Quality Assurance Project Plan

for

In-Stream Assessment of Biota and Migration Patterns of the South Fork Palouse River Watershed

U.S. Environmental Protection Agency Contract No. EP-C-08-004
Task Order No. 2010-07

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This quality assurance project plan (QAPP) has been prepared according to guidance provided in *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5, EPA/240/B-01/003, U.S. Environmental Protection Agency (EPA), Quality Assurance Division, Washington, DC, March 2001) to ensure that environmental and related data collected, compiled, and/or generated for this project are complete, accurate, and of the type, quantity, and quality required for their intended use. Tetra Tech will conduct work in conformance with the quality assurance program described in the quality management plan for Tetra Tech's Fairfax Group and with the procedures detailed in this QAPP.

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ACRONYMS AND ABBREVIATIONS

BMI	Benthic macroinvertebrate
DO	Dissolved oxygen
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
GRTS	Generalized Random Tessellation Design
ODEQ	Oregon Department of Environmental Quality
PDF	Portable Document Format
QA	Quality assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality assurance project plan
QC	Quality control
QCO	Quality Control Officer
RPD	Relative percent difference
RSD	Relative standard deviation
SAP	Sampling and analysis plan
TMDL	Total Maximum Daily Load
TOL	Task Order Leader
TOM	Task Order Manager
Tt	Tetra Tech, Inc.
WWTP	Waste Water Treatment Plant

DISTRIBUTION

This document will be distributed to the following U.S. Environmental Protection Agency (EPA), Tetra Tech, and state regulatory staff members who are involved in this project, as well as to all responsible subcontractors.

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1.0 PROJECT/TASK ORGANIZATION

The purpose of this document is to present the quality assurance project plan (QAPP) for conducting an in-stream survey to determine aquatic life uses, habitat condition and quality, migration patterns, and refugia utilization of biota in the South Fork Palouse River Watershed. A sampling team comprised of scientists from Tetra Tech's (Tt) Owings Mills, Maryland and Spokane, Washington offices will perform in-stream data collection. Tt will coordinate collection and handling of existing data, and analysis and interpretation of field-collected data with the assistance of sampling team personnel.

This QAPP provides general descriptions of the work to be performed to collect in-stream data, the objectives to be met, and the procedures that will be used to ensure that the data are scientifically valid and defensible and that uncertainty has been reduced to a known and practical minimum. The QAPP describes procedures used to prepare for the field effort, conduct field sampling using standard protocols, and post-process field data.

The organizational aspects of a program provide the framework for conducting tasks. The organizational structure can also facilitate project performance and adherence to quality control (QC) procedures and quality assurance (QA) requirements. Key project roles are filled by those persons responsible for ensuring the collection of valid data and the routine assessment of the data for precision and accuracy, as well as the data users and the person(s) responsible for approving and accepting final products and deliverables. The project organization chart, presented in Figure 1-1, includes relationships and lines of communication among all participants and data users. The responsibilities of these persons are described below.

Jill Gable is the EPA Task Order Manager (TOM). She will provide coordination of the technical and QA resources of the Agency and its contractors in executing this project. As the TOM, she will have the following responsibilities:

- Reviewing and approving the project work plan, QAPP, and other materials developed to support the project
- Providing oversight for study design, site selection, and adherence to design objectives
- Reviewing and approving all contract deliverables for the program, including draft, interim, and final reports
- Coordinating with contractors, reviewers, and others to ensure technical quality and contract adherence

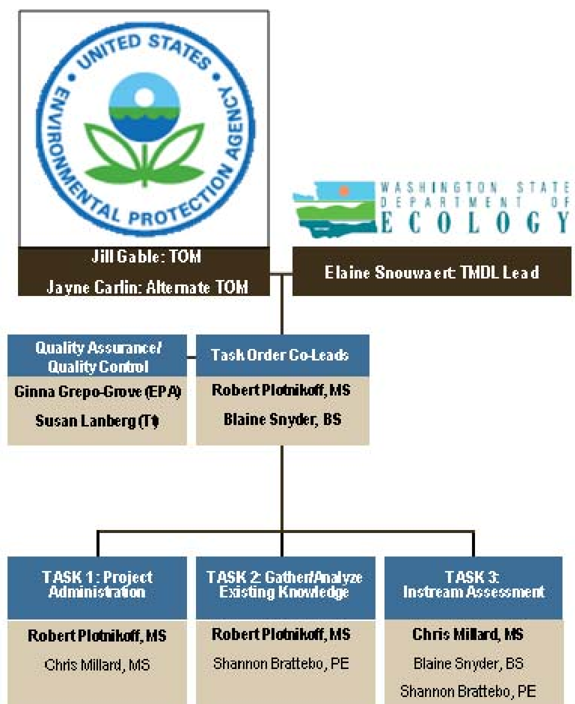

Figure 1-1. Project organization chart.

Project Organization

The local EPA Region 10 Quality Assurance Manager (QAM) is Ginna Grepo-Grove, who will be responsible for reviewing and approving all QAPPs and SAPs. Additional EPA Region 10 QAM responsibilities include the following:

- Reviewing and evaluating field procedures
- Conducting procedural reviews and supplemental training, as required, at the initiation of field activities
- Conducting external performance and system audits of the procedures
- Participating in EPA QA reviews of the study (QAM from EPA Region 10)

The Tt Task Order Leaders (TOLs), Robert Plotnikoff and Blaine Snyder, will participate in study design and implementation activities. Other specific responsibilities of the TOLs include the following:

- Coordinating project assignments in establishing priorities and scheduling
- Reviewing and evaluating field procedures with the field team and conducting procedural reviews and supplemental training at the initiation of field activities
- Ensuring completion of high-quality projects within established budgets and schedules
- Providing guidance, technical advice, and performance evaluations to those assigned to the project
- Implementing corrective actions and providing professional advice to staff
- Preparing or reviewing preparation of project deliverables, or both, including the QAPP and other materials developed to support the project
- Providing support to EPA in interacting with the project team, technical reviewers, and others to ensure that technical quality requirements are met in accordance with study design objectives

The Tt QAO (Susan Lanberg), whose primary responsibilities include the following:

- Monitoring QC activities to determine conformance
- Reviewing the project QAPP for completeness and noting inconsistencies
- Providing support to EPA and the Tt TOLs in preparing and distributing the work plan and QAPP
- Overseeing development of and approving the QAPP

The Field Task Manager (Task 3) is Chris Millard. He will participate in study design and implementation of specific field sample and data collection activities. He will coordinate and participate in the overall sampling efforts throughout the field data sample collection period. Other specific oversight responsibilities of the Field Task Manager include the following:

- Assisting in the development of the project QAPP
- Verifying adherence to the project QAPP
- Verifying the completeness and accuracy of appropriate field calibration and data records

- Overseeing the receipt and inspection of sampling equipment and supplies, including instrumentation, custody documents, and sample containers
- Verifying the completeness and accuracy of appropriate field calibration and data records
- Verifying the completeness and accuracy of chain-of-custody documentation
- Verifying the integrity of the sample custody processes in place for the program, regardless of whether that entails monitoring records and shipping, courier service, or hand-delivery
- Controlling and monitoring access to samples while in their custody

Additional technical staff will be responsible for conducting specific tasks during the project (e.g., performing field sampling and collecting physical, chemical, and biological water quality data) at the direction and discretion of the TOLs. The TOLs will supervise the technical staff participating in the project, including implementing the QC program, completing assigned work on schedule with strict adherence to procedures established in the approved QAPP, and completing required documentation. The TOLs will direct the work of the field sampling team including collection, preparation, and shipment of samples and completion of field-sampling records. To perform the required work effectively and efficiently, the field-sampling team will include scientific staff with specialization and technical competence in field-sampling activities, as required to ensure the highest quality data are collected without incident. They must perform all work in adherence with the project work plan and QAPP, including maintenance of field sample documentation. Where applicable, custody procedures are required to ensure the integrity of the samples with respect to preventing contamination and maintaining proper sample identification during handling. Where field samples are collected the sampling team is responsible for the following:

- Receiving and inspecting the sample containers
- Receiving, inspecting, calibrating, and maintaining field instrumentation
- Completing, reviewing, and signing appropriate field records
- Assigning tracking numbers to each sample (sample identification numbers)
- Controlling and monitoring access to samples while in their custody
- Verifying the completeness and accuracy of chain-of-custody documentation
- Initiating shipment and verifying receipt of samples at their appropriate destinations
- Verifying the results of sample measurements collected for compliance with the requirements of the reference methods and this QAPP

Additional oversight will be provided by the QC Officer (QCO), who is responsible for performing evaluations to ensure that QC is maintained throughout the sampling process, that the data collected will be of optimal validity and usability, and that limitations of the data set are minimized as much as is possible given the challenges of the routine field investigation. The QCO is a senior technical staff assigned the responsibility of providing a second-level review of all documentation and records developed during the sample and data collection process. The QC evaluations will include double-checking work as it is completed and providing written documentation of these reviews (minimally initialing and dating documents as they are reviewed) to ensure that the standards set forth in the QAPP or SAP are met or exceeded. Other QA/QC staff, such as technical reviewers and technical editors selected as needed, will provide peer review oversight on the content of work products and ensure that work products comply with the client's specifications.

Technical staff involved with the program will be responsible for reading and understanding this QAPP and complying with and adhering to its requirements in executing their assigned tasks relative to this project.

Although no formal field audits are anticipated for the project, Tt will perform at least one site visit and one procedural review with the field team and will minimally review the logistical support program established during the first sampling event. In addition, the local EPA QAM may reserve the right to audit at any time during the field data and sample collection program. Such an audit may entail a review of the data collection program to ensure that the data collected will be of optimal validity and usability, and that limitations of the data set are minimized as much as is possible given the logistical considerations and challenges of the data collection requirements. It is optimal to conduct field audits, where funding is available, during the first sampling events such that the QAO or designee can conduct procedural reviews if necessary to ensure compliance with EPA and ODEQ's standard operating procedures (SOPs) where applicable and to introduce any unique aspects of this field program. The field audit would generally include verification of compliance with the QAPP as well as adherence to the requirements established in this document.

