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INTRODUCTION, PURPOSE, OR ISSUE:

This Water Resources Division (WRD) Policy/Procedure establishes the process necessary to qualitatively monitor habitat and biological communities in large, nonwadeable rivers to meet the objectives of the Michigan Water Quality Monitoring Strategy.

AUTHORITY:

Section 3103(1) of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

PROCEDURES:

The development of these biological and habitat survey protocols resulted from the need for the WRD to more broadly understand the biological and physical habitat condition of Michigan's nonwadeable rivers and to make determinations of designated use support (per R 323.1100 of the Part 4 Water Quality Standards [Part 4 Rules] promulgated under Part 31, of the NREPA). Generally, large rivers are poorly understood due to sampling difficulties related to their size, power, and complexity (Johnson et al., 1995; Sheehan and Rasmussen, 1999; Lyons et al., 2001). This Policy/Procedure is based on research collaboratively conducted by the University of Michigan (habitat survey) and Michigan State University (biological survey), which was funded by a Clean Michigan Initiative grant. For additional and more detailed information regarding the development of these protocols, refer to Wessell, 2004; Opdyke, 2002; and Merritt et al., 2003.

This Policy/Procedure consists of qualitative methods for the assessment of benthic macroinvertebrate communities and physical habitat conditions of nonwadeable rivers. The Policy/Procedure was developed specifically for Michigan's nonwadeable rivers and was tested at 45 locations on 13 of Michigan's nonwadeable rivers in 4 ecoregions across the state (Omernik and Gallant, 1988). Accordingly, they are expected to assess the range of conditions in Michigan's nonwadeable rivers.

The assessment of nonwadeable rivers is conducted by randomly identifying survey reaches that are assumed to be representative of the larger river and catchment so that the information can be extrapolated to other similar areas, or by a targeted approach to answer more specific questions regarding the quality of the habitat and biological community.

Each nonwadeable river survey reach is described by an assessment of the benthic macroinvertebrate community and physical habitat condition. Each assessment is made according to a series of measurements or 'metrics'. The individual metrics for the benthic macroinvertebrate assessment provide information on a variety of biological attributes and, when combined, intend to indicate community response to various river quality conditions. Similarly, the individual metrics for physical habitat, related to both in-stream and riparian conditions, provide information on a variety of physical attributes at varying scales that typify the nonwadeable reach and assist in interpreting biological community data. A river of excellent quality will have substantially different metric values than a river of poor quality, providing a systematic evaluation of each site based on the two suites of metrics. These protocols provide a consistent and accurate method to determine the condition of a nonwadeable river relative to the best condition it might be expected to attain.

This procedure incorporates multiple transect samples taken within a 2 kilometer (km) reach that are composited to obtain a macroinvertebrate and habitat assessment that typifies the reach. Collection of the qualitative habitat and macroinvertebrate assessment at a reach should take approximately one-half day and demands at least two trained field personnel.

I. SAMPLING CONSIDERATIONS

In general, a nonwadeable river or river segment is one where water depths frequently exceed the maximum depth that can be safely and conveniently surveyed in chest waders thus sacrificing the ability to adequately and safely sample all available habitats. The exact boundary between wadeable and nonwadeable will always be indistinct, because water depth varies seasonally and with recent precipitation, with location, and may be influenced by impoundments or other human alterations. The need for this nonwadeable procedure stems from the broad scale of habitat features and the potential difficulties with collecting biological and habitat information representative of the entire river reach.

Stream gauge data provide a convenient dividing line between wadeable and nonwadeable locations. Based on experience, sites on rivers where the mean annual discharge exceeds 530 cubic feet per second are usually nonwadeable during summer flows. In Michigan, locations where the mean annual discharge exceeds 530 cubic feet per second usually are fifth order or higher, have drainage areas greater than 1,600 km^2, and main stem lengths greater than 100 km (Opdyke, 2002). According to these guidelines, there are 22 such rivers in Michigan; 15 of these are in the Lower Peninsula (Saginaw, Grand, St. Joseph, Tittabawassee, Muskegon, Au Sable, Manistee, Kalamazoo, Cheboygan, Flint, Thunder Bay, Raisin, Cass, Huron, and Thornapple) and 7 are in the Upper Peninsula (Menominee, Manistique, Ontonagon, Escanaba, Tahquamenon, Sturgeon, and Michigamme). Additionally, survey locations in the "Very Large" Valley Segment Ecological Classification stratum (Seelbach et al., 1997) will most likely need to be assessed using this procedure.

Ultimately, judgment by professional field personnel must be used to determine whether a river reach can be adequately navigated over a 2,000 meters (m) area by boat, regardless of the aforementioned flow information. This procedure is not to be used if the river reach can be safely and adequately surveyed following the Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers, WRD policy number WRD-SWAS-051.

Unless study objectives dictate otherwise, sampling should occur between June 1 and September 30 during periods of stable discharge, preferably under low or moderate flow conditions. This temporal and flow-stabilized target will help decrease some of the sampling variability and ensure proper assessment of potential macrophyte beds that are most abundant during the summer season. In addition, effects of pollutants and other stressful conditions are most often apparent during summer conditions, e.g., dilution is minimal for pollutants during low flow conditions, while elevated temperatures and plant productivity will produce maximum fluctuations in diurnal oxygen conditions. Higher temperatures typically found under baseflow conditions also increase macroinvertebrate metabolic rates, which may amplify pollutant effects. Sampling outside baseflow conditions may represent an increased safety risk due to flow and debris as well as an increased difficulty in conducting the survey due to extremes in turbidity and the potential for sampling terrestrial bank material rather than substrate that is available to macroinvertebrate colonization year-round. Where available, United States Geological Survey stream gauge information should be accessed prior to field sampling to aid in determining flow stability with the recognition that many large rivers will be slower to respond (both in rising and falling water levels) to precipitation in the watershed.

For basin investigations or long-term studies, where necessary, seasonal variability in macroinvertebrates distribution or abundance may be minimized by sampling during a more refined time frame.

Because of the potential hazards encountered on nonwadeable rivers, one of the two field personnel must be an experienced boat operator. Nonwadeable rivers, while generally navigable, will have shallow areas, riffles, boulders, logjams, strong current, etc. that may result in damage to equipment and personal injury if not approached with caution. Personal floatation devices should be worn at all times during this survey work. Personal safety is more important than data collection, and survey locations should be shifted if conditions are not suitable to safely conduct this procedure.

II. SITE SELECTION

Site selection will depend on the intended use for the information to be collected. Targeted reaches may be chosen for specific needs (e.g., investigate potential impacts of specific significant point sources, evaluate the effectiveness of specific water quality protection projects). Locations intended to support probabilistic status sampling should be gathered from reaches chosen randomly following the process described in the Macroinvertebrate Community Status and Trend Monitoring Procedure (DEQ, In Preparation).

Mouths of rivers as they enter the Great Lakes and upstream portions subject to seiche effects and reverse flows as well as sections immediately upstream or downstream of lakes should be avoided; these habitats are often influenced by the larger, lentic water body and are not representative of the lotic system for which these protocols were developed. A station should be 2,000 m in length, as this distance is considered logistically feasible to sample in a half day and captures much of the natural variation in habitat variables within the reach.

For safety and practicality it is best to use larger versus smaller flat-bottomed boats, which necessitates access to locations with boat ramps. Access sites should be located using various print publications (County map books, Atlas, and Gazetteer) as well as local knowledge (District staff input, particularly Fisheries Division, Department of Natural Resources), and Internet information (e.g., http://www.mcgi.state.mi.us/MRBIS/). Launch locations may be a primary consideration for reach selection or in considering riverine travel time to a selected reach. Access to, and the appropriateness and safety of sampling a reach must be carefully considered prior to sampling.

