/MF	Daily set of two controls	24-hour old culture of fecal streptococcus insolate	Blanks consisting of sterile buffer for MF method; uninoculated tube media for MPN

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained for that measurement under normal conditions. Events that may result in a reduction in measurement completeness include sample breakage during shipment, inaccessibility to proposed sampling location, and sampling equipment errors.

Field Completeness Objectives. Field completeness is a measure of the amount of valid results obtained from the measurements made. The Field Sampling Plan (submitted under separate cover) specifies the number of field and laboratory measurements to be made during the program. The completeness criterion for all *in situ* measurements (including flow measurements and continuous dissolved oxygen and temperature measurements) and analytical analyses is 90-percent (*i.e.* 90-percent of the planned samples must be collected and accepted for analysis). However, the completeness criteria may also be violated if a group of samples is missing from one sampling region, such as one sampling reach or all source characterization samples, even if the missing samples total less than 10-percent of the samples collected during the event.

Re-sampling may be required if the completeness criteria is not met for a specific field activity. Re-sampling for water quality parameters at in-stream stations is generally not feasible during wet-weather events due to the temporal variability associated with the water quality and flow conditions. However, re-sampling is possible at CSO and stormdrain outfalls to characterize the source inputs.

Laboratory Completeness Objectives. Laboratory completeness is a measure of the amount of valid measurements obtained from all the samples submitted by the CDM Project Team for each sampling activity. The laboratory completeness criterion is 95 percent.

Representativeness

Representativeness expresses the degree to which data accurately and precisely typify a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. One of the primary objectives of this field sampling program is to obtain water quality and flow data that is representative of conditions in the Study Area.

Measures to Ensure Representativeness of Field Data. Representativeness is dependent upon the proper design of the field sampling program. These performance criteria will be met by ensuring that the sampling protocols listed in the Field Sampling Plan are followed. Additionally, the Field Sampling Plan was developed considering the DQOs established herein and the appropriateness of sampling locations, sampling protocols, and water quality constituents. The sampling network designed and specified in the Field Sampling Program will provide data representative of the Study Area for the expressed purposes of the water quality and flow monitoring activities.

Measures to Ensure Representativeness of Laboratory Data. Representativeness in the laboratory is ensured by the use of proper analytical procedures, following "good laboratory practices" (GLPs), meeting sample holding times, and analyzing and assessing field duplicates. Both Aquatec and AMRO have Quality Assurance Plans and follow written SOPs for each analytical analysis.

Comparability

Comparability is an expression of the confidence with which one data set can be compared with another. Data collected in one segment of the Study Area may be compared to data from another area to allow for the relative comparison of water quality parameters and streamflow between stations. Additionally, during wet-weather, water quality and streamflow data collected over time at one station may be compared to determine the temporal variability.

Measures to Ensure Comparability of Field Data. Comparability of data is assured by a properly designed field sampling program and is satisfied by following proper sampling protocols as outlined in the Field Sampling Plan. For this program, data comparability is assured by the use of identical sampling, measurement, analytical and data reporting methodologies in accordance with documented procedures.

In situ dissolved oxygen measurements will be compared to a limited number of Winkler titration samples to assess the performance of the field probes. A comparability criteria of ±1.0 mg/L has been established for comparison between these two samples. *In situ* measurements falling outside this range will be either rejected or qualified accordingly.

Measures to Ensure Comparability of Laboratory Data. Comparable analytical data results from employing identical sampling and analytical methods as documented in this QAPP. Comparability of analytical data will be assessed under the supervision of the Technical Project Manager.

1.5 Special Training and Certification

This investigation includes only standard field sampling techniques, field analyses, laboratory analyses, and data validation techniques. Specialized training is therefore not required. All field personnel on the CDM Project Team are experienced in the standard protocols for surface water sampling and flow monitoring using the equipment discussed in this QAPP and associated Field Sampling Plan. Individual certifications relevant to implementation of this plan are not required. A kick-off meeting will be conducted prior to the commencement of the field sampling program to brief members of the CDM Project Team on the sampling procedures.

The sponsor communities of Manchester and Nashua, New Hampshire, Lowell and Haverhill, Massachusetts, and the Greater Lawrence Sanitary District (GLSD), Massachusetts may provide additional personnel to assist in the sampling of each city's respective CSOs. All municipal personnel would be required to attend the kick-off meeting (or equivalent training) and review the QAPP, Field Sampling Plan, and SOP Compendium prior to participating in the sampling program.

Both Aquatec and AMRO are certified to perform all analytical procedures that will be required during the completion of this field sampling program. A summary of the laboratory certifications for AMRO and Aquatec is provided in Table 1-3.

Table 1-3: Laboratory Certifications

Laboratory	Organization	Certified Analysis
AMRO	Massachusetts Department of Environmental Protection	• Nonpotable water (chemistry) • Potable water (chemistry)
	New Hampshire Environmental Laboratory Accreditation Program	• Drinking water metals & inorganics • Wastewater metals, inorganics, PCBs, pesticides, volatile organics, & semivolatile organics
	Department of the Army- U.S. Corps of Engineers	• USACE Hazardous, Toxic, and Radioactive Waste Program
Aquatec	Vermont Department of Health Laboratory	• Bacteria in Drinking Water

All laboratory personnel are trained in accordance with the procedures outlined in their respective Quality Assurance Plans:

- AMRO Environmental Laboratories Corporation. "Quality Systems Manual for Environmental Analyses Potable Water, Nonpotable Water, and Solid and Hazardous Waste." Revision No. 5, March 2002.

- Aquatec Biological Sciences. "Quality Assurance Program Plan". Revision 6, March 2001.

1.6 Documents and Records

This section of the QAPP describes how project data and information will be documented and tracked from its generation in the field to its final use and storage. This will ensure data integrity and defensibility.

1.6.1 QAPP Distribution and Version Control

CDM's QA Officer, Ms. Jeniffer Oxford, will be responsible for distributing copies of the approved QAPP and any subsequent revisions to individuals on the Distribution List. In addition, CDM will maintain on file a complete copy of the original document and all revisions of the QAPP, including addenda and amendments.

CDM will use document control procedures to identify the most current version of the QAPP. Each revision will be differentiated with a new revision number and date. The following document control information is included in the top right-hand corner of each page in this QAPP:

- Title of the document (abbreviated)

- Revision number and document status (*i.e.* draft, interim, final)
- Date of original or current revision
- QAPP section
- Page number in relation to the total number of pages

A Project Personnel Sign-Off Sheet will be used to document that all members of the CDM Project Team (including subcontractors and laboratories) have read the QAPP and will perform the tasks as described. CDM's QA Officer will maintain the Sign-Off Sheet. The following information will be required:

- Project personnel name, title, contact number, and signature
- Date QAPP was reviewed
- QAPP acceptable as written (Yes/No)

1.6.2 Data Reporting and Retention

Proper documentation of field and laboratory activities is essential for the attainment of the Data Quality Objectives outlined for this study. Data reporting is the detailed description of the data deliverables used to completely document the calibration, analysis, quality control measures, and calculations. Data acquired in the field will be reported after reduction and validation by the responsible technical staff. Data from laboratory analyses will be reported after the data are reviewed, assessed for quality assurance, and the data usability is assessed based on guidance provided in subsequent sections of this QAPP. Preliminary data will not be released as a part of this Study. All data will be validated prior to distribution.

Project Documentation and Records

CDM will maintain a Final Evidence File, which will be the central repository for all documents that constitute evidence relevant to sampling and analysis activities as described in this QAPP and associated Field Sampling Plan. Table 1-4 presents a summary of sample collection records, field analysis records, laboratory records, and data assessment records that will be contained in the file.

Table 1-4: Project Documents and Records

Sample Collection and Field Analysis Records	Laboratory Records	Data Assessment Records
• Field logbooks • Field data collection and analysis forms • Chain-of-custody (COC) records • Telephone and e-mail correspondence logs • Corrective action reports • Field QC checks and QC sample records • *In situ* measurement calibration, inspection, and maintenance logs • Field photographs • Copy of QAPP and Field Sampling Plan	• COC Records • Sample receipt/ tracking forms • Preparation and analysis forms/ logbooks • Data summary reports • Corrective action reports • QC checks and QC sample results	• Field sampling audit checklists and reports • Field analytical audit checklists and reports • Fixed laboratory audit checklists and reports • Data validation reports • Telephone and email correspondence logs • Corrective action reports • Progress reports • Interim progress reports and final reports

CDM's administrative staff will have the responsibility of implementing and maintaining a document control system, which includes a document inventory procedure and filing system. All members of the CDM Project Team will be responsible for project documents in their possession while working on a particular task. CDM's official policy on document retention dictates that a copy of all final project reports, final planning documents, and computer models, output, and results are permanently archived following the closure of a project. All other files, including field and laboratory data, are generally kept for a period of 10 to 20 years.

Electronic copies of all project files and deliverables, such as electronic databases, will be routinely backed-up and archived. The Technical Memorandum to be prepared at the conclusion of the field sampling program will be submitted to the USACE as hard copies and on CD in electronic text in Microsoft Word97. All data, reports, and materials obtained and/or created under this task will be turned over to the Contracting Officer at the completion of the contract to become property of the Government.

Field Analysis Data Package Deliverables and Reporting Formats

The Field Analysis Data Package Deliverables will include the list of items provided in Table 1-4 under "*Sample Collection and Field Analysis Records*." Field crews will be instructed to document all activities associated with site visits and sampling efforts, including unusual and anomalous conditions, which will be used during data interpretation and analyses. All documentation will require input in standardized data collection forms developed specifically for the Merrimack River Watershed Assessment Study, or in field logbooks.

Field Data Collection Forms. Field data collection forms will be used to document sample collection activities, flow measurements, and sample compositing procedures; they include:

- Dry-/Wet-Weather Sample Collection Sheets
  - Including sample compositing and grab sampling forms; *in situ* temperature, pH, DO, conductivity, and Secchi disk measurements; stage height; and QA samples collected
- Wet-Weather Outfall Sample Collection Sheet
  - Including *in situ* temperature, pH, DO, conductivity and QA samples
- Vertical Temperature/DO Profile Measurement Sheet
- Diurnal Dissolved Oxygen Measurement Sheet

Example worksheets are provided in the Field Sampling Plan.

Field Logbooks. Field logbooks will be used to document all investigation and data collection activities performed at the site that are not covered by the aforementioned standard forms. The logbooks will be permanently bound and paginated prior to the initial entry for the purpose of identifying missing pages after completion. Logbooks will be maintained by members of the CDM Project Team in accordance with SOP-DOC-001: *Field Logbook Content and Control*.

Laboratory Data Reporting Package and Reporting Formats

The Laboratory Analysis Data Package Deliverables will be provided in a "CLP-like" format. This includes, but is not limited, the following as appropriate for the respective analyses:

- Chain-of-custody forms (signed)
- Sample Receipt Log-in and Checklist Forms
- Case Narrative
- Analytical Results (including time, date, and appropriate qualifiers)

- Initial and Continuing Calibration Results
- Method Blank Results and Raw Data
- Sample Matrix Spike/Matrix Spike Duplicate Results and Raw Data
- Laboratory Control Sample Results and Raw Data
- Internal Standard Results
- Laboratory Duplicate Results and Raw Data
- Surrogate Results

Final laboratory data reports will be issued to the CDM Project Team's Technical Project Manager within ten to 28 days of the sample receipt, depending on the laboratory. Electronic data deliverables will also be provided.

Section 2
Data Generation and Acquisition

This section of the QAPP addresses all aspects of data generation and acquisition that will be performed during the Merrimack River Watershed Assessment Study field sampling program. Adherence to the guidelines outlined in this section will ensure that the appropriate methods for sampling, measurement and analysis, data collection and generation, data handling, and quality control activities are employed and documented throughout the completion of the task.

2.1 Sampling Process Design (Experimental Design)

The following section provides a general overview of sampling network design and rationale for the design developed for the Merrimack River Watershed. Specifics as to the types and numbers of samples required, exact sampling locations and frequencies, and sample matrices are addressed more fully in the Field Sampling Plan developed for the Merrimack River Watershed Assessment Study.

2.1.1 Sampling Network Design and Rationale

The field sampling program developed for the Merrimack River Watershed Assessment Study has been designed to meet the Data Quality Objectives discussed in Section 1.4 - Quality Objectives and Criteria.

Study Area Definition

For the purposes of the water quality sampling and flow monitoring efforts, the project Study Area has been defined as the portion of the Merrimack River mainstem located south of the Hooksett Dam in Hooksett, New Hampshire to the mouth of the River at the Atlantic Ocean near Salisbury and Newburyport, Massachusetts. The Hooksett Dam will be used to define the upstream boundary conditions for both the sampling and modeling efforts.

This Study Area includes the five sponsor communities of Manchester and Nashua, New Hampshire and Lowell, GLSD, and Haverhill, Massachusetts and four dams along the mainstem. The confluence of 11 major tributaries, many of which contribute to the total pollutant load in the mainstem, also occurs along the River within the Study Area (Table 2-1). A map of the overall watershed is provided in Figure 1-2.

Table 2-1: Confluence of Major Tributaries in the Study Area

Location of Confluence	Major Tributary
Manchester, NH	Piscataquog River Cohas Brook
Merrimack, NH	Souhegan River
Nashua, NH	Nashua River Salmon River
Lowell, MA	Stony Brook Beaver Brook Concord River
Lawrence, MA	Shawsheen River Spicket River
Amesbury, MA	Powwow River

The rationale for this Study Area delineation is based on several factors. First, the majority of the documented pollution problems within the overall Merrimack River watershed occur in this lower reach of the River. Based on a review of the most recent Massachusetts and New Hampshire water quality assessment documents, the majority of pollution problems occur south Hooksett, New Hampshire. Furthermore, this Study Area delineation brackets the five sponsor communities, providing a baseline water quality signal in the River upstream of the first CSOs in Manchester, New Hampshire and a comprehensive assessment of the downstream impacts of these pollutant sources. Additionally, this segment of the River encompasses all of the designated uses observed in the basin and described in Section 1.4, including drinking water supply, recreation (swimming and boating), and aquatic life/habitat. Finally, this Study Area definition was outlined by the USACE and Study Management Team in the project scope of work as the mainstem segment of interest.

Wet- and Dry-Weather Sampling Activities

This section describes the overall sampling schedule, general sampling locations, water quality parameters, and flow monitoring activities to be performed as part of this field sampling program. Specific requirements are discussed further in the Field Sampling Plan.

Sampling Schedule. Sampling will be performed between May and November 2003 to develop a calibration/validation data set for the water quality and hydrologic/hydraulic models to be developed under future tasks. Sampling during this period will likely cover the range of flow conditions observed in the basin, from high-flow conditions in the spring to low-flow conditions in the late summer, defined in accordance with the following seasonal ranges:

- *Spring* - May to mid-June 2003

- *Summer* – Mid-June through mid-September 2003
- *Fall* - Mid-September through November 2003

Winter sampling will not be performed as part of this Study.

Three dry-weather sampling events are scheduled to be performed during the sampling program. Two of the events will occur between May and mid-September; the third event will be conducted during October or November. Additionally, three wet-weather sampling events are proposed during the performance period. It is anticipated that one event will be sampled during the previously defined spring, summer, and fall seasons. However, the timing of these events is dependent upon prevailing precipitation conditions during the seven-month period.

Wherever possible dry and wet-weather sampling events will be performed under streamflow conditions at or below the mean monthly flow, as defined by historical flow records on the mainstem Merrimack River. However, flexibility in the scheduling of these surveys is required due to the potential for prevailing seasonal conditions to dictate higher streamflow conditions. Table 2-2 provides a summary of monthly mean streamflow for the two active USGS gaging stations on the Merrimack River during the months of interest.

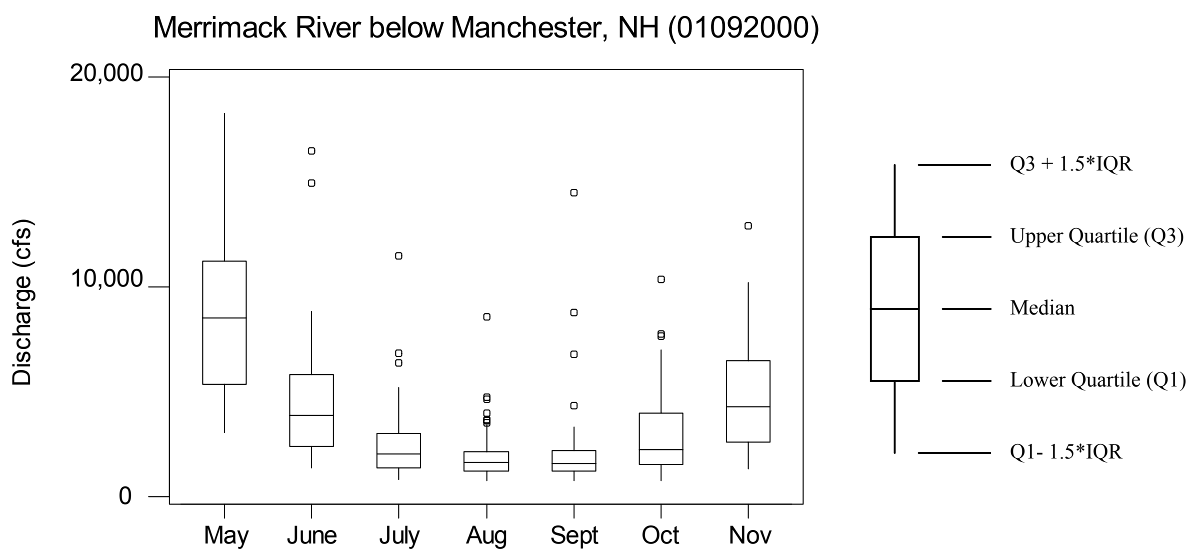
Table 2-2: Summary of Mean Monthly Streamflow for Active Gaging Stations on the mainstem Merrimack River

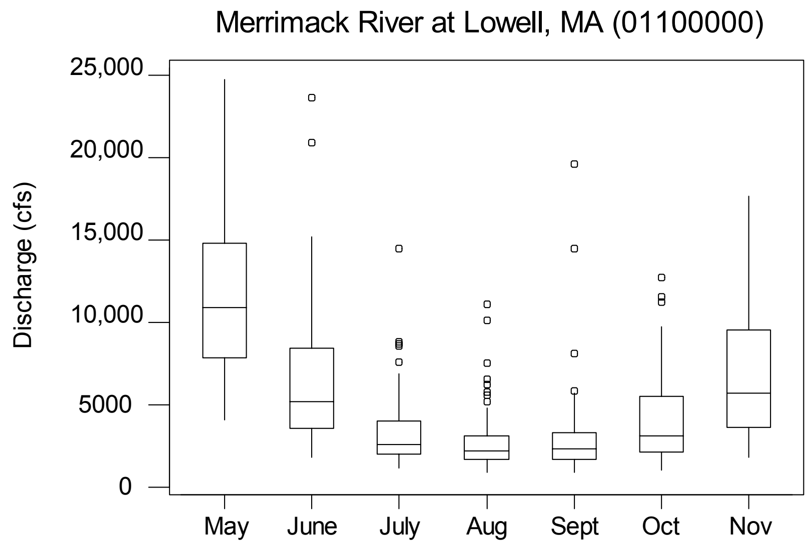
Month	Mean Monthly Streamflow (cfs)	
	Merrimack River near Goffs Falls, below Manchester, NH	*Merrimack River below Concord River at Lowell, MA*
May	8,632	11,590
June	4,520	6,360
July	2,459	3,408
August[1]	1,958	2,802
September	2,106	2,978
October	3,037	4,160
November	4,702	6,592

[1]For comparison purposes, 7Q10 at the Manchester, NH and Lowell, MA stations is 653 and 950cfs, respectively

Boxplots of the mean monthly streamflow for the period of record at each station are provided in Figure 2-1 for the two active stations on the mainstem Merrimack River. Boxplots are presented for the proposed sampling season (May through November) to provide an idea of the potential variability in the mean monthly streamflow values. The bottom of the box coincides with the lower quartile of the data and the top with the upper quartile of the data; a line through the box marks the median of the data. The vertical lines on each side of the box run from the quartiles to the smallest and largest numbers that fall within 1.5 times the interquartile range (IQR). The IQR is the difference between the upper and lower quartiles of the distribution. The lower quartile is defined as that number such that at least 25-percent of the data fall at or below it and at least 75-percent of the data falls at or above it. Similarly, the upper quartile is the number such that at least 75-percent of the data fall at or below it and at least 25-percent falls at or above it. Outliers beyond the IQR are marked by a point on the graph.

