

**NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER MONITORING AND STANDARDS ELEMENT
BUREAU OF FRESHWATER AND BIOLOGICAL MONITORING
P.O. Box 420; Mail Code 35-01
TRENTON, NEW JERSEY**

Quality Assurance/Quality Control Project Plan
Headwaters Index of Biotic Integrity (Raritan Region)
2019 Monitoring

Written By: _____ Date

Brian Henning, Project Officer
Bureau of Freshwater and Biological Monitoring
New Jersey Department of Environmental Protection

Approved By: _____ Date

Leslie McGeorge, Administrator
Bureau of Freshwater and Biological Monitoring
New Jersey Department of Environmental Protection

Approved By: _____ Date

Victor Poretti, Section Chief
Bureau of Freshwater and Biological Monitoring
New Jersey Department of Environmental Protection

Reviewed By: _____ Date

Leigh Lager, GIS Specialist 1
Bureau of Freshwater and Biological Monitoring
New Jersey Department of Environmental Protection

Reviewed By: _____ Date

Jack Pflaumer, Environmental Scientist 1
Bureau of Environmental Analysis Restoration and Standards
New Jersey Department of Environmental Protection

Approved By: _____ Date

Marc Ferko, Quality Assurance Officer
Office of Quality Assurance
New Jersey Department of Environmental Protection

Table of Contents

- 1.0 Project Name**
- 2.0 Requesting Agency**
- 3.0 Date of Project**
- 4.0 Project Fiscal Information**
- 5.0 Project Officer**
- 6.0 Quality Assurance Officer**
- 7.0 Special Training Needs/Certification**
- 8.0 Project Description/Objective**
- 9.0 Network Design/Site Selection**
- 10.0 Sampling Procedures**
- 11.0 Field Measurements/QAQC**
- 12.0 Fish Identification/QAQC**
- 13.0 Data Analysis:**
- 14.0 Time Line – Schedule of Tasks:**
- 15.0 Resource Needs**
- 16.0 Data Storage and Distribution:**
- 17.0 Data Reporting**
- 18.0 Audits**
- 19.0 Corrective Actions**
- 20.0 Literature Cited**
- 21.0 2019 Final Site Selection (as requested by OQA):**

Appendix A. HIBI Geographic Range

Appendix B. Water Quality Meter Calibration Procedures Appendix C. Data Management Tables

Table 1. Monitoring Locations

Table 2. Sample Types

Table 3. Partner Information

Table 4. Field Parameters

Table 5. Habitat

Table 6. Habitat metrics

Table 7. Individual index metrics

Table 8. Overall metrics

Table 9. Data Inventory Supplement

Table 10. Data Management Supplement

1.0 Project Name: Headwaters Index of Biotic Integrity 2019 Monitoring

2.0 Requesting Agency: NJDEP Water Monitoring and Standards

3.0 Date of Project: 5/2019 - 10/2019

4.0 Project Fiscal Information: Job Number 35950000, Activity Code V4DT

5.0 Project Officer: Brian Henning, Research Scientist I, BFBM

6.0 Quality Assurance Office: Marc Ferko, Office of Quality Assurance

7.0 Special Training Needs/Certification

Assistants to the project will be trained in the operation and use of all sampling equipment including the proper safety and handling procedures for electroshocking equipment. The training will entail calibration methods, deployment techniques and data retrieval from the equipment. The Project Officer will be responsible for any necessary training.

BFBM is certified by the Office of Quality Assurance (certified lab ID # 11896) for all parameters to be measured.

8.0 Project Description/ Objective:

The objective of the Headwaters IBI (HIBI) monitoring program is to assess stream condition and water quality in headwater streams of the State. The HIBI monitoring program provides a rapid, cost effective assessment of the water quality and condition of New Jersey's high gradient headwater streams (see Appendix A for map of high gradient headwater monitoring area) with drainage areas less than 4 mi². The HIBI complements the established northern Fish IBI (FIBI) program that evaluates streams with drainages greater than 4 mi². The HIBI is a multi-metric index that assesses the overall condition of a headwater stream based on the biological assemblage (fish, crayfish, and amphibians) present within and along a stream. The HIBI was developed to assess aquatic life use in NJ waters as mandated under the Federal Clean Water Act (CWA) and the data collected from this monitoring program is intended for use by the Department's Division of Water Monitoring and Standards – Bureau of Environmental Analysis, Restoration, and Standards (BEARS) in their biennial report to the USEPA entitled, "New Jersey Integrated Water Quality and Monitoring and Assessment Report." The Integrated Report consists of the 303 (d) List of Water Quality Limited Waters ("303 (d) Report") and the 305 (b) The Integrated List of Waters Report ("305 (b) Report") and provides the status of water quality and designated uses for New Jersey waterbodies. The data collected is also to inform Surface Water Quality Standards (SWQS), N.J.A.C. 7:9B (NJDEP 1996), stream classifications, (e.g. Trout Production), designated uses and anti-degradation categories (e.g., Category 1) for the State's surface water and to inform the public of the quality of the State's waters. NJ Threatened and Endangered Species are

reported to the NJ Division of Fish & Wildlife Endangered and Nongame Species Program when encountered.

Samples will also be collected at HIBI sites designated in this QAPP for the Biological Nutrient Correlation Project. Sample collection will take place during a HIBI sampling visit or a reconnaissance visit no more than three weeks beforehand. Total Phosphorus and Total Nitrogen (calculated) samples will be collected. Project description and other details are defined in the QAPP for the Biological Nutrient Correlation Project 2017-2019.

9.0 Network Design/ Site Selection

In 2019, the Bureau of Freshwater and Biological Monitoring's rotating basin schedule focuses monitoring in the Raritan region (Figure 1). A total of 30 regional fixed monitoring locations will be sampled in the Raritan region (Figure 1). The data from fixed sites is used to assess long term trends. Starting in 2017, the FIBI and HIBI programs made an effort to select new sites or relocate old fixed sites to ensure spatial coverage within each rotating basin. The goal is to have a representative fish site (FIBI or HIBI) at the pour point, or as close as conditions and site access permit, of as many hydrologic units (HUC-14) as possible. This site selection process aligns with the NJ water quality assessment process for the Integrated Report which is based on HUC-14 assessment units. In addition, 4 sentinel sites will be sampled to monitor reference conditions, variability through time, the effects of climate change, and evaluate trends in NJ headwater streams (Table 1). Sentinel sites were selected based on the following criteria: 1) previous sampling must indicate at least three sensitive taxa; 2) designated by NJDEP Surface Water Quality Standards as FW1-TP waters (nondegradation waters) or Category One (C1) waters with trout production status; and 3) the percent Urban Land Cover within the stream's drainage area must not exceed 10%, or are U.S. EPA's Regional Monitoring Network sites to detect climate change-related trends at sites with low anthropogenic disturbance and are protected from future development.

