Standard Operating Procedure
***In situ* water Quality Measurements and Meter Calibration**

Commonwealth of Kentucky
Energy and Environment Cabinet
Department of Environmental Protection
Division of Water

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4. Procedures

4.1. Scope and Applicability – This procedure covers the calibration and use of multiparameter and single parameter datasondes for monitoring of in situ water quality in streams, including real-time measurement and unattended data logging. In situ water quality parameters may include dissolved oxygen (DO), percent dissolved oxygen saturation (%DO), ORP, temperature, pH, conductivity, and turbidity.

4.2. Health & Safety Assertion –

Field staff working in and around potentially contaminated surface waters should receive immunization shots for Hepatitis A, Hepatitis B and Tetanus, to aid in the prevention of contracting those pathogens. At the minimum, staff should receive annual OSHA training and annual medical monitoring.

Personal protective equipment (PPE) must be used when sampling in known waters with the potential for adverse health effects, or in unknown waters that have been determined impaired, but the pollutants have not been identified. Examples of PPE that could be worn are: nitrile or latex gloves, chest waders, wading boots and protective eyewear.

4.3. Cautions –

1. When possible, do not deploy probes directly in riffles. Doing so will cause some results (DO and turbidity) to appear higher than they actually are.
2. While most meters are water resistant, many are not designed to be submersed in water. Check user manual for instrument specifications.
3. Calibration standards are intended as single use solutions. Always pour an aliquot into a separate container for use and discard when done. Never reuse aliquots or immerse probes into original standard containers.
4. The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers, which is indicated by unstable specific conductance values fluctuating to as much as 100 µS/cm. The entrapment of air can be minimized by slowly, carefully placing the probe into the water; when the probe is completely submerged, move it through the water quickly to release any air bubbles.
5. The accuracy of any measurement made with a probe is dependent upon the probe being clean and maintained in good condition at all times. Always rinse the probe with clean water after each use. Never store a dirty or contaminated probe.

4.4. Interferences –

Conductivity affects other parameters (specifically DO), therefore conductivity should always be the first parameter calibrated when using multiparameter probes. The EPA (USEPA, 2007) recommends the following order for calibration of a multiparameter probe:

1. Specific Conductance
2. pH
3. DO
4. Turbidity

There is no recommended order for calibration of other parameters.

4.5. Personnel Qualifications / Responsibilities –

All Field Activities Staff will meet at least the minimum qualifications for their job classification. In addition field staff will be trained by experienced field personnel in the proper calibration and use of monitoring equipment. Training will continue on-the-job and as formal educational opportunities become available.

4.6. Equipment –

A list of equipment currently used by KDOW is found in Appendix A. If using monitoring equipment not listed, the measurement accuracy must be greater than or equal to the following specifications:

Temperature: ± 0.5° C
Conductivity: ± 1 µS/cm
pH: ± 0.5 pH
Dissolved Oxygen: ± 0.2 mg/L ≤ 20 mg/L
± 0.6 mg/L > 20 mg/L
% Saturation: ± 2 % air saturation
Turbidity: ± 1% up to 100 NTU
± 3% up to 100 - 400 NTU
± 5% from 400 - 3000 NTU
ORP: ± 20 mV

4.7. Step by Step Procedure –

4.7.1 Instrument or Method Calibration and Standardization –

All equipment is maintained and calibrated according to user manuals, and/or manufacturer specifications at a frequency recommended by or exceeding the manufacturer. See Appendix A for a list of equipment user manuals. Any deviation to established procedures should be thoroughly explained and supported with appropriate documentation and recorded in all project reports, including the Quality Assurance Project Plan. All equipment manuals shall be kept on file, or in an established location.

Individual log books should be maintained for each piece of equipment requiring regular maintenance and calibration; or at a minimum, each piece of equipment should be recorded with serial number or unique identifying number in a calibration log book (example - Appendix B). All dates, lot numbers, notes and calculations related to maintenance and calibrations should be recorded in permanent ink and the log book kept in a secure location.

