PHYSICAL HABITAT AND WATER CHEMISTRY ASSESSMENT PROTOCOL FOR WADEABLE STREAM MONITORING SITES

I. PURPOSE

To describe the methods used by the Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to collect physical habitat and water chemistry information at stream monitoring sites for the purpose of assessing water quality and developing biological criteria.

II. SCOPE/LIMITATIONS

This procedure applies to all wadeable monitoring sites for which an integrated assessment of water quality is to be conducted. An integrated assessment involves the collection of biological (fish and macroinvertebrate communities), physical habitat, and chemical information to assess stream condition.

III. GENERAL INFORMATION

Sites may be selected for assessment for a number of reasons including: 1) sites randomly selected for condition monitoring as part of the Environmental Monitoring and Assessment Program (EMAP), 2) sites selected for the development and calibration of biological criteria, and 3) sites selected to evaluate a suspected source of pollution. Although the reasons for monitoring a site vary, the physical habitat and water chemistry assessment protocols outlined in this document apply to all wadeable stream monitoring sites unless otherwise noted. For our purposes, wadeable sites constitute those that are sampled for fish utilizing a backpack electrofisher or stream electrofisher (see SOP--"***Fish Community Sampling Protocol for Stream Monitoring Sites***").

IV. REQUIREMENTS

A. Qualifications of crew leaders: The crew leader must be a professional aquatic biologist with a minimum of a Bachelor of Science degree in aquatic biology or closely related specialization. He or she must have a minimum of six months field experience in physical habitat sampling methodology. Field crew leaders should also possess excellent map reading skills and a demonstrated proficiency in the use of a GPS (Global Positioning System) receiver and orienteering compass.

B. Qualifications of field technicians/interns: A field technician/intern must have at least one year of college education and coursework in environmental and/or biological science.

C. General qualifications: All personnel conducting this procedure must have the ability to perform rigorous physical activity. It is often necessary to wade through streams and/or wetlands, canoe, or hike for long distances to reach a sampling site.

V. RESPONSIBILITIES

A. Field crew leader: Implement the procedures outlined in the action steps and ensure that the data generated meets the standards and objectives of the Biological Monitoring Program.

B. Technicians/interns: Implement the procedures outlined in the action steps, including maintenance and stocking of equipment, data collection and recording.

VI. QUALITY ASSURANCE AND QUALITY CONTROL

Compliance with this procedure will be maintained through annual internal reviews. Technical personnel will conduct periodic self-checks by comparing their results with other trained personnel. Calibration and maintenance of equipment will be conducted according to the guidelines specified in the manufacturer's manuals.

In addition to adhering to the specific requirements of this sampling protocol and any supplementary site specific procedures, the minimum QA/QC requirements for this activity are as follows:

A. Control of deviations: Deviation shall be sufficiently documented to allow repetition of the activity as performed.

B. QC samples: Ten percent of sites sampled in any given year are resampled as a means of determining sampling error and temporal variability.

C. Verification: The field crew leader will conduct periodic reviews of field personnel to ensure that technical personnel are following procedures in accordance with this SOP.

VII. TRAINING

A. All inexperienced personnel will receive instruction from a trainer designated by the program manager. Major revisions in this protocol require that all personnel be re-trained in the revised protocol by experienced personnel.

B. The field crew leader will provide instruction in the field and administer a field test to ensure personnel can execute this procedure.

VIII. ACTION STEPS

A. Equipment list: Verify that all necessary items are present before commencement of this procedure (Table 1).

B. Data collection method: The location and length of the sampling reach is determined during site reconnaissance (see SOP--"***Reconnaissance Procedures for Initial Visit to Stream Monitoring Sites***"). Sampling is conducted during daylight hours within the summer index period of mid-June through mid-September. Sampling should occur when streams are at or near base-flow. Water chemistry is sampled immediately prior to fish sampling. The physical habitat assessment is conducted after fish sampling, so as not to disturb the fish community.