Exact site locations are initially determined via the Global Positioning System (GPS) using a Trimble unit and the appropriate correction sources utilized by NJDEP. All positions are logged into the Geographic Information System (GIS). Hand-held GPS units, either Garmin model "Oregon 450", Garmin nuvi 2797, or Trimble "Geo XT", will be used to confirm correct locations for this sampling.

2019 Headwaters IBI sites

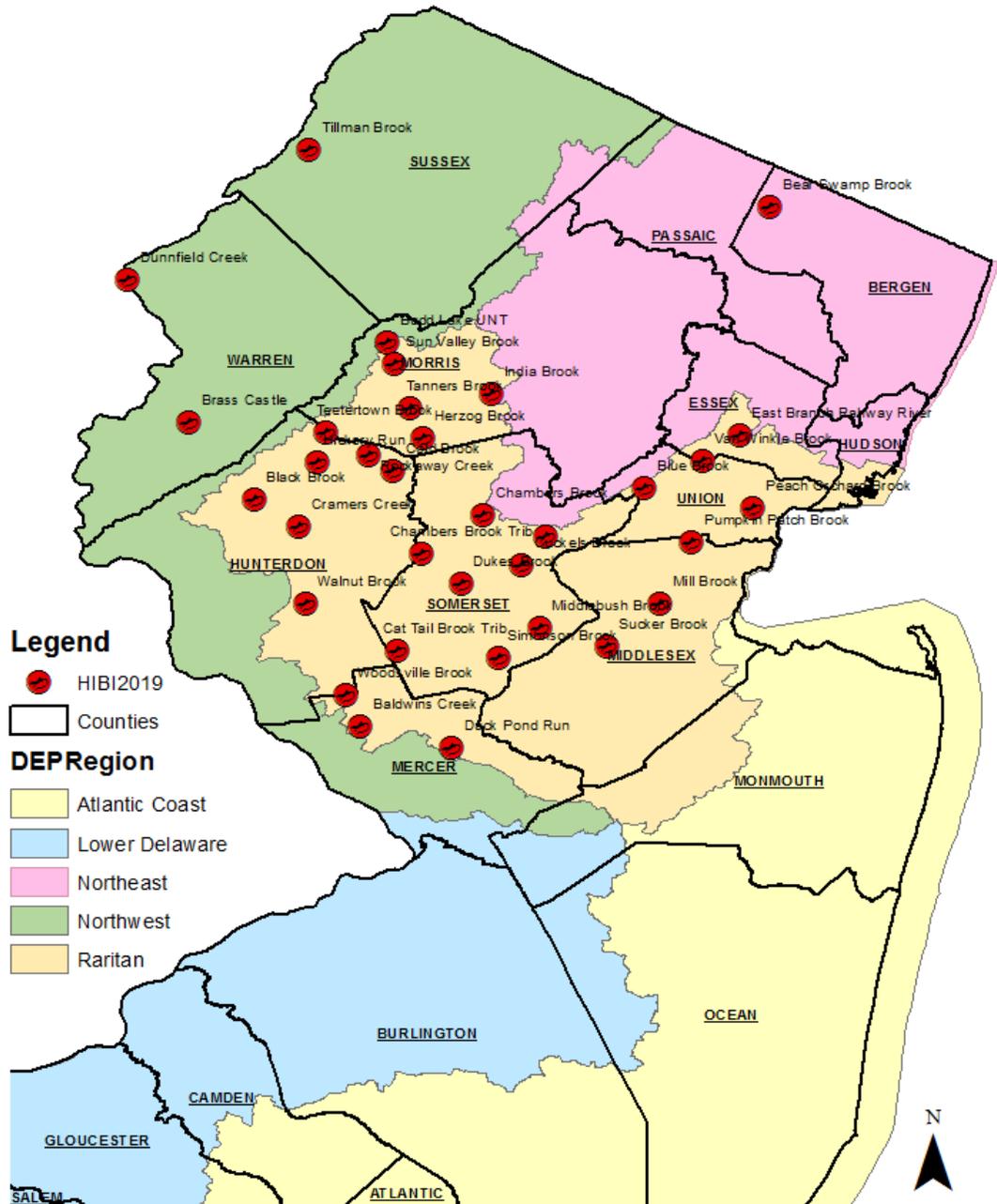


Figure 1. Map of 2019 HIBI monitoring locations.

Table 1. 2019 Headwaters IBI monitoring locations.