2.0 PROBLEM DEFINITION/BACKGROUND

As required by law, a plan, called a Total Maximum Daily Load (TMDL), must be developed to bring 303(d) listed waters back into compliance with the water quality standards. TMDLs are essentially holistic, integrated plans to solving point and nonpoint source (NPS) pollution problems. EPA's role is to provide information and assistance to states to support the development of TMDLs. This task order concerns impaired waterbodies in the South Fork Palouse River Watershed in Washington and Idaho and supports the Washington Department of Ecology (Ecology) and EPA Region 10 in developing TMDLs in Washington.

Ecology is currently developing TMDLs to address temperature, dissolved oxygen (DO), and pH impairments in the South Fork Palouse River watershed. Ecology conducted TMDL field studies in 2006 and 2007. Data from this TMDL field study is being used to develop a model to determine the loading capacity for heat and nutrients so TMDLs can be established to protect the streams' beneficial uses. These TMDLs will establish wasteload allocations for the City of Pullman's wastewater treatment plant (WWTP) and can also be used by EPA to determine if the wasteload allocations for the City of Moscow, Idaho's WWTP are appropriate to protect Washington's water quality standards immediately downstream. Early modeling appears to demonstrate that these streams may not have met water quality numeric criteria under natural conditions; therefore, TMDL development will focus on establishing loading capacity, and load and wasteload allocations based on the natural condition provision in Washington's water quality standards.

This in-stream biota assessment project will include the South Fork Palouse River, Paradise Creek and tributaries, including the portions in Idaho in order to accurately assess refugia and migration patterns. Assessment of the biota in the stream, including where and when they are likely to be found, and a determination of what the assemblage may have been prior to human alteration of the landscape, will be completed. This will provide the EPA with an understanding of the natural and historic conditions of the South Fork Palouse watershed and the uses the streams should be supporting. This will enable EPA and Ecology to accurately develop a TMDL for the waterbody based on natural conditions.

Snowmelt runoff from the headwaters of the South Fork Palouse watershed usually occurs from late winter to early spring with sediment transport occurring primarily during this time period. The watershed flows diminish considerably through the summer months. Ecology's TMDL has focused on the dry season when temperature, DO, and pH problems are more pronounced due to the low flow and warm temperatures. While the critical period for the development of a TMDL is primarily June through September, in-stream biota conditions may need to be assessed outside of this window. The aquatic life uses during the wet season may have unknown effects on success of the life stages for aquatic biota during other portions of the year.

The timing and type of changes that occur in water quality and physical habitat characteristics from dry season to the wet season may be critical for determining when biotic uses change and will inform on extent of seasonal aquatic life uses in the system. As a result, Ecology will present a range of values that describe the possible natural conditions, both currently and historically.

There is considerable uncertainty about the water quality and quantity characteristics prior to human alteration of the landscape. Hydrologic conditions in this watershed have changed from Pre-European settlement of the area in the mid-1800s due to alteration in some hydrologic characteristics of the watershed (e.g., drain tiles and lowered groundwater levels from pumping) which have reduced bank storage and the level of groundwater input to streams. Base water flow may have been historically higher in this watershed during the dry season, particularly in the major streams like South Fork Palouse River and Paradise Creek. Currently, a large portion of the instream flow in Paradise Creek and the South Fork Palouse River during the dry season is from treated wastewater discharged from the cities of Pullman, WA and Moscow, ID.

Existing technical literature that describes biological conditions throughout the Palouse River watershed will be used to address some of the primary questions presented in this study. Information describing biotic conditions in a contiguous watershed and located in the same landscape setting will be useful for direct comparison to the South Fork Palouse River watershed. Existing knowledge from similar watersheds will contribute important insight into reconstruction of biotic and vegetation patterns in the region. A description of aquatic and terrestrial biota in contiguous watersheds like the Palouse River will be an important comparison for determining the influence or independence of these two drainages (e.g., South Fork Palouse River versus Palouse River) in promoting survival of aquatic species; or specific life stages.

The objectives of this project focus on generating answers to the following questions:

Question 1: What were the historic aquatic-life uses in the waterbody:

- What fish, amphibian, and invertebrate species were historically resident in the watershed?
- What other notable historic biological information is available pertaining to aquatic life in the waterbody?

Question 2: What are the current aquatic-life uses in the waterbody:

- What fish, amphibian, and invertebrate species currently reside in the watershed?
- When are the fish, amphibian, and invertebrate species present?
- Do the fish have migration patterns and do they utilize thermal (or other) refugia in the watershed? Where are these refugia located and when are they utilized?

Question 3: What are aquatic life uses that would most likely occur within a range of estimated natural conditions in the waterbody (Ecology will provide a description for the range of estimated natural conditions, both currently and historically):

- What aquatic habitats could have occurred within the range of estimated natural conditions?
- What is a reasonable estimation of the biota assemblage that could be found in this system if the water quality and habitat were improved to within the range of estimated natural conditions?
- What are the effects of non-native riparian vegetation on the current aquatic community (i.e. reed canary grass compared to native riparian vegetation)?

The South Fork Palouse River watershed is located in a region of Washington and Idaho that has both forested and open grassland landscape features. Human influence on these landscape settings may have had major impacts to terrestrial and aquatic endemic species. As a result, the current aquatic communities may reflect the influence of human alteration in aquatic and riparian habitat. Information will be collected from an inventory of existing knowledge that describes historical and current biological communities.

Summarization of information gathered from existing knowledge and by generating data describing current conditions will address 3 important periods related to the above questions and are as follows:

- Pre-European conditions (Question 1; habitat and biotic conditions prior to arrival of original settlers).
- Current conditions (Question 2; field data from this study and more recent surveys),
- Trends from 1975-Current (Question 3; a reflection of environmental change over a 35 year period)

These 3 periods along a timeline, beginning with Pre-European settlement, will make for important comparisons in order to determine the extent of change in biotic communities that may have directly and indirectly been influenced by arrival of Europeans.

3.0 PROJECT/TASK DESCRIPTION

Task 1: QAPP Development

Development of a quality assurance project plan (QAPP) that will outline how in-stream data will be collected and analyzed. This QAPP clearly outlines a monitoring plan for agency review.

The QAPP is developed in accordance with EPA's *Requirements for Quality Assurance Project Plans (EPA QA/R-5)* (see http://yosemite.epa.gov/R10/OEA.NSF/webpage/QA+Reference+Documents) and Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (July, 2004) (see http://www.ecy.wa.gov/biblio/0403030.html).

Task 2: Development of In-stream Baseline Biota Assessment Study Plan

The focus for most of the characterization of fish assemblages and other aquatic life, water quality, and habitat will be in Washington State; with a small portion of the watershed located in Idaho. Figure 3-1 is an overall view of the drainage identifying major tributaries that confluence with the South Fork Palouse River (SFPR).

Stream types will be stratified by bottom substrate type (soft and hard substrate) as these features can be limiting to spawning success of several fish species known to occur in the SFPR. EPA's General Randomized Tessellation Stratified (GRTS) design will be used to select candidate sites in the Washington and Idaho portions of the SFPR watershed. A subset of approximately 20 sites will then be used for field surveys of fish, benthic invertebrates, habitat, and water quality parameters relevant to the TMDL process. Because of the GRTS design, a subset of 30 sites is normally considered adequate to represent the various features of the river basin for an assessment (Olsen et al. 2009). In this study, 20 sites will be used to represent fish population characteristics and 10 overlapping sites will represent both fish and benthic invertebrate populations. The final survey design will address factors that affect fish populations, and provide a basis for determining appropriate water quality criteria used to protect aquatic life beneficial uses, based on current regulations set forth by Ecology.

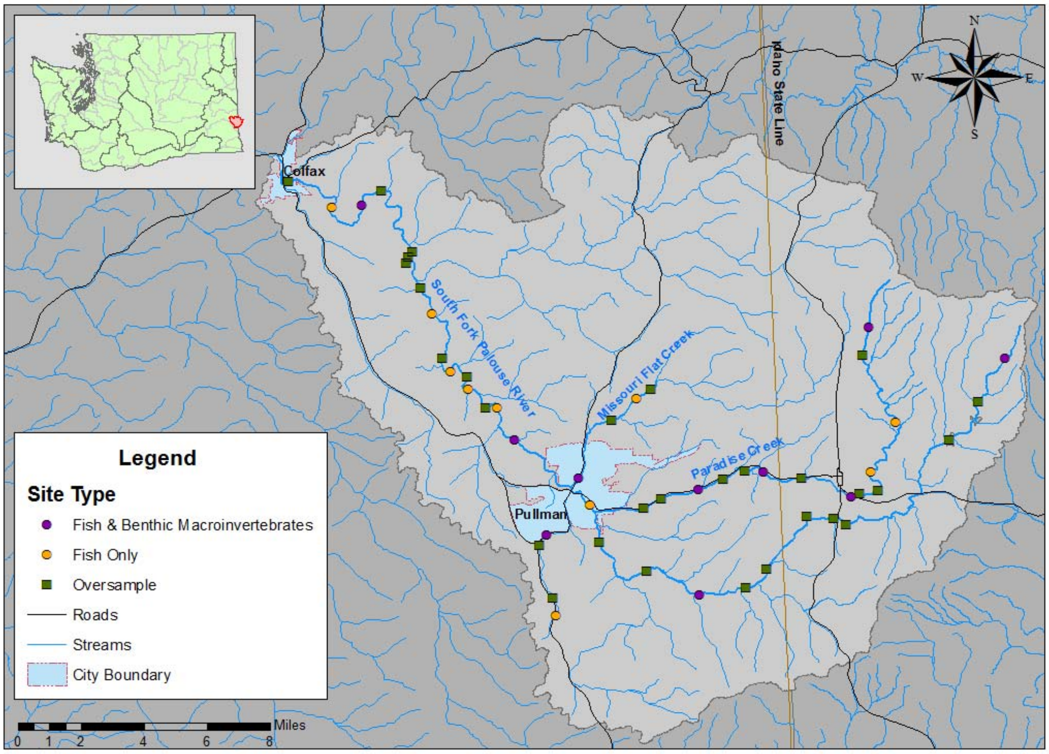

Figure 3-1. Map of study area and randomly selected sites in the South Fork Palouse River watershed.