III. TRANSECT ESTABLISHMENT

Each nonwadeable river sampling site consists of 11 transects spaced 200 m apart for a total reach length of 2,000 m (Figure 1). If selected randomly, the reach should incorporate the randomly chosen point based on valley segment (VSEG) classification (see Macroinvertebrate Community Status and Trend Monitoring Procedure, DEQ, In Preparation). Regardless of the site selection method, the VSEG number for the sample reach should be recorded on the Reach data sheet (Appendix I). The macroinvertebrate community and physical habitat survey components primarily focus on conditions near channel banks. This is both practical and reasonable because many large rivers tend to have a hydraulically efficient main channel with little habitat heterogeneity and their greatest biological and habitat richness is associated with edge or inshore zones (Stalnaker et al., 1989; Schiemer, 2000).

Establish the start of the reach (either upstream or downstream end depending on launch location relative to randomly chosen survey point) and use a GPS unit to set a waypoint. Choose one bank consistently to mark with survey flagging material (on overhanging branches or other visible location) and mark the first transect at this point. Establishing successive upstream/downstream transects is dependent on measured distances from each previous waypoint, all of which should be established along the same bank. Use the GPS unit to track distance from the starting waypoint, when the distance traveled equals 200 m (approx. 0.12 miles) the next transect should be marked on the shoreline with flagging and a second waypoint established. Proceed in this manner until 11 transects are marked, thus defining the reach. Care should be taken to mark and sample transects at the predetermined interval (unless safety issues dictate otherwise) to ensure that their placement is random and guard against bias. Transects are labeled A-K, from downstream to upstream (Figure 1).

While marking transects along the reach, depth and substrate are measured at approximately 40 m intervals along the thalweg for the entire reach for a total of 51 measurements (see Appendix II for Longitudinal Profile data sheet). The thalweg is defined as the deepest part of the channel and care must be taken to periodically verify that the correct path is followed. If an island is encountered along the longitudinal profile, navigate and survey the channel that carries the most flow (Kauffman, 2000). Left bank and right bank are determined by facing downstream.

Depth should be measured using a depth finder or a fiberglass/PVC sounding pole marked in 10 centimeter increments. The sounding pole is also used to determine thalweg substrate materials based on how the bottom "feels" when dragging the pole along it. The best results are obtained using a fiberglass surveying rod or PVC sounding tube and combining dragging motions with jabs against the bottom. The dominant thalweg substrate is classified as bedrock, boulder, cobble, coarse gravel, fine gravel, sand, or silt. In cases of heterogeneous substrate, up to two size categories may be recorded if each exceeds approximately 40 percent of the total composition of the 40 m interval.

While navigating the thalweg, record the presence of off-channel habitats, such as backwater pools, connected side channels, and other extensive lateral wetted habitat including tributaries at every location that the thalweg depth and substrate are measured. When side channels are present, checkmarks on the Longitudinal Profile data sheet should be used to show the points of convergence/divergence. In cases of tributaries, there will not be a point of divergence. Finally, maintain a tally of all large woody debris (LWD) greater than 0.1 m (approximately 4 inches) in diameter and 3 m in length that is found at least partially within the wetted channel throughout the 2,000 m reach. Branched trees that meet these size requirements are counted once and counts of log-jams should be made quickly to generally reflect how abundant individual pieces of LWD are in the group without needing to spend extra time getting exact counts in those instances.

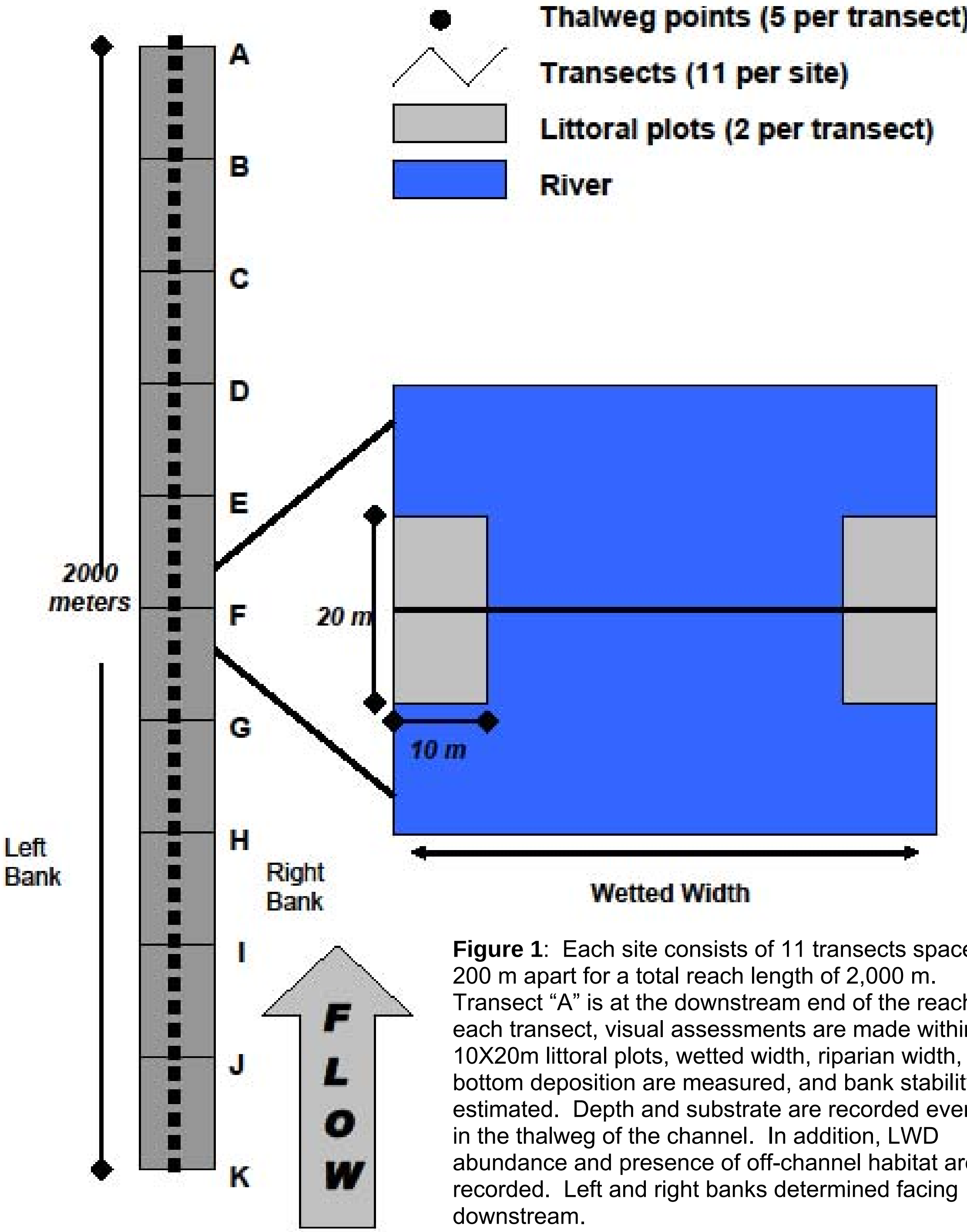

Figure 1: Each site consists of 11 transects spaced 200 m apart for a total reach length of 2,000 m. Transect "A" is at the downstream end of the reach. At each transect, visual assessments are made within 10X20m littoral plots, wetted width, riparian width, and bottom deposition are measured, and bank stability is estimated. Depth and substrate are recorded every 40 m in the thalweg of the channel. In addition, LWD abundance and presence of off-channel habitat are recorded. Left and right banks determined facing downstream.

