**Measurable Results Project**

**Comprehensive Sample and Analysis Procedure Plan**

Colorado Watershed Assembly

Contracting Entity

March 29, 2012

Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Nonpoint Source Project Manager Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Nonpoint Source Project Quality Assurance Officer Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

CDPHE NPS Program Coordinator Date



# A - Sampling Project Management

A-2 -- Table of Contents

Contents

[A - Sampling Project Management 2](#_Toc320783875)

[A-2 -- Table of Contents 2](#_Toc320783876)

[A-3 -- Distribution List 4](#_Toc320783877)

[A-4 -- Sampling Project or Task Organization 4](#_Toc320783878)

[A-5 -- Problem Definition / Background – Sampling Needs 5](#_Toc320783879)

[I – Problem Statement: 5](#_Toc320783880)

[II – Intended Use of Data: 6](#_Toc320783881)

[A-6 -- Sampling Project or Task Description 7](#_Toc320783882)

[I – General Overview of Project 7](#_Toc320783883)

[II – Sampling Project Timetable 12](#_Toc320783884)

[A-7 -- Data Quality Objectives for Measurement Data 12](#_Toc320783885)

[A-8 -- Training Requirements and Certification 14](#_Toc320783886)

[A-9 -- Documentation and Records 15](#_Toc320783887)

[B - Measurement / Data Generation and Acquisition 15](#_Toc320783888)

[B-1 -- Sampling Process Design 15](#_Toc320783889)

[B-2 -- Sampling Methods 16](#_Toc320783890)

[B-5 –- Instrument/Equipment Testing, Inspection and Maintenance 26](#_Toc320783891)

[B-6 -- Instrument / Equipment Calibration and Frequency 26](#_Toc320783892)

[B-7 -- Inspection / Acceptance Requirements for Supplies 26](#_Toc320783893)

[B-8 -- Data Acquisition Requirements 26](#_Toc320783894)

[B-9 -- Data Management 27](#_Toc320783895)

[C - Assessment and Oversight 27](#_Toc320783896)

[C-1 -- Assessment and Response Actions 27](#_Toc320783897)

[C-2 -- Reports 28](#_Toc320783898)

[D - Data Validation and Usability 28](#_Toc320783899)

[D-1 -- Data Review, Validation and Verification 28](#_Toc320783900)

[D-2 -- Validation and Verification Methods 29](#_Toc320783901)

[D-3 -- Reconciliation with Data Quality Objectives 29](#_Toc320783902)

|  |
| --- |
| **Appendices** |
| Appendix 1 -- SOP for WQ Monitoring Activities – 4 2008 Revision05.DOC |
| Appendix 2 -- EMAP Macros Protocols.pdf |
| Appendix 3 -- EMAP Fish Protocols.pdf |
| Appendix 4 -- CDPHE Practical Quantitation Limitation Guidance Document |
| Appendix 5 -- Greenline Vegetation Protocols.pdf |
| Appendix 6 -- CDPHE Standard Operating Procedures for Pebble Counts.doc |
| Appendix 7 -- CDPHE QAPP, page1, DataValidation.xls |
| Appendix 8 -- CDPHE QAPP, page2, DataValidation.xls |
| Appendix 9 -- EMAP Methods.pdf |
| Appendix 10 – CDPHE COC for Macroinvertebrate Samples |
| Appendix 11 – SOP for Field Methods |
| Appendix 12 – SOP for the Topographic Survey of Stream Channels |
| Appendix 13 – SOP for the Inventory and Modeling of Sediment Transport from Roads |
| Appendix 14 – SOP for the Assessment of In-Channel Structures  |
| Appendix 15 – SOP for the Collection of Stream Restoration Monitoring Photographs |
| Appendix 16 – SOP for the Collection of Streambank Soil Samples |
| Appendix 17 – SOP for the Collection of Soil Samples: EPA |
| Appendix 18 – SOP for the Collection of Macros: CDPHE |
| Appendix 19 – SOP for the Collection of Macros: River Watch |
| Appendix 20 – Proper Function and Condition Protocol  |
| Appendix 21 – MRP Basin Load Reduction Calculator  |
| Appendix 22 – CDPHE Water Quality Analysis Template |

A-3 -- Distribution List

|  |
| --- |
| **Table A-3.1 Distribution List** |
| Name | Organization | Contact Email |
| Michael Blazewicz | Measurable Results Program Manager, Colorado Watershed Assembly | michael@coloradowater.org |
| Curtis Hartenstine | CDPHE NPS Project Coordinator | chartens@smtpgate.dphe.state.co.us |
| Lucia Machado | CDPHE NPS Program Coordinator | lucia.machado@smtpgate.dphe.state.co.us |
| Chis Sturm | Colorado Water Conservation Board | chris.sturm@state.co.us |
| Jeff Crane  | Colorado Watershed Assembly Director | jeff@coloradowater.org |

A-4 -- Sampling Project or Task Organization

|  |
| --- |
| **Table A-4.1 Key Personnel and Responsibility** |
| Name | Project Title / Responsibility |
| Lucia Machado | CDPHE Nonpoint Source Program Manager |
| Curtis Hartenstine | CDPHE Nonpoint Source Project Coordinator |
| Colorado Watershed Assembly | Stakeholders Group (contact) |
| Michael Blazewicz | Project Coordinator |
| Michael Blazewicz | Project QAQC Officer – SAPP responsibilities |
| Michael Blazewicz | Field / Sampling Leader |

A-5 -- Problem Definition / Background – Sampling Needs

### I – Problem Statement:

Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants percolating them into groundwater and depositing them into lakes, rivers, wetlands, coastal waters. These pollutants include: excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas, oil, grease, and toxic chemicals from urban runoff and energy production, sediment from improperly managed construction sites, crop and forest lands runoff, eroding stream banks, salt from irrigation practices, acid drainage from abandoned mines, bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

States report that nonpoint source pollution is the leading remaining cause of water quality problems. The effects of nonpoint source pollutants on specific waters vary and may not always be fully assessed. However, we know that these pollutants have harmful effects on drinking water supplies, recreation, fisheries, and wildlife.

The State of Colorado manages NPS pollution through the Water Quality Control Division (WQCD), Nonpoint Source Management Area (NPS program) of the Colorado Department of Public Health and Environment (CDPHE). The NPS program partners with other entities such as the Nonpoint Source Alliance, federal and state agencies, and local watershed groups to promote a grants program that can provide funds to organizations seeking to reduce NPS pollution in watersheds or waterbodies in their area. Through section 319(h) of the Clean Water Act several million dollars may be awarded annually to Colorado to fund this grant program. These grants are then awarded to organizations seeking to address water quality impairment through projects aimed at reducing NPS pollution, updating watershed restoration plans, and providing education and outreach.

Where there is a NPS pollution reduction project as a component of the grant there exists only a 5-year contractual agreement for maintenance and monitoring of those pollution reducing practices. At the conclusion of this 5 year period, there is no obligation of the project sponsor to monitor or maintain the best management practices (BMPs) and no means by which to evaluate their long term effectiveness. Similarly, pre-project data detailing existing conditions is often minimal or deficient, leading to an incomplete understanding of the problem a given project intends to address.