Figure 2-1: Boxplots of monthly streamflow data for USGS stations on the mainstem Merrimack River





Event Definition. Specific criteria defining "wet-" and "dry-" weather events are specified in the Field Sampling Plan, including storm precipitation totals, duration, and antecedent dry-weather conditions. The development of these criteria is based on precipitation amounts required to activate CSOs in the five sponsor communities (wet-weather only), as well as the time required for the water quality effects from prior storm events to leave the Study Area (wet and dry-weather). It is important to note that the stormdrain outfalls and tributaries may respond differently than the CSOs. In general, the stormdrain outfalls will mostly likely respond more quickly than the CSOs; for example, they will most likely begin discharging at precipitation amounts less than 0.5-inches. Alternately, a response in the tributaries may take longer as compared to the CSOs due to the time of travel required for pollution from upstream sources to reach the stream and then be carried downstream to the confluence with the mainstem Merrimack River where sampling will be conducted.

General Sampling Locations. The sampling locations specifically defined in the Field Sampling Plan for wet- and dry-weather surveys were developed in accordance with the following three categories to meet the Data Quality Objectives stated in Section 1.4:

- Source Sampling: Calculate the pollutant loads entering the mainstem Merrimack River from the 11 major tributaries and measure pollutant concentrations discharge to the mainstem from representative CSO and stormdrain outfalls

- Instream Response: Measure the instream pollutant concentrations in the mainstem River downstream of major pollutant sources, including tributaries, CSO and stormdrain outfalls, WWTPs, and the City of Concord, New Hampshire.

Additionally, sampling will be performed upstream and downstream of Manchester and Nashua, New Hampshire and Lowell, Lawrence, and Haverhill, Massachusetts to determine the relative water quality impacts from each community during wet-weather.

- Sampling at Dams: Measure pollutant concentrations upstream and downstream of the major dams in the Study Area

Table 2-3 presents a summary of the general sampling locations that will be surveyed during wet- and dry-weather events. Additional details are provided in the Field Sampling Plan.

Table 2-3: Summary of General Wet- and Dry-Weather Sampling Locations

Sampling Category	Station	Dry	Wet
Source Sampling	Mouth of 11 major tributaries	X	X
	CSO outfall pipes	---	X
	Stormdrain outfalls	---	X
In-stream Response	Downstream of 11 WWTPs	X	X
	Upstream and downstream of sponsor communities	X	X
	Downstream of stormdrain outfalls	---	X
	Shellfishing beds	X	X
	Public Beach and Boat Launch	X	X
	Upstream and downstream of Concord, NH	X	X
Sampling at Dams	Upstream of Dams	X	X
	Downstream of Dams	X	X

The role of non-point sources in contributing to the overall pollutant load in the mainstem of the Merrimack River will be assessed through measurements of known pollutant loadings (*i.e.* major tributaries and CSO/stormdrain outfalls) during the wet- and dry-weather sampling events.

Water Quality Parameters. In general, the water quality parameters selected for analysis in this study have been shown to impede the designated uses in the Study Area, including bacteria and nutrients. A complete review of the documented water quality problems in the watershed was completed as part of the "*Description of Existing Conditions*" report prepared by the CDM Project Team under the first Task Order of the Merrimack River Watershed Assessment Study contract.

A summary of the field and laboratory measurements to be performed under this field program is provided in Table 2-4. The specific sampling matrices for this program are outlined in the Field Sampling Plan.

Table 2-4: Field and Analytical Analyses

Analytical Measurements	Field Measurements
Indicator Organisms • Fecal Coliform (fresh and marine waters) • E. Coli • Enterococcus (marine waters only) Nutrients and Impacts • Total Phosphorus • Nitrate/Nitrite • Total Kjeldahl Nitrogen (TKN) • Ammonia-N • Chlorophyll-a Oxygen and Oxygen Demand • Dissolved Oxygen (Winkler Titration) • BOD_5 • BOD_{20}	• *In situ* measurements o Temperature o Dissolved Oxygen (DO) o pH o Conductivity o Turbidity o Salinity • Secchi Disk depth (dry-weather only) • Vertical Temperature/DO profiles (upstream of dams during dry-weather only) • Diurnal DO sweeps (select stations during dry-weather only) • Streamflow (select stations only) • Continuous DO/Temperature measurements (select stations only)

As noted in Table 2-4, three indicator organisms will be assessed in this study. Both fecal coliform and E. Coli are required since currently Massachusetts and New Hampshire use different organisms as the basis for their bacterial water quality standards; analysis will be performed for both organisms to compare the results across the entire Study Area. Enterococcus will also be analyzed in tidally influenced portions of the Study Area (*i.e.* downstream of Haverhill, Massachusetts), as the United States Environmental Protection Agency (USEPA) has shown this organism to be a superior indictor of human health risk in marine waters (USEPA 2001). Intensive bacteria monitoring, approximately one sample per hour over a period of 12-hours, will be performed at the USGS gaging station in Lowell, Massachusetts to fully characterize the contaminant plume throughout the event.

The nutrients to be analyzed in this study were selected to provide an overview of the nitrogen and phosphorus process in the Merrimack River, as well as to characterize nutrient loads from the pollutant sources previously discussed. In freshwater, phosphorus in particular plays a major role in controlling the growth of algae and aquatic plants; nitrogen is of greater concern in marine waters. Additionally, low dissolved oxygen concentrations may adversely affect fish populations. Dissolved oxygen will be measured both as a field parameter at all stations and as a laboratory measurement (Winkler titration) at select stations to provide a check on the field probes.

Vertical temperature and dissolved oxygen measurements will be collected during all dry-weather sampling events upstream of the Amoskeag, Pawtucket, and Essex Dams. Due to safety concerns, these samples will be conducted at the mid-point of the float line upstream of each dam, unless a deeper location is found along the float line from the results of the bathymetric surveys. Additionally, diurnal sweeps of dissolved oxygen will be performed for two of the dry-weather surveys at all of the sampling stations. One sweep will be performed at dawn when DO concentrations will be at a minimum due to the loss of oxygen from respiration and decomposition; a second round of DO sampling will be performed in the late afternoon when production and photosynthesis is maximized.

In situ measurements of temperature, pH, dissolved oxygen, and conductivity will be performed at all instream sampling locations. Secchi disk measurements will be performed at all in-stream sampling stations with sufficient water depth (*i.e.* greater than two-feet) during dry-weather events only. In addition, continuous dissolved oxygen and temperature measurements will be taken at two locations along the mainstem Merrimack River. The meters will be deployed over an approximately one-month period between mid-July and mid-September when dissolved oxygen concentrations will presumably be at critical levels in relation to aquatic life support due to low-flow conditions. The exact timing of the monitoring will be determined based on prevailing streamflow and climatic conditions.

Instream Flow Monitoring. The USGS operates two streamflow gaging stations along the mainstem within the Study Area. One station is located just south of Manchester near Goffs Falls (01092000), and the other is located downstream of the Concord River confluence in Lowell, Massachusetts (01100000). Additional flow measurements will be required to account for pollutant mass loads both into the Study Area and within the river.

Detailed specifications for flow measurement techniques and locations are included in the Field Sampling Plan. Generally, flow will be measured at selected stations during a wide range of flow conditions, so that stage-discharge relationships can be used to quantify the flow at these stations during dry- and wet-weather surveys. Such relationships will be developed at the mouth of each tributary and at selected control stations along the mainstem to quantify the longitudinal variability of flow throughout the Study Area. This information will be used to help determine the relative contribution of pollutant loads from major tributaries. Staff gages will be installed at each station so that sampling teams can record the stage at each flow monitoring station during wet and dry-weather events.

2.2 Sampling Methods

This section describes the procedures for collecting samples and identifies the specific sampling equipment and performance requirements, sample preservation requirements, and decontamination procedures. Also addressed are the procedures for identifying sampling or measurement system failures and for implementing corrective actions.

2.2.1 Sample Collection, Preparation, and Decontamination Procedures

Monitoring performed during this sampling program will include the collection of spatial composite and grab samples, *in situ* field measurements, and quality control (QC) samples. Sample collection and *in situ* measurement procedures are briefly outlined in this QAPP. Detailed procedures are provided in the Field Sampling Plan; specific SOPs are listed in Table 2-5 and compiled in the "SOP Compendium", submitted under separate cover. The use of SOPs will ensure the collection of accurate, precise, and representative samples, as well as helping to ensure data comparability and usability. The field program will not require the use of any new or innovative procedures or sampling techniques.

Table 2-5: Summary of SOPs for Sample Collection

SOP	Title
SOP-FLD-001	Collection and Handling of Water Samples for Water Quality Analyses
SOP-FLD-002	Determination of Dissolved Oxygen (Modified Winkler, Full Bottle Technique)
SOP-FLD-003	Determination of Dissolved Oxygen (Membrane Electrode Technique)
SOP-FLD-004	Field Determination of Specific Conductance in Water
SOP-FLD-005	Calibration of Thermometers and Thermistors and Determination of Temperature
SOP-FLD-006	Field Determination of pH in Water (Electrometric Method)
SOP-FLD-007	Determination of Light Transparency (Secchi Disk Transparency)
SOP-FLD-008	Determination of Turbidity in Water
SOP-FLD-009	Operation of Global Positioning Systems (GPS)
SOP-FLD-010	Determination of Water Velocity and Stream Discharge

Dry and Wet-Weather Water Quality Sample Collection and Preparation Procedures

The following is a brief overview of the field mobilization and sample collection/preparation procedures to be used in the field program. Detailed procedures are provided in the SOPs (Table 2-5) and Field Sampling Plan.

Weather Tracking and Field Mobilization. Preparation for sampling activities includes weather tracking, review of SOPs, procurement of field equipment, laboratory coordination, confirmation of site access (if necessary), and coordination between Field Program Coordinators. Weather tracking will be performed by CDM's in-house meteorologist in coordination with the Technical Project Manager and CDM's Field Program Coordinator. Precipitation forecasts will be based on several different meteorological forecast models provided by the National Weather Service, the United States military, and the European and Canadian Meteorological Organizations. Although it is difficult to specify the accuracy of the precipitation forecasts for a particular area, according to the Boston National Weather Service's recent records, their precipitation probability forecasts range from 69-percent accurate (0 to 12-hour forecasts) to 56-percent accurate (24 to 36-hour forecasts) based on the 1999 data (Marc Wallace, CDM, personal communication, February 20, 2003).

Once in the field, initial set-up will include establishment of sample staging areas and mobile labs, distribution of required equipment, and distribution of bottles and coolers provided by the subcontracted laboratories.

Dry-Weather Field Sampling Procedures. Instream sampling in the Study Area will be performed by CDM Project Team boat and land crews during the dry-weather surveys. Spatial composite samples will be collected at each mainstem sampling stations for all parameters except indicator organisms. The spatial composite samples will be formed from three vertically integrated samples collected at the quarterpoints of the Merrimack River. Similarly, one vertically integrated sample will be collected at the centerpoint of the river at all tributary stations for all parameters except for indicator organisms. Vertically integrated samples will only be taken at in-stream stations with water depths greater than three-feet or approximately one-meter; samples will be pumped from the midpoint of the water depth at all stations with shallower depths. Grab samples will be collected at stations with water depths less than three-feet.

Grab samples will be collected for bacteria from the centerpoint of each mainstem and tributary sampling station. Detailed bacteria sampling procedures are provided in the Field Sampling Plan and applicable SOP.

Wet-Weather Field Sampling Procedures. During wet-weather events instream samples in the Study Area will be collected by CDM Project Team boat, land, and outfall crews. Spatial composite samples collected in the mainstem Merrimack River will be developed at each station from three vertically integrated samples taken at the quarterpoints of the River for all constituents except indicator organisms. Similarly, one vertically integrated sample will be collected at the centerpoint of each tributary station. As with the dry-weather sampling, vertically-integrated samples will only be collected at in-stream stations with water depths greater than three-feet or approximately one-meter; samples will be pumped from the midpoint of the water depth at all stations with shallower depths. Grab samples will be collected at stations with shallower water depths.

Grab and/or spatial composite samples for indicator organisms will be collected at each mainstem and tributary sampling station. One grab sample will be collected from the center of the reach for all tributary and mainstem Merrimack River segments that are assumed to be well-mixed. For all other reaches, one centerpoint grab sample and one spatial composite sample will be collected. The spatial composite samples will be formed from three vertically-integrated samples collected at the quarterpoints of the Merrimack River. Standard sampling procedures generally dictate the collection of grab samples for bacteria due to the high potential for contamination between samples. However, during the wet-weather sampling events, it is assumed that pollutant levels will be elevated throughout the basin, thus minimizing the impact of any cross-contamination. Additionally, the spatial composite samples provide a more representative picture of the overall in-stream bacteria concentration at each station, and as such, will be of increased value to the modeling effort. Specific sampling requirements and additional detail on the sampling methods for each station are provided in the Field Sampling Plan.

Manual grab samples for all constituents will also be collected by CDM Project Team outfall crews at stormdrain and CSO locations as specified in the Field Sampling Plan and applicable SOP. Depth measurements will be made at each outfall so that the flow at the time of sampling can be estimated.

Boat, land, and outfall crews will be required to make several sweeps of their sampling stations during wet-weather events to adequately characterize the variations in water quality during the events and to track the downstream progress of contaminant plumes. The number of sweeps to be performed varies for each constituent; specific schedules for each event are established in the Field Sampling Plan. Additionally, high-frequency bacteria monitoring (approximately one sample per hour over a period of 12 hours) will be performed at one station downstream of Lowell, Massachusetts. This station is co-located with the USGS gaging station to provide an estimate of the pollutant loads in the River.

Streamflow Measurements

All in-stream streamflow measurements will be performed in accordance with SOP-FLD-007: *Determination of Water Velocity and Stream Discharge*. Measurements will be made over a range of flow conditions and a stage-discharge relationship will be developed for each station. Velocity measurements will be used to compute the stream discharge at each station in accordance with the standard protocols outlined in "*Measurements and Computation of Streamflow: Volume 2. Computation of Discharge*" (USGS 1982). The Field Sampling Plan provides specific station locations where streamflow will be measured. Depth measurements will be made at each CSO and stormdrain outfall sampling station at the time of sampling; flow at each outfall will be estimated using Manning's equation.

Continuous Dissolved Oxygen and Temperature Measurements

Continuous dissolved oxygen and temperature measurements will be performed using continuous monitoring equipment deployed at two locations in the mainstem Merrimack River over a one-month period. Each site will be visited weekly to download the monitoring data and perform a quality assurance check of equipment, including a re-calibration of the temperature and dissolved oxygen probes.

Decontamination Procedures

All materials used during sample collection, such as collection buckets, funnels, and stirring rods, will be decontaminated between samples and after use with American Society of Testing and Materials (ASTM) type II (or better) water. Investigation-derived waste (IDW) will not be generated during any part of this investigation.

2.2.2 Sampling SOP Modifications

The SOPs provided in the Compendium to this QAPP have been adopted from the standard operating procedures used by various members of the CDM Project Team. For the purposes of this project, all references to the specific Team member (such as "CDM" or "Normandeau") shall be replaced by the "CDM Project Team."

2.2.3 Sampling/Measurement System Failure Response and Corrective Action

This section describes the sample and measurement system failure response and corrective action procedures that will be undertaken during field and laboratory activities.

Field Corrective Actions

Corrective action in the field may be required when a modification is made to the sampling network (*i.e.* due to changes in the frequency or number samples taken or changes in sampling locations) or when sampling procedures or field analytical methods require modification due to unexpected conditions. Any member of the CDM Project Team may identify a problem requiring corrective action; the field staff in consultation with the Field Program Coordinators will then recommend the corrective action. The Technical Project Manager will approve the corrective measure, which will be implemented by the members of the CDM Project Team. The Technical Project Manager will inform the USACE Study Manager of the problem and corrective action. All sampling or measurement system failures and resulting corrective actions will be accurately documented in the field logbooks. No member of the CDM Project Team may initiate corrective action without prior communication through the proper channels, as described above.

Laboratory Corrective Actions

Corrective action in the laboratory may occur prior to, during, or after initial analyses. A number of conditions, such as broken sample containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during the sample log-in or just prior to analysis. The bench chemist will identify the need for corrective action. The Section Supervisor, in consultation with the laboratory staff, will approve the required corrective action for implementation by the laboratory staff. The laboratory QA Officer will approve and document the corrective action in accordance with the laboratory's Quality Assurance Plan.

All corrective actions shall be performed prior to the release of the data from the laboratory. The corrective action will be documented in both the laboratory's corrective action file and the narrative data report sent from to the Technical Project Manager. If the corrective action does not rectify the situation, the laboratory will contact the Technical Project Manager.

2.3 Sample Handling and Custody

This section of the QAPP describes the procedures by which sample custody will be maintained by all members of the CDM Project Team and by the analytical laboratories. Also described are the sample handling and transport procedures that will be employed throughout the project.

