New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB)

Standard Operating Procedure (SOP) for

PROBABILISTIC MONITORING SURVEYS

Approval Signatures

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1.0 Purpose and Scope

The purpose of this procedure is to describe the process for designing and conducting probabilistic sampling projects. Probabilistic monitoring utilizes a randomized sample design to provide an unbiased evaluation of the condition of a defined population of surface waters. Probabilistic sampling entails collecting selected parameters and measurements at each sampling site to meet project goals and objectives. For example, SWQB's 2019-2021 watershed-based probabilistic surveys included the collection of physical habitat measurements, benthic macroinvertebrate samples, flow data, sonde instantaneous measurements and both chemical and bacteriological samples at each sampling site that SWQB utilized in the Integrated Report to determine water quality condition for select parameters in the study watersheds.

2.0 Personnel Responsibilities

The Monitoring, Assessment, and Standards Section (MASS) Program Manager is responsible for ensuring that sufficient resources are allocated to complete program commitments, that monitoring activities support protection of the surface waters of New Mexico and that grant deliverables are fulfilled.

The Project Manager is responsible for organizing and planning data collection activities and ensuring monitoring activities adhere to applicable SOPs and Sampling and Analysis Plan (SAP).

The Project Team is responsible for exclusion of sample sites through office and field reconnaissance, and for field sample measurements and sample collection; preparation and submittal of samples to state and/or contract laboratories; entering sampling information into the Bureau's database. Responsible for performing QA checks on data entry and calculations.

The Quality Assurance Officer (QAO) is involved in the development and revision of this SOP to ensure the SOP meets the requirements of the SWQB's Quality Assurance Project Plan. The QAO, along with the Project Manager and Program Manager will determine if any revisions to this SOP are needed at a minimum of every two (2) years in accordance with SOP 1.1 for the Creation and Maintenance of SOPs (https://www.env.nm.gov/surface-water-quality/sop/). Pending the review and approval of the document, the QAO will ensure the SOP is accessible through the SWQB's website.

Personnel who conduct probabilistic monitoring, data verification and validation activities or supervise those who do must be familiar with this SOP and all SOPs related to the type of field data and samples they are collecting.

3.0 Background and Precautions

3.1 Background

The SWQB utilizes probabilistic monitoring to achieve the objectives of assessing the condition of a specified category of surface waters. Sampling sites are randomly selected, and each sampling site is intended to represent a specific portion of the specified category of surface waters. Because sites are selected randomly, the results from the sample population can be extrapolated to the entire population and be used to make unbiased condition assessments of the specified category of surface water without monitoring every waterbody in the population.

3.2 Procedural Precautions

These are dependent upon the specified category of surface water and selected parameters and field measurements of interest. Refer to the appropriate SWQP SOPs.

If other stream sampling work is to be done simultaneously or prior to the collection of water samples, collect water samples at enough distance upstream to prevent interference or wait for disturbed water to flow past the collection site.

3.3 Safety Precautions

Wading across a stream bed can be very dangerous depending on flow and substrate conditions. Do not attempt to wade into a stream if the depth (in ft) multiplied by the velocity (in ft/s) equals or exceeds 10 square feet per second (ft^2/s). For example, a stream that is 2 ft deep, and has velocities of 5 ft/s or more, should be considered too dangerous to wade. If you unknowingly start to take measurements and discover part of the way across that you violate this rule ("the rule of ten"), return to the nearest bank and note "too fast/deep to measure" on the field form. Do not attempt to wade a stream if you feel it is unsafe, regardless of the outcome of the "rule of ten." Some wadeable streams may be unwadeable during spring runoff but will be wadeable when base flow resumes and during the period (August 15-November 15) in which probabilistic monitoring will occur. Refer to SWQB's Job Hazard Analysis (JHA) for further safety precautions when conducting field work.

Some channels have quicksand-like areas, deep holes, sharp rocks, excessive fallen logs, etc., that can lead to foot entrapment, injury, or falls. A wading rod, surveyor's rod, ski pole, or stick can be used for stabilization and to probe the streambed when conditions are uncertain. Staff should use best professional judgement to assess risks involved with data collection. Refer to SWQB's JHA for further safety precautions when conducting field work.

Field staff should exercise their professional judgement regarding all sampling conditions and whether to begin or continue traveling to a field site or conduct sampling. Field staff should not risk traveling to remote sites during weather events such as severe monsoon rainstorms or snowstorms and should not sample during nearby thunderstorms. Sampling should be rescheduled or delayed accommodating unsafe conditions. Field staff should alert their supervisor on their sampling plan for the day and carry a cellphone at all times in case of emergency. Field staff should carry driving directions, a navigation device, and a map of the area surrounding the site for navigating.