The Colorado NPS program along with the Colorado Water Conservation Board’s Healthy Rivers Program has therefore implemented the Measurable Results Project (MRP) to collect data to evaluate the water quality and aquatic habitat improvements resulting from the implementation of NPS projects that involve on-the-ground implementation of best management practices (BMPs). *[****Note****: The MRP will not address NPS projects that do not have a measurable component of environmental change such as watershed plans and information and education projects]*

### II – Intended Use of Data:

The goal of the MRP is to provide sufficient data to evaluate whether and to what extent NPS projects and associated BMPs are improving water quality and aquatic habitats. The documentation of such evidence will lend credence to the Colorado 319 expenditure of grant funds and may help identify and prioritize the most cost effective measures to achieve realistic water quality goals within appropriate timeframes.

Each project selected to be evaluated by the MRP will have the stated intentions and desirable goals of the project (as outlined in a “project implementation plan”) set as a benchmark for judging “success” of the project. As discussed previously, the primary goal for this program is to evaluate the effectiveness of NPS projects that involve BMPs to address impairment. The effectiveness will be measured by generating sufficient data to do one or more of the following:

* determine change in a system as the result of BMPs by comparing pre-project and/or historical data
* describe trends in the project area (are conditions moving toward achieving standards?) in order to compile a “weight-of-evidence” of improving conditions.
* use Stae standards, reference, or expected condition as a benchmark of success following BMP implementation
* achieve restoration goals associated with the project
* potential to de-list a segment on the 303(d) impaired streams list

It is recognized that “success” as defined in a project’s Sampling Analysis and Procedure Plan (SAPP) may take longer than the timeframe to implement a BMP project (i.e. typical 5-year NPS project implementation period). It is the goal that the MRP will provide the continuity needed to collect post-project data and better evaluate long-term project success.

The primary users of these data are the organizations using NPS funds to implement BMPs; CDPHE WQCD, CWCB, CWA and the EPA. Secondary users of this information are those entities that access the validated data. Those data will be made public via the Colorado Data Sharing Network, the NPS program, EPA National Water Quality Database, and the sponsoring organization. These users may find the data valuable to help determine future NPS (or similar) projects. The data generated in this study may also have significant research value for the educational sector or for those who seek to better understand conditions of a given body of water.

An effort will be made to ensure that final reports on the assessment of individual projects will be written in a way that is understood by all involved. This will be accomplished when possible through the relevant statistical analysis of data and through narrative discussions of data interpretation. The interpretation will be initially conducted by the Colorado Watershed Assembly (CWA), and coordinated (as will many other assessment portions of this program that are described in detail in the following sections) with the CDPHE NPS program staff. Final reports will also support the reporting requirements of the NPS program to EPA.

A-6 -- Sampling Project or Task Description

### I – General Overview of Project

**Project Scope**

The MRP is designed to monitor and assist in the monitoring of physical, biological, and chemical characteristics related to water quality or aquatic life changes as the result of BMP implementation by collecting pre and post project (as defined by the contract period of the project) data to augment the Sponsor’s own data collection efforts using CDPHE approved monitoring and assessment procedures. Through investigation of appropriate monitoring parameters the MRP attempts to determine effectiveness of BMPs in isolation and/or in combination at the *project or segment* scale. At this time the MRP is not a tool to measure BMP effectiveness at the watershed (i.e., 12 or 8-digit Hydrologic Unit Code (HUC)) level, however, future advancements in modeling programs, such as the Colorado State University *eRams* program, may allow for such measurement.

Drawing these larger conclusions about BMPs (and thus justifying and focusing future programmatic expenditures) will require *replicating* monitoring techniques (and getting similar results) at several different project sites. Sharing a common toolbox of monitoring parameters and protocols and applying the MRP to restoration sites around the state will help to develop a broader replicate data set from which to better draw conclusions about which types of BMPs work in which types of stream systems.

A variety of sampling methods to measure water quality and habitat changes at the project and reach scale are outlined in this document. These parameters have been selected for their simplicity and ability to be replicated, and to the extent feasible are *not* focused on qualities that are subject to temporal and spatial variation due to watershed-scale processes. Each NPS project will have a specific set of goals and SAPP created for it with the goal of generating sound and useful scientific data. Project SAPPs will be constructed with the goals of the project in mind, the data needs of the decision makers, and a means to turn data into information. From the MRP Toolbox monitoring parameters that are integral at all projects (“core”) as well as supplemental site-specific (“add-on”) parameters will be chosen in order to best measure change specific to the project. Sampling time and frequency, collection of historical pre-construction data, utilization of reference sites, and/or expected condition will also be outlined in project SAPPs.

To monitor the effectiveness of these projects, a general sample design will begin by asking the following questions and the evaluation of these questions will drive the development of the sample design:

1. What is the scale of the impairment to be addressed (project, segment, watershed level)?
2. What is the cause or causes of impairment? Is it the result of more than one contribution or area?
3. What are the BMPs being implemented?
4. What is the timeframe in which the BMPs will be constructed/implemented?
5. Are there historical data that pertain to the project and the study design?
6. Are there reference or control sites that can be used when insufficient historical data exist?
7. What is the existing and reference condition of the stream channel at the project site, drainage area, and physiographic region (for comparison to other projects)?

**Project Length and Timing**

The MRP is designed to provide pre and post project data collection and analysis for NPS projects. During the project, the sponsor enters a contract with the State to execute the scope of work outlined in project documents (Project Implementation Plan). A contractual obligation is assumed by the Sponsor to monitor the project in accordance with the approved SAPP for the project. Therefore, while the MRP may assist in SAPP development and pre project monitoring before a contract is signed, all monitoring responsibilities lie with the project sponsor during the timeframe of the contract.

The earliest contact that can be made with a project sponsor to both examine opportunities for pre-project data collection and to coordinate the post-project monitoring is typically in March, when project sponsors are notified that their project is selected for funding (see below for full NPS timetable). Following this notification, the sponsor then works with NPS staff to develop a Project Implementation Plan (PIP). The PIP is an essential document for NPS related projects and requires approval from EPA before work can begin on any project. All projects that intend to collect environmental data must have a SAPP developed prior to sampling or data collection. The SAPP will detail how sampling and monitoring will be conducted and outline the MRPs role in the project. During SAPP development by the project sponsor, the project sponsor, the MRP coordinator and NPS Project Coordinator must staff communicate to ensure coordination on the type of monitoring to be implemented and identify who is responsible for which aspect of the monitoring. By utilizing the standard operating procedures developed by CDPHE and the MRP (see Appendices), reproducible, recognizable and approved methods will be instituted which will lead to data sets that meet the ultimate goal of documenting change in the environment as a result of BMP implementation.

Typical schedule of events for the NPS grant process includes the following:

* Request for Proposals (RFPs) are announced in September, proposals are due in December
* Approval of proposals is completed in March (3 months after due date) grant award depends on EPA timing, usually around September (one year after the RFP announcement)
* Draft Project Implementation Plans (PIPs) are due to the NPS program in July prior to the awarding of the grant to the State
* If PIPs are complete and approved, contracts can be executed immediately after grant is awarded. Projects with an “on-the-ground” component must have an approved SAPP in place.
* The projects continue from March of year One for 5 years. At this point all money associated with the project must be spent and final reports completed
* Implementation of projects actually should take about 3 and 1/2 to 4 years; projects must be closed out 6 months prior to grant closure.

