**Sampling & Analysis Plan**

2020 Monitoring

Biocriteria Development Monitoring

CN 531.0

May 2020



Massachusetts Department of Environmental Protection

Division of Watershed Management

Watershed Planning Program

8 New Bond Street

Worcester, MA

***NOTE: This draft sampling plan provides detail re: sampling locations, frequencies, analytes, etc. and is intended to augment WPP’s multi-year programmatic QAPP approved by EPA for 2015 through 2019. The contents mirror selected elements of WPP’s programmatic QAPP (i.e.,QA-R5 EPA Guidance). See the QAPP for relevant information not provided in this SAP.***

**Table of Contents**

[Project Organization 3](#_Toc40185454)

[Project Definition and Background 4](#_Toc40185455)

[Project Description 5](#_Toc40185456)

[Sampling Process Design 5](#_Toc40185457)

[Non-Direct Measurements 12](#_Toc40185458)

[Cited Sources 13](#_Toc40185459)

**List of Tables**

[**Table 1.** Project Roles and Responsibilities related to monitoring and data use. 3](#_Toc40186362)

[**Table 2.** WH IBI metrics and scoring formulas (Stamp 2020) 5](#_Toc40186363)

[**Table 3.** HDI landscape/disturbance metrics (Jessup and Stamp 2019) 6](#_Toc40186364)

[**Table 4.** HDI metrics categorization and scoring ranges (Jessup and Stamp 2019) 7](#_Toc40186365)

[**Table 6.** Candidate sampling locations for 2020. 10](#_Toc40186366)

[**Table 7.** Project Schedule for Biocriteria Development Monitoring. 12](#_Toc40186367)

[**Table 8.** External data sources used for the Reference Site Network 2019 monitoring. 12](#_Toc40186368)

**List of Figures**

[**Figure 1.** Massachusetts site classifications (Jessup and Stamp 2019). 4](#_Toc40186813)

[**Figure 2.** Candidate catchments with high levels of human disturbance. 8](#_Toc40186814)

[**Figure 3.** Candidate sampling locations for 2020. 9](#_Toc40186815)

# Project Organization

Targeted monitoring networks are a component of the Massachusetts Department of Environmental Protection (MassDEP), Division of Watershed Management (DWM), Watershed Planning Program (WPP) water monitoring strategy and used to achieve a wide range of objectives. The types of monitoring objectives that can be addressed with targeted monitoring include source identification, stressor identification, trend analysis, TMDL development, water quality criteria/biocriteria development and 303(d) list development. Targeted monitoring networks have typically been implemented on rotating basin schedules in conjunction with the other components of the monitoring strategy. The major basins in the state are regionally split into groups with each group containing an approximately equal quantity of the water resource. During each year of a cycle, one basin group will be monitored by WPP personnel, thus covering the entire state in a set time frame. The focus of this SAP is biocriteria development monitoring, which is implemented on a statewide or regional scale and not a rotating basin cycle.

Biocriteria development monitoring focuses on the biological communities (macroinvertebrates, fish, and periphyton) and associated water quality conditions at sites across a human disturbance gradient (e.g. pristine to severely disturbed). Sites selected for monitoring may be monitored for just one or multiple years by WPP personnel, depending on the project objectives. The finalized monitoring data will be used by WPP to study the response of biological communities to human disturbance for biocriteria development. Biocriteria are commonly expressed as multimetric indices of biotic integrity (IBI) and the metrics comprising an IBI are selected based on the strength of their ecological response to human disturbance.

This Sampling and Analysis Plan (SAP) provides details of the monitoring plans for collecting data (e.g., benthic macroinvertebrate assemblages) in 2020 for biocriteria development. Specific descriptions of WPP staff roles and responsibilities for the project are detailed in Table 1.

