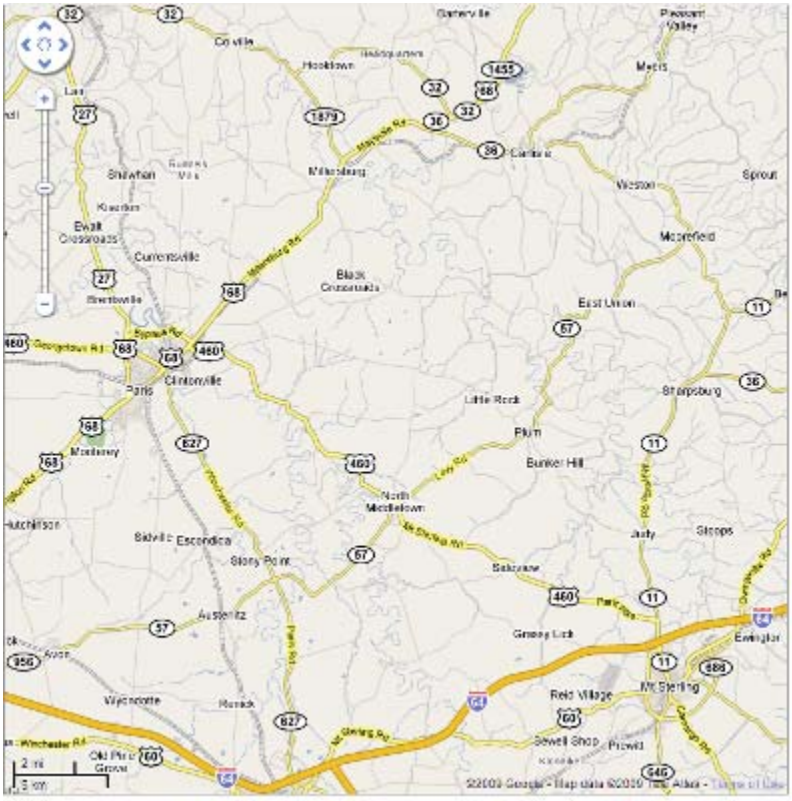
Quality Assurance Project Plan

for the

Hinkston Creek Watershed Project

East Central Kentucky



April 14, 2010 Final Amended Version

Submitted by:

Barry Tonning, Project Manager

Tetra Tech

Group A Project Management

A1 Title and Approval Sheet

Title: Quality Assurance Project Plan
for the Hinkston Creek Watershed Project

Prepared by Barry Tonning. April 14, 2010 Version (Second Amended Draft)

Approvals:

_____
NPS and Basin Team Section Supervisor, KDOW

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Larry Taylor, Quality Assurance Officer, KDOW

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Lisa Hicks, Quality Assurance Officer, KDOW

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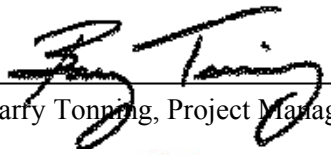
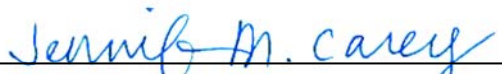
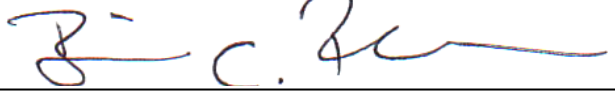
Jim Roe, Nonpoint Source Section, KDOW


Barry Tonning, Project Manager, Tetra Tech


Jennifer Carey, Quality Assurance Manager, Tetra Tech


April Haight, Morehead State University IRAPP


Brian Reeder, Morehead State University, Ecology Laboratory

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A3 Distribution List

Distribution of the Quality Assurance Project Plan will be handled electronically whenever possible. The following individuals will need copies of the QA Project Plan and any subsequent revisions:

Name	Organization	Mailing Address	Email and Phone
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Barry Tonning	Tetra Tech	343 N Maysville St, Mt. Sterling KY 40353	barry.tonning@tetratech.com 859.585.370
Jennifer Carey	Tetra Tech	800 Corporate Drive, Ste 200, Lexington KY 40503	jennifer.carey@tetratech.com 859.223.8000
Brian Reeder	MSU Ecology Lab	MSU Lappin Hall, Morehead KY 40351	b.reeder@moreheadstate.edu 606.783.2957
April Haight	MSU IRAPP	MSU IRAPP, LC101A, Morehead KY 40351	a.haight@moreheadstate.edu 606.783.2455
Rita Wright	MSU Water Testing Lab	MSU Water Testing Lab, Morehead KY 40351	r.wright@moreheadstate.edu 606.783.2961

A4 Project and Task Organization

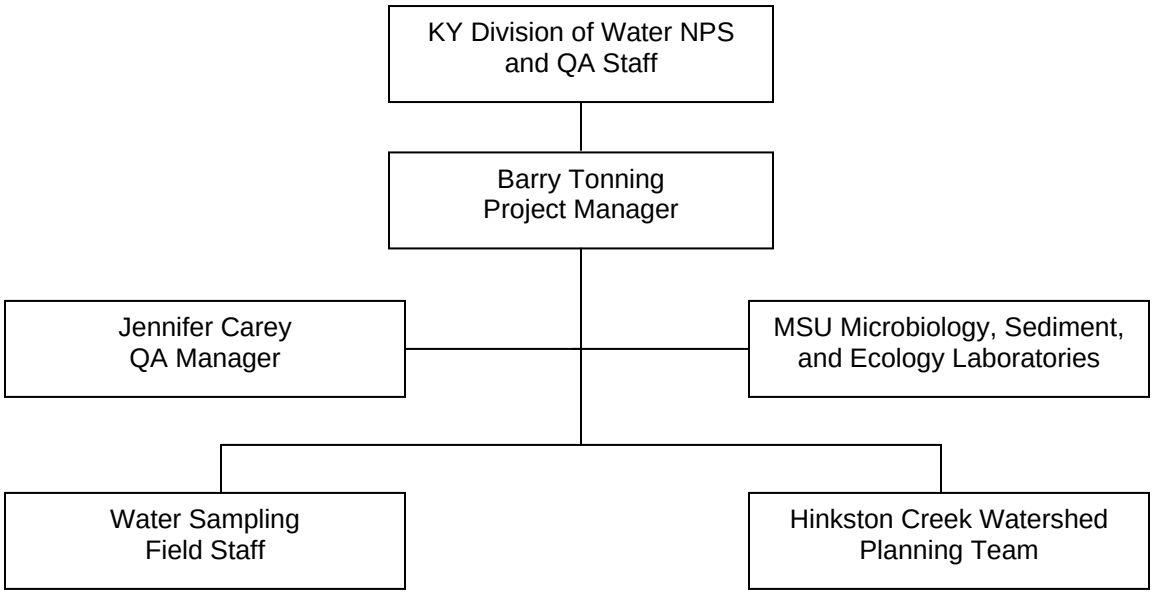
Jennifer Carey of Tetra Tech will be the quality assurance manager. Project Manager Barry Tonning of Tetra Tech will coordinate water quality sampling with sampling staff from Tetra Tech and Morehead State University. Mr. Tonning will also receive results from the analytical laboratories – the Morehead State University Microbiology Laboratory, Ecology Laboratory, and Sediment Laboratory – and report findings.

The Kentucky Division of Water will provide overall project monitoring and recommendations. The Hinkston Creek Watershed Team will use the data to develop the watershed plan and specify BMP types and locations to address identified problems. A simplified project organizational chart appears below, following the *Project and Task Organization* table.

Table 1. Project and Task Organization.

Title	Name	Role
Quality Assurance Manager	Jennifer Carey Tetra Tech	Ensure that all protocols are followed; ensure that all personnel are trained and oriented to tasks; provide overall quality assurance supervision
Project Manager	Barry Tonning Tetra Tech	Ensure that samples are collected, handled, analyzed, and reported in accordance with protocols; ensure communication and coordination among project participants and staff; ensure that monitoring data are used in the development of the watershed management plan
KY Division of Water	Nonpoint Source & Quality Assurance Staff	Monitor project progress and provide input and recommendations on monitoring program, analysis of data, and development of watershed management plan
Water Quality Sampling Staff	Tetra Tech and MSU Samplers	Conduct in-field tests with digital probes; assist in sample collection; ensure that sampling protocols are followed for collection, handling, delivery to laboratories; complete chain of custody forms; attend training and orientation
MSU Microbiology Laboratory	Rita Wright Lab Manager	Ensure compliance with lab and analytical protocols for bacteriological analysis; review chain of custody forms to ensure compliance with holding times and other protocols; conduct lab analyses; report findings
MSU Ecology Laboratory	Brian Reeder Lab Manager	Ensure compliance with lab and analytical protocols for nutrient analysis; review chain of custody forms to ensure compliance with holding times and other protocols; conduct lab analyses; report findings
MSU Sampling Staff Director	April Haight IRAPP Sampling Manager	Ensure compliance with lab and analytical protocols; review chain of custody forms to ensure compliance with holding times and other protocols; conduct lab analyses; report findings
Watershed Planning Group	Hinkston Creek Watershed Management Team	Review monitoring data; use monitoring data in development of watershed management plan; consider monitoring data in decisions regarding BMP selection, siting, and sizing

Figure 1. Organization of Monitoring Program and Project Staff.



A5 Problem Definition/Background

The monitoring activities described in this document seek to characterize and quantify existing loads for selected pollutant parameters in the Hinkston Creek watershed in east central Kentucky. Hinkston Creek originates in the southern and western portions of Montgomery County, flows through the city of Mt. Sterling, and then proceeds northward through Bourbon County, where it joins with Stoner Creek to form the South Fork of the Licking River. The creek drains much of western Nicholas County, and a portion of western Bath County. Major tributaries include Boone's Creek, Grassy Lick Creek, Black's Creek, Somerset Creek, Big Brushy Creek, and Taylor's Creek, among others. Hinkston Creek and some of its tributaries have become impaired and significantly degraded by nonpoint pollution from poor livestock grazing practices, removal of streamside vegetation, the dumping of waste along banks, runoff from the city of Mt. Sterling (not a KPDES Phase II community), sedimentation, and other causes.

Specifically, a segment of Hinkston Creek in Montgomery County (river miles 51.5 to 65.9) has been listed as impaired for the past 10 years by the Kentucky Division of Water due to poor habitat conditions for warm water aquatic species. Other Hinkston Creek segments in Bourbon and Bath counties (river miles 0 to 12.4; 20.8 to 31.0; 41.8 to 49.1)are also listed as impaired, as well as several minor Hinkston Creek tributaries (e.g., Black's Creek, Grassy Lick Creek, Boone Creek). The causes of impairment listed by the Division of Water include siltation, organic enrichment, nutrients and unknown toxicity, among other causes. Wastewater treatment plants for Mt. Sterling, Sharpsburg, and Carlisle discharge into Hinkston Creek and its tributaries. There are a few other minor – mostly stormwater – point source discharges located in the Hinkston Creek watershed, but KY DOW publications list impairments as primarily related to agriculture.

The KY Division of Water has collected nutrient and suspended sediment data in the Hinkston Creek watershed in advance of developing a TMDL, though little work has been initiated on the TMDL itself. KY DOW information in the 2006 Integrated Report notes that the state is in the process of developing nutrient criteria for streams, and that TMDLs for streams impaired by nutrients and/or organic enrichment will not be finalized until the nutrient criteria are promulgated. Additional information on Hinkston Creek has been collected by other organizations. A survey and mapping program undertaken by the Gateway District Health Department as part of a five-county nonpoint program found widespread erosion along the banks of feeder streams and the creeks themselves, little riparian cover or buffers along waterways, relatively unrestricted cattle access to sensitive bank areas, confined animal feeding operations adjacent to streams, row cropping on erodible lands and riparian areas along waterways, and poor manure management on farms throughout the Hinkston Creek watershed. Macro invertebrate sampling conducted by Gateway District Health Department staff at sites in Hinkston Creek found that sites were devoid of both moderate and high quality organisms (GDHD, 1994, 1995). As noted, the Kentucky Division of Water 305(b) Report for 2006 lists segments of Hinkston Creek and two tributaries as impaired due to fecal coliform, sedimentation/siltation, nutrient / eutrophication, biological indicators, and other unknown causes.

