City of Keene *Escherichia coli* Impairment Investigation and Remediation, and Habitat Restoration Plan for Beaver Brook Quality Assurance Project Plan

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Revisions to the QAPP will be numbered and a summary description provided in the table below.

Date	Revision #	Description	Part(s)
5-31-07	-	Initial Approval	All

3 – Distribution List

The following individuals will receive a copy of the approved QAPP plan and any subsequent revisions:

City of Keene:
Eric Swope, Project Manager
Aaron Costa, Laboratory Technician
Donna Hanscom, Assistant Director of Public Works/Laboratory Manager

NHDES:
Natalie Landry, Coastal Watershed Supervisor
Jillian McCarthy, Nonpoint Source Specialist
Vincent Perelli, NHDES Quality Assurance Manager

US EPA:
Warren Howard, EPA Region 1 Project Manager
Quality Assurance Representative, EPA QA Manager

Additionally, any staff or volunteer group leaders participating in field sampling will be provided with an updated version of the SOP portion of the QAPP pertinent to the samples that they will be collecting.

4 – Project/Task Organization

This section identifies the individuals and organizations that will be participating in the project and identifies roles and responsibilities (see Table 1 and Figure 1).

The project will be implemented under the guidance of the City of Keene, NH. Additional organizations will be contacted and invited to take part in various aspects of the project ranging from data collection to remediation activities. Organizations that have been contacted so far include: The Peterborough, NH Chapter of Trout Unlimited (habitat assessment field work); The Ashuelot River Local Advisory Council (ARLAC) (assist with water sample collection); The Ashuelot Valley Environmental Observatory (AVEO) (publicize to its supporters activities requiring volunteer participation).

This project is broad in scope and includes many segments not subject to QAPP criteria (e.g., public education components). Therefore, this section will focus on those aspects of the project that include data collection and fall under the QAPP.

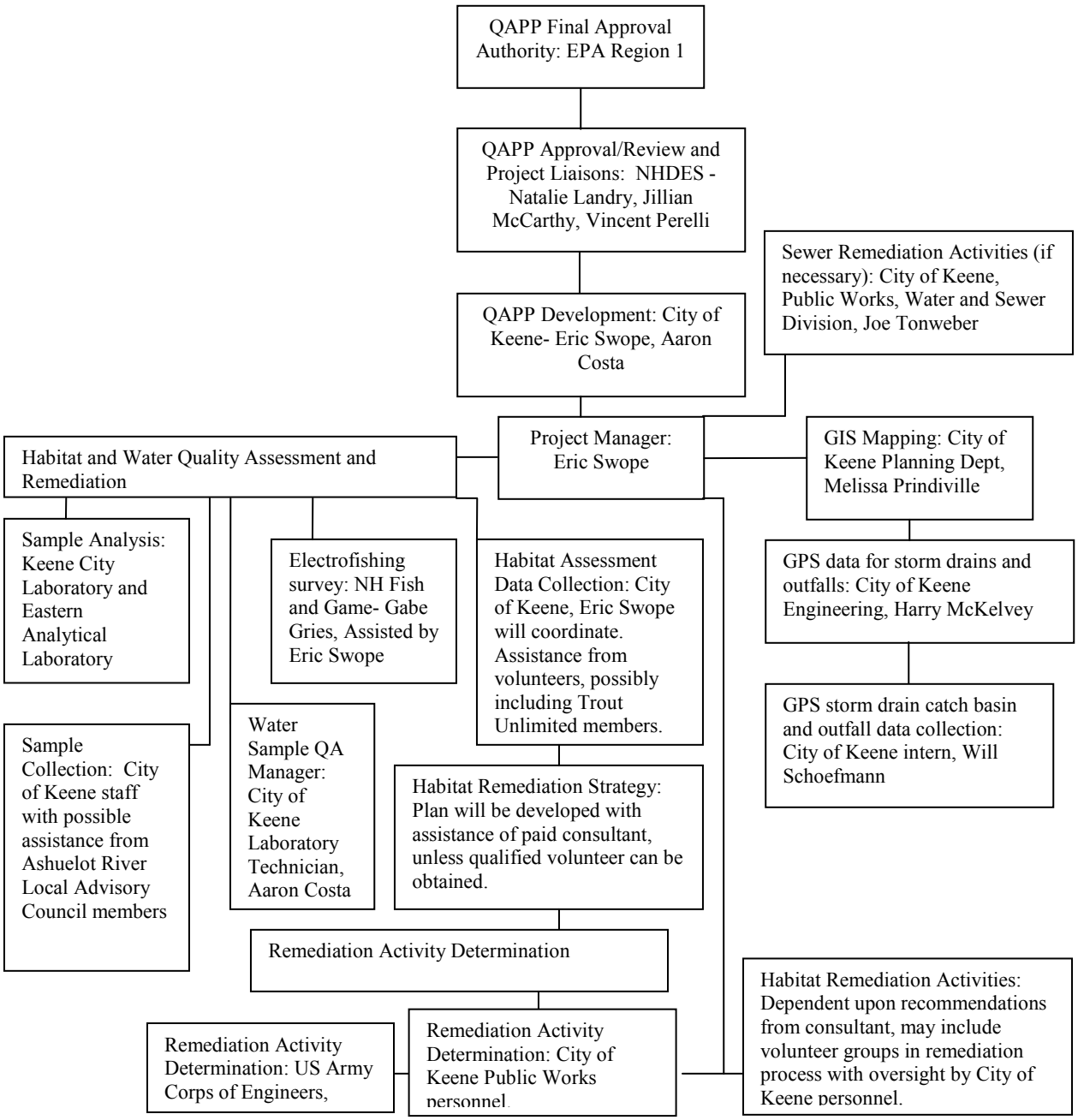
Table 1. Personnel Responsibilities and Qualifications

Name and Affiliation	Responsibilities	Qualifications
Eric Swope, City of Keene	Project Manager in charge of oversight /assistance with all work relating to habitat and water quality assessment,	Bacteria and other surface water quality sampling

	and remediation. Assist with evaluation of sampling and habitat assessment data. Preparation and submission of all required reports. Contact for laboratory to arrange for courier pick-up of samples. Serves as the primary contact with DES.	experience. Stream habitat assessment and electrofishing experience as NH Fish and Game seasonal employee.
Aaron Costa, City of Keene	Water Quality QA Manager for project. Laboratory analysis for some parameters. May also assist in sampling, habitat assessment, or other activities as needed, including evaluation of sampling data.	Bacteria and other surface water quality sampling experience. Laboratory analysis and QA/QC implementation and review experience.
Melissa Prindiville, City of Keene	Development of all GIS maps for project.	Experience in map-making and all aspects of GIS in role as GIS Specialist for Planning Department.
Harry McKelvey, City of Keene	In charge of oversight /assistance collection of GPS storm drain catch basin and outfall data and development of digital database.	Experience in GPS/GIS data collection and use in role as Engineering Technician for Public Works Department.
Will Schoefmann, City of Keene	In charge of collecting GPS data for storm drain catch basin and outfall data and assisting in development of digital database.	Experience in GPS/GIS use in role as Intern for the Planning Department.
Joe Tonweber, City of Keene	In charge of oversight in all aspects of sanitary sewer remediation, if deemed necessary from investigation.	Superintendent of the City's Water and Sewer Division of the Public Works Department.
Natalie Landry, NHDES, Watershed Management Bureau	Serves as NHDES Project Manager.	On file at DES.
Jillian McCarthy, NHDES, Watershed Management Bureau	Serves as NHDES Program QA Officer and provides assistance and review of Quality Assurance Project Plan.	On file at DES.
Vincent Perelli, NHDES, Planning, Prevention, and Policy Unit	Serves as NHDES QA Manager and is responsible for reviewing and approving QAPPs for NHDES.	On file at DES.
Gabe Gries, NH Fish and Game	In charge of all electrofishing survey activities. Assist with evaluation of electrofishing data.	Fisheries Biologist for NH Department of Fish and Game
James Lewis, US Army Corps of Engineers	Assist with determination of remediation activities. 1	Experience with contractual Beaver Brook maintenance requirements.
Volunteers: Various environmental and service oriented organizations or groups.2	Volunteers will be recruited and utilized for many portions of the project. Activities may include habitat assessment, water sampling, and habitat remediation	All volunteers will be trained in approved methods. Volunteer strengths and experience will be utilized whenever possible. 2

[1]The City is under contract with the US Army Corps to maintain portions of the stream for flood control purposes. James will assist in determining which actions are allowable and whether and where the contract may be flexible.
[2]Groups that have expressed willingness to help include Trout Unlimited (TU) and the Ashuelot River Local Advisory Council (ARLAC). The City expects to utilize TU volunteers in the habitat assessment phase. All have extensive in-stream familiarity. The City plans to utilize ARLAC volunteers in the sample collection phase. ARLAC has extensive experience and training with surface water sampling in the Ashuelot River.

Figure 1. Project organizational chart



5 – Problem Definition/Background

Historical Information

Beaver Brook flows through Keene, NH from north to south, before discharging into the Branch River, and shortly thereafter the Ashuelot River, on the south side of the city. The brook receives storm drain discharges from residential, business, and industrial areas including most of the east side of the city. The northern reaches of the brook flow through woods and have been shown to be good brook trout habitat via electrofishing assistance from NH Fish and Game in 2003 and 2006. As the stream flows into the main downtown, some stretches have been channelized, many of the banks cleared of woody vegetation, and it has been impacted by general urban influences.

This project will seek to answer the following questions:

- Which areas of the brook are most heavily impacted by *E. coli* contamination?
- What are the potential sources of contamination?
- What actions will aide in the reduction and/or elimination of these sources?
- What is the current habitat suitability for coldwater fish species?
- How can that habitat be improved?
- What fish species are currently represented in the brook?

E. coli and other sampling data collected during the course of the project will used by City of Keene personnel to try to pinpoint problem areas and sources, and to monitor the success of remedial actions. Pending a successful outcome to remediation activities, this data may also be used by NH DES to determine whether Beaver Brook should continue to be listed as an impaired waterbody.

Habitat Assessment data will be used by City of Keene personnel and consulting specialists to determine the current state of aquatic habitat in the study area and to develop a strategy for restoration of habitat.

Electrofishing data will be evaluated by City of Keene personnel and NH Fish and Game personnel to determine fish species present and success of restoration efforts.

A map of the main project study area is included in Attachment 1.

E.coli Impairment and Other Pollutants

The 2004 NH DES List of Impaired Waterbodies indicates that 4.38 miles of Beaver Brook is impaired for *E. coli*, source unknown. Additionally, the City has received and investigated sporadic reports from local citizens of pollutants in the brook. Reports have included odors and water discoloration. Some of these have been identified and eliminated, including vehicle wash and other cleaning process wastewaters. Other discharges are of unknown source and type and either a satisfactory result was not obtained, or it was unclear if remedial actions fully addressed the problem. Available

historical data indicates that the most heavily impacted area is somewhat smaller than the listed 4.38 miles. The linear distance of stream covered by the initial investigation of this project is estimated at roughly 3 miles, with the bulk of the investigation expected to be more concentrated in the most urban area between Beaver Street and its confluence with the Branch River, roughly 1.5 linear miles. Some historical sources of *E. coli* and other pollutants have been identified and eliminated, but problems persist.

Habitat Impairment

Much of the stretch of Beaver Brook between Spring Street and Water Street has been channelized. The banks along the stretch between Spring Street and Harrison Street are high concrete walls. In large areas from Roxbury Street, on down to the outfall on the Ashuelot River, the stream banks are routinely cleared of vegetation via mowing. Much of this is done per contract with the US Army Corps of Engineers (USACE). While some maintenance of the streamside vegetation is required, the City will work with the USACE to determine the degree to which the riparian zone may be managed in a way that is conducive to habitat enhancement. Specifically, long stretches of the stream are cleared of any overhanging vegetation. Historical sampling by City of Keene personnel indicates that in the reach between Roxbury Street and Baker Street, temperatures may rise by as much as six degrees Celsius. The rise in temperature corresponds closely to areas in which vegetative canopy has been reduced or eliminated. Since eastern brook trout and Atlantic salmon are both cold-water fishes, this is detrimental to both species.

6 – Project/Task Description

The intent of this project is to identify contributing sources of *E. coli* and other pollutants to Beaver Brook, and to reduce or eliminate the primary sources of contamination through remediation work and public education. In addition, the project seeks to revitalize Beaver Brook as a fishery for brook trout and other cold-water fishes through habitat restoration and public education. This will be accomplished through the following tasks:

Pollutant Source Identification and Remediation

Pollutants have the potential to be carried significant distances to the brook. Since outfalls to Beaver Brook include the storm drainage system for a large section of downtown Keene, an extensive GIS database and maps of the Beaver Brook drainage system will be developed to assist in efforts to track pollutants to their sources. The early stages of this project include first wading the stream from its outfall to its northernmost densely residential areas. Outfalls will be mapped via GPS, and a habitat assessment conducted. *E. coli* sampling, historical data, and new outfall information will be analyzed to try to pinpoint areas of concern and identify potential sources in these areas. The City will also conduct a nutrient sampling survey to see if other water quality problems are identified. See Appendix A for *E. coli* sampling, nutrient sampling, and Illicit Discharge Detection SOPs.

