



MassDEP

**Massachusetts Department of Environmental Protection
Bureau of Water Resources
Division of Watershed Management
Watershed Planning Program**

STANDARD OPERATING PROCEDURE

Site Evaluation Guidelines for the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2), Wadeable Rivers and Streams

CN 306.2

12/12/24 – 12/12/26

Revision Date: 12/12/24

Prepared and
Approved by:

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Date: 7/17/25

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Date: 7/17/25



LIST OF REVISIONS

Rev. #	Date	Description of Revision(s)	Page #s
0	July 2009	Original document CN 306.0	
1	August 2010	Significant revisions to reflect change in the sampling frame from 1:100,000 NHD-Plus to 1:24,000 NHD-UMass Enhanced. CN 306.1	Multiple
2	February 2013	Minor changes for the addition of cranberry bog as a site rejection category. CN 306.1	4
3	September 2024	Revisions to reflect the new MAP2 wadeable rivers and streams survey (2025 – 2028) and subsequent changes to the site evaluation procedures as a result of knowledge from the 2011-2015 survey. CN 306.2	Multiple
4	December 2024	Added a category of Sample Frame Error (FE) and updated the example access permission letter and postcard.	5,22,23

NOTICE

The goal of the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2) is to provide a comprehensive unbiased assessment of the condition of “waters” in Massachusetts through the implementation of probabilistic surveys. Over the last 14 years, probabilistic surveys were completed for wadeable rivers and streams (2011 – 2015), lakes (2016 – 2018), and coastal waters (2020 – 2023). A new probabilistic survey of wadeable rivers and streams will be implemented from 2025 – 2028. Additional probabilistic surveys of the other water resource types (lakes and coastal waters) will follow in the future if resources allow.

This document contains an overview of the process involved in locating a sampling site, evaluating the site, and selecting appropriate alternate sites when necessary. It is adapted from the guidelines developed and followed in the National Rivers and Streams Assessment conducted by USEPA (USEPA, 2007). **Methods described in this document are to be used specifically in work relating to probabilistic sites on wadeable rivers and streams.**



SITE EVALUATION PROCESS

This document is provided to clarify all of the steps involved in the process of locating and evaluating a probabilistically selected sampling site on wadeable rivers and streams. Survey coordinators will obtain their assigned sites from the site manager and be responsible for completing the site evaluation process for each assigned site. There are 4 steps involved in the site evaluation process (Figure 1):

1. Locate the site in GIS.
2. Verify the representativeness and accessibility of the site (Desktop Reconnaissance).
 - a. If access permission from landowners is NOT required for a site visit, skip step 3 and verify the representativeness and accessibility of the site (Site Visit).
3. Obtain access permission from landowners.
4. Verify the representativeness and accessibility of the site (Site Visit).

The site evaluation process will begin during late summer/early fall of the year preceding the sampling year and could extend into spring of the sampling year for some sites. The site evaluation process for sites where landowner access permission is not required for a site visit to verify representativeness and accessibility will be completed by October 31st. If landowner access permission is required for a site visit to verify representativeness and accessibility, it will be requested in January/February and the site evaluation process will be completed by April 1st. Some sites will require a site visit to determine the most appropriate access option and the specific landowner, if any, that will need to grant access permission. The information regarding site evaluation decisions will be maintained on a master site evaluation spreadsheet by the site manager.

Survey coordinators should complete a site evaluation field sheet (Attachment 1) and assemble a dossier containing important location and access information for each site they are assigned by the site manager. The dossier should contain the appropriate maps, contact information for access permission, copies of permission letters (if applicable), and access instructions.

LOCATE THE SITE IN GIS

Wadeable river and stream probabilistic sampling sites were selected from the stream network represented on United States Geological Survey (USGS) National Hydrography Dataset Plus High Resolution (NHDPlus HR) GIS coverage using the Generalized Random Tessellation Stratified (GRTS) design developed by the EPA Office of Research and Development-Western Ecology Division. The specific survey design for the 2025-2028 MAP2 wadeable rivers and streams survey is provided as Attachment 2.

The site will be defined as any point on the stream within 100 feet of the selected site as long as there are no factors (e.g. a confluence with a tributary, a pipe discharge, etc.) within the 100 feet that would affect water quality. If the indicator being sampled or measured requires a reach-wide approach (e.g. macroinvertebrates, periphyton, fish), any reach designation based on best professional judgment regarding representativeness, accessibility and habitat availability is appropriate as long as the site as defined above is located within the reach.



PRELIMINARY SITE VERIFICATION – DESKTOP RECONNAISSANCE

Desktop reconnaissance involves using available GIS coverages, aerial photos and watershed tools to make a predetermination if a site is not representative of the target population (non-target) or inaccessible. The primary purpose of desktop reconnaissance is to efficiently reject those sites that are **obviously** non-target or inaccessible prior to expending the resources necessary to obtain landowner permission and conduct site visits. **If there is doubt, the site evaluator will err on the side of caution, obtain landowner permission and conduct a site visit.**

The target population is defined as all wadeable 1st – 5th Strahler stream order non-tidal perennial rivers and streams with a total drainage greater than 1.5 km² within the Commonwealth of Massachusetts. The sites that are determined to be non-target or inaccessible will be categorized based on the reason for rejection. Some of the non-target categories are impossible to verify using desktop reconnaissance and will require a site visit. Note the non-target category on the site evaluation field sheet.