2.3.1 Sample Labeling

Sample labels will be attached to individual sample aliquots for each investigation or quality control sample. Sample labels will be provided by the laboratories along with the sample bottles. Field Program Coordinators will be responsible for ensuring that all labels are affixed to the bottles prior to event mobilization. Sample labels will include the following information:

- Name of the investigation
- Sample identification number
- Sample collection location
- Date and time (military) of collection
- Number of dry-/wet-weather sampling event
- Number of sampling sweep (wet-weather events only)
- Analysis requested

- Preservative

The unique sample identification numbers will be specified in accordance with the following guidance:

MR-XXXX-ABCDEF

MR- denotes Merrimack River survey and will be the same for all the samples

XXXX- four letter/digit sampling location, as per the Field Sampling Plan

A- "D" or "W" for dry- or wet-weather sampling events, respectively

B- Number of sampling event, 1 to 3

C- Number of sampling sweep, 1 to 5 (wet-weather events only)

D- Analysis requested (abbreviated), see Table 2-7

E- Type of sample -- "C" for spatial composite samples, "G" for River grab samples, and "O" for CSO or stormdrain outfall grab samples

Fictitious station numbers will be developed to identify the field blank and duplicate samples in accordance with the following designations:

Series 000- regular water quality samples

Series 100- field blanks

Series 200- field duplicates

Series 300- equipment blanks

For example, M101 is a field blank collected at station M001.

Table 2-6 presents a summary of the abbreviations to be used for each of the water quality parameters on the sample labels.

Table 2-6: Water Quality Parameter Abbreviations for Sample Labels

Parameter	Abbreviation
Fecal Coliform	FC
E. Coli	EC
Enterococcus	ENT
Total Phosphorus	TP
Nitrate/Nitrite	NO23
Total Kjeldahl Nitrogen	TKN
Ammonia-Nitrogen	N
Chlorophyll-a	Chla
Dissolved Oxygen (Winkler Titration)	DO
BOD_5	BOD5
BOD_{20}	BOD20

An example label is provided in Figure 2-2, for a wet weather fecal coliform sample collected during at outfall station O001 during the first sweep:

Figure 2-2: Example Sample Label

CDM Merrimack River WQ Survey

Date: 10/25/02	Time: 1200
MR-O001-W11FCO	
Station: O001	Preservative: N/A
Wet Event 1/Sweep 1	Analysis: Fecal Coliform

2.3.2 Chain-of-Custody Procedures

Each sample must be properly documented to ensure the timely analysis of all parameters requested and to track the progress of the samples in the laboratory. To this end, chain-of-custody forms will be completed for all samples collected.

The analytical laboratories will provide chain of custody forms (Figure 2-3 and 2-4) for all samples. The forms will be filled out by the respective boat, land, or outfall crews at the end of each sampling round; the sample numbers and locations will be listed on the forms. When transferring sample custody, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. This record documents the transfer of sample custody from the sampler to another person, to the permanent or mobile laboratory, or to/from a secure storage area. Representatives from both the CDM Project Team and the laboratories will retain a copy of the forms.

The chain-of-custody forms will be kept until all data has been received from the laboratories.

Specific laboratory custody procedures are described in Aquatec's and AMRO's Quality Assurance Plans, including:

- Chain-of-custody procedures for assuming control of field samples
- Detailed sample log-in procedures
- Detailed internal sample tracking procedures
- Procedures for internal transfer of sample custody
- Specifications for sample storage
- Disposal procedures for samples, extracts, and digestables

Procedures for custody of analytical data and final data storage

2.3.3 Sample Handling and Packaging

All spatial composite and grab samples will be collected in clean, pre-preserved bottles supplied by either Aquatec or AMRO in accordance with the applicable SOPs. Samples will be placed in laboratory-supplied coolers with sufficient ice to meet holding requirements. A chain-of-custody form for the samples will be placed in a waterproof, plastic bag and affixed to the inside cover of the cooler. A return name and address for the sample cooler will be written on the inside of the lid in permanent ink to ensure that the cooler is returned to its owner. All samples will be preserved in accordance with specified analytical guidelines. Table 2-7 provides a summary of the required sample volumes, collection containers, holding times, and preservatives for each water quality parameter. It should be noted that separate analytical methods (see Section 2.4 - Analytical Methods) will be used for fecal coliform analysis in fresh and marine waters.

AMRO Environmental Laboratories Corporation
111 Herrick Street
Merrimack, NH 03054

CHAIN-OF-CUSTODY RECORD

43790

Office: (603) 424-2022
Fax: (603) 429-8496

Project No.:	Project Name:	Project Manager:	Samplers (Signature):	AMRO Project No.:
	Project State:			

Sample ID	Date/Time Sampled	Matrix A= Air S= Soil GW= Ground W. WW= Waste W. DW= Drinking W. O= Oil Other= Specify	Total # of Cont. & Size	Comp	Grab	Analysis Required													Remarks
Preservative: Cl-HCl, MeOH, N-HN03, S-H2SO4, Na-NaOH, O- Other																			
Container Type: P- Plastic, G-Glass, V-Vial, T- Teflon, O-Other																			

Send Results To:	FAX No.:	Seal Intact? Yes No N/A	P.O. No:	GW-1* ___ GW-2 ___ GW-3 ___ MCP Level Needed:
		Results Needed By:		*= May require additional cost

Relinquished By	Date/ Time	Received By

PRIORITY TURNAROUND TIME AUTHORIZATION

Before submitting samples for expedited TAT, you must have requested in advance and received a coded **AUTHORIZATION NUMBER.**

Samples arriving after 12:00 noon will be tracked and billed as received on the following day.

AUTHORIZATION No. ________ **BY:** ________

Please print clearly, legibly and completely. Samples can not be logged in and the turnaround time clock will not start until any ambiguities are resolved.

NOTES: Preservatives, Special reporting limits, Known Contamination, etc;

AMRO policy requires notification in writing to the laboratory in cases where the samples were collected from highly contaminated sites.

White: Lab Copy Yellow: Accompanies Report Pink: Client Copy **SHEET** **OF**

Page _______ of _______

Aquatec Biological Sciences
Chain-of-Custody Record

75 Green Mountain Drive
South Burlington, VT 05403
TEL: (802) 860-1638
FAX: (802) 658-3189

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE (NOTE 4)
Name: ____________	Project Name: ____________	Carrier: ____________	
Address: ____________	____________		
____________	Project Number: ____________	Airbill Number: ____________	
____________	Sampler Name(s): ____________		
Telephone: ____________	____________	Date Shipped: ____________	
Facsimile: ____________	____________		
Contact Name: ____________	Quote #: ________ Client Code: ________	Hand Delivered: Q Yes Q No	

SAMPLE IDENTIFICATION (NOTE1)	COLLECTION		GRAB	COMPOSITE	MATRIX	ANALYSIS/REMARKS (NOTE 2,3)	NUMBER OF CONTAINERS					
	DATE	TIME										

Relinquished by: *(signature)*	DATE	TIME	Received by: *(signature)*
Relinquished by: *(signature)*	DATE	TIME	Received by: *(signature)*
Relinquished by: *(signature)*	DATE	TIME	Received by: *(signature)*

NOTES TO SAMPLER(S): (1) Limit Sample Identification to 30 characters, if possible; (2) Indicate designated Lab Q.C. sample and type (e.g.:MS/MSD/REP) and provide sufficient sample; (3) Field duplicates are separate sample; (4) e.g.: 40 ml/glass/H_2SO_4

Notes to Lab:
____
____
____

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

Figure 2-3:
Sample Chain-of-Custody Form, Aquatec Biological Sciences

Table 2-7: Summary of Analyte Collection Container, Holding Time, and Preservative

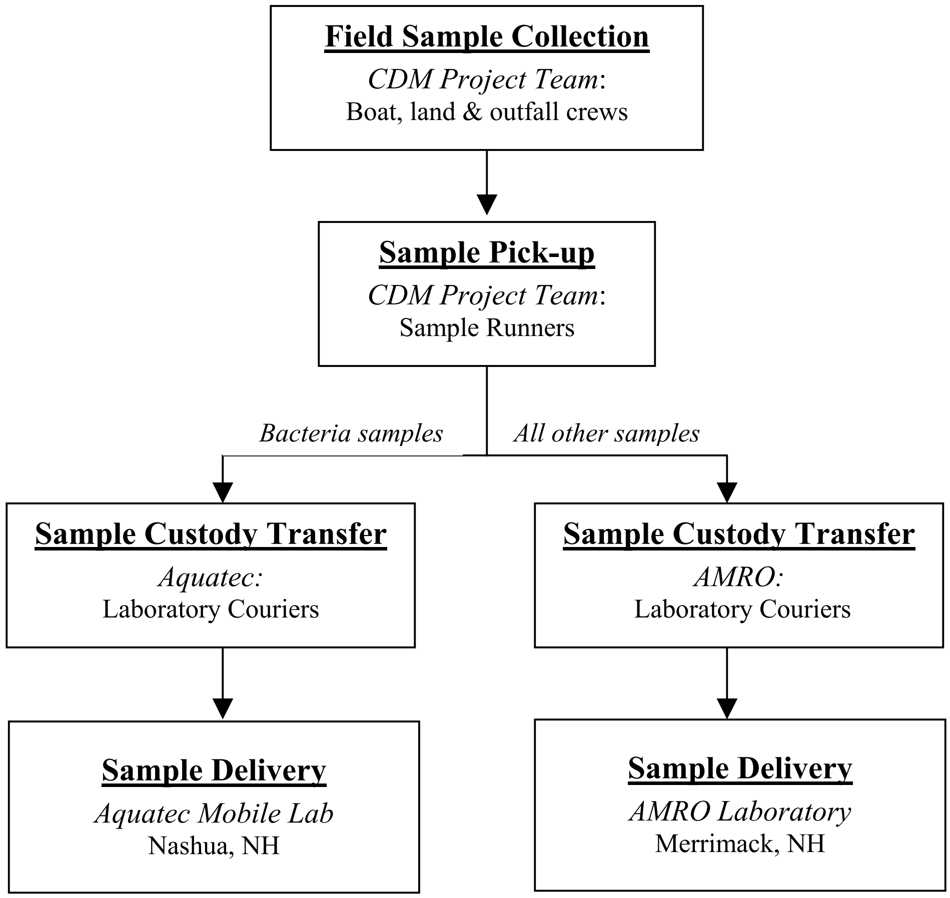
Parameter	Container		Holding Time	Method of Preservation
	Volume	*Type*		
Fecal Coliform (freshwater)	125-mL	Sterile Poly or Glass	6 hours	4°C
Fecal Coliform (marine water)	125-mL	Sterile Poly or Glass	6 hours	4°C
E. coli	125-mL	Sterile Poly or Glass	6 hours	4°C
Enterococcus	125-mL	Sterile Poly or Glass	6 hours	4°C
Total Phosphorus	250-mL	Poly	28 days	H_2SO_4 to pH<2, 4°C
Nitrate/Nitrite	250-mL	Poly	28 days	H_2SO_4 to pH<2, 4°C
TKN	500-mL	Poly	28 days	H_2SO_4 to pH<2, 4°C
Ammonia-N	500-mL	Poly	28 days	H_2SO_4 to pH<2, 4°C
Chlorophyll-a	500-mL	Amber Poly or Glass	24 hours	4°C
Dissolved Oxygen (Winkler Titration)	300-mL	BOD bottle	8 hours	Manganous sulfate & alkali-iodide azide (added in the field); 4°C
BOD_5	1-L	Poly or Glass	48 hours	4°C
BOD_{20}	1-L	Poly or Glass	48 hours	4°C

Field samples collected by CDM Project Team boat and land crews will be picked-up by sample runners from the CDM Project Team at predetermined locations in the field. It is not anticipated that any samples will need to be shipped to the laboratories. The sample runners will then either meet designated couriers from the laboratories at centrally accessible locations or transport samples directly to the laboratories, where sample custody will be relinquished. Due to the size of the Study Area, there will be several rounds of sample collection/drop-off; further information is provided in the Field Sampling Plan. Sample delivery will be performed in a timely manner to meet the required holding times for all analytes (Table 2-7).

Additionally, due to the large number of bacteria samples that will be generated during the sampling events and the critical six-hour holding time, Aquatec will establish a mobile laboratory at a designated location in the watershed to meet the required holding time during both wet and dry-weather events. Bacteria samples will be provided to the laboratory approximately four-hours after sample collection to provide adequate time in the laboratory to prepare and analyze the samples within the required six-hour holding time. Additional information on travel time from drop-off points is provided in the Field Sampling Plan.

Figure 2-5 presents a flow chart diagramming the flow of samples from the time of collection to laboratory delivery.

Figure 2-5: Sample Handling Flow Chart



FSP= Field Sampling Plan

2.4 Analytical Methods

Analytical methods are written instructions that describe how to prepare a sample for analysis, prepare and calibrate test equipment, perform the test, and calculate results. This section of the QAPP identifies the analytical field and laboratory measurements that will be made in support of the Merrimack River Watershed Assessment Study. Detailed information on field measurement techniques is provided in the Field Sampling Plan and referenced Standard Operating Procedures (SOPs); all laboratory methods are documented in the applicable SOPs (see SOP Compendium).

2.4.1 Field Analytical Methods

This section describes the field analytical methods that will govern the *in situ* water quality and streamflow measurements conducted as part of this project.

In situ Measurements

In situ measurements for temperature, dissolved oxygen, pH, conductivity, salinity (select stations) and turbidity (select stations) will be performed on all spatial composite and grab samples collected during wet- and dry-weather events. Vertical temperature and dissolved oxygen profiles will be collected upstream of the four dams during the dry-weather events. Diurnal dissolved oxygen sweeps will be conducted at all sampling stations during two dry-weather surveys; measurements will be made at or near dawn and again during the late afternoon.

Portable field units with specifically designed electronic sensors capable of taking *in situ* measurements will be used in wet- and dry-weather sampling events. All equipment will be furnished by members of the CDM Project Team or rented from an approved distributor. A list of the field analytical equipment, operating ranges, and the supplying Team member is provided in Table 2-8.

Table 2-8: Field Analytical Equipment, Operating Ranges, & Supplying Team Member

Equipment (Make/Model)	Analyte(s) Measured	Operating Range	Resolution	Accuracy	Supplying Team Member
YSI Model 85	Conductivity	0 to 200 mS	0.1 µS	±0.5% fs	CDM, NEA, Normandeau
	Salinity	0 to 80 ppt	0.1 ppt	±0.1 ppt	
	Temperature	-5 to +65 °C	0.1°C	±0.1°C	
	DO	0 to 20 mg/L 0 to 200% air	0.01 mg/L 0.1% air	±0.3 mg/L ±2 mg/L	
YSI Model 57	Temperature	-5 to 45°C	0.1°C	±0.2°C	Normandeau
	DO	0 to 20 mg/L	0.1 mg/L	±0.3 mg/L	
YSI Model 33	Conductivity	0 to 50,000 µS/cm;	0.1 µS	±0.5% fs	Normandeau
	Salinity	0 to 40 ppt	0.1 ppt	±0.1 ppt	
	Temperature	-2 to 50°C	0.1°C	±0.1°C	
YSI Model 6920	Turbidity	0 to1000 NTU	0.1 NTU	±5% of reading or 2 mg/L (whichever is greater)	Normandeau
	DO	0 to 50 mg/L 0 to 500% air	0.01 mg/L 0.1%	0 to 20 mg/L 0 to 200%	
	Temperature	-5 to 45°C	0.01°C	±0.15°C	
	Conductivity	0 to 100 µS/cm	0.001 to 0.1 mS/cm	±0.5% of reading	
	pH	0 to 14 units	0.01 unit	±0.2 unit	
YSI Model 60	Temperature	-5 to +75°C	0.1°C	±0.15°C	CDM
	pH	0 to 14 units	0.01 unit	±0.1 unit within 10°C of calibration; ±0.2 unit within 20°C of calibration	
YSI 600-XL	Turbidity	0 to1000 NTU	0.1 NTU	±5% of reading or 2 mg/L (whichever is greater)	CDM
	DO	0 to 50 mg/L 0 to 500% air	0.01 mg/L 0.1%	0 to 20 mg/L 0 to 200%	
	Temperature	-5 to 45°C	0.01°C	±0.15°C	
	Conductivity	0 to 100 µS/cm	0.001 to 0.1 mS/cm	±0.5% of reading	
	pH	0 to 14 units	0.01 unit	±0.2 unit	
Orion pH pocket meter (Model 106)	pH	0 to 14 units	0.1 units	±0.1 unit	Normandeau
Hach 2100P	Turbidity	0-1000 NTU	0.01 on lowest range	±2% of reading or ±1 least sig digit (0 to 500 NTU); ±3% of reading from 500 to 1000 NTU	CDM

In addition to the equipment in Table 2-8, a standard 25-cm Secchi disk will be used to measure water clarity at sampling stations on the mainstem Merrimack River.

All *in situ* temperature, DO, pH, and conductivity measurements will be collected in accordance with the following SOPs:

- SOP-FLD-003**:** *Determination of Dissolved Oxygen (Membrane Electrode Technique)*
- SOP-FLD-004**:** *Field Determination of Specific Conductance in Water*
- SOP-FLD-005**:** *Calibration of Thermometers and Thermistors and Determination of Temperature*
- SOP-FLD-006**:** *Field Determination of pH in Water (Electrometric Method)*

SOP-FLD-004 is also applicable to salinity measurements. All field equipment will measure the expected range of the *in situ* parameters. The use of nonstandard field analytical methods is not required for this project.

Failures in the field analytical system will be addressed in accordance with Section 2.2.3 - Sampling/Measurement System Failure Response and Corrective Action; this section also specifies the individuals responsible for corrective action and how the effectiveness of the corrective action will be determined and documented.

Streamflow Measurements

Velocity measurements for streamflow calculations will be made in accordance with SOP-FLD-007**:** *Determination of Water Velocity and Stream Discharge*. Velocities will be measured using a current meter, such as Marsh-McBirney Model 201. All equipment will be provided by members of the CDM Project Team or rented from an approved distributor. A list of the velocity measurement equipment, operating ranges, and supplying Team member is provided in Table 2-9.

Table 2-9: Current Meters, Operating Ranges, and Supplying Team Member

Equipment (make/model)	Operating Range	Supplying Team Member
Marsh-McBirney/Model 2000/Digital	-0.5 to 19.999 ft/sec (-0.15 to 6.0 m/sec)	CDM, Normandeau
Marsh-McBirney/Model 201/Analog	2.5 to 10 ft/sec (75 to 300 cm/sec)	Normandeau

2.4.2 Laboratory Analytical Methods

Aquatec and AMRO laboratories will provide effective and timely analyses of the environmental samples collected under the Merrimack River Watershed Assessment Study. The required turnaround time for laboratory reports to be provided to the

CDM Project Team is 28 days. Whenever possible, Electronic Data Deliverables (EDDs) shall be provided.