Storm drain and other outfalls will be traced back to identify potential pollutant sources and define remedial actions. If warranted, an outside contractor will be used to investigate problem lines via sewer cameras and/or other measures deemed appropriate. If problems such as illicit discharges or broken sewer lines are identified, remedial actions will be taken or required by the City. Small easy remedies will be implemented quickly. However, if large-scale problematic issues are identified, it may be necessary to allow for time to budget for remedial actions. A general storm drain education campaign will be instituted with areas of greatest problems targeted. Follow-up sampling will be done to determine project effectiveness. The City's goal is to consistently achieve the NH Water Quality Criteria for Class B Fresh Waterbodies of 406 *E. coli* colonies/100 ml, as well as to eliminate or reduce other pollutant sources.

Habitat Assessment and Restoration

Additionally, the City proposes habitat restoration in areas that have been channelized, cleared of woody vegetation, or otherwise negatively impacted. A consultant will be contracted to develop a habitat restoration plan. The scope of restoration activities is to be determined, but the City anticipates that this may include actions such as planting of trees for canopy cover to reduce water temperature, altering bank mowing/clearing practices, and evaluating brook for other habitat improvement opportunities. Any changes to riparian zone maintenance will be done in coordination with US Army Corps of Engineers.

Electrofishing surveys under the oversight of a NH Fish and Game Fisheries Biologist will be conducted to determine the composition of fish species in selected impacted areas. Historical electrofishing data exists, and additional sampling will be conducted prior to and after habitat remediation activities. Surveys will be used to assess gains in habitat and water quality improvement activities.

Public Education Activities

The public education portion of the project includes, involving local elementary schools with a program in which Atlantic salmon are raised in the classroom (as part of the stream restoration) and released into the brook, and teaches children about brook and water quality stewardship. Other public education activities include a water quality event in conjunction with World Water Monitoring Day, development of a stormwater pollution prevention mailer for residents in the Beaver Brook Watershed, and other activities to be determined.

A summary of the project timeline and an overview of deliverables is included in Table 2 below. A map of the urban portion of the brook is included in Attachment 1. Locations of specific tasks are indicated on the attachment.

Table 2. Project Schedule Timeline

Task #	Description of Task	Target Completion Date	Deliverable
1	Complete and submit QAPP	May 2007	QAPP Document

2	Map outfalls and catch basins. Conduct habitat survey.	June 2007	Digital database and maps of catch basins, storm drainage system, and outfalls in most densely populated and problem areas of Beaver Brook Watershed. Habitat survey of brook from outfall to northern edge of densely populated sections of stream (roughly, Washington Street Extension).
3	Initial electrofishing survey.	November 2007	Fish species survey data
4	Collect and analyze samples.	September 2007	*E. coli*, ammonia, nitrate, nitrite and total phosphorus conductivity, temperature results
5	Examine problem areas.	November 2007	Assessment of results.
6	Locate and map problem areas, including contributing outfalls.	December 2007	Map/determination of problem areas based upon sample results, observations, and location of outfalls.
7	Hire vendors (as necessary) to inspect sewers and/or storm drains using cameras and other means. Develop remedial strategy.	May 2008	If this is deemed necessary- video or other evaluation of sewers/storm drains adjacent to pollution problem areas.
8	Implement remedial actions	Timing of remedial actions may be hard to predict. This is dependent upon findings of investigations. Small-scale problems with sewers may be fixed quickly. If larger scale problems are identified, then greater remediation times would be expected.	If this is deemed necessary- may include repairs to broken sewer lines, elimination of illicit discharges or other remedial actions as identified.
9	Hire consultant to review survey and design habitat restoration plan.	June 2007	Proposal from Consultant, Contract including scope of services.
10	Consultant's habitat restoration report due.	October 2007	Report documenting main areas of impact and recommending habitat restoration actions and expected results.
11	Conduct restoration activities.	Will begin habitat restoration activities when the full report becomes available. Will complete restoration activities, as allowed by available funds, by November 2008. Additional restoration activities may extend beyond the life of the grant.	To be determined. Anticipate that this may include such things as tree and other vegetation planting, addition of cover within stream, etc.

12	Public Education and Outreach: a. Develop and print brochures. b. Distribute brochures. c. Work with local media. d. Work with local schools. e. Release salmon fry into Brook. f. Additional public education events	First release of salmon fry into Brook in spring of 2006. Release of salmon from two schools planned for Spring 2007. World Water Monitoring Day water quality education event hosted on October 17, 2007. Additional public education components implemented throughout the life of the project.	Not really applicable to QAPP. However, anticipate, improvement in overall knowledge of human activities on water quality and habitat, resultant improved water quality, and increased stewardship of Beaver Brook.
13	Collect post-remediation water samples.	November 2008	*E. coli*, conductivity and temperature results.
14	Electrofishing survey	November 2008. This may need to be repeated in future years. Some habitat restoration actions may take several years to have pronounced effect, e.g., planting of tree species will require multiple years to maturity.	Fish species survey data. Goal is eventual expansion of brook trout presence and re-establishment of Atlantic salmon.
15	Progress Reports	June and December each year through 2008.	Semi-annual report documents
16	Final Report	December 2008	Final Report document

7 – Quality Objectives and Criteria

The City of Keene will use the data from the water quality sampling portion of the project to identify/verify pollution problem areas, locate pollutant sources, and reduce or eliminate pollutants at the source. Specific remedial actions will be determined based upon the results of the investigation.

Water Quality Sampling

Water samples will be collected according to descriptions outlined in Sections 10 and 11 and SOPs in Appendix A. Sample sites will be selected based upon accessibility, the location of outfalls, and representativeness of typical in-stream conditions. Sites will be selected so as to assist in sectioning off the stream into units with easily identified landmarks used to help delineate stream sections. E.g., collecting a sample upstream of a specified outfall will assure that any pollutant identified came from the stream segment stream (and/or storm drain or other drainage outfalls) upstream of that specific outfall. At a minimum, samples will be collected at eight sites during the initial sampling phase with most samples coming from the areas with highest historical *E. coli* contamination records.

Samples will be analyzed according to the approved laboratory procedures defined in Appendix D. Data will be validated for precision and accuracy/bias, according to criteria defined in Sections I., J., and M., of the analytical methods for each parameter, found in Appendix D. The general approach to site selection and the frequency and number of samples will be determined by the relative level and location of contamination observed as described in Section 10.

The main focus of the water quality sampling from this study is to reduce and/or eliminate *E. coli* contamination sources. Comparability of *E. coli* results from this study and previous studies that established the *E. coli* impairment should be achieved through consistency of analytical methods and sample collection techniques. Previous *E. coli* data was analyzed at the Keene City Laboratory using the methods described in Appendix D. Samples were collected by Keene City staff and volunteers using roughly the same techniques described in the sampling SOPs in Appendix A. Sample results obtained from this study will be collected using a similar (or equal) sampling method, but slightly more formally delineated sampling protocols. Sensitivity and quantitation limits of analytical methods for each water quality parameter are included in Table 1 of Appendix B.

The specific number of samples and their locations will be determined based upon a review of historical information, information obtained during outfall mapping, and observations. However, a minimum of seven (7) samples for each parameter indicated in Section 10 (*E. coli*, nitrates, nitrites, ammonia, and total phosphorus) will be collected during the initial sampling event. Follow up sampling will be conducted as necessary.

All sample collection, sample handling, sample documentation, sample analysis, and field meter preparation including calibration and QC checks will be performed according to procedures defined in Sections 10 - 17 and Appendices C-D. Appendix B shows analyte detection and reporting limits. All samples will meet the criteria indicated in the method description for each analyte in Appendix D, Sample Analysis Methods. All applicable quality control and data assessment protocols are detailed in the Quality Control, Calculations, and Data Assessment sections of the method description for each analyte.

<u>Fish Species Surveying</u>

An electrofishing fish species survey will be conducted under the guidance of a NH Fish and Game, Fisheries Biologist. Site selection and sampling methodology are described in Section 11. The objective of this is to provide further data establishing a baseline of species present in impacted areas of the brook. A follow up fish survey will be conducted near the end of the project to try to determine the success of restoration efforts.

A minimum of three sections of the brook will be selected with the advisement of NH Fish and Game fisheries staff. Sections of the brook, representative of areas heavily impacted by brook alteration and areas less (or non-) impacted will be selected. Fish will be identified to species and measured as described in the Appendix A, SOP for Fish Surveying.

Habitat Assessment

Data from the habitat assessment portion of the project will be used as a baseline and to identify actions with potential to lead to general stream restoration and habitat improvement. Specific actions to be taken will be determined based upon the advice of a consultant, and will be implemented in agreement with the US Army Corps of Engineers.

Habitat will be assessed for parameters defined in Section 15. The planned approach is to assess the entire section of brook from its mouth at the Branch River upstream to the approximate northernmost densely residential areas (see Section 15 for description). At a minimum, 90% of the linear distance of the brook between the mouth and George Street will be assessed, and all in-brook habitat types will be represented.

8 – Special Training/Certification

All personnel and volunteers utilized for portions of this project that fall under the QAPP will be trained and/or have documentation of previous training, in the methods required by the QAPP in Section 11. Training requirements for personnel performing specific tasks is provided in Table 3 below.

Table 3. Special Personnel Training Requirements

Project Function	Description of Training	Training provider	Training Recipients	Location of training records
Field analysis of water quality parameters (conductivity, temperature)	Proper use of conductivity meter	City of Keene WWTP staff	All personnel who will be leading sampling teams	City of Keene WWTP
Sample collection for laboratory analysis (*E. coli*, nitrates, nitrites, ammonia, total phosphorus)	Proper techniques for sample collection, preservation, and documentation	City of Keene WWTP staff	All personnel who will be leading sampling teams	City of Keene WWTP
Fish surveying	Proper techniques for conducting electrofishing sampling	Gabe Gries, NH Fish and Game	Review of procedure provided to Eric Swope	City of Keene WWTP
Field assessment of brook habitat	Proper collection of measurements (e.g., brook depth, width, flow), classification of brook channel's physical (riffle, run, pool), substrate, and	Eric Swope, City of Keene and/or other volunteers or professionals with habitat assessment experience	All personnel who will be leading habitat assessment teams.	City of Keene WWTP

	riparian zone characteristics.			

9 – Documents and Records

The Project Manager will be the primary contact for all parties involved in this study. If problems arise in the field, laboratory, or any phase of the project, the Project Manager will be contacted and will determine the best course of action. In the event that revisions to the QAPP are required, the Project Manager will ensure that updated QAPPs are distributed to all parties listed on the QAPP distribution list in Section 3 above. All revised versions will be clearly marked with the date and revision number.

Table 4 below lists reports and records related to the project and indicates where copies will be kept.

Table 4. Document and Record Distribution and Storage

Document or Record	Format	Stored at:
Documentation of all required training (see Table 3)	Hard copy	Keene WWTP for a minimum of five years
Field meter calibration and QC check documentation.	Hard copy (Field meter Calibration and QC Check Log Book)	Keene WWTP for a minimum of five years
Laboratory reports, including all analyses results, chains-of custody, and QC reports.	Hard copy	Keene WWTP for a minimum of five years
Habitat Assessment field data sheets	Hard copy	Keene WWTP for a minimum of five years
Habitat Assessment Summary Report	Hard copy and Microsoft Office electronic copy	Keene WWTP for a minimum of five years
Habitat Assessment consultant evaluation and recommendation report	Hard copy and Microsoft Office compatible electronic copy	Keene WWTP for a minimum of five years and main Public Works file storage.
Electrofishing survey field data sheets	Hard copy	Keene WWTP for a minimum of five years
Electrofishing Survey Summary Report	Hard copy and Microsoft Office electronic copy	Keene WWTP for a minimum of five years
Semi-annual reports	Hard copy and Microsoft Office electronic copy	Keene WWTP for a minimum of five years
Final Report	Hard copy and Microsoft Office	Keene WWTP for a minimum of five years and

	electronic copy	main Public Works file storage.

10 – Water Quality Sampling Process Design

This section describes the rationale for sample site selection and sampling procedures to be performed by the City of Keene. Beaver Brook flows through the City of Keene and receives storm drain discharges from residential, business and industrial areas including most of the east side of the city. The City of Keene staff will collect samples at times of normal flow levels for *E. coli*, ammonia, nitrate, nitrite and total phosphorus along the appropriate reaches of Beaver Brook. Each sample will be labeled and tracked as described in detail in Section 12. Sample ID typically includes a unique identifying feature and the date. E.g., a sample collected in the brook at Baker Street on July 11, 2007 might be labeled #BKR-071107. The identification number will also be recorded on the chain-of-custody form along with a description of the location. Standard Operating Procedures (SOPs) for each sample type are provided in Appendix A. The City of Keene will also be taking field measurements of conductivity and temperature.

The City of Keene has collected *E. coli* samples from Beaver Brook in recent years and proposes to further investigate potential *E. coli* problem areas as well as investigate other pollutant sources. As proposed, the City of Keene will map the brook from the outfall to the northern most residential areas. The number and locations of sampling sites are yet to be determined, but initial sampling locations and numbers of samples will be based on historical sampling locations (See Attachment 1, Table B), location of storm drains and other potential problem areas. The City's goal is to consistently achieve the NH Water Quality Criteria for Class B Fresh Waterbodies of 406 *E. coli* colonies/100 ml, as well as to eliminate or reduce other pollutant sources. Therefore, areas with sample results yielding greater than 406 *E. coli* colonies/100 ml will receive that greatest attention. Follow up sampling and investigations will also take into account relative levels of all pollutants measured compared across sampling sites.