**Pre-Project and Comparative Data**

The amount of water quality, biological and or physical habitat data available before the project implementation begins are concerns that will need to be addressed individually with each group during the development of project design. Pre-construction monitoring for several years (in order to obtain statistically valid data) ahead of a restoration treatment is rare. Instead it is likely that the MRP will typically be forced to attempt to examine trends that occur from just before construction to a number of years (perhaps as many as 20) following construction. This lack of pre-construction data eliminates the ability to obtain rigorous statistics to align particular treatments to specific changes[[1]](#footnote-1). Instead, the MRP will need to look for trends in the data that allow us to infer positive or negative effects of restoration activities. Compiling these trends has been termed a “weight-of-evidence” perspective and is being used by other monitoring programs that find themselves in the same situation (most notably the Bonneville Environment Foundations Model Watershed Program in the Pacific Northwest). The weight of evidence may not be ideal to discuss the effectiveness of the project, but may provide useful data to discuss the effects the project is having on the system over the long-term.

To the extent practicable, monitoring should include pre-treatment data collection, use of treated and control segments, and post-treatment follow-up monitoring. The type and timing of pre-project data collection is described below in Diagram A-6.1 and ensuing text. This pre-project assessment can be completed using any or all of the three methodologies, described below:

1. Pre-Project Data Collection - The collection of pre-project data is the preferred option when generating a baseline condition as this will enable the MRP to collect data from replicate sources and use the same sampling methods for pre- and post-project sampling. Pre-project data collection study designs will be generated to specifically target the areas of a system that are likely to produce change with regard to the project. Once the project has been completed to remove or address the water quality concern, post-project monitoring using the same techniques, station locations and associated procedures can be implemented to increase likelihood of capturing changes in the system that have occurred as a result of the work done.
2. Historical Data - An effective means with which we can determine measurable change in an ecosystem is by the comparison of post project data to historical data that was collected prior to the project implementation. These data, as described below in table A-6.1, must be checked for completeness, compatibility with the post data sampling Standard Operating Procedures (SOP) and timeliness. Types of data that will be searched for include: water quality, physical habitat, biological, land use and GIS layers. It is expected that historical data will not be available for many of the sites in question.
3. Reference Sites/Expected Condition - Programs such as the WQCD bio-assessment protocol for macroinvertebrates, application of Rosgen Stream Classification system or EMAP for physical habitat have helped identify reference sites and/or expected condition throughout the State. That information may be used to compare post-project data in order to quantify change.
4. Control Sites – For projects with and without pre-project, historical, or good reference sites, the selection and monitoring of a control reach may also be useful. A control site would have similar characteristics to but would not benefit from restoration treatments and therefore would not be expected to show improvements that may be detected at the restoration site. Control site monitoring can also help to account for changes in stream systems (positive or negative) that are not related to an NPS project such as impacts of climate change, flow manipulation, and/or changes in biological productivity.

In any of the four above listed methodologies, the type of pre-project data or the reference/control site selected must match the type of data to be collected after project completion. To determine the completeness of existing pre-project data, a decision tree (Diagram A-6.1) will be used. In addition the following text taken from the CO *WQCD Guidance on Data Requirements and Data Interpretation Methods Used in Water Quality Standards and Classification Proceedings***,** Water Quality Control Division, August 2004, provides insight on quantity of water quality data sufficient for the MRP purpose.

*Abundance of Data in Segment: The Division considers 10 or more samples collected routinely or randomly over a year or longer period up to five years to meet nearly all data needs for classification and standards proceedings in regards to metals, nutrients, and TSS. Where there is an abundance of data, only the most recent last five years will be considered in order to insure that the data are representative of present conditions. Most recent is considered to be within the last five years. Where data are from more than one source, it may be combined if comparable. In general, data are considered comparable where same analytical techniques are used or the detection limits are at/or below the level of the standards. However, where data appear to not be comparable, a final determination as to its comparability may be made by referring to the comparability of the QA/QC requirements for the collection and analysis of the samples. For fish, macroinvertebrates, and physical habitat CDPHE considers 1 sample event in one year to meet their needs for classification and standards proceedings (see Table A-6.1).*

*Paucity of Data in Segment: When limited or no data are available within a segment, the Division generally will consider all data within, upstream or downstream of the segment that are considered comparable and use best professional judgment to make a sufficiency determination. Ancillary data will play an important role in exercising this judgment. Ancillary data within or outside the segment of concern critical to interpreting water quality data include but are not limited to land use/land cover, water use, population and demographics, geology, soils, municipal and industrial waste disposal, climatological data, health of aquatic community and toxic levels of characteristics of concern.*

**Diagram A-6.1** -- **Pre-Project Data Decision Tree**

Historical Data Yes

Historical Data No

Pre Project Data Sets Complete

Minimum Data Elements Yes

Minimum Data Elements No

Monitoring of “core” and “add-on” parameters conducted. Data recorded into appropriate electronic storage.

Monitoring of “core” and “add-on” parameters conducted. Data recorded into appropriate electronic storage.

Reference Site Exist with Comparable Data Points

Control Site Exists

Pre Project Data Sets Complete

Project

Not-constructed

Project Constructed

Isolated Project

Monitoring of “core” and “add-on” parameters conducted. Data recorded into appropriate electronic storage.

Determine trends over time and ability to meet standards

|  |
| --- |
| **Table A-6.1 - Minimum Historical Data Requirements** |
| Parameter | Requirements |
| Water Quality | 10 sample events within 5 years (Metals/Nutrient/TSS) |
| Macroinvertebrates | 1 sample event within 1 years- See Section B2 for sample timing  |
| Fish | 1 sample event within 3 years  |
| Physical Habitat | 1 sample event within 1 years |

**Post Project Data Collection**

If a project has already been completed before a monitoring plan is established, monitoring goals should focus on quantifying changes over time by establishing trends (e.g., trending toward meeting water quality standards). Project design should be addressed in three main categories: water quality, sediment/physical habitat, and aquatic life.

Post-project monitoring is to be conducted for as long as it takes for the system to reach new equilibrium, until water quality standards are met, or until program staff determine the project deserves no further monitoring due to BMP failure, funding/time limitations or other rationale. Each project will be evaluated on an individual basis and the parameters to be sampled and their frequency of sampling will reflect the intent of the project.

### II – Sampling Project Timetable

As this MRP Comprehensive SAPP is meant to capture any and all components of project designs that can be applied to any kind of MRP project, a specific timeline of events is difficult to construct. Variations in when projects begin, the nature of impairments the project is meant to address, the type of data required to assess the project will all adjust the timeline for each individual project.