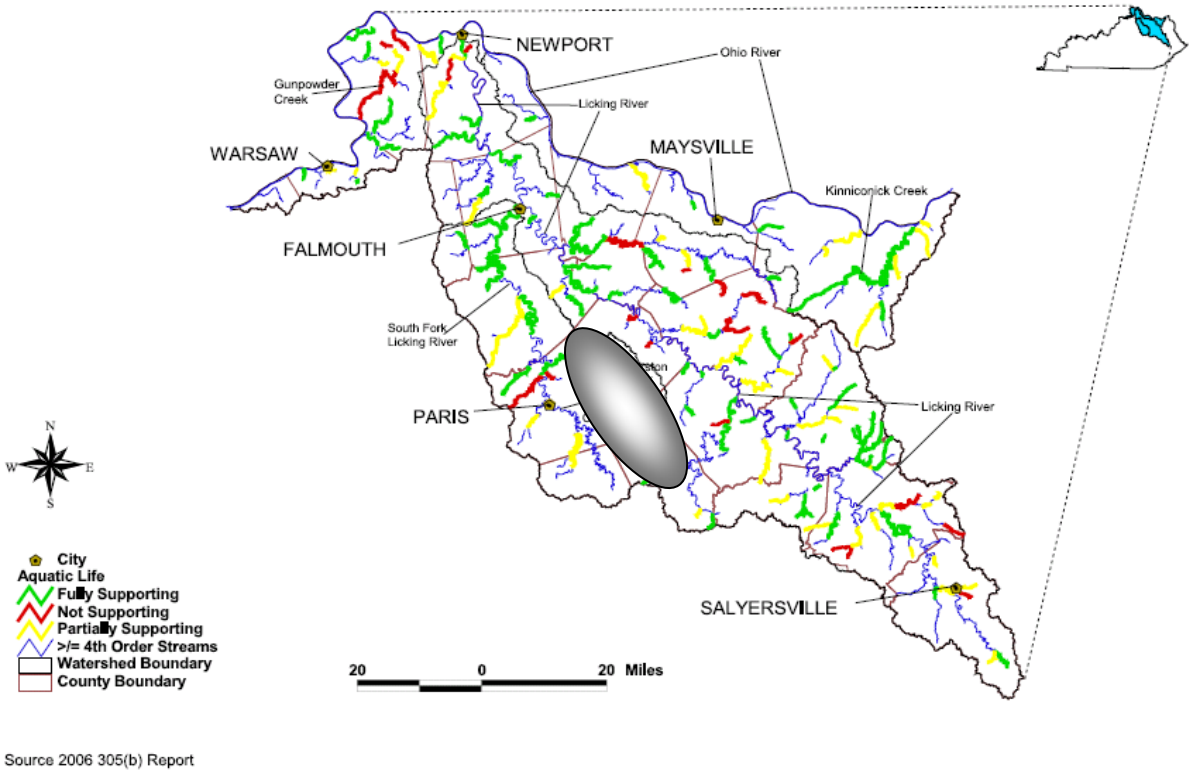
Habitat assessments and chemical/physical monitoring conducted by the KY Division of Water and the nonprofit Licking River Watershed Watch organization have found poor instream and riparian habitat for Hinkston Creek in the vicinity of Mt. Sterling, little to no vegetated buffer in many locations, waste deposited in the stream and along the banks, and bank erosion throughout the upper reaches. Tetra Tech staff have conducted screening surveys of the upper portion of Hinkston Creek in Montgomery County to determine the nature and extent of nonpoint source pollution problems in the watershed. This survey found that there are a number of suspected problems in the Hinkston Creek drainage in and around Mt. Sterling that could be addressed through a nonpoint source project, including:

- Livestock access impacts to stream banks and stream water quality
- Extensive loss of riparian vegetation along the creek and its tributaries
- Poorly controlled runoff from construction sites throughout the drainage area
- Poor runoff quality from commercial and other areas along the creek
- Dumping of trash and debris along the creek in scattered locations
- Eroded/eroding stream banks at various locations in the watershed

The sampling program described in this document seeks to characterize existing bacteria, settleable solids, un-ionized ammonia, nitrite-nitrate nitrogen, total Kjeldahl nitrogen, and total phosphorus loads in the Hinkston Creek watershed, as well as a range of other conditions, including dissolved oxygen concentrations, temperature, conductivity, pH, physical habitat at selected sites (i.e., via the USEPA *Rapid Bioassessment Protocols*), and general streambank stability (i.e., via the NRCS *Stream Visual Assessment Protocol*).

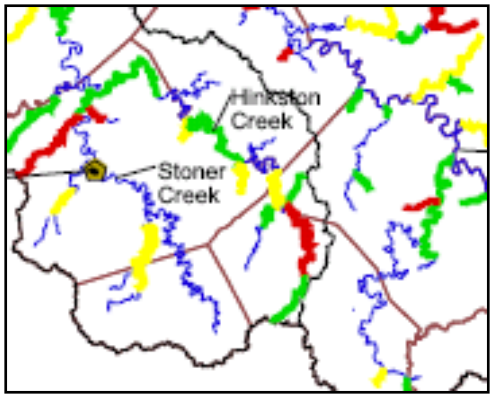
Flow information will be provided for each sampling event, using flow meters provided by Morehead State University. Modeling conducted in support of watershed plan development will be restricted to spreadsheet-type tools (STEPL) and GIS applications (AVGWLF; PREDICT). Guidance associated with the use of these tools is available from USEPA and Tetra Tech (STEPL) and the Pennsylvania State University (AVGWLF; PREDICT).

Figure 2. Reach Indexing Results of Streams Assessed in the Licking River Basin and Ohio River Minor Tributaries for Aquatic Life Use.



Source 2006 305(b) Report

A6 *Project/Task Description*



Hinkston Creek is designated to support primary contact recreation, secondary contact recreation, fish consumption, warm water aquatic habitat, and domestic water supply. Narrative water quality criteria include provisions that surface waters shall not be aesthetically or otherwise degraded by substances that:

- Settle to form objectionable deposits;
- Float as debris, scum, oil, or other matter to form a nuisance;
- Produce objectionable color, odor, taste, or turbidity;
- Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, or fish and other aquatic life;
- Produce undesirable aquatic life or result in the dominance of nuisance species; or
- Cause fish flesh tainting.

Applicable numeric water quality criteria for Hinkston Creek include the parameters listed in the following tables. Values for the parameters are included in the tables, along with some of the averaging periods and recurrence intervals that comprise these regulatory targets.

Table 2. Numeric Water Quality Criteria for Warmwater Aquatic Habitat and Primary/Secondary Contact Recreation.

Parameter	Values
Dissolved Oxygen	5.0 mg/l Daily Average; 4.0 mg/l Instantaneous*
pH	6.0 – 9.0 Standard Units*
Temperature	89° F Instantaneous; 84° F 30-Day Summer Average (31.7° and 28.9° C, respectively)*
Total Dissolved Solids	No adverse effects on indigenous aquatic community
Total Suspended Solids	No adverse effects on indigenous aquatic community
Settleable Solids	No adverse effects on indigenous aquatic community
Ammonia	< 0.05 mg/l after mixing*
Fecal Coliform (Primary Contact Recreation)	200 CFU / 100 ml geometric mean for 5 samples over 30 days, 5/1 – 10/31. 20% of samples must not exceed 400 CFUs.
Escherichia Coli (Primary Contact Recreation)	130 CFU / 100 ml geometric mean for 5 samples over 30 days, 5/1 – 10/31. 20% of samples must not exceed 240 CFUs.
Fecal Coliform (Secondary Contact Recreation)	1000 CFU / 100 ml geometric mean for 5 samples over 30 days, year-round 20% of samples must not exceed 2000 CFUs.

* Must be met in 90+ percent of samples

Source: Kentucky Water Quality Standards

Table 3. Numeric Criteria for Other Key Water Quality Parameters in Surface Waters.

Parameter	CAS1 #	Acute Condition Limit	Chronic Condition Limit
Aldrin	309002	3.0	
alpha-Endosulfan	959988	0.22	0.056
Arsenic	7440382	340	150
Beta-Endosulfan	33213659	0.22	0.056
Cadmium	7440439	e(1.0166 (ln Hard*)-3.924)	e(0.7409 (ln Hard*)- 4.719)
Chlordane	57749	2.4	0.0043
Chloride	16887006	1,200,000	600,000
Chloropyrifos	2921882	0.083	0.041
Chromium (III)	16065831	e(0.8190 (ln Hard*)+ 3.7256)	e(0.8190 (ln Hard*)+ 0.6848)
Chromium (VI)	18540299	16	11

Parameter	CAS1 #	Acute Condition Limit	Chronic Condition Limit
Copper	7440508	e(0.9422 (ln Hard*)- 1.700)	e(0.8545 (ln Hard*)- 1.702)
Cyanide, Free	57125	22	5.2
Demeton	8065483		0.1
Dieldrin	60571	0.24	0.056
Endrin	72208	0.086	0.036
gamma-BHC (Lindane)	58899	0.95	
Guthion	86500		0.01
Heptachlor	76448	0.52	0.0038
Heptachlor epoxide	1024573	0.52	0.0038
Iron6	7439896	4,000	1,000
Lead	7439921	e(1.273 (ln Hard*)- 1.460)	e(1.273 (ln Hard*)- 4.705)
Malathion	121755		0.1
Mercury	7439976	1.7	0.91
Methoxychlor	72435		0.03
Mirex	2385855		0.001
Nickel	7440020	e(0.8460 (ln Hard*)+ 2.255)	e(0.8460 (ln Hard*)+ 0.0584)
Parathion	56382	0.065	0.013
Pentachlorophenol	87865	e(1.005 (pH)-4.869)	e(1.005 (pH)-5.134)
Phthalate esters	N/A		3
Polychlorinated Biphenyls (PCBs)	N/A		0.0014
Selenium	7782492	20	5.0
Silver	7440224	e(1.72 (ln Hard*)-6 .59)	
Hydrogen Sulfide, Undissociated	7783064		2.0
Toxaphene	8001352	0.73	0.0002
Zinc	7440666	e(0.8473 (ln Hard*)+ 0.884)	e(0.8473 (ln Hard*)+ 0.884)
4,4'-DDT	50293	1.1	0.001

1CAS = Chemical Abstracts Service.
3Metal concentrations shall be total recoverable metals to be measured in an unfiltered sample, unless it can be demonstrated to the satisfaction of the cabinet that a more appropriate analytical technique is available that provides a measurement of that portion of the metal present which causes toxicity to aquatic life.
6The chronic criterion for iron shall not exceed three and five tenths (3.5) mg/l if aquatic life has not been shown to be adversely affected.
**Hard = Hardness as mg/l CaCO3.*

Source: Kentucky Water Quality Standards

Besides the regulatory numeric and narrative criteria, the Kentucky Division of Water has also collected data on some of the relatively undegraded, unimpaired streams in the Bluegrass Region. The table below lists mean values for these parameters, and will be used by project staff for general reference and comparisons.

Table 4. Mean Parameter Concentrations from Reference Reaches in the Bluegrass Bioregion.

pH	8.06 SU	Arsenic	0.002 mg/L
DO	9.06 mg/L	Barium	0.021 mg/L
Specific Conductance	457.6 µmhos	Cadmium	0.001 mg/L
Temperature	17.6 ^{o}C	Calcium	66.56 mg/L
Ammonia	0.044 mg/L	Chromium	0.001 mg/L
Nitrate+Nitrite	0.656 mg/L	Copper	0.001 mg/L
TKN	0.320 mg/L	Iron	0.535 mg/L
Total Phosphorus	0.132 mg/L	Lead	0.002 mg/L
Hardness	224.3 mg/L	Magnesium	13.19 mg/L
Alkalinity	194.8 mg/L	Manganese	0.115 mg/L
Acidity	4.71 mg/L	Mercury	0.00005 mg/L
TDS	290.2 mg/L	Nickel	0.016 mg/L
TSS	9.82 mg/L	Potassium	3.54 mg/L
Chloride	10.6 mg/L	Selenium	0.002 mg/L
Fluoride	0.227 mg/L	Silver	0.0046 mg/L
Sulfate	47.3 mg/L	Sodium	8.91 mg/L
TOC	3.04 mg/L	Zinc	0.023 mg/L
Aluminum	0.356 mg/L		

Note: Aluminum through Zinc above based on only 8 samples per parameter.

Source: Brian Marbert, Kentucky Division of Water

The sampling program described in this document seeks to characterize existing E. coli bacteria, suspended solids, un-ionized ammonia, nitrite-nitrogen, nitrate-nitrogen, total Kjeldahl nitrogen, and phosphorus loads in the Hinkston Creek watershed, as well as a range of other conditions, including dissolved oxygen concentrations, temperature, conductivity, pH, physical habitat at selected sites (i.e., via the USEPA *Rapid Bioassessment Protocols*), and general streambank stability (i.e., via the NRCS *Stream Visual Assessment Protocol*). Flow information will be collected for each sampling event, using flow meters or gauges installed through this project. Modeling conducted in support of watershed plan development will be restricted to spreadsheet-type tools (STEPL) and GIS applications (AVGWLF; PREDICT). Guidance associated with the use of these tools is available from USEPA and Tetra Tech (STEPL) and the Pennsylvania State University (AVGWLF; PREDICT).