Site selection was focused on four streams and creeks of the South Fork Palouse River watershed: South Fork Palouse River, Paradise Creek, Missouri Flat Creek, and Dry Fork Creek. These tributaries and mainstem regions of the South Fork Palouse River watershed are known to remain wetted along the entire study area or, in the case of tributaries, at the lower portion of the creek prior to confluence with mainstem South Fork Palouse River. If additional sites in Four Mile Creek and Spring Flat Creek are found to be wetted during the dry season, they may be included in the sample schedule. A representation of the primary sites and the oversample sites are reported in Figure 3-1.

To address the central issue of sustaining a viable fish assemblage and other aquatic life within the SFPR and which also is attentive to WA Ecology’s aquatic life use designation; Tt’s approach will be to survey the current status of the fish community, benthic macroinvertebrate community at select locations, physical habitat condition, and conventional water quality conditions. Based on an analysis of historical data, trends in the viability of the fish assemblage can be ascertained from a direct comparison (past versus present assemblages), estimates of food availability and environmental conditions (as assessed from benthic macroinvertebrate collections) from historical and current data, and descriptions of existing refugia from physical habitat assessments.

Task 3: Obtain Sampling Equipment and Supplies

Tt will provide all necessary sampling equipment, sample bottles, safety equipment (including any specialized equipment required by its field teams and subcontractors), and other supplies needed for successfully conducting the sampling event. Tt notes that the purchase of equipment will require prior authorization of the Contract Officer and does not foresee the purchase of any large sampling equipment to be paid by the contract. Tt will comply with all Occupational Safety and Health Administration safety requirements. Tt will make all logistical arrangements necessary to have equipment, supplies, and appropriate personnel at the site in accordance with the schedule negotiated with the EPA project team.

Task 4: Conduct In-Stream Survey

Twenty (20) sample sites in the Washington and Idaho portions of the SFPR watershed were chosen using EPA's GRTS method to evaluate water quality, habitat and fish and benthic macroinvertebrate communities relevant to the TMDL process. Field data collections will follow Washington State Department of Ecology's guidance for site verification and layout, *in situ* water quality, substrate characterization, and fish community composition (Washington Department of Ecology 2009 [draft]). Benthic macroinvertebrate assessments will follow Hayslip (2007) biological collection protocols that have been adopted by PNAMP (Pacific Northwest Ambient Monitoring Partnership). An additional evaluation of habitat quality will be accomplished using EPA's Rapid Bioassessment Protocols (RBP) developed by Barbour et al. (1999).

Site Verification and Layout

Sample reaches are defined as 20 times mean bankfull width. Sites with a mean bankfull width of less than 8m will be extended to the minimum reach length of 150m and will not exceed 2000m.

Water Quality

Water quality parameters, including temperature, dissolved oxygen, pH and conductivity will be measured using a YSI or Hydrolab multimeter probe. Data will be collected twice, at the start and end of sampling at the site, in the vicinity of the mid-point of the sampling reach.

Substrate Characterization

Substrate will be characterized at each of 10 equidistant transects along the length of the sampling reach. Particle size class, based on the intermediate axis length, will be recorded at 11 equally-spaced stations along each transect. Other morphological features, including wetted width, bankfull width, wet depth, bankfull depth, and substrate embeddedness, will also be evaluated.

Fish Community Composition

Fish community sampling will be done using a single-pass electrofishing estimate. All habitats are sampled over the stream reach. Specimens will be enumerated and identified to species, categorized by life stage (juvenile or adult), and measured to determine the minimum/maximum length by species. All fish will be returned back to the stream following processing.

Benthic Macroinvertebrates

Benthic macroinvertebrate communities will be characterized using existing information beginning with collections from the past 20 years. More recent community composition will be characterized with benthic macroinvertebrate collections at 10 randomly selected sites (collected simultaneously at 10 of the 20 fish population sites) and compared against data that had been collected from the early 1990s in order to determine trends in condition of this community. Historical information will be collected from the data inventory conducted as the first part of this project. Literature located in the regional University libraries will be examined for identity of species and condition assessment of streams in this watershed.

Physical Habitat

The RBP habitat evaluation is visually-based and consists of scoring a continuum of conditions for each parameter into one of four categories represented as optimal, suboptimal, marginal, and poor. Included is a 20-point scale for each parameter with 0 being the poorest and 20 the optimal. Habitat quality is scored by visually assessing (i.e., scoring) parameters along stream reach. The total possible score for physical habitat is 200. Riparian conditions will be assessed using both a rapid, visual scoring survey as well as a quantitative estimate using a canopy densiometer (Washington Department of Ecology 2009, [Draft]). Canopy cover will be measured at each of the benthic macroinvertebrate collection transects within a reach. The protocol will be consistent with Ecology's (2009) method for estimating effective shading of stream reaches. Canopy cover contributes food energy to the benthic macroinvertebrate community and provides temperature regulation on a localized scale during the warmer months in the southeast region of Washington State. The type and presence of canopy cover, in part, has a strong influence on benthic communities promoting more diverse assemblages composed of species sensitive to the temperature gradient (e.g., cold-water taxa in the presence of canopy cover).

Task 5: Prepare Sampling Reports

Reporting of all information will be in a Technical Memorandum format, data tables, a Draft Final Technical Report, and a Final Technical Report (see schedule presented as Table 3-1) . The following provides an overview for the type of reporting and the purpose for preparation of a report:

Task 5.1 A technical memo will be developed describing the approach and findings from the literature review and interviews.

Task 5.2 A Draft Report will be developed that will include:

- bibliography of literature review and professional interviews,
- results of instream assessment, and
- an estimation of what species, habitat and refugia would be present under natural conditions,
- an estimation of the minimum amount of water and dissolved oxygen, pH and temperature conditions that are needed to support the appropriate aquatic life.

Task 5.3 A summary of EPA and Ecology comments and how each was addressed in the final report.

Task 5.4 A Final Report including the results of field work, how information was used, and references from the literature survey that assisted in re-constructing the historic biological condition.

Table 3-1. General schedule for South Fork Palouse River Watershed monitoring program deliverables**.**

Deliverable	Due date
Draft QAPP	July 2, 2010
Final QAPP	One week after receiving comments from EPA
Obtain and inspect materials/supplies	Approximately 3 days before the sampling event
Start of sampling event	Upon approval of final QAPP. Sampling will begin September 20 and continuing through October 1, 2010.
Draft Sampling Event Report	Within 2 weeks of completion of each sampling event
Draft Final Sampling Event Report	Within 1 week after receipt of TOM's comments
Draft Final Data Report	Estimated December 2010

4.0 DATA QUALITY OBJECTIVES AND CRITERIA

Data quality objectives (DQOs) are qualitative and quantitative statements that clarify the intended use of the data, define the types of data needed to support the decision, identify the conditions under which the data should be collected, and specify tolerable limits on the probability of making a decision error due to uncertainty in the data (if applicable). Data users develop DQOs to specify the data quality and quantity needed to support specific decisions.

4.1 Project Quality Objectives

The quality of an environmental monitoring program can be evaluated in three steps: (1) establishing scientific assessment quality objectives, (2) evaluating program design to evaluate whether the objectives can be met, and (3) establishing assessment and measurement quality objectives that can be used to evaluate the appropriateness of the methods being used in the program. The quality of a data set is some measure of the types and amount of error associated with the data.

Sources of error or uncertainty in statistical inference are commonly grouped into two categories:

Sampling error: The difference between sample values and in situ *true* values from unknown biases due to sampling design. Sampling error includes natural variability (spatial heterogeneity and temporal variability in population abundance and distribution) not specifically accounted for in a design (for design-based inference), and variability associated with model parameters or incorrect model specification (for model-based inference).

Measurement error: The difference between sample values and in situ *true* values associated with the measurement process. Measurement error includes bias and imprecision associated with sampling methodology, specification of the sampling unit, sample handling, storage, preservation, identification, instrumentation, and the like.

The data requirements for this project encompass aspects of database management to reduce sources of errors and uncertainty in the use of the data. Data needed to fulfill the requirements for future modeling by Ecology staff are listed in Table 4-1.

Physicochemical (Field) Parameters

Electrical conductivity will be monitored at each sampling location in the system because this measurement is a good indicator of the dissolved mineral content in stream ecosystems. Dissolved minerals and mineral salts can limit the beneficial use options of an impaired stream or watershed. Another field parameter to be monitored is **pH**, which is a measure of the acidity (hydrogen/hydroxide ion concentration) of waterbodies identified for characterization and assessment. Most aquatic organisms have a preferred range of pH, usually pH 6 to 9. Beyond that range, aquatic organisms begin to suffer stress, which can lead to death. High pH concentrations also force dissolved ammonia into its toxic, un-ionized form, which can further stress fish and other organisms.

Temperature is measured in the field at all sampling stations. Temperature can indicate flow conditions and will be useful in the overall watershed characterization for thermal modifications.

DO is a field chemistry parameter that will be monitored because it is an important measure of the quality of the habitat and overall health of the ecosystem. Oxygen depletion can be an indicator for a number of undesirable physical, chemical, and biological conditions in the watershed. Without sufficient DO, fish and other aquatic organisms suffocate and die. Because oxygen is critical to the survival of aquatic organisms, it is important to assess DO levels when characterizing a watershed.

Table 4-1. Examples of some environmental data to be collected for this project.