4.7.2 Instantaneous In-situ Water Quality Measurements

Instantaneous water quality measurements include any measurements taken by field instruments, such as single- or multi-parameter probes.
Data are recorded on a field sheet, discharge measurement sheet, or habitat assessment sheet. In-situ water quality parameters may include:

1. Water Temperature
2. pH
3. Specific Conductivity
4. Dissolved Oxygen
5. Percent oxygen saturation
6. Turbidity
7. ORP

4.7.2.1 Multi-parameter probes

Deployment of a multi-parameter probe in streams will follow the following procedures:

4 Instrument should be placed mid-stream of the channel or in a flowing, well-mixed channel of stream (in thalweg) and mid-depth within the monitoring location.
5 Instrument should be allowed to equilibrate to environmental conditions per manufacturer's recommendations.
6 If parameter readings are still fluctuating after the initial equilibration period, allow the instrument another 1-2 minutes to stabilize. If readings remain unstable, evaluate the location of the probes, and try these steps;
    - Move unit to a different location in stream
    - Examine probes for acceptable operating condition
    - Change location of probes, e.g. suspend probes vertically in water column.
7 If unable to record data, document on field data sheets.

When parameter readings cannot be measured in-stream, they can be measured in a bucket. The following conditions must be met when measuring from a bucket.

- The bucket must be large enough to allow full immersion of the probe. The bucket is to be rinsed with river water at each site prior to collecting sample.
- The probe must be placed in the bucket immediately before temperature and oxygen levels change.
- The bucket must be shaded from direct sunlight and strong breezes before and during temperature measurement.
- The probe must be allowed to equilibrate for at least 1 minute before readings are recorded.

4.7.2.2 Single-parameter probes

Before taking field measurements, sensors must be allowed to equilibrate to the temperature of the water being monitored. Sensors have equilibrated adequately when temperature readings have stabilized. Field measurements should be made in-stream if possible (at the centroid of flow) if the stream appears to be completely mixed from bank to bank.

Deployment of single-parameter probes will follow the following procedures:

4.7.2.2.1 Temperature

Water temperatures should be determined using a thermistor, an electrical device made of a solid semiconductor that has a high temperature coefficient of resistivity. Thermistor calibration should be checked in the laboratory or office once a year using an American Society for Testing and Materials (ASTM) thermometer. Water temperatures should represent the mean temperature of the stream at the time of the observation. Hold the thermistor or probe by its top and immerse it in the water at centroid of flow and at mid- depth. Allow reading to stabilize, then read and record the temperature to the nearest 0.1° C without removing from the water.

When temperature cannot be measured in-stream, it can be measured in a bucket. The following conditions must be met when measuring temperature from a bucket.

- The bucket must be large enough to allow full immersion of the thermistor or probe. The bucket is to be rinsed with river water at each site prior to collecting sample.

- The thermistor or probe must be placed in the bucket immediately before the temperature changes.
- The bucket must be shaded from direct sunlight and strong breezes before and during temperature measurement.
- The thermistor or probe must be allowed to equilibrate for at least 1 minute before temperature is recorded.

4.7.2.2.2 pH

Preferably, pH is measured directly in-stream at centroid of flow and at mid-depth. Allow the pH probe to equilibrate according to manufacturer's recommendations before pH is recorded to the nearest 0.01 standard unit without removing from the water.

If pH cannot be measured in-stream, it should be measured in a bucket using the precautions outlined in section 4.7.2.2.1.

4.7.2.2.3 Dissolved Oxygen

Dissolved oxygen (DO) is normally measured with a DO meter, preferably at the centroid of flow and at mid-depth. The DO probe must equilibrate according to manufacturer's recommendations before DO is recorded.

Some types of probes require sufficient flow of fresh water across the membrane to maintain accuracy and precision of DO analysis. The stirrer should always be on, if equipped. If dissolved oxygen cannot be measured in-stream, it can be measured in a bucket using the precautions outlined in section 4.7.2.2.1. When taking a DO measurement in a bucket, either turn on the stirrer, if equipped, or physically move the probe in a gentle motion. Stirring too vigorously may result in adding oxygen to the water.

4.7.2.2.4 Specific Conductance

Preferably, specific conductance is measured directly in-stream at centroid of flow and at mid-depth. Allow the conductivity probe to equilibrate according to manufacturer's recommendations before specific conductance is recorded.

If specific conductance cannot be measured in-stream, it should be measured in a bucket using the precautions outlined in section 4.7.2.2.1.

4.7.2.2.5 Turbidity

In-situ turbidity samples are analyzed in the field using a portable turbidimeter. Sample aliquots should be well mixed and portioned from the bulk parameters sample bottle or other unpreserved sample bottle. Follow manufacturer's procedures for measurement.

4.7.2.2.6 Oxidation-Reduction Potential (ORP)

Preferably, ORP is measured directly in-stream at centroid of flow and at mid-depth. Allow the probe to equilibrate according to manufacturer's recommendations before ORP is recorded.

If ORP cannot be measured in-stream, it should be measured in a bucket using the precautions outlined in section 4.7.2.2.1. Temperature affects the stability of the oxidation-reduction potential. Therefore, readings should be taken before temperature can fluctuate.