Habitat within a station is quantified utilizing the transect-point method (modified from: Simonson, T.D., Lyons, J., and Kanehl, P.D. 1994. Guidelines for Evaluating Fish Habitat in Wisconsin Streams. Gen. Tech. Rep. NC-164. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Experiment Station. 36 p.). Thirteen transects are established within the reach and four equally spaced points plus the thalweg are located along each transect. Measurements or visual estimates are made to characterize key components of the physical habitat structure important in influencing stream ecology. Key components include: channel morphology, substrate, cover, and riparian condition.

Three data sheets are required for the physical habitat and water chemistry assessment. One copy of the **Station Features** and **Visit Summary** form is needed for each site. One copy of the **Transect** form is needed for each of the thirteen transects (or only seven copies if forms are doubled-sided). Copies of these forms are attached. Guidelines for filling out each data sheet are described in the following pages.

C. Station Features Data Sheet

This data sheet describes the length and location of the major morphological features within a sampling station (bends, pools, riffles, runs, log jams, islands, and beaver dams). The **Station Features** data is collected in conjunction with the **Transect** data as you proceed from the downstream end to the upstream end of the station. The variables on this data sheet are as follows:

1) *Field Number* – A seven-digit code that uniquely identifies the station. The first two digits identify the year of sampling, the second two identify the major river basin, and the last three are numerically assigned in sequential order (example: 02UM001).

2) *Date* – The date habitat sampling is conducted in month/day/year format (MM/DD/YY).

3) *Crew* – The personnel who collected the habitat data.

4) *Distance From Start* (column) – The distance from the downstream end of the station to the downstream end of each *stream feature*. Bends, log jams, and beaver dams are measured only to their midpoint because they are features that are located within one of the channel morphology types (i.e. riffle, run, or pool). Measure distances to the nearest tenth of a meter following the center of the stream channel. The first value is always "0" to indicate the *stream feature* at the beginning of the station. As you proceed upstream it is not necessary to continue to measure from the downstream end of the station, as each successive **Transect** data sheet has the distance of that transect from the downstream end of the station recorded. The last value in this column is the total length of the station.

5) *Stream Feature* (column) – Record the major morphological features encountered as you proceed upstream. If a cross-section of stream contains two or more channel morphology types (i.e. riffle, run, or pool) record the dominant type. Stream features recorded include:

   Riffles: Portions of the stream channel where water velocities are fast, water depths are relatively shallow, and substrates are typically coarse. Steeper stream gradient results in obvious surface turbulence. Areas of high gradient that are deep, fast, and turbulent are called **rapids**.

   Runs: Water velocities may be moderately fast to slow but the water surface typically appears smooth with little or no surface turbulence. Generally, runs are deeper than a riffle and shallower than a pool. Runs with very slow water velocities are sometimes called **glides**. For our purposes, if the channel type is not considered a riffle or pool it is defined as a run.

   Pools: Water is slow and generally deeper than a riffle or run. Water surface is smooth, no turbulence. A general rule that can be used to distinguish a pool is if two or more of the following conditions apply; the stream channel is wider, deeper, or slower than average.

   Bends: A change in the direction of the stream channel of at least 60 degrees.

   Islands: Areas of land within the stream channel that is surrounded on all sides by water and is dry even when the stream is experiencing bankfull flow. Areas with nearly all of the stream's flow on one side and just a trickle of water on the other are not considered islands. Islands usually contain vegetation. **Bars**, channel features below the bankfull flow level that are dry during baseflow conditions, are not recorded.

   Log Jams: Woody material that is of sufficient size to appreciably alter the direction of flow or change the morphology within the stream channel. Large log jams can be similar in effect and appearance to beaver dams.

   Beaver Dams: Structures constructed by beavers that span the entire stream channel and block flow. Beaver dams consist of sticks and mud, but older dams may be overgrown with vegetation.

   Other noteworthy features include: **bridges**, **culverts**, **dams**, and **tributaries**. The last feature noted in this column is the upstream **end of the reach**.

6) *Length* (column) – The length, measured to the nearest tenth of a meter, of each *stream feature* encountered within the reach. The length of bends, log jams, and beaver dams are not recorded. It is not necessary to complete this column while in the field as this information is derived from the *Distance from start* and *Stream feature* columns.