Table 2-10 presents a summary of the analytical methods, method detection limits, reporting limits, and respective analyzing laboratory for each water quality parameter of interest, as well as the state water quality standards. Method Detection Limits (MDLs) are the lowest values at which a parameter can be measured using the reference method. The MDL is defined as the constituent concentration that, when processed through the complete method, produces a signal with 99 percent probability that it is different from the blank. MDLs are developed for each particular analyte of interest and are established as targets for ensuring that the data quality obtained is adequate for interpreting the data; these MDLs are the minimum to be achieved by Aquatec and AMRO. The reporting limit is defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Table 2-10: Summary of Analytical Methods, Laboratory Reponsibilities, MDL's, Reporting Limits, and State Water Quality Standards

Parameter	Laboratory[1]	Analytical Method	MDL[2,3]	Reporting Limit[3]	State Water Quality Standard		
					MA Class B	*MA Class SB*	*NH Class B*
Fecal Coliform (freshwater)	Aquatec (ML)	9222D of Standard Methods	1/100ml	1/100ml	<200org/100mL (geometric mean) & <10% of samples can exceed 400org/100mL	N/A	N/A
Fecal Coliform (marine waters)	Aquatec (ML)	9221E of Standard Methods	2/100ml	2/100ml	N/A	Less than an MPN of 88org/100mL & <10% of samples exceeding an MPN of 260org/100mL	N/A
E. Coli	Aquatec (ML)	9213D or 9221F of Standard Methods	1/100ml or 2/100ml	1/100ml or 2/100ml	N/A	N/A	<125 E. Coli/ 100mL (based on geometic mean[4]) or <406 E. Coli/100mL in any one sample; 1000org/100mL at end of CSO pipe
Enterococcus	Aquatec (ML)	9230C of Standard Methods	1/100ml	1/100ml			
Total Phosphorus	AMRO	EPA 365.2/SM 4500-P B,E	0.017 mg/L	0.05 mg/L			
Nitrate	AMRO	EPA 300.0 and SW-846 Method 9056	0.019 mg/L	0.2 mg/L			
Nitrite	AMRO	EPA 300.0 and SW-846 Method 9056	0.016 mg/L	0.2 mg/L			
TKN	AMRO	EPA 351.3	0.508 mg/L	1.0 mg/L			
Ammonia-N	AMRO	EPA 350.2/SM 4500-NH3- B,C	0.235 mg/L	1.0 mg/L			pH dependent- see Table 1703.4 in Env-Ws 1700
Chlorphyll-a	Aquatec	10200H3 of Standard Methods	0.05 mg/L	0.1 mg/L			
Dissolved Oxygen (Winkler Titration)	Aquatec	4500-O of Standard Methods	0.05 mg/L	0.1 mg/L	See Field Measurements		
BOD_5	AMRO	EPA 405.1	N/A	2.0 mg/L			
BOD_{20}	AMRO	EPA 405.1	N/A	2.0 mg/L			
Field Measurements:							
Temperature	N/A	N/A	N/A	N/A	<68°F in CWF; <83°F in WWF	<85°F or <daily mean of 80°F	In accordance with RSA 485-A:8, II, & VIII
Dissolved Oxygen	N/A	N/A	N/A	N/A	>6.0mg/L in CWF; >5.0mg/L in WWF	>5.0 mg/L	Daily average of >75% saturation and instaneous >5.0mg/L
pH	N/A	N/A	N/A	N/A	6.5- 8.3 & <0.5 units outside of the background range	6.5- 8.5 & <0.2 units outside of the normally occuring range	6.5- 8.0 except when due to natural causes

[1]ML=Mobile Laboratory

[2]N/A= Not Applicable

[3]Theoretical MDLs and Reporting Limits for bacteria analysis are dependent upon the volume sampled. Values presented above assume that 100mL is filtered for the MF methods, while a three-dilution (10 mL, 1.0 mL, and 0.1 mL) five-tube series was assumed for MPN methods.

[4]Based on geometric mean of at least 3-samples obtained over a 60-day period

As noted in Table 2-10, separate methods will be used for the analysis of fecal coliform in fresh and marine waters -- Membrane Filtration (MF) and Most Probable Number (MPN), respectively. This conforms to the standard method of analysis currently used by the Massachusetts Department of Environmental Protection (MADEP) and Massachusetts Division of Marine Fisheries in fresh and salt waters.

Analytical methods will be performed in accordance with the applicable laboratory SOP (Table 2-11). All equipment requirements are specified in the respective SOPs. No nonstandard laboratory analyses will be required as part of this study.

Table 2-11: Analytical SOPs

Analytical Parameter	SOP Number and Title
Bacteriological Sample Handling	**SOP-LAB-001:** Method for Bacterological Sample Handling
Fecal Coliform (freshwater)	**SOP-LAB-002:** Method for Membrane Filtration for Fecal Coliforms
Fecal Coliform (marine water)	**SOP-LAB-003:** Method for Most Probable Number for Fecal Coliforms
E. Coli	**SOP-LAB-004:** Method for MTEC for E. Coli **SOP-LAB-005:** Method for EC+MUG MPN for E. Coli
Enterococcus	**SOP-LAB-006:** Method for MPN/MF for Fecal Streptococcus/Enterococcus
Total Phosphorus	**SOP-LAB-007:** Total Phosphorus/Orthophosphate: Aqueous Samples by EPA Method 365.2/SM 4500-P B,E
Nitrate/Nitrite	**SOP-LAB-008:** Determination of Inorganic Anions by Ion Chromatography - EPA Method 300.0 and SW-846 Method 9056
TKN	**SOP-LAB-009:** Total Kjeldahl Nitrogen: Aqueous EPA 351.3
Ammonia-N	**SOP-LAB-010:** Nitrogen, Ammonia: Aqueous EPA Method 350.2/SM 4500-NH3-B, C
Chlorophyll-a	**SOP-LAB-011:** Method for Processing and Analysis of Chlorophyll a
Dissolved Oxygen (Winkler Titration)	**SOP-LAB-012:** Method for Iodometric Determination of Dissolved Oxygen
BOD_5/BOD_{20}	**SOP-LAB-013:** Biochemical Oxygen Demand 5-day at 20°C EPA 405.1

Failures in the laboratory analytical system will be addressed in accordance with Section 2.2.3 - Sampling/Measurement System Failure Response and Corrective Action; this section also specifies the individuals responsible for corrective action and how the effectiveness of the corrective action will be determined and documented.

2.5 Quality Control

Quality Control (QC) is the system of technical activities that measures the performance of a process. Internal QC checks will be performed for sampling, field, and laboratory analysis to verify compliance with project investigation requirements in accordance with the Data Quality Objectives and Measurement Performance Criteria established in Section 1.4 - Quality Objectives and Criteria.

This following section describes the general QC procedures that have been established for the Merrimack River Watershed Assessment Study; specific information as to the location and types of quality control checks is provided in the Field Sampling Plan.

2.5.1 Field Quality Control Checks

Sampling Quality Control Check

Sampling quality control will be assessed based on the use of field duplicates and field blanks that will be prepared in the field and transported to the subcontractor laboratories in accordance with standard procedures. The respective laboratories will analyze the QC samples in accordance with the analytical methods at the method-required frequency. A description of the QC samples follows.

Field Duplicates. Spatial composite and grab sample field duplicates will be collected by splitting the original sample. They will be carried through all phases of the sampling and analytical procedures in an identical manner to provide overall precision information for each sampling event.

Field duplicates will be collected for all parameters analyzed in the field at a frequency of five percent, or one duplicate per 20 samples.

Field Blanks. Field blanks will consist of distilled, deionized water. The blanks will be preserved as appropriate, will accompany the samples during transport to the laboratory, and will be analyzed as appropriate. Samples will be submitted blindly to the laboratory at a rate of five percent, or one blank per 20 samples.

The desired field precision, accuracy, and field blank cleanliness for each parameter based on the quality objectives set forth in this QAPP is provided in Table 1-1. Precision and accuracy will be calculated in accordance with the procedures established in Section 1.4 - Quality Criteria and Objectives. Outlier data points will be considered on an individual basis and may be qualified depending on both upstream and downstream data measurements and on concentrations measured at different times, as applicable.

Field Analytical Quality Control Checks

Quality control checks on all instruments used to conduct field measurements will be conducted on a pre-determined basis; specific procedures will be discussed further in Sections 2.6 and 2.7. *In situ* dissolved oxygen measurements will be further verified using laboratory DO Winkler Titration methods at selected stations, as per the Field Sampling Plan.

2.5.2 Laboratory Quality Control Check

Aquatec and AMRO will use the procedures outlined in their respective Quality Assurance (QA) Plans to ensure the reliability and validity of analytical results. The most recent version of these Plans is as follows; copies of these Plans are included as attachments to this QAPP:

- AMRO Environmental Laboratories Corporation. "Quality Systems Manual for Environmental Analyses Potable Water, Nonpotable Water, and Solid and Hazardous Waste." Revision No. 5, March 2002.

- Aquatec Biological Sciences. "Quality Assurance Program Plan". Revision 6, March 2001.

Compliance with the QA Plans is coordinated and monitored by the respective laboratory's QA Officer. QC samples prepared by the laboratories may include, as specified in the respective Plans:

- Laboratory duplicates and blanks

- Matrix spikes and matrix spike duplicates (MS/MSDs)

- Laboratory Control Standard and Laboratory Control Standard Duplicates (LCS/LCSDs)

Additional information regarding laboratory QC procedures is provided in the specific analytical SOPs (see SOP Compendium). Specific criteria for the evaluation of laboratory precision and accuracy are provided in Section 1.4 - Quality Objectives and Criteria and Table 1-1. Any samples analyzed in nonconformance with the QC criteria will be reanalyzed in the respective laboratory if sufficient sample volume is available.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

This section of the QAPP describes the procedures and documentation activities that will be performed during the field sampling program to ensure that all equipment is in working order.

2.6.1 Field Instruments and Equipment

The inspection, testing, and maintenance of all field equipment and instruments will be performed in accordance with the applicable SOPs as noted in Section 2.4.1. Field meters designed for the collection of *in situ* temperature, pH, dissolved oxygen, and conductivity (as per Table 2-8) will be visually inspected prior to use and tested through the comparison of readings to pH and conductivity standard solutions.

In all cases, specific preventative maintenance procedures as defined by the respective manufacturers will be followed. Additionally, field notes from previous sampling events will be reviewed by the respective Field Program Coordinators, or designated substitutes, to ensure that any previous equipment problems have been identified, and that all necessary repairs have been made.

The Field Program Coordinators, or a designated substitute, will be responsible for testing, inspection, and maintenance of all equipment prior to mobilization. The designated CDM Project Team member will then be responsible for completing the Equipment Inspection, Testing, and Maintenance Sheet; an example is provided in the Field Sampling Plan.

2.6.2 Laboratory Instruments

Each laboratory will perform routine preventative maintenance in accordance with their respective Quality Assurance Plans (see attached) and with manufacturer's specifications to minimize the occurrence of instrument failure and other system malfunctions. Each laboratory will maintain factory-trained repair staff with in-house spare parts or will maintain service contracts with applicable vendors.

Records of preventative maintenance, equipment repairs and replacement, and documentation of maintenance procedures will be maintained by the designed laboratory Quality Assurance Officer, and subject to auditing by the CDM Project Team QA Officer.

2.7 Instrument/Equipment Calibration and Frequency

This section describes the calibration procedures that will be followed for all equipment used to conduct field and laboratory analyses to maintain reliable and accurate measurement results. All calibrations will be performed in accordance with manufacturer's recommendations.

2.7.1 Field Instruments and Equipment

Instruments and equipment used to perform *in situ* measurements, including temperature, pH, conductivity, and dissolved oxygen will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of the results are consistent with the manufacturer's specifications and applicable SOP. In general, pre-sampling and post-sampling calibration will be performed. A mid-day calibration will be performed systematically between all teams during dry-weather sampling events. During wet-weather sampling events, each boat and land crew will perform a calibration check of their respective sampling equipment between the six and 12-hour sampling rounds; the meters will be recalibrated as necessary based on the results of the check. Outfall sampling crews will perform a calibration check/ recalibration between the two and three-hour sample collection rounds.

Table 2-12 provides a list of the field equipment to be used to during the sampling program and denotes the required calibration method. Additional information is provided in the respective SOPs.

Table 2-12: Summary of Field Instrument/Equipment Calibration Method

Instrument/Equipment	Calibration Method
DO membrane electrode (probe)	Air Calibration
Specific Conductance	Manufacturer's two-point method
Thermometers	Calibrated against NIST certified/traceable thermometer
Thermistors (contained in DO probes)	Checked against previously calibrated hand thermometers
pH (electrometric method)	Calibration based on standard solution

The Field Program Coordinators, or designated others, will be responsible for ensuring that all equipment has met the required calibration standards prior to event mobilization. In the event that an internally calibrated field instrument fails to meet calibration/check-out procedures, it will be returned to the manufacturer for service. Calibration procedures and frequency will be recorded in a field logbook and on the Equipment Calibration Sheet (see Field Sampling Plan) along with instrument identification numbers and the buffer solution lot numbers, where appropriate. All standard solutions used during the calibration process will be specifically designed for the instruments being calibrated and inspected per the guidance in Section 2.8.

2.7.2 Laboratory Instruments/Equipment

Calibration procedures and frequencies of all laboratory equipment will be performed in accordance with the respective laboratory's Quality Assurance Plans (see attached), manufacturer's specifications, analytical SOPs, and written procedures approved by laboratory management. Records of calibration method and frequency will be filed and maintained by the designated laboratory Quality Assurance Officers; these may be subject to auditing by the CDM Project Team QA Officer.

2.8 Inspection and Acceptance of Supplies and Consumables

All supplies to be used during the field sampling program will be inspected prior to acceptance to ensure that they are in satisfactory condition and free of defects or contamination in accordance with the methods specified in Table 2-13.

Table 2-13: Summary of Supplies and Inspection Requirements

Critical Supplies and Consumables	Inspection Requirements and Acceptance Criteria
Sample bottles	Visually inspected upon receipt for cracks, breakage, cleanliness, and preservation solution (as needed)
Chemicals and reagents	Visually inspected for proper labeling, expiration dates, and approximate grade
Water quality monitors/current meters	Functional checks to ensure proper calibration and operating capacity per Sections 2.6 and 2.7
Sampling equipment	Visually inspected for obvious defects, damage, and contamination

The respective Field Program Coordinators, or designated substitutes, will be responsible for ensuring the acceptability of all material to be used during field activities prior to event mobilization and for implementing corrective action, if necessary. Designated personnel from Aquatec and AMRO will be responsible for the inspection and acceptance of all material relating to laboratory analysis.

2.9 Non-Direct Measurements

It is not anticipated that any non-direct measurements will be required during the implementation of the field sampling program. All environmental and flow measurements performed under this activity will be taken directly by the CDM Project Team and subcontracted laboratories.

2.10 Data Management

This section describes the data management strategies that will be used during the collection, review, and reduction of all environmental data collected as a part of the Merrimack River Watershed Assessment Study field sampling program.

2.10.1 Data Recording, Handling, and Tracking

This section details the computerized and manual data recording, handling, and tracking procedures that will be used during the sampling program.

Data Recording and Tracking

Field Data. Field environmental measurements collected by the CDM Project Team during sampling events will be recorded in field logbooks and field data collection forms in accordance with guidance provided in Section 1.6 Documents and Records. Upon completion of the sampling event, the data collected will be transposed to a project-specific electronic database, the format of which will be discussed in subsequent sections. The transfer of data from paper (*i.e.* logbooks or collection forms) to electronic format will be performed by a designated member of the CDM Project Team; a second individual will then spot check the entries.

Copies of all field data will be maintained by CDM in a Final Evidence File in accordance with the document retainage and control guidelines discussed in Section 1.6.

Laboratory Data. Laboratory results will be reported in accordance with the guidance provided in Section 1.6. All information related to sample analysis will be documented in controlled laboratory logbooks, instrument printouts, or other approved forms in accordance with the laboratory's Quality Assurance Plan. Analytical laboratory records will be reviewed by the respective laboratory Quality Assurance Officer, and subject to auditing by the CDM Project Team QA Officer.

Prior to releasing the final data, each laboratory will employ a tiered review process. Each analyst will be responsible for reviewing the analytical and quality control that he/she has generated; the analyst will verify that:

- The appropriate methodology has been used

- Instrumentation and equipment was functioning properly
- QC analyses were performed at the proper frequency and the analyses met the acceptance criteria
- Samples were analyzed within the required holding times
- All analytes were quantitated within the calibration range
- Matrix interference problems were confirmed
- Method specific analytical requirements were met
- Calculations, dilution factors, and detection limits were verified

The raw data will then be released to the respective area supervisor who will also review the data for attainment of quality control criteria as required in the applicable standard method and for overall reasonableness. The area supervisor will be responsible for generating the data summary report, which will be reviewed by the laboratory Quality Assurance Officer. This review will verify that the report format and content meet the client specifications, that the data were reported correctly, and that analytical and quality control problems were addressed and documented in the file and summary report (if appropriate). Upon acceptance of the preliminary reports by the QA Officer, the final reports will be generated and signed by the Laboratory Project Manager.

Following the receipt of the data reports by the CDM Project Team Technical Project Manager or designated substitute, all results will be transposed or uploaded to the electronic database developed for the project by a member of the CDM Project Team. Data transcription will be spot checked by a second member of the Team. The final database will include all the data provided by the laboratories, as well as laboratory-provided data flags, including:

- Concentrations below the required detection limits
- Estimated concentration due to poor relative percent difference
- Estimated concentration due to poor spike recovery or other outlying QC data
- Concentration of chemical also found in laboratory blank

Data Handling

All data gathered or generated as part of the Field Sampling Plan will be entered into a project-specific database, developed using Microsoft Access. Data will be organized according to the unique sampling station locations (*i.e.* Station ID) provided in the Field Sampling Plan. Each site will be referenced based on its latitude and longitude. Every effort will be made to make the database compatible with the USEPA's STORET (short for STOrage and RETrieval) database format, including the incorporation of all required fields per NHDES' "Suggested Chemical Water Quality Data Elements" (May 2001). The database will include at a minimum:

- Sampling date (MM-DD-YYYY)
- Sampling round (D1- D4; W1-W4)
- Sampling sweep (wet-weather only- *i.e.* 1 through 5)
- Station ID
- County where station is located (Massachusetts and New Hampshire)
- Station longitude and latitude
- GeoMethod- Geopositioning method used to determine state latitude and longitude
- GeoDatum- Datum that longitude and latitude coordinates are in
- Sample collection time
- Sample type (*i.e.* vertically integrated quarterpoint spatial composite, vertically integrated centerpoint sample, bacteria grab sample, outfall grab sample)
- QC sample type, if applicable (duplicate - DUP or blank - BL)
- Parameter ID (Table 2-5)
- Analytical results (*i.e.* constituent concentration)
- Units
- Reporting limits
- Analyzing laboratory

- *In situ* measurements, including pH, temperature, conductivity, dissolved oxygen, turbidity (select stations), salinity (select stations), secchi disk depth (select stations, dry-weather only)
- Stage and corresponding discharge at time of sample collection based on pre-determined stage-discharge relationships
- Data Qualifier (Table 2-14)
- Brief field or laboratory notes

Field and laboratory analytical data will be flagged based on the results of the data validation described in Section 4. Table 2-14 presents a summary of the data qualifiers or "flags" that will be used throughout the database, as specified in the "Region 1 Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses" (USPEA 1988).