Station ID	Waterbody/Location	Latitude-dd	Longitude-dd	County	Municipality	Network
FIBI403	Budd Lake UNT	40.88213	-74.75851	Morris	Mount Olive	Fixed
FIBI404	Blue Brook	40.67504	-74.39417	Union	Berkeley Heights	Fixed
FIBI423	Duck Pond Run	40.30624	-74.66779	Mercer	West Windsor	Fixed
FIBI460	Sun Valley Brook	40.85137	-74.74815	Morris	Mount Olive	Fixed
FIBI504	East Branch Rahway River	40.75120	-74.25901	Essex	South Orange	Fixed
FIBI510	Chambers Brook	40.63690	-74.62260	Somerset	Bridgewater	Fixed
FIBI514	Peach Orchard Brook	40.64760	-74.24120	Union	Linden City	Fixed
FIBI515	Pumpkin Patch Brook	40.59860	-74.32810	Middlesex	Woodbridge	Fixed
FIBI526	Teetertown Brook	40.75430	-74.84559	Hunterdon	Lebanon	Fixed
FIBI531	Herzog Brook	40.74630	-74.70790	Morris	Chester	Fixed
FIBI532	Rockaway Creek	40.72290	-74.78530	Hunterdon	Tewksbury	Fixed
FIBI533	Walnut Brook	40.51148	-74.87405	Hunterdon	Raritan	Fixed
FIBI535	Cat Tail Brook Trib	40.44461	-74.74477	Somerset	Hillsborough	Fixed
FIBI536	Simonson Brook	40.43531	-74.60029	Somerset	Franklin	Fixed
FIBI537	India Brook	40.80980	-74.61090	Morris	Randolph	Fixed
FIBI539	Dock Watch Hollow Brook	40.60597	-74.53514	Somerset	Warren	Fixed
FIBI540	Mill Brook	40.51128	-74.37197	Middlesex	Edison	Fixed
FIBI541	Woodsville Brook	40.38267	-74.81796	Mercer	Hopewell	Fixed
FIBI580	Baldwins Creek	40.33830	-74.79700	Mercer	Hopewell	Fixed
FIBI581	Sucker Brook	40.45170	-74.44800	Middlesex	Milltown Boro	Fixed
FIBI582	Middlebush Brook	40.47790	-74.54310	Somerset	Franklin	Fixed
FIBI583	Cuckels Brook	40.56690	-74.56860	Somerset	Bridgewater	Fixed
FIBI584	Hickory Run	40.71270	-74.85890	Hunterdon	Lebanon	Fixed
FIBI585	Tanners Brook	40.78830	-74.72580	Morris	Chester	Fixed
FIBI586	Van Winkle Brook	40.71450	-74.31240	Union	Springfield	Fixed
FIBI587	Cold Brook	40.70070	-74.75020	Hunterdon	Tewksbury	Fixed
FIBI588	Dukes Brook	40.53910	-74.65460	Somerset	Hillsborough	Fixed
FIBI589	Black Brook	40.66020	-74.94810	Hunterdon	Union	Fixed
FIBI590	Cramers Creek	40.62090	-74.88360	Hunterdon	Clinton	Fixed
FIBI591	Chambers Brook Trib	40.58330	-74.70960	Somerset	Branchburg	Fixed
FIBI407	Bear Swamp Brook	41.07381	-74.21567	Bergen	Mahwah	Sentinel
FIBI421a	Dunnfield Creek	40.97149	-75.12672	Warren	Hardwick	Sentinel
FIBI462	Tillman Brook	41.15611	-74.86989	Sussex	Walpack	Sentinel
FIBI502	Brass Castle	40.76846	-75.03983	Warren	Washington	Sentinel

Site list may change due to site conditions and access (Final site list will be amended in the Addendum after the field season).

10.0 Sampling Methods

The Headwaters IBI sampling will take place between May 1 and September 31, 2019. All sampling is conducted during daylight hours between 0900 and 1600.

Electrofishing - A stream reach of 150 m is sampled using one or two backpack electrofishing units with a crew of two to five individuals. Electrofishing is conducted in an upstream manner in which the operator systematically samples all available habitats. Block nets are placed at the end of the reach to prevent fish from escaping upstream of the sampled area. All stunned fish, crayfish, frogs and salamanders are collected by the crew using dip nets and placed into live wells for later identification. All biota sampled by electrofishing are identified to species and enumerated. All fish are examined for anomalies or DELTs (DELT-Deformities, eroded fins, lesions or tumors), and the total length (TL; mm) of sport fish are measured and recorded on field data sheet. Any fish, crayfish or amphibian not readily identified in the field (except for NJ listed threatened or endangered species) or collected for voucher will be preserved in 10% formalin in a reusable 1 L high-density polyethylene bottle for later identification in the laboratory.

Area Constrained Surveys – An area of 90 m² (2 transects measuring 15 x 1 m area in the water and a 15 x 2 m area along the shore) is sampled by area constrained survey (ACS) by a crew of two individuals. All available cover (rocks, logs, debris) within the 90m² area greater than 15 inches² were turned over by hand and all crayfish, salamanders and frogs were captured with the aid of dip nets. All objects turned in the survey are returned to their original position to reduce habitat disturbance. The two transects of the ACS are conducted one on each bank, targeting the best available and diverse habitats. If the 30m² search area on shore contained insufficient moveable cover, then the search area was moved onto the adjacent floodplain. Taxa observed that escaped catchment are recorded and identified to the lowest taxonomic level based on observed characters. All biota sampled by ACS are identified to species and enumerated. The life stage (larval or adult) of each amphibian sampled is recorded. Larval specimens not readily identified in the field will be preserved in 10% formalin in a reusable 1 L high-density polyethylene bottle for later identification in the laboratory using taxonomic keys (Altig, 1970; Petranka, 1998). Photo vouchers will be taken for all New Jersey State listed threatened (e.g. Eastern mud salamander *Pseudotriton montanus montanus* and longtail salamander *Eurycea longicauda longicauda*) and endangered species (e.g. Blue-spotted salamander *Ambystoma laterale*). Photo vouchers will consist of several photos for each specimen highlighting the distinguishing characteristics of each species so that positive identification can be made without sacrificing the animal. Each photo voucher will contain site information (e.g. waterbody name, date) in the picture along with the animal and be reported to the NJ Division of Fish Wildlife Endangered and Nongame Species Program when encountered. Animals will be released in close proximity to the object or habitat from which it was captured (e.g. rock, log, debris) so that the animal may return to the underside of an object on its own.

Field Precautions for aquatic invasive species - To prevent the potential spread of nuisance or invasive organisms such as *Didymosphenia* sp. from stream to stream, all nets, waders, etc. will be decontaminated in the field between sites by cleaning with a

commercial disinfectant and rinsing with tap water. Also, the use of felt-soled waders will be avoided.

11.0 Field Measurements

Dissolved oxygen (DO), pH, water temperature, and specific conductivity will be measured in-field at each site by biomonitoring staff, concurrent with faunal sampling, in accordance with N.J.A.C. 7:18 *Regulations Governing the Certification of Laboratories and Environmental Measures* (NJDEP, 2003), Subchapter 8, Analyze-Immediately Environmental Measurements, and NJDEP's *Field Sampling Procedures Manual* (NJDEP, 2005). These physical/chemical parameters will be taken *in situ*, mid-depth, in a free-flowing area of the stream. BFBM is certified by the Office of Quality Assurance for each parameter sampled (Certified Lab ID # 11896). Water temperature, pH, specific conductance, and dissolved oxygen are measured using a Hydrolab MS5. The Hydrolab MS5 is a multi-parameter water quality system that combines temperature, pH, conductance, and luminescent dissolved oxygen (LDO) probes into one meter. The pH, specific conductance, and dissolved oxygen probes will be calibrated on a weekly basis per the manufacturer recommendations (Appendix B).