Non-Target Population Categories (permanent condition; stream becomes non-target)

- Not Wadeable (NW) – Greater than 50% of the site will not be wadeable. Wadeable is defined as shallow enough that a representative sample of the indicator can be safely collected during the index period under normal hydrological condition. It's best if this non-target category is verified with a site visit in July or August during normal hydrological conditions for that time period but often this is not possible, so some forecasting is necessary. Note on the site evaluation field sheet if the site is not wadeable due to natural impoundment (NI) or man-made impoundment (MI).
- Wetland (WE) - There is standing water present, but no definable stream channel upstream or downstream of the site during low flow conditions. In cases of wetlands surrounding a recognizable stream channel, define the site as target but restrict sampling to the stream channel. If the site is wetland due to a man-made (MI) or natural impoundment (NI), note it on the site evaluation field sheet. In the case of a recently constructed natural impoundment, it is appropriate to reject the site if the expectation is that the site will become wetland.
- Cranberry Bog (CB) – Greater than 50% of the site is located on an active cranberry bog ditch that is not artificial. Historical USGS topographic maps can be used to determine if the ditch is artificial or a channelized stream. The water level and flow fluctuation created by the management of the cranberry bog makes sampling the site impossible.
- Sampling Frame Error (FE) – The sampling frame is a GIS coverage based on NHDPlus HR that defines the target population. Using the NHDPlus HR stream categorization attributes and other GIS coverages, allowed some of the non-target stream types to be removed prior to site selection. If a selected site is located on one of the removed non-target stream types, it will be categorized as a sampling frame error. The following non-target stream types were removed:
 1. Tidal (T) – A stream influenced by the salt wedge of a tide.
 2. Artificial (A) – A ditch, canal, aqueduct or pipeline that never existed as a natural stream.
 3. Intermittent (I) – A discernible stream channel is present but there is either no water or only isolated pools of water. If there is information that the lack of water is the result of human alteration do not classify the site as intermittent. If a site does not fall into this



category at the time of a site visit but there is an expectation it would under different hydrological conditions, use USGS StreamStats watershed delineation and flow estimation tools to determine the probability that the site would have perennial flow. If the perennial probability is below 0.56, the site will be categorized as intermittent. See the [USGS StreamStats Web Site](#) for more detailed instructions (Bent and Steeves 2006).

4. Impounded (man-made) (M) – A stream submerged under a lake or pond created by a man-made impoundment.
 5. Drainage area (D) – The sampling frame was limited to NHDPlus HR reaches with drainage areas greater than 1.5 km² (end of the reach is the pour point). However, sites may be located on the upper portion of a NHDPlus HR reach and the drainage area for the stream using the site as the pour point is less than 1.5 km² thus a non-target stream.
- Other (O) - The site is non-target for reasons other than those above. Note the rejection reason on the site evaluation field sheet.