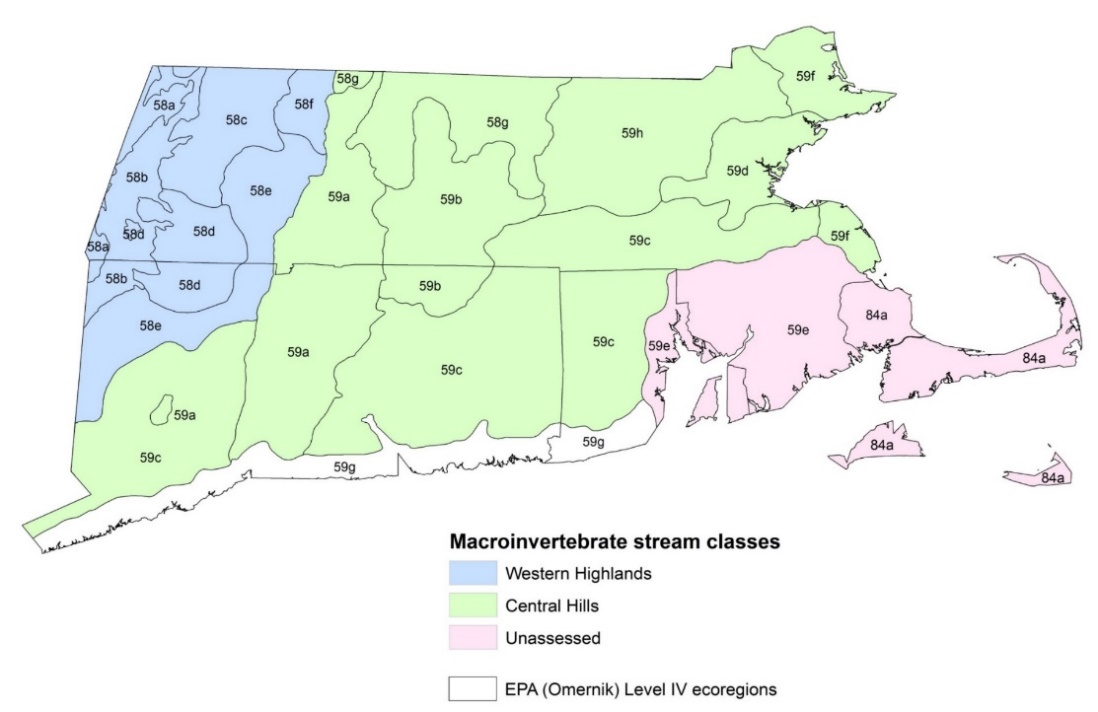
| **Table 1.** Project Roles and Responsibilities related to monitoring and data use. | |
| --- | --- |
| **Project Personnel** | **Responsibility** |
| Project Coordinator  -James Meek | Responsible for site reconnaissance, obtaining landowner access permission, defining logistics for efficient monitoring and generation of useable data at assigned sites using the procedures contained in WPP SOPs. |
| Benthic macroinvertebrate survey crews  -James Meek (lead)  -Allyson Yarra (lead)  -Dan Davis (lead)  -Pete Mitchell (lead)  -Dahlia Tympanick (lead)  -WPP staff and seasonal employees | Responsible for benthic macroinvertebrate and aquatic habitat survey data collection using procedures contained in WPP SOPs. |

# Project Definition and Background

WPP is actively developing biocriteria using benthic macroinvertebrate assemblages through a contract with Tetra Tech, Inc (Jessup and Stamp 2019). The implementation of biocriteria increases the accuracy and precision of aquatic life use assessments and improves water quality goal-setting processes. After the initial phases of biocriteria development were completed, it was apparent that gaps existed in the Massachusetts macroinvertebrate dataset. The two most significant data gaps are from:

* High gradient streams in the Western Highlands (WH) with high levels of human disturbance (Figure 1).
* Low gradient streams in the Central Hills (CH) and southeastern Massachusetts with low levels of human disturbance (i.e. reference) (Figure 1).

**Figure 1.** Massachusetts site classifications (Jessup and Stamp 2019).



Filling these data gaps would aid in future development efforts to refine, expand, and improve the accuracy of the macroinvertebrate biocriteria indices. The focus of the biocriteria development monitoring effort in 2020 will be on the identified data gap in the Western Highlands. The goal of the monitoring surveys in 2020 is to collect benthic macroinvertebrate data at 50 - 75 sites with high levels of human disturbance in the Western Highlands. The types of data that could be collected at each of the sites to reach this goal are:

* Benthic macroinvertebrate community
* Habitat assessments
* Aesthetics observations

# Project Description

**Overview of biocriteria development monitoring in 2020**

*Benthic Macroinvertebrate Community*

The benthic macroinvertebrate community will be sampled once at all sites in late summer (July - Sept). These organisms can integrate environmental conditions (chemical – including nutrients and toxics; and physical – including flow and water temperature) over a long period of time and are an excellent measure of the water body’s health. The sampling methodologies will vary per WPP standard operating procedures depending on available habitat (i.e. high gradient versus low gradient). Specimens will be placed into 2L Nalgene jars, preserved with denatured 95% ethanol, and transported to the WPP lab for storage. A contractor will process (i.e. subsample) the macroinvertebrate samples and complete the necessary taxonomic identifications. In addition, RBP habitat assessments and aesthetics observations will be completed at all sites sampled for benthic macroinvertebrates.