At the time of sampling, visual based habitat assessments will be performed at each site using the format given in the Rapid Bioassessment Protocols (Barbour et al, 1999) for high gradient streams. A number of qualitative measurements will be made based on visual observation including: substrate composition, weather conditions, water clarity, and presence of aquatic vegetation. Additionally, grab samples for Total Phosphorus, Nitrite-Nitrate, and Total Kjeldahl will be collected mid-depth, mid-stream, during biological sample collection or during reconnaissance visits up to three weeks prior to sampling. If collected at time of biological sampling, nutrients will be collected prior to sampling to avoid disturbance of the substrate (See Biological Nutrient Correlation QAPP (BFBM, 2019).

Dissolved oxygen – Dissolved Oxygen is measured at each sampling location at mid depth in the thalweg of the channel in flowing water using the Hydrolab MS5 Water Quality Monitoring System. The meter and probe will be maintained and calibrated in accordance with the Operating Manual (February 2006 Edition 3, HACH Environmental, Loveland, CO). The meter is barometrically compensated and checked at each sampling site. Weekly Winkler titrations will be performed to calibrate the dissolved oxygen probe. All titrations and field DO measurements are recorded in the Headwaters IBI Field Log Book.

pH- The pH is measured at each sampling location at mid depth in the thalweg of the channel in flowing water using the Hydrolab MS5 Water Quality Monitoring System. The meter and probe will be maintained and calibrated in accordance with the Operating Manual (February 2006 Edition 3, HACH Environmental, Loveland, CO). The pH probe will be calibrated prior to each sampling event with certified pH buffers for the expected range of pH at the sampling location (e.g. pH buffers 4.0 and 7.0 for acidic streams and 7.0 and 10.0 for alkaline streams). After three hours of continuous use, the pH of the certified buffer will

be checked. All pH calibration readings and field pH measurements are recorded in the Headwaters IBI Field Log Book.

Specific Conductance- The specific conductance is measured at each sampling location at mid depth in the thalweg of the channel in flowing water using the Hydrolab MS5 Water Quality Monitoring System. The meter and probe will be maintained and calibrated in accordance with the Operating Manual (February 2006 Edition 3, HACH Environmental, Loveland, CO). The specific conductance probe will be calibrated prior to each sampling event with certified conductivity standards (1800 $\mu\text{mhos/cm}$). All specific conductance calibration readings and field specific conductance measurements are recorded in the Headwaters IBI Field Log Book.

Water Temperature- The water temperature is measured at each sampling location at mid depth in the thalweg of the channel in flowing water using the Hydrolab MS5 Water Quality Monitoring System. The meter and probe will be maintained and calibrated in accordance with the Operating Manual (February 2006 Edition 3, HACH Environmental, Loveland, CO). The temperature readings of the Hydrolab Quanta Water Quality Monitoring System will be tested against a NIST certified thermometer to ensure accuracy. All temperature checks and field water temperature measurements are recorded in the Headwaters IBI Field Log Book.

Canopy Cover- The canopy cover of the stream is measured at 50 m intervals from the starting location to the end point of sampling (0 m, 50 m, 100 m and 150 m) during every sampling event. The canopy cover will be estimated using a convex spherical crown densitometer at breast height from the middle of the stream channel.

Habitat Assessment – Headwater habitat will be assessed at every site visited. Rapid habitat assessments were performed using EPA's Rapid Habitat Assessment Form (Barbour et al, 1999), including the following measures: epifaunal substrate, embeddedness, velocity/depth regimes, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, bank vegetative protection, and riparian vegetative zone width.

Nutrients: Phosphorus and nitrogen samples are being collected at IBI sites as part of the ongoing Biological Nutrient Correlation Project. See Biological Nutrient Correlation QAPP for more information.

12.0 Identification of Stream Fauna\ QAQC

References used for the identification of species collected in HIBI sampling.

Altig, R. (1970). A key to the tadpoles of the continental United States and Canada. *Herpetologica*, 180-207.

- Conant, R., and J. T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. Houghton Mifflin, Boston.
- Cooper, E.L. 1983. Fishes of Pennsylvania and the Northeastern United States. Pennsylvania State University Press, University Park, Pennsylvania, 243 pp.
- Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., hayek, L.-A., Foster, M.S., 1994. Measuring and Monitoring Biological Diversity. Standard Methods for Amphibians. Smithsonian Institution Press, Washington.
- Peckarsky, B. L., P. R. Fraissinet, M. A. Penton, and D. J. Conklin, Jr. 1990. Freshwater macroinvertebrates of northeastern North America. Cornell University Press, Ithaca, New York, USA.
- Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press.
- Schwartz, V. and D.M. Golden. 2002. Field Guide to Reptiles and Amphibians of New Jersey. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program.
- Smith, C. L. 1985. The inland fishes of New York State. N.Y.S. Dept. of Environmental Conservation, Albany, NY.
- Stranko, S., S. Smith, L. Erb, and D. Limpert. 2010. A Key to the Reptiles and Amphibians of Maryland. Maryland Department of Natural Resources.
- Swecker, C. D., Jones, T., & Kilian, J. 2008. Photographic Key to the Crayfishes of Maryland. Marshall University.

13.0 Data Analysis

Fish sampling results (e.g. counts, lengths, DELTs, habitat) will be entered in a Microsoft Access database and overall Headwaters IBI score will be calculated. Data entered and calculated HIBI scores will be independently reviewed and scored for consistency and accuracy by the project officer and another designated BFBM staff member. An additional third reviewer will be used should any discrepancies occur in the data entered or calculated scores.

14.0 Project Timeline

The Headwaters IBI sampling takes place between May and October. This sampling schedule reduces the occurrence of spawning migratory fish (e.g. white sucker *Catostomus commersonii*) in headwater streams and presumes a resident fish assemblage. In addition, the sampling timeline provides stable flows that permit safe wading conditions and increases electrofishing sampling efficiency. Sampling will not be conducted in trout production waters after September 1 to prevent disturbance of spawning trout and destruction of redds (egg nests).

15.0 Resource Needs: BFBM will need two hourly staff in addition to available full-time staff to complete this project.

16.0 Data Storage and Distribution

Sampling results will be stored locally in a Microsoft Access database. Following the QA/QC verification of fauna identifications, data will be entered into New Jersey's Water Quality Data Exchange (WQDE) and will be accessible through the USEPA, USGS and National Water Monitoring Council's Water Quality Portal by June of the following year it is verified. All raw data records shall be maintained for a period of no less than five years.

17.0 Data Reporting

All habitat assessment data, physical/chemical analysis, and site observations will be recorded on the BFBM's Biological Field Observations and Data Sheet, and also recorded electronically in a Microsoft Access database.