Data type	Measurement endpoint(s) or units
Physicochemical parameters	
Temperature	degrees Celcius (°C)
DO	milligrams per liter (mg/L)
Conductivity	microsiemens per centimeter (µS/cm)
pH	Range from 0 to 14
Biological parameters	
Fish abundance	Number of individuals per species
Fish presence	Species
Fish autecological characteristics	Weight and length of individuals; age of select specimens from long-lived species.
Resident versus Migratory Species	Number of specimens; catch per unit effort; total number of species; number of resident species (and individuals); number of non-resident or migratory species (and individuals); adult, juvenile, or adult life stages; number of native species (and individuals); number of non-native species (and individuals)
Existing and Current Benthic Macroinvertebrate Community Data	Community characteristics (e.g., structural and functional) and tolerance of dominant species to environmental stressors.
Existing Periphyton Data	Community characteristics (e.g., structural and functional) and tolerance of dominant species to environmental stressors; including June 2010 and August 2010 collections (collected by Ecology).
Physical habitat parameters	
Substrate Characterization	Grain size distribution (110 particles); substrate embeddedness; mean depth; mean wetted width; mean bankfull width.
Data type	**Measurement endpoint(s) or units**
RBP Habitat Assessment	Overall habitat score up to 200 points; individual metric scores 0 – 20 points.
Riparian Characteristics	Vegetation characterizations (historical and current from existing technical literature); groundwater input (from Ecology data and existing information); canopy densiometer measurements.

Biological Parameters

Fish Abundance

Fish will be collected from the South Fork Palouse River drainage sampling stations, with results for abundance used to characterize the current assemblage. All fish will be identified to species and enumerated (i.e., counts of numbers of individuals per species). Results will be summarized as total number of individuals per station and catch-per-unit-effort (e.g., number per sampled area or catch per minute). Most fish will be released on site; however, selected specimens may be preserved and shipped to the Tt Center for Ecological Sciences for taxonomic verification. The potential for sampling the same fish at sequential sites could occur if the sites randomly selected occur within close proximity of the other. If the proximity of sequential sites could result in “double counting” individual fish, a barrier net may be used between the sites prior to electrofishing at the second location.

The description of refugia will be based on the characterization of physical habitat, physicochemical surface water quality, and other biological communities. These additional characterizations are made at the same reaches as fish community assessments and with results considered as a combination of environmental preferences selected by individual fish. The potential for migration will be evaluated by comparing the refugia descriptions of sequential sites in a stream and identifying the distance along a stream the primary preferences (determined for each species) are continuously present. Stream reaches where primary preferences for a species are not present along this continuum indicates a limitation to potential migratory patterns of individuals and populations.

Fish Presence

Considering the aquatic life-use focus of this project, it will be important to document the presence and identity of fish that currently reside in the study area (as well as those that move or migrate through the study area). Fish collected at each of the South Fork Palouse River drainage stations during the field sampling events will be identified to the lowest practicable taxonomic level, preferably species, resulting in a contemporary species list for each of the sampling stations.

Ecological Function

Ecological function metric values will be tallied (using fish catch data from each sampling station) to address the objectives and questions in Section 2.0. Applicable metrics include:

- total number of species
- number of resident species (and individuals)
- number of non-resident or migratory species (and individuals)
- life stages by species (percentage of adults, juveniles, and young)
- number of native species (and individuals)
- number of non-native species (and individuals)

Existing Benthic Macroinvertebrate Data

Existing benthic macroinvertebrate data can be used to describe structural and functional attributes of the community. The identity and densities of each species can be used to inform on influential environmental gradients and how these gradients are influenced by increasing pressure from human development and land use. Benthic macroinvertebrate data described from past collections will be used to determine the relative effect the density of human development has on the South Fork Palouse River drainage. Once status of biological condition is determined, direction of change for previous and current biological conditions can be established.

Current Benthic Macroinvertebrate Community Data

The benthic macroinvertebrate community will be characterized by enumerating each sample and determining density estimates. In addition the functional feeding group (FFG) designation will be determined for each species identified from samples in order to characterize dominance for a community at each site. The benthic macroinvertebrates will be used to: 1) assess conditions at each site, and 2) understand how existing environmental gradients influence current benthic macroinvertebrate community conditions. The combination of assessment and diagnosis using community composition will be useful in extrapolating hypothetical biological conditions and aquatic life uses during Pre-European periods.

4.2 Measurement Performance Criteria

Measurement performance criteria are quantitative statistics used to interpret the degree of acceptability or utility of the data to the user. These criteria, also known as DQIs, include the following:

- Precision
- Accuracy
- Representativeness
- Completeness
- Comparability

Precision

Precision is a measure of internal method consistency. It is demonstrated by the degree of agreement between individual measurements (or values) of the same property of a sample, measured under similar conditions.

Sampling method consistency and adherence to Standard Operating Procedures will be assessed during field audits and documented in a Field Sampling QA Report. In the event that the field audit identifies problems requiring attention, the Tetra Tech Task Leader and/or the EPA QA Officer will immediately consult with the EPA Project Manager. The corrective action system for this project is described in Section 17.0.

Accuracy

Accuracy is defined as the degree of agreement between an observed value and an accepted reference or true value. Accuracy is a combination of random error (precision) and systematic error (bias), introduced during sampling and analytical operations. Bias is the systematic distortion of a measurement process that causes errors in one direction, so that the expected sample measurement is always greater or lesser to the same degree than the sample’s true value.

Representativeness

Representativeness is defined as "the degree to which the data accurately and precisely represent a characteristic of a population parameter, variation of a property, a process characteristic, or an operational condition" (Stanley and Verner 1985; Smith et al. 1988). At one level, representativeness is affected by problems in any or all of the other attributes of data quality.

At another level, representativeness is affected by the selection of the target surface water bodies, the location of sampling sites within that body, the time period when samples are collected, and the time period when samples are analyzed. The probability-based sampling design should provide estimates of condition of surface water resource populations that are representative of the region. The individual sampling programs defined for each indicator attempt to address representativeness within the constraints of the sampling design and index sampling period. Use of QC samples (e.g., water quality sample replicates collected at the time of sampling) which are similar in composition to samples being measured provides estimates of precision and bias that are applicable to sample measurements.

Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid according to specific criteria and entered into the data management system. To optimize completeness, every effort is made to avoid sample and/or data loss. Accidents during sample transport or lab activities that cause the loss of the original samples will result in irreparable loss of data, which will reduce the ability to perform analyses, integrate results, and prepare reports.

Completeness requirements are established and evaluated from two perspectives. First, valid data for individual indicators must be acquired from a minimum number of sampling locations in order to make subpopulation estimates with a specified level of confidence or sampling precision. The objective of this study is to complete sampling at 95% or more of the 1800 initial sampling sites and the 100 reference sites. Percent completeness is calculated as:

$$\%C = \frac{V}{T} \times 100\%$$

where V = number of measurements/samples judged valid, and T = total number of planned measurements/samples. Within each indicator, completeness objectives are also established for individual samples or individual measurement variables or analytes. These objectives are estimated as the percentage of valid data obtained versus the amount of data expected based on the number of samples collected or number of measurements conducted. Where necessary, supplementary objectives for completeness are presented in the indicator-specific sections of this QAPP.

Comparability

Comparability is an expression of the confidence with which one data set can be compared to another. Comparability is dependent on the proper design of the sampling program and on adherence to accepted sampling techniques, standard operating procedures, and quality assurance guidelines. For the fish and benthic macroinvertebrate community characterization task, comparability of data will be accomplished by standardizing the sampling season, the field sampling methods, and the field training as follows:

- All samples will be collected within the Index Period of 2010 (July 1 – October 15). Adjustments to this schedule may be necessary (based on availability of sampling personnel and equipment, and/or weather and water conditions); however, all adjustments must be approved by the EPA Project Manager.
- All samples will be collected and prepared for storage or shipment according to standard operating procedures contained in this QAPP.
- All field personnel involved with sampling will have adequate training and appropriate experience (Section 5.0).

DQIs that cannot be expressed in terms of accuracy, precision, or completeness will be reported by fully describing the specified method; all other quality requirements will be fulfilled. Measurement performance criteria for data to be collected during this project are provided in Table 5-1, and are further discussed in Section 11.

5.0 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

This QAPP and supporting materials will be distributed to all participants. The local TOL, Rob Plotnikoff, will conduct a procedural review before the field team is mobilized for sampling. The procedural review will include the requirements of the QAPP and referenced SOPs, as well as instrument manufacturers' operation and maintenance instructions. It will be performed concurrently with a check that all equipment and sampling gear are fully functional and ready for deployment. In addition, there will be discussions and demonstrations of sampling method(s) to be used and discussions regarding specific health and safety concerns. Each sampling team will consist of, at a minimum, one sample collector and a QC Officer, who will ensure strict adherence to the project protocols, check all documentation for correctness, and verify that no transcription errors have been made in preparing sample custody records and other project documentation.

Table 5-1. Measurement performance criteria for physicochemical analyses.

	Water		
Measurement parameter	Precision RPD (%)[a]	Accuracy Recovery (or %Diff)	**Completeness (%)**
Field Water Quality Measurements			90
- Temperature	± 1.5 °C[b]	± 20%	
- DO	± 0.3 mg/L[b]	± 20%	
- Conductivity	± 0.1 µS/cm[b]	± 20%	
- pH	± 0.3 units[b]	± 20%	
Biological Indicators	± 20% for metrics	NA	95
Physical Habitat	± 20% for variables	NA	95

NA = Not available
[a] RPD = relative percent difference
[b] Dependent upon range of measurement used on the field sensor

6.0 DOCUMENTATION AND RECORDS

Thorough documentation of all field sample collection is necessary for proper processing of data and, ultimately, for interpreting study results. Field sample collection will be documented in writing, on forms included in (to be included in Appendix A), as well as on the following forms and labels:

- A field log notebook for general observations and notes
- A Field Data Record Form that contains information about observations and measurements made and samples collected at the site
- Checklists for each sampling event, sampling point, and sampling time.

The TOLs, and the appropriate PMs within subcontractor organizations will maintain files, as appropriate, as repositories for information and data used in preparing any reports and documents during the project and will supervise the use of materials in the project files. The following information will be included:

- Any reports and documents prepared
- Contract and Task Order information
- Project QAPP
- Results of technical reviews, data quality assessments, and audits
- Communications (memoranda; internal notes; telephone conversation records; letters; meeting minutes; and all written correspondence among the project team personnel, subcontractors, suppliers, or others)

- Maps, photographs, and drawings
- Studies, reports, documents, and newspaper articles pertaining to the project
- Special data compilations
- Spreadsheet data files: physical measurements, analytical chemistry data (hard copy and disk)

Copies of the field log books and physical characterization/water quality data sheets and sampling checklists will be supplied to the Field PMs at the close of each sampling event. These data will be used in conjunction with inspection checklists to compile the sampling event reports. Formal reports that are generated from the data will be subject to technical and editorial review before submission to EPA, and will be maintained at Tt's Seattle, Washington, office in the central file (disk and hard copy). The data reports will include a summary of the types of data collected, sampling dates, and any problems or anomalies observed during sample collection.