4.7.3 Continuous In-situ Water Quality Measurements

Unattended deployment entails pre-programming and deployment of a water quality data sonde at a specific location to log monitoring data in the absence of observation by a field investigator. Unattended deployments are useful for collecting data at regular intervals over extended monitoring periods, frequently up to 3 – 4 days. However, since no data are recorded by hand during the deployment, it is critical that the sonde be correctly programmed.

Programming of the sonde should follow the manufacturer's procedures for unattended deployment. The sonde may be programmed in the lab prior to a field study or programmed in the field. Programming of the sonde is typically accomplished either by the sonde's display unit or by computer. Programming requires input of a start date/time (24 hour), deployment duration, data log filename, and monitoring interval. Programming times should always be input in local time for the study area, unless otherwise noted on the field sheet (example field sheet – Appendix C). The field sheet should include the sonde identifier, the date/time of initial deployment, date/time of retrieval, deployment location, and sonde depth. Similarly, recorded times should be in local time for the study area.

In following EPA guidance (USEPA, 2007), KDOW uses the following procedures for sonde deployment for obtaining continuous in-situ water quality data:

1. Set sonde to record desired parameters (i.e. water temperature, pH, specific conductivity, and dissolved oxygen) at desired intervals (i.e. 15 min., 30 min.), for the desired monitoring period (i.e. 3 days, 7 days). Use the appropriate software included with the data units.
2. Calibrate all parameters prior to deployment, according to user manuals.
3. If high potential for disturbance to units, attach a waterproof card to unit, with instructions where and who to contact for information on the data unit, and/or 'warning' labels against disturbing the units.
4. Use wire cable and padlocks (for security) to attach the data unit to a permanent structure on the bank (tree, bridge piling) or use rebar or fence-posts sunk into the bank.
5. Suspend the sondes in the water column using floats, or set units on rocks or cement blocks, so all sensors are clear of streambed.
6. Deploy sondes in a well-mixed area of the stream, but not directly in riffles, within high velocities, or in highly aerated areas; if deploying in pools or during low discharges, ensure sensors do not touch the bottom of the channel, and water will flow freely around the sensors; if necessary to deploy in high discharges, ensure units are secured to structures and will not contact banks, channel debris, etc.
7. Obtain water grab samples and measure stream discharge at the beginning of deployment and at retrieval of sondes, for all parameters outlined in project specific plans (if applicable to study object).
8. Post-calibrate sondes.
9. Download data and file in electronic project folders.

4.7.4 Sample Collection –

Not Applicable for this SOP

4.7.5 Sample Handling and Preservation –

Not Applicable for this SOP

4.7.6 Sample Preparation and Analysis –

Not Applicable for this SOP

4.7.7 Troubleshooting –

To troubleshoot meter errors, refer to the appropriate user manual (Appendix A) or other available resources.

4.7.8 Data Acquisition, Calculations & Data Reduction Requirements –

Not Applicable for this SOP

4.7.9 Computer Hardware & Software –

Hydrolab© Hydras 3 LT Software

4.8 Data and Records Management –

Records (i.e. field sheets, field notebooks) completed during each sampling event for every water sample (if applicable) collected are maintained in the administrative record file cabinets upon completion of monitoring. Records should be kept according to DEP record retention policy. Data collected from single- and multi-parameter water quality meters are read from the field sheets and entered into the departmental databases (i.e. EDAS). Data collected from continuous water quality meters are stored on a DEP server in a project folder.

5. Quality Control and Quality Assurance Section

When at all possible, after calibration is complete, calibration should be checked with a known check-standard not used in the calibration procedure. This reading should be recorded in the calibration log.

QC procedures that are required to demonstrate successful performance of the method and actions required when QC data exceed QC limits can be found in the appropriate monitoring QAPP.

6. Reference Section

1. HACH Company. Portable Turbidimeter Model 2100P Instrument and Procedure Manual. 1991-2004.

2. Horiba, Ltd. U-10 Water Quality Checker Instruction Manual. 2006.

3. Hydrolab Corporation. DS5X®, DS5®, and MS5® Water Quality Multiprobes User Manual. Third Edition. 2006.

4. ---. Hydras 3 LT Quick Start Software Manual. Second Edition. 2005.

5. ---. Quanta® Water Quality Monitoring System Operating Manual. Revision C. 2002.

6. ---. Scout® 2

7. ---. Surveyor® 4 Water Quality Data Display User's Manual. Revision D. 1999.