7) *Distance Between Bends* – The distance (m) between successive bends contained within the station. The first row is the distance between the mid-point of the first and second bend. The second row is the distance between the second and third, and so forth. These values can be derived using the information contained in the columns *Distance from start* and *Stream feature*. The "sum" and "mean" rows summarize all the distances between bends within the station.

8) *Distance Between Riffles* – The distance (m) between successive riffles contained within the station. The first row is the distance between the upstream end of the first riffle and the downstream end of the next riffle upstream, and so forth. Distances can be derived using the *Distance from start* and *Stream feature* columns. The "sum" and "mean" rows summarize these distances.

9) *Length of Individual Riffles, Pools, and Runs* – The individual length (m) of each riffle, pool, or run within the station, which can be derived using the *Stream feature* and *Length* columns. The sum of their lengths is also recorded here.

D. Transect Data Sheet

Record the data generated from each of the thirteen transects on this data sheet. One data sheet is needed for each transect. To determine the placement of each of the thirteen transects within the station divide the station length (determined during reconnaissance) by thirteen, this number is the *transect spacing* or distance between transects. The first transect is located one half of the transect spacing distance from the downstream end of the station. Each subsequent transect is then the distance of one transect spacing from the previous transect. All numbers are rounded to the nearest half meter.

For example, if the station length is 150 m, 150 ÷ 13 = 11.5 (equals the transect spacing). The first transect would then be located a distance of 6 m from the downstream end of the station, 11.5 ÷ 2 = 5.75 (equals 6 rounded to the nearest half meter). The second transect would then be located a distance of 17.5 m from the downstream end of the station, 6 + 11.5 = 17.5, and so forth for subsequent transects.

Each transect consists of several measurements or visual estimates, made within 0.3 m x 0.3 m quadrates at set intervals, or along the transect line perpendicular to the stream channel. The variables on this data sheet are as follows:

D.1. Location Information

1) *Field Number* – Same as for **Stream Features** data sheet.

2) *Date* – Same as for **Stream Features** data sheet.

3) *Transect Number* – The number (1-13) of the current transect as you proceed upstream. The downstream most transect is number one, the next transect upstream is two, and so on.

4) *Crew* – Same as for **Stream Features** data sheet.

5) *Distance from Start* – The distance from the downstream end of the station to the current transect following the center of the stream channel, rounded to the nearest half meter.

6) *Stream Width* – The wetted width of the stream channel at the transect, measured to the nearest tenth of a meter. Exposed bars and boulders are included in the wetted width of the stream channel, but islands are not. Backwaters not in contact with the stream at the transect are also excluded. If a channel is split by an island(s), the wetted widths of each side channel should be combined so that a single number is recorded in *stream width*. In low gradient streams the wetted width is the defined portion of the stream channel, it does not include adjacent wetlands and areas of emergent vegetation.

7) *Channel Type* – Circle the predominant channel type at the transect. See the **Station Features** section for riffle, pool, and run definitions.

D.2. Transect Point Measurements: At each transect, measurements or visual estimates are made at five points along the transect. Variables quantified include: *water depth, depth of fines and water, embeddedness, substrate, percent algae, and percent macrophytes*. Four points are equally spaced across the stream channel and the fifth point is the thalweg, or deepest point along the transect line. Divide the *stream width* at the transect by five to determine the 1/5, 2/5, 3/5, and 4/5 locations across the wetted width of the stream channel. Measurements are made at each of these four locations moving from the right bank to the left bank along the

transect. The right stream bank is on the right as you are facing downstream. For example, if the stream is 10 m wide, measurements are taken at the thalweg and along the transect at 2.0, 4.0, 6.0, and 8.0 m from the right bank. In some instances, the thalweg will occur at the same location as one of the four other points, in which case their measurement values will be the same.

1) *Water Depth* – The depth of the stream channel at each transect point. Measure the vertical distance of the water column from the streambed to the water surface to the nearest centimeter with a calibrated wading rod or meter stick. If the water depth is over 120 cm, record as >120 cm.