Metrics based on benthic macroinvertebrate functional feeding group, community composition, biotic index using pollution tolerance, and abundance will be calculated to determine the WH IBI score and corresponding biological condition (Jessup and Stamp 2019) (Stamp 2020) (Table 2). This data will be used in future benthic macroinvertebrate biocriteria development efforts to refine and improve the WH IBI.

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| **Table 2.** WH IBI metrics and scoring formulas (Stamp 2020) | | | |
| **Metric Description** | **Metric Category** | **Trend** | **Metric Scoring Formula** |
| Number of taxa - total | RICH | Dec. | 100\*(metric)/ 17.8 |
| Percent individuals - Order Plecoptera | COMP | Dec. | 100\*(metric)/ 18.3 |
| Percent individuals - FFG - collector-filterer (CF) | FFG | Inc. | 100\*(50.5-metric)/ 40.7 |
| Percent individuals - FFG - shredder (SH) | FFG | Dec. | 100\*(metric)/ 21.8 |
| Percent individuals - tolerance value - intolerant ≤ 3 | TOLER | Dec. | 100\*(metric)/ 45.4 |
| Becks Biotic Index\* | TOLER | Dec. | 100\*(metric)/ 24.8 |
| **WH IBI Score** | | | Average (Metric Scores) |

\* Beck’s Biotic Index (Terrell and Perfetti 1996) = 2\*[Class 1 Taxa]+[Class 2 Taxa] where Class 1 taxa have tolerance values of 0 or 1 and Class 2 taxa have tolerance values of 2, 3 or 4.

# Sampling Process Design

Sites with a high level of disturbance in the Western Highlands were identified using a human disturbance index (HDI) developed by Tetra Tech during biocriteria develelopment. The HDI developed by Tetra Tech is based on StreamCat landscape/disturbance metrics and the corresponding NHDPlusV2 catchment delineations (Hill, et al. 2016). After evaluating the hundreds of landscape/disturbance metrics available in StreamCat using principle component analysis, 7 metrics were selected for the HDI (Jessup and Stamp 2019) (Table 3).

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| **Table 3.** HDI landscape/disturbance metrics (Jessup and Stamp 2019) | | |
| **HDI metric** | **Description** | **Scoring** |
| ICI | Index of catchment integrity  (Thornbrugh et al. 2018) | Higher score = less disturbance |
| IWI | Index of watershed integrity  (Thornbrugh et al. 2018) |
| PctUrbLMH2011Ws | % of watershed area classified as developed, high + medium + low-intensity land use (NLCD 2011 class 24+23+22) | Higher value = more disturbance |
| RdDensCat | Density of roads (2010 Census Tiger Lines) within catchment (km/square km) |
| DamNrmStorWs | Volume all reservoirs (NID\_STORA in NID) per unit area of watershed (cubic meters/square km) |
| PctHayCrop2011Cat | % of catchment area classified as hay and crop land use (NLCD 2011 class 82+81) |
| AllAgNWs | [CBNFWs]+[FertWs]+[ManureWs]\* |

\*CBNFWs = Mean rate of biological nitrogen fixation from the cultivation of crops in kg N/ha/yr, within watershed

\*FertWs = Mean rate of synthetic nitrogen fertilizer application to agricultural land in kg N/ha/yr, within watershed

\*ManureWs = Mean rate of manure application to agricultural land from confined animal feeding operations in kg N/ha/yr, within watershed

The values of each selected HDI metric for all NHDPlusV2 watersheds or catchments (n=21,532) in Massachusetts, Rhode Island and Connecticut were assigned to seven disturbance level categories and unit-less scores (3 to -3) based on set value ranges for each metric (Table 4). The breakpoints in the HDI metric value ranges were selected by visual inspection of the metric distributions and best professional judgment. Based on the scores of the seven HDI metrics in each NHDPlusV2 catchment, the catchments were assigned to an HDI disturbance category using the evaluation criteria described in Table 5. Candidate catchments with high levels of human disturbance were identified in the Western Highlands using the defined HDI categories and GIS for desktop reconnaissance to validate the human disturbance category designations. Catchments in the Stress and High Stress categories were considered as potential candidate catchments as well as a small portion of the Some Stress catchments with high levels of localized urbanization. In total, 153 candidate catchments were identified through this process (Figure 2).