If any change(s) in this QAPP are required during the study, a memo will be sent to each person on the distribution list describing the change(s), following approval by the appropriate persons. The memos will be attached to the QAPP. All written records relevant to the sampling and processing of samples will be maintained at Tt's Baltimore, Maryland, office in the central file. Unless other arrangements are made, records will be maintained for a maximum of 2 years following project completion.

7.0 SAMPLING DESIGN

The sampling design follows EPA's GRTS method to select candidate sites in the Washington and Idaho portions of the SFPR watershed. A subset of 20 sites was subsequently selected for field surveys of fish, benthic macroinvertebrates, habitat, and water quality parameters relevant to the TMDL process (Table 7-1). Olson et al. (2009) concluded that 30 sites are generally adequate to evaluate the various features of the river basin; however, the current study's focus on mainstem reaches and tributaries suggests that a lower number of sites will be representative of conditions.

Existing benthic macroinvertebrate and periphyton data will also be used for determining community composition (structure), function, and general tolerance characteristics (indicates response to stressors). These data were generated based on targeted designs where sites were selected to describe gradients of condition and response by the biotic community. This information will be associated with the nearest fish sampling sites and interpretations extrapolated based on similarity of physicochemical setting.

8.0 SAMPLING METHODS

Fish will be sampled using backpack electrofishers. The specific method used is that of the Washington State Department of Ecology for Status and Trend Monitoring of Watershed Health and Salmon Recovery (Washington State Department of Ecology 2009 [draft]). All habitats are sampled over a stream reach defined as 20 times the mean bankfull width. Sites with a mean bankfull width of less than 8 meters will be extended to the minimum reach length of 150 meters. All fish will be netted and placed into a bucket or live-well for processing. Specimens will be identified to species and life-stage and minimum/maximum length will be determined. All fish will be placed back into the stream following processing. Selected individuals that are difficult to identify may be preserved in 10% formalin and returned to the laboratory for final identification.

Table 7-1. Proposed study sites in the South Fork Palouse River watershed (Primary* = Fish survey and Benthic macroinvertebrates collected at a site; † = Fish surveys conducted at a site).

Sample Type	Site ID	Stream Name	Longitude	Latitude	Stream Order
Primary†	CBW05583-012619	Dry Fork Creek	-117.19442	46.674303	NA
Primary*	CBW05583-037195	Dry Fork Creek	-117.197887	46.711083	NA
Primary*	CBW05583-008523	Missouri Flat Creek	-117.17504	46.736617	3
Primary†	CBW05583-030283	Missouri Flat Creek	-117.134637	46.771865	3
Primary*	CBW05583-022859	Paradise Creek	-117.095902	46.729244	2
Primary†	CBW05583-026642	Paradise Creek	-116.980223	46.733622	2
Primary*	CBW05583-033099	Paradise Creek	-116.977217	46.799976	1
Primary*	CBW05583-080203	Paradise Creek	-117.052307	46.735872	2
Primary†	CBW05583-081483	Paradise Creek	-116.962549	46.756036	2
Primary*	CBW05583-108562	Paradise Creek	-116.994418	46.722794	2
Primary*	CBW05583-004626	South Fork Palouse River	-116.887409	46.782886	1
Primary†	CBW05583-018763	South Fork Palouse River	-117.246252	46.779403	4
Primary†	CBW05583-024907	South Fork Palouse River	-117.227364	46.770388	4
Primary*	CBW05583-031051	South Fork Palouse River	-117.097929	46.680996	3
Primary†	CBW05583-033355	South Fork Palouse River	-117.332451	46.865166	5
Primary†	CBW05583-043339	South Fork Palouse River	-117.268576	46.814567	4
Primary†	CBW05583-051531	South Fork Palouse River	-117.257404	46.787689	4
Primary†	CBW05583-057675	South Fork Palouse River	-117.168426	46.72413	4
Primary*	CBW05583-098891	South Fork Palouse River	-117.3125	46.865718	5
Primary*	CBW05583-106827	South Fork Palouse River	-117.216619	46.75549	4
Oversample	CBW05583-078155	Dry Fork Creek	-117.203285	46.706662	NA
Oversample	CBW05583-274763	Dry Fork Creek	-117.196071	46.682124	NA
Oversample	CBW05583-139595	Missouri Flat Creek	-117.151966	46.762297	3
Oversample	CBW05583-161355	Missouri Flat Creek	-117.124288	46.775849	3
Oversample	CBW05583-121163	Paradise Creek	-117.06438	46.73677	2
Oversample	CBW05583-153931	Paradise Creek	-117.132716	46.721583	2
Oversample	CBW05583-174098	Paradise Creek	-116.98844	46.723699	2
Oversample	CBW05583-178507	Paradise Creek	-117.026987	46.732128	2
Oversample	CBW05583-196939	Paradise Creek	-116.982509	46.787075	1
Oversample	CBW05583-268619	Paradise Creek	-117.078677	46.733491	2
Oversample	CBW05583-285003	Paradise Creek	-117.12115	46.725716	2
Oversample	CBW05583-305170	Paradise Creek	-116.976162	46.72485	2
Oversample	CBW05583-123211	South Fork Palouse River	-117.163538	46.706892	3
Oversample	CBW05583-126994	South Fork Palouse River	-116.927215	46.746713	3
Oversample	CBW05583-127307	South Fork Palouse River	-117.284617	46.838252	5
Oversample	CBW05583-137547	South Fork Palouse River	-117.024193	46.714705	3
Oversample	CBW05583-149835	South Fork Palouse River	-117.234916	46.770581	4
Oversample	CBW05583-157714	South Fork Palouse River	-116.998424	46.709994	3
Oversample	CBW05583-158027	South Fork Palouse River	-117.067112	46.683377	3
Oversample	CBW05583-162123	South Fork Palouse River	-117.132475	46.692832	3
Oversample	CBW05583-164427	South Fork Palouse River	-117.298968	46.871607	5
Oversample	CBW05583-172562	South Fork Palouse River	-116.906997	46.76377	2
Oversample	CBW05583-174411	South Fork Palouse River	-117.275001	46.826401	4
Oversample	CBW05583-192843	South Fork Palouse River	-117.283091	46.841016	5
Oversample	CBW05583-195659	South Fork Palouse River	-117.360461	46.877789	5
Oversample	CBW05583-203083	South Fork Palouse River	-117.006317	46.713257	3
Oversample	CBW05583-215371	South Fork Palouse River	-117.262938	46.793846	4
Oversample	CBW05583-225611	South Fork Palouse River	-117.280036	46.843416	5
Oversample	CBW05583-231755	South Fork Palouse River	-117.247051	46.784855	4
Oversample	CBW05583-239947	South Fork Palouse River	-117.052395	46.691321	3

Benthic macroinvertebrate (BMI) samples will be collected within the same sampling reach at select fish survey sites. Ten of the twenty sites identified for this study will have both fish surveys and benthic macroinvertebrate collections; the ten BMI sites will have a full complement of biological and physicochemical data used to determine the biological benefit from physical settings. The BMI samples will be stored in one-gallon freezer bags, labeled, and preserved in the field for return to the laboratory and taxonomic analysis. Protocol details for sample collection and handling are reported in PNAMP (2007).

9.0 SAMPLE HANDLING AND CUSTODY

All fish collected within the sample reach will be identified to species. Specimens that cannot be identified in the field are preserved in a 10% formalin solution and stored in labeled jars for subsequent laboratory identification.

10.0 ANALYTICAL METHODS

Fish specimens of questionable quality or not readily identified in the field are retained for laboratory examination or voucher collection purposes. Specimens must be properly preserved (e.g., 10% formalin for tissue fixing and 70% ethanol for long-term storage) and labeled with site location data, collection date, collector's names, species identification (for fishes identified in the field), species totals, and sample identification code or station number. All samples received in the laboratory should be tracked using a sample log-in procedure. Laboratory fisheries professionals and benthic macroinvertebrate taxonomists must be capable of identifying fish and aquatic insects to the lowest possible taxonomic level (i.e., species or subspecies) and should have access to suitable regional taxonomic with current and consistent taxonomic nomenclature.

11.0 QUALITY CONTROL

Data quality is addressed, in part, by consistent performance of valid procedures documented in the SOPs. It is enhanced by the training and experience of project staff (Section 5.0) and documentation of project activities (Section 6.0). This QAPP, SAPs, and other supporting materials will be distributed to all sampling personnel. A QC Officer will ensure that samples are taken according to the established protocols and that all forms, checklists, and measurements are recorded and completed correctly during the sampling event.

Measurement performance criteria for data to be collected during this project are discussed in the following sections.

<u>Precision</u>

Precision is a measure of internal method consistency. It is demonstrated by the degree of mutual agreement between individual measurements or enumerated values of the same property of a sample, usually under demonstrated similar conditions. The usability assessment will include consideration of this condition in evaluating field measures from the entire measurement system. Although precision evaluation within 20 percent relative percent difference (RPD) are generally considered acceptable for water quality studies and analyses, no data validation or usability action will be taken for results in excess of the 20 percent limit. Instead, the results will be noted and compared with the balance of the parameters analyzed for a more comprehensive assessment before any negative assessment, disqualification, or exclusion of data.

This QC calculation also addresses uncertainty due to natural variation and sampling error. Precision is calculated from two duplicate samples by RPD as follows:

$$RPD = \frac{|C_1 - C_2|}{\overline{(C_1, C_2)}} \times 100\%$$

where C_1 = the first of the two values and C_2 = the second of the two if precision is to be calculated from three or more replicate samples (as is often the case in laboratory analytical work), the relative standard deviation (RSD) will be used and is calculated as

$$RSD = \frac{s}{\overline{\chi}}$$

where χ is the of the replicate samples, and *s* is the standard deviation and is determined by the following equation:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(\chi_i - \overline{\chi}\right)^2}{n-1}}$$

where χ_i is the measured value of the replicate, $\overline{\chi}$ is the mean of the measured values, and *n* is the number of replicates.