2) *Depth of Fines and Water* – The water depth plus the depth of fine sediments at each transect point. Fine sediments are those that are less than 2.0 mm in diameter and generally consist of sand, silt, clay, or detritus. Without using the weight of your body, push a wading rod into the sediment as far as possible, measure to the water surface to the nearest centimeter. This measurement is later converted to depth of fines by subtracting *water depth*.

3) *Embeddedness of Coarse Substrates* – The extent to which coarse substrates are surrounded by or covered with fine sediments. Coarse substrates consist of gravel, rubble/cobble, and boulders. If the dominant substrate within the quadrate is coarse, embeddedness should be visually estimated to the nearest 25%. Estimate the average percent embeddeness of coarse substrates within the 0.3 m x 0.3 m quadrate centered on the channel position. An embeddedness rating of 0% corresponds to very little or no fine sediments surrounding coarse substrates. Course substrate material completely surrounded and covered with sediment is considered 100% embedded. If the dominant substrate within a quadrate is anything other than gravel, rubble/cobble, or boulder then the column should be left null.

4) *Dominant Substrate* – The predominant substrate type within each quadrate. Visually estimate which substrate type is predominant within each quadrate and place a check mark in the appropriate column. If the stream bottom cannot be seen, use your hands and feet to determine the dominant substrate type. Choose from the following substrate types:

   Bedrock: A solid slab of rock, > 4000 mm in length (larger than a car).

   Boulder: Large rocks ranging from 250 mm to 4000 mm in diameter (basketball to car size).

   Rubble/Cobble: Rocks ranging in diameter from 64 mm to 250 mm (tennisball to basketball).

   Gravel: Rocks varying in diameter from 2 mm to 64 mm (BB to tennisball).

   Sand: Inorganic material that is visible as particles and feels gritty between the fingers. 0.06 mm to 2.0 mm in size.

   Silt: Fine inorganic material that is typically dark brown in color. Feels greasy between fingers and does not retain its shape when compacted into a ball. A person's weight will not be supported if the stream bottom consists of silt.

   Clay: Very fine inorganic material. Individual particles are not visible or are barely visible to the naked eye. Will support a person's weight and retains its shape when compacted.

   Detritus: Decaying organic material such as macrophytes, leaves, finer woody debris, etc. that may appear similar to silt when very fine.

   Other: Any substrate type not listed above, specify the type. Possibilities could include woody debris, culverts, tires, or mussel beds.

5) *Algae (%)* – Visually estimate the amount of algae within the quadrate, to the nearest 5 %. Algae can either be attached to the substrate in the form of a mat or crust; or filamentous algae, which forms dense mats of long, hair-like strands and is usually green in color.

6) *Macrophytes (%)* – Visually estimate the amount of aquatic vegetation within the quadrate, to the nearest 5 %. Aquatic macrophytes can be either submergent or emergent and are defined under *cover for fish.*

D.3. Cover and Land Use Characteristics

1) *Cover for Fish (%)* – The amount of cover or shelter available for fish along the transect. Visually estimate the percentage (nearest 5 %) occupied by each cover type along the transect within a 0.3 m band centered on the transect line. If a cover type is absent, enter a zero. In order to be considered cover, the water depth must be at least 10 cm where the cover type occurs. Cover for fish consists of objects or features dense enough to provide complete or partial shelter from the stream current or concealment from predators or prey.

   Undercut Banks: Stream banks where the stream channel has cut underneath the bank. The bank could overhang the water surface when water levels are low. The undercut bank must overhang (horizontally) the wetted stream channel a minimum of 15 cm and the bottom of the bank must be no more than 15 cm above the water level in order to be considered cover for fish.

   Overhanging Vegetation: Terrestrial vegetation overhanging the wetted stream channel that meets the same criteria for cover as undercut banks.

   Woody Debris: Logs, branches, or aggregations of smaller pieces of wood in contact with or submerged in water.

   Boulders: Large rocks as described under *Substrate.*

   Submergent Macrophytes: Vascular plants that have all of their biomass (except flowers) at or below the surface of the water. Examples include *Vallisneria*, *Elodea*, *Potamogeton*, *Nymphaea* and *Ceratophyllum*.

   Emergent Macrophytes: Vascular plants that typically have a significant portion of their biomass above the water surface. Examples include *Typha, Scirpus,* and *Zizania*.