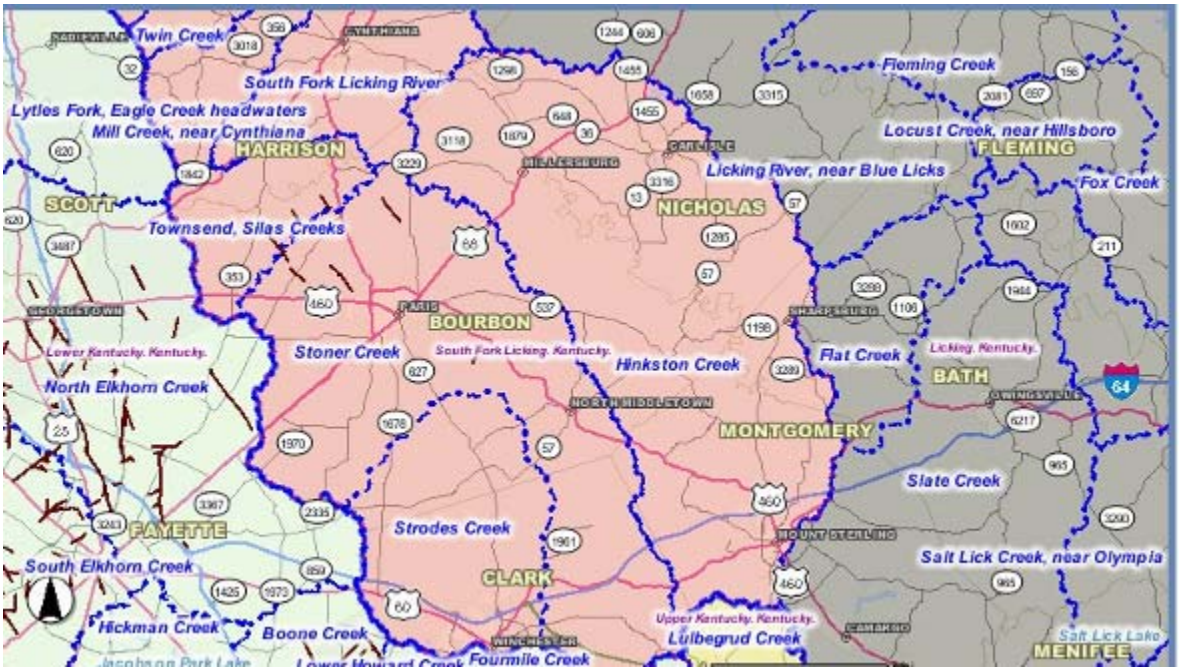
Sampling will be conducted from November 2009 until October 2010. Sampling events will occur during the first week of each month at the 12 monitoring sites identified below. It is expected that due to the highly variable rainfall and flow conditions in east-central Kentucky, the monitoring schedule will capture a range of flow conditions from low-flow (e.g., during the fall sampling period) to moderate and high flows (e.g., during the late winter and spring).

Table 5. Project Monitoring Activities, Schedule, and Reports to be Generated.

Key Activities	Schedule	Reports
Orient project staff on project goals, objectives, monitoring locations, QAPP, sampling protocols, sample handling procedures, documentation, and other key project topics	October 2009	KDOW 319 quarterly report on project activities
Produce land use, land cover, KPDES, and other maps for initial spatial analysis	November 2009	Include in subsequent KDOW 319 quarterly report on project activities
Collection of water quality samples for ammonia, nitrite-nitrate, TKN, TP, E coli, pH, temperature, conductivity, DO, and flow	First week of each month, beginning in November 2009, and monthly thereafter	Monthly report on water quality sampling with flow data
Convene Hinkston Creek Stakeholder Committee and begin to analyze and assess water quality, mapping, and other initial information	November 2009, and every other month afterwards	Meeting minutes, KDOW 319 quarterly report on project activities
Conduct visual streambank stability and habitat surveys at selected sites	January and February, 2010	Streambank stability and habitat condition reports
Meet with land owners, managers, and agricultural producers to discuss initial watershed assessment results	May – October, 2010	Meeting minutes, KDOW 319 quarterly report on project activities
Compile sampling and other data into comprehensive watershed assessment, identifying stressors and sources and relative pollutant loads	October – November, 2010	Watershed plan assessment section
Identify types, locations, and extent of needed BMPs, and estimate load reductions expected	January – March, 2011	Watershed management plan BMP section
Complete watershed-based plan for the Hinkston Creek watershed; conduct public outreach and education efforts to convey key elements	May 2011	Watershed Plan for the Hinkston Creek Drainage Area
Develop BMP cost-share program and establish procedures for funding needed projects	March 2011	KDOW 319 quarterly report on project activities
Identify willing landowners for BMP cost-share program	May 2011	KDOW 319 quarterly report on project activities
Install BMP projects and establish operation and maintenance procedures	June – September, 2011	KDOW 319 quarterly report on project activities
Close out project	September 2011	Final KY DOW 319 project report

Sampling stations will be located along the mainstem of Hinkston Creek, and the mouth of the major tributaries (see map and list in the next section). Sampling staff will include employees of Tetra Tech and paid samplers from Morehead State University. All sampling personnel will be oriented regarding project goals, objectives, and this Quality Assurance Project Plan. Field procedures and protocols will be covered during this training, and all samplers will demonstrate thorough knowledge of the procedures and protocols prior to commencing with field work.

Figure 3. Location of the Hinkston Creek Watershed in East Central Kentucky.



A7 Data Quality Objectives For Measurement Data

Statement of the Problem: Portions of Hinkston Creek and its tributaries are impaired for contact recreation and aquatic life support due to siltation, organic enrichment, nutrients and unknown toxicity, among other causes. The project seeks to identify the sources of impairment, and characterize their magnitude in order to determine the type, location, and scope of management practices needed to address them.

Decision: Project staff will require monitoring, mapping, aerial photography, land use/cover, and existing management practice information in order to determine the causes, sources, and extent of impairment and the management practice types and locations required.

Inputs to the Decision: Water quality monitoring data, land use/cover maps, information on existing land and other management practices, information on the present stability of stream channels, and information on possible management practices to address identified problems will be required to determine what sort of practices will be needed.

Boundaries of the Study: The project will occur within the drainage of Hinkston Creek and its tributaries, and area lying partially in the following counties: Montgomery, Bourbon, Bath, Nicholas, and Harrison. The Hinkston Creek watershed will be the focus of the study and efforts to improve water quality.

Decision Rule: Decisions will be made via a weight-of-evidence approach, whereby identified stressors will be linked with suspected sources through water quality sampling, analysis of aerial photography, and visual confirmation of land use/cover and management practices. Measured water quality data will be key to making initial decisions, i.e., is the stream segment discharging to the sampling station impaired, and,

if so, what are the impairments and what are the extent of the impairments? The water quality data will be assessed along with the associated flow data, in order to conduct a simple screen on whether nonpoint pollution runoff is the primary source of elevated pollutant concentration levels, or whether the elevated levels are linked to point source discharges, groundwater impacts, or other non-runoff factors (e.g., cattle congregating in stream channels as a source of elevated ammonia concentrations). Assumptions regarding pollutant sources and magnitude (i.e., extent) derived from analyses of water quality and other data will be confirmed via visual surveys of the affected area, to determine whether or not the conditions indicated by the data actually exist on the ground. Upon confirmation of 1) elevated pollutant levels coming from 2) a specified source at 3) a level of magnitude indicating water quality impacts to beneficial water body uses, project staff will research appropriate land management, agricultural, stream stability, or other management practices in order to provide recommendations capable of addressing the type, scope, and extent of the impacts discerned.

Tolerable Limits on Decision Error: Because the water quality data provides the foundation for the initial screening, pollutant identification, and estimates regarding the scope of relative impacts, precise measurements of instream water quality parameters are essential. Measurements of *E. coli* counts, suspended sediment concentration (SSC), bank and channel instability, nutrients, discharge, physical parameters (DO, pH, etc.), habitat assessments and biological assessments will be collected and analyzed to assess the quality of streams both in their current state and after implementation of BMPs. The table below summarized the precision, accuracy, and detection limits for water quality data collected for the Hinkston Creek watershed project.

Table 6. Precision, Accuracy, and Detection Limits for Water Quality Data.

Parameter/Equipment	Precision	Accuracy	Detection Limits
Water Chemistry			
Total Phosphorus	0.007 mg P/L	NA	0.063 mg P/L
Ammonia	0.02 mg N/L	NA	0.05 mg P/L
Nitrate	0.003 mg/L	NA	0.012 mg/L
Nitrite	0.003 mg/L	NA	0.012 mg/L
Total Nitrogen	0.15 mg/L	NA	0.4 mg/L
Physical Parameters			
pH	0.01 units	+/- 0.2 units	0 14 units
Dissolved Oxygen	0.01 mg/L	+/- 0.2 mg/L at ≤ 20 mg/L; +/- 0.6 mg/L at > 20 mg/L	0 mg/L
Temperature	0.01 ^{o}C	+/- 0.10 ^{o}C	-5 ^{o}C
Conductivity	0.0001 units	+/- 0.001 mS/cm	0 mS/cm
Flow			
Swoffer Model 2100	NA	+/- 1%	0.1 ft/s
Sediment			
Denver Analytical Balance for TSS and SSC	Repeatable to 0.0001g	+/- 0.0001g	0.0001 g
Isotemp drying oven	Uniformity at 200 ^{o}C +/- 4.5^{o}C	+/- 1^{o}C	50 ^{o}C
Land Use/Land Cover			
USGS Level II Classes	NA	≥ 75%	NA
Pathogens			
mTEC medium	1 CFU/100 mL	1 CFU/100 mL	20 CFU/100 mL

Design for Obtaining Data: Water quality monitoring data will be collected during the first week of every month for a 12 month period. This schedule will support the collection of data during a range of discrete flow regimes, because flows vary according to rainfall averages during the season and year. Collection of data during high, moderate, and low flow periods will help project staff sort out the relative influences of nonpoint source pollution (i.e., polluted runoff), point source discharges (e.g., from municipal wastewater treatment plants), and other impacts, such as cattle congregating in tree-shaded streams during hot weather.

A8 Special Training

Field data will be collected by staff from Tetra Tech and Morehead State University. All sampling staff will receive mandatory training on the project and field procedures and protocols. Training will include the use of digital probes for dissolved oxygen, conductivity, temperature, and pH, and the collection of stream water samples in a manner that avoids contamination of the sample by the sampler or his/her actions or activities prior to sample collection. Samplers will be trained on the use of flow meters, record-keeping, and sample processing and transport – including acceptable transport times for specific samples.

Samples will be analyzed by staff associated with Morehead State University's microbiology and ecology laboratories. All training records will be kept in a notebook maintained by each laboratory on the Morehead State University campus. The trainer will verify that each sampler has been trained. See the corresponding sub-sections of Group B for details related to sampling, laboratory methods, and quality assurance.

Macroinvertebrate collection, assessment, and reporting will be done for screening purposes only, by trained members of the Licking River Watershed Watch group. The data will be used to screen for overall stream health during the process of selecting reaches for BMPs.

A9 Documents and Records

The following reports and data will be provided to the Kentucky Division of Water:

- Quality Assurance Evaluation Report – at end of data collection, and whenever requested
- Submittal of raw data – in the form of field sheets and calibration records, may be requested randomly at the discretion of KDOW – and/or at end of data collection
- Progress reports – due at time of invoicing, or at agreed upon schedule for project review
- Final data – submitted in Excel format (exact format to be provided or as agreed upon by Tetra Tech and KDOW)

Field data chain-of-custody forms (see appendices) will record the sampler name, date, site, flow, rainfall, and field parameter results recorded for each site and will be stored with the laboratory records. Lab forms, log entries, quality assurance reports, and lab notebooks will be kept on file in the ecology and microbiology laboratories on the Morehead State University campus, to facilitate recordkeeping in a central location. Lab results will be reported within one week. Project manager Barry Tonning of Tetra Tech will maintain copies of all reports submitted to the Kentucky Division of Water. Tetra Tech recognizes and acknowledges that the results of this project may be used for future research, publications and presentations by the Division of Water and Morehead State University. Results will be tabulated in Microsoft Excel spreadsheets, stored on two secured computers, and backed-up on appropriate electronic storage media. All calculations and statistical data analysis will be stored as described above and submitted in the final report. All documents for this project will be kept for a minimum of five years.

Group B Data Generation and Acquisition

B1 Sampling Process Design

The study design and methods discussed in the following sections seeks to characterize existing pollutant loads in the Hinkston Creek watershed by analyzing pollutant concentrations and flow in the mainstem and principal tributaries, examining land use / cover / management practices, and observing stream bank stability conditions. This information will be used to identify stream segments that may not be supporting their designated uses and to develop management recommendations that address any impairment causes and sources identified.

Aerial photographs and existing land use/cover information will be reviewed to identify possible sources of pollution and stream banks lacking a protective vegetative buffer. Water quality sampling sites were selected to capture the impacts from segments of the Hinkston Creek mainstem and the principal tributaries. This approach will help to screen segments of the mainstem and tributary drainage areas that appear to be supporting instream use designations from those where impairments may exist. Where poor water quality is found – as determined by comparing the monitoring data against the applicable KDOW water quality criteria – further analysis will be conducted to determine the source(s) of pollutant parameters that exceed the criteria. This analysis will require further study of aerial photographs and visual surveys of watershed and subwatershed land uses, land cover, and land management practices to identify areas with high pollutant loading potential, such as steep unvegetated slopes, actively eroding stream banks, cattle congregating in stream channels, or other conditions causing elevated pollutant concentrations in the receiving waters.