Table 2-14: Summary of Data Qualifiers

Data Qualifier	Description
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantification limit or the sample detection limit
J	The associated value is an estimated quantity
R	The data are rejected
UJ	The material was analyzed for but not detected. The associated value is an estimate and may be inaccurate or imprecise.

All electronic data files will be stored and maintained in accordance with the procedures detailed in Section 1.6 - Documents and Records.

Section 3
Assessment and Oversight

Section 3.0 of this QAPP addresses the activities required for assessing the effectiveness of the field sampling program implementation and associated quality assurance and control activities. The purpose of the assessment is to ensure that the QAPP is implemented as prescribed and that appropriate responses are in place to address any non-conformances and deviations from the QAPP.

3.1 Assessments and Response Actions

Performance and system audits of both laboratory and field activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in this QAPP and corresponding Field Sampling Plan. Field and laboratory performance audits are performed as an independent evaluation, through a review of internal quality control checks and procedures, of the data being generated. System audits are conducted as an onsite review and evaluation of facilities, instrumentation, quality control practices, data validation, and documentation practices.

3.1.1 Field Audits

Internal system and performance audits of field activities (sampling and measurement) will be conducted by the CDM Project Team QA Officer. The scope of these audits may include, but is not limited to:

- Field sampling and measurement records
- Field instrument operating records
- Sample collection, handling, and packaging procedures
- Maintenance of QA procedures
- Chain-of-custody procedures

Audits typically occur at the onset of field operations to verify that all established procedures are implemented. A follow-up audit will be conducted once during the course of the investigation to correct deficiencies and to verify that QA procedures are maintained through the project, most likely during the second or third sampling event. The audits will involve review of field measurement records, instrumentation calibration records, and sample documentation.

3.1.2 Laboratory Audits

Internal system and performance audits will be conducted by the respective laboratories in accordance with their specified Quality Assurance Plans. The type and frequency of these audits is dictated in the Plans (see attached).

Additionally, external laboratory audits may be conducted by CDM if problems with the data are observed, such as errors in a laboratory's internal sample tracking.

3.1.3 Audit Reporting and Corrective Action

Audit reports will be generated by the responsible party (*i.e.* QA Officer) at the completion of each assessment. The audit report will identify proficiencies, deficiencies, and opportunities for improvement, as applicable.

Corrective action includes the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or practices that result in data quality beyond the required quality control performance standards. Such actions may occur during field activities, laboratory analyses, data validation, and data assessment.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. Any nonconformance with the established quality control procedures in the QAPP and Field Sampling Plan will be identified and corrected in accordance with the QAPP. The Technical Project Manager, or an approved substitute, will issue a Nonconformance Report for each condition. All corrective actions will be further documented in the QA section of the project deliverables.

Field Corrective Action

Corrective actions in the field will be implemented on a case-by-case basis. Minor response actions taken in the field to immediately correct a problem will be discussed with the respective Field Program Coordinator and documented in the field logbook. The corrective action will be verbally relayed to the Technical Project Manager. Major corrective actions taken in the field will require approval by the Field Program Coordinator and Technical Project Manager prior to implementation. Such actions may include revising procedures in the field, resampling, or retesting.

Laboratory Corrective Action

Corrective action undertaken by the laboratories will be completed in accordance the procedures outlined in their respective Quality Assurance Plans. All corrective actions will be reported to the CDM Project Team's Technical Project Manager and will be documented in the respective data reports for each sampling round. The laboratories will also be required to take and document corrective actions for problems identified by CDM.

3.2 Reports to Management

During the active phases of the sampling project, CDM will submit written monthly status reports to the USACE identifying the activities performed, planned activities, and updated schedules. The CDM Project Team will also develop a final Interim Task Report to summarize the sampling events and environmental data obtained during the sampling program.

Quality assurance reports will be provided to the USACE Study Manager and the CDM QA Officer (copies) when data or measurement quality problems are encountered. As previously noted, all corrective actions and nonconformance problems will be documented in the field logbooks and Nonconformance Reports. These will be further detailed in the task deliverable.

Section 4 Data Validation and Usability

The data review, verification, and validation procedures and criteria to be performed by the CDM Project Team and subcontracted laboratories are addressed in this section of the QAPP. These procedures and criteria will identify and qualify data that do not meet the established measurement performance criteria.

4.1 Data Review, Verification, and Validation

Ten-percent of the data analyzed and reported by CDM's subcontracted laboratories will be validated. The validation efforts will be more heavily weighted towards samples collected at the beginning of the field sampling program to ensure the identification of reporting problems early in the program. The remaining 90-percent of the data will be evaluated to determine the precision, accuracy, representativeness, completeness, comparability, sensitivity and field QC samples. Additional information on the validation and evaluation methods is provided in Section 4.2.

Suspect calibration information for *in situ* measurements, *i.e.* samples collected using equipment that was later determined to be out of calibration, will be noted in the field logbook upon discovery. Measurements made during the period of suspect calibration will be flagged as questionable.

4.2 Verification and Validation Methods

Validation (10-percent of the data) will be conducted in accordance with the "*Region 1 Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*", dated February 1989. A validation report will be developed for each SDG that is validated until the 10-percent criteria is met. A summary of these specific SDG validation reports will be presented in the data evaluation summary report. The specific SDG validation reports will be an appendix to this document.

Data evaluation (90-percent of the data) for precision, accuracy, representativeness, completeness, comparability, sensitivity and field QC sample parameters will include a review of holding times, preservation, method of preparation blanks, laboratory duplicates, MS/MSDs, and/or LCS/LCSDs, sampling and analytical procedures, data usability, method detection limits, field rinsate blanks, and field duplicate results. During data validation and evaluation, analytical data may be qualified as specified in the above-referenced guidance documents. A data evaluation summary report will be generated at the completion of the evaluation effort. This report will summarize both the validation and evaluation results for the sampling event. Included in an appendix to this report will be the specific SDG evaluation reports (usually presented in table format), and the specific SDG validation reports. These will be included in an appendix.

4.2.1 Corrective Action

The need for corrective action may be identified during either data validation or data assessment. Potential types of corrective action may include resampling by the field team (if possible) or reanalysis of samples by the subcontracted laboratory. These actions are dependent upon the ability to mobilize the field team and whether or not the data is necessary to meet the required project and Data Quality Objectives.

If a CDM Project Team assessor identifies a needed corrective action, the Technical Project Manager will be responsible for approving the implementation of the response action. Problems that may be attributed to laboratory quality assurance issues will be brought to the attention of the laboratory's Quality Assurance Officer, who will determine what, if any, action is required. The laboratory QA Officer will be responsible for implementing and reporting the corrective action.

4.3 Reconciliation with User Requirements

One-hundred percent of the analytical data from the subcontracted laboratories will be either validated or evaluated. CDM will determine which data are usable for their intended purposes, as defined by the Data Quality Objectives established in Section 1.4. This review will consist of the following steps:

- Review Data Quality Objectives and sampling design
- Conduct preliminary data review
- Identify data limitations
- Draw conclusions from the data

The measured environmental and streamflow data will be compared to the applicable water quality standards for Massachusetts and New Hampshire. The findings of the data reconciliation will be presented in the final Interim Task Report to be developed at the conclusion of the sampling program.

Section 5
References

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Appendix A: Response to comments received on the Draft QAPP and Field Sampling Plan

CDM

Memorandum

To: *Distribution*

From: *Gary Mercer, Kirk Westphal, and Beth Rudolph (CDM)*

Date: *April 2, 2003*

Subject: *Merrimack River Watershed Assessment Study- Modifications to the Field Sampling Program*

Copies of the DRAFT Quality Assurance Project Plan (QAPP) and Field Sampling Plan for the Merrimack River Watershed Assessment Study were provided to Nora Conlon (USEPA), Dave Gray (USEPA), Arthur Screpetis (MADEP), Paul Currier (NHDES), and Paul Piszczek (NHDES) in January 2003 for their review and comment. A meeting was held on February 13, 2003 with representatives from CDM, the USACE, and the above-mentioned reviewers to discuss comments on the draft documents.

Following this meeting, CDM and the USACE worked to address these comments with the goal of shifting emphasis to elements of the sampling program seen as most critical by the reviewing agencies. However, in evaluating the budgetary impacts of these changes, certain trade-offs were required in the scope of the field sampling effort to meet the budgetary constraints of the program. CDM and the USACE developed a revised sampling program which preserves the core elements of the original plan and supports the following program objectives agreed upon at the February 13, 2003 meeting:

- Collect water quality and streamflow data sufficient for the calibration and validation of water quality and hydrologic/hydraulic models to be developed under subsequent tasks of this Study

- Collect water quality data to determine the relative likelihood that segments of the mainstem Merrimack River meet state water quality standards

The following section summaries the major modifications to the QAPP and Field Sampling Plan, including those items added to the program based on discussions at the February 13, 2003 meeting. These modifications bring the sampling program within the budgetary constraints.

Modifications to the Field Sampling Program

- **Addition of continuous dissolved oxygen and temperature monitoring.** Under the revised plan, continuous dissolved oxygen and temperature monitoring will be performed at two stations in the mainstem Merrimack River (upstream of Amoskeag Dam in Manchester, New Hampshire and upstream of Pawtucket Dam in Lowell, Massachusetts) for a one-month period between mid-July and mid-September. The exact timing of continuous monitoring will be determined based on prevailing streamflow and climatic conditions.

- **Data Validation/Evaluation.** Under the revised program, data validation will be performed for ten-percent of the data collected under the sampling program, in accordance with the "*Region 1 Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*". Data evaluation will be performed for the remaining 90-percent of the data.

- **Addition of Performance Evaluation Samples.** A limited number of performance evaluation samples will be used as a double-blind evaluation of the respective laboratory performances for the following parameters: fecal coliform, E. coli, total phosphorus, nitrate/nitrite, ammonia, TKN, hardness, and BOD.

- **Composite bacteria samples.** Under the original sampling plan, three discrete bacteria samples were planned to be collected at stations that were assumed to be poorly mixed. Based on discussions at the February 13, 2003 meeting, it was agreed that composite samples would be collected at these stations, as they will provide a more accurate picture of water quality conditions for model calibration/validation purposes. Equipment blanks will be collected at each station to quantify the amount of cross-contamination between stations. Additionally, one grab sample will be collected at these stations at the center-point of the River in accordance with standard bacteria sampling procedures.

- **Remove macroinvertebrate sampling.** Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling was dropped from the sampling program, as it did not directly support the revised sampling program objectives.

- **Remove metals and hardness.** CDM and the USACE originally proposed sampling for six metals (cadmium, copper, iron, lead, nickel, and zinc) during the first two dry-weather events and the first wet-weather event, with continued monitoring during subsequent events only for those parameters where exceedances of state and federal water quality standards were observed. However, sampling for metals and hardness will be deleted from the QAPP reduce cost of the sampling program to reach the budget limit.

- **Reduce nutrient and BOD_5 wet-weather sampling to one sweep.** Under the original sampling plan, two sweeps of the sampling stations were planned for nutrients (total phosphorus, nitrate/nitrite, ammonia, TKN) and BOD_5 during wet-weather sampling events. Under the revised plan, sampling for these constituents will be performed during the second sweep of the wet-weather sampling events. Nutrient sampling will remain unchanged from the original plan during the dry-weather sampling. CDM and the USACE are comfortable that the reduced sampling during wet weather will not impact the ability to calibrate and validate the water quality models or the ability to assess regulatory compliance.

- **Remove one dry-weather sampling event.** Four dry-weather sampling events were planned under the original sampling plan between April and November 2003. Under the revised plan, three dry-weather sampling events will be performed over the course of the program. Two of the events will occur between May and mid-September; the third event will be conducted during October or November. CDM and the USACE are comfortable that the three dry-weather events will adequately cover the critical range of conditions necessary to assess water quality conditions in the Merrimack River.

- **Revised stormdrain sampling protocol.** Under the original plan, sampling was planned at two stormdrains per community (Manchester and Nashua, New Hampshire; Lowell, Lawrence, and Haverhill, Massachusetts) during each wet-weather sampling event, for a total of 10 stormdrains per event. Under the revised plan, sampling will be performed at one stormdrain outfall per community per wet weather event, for a total of five stormdrains per event. However, unlike the original plan where the same outfalls were sampled during each event, the revised plan calls for different outfalls to be sampled during each of the three wet-weather events (*i.e.* three different outfalls per community). Thus, providing a more comprehensive evaluation of different stormdrain inputs to the Merrimack River.

  Additionally, based on available personnel during wet-weather events, the stormdrain and CSO outfalls may be sampled during separate wet-weather events from when the in-stream sampling is performed. CDM and the USACE are comfortable that separate source sampling will not affect the ability to calibrate and validate the water quality models.

CDM and the USACE are currently working to finalize the QAPP and Field Sampling Plan based the modifications discussed above, as well as other the comments received at the February 13, 2003 meeting. Please feel free to contact Gary Mercer (CDM) at 617-452-6238 or mercergw@cdm.com with any comments regarding the modifications to the sampling program.

CDM

Memorandum

To: *Distribution*

From: *Gary Mercer, Kirk Westphal, and Beth Rudolph - CDM*

Date: *January 22, 2003*

Subject: *Initial Response to USEPA comments on the Merrimack River Watershed Assessment Study Draft QAPP and Field Sampling Plan*

This memo is prepared in response to comments received from Nora Conlon, Ph.D., USEPA Region 1 QA Chemist, and David Gray, USEPA Region 1 Massachusetts State Program Office, on the following materials developed for the Merrimack River Watershed Assessment Study:

- Draft Quality Assurance Project Plan
- Draft Field Sampling Plan
- Draft Standard Operating Procedure (SOP) Compendium
- Laboratory Quality Assurance Project Plans for AMRO Environmental Laboratories Corporation and Aquatec Biological Sciences

The comments from USEPA were discussed on January 21, 2003 at a meeting with Nora Conlon (USEPA), David Gray (USEPA), Barbara Blumeris (USACE), Townsend Barker (USACE), Harold Costa (City of Lowell, MA), and representatives from CDM.

Response to Comments from Nora Conlon

1. *Water quality standards for Massachusetts and New Hampshire are referenced; however, the numeric values are not included. Please add a table the lists the numeric values. These values are important for evaluating the SOPs and the laboratory quantitation limits. (A good place to add this information is in Table 2-9.)*

   Response: CDM will add a table of water quality criteria and work with the laboratories to ensure that detection limits are at or below the criteria wherever possible. If there are cases where laboratory detection limits exceed regulatory standards, CDM will provide a discussion of how the data will be qualified and used in the context of the study.

2. *I'm concerned about the ability to meet the holding time on the bacteria samples; both for the wet and dry weather sampling events. Please include the mobile laboratories sample capacity; the time it will take to sample a "reach" from start to finish; the travel time from the drop-off points back to the laboratory. I think it's a long way from Newburyport to Nashua and an almost impossible distance to Williston, VT - especially adding in sampling time.*

   Response: CDM will document the required times for sample collection, transportation, and laboratory analysis required to meet the six hour holding time for bacteria for both wet and dry wet events. Modifications to the sampling plan will be made as necessary to ensure that holding times will be met. CDM will work with Aquatec to determine the mobile laboratory capacity. Also for data validation, CDM will specify time periods for extended hold times for which analytical results will be flagged but not discarded.

3. *For the wet weather events, please verify that all events will not take place in the spring even if the weather criteria are met.*

   Response: CDM will clarify this in the text.

4. *For the Quality Objectives section*

   A. Please identify if there are any critical samples that are needed for characterizing the river. For example, although you have established a 90% completeness criterion, do you need 100% completeness for the quarterpoint samples to get a good picture of the river? Also, are there instances when resampling will be required or is it technically not possible to resample since there is a time dependency to these events?

   Response: CDM will clarify the completeness criteria in the text. For example, if a group of samples are missing from one sampling region, *i.e.* one sampling reach or all source characterization samples (CSO or stormdrain outfalls), the completeness criteria may also be violated. CDM will also add a note regarding the resampling guidelines. In general, re-sampling at instream stations is not feasible during wet-weather events due to the temporal variability. However, resampling is possible at CSO and stormdrain outfalls to characterize the source inputs.

   B. For accuracy measurements, are any Performance Evaluation (PE) samples planned? They can be very useful, especially in the first sampling round or as a test for the laboratories before sampling begins. Also, please include the QA objectives for bacteria which typically entail positive and negative controls.

   Response: CDM will consider including a limited number of PE samples. CDM will work with the laboratory to determine QA objectives for bacteria.

5. *For the Laboratory Data Reporting Package, please clarify if CDM will be receiving raw data packages. The data validation section refers to a 3-tier validation system; however, the EPA Region 1 Data Validation Functional Guidelines are not referenced. Will they be used? Raw data packages are a requirement for Region 1 data validation. Also, there is a big section on the internal laboratory data review but it looks like CDM is only doing a transcription review. Also, the extensive list of data qualifiers does not include a flag for estimated concentrations. I'd like to discuss the data procedures on Tuesday.*

   Response: CDM will note that we will receive raw data packages from the laboratories. CDM will also revise the Data Validation section to be consistent with Region 1 guidelines; the data flags will be revised accordingly.

6. *More than one dissolved oxygen method will be used. Please include comparability criteria between the field measurement and the Winkler method.*

   Response: CDM will add comparability criteria for the two methods.

7. *Please clarify the starting time for the diurnal sweep. The tables in the FSP say 1 a.m. and 1 p.m.; the QAPP states dawn and late afternoon.*

   Response: The tables contain a typographical error; they should read 7am and 1pm.

8. *Section 3.1.2 Laboratory Audits - only internal lab audits are described. Does CDM plan on doing any external audits? Are there any data problems that may trigger an external audit?*

   Response: CDM will add a notation that external laboratory audits may be conducted if problems are observed- *i.e.* errors in internal sample tracking, etc.

9. *FSP page 3-4: Good information is provided on how case-by-case weather decisions will be made -also include how they will be communicated and documented.*

   Response: CDM will add a discussion on communication and documentation procedures.

10. *There are slight differences in the total number of samples for each of the dry weather events; please include why there are differences. Also, please explain why bacteria only is being sampled at the Lowell Public Beach.*

    Response: CDM will add clarification in the text regarding the differences in sample numbers for the dry weather events. Bacteria only are being conducted at the Lowell Public Beach due to the state swimming standard.