For this project, duplicate field samples will be collected to assess sampling precision and field blanks will accompany samples to assess the potential for contamination in the sample collection process.

Accuracy

Accuracy is defined as the degree of agreement between an observed value and an accepted reference or true value. Accuracy is determined by using a combination of random error (precision) and systematic error (bias) due to sampling and analytical operations. Bias is the systematic distortion of a measurement process that causes errors in one direction so that the expected sample measurement is always greater or lesser to the same degree than the sample's true value. EPA now recommends that the term *accuracy* not be used and that *precision* and *bias* be used instead.

Because accuracy is the measurement of a parameter and comparison to a *truth*, and the true values of environmental physicochemical characteristics cannot be known, use of a surrogate is required. Accuracy of field measurements will be assumed to be determined through use of precision.

The accuracy of field equipment for the measurement of temperature, DO, conductivity, salinity, and pH will be determined at a minimum of two points that span the expected range of values for these parameters. Instruments used and procedures for determining accuracy include the following:

Temperature sensors:

The accuracy of temperature sensors used in this project will be checked using a standard thermometer.

DO sensors:

The accuracy of DO sensors and methods used in this project will be determined using the ambient air oxygen concentration before deploying continuous monitoring devices, and instantaneous measurement will be verified by Winkler titration in the field. The actual concentration of DO at saturation is determined by measuring temperature and reading the corresponding concentration from a standard table and by making the required correction for nonstandard atmospheric pressure conditions.

Conductivity sensors:

The accuracy of the salinity and conductivity sensor used in this project will be checked using the calibration solution provided by Pine Environmental Services, Inc. The conductivity sensor is calibrated from the autocal solution, which contains a certified 0.449 µS/cm solution.

pH sensors:

The accuracy of pH sensors used in this project will be checked using the autocal solution provided by Pine Environmental Services, Inc. (or equivalent quality), which contains a certified pH 4 buffer solution.

Accuracy of data entry into the project database will be controlled by double-checking all manual data entries.

Representativeness

Data representativeness is defined as the degree to which data accurately and precisely represents a characteristic of a population, parameter, and variations at a sampling point, a process condition, or an environmental condition. It therefore addresses the natural variability or the spatial and temporal heterogeneity of a population. The number of sampling points and their location within the study area will be examined to ensure that representative sample collection of each area of the watersheds and each target analyte series occurs.

Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid according to specific criteria and entered into the data management system. To achieve this objective, every effort is made to avoid accidental or inadvertent sample or data loss. Accidents during sample transport or lab activities that cause the loss of the original samples will result in irreparable loss of data. Lack of data entry into the database will reduce the ability to perform analyses, integrate results, and prepare reports. Samples will be stored and transported in unbreakable (plastic) containers wherever possible. All sample processing (subsampling, sorting, identification, and enumeration) will occur in a controlled environment within the laboratory. Field personnel will assign a set of continuous identifiers to a batch of samples. Percent completeness (*%C*) for measurement parameters can be defined as follows:

$$\%C = \frac{V}{T} \times 100\%$$

where V = the number of measurements judged valid and T = the total number of measurements planned.

For this project, sampling will be considered complete when no less than 90 percent of the samples collected during a particular sampling event are judged valid.

Comparability

Two data sets are considered to be comparable when there is confidence that the two sets can be considered equivalent with respect to the measurement of a specific variable or group of variables. Comparability is dependent on the proper design of the sampling program and on adherence to accepted sampling techniques, and QA guidelines.

12.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Periodic regular inspection of equipment and instruments is needed to ensure the satisfactory performance of the systems. Equipment to be used during the sampling event is listed in the appropriate SOPs. Before any piece of sampling or measurement equipment is taken into the field, it will be inspected to ensure that the equipment is appropriate for the task to be performed, all necessary parts of the equipment are intact, and the equipment is in working order. In addition, the equipment will be visually inspected before its use. Broken equipment will be labeled "DO NOT USE" and returned to the Tt office to receive necessary repairs, or it will be disposed of. Backup field equipment will be available during all field activities in the event of equipment failure.

The objective of preventive maintenance is to ensure the availability and satisfactory performance of the measurement systems. All field measurement instruments will receive preventive maintenance in accordance with the manufacturer's specifications.

13.0 INSTRUMENT CALIBRATION AND FREQUENCY

The field instruments will be used for in-field, instantaneous measurement of temperature, DO, conductivity, salinity, and pH. In addition, pH measurement accuracy will be checked against standard solutions in the field and adjustments made to the meter prior to the next measurement. The instrument is pre-calibrated upon arrival and has a specially formulated calibration solution that allows a one-step calibration for all probes prior to use.

The calibration of temperature, DO, conductivity/salinity, and pH probes will be checked before and after each sampling event, or as deemed necessary by the multiprobe's manufacturer, using the certified standard solution. Field calibrations will be recorded in the field sampling log book. Individual sensors will be considered to be operating correctly if the instrument reading is within 15 percent of the calibration standard value. If the two values are not within 15 percent of each other, the probe will be cleaned and recalibrated. If these two values are still not within 15 percent of each other following cleaning and recalibration, the probe itself will be replaced.

14.0 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies and consumables are those items necessary to support the sampling and analysis operation. They include bottleware, calibration solutions, hoses, decontamination supplies, preservatives, and various types of water (e.g., potable, deionized, organic-free). Upon delivery of supplies, Tt will ensure that types and quantities of supplies received are consistent with what was ordered, and with what is indicated on the packing list and invoice for the material. If any discrepancies are found, the supplier will be contacted immediately.

While preparing for specific sampling events, the field sampling Task Leaders will be responsible for acquiring and inspecting materials and solutions that will be used for obtaining the samples for field measurements. Other materials must also meet specific requirements as indicated by the appropriate manufacturer; for example, only certified standard solutions will be used for the multiprobe calibration. Buffers and standards will be checked for expiration dates and appearance (correct color).

15.0 NONDIRECT MEASUREMENTS

Comparison of data collected during this field effort to historical data will be used for qualitative assessment only. Assessment of applicability for historical data is outside the scope of this document and is not addressed further.

16.0 DATA MANAGEMENT

Samples will be documented and tracked on Field Data Record forms, Sample Identification labels, and Chain of Custody records. The Field Task Leaders (one for each team) will be responsible for ensuring that these forms are completed and reviewed for correctness and completeness by the designated field QC Officer. Tt will maintain copies of these forms in the project files. A sampling report will be prepared following each sampling event. Another person will manually check data entered into any spreadsheet or other format against the original source to ensure accurate data entry. If there is any indication that requirements for sample integrity or data quality have not been met (for samples or measurements collected by Tt), the Tt QAO will be notified immediately (with an accompanying explanation of the problems encountered).

Hard copy data packages will be paginated, fully validated raw data packages that include an analytical narrative with a signed certification of compliance with this QAPP and all method requirements; copies of Chain of Custody forms; sample inspection records; laboratory sample and QC results; calibration summaries; example calculations by parameter; and copies of all sample preparation, analysis, and standards logs adequate to reconstruct the entire analysis. The CD-ROM data will include a full copy of the paginated report scanned and stored in portable document format (PDF) for potential future submission to the client, if requested, and for long-term storage in the project files. Initially, the full raw data package will be submitted to the Tt QAO for assessment of compliance with the program goals and guidance.

All computer files associated with the project will be stored in a project subdirectory by Tt (subject to regular system backups) and will be copied to disk for archive for the 5 years subsequent to project completion (unless otherwise directed by the EPA TOM). The data may eventually be submitted for entry to Ecology’s EIM (Environmental Information Management) database.

17.0 ASSESSMENT AND RESPONSE ACTIONS

The QA program under which this task order will operate includes technical system audits, with independent checks of the data obtained from sampling, analysis, and data-gathering activities. This process is illustrated in Figure 17-1. Tt will review the QA programs that subcontractors follow to ensure similar levels of QA and QC are attained. The essential steps in the QA program are as follows:

- Identify and define the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Assign and accept responsibility for implementing appropriate corrective action
- Establish the effectiveness of and implement the corrective action
- Verify that the corrective action has eliminated the problem

Many of the technical problems that might occur can be solved on the spot by the staff members involved; for example, by modifying the technical approach, repairing instrumentation that is not working properly, or correcting errors or deficiencies in documentation. Immediate corrective actions form part of normal operating procedures and are noted in records for the project. Problems not solved this way require more formalized, long-term corrective action. If quality problems that require attention are identified, Tt or the subcontractor will determine whether attaining acceptable quality requires short- or long-term actions. If a failure in an analytical system occurs (e.g., performance requirements are not met), the appropriate QC Officer or subcontractor QA Manager will be responsible for corrective action and will immediately inform the Tt PM or QAO, as appropriate. Subsequent steps taken will depend on the nature and significance of the problem, as illustrated in Figure 17-1.

The Tt TOLs have primary responsibility for monitoring the activities of this project and identifying or confirming any quality problems. These problems will also be brought to the attention of the Tt QAO, who will initiate the corrective action system described above, document the nature of the problem, and ensure that the recommended corrective action is carried out. The Tt QAO has the authority to stop work on the project if problems affecting data quality require extensive effort to resolve and are identified.

The EPA TOM and Tt TOLs will be notified of major corrective actions and stop work orders. Corrective actions might include the following:

- Reemphasizing to staff the project objectives, the limitations in scope, the need to adhere to the agreed-upon schedule and procedures, and the need to document QC and QA activities
- Securing additional commitment of staff time to devote to the project
- Retaining outside consultants to review problems in specialized technical areas
- Changing procedures
- The Tt TOLs may replace a staff member or subcontractor, as appropriate, if it is in the best interest of the project to do so.
- The Tt QC Officers are responsible for overseeing work as it is performed and periodically conducting checks during the data entry and analysis phases of the project. As data entries, calculations, or other activities are checked, the person performing the check will sign and date a hard copy of the material or complete a review form, as appropriate, and provide this documentation to the Tt TOLs for inclusion in the project files. Field audits and technical system audits will not be conducted under this task order.
- Technical system audits are qualitative reviews of project activity to check that the overall quality program is functioning and that the appropriate QC measures identified in the QAPP are being implemented. A technical system audit will not be performed during this program because the deliverables scheduled for submission to the QAO will afford for real-time monitoring of compliance throughout the data collection and would be considered a redundant burden on the project budget.