IV. QUALITATIVE BENTHIC MACROINVERTEBRATE SAMPLING PROCEDURE AND DATA ANALYSIS

The biological portion of the protocol for evaluating the ecological health of nonwadeable rivers in Michigan is based on sampling all transects (A-K) at one randomly chosen bank. Biological assessments are done using a composite sample of all habitats present at each transect (fine particulate organic matter (FPOM), sand, coarse sediments, cobble, LWD, and macrophytes).

Metrics included in the final protocol were chosen after several steps of data reduction, which helped determine which biological attributes provided unique information, described the most variation among sites, and had a linear or otherwise unambiguous response to anthropogenic impacts. For an in-depth discussion of the metric selection process, see the supporting document from Wessell (2004).

OVERVIEW OF BENTHIC MACROINVERTEBRATE PROCEDURES

An equipment checklist is provided (Appendix III) to ensure all necessary equipment is brought along for the benthic macroinvertebrate community assessment. A random method should be used (e.g., coin flip, die roll) to decide which bank to sample for each transect. Sample all available habitats within an area approximately 10 m upstream and downstream of the marked transects (A-K) (Figure 1). Sampling should take place within 10 m from the wetted margin in shoreline areas where safely wadeable (generally <1 m deep). If river depth at the selected bank is too deep to safely and adequately wade, select the opposite bank for that transect. If neither bank is able to be safely sampled, no benthic macroinvertebrate sample is collected. The flagging should be removed as each transect is assessed and completed. See the next section for detailed description of sampling procedures.

By using a composite sample approach, the biological assessment will reflect the broadly available habitat as well as in-stream water quality. This sampling procedure involves sampling all available habitats at each transect and combining the individual samples into one composite for the entire reach. At each transect:

1. Tally the individual habitat types available in the littoral plot (Figure 1). Habitats must be in sufficient abundance to collect 15-second samples in order to be tallied and may include:

    a) FPOM
    b) Sand (gritty up to ladybug sized)
    c) Coarse Substrate (Gravel - ladybug to tennis ball sized)
    d) Cobble (tennis ball to basketball sized)
    e) LWD
    f) Macrophytes

2. For each habitat type, take timed samples (15 seconds each) with a D-frame aquatic dip net with mesh size = 0.8-1.0 millimeters. Habitat-specific considerations are as follows:

    a) FPOM: If there is flow through the sampling area, use kick methods to reduce the amount of detritus in the sample. If there is no flow, sweep the net along the bottom and make sure to wash as much detritus from the net as possible.
    b) Sand: Same as above.
    c) Gravel: If there is flow through the sampling area, use kick methods to stir up gravels, with the net held downstream to capture dislodged benthos. If there is no flow, use kick methods to stir up gravels then sweep the net along the bottom to capture dislodged benthos.
    d) Cobble: It is difficult to take timed sweeps of cobble habitat; therefore, try to choose a piece of cobble at least 15 centimeters in diameter. Place the cobble in a bucket and brush organisms off with a brush.
    e) LWD: Sampling LWD presents challenges, especially when the debris cannot be removed from the river. Use a brush to dislodge organisms from the LWD and follow closely behind the brush with the net. If there is high flow in the area being sampled, make sure the net opens into the current and the brush is upstream of the net. Do this for 15 seconds.
    f) Macrophytes: If there are macrophytes in the study reach, take timed sweeps (15 seconds) of the stems to dislodge attached macroinvertebrates.

3. Empty the net into a sample processing pan or bucket filled with water. This allows one to easily wash out the net (attached organisms may need to be picked from the net with forceps).

4. Remove as much detritus and macrophytes as possible, taking care to scrub or otherwise vigorously shake materials in the collection bucket to retain any benthos. After all transects are sampled, use a sample splitter to divide the composite sample into quarters. All macroinvertebrates present in one of the quarter subsamples must be counted. The quarter sample may have to be processed in portions, based on the density of macroinvertebrates and detritus, to accurately identify and count.

5. Identify and count the macroinvertebrates in the subsample to family level and record on the Macroinvertebrate Data Sheet (Appendix IV).

6. Upon return to the office, the macroinvertebrate data are entered into the appropriate database for storage.

7. Biological data are summarized and metric scores (below) calculated.

BIOLOGICAL METRIC DESCRIPTION AND SCORING

Inferring stressor-response relationships in nonwadeable rivers is difficult due to the different scales of human impacts and should rely heavily on professional judgment. The following list defines the suite of biological metrics used in this Policy/Procedure and discusses specific stressors to which the metrics may respond; these should only be used as guidelines and are based on analyses conducted by Wessell (2004) for the development of this procedure. This information can be useful in assessing the types of human influences that may affect the river including: influences from water chemistry (e.g., pH, nutrients), in-stream habitat, and riparian and catchment land use.

A. Calculate values and corresponding scores for each metric as follows:

1. **Functional Feeding Group (FFG) Diversity** (calculated based on abundance of FFGs similar to the Shannon Index of Diversity, $-\Sigma[pi(Log_2 pi)]$ where p_i is the proportion of individuals represented by each FFG, see Appendix V; scoring out of 25: <0.95 = 0, </=1.41 = 8, </=1.7 = 16, >1.7 = 25): Shows significant negative correlation with measures of human disturbance (Human Disturbance Gradient, see Opdyke, 2002) including riparian land use and a negative correlation with water quality measures like total phosphorus and turbidity.

2. **Habitat Stability FFG Surrogate** [(# Scrapers + # Collectors Filterers)/(#Collectors Gatherers + #Shredders); scoring out of 25: <0.09 = 0, </=1.41 = 8, </=1.7 = 16, >1.7 = 25]: This FFG surrogate responds to overall in-stream habitat quality (LWD) (Merritt et al., 1996), with a negative correlation to urban and agricultural watershed land use, and a positive correlation to natural land use.

3. **Percent Trichoptera** (Relative abundance of Trichoptera; Trichoptera abundance/total abundance; scoring out of 20: </=1.3% = 0, </=3.4% = 7, </=6.8% = 14, >6.8% = 20): This metric shows a negative correlation to agricultural riparian land use.

4. **Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa Richness** (Total number of EPT families; scoring out of 8: <4 = 0, </=6 = 3, </=9 = 6, >9 = 8): This metric shows positive correlations with extent of LWD at sites and a negative correlation to urban land use in the watershed.

5. **Total Taxa Richness** (Total number of families in the sample; scoring out of 7: <15 = 0, </=18 = 2, </=24 = 5, >24 = 7): This metric has a negative correlation to percent urban land use in the watershed.

6. **Diptera Taxa Richness** (Total number of Diptera Families; scoring out of 5: <2 = 0, </=3 = 2, </=5 = 4, >5 = 5): This metric shows a negative correlation with water quality measures like total Nitrogen, turbidity, and suspended chlorophyll. Sites with Diptera taxa richness equal to 1 or 2 are usually dominated by Chironomidae.

7. **Plecoptera Taxa Richness** (Total number of Plecoptera families; scoring out of 5: 0 = 0, 1 = 2, 2 = 4, >2 = 5): Plecoptera appear to respond to riparian stressors (positive correlations with percent natural land use in riparian buffers) and LWD presence.

8. **Percent Dominance** (Relative abundance of dominant taxon; scoring out of 5: <35% = 5, </=46% = 4, </=60% = 2, >60% = 0): This metric shows a negative correlation with percent natural riparian land use in the watershed and in the riparian buffer. When percent dominance is extremely high, the sample is usually dominated by Chironomidae.