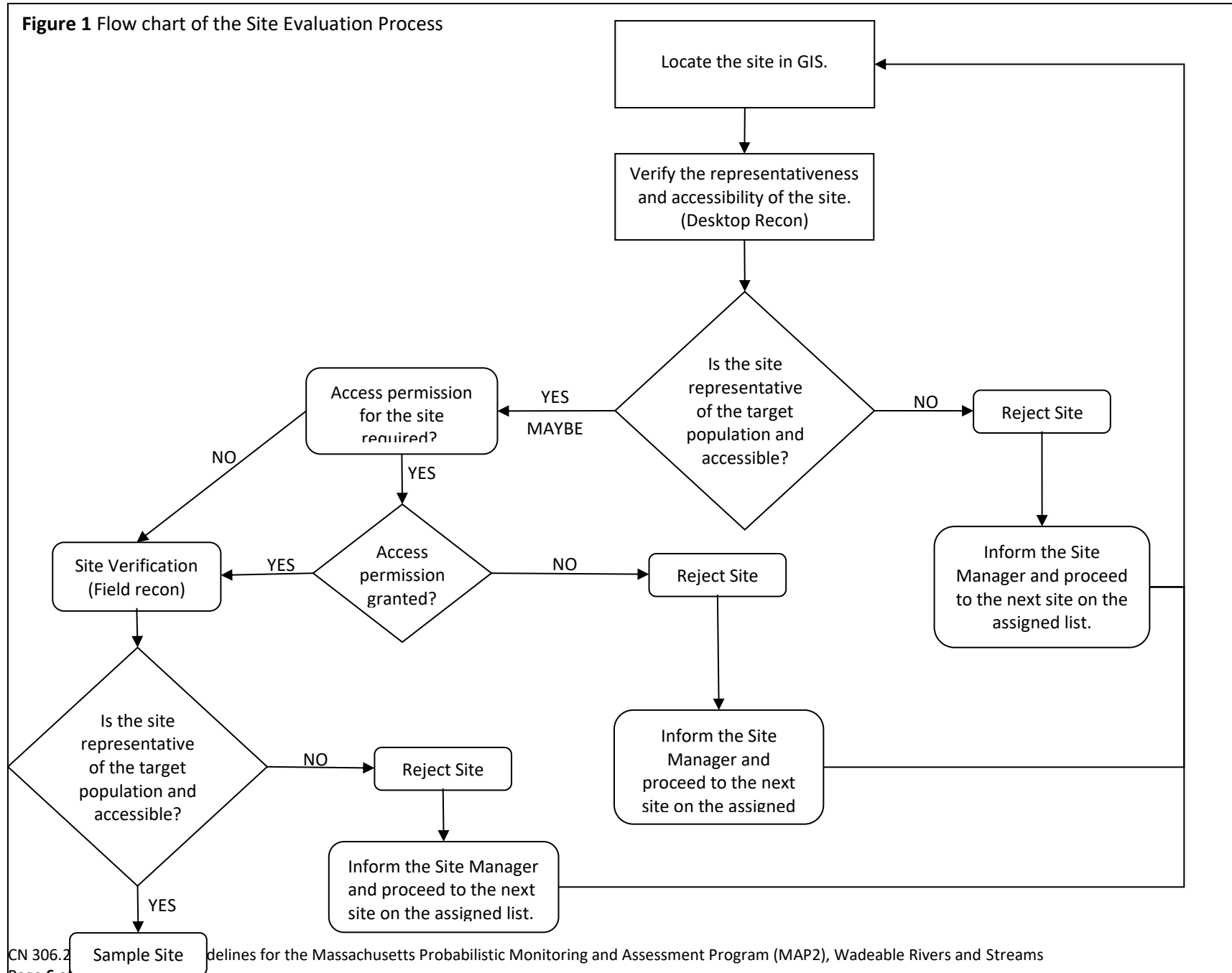
Inaccessible Site Categories

- Access Permission Denied (APD) - Access to the site is denied by the landowners.
- No Response from Landowner (NRL) – Landowner failed to respond to the request for access permission. Multiple attempts to contact the landowner by phone and letter should be made prior to rejecting the site.
- Physically Inaccessible (PI) - Site is unlikely to be sampled by anyone due to physical barriers that prevent access to the site or sampling reach. This non-target category must be verified with a site visit. Physical barriers may include soft bottom sediments that make it **impossible** to walk the stream channel and excessive shrub growth over the stream that would require **extensive** cutting and habitat alterations to make it possible to walk the channel. In determining if a physical barrier exists, safety and avoidance of major habitat alteration not time and effort should be the primary factor. Rejecting a site based solely on the effort it will take to access the site, or the effort needed to make it more accessible will bias the overall design and should only be done in the most extreme circumstances.

If desktop reconnaissance **definitively** shows that a site is non-target or inaccessible, reject the site and provide the site manager with the site evaluation field sheet detailing the reasons for the rejection. All site rejections must be properly documented. If necessary, the site manager will allocate additional sites to the appropriate survey coordinators.



Figure 1 Flow chart of the Site Evaluation Process



OBTAIN LANDOWNER PERMISSION

It is likely that to access the site, the sampling crew will be required to cross private property. Staff conducting site evaluations should review WPP's guidance on property access (CN1.27). Obtaining landowner permission to access their property is a critical step in the site evaluation process and cannot be skipped. The steps for obtaining landowner permission are as follows.

1. Determine the different options for accessing the site using GIS coverages, aerial photos, and pictometry. Create a map for each access option. If the access options involve public land, a common public area (e.g. a Wal-Mart parking lot) and/or right of ways, it may be appropriate to skip some of the following steps. Some sites might require a site visit to determine the most appropriate access option.
2. Identify the landowner(s) that will need to be contacted for access permission on each option. There are several tools that can be used to identify the landowner(s). A GIS layer is available from MassGIS that contains parcel and landowner information for most towns. Many towns have their own interactive maps or databases. A web search on the town name and assessor can identify those sites.
3. Mail a standard letter with an access permission postcard (postage paid) to each landowner identified explaining the probabilistic sampling program and asking them to contact us to grant or deny access permission (Attachment 3). The landowner's response can be the return of the access permission postcard, a phone call or email. Include a map of the site with their property identified in the letter. Depending on the situation, it may be more appropriate to either attempt contacting them by phone or in person without sending a letter.
4. If no response to the initial letter after 3-4 weeks, send a second letter to the landowner. If no response to the second letter after 3-4 weeks, attempt contacting the landowner(s) by phone or in person during a site visit to obtain final permission. Note the landowners name and contact information, whether permission was granted, and any special conditions on the site evaluation field sheet. Also note when an attempt to contact the landowner was made and failed.

If access permission is denied, reject the site and provide the site manager with the site evaluation field sheet detailing the reasons for the rejection. All site rejections must be properly documented. If necessary, the site manager will allocate additional sites to the appropriate survey coordinators.