A-7 -- Data Quality Objectives for Measurement Data

Data quality objectives (DQOs) for the MRP are to generate sufficient data to document one or more of the following:

* attainment of a standard due to the successful completion of the project implementation plan
* capture trends due to BMPs implementation (are conditions moving toward standards?)
* achievement restoration goals associated with the project (for example increase sinuosity by 10% or increase stream depth to width ratio)
* analysis of project observed data to reference or expected condition and its approach/deviation from the expected condition
* assessment of changes in the system (as compared to pre-project or historical data)

DQOs for measurement data or data quality indicators for precision, accuracy, representativeness, completeness, comparability and measurement range for the MRP will be the calculated result of evaluating each project individually for the overall goals of the project and the types of data necessary for the decision maker.

In all cases, data quality objectives for each site specific SAPP will be defined. Specific, enumerated data objectives that consider the quantity of data and the level of accuracy necessary will be addressed. These determinations will be made with cooperation with the NPS program staff to ensure completeness and quality of data.

If the project-specific monitoring plans must be changed for unforeseen circumstances, the MRP coordinator will prepare a proposal for any changes and submit it to NPS program staff for approval prior to instituting any changes.

1. ***Data Precision, Accuracy and Measurement Range***

For the analysis of water quality data, the MRP will follow data precision and accuracy protocols as set forth by the WQCD’s Environmental Data Unit DQOs for precision and accuracy, which are addressed in the CDPHE Practical Quantitation Limitation Guidance Document, found in Appendix 4.

**Precision** of MRP water quality and macroinvertebrate sampleswill be measured through the collection of 10% of duplicate samples of all MRP projects annually. Precision will be calculated through the analysis of the duplicate sample analysis values as compared to sample values using the EPA relative percent difference calculations:

RPD = [(x1 – x2) / {(x1 + x2)/2}] x 100

RPD = relative percent difference (%)

x1 and x2 = duplicate measurements of the same parameter

The smaller the RPD, the more precise are the measurements. The usability of duplicate measurements is assessed during data validation. (See Data Validation and Usability Section)

**Accuracy** of MRP water quality sampleswill be measured through the WQCD’s Environmental Data Unit DQOs for precision and accuracy are addressed in the CDPHE laboratory’s QAPP. Each NPS project needs to define accuracy or Percent Recovery (%R) according to the laboratory that will be used for the project’s data analyses.

%R = {100 (xs – xu) / K

%R = Percent Recovery or Accuracy

xs = measured value for spiked sample

xu = measured value for unspiked sample

K = known value of the spike in the sample

**Measurement Range:**See Appendix 4 CDPHE Practical Quantitation Limitation Guidance Document for water quality (metals, nutrients) parameters.

***b. Data Representativeness:*** The selection of the standardized monitoring parameters provides a uniform method of establishing data at a variety of sites that encompass a variety of habitat types and conditions within the reach.

***c. Data Comparability:***

Standardized sampling methods that have been vetted in the scientific community will be the only methods used by the MRP. By adopting these standardized methods, data will be comparable to previous efforts by various entities and organizations. Standard operating procedures (SOPs) for all MRP approved methods are included in the Appendices to this document.

In the interest of reproducibility, the seasons that the aquatic life and physical habitat parameters are first sampled in will be the same for any subsequent sampling of the same parameter. Water quality samples will be collected routinely and will follow an established sampling frequency throughout the years of the study.

***d. Data Completeness:***

Completeness can only be judged when individual sample designs are constructed for particular projects. Each sample design will have data completeness table that indicated the desired/anticipated number of samples per parameter.

A-8 -- Training Requirements and Certification

Volunteer training will be conducted on as needed basis. The goals of these training will be to equip volunteers with the knowledge, capability, and equipment necessary to accurately sample for a variety of water quality parameters and flow/discharge that are of interest to the MRP and the project in question. Volunteers will receive ample instruction in the classroom and in the field on these matters and all volunteers will have to pass an exam testing their abilities prior to final certification. Emphasis will be placed on QA/QC, safety, the purpose of sampling and the adherence to specific protocols. Volunteers will be utilized whenever possible in this project in the following areas:

* Data mining - Volunteers associated with study projects will be encouraged to provide historical chemical, physical habitat and biological data, GIS data, and other information that may be beneficial to understanding the condition of the stream segment pre- and post-project.
* Field sampling - Volunteers may be required to assist in the sampling of water bodies

for chemical parameters. Volunteers will be trained by MRP staff in the MRP protocols as needed. Volunteers may be called upon to assist MRP staff in the collection of physical habitat and biological sampling. These volunteers will be trained on site for the specific data collection tasks of the day. Volunteers will not be collecting physical habitat or biological samples in the absence of MRP staff.

* Flow/Discharge Collection - Volunteers may be utilized to record flow and /or discharge data on site at prescribed intervals and during storm and peak flow conditions. Ideally, suitable flow meters will be available; the option of the instillation of staff gauges at certain sites may also be used to gather accurate discharge data.

A-9 -- Documentation and Records

All paperwork including field data sheets, chain of custody documents, laboratory submittal forms and others will be saved and cataloged for at least 5 years. Bi-annually electronic files stored on the MRP computer will be backed up on a separate external hard-drive as well as on a DVD(s) which will be submitted to the CDPHE project coordinator.

Field Sheets - EMAP Site Description Sheets will be used to catalog site description, location, transects and other general features of sample area (see Appendix 9 - EMAP Methods). Additional field sheets will be utilized per sampling parameter as outlined in individual SOPs. Documentation of location is very important for precision in repeat monitoring and should include GPS waypoints at a minimum and ideally marking (stakes, rebar, flagging, etc.) in the field.

# B - Measurement / Data Generation and Acquisition

B-1 -- Sampling Process Design

***a. Rationale for Selection of Sampling Sites:***

Quantity and location of sample sites will depend on the nature of specific projects selected by the NPS program. Each project will be designed individually; selected sample sites will be determined by the type of water quality problem or physical characteristic that are defining the nonpoint source impact. While professional judgment on the selection of sample sites will be supplemented with advice from the project sponsor, WQCD staff, members of the Nonpoint Source Alliance, and recommendations of sampling protocols, it is the goal of the program to choose sites of enough diversity, spacing, and number to obtain a dataset that adequately represents the project. Additionally when possible long-term monitoring sites will be designated where ALL appropriate parameters are monitored (rather than having parameters scattered throughout but not overlapping) thereby creating the possibility that cause and effect relationships can be established.

Through investigation of appropriate monitoring parameters the MRP attempts to determine effectiveness of BMPs in isolation and/or in combination at the project or segment scale. By placing monitoring locations above and below the BMP, in conjunction the understanding of the anticipated effectiveness of the BMP, MRP can assess the effectiveness of the BMP. In simple terms, “did the BMP work as it was designed to?” In parallel to the BMP evaluation, the segment level monitoring approach will seek to determine the effect of the BMP (or multiple BMP’s) in the reach containing the BMP or the receiving water body. It is possible that a a fully functional BMP that is installed and working as designed has little or no impact on the segment or receiving water body due to a variety of circumstances. This designation is important so that the NPS program is better informed of BMPs, their efficiency and the appropriate use of them.

Further guidelines are as follows:

Weather/Seasonal Variations - The sampling of aquatic life and physical habitat parameters will be conducted late summer/fall and early spring (before runoff) seasons to ensure that water levels are safe for technicians to work in and are representative of periods when aquatic life is suitable for sampling.