B. Add the scores for each metric to obtain a composite value with the range of scores used to classify each metric described in the following rating table. The range of total scores for biological metrics (i.e., the sum of metrics 1-8) is 0-100.

METRIC	**SCORING RANGE/RATING**			
	Excellent	Good	Marginal	Poor
1. FFG Diversity	25	16	8	0
2. Habitat Stability FFG Surrogate	25	16	8	0
3. Percent Trichoptera	20	14	7	0
4. EPT Taxa Richness	8	6	3	0
5. Total Taxa Richness	7	5	2	0
6. Diptera Taxa Richness	5	4	2	0
7. Plecoptera Taxa Richness	5	4	2	0
8. Percent Dominance	5	4	2	0

V. QUALITATIVE HABITAT ASSESSMENT SAMPLING PROCEDURE AND DATA ANALYSIS

The qualitative habitat assessment portion of this Policy/Procedure is based on sampling both banks of all 11 transects as well as reach-wide sampling (e.g., LWD count, thalweg substrate, off-channel habitat). Transect data are recorded on the Transect Habitat data sheet (Appendix VI). At each transect, wetted width (the wetted surface of the river from one bank to the other) is visually estimated or measured. If a large island blocks the view from bank to bank, record the width of the main channel to the edge of the island, flag the observation, and write a comment indicating that the measurement refers only to the main channel (Kaufmann, 2000).

Extent of vegetative coverage in littoral plots is assessed by estimating the percent coverage by aquatic vegetation including filamentous algae and macrophytes within 10x20 m plots centered on the imagined transect line extending from the channel margin towards the middle of the river (Figure 1). These dimensions are estimated, so it is helpful to know the length of the sampling boat or have measurement marks taped onto the side of the boat in order to constantly calibrate visual estimates of distance.

In-stream vegetative coverage is recorded as absent (0%), sparse (<10%), moderate (10-40%), heavy (40-75%), and very heavy (>75%) within the littoral plots of both left and right banks (categories consistent with those used by Kauffman [2000]). These estimates should be made visually unless water clarity precludes this, in which case proportional coverage will be estimated by using the PVC sounding pole. Filamentous algae are long-streaming algae typically found in slow moving waters and aquatic macrophytes include plants found in the water, mosses, and live wetland grasses (Kaufmann, 2000).

The width of the intact riparian vegetative zone is estimated for both banks by visually extending the transect line perpendicular to the river channel. An intact riparian vegetative zone is able to stabilize stream banks, filter runoff, provide shade, and contribute allochthonous input and LWD. Riparian width is recorded for widths from 0 to 25 m and it is noted if the riparian buffer extends beyond this distance. In cases with extremely dense vegetation, reconnaissance on foot may be necessary to observe riparian conditions to 25 m.

Fine sediment deposition is estimated by recording the approximate width of streambed along the transect covered with enough silt sediment to limit habitat available to macroinvertebrate colonization and converting this to a proportion of the wetted width. Sand substrates are not considered in this estimate.

Bank stability is estimated visually for both banks by observing conditions approximately 50 m upstream and downstream of the transect. Stable banks with gradual side slopes and little erosion potential receive higher scores than unstable banks with steep side slopes and well defined erosional areas.

Upon return to the office, data from transect and reach-wide habitat surveys are entered into the appropriate database.

HABITAT METRIC DESCRIPTION AND SCORING

The following list defines the suite of habitat metrics and discusses specific stressors to which they respond. This information will be useful in assessing what types of human influences may affect the river being assessed. Data for these metrics comes from the Habitat Data Sheet (Appendix VI) and are collected at each of the 11 transects, then averaged over the entire reach to obtain a single metric score and a composite metric score for that reach. Metric calculation is described below and scoring information is contained in Appendix VII.

<u>Metric 1</u>. Riparian Vegetation Width

An intact zone of riparian vegetation stabilizes stream banks and reduces erosion, provides storage for flood waters, removes excess nutrients and sediment from runoff and shallow groundwater, and provides shading to maintain optimal temperature regimes for aquatic plants and animals. In large rivers, the ability of the riparian zone to supply woody debris to the stream channel strongly influences biological communities and organic carbon storage in the form of stable particulate deposition.

Factors to Consider: Higher scores for Metric 1 are associated with riparian zones that contain LWD, both standing or downed, in close approximation to the stream channel that can reach the stream channel through natural processes. A more intact riparian zone may have the ability to buffer high-water events through water storage. Lower scores reflect buffer zones that provide little opportunity of LWD recruitment and/or water storage function has been reduced by anthropogenic disturbance.

Metric Calculation: All 22 riparian width estimates (left and right bank at each of 11 transects) are scored following Appendix VII, and then the average of all 22 scores is calculated as the reach score.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
1. Riparian vegetation width	Mean riparian width > 24 m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest.	Mean riparian width 18-24 m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.	Mean riparian width 10-17 m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.	Mean riparian width < 10 m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.
Score	25 - 20	19 - 13	12 - 6	5 - 0

Metric 2. LWD

Woody debris is an important component of streams and rivers, providing substrate for invertebrates, cover for fish, and influencing channel structure and habitat complexity. This habitat metric is based on the assumption that more wood results in better physical habitat conditions. Rivers dominated with large pieces of wood that are firmly anchored should score in the higher range of this category than those dominated by less substantial, and therefore more transient, pieces of wood.

Factors to Consider: LWD is defined for these surveys as approximately 4 inches (soft ball size) or larger in diameter and 10 feet long or greater that is mostly in the wetted channel.

Metric Calculation: LWD is counted on the Longitudinal Profile Data Sheet and summed for the entire reach and scored following Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
2. LWD	Greater than 200 pieces of LWD in 2,000 m reach.	Between 100 and 200 pieces of LWD in 2,000 m reach. LWD is still plentiful and provides cover and habitat where present.	Between 50 and 100 pieces of LWD in 2,000 m reach. LWD is scattered infrequently throughout the river channel.	Fewer than 50 pieces of LWD in 2,000 m reach. The lack of LWD is obvious, causing the river reach to lack substantive cover, habitat, and substrate.
	20 - 16	15 - 11	10 - 6	5 - 0

Metric 3. Aquatic Vegetation

Macrophytes are important in providing seasonally stable habitat for macroinvertebrates, creating local flow variability for habitat and fish refugia, local sediment deposition, and an autochthonous energy source. The scoring of this metric assumes that, in large rivers, sites with more aquatic vegetation are biologically healthier.

Factors to Consider: There may be circumstances where excessive aquatic vegetation is detrimental and limits flow and habitat variability; if excessive aquatic vegetation is widespread at all transects, the reach's overall scoring should reflect this decrease in condition.

Metric Calculation: For each bank of each transect, determine the highest cover percentage category for either macrophytes or filamentous algae. Use the midpoint of the range from the Habitat Data Sheet (Appendix VI) for each category (0=0%; 1=5%; 2=25%; 3=57.5%; 4=87.5%) and average all values (one for each bank at 11 transects, 22 measurements in total) and score following Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
3. Aquatic Vegetation	Greater than 25% of the littoral plots, averaged over all transects for 2,000 m reach, are covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are dense and extensive.	15-25% of the littoral plots is covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are relatively common throughout the stream reach in the shallow areas.	6-14% of the littoral plots is covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are infrequent.	Lack of aquatic vegetation is obvious. 5% or less of the littoral plots is covered with submerged or emergent aquatic vegetation.
	20 - 16	15 - 11	10 - 6	5 - 0

Metric 4. Thalweg Substrate

Substrate particle size, heterogeneity, and embeddedness are important determinants of habitat for aquatic life. Substrate composition determines channel roughness, provides microhabitat for fish species, influences macroinvertebrate and freshwater mussel distribution and abundance, and can be an indicator of significant land use or riparian disturbance. Large, stable substrate is generally accepted to be more favorable for epifaunal colonization and fish cover. However, coarse substrates are inherently rare in low gradient rivers.