It is expected that Tt will oversee a single sampling procedure review that will be conducted by the Field Task Manager during the first sampling period. This review will serve as an opportunity to observe the sampling techniques used by the field teams, assist in orchestration of couriers and logistical support, and document any required procedural modifications that might be required due to prevailing site or sample conditions. EPA Region 10 may elect to conduct further audits of the sampling teams or analytical laboratories at any time during sample collection and analysis activities. Such audits would be performed to ensure that data collected have optimal validity and usability and that limitations of the data set are minimized as much as is possible given logistical considerations. It is expected at this time that only a procedural review will be performed by Tt during the first sampling event, and that no additional audits will be conducted in conjunction with this data collection. The procedural reviews will be conducted to ensure compliance with the ODEQ SOPs referenced in the SAP and to introduce any unique aspects of this field program.

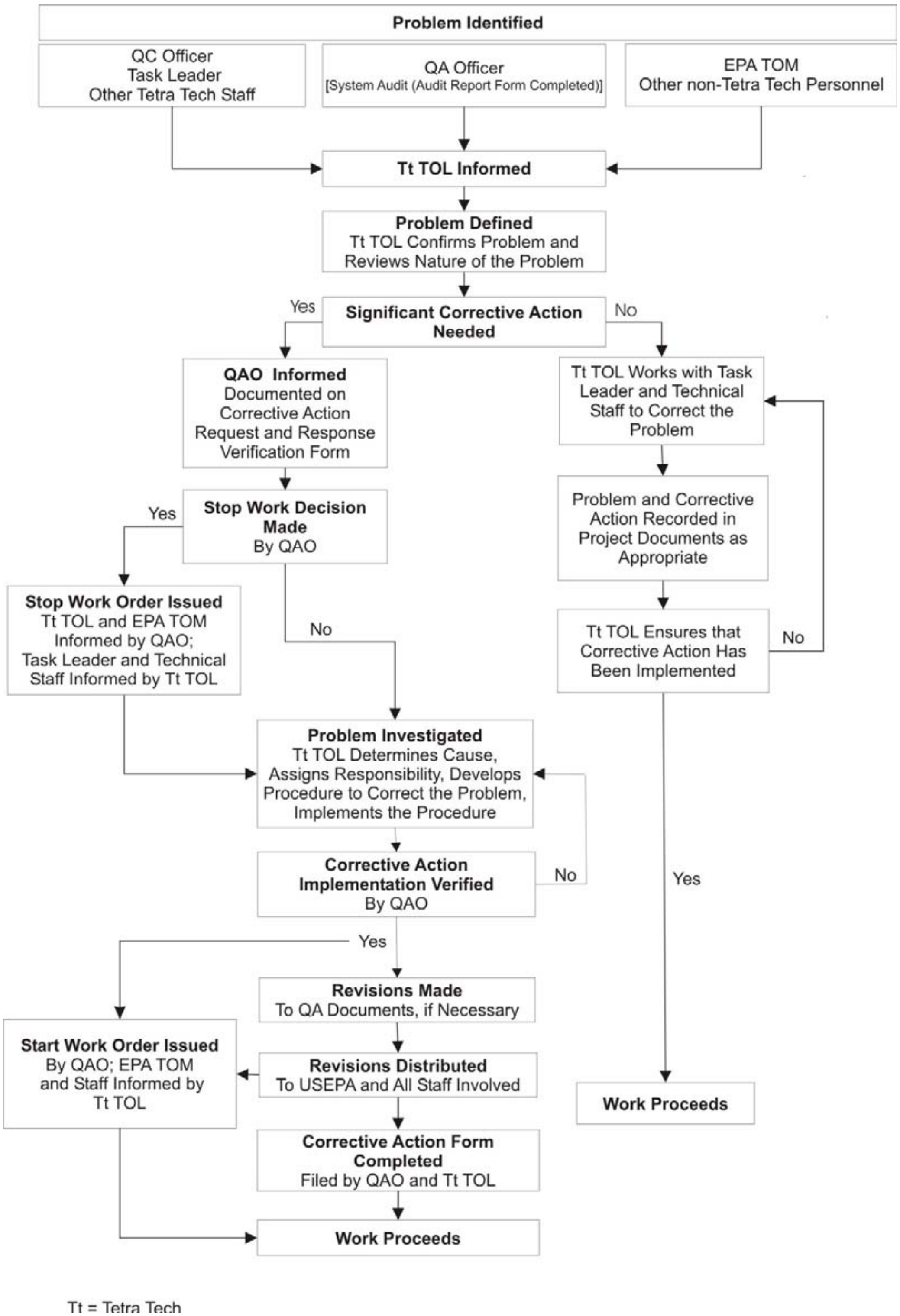

Figure 17-1. Problem assessment and correction operations.

18.0 REPORTS TO MANAGEMENT

Upon completion of sampling activities, the Tt TOLs will contact the EPA TOM to summarize sampling team progress. Following completion of field sampling, Tt will prepare a field sample collection summary (detailed listing of all sampling participants, sampling locations, and specimens collected) for review by EPA.

Following the completion of each data quality assessment, the Tt QAO or designee will prepare a Data Quality Assessment Report and submit copies to the TOM for inclusion in project records and to EPA, if required. The data quality assessment will include any required qualification of data based on observations, field QC analyses, or other observations that might affect data quality.

When required, reports summarizing incidents of technical direction requests from field staff, required corrective actions, and any other issues affecting data quality or usability will be submitted to the TOM. These observations will be compiled and submitted in interim QA reports where warranted, in informal file memoranda to the TOM for inclusion in the project files, or for submission to the EPA QAM, as required. These regular QA reports and memoranda, along with routine data quality assessments performed throughout the data collection will be the basis of the final QA report for this collection effort.

19.0 DATA REVIEW, VERIFICATION, AND VALIDATION

Data validation and review services provide a method for determining the usability and limitations of data and provide a standardized data quality assessment. All Field Data forms will be reviewed by the Tt TOLs (assisted by the QAO, as needed) for completeness and correctness. Tt will be responsible for reviewing data entries and transmissions for completeness and adherence to QA requirements. Data quality will be assessed by comparing entered data to original data or by comparing results to the measurement performance criteria summarized in Section 4.2 to determine whether to accept, reject, or qualify the data. Results of the review and validation processes will be reported to the TOLs.

20.0 VERIFICATION AND VALIDATION METHODS

The Tt TOLs or designee will review all Field Data Record forms. The Tt QAO will review a minimum of 5 percent of the Field Data Record forms and other records. Any discrepancies in the records will be reconciled with the appropriate associated field personnel and will be reported to the Tt TOLs. The EPA TOM will be consulted with deficiencies, observations, and findings, as well as with corrective action and technical directive recommendations for consideration and approval.

21.0 RECONCILIATION WITH USER REQUIREMENTS

As soon as possible following completion of the sample collection and analyses, Tt will assess the precision, accuracy, and completeness measures and compare them with the criteria discussed in Section 4.0. This will be the final determination of whether the data collected are of the correct type, quantity, and quality to support their intended use for this project. Any problems encountered in meeting the performance criteria (or uncertainties and limitations in the use of the data) will be discussed with the project QA personnel and EPA TOM, and will be reconciled if possible.

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APPENDIX A Field Forms

Reviewed by (Initials):________

Status and Trends Program - Site Verification Form 2009

	Site Number		YY	MMDD	HH : MM
DCE:	W A M 0 6 0 0 -	- D C E - 2 0	-	-	:

DCE Start Date	/ / 2 0 0 9		DCE End Date	/ / 2 0 0 9

Water Name:

Waterbody Type: Saltwater/Brackish ☐ River/Stream ☐ Canal/Ditch ☐ Wetland ☐ Reservoir ☐ Lake ☐ Other ☐

Safe to Sample?:	Y N	If not sampled, why not?
Permission?:	Y N	
Sampled?:	Y N	
Wade or Raft?:	W R	

Crew	1 (Leader)	Crew Member 2	Crew Member 3	Crew Member 4
First Name / Last Name:				
Organization:				
Habitat:	☐	☐	☐	☐
Water:	☐	☐	☐	☐
Sediment:	☐	☐	☐	☐
Invertebrates:	☐	☐	☐	☐
Fishing:	☐	☐	☐	☐

Other People?