   Other Debris: Additional objects that meet the criteria of cover, typically of human origin. Examples would include filamentous algae, culverts, docks, tires, discarded appliances, etc. Specify the type.

2) *Bank Erosion* – The amount of the stream bank that is actively eroding. To be considered as erosion, the bank must be actively eroding through break down, soil sloughing, or false banks. False banks are natural banks that have been cut back, usually by livestock trampling. For each bank, along the transect line, use a wading rod or measuring tape to quantify the length (nearest 0.1 m) of bare soil. Measure the amount of exposed soil from the waters edge to the top of the stream bank, up to a maximum of 5 m. If there is no bare soil, record 0.

3) *Riparian Land Use* – The predominant land use within the riparian zone. For each bank, extending along the transect line, visually estimate the predominant land use within 30 m of the waters edge and place a check mark in the corresponding column. Repeat this same procedure for the riparian zone 30 – 100 m from the waters edge. Land use categories are as follows:

   Cropland: Land that is cultivated with crops for forage or cover. Includes those areas under intensive cropping or rotation, or that are regularly mowed for hay.

   Pasture: Land that is regularly grazed by livestock.

   Barnyard: Land associated with farmsteads and the adjoining farmyard area. Includes grain storage facilities, barns, farmhouses, and feedlots (areas used to confine and feed high densities of livestock).

   Developed: Land that has been modified (rural or urban) for commercial, industrial, or residential use. Includes commercial buildings/structures, parking lots, all roads, railroads, and power utilities. Also includes residential buildings, lawns, parks, golf courses, ball fields, etc. Specify the type in the space provided.

Exposed Rock: Natural areas of rock outcrops that lack appreciable soil development or vegetative cover.

Meadow: Land dominated by grasses and forbs with little woody vegetation, which is not subject to regular mowing or grazing.

Shrub: Land consisting primarily of woody vegetation less than 3 m in height. Typical shrubs include alder, dogwood, and willows.

Woodland: Land dominated by deciduous or coniferous tree species, generally taller than 3 m.

Wetland: Low-lying areas that are saturated or inundated with water frequently or for considerable periods of time on an annual basis. Wetlands include bogs, marshes, and swamps and contain vegetation adapted for life in saturated conditions.

Other: If a land use category other than one of those listed above is predominant, specify the type.

4) *Riparian Buffer Width* – The amount of contiguous undisturbed land use within a 10 m buffer zone. For each bank, starting from the waters edge and extending out along the transect line 10 m, measure the width (nearest meter) of contiguous land that is considered undisturbed. Meadow, shrub, woodland, wetland, and exposed rock are considered undisturbed. If no undisturbed land uses are directly adjacent to the stream, then the riparian buffer width is 0 m. If more than 10 m is present, record it as >10 m.

5) *Canopy/Shading* – A measure of overhead canopy cover that is shading the stream channel. A concave spherical crown densiometer is utilized for this measurement. The densiometer must be taped as shown in Figure 1 to limit the number of grid intersections to 17. Hold the densiometer at elbow level in front of you, making sure the instrument is level using the bubble level, count and record the number (0 to 17) of grid intersections that have vegetation covering them. If the reflection of a tree, branch, or leaf overlies any of the intersection points, that particular intersection is counted as having cover. Perform this measurement from the center of the stream channel along the transect line in each of four directions; facing upstream, downstream, towards the left bank, and towards the right bank. In addition, perform the measurement at the wetted edge of both the left and right banks facing the stream bank.

E. Visit Summary Data Sheet

This data sheet contains location information, water chemistry data, and channel characteristics of the station. Some of the data is derived from maps or from the other data sheets. Record the following information on this data sheet:

E.1. Location Information

1) *Field Number* – Same as for **Station Features** data sheet.

2) *Date* – Same as for **Station Features** data sheet.

3) *Stream Name* – The name of the stream as shown on the most recent USGS 7.5" topographic map. Include all parts of the name (i.e. "North Branch", "Creek", "River", "Co. Ditch", etc.).

4) *Location* – A general description of where the sampling station is located. Usually includes the nearest road crossing and town. For example, "0.5 mi. downstream of C.R. 30, 4 mi. SW of Northome".