It is recommended that field staff use gloves when conducting field measurements in waters suspected of having high bacterial contamination. If a wastewater treatment plant (WWTP) is upstream of a site, check with staff from the SWQB Point Source Regulation Section to determine if the plant is properly treating wastewater before discharging to the water course. If available, review data from routinely sampled stations to see if there have been elevated levels *E. coli.* Watercourses receiving untreated water should be avoided.

4.0 Definitions

For common definitions and acronyms not defined in this SOP, refer to the most up to date SWQB Quality Management Plan for Environmental Information Operations.

Instantaneous measurements – An instrument reading collected manually at a single point in time. Synonymous with a grab measurement.

Sample Population – The entire group that you want to draw conclusions about. For example, the 2019 – 2021 watershed survey-based sampling population was perennial, wadeable streams and rivers in New Mexico within a specific watershed as defined in the SWQB Comprehensive Assessment and Listing Methodology, or CALM, for Sedimentation (NMED/SWQB 2023).

Sampling and Analysis Plan (SAP) – A document that details the procedural and analytical requirements for a one-time or time-limited project. A SAP contains all the elements of a QAPP and a FSP that must be provided to meet the requirements for any project funded by the EPA under which environmental measurements are to be taken

Sampling Frame – A researcher's list or device to specify the population of interest. It's a group of components that a researcher can use to select a sample from the population. For example, the 2019 – 2021 watershed survey based sampling frame consisted of approximately 25,000 500-meter presumed wadable, perennial stream increments in New Mexico.

Sampling queue – Thirty sites within a specific watershed that are selected from the sample population using the "Probabilistic Stream and River Site Criteria" listed in this SOP.

5.0 Equipment and Tools

These are dependent upon the specified sample population and selected parameters and field measurements of interest. Refer to the appropriate SWQB SOPs.

6.0 Step-by-step Process Description

6.1 Office Procedures (Prior to field work)

Systematic planning for environmental data collection as detailed in the SWQB QMP is utilized for the development of a SAP for probabilistic monitoring activities (NMED/SWQB 2024a). Probabilistic sampling entails collecting data related to the parameter(s) of interest at each probabilistic sampling site.

6.1.1 Developing a Sampling Population from the Sample Frame

The first step in systematic planning for probabilistic monitoring is developing a statistically sound sampling frame from a target population. The target sample population for SWQB probabilistic sampling is defined in the current probabilistic monitoring survey's SAP. Potential sampling sites are randomly generated from the sample frame by staff at the EPA National Health and Environmental Effects Research Laboratory in Corvallis, OR, within the specific watershed by computer using USGS National Hydrography Dataset (NHD) Plus (a stream network coverage at the 100k scale) as a sample frame, which is then validated with SWQB information. This process occurs externally and is outside the scope of this SOP.[1] See the SWQB MASS Program Manager or Project Manager for further information regarding the probabilistic sampling frame and generation of a sampling population. For example, during the 2019-2021 watershed survey-based studies, random site generation produced 300 sites for a specific watershed from the sampling frame selected for each year of the survey with the first thirty sites serving as the sample population (base sites) and the remaining 270 sites as alternates (overdraw sites). Each probabilistic sampling site was a point (longitude and latitude) along the stream length determined during the development of the sampling population.

The entire population list for the probabilistic monitoring must be included in a SAP as an appendix. The SWQB Project Manager will lead the effort to individually validate sampling sites from the sampling population, beginning with the first 50 (per EPA's recommendation) and working consecutively down the list until 50 suitable probabilistic monitoring sites are found and placed in the sampling queue. An excel file containing a site ID, stream name (if available), latitude and longitude, Hydrological Unit Code (HUC), SWQB Assessment Unit (AU) (if available) name and comments, Water Quality Standards (WQS) reference, ecoregion, and other pertinent information is generated as part of the sampling frame and made available to SWQB staff assisting with the survey. The site ID for each location is provided in the following format: NM[*last two digits of survey year*]-[*number indicating order in which site was randomly generated*] (e.g., NM20-10302). This naming convention should be adapted to include the stream name at the beginning of the site ID once the stream name has been identified. For example, probabilistic site NM20-10302 in the Gila River selected for sampling in the year 2020, would become Gila-NM20-10302.