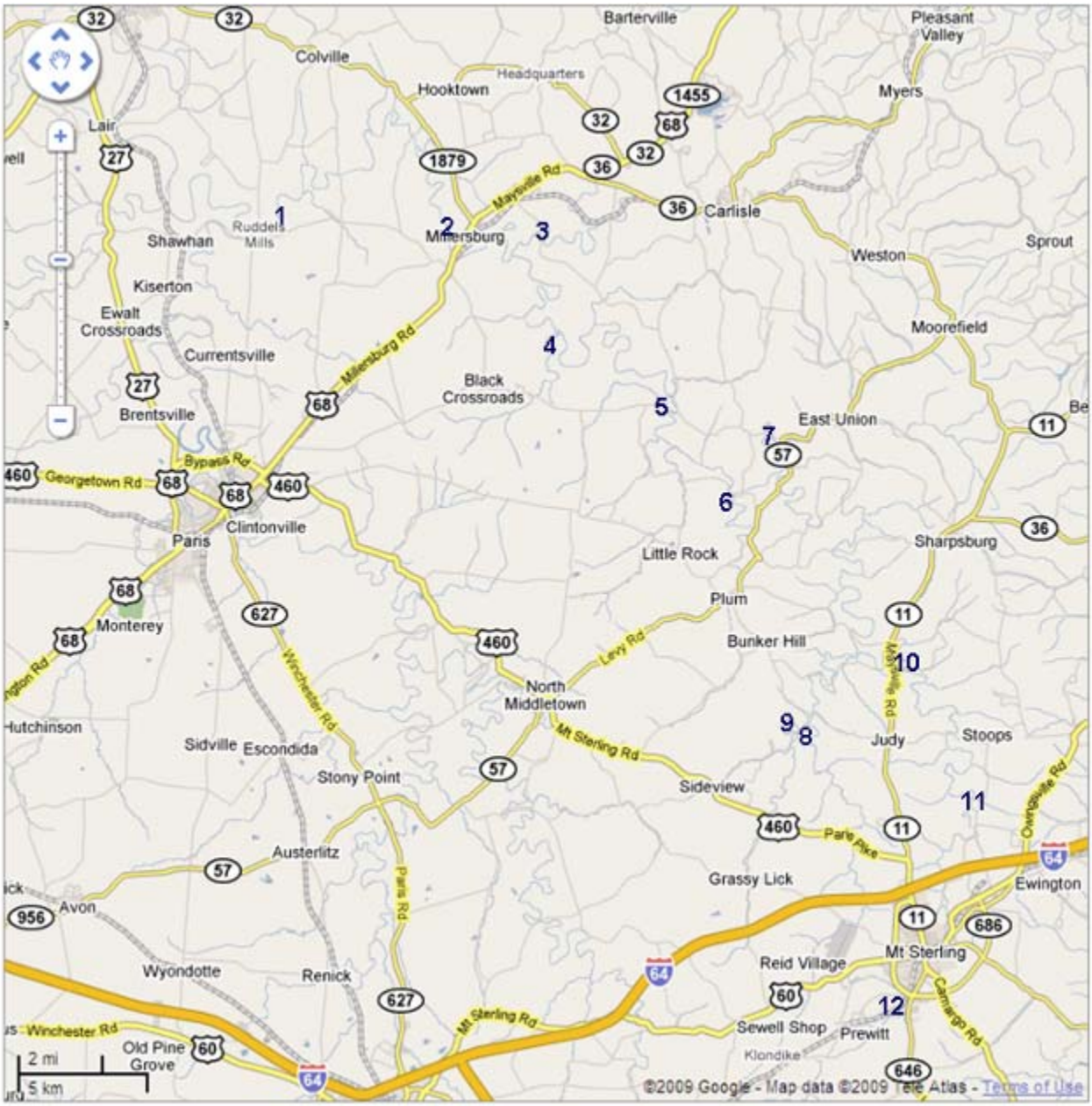
The types and numbers of water quality samples for each monitoring site are listed below. In general, each of the 12 monitoring stations will be sampled during the first week of each month for all parameters listed. The rationale for selection of these parameters is based on the impairment causes listed by KDOW in its *Integrated Report on Water Quality* entries for Hinkston Creek, which identifies nutrients, sediment, bacteria, and low dissolved oxygen as potential causes of impairment.

Table 7. Sampling Parameters and Monitoring Frequency.

Parameter	Link to Impairment	Monitoring Frequency
Dissolved oxygen	Organic enrichment	Monthly for 12 months
Conductivity	Unknown causes (e.g., septic systems, sewage)	Monthly for 12 months
Total Suspended Sediment	Sedimentation	Monthly for 12 months
pH	Unknown causes (e.g., biological indicator support)	Monthly for 12 months
Temperature	Unknown causes (e.g., biological indicators support)	Monthly for 12 months
Flow	Screening out nonpoint from point sources	Monthly for 12 months
Nitrite-Nitrate	Nutrients	Monthly for 12 months
Ammonia	Nutrients, biological indicators	Monthly for 12 months
TKN	Nutrients	Monthly for 12 months
Total Phosphorus	Nutrients	Monthly for 12 months
E. coli	Bacteria; primary/secondary contact recreation	Monthly for 12 months

Sampling locations for collection of water quality data are designated on the map. A list of each site, containing detailed information on location, is also provided. Project staff will collect latitude and longitude information for each site during the sampler training program.

Figure 4. Locations of Water Quality Monitoring Sites in the Hinkston Creek Watershed.



Sampling Location Details:

1. Hinkston Creek mainstem at the mouth, just upstream from the confluence with Stoner Creek at Ruddels Mill in Bourbon County. Site is located near the KY 1940 bridge over Hinkston Creek.

2. Hinkston Creek mainstem at Millersburg in Bourbon County. Site is located downstream of the US 68 bridge over Hinkston Creek.
3. Big Brushy Creek mainstem just upstream from the Hinkston Creek confluence and south of US 68 in Nicholas County. Site is located near the KY 386 bridge over Big Brushy Creek.
4. Blacks Creek mainstem just upstream from the Hinkston Creek confluence northeast of Blacks Crossroads in Bourbon County. Site is located at Stoker Road bridge over Blacks Creek.
5. Hinkston Creek mainstem near Jackstown at the Bourbon –Nicholas county line. Site is located at the KY 13 bridge over Hinkston Creek.
6. Boone Creek mainstem just upstream from the Hinkston Creek confluence northeast of Little Rock in Bourbon County. Site is located at the Soper Road bridge over Boone Creek, near the Burris Road bridge over Hinkston Creek.
7. Somerset Creek[1] mainstem just upstream from the Hinkston Creek confluence southwest of East Union in Nicholas County. Site is located near the KY 57 bridge over Somerset Creek.
8. Grassy Lick Creek mainstem just upstream from the Somerset Creek[2] confluence north of Aaron's Run Road in Montgomery County. Site is located west of Judy, just NW of the Aaron's Run Road bridge over Somerset Creek near the Fiddlers Hill Farm at 3002 Aaron's Run Road.
9. Somerset Creek[2] mainstem just upstream from the Grassy Lick Creek confluence north of Aaron's Run Road in Montgomery County. Site is located west of Judy, just NW of the Aaron's Run Road bridge over Somerset Creek near the Fiddlers Hill Farm at 3002 Aaron's Run Road.
10. Hinkston Creek mainstem at the Montgomery – Bath county line near KY 11. Site is located near the new KY 11 bridge over Hinkston Creek.
11. Hinkston Creek mainstem north of Mount Sterling. Site is located about 50 yards upstream of the Hinkston Pike (KY 1991) bridge over Hinkston Creek, near the entrance to the Twin Oaks subdivision in Montgomery County.
12. Hinkston Creek mainstem, just downstream of the confluence of the two headwaters segments that join to form Hinkston Creek. Site is located south of Mt. Sterling and just west of KY 11, downstream of the Calk Road bridge near several old manufacturing plants.

    Notes:
    Somerset Creek[1] – this stream, which has the same name as a nearby stream in Montgomery County, is located in Nicholas County, and flows into Hinkston Creek from the east.

    Somerset Creek[2] – this stream, which has the same name as a nearby stream in Nicholas County, is located in Montgomery County and flows into Grassy Lick Creek prior to its confluence with Hinkston Creek, on the west side.

For each sampling event, one replicate (duplicate) sample will be taken and one field blank will be submitted to the laboratory. The replicate sample will be rotated throughout the 12 monitoring locations during the 12 sampling events over the 12 month period on a random basis.

Field blanks will be containers with de-ionized water; replicates will be duplicate samples taken in the same manner as the regular ambient grab sample taken at the monitoring station designated as the replicate site for that sampling event. The table below summarizes the quality control objectives for the various parameters, including the field parameters measured with the digital probes.

All problems detected during sampling and analysis will be reported to the project manager, who will be responsible for exploring the problem, identifying corrective measures, and implementing those measures prior to the next sampling event.

Table 8. Quality Control Objectives for Water Quality Samples.

Variable	Accuracy	Precision (Relative Percent Difference)	Completeness
Field Measurements:			
Water temperature	± 0.5 degrees C	RPD within 20%	90%
Specific conductance	± 5% of meter range	RPD within 20%	90%
pH	± 0.2 SU	RPD within 20%	90%
Dissolved Oxygen	± 5%	RPD within 20%	90%
Surface water laboratory chemical analysis:			
Suspended sediment	± 3 standard deviations of known concentrations	RPD within 20%	90%
Major ions	Same as above	RPD within 20%	90%
Nutrients	Same as above	RPD within 20%	90%

B2 Sampling and Measurement Methods

Field sampling and measurements and collection of laboratory samples will be conducted by trained Tetra Tech staff, scientists from Morehead State University, and/or trained university students. All sampling will follow the timelines and approaches summarized in Section B1. Prior to departing for the sites, samplers will check to ensure that they have site maps and all sampling containers, field data and chain-of-custody forms, field measurement equipment, calibration supplies, and other needed items. At each monitoring location, sampling staff will take field measurements and collect laboratory samples from a non-pool area (i.e., run or riffle – head of riffle is preferred) within a representative stream reach. The same location will be used for each of the 12 monthly sampling events.

At the site, samplers will wade into the stream, approaching from a downstream location, to take measurements and samples. Field measurements will be taken with a multiparameter digital probe in the middle of the stream, below the water surface while standing downstream of the sampling location. Results will be recorded immediately on the field forms. Grab samples will be taken in a similar manner, taking care not to disturb the area upstream of the sampling location and not to touch or otherwise contaminate the sample container or lid.

Field sampling procedures and practices will follow the Kentucky Ambient/Watershed Water Quality Monitoring Standard Operating Procedure Manual (2005). Laboratory procedures and practices will follow the Morehead State University Water Testing Laboratory Quality Assurance Manual (2008). Both documents are included in the appendices. Specific procedures for each parameter are detailed in the following sections.

Escherichia coli: EPA-approved, sterile sample containers will be distributed to samplers prior to sampling along with a pre-printed Chain of Custody form, sampling instructions, and sample delivery logistics information. To collect samples for bacteria in wadeable streams, samplers will wade to the middle of the stream and dip the sterile sample container to a depth of four inches with the open end of the container facing upstream. If the stream exhibits a low flow, the sampler will push the mouth of the container upstream at this depth until the container is nearly full. The opened mouth of the container will

at all times be upstream of the sample collector, sampling apparatus, and any disturbed sediments. To collect samples for bacteria in non-wadeable streams, the sample container will be attached to a swivel tied to a fishing line. The container will be lowered from a bridge to the middle of the stream to collect the sample. The samples will be immediately chilled in an ice chest at a temperature of 1° to 4°C for transport back to the microbiology lab. All samples will be processed for the assessment of E. coli density within six hours of collection.

Suspended Sediment Concentration: If used in this project, the methods of Edwards and Glysson (1998) will be used to collect samples for SSC, although specific methods will vary depending on flow conditions and personnel available. In very shallow, wadeable streams, velocity is often less than 2 ft/s and all personnel will collect simplified single vertical samples. In this case, a cleaned and pre-weighed, pre-labeled sample bottle (1-pt glass or 1-L wide-mouth Nalgene) will be tilted at a 45o angle to the streambed with the mouth pointed upstream and lowered to the streambed and back to the surface without touching the mouth to the streambed. When streams are very shallow, 250-ml or 100-ml bottles will be used. If the stream is not wadeable but velocity is still low (less than 2 ft/s), a weighted bottle on a hand line or mounted on a telescoping rod will be lowered to the bottom and pulled back to the surface. At the same time these samples are collected, and if flow conditions permit, trained MSU students or a project manager will sample at least one vertical using true depth-integrated, discharge-weighted suspended sediment sampling methods as described in Edwards and Glysson (1998). When stream velocity is between 2 and 12 cfs and depth is less than 15 ft, trained samplers will use standard depth integrating samplers. A DH-48 sampler and 1-pint standard glass sample bottles (cleaned, pre-weighed, and pre-labeled) will be used for wadeable streams. Samples will be collected using multiple verticals and the equal width increment (EWI) method of Edwards and Glysson (1998). At very high flow, only surface or dip samples will be collected, regardless of personnel involved. This is necessary for the safety of personnel and to prevent damage or loss of equipment. Weighted bottles on lines or bottles on rod extensions will be employed under these conditions.

Total Suspended Solids: TSS will be collected by wading (if possible) into the center of the stream. The sampler will dip clean 250-ml or 100-ml polyethylene bottles upstream at approximately mid-depth. The pre-labeled bottle will then be capped. The opened mouth of the container will at all times be upstream of the sample collector, sampling apparatus, and any disturbed sediments.

Stream Discharge: A Swoffer Model 2100 and cross-sectional measurements will be used to determine discharge each time water quality samples are collected. The neutrally buoyant object method will be used to measure velocity in streams that are too shallow or slow for flow meters, too deep and swift to safely wade into, or where working from a bridge is deemed unsafe. In these cases, velocity will be measured by timing neutrally buoyant objects as they float through a measured stream reach.