5) *County* – The county in which the station is located.

6) *Visit Result* – The result of the sampling trip, typically as it pertains to fish collection. Circle only one of the available choices. A visit or sampling trip is considered "reportable" when sampling is conducted for the first time at a station and no problems are encountered that would render the data questionable. If subsequent sampling trips are made to the same station and no sampling problems occur, the *visit result* is considered a "replicate". Circle "other", and explain in the space provided, in the event that the data generated is

questionable or unsuitable for use. Reasons might include equipment problems, poor sampling efficiency, excessive water velocity, poor fish taxis, or other sampling deficiencies.

7) *GPS File Name* – The unique identifier of a rover file assigned by the GPS unit. If a GPS file is taken (to record the location of a sampling site), the unit will assign an eight-digit code consisting of a file prefix, date stamp, and time stamp that uniquely identifies that file. In most instances, it is not necessary to take a GPS file during the sampling visit because sampling sites are located and flagged during site reconnaissance. However, circumstances may occur that necessitate a file be taken during the sampling visit. These include but are not limited to: original reconnaissance file unreliable or inaccurate, flagging cannot be located, initial site location determined to be incorrect, and GPS file not obtained during initial site reconnaissance. If sampling and initial site reconnaissance are conducted at the same time, the GPS information should be recorded as part of the reconnaissance protocol. Consult the GPS user's manual and SOP--"***Reconnaissance Procedures for Initial Site Visit to Stream Monitoring Sites***" for additional guidance on GPS operation and protocol.

8) *Type of GPS Fix* – If a GPS file is taken during the sampling visit, indicate the position mode (3D or 2D) in which the GPS file was recorded.

9) *PDOP* – If a GPS file is taken during the sampling visit, record the approximate Position Dilution of Precision (PDOP) value that was observed while the GPS file was being recorded.

10) *Data Source* – The source or entity that generated the data. For Minnesota Pollution Control Agency (MPCA) staff within the Biological Monitoring Unit this field should be recorded as "MPCA".

11) *Project* – The specific project that the data collection effort is associated with. Some possibilities include EMAP, biocriteria development, problem investigation, and longitudinal survey.

E.2. Field Water Chemistry: Water chemistry parameters should be sampled immediately prior to fish sampling. All water chemistry parameters are measured from the same general location at a representative stream cross-section within the sampling reach. Samples are taken at a point that is judged to represent the water quality of the total instantaneous flow at the cross-section. Avoid sampling areas that are poorly mixed, contain springs, or are upstream of or immediately adjacent to tributaries within the sampling reach. Water chemistry measurements and water samples are taken at an intermediate depth in the water column without disturbing substrate materials or collecting floating materials and constituents from the water surface. Refer to the manufacturer's owners manual for guidance concerning the calibration and operation of water quality meters.

1) *Time* – The time of day (24-hour clock) that field water chemistry parameters are measured.

2) *Air Temp* – The ambient air temperature (ºC) at the time of sampling, measure to the nearest degree with a dry thermometer.

3) *Water Temp* – The water temperature (ºC) of the station at the time of sampling, measure to the nearest tenth of a degree with a thermometer or water quality meter.

4) *Conductivity* – Temperature compensated conductivity, or *specific conductance*, is the parameter actually being determined and is a measure of the ability of water to carry an electrical current. Consult your conductivity meter's manual for guidance measuring specific conductance (measured in µmhos/cm) compensated for temperature to 25 °C.

5) *Dissolved Oxygen* – The amount of oxygen present in a water sample, expressed as milligrams of oxygen per liter of water (mg/L). Two water samples should be taken and measured for dissolved oxygen concentrations using a DO meter or the Winkler Titration Method.

6) *Turbidity* – The light scattering property associated with suspended particles in the water, measured with a turbidimeter in nephelometric turbidity units (NTUs). A turbid sample will appear cloudy. A water sample is taken in a 500-ml plastic bottle rinsed with stream water three times. Due to the sensitivity of the turbidimeter

to road dust and other conditions encountered while in the field, place the sample on wet ice until days end and measure turbidity in a more suitable environment (office or hotel room).