Metric Calculation: Thalweg substrate is calculated as the proportion of 51 measurements on the Longitudinal Profile Data Sheet (Appendix II) recording some proportion of fine gravel or larger particle sizes (including woody debris and other, see page 4). Add the number of measurements recording coarse substrate (fine gravel or larger), including those that may have a mix of a coarse and fine substrate (e.g., both fine gravel and sand circled, indicating a heterogeneous substrate). Divide the resulting number by 51 (or the total count of measurements, if different) to get the proportion containing coarse substrate (e.g., 6 stations recorded only SA (sand) and/or FN (fine) substrates, so 45/51 = 88 percent with coarse substrates). Once the proportion is calculated and multiplied by 100 to convert to percentage, it can be scored following Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
4. Thalweg Substrate	More than 60% of the thalweg river bed, averaged over the 2,000 m reach, consists of fine gravel (>2 millimeters) or larger substrate that are relatively stable and suitable for cover and colonization.	35-60% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate, with less stable sand or fine substrate dominating the remainder of the thalweg river bed.	15-34% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate. Sand or fine substrate dominates the thalweg river bed contributing to a scarcity of stable substrate or cover.	Less than 15% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate. The lack of stable substrate is obvious with the thalweg river bed almost exclusively sand or fine sediment.
	10 - 9	8 - 6	5 - 3	2 - 0

Metric 5. Bottom Deposition

Bottom deposition measures the proportion of the entire riverbed that is overlaid with silt, muck, and other fine sediments. Deposition leads to high embeddedness filling interstitial spaces in the riverbed and is typically considered to be detrimental to the quality of stream habitat and negatively affects benthic invertebrates and fish spawning conditions.

Factors to Consider: FPOM may be common in reduced flow areas, and should not be considered as a detriment to habitat quality nor counted in this metric. Professional judgment should be exercised to distinguish between naturally occurring FPOM and excessive, typically inorganic fines from disturbance-related events. Deposition is estimated as a proportion of the entire wetted width and does not consider sand substrates.

Metric Calculation: Sum all depositional area widths for each bank and each transect (22 measurements) and divide by the sum of all wetted widths (11 measurements) to get a proportion of total wetted width covered by depositional area. Multiply by 100 to get percentage of depositional coverage and score following Appendix VII.

Habitat Parameter	Condition Category Excellent	Good	Marginal	Poor
5. Bottom Deposition	Less than 5% of the riverbed, averaged over all transects in the 2,000 m reach, have apparent deposition of fine sediments. Natural substrate may consist of sand, or fine gravel to larger substrate, which is clean of depositional debris. Even shallow areas with slower river velocity and flow are relatively free of fine sediment deposition.	5-24% of the riverbed affected by deposition and sedimentation. Remaining natural substrate may consist of sand, or fine gravel to larger substrate. Limited deposition in the shallow, low flow river bank areas and pools leaving the thalweg substrate relatively clean and free of fine sediments.	25-50% of the riverbed affected by deposition and sedimentation. Riverbed habitat noticeably degraded by embedded sediments covering surfaces and filling interstices. The depositional areas extend beyond the shallows into the main river channel.	More than 50% of the riverbed affected by deposition and sedimentation. Extensive sediment deposits cover most surfaces and fill most interstices. These depositional areas are not confined to shallow and low flow areas and extensively affect habitat availability throughout the river channel. Heavy deposition at sediment bars and islands.
	10 - 9	8 - 6	5 - 3	2 - 0

Metric 6. Bank Stability

Banks are an important transition zone between rivers and adjacent terrestrial areas. Banks in good condition provide cover and reduce pollutant input, while banks in poor condition lead to increased erosion and in-stream sediment deposition. Bank erosion is a natural and continuous process in lotic systems. Certain land use activities, channelization, or disturbance related to frequent high flow events or boat wakes in larger rivers accelerates bank erosion rates altering channel morphology and limiting habitat for organisms.

Factors to Consider: The use of rip-rap to stabilize erosive shorelines may be common in some segments of larger rivers. When scoring a rip-rapped streambank, it should be rated on an assessment of its condition *absent* the rip-rap as much as possible. This will reflect the instability causing the need for protection versus the artificially provided stability of the streambank protection.

Metric Calculation: The composite score results from summing of scores for each specific bank and dividing by 11 to get an average score at each bank, then adding left and right bank (i.e., add up all scores for left and right bank, respectively, divide each by 11 to get overall bank-specific score, then add the overall left and right bank scores to get the composite). Score following Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
6. Bank Stability (score each bank). Note: determine left or right side facing downstream SCORE __(LB) SCORE __(RB)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for 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% of bank has erosional scars.
Left bank Right bank	5 5	4 - 3 4 - 3	2 - 1 2 - 1	0 0

Metric 7. Off-Channel Habitat

Off-channel and backwater habitats can be biological hotspots in large rivers, containing disproportionately high fish biomass. These areas frequently are nutrient enriched and are used for spawning and nursery purposes, in addition to being places of refugia during disturbance events. They contribute to the habitat complexity found in large rivers and the overall habitat diversity. Similarly, tributary mouths also may be areas of increased species richness, abundance, and density.

Factors to Consider: Off-channel habitats may be wetted or seasonally dry. Look for the presence or evidence of areas of river connection to the floodplain and the confluence of tributaries (including intermittent drainage ways and water storage potential).

Metric Calculation: Sum all off-channel habitat counts and score following the table below or Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
7. Off-channel Habitat.	More than 5 off-channel habitats per 2,000 m reach. Backwaters of large area, with a range of depths and flows.	4-5 off-channel habitats per 2,000 m reach. Backwaters are relatively common and still provide refugia and additional habitat.	2-3 off-channel habitats per 2,000 m reach.	Fewer than 2 off-channel habitats per 2,000 m reach. Backwater habitats are rare to nonexistent.
	5	4 - 3	2 - 1	0

Integration of Habitat Metrics

The seven variables included in the final habitat index are given different weightings as reflected in the maximum score of each metric, based on the analysis described below (see also Opdyke, 2002). Riparian width (up to 25 points), woody debris, and aquatic vegetation (up to 20 points each) are given the highest weight because they were most frequently associated with high quality habitat. Bottom deposition, thalweg substrate, and bank stability are given an intermediate weight and are scored on a ten-point scale. Off channel habitat is given the lowest weight and is scored on a five-point scale. The process by which transect data is converted to an overall site score for individual metrics is described in Appendix VII.

The sum of the scores from each metric give a total score representative of the habitat quality for each reach, with a maximum of 100 points. The individual metric scores may be translated into a qualitative rating as described previously, and the same can be done for the sum of all metrics over the sample reach: "excellent" (84-100), "good" (56-83), "marginal" (28-55), or "poor" (0-27). It is important to communicate that the overall riverine habitat description is a holistic assessment that may be too general in nature to adequately correlate with the biological data or describe anything but broad differences between sites and over time. The ability or inability of a stream to support optimal macroinvertebrate communities is best communicated by scores from individual metrics that provide the specifics of existing conditions that directly affect biological communities or the potential to support biological communities. An individual metric with a poor rating can be isolated and addressed relative to the corresponding biological data. Additionally, impacts from large-scale riparian disturbance may be realized well downstream from the source of the disturbance; therefore, not reflected in the adjacent biological scores.