11 – Water Quality Sampling Methods

Consistency in data collection is an integral part of this project. The measurements and collection techniques will be specific to Beaver Brook. Staff members and trained volunteers will wade into the brook to collect samples and take field measurements. See Section 21 for description of evaluation of, and corrections to, field sampling methods. All samples will be analyzed at the Keene City Laboratory, or at an outside laboratory accredited through the State of New Hampshire Environmental Laboratory Accreditation Program (NELAP). Standard Operating Procedures (SOPs) for each sample type are provided in Appendix A.

The historical *E. coli* and electro fishing results show that the northern most section of the brook is a viable habitat for brook trout with little pollution. The staff will start collecting samples in less contaminated areas and work downstream to the more contaminated areas. Collecting samples and taking measurements in this fashion will minimize the chance for cross contamination. Staff will wear disposable latex or nitrile gloves during sample collection.

Grab samples for *E. coli* will be collected in plastic sterile bottles provided by Keene City Laboratory. Keene City Laboratory will provide upon request records of autoclave performance as well as associated sterility checks. All sampling for *E. coli* will follow the SOP for *E. coli* sampling found in Appendix A.

A grab sample from the stream will be collected in a clean plastic bucket in the middle of the stream. Samples may also be collected from storm drains or other locations in an attempt to isolate problem areas. Water from the bucket will be transferred to the appropriate containers for ammonia, nitrate, nitrite and phosphorus samples and will be preserved according to the appropriate method. All sampling for these parameters will follow the sampling SOP for the individual parameters found in Appendix A

Conductivity and temperature measurements will be taken using a VWR field conductivity meter. Using the hand held field meter measurements will be taken directly from the stream. The probe will be submerged below the surface and the reading will be taken.

Additional temperature measurements may be obtained using Optic Stowaway temperature data loggers provided by NH Fish and Game. The use of the data loggers is dependent upon their availability during the sampling season. If used, the data loggers would be placed in the brook, submerged in 2-4 separate locations, and the temperature fluctuations logged over the course of the summer. Site selection would be determined with the assistance of NH Fish and Game personnel. At lease one location with canopy coverage upstream of the urbanized area of the brook and one location without canopy cover within the urbanized area would be selected to see how much the water temperature changes as the brook flows through the City and is exposed to more sunlight. The timing of deployment of the data loggers is expected to cover the summer months, ideally from at least late June through early September. Data loggers will be placed so as to be hidden from view of passersby as much as possible.

Table 5. Sample Requirements

Analytical parameter	Collection method	Sampling SOP	Sample volume	Container size and type	Preservation requirements	Max. holding time (preparation and analysis)
Total phosphorus	Grab	Appendix A	100 mL	100 mL brown polyethylene or glass	H_2SO_4 to pH<2, light protected, chilled to 4ºC	28 days
Nitrate+nitrite (NO_3+NO_2)	Grab	Appendix A	50 mL	100 mL white polyethylene or glass	H_2SO_4 to pH<2, chilled to 4ºC	48 hours

Ammonia	Grab	Appendix A	250 mL	1000 mL white polyethylene or glass	H_2SO_4 to pH<2, chilled to 4ºC	28 days
E. coli	Grab	Appendix A	250 mL	250 mL sterile white polyethylene	Chilled to ≤ 10ºC	6 hours
Temperature	measured in-situ	Appendix A	NA	NA	NA	NA
Conductivity	measured in-situ	Appendix A	NA	NA	NA	NA

12 – Water Quality Sample Custody and Handling

In the field, sample bottles will be labeled with the name of the water body, the sample location, a unique identification number, sample date, sample time, the collector's initials and the parameters to be analyzed. Each sample will have a corresponding chain-of-custody form with the same information. Keene City Laboratory will provide the chain-of-custody. See Appendix D for a copy of the chain-of-custody form. The chain-of-custody will remain at Keene City Laboratory and will be submitted with the final report.

Samples will be transported to Keene City Laboratory by staff. Samples going to a contract laboratory for analysis will be kept on ice and then refrigerated until ready for analysis. The samples will then be picked up and transported on ice by a courier service provided by the contract laboratory.

In the laboratory, samples will be logged into the Non-Routine Sample Logbook. Information such as the date, sample location, lab number and preservation will be recorded. See Appendix F for a copy of the logbook page. All samples will be analyzed before the holding time has expired (see Table 5).

13 – Water Quality Analytical Methods

Samples will be analyzed using methods approved by EPA or Standard Methods. For a complete listing of methods to be used, see Appendix D. *E. coli*, nitrate, nitrite, and ammonia samples will be analyzed at the Keene City Laboratory. Results will typically be available 24 hours after analysis begins. Total phosphorus will be analyzed by a contract laboratory, Eastern Analytical Inc, (EAI) with results typically returned within two weeks. See Table 1 in Appendix B for the associated methods and detection limits.

14 – Water Sampling & Analysis Quality Control

The quality controls deemed appropriate by the laboratory as well as the corrective actions and calculations are written into the individual methods, see Appendix D for specific details on the quality control requirements.

In the field, staff will collect field duplicates and field blanks as quality control samples for this project. Currently the number of samples sites in unknown. However, staff will collect a minimum of 1 field duplicate for every 10 samples collected. For *E. coli*, staff will only collect the appropriate number of field duplicates. De-ionized water from the laboratory will be brought into the field to prepare the blanks. One set of field blanks will be prepared by rinsing the field bucket used to collect water from the brook three times with deionized water, then fill the bucket with deionized water and pour into the appropriate sample bottles. This will be done after several samples have been collected. The other field blank will be prepared by pouring the deionized water directly into the sample bottles. Using this method to collect the field blanks will help determine the source of contamination.

If any of the field blanks contain a concentration greater than the reporting detection limit (RDL). The results will be flagged by the laboratory manager. If any of the field duplicate samples have a relative percent difference greater than 20 %, the results will be flagged by the laboratory manager.

For field measurements, a field duplicate measurement will be performed at a frequency of 1 duplicate measurement for every 10 sample locations. If the readings do not agree within 20 %, the staff will troubleshoot the problem by changing the batteries and recalibrating the meter. If further problems persist samples for conductivity will be collected and analyzed in the laboratory.

15 - Additional Sampling & Surveys

Habitat Assessment Overview and Sampling Process Design

A habitat assessment of Beaver Brook will be conducted by wading all sections of the brook from its mouth, upstream to its northernmost densely residential areas (northernmost portion will be roughly, between George Street and Old Concord Road- see Attachment 1 for map).

In general, the assessment aims to provide a basis for an evaluation of the habitat value of the stream in its current condition and to provide a foundation for recommendations for improvements. The focus is on habitat suitable to cold-water fish species, particularly brook trout and Atlantic salmon, as well as for habitat improvements for other animal species consistent with restoration toward a natural state.

Habitat Assessment Sampling Methods
Initial habitat assessment will consist of teams of trained volunteers and/or staff collecting field data indicated on the Habitat Assessment Data Sheet (Appendix G). The Habitat Assessment SOP in Appendix A will be followed for data collection. The brook will be divided into discrete sections, typically separated by easily identified landmarks auch as bridges. Each team will be equipped with a measuring tape, a watch with a second hand for estimating velocity, and waders for brook access.

Habitat data will be recorded on the field data sheet printed on waterproof paper. The brook will be divided into sections based upon the type of physical characteristics observed (e.g., run, riffle, pool). For each section, the following data will be recorded:

> *Name of of data collectors; date; time; description of section location; section type (run, riffle, pool); section measurements, including length, width (at a point representative of the section), deepest point, and average depth at ¼, ½, and ¾ of way across brook (at a point representative of the section); modifications to channel; estimated % substrate type (silt/mud, sand, gravel, cobble, boulder, bedrock, detritus, artificial); observed fish cover; riparian zone characteristics including land use type, vegetated buffer width, dominant vegetation species (if known), and invasive species present (if known); outfall information including location, flow, evidence of pollutants; obstructions to fish passage; and other pertinent observations*.

All data sheets will be turned in to the Project Manager for review and will kept in the project file at the WWTP. Data that is unclear will be checked by contacting the observers to verify/clarify.

Habitat Restoration Plan
The Project Manager will work with the Planning Department Geographic Information System (GIS) Specialist to develop a GIS map with pertinent layers of habitat data. All data sheets and resulting habitat maps will be retained as part of the project file at the Keene WWTP, along with electronic back-up files.

A consultant with habitat restoration experience will then be retained to make recommendations for restoration actions. The specific actions and scope of restoration activities are to be determined, but some factors influencing considerations may include: compliance with the City's requirements for brook maintenance per US Army Corps of Engineers; cost of recommended actions; buy-in from private citizens, business owners, and other stakeholders.

Measures of success for restoration activities may be largely long-term, dependent upon the nature of recommended measures and the amount of time required to realize results (e.g., tree plantings will take some time to grow; measures resulting in re-population, or species expansion would require time to take hold). More immediate anticipated measures of success may be aesthetic and/or of educational value, such as greatly

increased awareness of the brook and water quality issues, and greater stewardship on part of citizenry.

Fish Survey Overview

The objective of the fish survey is primarily to determine presence/absence of trout and salmon and to determine the other fish species present in the brook. Historical data will also be utilized for this purpose. An initial electrofishing survey will be conducted in the spring or summer of 2007. A follow-up electrofishing event will take place in 2008 to see if restoration efforts have had an initial effect on expansion of cold-water species. However, it is anticipated that effects of restoration efforts may only be known over the long-term, as many anticipated remedial actions may take a significant amount of time to produce an effect. For example, tree and other vegetation planting actions may require several years of plant growth for before a potential impact of canopy cover on water temperature is realized. Likewise, Atlantic salmon stocking efforts may take several years to produce an effect. The City will explore with NH Fish and Game the possibility of additional surveys in ensuing years after the life of the grant.

Fish Survey Process Design and Site Selection

A minimum of three (3) sites, or sampling stations, will be selected for electrofishing surveys. Electrofishing will be done according to the Fish Survey SOP in Appendix A. At least one site will be representative of a section of the brook that is upstream of the main urban area and believed to be relatively intact. At least one site will be a section of the brook that is in, or downstream of, one of the more urbanized, heavily-impacted areas of the brook. Sites will be selected based upon City of Keene personnel familiarity with the brook and upon recommendation from NH Fish and Game personnel.

Specific sampling reaches of the brook will be selected to include a representation of habitat types found in that section of the brook (e.g., mix of runs, riffles, and pools, if present).

Fish Survey Sampling Methods and Data Collection

Electrofishing will be done using backpack electrofishing units provided by NH Fish and Game. Electrical settings for the unit will be determined by the Fisheries Biologist and will be consistent with settings used in the biologist's experience. To aid in collection of fish samples, electrofishing will take place during a period when brook flows permit for easy wadeability and visibility is not impaired by post-storm turbidity.

Each survey sample site will cover between 50-100 linear yards of brook. A net will be placed across the upstream section of the brook (unless an existing barrier such as a dam is already present) to prevent fish within the reach from escaping from the sample area ahead of the electrofishing unit. Sampling will include a single pass through each site with at least one person in addition to the biologist collecting fish. Sampling will begin at the downstream end of the section and will proceed upstream to the barrier. An attempt will be made to collect all fish observed during the shocking using mesh scoop

nets to scoop fish into hand-held buckets. Fish will be retained in buckets until the end of the section sampling event.

At the end of each sampling event total shock time for the reach will be recorded. Fish will then be identified to species and tallied. Salmonid species will be measured for total length (mm), except young-of-year fish will be tallied only. All fish will be released after survey results are recorded. Results will be entered on a field data sheet (Appendix G) printed on waterproof paper and transferred into an Excel spreadsheet for inclusion in the final file and report. Copies will be kept at the WWTP in both hard copy and electronic format.

16 - Instrument/Equipment Testing, Inspection, and Maintenance

Keene City Laboratory performs routine maintenance and repairs on its instrumentation, entries are made into maintenance logbooks for each instrument. All equipment is kept in a state of good repair.

The field conductivity meter which will be used for conductivity and temperature measurements is cleaned after each use. When put back into service after an extended period of storage, the probe is soaked overnight in a cup of de-ionized water. The battery is changed when low. If there are problems with the meter working properly, it is sent back to the service company for maintenance.

The Keene City Laboratory performs routine maintenance and repairs on its instrumentation as required. The laboratory runs extensive quality controls during analysis, as described in Appendix D, Section I. Quality Control, of each method. QC results are evaluated, and the steps for deficiency resolution are followed, per requirements in Appendix D, Section M. Data Assessment. All QC results are documented and kept on file at the Keene WWTP.

17 - Instrument/Equipment Calibration and Frequency

Calibration information is included with each of the SOPs provided in Appendix D. Fixed laboratory instrument calibration is performed on a daily basis by the laboratory technician prior to analyzing any samples.

The field meter will be calibrated by staff every day prior to use and validated with a quality control standard. This will be documented in the maintenance logbook. At the end of the sampling day the meter will again be validated with a quality control standard performed at the Keene City Laboratory. If the quality control standard check is deemed acceptable, no further action is required. If the quality control standard check is deemed not acceptable, the degree to which the QC varied from acceptability will be evaluated. The Project Manager may then opt to either resample with the conductivity meter with a QC performed after every two-three sample sites, or to collect samples from each site which will be measured in the laboratory and reported as specific conductance at 25°

Celsius. Note that the purpose of conductivity sampling in this project is to track trends and identify areas where conductivity spikes occur that may be indicative of pollutant sources rather than to come up with a defensible value.