All fauna identifications will be recorded on the BFBM's Data Sheet and entered into a Microsoft Access database. Habitat assessment data, taxonomic data and counts, and metric and index scores will also be transferred into NJDEP's Water Quality Data Exchange (WQDE) and will be accessible through the USEPA, USGS and National Water Monitoring Council's Water Quality Portal by June of the following year it is verified.

A data summary table, including index scores and ratings, will be posted on the BFBM website (www.state.nj.us/dep/wms/bfbm) after completion of all sample analyses for the Water Region and data review within one year from the date of sampling.

A summary report will be issued for each site and will contain at a minimum: taxa counts, field chemistry results, index score and assessment of biological condition ratings, and habitat assessment score and rating. Information on potential stressors for sites with poor or very poor ratings that are deemed non-attaining for Aquatic Life Use will also be included as available.

18.0 Audits

The Office of Quality Assurance will be notified prior to performing any sampling activity to allow the Office of Quality Assurance to conduct an audit.

19.0 Corrective Actions

The Project Officer will be responsible for the oversight of all activities relating to this project. The Project Officer will assess field collection functions and make corrections when necessary to maintain the data accuracy as defined in this plan. If any changes or modifications are made to this plan regarding data collection, as it relates to the objectives(s) and data accuracy required in this project, all original signees of the QAPP will be notified.

20.0 Literature Cited

- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. "Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition." EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.
- Bovee, K.D., and R.T. Milhous. 1978 Hydraulic simulation in instream flow studies: theory and techniques. U.S. Fish and Wildlife Service FWS-OBS-78/33. (Instream Flow Paper 5).
- Keller, D.H., R.J. Horwitz, A.M. Kreit, and P.F Overbeck. 2012. Development of Bioassessment Criteria for Headwater Streams, Phase III. The Academy of Natural Sciences of Drexel University. Philadelphia, PA.
- NJDEP. 1996. Regulations governing the certification of laboratories and environmental measurements. N.J.A.C. 7:18.

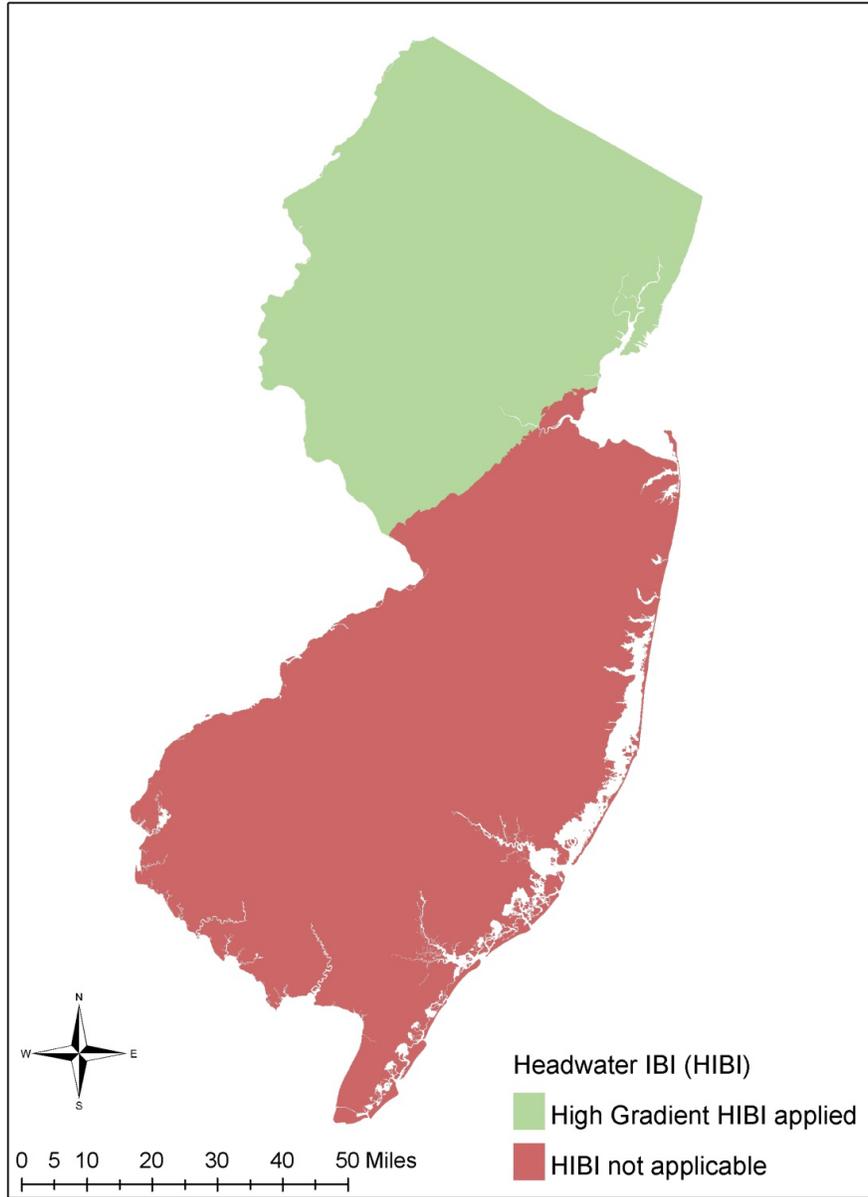
ADDENDUM

21.0 2019 Final Site Selection (as requested by OQA):

Station ID	Waterbody/Location	Latitude-dd	Longitude-dd	County	Municipality	Network
FIBI403	Budd Lake UNT	40.88213	-74.75851	Morris	Mount Olive	Fixed
FIBI404	Blue Brook	40.67504	-74.39417	Union	Berkeley Heights	Fixed
FIBI460	Sun Valley Brook	40.85137	-74.74815	Morris	Mount Olive	Fixed
FIBI514	Peach Orchard Brook	40.64760	-74.24120	Union	Linden City	Fixed
FIBI515	Pumpkin Patch Brook	40.59860	-74.32810	Middlesex	Woodbridge	Fixed
FIBI531	Herzog Brook	40.74630	-74.70790	Morris	Chester	Fixed
FIBI532	Rockaway Creek	40.72290	-74.78530	Hunterdon	Tewksbury	Fixed
FIBI536	Simonson Brook	40.43531	-74.60029	Somerset	Franklin	Fixed
FIBI539	Dock Watch Hollow Brook	40.60597	-74.53514	Somerset	Warren	Fixed
FIBI541	Woodsville Brook	40.38267	-74.81796	Mercer	Hopewell	Fixed
FIBI580	Baldwins Creek	40.33830	-74.79700	Mercer	Hopewell	Fixed
FIBI583	Cuckels Brook	40.56690	-74.56860	Somerset	Bridgewater	Fixed
FIBI584	Hickory Run	40.71270	-74.85890	Hunterdon	Lebanon	Fixed
FIBI587	Cold Brook	40.70070	-74.75020	Hunterdon	Tewksbury	Fixed
FIBI589	Black Brook	40.66020	-74.94810	Hunterdon	Union	Fixed
FIBI590	Cramers Creek	40.62090	-74.88360	Hunterdon	Clinton	Fixed
FIBI591	Chambers Brook Trib	40.58330	-74.70960	Somerset	Branchburg	Fixed
FIBI462	Tillman Brook	41.15611	-74.86989	Sussex	Walpack	Sentinel