11. *On the tables, are blanks field blanks or equipment blanks or something else?*

    Response: These are field blanks.

12. *For the samples being taken for both dissolved and total metals, please ensure that separate quality control samples are included for each.*

    Response: CDM will verify separate QA samples.

13. *For CSO samples, there was some discussion about using wastewater treatment plant personnel to assist in the sampling. Is this still a possibility?*

    Response: This is still a possibility. CDM will add a section on training procedures for potential samplers outside of the CDM Project Team.

14. *There was some discussion about the preliminary release of data. Is this still a possibility?*

    Response: Preliminary data will not be released. All data will be validated prior to distribution.

Response to Comments from David Gray

2-3 *"Field" vs. "Trip" Blanks – prepare field blanks in field*

QC Checks – check and/or calibrate at start and mid-point of each sampling round?

Response: The field blank and calibration procedures will be clarified in the text.

3-2 *How was Maximum 7-Day ADP derived in terms of expected pollutant uptake and die-off (i.e., back of envelop)? Or was it based only on historic flow?*

Response: The seven-day ADP was derived based on assumed pollutant die-off (particularly for bacteria) and travel times.

3-3 *Do >0.5-inch storm events trigger most CSOs under all seasons or does high water table typically govern?*

Response: Based on the LTCPs for the five communities, 0.5-inches will trigger most CSO outfalls in the watershed.

3-3 *Full vs. Partial Coverage Events (frontal vs. intense/isolated) – Total number of wet weather events. If full coverage event captured in spring, attempt to get a 4th full coverage in fall? Plus two partial coverage events in summer.*

Response: Additional events will be considered based on budget constraints.

3-3 *Specify that partial coverage events must cover distinct reaches. Is this sufficient?*

Response: CDM will clarify in the text that partial coverage events will be selected to cover distinct reaches.

3-4 *If isolated storm occurs in lower reaches only – will upper reaches be sampled? Or will budget be retained for monitoring an additional storm that occurs in the upper reaches.*

Response: For partial coverage events, sampling will be performed in the immediate area that the event occurred, as well as in any reaches downstream of the event.

3-4 *Break point on previous storm's hydrograph to qualify next storm event – after peak, ½ of falling limb, etc?*

Response: Sampling will not occur until the previous storm hydrograph has receded by at least 75-percent.

5 *Sampling Stations:*

Was M-27 chosen in consultation with MDMF? More realistic to choose an u/s growing area?

Response: M-27 was chosen as a dual shellfishing/recreation station. Efforts will be made to relocate one of the shellfishing stations in an upstream growing station.

U/S WWTP dry weather monitoring not necessary?

Response: Monitoring is not performed immediately upstream of the sponsor communities. This is only performed during wet weather to assess the cumulative impacts of the stormdrain and CSO outfalls- the upstream stations is used as the reference point to determine the relative input from each community.

Analyze for ENT at all stations.

Response: Fecal coliform & E. Coli will be sampled at all stations, since these are the current indicators referred to in MA and NH water quality standards. In accordance with current EPA guidelines, Enterococcus will only be sampled in marine waters.

T5-1 Not all tribs are accessible by boat – conflict with 6-13? (7 vs. 4 stations by land)

Response: CDM will clarify this in the text.

5-9 High-Frequency Bacteria Station (M-15) – can/should it be moved further d/s?

Response: This station is co-located at the USGS gaging station to provide continuous load estimates.

5-10 For stormdrain outfall sampling – EPA lab did investigation in Lawrence; NHDES did same in Nashua.

Response: CDM/EPA to follow-up on study results.

5-10 For CSO sampling, confirm that selected CSO also has a history of mean bacteria densities equivalent to others within the community.

Response: CDM will clarify this in the text.

T5-2 QC samples all collected at the same recurring stations – spread throughout for randomness and to keep unknown to labs.

Response: QC samples will be collected at the same station; they are distributed through the sampling teams.

5-2/10 Tidal effects – sampling to be completed during slack or strong ebb tide? For wet weather, consider completing monitoring after once ebbing regardless of timing (i.e. wait up to the full 6-1/2 hours+ to monitor).

Response: CDM will revise the text to indicate that final monitoring sweeps will occur on outgoing tide.

6-6 Protocol for determining sampling frequency for shorter events (<12 hrs) – (e.g. t=0, 2, 4, 8, 16 or t=0, 1, 2, 4, 8). Or will frequency be reduced to maintain sampling 24 hours after?

Response: The sampling frequency will be revised based on estimated event durations, etc. This will be clarified in the text. We will allow for some flexibility in the schedules for source sampling, but will maintain the same 24-hour spread for in-stream sampling regardless of event size or duration.

7-5 *Bacteria sampling – single grabs and no depth profiles; quartile sampling at a few stations when assumed not well-mixed – how determine? Consider quartile sampling regardless. Concern over compositing really valid?*

Response: CDM would prefer to collect composite bacteria samples to get a better picture of the average bacteria concentrations. Further research will be done to determine acceptance of this approach within EPA and the state agencies. Also, research will be conducted on the precedence of this sampling technique.

9-1 *QC nomenclature should make samples "blind" to labs.*

Response: The sample labeling nomenclature will be revised accordingly.

CDM

Memorandum

To: *Distribution*

From: *Gary Mercer, Kirk Westphal, & Beth Rudolph- CDM*

Date: *March 20, 2003*

Subject: *CDM Response to MADEP comments on the Draft QAPP/ FSP*

The following is a response to comments received from Arthur Screpetis at the Massachusetts Department of Environmental Protection (MADEP), dated January 29, 2003, on the Draft Quality Assurance Project Plan (QAPP) and Field Sampling Plan prepared for the Merrimack River Watershed Assessment Study. The response to these comments is based on discussions with Mr. Screpetis (MADEP), Paul Currier and Paul Piszczek (NHDES), Nora Conlon (USEPA), Dave Gray (USEPA), and representatives from CDM and the USACE at a meeting on February 13, 2003. The corresponding section and page(s) where these responses have been addressed in the QAPP and Field Sampling Plan documents is also provided for reference purposes.

1. Better define/clarify duties for CDM's Technical Manager (Gary Mercer) and CDM's Field Program Coordinator (Beth Rudolph) relative to the field sampling program. Will Mr. Mercer or Ms. Rudolph be responsible for overall coordination of sampling crews from NAI, NEA, and CDM? The text indicates that Mr. Mercer will be responsible, however, it appears from the Project Organizational Chart (Figure 1-1) that Ms. Rudolph will be directly responsible for coordinating all field activities. (1.1.2)

   CDM RESPONSE: CDM has clarified this in Section 1.1.2 and Figure 1-1 of the QAPP. Gary Mercer will be responsible for the ultimate coordination of sampling teams from CDM, Normandeau, and NAI.

2. Clarify/identify parameters to be tested by Aquatec Biological Sciences and AMRO Environmental Laboratories Corporation. (1.1.2)

   CDM RESPONSE: A reference has been added in Section 1.1.2 to Table 2-9 where this information is provided.

3. Identify/discuss the role, if any, for NHDES and MDEP in the study. (1.1.2)

CDM RESPONSE: The role of USEPA, NHDES, and MADEP has been added to Section 1.1.2 and Figure 1-1. NHDES and MADEP will review the QAPP and Field Sampling Plan and will be asked to sign-off on the plans as technical reviewers. Both agencies will be kept abreast of progress once the sampling program begins. Correspondence will generally be routed through the USACE Study Manager, Ms. Barbara Blumeris.

4. Explain the difference between "beneficial uses" and "designated uses" relative to the Massachusetts and New Hampshire Surface Water Quality Standards Classifications. Aquatic Life, Fish Consumption, Drinking Water, Primary Contact Recreation, Secondary Contact Recreation, Aesthetics and Agricultural and Industrial are the identified designated water uses in Massachusetts. (1.2.2)

   CDM RESPONSE: The QAPP and Field Sampling Plan have been changed to use the term "designated uses" throughout.

5. Explain what additional data beyond that collected during Phase I may be required to perform the more detailed cost-benefit analysis for the next phase of the study. (1.2.2).

   CDM RESPONSE: Any additional information collected beyond Phase I of the project would be addressed in an amendment to the QAPP.

6. Update the text (and the citation) discussing the Massachusetts 1998 303(d) list using the Massachusetts Year 2002 Integrated List of Waters. (1.2.3)

   CDM RESPONSE: The information in Section 1.2.3 was updated based on the 2002 list.

7. Explain why sampling will be performed under specific [stream] flow regimes and what those specific [stream] flow regimes are. (1.3.1)

   CDM RESPONSE: CDM will attempt to perform all sampling at or below the mean monthly flow unless prevailing seasonal conditions dictate higher streamflow conditions. The mean monthly streamflow was added in Table 2-2 based on historical records at the USGS gaging stations in Manchester, New Hampshire and Lowell, Massachusetts; a reference to that section was added in Section 1.3.1.

8. Explain if water quality modeling will be performed and for what purpose. Identify what model will be used and if the data collection program (water quality, streamflow) is designed to support model calibration and verification. (1.3.1)

   CDM RESPONSE: A "Modeling Methodology" technical memorandum was developed under a separate task; a short write-up summarizing the modeling plan was added to Section 1.3.6.

9. The sampling program's objectives identified in Table 1-1 could be better organized or presented. The monitoring goals (Objectives in Table 1-1?) should relate to specific objectives or needs (Plan to Achieve in Table 1-1?). For example, what specific [project] objective(s) will be achieved by seasonal water quality sampling? Why is dry and wet-weather sampling being performed? What objective or information relates to model development and use?

   CDM RESPONSE: Based on a discussion at the February 13, 2003 meeting the following objectives were developed for the field sampling portion of the Merrimack River Watershed Assessment Study:

   - Collect water quality and streamflow data sufficient for the calibration and validation of water quality and hydrologic/hydraulic models to be developed under subsequent tasks of the Study

   - Collect water quality data to determine the relative likelihood that segments of the mainstem Merrimack River meet state water quality standards

   The sampling program objectives provided in Table 1-1 were deleted; all discussion of the sampling objectives was moved to Section 1.4.1 Data Quality Objectives.

10. Will time of travel (TOT) measurements be performed? Is TOT needed to meet model needs? (1.3.2)

    CDM RESPONSE: Time of travel studies are being conducted in conjunction with the USGS. These studies are being used to validate a comprehensive time of travel study conducted in the Merrimack River in 1966 by the U.S. Department of the Interior Federal Water Pollution Control Administration. This work is authorized under a separate task order.

11. Clarify or better define the "designated uses" in the study area. (1.3.2)

    CDM RESPONSE: A complete description of designated uses in the watershed was provided in Section 1.4.1.

12. Identify what field measurements will be performed during dry-weather surveys. Identify the indicator organisms that will be assayed. Are specific streamflow regimes targeted for dry-weather sampling? (1.3.2)

    CDM RESPONSE: References were added to Section 2.1.1 of the QAPP and the Field Sampling Plan where additional information is provided.

13. Explain how selected stormdrains and CSOs will be identified for wet-weather sampling. Clarify if discharge will be measured from the outfalls being sampled. Identify what field measurements will be performed during wet-weather surveys. Identify what indicator organisms will be assayed. (1.3.2)

    <u>CDM RESPONSE</u>: References were added to Section 2.1.1 of the QAPP and the Field Sampling Plan, where additional information is provided.

14. Clarify if sampling for aquatic macroinvertebrates will be performed during dry-weather conditions. Clarify if habitat assessment will be conducted in conjunction with aquatic macroinvertebrate sampling and if this will be performed before, during or after [multi-plate] sampler deployment. (1.3.2)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of the Merrimack River Watershed Assessment Study.

15. Identify what range of flows will be measured to develop discharge rating curves for each staff gage. (1.3.2)

    <u>CDM RESPONSE</u>: A reference was added in Section 1.3.4 to the Field Sampling Plan where additional information is provided.

16. Explain if data/information from municipal wastewater treatment plants will be used, if at all. (1.3.2)

    <u>CDM RESPONSE</u>: Data from monthly monitoring reports submitted to USEPA may be used; a discussion of this was provided in Section 1.3.

17. Clarify/explain if the data quality objectives will be sufficient to meet model needs. (1.4.1)

    <u>CDM RESPONSE</u>: Section 1.4.1 was modified to reflect the revised objectives developed at the February 13, 2003 meeting that specify the collection of data for model calibration/validation as a data quality objective.

18. Clarify/explain if Massachusetts and New Hampshire surface water quality standards and designated water uses are similar. (1.4.1)

    <u>CDM RESPONSE</u>: Addition discussion on the designated uses for Massachusetts and New Hampshire was provided in Section 1.4.1. A summary of the applicable state water quality standards was added to Table 2-10.

19. Clarify if the data quality objectives also apply to aquatic macroinvertebrate, habitat assessment, bacteria, and flow measurements. (1.4.1)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of the Merrimack River Watershed Assessment Study. Additional discussion on the measurement performance criteria for flow monitoring and bacteria samples was added in Section 1.4.2.

20. Discuss quality assurance precision and accuracy objectives for field measurements including temperature, dissolved oxygen, water clarity (Secchi disk), pH, turbidity, salinity. (1.4.1)

    <u>CDM RESPONSE</u>: A discussion of the measurement performance criteria for field measurements was added to Section 1.4.2.

21. Clarify/identify analytical parameters Aquatec and AMRO are certified to perform. Clarify if the laboratories are certified in Massachusetts, New Hampshire or Vermont and if they are certified for potable or non-potable water. (1.5)

    <u>CDM RESPONSE</u>: This information was clarified in Table 1-2.

22. Clarify if the project team has previous experience in aquatic macroinvertebrate sampling (using artificial substrates) and habitat assessment in large lower perennial streams like the Merrimack River. (1.5)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this study.

23. Clarify if a field form will be used to document aquatic macroinvertebrate sampling and habitat assessment activities. (1.6.2)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this study.

24. Clarify or better describe what the designated water uses are in Massachusetts and New Hampshire. (2.1.1)

    <u>CDM RESPONSE</u>: A discussion on the designated uses in both states was provided in Section 1.4.1. A reference to this section was provided in Section 2.1.1.

25. Explain how seasonal variations will be characterized. Winter-time sampling is not planned. (2.1.1)

<u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, the characterization of seasonal water quality variability is no longer a specified project objective. However, the collection of data over various seasons is important to the development of a model calibration/validation data set. A clarification that winter-time sampling will not be performed was added.

26. Define the range of [stream] flow conditions expected. Define mean August flow relative to 7Q10 conditions and what that stream-flow is. (2.1.1)

    <u>CDM RESPONSE</u>: Additional information regarding the range of streamflow conditions expected, the mean monthly streamflow, and the7Q10 was added to Section 2.1.1.

27. The text states that precipitation amounts required to activate CSO's were used to define wet-weather events. Explain if these criteria apply equally or similarly to the mainstem Merrimack River (where sampling will take place) as well as to the 11 tributary streams to be sampled. That is, do rivers and streams and stormwater outfalls "respond" similarly to the CSOs? (2.1.1)

    <u>CDM RESPONSE</u>: A discussion was added in Section 2.1.1 describing expected differences in the response of stormdrain outfalls and tributaries as compared to the CSO's. For example, the stormdrain outfalls will most likely respond more quickly than the CSO's-*i.e.* they will begin discharging at precipitation amounts less than 0.5-inches. Alternately, a response in the tributaries may take longer as compared to the CSO's, due to the time of travel for pollution from upstream sources to reach the stream and then be carried downstream to the point of confluence with the Merrimack River where the sampling will be conducted.

28. Reconcile monitoring goals and objectives in Table 2-2 (Summary of General Wet and Dry-Weather Sampling Locations) with Table 1-1 (Sampling Program Objectives). (2.1.1)

    <u>CDM RESPONSE</u>: This has been completed based on the revised sampling objectives provided in #9 above.

29. Clarify if dissolved oxygen and temperature profiles and other measurements will be performed at the "deep hole" of each impoundment. How will the deep hole be identified? (2.1.1)

    <u>CDM RESPONSE</u>: Due to safety concerns, sampling will be conducted at the mid-point of the float line of each impoundment, unless a deeper location along the float line is found from the results of the bathymetric survey; this was clarified in Section 2.1.1.

30. Discuss when and how deployment of instrumentation to collect continuous DO/temperature measurements will be made. (2.1.1)

    <u>CDM RESPONSE</u>: Add discussion on the proposed continuous DO/temperature monitoring was provided in Section 2.1.1 and elsewhere in the QAPP and Field Sampling Plan.

31. Clarify if habitat assessment will be performed in conjunction with aquatic macroinvertebrate sampling. (2.1.1)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling is no longer being conducted as part of this study.

32. Define what constitutes the tidally-influenced portion of the Merrimack River. During low-flow periods the Merrimack River may be tidally-influenced from the estuary upstream to the Essex Dam in Lawrence. (2.1.1)

    <u>CDM RESPONSE</u>: For the purposes of this study, only the portion of mainstem Merrimack River downstream of Haverhill, Massachusetts is considered to be "tidally-influenced". This was clarified in Section 2.1.1 and elsewhere in the QAPP and Field Sampling Plan.

33. Intensive bacteria monitoring is proposed during dry or wet-weather conditions at one station below Lowell over 12-hours. Explain how that station will be selected. (2.1.1).

    <u>CDM RESPONSE</u>: Sampling will be performed at the USGS gaging station in Lowell; this was clarified in Section 2.1.1.

34. Explain how and why flow measurements will be used to evaluate the effects of dams on flow levels. What specific project objective will this address? (2.1.1)

    <u>CDM RESPONSE</u>: Flow measurements are not being conducted at the dams; the effect of dams on streamflow and water quality conditions in the River will be simulated using the models developed under a subsequent task of this Study.

35. Clarify if staff gages will be installed at each major tributary stream and if/how these will be maintained (including QC). (2.1.1)

    <u>CDM RESPONSE</u>: A discussion on how the staff gages will be installed and maintained was added to Section 1.4.2 and to the Field Sampling Plan.

36. Describe where information will be obtained to track weather conditions and how accurate or reliable these data are. (2.2.1)

<u>CDM RESPONSE</u>: Additional detail on the sources and accuracy of the precipitation forecasts was provided in Section 2.2.1.

37. What is the minimum depth at which vertically-integrated composite dry-weather sampling will be performed? Explain if this applies to field-collected measurements. (2.2.1)

    <u>CDM RESPONSE</u>: The minimum depth at which vertically-integrated samples will be collected is approximately three-feet (or one-meter); this was clarified in Section 2.2.1 and in the Field Sampling Plan.

38. Clarify if flow measurements will be performed concurrently with stormdrain and CSO pipe sampling. (2.2.1)

    <u>CDM RESPONSE</u>: Depth measurements will be taken at the CSO and stormdrain sampling locations; this was clarified in Section 2.2.1 and in the Field Sampling Plan.