18 - Inspection/Acceptance of Supplies and Consumables

The necessary supplies and consumables for this study will be provided by the City of Keene. Laboratory staff will prepare sample bottles by acid washing, autoclaving, labeling and adding the appropriate preservative as required by the method. All field equipment will be maintained, cleaned and checked prior to the start of each sampling day.

19 - Non-Direct Measurements

Some historical data will be used during this project. Specifically, *E. coli* data will be used to provide background from which to identify historical problem areas for *E. coli* contamination in the brook, and to identify areas upon which to begin the focus of the study. Samples used to generate this data were collected by City staff and volunteers instructed in proper sampling protocols. Samples were tracked using existing Keene City Laboratory chains-of-custody and analyses performed at the Keene City Laboratory per approved methods.

Fish sampling data from several electrofishing events with a NH Fish and Game fisheries biologist will also be used to cite presence/absence of various fish species in sections of the brook that are impacted/not heavily impacted. The study is not intended to fully document populations of species, but rather to determine which species populated various impacted sections of streams.

20 - Data Management

All pertinent field data such as equipment calibration and validation, sample locations, samples collected and notes will be written into a designated water proof field notebook and will remain in the project manager's possession until the project has been completed. Additional details are provided in Section 12.

Field information and measurements will be generated at the same time samples will be collected for laboratory analysis. All field and laboratory measurements will be recorded in permanent ink. The field measurements will be recorded into the designated field notebook. The field information will then be transferred to the appropriate chain of custody form and then to a spreadsheet which will be stored on the City of Keene's network. Entries into the spreadsheet will be verified and checked by a second person.

The results generated by Keene City Laboratory will be recorded in the appropriate laboratory bench logs. All data generated by Keene City Laboratory is verified by a second person to ensure data quality. The results will then be transferred onto the appropriate chain of custody and then into a spreadsheet. The chains of custody will be kept in the laboratory and submitted to the project manager with the final lab report.

The contract laboratory will submit a laboratory report. The data will be transferred to the appropriate chain of custody and then into a spreadsheet. A copy of the laboratory report will be submitted with the final report and filed with the project manager.

21 - Assessments and Response Actions

In order to determine that field sampling and field data collection (including habitat assessment and water quality data) are occurring as planned, the Project Manager will convene with field personnel to discuss methods and determine any deviations from, or difficulties with, sampling protocols. Any concerns shall be addressed and necessary changes made to ensure consistency and quality of subsequent sampling and data collection. Water quality sampling protocol includes procedures that are already utilized by City of Keene staff and no difficulties are anticipated. Samples will be checked at the laboratory to ensure adherence to Keene City Laboratory sample acceptance policy.

Laboratory activities and associated QA/QC data will be reviewed by the project's Water Quality QA Manager. QA/QC information will be reviewed and assessed as it becomes available from the contract laboratory and the Keene City Laboratory. At this time all concerns regarding analytical techniques and QA deviations will be addressed and changes deemed necessary shall be made to ensure consistency and quality of subsequent sample analysis.

Habitat assessment field data sheets will be reviewed by the Project Manager for completeness and clarity. Any difficulties will be discussed and remedied during discussion with field personnel. Any necessary written/structural changes will be made through a revision in the protocol for that activity.

Fish surveying activities will be overseen by the NH Fish and Game Fisheries Biologist. Any deviation from protocol will be assessed and changes implemented as deemed necessary to ensure consistency and quality of subsequent sample analysis.

22 - Reports to Management

No QA management Reports will be generated for the project. In lieu of QA Management Reports, the final project report will include a section on QA/QC and will include the following items:

- Summary of QA/QC programs and trainings conducted during the project
- Conformance of project activities to QAPP requirements
- Deviations from QAPP and approved amendments to QAPP
- Required corrective actions and effectiveness of corrective action implementation
- A summary of the results of all QA/QC checks called for in the QAPP (e.g., comparison of field duplicate samples)
- Any relevant QA/QC documentation from the laboratory
- A complete table of all data
- Summary of limitations on the use of data generated

In addition to the Final Report, semi-annual reports will be submitted by the Project Manager to NH DES throughout the life of the project. Any significant problems with QA/QC programs or other QAPP components will be reported at that time, as well as during correspondence in periods between reports.

23 - Data Review, Verification, and Validation

The project's Water Quality QA Manager will conduct a review of all raw data. Results of checks and data quality objectives will be assessed per requirements described in Appendix D, Data Assessment Section for each analysis method.

Data validation for water quality parameters will be determined through the detailed examination of raw data to check for calculation, measurement within calibration range, parameter identification, and transcription errors. Any errors identified will be corrected. In addition, the results of QC checks will be assessed. Chains-of –custody (See Appendix E) will accompany each sample and copies will be retained with the permanent record at the Keene WWTP.

Data validation for habitat assessment data will be determined by a thorough review of the data sheets (see Appendix G) and discussions with field personnel. Data will also be compared against Project Manager knowledge of the brook. Habitat assessment notes will be recorded in the field at each site and will be reviewed by the Project Manager for consistency and completeness.

24 - Verification and Validation Procedures

The Water Quality QA Manager will review all analytical data. Only water quality data that meets Keene City Laboratory acceptance policies will be used. Details of analytical procedures, data generation, quality control, and data assessment procedures are included in the laboratory methods for each parameter in Appendix D. Adherence to these procedures will assure consistency and quality of data generated. All sample results will be submitted to the Project Manager along with chains-of-custody.

Habitat Assessment data sheets will be submitted to, and reviewed by, the Project Manager. In the event that survey sheets are incomplete or the data generated is questionable, the Project Manager will discuss data with the field personnel to determine reason for problems and to complete missing data. If satisfactory result is not obtained, some sites may require revisiting.

Fish survey data collection will be performed under the oversight of a NH Fish and Game Fisheries Biologist. Species identification will be verified by the biologist. Data will be recorded in the field at the time of collection and copies of data sheets will be submitted as part of the final report. An inherent bias in fish sampling is that not all fish are captured when electrofishing. However, since the objective of sampling in this study is to determine presence/absence and relative abundance of fish species in sections of the brook, the method described in Section 15 above is appropriate to the data required.

25 - Data Reconciliation with User Requirements

Water Quality

The purpose of the water quality sampling portion of this study is to aid in the locating of, and reduction or elimination of, pollutant sources in Beaver Brook. Therefore, relative differences between high impact and low impact areas of the brook, and differences within high impact areas of the brook are of the greatest importance. *E. coli* results are the primary focus with additional "sewer-associated" pollutant results intended to help identify *E. coli* sources and to indicate more general areas of concern.

Water quality sampling data will be reviewed for completeness throughout, and at the end of, the field study.

Appendix D defines the criteria by which each analyte will be compared to determine acceptability. Criteria include review of duplicate results to determine precision (agreement between duplicates) and review of duplicate and blank results to determine sample contamination. Samples that are deemed invalid will be excluded from consideration and re-sampling may be required.

Sample data will be reviewed for completeness by comparing the total minimum number of samples required in Secton 7 to the actual number collected. However, since the

project plan calls for additional sampling based upon results of initial sample round, an undetermined and unquantifiable amount of follow up sampling will be required so completeness must remain somewhat subjective.

Habitat Assessment

Habitat assessment data sheets will be reviewed for completeness throughout, and at the end of, the study. Required sections of each sheet must be completed. Incomplete or unclear sections will be verified/clarified through conversations with field samplers and/or through field verification.

As described in Section 7, a minimum of 90% of the linear brook distance between its mouth and George Street will be assessed. Data sheets will be summarized and forwarded to a consultant for evaluation and restoration recommendation.

Fish Species Survey

This portion of the project is primarily to document presence/absence of fish species (with a focus on cold-water species) and to see if that changes over time with improvements in habitat (and aided by anticipated improvements in water quality). If the minimum number of sites identified in Section 7 are sampled, then the project objectives have been met.

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Appendix A.

Standard Operating Procedures (SOPS) for Sample Collection Activities

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Appendix A. Standard Operating Procedures (SOPS) for Sample Collection Activities

Aaron Costa and Eric Swope, May 24, 2007

Modified from:

"Sampling for Bacteria" information sheet obtained from NH Department of Environmental Services);

"Standard Operating Standard Operating Procedure for Bacterial Indicators Sample Collection", Prepared by Natalie Landry, NHDES;

"Volunteer River Assessment Program Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors", NHDES, April 2007

SOP for Escherichia coli sampling

The staff will start collecting brook samples in less contaminated areas and work downstream to the more contaminated areas. Collecting samples and taking measurements in this fashion will minimize the chance for cross contamination. Staff will wear disposable latex or plastic gloves during sample collection.

Grab samples for *E. coli* will be collected in plastic sterile bottles provided by Keene City Laboratory.

Sampling from the brook

1. Bacteria samples will be collected directly in the sterile containers.
2. In an effort to obtain a representative sample staff will try not to disturb the brook bottom while sampling.
3. Where possible, samples will be collected from the middle of the brook by wading carefully into the brook. If it is not possible or safe to enter the brook, samples may be collected by affixing the bottle to a sampling pole taking care to follow the steps below as much as possible.
4. Samples will be collected upstream of point of entry into the brook so as to avoid collecting sediments disturbed by sampler.
5. Remove the cap of a sterilized bottle when ready to collect the sample. Avoid touching the inside the bottle or cap to prevent contamination.
6. The samples will be collected by plunging the mouth of the bottle through the surface of the water. Position the bottle so that the mouth is going up the brook about 6-12 inches below the surface. If the water does not have a current, move the bottle horizontally in the direction so that it is pointed away from the sampler. Tip the bottle slightly upward to allow the air to exit and the bottle to fill. After removing the bottle from the water pour out a small portion of the sample so that a small air space will remain. Then recap the bottle.

7. If the brook is too shallow at a specific location to allow for sampling deeper than 6", adjustments will be made to collect a representative sample as best as conditions allow.

8. After the *E. coli* sample has been collected it will be put on ice and remain chilled until it has reached the laboratory. Care will be taken not to freeze the samples. Any samples with ice present will be rejected and another sample will be collected. All samples collected must meet the associated sample acceptance policy deemed appropriated by the laboratory (see Appendix B).

9. In the field, sample bottles will be labeled with the name of the water body, the sample location, a unique identification number, sample date, sample time, the collector's initials and the parameters to be analyzed.

10. Each sample will have a corresponding chain-of-custody form with the same information. Keene City Laboratory will provide the chain-of-custody. See Appendix E for a copy of the chain-of-custody form.

Sampling from a storm drain or other location

Samples for *E. coli* may also be collected from storm drains or other locations in an attempt to isolate problem areas. If sampling from the storm drain:

1. Bacteria samples will be collected directly in the sterile containers.
2. In an effort to obtain a representative sample staff will try not to disturb the pipe bottom while sampling.
3. If sampling at an outfall, samples will be collected from flow at the middle of the pipe. If it is not possible or safe to enter the brook to access the outfall, or if sampling from a manhole or storm drain catch basin, samples may be collected by affixing the bottle to a sampling pole taking care to follow the steps below as much as possible.
4. Remove the cap of a sterilized bottle when ready to collect the sample. Avoid touching the inside the bottle or cap to prevent contamination.
5. Avoid collecting sediments disturbed by sampler. If this cannot be avoided, make a note of this on the chain-of-custody.
6. If possible, place bottle underneath the pipe to capture flowing water. If the pipe is flush with the water surface, place the bottle in the pipe, and try to capture representative water. Try not to disturb sediments in the pipe. If the sediment is disturbed, collect the sample away from the disturbed area to minimize contamination possibilities. If sample collection away from the disturbed area is not possible, note this on the chain-of-custody.
7. If the water does not have a current, as in a catch basin, allow the bottle to fill below the surface if water is deep enough. Tip the bottle slightly upward to allow the air to exit and the bottle to fill. After removing the bottle from the water pour out a small portion of the sample so that a small air space will remain. Then recap the bottle.
8. After the *E. coli* sample has been collected it will be put on ice and remain chilled until it has reached the laboratory. Care will be taken not to freeze the samples. Any samples with ice present will be rejected and another sample will be collected. All samples collected must meet the associated sample acceptance policy deemed appropriated by the laboratory (see Appendix B).

9. In the field, sample bottles will be labeled with the name of the water body, the sample location, a unique identification number, sample date, sample time, the collector's initials and the parameters to be analyzed.

10. Each sample will have a corresponding chain-of-custody form with the same information. Keene City Laboratory will provide the chain-of-custody. See Appendix E for a copy of the chain-of-custody form.

SOP for Nutrient Sampling

Aaron Costa and Eric Swope, May 24, 2007

Modified from:

"Ambient River Monitoring Program Standard Operating Procedures (SOP) Sampling, Custody, and Laboratory Login", Revision 3: April 20, 2006", NH Department of Environmental Services

Nutrient sampling will be conducted primarily to record relative differences in brook conditions in order to locate likely areas of pollutant origin. Absolute values will not be as important as locating spikes in nutrients.

A grab sample from the brook will be collected in a clean plastic bucket in the middle of the brook. Samples may also be collected from storm drains or other locations in an attempt to isolate problem areas. Where possible, sample will be collected by wading to the center of the brook according to procedure outlined in Section B, "Bucket by Stream Wading" below. Where this method is impractical or unsafe, sample will be collected by wading to the center of the brook according to procedure outlined in Section A, "Bucket from Crossing" below.