Nutrient Measurements: Water samples will be collected using clean, acid washed polyethylene bottles. A total of 500-mL will be collected at each site. The field sampler will wade to the center of the stream and, while facing upstream, dip the pre-labeled bottle to mid depth to fill the container completely. If the stream is too deep and/or the velocity is too high for wading, the bottle will be attached to a rod and the sample collected as close as possible to the center of the stream. The opened mouth of the container will at all times be upstream of the field worker, sampling apparatus, and any disturbed sediments. Samples will be preserved and stored as outlined in section B4.

Other Measurements: Handheld YSI 556 units will be used to record temperature, conductivity, pH, and dissolved oxygen at the same time and location that nutrient and bacteria samples are collected. Readings will be taken in the middle of the stream, below the water surface, at the head of a riffle or within a run.YSI units will be calibrated for pH and DO before and after each use since both instruments tend to

require frequent calibration. Conductivity will be checked at least once a month or if readings appear to be incorrect.

Bank and Channel Instability: Bank and channel instability will be assessed via 1) screening aerial photography to determine bank areas where instability is likely, due to the apparent lack of a vegetative buffer, especially if channel widening is evident; 2) windshield surveys to confirm aerial photographic analyses and to identify areas not discovered via aerial photographic analysis; and 3) rapid visual stream stability assessments conducted along reaches where high sediment loads are indicated by monitoring or assessment data. Rapid assessments will utilize the stream bank parameters included in the *Rapid Bioassessment Protocols* (US EPA, 2002): Bank Stability, Vegetative Protection, and Riparian Zone Width. Full utilization of these procedures will be dependent on obtaining landowner permission to access stream reaches on private property.

Biological Assessment: Macroinvertebrates will also be collected and assessed in accordance with the Licking River Watershed Watch protocols by members trained by that organization. The information reported will be used for screening purposes only, during the BMP selection/siting process. Assessments will be done at all sites except the four most downstream mainstem sites (8 sites total). This will be a one-time baseline assessment, conducted in the fall of 2010 or late the following spring. The assessment will occur during a low flow period, and may not coincide with the water quality sampling schedule. Information collected for this assessment will provide further data of the weight-of-evidence screens regarding subwatershed support for beneficial uses and targeting of management practices.

Data Analysis: Microsoft Excel or other appropriate analytical software will be used for data analysis and to generate graphs and charts for reports and presentations. Nutrient concentrations in the water (e.g. milligrams per liter) will be analyzed as flow-weighted concentrations (e.g. grams per day). The maximum, minimum, average, geometric mean, and median will be calculated for individual sites and for all of the sites combined. The geometric mean will be calculated using Excel or other appropriate software. Data analysis will also include comparisons of project results to Kentucky water quality criteria (401 KAR 5:002; 5:026; 5:029; and 5:031) for surface water quality, and other specific standards adopted by the Kentucky Division of Water.

B3 Sample Handling and Custody

Sample collection and handling will be thoroughly documented on field data sheets (see Appendix), chain of custody (COC) forms (see Appendix), and laboratory notebooks and/or lab data sheets (see Appendix). Project documentation will follow these guidelines:

- Field records will be completed at the time the samples are collected
- Names of sample collectors and witnesses who are present will be recorded
- All entries will be signed, including date and time, by the sample collector
- In the field, the sample collector will immediately perform the following tasks to ensure sample integrity (see Table 9)
- Sample containers will be sealed and marked with stream name, station (sample site), gage height (if staff gage is present), date, time, sample number, and name of sample collector(s)
- Samples will be stored in an appropriate, secured storage container
- Bacteria and nutrient samples will be stored on ice
- Suspended sediment samples will be placed in the dark but not chilled

Table 9. Summary of Sampling Equipment and Sample Preservation Details.

Parameter	Field Equipment	Sample Container	Sample Preservation
Physical Parameters			
Dissolved Oxygen	YSI probe and Hydrolab	NA	NA
pH	YSI probe and Hydrolab	NA	NA
Conductivity	YSI probe and Hydrolab	NA	NA
Temperature	YSI probe and Hydrolab	NA	NA
Biological Assessment			
Macroinvertebrates	Aquatic Nets	NA	NA
Nutrients			
All	NA	High density polystyrene bottle	Store on ice/water mix ($4^{o}C$)
Sediment			
TSS	NA	High density polystyrene bottle	Store on ice/water mix ($4^{o}C$)
Bank Instability	Bank Parameters Field Form	NA	NA
Bacteria			
E. Coli	NA	Sterile Polystyrene bottle with snap lock lid	Store on ice/water mix ($4^{o}C$) for less than 4 hours
Discharge			
Velocity	Swoffer Model 2100	NA	NA

One individual will be designated as sample custodian for each sampling event. For group sampling events, this person will be the on-site sampling team leader. In these cases, collectors will deliver all field samples to the custodian after sample collection. The transfer of possession of the samples to the sample custodian will be documented on the chain-of-custody form specific to each sample type. Both the sample collector(s) and the sample custodian will sign the form noting the time and date of transfer. In the event a field worker is alone, (s)he will act as both sampler and sample custodian while taking all appropriate precautions.

The sample custodian has ultimate responsibility for field documentation and processing, including properly grouping the samples into quality control sample batches. The custodian shall also ensure safe and proper handling of samples that will not immediately be delivered to the appropriate lab for analysis or storage.

Samples will remain under the control of the sample custodian until samples are transferred to laboratory staff for processing and analysis. When samples are received at the laboratory, the project manager in charge of each specific sampling program and its corresponding lab (or other approved and trained personnel) will receive the field samples and verify each and every sample against the chain of custody forms, note any discrepancies or losses of samples, leakage, or damage to sample bottles, and then sign for receipt of the samples. Following transfer to the project manager and laboratory staff, all samples will

remain in lab custody and such custody will be documented. All samples that are received at the laboratory must be accompanied by a chain of custody form. The sampling team manager will maintain a permanent log that records the complete chain-of-custody forms and the fate of all samples and analyses.

B4 Analytical Methods

Table 10 summarizes the analytical methods that will be used in this project. All data will be validated by program staff. See section C-1 for details on data quality assurance. All of the analytical procedures used in this study are standard methods, approved by US EPA. Descriptions and citations for methods used are presented below.

Table 10. Summary of Laboratory Analytical Methods To Be Used.

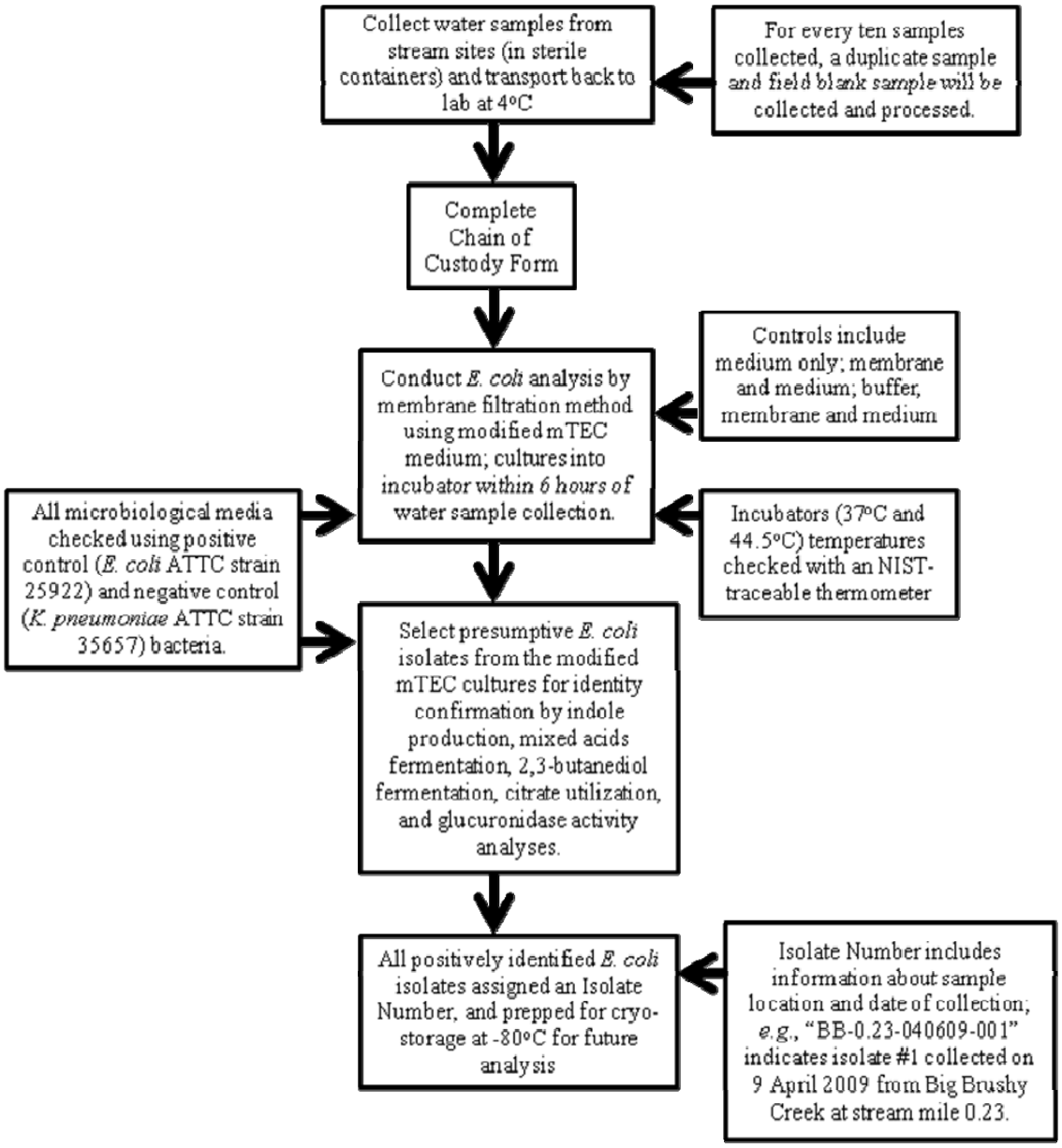
Parameter	Analytical Equipment	Sample Holding Container	Method Sample Preservative	Maximum Holding Time	EPA Method or Equivalent
Nutrients					
Ammonia	SEAL™ AQ2	HDPE bottle	Stored at 4°C	28 days	EPA-104-A
Nitrate	SEAL™ AQ2	HDPE bottle	Stored at 4°C	48 hours	EPA-132-A
Nitrite	SEAL™ AQ2	HDPE bottle	Stored at 4°C	48 hours	EPA 354.1
Ortho-Phosphate	SEAL™ AQ2	HDPE bottle	Stored at 4°C	28 days	EPA-128-A
Total Phosphorus (Digestion)	FOSS Tecator™ Digestor and Seal AQ2	HDPE bottle	Stored at 4°C, 25% H2SO4 to pH<2	28 days	EPA-365-A
Total Kjeldahl Nitrogen	SEAL™ AQ2	HDPE bottle	Stored at 4°C, 25% H2SO4 to pH<2	28 days	EPA 351.2
Sediment					
TSS	Denver Analytical Scale	HDPE bottles	Stored in refrigerator	7 days	EPA 160.2
Bacteria					
Escherichia coli	NA	Sterile Polyethylene Bottle	Stored at 4°C	6 hours	EPA 1603

Escherichia coli: Samples will be analyzed in the microbiology laboratory (i.e., MSU Water Testing Laboratory) using the membrane filtration method described by Standard Methods (APHA, 1998) and EPA Method 1603 (USEPA, 2002) for the detection and enumeration of *Escherichia coli*. For each site-collected sample, volumes of 1, 5 and 20 milliliters (ml) will each be filtered through a 0.45-µm pore size sterile membrane filter by vacuum aspiration. Membranes will then be transferred to modified mTEC medium culture plates and incubated for 2 hr at 37°C, followed by 22 hr of incubation at 44.5°C. Colonies exhibiting a brick-red color will be counted as *E. coli*. Cultures with a colony count between 20 and 60 will be assessed. The bacterial density of the water sample will be reported as the number of positive colony forming units per 100 ml of sample (CFU/100 ml). During selected sampling periods, geometric

means for the five analyzed samples from each site collected over a 30-day period will be calculated and reported.

The laboratory will maintain and have available all quality assurance documentation as called for in Standard Methods (APHA, 1998). Selected *E. coli* isolates collected from the mTEC cultures will be internally coded with the sample site, collection date, and isolate number in order to facilitate tracking in the laboratory. Each isolate's identity will be confirmed by evaluation on an EMB agar plate, EC-MUG broth, indole deep, MR-VP broth, and citrate slant media. All isolates whose identification as E. coli has been confirmed will be cryopreserved an a 1:1 mixture of sterile tryptic soy broth:glycerol, and stored at 80^{o}C for future analysis (see Figure 5). *E. coli* isolate names/numbers and designations will become part of the permanent record of the following: a laboratory notebook dedicated to the project; a data log; an Excel spreadsheet linking sample information, isolate information, and media and biochemical test information for identification and confirmation of *E. coli*.