The 153 candidate catchments were evaluated using GIS and Google Street View to identify viable sampling locations. In some cases, viable sampling locations could not be identified in the candidate catchment. The most common reasons were the stream channel was clearly low gradient or not wadeable, no viable public access, and the catchment was small (i.e. disturbance best captured in the next downstream catchment). In total, 125 candidate sampling locations were identified in this process. Due to the limited areas of high levels of human disturbance in the Western Highlands, the size of some catchments and the stated monitoring objectives, multiple sampling location were often selected in a single catchment. The 125 candidate sampling locations were evaluated in more detail based on the human disturbance patterns (e.g. severity and proximity to the stream) to assign a priority ranking (high, moderate and low) to the site. Based on the priority rankings, 85 potential sampling locations were selected for 2020 with the goal to sample 50 – 75 sites (Table 6 and Figure 3). A portion of the 85 sites will likely not be sampled due to the site being non-wadeable or inaccessible and general resource limitations. Pre-survey reconnaissance of the proposed sites was not possible due to time constraints and the COVID-19 pandemic. The SAP will be revised at the conclusion of sampling to reflect the sites sampled in 2020.

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| **Table 4.** HDI metrics categorization and scoring ranges (Jessup and Stamp 2019) | | | | | | | |
| **Category (score)** | **IWI v.1** | **ICI v.1** | **PctUrbLMH2011Ws** | **PctHayCrop2011Cat** | **AllAgNWs** | **RdDensCat** | **DamNrmStorWs** |
| Disturb Level 1 (least disturbed)  (+3) | ≥0.875 | ≥0.875 | ≤1% | ≤1% | ≤0.5 | ≤1.5 | ≤0.1 |
| Disturb Level 2  (+2) | ≥0.85 | ≥0.85 | ≤2% | ≤2% | ≤1 | ≤2 | ≤1,000 |
| Disturb Level 3  (+1) | ≥0.80 | ≥0.80 | ≤5% | ≤5% | ≤2.5 | ≤3 | ≤10,000 |
| Disturb Level 4  (0) | >0.75 and <0.80 | >0.75 and <0.80 | >5 and <10% | >5 and <10% | >2.5 and <5 | >3 and <5 | >10,000 and <50,000 |
| Disturb Level 5  (-1) | ≤0.75 | ≤0.75 | ≥10% | ≥10% | ≥5 | ≥5 | ≥50,000 |
| Disturb Level 6  (-2) | ≤0.60 | ≤0.60 | ≥40% | ≥15% | ≥7.5 | ≥7.5 | ≥100,000 |
| Disturb Level 7  (most disturbed)  (-3\_ | ≤0.50 | ≤0.50 | ≥60% | ≥20% | ≥10 | ≥10 | ≥200,000 |

|  |  |
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| **Table 5.** Watershed HDI category designation criteria | |
| **Disturbance category** | **Scoring criteria (based on scores for the seven metrics)** |
| Best Reference (BestRef) | Minimum (min) score >= 2 |
| Reference (Ref) | Min score = 1 |
| Sub Reference (SubRef) | All but 1 or 2 scores are > 0 |
| Other | If other criteria are not met (min score = 0) |
| Some Stress (SomeStrs) | If min score = -1 OR count of negative (strs) scores < 2 |
| Stress (Strs) | If (min score < -1 AND >1 negative (strs) scores) OR (min score = -1 AND >3 negative (strs) scores) |
| High Stress (HighStrs) | If >3 negative (strs) scores AND min score = -3 |