6.1.2 Site Selection and Elimination

Once a sample population has been made available, the next step in systematic planning for probabilistic monitoring is determining which sites can actually be sampled. The SWQB Project Manager will lead the effort to individually validate sampling sites from the sampling population, beginning with the first 50 (per EPA's recommendation) and working consecutively down the list until 50 suitable probabilistic monitoring sites are found and placed on the list of sites to be sampled, or the sampling queue. Once sampling commences, if a site in the sampling queue is deemed unsuitable due to unforeseen conditions, continue down the sampling population list until the next suitable site is determined. In order to determine sampling feasibility for each site, utilize the Probabilistic Site Criteria and Accessibility Criteria for probabilistic monitoring as defined in applicable SAP for probabilistic monitoring. If a site does not meet the criteria, it should be excluded from the sampling queue. GIS

[1] EPA's National Aquatic Resource Surveys website contains several manuals and additional references related to probabilistic survey designs at: https://www.epa.gov/national-aquatic-resource-surveys/manuals-used-national-aquatic-resource-surveys.

programs, such as ArcMap, can be used to exclude sites due to accessibility. Excluded sites should be replaced by alternate sites in successive order. If staff are unsure about the eligibility of a site for sampling they should consult with their supervisor and other field staff for secondary opinions and make every reasonable effort to gain more information about the site before ruling it out for sampling (i.e., contacting the forest service, landowner, land grant, or some other person familiar with the area etc.).

Systematic sampling site determination
Beginning with the first 50 of the possible sites, view satellite imagery using the online SWQB mapping tool or another online imagery application (e.g., Google Earth) to determine whether a site meets target population criteria, accessible, sufficient in length, and whether landowner permissions are needed. Select sites in order of occurrence, starting with site number one (1) until 50 sites have been determined to meet the, for example, Probabilistic Site Criteria and the Accessibility Site Criteria, and have been placed in the sampling queue.

Probabilistic Site Criteria – Sample population must meet the target population criteria as defined in applicable SAP along with the following procedure:

- Sites must be selected or eliminated in numerical order from the provided list. Sites may not be selected or eliminated preferentially (for instance, because they appear to have easier access than sites occurring earlier on the list or alternatively lie within an undesirable location).
- Satellite imagery (e.g., Google Earth), the SWQB Mapper application, or stream gauge data (if available) can help staff determine whether a site meet requirements defined in applicable SAP.
- If physical habitat or periphyton are a parameters of interest, a sufficient length of stream either beginning or ending within 500 meters of stream length from the site of the GPS coordinates should be available for sampling per SWQB SOPs. This means that at least 160 meters or at least 40 times the average width of the stream should be available, accessible, wadeable, and not include any tributaries.
- A site that has 100% of its flow from WWTP effluent and has been shown to routinely exceed the primary contact single sample of 410 cfu/100 mL or MPN/100 mL may be excluded. A site may also be excluded if an upstream WWTP is known to not be treating wastewater before discharge.

Probabilistic Accessibility Criteria – accessibility outside these conditions may be considered on a case-by-case basis.

- Sites should be within a 1-hour hike from the vehicle (approximately 2 miles via hiking trail or open and even terrain along a stream bank, or approximately 0.5 miles via backcountry bushwhack). A site greater than 2 miles from vehicular access via hiking trail or greater than 0.5 mile via bushwhack access can be automatically eliminated from the site sampling list.
- Sites should be within 2-hours of a road traversable in inclement weather. Oftentimes, there are forest service roads visible on the map or satellite imagery, but such roads may be closed. Consult the Forest Service travel management map for up-to-date road closures or call the local ranger district.
- If the sample population contains non-wadeable rivers or stream segments, truck access to boat launches and takeouts should be taken into consideration.

- Sites should be either on public land or private land for which property ownership can be determined and permission for entering the property can be obtained.
- If mailers requesting landowner permission for sampling streams have not been returned within 30 days of being sent out, then the site is determined to be inaccessible and the next site should be considered.
- No foreseeable physical barriers to sampling the site exist. Examples of physical barriers to sampling could be waterfalls, cliffs, streams consistently too deep to wade (if parameter of interest includes physical habitat measurements), or a stream that has become impounded for instance, by a beaver dam or other unsurmountable obstacles that make sampling either dangerous or impossible. If there are physical barriers prohibitive to hiking into the site or sampling the site other than landownership issues (e.g., a gated road), sites may be automatically eliminated from the sampling list. Sites should be promptly eliminated for sampling if they fall inside private property and landowner permission to sample is not granted.