Site Access - Working with the project sponsor, site access will be obtained for each project area. If additional access is needed, it will be requested from private landowners or other appropriate entity.

Segment Length - Each sampling transect will be surveyed from the channel bottom on a perpendicular line to the thalweg; baseline data necessary for evaluation of the vertical and lateral stability of the channel will be collected. Each transect is intended to be 20 times the bankfull width in length. If these widths become too large (i.e. in excess of 300 and 400 feet) this methodology will become economically impractical. Therefore, profile lengths will be reduced to a distance long enough to obtain necessary pattern dimensions such as radius of curvature, meander lengths, belt widths, and valley lengths relative to river lengths. This protocol is associated with EMAP & CDPHE methods for imbeddedness and pebble counts, and all EMAP reach wide monitoring. For change detection based on repeat monitoring it is best if the segment and transects are defined and recorded the first year of monitoring and that subsequent years of monitoring utilize the same locations for transects.

***b. Rationale for Selection of Monitoring Parameters:***

The MRP recognizes that there is no “one-fit” solution to deciding which parameters to monitor for any given project. Each NPS project and associated BMPs will have a specific study design and SAPP created for it with the goal of generating sound scientific data over a specified period of time. This SAPP will be constructed with the goals of the project in mind, the data needs of the decision makers, and a means to turn data into information. ”Core” as well as “add-on” parameters will be chosen to measure change specific to the project. Sampling time and frequency, collection of historical/pre project data, utilization of reference sites, and/or expected condition will also influence selection of monitoring parameters.

B-2 -- Sampling Methods

Monitoring parameters have been classified into “core” and “add-on” groups (see Table B-2.1). “Core” parameters will be collected at every MRP site based on the project type. “Add-on” parameters will also be matched to the project type and will be based on project goals and professional judgment.

|  |
| --- |
| **Table B-2.1: MRP Monitoring Parameter Summary** |
| **Project Type** | **Core Parameters** | **Add-on Parameters** |
| BMPs to improve water quality for metals or selenium | Temperature, Conductivity, Filtered and Non Filtered Metals, Dissolved Oxygen, pH, Discharge, Macroinvertebrates, Nutrients | Photos |
| In-channel structures including rock structures, large woody debris, and bar/riffle development aimed at reducing bank erosion | Cross sections, Discharge, Nutrients, Macroinvertebrates | Temperature, Sediment, Thalweg, , Photos, Structures, Metals, Topographic survey, Hydraulic Analysis (Hec-Ras) |
| Riparian Enhancement | Temperature, Canopy Cover, Discharge, Nutrients, vegetation survey, Macroinvertebrates | Thalweg, Cross sections, , Photos |
| Sediment related channel reconfiguration/floodplain restoration | Cross sections, Sediment, Discharge, Nutrients, Macroinvertebrates | Temperature, , Thalweg, Photos, Metals, Topographic survey, Hydraulic Analysis (Hec-Ras) |

Descriptions of sampling methods are as follows:

**Discharge Monitoring** – “core” for all projects. The stability and condition of stream restoration projects (as with natural river channels) may be upset or significantly altered by flood events. Monitoring efforts that seek to detect change in or stability of a project may see significant deviations in data following large flow events. It is therefore important to consider what flows a project was subjected to in the year preceding monitoring efforts before drawing conclusions from the data.

When possible MRP SAPP’s should spell out to what flows a restoration project has been designed to withstand thereby ensuring that BMPs and engineers are not held to a higher standard than anticipated. Events that exceed the design flow may disrupt the restoration activities enough so as to warrant an end to MRP monitoring. Monitoring that continues after design flows have been exceeded should take into account these flows and not necessarily appoint restoration activities as cause for stream degradation or lack of project success. Similarly, variations in monitoring data may be able to be explained by either lack of channel forming flows or excessive flows.

*Flood Frequency Analysis:*

MRP SAPPs may be written so that a certain flow event (e.g., 2, 5, 10, 25 year event) triggers a round of monitoring. Where in-depth flow-frequency analysis have been conducted as part of the pre-project development, project partners should agree upon and publish the results of this data in relation to the project in the SAPP. Where this data has not been collected parties may defer to the CWCB “Floodplain and Stormwater Criteria Manual” <http://cwcb.state.co.us/technical-resources/floodplain-stormwater-criteria-manual/Pages/main.aspx> The Manual recommends techniques according to Figure 1.



**Figure 1: CWCB selection of analysis methods for flood frequency.**

To simplify the techniques further for the MRP, for projects within close proximity to gages with 10+ years of record a “statistical analysis” will be used to determine flood frequency. According to the CWBC document, “The statistical analysis method acceptable for use in Colorado is the one that utilizes Log Pearson Type III Distribution as described in “Guidelines for Determining Flood Flow Frequencies,” Bulletin 17B, Water Resources Council (March 1982). HEC-SSP a software program developed by the ACOE will be used to perform this analysis.

Where restoration projects are not within close vicinity of stream gages or where gage records are <10 years the CWCB recommends using a regional regression analysis. USGS StreamStats performs this analysis for the 5 year event and should be used as the MRP method of choice under these conditions.

**Sediment/Nutrients**  - “core” for all projects . Reporting sediment and nutrient load reduction is a requirement of all 319 projects. Samples for nutrient analysis (nitrogen and phosphorus) are taken based on MRP Streambank SOP (Appendix 16) for eroding streambanks. For soils captured by a BMP (such as a sediment detention basin) samples are collected as per the EPA Soil Sampling SOP (Appendix 17).

*Analysis:* Along with soil chemistry data, a lateral recession (erosion) rate must be determined for the streambank in order to calculate annual load and load reduction following BMP implementation. Lateral recession rates will be determined through cross section monitoring efforts (see MRP SOP for Topographic Surveys of Stream Channels). Load reductions for eroding and stabilized streambanks will be determined by using the “bank stabilization” tab of the EPA’s Region 5 Load Estimation Tool <http://it.tetratech-ffx.com/steplweb/>. Where sediments are captured (e.g. a detention basin) load reductions will be calculated with the “MRP Basin Load Reduction Calculator” (Appendix 21).

**Cross-section survey** – “core” parameter. When projects are aimed at addressing specific geomorphic issues related to w/d ratio, incision ratio, cross-sectional area, and/or streambank erosion monumented surveys of the channel should be completed. From these cross sections we can determine an estimated annual lateral recession rate and compare to a control reach. Enter data into Ohio DNR Stream Module spreadsheet developed for the MRP which has tools for comparison and analysis. Follow MRP SOP for Topographic Surveys of Stream Channels (Appendix 12).

*Additional methods for measuring streambank erosion*: Assessment of bank erosion may also be indicated through the installation of bank pins. Bank pins consist of 4 foot lengths of 1/2” rebar driven in flush to the bank. They are checked periodically and their exposed ends measured (to determine a recession rate) and then re-hammered to be flush with the bank.