**Figure 2.** Candidate catchments with high levels of human disturbance.

A close up of a map

Description automatically generated

**Figure 3.** Candidate sampling locations for 2020.

A close up of a map

Description automatically generated

| **Table 6.** Candidate sampling locations for 2020. | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Site ID** | **Waterbody Name** | **Watershed** | **Town** | **Latitude** | **Longitude** |
| [WH006](http://maps.google.com/maps/place/42.25951757,%20-72.8769175/data=!3m1!1e3) | MBr. Westfield River | Westfield | Huntington | 42.25952 | -72.87692 |
| [WH007](http://maps.google.com/maps/place/42.53895723,%20-73.3333463/data=!3m1!1e3) | Kinderhook Creek | Hudson | Hancock | 42.53896 | -73.33335 |
| [WH014](http://maps.google.com/maps/place/42.2998013,%20-72.7434424/data=!3m1!1e3) | NBr. Manhan River | Connecticut | Westhampton | 42.29980 | -72.74344 |
| [WH017](http://maps.google.com/maps/place/42.52845791,%20-73.2337445/data=!3m1!1e3) | Town Brook | Housatonic | Lanesborough | 42.52846 | -73.23374 |
| [WH019](http://maps.google.com/maps/place/42.48544252,%20-73.1399461/data=!3m1!1e3) | Wahconah Falls Brook | Housatonic | Dalton | 42.48544 | -73.13995 |
| [WH020](http://maps.google.com/maps/place/42.48611561,%20-73.1370001/data=!3m1!1e3) | Wahconah Falls Brook | Housatonic | Dalton | 42.48612 | -73.13700 |
| [WH021](http://maps.google.com/maps/place/42.49002222,%20-73.2749747/data=!3m1!1e3) | Daniels Brook | Housatonic | Pittsfield | 42.49002 | -73.27497 |
| [WH022](http://maps.google.com/maps/place/42.48480788,%20-73.1480147/data=!3m1!1e3) | Wahconah Falls Brook | Housatonic | Dalton | 42.48481 | -73.14801 |
| [WH023](http://maps.google.com/maps/place/42.47718858,%20-73.1448309/data=!3m1!1e3) | Cleveland Brook | Housatonic | Dalton | 42.47719 | -73.14483 |
| [WH024](http://maps.google.com/maps/place/42.46445083,%20-73.254942/data=!3m1!1e3) | Onota Brook | Housatonic | Pittsfield | 42.46445 | -73.25494 |
| [WH025](http://maps.google.com/maps/place/42.46801187,%20-73.2003601/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.46801 | -73.20036 |
| [WH026](http://maps.google.com/maps/place/42.46873747,%20-73.1821258/data=!3m1!1e3) | EBR. Housatonic River | Housatonic | Dalton | 42.46874 | -73.18213 |
| [WH027](http://maps.google.com/maps/place/42.46355081,%20-73.198187/data=!3m1!1e3) | Barton Brook | Housatonic | Pittsfield | 42.46355 | -73.19819 |
| [WH029](http://maps.google.com/maps/place/42.45282902,%20-73.2064324/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.45283 | -73.20643 |
| [WH032](http://maps.google.com/maps/place/42.44115013,%20-73.2989774/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.44115 | -73.29898 |
| [WH033](http://maps.google.com/maps/place/42.43968683,%20-73.3024379/data=!3m1!1e3) | Jacoby Brook | Housatonic | Pittsfield | 42.43969 | -73.30244 |
| [WH034](http://maps.google.com/maps/place/42.43973279,%20-73.2934341/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.43973 | -73.29343 |
| [WH035](http://maps.google.com/maps/place/42.44614434,%20-73.2620562/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.44614 | -73.26206 |
| [WH036](http://maps.google.com/maps/place/42.45148114,%20-73.2623858/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.45148 | -73.26239 |
| [WH037](http://maps.google.com/maps/place/42.44115209,%20-73.2601301/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.44115 | -73.26013 |
| [WH038](http://maps.google.com/maps/place/42.44012598,%20-73.2712005/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.44013 | -73.27120 |
| [WH039](http://maps.google.com/maps/place/42.44176978,%20-73.2782414/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.44177 | -73.27824 |
| [WH040](http://maps.google.com/maps/place/42.43478083,%20-73.3052966/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.43478 | -73.30530 |
| [WH047](http://maps.google.com/maps/place/42.34831444,%20-73.3651262/data=!3m1!1e3) | Cone Brook | Housatonic | West Stockbridge | 42.34831 | -73.36513 |
| [WH049](http://maps.google.com/maps/place/42.31372126,%20-73.331852/data=!3m1!1e3) | Larrywaug Brook | Housatonic | Stockbridge | 42.31372 | -73.33185 |
| [WH050](http://maps.google.com/maps/place/42.29402233,%20-73.2396438/data=!3m1!1e3) | Goose Pond Brook | Housatonic | Lee | 42.29402 | -73.23964 |