Figure 5. Sample Processing and Quality Assurance in the Microbiology Lab.

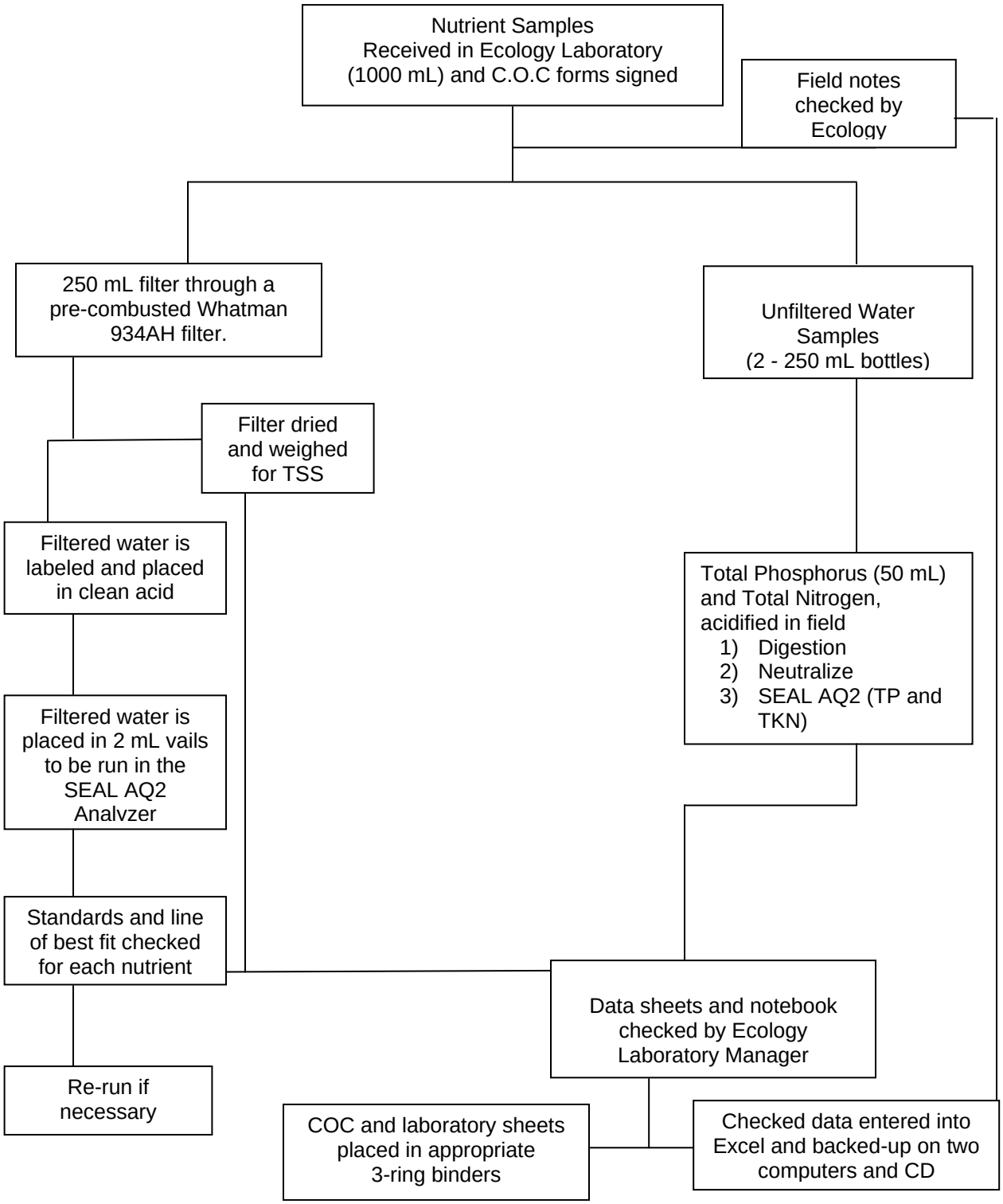


Suspended Sediment Concentration: If used in this project, SSC will be determined in the MSU sediment lab following the methods of Guy (1969) and ASTM standard D3977-97 (ASTM, 2002). The filtration method will be used for samples containing less than 10,000 mg/L sand and less than 200 mg/L clay. The evaporation method will be used for samples containing higher concentrations of sand or clay.

Nutrients: Nutrient samples will be processed according to the procedures exhibited in Fig. 7. Filtered and unfiltered water samples for nutrient analysis will be stored in high density polyethylene bottles at $4^{o}C$ until nutrients are analyzed. Alkalinity will be measured by titrating into unfiltered water with 0.02 N $H^{2}SO^{4}$ using an ASTM certified class A buret (precision ± 0.02 ml) to a pH of 4.8 (Larson and Henley 1955).

Dissolved nutrients will be determined from filtered water with the aid of a SEALTM autoanalyzer to mix reagents, time reactions, and make spectrophotometer measurements, as well as perform standardization, prepare spikes, and make duplicate sample determinations. The Seal AQ2+ and AQUA software is used to track the quality control of the soluble nutrients. The charts generated by this software show the calculated values of the repeated standard against control limits. Ammonium (NH^{4}) will be quantified using a phenolhypochlorite reaction (Solorzano, 1969). If analyzed as part of this project, soluble reactive phosphorus (SRP) will be measured using the ascorbic acid method (Murphy and Riley 1962). Total phosphorus (TP) will be determined as SRP after digesting (using a FOSS Tecator™ Digestor or Autoclave) unfiltered water with sulfuric acid and perchloric acid (Sommers and Nelson, 1972). Total nitrogen will be determined using the total Kjeldahl nitrogen method. Samples will be analyzed in the Seal AQ2 after processing. Nitrate + Nitrite will be analyzed using the cadmium coil reduction followed by sulfanilamide reaction in the presence of N-dihydrochloride.

Figure 7. Sample Processes and Quality Assurance in the Ecology Lab.

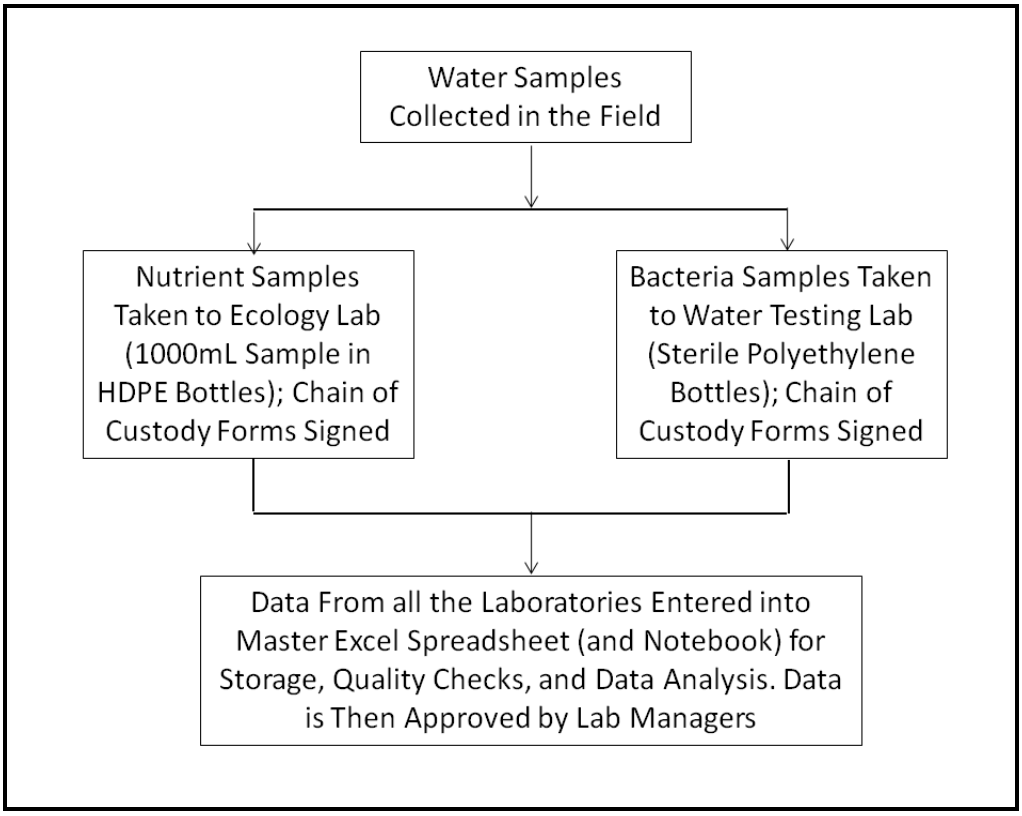


Total Suspended Solids: TSS samples will be analyzed immediately upon return to the ecology laboratory. TSS will be determined by suction, filtering water through a pre-combusted 0.45 µm pore-size glass-fiber filter (Whatman 934AH), and drying the filter and solids at 100-105oC to a constant weight (Wyckoff, 1964). The filters will be weighed using a Denver Instrument Analytical Scale (Summit Series) and these weights will be recorded to the 4th decimal place.

B5 Quality Control

Sampling: Samples will be collected under the supervision of trained personnel. The supervising sampler will be responsible for adherence to the standard operating procedures outlined in under section B2 of this QAPP. Any problems found with data collected by project staff will be noted on the chain-of-custody form and recorded in the appropriate laboratory notebook. Only appropriate containers will be used to collect water samples. Nutrient and TSS samples will be collected in pre-labeled clean, acid washed polyethylene bottles. Bacteria samples will be collected in pre-labeled new, 100-mL, EPA-approved, sterile, high-density polyethylene (HDPE) bottles. Suspended sediment samples will be collected in clean glass bottles that are specifically designed for the DH-48 sampler. Containers that are dirty, discolored, or cracked will not be used. Data that do not meet project accuracy (10%) and precision objectives will be removed from the data set by the project managers, and will not be used in any analysis or reporting.

Figure 8. Diagram of Quality Assurance and Sample Process.



Calibration and Standardization:

YSI 5600 will be pre- and post-calibrated. Data from probes that do not calibrate within the acceptable range listed by the manufacturers, or the probe cannot be calibrated (indicating a dysfunctional probe) will not be used. Probes will be calibrated both before and after sampling in order to determine measurement drift. Probes that deviate more than 10% from standards on post-calibration checks will not be considered reliable and will not be used in this project. The pH probe will be calibrated using two to three standard solutions (freshly made HydrionTM buffers of 4.00 and 7.00, and sometimes 10.00). The conductivity probe will be calibrated against NIST traceable Fisher Scientific standards of approximately 100 and 1000 µS cm-1.

Seal Analytical AQ2 – Dissolved Nutrients equipment will be used to analyze dissolved phosphate, sulfate, and nitrate. Standards will be run with each set. The Seal Analytical AQ2 produces a calibration graph at the end of each run. If the calibration graph does not produce an acceptable best fit line (R-value greater than 0.95), the samples will be re-run after checking the quality of the reagents. Reagents will be remade, if necessary. Data quality will also be assessed by checking whether the results (mg/l) are higher or lower than typically expected. Samples which fail this check will be re-run after inspecting the standards, reagents, and light wave functions of the machine. All of the results will be printed and placed in a laboratory notebook. The results will be recorded in the master laboratory notebook in the ecology lab.

While running total phosphorus samples, standards and a control (nanopure water) will be run with each digestion set for quality assurance. In addition, all glassware will be acid washed prior to use. A Foss Tecator™ Digestor (or autoclave) will be programmed to automate the temperature and digestion time. The standards and control for each run will then be graphed with a best fit line determined using Excel or other appropriate software. Only water samples that have an r-value of 0.90 or higher will be used. The r-value will be determined using a line of best fit (standard concentration vs. light wave). Samples that do not meet the quality standard will be re-run if enough of the water sample remains and after new reagents are made and standards are re-checked for quality. To ensure that no contamination exists, all glassware will be acid washed again and rinsed with distilled water. All results will be printed and placed in an ecology laboratory notebook, as well as stored electronically.

Ecology Lab Temperature Logs will be maintained by the laboratory for the refrigerator and the Boekel oven in rooms 243B and 243 of MSU's Lappin Hall, respectively. The oven and refrigerator temperatures will be recorded using a Fisher-brand temperature probe, -20 to 120 ◦C, (part number 14-985C). The oven temperature will be recorded when filters are placed in the oven to pre-dry, when filters with samples are placed in the oven to dry, and when filters are removed for post-weighing. The refrigerator temperature will be recorded twice a week when samples are being stored.

Flow meters, specifically the Swoffer Model 2100, will be calibrated every other month or as needed. Calibration will be conducted using Swoffer Instruments, Inc. calibration test methods. The Swoffer propeller will be inspected before each use and replaced as needed.

Microbiology lab supplies and equipment will be governed by the lab's Quality Assurance Manual. All micropipetters used will be calibrated annually to NIST standards. All microbiological media and supplies, and all other reagents used in this project, will be purchased from the same suppliers to ensure consistency. All reagents will be labeled with a receipt and opened date, lot numbers recorded, and stored according to the manufacturers' directions. All reagents will be used within the reported shelf life. The adequacy of microbiology media and biochemical reagents used for water testing and *E. coli* isolations will be determined by the responses of a positive control reference strain of *E. coli* (ATCC 25922) and

negative control reference strain of Klebsiella pneumoniae (ATCC 35657) tested on the media for which typical responses are known.