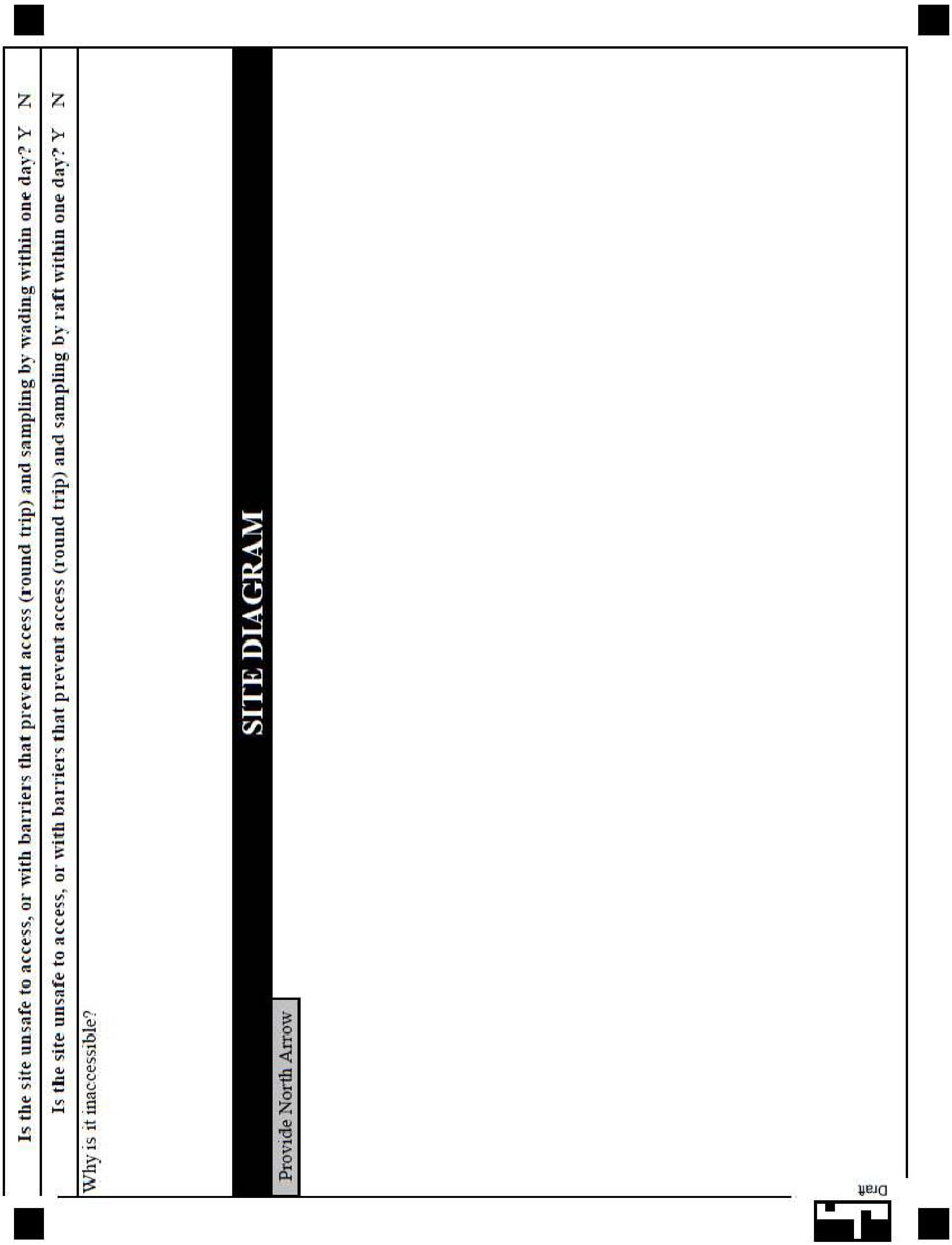
Montgomery & Buffington Reach Type	**Bankfull Width** Estimate near Index Station (avg. of 5) (m)	**Site Length** 20 x BFW but between 150-2000 (m)
	Downstream Thalweg Distance (X to A) (m.x)	**Upstream Thalweg Distance** (X to A) (m.x)

Colluvial ☐
Alluvial:Braided ☐
Alluvial:Regime ☐
Alluvial:Pool-Riffle ☐
Alluvial:Plane Bed ☐
Alluvial:Step Pool ☐
Alluvial:Cascade ☐
Bedrock ☐

General Notes

Draft

Site Verification Form (Front)



Is the site unsafe to access, or with barriers that prevent access (round trip) and sampling by wading within one day? Y N

Is the site unsafe to access, or with barriers that prevent access (round trip) and sampling by raft within one day? Y N

Why is it inaccessible?

SITE DIAGRAM

Provide North Arrow

Draft

Site Verification Form (Back)

Crew Number (e.g. 1, 2, 3): ______

Reviewed by (Initials): ______

Vertebrate Collection Form - Streams/Rivers

Site Number	YY	MMDD	HH : MM
DCE: W A M 0 6 0 0 - ______ - D C E - 2 0		- ______	- __ : __

FPARS Type ______ FPARS FLAG ______ Fished? ☐ Fished but no verts detected ☐ Fished/Not Fished FLAG ______

On Button Time (sec) ______ Fishing+Processing Time (min) ______ Sample Distance (m) ______

Gear: ☐ Backpack ☐ Raft FLAG for other Sampling Information ______ Water Visibility ☐ Good ☐ Poor Water Temp (c) ______ Cond (cm) ______

Volts: ______
Frequency: ______ Hz
Duty Cycle: ______ %

Notes regarding electrofisher operation:

Jar No.	COMMON NAME	A	J	Tally	Total Count	DNA Count	LENGTH (mm)* Min	LENGTH (mm)* Max	Mortality	Flag	SEGMENTS
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J
											O A O C O E O G O I O B O D O F O H O J

Flag	Comment

Draft

Page ______ of ______

K = No measurement made, U = Suspect measurement, F1, F2, etc. = flags assigned by each field crew

LENTH* - Enter single fish as minium.

Fish Collection Form (Front)

Tag No.	COMMON NAME	A	J	Tally	Total Count	Voucher Count	LENGTH (mm)*		Mortality	Flag	SEGMENTS
							Min	Max			
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J
											○A ○B ○C ○D ○E ○F ○G ○H ○I ○J

Flag	Comment

Draft

Page ______ of ______

K = No measurement made, U = Suspect measurement, F1, F2, etc. = flags assigned by each field crew

LENTH* - Enter single fish as minium

Fish Collection Form (Back)

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

SITE ID:	**DATE:** 2010-___ ___- ___ ___ (YYYY-MM-DD)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

RBP Habitat Form (Front)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE _________	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE _______ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _______ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE _______ (LB)	Left Bank 10 9 9	8 7 6	5 4 3	2 1 0
SCORE _______(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE _______ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _______ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

RBP Habitat Form (Front)

Major Transect Form

Reviewed by (Initials):________

Transect	Channel #	Site Number	YY	MMDD	HH : MM
		DCE: W A M 0 6 0 0 -	- D C E - 2 0	-	- :

SUBSTRATE

	Wet Depth	BF Depth XXX CM	Size Class	Embd. 0-100%	Flag
left bank					
.1					
.2					
.3					
.4					
.5					
.6					
.7					
.8					
.9					
right bank					

FISH COVER

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)
(circle one)

	Cover in Channel	Flag
Filamentous Algae	0 1 2 3 4	
Macrophytes	0 1 2 3 4	
Woody Debris >0.3 m(BIG)	0 1 2 3 4	
Brush/Woody Debris < 0.3 m (SMALL)	0 1 2 3 4	
Live Trees or Roots	0 1 2 3 4	
Overhanging Veg. =<1 m of Surface	0 1 2 3 4	
Undercut Banks	0 1 2 3 4	
Boulders	0 1 2 3 4	
Artificial Structures	0 1 2 3 4	
Bryophytes	0 1 2 3 4	

RIPARIAN

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

D = Deciduous
C = Coniferous
E = Broadleaf Evergreen
M = Mixed
N = None

RIPARIAN VEGETATION COVER	Left Bank	Right Bank	Flag
Canopy (>5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
BIG Trees (Trunk >0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
SMALL Trees (Trunk <0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
Understory (0.5 to 5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses, & Forbs	0 1 2 3 4	0 1 2 3 4	
Ground Cover (<0.5 m high)			
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses and Forbs	0 1 2 3 4	0 1 2 3 4	
Barren, Bare Dirt or Duff	0 1 2 3 4	0 1 2 3 4	

HUMAN INFLUENCE

0=not present, 1= 10-30m, 2= 0-10m, 3= on bank

HUMAN INFLUENCE	Left Bank	Right Bank	Flag
Wall/Dike/Revetment/ Riprap/Dam	0 1 2 3	0 1 2 3	
Buildings	0 1 2 3	0 1 2 3	
Unpaved Motor Trail	0 1 2 3	0 1 2 3	
Clearing or Lot	0 1 2 3	0 1 2 3	
Human Foot Path	0 1 2 3	0 1 2 3	
PavedRoad/Railroad	0 1 2 3	0 1 2 3	
Pipes (Inlet/Outlet)	0 1 2 3	0 1 2 3	
Landfill/Trash	0 1 2 3	0 1 2 3	
Park/Lawn	0 1 2 3	0 1 2 3	
Row Crops	0 1 2 3	0 1 2 3	
Pasture/Range/Hay Field	0 1 2 3	0 1 2 3	
Logging Operations	0 1 2 3	0 1 2 3	
Mining Activity	0 1 2 3	0 1 2 3	

BANK

		Flag
Wetted Width XXX.X m		
Bar Width XX.X m		
Bankfull Width XXX.X m		
R Bankfull Height XX.X		
L BankfullHeight XX.X		
B Height Average		
LB Instability %		
RB Instability %		

Densiometer

(0-17Max)

		Flag			Flag
CenUp			CenR		
CenL			Left		
CenDwn			Right		

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, etc. = flag assigned by field crew. Explain all flags in comment sections.

Flag	Comments

Draft

04/07/2009

Transect Data Form (Front)

SITE ID:		**DATE:** 2010- - (YYYY-MM-DD)									
		Grabs									
Transect	**Feature Type**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

Abbreviations:

Silt/Clay	= SC	Sand – Coarse	= C
Sand – Very Fine	= VF	Sand – Very	= VC
Sand – Fine	= F	Small Boulder	= SB
Sand – Medium	= M	Medium	= MB
Hardpan Clay –	= HP	Large Boulder	= LB
Bedrock – BR	= BR		

Feature Types:

Riffle	= RF
Run	= RN
Glide	= G
Pool	

After recording transects above transcribe data into table below. Usually done by data entry person.

Size Class		Size (mm)	Feature	Number	Feature	Number	Feature	Number	Total (for all features)	Cumulative Total (for all sizes)
Silt/Clay		< 0.062								
Sand	Very Fine	0.062-0.125								
	Fine	0.125-0.25								
	Medium	0.25-0.50								
	Coarse	0.50-1.0								
	Very Coarse	1.0-2.0								
Gravel	Very Fine	2-4								
	Fine	4-6								
		6-8								
	Medium	8-12								
		12-16								
	Coarse	16-24								
		24-32								
	Very Coarse	32-48								
		48-64								
Cobble	Small	64-96								
		96-128								
	Large	128-192								
		192-256								
Boulder	Small	256-384								
		384-512								
	Medium	512-1024								
	Large - Very Large	1024-4096								
Bedrock		> 4096								

Transect Data Form (Back)