Topographic maps may also be used, combined with satellite imagery, to aid in determining whether stream gradient is too steep or the terrain traveling into the stream is impossible to reasonably traverse. Best professional judgment should be exercised when determining what terrain and conditions field staff are capable of traveling and sampling in. Time permitting, field reconnaissance of the site is highly encouraged. Field safety precautions should be used at all times to determine whether sampling should take place.

6.1.3 Mailers

Use a county assessors' online tool or a landownership application to determine land ownership. Permission to sample must be granted by private landowners and/or land grant leadership before sites can placed in the sampling queue. Mailers with a letter explaining the survey and the location of interest, as well as a post card with pre-paid postage granting or denying the SWQB permission should be mailed out to landowners and/or land grants no later than 6 weeks before surveying commences. An easy way to create a large shipment of mailers with many associated addresses is to use the "mail merge" function in Microsoft Word. See "mailers" instructions sheet on the SOP webpage under "related SOP forms."

6.1.4 Endangered Species and Special Permits

All streams and tributaries should be checked for possible endangered species using the U.S. Fish and Wildlife Service Environmental Conservation Online System[2]. This online tool indicates where threatened and endangered species are known to be located. If there is a threatened or endangered species located in an area where a potential site is located, and sampling activities have detrimental impacts on the species or its habitat, a special permit must be obtained prior to sampling.

6.1.5 Scheduling

All sampling sites making up the sampling population for the current year probabilistic monitoring are included in the applicable SAP for the probabilistic monitoring survey. The SAP for the current year's

[2] Available at: https://ecos.fws.gov/ecp/report/table/critical-habitat.html

survey is used for generating a sampling schedule and is critical for project management. Typically, a team of two or three staff conduct probabilistic sampling depending on the parameters and data to be collected. Site conditions, access, proximity of sites, and landowner permissions and schedules must all be accounted for when determining sample schedule. Additionally, considerations for chemical and benthic macroinvertebrate sample hold times and submittal to the laboratory, as well as SWQB's Biological Index Period, should be taken under consideration when arranging the sampling schedule if these are parameters of interest in the survey. Refer to relevant SWQB SOPs for details.

6.2 Logistics and Field Data Collections

Data to be collected at each sample location includes all parameters of interest identified in the project SAP. For detailed protocols on how to collect data of interest please refer to the appropriate SWQB SOP. All SWQB SOPs can be found at https://www.env.nm.gov/surface-water-quality/sop/. All data collection and measurements are recorded on field forms that can be found under Related SOP Forms next to their associated SOP.

6.2.1 Site Verification

Each probabilistic sampling site is a point (longitude and latitude) along the stream/river length determined during the development of the sampling population as stated previously. Sampling teams should use all available means to ensure that they are at the correct site location by verifying latitude and longitude using mobile GIS programs, maps, or a navigation device.

For Probabilistic Monitoring, all data collection at a specific sampling site should be performed concurrently but no greater than 48 hours apart. Once a particular survey (e.g., pebble count) has been started by an observer, the initial observer will be required to complete the survey in its entirety for that sampling site. Observers may change from one particular survey to another at each sampling site (e.g., one observer may collect data for the pebble count survey and a different observer may collect data for percent canopy cover survey for the same sampling site).

6.2.2 Reach Selection (if SAP includes physical habitat measurements or periphyton collection)

Reaches may be adjusted to fall within 500 meters of stream length (beginning or ending) from the site's GPS location, provided adjusting the sample location does not cause the reach to intersect with a stream confluence. Prior to field work, use an online imagery application to identify points 500 steam length meters upstream and downstream of the sampling site. Do not adjust the reach location to avoid human disturbances like bridges, culverts, rip/rap, or channelized areas (a key difference from SOP 5.0 Physical Habitat Measurements). If probabilistic sampling sites occur near enough to each other along the same stream, stream reaches may overlap. In this case, if it is possible to shift a stream reach upstream or downstream to begin within 500 meters of stream length from the probabilistic site GPS coordinates field staff should do so and otherwise proceed normally with sampling. Include GPS coordinates from the top and bottom of the reach (Transect A and Transect E) on the data sheets so that discrepancies between actual sample location and the assigned site are recorded.

6.2.3 Photo-documentation

It is essential to take several photos of the reach condition and any disturbances or modifications that are relevant to data collection and assessment. Use a camera with GPS capabilities so that locations are collected with the metadata. Once back from the field, download photos into the project file.

6.3 Field Verification of Data Sheets for Completion and Accuracy

Prior to departing the probabilistic sampling site ensure that all applicable data forms are present and complete. Verify that sampling location information such as station ID, field data, GPS coordinates from the top and bottom of the reach, and field staff are recorded.