Water from the bucket will be transferred to the appropriate containers (see table 5) and preserved according to the appropriate method. Samples will be transported and analyzed by the laboratory within the prescribed holding times. For sample holding times, detection limits and methodology see table 1 and 2 in Appendix A. Grab samples for ammonia and phosphorus will be collected in clean plastic containers with the appropriate preservative provided by the laboratory. Grab samples for nitrate and nitrite will be collected in clean unpreserved plastic containers. All samples will be put on ice and remain chilled until they have reached the laboratory. Once the samples have been received by the laboratory they will be refrigerated until the time of analysis. All samples collected must meet the associated sample acceptance policy deemed appropriated by the laboratory (see Appendix B).

The sample buckets and field equipment will be rinsed between samples. At each site, the bucket will be triple rinsed using water from the brook at that location prior to collecting samples.

Samples going to a contract laboratory for analysis will be kept on ice and then refrigerated. The samples will then be picked up and transported on ice by a courier service provided by the contract laboratory.

In the field, sample bottles will be labeled with the name of the water body, the sample location, a unique identification number, sample date, sample time, the collector's initials and the parameters to be analyzed. Each sample will have a corresponding chain-of-custody form with the same information. Keene City Laboratory will provide the chain-

of-custody. See Appendix E for a copy of the chain-of-custody form. A step-by-step summary of the sampling SOP is below. For purposes of this SOP, the term thalweg is defined as the line connecting the deepest points of the brook bed.

A. Bucket from Crossing

Step 1. Position the bucket over the thalweg of the brook channel on the upstream side of the crossing. Position the bucket over the center of the channel if a thalweg is not apparent.

Step 2. Lower the bucket to the brook surface and fill approximately ¼ or more of the bucket with water. Hoist the bucket to the crossing deck and rinse the bucket by swirling the water around the entire inner surface of the bucket, including the spout. **Discard the water away from the point of sample collection.**

Step 3. Repeat Step 2 and Step 3 twice, for a total of three rinses.

Step 4. Lower the bucket to the brook. Fill approximately ¾ of the bucket with the water sample by slowly immersing the lip of the bucket into the water.

Step 5. Hoist the bucket to the crossing deck, being careful not to agitate the sample [by bouncing the bucket or bumping the bucket against the crossing]. Carry the bucket to a location away from traffic and airborne contaminants (i.e., away from the road), again being careful not to agitate the sample.

Step 6. Fill all labeled water sample bottles completely with the water sample contained in the bucket.

Step 7. Place all filled water sample bottles on ice in the cooler as soon as possible after collection, and ensure the top of the cooler is tightly closed.

Step 8. **Record on the chain-of custody** all field notes, including station ID, date, time, field measurement results, samples collected, etc.

Step 9. Transport and submit the samples to the Keene City Laboratory within the sample holding time appropriate to each water quality parameter.

B. Bucket by Stream Wading

Step 1. Determine a safe access path to the brook. Avoid steep or slippery slopes, jagged rocks, poison ivy, etc. whenever possible.

Step 2. Approach the sampling station from downstream to upstream by wading into the thalweg of the stream as close as possible to the center and position the top of the bucket at an arm's length upstream. If a thalweg is not apparent, wade into the center of the channel and position the top of the bucket upstream.

NOTE: Do not enter the water if safety concerns exist, particularly if the water is greater than or equal to waste deep.

Step 3. Fill approximately ¼ or more of the bucket with water and rinse the bucket by swirling the water around the entire inner surface of the bucket, including the spout. Discard the water downstream from the location from which the

sample was drawn.

NOTE: Do not fill the bucket with water that has contacted legs or waders.

Step 4. Repeat Steps 2 and 3 twice, for a total of three rinses.

Step 5. Fill approximately ¾ of the bucket with the water sample by holding the bucket at an arm's reach upstream and slowly immersing the lip of the bucket into the flowing water.

Step 6. Wade out of the brook and proceed with Step 5 through Step 9 in Section A.

SOP for Conductivity and Temperature Measurements

Aaron Costa and Eric Swope, May 24, 2007

Modified from:

"Ambient River monitoring Program Standard Operating Procedures (SOP) Specific Conductance, Revision 3: April 2005", NH Department of Environmental Services, and VWR's "Hand Held Conductivity Meter" manual;

Conductivity and temperature measurements will be taken using a VWR field conductivity meter. Conductivity measurements will be taken primarily to record relative differences in brook conditions in order to locate likely areas of pollutant origin. Absolute values will not be as important as locating spikes in conductivity.

The conductivity meter will be calibrated in the laboratory prior to use in the field. The meter will be calibrated using a single standard, typically a solution of 1412 us/cm. The calibrated meter will be given a quality control check with a solution of known QC, typically 141.2 us/cm. QC reading must be within 10% of the known QC value.

Meter Calibration

Calibration will follow the steps below:

1. Rinse the probe with deionized water (DI) and wipe with a Kimwipe.
2. Immerse the conductivity probe into a standard solution (typically 1412 us/cm) and allow to stabilize.
3. Open the battery compartment and, using a small screwdriver, adjust the "Calibration Adjust Pot" screw (middle screw of a row of five), until the display indicates the value of the calibration solution.
4. Remove probe form calibration solution, rinse with DI and wipe with a Kimwipe.
5. Immerse the conductivity probe into a QC solution (typically 141.2 us/cm) and allow to stabilize.
6. If reading is within 10% of the known QC value, then calibration is acceptable.
7. If reading is not within10% of the known QC value, then repeat steps 1-6 above.
8. Record calibration and QC check events in the Keene City Laboratory's Field Meter Calibration book. Include standard values, readings, and solution lot numbers.

Measurement

Measurements will be taken directly from the brook. A brook sampling location will be chosen that is representative of flow in that portion of the brook. The probe will be submerged below the surface and the conductivity and temperature readings will be taken and recorded as described below:

1. Immerse the conductivity probe into the water and allow to stabilize.
2. The meter comes with three separate range settings marked as "200µs", "2ms" and "20ms". If the display shows "----", it indicates an out-of-range condition. Select the next lower or higher range, as appropriate.

3. Record the conductivity and temperature readings on the chain-of-custody sheet for the sample site.
4. Record any pertinent observations regarding brook conditions on the chain-of-custody sheet.

The conductivity meter will be given a QC check with a solution of known conductivity after the last field reading has been collected according to the procedure below:

QC Check

1. Rinse the probe with DI and wipe with a Kimwipe.
2. Immerse the conductivity probe into a QC solution (typically 141.2 us/cm) and allow to stabilize.
3. If reading is within 10% of the known QC value, then calibration is acceptable.
4. If reading is not within10% of the known QC value, then values of data collected since last QC check will not be accepted as accurate. Data **may** still be used for comparative purposes as a tool to locate origin of relative differences within the brook and a starting point for further investigations
5. Record calibration and QC check events in the Keene City Laboratory's Field Meter Calibration book. Include standard values, readings, and solution lot numbers.

Maintenance

Conductivity probe will be rinsed with DI water and wiped with a Kimwipe at the end of the day and prior to storage. Batteries will be replaced as needed. Meter may also be sent to manufacturer for maintenance if it does not perform correctly.

Additional temperature measurements may be obtained using Optic Stowaway temperature data loggers provided by NH Fish and Game. If used, the data loggers would be placed in the brook submerged in 2-4 separate locations and the temperature fluctuations logged over the course of the summer. Site selection would be determined with the assistance of NH Fish and Game personnel. At least one location with canopy coverage upstream of the urbanized area of the brook and one location without canopy cover within the urbanized area would be selected to see how much the water temperature changes as the brook flows through the City and is exposed to more sunlight. Specific placement of the data loggers would be in spots out of sight from casual observers and representative of main flow in-brook conditions.

SOP for Illicit Discharge Detection
Eric Swope, April 20, 2007

Specific location of sample collection will be noted (e.g., "upstream of Baker Street bridge, mid-stream") to allow for sectioning of the brook for the purpose of isolating any pollutant source identified. Typically, samples will be collected upstream of a bridge and associated storm drain outfalls. However, there may be some deviation to this approach due to site inaccessibility, observation of dry weather storm drain flows, or other factors identified in the field. Regardless, this will allow for sectioning of the brook and for trends to be tracked as sampling progresses downstream through areas with greatest potential for impact.

Sample results and collection site data will be examined for trends and spikes in pollutant levels across all sampling sites. Sample data from sites with elevated concentrations of pollutants will be analyzed to compare areas or specific locations against outfalls and to try to pinpoint potential problem sources.

Problem areas will be examined using data trends and spikes, maps, and field observations (including, but not limited to, evidence of chemical pollutants, animal wastes, etc.) and a follow up sampling plan devised. Areas indicated by sample results to be impacted by *E. coli* will be resampled. Locations will be selected so as to try to further pinpoint the source of the *E. coli* contamination.

If *E. coli* contamination can be pinpointed to a specific storm drain or other outfall, the investigation will proceed up the outfall. Methods used may include, but not be limited to, sampling of upstream catch basins, using a sewer cameral to televise suspect storm drain or sewer lines, and dye testing of sewers mains and sewer lines from buildings.

SOP for Habitat Assessment Data Collection
Eric Swope, April 20, 2007

The study area of Beaver Brook will be divided into discrete sections, typically separated by easily identified landmarks auch as bridges. Teams of trained volunteers and/or staff will be provided with maps identifying the section from which they will be collecting data. Each team will also be equipped with Habitat Assessment Data Sheets (See Appendix G), a measuring tape, a watch with a second hand for estimating velocity, and waders for brook access.

Habitat data will be recorded on the field data sheet printed on waterproof paper. The brook will be further divided into sub-sections, or "reaches", based upon the type of physical characteristics observed (e.g., run, riffle, pool). For each section, the following data will be recorded on a separate data sheet:

> *Name of of data collectors; date; time; description of reach location; reach type (run, riffle, pool); reach measurements, including length, width (at a point representative of the section), deepest point, and average depth at ¼, ½, and ¾ of way across brook (at a point representative of the section); modifications to channel; estimated % substrate type (silt/mud, sand, gravel, cobble, boulder, bedrock, detritus, artificial); observed fish cover; riparian zone characteristics including land use type, vegetated buffer width, dominant vegetation species (if known), and invasive species present (if known); outfall information including location, flow, evidence of pollutants; obstructions to fish passage; and other pertinent observations. Where subjective assessments or estimates are required, data will be determined by team member consensus.*

Reach measurements will be taken by measuring tape. The section (pool, run, or riffle) will be measured for length. Width of the brook will be measured in an area of the section that is subjectively determined to be "typical". At this location depth measurements will be collected for points at ¼, ½, and ¾ of the brook width. The deepest spot within the reach will also be measured.

Velocity of the brook will be estimated by measuring out a known distance of at least ten feet and performing a minimum of two trial runs timing a floating object to travel the known distance in units feet/second

Any modifications to the brook channel will be noted and described on the data sheet.

Substrate characteristics will be recorded by estimating the % of the bottom covered by each of the following: silt/mud; sand (<1/4"); gravel (1/4'3"; cobble (3-12"); boulder (>12"); bedrock; detritus; artificial (with description provided). Any fish cover observed will also be noted/described including, but not limited to: islands; large woody debris; large boulders; undercut banks; over-hanging vegetation; other.

Riparian zone characteristics will be recorded by estimating the % of land within 100 feet of each bank with the following land uses/types: mature forest; immature forest;

shrub/thicket; marsh/wetland; field/agriculture; industrial/urban; suburban/residential/park; construction; road; other (describe). The estimated width of any vegetation buffer will be recorded for each bank under the following width categories: > 100'; 50-100'; 10-50'; 1-10'; none. If any of the team members are knowledgeable in plant identification, notation of dominant species and presence and identification of invasive species will also be recorded.

Any outfalls within the area of a reach will be recorded and the point of outfall described. Outfalls may include storm drains, other pipes, drainage ditches, etc. If there is a flow from the outfall at the time of observation, a description of the flow will be recorded including observations any evidence of pollution.

Dams or obstructions to fish passge will be recorded and described and any other observations deemed pertinent to the assessment will be noted.

SOP for Fish Surveying
Eric Swope, April 20, 2007

Specific sampling reaches of the brook will be selected to include a representation of habitat types found in that section of the brook (e.g., mix of runs, riffles, and pools, if present).

Electrofishing will be done using backpack electrofishing units provided by NH Fish and Game. Electrical settings for the unit will be determined by the Fisheries Biologist and will be consistent with settings used in the biologist's experience. To aid in collection of fish samples, electrofishing will take place during a period when brook flows permit for easy wadeability and visibility is not impaired by post-storm turbidity.

Each survey sample site will cover between 50-100 linear yards of brook. A net will be placed across the upstream section of the brook (unless an existing barrier such as a dam is already present) to prevent fish within the reach from escaping from the sample area ahead of the electrofishing unit. Sampling will include a single pass through each site with at least one person in addition to the biologist collecting fish. Sampling will begin at the downstream end of the section and will proceed upstream to the barrier. Typically, the NH Fish and Game biologist will progress upstream with additional team member(s) positioned slightly to the side and behind. The electrofishing wand is submerged in the water and slowly waved from side to side in the brook. An attempt will be made to collect all fish observed during the shocking using mesh scoop nets (all team members will have a net) to scoop fish into hand-held buckets. Fish will be retained in buckets until the end of the section sampling event.

At the end of each sampling event, total shock time for the reach will be recorded. Fish will then be identified to species and tallied. Salmonid species will be measured for total length (mm), except young-of-year fish will be tallied only. All fish will be released after survey results are recorded. Results will be entered on a field data sheet (Appendix H) printed on waterproof paper.