Other measurements of river condition that may be helpful in interpreting assessments of the river are thalweg depth and width-to-depth ratio. These measurements help define expectations for habitat and biology, but are not associated directly with habitat quality. Thalweg depth (recorded on the Longitudinal Profile Data Sheet) is the mean vertical distance from the riverbed to the water surface for 51 measurements along the 2,000 m reach in the deepest part of the channel. Variation in thalweg depth provides an estimate of heterogeneity in habitat.

Width-to-depth ratio is calculated by dividing the mean width of the 11 transects (found on the Transect Habitat Data Sheet) by the mean thalweg depth (derived from the Longitudinal Profile Data Sheet). This ratio indicates general channel shape and is a correlate of glide/pool and riffle/run variation, typically measured in wadeable streams and rivers.

VI. OVERALL APPLICATION AND INTERPRETATION

While biological and habitat assessments are expected to provide broadly similar site evaluations in most circumstances, substantial discrepancies between biological and habitat scores may occur, and could indicate chemical contamination or some other unidentified pollutant. Each site should be carefully evaluated using both the habitat and biological protocols outlined above and in combination with other relevant field notes.

VII. PROCEDURAL CONSISTENCY AND DATA MANAGEMENT

A. Training of DEQ Personnel

All personnel conducting nonwadeable river assessments should be trained in a consistent manner to ensure procedures are conducted in a standardized fashion. Periodic training of new field biologists and refresher training of experienced biologists should be performed, and techniques should be cross-checked by experienced personnel. Training may be in the classroom, field, or a combination of these. At least one investigator for each site will be a professional biologist trained and skilled in field aquatic sampling methods and organism identification.

B. Standard Procedures

The standard procedures described in this document are followed in the surveys. Field experience and taxonomic expertise requirements must be met by staff involved in surveys. Any deviations from the procedures should be documented as to the reason for the deviation.

C. Documentation

Field data sheets should be filled out completely for each survey. Data collected using this procedure should be stored in an appropriate electronic database in a timely manner for future reference. Field data sheets are filed in the Surface Water Assessment Section raw data files.

D. Benthic Macroinvertebrate Collections

The sampling methodology should be closely followed. Reference collections and voucher specimens should be maintained by the DEQ. With regard to voucher specimens, representatives of macroinvertebrates that cannot be identified in the field should be placed in vials containing preservative and clearly labeled with site information and number of each taxa in the sample. These specimens should be taken back to the laboratory for examination and identification under a microscope using appropriate taxonomic keys.

Who	Does What
Surface Water Assessment Section Staff	Select site, conduct monitoring per the procedure or oversee grantee monitoring per the procedure, calculate habitat and biological community score, determine condition and water quality standard attainment for each site within a watershed, and store and summarize data for use in rotating basin water quality monitoring reports.

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APPENDICES:

Appendix I. Nonwadeable Procedure Reach Data Sheet.
Appendix II. Nonwadeable Procedure Longitudinal Profile Data Sheet, Pages 1 and 2.
Appendix III. Nonwadeable Procedure Field Equipment List.
Appendix IV. Nonwadeable Procedure Macroinvertebrate Data Sheet.
Appendix V. Nonwadeable Procedure Macroinvertebrate FFG Identification.
Appendix VI. Nonwadeable Procedure Transect Habitat Data Sheet.
Appendix VII. Nonwadeable Procedure Habitat Metric Calculation and Scoring Information.

DIVISION/SECTION/UNIT CHIEF APPROVAL:

Diana Klemans

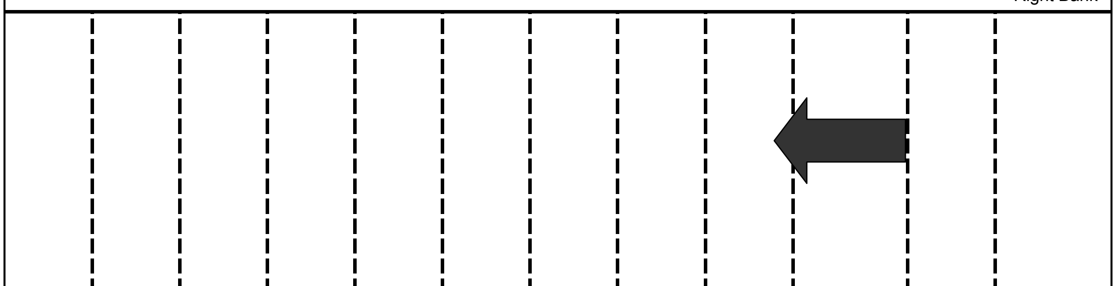
Diana Klemans, Chief Surface Water Assessment Section	February 6, 2013 Date

Appendix I. Nonwadeable Procedure Reach Data Sheet.

DATE:	**CREW:**		
RIVER:	**REACH LOCATION**		
	GPS or Gazetteer Info	**Other information**	
		Upstream **Downstream**	**Of (City, Dam, etc.)**
Other Notes:			

On the diagram below, mark the locations at which macroinvertebrate samples were taken.

Right Bank



Left Bank

A B C D E F G H I J K

For composite assessments, note which macroinvertebrate habitats were present at each transect.

A	**F Sa C Cb W M OU**	**G**	**F Sa C Cb W M OU**
B	**F Sa C Cb W M OU**	**H**	**F Sa C Cb W M OU**
C	**F Sa C Cb W M OU**	**I**	**F Sa C Cb W M OU**
D	**F Sa C Cb W M OU**	**J**	**F Sa C Cb W M OU**
E	**F Sa C Cb W M OU**	**K**	**F Sa C Cb W M OU**
F	**F Sa C Cb W M OU**	**Total Samples:**	

F = FPOM; Sa = Sand; C = Coarse substrates; Cb = Cobble; W = LWD; M = Macrophytes, OU = Overhang/Undercut

Appendix II. Nonwadeable Procedure Longitudinal Profile Data Sheet, Page 1.

LONGITUDINAL PROFILE

Site Name:

Investigators: **Date:**

GPS for Boat Launch: **GPS file name:**

BH – Bedrock/Hardpan (larger than a car)
BL – Boulder (250 to 4000mm; basketball to car)
CB – Cobble (64 to 250mm; tennis ball to basketball)
GC – Coarse Gravel (16 to 64mm; marble to tennis ball)
GF – Fine Gravel (2 to 16mm; labybug to marble)
SA – Sand (0.06 to 2mm; gritty - up to ladybug size)
FN – Silt/Clay/Muck (< .06mm, not gritty)
WD – Woody debris
OT – Other (metal, tires, asphalt, concrete, etc.; Comment)

THALWEG SUBSTRATE AND DEPTH PROFILE

Station	Depth meters or feet	Off Channel	Substrate (Circle the dominant type; up to two can be circled in heterogeneous areas)	Comments
A			FN SA | GF GC CB BL BH WD OT	
A-B 1			FN SA | GF GC CB BL BH WD OT	
A-B 2			FN SA | GF GC CB BL BH WD OT	
A-B 3			FN SA | GF GC CB BL BH WD OT	
A-B 4			FN SA | GF GC CB BL BH WD OT	
B			FN SA | GF GC CB BL BH WD OT	
B-C 1			FN SA | GF GC CB BL BH WD OT	
B-C 2			FN SA | GF GC CB BL BH WD OT	
B-C 3			FN SA | GF GC CB BL BH WD OT	
B-C 4			FN SA | GF GC CB BL BH WD OT	
C			FN SA | GF GC CB BL BH WD OT	
C-D 1			FN SA | GF GC CB BL BH WD OT	
C-D 2			FN SA | GF GC CB BL BH WD OT	
C-D 3			FN SA | GF GC CB BL BH WD OT	
C-D 4			FN SA | GF GC CB BL BH WD OT	
D			FN SA | GF GC CB BL BH WD OT	
D-E 1			FN SA | GF GC CB BL BH WD OT	
D-E 2			FN SA | GF GC CB BL BH WD OT	
D-E 3			FN SA | GF GC CB BL BH WD OT	
D-E 4			FN SA | GF GC CB BL BH WD OT	
E			FN SA | GF GC CB BL BH WD OT	
E-F 1			FN SA | GF GC CB BL BH WD OT	
E-F 2			FN SA | GF GC CB BL BH WD OT	
E-F 3			FN SA | GF GC CB BL BH WD OT	
E-F 4			FN SA | GF GC CB BL BH WD OT	
			# With Larger Substrate (A-E):	

Tally Large Woody Debris > 0.1 m in diameter and 3 m in length in space below & total for A-F
Total A-F:

Appendix II (cont.). Nonwadeable Procedure Longitudinal Profile Data Sheet, Page 2.