APPENDIX A

New Jersey Headwater IBI Monitoring



APPENDIX B Water Quality Meter Calibration Procedures

HYDROLAB MS5 Datasonde

Things to Remember and Maintenance

Things to Remember

1. Maintenance of all probes must be performed at least monthly.
2. As specified by NJDEP OQA, Hydrolab MS5 must be calibrated weekly and checked daily. Results of lab/field calibrations and checks must be recorded in field notebook with proper units.
3. All water and standards used for rinse or LDO checks must be room temp.
4. Always rinse 3X with room temp DI after each standard.
5. ALWAYS pour fresh standards into corresponding "rinse" container after use in calibration/check.
6. Calibrate specific conductivity before any other parameters. All probes and calibration cup must be dried with Kimwipes so there is NO residual water as indicated in the "*Weekly Calibration Guide.*"
7. If there is significant difference from the standard when checking, record extra readings to ensure stabilization.
8. When storing sonde, fill calibration cup with appx 15mL of pH 4 buffer or tap water.
9. LDO must be calibrated with site-specific barometric pressure and checked using the air-saturated water method.

Monthly Maintenance

- Record Date and Type of Maintenance in the Field Notebook
- Invert the sonde vertically and secure in a stable lab stand.
- Gently clean probes with Simple Green and toothbrush then rinse thoroughly.
- For integrated pH probe, cover pH bulb with thumb and use flathead screwdriver to carefully unscrew the Teflon junction cap.
- For standard pH probe, hold the base of reference probe and unscrew Teflon junction cap.
- Empty contents into sink, shaking or use q-tip end, and flush with fresh pH reference solution (AgCl).
- Flush pH tube (use syringe for integrated probe) with AgCl. Add two KCl crystals and refill with AgCl to prevent introduction of air bubbles.
- Teflon junction cap should be replaced annually.
- When replacing integrated Teflon junction, plastic will cross thread easily so begin by hand then tighten with screwdriver to top of probe.
- LDO probe maintenance consists of unscrewing the cap by hand and blotting any moisture inside with Kimwipes.
- LDO cap should be replaced annually.

HYDROLAB MS5 Datasonde Daily Calibration Guide

Calibration Prep

1. Connect sonde to computer by lining up dimple on probe and dot on plug then "burp" the plug to ensure a proper fit. Sonde will audibly "beep" when connected.
2. Open HYDRAS 3 LT on desktop and sonde will beep again.
3. Once sonde appears (COM1), double click to initialize the sonde. If the sonde does not appear in the list, click "Re-Scan for Sondes." Full initialization takes appx 30 seconds and during this process you should see a blue progress bar at the bottom of the screen.
4. **THIS STEP DESCRIBES INITIAL SETTINGS AND SHOULD BE SET FROM PREVIOUS USE.**
In "System" tab, click on "Level 3", then enter the password "Hydrolab." In "Parameter Setup", click the "pH" tab and "Cal Points" field should contain a "2." If not, type "2" and click "Save Settings".

Specific Conductivity

1. Navigate to the "Calibration" tab and then the "SpC $\mu\text{S}/\text{cm}$ " tab.
2. Rinse 3X with DI then dry probes and calibration cup with Kimwipes.
3. Click the "Reset" button and asterisk will appear next to reading.
4. Calibrate to zero first by typing "0" in the standard field and click "Calibrate."
5. Rinse with the 1800 $\mu\text{S}/\text{cm}$ "rinse" then fill with fresh standard.
6. Let readings stabilize, type standard value (1800), then click "Calibrate."
7. Once proper calibration is complete, the asterisk will disappear.
8. Perform CHECK as described on the "Daily Checks in Lab" instruction sheet.

pH

1. Navigate to the "Calibration" tab and then to the "pH" tab
2. Click the "Reset" button and an asterisk will appear next to reading.
3. Get the pH standards of 7 and 4 or 7 and 10 ready, depending on expected field conditions.
4. Rinse probes 3X with DI, then rinse with the bottle labeled "pH 7 Rinse."
5. Fill the probe with fresh pH 7 standard and record the temperature of the standard.
6. In front of the large boxed pH container, there will be a chart comparing the pH value to temperature. Use the pH value listed next to the nearest temperature.
7. Let the readings stabilize, type in the temperature corrected value, and click "Calibrate."
8. Repeat steps 4 - 7 with the next pH standard.
9. Once proper calibration is complete, the asterisk will disappear.
10. Perform CHECK with pH standard 5 or 8 depending on expected field conditions as described on the "Daily Checks in Lab" instruction sheet.

Luminescent Dissolved Oxygen

The LDO must be calibrated daily by compensating for barometric pressure. LDO should be checked in the lab bubbler water bath. After traveling to your sampling location, LDO should be calibrated with site-specific barometric pressure and checked using the air-saturated water method. See the "Daily Checks in Lab" instruction sheet for both methods.

HYDROLAB MS5 Datasonde
Daily Checks in Lab

Specific Conductivity

1. After calibrating, navigate to "Online Monitoring" and check SpCond in $\mu\text{S}/\text{cm}$ in the Parameters list.
2. Set "Monitoring Interval" to 30 seconds and click "Start" at top right-hand side.
3. "Online monitoring in progress" will begin to blink red. Once the "# Samples" reaches "1," the buttons below will become clickable.
4. Click "New Table" and a new window will appear which will display readings according to the set monitoring interval. Record for 2 minutes or until reading stabilizes.
5. Write both time and reading in note book and be sure to include proper units.
6. If the check gives results outside of the acceptable range (99% - 101%), recalibrate and repeat the check.

pH

1. After calibrating, rinse probes 3x with DI, no need to dry.
2. Depending on calibration or expected field conditions, check with pH with 5 or 8 standard.
3. Rinse with standard from "rinse" container then fill with fresh standard and allow 2 minutes for stabilization.
4. Navigate to "Online Monitoring" and check pH in the Parameters list.
5. Repeat steps 5 through 9 from *Specific Conductivity* section above.