7.0 Data Entry/Management

Enter all field form data into appropriate electronic field forms when returning to the office (forms can be found on the SWQB SOP website). Save these forms in the electronic project folder. Save paper copies in the project binder stored at the SWQB office. Refer to SOP 15.0 for data verification and validation procedures.

7.1 SQUID Probabilistic Sampling Event Creation

7.1.1 Creating a New Sampling Station in SQUID

Because probabilistic sample locations are randomly generated, pre-existing or historic SWQB sampling stations may not exist for probabilistic sites and new stations may need to be created in SQUID prior to sampling event and data upload. Occasionally, a new assessment unit (AU) will also need to be created to accompany the new station (contact the Bureau assessment coordinator for the creation of new assessment units) if the stream in question has no associated data in SQUID. See the SWQB project manager or SQUID manager administrator for permissions for creating new stations and adding new stations to a project folder. Refer to the SWQB SQUID manual for further instruction on creating a new sampling station.

7.2. Uploading Data to a Sampling Event in SQUID

Refer to the applicable SWQB SOP for guidance on uploading data to a Sampling Event.

8.0 QA/QC

The SWQB controls the quality of the probabilistic field data by using standardized methods that are documented in the associated SOPs. All personnel who collect probabilistic monitoring data must be familiar with these protocols, sign the acknowledgment form associated with this specific SOP and collect data in accordance with the procedures as they are defined in this SOP and all other applicable SOPs. In addition to standardized methods, proper training of field personnel represents a critical aspect of meeting the data quality objectives to fulfill the goals of the SWQB's QAPP (NMED/SWQB 2024b).

Assurance of field data collection for probabilistic monitoring are done through adherence to the process outlined in this and other applicable SOPs and oversight of the process by the QAO. If at any time the QAO determines this process is not being adhered to, the QAO has the authority to cease activities specific to this SOP with prior support and approval by the SWQB Bureau Chief and MASS Program Manager, until such a time that the issue can be resolved.

9.0 Related SOPs and Forms (dependent on parameter of interest)

Field Equipment Checklist
SOP and field forms for physical habitat measurements
SOP and field forms for chemical sampling

SOP for stream flow sampling
SOP for benthic macroinvertebrate sampling
SOP for sonde measurements
Hydrology Protocol
WQMP/CPP

10.0 Revision History

• Revision 0. March 20, 2020. Original.
Miguel Montoya, QAO; Meredith Zeigler, SME; Kristopher Barrios, Program Manager.
• Revision 1. November 19, 2021. The numbering of the SOP has been changed from 17.1 to 13.1 to align with revisions approved in the 2021 SWQB QAPP. The SME for the SOP has been updated to reflect current staff responsibilities. References updated throughout the SOP to reflect the most up to date SWQB WQMP/CPP, QMP, QAPP and CALM.
Miguel Montoya, QAO; Elizabeth Stuffings, SME; Kristopher Barrios, Program Manager.
• Revision 2. January 31, 2022. Better define the 500 meters from a site as 500 meters of stream length. Update safety concerns and site exclusion due to untreated wastewater. The definition for SQUID has been updated to better describe the internal database. Reference to the HP was revised so that the procedures align with the 2020 WQMP/CPP.
• Revision 3. December 31, 2024. Broaden description of probabilistic monitoring from the 2019-2021 approach to acknowledge specific SOPs depend on the sampling population and parameter(s) of interest as detailed in the associated SAP. Added endangered or threatened species mapper and special permit application.

11.0 References

New Mexico Environment Department / Surface Water Quality Bureau (NMED/SWQB). State of Mexico Surface Water Quality Bureau Standard Operating Procedure. Available at: https://www.env.nm.gov/surface-water-quality/sop/.

NMED/SWQB. 2020. State of New Mexico Statewide Water Quality Management Plan and Continuing Planning Process. Available at: https://www.env.nm.gov/surface-water-quality/wqmp-cpp/.

NMED/SWQB. 2023 Comprehensive Assessment and listing Methodology (CALM). Available at: https://www.env.nm.gov/surface-water-quality/calm/.

NMED/SWQB. 2024a. Quality Management Plan for Environmental Data Operations [QMP]. Available at: https://www.env.nm.gov/surface-water-quality/protocols-and-planning.

NMED/SWQB. 2024b. Quality Assurance Project Plan for Water Quality Management Programs. Available at: https://www.env.nm.gov/surface-water-quality/protocols-and-planning.