Station	Depth meters or feet	Off Channel	Substrate (Circle the dominant type; up to two can be circled in heterogeneous areas)									Comments
F			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
K			FN	SA	GF	GC	CB	BL	BH	WD	OT	

With Larger Substrate (F-K):

Total Count (A-K):

Tally Large Woody Debris > 0.1 m in diameter and 3 m in length in space below & total

Total F-K:

Total A-K:

Additional comments or notes (including turbidity, color, oil films, floating/suspended/settleable solids, foams, or deposits):

Nuisance aquatic plants or slimes present? (circle one) Yes No

Dominant species/type present?

Appendix III. Nonwadeable Procedure Field Equipment List.

	ITEM		
Boating	Flat-bottomed boat, motor, trailer, spare propeller		
	Anchor		
	Oar(s)		
	Personal Floatation (one for each person) + throwable cushion		
	Throwable Safety Line		
	First Aid kit		
	Sunscreen, bug spray, drinking water		
Macroinvertebrate	D-frame bug dip net		
	Scrubbing/Toilet brush		
	5-gallon bucket with lid		
	Extra 5 gallon buckets		
	White shallow sorting pans		
	Vials for I.D./Voucher specimens, Ethanol/Isopropyl		
	Sample Splitter		
	Forceps, hand lenses		
Data sheets	Data sheets – Longitudinal Transect		
	Data sheets – Cross-sectional Transects		
	Data sheets – Macroinvertebrate enumeration		
	Data sheets – Biological survey field sheet		
Habitat	PVC/Fiberglass sounding pole (3 m+ long)		
	Depth finder		
	Laser rangefinder		
	Field flagging		
	GPS Unit and batteries		

Appendix IV. Nonwadeable Procedure Macroinvertebrate Data Sheet.

NON-WADEABLE BENTHIC MACROINVERTEBRATES

Site Name: Date:

Comments:

PORIFERA _____
PLATYHELMINTHES
Turbellaria _____
NEMATOMORPHA _____
BRYOZOA _____
ANNELIDA
Hirudinea _____
Oligochaeta _____
ARTHROPODA
Crustacea
Amphipoda _____
Decapoda _____
Isopoda _____
Arachnoidea
Hydracarina _____
Insecta
Ephemeroptera
Ametropodidae _____
Baetiscidae _____
Baetidae _____
Caenidae _____
Ephemerellidae _____
Ephemeridae _____
Heptageniidae _____
Isonychiidae _____
Leptohyphidae (Tricor.) _____
Leptophlebiidae _____
Metretopodidae _____
Polymitarcyidae _____
Potamanthidae _____
Siphlonuridae _____
Odonata
Anisoptera
Aeshnidae _____
Cordulegastridae _____
Corduliidae _____
Gomphidae _____
Libellulidae _____
Macomiidae _____
Zygoptera
Calopterygidae _____
Coenagrionidae _____
Lestidae _____
Plecoptera
Capniidae _____
Chloroperlidae _____
Leuctridae _____
Nemouridae _____
Peltoperlidae _____
Perlidae _____
Perlodidae _____
Pteronarcyidae _____
Taeniopterygidae _____

Hemiptera
Belostomatidae _____
Corixidae _____
Gelastocoridae _____
Gerridae _____
Mesoveliidae _____
Naucoridae _____
Nepidae _____
Notonectidae _____
Pleidae _____
Saldidae _____
Veliidae _____
Megaloptera
Corydalidae _____
Sialidae _____
Neuroptera
Sisyridae _____
Trichoptera
Brachycentridae _____
Glossosomatidae _____
Helicopsychidae _____
Hydropsychidae _____
Hydroptilidae _____
Lepidostomatidae _____
Leptoceridae _____
Limnephilidae _____
Molannidae _____
Odontoceridae _____
Philopotamidae _____
Phryganeidae _____
Polycentropodidae _____
Psychomyiidae _____
Rhyacophilidae _____
Sericostomatidae _____
Uenoidae (*Neophylax*) _____
Lepidoptera
Noctuidae _____
Pyralidae _____
Coleoptera
Chrysomelidae (a/l) _____
Curculionidae (a/l) _____
Dryopidae _____
Dytiscidae _____
Elmidae _____
Gyrinidae (a/l) _____
Haliplidae (a/l) _____
Heteroceridae _____
Hydraenidae _____
Hydrophilidae _____
Lampyridae (a/l) _____
Limnichidae (a/l) _____
Noteridae (a/l) _____
Psephenidae(a/l) _____
Ptilodactylidae (a/l) _____
Scirtidae (a/l) _____

Diptera
Athericidae _____
Ceratopogonidae _____
Chaoboridae _____
Chironomidae _____
Culicidae _____
Dixidae _____
Dolichopodidae _____
Empididae _____
Ephydridae _____
Muscidae _____
Ptychopteridae _____
Psychodidae _____
Sciomyzidae _____
Simuliidae _____
Stratiomyidae _____
Syrphidae _____
Tabanidae _____
Thaumaleidae _____
Tipulidae _____
MOLLUSCA
Gastropoda
Ancylidae _____
Bithyniidae _____
Hydrobiidae _____
Lymnaeidae _____
Physidae _____
Planorbidae _____
Pleuroceridae _____
Pomatiopsidae _____
Valvatidae _____
Viviparidae _____
Pelecypoda
Corbiculidae _____
Dreissenidae _____
Sphaeriidae (Incl. Pisid.) _____
Unionidae _____
__________ _____
__________ _____
__________ _____
__________ _____

Appendix V. Nonwadeable Procedure Macroinvertebrate FFG Identification.

CF = collector filterer P = predator Sh = shredder
CG = collector gatherer Sc = scraper

TAXA	FFG
PORIFERA (sponges)	CF
PLATYHELMINTHES (flatworms)	
Turbellaria	CG
NEMATOMORPHA (roundworms)	P
BRYOZOA (moss animals)	CG
ANNELIDA (segmented worms)	
Hirudinea (leeches)	P
Oligochaeta (worms)	CG
ARTHROPODA	
Crustacea	
Amphipoda (scuds)	Sh
Decapoda (crayfish)	CG
Isopoda (sowbugs)	Sh
Arachnoidea	
Hydracarina	P
INSECTA	
Ephemeroptera (mayflies)	
Ametropodidae	CF
Baetiscidae	CG
Baetidae	CG
Caenidae	CG
Ephemerellidae	Sc
Ephemeridae	CG
Heptageniidae	Sc
Isonychiidae	CF
Leptophlebiidae	CG
Metretopodidae	CG
Oligoneuriidae	CF
Polymitarcyidae	CG
Potamanthidae	CF
Siphlonuridae	CG
Leptohyphidae (Tricor.)	CG
Odonata	
Anisoptera (dragonflies)	
Aeshnidae	P
Cordulegastridae	P
Corduliidae	P
Gomphidae	P