Appendix B: Water Sample Detection Limits and Sample Requirements

Table 1. Surface Water Analytes and Detection Limits

Laboratory

Analyte	Technical Project Quantification Limits	Analytical Methods	Keene City Laboratory Method Number	Analytical/ Achievable Method Detection Limits	Analytical/Achievable Laboratory Quantitation Limit
Escherichia coli	1 colony/100 ml	SM 9223	Quanti-Tray-2007	1 colony/ 100 ml	1 colony/100 ml
Ammonia NH3-N	0.2 mg/L	SM 4500-NH3 B SM 4500-NH3 C	NH3 - 2002	0.2 mg/L	0.2 mg/L
Nitrite-N02	0.1 mg/L	SM 4110B	Anions - 2002	0.1 mg/L	0.1 mg/L
Nitrate – N03	0.1 mg/L	SM 4110B	Anions - 2002	0.1 mg/L	0.1 mg/L
Total Phosphorus P	0.05 mg/L	EPA 365.3	N/A	0.05 mg/L	0.05 mg/L

Field

Temperature	0-60º C	VWR Field Conductivity Meter	N/A	N/A
Conductivity	0-2000 mS	VWR Field Conductivity Meter	N/A	N/A

Table 2. Sample Requirements

Analytical Parameter	**Collection Method**	**Sample Volume**	**Container Size and Type**	**Preservation Requirements**	**Max Holding time**
E. coli	Grab	500 mls	500 milliliter sterile plastic	Chilled to 4 ºC	6 hours
Ammonia-NH3-N	Grab	250 mls	1 Liter plastic or brown glass	Sulfuric Acid	28 days
Nitrite-NO2	Grab	20 mls	200 milliliter plastic	Chilled to 4 ºC	48 hours
Nitrate-NO3	Grab	20 mls	Same as nitrite	Chilled to 4 ºC	48 hours
Total Phosphorus	Grab	50 mls	250 milliliter plastic	Sulfuric Acid	28 days
Specific Conductance @ 25 ºC	Grab	50 mls	250 milliliter plastic	Chilled to 4 ºC	28 days

Appendix C. Sample Acceptance Policy

Sample Acceptance Policy: Applies to all reportable, routine or compliance samples received by the Keene City Lab. Non-routine, non-compliance samples are received on a case-by-case basis with lab staff approval.

Sample Source	Sample type	Preservation	Container type
Keene WWTP –	Grab samples - influent, effluent, primary effluent	Do not need to be refrigerated, but MUST be delivered within 10 minutes of collection.	pH and turbidity are collected in plastic containers. ***E. coli*** must be in STERILE bottle.
Keene WWTP -	Composite samples, influent, effluent, primary effluent	Refrigerated, or on ice during sampling. Effluent ammonia and phosphate samples are also preserved with sulfuric acid during sample compositing.	**Phosphate samples** are collected in amber glass bottles. **All other samples** are collected in Nalgene bottles.
Keene drinking water distribution system. Samples collected by Water/Sewer staff or WTF personnel	Grab samples	Samples are kept in an iced cooler after sampling and during transport to lab. They MUST be delivered within 4 hours of sampling. The temperature when received by the lab must be cooler than when it was sampled. Samples are not received on Fridays or after 100 on weekdays without prior approval.	**Bacteria samples** are collected in sterile whirl pack bags with sodium thiosulfate, except duplicates collected in 500 mL Nalgene bottle with thiosulfate. **Alkalinity samples** are collected in amber glass bottles. **Anion samples** are collected in small glass or plastic bottles.
Field samples collected by laboratory personnel	Grab or composite	Samples must be kept in iced coolers after collection and during transport to laboratory.	Sample bottles may be plastic or glass as required by the method. The bottles are preserved before being taken out of the lab.
Lead/copper samples collected by homeowners	Grab	No preservation until received at the laboratory.	Samples are collected in 1-liter Nalgene bottles.

All samples must be accompanied by a completed chain of custody sheet, or logged in on the WWTP daily sheet.

If any of the routine samples are not received in the expected condition, don't have enough volume for the analysis, are past the required holding time, are improperly labeled, or show other irregularities, the sampler and Laboratory Manager are notified. They then make a final determination on whether or not to proceed with the analysis, and a note is made on the sample sheet or chain of custody. These discussions are documented on either the sample sheet, chain of custody or the log in book.

Samples from other sites are accepted only with pre-approval of the Laboratory Manager.

Appendix D: Sample Analysis Methods

:

Keene City Laboratory

Method Number: Quanti-Tray-2007

Escherichia coli Using Quanti-Tray with 24 hour Colilert

Version 1
Number of pages, including title page: 5

SOP prepared by: Aaron Costa, Laboratory Technician

SOP approved by: Donna Hanscom, Laboratory Manager

Effective Date: May 17, 2007

E. coli Bacteria using Quanti-Tray 2000 with 24 hour Colilert

Method Reference: Standard Methods, 21st Edition, method 9223 B, page 9-72
Sample Type: Wastewater and Surface water
Method Detection Limit: One colony per 100 mL
Preservation: Store at <10°C
Holding Time: 6 hours from time of collection
Required Volume: 100 mL
Container Type: Sterilized plastic or glass
Special Notes: None

A. Overview

Wastewater and surface water samples are tested for the presence of E.coli. One packet of Colilert-24 is added to 100 mL of wastewater or surface water and the sample is then incubated at 35°C for 24 hours. A yellow color indicates the presence of coliform, and is tested for E. coli using a ultra-violet light. Blue-green fluorescence under UV light is E. coli positive.

B. Definitions

Aseptic means free from germs or bacteria.

C. Interferences

If you see a blue flash when adding the powder, a heavy chlorine residual may be present. If this is seen, consider the sample invalid and discontinue testing.

D. Safety

Pure bacteria cultures should be handled in accordance with Good Laboratory Practices.

E. Equipment and Supplies

100 milliliter sterile vessel
Quanti-Tray 2000 and Sealer
Incubator, 35°C
Ultra-violet light 6-watt, 365nm

F. Scope of Application

This method is used for wastewater and surface water.

G. Reagents

1. 24 hour Colilert Reagent, prepared by Idexx Laboratories.

2. Sterile water

   To sterilize water add deionized water from the RO system into (1) liter bottles and autoclave for 30-45 minutes. A sterility check must be done before the water can be used for testing.

3. IDEXX color comparator

4. Pure cultures of E. coli, Pseudomonas aerginosa, and Klebsiella pneumoniea

H. Procedure

1. Sterilize the rubberized Quanti-Tray by wrapping in foil and autoclaving for 20 minutes.

2. If the percent transmittance of the secondary effluent sample is less than 50 and the turbidity is greater than 10.0 ntu the sample will require a dilution. Base the dilution factor on the effluent quality.

3. Use only sterile, non buffered, oxidant-free water for dilutions.

4. Aseptically, pour 100 mL of sample into the 100 milliliter sterile vessel. The bottles are marked with a line at the 100 mL mark.

5. Aseptically, add one tube of 24 hour Colilert powder to the bottle. Cap and shake until dissolved.

6. Pour sample/reagent mixture into Quanti-Tray and seal in an IDEXX Quanti-Tray Sealer.

7. Place the sealed tray in an incubator at 34.5^{o}C to 35.5^{o}C for 24 hours.

8. Colilert-24 results are definitive at 24-28 hours. In addition, positives for E. coli observed before 24 hours and negatives observed after 28 hours are also valid.

9. At the end of 24 hours, remove the trays from the incubator. Using the black box and UV light, count the number of large and small wells positive for E.coli and refer to the MPN (Most Probable Number) table.

Appearance	**Result**
Less yellow than the comparator	Negative for total coliforms and E. coli
Yellow equal to or greater than the comparator	Positive for total coliforms
Yellow and fluorescence equal or greater than the comparator	Positive for E.coli

10. Record the results, time and date of incubation and time and date removed from the incubator.

11. Use the chart provided to quantify the results.

I. Quality Control

1. Blanks:
Analyze a blank with each run. Use 100 mL of sterile water as the sample.

2. Duplicates:
For every twenty samples, perform one duplicate analysis. If fewer than twenty samples are analyzed, perform one duplicate.

3. Positive Control:
Positive controls must be run before a new lot number of reagent may be used for samples, and then monthly thereafter. Perform a positive control using the pure cultures of E. coli, and Klebsiella.

4. Negative Control:
A negative control must be run before a new lot number of reagent is used for samples. Perform a negative control using pure culture of Pseudomonas aerginosa.

5. Sterility Check:
   Once each week, a spore ampoule must be autoclaved and tested to check the autoclave performance.

6. Analyst Comparison:
   Each month, all analysts approved for the Quanti- Tray analysis must perform parallel counts on a tray that contains E.coli positive wells.

J. Calculations

If dilutions are made, multiply the MPN value by the dilution factor.

K. Miscellaneous

L. Pollution Prevention:

If possible, chemicals are not purchased in larger quantities than will be used before their expiration dates.

M. Data Assessment:

If a blank is positive, the run is invalid.

N. Waste Management:

Autoclave all used Quanti-trays for 20 minutes then discard in trash.

O. References

IDEXX Colilert instructions, 2002 document number 06-01701-04

IDEXX Quanti-Tray/2000 MPN Table

\# Small Wells Positive

\# Large Wells Positive

[illegible]

IDEXX Quanti-Tray /2000 MPN Table

# Large Wells Positive	# Small Wells Positive																							
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	0.0	0.4	2.7	5.6	9.0	13.5	21.3	33.6	52.9	84.7	135.7	218.0	347.6	548.4	857.0	1311.0	2121.1	3181.1	4640.3	6449.3	8449.3	11270.0	14600.0	18600.0
1	0.5	2.7	5.9	9.6	13.6	21.11	32.5	50.6	76.0	118.1	177.2	268.2	413.8	631.4	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0
2	2.7	5.6	9.0	12.1	16.5	23.2	34.5	52.4	78.5	121.7	181.8	275.7	423.8	651.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0
3	5.6	9.0	12.1	16.5	20.6	34.7	56.0	83.6	127.8	198.0	298.1	441.2	652.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0
4	9.0	13.5	16.6	20.6	26.0	38.1	57.3	91.3	139.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0
5	13.5	21.3	23.2	34.7	38.1	57.3	91.3	139.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0
6	21.3	33.6	34.5	56.0	57.3	91.3	139.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0
7	33.6	52.9	52.4	83.6	91.3	139.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0
8	52.9	84.7	78.5	127.8	139.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0
9	84.7	135.7	121.7	198.0	215.0	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0
10	135.7	218.0	181.8	298.1	330.0	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0
11	218.0	347.6	275.7	441.2	490.1	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0
12	347.6	548.4	423.8	652.0	750.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0
13	548.4	857.0	651.0	1000.0	1000.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0
14	857.0	1311.0	1000.0	1500.0	1500.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0
15	1311.0	2121.1	1500.0	2300.0	2300.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0
16	2121.1	3181.1	2300.0	3500.0	3500.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0
17	3181.1	4640.3	3500.0	5000.0	5000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0
18	4640.3	6449.3	5000.0	7000.0	7000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0
19	6449.3	8449.3	7000.0	9000.0	9000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0
20	8449.3	11270.0	9000.0	12000.0	12000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0
21	11270.0	14600.0	12000.0	16000.0	16000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0
22	14600.0	18600.0	16000.0	20000.0	20000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0
23	18600.0	23600.0	20000.0	30000.0	30000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0
24	23600.0	30000.0	30000.0	40000.0	40000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0
25	30000.0	40000.0	40000.0	50000.0	50000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0
26	40000.0	50000.0	50000.0	60000.0	60000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0
27	50000.0	60000.0	60000.0	70000.0	70000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0
28	60000.0	70000.0	70000.0	80000.0	80000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0
29	70000.0	80000.0	80000.0	90000.0	90000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0
30	80000.0	90000.0	90000.0	100000.0	100000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0
31	90000.0	100000.0	100000.0	110000.0	110000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0
32	100000.0	110000.0	110000.0	120000.0	120000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0
33	110000.0	120000.0	120000.0	130000.0	130000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0
34	120000.0	130000.0	130000.0	140000.0	140000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0
35	130000.0	140000.0	140000.0	150000.0	150000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0
36	140000.0	150000.0	150000.0	160000.0	160000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0
37	150000.0	160000.0	160000.0	170000.0	170000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0
38	160000.0	170000.0	170000.0	180000.0	180000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0
39	170000.0	180000.0	180000.0	190000.0	190000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0
40	180000.0	190000.0	190000.0	200000.0	200000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0
41	190000.0	200000.0	200000.0	210000.0	210000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0
42	200000.0	210000.0	210000.0	220000.0	220000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0
43	210000.0	220000.0	220000.0	230000.0	230000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0
44	220000.0	230000.0	230000.0	240000.0	240000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0
45	230000.0	240000.0	240000.0	250000.0	250000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0	440000.0
46	240000.0	250000.0	250000.0	260000.0	260000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0	440000.0	450000.0
47	250000.0	260000.0	260000.0	270000.0	270000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0	440000.0	450000.0	460000.0
48	260000.0	270000.0	270000.0	280000.0	280000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0	440000.0	450000.0	460000.0	470000.0
49	270000.0	280000.0	280000.0	290000.0	290000.0	300000.0	310000.0	320000.0	330000.0	340000.0	350000.0	360000.0	370000.0	380000.0	390000.0	400000.0	410000.0	420000.0	430000.0	440000.0	450000.0	460000.0	470000.0	480000.0

SS-03202-03 2/15

Keene City Laboratory

Keene City Laboratory **Method Number NH3 - 2002**
Standard Methods: SM 4500-NH3 B
SM 4500-NH3 C

Ammonia Analysis

Revision Number: 1.1

Number of pages, including title page: 64

SOP prepared by: Donna Hanscom, Laboratory Manager

SOP approved by: Donna Hanscom, Laboratory Manager

Effective Date: June 25, 2002

Ammonia Analysis, Reported as N

Method Reference: Standard Methods, 18th Edition,
Preliminary Distillation page 4-77, 4500-NH_3 B
Nesslerization Method page 4-78, 4500-NH_3 C
Sample Type: Water or Wastewater
Method Detection Limit: 0.2 mg/L
Preservation: pH < 2 with sulfuric acid and 4°C
Holding Time: 28 days
Required Volume: 1000 mL
Container Type: Polyethylene or glass

A. Summary of Method

Samples at pH of 9.5 su are distilled into a boric acid solution to remove potential interferences. Ammonia is released as a gas, condensed, and absorbed into the acid solution. Nessler reagent is added to the distillate. It combines with ammonia in alkaline solution to form a yellowish-brown colloidal dispersion whose intensity of color is directly proportional to the amount of ammonia present.