7) *pH* – A measure of the negative log of the hydrogen ion [H^+] concentration in the water. Pure water has a pH of 7.00 and is considered neutral. Measure pH utilizing a temperature compensating pH meter.

8) *Stream Flow* – Also known as discharge, it is the volume of water moving downstream per unit time, and is the product of current velocity and the dimensions of the stream channel. Measure the instantaneous flow rate (cubic meters/second) at a suitable stream cross-section using a current meter. Detailed guidelines for determining stream flow at a station are available from the USGS.

9) *Transparency* – A measure of water clarity, an indicator of the water's ability to transmit light. Stream transparency serves as an indirect measure of the amount of dissolved and suspended materials present. Measure (nearest cm) with a transparency tube, a clear tube 60 cm in length with a secci-type disk at the bottom.

10) *Water Level* – An estimation of water level as it relates to summer base flow expectations. Check the appropriate category and measure the vertical distance (nearest 0.1 m) above or below the normal water line. In most streams, the "normal" water level can be determined with relative ease by observing channel characteristics.

E.3 Lab Water Chemistry: Water samples taken for laboratory analyses typically include total phosphorus (P), total suspended solids (TSS), ammonia nitrogen (NH^3+NH^4), and nitrite-nitrate (NO^2+NO^3). Additional parameters may be measured in special circumstances. Samples taken for laboratory analyses are subject to the same general guidelines concerning sampling location and time as outlined above under *field water chemistry*. Sterilized sample bottles are obtained from the Minnesota Department of Health. Before collecting samples, label the containers with the *date* and *field number* with a waterproof pen or pencil. Collect a 250 ml nutrients sample and a one-liter general chemistry sample for laboratory analysis. The bottles should be lowered mouth down to an intermediate depth and then turned upstream to collect the sample, the Dept. of Health does not recommend rinsing their sample bottles. Immediately after sample collection, 5 ml of 10% sulfuric acid preservative solution is added to the nutrients sample. Both sample bottles must be stored at 4 ° C and shipped to the Dept. of Health Water Lab within the minimum holding times.

1) *Collection Time (field sample)* – The time of day (24-hour clock) that water samples for laboratory analysis are collected.

2) *Collection Time (field duplicate)* – A field duplicate is a second sample taken immediately following an initial sample in the same manner and location. Duplicate samples are taken at 10% of all sampling sites for quality assurance and control (QA/QC) purposes. If a duplicate water sample is taken, record the time (24 hour clock) here.

E.4 Channel Characteristics

1) *Transect Spacing* – Document the distance (m) that was used to space transects from one another (see **Transect** data sheet section).

2) *Station Length* – The actual length (m) of the sampling reach as determined during the physical habitat assessment. The station length should be recorded directly from the **Stream Features** data sheet, as measured from the start of the station to the upstream end of the reach, rounded to the nearest meter. This measurement of station length is considered more accurate than the measurement conducted during the initial site reconnaissance.

3) *Channel Condition* – The condition of the stream channel at the station, check the category that best describes the state of the stream channel: natural channel, old channelization, recent channelization, or concrete channel.

4) *Mean Distance Between Bends* – The average distance (m) between successive bends contained within the station. Obtained from the **Station Features** data sheet.

5) *Mean Distance Between Riffles* – The average distance (m) between successive riffles contained within the station. Obtained from the **Station Features** data sheet

6) *Total Length of Riffles, Pools, and Runs* – The sum of the lengths (m) for all riffles, pools, and runs contained within the station. Obtained from the **Station Features** data sheet.

7) *Total Number of Riffles, Pools, Runs, Bends, and Log Jams* – The number of each of these stream features contained within the station. Obtained from the **Station Features** data sheet.

E.5. Comments/Notes: Record any additional information about the station in the space provided.

Table 1. Equipment List – This table identifies all equipment needed in the field in order to implement the sampling protocol as described.