LDO

Lab Bubbler Water Bath

1. This procedure should be performed before leaving the office (AM) and upon return (PM).
2. Remove the calibration cup and install the probe guard then attach the Surveyor handheld.
3. Immerse the sonde and immerse in the water bath and allow it to stabilize.
4. Enter the barometric pressure in the "LDO%" calibration screen on the Surveyor handheld and select "Calibrate."
5. Compare the sonde temp and DO readings to the USGS Oxygen Solubility Table and record barometric pressure, sonde temp and DO along with USGS Table DO.

Field Air-saturated Water

1. **Uncap then recap** 1L bottle of water (keep bottle in truck cab to maintain room temp) and shake bottle appx 1 minute to saturate with oxygen.
2. Fill calibration cup so water covers the LDO probe by appx 0.5 inches and allow it to stabilize.
3. Set the cap on top and enter the barometric pressure in the "LDO%" calibration screen on the Surveyor handheld and select "DONE."
4. Perform CHECK.

APPENDIX C

Data Management Tables

For Data Management purposes, Water Chemistry is defined as parameters analyzed by a lab; Field measurements are defined as analyze immediately parameters.

Table 1. Sample locations

Station ID(WQDE compliant and referenced)	Waterbody/Location	Latitude-dd	Longitude-dd	County	Site exists in WQDE already?	Location Type
FIBI403	Budd Lake UNT	40.88213	-74.75851	Morris	No	River/Stream
FIBI404	Blue Brook	40.67504	-74.39417	Union	No	River/Stream
FIBI423	Duck Pond Run	40.30624	-74.66779	Mercer	No	River/Stream
FIBI460	Sun Valley Brook	40.85137	-74.74815	Morris	Yes	River/Stream
FIBI504	East Branch Rahway River	40.75120	-74.25901	Essex	Yes	River/Stream
FIBI510	Chambers Brook	40.63690	-74.62260	Somerset	Yes	River/Stream
FIBI514	Peach Orchard Brook	40.64760	-74.24120	Union	Yes	River/Stream
FIBI515	Pumpkin Patch Brook	40.59860	-74.32810	Middlesex	Yes	River/Stream
FIBI526	Teetertown Brook	40.75430	-74.84559	Hunterdon	Yes	River/Stream
FIBI531	Herzog Brook	40.74630	-74.70790	Morris	Yes	River/Stream
FIBI532	Rockaway Creek	40.72290	-74.78530	Hunterdon	Yes	River/Stream
FIBI533	Walnut Brook	40.51148	-74.87405	Hunterdon	Yes	River/Stream
FIBI535	Cat Tail Brook Trib	40.44461	-74.74477	Somerset	Yes	River/Stream
FIBI536	Simonson Brook	40.43531	-74.60029	Somerset	Yes	River/Stream
FIBI537	India Brook	40.80980	-74.61090	Morris	Yes	River/Stream
FIBI539	Dock Watch Hollow Brook	40.60597	-74.53514	Somerset	Yes	River/Stream
FIBI540	Mill Brook	40.51128	-74.37197	Middlesex	Yes	River/Stream
FIBI541	Woodsville Brook	40.38267	-74.81796	Mercer	Yes	River/Stream
FIBI580	Baldwins Creek	40.33830	-74.79700	Mercer	No	River/Stream
FIBI581	Sucker Brook	40.45170	-74.44800	Middlesex	No	River/Stream
FIBI582	Middlebush Brook	40.47790	-74.54310	Somerset	No	River/Stream

FIBI583	Cuckels Brook	40.56690	-74.56860	Somerset	No	River/Stream
FIBI584	Hickory Run	40.71270	-74.85890	Hunterdon	No	River/Stream
FIBI585	Tanners Brook	40.78830	-74.72580	Morris	No	River/Stream
FIBI586	Van Winkle Brook	40.71450	-74.31240	Union	No	River/Stream
FIBI587	Cold Brook	40.70070	-74.75020	Hunterdon	No	River/Stream
FIBI588	Dukes Brook	40.53910	-74.65460	Somerset	No	River/Stream
FIBI589	Black Brook	40.66020	-74.94810	Hunterdon	No	River/Stream
FIBI590	Cramers Creek	40.62090	-74.88360	Hunterdon	No	River/Stream
FIBI591	Chambers Brook Trib	40.58330	-74.70960	Somerset	No	River/Stream
FIBI407	Bear Swamp Brook	41.07381	-74.21567	Bergen	Yes	River/Stream
FIBI421a	Dunnfield Creek	40.97149	-75.12672	Warren	Yes	River/Stream
FIBI462	Tillman Brook	41.15611	-74.86989	Sussex	Yes	River/Stream
FIBI502	Brass Castle	40.76846	-75.03983	Warren	Yes	River/Stream

Table 2. Sample types

STATION ID	Field Msr/Obs	Flow	Water Chemistry	Continuous Monitoring	Biological	Sediment	Bacteria Collection	Habitat	Metrics	Indices
					Sampling	Collection				
FIBI403	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI404	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI423	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI460	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI504	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI510	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI514	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI515	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI526	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI531	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI532	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI533	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI535	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI536	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI537	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI539	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI540	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI541	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI580	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI581	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI582	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI583	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI584	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI585	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI586	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI587	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes

FIBI588	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI589	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI590	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI591	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI407	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI421a	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI462	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes
FIBI502	YES	NO	NO	NO	YES	NO	NO	Yes	Yes	Yes