39. Clarify if habitat assessment will be performed in conjunction with the aquatic macroinvertebrate sampling. (2.2.1)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this sampling program.

40. Clarify if field-collected measurements will be recorded on standard field forms. (2.2.3)

    <u>CDM RESPONSE</u>: Yes, collection forms are appended to the Field Sampling Plan.

41. Will pre-preserved bottles to collect samples for bacteria assays contain thiosulfate? (2.3.3)

    <u>CDM RESPONSE</u>: No, residual chlorine is not expected to be a problem.

42. Discuss how aquatic macroinvertebrate samples will be stored for transport to the analytical laboratory. (2.3.3)

    <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this sampling program.

43. Clarify if *in situ* measurements include Secchi Disk, salinity and turbidity. (2.4.1)

    <u>CDM RESPONSE</u>: This was clarified in Section 2.4.1.

44. Discuss quality control checks for aquatic macroinvertebrates, habitat assessment and flow measurements. (2.5.1)

<u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this sampling program.

Merrimack River Watershed Assessment Field Sampling Plan

(Some of the comments above also apply to the Field Sampling Plan document. These comments are generally not repeated here.)

1. Explain that winter-time sampling will not be performed. (1.2)

   <u>CDM RESPONSE</u>: This was clarified in Section 1.2.

2. Clarify if Gary Mercer or Beth Rudolph will have overall responsibility for the field sampling program. (1.4)

   <u>CDM RESPONSE</u>: Gary Mercer will have overall responsibility for the field sampling program; this was clarified in Section 1.4.

3. Discuss quality assurance objectives for aquatic macroinvertebrates and habitat assessment. (2.1)

   <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this sampling program.

4. Explain how applicable the time of travel estimates are given that USGS data are from 1966. It is likely that significant land use changes have occurred since that time which may influence runoff and streamflow conditions. (3.1)

   <u>CDM RESPONSE</u>: Although land use changes may alter the runoff and streamflow conditions, it is not anticipated that these changes have affected the hydraulics, and thus, the time of travel estimates for the mainstem Merrimack River since 1966. Additional discussion on this point was provided in Section 3.1.

5. Explain how expected pollutant uptake and [bacteria] die-off were estimated. (3.1)

   <u>CDM RESPONSE</u>: These estimates were quantitatively estimated based on standard pollutant uptake and die-off rates; additional discussion was provided in Section 3.1.

6. Define or explain tidal requirements for sampling and where tidal data will be obtained. (5.1)

<u>CDM RESPONSE</u>: Additional discussion tidal requirements and sources of the tide data was provided in Section 5.1.

7. Is it possible that samples collected on the downstream side of bridges may be contaminated by pigeons roosting under bridges? Was field reconnaissance performed to determine if [these] bridges are roosting areas? (5.1)

   <u>CDM RESPONSE</u>: Field crews will note any visible wildlife during sampling runs that may affect pollutant concentrations.

8. At what specific USGS gages will the sampling teams be measuring streamflow to assess accuracy of flow measurements performed at study locations? (5.3)

   <u>CDM RESPONSE</u>: Flow monitoring teams will check their accuracy at the Merrimack River near Goff Falls below Manchester, NH and/or Merrimack River below Concord River at Lowell, MA (real-time data is available at both stations); this was clarified in Section 5.3.

9. Clarify if habitat assessments will be performed in conjunction with aquatic macroinvertebrate sampling. (5.4)

   <u>CDM RESPONSE</u>: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be completed as part of the sampling program.

10. Clarify if flow measurements will be performed in conjunction with stormdrain and CSO sampling. (5.4)

    <u>CDM RESPONSE</u>: Depth measurements will be performed at the CSO and stormdrain locations; this was clarified in Section 5.3.

11. Measuring/collecting dissolved oxygen measurements at stormdrain and CSO outfalls from samples collected in a five-gallon bucket is not appropriate. The sample may not be representative because it may be aerated. (7.2)

    <u>CDM RESPONSE</u>: *In situ* measurements will be performed in the effluent where sufficient depth allows. In all other cases sampling will be performed in a five-gallon bucket and the dissolved oxygen concentrations will be qualified accordingly. This was clarified in Section 7.2.

12. To better characterize conditions over time, it is suggested that habitat assessment be conducted at both the time of deployment of aquatic macroinvertebrate samplers and immediately following deployment. Habitat conditions may change during the course of the deployment period. (7.3)

CDM RESPONSE: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of the sampling program.

13. Identify/discuss aquatic macroinvertebrate and habitat assessment and streamflow measurement forms. (8.1)

    CDM RESPONSE: Streamflow measurement forms were added to the SOP. Habitat assessment forms are no longer required.

14. Discuss sample handling for aquatic macroinvertebrate collections. (10.1)

    CDM RESPONSE: Based on discussions at the February 13, 2003 meeting, macroinvertebrate sampling will not be conducted as part of this sampling program.

Standard Operating Procedure (SOP) Compendium

1. The field SOPs should be presented separately from the laboratory SOPs. The laboratory SOPs should be included with the appropriate analytical laboratory's QA plan.

   CDM RESPONSE: The review package presented does not necessarily reflect that which will be provided to the field sampling teams. Their packages will most likely not contain the laboratory SOP forms or QA plans. For the purposes of this submittal, however, these materials have been packaged together.

2. The field SOP for the collection and handling of water samples for water quality analysis are somewhat generic. The SOP should identify specific parameters, as applicable. Stormdrain and CSO outfall sampling and other methods (e.g., sweep sampling) briefly discussed in the text of the QAPP and the field sampling plan are not discussed. (SOP-FLD-001)

   CDM RESPONSE: Additional information on the sampling procedures is provided in Section 7.2 of the Field Sampling Plan.

3. The field SOPs for the determination of dissolved oxygen, temperature, specific conductance, and pH do not specifically address how samples from stormdrains and CSOs will be collected or how depth-integrated (profile) measurements (e.g., at the impounded sites) will be made. (SOP-FLD-002, SOP-FLD-003, SOP-FLD-004, SOP-FLD-005, SOP-FLD-006).

   CDM RESPONSE: Additional information on the specific sampling procedures at stormdrain and CSO outfalls is provided in Section 7.2 of the Field Sampling Plan.

4. Field SOPs for measuring salinity and turbidity, Secchi disk and habitat assessment are not presented.

   <u>CDM RESPONSE</u>: An SOP for turbidity and Secchi disk measurements has been added. Salinity measurements will be made in accordance with the SOP for conductivity measurements; this has been clarified in the text. Habitat assessments are no longer being conducted as part of this monitoring effort.

5. The field SOP for the determination of water velocity and stream discharge does not address staff gage installation and calibration procedures or maintenance activities. (SOP-FLD-007)

   <u>CDM RESPONSE</u>: Additional information of the staff gage installation and maintenance procedures is provided in Section 7.1 of the Field Sampling Plan.

6. The field SOP for collecting aquatic macroinvertebrate samples with a basket sampler is simply a copy of the ASTM method and is not specific to what is presumably planned for the Merrimack River Study. For example, the ASTM method offers different options for sample handling (field or laboratory processing of baskets). It is not clear or apparent what option will be used for the Merrimack Study. (SOP-FLD-008)

   <u>CDM RESPONSE</u>: Based on discussions at the meeting on February 13, 2003, macroinvertebrate sampling will not be conducted as part of the sampling program.

7. The field SOP for the deployment/collection of continuous-recording dissolved oxygen/temperature measurements should be provided when available.

   <u>CDM RESPONSE</u>: A discussion of the installation and maintenance of the continuous DO/temperature measurements is provided in Section 7.3 of the Field Sampling Plan.

CDM

Memorandum

To: *Distribution*

From: *Gary Mercer, Kirk Westphal, & Beth Rudolph- CDM*

Date: *February 28, 2003*

Subject: *Response to NHDES comments on the Draft QAPP and FSP for the Merrimack River Watershed Assessment Study*

The following is a response to comments received from Paul Piszczek at the New Hampshire Department of Environmental Services (NHDES), dated January 17, 2003, on the Draft Quality Assurance Project Plan (QAPP) and Field Sampling Plan prepared for the Merrimack River Watershed Assessment Study. The response to these comments is based on discussions with Paul Currier and Paul Piszczek (NHDES), Arthur Screpetis (MADEP), Nora Conlon (USEPA), Dave Gray (USEPA), and representatives from CDM and the USACE at a meeting on February 13, 2003. The corresponding section and page(s) where these responses have been addressed in the QAPP and Field Sampling Plan documents is also provided for reference purposes.

Draft QAPP

Section 1

1. Page 2, third bullet: *Willisten* should be *Williston*

   CDM RESPONSE: CDM has corrected this throughout the document.

2. Page 6, Section 1.2.3: NHDES has not received a copy of the "Description of Existing Conditions" report. All evaluations of existing water quality conditions relative to surface water quality standards and designated use support should be based on the Comprehensive Listing and Assessment Methodology (CALM) used by NHDES to evaluate use support for each NH Assessment Unit. A new NH 303(d) list has recently been published, based on assessments using CALM procedures. The CALM, draft 303(d) list, and other information about use support assessments for New Hampshire can be found at http://www.des.state.nh.us/wmb/swqa/draft_2002_swqa.htm.

Please send us a copy of the "Description of Existing Conditions" report. We would be glad to advise you on appropriate procedures for assessing use support using the available data.

CDM RESPONSE: CDM sent a copy of the "Description of Existing Conditions" report to NHDES on February 7, 2003. This report reflects the new CALM assessment procedures.

3. Page 7, Table 1-1 General comment #1: The objectives listed in table 1-1 do not match the objectives listed in Section 1.4.1, nor do these match the objectives in the Field Sampling Plan, Section 1.2. Thus we have great difficulty determining what the study intends to accomplish.

   CDM RESPONSE: See response to question #4 below.

4. Page 7, Table 1-1 General comment #2: We strongly recommend that the Program Objectives be further developed using the process described in EPA guidance document "*Guidance for the Data Quality Objectives Process (EPA QA/G-4)*". This document provides a standard working tool for project managers and planners to develop data quality objectives for determining the type, quantity, and quality of data needed to reach defensible decisions. We would recommend further work to identify the key question or questions that the study will attempt to address. We recommend that the objectives be framed in terms of questions, the answers to which will assist in management decisions about actions to improve or preserve water quality. As written, only 3 of the objectives can be framed in terms of questions that will assist in management decisions.

   For example, two questions that could be used as objectives might be "Do mainstem reaches meet state WQ standards during wet weather conditions?" and "Do mainstem reaches meet state WQ standards during dry weather conditions?"

   In general, the study objectives are not stated well enough so that we can determine if the proposed sampling program will meet them. In many cases, we believe it is likely that the objectives will not be met due to insufficient data, or data taken an the wrong time or place. We would be glad to discuss the issue of objective formulation further if it would be useful. While we recognize that the study is not receiving funding from New Hampshire, it appears that many if not all of the study objectives involve water quality management decisions that will be made by NHDES in the context of Clean Water Act program administration. We believe it would significantly enhance the study value to frame these decisions concisely at the outset so the sampling program delivers the appropriate data.

Page 7, Table 1-1 "Measure water quality during different seasons" The purpose of measuring water quality during different seasons should be stated. What management decision will this feed? Reference to "statistical comparison" leads us to believe a comparison of data from different seasons is contemplated, but its purpose is not stated. In any case, we do not think the dataset will be large enough for most statistical methods to be useful. The specific statistical tests and their purpose should be stated within the document.

Page 7, Table 1-1 "Measure water quality during dry and wet-weather conditions": See the preceding comment.

Page 7, Table 1-1 "Measure effects of pollutants in the mainstem": The effects to be measured should be stated. We did not find any reference to specific effects or their measurement, only reference to measurement of pollutants.

CDM RESPONSE: Based on a discussion at the February 13, 2003 meeting the following objectives were developed for the field sampling portion of the Merrimack River Watershed Assessment Study:

- Collect water quality and streamflow data sufficient for the calibration and validation of water quality and hydrologic/hydraulic models to be developed under subsequent tasks of this Study
- Collect water quality data to determine the relative likelihood that segments of the mainstem Merrimack River meet state water quality standards

The sampling program objectives provided in Table 1-1 were deleted; all discussion of the sampling objectives was moved to Section 1.4.1 Data Quality Objectives.

5. Page 7, Table 1-1 "Assess the biological health and integrity of the ecosystem": Rock basket macroinvertebrate sampling is proposed. Rock baskets are not the appropriate sampling method to assess biological health and integrity of the ecosystem in a large, non-wadeable river. A better objective, if rock baskets sampling for macroinvertebrates is to be conducted, is "Are macroinvertebrate communities collected from rock basket artificial substrates at stations in the study area significantly degraded from communities at upstream or reference stations?" The proposed sampling stations bracketing the CSO communities (Section 5.4) would seem to be designed more to answer this question than to assess biological health and integrity.

   CDM RESPONSE: Based on discussions at the February 13, 2003 meeting, it was decided that macroinvertebrate sampling did not meet either of the revised objectives for this sampling program; all reference to this sampling has been deleted from the QAPP and Field Sampling Plan.

6. Page 8, under Section1.3.2, third paragraph, final sentence: *Determination of compliance with these standards is the responsibility of the state and federal environmental agencies.* The state of New Hampshire recently developed a draft Comprehensive Listing and Assessment Methodology (CALM). The document describes the state's methods for the determination of compliance with surface water quality standards. Thus, any/all data collected in New Hampshire for this study must be collected consistent with the CALM to ensure proper compliance determinations in the State of New Hampshire. This document is available on the web at www.des.state.nh.us/wmb/swqa/draft_2002_swqa.htm.

   CDM RESPONSE: The CALM guidance will be consulted to determine NHDES's requirements for the determination of compliance with state water quality standards.

7. Page 9, first paragraph (see also Section 2, Page 2): *Designated uses found in the Study Area include…hydropower…* Hydropower should be omitted from this sentence (and others in the draft QAPP), as the State of New Hampshire **does not** recognize hydropower as a designated use for any waterway in the state. All designated uses for New Hampshire surface waters are listed in the CALM document.

   CDM RESPONSE: CDM has revised the document accordingly; a complete description of designated uses in the watershed was added to Section 1.4.1.

8. Page 11, Biological Monitoring: Additional detail is necessary relative to data evaluation, and should include a description of the criteria and/or metrics that will be used for assessment.

   CDM RESPONSE: Per the discussion at the meeting on February 13, 2003, biological monitoring will not be performed as part of the Merrimack River Watershed Assessment Study.

9. Page 11, 12, Instream Flow Measurements: This study is partially designed to identify pollutant loads to streams. Therefore, additional detail should be provided regarding the verification/accuracy of the stage-discharge relationships.

   CDM RESPONSE: A discussion on how the staff gages will be installed and maintained (including QC procedures) was added to Section 1.4.2 and to the Field Sampling Plan.

10. Page 12, Section 1.4.1, fourth bullet: The assumption is that seven events will be adequate to establish baseline water quality conditions in the river. Water quality is spatially and temporally dynamic, as a result of land use practices and water management, with variations within seasons or within particular months. Thus, a greater number of sampling events are most likely needed to establish true baseline water quality conditions. The data quality objective (DQO), as written in the draft QAPP, for establishing a baseline should be revised to reflect that the data will only represent a small degree of data needed to establish a true baseline.

    CDM RESPONSE: The data quality objectives were revised per #4 above; reference to "baseline" conditions was deleted throughout the document.

11. Page 15, Table 1-2: The field precision relative percent differences (RPD) of ≤30% for non-bacteria parameters may be too liberal. For example, in its Ambient River Monitoring Program, NHDES has been successful using a higher degree of precision (≤15%) for field duplicates.

    CDM RESPONSE: At the February 13, 2003 meeting, Nora Conlon noted that USEPA used the ≤30% standard; this was agreed to by NHDES.

12. Page 17, Comparability: The last word of paragraph should be "variability".

    CDM RESPONSE: CDM has corrected this in the document.

13. Page 20, first paragraph: Discusses the retention of final reports, computer models, output, and results. The duration of field and laboratory data retention should also be discussed.

    CDM RESPONSE: CDM added a note regarding the retention of laboratory and field data to Section 1.6.2.

Section 2

14. Page 3, first paragraph: A flow trigger is defined for summer for low flow periods (equal to or less than mean August flow). A flow trigger should also be defined for sampling during spring and fall. NHDES recommends the use of the mean monthly flow between March and May, as recorded at the Goffs Falls gage below Manchester (#01092000).

    CDM RESPONSE: CDM will attempt to perform all sampling at or below the mean monthly flow unless prevailing seasonal conditions dictate higher streamflow conditions. The mean monthly streamflow was added in Table 2-2 based on historical records at the USGS gaging stations in Manchester, New Hampshire and Lowell, Massachusetts.

Page 13, Table 2-5: Notes the abbreviation "M" to represent metals. This is inconsistent with Table 9-1, where abbreviations for individual metal species are listed. The table should be revised accordingly.

CDM RESPONSE: Metals will no longer be included as part of this field sampling effort.

15. Page 23, Table 2-9: The detection limit for copper is greater than the NH acute (3.6 µg/l) and chronic (2.7 µg/l) surface water quality standard for copper. Also, the detection limit for lead is greater than the NH chronic (0.54 µg/l) surface water quality standard for lead. This will not allow the data to be used for comparison to NH surface water quality standards. The laboratory should be contacted to determine if lower detection limits are achievable.

    CDM RESPONSE: Metals analysis will no longer be performed as part of this field sampling effort.

16. Page 27, first paragraph under Section 2.6.1, last sentence: *…by conducting a "free-spin" test…* Table 2-8 notes the use of the Marsh-McBirney model 2000 and/or 201. These instruments use electromagnetic technology for measuring water velocity. Thus, a "free-spin" test is not possible. The text should be revised as appropriate, or Table 2-8 should be revised to include any mechanical device used for measuring water velocity.

    CDM RESPONSE: The text was revised accordingly based on available equipment.

17. Page 28, first paragraph and Table 2-11 under Section 2.7.1: Calibration frequency should occur systematically among all sampling teams three times per day, including a pre-sampling calibration, a mid-day calibration, and a post-sampling calibration. This will increase measurement consistency among the sampling equipment.

    CDM RESPONSE: A discussion of the calibration frequency for dry and wet-weather sampling was added to Section 2.7.1.

18. Page 32, first paragraph: NHDES is working to ensure full compatibility of its water quality data with the STORET database. Therefore, any database containing water quality data collected in New Hampshire during this study should be compatible with STORET. Compatibility includes data organization according to the STORET data

model, preferably with identical field formats and definitions. This is extremely important, as data with missing metadata cannot be used for decision-making. NHDES is attaching two documents that give an overview of STORET data requirements. A spreadsheet format that follows these requirements is being forwarded separately.