FINAL SITE VERIFICATION – SITE VISIT

The final site verification is completed during a site visit. The purpose of the site visit is to make a final determination if the site is non-target or inaccessible and gather access information. The access information gathered during the site visit will allow others to find the site again in the spring of the following year. The site verification steps are as follows.

1. Using a GPS unit, find the site location in the field corresponding to the site coordinates and maps of the site. If it is not possible to access the site due to physical barriers, note it on the site evaluation field sheet and reject the site. If it is possible to access the site, record the routes taken and other directions on the site evaluation field sheet or attach a map that displays the route.

2. Use the GPS unit to confirm the latitude and longitude of the site with the coordinates for the site. Make sure the GPS unit is set to reference the NAD 83 geospatial data set.
3. Use all available means to ensure that you are at the correct location as marked on the map including: 1:24,000 USGS map, topographic landmarks, county road maps, local contacts, etc.
4. Wade upstream from the site and determine whether the site is non-target or physically inaccessible using the categories detailed in the Site Verification-Desktop Reconnaissance section. If wading upstream indicates that the site is non-target or physically inaccessible, then wade downstream from the site. If both the upstream and downstream reaches are non-target or physically inaccessible, then reject the site.
5. Complete the sampling information portion of site evaluation field sheet. The purpose of this section is to provide information to assist in determining the appropriate sampling methodology.
6. Flag the site and the access route as appropriately so that the site can be located again without the aid of a GPS unit. If the situation requires (i.e. dense vegetation) and approved by the landowner, attempt to create a path using a lopper and machete.

If the site is rejected during the final verification process, provide the site manager with the site evaluation field sheet detailing the reasons for the rejection and notify the landowner(s) who granted access permission that the site will not be sampled. All site rejections must be properly documented. If necessary, the site manager will allocate additional sites to the appropriate survey coordinators.

REFERENCES

Bent, G.C., and Steeves, P.A., 2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006-5031, 107 p., 1 CD-ROM.

ATTACHMENT 1
MAP2 Wadeable Rivers and Streams (2025 – 2028)
Site Evaluation Field Sheet

Massachusetts Department of Environmental Protection/Division of Watershed Management
Probabilistic Site Evaluation
Wadeable Rivers and Streams
2025

Step 1. Locate Site	
Site ID:	Lat/Long (Design File):
River:	Town:
Site Description	Watershed:
Step 2. Preliminary Verification – Desktop Reconnaissance	
Date:	Desktop Evaluator:
Reject Site? <input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, circle the non-target category. NW WE CB FE PI O
Estimate the level of effort that will be required to sample the site OR provide details on the reason(s) for rejection?	
Step 3. Obtain Landowner Access Permission. (Attach map with landowner information for each access option.)	
Access Permission? <input type="checkbox"/> Granted <input type="checkbox"/> Denied <input type="checkbox"/> No Response <input type="checkbox"/> Not Required <div style="border: 1px solid black; padding: 2px; display: inline-block; font-size: small;">See landowner access permission log on the back of this sheet.</div>	
Step 4. Final Site Verification (Attach map showing access path and relevant landowner information)	
Date:	Field Evaluator:
Reject Site? <input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, circle the non-target category. NW WE CB FE PI O
Describe how the site will be accessed OR provide details on the reason(s) for rejection OR other notes?	
NW=Not Wadeable, WE=Wetland, CB=Cranberry Bog, FE=Sample Frame Error, PI=Physically Inaccessible, O=Other	
Sampling Information	
Water Quality	Will a sampling pole be required at this site early in the survey season (May/June)? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Sure
Probe Deploys	Will an anchor block be required at this site? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Sure
Macroinvertebrate	Is there sufficient riffle area to collect 10 kicks? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Sure
Fish	Will a tote barge electroshocker be required for this site? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Sure
Sampling Comments/Notes	

Step 3. Landowner Permission Log							
Access Option	Name	Address	Phone	Contact Attempts	Access Permission		
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
					<input type="checkbox"/> Granted	<input type="checkbox"/> Denied	<input type="checkbox"/> Not Required
Notes/Comments/Sketches							

ATTACHMENT 2
MAP2 Wadeable Rivers and Streams (2025 – 2028)
Survey Design

Massachusetts Probabilistic Monitoring and Assessment Program (MAP2)

Wadeable Rivers and Streams Survey Design

2025-2028

Description

The goal of the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2) is to provide a comprehensive unbiased assessment of the condition of “waters” in Massachusetts through the implementation of probabilistic sampling designs. As of 2024, three probabilistic sampling designs have been completed: wadeable rivers and streams (2011-2015), lakes (2016-2018), and coastal waters (2020-2023). This survey design marks the first time the condition of a water resource type (i.e., wadeable rivers and streams) will be assessed for a second time. The survey designs for MAP2 are geographically stratified with a different stratum getting sampled each year to provide state-wide coverage and allow a statistically significant sample size with the resources available.