Table 3. Partners

STATION ID	Field Msr/Obs	Flow	Water Chemistry*	Continuous Monitoring	Biological	Sediment	Bacteria Collection
					Sampling	Collection	
FIBI403	DEP	NO	YES	NO	DEP	NO	NO
FIBI404	DEP	NO	YES	NO	DEP	NO	NO
FIBI423	DEP	NO	YES	NO	DEP	NO	NO
FIBI460	DEP	NO	YES	NO	DEP	NO	NO
FIBI504	DEP	NO	YES	NO	DEP	NO	NO
FIBI510	DEP	NO	YES	NO	DEP	NO	NO
FIBI514	DEP	NO	YES	NO	DEP	NO	NO
FIBI515	DEP	NO	YES	NO	DEP	NO	NO
FIBI526	DEP	NO	YES	NO	DEP	NO	NO
FIBI531	DEP	NO	YES	NO	DEP	NO	NO
FIBI532	DEP	NO	YES	NO	DEP	NO	NO
FIBI533	DEP	NO	YES	NO	DEP	NO	NO
FIBI535	DEP	NO	YES	NO	DEP	NO	NO
FIBI536	DEP	NO	YES	NO	DEP	NO	NO
FIBI537	DEP	NO	YES	NO	DEP	NO	NO
FIBI539	DEP	NO	YES	NO	DEP	NO	NO
FIBI540	DEP	NO	YES	NO	DEP	NO	NO
FIBI541	DEP	NO	YES	NO	DEP	NO	NO
FIBI580	DEP	NO	YES	NO	DEP	NO	NO
FIBI581	DEP	NO	YES	NO	DEP	NO	NO
FIBI582	DEP	NO	YES	NO	DEP	NO	NO
FIBI583	DEP	NO	YES	NO	DEP	NO	NO
FIBI584	DEP	NO	YES	NO	DEP	NO	NO
FIBI585	DEP	NO	YES	NO	DEP	NO	NO
FIBI586	DEP	NO	YES	NO	DEP	NO	NO

FIBI587	DEP	NO	YES	NO	DEP	NO	NO
FIBI588	DEP	NO	YES	NO	DEP	NO	NO
FIBI589	DEP	NO	YES	NO	DEP	NO	NO
FIBI590	DEP	NO	YES	NO	DEP	NO	NO
FIBI591	DEP	NO	YES	NO	DEP	NO	NO
FIBI407	DEP	NO	YES	NO	DEP	NO	NO
FIBI421a	DEP	NO	YES	NO	DEP	NO	NO
FIBI462	DEP	NO	YES	NO	DEP	NO	NO
FIBI502	DEP	NO	YES	NO	DEP	NO	NO

* Grab samples for Total Phosphorus, Nitrite-Nitrate, and Total Kjeldahl will be collected at time of biological sampling (See Biological Nutrient Correlation QAPP (BFBM, 2019)).

Table 4. Field measures

<u>Field Name</u>	<u>WQDE Name</u>	<u>Media</u>	<u>Units</u>
DO	Dissolved oxygen (DO)	Water	mg/l
Water Temp	Temperature, Water	Water	deg C
Spec Cond	Specific conductance	Water	uS/cm
pH	pH	Water	None

Analysis (lab name)	EPA Characteristic Name	Method Speciation Name	Result Sample Fraction	Result Measure Unit	Result Value Type	Sample Collection Type	Sample Collection Equipment
Nitrite + Nitrate as N	Inorganic nitrogen (nitrate and nitrite)	as N	Total	mg/l	Actual	Grab	Water Sampler (Other)
Total Kjeldahl Nitrogen	Kjeldahl nitrogen	as N	Total	mg/l	Actual	Grab	Water Sampler (Other)
Ammonia as N	Ammonia-nitrogen	as N	Total	mg/l	Actual	Grab	Water Sampler (Other)
Phosphorus, Total	Phosphate-phosphorus	as P	Total	mg/l	Actual	Grab	Water Sampler (Other)

Table 5. Habitat

Characteristic Name
RBP2, High G, Embeddedness (choice list)
RBP2, High G, Velocity/Depth Regime (choice list)
RBP2, High G, Sediment Deposition (choice list)
RBP2, High G, Channel Flow Status (choice list)
RBP2, High G, Frequency of Riffles (or bends) (choice list)
RBP2, High G, Epifaunal Substrate/Available Cover (choice list)
RBP2, High G, Bank Stability, Right Bank (choice list)
RBP2, High G, Channel Alteration (choice list)
RBP2, High G, Bank Stability, Left Bank (choice list)
RBP2, High G, Vegetative Protection, Left Bank (choice list)
RBP2, High G, Vegetative Protection, Right Bank (choice list)
RBP2, High G, Riparian Vegetative Zone Width, Left Bank (choice list)
RBP2, High G, Riparian Vegetative Zone Width, Right Bank (choice list)

Table 6. Habitat metrics

CharacteristicName
RBP2, High G, habitat assessment total score
RBP2, High G, habitat assessment total rating

Table 7. Individual index metrics

CharacteristicName
Intolerant Vertebrate Richness
Proportion of Vertebrate Richness as Top Carnivore
% Tolerant Fish Individuals
Proportion of Total Richness as Native
% Native Crayfish
Brook Trout Density (individuals/100m2)

Table 8. Overall metrics

CharacteristicName
Headwaters Index of Biotic Integrity
HIBI Rating

Table 9. Data Inventory Supplement

Geographic Regions	Highlands, Upper Passaic, Whippany & Rockaway, Hackensack, Hudson & Pascack, Lower Passaic and Saddle, Pompton, Pequannock, Wanaque & Ramapo, Upper Delaware
Counties	Bergen, Essex, Hunterdon, Mercer, Middlesex, Morris, Somerset, Sussex, Union, Warren
Dates	5/1/2019 - 10/1/2019
Status	Future/Planned
Sample Frequency	Once
Seasons Sampled	Spring, Summer, Fall
Waterbody Type	River/Stream
Salinity Category	Fresh
Tidal Influence	Non-tidal
Project Description	The objective of the project is to enhance the ability of the Division of Water Monitoring & Standards to evaluate environmental conditions at selected sites by providing an additional level of biological assessment. This will be done using the Headwaters Index of Biotic Integrity (HIBI). The intended uses are the assessment of aquatic life use in State waters as required by the federal CWA under section 305(b), the identification of State impaired waters under section 303(d) of the federal CWA, and to provide the public with water quality information on headwater streams.
Parameters analyzed type	Habitat, Biological: Fish, macroinvertebrates, amphibians

Table 10. Data Management Supplement

QAPP network path file location?	V:\LUM\BFBM\Bfbm\Quality Assurance Plans\Calendar Year 2019 QAPPS\HeadwatersIBI_2019DRAFT
Where will data be recorded in field (media)	Paper
If on tablets or phones, will download at office occur or will you connect wirelessly?	
If on tablets or phones, who will do the download?	
If data collected electronically, where will it be stored?	
Format to be received from Lab	
Method of receipt from lab/s	
Personnel receiving outside lab data	
Is data expected to go to WQDE/STORET?	Yes
Data manager - (Bureau and Name)	BFBM Leigh Lager