8. Kentucky Division of Water (KDOW). 2007. Kentucky Total Maximum Daily Load Water Quality Monitoring Standard Operating Procedures Manual. Department for Environmental Protection, Division of Water, Water Quality Branch, Frankfort, KY.

9. ---. 2008. Quality Assurance Project Plan Water Quality Monitoring for TMDL Development. Department for Environmental Protection, Division of Water, Water Quality Branch, Frankfort, KY.

10. Oakton Instruments. PC10 Waterproof Hand-held pH / Conductivity / Temperature Meter Instruction Manual. Revision 5. 2004.

11. Orion Research, Inc. Model 210A pH Meter Instruction Manual. 1997.

12. U.S. Environmental Protection Agency (EPA). 2007. In Situ Water Quality Monitoring Operating Procedure. United States Department of the Interior, Science and Ecosystem Support Division, Ecological Assessment Branch, Region 4. Atlanta, GA.

13. YSI, Inc. Model 30 Handheld Salinity, Conductivity, & Temperature System Operations Manual.

14. ---. Model 55 Handheld Dissolved Oxygen & Temperature System Operations Manual. 1997.

15. ---. 556 MPS Multi Probe System Operations Manual. 2004.

7. Attachments and Checklists/Appendices

Appendix A – Equipment and User Manuals

Equipment	User Manual
Hydrolab© MS5® Water Quality Multiprobe	Hydrolab© DS5X®, DS5®, and MS5® Water Quality Multiprobes User Manual
Hydrolab© DS5X® Water Quality Multiprobe	
Hydrolab© Surveyor® 4 Data Display	Hydrolab© Surveyor® 4 Water Quality Data Display User's Manual
Hydrolab© Quanta® Water Quality Monitoring System	Hydrolab© Quanta® Water Quality Monitoring System Operating Manual
Oakton® PC10 pH/Conductivity/Temperature meter	Oakton® PC10 Waterproof Hand-held pH/Conductivity/Temperature Meter Instruction Manual
Horiba U-10 Water Quality Checker	Horiba U-10 Water Quality Checker Instruction Manual
YSI 556 MPS Multiprobe System	YSI 556 MPS Multi Probe System Operations Manual
HACH® 2100P Portable Turbidimeter	HACH® Portable Turbidimeter Model 2100P Instrument and Procedure Manual
Orion 210A handheld pH meter	Orion Model 210A pH Meter Instruction Manual
YSI 55 handheld dissolved oxygen and temperature meter	YSI Model 55 Handheld Dissolved Oxygen & Temperature System Operations Manual
YSI 30 handheld salinity, conductivity, and temperature meter	YSI Model 30 Handheld Salinity, Conductivity, & Temperature System Operations Manual
Hydrolab© Scout® 2, with submersible water quality data transmitter	Hydrolab© Scout® 2, with submersible water quality data transmitter

Appendix B – Example Sample Calibration Log Sheet

Hydrolab Calibration Log

Date	Initials	Meter #	SC std Lot #	SC (µs / cm) reading	SC 500 µs/cm check std.	pH 4 std. lot #	pH 4 reading	pH 7 std. lot #	pH 7 reading	pH 10 std. lot #	pH 10 reading	pH check std.	Temp (°C)	Initial DO	Expected DO	BP (mmHg)	Final DO

Appendix C – Example Sample Field Data Sheet

DIVISION OF WATER
TMDL DEVELOPMENT MONITORING

Site Identification

Site ID #: _________________________________

Location: _________________________________

Sample Collected By: _______________________

Collection Date/Time

Date: _______________

Time: ______________

County: _____________

Field Measurements

Tw: _____°C SpC: _____uS/cm pH: _____ D.O.: _____mg/L %Sat: _____ Turbidity: _____

Multi-Parameter Probe: Hydrolab #: ____________ Calibration Date: _______________

Stage Height/Flow Measurements

Cross-section Location: ___________________________________

Flow Tracker Meter: ______________

Other Flow Measurement Method: ___________________________

Station	Width	Depth	Area	Run Length	Secs	Velocity	Discharge

Reference Point Reading (tapedown): ______________________ feet

Stage Reading: ___________ feet (o USGS wire-weight, o USGS Internet, o WWTP)

Flow: _________ (o Measured, o USGS Internet, o Stage/Flow Table, o WWTP, o Estimated)

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

	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	☐ $1m^2$ ☐ 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.	2 **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				

NOTES/COMMENTS:

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 <u>not</u> new fall and <u>not</u> 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 amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
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 has erosional 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 RB	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.

Total Score **NOTES/COMMENTS:**