Monitoring Goals and Objectives

Goals:

1. Provide an unbiased assessment (Support/Impaired) of aquatic life and recreational uses in the target population.
2. Provide an analysis of trends in aquatic life and recreational uses assessments in the target population.*

*The use of a refined sampling frame for this survey design may limit this goal. Additional research is needed to determine the impact on analyzing trends.

Objectives:

1. Determine with a known statistical confidence the percentage of the target population supporting and not supporting aquatic life uses statewide.
2. Determine with a known statistical confidence the percentage of the target population supporting and not supporting recreational uses statewide.

Target Population

The target population is defined as all wadeable 1st – 5th Strahler stream order non-tidal perennial rivers and streams with a total drainage greater than 1.5 km² within the Commonwealth of Massachusetts.

Sample Frame

The sample frame for this MAP2 survey design is derived from the United States Geological Survey (USGS) National Hydrography Dataset Plus High Resolution (NHDPlus HR) National Release 1 (USGS, 2022). Once an initial shapefile that included all NHDPlus HR flowlines within the Commonwealth of Massachusetts was created, NHDPlus HR attributes (e.g., Feature Code, Total Drainage Area, Strahler Order) and other GIS shapefiles (e.g., National Wetland Inventory, NHDPlus HR waterbodies) or digital aerial imagery were used to edit the shapefile to represent the target population more accurately. The goal of the editing process was to reduce over-coverage (i.e., inclusion of flowlines that are not part of the target population) in the sample frame while not creating significant under-coverage (i.e., exclusion of flowlines that are part of the target population) in the sample frame. As a result, the sample frame will still have some over-coverage that will be resolved using the site evaluation process. Details of the

editing process and a table summarizing the rejection reasons by feature code are provided in Appendix A. The total sample frame length is 10,092 kilometers (6271 miles).

Survey Design

A Generalized Random Tessellation Stratified (GRTS) survey design with stratification and unequal inclusion probabilities for an infinite resource is used for this MAP2 survey design. The design includes reverse hierarchical ordered of replacement sites (i.e., over-sample).

GRTS Characteristics (as taken from [EPA-ORD-NHEERL-WED-Aquatic Resource Monitoring webpage](#))

1. Spatially balances sample across the resource (improved precision)
2. Enables design-based estimators including variances.
 - a. Precise control over inclusion probabilities
 - b. Element & region variable probability assignment
 - c. Joint inclusion probability can be determined.
3. Controls sample and subsample spatial balance
4. Nested subsamples easily selected.
5. Unified theory for point, network, and areal resources such as lakes, streams, and coastal waters

GRTS Design Options (as taken from [EPA-ORD-NHEERL-WED-Aquatic Resource Monitoring webpage](#))

1. Multiple density categories to allocate samples, supports unequal selection probability.
2. Nested subsamples for measuring additional indicators or duplicate samples.
3. Panels for monitoring over time
4. Over-sample selection to address non-target and inaccessible sites.
5. Special study areas within study-wide design
6. Explicit stratification
7. Incorporate multiple stage sampling.

Stratification

This MAP2 survey design is stratified by four geographic regions (or strata) based on major basins in the Commonwealth of Massachusetts to improve sampling logistics (Figure 1). One stratum will be targeted and sampled each year from 2025 to 2028, starting with the Southeast stratum in 2025 and concluding with southeast in 2028.

Unequal Inclusion Probability Categories (Multi-density Categories)

This MAP2 survey design uses unequal inclusion probability categories in all strata. Five unequal probability categories are defined based on Strahler stream order (1st, 2nd, 3rd, 4th, 5th) to ensure river and stream sizes with low representation in the target population are included in the survey. Unequal inclusion probabilities are executed by targeting a sample size by unequal inclusion probability category in each stratum.