TAXA	FFG
Libellulidae	P
Macromiidae	P
Zygoptera (damselflies)	
Calopterygidae	P
Coenagrionidae	P
Lestidae	P
Plecoptera (stoneflies)	
Capniidae	Sh
Chloroperlidae	P
Leuctridae	Sh
Nemouridae	Sh
Peltoperlidae	Sh
Perlidae	P
Perlodidae	P
Pteronarcyidae	Sh
Taeniopterygidae	Sh
Hemiptera (true bugs)	
Belostomatidae	P
Corixidae	CG
Gelastocoridae	P
Gerridae	P
Mesoveliidae	P
Naucoridae	P
Nepidae	P
Notonectidae	P
Pleidae	P
Saldidae	P
Veliidae	P
Megaloptera	
Corydalidae (dobson flies)	P
Sialidae (alder flies)	P
Neuroptera (spongilla flies)	
Sisyridae	P
Trichoptera (caddisflies)	
Brachycentridae	CF
Glossosomatidae	Sc
Helicopsychidae	Sc
Hydropsychidae	CF
Hydroptilidae	Sc

TAXA	FFG
Lepidostomatidae	Sh
Leptoceridae	Sh
Limnephilidae	Sh
Trichoptera (caddisflies) cont'd	
Molannidae	Sc
Odontoceridae	Sc
Philopotamidae	CF
Phryganeidae	Sh
Polycentropodidae	P
Psychomyiidae	Sc
Rhyacophilidae	P
Sericostomatidae	Sc
Uenoidae	Sc
Lepidoptera (moths)	
Noctuidae	Sh
Pyralidae	Sh
Coleoptera (beetles)	
Chrysomelidae (adults)	Sh
Curculionidae (adults)	Sh
Dytiscidae (total)	P
Gyrinidae (adults)	P
Haliplidae (adults)	Sh
Heteroceridae (total)	CG
Hydraenidae (total)	Sc
Hydrophilidae (total)	P
Lampyridae (adults)	--
Limnichidae (adults)	CG
Noteridae (adults)	P
Psephenidae (adults)	Sc
Ptilodactylidae (adults)	Sh
Scirtidae (adults)	Sc
Chrysomelidae (larvae)	Sh
Curculionidae (larvae)	Sh
Dryopidae	Sc
Elmidae	CG
Gyrinidae (larvae)	P
Haliplidae (larvae)	Sh
Lampyridae (larvae)	P
Limnichidae (larvae)	CG
Noteridae (larvae)	P

TAXA	FFG
Psephenidae (larvae)	Sc
Ptilodactylidae (larvae)	Sh
Scirtidae (larvae)	Sc
Diptera (flies)	
Athericidae	P
Ceratopogonidae	P
Chaoboridae	P
Chironomidae	CG
Culicidae	CF
Dixidae	CG
Dolichopodidae	P
Empididae	P
Ephydridae	Sh
Muscidae	P
Psychodidae	CG
Ptychopteridae	CG
Sciomyzidae	P
Simuliidae	CF
Stratiomyidae	CG
Syrphidae	CG
Tabanidae	P
Thaumaleidae	Sc
Tipulidae	CG
MOLLUSCA	
Gastropoda (snails)	
Ancylidae (limpets)	Sc
Bithyniidae	Sc
Hydrobiidae	Sc
Lymnaeidae	Sc
Physidae	Sc
Planorbidae	Sc
Pleuroceridae	Sc
Pomatiopsidae	Sc
Valvatidae	Sc
Viviparidae	Sc
Pelecypoda (bivalves)	
Corbiculidae	CF
Dreissenidae	CF
Sphaeriidae (clams)	CF
Unionidae ('mussels')	CF

Appendix VI. Nonwadeable Procedure Transect Habitat Data Sheet.

TRANSECTS

Site Name: **Time:**
Investigators: **Date:**
Transect: A B C D E F G H I J K (A=Downstream; K=Upstream)

GPS LB RB Center
Latitude: **Longitude:**

Wetted Width (m): **Bar/Island Present? If yes, width (m):**

Riparian Width Estimate

	Mean riparian width > 24m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest	Mean riparian width 18 - 24m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.	Mean riparian width 10 – 17m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.	Mean riparian width < 10m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.
LB:	25 23 21 24 22 20	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0
RB:	25 23 21 24 22	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0

Vegetative Cover: (measured within 10x20m plot: 10m up and 10m downstream of transect) 0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)

	LEFT BANK	RIGHT BANK
Filamentous Algae	0 1 2 3 4	0 1 2 3 4
Macrophytes	0 1 2 3 4	0 1 2 3 4

Bank Stability (circle a score for each bank):

	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; <5% banks 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% of bank has erosional scars.
LB:	5	4 3	2 1	0
RB:	5	4 3	2 1	0

Bottom deposition: Total width of depositional area near the
LB: **RB:** **TOTAL:**

Comments/Sketch of Transect:

TRANSECTS

Site Name: **Time:**
Investigators: **Date:**
Transect: A B C D E F G H I J K (A=Downstream; K=Upstream)

GPS LB RB Center
Latitude: **Longitude:**

Wetted Width (m): **Bar/Island Present? If yes, width (m):**

Riparian Width Estimate

	Mean riparian width > 24m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest	Mean riparian width 18 - 24m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.	Mean riparian width 10 – 17m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.	Mean riparian width < 10m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.
LB:	25 23 21 24 22 20	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0
RB:	25 23 21 24 22	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0

Vegetative Cover: (measured within 10x20m plot: 10m up and 10m downstream of transect) 0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)

	LEFT BANK	RIGHT BANK
Filamentous Algae	0 1 2 3 4	0 1 2 3 4
Macrophytes	0 1 2 3 4	0 1 2 3 4

Bank Stability (circle a score for each bank):

	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; <5% banks 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% of bank has erosional scars.
LB:	5	4 3	2 1	0
RB:	5	4 3	2 1	0

Bottom deposition: Total width of depositional area near the
LB: **RB:** **TOTAL:**

Comments/Sketch of Transect:

Appendix VII. Nonwadeable Procedure habitat Metric Calculation and Scoring Information.

Metric

1. Riparian Width (sumX/11)	Metric Value (m)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
(average of all transects, in meters)	Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

2. Large Woody Debris	Metric Value	0-7	8-15	16-23	24-32	33-40	41-49	50-59	60-69	70-79	80-89	90-99	100-119	120-139	140-159	160-179	180-200	201-225	226-250	251-275	276-300	300+
(total count entire site)	Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

3. Vegetative Cover (sumX/22)	Metric Value (%)	0	<10	10-40	40-75	>75
(average of all transect scores LB and RB)	Score	1	5	10	15	20

4. Thalweg Substrate (sumX/61 x 100)	Metric Value (%)	0-4	5-9	10-14	15-21	22-27	28-34	35-42	43-51	52-60	61-80	81-100
(proportion of measurements (x) with fine gravel or larger)	Score	0	1	2	3	4	5	6	7	8	9	10

5. Bottom Deposition	Metric Value (%)	100-85	84-68	67-51	50-43	42-34	33-25	24-19	18-12	11-5	4-2	1-0
[sum(deposition A-K)/sum(wetted width A-K)] x 100	Score	0	1	2	3	4	5	6	7	8	9	10

6. Bank Stability	Metric Value	0	1	2	3	4	5	6	7	8	9	10
(sum each bank X/11; sum LB and RB)	Score	0	1	2	3	4	5	6	7	8	9	10

7. Off-channel Habitat	Metric Value	0-1	2	3	4	5	6+
(total count entire site)	Score	0	1	2	3	4	5