| [WH051](http://maps.google.com/maps/place/42.30160665,%20-73.3341811/data=!3m1!1e3) | Larrywaug Brook | Housatonic | Stockbridge | 42.30161 | -73.33418 |
| [WH053](http://maps.google.com/maps/place/42.19683145,%20-73.3593842/data=!3m1!1e3) | Housatonic River | Housatonic | Great Barrington | 42.19683 | -73.35938 |
| [WH054](http://maps.google.com/maps/place/42.19463935,%20-73.3581176/data=!3m1!1e3) | Housatonic River | Housatonic | Great Barrington | 42.19464 | -73.35812 |
| [WH055](http://maps.google.com/maps/place/42.18792149,%20-73.4134449/data=!3m1!1e3) | Green River | Housatonic | Great Barrington | 42.18792 | -73.41344 |
| [WH056](http://maps.google.com/maps/place/42.19072156,%20-73.3996478/data=!3m1!1e3) | Green River | Housatonic | Great Barrington | 42.19072 | -73.39965 |
| [WH057](http://maps.google.com/maps/place/42.17854693,%20-73.3781367/data=!3m1!1e3) | Green River | Housatonic | Great Barrington | 42.17855 | -73.37814 |
| [WH058](http://maps.google.com/maps/place/42.16375837,%20-73.3652542/data=!3m1!1e3) | Green River | Housatonic | Great Barrington | 42.16376 | -73.36525 |
| [WH061](http://maps.google.com/maps/place/42.05407965,%20-73.334269/data=!3m1!1e3) | Konkapot River | Housatonic | Sheffield | 42.05408 | -73.33427 |
| [WH062](http://maps.google.com/maps/place/42.04643282,%20-73.3111921/data=!3m1!1e3) | Konkapot River | Housatonic | North Canaan, CT | 42.04643 | -73.31119 |
| [WH063](http://maps.google.com/maps/place/42.04551419,%20-73.2883886/data=!3m1!1e3) | Konkapot River | Housatonic | North Canaan, CT | 42.04551 | -73.28839 |
| [WH064](http://maps.google.com/maps/place/42.07602001,%20-73.2828056/data=!3m1!1e3) | Konkapot River | Housatonic | New Marlborough | 42.07602 | -73.28281 |
| [WH065](http://maps.google.com/maps/place/42.46395619,%20-73.253232/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.46396 | -73.25323 |
| [WH066](http://maps.google.com/maps/place/42.46668288,%20-73.2505636/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.46668 | -73.25056 |
| [WH067](http://maps.google.com/maps/place/42.46929938,%20-73.249247/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.46930 | -73.24925 |
| [WH068](http://maps.google.com/maps/place/42.47440979,%20-73.2460232/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.47441 | -73.24602 |
| [WH069](http://maps.google.com/maps/place/42.4825016,%20-73.2468944/data=!3m1!1e3) | WBr. Housatonic River | Housatonic | Pittsfield | 42.48250 | -73.24689 |
| [WH070](http://maps.google.com/maps/place/42.43705841,%20-73.2477474/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.43706 | -73.24775 |
| [WH071](http://maps.google.com/maps/place/42.44077351,%20-73.2480777/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.44077 | -73.24808 |
| [WH072](http://maps.google.com/maps/place/42.44270171,%20-73.2464629/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.44270 | -73.24646 |
| [WH073](http://maps.google.com/maps/place/42.44468927,%20-73.2446039/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.44469 | -73.24460 |
| [WH074](http://maps.google.com/maps/place/42.45114618,%20-73.2267697/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Pittsfield | 42.45115 | -73.22677 |
| [WH077](http://maps.google.com/maps/place/42.31369598,%20-73.2468864/data=!3m1!1e3) | Housatonic River | Housatonic | Lee | 42.31370 | -73.24689 |
| [WH078](http://maps.google.com/maps/place/42.3229596,%20-73.2421625/data=!3m1!1e3) | Housatonic River | Housatonic | Lee | 42.32296 | -73.24216 |
| [WH079](http://maps.google.com/maps/place/42.29377996,%20-73.2416076/data=!3m1!1e3) | Housatonic River | Housatonic | Lee | 42.29378 | -73.24161 |
| [WH080](http://maps.google.com/maps/place/42.30338408,%20-73.2506784/data=!3m1!1e3) | Housatonic River | Housatonic | Lee | 42.30338 | -73.25068 |
| [WH081](http://maps.google.com/maps/place/42.28336539,%20-73.2408589/data=!3m1!1e3) | Housatonic River | Housatonic | Lee | 42.28337 | -73.24086 |
| [WH082](http://maps.google.com/maps/place/42.28336567,%20-73.2472906/data=!3m1!1e3) | Willow Brook | Housatonic | Lee | 42.28337 | -73.24729 |
| [WH084](http://maps.google.com/maps/place/42.21348407,%20-73.391965/data=!3m1!1e3) | Seekonk Brook | Housatonic | Great Barrington | 42.21348 | -73.39197 |
| [WH085](http://maps.google.com/maps/place/42.23824708,%20-73.4117301/data=!3m1!1e3) | Alford Brook | Housatonic | Alford | 42.23825 | -73.41173 |
| [WH087](http://maps.google.com/maps/place/42.47174593,%20-73.1616629/data=!3m1!1e3) | EBr. Housatonic River | Housatonic | Dalton | 42.47175 | -73.16166 |