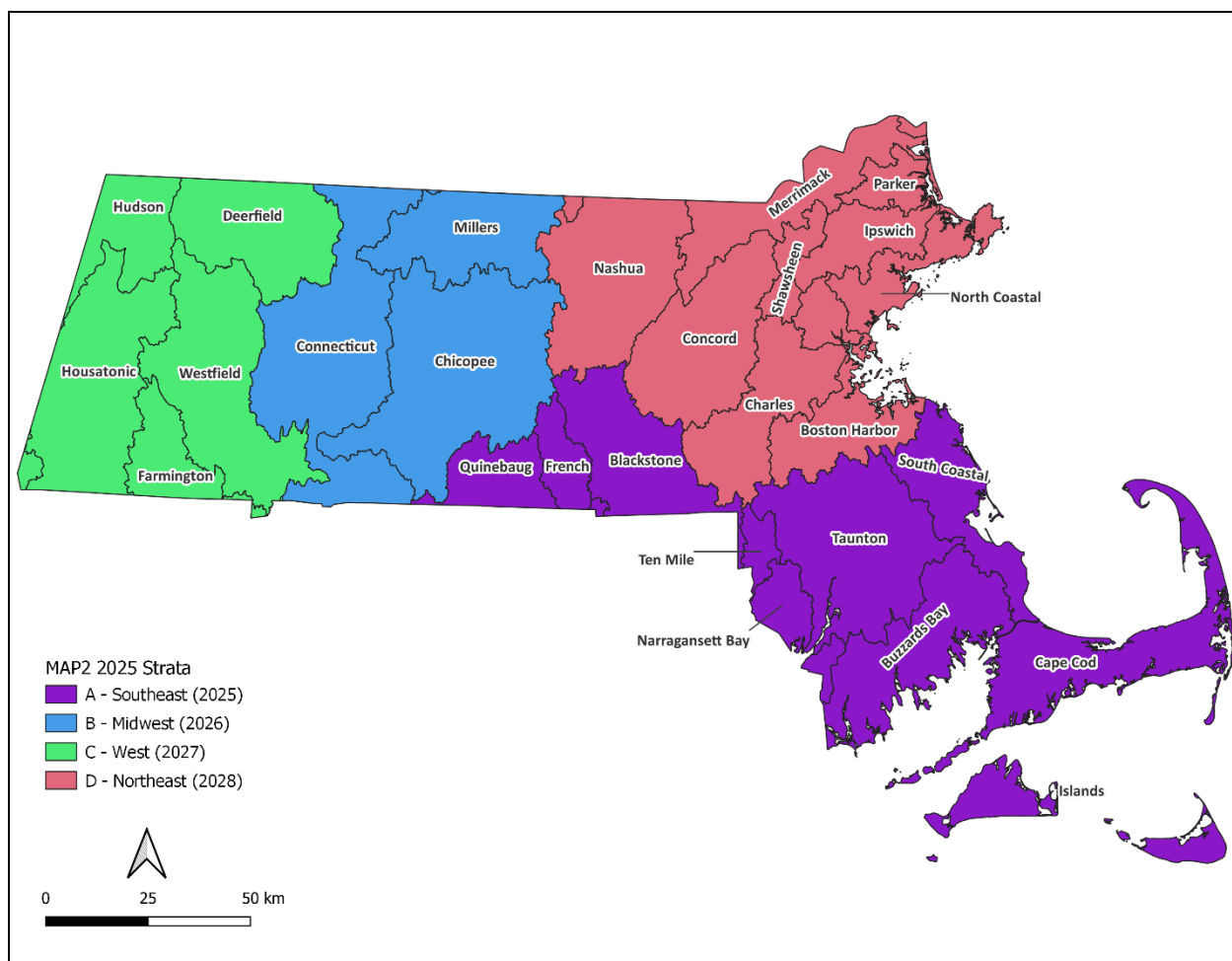


Figure 1. MAP2 Wadeable Rivers and Streams 2025 - 2028 Strata

Panels

This MAP2 survey design is a single panel design.

Expected Sample Size

The designed sample size is a total of 80 site for the state with 20 sites in each stratum. In addition, 60 oversample sites were selected in each stratum. The sample size within each stratum for the unequal probability categories is described in Table 1. The rationale for this assignment of sample sizes in the unequal probability categories is to ensure river and stream sizes with low representation in the target population are included in the survey while not deviating significantly from the Strahler stream order proportions in the sample frame.

Table 1. Target sample size in each stratum by Strahler stream order for unequal inclusion probabilities.

Strahler Stream Order				
1st	2nd	3rd	4th	5th
4	5	5	3	3

Site Use and Replacement

Each site selected to be sampled is given unique site identification (site ID). Site numbers consist of the project abbreviation (MAP25) and a number between 001 and 320. Within each stratum, sites evaluated for potential sampling must have all site IDs from the largest to the lowest number evaluated.

For example, if MAP25-262 is the largest site ID evaluated within the northeast stratum, then all site IDs that are lower than 262 within the northeast stratum must be evaluated. Even more critical is that if MAP25-262 is the largest site ID that is actually sampled in the field, then all lower site IDs within the northeast stratum that are evaluated as part of the target population and are accessible must be sampled in the field.

Sample Frame Summary (km)

	Strahler Stream Order					
Stratum	1 st	2 nd	3 rd	4 th	5 th	Total
Southeast	350	748	655	365	215	2333
Midwest	555	878	574	301	167	2475
West	636	889	532	352	221	2630
Northeast	504	809	670	343	328	2654
Total	2045	3324	2430	1361	931	10092

Site Selection Summary (Site Selection)

		Strahler Stream Order					
Site Use	Stratum	1 st	2 nd	3 rd	4 th	5 th	Total
Base	Southeast	4	3	8	1	4	20
	Midwest	5	6	4	3	2	20
	West	3	5	8	1	3	20
	Northeast	4	5	5	3	3	20
	Total	16	19	25	8	12	80
Oversample	Southeast	11	16	16	8	9	60
	Midwest	8	15	15	9	13	60
	West	11	10	15	14	10	60
	Northeast	5	19	18	10	8	60
	Total	35	60	64	41	40	240

Description of Sample Design Output

Variable	Description
siteID	A site identifier (as named using the DesignID and SiteBegin arguments to grts()).
siteuse	Whether the site is a legacy site (Legacy), base site (Base), reverse hierarchically ordered replacement site (Over), or nearest neighbor replacement site (Near).
replsite	The replacement site ordering. replsite is None if the site is not a replacement site, Next if it is the next reverse hierarchically ordered replacement site to use, or near, where the word following _ indicates the ordering of sites closest to the originally sampled site.
lon_WGS84	Longitude coordinates using the WGS84 coordinate system (EPSG:4326). Only given if coordinates are projected.
lat_WGS84	Latitude coordinates using the WGS84 coordinate system (EPSG:4326). Only given if coordinates are projected.