A reference stain of *E. coli* (ATCC 25922), for which typical responses are known, will serve as a positive control for all selective and differential media and biochemical tests used in the isolation and identity confirmation of *E. coli*. A reference strain of *K. pneumoniae* (ATCC 35657), for which typical responses are known, will serve as the negative control for all selective and differential media and biochemical tests used in the isolation and confirmation of E. coli. One set of control bacterial strains will be inoculated onto each type of media on each day that water samples are tested for the presence of *E. coli*, and on each day that isolations and confirmation tests are performed.

Isolates obtained from watershed samples will be compared to positive (*E. coli* ATCC 25922) and negative (*K. pneumoniae* ATCC 35657) controls for which typical responses are known. Isolates that yield typical responses on all media and biochemical tests, compared to the *E. coli* reference strain, will become part of the microbiology lab's permanent culture collection for future analysis.

B6 Instrument/Equipment Testing, Inspection and Maintenance

All equipment will be tested and inspected according to the manufacturers' recommendations**.** Each laboratory will be responsible for ensuring that the equipment is properly maintained. Each laboratory will record any testing, inspection and maintenance information for the equipment used. All equipment will be checked to ensure that it is operating correctly before taking out into the field. If it is determined that the equipment is malfunctioning, the issue(s) will be resolved before using the equipment in the field and/or laboratory or a different unit will be used that day.

B7 Instrument/Equipment Calibration and Frequency

Instruments will be calibrated every 30 days and/or according to the manufacturers' recommendations. The calibration technician's name, dates, times, results, and any problems will be recorded in a laboratory notebook in each lab. The project will be utilizing two different MSU laboratories (Ecology Lab and Water Testing Lab). Each laboratory will be responsible for maintaining an instrument calibration notebook. See section B5 for specific calibration procedures for different instruments. Balances will be calibrated using standard weights and built-in internal calibration procedures. Generally, modern balances with internal calibration require infrequent calibration, often only once per year if left on at all times. However, balances will be calibrated before pre- and post-monitoring, after power outages or if the balances are turned off, or if ambient lab conditions change dramatically.

The YSI and Hydrolabs will be calibrated for pH, dissolved oxygen, and conductivity. Conductivity will be calibrated once per month. The pH and dissolved oxygen will be calibrated before and after each use. The temperature will be verified before using both devices. The pH, dissolved oxygen and conductivity data will be accepted after post-calibration, if devices calibrate within 10% of the standard.

B8 Inspection/Acceptance of Supplies and Consumables

Only sample containers approved for use with the methods described above will be used during this project. The sampling event coordinator or a project manager will be responsible for distributing appropriate sample materials to supervising samplers or trained samplers. For *E. coli*, sample containers will undergo a sterility check by the sampling team leader. Nutrient broth media will be introduced into

the containers and incubated for 24 hours at 35°C. At least 3 containers will be checked per lot of 100. Membrane filters, media and other reagents will be tested prior to each sampling event for sterility. Sediment sample bottles will be checked for cleanliness and weighed before being sent into the field. Bottles whose weight has changed due to chipping or other damage will be discarded and replaced with a new bottle. Glass fiber filters will be checked for tears and crucibles will be inspected for cracks. Nutrient sample bottles will be checked for cleanliness before being sent to the field. Bottles that are discolored or contain any visible residue will be discarded. All supplies, standards, reagents that are used will be checked for date of expiration and any visible contamination. Any standards that are expired or determined to be contaminated will not be used.

B9 Data Acquisition Requirements for Non-direct Measurements

Existing digital (GIS) map layers (e.g., land use/cover, soils, elevation, etc.) for this project will be obtained from government agencies (e.g., US Geological Survey, Kentucky Division of Geographic Information, Kentucky Geological Survey, National Climate Data Center, Natural Resource Conservation Service, etc.). New digital map layers created for this project will conform to professional geospatial practices and standards (e.g., Congalton and Green, 1999). These maps will be used for report writing and presentations, as well as for pollutant load analysis. Verified climate data will be obtained from the National Climate Data Center, the U.S. Army Corps of Engineers, and the U.S. Forest Service. Missing data values will be estimated using standard procedures; verified USGS flow data may also be used to help assess model estimated flows.

Non-direct measurement data listed above will be used to identify likely areas of pollutant loading, unstable banks, predicting rainfall runoff, and other watershed assessment tasks. Non-direct measurements and data collected may be limited in accuracy and/or usefulness. Accuracy limitations can be characterized, based on the quality assurance and quality control measures used to collect, analyze, and report the original data. In the case of maps, flow information, and other data from known sources, this information should be available for review and assessment. Usefulness of data can also be limited, due to accuracy, scale, and spatial and temporal considerations. For example, the project will have flow data from one USGS gauge, located on the Hinkston Creek mainstem at Jackstown. However, this gage is automated, and has experienced operational problems in the past, due to flood debris and other issues. Project staff will use the gauge data for comparison purposes, and note any problems or operational issues with the gauging station as reported by USGS.

Data used – but not collected by – project staff will be checked for general accuracy prior to use. Data not accompanied by information regarding how it was collected, analyzed, and reported will not be used.

B10 Data Management

All GIS/remote sensing datasets and maps for this project will be stored on computers under the supervision of the project manager. A lab notebook will be kept to document all field sample processing steps and output; data will be backed up to Excel and two external devices in the custody of project managers. All chain-of-custody sheets will be kept in a notebook in the ecology laboratory (MSU Lappin Hall Room 243). Quality Assurance logs (i.e. oven, incubator, and refrigerator temperatures) will be kept in the appropriate laboratory. Nutrients related logs will be kept in the ecology laboratory in Lappin Hall room 243.

Each field sampler will maintain a laboratory notebook. These notebooks will include time, date, and location of each sample collected. Physical parameters will be recorded as well as flow and depth

measurements. In addition, the samplers will record visual observations and make notes of any problems encountered while sampling in the field. All of the field data will be recorded in a master notebook stored in the ecology lab. These data will be checked by the project manager. After the data is reviewed and approved, it will be entered into an Excel™ spreadsheet. All electronic sampling documents will be kept on file in the ecology laboratory with each lab manager maintaining a back up file in their respective laboratory/office. All output produced in this project will be discussed and analyzed by the project manager in order to ensure that all of the data, results, and conclusions are accurate and appropriate. The results of this project will be shared with the Hinkston Creek stakeholder group at their regularly scheduled meetings. All electronic files will be reviewed and approved by the project manager before any document is considered final.

Group C Assessment and Oversight

C1 Assessments and Response Actions

The project manager will review data collection processes and sample analytic techniques with sampling team leaders. If necessary, corrective actions will be taken through supervisory controls or contract administration. The types of assessments and responses to data collection activities are listed below. Each laboratory will maintain records related to field monitoring, laboratory testing, and data analysis.

- Field monitoring will occur on a continuous basis. Monitoring will include review of the project status and field records to ensure that project requirements will be met.
- Laboratory testing will occur on a monthly basis (according to SOP). Modification to the QAPP, if necessary, will be requested in writing to the KDOW.
- Data analyses and newly collected data will be reviewed by the project manager and staff to ensure sufficient quality to develop a watershed based plan for the Hinkston Creek Watershed.

C2 Reports to Management

The following reports and submittals will be provided by the project:

- Quality Assurance Evaluation Report – at end of data collection, and whenever requested
- Submittal of raw data in the form of field sheets and calibration records, requested randomly at the discretion of KDOW – and/or at end of data collection
- Progress reports, due at time of invoicing, or at agreed upon schedule for project review
- Final data submitted in Excel format – exact format to be provided or as agreed upon by Tetra Tech and KDOW

The quality assurance report will be issued to inform appropriate parties as to the performance and progress of the project work plan (written and/or orally). The purpose of this report will be to identify the

individuals responsible for reporting quality control (QC) results, and to present these data so that KDOW can monitor the data quality effectively. The following items will be described in the QA report:

- Status of the project
- Significant QA/QC problems, recommended solutions, and results of corrective actions
- Changes to the Quality Assurance Project Plan (as approved by KDOW)
- Data quality assessment

Internal verbal reports on the status of projects will be conducted monthly by project staff. These meetings will include discussion on the QA and QC issues before each intensive field data collection period. Data collection procedures will be discussed, problems will be addressed, and any necessary corrective actions will be taken on as needed basis. The quality assurance team will also meet with the field data collection team to discuss QA and QC issues before each intensive field data collection period. Quarterly progress reports (contract deliverables) to KDOW will be prepared by the project manager and submitted to the KDOW Project Manager in accordance with contract requirements. Any changes to the QA/QC procedures will be submitted at this time.

Group D Data Validation and Usability

D1 - Data Review, Verification, and Validation

Field and laboratory data will be reviewed by the project manager within 30 days of collection/processing. The project manager will then decide whether or not to accept the data. Field and laboratory data will be reviewed and verified for compliance with project requirements and validated against the data quality objectives listed in Section A7. Data that meet quality objectives defined by this project will be considered acceptable, and will be included in project reports. Data that do not meet data quality objectives will be rejected and will not be included in statistical analysis, tables, and/or graphs.

Project staff – including sampling staff, laboratory staff, and data entry staff – are each responsible for verifying that all records and results they produce or handle are completely and correctly recorded, transcribed, and transmitted. Each staff member also is responsible for ensuring that all activities (sampling, measurements, and analyses) are performed with care and diligence in order to produce the best quality sample analysis or data measurement possible.

Laboratory data flags and data qualifiers used to indicate non-compliant data include samples collected by untrained personnel, samples not collected at designated sampling sites, samples not collected via established protocols, missing or incomplete chain-of-custody forms, samples not analyzed within specified holding times, analytical results produced by untrained personnel, analytical results not obtained via established laboratory protocols, and data not accompanied by data unit designations when such designations are key to understanding the data (e.g., milligrams vs micrograms).

D2 Verification and Validation Methods

Data collected, analyzed and reported via this project will be subject to checks for errors in transcription, calculation, and computer input. All field and laboratory data forms will be accurate and complete. Any changes to notes or data forms will be initialed and dated. The staff involved in the field, laboratory, and data management tasks are responsible for initial verification of the data that each task generates or handles. Verification of data from each laboratory will be accomplished using self-assessments and peer

review by laboratory staff. Outliers identified by project or laboratory staff will be examined for potential reasons for any unusual results, to determine whether the data point is in error. The QA managers for each laboratory will be responsible for resolving issues regarding outliers. If an issue cannot be corrected, the data associated with the issue will be rejected. All problems will be outlined in the appropriate notebook in each laboratory as well as any corrective actions taken. Corrective actions may include, but are not limited to, equipment maintenance or retraining of employees. Data incorporated in the database will be reviewed and tested by the QA manager.

D3 Reconciliation with User Requirements

Data will be continuously evaluated by project staff during the course of the project to ensure that they meets the quality objectives outlined in Section A7 of this document. Below are the evaluation questions that will be addressed by project staff during quarterly reviews of the project:

- Were samples collected in the correct location
- Are all locations identified so a third person can find them
- Were samples collected in the correct container and within holding times
- Was the COC properly filled out and included all samples
- Was the correct analysis performed
- Were the QA/QC results within the acceptance criteria for the project
- Were problems by the laboratory noted and explained.

If the data do not meet the goals specified in Section A7, they will not be included in graphs, relationships and equations reported to the KDOW. Any suspected outliers in field or laboratory data will be re-sampled as soon as possible. Outliers will be determined by project or laboratory staff based on their collective knowledge of field sampling, laboratory analysis techniques, and local environmental knowledge. In addition, results that do not meet the quality assurance plan (i.e. not labeled properly or do not have a chain-of-custody form) will be re-sampled if possible. Following completion of the project all data will be stored either electronically or in paper format at the project office and the laboratories for a minimum of 5 years.