Scour chains may also been installed on selected projects. They are used to measure the aggradation or degradation of the streambed. A steel point is welded on to an end link of 18 to 20 inches of 1/2” chain. A steel doweled rod and driver are used to drive the chain vertically into the channel bed near the thalweg. The chain is driven into the bed until the last link is flush with the bed and then the location is documented prior to removing the driver. After the peak flow event the chain will be located. The length of chain lying horizontally to the bed indicates the depth of scouring while the depth of fill over the chain indicates the magnitude of deposition. Successive trips to the site can also reveal adjustment tendencies and rates.

**Macroinvertebrates** – “Core” parameter for most sites in order to collect data for comparison to CDPHE bio-criteria policy for 303(d) listing purposes. Protocols may include the EMAP (Appendix 2), CDPHE (Appendix 18) or River Watch (Appendix 19). For monitoring of reaches at the segment scale, EMAP protocols should be followed. BMP effectiveness monitoring should utilize CDPHE or River Watch.

*Analysis:* Taxonomy will be analyzed by TCDPHE approved contractor to a 300 sub count. In instances where new taxa are encountered, these macroinvertebrates will be identified to the “lowest practical taxonomic level” based primarily on Merritt and Cummins (1984) and Ward et al. (2002). This level of identification is usually genus or species for mayflies, stoneflies, caddisflies and many dipterans. The midge family Chironomidae will be identified to the level of subfamily or tribe.

Each macroinvertebrate sample will be selectively picked by removing organisms until specimens from each taxon in the sample have been noted. Any large and rare taxa in the sample will be picked to 100%. EDAS Multi metric indices shall be used to evaluate macroinvertebrate data in accordance with CDPHE Policy 10-1 (<http://www.cdphe.state.co.us/op/wqcc/New/10-1.pdf> ).

**Canopy Cover** - A “core” parameter for all riparian/fencing/planting projects. Canopy cover using a densitometer as per EMAP survey protocols (Appendix 9). Projects that attempt to improve the condition of riparian vegetation should show a trend towards increased canopy cover thus building a weight of evidence that riparian restoration is reaching one of its goals.

**Sediment** – “Core” for all projects aimed at addressing reach related embeddedness and transport issues. “Add-on” for other projects. Utilize the CDPHE Standard Operating Procedures for Pebble Counts (Appendix 6).

*Analysis:* CDPHE developed policy 98-1 “Implementation Guidance for Determining Sediment Deposition Impacts to Aquatic Life in Streams and Rivers (as intended for higher gradient, cobble-bed, course-grained streams) shall be used to evaluate pebble count data. <http://www.cdphe.state.co.us/op/wqcc/StatutesRegsPolicies/Policies/98-1-2010.pdf>

*Suspended sediment* may be measured through the analysis of Total Suspended Sediment samples as an “add-on” parameter. Sediment rating curves may be constructed to illustrate the relationship between TSS and discharge, the comparison of these curves during bankfull events pre- and post- project will provide sediment yield shifts as a result of activities in the stream.

**Temperature** – Also a “core” parameter where project goals are to reduce or maintain stream temperatures through a project site. Temperature data may be collected for comparison to statewide standards. Projects may be monitored for their ability to meet these standards.

Another method[[2]](#footnote-2) seeks to track a reduced change in temperature from upstream end of project site to downstream end of project site contributes to weight of evidence that BMP implementation efforts are helping to prevent thermal pollution. Note: daily high temps, mean temps, etc. may be influenced by annual variation and do not contribute to information on the effectiveness of reach-scale restoration efforts (but may contribute to 303(d) compliance information).

*Analysis:* CDPHE developed analysis for daily maximum and maximum weekly temperature shall be used to evaluate data in accordance with CDPHE Policy 06-1. <http://www.cdphe.state.co.us/op/wqcc/StatutesRegsPolicies/Policies/06-1-2011.pdf>

**Riparian Vegetation Evaluation** – “add-on”. Depending on a project goal improvements in riparian condition may be monitored by temperature, canopy cover, and even channel cross sections (bank stability). Certain projects may require specific riparian vegetation monitoring be assigned in order to address project goals. Proper Function and Condition Assessment (PFC) (Appendix 20) and Greenline (Appendix 5) are two examples of techniques that have been used successfully in Colorado. A new protocol is being developed at the University of Denver for the study of Tamarisk that may be adaptable to other species and sites around the state.[[3]](#footnote-3)

**In-channel Structures Monitoring** – “Add-on” monitoring parameter through a qualitative assessment of structures based on the MRP SOP for the Assessment of In-Channel Structures (Appendix 14). Also the effectiveness of structures used to reduce streambank erosion may be monitored through examining lateral recession rates and shear stress via survey monitoring.

**Photo Point Monitoring** – “Add-on” parameter. Use MRP SOP for the Collection of Stream Restoration Monitoring Photographs (Appendix 15).

**Water Quality** – “Add-on” where water chemistry improvements are a target of restoration goals. See Appendix 1 – Standard Operating Procedures for WQ Monitoring Activities, April 2008, Revision 05.DOC

*Analysis:* An “inductively coupled plasma spectrophotometer” (ICP) will be used for metals analysis. Hardness and alkalinity will use River Watch or similar titration based method. The pH and conductivity will be analyzed with a multi-probe. Soil analysis will use a digested sample analyzed by ICP (see (Appendix 4 - CDPHE Lab PQLs and QC.xls). Data shall be evaluated with CDPHE analysis spreadsheet for water quality data <http://www.cdphe.state.co.us/wq/EDU/FormsDocs/Template-STREAMS_091009.xlsm> (Appendix 22).

**Hydraulic Analysis** – “Add-on” parameter. HEC-RAS provides a useful tool for understanding open-channel bank sheer stress. The MRP can utilize channel cross sections and HEC-RAS to understand how bank sheer stresses change pre- to post-project and beyond. Key to running HEC-RAS is a calibration of the model through the use of stream gages and the on-sight marking of various flows. This is because channel roughness (manning’s n) may significantly influence water levels and bank stress. Make best attempts to quantify manning’s remotely and then utilize field observations to tweak n until water surface elevations in the model match real-world observations at known flows. If HEC-RAS derived sheer stress increases post-construction/BMP implementation and increased bank erosion is also observed/measured than we can begin to learn about how/why such a project was inappropriate as a restoration technique. See Hec-Ras tutorials for developing this process.[[4]](#footnote-4)

**Topographic Survey** – “Add-on” parameter. Development of DEM’s and TIN’s (GIS layers) from ground surveys can be useful for creating planning maps, grading plans (calculation of earthwork volumes), monitoring, visualization tool, and deriving habitat and geomorphic maps. Doing this would require gathering many more points (to create a topographic map essentially) than MRP is currently collecting by only surveying cross sections. Protocols are outlined in MRP Survey SOP (Appendix 12). There are numerous topographic survey technologies available– tradeoff’s exist between extent and resolution of the data along with the cost. Most of the technologies are potentially interesting to the MRP. Lidar is good for detecting large-scale change. The USGS now is using “green” lidar to map below the water surface – this could be useful on larger rivers down the road – post processing of lidar is cumbersome and would require more training/expertise. Total stations/GPS are great for coarse data acquisition. Terrestrial Laser Scanners (TLS) are like a ground based LiDAR and can be useful for detecting precise change of streambanks, grain sizes, bars, etc

**Thalweg Survey** - Collect specifically thalweg profile data as a “add-on” parameter on all projects that have a specific channel bed complexity restoration component (e.g., increase number and depth of pools and increase riffle length). Increased standard deviation of thalweg, from a highly altered unnatural channel, is a “weight of evidence” component that can be tracked to determine if restoration projects are successful. Use Stream Module spreadsheet for data entry.