| [WH088](http://maps.google.com/maps/place/42.4696795,%20-73.2564964/data=!3m1!1e3) | Onota Brook | Housatonic | Pittsfield | 42.46968 | -73.25650 |
| [WH089](http://maps.google.com/maps/place/42.43993663,%20-73.2889469/data=!3m1!1e3) | SWBr. Housatonic River | Housatonic | Pittsfield | 42.43994 | -73.28895 |
| [WH091](http://maps.google.com/maps/place/42.67868468,%20-72.6289212/data=!3m1!1e3) | Glen Brook | Deerfield | Leyden | 42.67868 | -72.62892 |
| [WH093](http://maps.google.com/maps/place/42.63168647,%20-72.6560728/data=!3m1!1e3) | Hinsdale Brook | Deerfield | Shelburne | 42.63169 | -72.65607 |
| [WH095](http://maps.google.com/maps/place/42.60170092,%20-72.7779327/data=!3m1!1e3) | Clesson Brook | Deerfield | Buckland | 42.60170 | -72.77793 |
| [WH096](http://maps.google.com/maps/place/42.57790656,%20-72.6846171/data=!3m1!1e3) | Dragon Brook | Deerfield | Shelburne | 42.57791 | -72.68462 |
| [WH097](http://maps.google.com/maps/place/42.55487083,%20-72.8096152/data=!3m1!1e3) | UBr. Clesson Brook | Deerfield | Ashfield | 42.55487 | -72.80962 |
| [WH098](http://maps.google.com/maps/place/42.51072048,%20-72.7739779/data=!3m1!1e3) | South River | Deerfield | Ashfield | 42.51072 | -72.77398 |
| [WH100](http://maps.google.com/maps/place/42.51623161,%20-72.7463777/data=!3m1!1e3) | South River | Deerfield | Conway | 42.51623 | -72.74638 |
| [WH103](http://maps.google.com/maps/place/42.72549986,%20-73.2074001/data=!3m1!1e3) | Hemlock Brook | Hudson | Williamstown | 42.72550 | -73.20740 |
| [WH104](http://maps.google.com/maps/place/42.72871362,%20-73.2069229/data=!3m1!1e3) | Hoosic River | Hudson | Williamstown | 42.72871 | -73.20692 |
| [WH105](http://maps.google.com/maps/place/42.73026707,%20-73.2156402/data=!3m1!1e3) | Hoosic River | Hudson | Williamstown | 42.73027 | -73.21564 |
| [WH106](http://maps.google.com/maps/place/42.71938749,%20-73.2096708/data=!3m1!1e3) | Hemlock Brook | Hudson | Williamstown | 42.71939 | -73.20967 |
| [WH107](http://maps.google.com/maps/place/42.7174143,%20-73.1884944/data=!3m1!1e3) | Hoosic River | Hudson | Williamstown | 42.71741 | -73.18849 |
| [WH109](http://maps.google.com/maps/place/42.70404366,%20-73.1736285/data=!3m1!1e3) | Hoosic River | Hudson | North Adams | 42.70404 | -73.17363 |
| [WH110](http://maps.google.com/maps/place/42.69984332,%20-73.1614103/data=!3m1!1e3) | Hoosic River | Hudson | North Adams | 42.69984 | -73.16141 |
| [WH111](http://maps.google.com/maps/place/42.70384752,%20-73.1768943/data=!3m1!1e3) | Paull Brook | Hudson | Williamstown | 42.70385 | -73.17689 |
| [WH112](http://maps.google.com/maps/place/42.67436082,%20-73.2323523/data=!3m1!1e3) | Green River | Hudson | Williamstown | 42.67436 | -73.23235 |
| [WH113](http://maps.google.com/maps/place/42.66013331,%20-73.2414902/data=!3m1!1e3) | WBr. Green River | Hudson | Williamstown | 42.66013 | -73.24149 |
| [WH114](http://maps.google.com/maps/place/42.69321506,%20-73.1120415/data=!3m1!1e3) | Hoosic River | Hudson | North Adams | 42.69322 | -73.11204 |
| [WH115](http://maps.google.com/maps/place/42.63996482,%20-73.1085916/data=!3m1!1e3) | Hoosic River | Hudson | Adams | 42.63996 | -73.10859 |
| [WH116](http://maps.google.com/maps/place/42.64765755,%20-73.1084575/data=!3m1!1e3) | Hoosic River | Hudson | Adams | 42.64766 | -73.10846 |
| [WH119](http://maps.google.com/maps/place/42.71028629,%20-73.1941303/data=!3m1!1e3) | Green River | Hudson | Williamstown | 42.71029 | -73.19413 |
| [WH120](http://maps.google.com/maps/place/42.70559697,%20-73.1992451/data=!3m1!1e3) | Green River | Hudson | Williamstown | 42.70560 | -73.19925 |
| [WH121](http://maps.google.com/maps/place/42.69107479,%20-73.2012681/data=!3m1!1e3) | Green River | Hudson | Williamstown | 42.69107 | -73.20127 |
| [WH122](http://maps.google.com/maps/place/42.70298277,%20-73.1237445/data=!3m1!1e3) | Hoosic River | Hudson | North Adams | 42.70298 | -73.12374 |
| [WH123](http://maps.google.com/maps/place/42.68585264,%20-73.2311797/data=!3m1!1e3) | Sweet Brook | Hudson | Williamstown | 42.68585 | -73.23118 |
| [WH124](http://maps.google.com/maps/place/42.60745216,%20-73.1256272/data=!3m1!1e3) | Unnamed Tributary | Hudson | Adams | 42.60745 | -73.12563 |
| [WH125](http://maps.google.com/maps/place/42.44764351,%20-73.1305038/data=!3m1!1e3) | EBR. Housatonic River | Housatonic | Hinsdale | 42.44764 | -73.13050 |