Variable	Description
stratum	A stratum indicator. stratum is None if the sampling design was unstratified. If the sampling design was stratified, stratum indicates the stratum.
wgt	The design weight.
ip	The site's original inclusion probability (the reciprocal) of (wgt).
caty	An unequal probability grouping indicator. caty is None if the sampling design did not use unequal inclusion probabilities. If the sampling design did use unequal inclusion probabilities, caty indicates the unequal probability level.

Statistical Analysis/Reporting

The survey design and statistical analysis will be conducted with spsurvey, a R software package originally developed by U.S. EPA EMAP Design Team and currently updated and maintained by Michael Dumelle at U.S. EPA. The spsurvey package is used for spatial probability survey design and analysis and implements the Generalized Random Tessellation Stratified (GRTS) algorithm to select spatially balanced probability samples. The spsurvey package also implements population parameter estimation using a suite of analysis approaches, including categorical variable analysis, continuous variable analysis, relative risk analysis, attributable risk analysis, risk difference analysis, change analysis, and trend analysis. This package is used by U.S. EPA to design and analyze the National Aquatic Resource Surveys (NARS).

The primary product of the statistical analysis will be an estimate on the portion of the target population in each assessment category (Support, Impaired, and Not Assessed). Details of other statistical analysis to be completed will be determined later in the design phase but could include population means and variance, cumulative distribution function (CDF) estimates of a variable and testing for difference of two CDF.

Appendix A

Sample Frame Creation

Note: Final code and determination for each flowline is stored in the attribute table (field name: Final) of the draft sample frame (2025_SampleFrame_Draft_Project.shp).

- Eliminated USGS National Hydrography Dataset Plus High Resolution (NHDPlus HR) coded coastlines (Feature Code: 56600). Final code = NCL
- Eliminated all NHDPlus HR coded intermittent streams (Feature Code: 46003). Final code = NI
 - A small number of flowlines with other feature codes (e.g., 55800) were eliminated as associated with intermittent streams. These were primarily flowlines bracketed up and down stream by intermittent streams (46003).
- Eliminated all NHDPlus HR flowlines (Feature Codes: All) with a total drainage area (totdasqkm in attribute table) less than 1.5 km². Final code = NIE
- Eliminated all NHDPlus HR coded pipelines/aqueducts (Feature Codes: 42801, 42803, and 42807). Final code = NPL
 - A small number of flowlines with other feature codes (33400, 46006, 55800) were eliminated as pipelines/aqueducts. These were primarily very short flowline pieces associated with the pipeline/aqueduct feature codes. All of these flowlines totaled 1.6 miles.
- Eliminated NHDPlus HR flowlines associated with artificial canals (Feature code: 33600, 46006, 55800). Final code = NCN. All of these flowlines totaled 9 miles.
- Eliminated all NHDPlus HR flowlines (Feature Codes: All) completely within National Wetland Inventory (NWI) Estuarine/Marine Wetland or Deepwater. Final code = NTD
 - Eliminated flowlines predominately in NWI Estuarine/Marine Wetland or Deepwater. On rare occasion when the majority of the flowline was outside the flowline was cut at the NWI Estuarine/Marine Wetland or Deepwater boundary and only a portion was eliminated. Final code = NTD
- Eliminated NHDPlus HR artificial pathways (Feature Code: 55800) associated with NHDPlus HR waterbodies (Lake/Ponds/Estuaries) or NWI open water classifications. Final code = NWB
 - Reviewed eliminated artificial pathways not associated with NWI lacustrine and palustrine unconsolidated bottom and added back if appropriate (i.e., no open water visible in aerial photos). Final Code=Y
 - Reviewed eliminated artificial pathways associated with existing river Assessment Units and added back if appropriate (i.e., no open water visible in aerial photos). Final Code = Y
- Eliminated NHDPlus HR connectors and artificial ditches (Feature Code: 33400 and 33600) associated with cranberry bog operations (i.e., running through cranberry bogs). Final Code = NCB
 - A small number of flowlines with other feature codes (46006 and 55800) were eliminated as associated with cranberry bog operations. All of these flowlines totaled 3.7

miles. These were primarily very short flowline pieces bracketed up and down stream by connectors and artificial canals/ditches.