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Field Data Sheet for Discharge (Detailed Area Velocity Method)

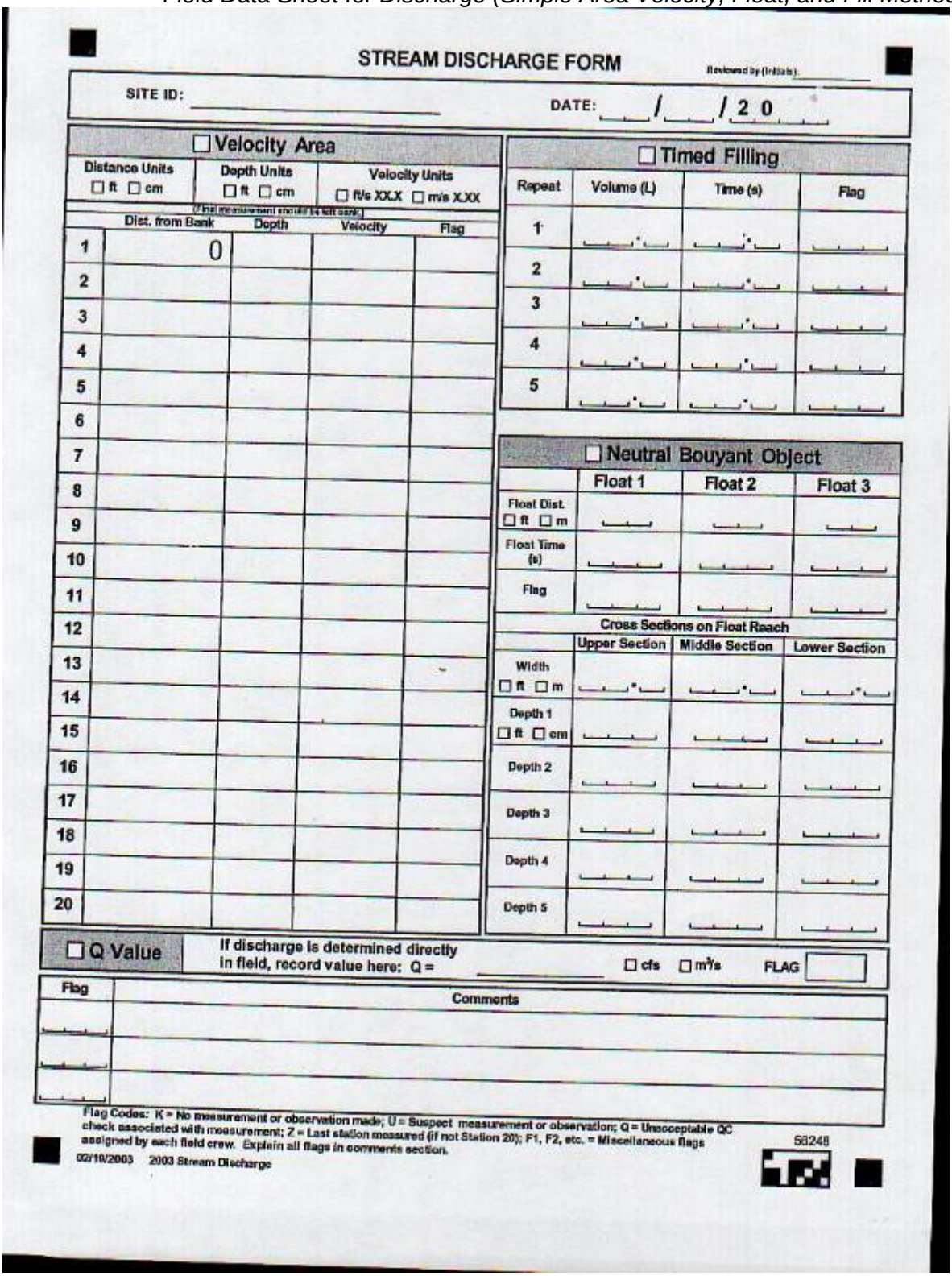
Discharge Measurement Notes & Raw Data
Current Meter Method

Site:____________________
Operator:____________________
Stream Condition:________________
Water Temperature:_______________
Air Temperature:________________
Gage Height:________ Time:________
Gage Height:________ Time:________
Gage Height:________ Time:________

Date:____________________
Current Meter:________________
Serial Number:________________
Flow Condition:_______________
Weather:____________________
Other:_____________________
Remarks:____________________

Dist. From Initial Point (ft.)	Width (ft.)	Depth d (ft.)	Obs. Depth (.6 or .2/.8)	Revolu-tions	Time t (sec.)	Velocity (fps)		Area A (ft^2)	Discharge Q (cfs)
						@point	Ave.		

Field Data Sheet for Discharge (Simple Area Velocity, Float, and Fill Methods)



STREAM DISCHARGE FORM

Reviewed by (Initials): _____

SITE ID: _____ DATE: ___/___/20___

☐ Velocity Area

Distance Units	Depth Units	Velocity Units
☐ ft ☐ cm	☐ ft ☐ cm	☐ ft/s XX.X ☐ m/s X.XX

(First measurement should be left bank)

	Dist. from Bank	Depth	Velocity	Flag
1	0			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

☐ Timed Filling

Repeat	Volume (L)	Time (s)	Flag
1	___.___	___.___	
2	___.___	___.___	
3	___.___	___.___	
4	___.___	___.___	
5	___.___	___.___	

☐ Neutral Bouyant Object

	Float 1	Float 2	Float 3
Float Dist. ☐ ft ☐ m			
Float Time (s)			
Flag			

Cross Sections on Float Reach

	Upper Section	Middle Section	Lower Section
Width ☐ ft ☐ m	___.___	___.___	___.___
Depth 1 ☐ ft ☐ cm			
Depth 2			
Depth 3			
Depth 4			
Depth 5			

☐ Q Value — If discharge is determined directly in field, record value here: Q = _____ ☐ cfs ☐ m^3/s FLAG ☐

Flag	Comments

Flag Codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; Z = Last station measured (if not Station 20); F1, F2, etc. = Miscellaneous flags assigned by each field crew. Explain all flags in comments section.

02/19/2003 2003 Stream Discharge

58248

STREAM NAME:		**LOCATION:**	
STATION #:		**COUNTY:**	**PROGRAM:** **PROJECT:**
INVESTIGATORS:		**DATE:**	**TIME (24hr)** **Start:** **Finish:**
Verify Site LAT/LONG vs GPS ☐YES ☐NO ☐N/A			

	Station	Reach: Downstream	Reach: Upstream
LAT			
LONG			

CANOPY COVER::
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☐ Partially Shaded (50-75%)
- ☐ Fully Shaded (75-100%)

STREAM TYPE:
- ☐ Perennial
- ☐ Ephemeral
- ☐ Intermittent

WEATHER
Has there been a scouring rain in the last 14 days?
☐ Yes ☐ No

Now	Past 24 hours
☐	☐ Heavy rain
☐	☐ Steady rain
☐	☐ Intermittent showers
☐	☐ Clear/sunny
☐	☐ Cloudy

LOCAL WATERSHED FEATUREES (Predominant Surrounding Land Use):
- ☐ Surface Mining
- ☐ Deep Mining
- ☐ Oil Wells
- ☐ Land Disposal
- ☐ Residential
- ☐ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☐ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

INSTREAM FEATURES
Stream Width _____ ft
Maximum Depth _____ ft
Reach Length _____m

Riffle/Run/Pool Sequence
(No. Sampled in Reach)
_____Riffle _____Run _____Pool

HYDRSULIC STRUCTURES
- ☐ Dams
- ☐ Bridge Abutments
- ☐ Island
- ☐ Waterfalls
- ☐ Other:

STREAM FLOW
- ☐ Dry
- ☐ Pooled
- ☐ Low
- ☐ High
- ☐ Normal

RIPARIAN VEGETATION
Dominate Type:
☐ Trees ☐ Herbaceous
☐ Grasses ☐ Shrubs
Number of strata ____ Dom. Tree/Shrub Taxa

CHANNEL ALTERATIONS
- ☐ Dredging
- ☐ Channelization (☐Full ☐Partial)

P-CHEM Instrument Used: _____ Date Calibrated: _____

Temp(°C)_____ D.O. (mg/l)_____ %Saturation_____ pH(S.U.)_____ Cond._____ Turb._____

Sample Collection Verification

Algae	Sample: ☐ QualMHC ☐ Other ☐ Visual Assessment	Lead Collector:
Fish	☐BPEF ☐ Seine ☐ Other Time: BPEF_____ Seine_____	Lead Collector:
Habitat	☐ RBP ☐ Substrate ☐ Other:	Lead Collector:
Invertebrates	☐ 1m² ☐ Qual ☐ Other: ☐ 20 Jab (#Jabs: Cobble_____ Snags_____ Veg. Banks_____ Sand_____ Macrophytes_____ Other _____)	Lead Collector:
Tissue:	No. of Samples collected_____ Sp:	Lead Collector:
Water Chem	☐ Acid/Alk ☐ Bulk ☐ Nutrients ☐ Metals ☐ Low Hg ☐ Herbicides ☐ Pesticides ☐ Ortho P ☐ Other:	Lead Collector:

Duplicate Samples Taken:

Substrate Characterization

Substrate ☐Est. ☐P.C.	**Riffle_____%**	**Run_____%**	**Pool_____%**	**Reach Total**
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)				
Gravel (2-64 mm)				
Cobble (64 – 256 mm)				
Boulders (>256 mm)				
Bedrock				

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover **Score**	Greater than 70% 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).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2.Embeddedness **Score**	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
3.Velocity/ Depth Regime **Score**	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
4. Sediment Deposition **Score**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5.Channel Flow Status **Score**	Water reaches base of both lower banks, and minimal amt of channel substrate 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.
6.Channel Alteration **Score**	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.
7.Frequency of Riffles (or bends) **Score**	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB RB	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 = erosion scars.
9. Vegetative Protection LB RB	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.
10. Riparian Vegetative Zone Width LB	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.

RB				

Chain of Custody Form

Stream and Sampler Information

Site Identification:	Supervising Sampler:	Other samplers:
Date: Time:	Samples Collected: □ Bacteria (Sterile container) □ Nutrient and TSS Sample (500 mL acid washed container) □ Nutrient – acid treated	

Stream Conditions

Rain in the last 24 hours: □ 0 inch □ 0 – 1/2 inch □ ½ - 1 inch □ 1 - 2 inches □ 2 – 3 inches □ Other _____ Site source	Flow Rate (visual observation): □ Flood (over banks) □ Bank Full □ High Flow □ Normal □ Low □ Ponded (if ponded, samples will not be collected)
pH _____ Temp (C) _____ Conductivity _____ stream width _____ Average depth = (___+ ____+ ____+ ____ + ____ + ____ + _____+ ____)/ ____ = ____ Average flow = (___+ ____+ ____+ ____ + ____ + ____ + _____+ ____)/ ____ = ____	
Other Observations (smells, animals, land use changes, etc):	

Gage height (if applicable): _____

Sample Release (Sign and Record Date and Time)

Laboratory Drop Off	**Signature, Date, Time**
Microbiology Lab (Bacteria sample)	
Ecology Lab (Nutrient and TSS sample)	
Sampler (after dropping off all of the samples)	

Note: Physical parameter, velocity, depth, and channel width will be recorded in the field notebook of the sampler.

SUSPENDED SEDIMENT SAMPLE CHAIN OF CUSTODY FORM

FIELD WORKER NAME:
DATE: TIME:
SITE ID: STREAM NAME:
GAGE HEIGHT: Q MEASURED SAME TIME & DATE?:

SAMPLING METHOD (Check appropriate):
___ EWI with DH-48
___ Single Vertical with DH-48
___ Single Vertical by hand, rod or line
___ Surface Dip by hand, rod or line

TOTAL NUMBER OF BOTTLES USED:

BOTTLE ID NUMBER	**BOTTLE ID NUMBER**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

SIGNATURES

Field worker: _____ Time: Date:

Sample Receiver: _____ Time: Date:

Lab Manager: _____ Time: Date:

Signature of field worker indicates collection and delivery of sample bottles to lab. Signature of lab manager indicates all sample bottles received in proper condition.

Ecology Lab, Room 243B
Refrigerator Temperature Log Form
(Record temperature when in use, Monday - Friday)

Date	Time	Temperature °C	Recorder Initials	Date	Time	Temperature °C	Recorder Initials

Ecology Lab, Room 243
Oven Temperature Log Form
(Record temperature before and after samples are placed in the oven)

Date	Time	Temperature ^{o}C	Recorder Initials	Date	Time	Temperature ^{o}C	Recorder Initials

Lab Form for SSC

Form 9-269e (REV. 10-62)

UNITED STATES DEPARTMENT OF THE INTERIOR

Geological Survey-Water Resources Division

SEDIMENT CONCENTRATION NOTES, DEPTH INTEGRATED SAMPLES (Short form)

Stream and location ____________ Computed by ________ Checked by ________

Date											
Time											
Gage height											
Sampling Sta.											
Temp. and Spec. Cond.		/	/	/	/	/	/	/	/	/	/
Remarks											
WEIGHT OF SAMPLE	Gross										
	Tare										
	Net										
Container no.											
WEIGHT OF SEDIMENT	Gross										
	Tare										
	Net										
	D.S. Corr.										
	Net										
Conc. (ppm)											

Date											
Time											
Gage height											
Sampling Sta.											
Temp. and Spec. Cond.		/	/	/	/	/	/	/	/	/	/
Remarks											
WEIGHT OF SAMPLE	Gross										
	Tare										
	Net										
Container no.											
WEIGHT OF SEDIMENT	Gross										
	Tare										
	Net										
	D.S. Corr.										
	Net										
Conc. (ppm)											

Figure 4.—Sample of laboratory form, Sediment Concentration Notes, Depth Integrated Samples (Short form)

MICROBIOLOGICAL DATA SHEET FOR ENVIRONMENTAL WATER SAMPLES

LABORATORY:			YEAR	PAGE #	
			Method Code: mFC = 9222D mTEC = 1603 mEIA = 1106.1		

Lab #	Collected		Received		Incubated		Sample Location	Sample Type	Method Code	Date/Time Read	Fecal Coliform		*E. coli*		Fecal Strep		Analyst Initial
	Date	Time	Date	Time	Date	Time					Count	/100 mL	Count	/100 mL	Count	/100 mL	

Lot #: Collection Bottles_____ Culture Plates_____ MF Filters_____
Media: Lot# for mTEC_____ mFC_____ mEIA_____

Addenda

Kentucky Division of Water Standard Operating Procedures
(On File)

MSU Water Testing Lab Quality Assurance Manual
(On File)