**Aquatic Vertebrates (Fish)** – “Add-on” where the specific goal of fisheries improvement (richness and/or diversity) are stated. See Appendix 3 - EMAP Fish Protocols

|  |
| --- |
| **Table B-2.2 Sampling Needs for MRP Parameters needing Lab work** |
| **Parameter / Matrix** | **Sampling Method** | **Sampling Procedures (a)** | **Sample Container** | **Sample Preservation** | **Holding Times** |
| Water Quality (metals) | CDPHE | Grab or composite | P,G-AW | HNO3 to pH<2, w/in 10 days of sampling | See Appendix 1 |
| Water Quality (nutrients) | CDPHE | Grab or composite | P,G | See Appendix 1 | See Appendix 1 |
| Macroinvertebrates | EMAP, CDPHE, or RiverWatch | composite | 2L Nalgene | Ethyl Alcohol | 6 months |
| Soil Chemistry | MRP or EPA  | composite | Ziplock | N/A | 2 weeks |

(a) – for example, a grab sample, composite sample, etc

|  |
| --- |
| **Table B- 2.3 Equipment Needs** |
| **Parameter / Matrix** | **Sampling Equipment** | **Equipment Decontamination /Cleaning Method** | **Equipment Inspection / Maintenance *(include methods and dates)*** | **Spare Parts / Back-up Equipment Needed** | **Calibration** |
| Macroinvertebrates | D-net with dolphin,Buckets,# 30 sieve,brush,90% ethanol solution,1 L Nalgene,labels, pens, SOPs for collection in waterproof 3 ring binder | Remove debris and stones from net, rinse thoroughly before and after sampling, Clean all sampling gear that enters the water with sparquat or Formula 409 with degreaser at end of sampling for each water body | Weekly inspection during sampling season | Spare dolphin, buckets, sieves, preservative | N/A |
| Channel and Cross section survey | Total station, prism, pin marking equipment, gps | n/a | Weekly inspection during sampling season | Battery charger, spare prism | Calibration for total station to follow manufacturer recommendation |
| EMAP Geo Morph and Physical Habitat | SOPs for collection in waterproof 3 ring binder,depth rod, clinometers, densiometer, measuring tapes,  | N/A | Weekly inspection during sampling season | Spare clinometers, depth rods, tapes, grids, survey equipment. | N/A |
| Catchment soil sediment chemistry | Trowel, ziplock bags, labels, pens, SOPs for collection in waterproof 3 ring binder | N/A | Monthly inspection during sampling season | Spare sample containers | N/A |
| Temperature | Data logger | N/A | Monthly inspection during sampling season | N/A | Calibration for logger to follow manufacturer recommendation |
| Water quality | Bottles, DO meter, Flow Meter | Acid rinse cleaning | DO and Flow meter to be cleaned and calibrated professionally annually | Spare, bottles meter | N/A |
| Fish | Electroshocking equipment (backpack and bank rig), nets, buckets | Formula 409 scrub and rinse | Weekly inspection during sampling season | Spare parts for generators, electrodes | N/A |

**B-3 -- Sample Handling and Chain of Custody**

Water quality - Samples will be labeled with CDPHE labels for all samples and submitted for analysis with CDPHE Chain of Custody (COC) forms. All samples to be kept cold and delivered to CDPHE lab depending on CDPHE requirements (see Appendix 1 - SOP for WQ Monitoring Activities).

Macroinvertebrates - Samples will be labeled with station name, number, date and time of collection and type of sample (regular or QC). Method used to collect sample will also be described. Macroinvertebrate COC has been included in Appendix 10. Samples will be kept separate and delivered to taxonomist in monthly batches.

Soils - Sample containers for soil samples will be labeled prior to arrival in the field. Soil Samples will be collected as determined by the MRP SOP for Streambank Soils (Appendix 16) or EPA SOP for Soil Sampling (Appendix 17). Chain of custody requirements will be followed as described by CDPHE lab. Samples will be sent to CDPHE lab within 7 days of sampling. Copies of the COC and results will be maintained at the MRP office. The below information should be transferred to all data sheets and sample vials during processing:

1. Water body name
2. Site description
3. Site Number or Code
4. Date
5. Time
6. Sample device
7. Collector / Agency

**B-4 -- Quality Control Requirements**

*a. Field QC Checks:*

10% of total annual MRP water quality, soil samples and macroinvertebrates will be collected as replicates and sent to the lab with all other soil samples. Water quality blank samples will be collected at a rate of 10% of all annual MRP gathered samples.

*b. Laboratory QC Checks:*

CDPHE, lab will conduct ICP metals analysis and have well defined and documented QC protocols (see Appendix 4 CDPHE Lab\_PQLs and QC). All outliers will be noted in data sets presented at the end of analysis.

Macroinvertebrate protocols at Timberline Aquatics, Inc: all sorted macroinvertebrate samples will be checked by an additional taxonomist, and approximately 10% of the identifications will be checked by a qualified taxonomist at Colorado State University. As an additional means of QA/QC, in instances where the classification of a taxon is difficult or questionable, some specimens will be sent to another specialist for confirmation. All outliers will be noted in data sets presented at the end of analysis.

*c. Data Analysis QC Checks:*

As water quality, soil and macroinvertebrate sample data is received from the lab, it will be checked against the replicate samples for accuracy. Samples will be re-run by contract lab as requested by QA/QC officer.

Water quality QC data quality will be determined by checking reported data against duplicates for X percent recovery calculated by:

RPD = [(x1 – x2) / {(x1 + x2)/2}] x 100

RPD = relative percent difference (%)

x1 and x2 = duplicate measurements of the same parameter

Macroinvertebrate QC data will be checked through the evaluation of QC samples to determine the number of individual specimens that are present in the sample. The goal is that no additional specimens should be found in the QC sample.

When the project is over, data quality is determined by evaluating the results of all the QC samples and determining precision and accuracy. Lab reported precision and accuracy results can be checked during data validation. The decision to accept data, reject it, or accept only a portion of it is should be made after analysis of all QC data.

B-5 –- Instrument/Equipment Testing, Inspection and Maintenance

All field equipment will be inspected one week prior to sampling, throughout the sampling period and after sampling.

Factory recommended maintenance of Total Station survey equipment will be followed to ensure equipment reliability and accuracy.

Soil and water chemistry analysis instrument testing will be completed by the CDPHE laboratory as specified in Appendix 4 - CDPHE Lab PQLs and QC.xls

B-6 -- Instrument / Equipment Calibration and Frequency

**Table B-7.1 -- Instrument / Equipment Calibration and Frequency**

|  |  |  |
| --- | --- | --- |
| **Equipment / Instrument Type** | **Calibration Frequency** | **Standard or Calibration Instrument Used** |
| Total Station | Annually | Serviced by Wagner Equipment, Denver, CO |
| YSI 85 DO meter | annually | Serviced by Geotech Inc (Denver). Calibration record stored in binder. |
| Marsh McBirney Flow Meter | NA | NA |

B-7 -- Inspection / Acceptance Requirements for Supplies

All materials and supplies will be utilized by the specification of the appropriate SOP for each parameter to be collected. All materials will be purchased from retail suppliers such as Ben Meadows, VWR, Hach and other reputable sources.