The project and monitoring schedules are outlined in Table 6.

| **Table 7.** Project Schedule for Biocriteria Development Monitoring. | | | |
| --- | --- | --- | --- |
| **Activity** | **Approx. Date of Initiation** | **Approx. Date of Completion** | **Deliverable** |
| Coordination, meetings, river/stream sampling plan development, site selection, etc. | May 2020 | May 2020 | Draft sampling plan; meeting notes, etc. |
| Draft sampling plan review and approval | May 2020 | June 2020 | Internal WPP concurrence on sampling plan |
| 2020-2024 WPP monitoring QAPP | Mar 2020 | May 2020 | 2020-2024 WPP Monitoring QAPP |
| Benthic/Habitat sampling surveys  (1 visits) | Jul 2019 | Sep 2019 | Field data; benthic samples to contractor |
| Data QA/QC review and validation | Feb 2021 | Jun 2021 | Updated macroinvertebrate database |
| Data review and analysis | Jun 2021 | Mar 2022 | Final data analysis |

# Non-Direct Measurements

Table 8 is a brief list of relevant external data sources that may be used in coordinating monitoring efforts or the interpretation of monitoring data. For example, stage data from the USGS could be used to determine if water levels are appropriate for certain types of sampling or rain data from NCDC could be used to determine if a sampling event occurred during wet or dry weather.

**Table 8.** External data sources used for the Reference Site Network 2019 monitoring.

|  |  |
| --- | --- |
| **Organization** | **Data** |
| United States Geological Survey (USGS)  <http://ma.water.usgs.gov/> | Continuously stream stage and discharge measurements at gage stations within the project extent. |
| National Centers for Environmental Information (NCEI)  <http://www.ncdc.noaa.gov/oa/ncdc.html> | Daily precipitation and temperature data weather stations within the project extent. |
| The Weather Underground  <http://www.wunderground.com/> | Daily precipitation and temperature data weather stations within the southwestern basin group. |

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