CDM RESPONSE: Based on a review of the NHDES guidance on STORET data requirements, it appears that the data collected under this program will provide all the *required* input fields for STORET. It is not anticipated that the spreadsheet template provided by NHDES will be used for data input purposes; however, a compatible format (*i.e.* Microsoft Excel or Access) will be used.

Section 3

19. Page 1, second paragraph under Section 3.1.1: *A follow-up audit will be conducted once during the course of the investigation…* NHDES recommends that this audit be performed during the 2nd or 3rd sampling events.

    CDM RESPONSE: CDM agrees that this seems like a reasonable point to conduct the audit.

Draft Field Sampling Plan

Section 2

1. Page 2-2, final sentence of page: Field duplicates will be collected at a frequency of 5%. NHDES water quality programs typically collect field duplicates at a frequency of 10%, which increases data confidence and decision-making. It is recommended that field duplicates be collected at a frequency of at least 10%.

   CDM RESPONSE: Due to the budgetary constraints, field duplicates and field blanks will be collected at a rate of 5% each, for a total of 10% QA samples.

2. Page 5-3, Table 5-1: *Ameskeag* should be *Amoskeag*

   CDM RESPONSE: CDM has corrected this throughout the report.

3. Page 5-9, second paragraph: High-frequency bacteria monitoring consists of one sample per hour during a 12-hour period. This period should be extended to 14 hours to allow for sampling prior to the onset of the rising limb of the hydrograph, as bacteria levels may be diluted during peak storm flow.

<u>CDM RESPONSE</u>: The 12-hour sampling period was intended to begin at or near the beginning of the storm event to fully characterize the pollutant plume as it passes downstream.

4. Page 5-10, second-to-last paragraph: *One CSO outfall will be sampled per community. The selected CSOs will represent the outfall with the largest overflow volume and most frequent discharge in each community.* The proposed plan does not seem adequate for characterizing the quality and loadings from CSOs and stormdrains. It is recommended that at least 3 CSOs and stormdrains from each community be sampled. For CSOs, consideration should be given to not only frequency and volume of discharge but also the presence of sources that may impact water quality (e.g., the presence of industrial sources which may impact toxicity). CSOs with different ratios of sewage to stormwater at the point of overflow, should also be sampled. The quality of a CSO that is primarily stormwater is likely to be substantially different from CSO that is primarily sewage. For stormdrains, drainage area and land use should be important factors in the selection process. For each CSO and stormdrain, multiple samples and flows should be taken during each storm to adequately characterize the discharge quality and loads. It is recommended that samples be taken at 0.5, 1, 2, 4, 6, and 8 hours from the start of discharge.

   <u>CDM RESPONSE</u>: Due to cost constraints, one CSO from each of the five sponsor communities will be sampled. In general, these CSOs will represent the outfall with the largest overflow volume and most frequent discharge in each community. However, alternate CSOs may be selected due to safety concerns during the sampling program. A total of five samples will be collected from each CSO and stormdrain outfall at the following intervals: 0.5, 1, 2, 3, and 5 hours from the start of discharge.

5. Page 5-15, Table 5-4: Revise to show the locations of active USGS gages on tributaries.

   <u>CDM RESPONSE</u>: CDM has revised the table accordingly.

6. Page 6-6, third paragraph: *Sampling will not commence until CSO outfalls in the designated wet reach have begun discharging*. This implies that sampling may begin within several minutes of the onset of CSO discharge. If sampling begins several minutes after the onset of discharge, the samples will not adequately represent river conditions during CSO discharge. Hourly sampling at the CSOs is recommended to adequately capture pollutant loads. Furthermore, within the first hour, samples should be collected a 30-minute intervals. A time frame should be established as to when sampling will commence.

   <u>CDM RESPONSE</u>: Sampling will commence approximately 0.5-hour following the onset of discharge and will proceed at the following intervals: 0.5, 1, 2, 3 and 5 hours from the start of discharge. Sampling intervals for shorter events will be determined based on the expected storm duration for a total of five samples.

7. Page 7-1, first paragraph under Section 7.1: A variety of instruments may be used to measure water velocity. However, Table 2-8 in the draft QAPP only lists the Marsh-McBirney models 201 and 2000. The text and/or table should be revised as appropriate.

   CDM RESPONSE: CDM has revised the text accordingly.

8. Page 7-4, final bullet: Condensation rapidly occurs on the outside of the sample bottle after the bottle is filled. Therefore, NHDES recommends that bottles be labeled prior to sample collection.

   CDM RESPONSE: CDM agrees that labels should be applied prior to sampling.

9. Page 7-6, second-to-last paragraph: …*In situ measurements will be taken…after the required laboratory sample bottles have been filled…* Field crews should be advised to exercise caution when using this method, as any agitation of the water prior to such field measurements as dissolved oxygen may cause erroneous results.

   CDM RESPONSE: For outfall and CSO monitoring, *in situ* measurements will be performed in the effluent where depth allows; measurements will be made in the bucket in all other situations. The Field Sampling Plan has been revised accordingly to reflect this procedure.

10. Page 7-7, first paragraph: Implies that depth intervals may change at the discretion of the sampler, based on field conditions. NHDES recommends that the equivalent depth intervals are used for all measurements taken by all sampling teams. This increases data confidence and comparability among stations.

    CDM RESPONSE: Half-meter intervals will be used throughout; the Field Sampling Plan has been revised accordingly.

11. Page 7-7, Diurnal dissolved oxygen measurements: NHDES requires the calculation of a daily average % of saturation in addition to an instantaneous measurement for determining whether the dissolved oxygen standard is met. Thus, NHDES recommends the use of automated instrumentation to collect dissolved oxygen data at one-hour intervals during the sampling day.

    CDM RESPONSE: Continuous dissolved oxygen/temperature meters will be deployed in the Merrimack River at two locations- upstream of the Amoskeag Dam in

Manchester, New Hampshire and upstream of the Pawtucket Dam in Lowell, Massachusetts- for one-month between mid-July and mid-September.

12. Page 7-8, Section 7.3: States that rock baskets will be used to describe benthic macroinvertebrate communities. This equipment is inappropriate for deep-water (e.g., > six feet) applications, of which many are present within the study area. Therefore, a benthic dredge (e.g., Eckman, Ponar) should be employed, and will likely provide a more representative sample of the study area. Section 7.3 also notes that a habitat assessment will be conducted prior to the deployment of rock baskets. Additional detail should be provided regarding the assessment procedure.

    CDM RESPONSE: Per discussions at the meeting on February 13, 2003, macroinvertebrate sampling will not be conducted as part of this program.

13. Page 9-2, Table 9-1: Lists the abbreviation for individual metal species, which is inconsistent with Table 2-5 in the draft QAPP. The table should be revised accordingly.

    CDM RESPONSE: CDM has revised Table 2-5 accordingly to match Table 9-1.

Draft SOP Compendium

Dissolved Oxygen

Page 6, Section 8.0: The quality control section should include the submersion of the electrode in a zero dissolved oxygen standard prior to field use. This will determine whether the instrument is capable of measuring the full range of potential dissolved oxygen levels at each sampling station.

CDM RESPONSE: CDM agrees that this procedure should be performed; a note to this effect has been added in Section 2.2.2 of the QAPP.

Global Positioning System (GPS)

An SOP for the operation of a GPS should be included in the compendium.

CDM RESPONSE: An SOP for operation of GPS units has been added to the compendium.

Rudolph, Beth

From: Screpetis, Arthur (DEP) [Arthur.Screpetis@state.ma.us]
Sent: Tuesday, April 08, 2003 6:52 AM
To: Rudolph, Beth
Cc: Pancorbo, Oscar (DEP); Brander, Kevin (DEP); Isaac, Russell (DEP); Chase, Richard F. (DEP); conlon.nora@epamail.epa.gov; gray.david@epamail.epa.gov; barbara.r.blumeris@nae02.usace.army.mil
Subject: FW: Modifications to the Merrimack River QAPP and Field Sampling Plan

Hi Beth,

Here are some comments on the revised field sampling plan from Dr. Pancorbo, Director of MDEP's Wall Experiment Station.

I will also forward to you comments by Kevin Brander, MDEP's CSO coordinator.

Thanks for the opportunity to comment.

Arthur Screpetis

-----Original Message-----
From: Pancorbo, Oscar (DEP)
Sent: Monday, April 07, 2003 2:46 PM
To: Screpetis, Arthur (DEP); Brander, Kevin (DEP)
Cc: Isaac, Russell (DEP); Dunn, Dennis (DEP); Chase, Richard F. (DEP); Casella, Mark (DEP); Mahin, Thomas (DEP)
Subject: RE: Modifications to the Merrimack River QAPP and Field Sampling Plan

---For Use in Intra-Agency Policy Deliberations---

Hi Art and Kevin,

I reviewed the QAPP, SOPs, and Lab QA Plans for this project as well as the proposed modifications. I think that the proposed modifications are acceptable. I agree with you, Art, that the QAPP is very well done.

However, I am concerned about them not meeting the bacterial holding time of 6 hours in the field + 2 hours in the laboratory (i.e., an 8-hour total holding time) for lower Merrimack samples from MA stations. The laboratory that will be performing the bacterial analyses (i.e., Aquatec Biological Sciences) is located in Williston, VT, which is over 180 miles (3 hr driving time) from Lawrence-Haverhill. Given that elevated bacterial indicator concentrations represent one of the principal impairments of the Merrimack Watershed, it is critical that the holding time for these analyses be met. Tom Mahin, David Gray, and I are currently preparing the final report for the 104b3 Storm Water Study involving 4 watersheds, including the Merrimack. As part of this study, we demonstrated substantial die-off of fecal coliforms and E. coli in Merrimack storm water samples (i.e., as much as 1 log within 10 hours). In the same Merrimack storm water samples, enterococcus densities were stable for more than 140 hours. With good coordination, the bacterial holding time can be met even if the samples are analyzed by Aquatec Biological Sciences but you should warn the study leaders that failure to meet the bacterial holding time for fecal coliforms and E. coli will invalidate the results and jeopardize the study.

I also had a couple of comments regarding the bacterial quality control described in the Aquatec Biological Sciences SOPs. The laboratory is correctly running a positive control with every batch of samples. However, for membrane filtration methods, it is running only one negative control (i.e., filter blank); the laboratory must run a filter blank at the beginning and end of a sample batch, and after every 10th sample. Also, the laboratory is not assessing laboratory precision (see QAPP, Page 15, and bacterial SOPs); the laboratory must analyze at least one sample in duplicate with every batch of 10 or fewer samples, and develop control charts as follow:

1) Calculate the logarithm of each duplicate result. If either duplicate value is < 1, add 1 to both results before calculating the logarithms.

2) Calculate, chart, and report the range of the logarithms for each duplicate set. When 15 sets of duplicate results are available, calculate the precision QC criterion which equals 3.27 times the mean range of logarithms for the 15 duplicate sets. Thereafter, if the logarithm range of a duplicate set is greater than the precision criterion, there is a greater than 99% probability that the laboratory variability is excessive (American Public Health Association. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition, Pages 9-10).

3) If the precision QC criterion is exceeded for a sample batch, all analytical results for the batch of samples must be qualified as estimated data due to unacceptable precision. Prior to the analysis of new samples, the laboratory must investigate and resolve its analytical precision problem.

4) Periodically, the laboratory must derive a new precision QC criterion using the most recent sets of 15 duplicate results.

Also note that the field precision for bacterial analyses should be expressed as the range of the logarithms for the field duplicate set rather than as relative percent difference (see QAPP, Page 15, Table 1-2).

Let me know if you have any questions or comments. Thanks.

Oscar

Oscar C. Pancorbo, Ph.D.
Director
Sen. W. X. Wall Experiment Station
Massachusetts Dept. Environmental Protection
37 Shattuck Street, Lawrence, MA 01843
Voice: (978) 682-5237, ext. 314 FAX: (978) 688-0352
http://www.mass.gov/dep/bspt/wes/weshome.htm

-----Original Message-----
From: Screpetis, Arthur (DEP)
Sent: Monday, April 07, 2003 9:01 AM
To: Brander, Kevin (DEP)
Cc: Isaac, Russell (DEP); Dunn, Dennis (DEP); Pancorbo, Oscar (DEP); Chase, Richard F. (DEP); Casella, Mark (DEP)
Subject: FW: Modifications to the Merrimack River QAPP and Field Sampling Plan

Hi Kevin,

The proposed modifications are genertally consistent with discussions we had on February 13, 2003 at EPA's N. Chelmsford Lab. I was a little uncomfortable at first about the bacteria sample compositing, however, CDM will collect an additional grab sample concurrently with the other grabs used for compositing. Please let me know if you have any questions. CDM has done a pretty good job on this QAPP. Thanks.

-----Original Message-----
From: Rudolph, Beth [mailto:RudolphBE@cdm.com]
Sent: Wednesday, April 02, 2003 4:28 PM
To: Nora Conlon Ph. D. (E-mail); Arthur Screpetis (E-mail); 'pcurrier@des.state.nh.us'; 'ppiszczek@des.state.nh.us'; 'gray.davidj@epa.gov'
Cc: Mercer, Gary; Westphal, Kirk; Barbara Blumeris (E-mail)
Subject: Modifications to the Merrimack River QAPP and Field Sampling Plan

Attached please find a memo summarizing the modifications to the QAPP and Field Sampling Plan for the Merrimack River Watershed Assessment Study. The modifications include those items agreed upon at the February 13, 2003 meeting with representatives from USEPA, MADEP, NHDES, CDM and the USACE, as well as additional modifications made by CDM and the USACE to meet the budgetary constraints of the sampling program.

We welcome your input and further discussion on these modifications as we work to finalize the QAPP and Field Sampling Plan.

Thank you,
Beth

<<Summary of QAPP-FSP Modifications-040203.pdf>>

Beth Rudolph
CDM
One Cambridge Place
50 Hampshire Street
Cambridge, MA 02139
Tel: 617-452-6356
Fax: 617-452-8356
Email: rudolphbe@cdm.com

Rudolph, Beth

From: Screpetis, Arthur (DEP) [Arthur.Screpetis@state.ma.us]
Sent: Tuesday, April 08, 2003 6:58 AM
To: Rudolph, Beth
Cc: Pancorbo, Oscar (DEP); Brander, Kevin (DEP); Isaac, Russell (DEP); Chase, Richard F. (DEP); conlon.nora@epamail.epa.gov; gray.david@epamail.epa.gov; barbara.r.blumeris@nae02.usace.army.mil
Subject: FW: Modifications to the Merrimack River QAPP and Field Sampling Plan

Hi again Beth,

Here are Kevin's comments for your consideration.

Please contact me if you have any questions.

Thanks.

Arthur Screpetis

-----Original Message-----
From: Brander, Kevin (DEP)
Sent: Monday, April 07, 2003 9:39 AM
To: Screpetis, Arthur (DEP)
Subject: RE: Modifications to the Merrimack River QAPP and Field Sampling Plan

Hi Arthur. Thanks, as always, for your excellent work in reviewing the sampling plan. I do have just a few comments/questions:

1) on the bacteria compositing, I expect that they will still meet the holding time requirement. Oscar has told me on numerous occasions that holding time is a critical element in bacterial analyses. He said that there can be significant die-off, even in the later stages of the 6-hour holding period.

2) Storm Drain sampling: although it would be preferable to sample the same storm events for which they are collecting instream data, I realize that mobilization of crews is very much a limiting factor. It also seems that they have chosen only SW sampling sites in the CSO communities, which would likely be reflective of urban stormwater. These results may not be directly transferable to the many other communities on the Merrimack which are not so urbanized. Again, I realize that resources are limited in this regard, but it would be good to give this matter at least some consideration and develop an approach (literature values or other means) to approximate loads from these other communities.

Feel free to call if you wish to discuss.

KB

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Thank you,
Beth

<<Summary of QAPP-FSP Modifications-040203.pdf>>

Beth Rudolph
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Email: rudolphbe@cdm.com

Aquatec Biological Sciences

Ecology Environmental Toxicology Natural Resource Assessments Microbiology

MEMORANDUM

May 12, 2003

To: **Beth Ruldolph**
CDM Federal

From: **Philip C. Downey, Ph.D.**
Aquatec Biological Sciences, Inc.

I appreciate Dr. Pancorbo's comments and responded to my interpretation of the two major comments on our microbiological methodologies:

1. **However, for membrane filtration methods, it is running only one negative control (i.e., filter blank); the laboratory must run a filter blank at the beginning and end of each sample batch, and after every 10th sample.**

Aquatec Biological agrees that we should run a filter blank at the beginning and end of each sample batch as is our routine operations. We will update our SOP's to correct that editorial error.

Aquatec Biological questions the practically of conducting blank analyses for every 10th sample. Due to the large volume of samples which will be processed in a day, at least 10 blanks for each coliform analysis will be conducted providing an ongoing documentation of sterile equipment. As noted in Standard Methods "For membrane filter tests, check sterility of media, membrane filters, dilution and rinse water, and glassware and equipment, as a minimum at the end of each series of samples, using sterile water as the sample." By running filter blanks at the beginning and end of each sampling (i.e., times 0, 3h, 6h, 12h and 24h), we believe meets Standard Methods guidance.

2. **The laboratory is not assessing laboratory precision; the laboratory must analyze one duplicate with every batch of 10 or fewer samples, and develop control charts.**

Aquatec Biological will develop field precision criteria for qualifying results should duplicate precision measurements are out of range. We will conduct the first 15 field samples of this project in duplicate to generate an initial field control chart. The control chart will be generated following Standard Methods (i.e., based on logarithms) which were also presented in Dr. Pancorbo's comments. The control chart will be updated after each field-sampling event to include the new duplicate values.

After the construction of the initial field control chart, duplicate analyses will be conducted on one sample of every 20 samples in a batch (or 1 duplicate if the batch is less than 20). In addition to the laboratory duplication, we are collecting field duplicate samples also at a rate of 1/20. This field duplication provides an additional measure of precision (although slightly confounded statistically with the variability associated with the field duplication of sampling).

Unlike typical chemical analyses, a dilution series is usually conducted on every environmental microbiology sample. This duplication of every sample provides additional information and verification of orders of magnitude (logs) of bacterial concentration in each sample.

In the section 9020 sub-section 4a4 of Standard Methods, the guidance states "Perform duplicate analyses on 5% of samples and on at least one sample per test run." For all of there reasons stated above, we believe that the 1/20 duplication of laboratory analyses adequately addresses the guidance for general quality control procedures outlined in Standard Methods particularly since large batches of samples are being analyzed in a short period of time (75-100 samples for 5 sampling events during the 24h period).

If a duplicate analysis falls out of range of the control chart, we will qualify the reported results for the 20 associated samples with an "E", to indicate estimated data due to low precision. If we should have unacceptable precision during one of our field batches, the Laboratory Director will evaluate the procedures and develop a corrective action plan as necessary.

We appreciated Dr. Pancorbo's comments in improving this program.

If you have any questions or there are further comments please don't hesitate to contact me.