B. Definitions- Reserved

C. Interferences

Glycine, urea, glutamic acid, cyanates and acetamide may hydrolyze in solution.
Glycine, hydrazine, and some amines will react with Nessler reagent to give the characteristic yellow color.
Some organic compounds: ketones, aldehydes alcohols, and some amines may cause a yellowish or greenish off-color or a turbidity after Nesslerization, even following distillation.

D. Safety

General laboratory safety procedures must be followed when performing this procedure. The analyst must have read and be familiar with all MSDS sheets for the all chemicals listed in the reagents section of this method. *This procedure uses compounds containing mercury* – *mercury can be harmful if inhaled, ingested, or absorbed through the skin*. Read and understand all pertinent MSDS sheets before using or preparing Nessler Reagent. When using concentrated acids, nitrile gloves and eye protection must be worn.

E. Equipment and Supplies

Ammonia distillation glassware
Various glass beakers and pipettes
Volumetric flasks
Heating mantle
Spectronic 20 Genesys Spectrophotometer

F. Scope and Application

This method may be used on drinking water, wastewater, groundwater, or surface water.

G. Reagents

1. Sodium tetraborate (0.025 M): 9.5 g of $Na_2B_40_7$-10 H_20 dissolved in 1000 mL of DI water

2. Borate buffer: Add 88 mL of 0.1 N NaOH solution to 500 mL of 0.025 M sodium tetraborate and dilute to 1000 mL.

3. 6 N NaOH: 240 g NaOH dissolved in 1000 mL of DI water.

4. Boric acid absorbing solution: Dissolve 20 g boric acid (H_3BO_3) in water and dilute to 1000 mL.

5. Stock ammonia standard: Dry approximately 4.5 g of anhydrous NH_4Cl in the 103°C oven for several hours. Dissolve 3.810g in DI water and dilute to 1000 mL. The value of this standard is 1000 mg/l NH_3-N.

6. Purchased ammonia standard: 100 ppm.

7. 10 N NaOH: Dissolve 400 g NaOH in 800 mL of water. Put on stirring plate and stir in hood. Allow to cool and dilute to 1000 mL with water.

8. Nessler Reagent: Dissolve 10 g HgI_2 and 7 g KI in a small quantity of DI and add this mixture slowly, with stirring, to a cool solution of 16 g NaOH dissolved in 50 mL DI. Dilute to 100 mL. Store in rubber-stoppered borosilicate glass bottle and out of sunlight.

H. Procedure

1. Steam out the distillation equipment as follows:
   a. Set up distillation apparatus as shown in diagram in the fume hood.

   b. Place tip of condenser below surface of 50 mL of DI water.

   c. Add 250 mL DI water to a 500 mL beaker. Record the pH, which must be less than 2 for samples that have been preserved.

Ammonia distillation set up.

d. Add 12.5 mL of borate buffer to the sample. Using pH meter, adjust pH to 9.5 (+/- 0.05) with NaOH or H_2SO_4 as needed. Add 4-5 boiling beads. Turn on heating mantle and distill 150 mL into the DI water .

e. Discard this steam out solution.

Sample Distillation:

1. Leave apparatus assembled after steaming out until just before starting sample distillation. Disconnect empty steamed out flask and add sample. Reconnect to distillation apparatus. Replace absorbing solution.

2. To 250 mL of non-chlorinated sample, add 12.5 mL of borate buffer. Adjust pH to 9.5 as in step H.1.d above.

3. Place tip of condenser below surface of 50 mL of boric acid absorbin solution.

4. Distill at a rate of 6 - 10 mL per minute. Collect at least 200 mL in the cup.

5. When distillation is complete, lower collected distillate free of contact with the condenser tube, unplug heating mantle, and continue to distill for 1 to 2 minutes.

6. Dilute distillate into 250 mL volumetric flask. Analyze distillate as described in the Colorimetric section below. If necessary, you can store the distillate in a clean Nalgene bottle in refrigerator until colorimetric analysis can be performed. Do not store any distilled sample longer than the undistilled sample's holding time.

Standard Preparation:

Make standards from 1000 ppm NH_4Cl stock solution as follows:

100 ppm intermediate stock solution: Dilute 5 mL of stock solution to 50 mL with DI H_2O in 50 mL volumetric flask.

Use this to make the following standards.

- 1.0 mg/L standard: Dilute 2.0 mL of 100 ppm stock solution to 200 mL.
- 2.0 mg/L standard: Dilute 2.0 mL of 100 ppm stock solution to 100 mL.
- 0.2 mg/L standard: Dilute 20.0 mL of 1.0 ppm standard to 100 mL.
- 0.5 mg/L standard: Dilute 25.0 mL of the 2.0 mg/L standard to 100 mL
- Blank: 25 mL of DI only

QC checks are made up from the 100 ppm QC stock as follows:

- 1.0 mg/L QC: Dilute 1.0 mL of the 100 ppm QC stock to 100 mL
- 0.5 mg/L QC: Dilute 1.0 mL of the 100 ppm QC stock to 200 mL.

Colorimetric Procedure.

a. Using 25 mL pipette or a graduated cylinder, measure 25 mL of all distilled samples, and each standard and blank into plastic cups.

b. Add 1 mL of Nessler Reagent, and wait 20-30 minutes for color development. If dilutions are required, make them BEFORE adding the Nessler Reagent.

c. Read on the Genesys 20 spec at wavelength of 425 nm. Record absorbances and calculate mg/L from the curve using linear regression. Multiply dilution factors as necessary.

I. Quality Control

1. Distill a minimum of 2 standards and one blank for every set of samples

2. If the distillation process for a given batch of samples takes more than one day, a blank and one standard (internal standard or ERA) must be distilled each day.

3. For every ten samples, distill one QC standard. Plot the results of the standard on the ammonia control chart. It must fall within the acceptable range and meet all control chart rules for the sample analysis to be considered valid.

4. For every twenty samples, perform one duplicate analysis. If less than twenty samples are analyzed, perform one duplicate.

5. For every twenty samples, perform one spike analysis. If less than twenty samples are analyzed, perform one spike.

6.

J. Calculations

Sample

Calculate mg/L phosphate by calculating the curve from the absorbance readings. Calculating a standard curve on the Casio FX-115S calculator as described in the appropriate section of the Instrumentation SOP Manual.

Adjust for any dilutions by multiplying the mg/L by the dilution factor.

Percent Spike Recovery

$$\frac{\text{(concentration of spike + sample)-(concentration of sample)}}{\text{Spike concentration}} \times 100$$

Duplicate Percent Difference

$$\frac{\text{(result)- (duplicate result)}}{\text{average of the two sample}} \times 100$$

QC Percent Recovery

$$\frac{\text{(QC result)}}{\text{(QC amount)}} \times 100$$

K. Miscellaneous- ReservePollution Prevention

If possible, do not purchase chemicals in larger quantities than will be used before their expiration dates. To reduce the amount of mercury waste produced, 25 mL of sample and 1 mL of Nessler Reagent is used in the colorimetric analysis instead of 50 mL of sample and 2 mL of reagent as described in Standard Methods.

L. Data Assessment

- Sample absorbance must be lower than the highest standard. If it is not, dilute a portion of the distilled sample, add Nessler Reagent, and read after 20-30 minutes. The diluted sample should fall within the middle 2/3 of the curve.
- When reporting below detection: Use the lowest standard run as the detection limit
- The distilled QC samples must fall within acceptable ranges and on the Laboratory's Control Charts. The Control Chart rules are described in Section the Quality Systems manual.
- If the sample is cloudy after adding Nessler reagent, contact the Lab Supervisor immediately.
- The correlation coefficient for the curve must be 0.995 or greater. If it is not, a new curve must be run before samples are read.
- If the WWTP samples do not fall into the following ranges, notify the Lab Supervisor at once:

	Influent	Primary Effluent	Effluent
June 1 – October 30	15-25 mg/L	25-30	< 2.0
November 1 – May 31	10-20 mg/L	15-25	< 5.0

Correction Action:

Reference the Quality Systems Manual at Keene City Laboratory.

Out of Control Data:

If the distilled QC sample does not meet the Control Chart Rules described in the Quality Systems Manual, mix the remainder of the distilled sample again, measure another 25 mL portion, add Nessler reagent, wait 30 minutes and read on the spec. If this sample still is not acceptable, all samples in the batch must be re-distilled and re-tested.

M. Waste Management

Because they contain mercury, no Nesslerized samples may be discharged into the lab sinks. All mercury is clearly marked "Hazardous Waste" and is stored in the hazardous waste storage cabinet. An authorized hazardous waste disposal company removes the waste twice a year.

N. References- Reserved

O. Other

- The intermediate stock is made up every week from a stock standard not older than 6 months.
- Upon a change in method or instrument type, a series of standards is run which reflects the detection limit of the instrument. New MDLs are calculated for each parameter. Record results, adjust detection limits if necessary.
- Dilute samples as necessary to ensure that all readings fall below the concentration of the high standard. Dilution is done after digestion and BEFORE color reagents are added. All sample readings must fall in the range of the low and high standards.

Keene City Laboratory

Keene City Laboratory Method Number: Anions-2002

Standard Method 4110B

Anions By Ion Chromatography

Revision Number: 3

Number of pages, including title page: 64

SOP prepared by: Aaron Costa, Laboratory Technician 2

SOP approved by: Donna Hanscom, Laboratory Manager

Effective Date: September 22, 2005

Anions by Ion Chromatography

Method Reference: Standard Methods, 19th Edition, method 4110B, page 4-1
Sample Type: Drinking Water
Method Detection Limit: See individual anion methods
Preservation: < 5°C
Holding Time: 48 hours for nitrate, nitrite, and phosphate
28 days for chloride and sulfate
Required Volume: 50 mL
Container Type: Plastic or Glass

A. Summary of Method

Anions are analyzed by Ion Chromatography with nitrogen gas carrier. Samples with a high turbidity are filtered through a 0.45-micron capsule filter. The DX-120 sends an analog signal to the Dionex chromeleon software, which uses linear regression to determine values in mg/L by measuring the area under the peak.

B. Definitions

C. Interferences

High levels of chloride can mask a nitrite signal because the two compounds elute so close together.

D. Safety- Reserved

E. Equipment and Supplies

- The Dionex DX 120 ion chromatograph
- Syringe with Luer-loc fitting
- 0.45 micron capsule filters
- AS40 Autosampler

F. Scope and Application

This method is used to analyze chloride, nitrite, nitrate, phosphate, and sulfate in drinking water and landfill ground and surface water samples. It may be used for non compliance wastewater samples.

G. Reagents

IC Eluent**:** weigh out 0.7632 g sodium carbonate and 0.0.5712 g sodium bicarbonate and dilute to 4 liters. Eluent may be kept for 1 month.

H. Procedure

Set up the DX-120 and Chromeleon software according to the Dionex 120 method. The instrument is calibrated with stock standards, and the calibration is checked with QC standards.

Make Anion standards as follows:

To make anion **stock standard** and **stock QC**, use chemicals dried for at least 4 hours at 104°C. Stock Standards may be kept for 2 weeks. Stock dry chemicals used for the calibration curve must be from a different dry chemical lot (preferably a different manufacturer) than the ones used for the QC.