B-8 -- Data Acquisition Requirements

Historical data are a very important component of this project. Any historical data that are gathered for this project will have to be of sufficient quality to be of use. Only validated data from trusted sources such as the CDPHE, USGS, Colorado Division of Wildlife, River Watch, the Colorado Data Sharing Network and others will be considered. Data from other sources without sufficient credibility will be evaluated on a case by case basis in cooperation with the CDPHE WQCD to determine the appropriate use of the data. SOP, QA/QC components and validation of these data sources will be investigated and documented if the data is to be utilized in the study. Historical data must be timely to be included in the study and are described in table A-6.1

B-9 -- Data Management

Backup copies of MRP electronic files and data will be delivered to CDPHE biannually as well as backed up on the MRP desktop computer (surrogate for an external hard-drive).

Water quality data will be checked for completeness as compared to the chain of custody records. Data will also be checked for outliers and any qualifiers associated with the data. Appropriate return requests will be sent to the lab as needed. Data will be managed in excel files for storage and manipulation. All water quality and macroinvertebrate data will be reported to the WQCD-NPS project coordinator and uploaded to WQX (via EPA link) and the Colorado Data Sharing Network (via DSN coordinator).

Macroinvertebrate data will be checked for completeness as compared to the chain of custody records. All macroinvertebrate data will be stored and analyzed in EDAS software.

Water quality and macroinvertebrate data will be annually validated and then updated (pending CDPHE approval) to the Colorado Data Sharing Network (CDSN) via MRP staff. Data will be uploaded annually to EPA National Water Quality Database (Water Quality Exchange and STORET) via the CDSN.

Cross-section, topographic, and thalweg survey data will be stored in excel spreadsheets and/or as a Hec-Ras project. Digital photographs associated with these surveys will be catalogued for future reference in electronic folders.

Canopy cover, vegetation, structures, sediment, and fish data will be collected on field data sheets in the field. Validation of data entry will be maintained by parties that enter and check the data against the datasheets as they are entered onto a document or spreadsheet file.

Soil chemistry data (nutrients/metals) will be checked for completeness as compared to the chain of custody records. Data will also be checked for outliers and any qualifiers associated with the data. Appropriate return requests will be sent to the lab as needed. Data will be stored and manipulated in Excel data sheets.

Photo monitoring digital photographs will be labeled per the MRP SOP for Photo Monitoring and catalogued for future reference in electronic folders.

# C - Assessment and Oversight

C-1 -- Assessment and Response Actions

Annual data audits will be completed to compare actual data results with project data quality objectives (DQOs).

All biological and physical data collection will be completed by MRP staff and will be evaluated by the field crew leader during the collection.

In the event that assessment methods yield inconsistent or incorrect data, the sampling frequency of that particular parameter in question may be increased for further events to meet data quality/quantity objectives.

C-2 -- Reports

* Monthly bulleted progress reports will be submitted to 319 Program Manager.
* Semi-annual progress reports including number of sites sampled, types of data collected, hours spent with project sponsors and hours spent with 319 program staff will be submitted to 319 Program Manager.
* Final reports for each site will be submitted at the end of the two year study. Final reports may include:
	+ Presentation of all tabular data
	+ Graphics and other illustrations as necessary
	+ Evaluation of trends associated with project implementation
	+ Photographs
	+ GIS maps
	+ TMDL data for the site (if available)
	+ WQCD Standards for the segments in question

# D - Data Validation and Usability

D-1 -- Data Review, Validation and Verification

The tasks of data review, validation and verification will be the responsibility of the MRP Project Manager. He/she will work closely with the QA/QC manager to accomplish the tasks necessary. Any suspicious or flagged data will be immediately removed and corrective action taken. This action may include the discarding of the data, the normalizing of the data, or having samples re-run by contract lab. CDPHE will be notified of significant or reoccurring validation and verification problems.

Water and soil chemistry data will be checked for completeness as compared to the chain of custody records. Data will also be checked for outliers and any qualifiers associated with the data. Appropriate return requests will be sent to the lab as needed.

As outlined in section B-10*,* Physical habitat data will be collected on field data sheets and entered directly into EMAP databases for storage and data manipulation. Validation of data entry will be maintained by parties that enter and check the data against the datasheets after it has been entered.

D-2 -- Validation and Verification Methods

The following steps describe the validation and verification methods that the WQCD Environmental Data Unit uses to verify precision and accuracy and will be adopted by the MRP.

“Unless otherwise specified, acceptable precision for each analytical parameter (e.g., zinc) for a pair of split samples will be < 30%, expressed as relative percent difference (RPD).

Precision = RPD = (C - C) x ½ x 100%

 (C + C)

In the event that the difference between split samples is > 30%, data from that site/time will be considered qualified and either deleted or interpreted with caution. Qualified data will be clearly denoted as such in the database.

Estimates of overall precision of a parameter (e.g., zinc) will be derived from the pooled standard deviations (SD) from all individual split pairs. The pooled standard deviation statistic is termed the root mean square and is calculated as:

Percent relative standard deviation = %RSD = (SD / Mean) x 100%

Root mean square = RMS = %RSD0.5 + %RSD0.5 … + etc.0.5

 N

Unless otherwise specified, acceptable RMS for each parameter is < 30%. If RMS is > 30%, then the analysis for that parameter will be deleted from the database or considered as qualified data and interpreted with caution. Qualified data will be clearly denoted in the database.

D-3 -- Reconciliation with Data Quality Objectives

Data reconciliation for this project will be accomplished by calculating and comparing the project’s actual data quality indicators (precision, accuracy, completeness, representativeness, and comparability) as specified in Data Quality Objectives for Measurement Data. If the data is not as defined in the section, it will be flagged as such and removed from data analysis. The raw, qualified data will still be included in the final report with an explanation for its qualification.

1. Rigorous statistical conclusions are better made from “Before-After-Control-Impact” (BACI) designs. Because of time and expense BACI monitoring is practical only for a subset of projects in the state and is typical of a University or federal agency study. (see Downes, B. J., L. A. Barmuta, P. G. Fairweather, D. P. Faith, M. J. Keough, P. S. Lake, B. D. Mapstone, and G. P. Quinn. 2002. *Monitoring ecological impacts: concepts and practice in flowing water.* Cambridge University Press, New York, New York, USA.) [↑](#footnote-ref-1)
2. <http://www.swwrc.wsu.edu/conference2003/pdf/Proceedings/Proceedings/Session%207B/PAPER_Miner%20and%20Godwin.pdf> [↑](#footnote-ref-2)
3. Contact Professor Anna Sher for details (update this next time the SAPP is updated). [↑](#footnote-ref-3)
4. <http://www.hec.usace.army.mil/software/hec-ras/> [↑](#footnote-ref-4)