- Some connectors and artificial ditches (Feature Code: 33400 and 33600) associated with cranberry bog operations were not eliminated if evidence indicates the flowlines were once a natural river or stream. All of these flowlines totaled less than 60 miles. This was based on a few factors:
 - The connector and ditch flowline had a GNIS name.
 - The connector and ditch flowline represented a river or stream that was an existing assessment unit.
 - The connector and ditch flowlines were outside of cranberry bog operations.
- Eliminated NHDPlus HR flowlines that flow underground (Feature codes: 33400, 55800, 33600). Final Code = NUG
 - Almost all eliminated flowlines were 33400 (34.0 miles) with just 2.7 miles attributed to 55800 and 33600.
- Eliminated NHDPlus HR flowlines that over-represent a single stream channel or are isolated from the stream network (e.g., old oxbows, braids, stream bend cut throughs, isolated flowlines not connected). Final Code=NX
 - Named flowlines were selected over unnamed flowlines when removing over-representation.
 - Eliminated as encountered so more could be present in final sample frame.
- Eliminated flowlines with Strahler stream order > 5. Final Code=YSO
- Any NHDPlus HR flowlines not excluded in previous steps were included in the sample frame. Final Code=Y
- Exported all flowlines with a Final code of Y into the final sample frame shapefile (*2025_SampleFrame_Final.shp*).
- Add design strata (e.g., Southeast, West) to the shapefile (*2025_SampleFrame_Final_Strata.shp*).
- See Table on next page for final decision code by feature code.

Table 1. Summary of feature codes and final determinations for inclusion or exclusion from the sample frame (in kilometers).

Feature code	Final Decision Code												
	NCB	NCL	NCN	NI	NIE	NPL	NTD	NUG	NWB	NX	Y	YSO	Total
33400	67.71				469.33	0.04	3.98	55.77	12.86	3.44	61.11	0.16	674.40
33600	20.52		0.99		113.56		30.48	4.01	2.87	7.71	34.96		215.10
33601											0.01		0.01
42801						26.63							26.63
42803						92.33							92.33
42807						65.32							65.32
46000					1.95		0.42		0.16	1.00	1.93		5.46
46003				5932.70							0.57		5933.27
46006	5.61		0.34		4064.35	2.17	1075.22		37.91	51.55	8334.95	2.13	13574.23
55800	1.44		13.10	1.86	1763.56	0.32	506.74	0.27	1938.37	7.98	1658.64	476.46	6368.74
56600		2306.85			0.02								2306.87
Total	95.28	2306.85	14.43	5934.56	6412.77	186.81	1616.84	60.05	1992.17	71.68	10092.17	478.75	29262.36

ATTACHMENT 3

MAP2 Wadeable Rivers and Streams (2025 – 2028)

Example Letter Requesting Access Permission and Return Postcard



Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

100 Cambridge Street Suite 900 Boston, MA 02114 • 617-292-5500

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

January 10, 2025

John Doe
123 Alphabet Avenue
Norwell, MA 02061

Dear Property Owners:

The Massachusetts Department of Environmental Protection (MassDEP), through its Watershed Planning Program, regularly conducts environmental monitoring of rivers and streams across Massachusetts. For intended monitoring activities in 2025, eighty river and stream monitoring sites were selected throughout the state using an automated and randomized process to identify potential sites. According to parcel maps and aerial photos, MassDEP staff would need to access your property to reach one of the potential sites located on Wildcat Brook in Norwell, MA, Site ID: MAP25-081 (see enclosed map). The purpose of this letter is to request access permission to conduct the stream monitoring. We realize that accessing your property is a privilege; therefore, we will respect your rights and wishes at all times.

Water resources such as rivers and streams are vital to the Commonwealth. If healthy, these systems provide a variety of beneficial uses and services that support aquatic life, sustain natural habitat, and promote public health. MassDEP is the state agency charged with the duty and responsibility to protect public health and enhance the quality and value of the Commonwealth's water resources. The goal of the monitoring is to collect sufficient data to determine the health status of rivers and streams throughout the Commonwealth. MassDEP staff will monitor water chemistry, aquatic life, and habitat conditions at each of the selected sites to achieve this goal. Monitoring activities will involve approximately ten site visits between April and October 2025, with most visits lasting approximately 20 minutes to collect water samples. On two of the site visits, MassDEP staff will spend up to two hours at the site collecting biological samples (i.e., aquatic insects and fish present at the site). All monitoring will occur on weekdays during regular business hours.

Please complete and mail the enclosed self-addressed and stamped access permission postcard granting or denying MassDEP permission to access your property by February 3, 2025. You can also contact me directly at James.Meek@mass.gov or 617-780-4149 to grant or deny permission. In addition, feel free to contact me with any questions. Thank you for your consideration of this request.

Sincerely,

James Meek
Environmental Analyst
Watershed Planning Program
8 New Bond Street
Worcester, MA 01606



James Meek
Department of Environmental Protection
Watershed Planning Program
8 New Bond Street
Worcester, MA 01606

**MassDEP: Environmental Monitoring of Rivers and Streams
2025 Property Access Permission Postcard 032 (Site ID: MAP25-081)**

☐ YES, I grant MassDEP permission to access my property to conduct the described stream monitoring.

Are there any conditions or instructions MassDEP must follow when accessing your property? If so, please provide information below.

☐ NO, I deny MassDEP permission to access my property to conduct the described stream monitoring.

Signed: _____

Date:

Property Owner Name