Stock standard and stock QC are both made up as follows:

Chemical	Amount required, g	Final Volume	Concentration, ppm
NaCl	1.6485	500 mL	2000 chloride
$NaNO_2$	2.4629	500 mL	1000 nitrite
$NaNO_3$	3.0340	500 mL	1000 nitrate
KH_2PO_4	2.1969	500 mL	1000 phosphate
K_2SO_4	9.0705	500 mL	10,000 sulfate

Make the **daily intermediary stock standard**, dilute the stock standard 2 mL into 200 mL = Intermediary Standard with concentrations:

	Cl^-	NO2	NO3	PO4	SO4
2 mL into 200 mL	20	10	10	10	100

Make **Daily Calibration standards** with the daily intermediary standard as follows:

	Cl^-	NO2	NO3	PO4	SO4
1 mL into 100 mL = Standard 1	0.2	0.1	0.1	0.1	1.0
5 mL into 200 mL = Standard 2	0.5	0.25	0.25	0.25	2.5
5 mL into 100 mL = Standard 3	1.0	0.5	0.5	0.5	5.0
10 mL into 100 mL = Standard 4	2.0	1.0	1.0	1.0	10.0
15 mL into 100 mL = Standard 5	3.0	1.5	1.5	1.5	15.0
25 mL into 100 mL = Standard 6	5.0	2.5	2.5	2.5	

Make a **daily intermediary QC standard**, using the QC stock standard:

	Cl^-	NO2	NO3	PO4	SO4
5 mL into 200 mL	50	25	25	25	250

To make the **daily QC standards**, use the intermediary QC Standard

	Cl^-	NO2	NO3	PO4	SO4
5 mL into 100 mL =Anion QC 1	2.5	1.25	1.25	1.25	12.5
5 mL into 200 mL = Anion QC 2	1.25	0.625	0.625	0.625	6.25

Inject samples using the plastic syringe, through the front of the IC. Press the sample button, or start the autosampler.

After the sample has run, press the sample button and inject the next sample

I. Quality Control

For each batch of twenty or less samples, do a blank, a duplicate, and a spike. The spike should include every anion that is to be run with that batch.

A QC standard must be run every ten samples. QC standards must also start and end each run.

An RDL must be run for each anion unless the instrument was calibrated the same day. The RDL is the same concentration as the low standard (standard 1).

J. Calculations

Sample

None required unless dilutions were made before injection. If dilutions were made, multiply the mg/L concentration by the dilution made.

Spike Recovery

$$\frac{\text{(spike result, mg/l) - (sample result, mg/l)}}{\text{spike amount, mg/l}} \times 100$$

Duplicate Percent Difference

$$\frac{\text{(result)- (duplicate result)}}{\text{average of the two samples}} \times 100$$

QC Percent Recovery

$$\frac{\text{QC concentration from instrument}}{\text{QC concentration}} \times 100$$

K. Miscellaneous

L. Pollution Prevention

All standards are purchased in the smallest quantity possible.

M. Data Assessment

The spike recoveries must meet the ranges outlined in each anion's control chart.

Corrective Action

If a QC does not fall in acceptable range, all samples tested since the last acceptable QC sample must be re-run after an acceptable QC has been run.

Out of Control Data

If the QC does not pass all of the Control Chart rules as described in Section 6.7.3 of the Quality Systems Manual, all samples will be re-run.

N. Waste Management

All chemicals and samples used in this analysis may be discharged down the lab sinks.

O. References- Reserved

P. Other

With any change in method, column, instrument type, or analyst, a series of standards are run which reflects the detection limit of the instrument. New MDLs are calculated for each parameter. Record results, adjust detection limits if necessary.

Dilute samples as necessary to ensure that all readings fall below the concentration of the high standard. All sample readings must fall in the range of the low and high standards

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Keene City Laboratory

Keene City Laboratory Method Number: IC -2004

Ion Chromatography with the Dionex DX 120

Revision Number: 3

Number of pages, including title page: 64

SOP prepared by: Aaron Costa, Laboratory Technician 2

SOP approved by: Donna Hanscom, Laboratory Manager

Effective Date: September 16, 2005

Dionex DX-120 Ion Chromatograph

Overview:

The DX-120 is calibrated monthly; QC check samples are run each day the instrument is used. If the QC falls in the acceptable range, the calibration is still considered valid, and samples may be run. QC check samples are run after every 10 samples, and at the beginning and end of each run. For every 20 samples run an RDL (unless calibrated the same day), one sample must be spiked and the spiked sample must be duplicated.

A. Prepare Auto Sampler Vials

For analyses requiring low part per billion level contamination can occur. The AS-40 auto sampler caps and vials should be cleaned prior to use

1. The auto sampler vials and caps are kept in a DI water bath until time of use.
2. Remove vials and caps from water bath and triple DI rinse.
3. Allow to air dry on the counter before using.

B. Prepare the instrument

1. Open the tank of nitrogen to the left of the DX-120. It must be opened all the way by turning counterclockwise until it stops. The regulator pressure must maintain 10 psi.
2. The instrument is always left with the power On.
3. The peak net software controls the instrument remotely. Click on the peak net icon on desktop. Locate the Control panel.
4. Click the Icon labeled Eluent Pressure.
5. Click on the Icon labeled Pump and open flow control so no eluent is flowing through the suppressor. Prime the pump for about 30 seconds then close the flow control valve.
6. Once the pressure has risen to over 1000 psi, now click on the Icon labeled Suppressor.

The instrument will need 15 to 20 minutes for the baseline to stabilize. You can track the baseline by clicking on the blue icon labeled acquisition on. After the conductivity

has stabilized, the display should settle out at between 14.5-16.5, when the instrument is ready, click the blue icon acquisition off.

7. The DX 120 should be exercised weekly. This will keep the internal components such as the suppressor and columns hydrated. Allowing these components to dry out could cause irreversible damage. It is recommended to exercise the instrument for a minimum of 4 hours per week. This will increase the stability of the instrument. If the instrument is not exercised weekly, drifting may occur on longer or multi day runs. This drifting could cause the quality control samples to drift out of their acceptable range.

C. Prepare Dionex Chromeleon software and Autosampler

1. On the “Browser ”screen you will see an existing sample table, remember before changing the existing sample table to go to File/ Save As. This will now save your method and calibration.
2. Set up a table for that run. Information must be filled in for Vial, Sample Name, Method Name, Inj/Vial, sample type and dilutions if required. The last item in the sample table should be a shutdown command. This will shut down the pump when the run is finished.

3. Save the changes.

4. Setup the Auto sampler, with the vials in the same order as determined by the sample table.

5. Under “Batch” choose “ Batch Reporting “ then find the new sample table and click ready check

6. IF ready check was successful the click Start Batch

7. Then immediately hit the load/run button on the auto sampler

8. The batch will run completely and shutdown after the last sample.

9. The software will print out the sample as soon as the next sample has been injected.

10. The software is also programmed to automatically integrate the chloride and Nitrite peaks, so no manual integration is required.

D. Exporting Data

1. To export data to the City network you must be in the Browser. Under the Browser menu highlight the sequence to be exported. Under the File menu click the Export/Backup and then select Backup.

2. A destination box will appear. Select the desired destination, such as K drive/ Laboratory/ IC results/ 2005/ September 2005.

3. Select the appropriate folder and give the file a name, then click save.

4. This address will now be in the destination box.

5. Then in the Title box, type the name of the sequence to be exported. Ex: September 2005 091505

6. Then click Start. Backup finished 100% complete.

7. Then click OK. To free up space on the hard drive sequences exported can be deleted.

E. Restoring Data

1. Under the Browser menu, have the folder you want to restore data in highlighted.

2. Go to File and select Import/Restore and then select Restore.

3. Find the file under K Drive/Laboratory/IC Results

4. Click open and then OK

5. Restore finished, 100% complete. This will restore data back to its original form in the peak net software. All raw data, chromatograms and sample tables can be viewed.

Appendix E: Keene City Laboratory Chain-of-Custody and Sampling Report

Keene City Laboratory Chain of Custody and Sampling Report

Sample Number: _____ Date Received: _____

Sample Site: _____

Address: _____

Sample Taken From: _____

Sampling Method: _____Grab at _____(Time)

_____Time Composite From_____

To_____

(Date and Time)

_____Flow Composite From_____

To_____

(Date and Time)

Sample Quantity Collected: _____ Split Sample? _____

Condition of Sampling Site: _____

_____

Chain of Custody

Person Collecting Samples: _____ Date: _____ Time: _____

Transported to the Keene City Lab by: _____ Date: _____

Contract Lab: _____ Date Sent: _____

Method of Delivery: _____ Packaged By: _____

Parameters Sent: _____

BACK

Sample Number: _____

Parameter	**Results**	**Date of Analysis**	**Initials**	**Volume Collected**	**Method of Preservation**	**Preservation pH/temp**	**Container Type**
Temperature (^{o}C) (Field)							
Conductivity (Field)							
Specific Conductance @ 25 º C (Lab)							
Ammonia mg/L							
Nitrite mg/L							
Nitrate mg/l							
Phosphorus mg/L							
E. coli Colonies/ 100 mls							

Appendix F: Non-Routine Sample Log

Non-Routine Sample Log

Date	Sample Location	Log-In Time	Lab Number	Grab or Comp?	Preserved?	Initials

Appendix G Habitat Assessment Data Sheet

Beaver Brook Habitat Assessment Sheet

Ashuelot River tributary, Keene, Cheshire County, New Hampshire

Observers:_____ **Date:**_____ **Time:**_____ **Photo ID (if taken):**_____
Weather in past 24 hours: **GPS coordinates** (if GPS unit available):_____

Location of section (brief, detailed description that will help pinpoint the area):

Physical properties:
Section type (Circle one): Pool, Riffle, Run Depth at 1/4_____1/2____3/4_____
Length of section (in ft):_____ **Average width:**_____ **Maximum depth in section**_____
Velocity: Time a floating object to travel a known distance. **Trial 1**_____feet/sec **Trial 2**_____feet/sec
Avg = _____feet/sec
Stream channel modification (circle one): Natural, Modified
Circle modifications noted: Channelized/straightened, cement embankment, cement bottom, other
Describe briefly:

Estimated % Substrate type (total 100%):
_____silt/mud _____cobble (3-12") _____detritus
_____sand (<1/4") _____boulder (>12") _____artificial
_____gravel (1/4-3") _____bedrock

Fish cover. Circle all that are present and briefly describe:
Large woody debris on bottom, islands, large boulders, undercut banks, over-hanging vegetation, other
_____

If artificial substrate, indicate type if known (circle): concrete, rip-rap, metal, plastic, other:_____
Comments:_____

Riparian zone:
% Land use within 100 feet of both sides (facing upstream):

Left Side		**Right side**	
_____mature forest	_____industrial urban	_____mature forest	_____industrial urban
_____immature forest	_____suburban/residential/park	_____immature forest	_____suburban/residential/park
_____shrub/thicket	_____construction	_____shrub/thicket	_____construction
_____marsh/wetland	_____road	_____marsh/wetland	_____road
_____field/agricultural	_____other (describe):_____	_____field/agricultural	_____other:_____

Comments:

Estimated width of vegetative buffer on both sides:

Left	Right	
_____	_____	>100'
_____	_____	50-100'
_____	_____	10-50'
_____	_____	1-10'
_____	_____	None

Vegetation dominant species, if known:

Invasive species present, if known:

Outfalls:
Describe location of each outfall in the section. Include pipes, ditches, and any other drainage or discharge features: Landmarks or other description that will help to pinpoint location?

Any flow from outfall? Describe:

Circle all that apply: Turbid, clear, color, floatables (e.g., suds, etc.), oily sheen (if so, does it fragment when touched?), evidence of other pollutants_____
Dams or other obstruction to fish passage? Yes, No

Comments (continue on back if necessary):

Appendix H Beaver Brook Electrofishing Data Sheet

Beaver Brook Electrofishing Data Sheet

Date:_____ Weather:_____ # seconds:_____

Equipment settings:_____

# of dip nets:_____ Crew:_____

Comments:

Run	**Species**	**# of fish** (or Total Length [mm])	**Run**	**Species**	**# of fish** (or Total Length [mm])

Standard abbreviations for common New England fish species: TBH= Yellow Bullhead; BBH= Brown Bullhead; AE= American Eel; CWS= Common White Sucker; TD= tessellated Darter; CFS= Pumpkinseed; BG= Bluegill; SMB= Smallmouth Bass; LMB= Largemouth Bass; CS= Common Shiner; GS= Golden Shiner; YP= Yellow Perch; NRD= Northern Redbelly Dace; BND= Blacknose Dace; LND= Longnose Dace; ATS= Atlantic Salmon; BT= Brown Trout; EBT= Eastern Brook Trout; CC= Creek Chub; FF= Fall Fish

References

2002 QAPP for the Upper Ashuelot River TMDL Study
Peg Foss, New Hampshire Department of Environmental Services
July 17, 2002

Microbiological Methods for Monitoring the Environment, Water and Wastes
Environmental Monitoring and Support Laboratory, Office of Research and Development
United States Environmental Protection Agency
December 1978

Generic Quality Assurance Project Plan for Stream Morphology Data Collection
Sean Sweeney and Susan Simpson
Provan & Lorber, Inc.
June 17, 2003

Stream Sampling Manual
New Hampshire Fish and Game Department
January 1999

Utah Stream Team Manual
John Geiger and Nancy Mesner,
Utah State College of Natural resources
Utah State University Cooperative extension Service and Department of Geography and Earth Resources

Illicit Discharge and Detection Elimination: A Guidance Manual for Program Development and Technical Assessments
Robert Pitt, university of Alabama, and
Edward Brown and Deb Caraco, Center for Watershed Protection
October 2004

Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities
New England Interstate Water Pollution Control Commission
January 2003

Standard Operating Standard Operating Procedure for Bacterial Indicators Sample Collection, by Natalie Landry, NHDES

Volunteer River Assessment Program Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors
NHDES
April 2007

Ambient River Monitoring Program Standard Operating Procedures (SOP) Sampling, Custody, and Laboratory Login", Revision 3: April 20, 2006", NH Department of Environmental Services

"Ambient River monitoring Program Standard Operating Procedures (SOP) Specific Conductance, Revision 3: April 2005", NH Department of Environmental Services

VWR "Hand Held Conductivity Meter" manual.