Physical Habitat Sampling

Measuring tape (m) – for measuring distances

Wading rod – for measuring depths and short distances

Spherical crown densiometer (concave) – to measure canopy cover

Water Chemistry Sampling

Thermometer – for measuring air and water temperature

Conductivity meter – for measuring conductivity

Turbidimeter – for measuring turbidity

D.O. meter or Winkler-Titration kit – for measuring dissolved oxygen

pH meter – for measuring pH

Current meter – for measuring stream discharge

Transparency tube – for measuring stream water transparency

1-L plastic bottle – to collect general chemistry sample for lab analysis

250-ml plastic bottle – to collect nutrients sample for lab analysis

500-ml plastic bottle – to collect turbidity sample

5-ml of 10% sulfuric acid – for preserving nutrients sample

Cooler and ice – for holding and preserving water samples

Miscellaneous

Clipboard – to store forms and record data

Forms – for recording data

Pencil – for filling out forms

GPS – to locate and document sampling location (if necessary)

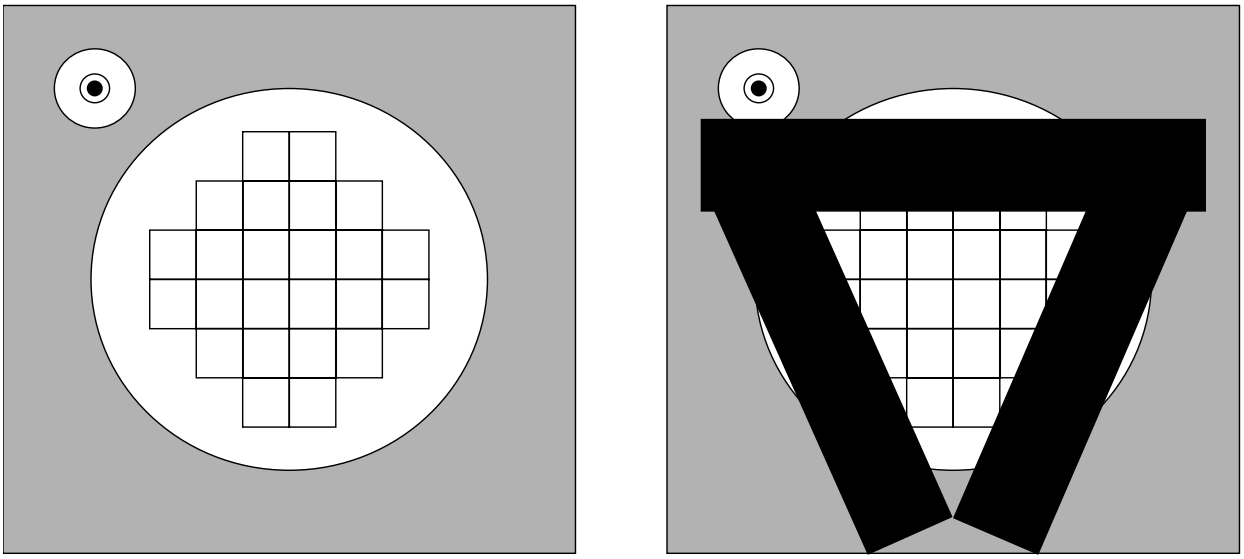

Figure 1. Illustration depicting how a spherical crown densiometer should be taped to limit the number of grid intersections to 17.

STATION FEATURES MPCA

Field Number:_____ Date(mm/dd/yy):_____ Crew:_____

DISTANCE FROM START (m)	STREAM FEATURE (Riffle, Pool, Run, Bend Log Jam, etc.) *	LENGTH (m)
0		

DISTANCE SUMMARY

Distance Between Bends(m):

1st - 2nd:_____
2nd - 3rd:_____
3rd - 4th:_____
4th - 5th:_____
5th - 6th:_____
6th - 7th:_____
7th - 8th:_____
8th - 9th:_____
9th - 10th:_____
10th - 11th:_____
11th - 12th:_____
12th - 13th:_____
13th - 14th:_____
14th - 15th:_____

Sum:_____

Mean:_____

Distance Between Riffles(m):

1st - 2nd:_____
2nd - 3rd:_____
3rd - 4th:_____
4th - 5th:_____
5th - 6th:_____
6th - 7th:_____
7th - 8th:_____
8th - 9th:_____
9th - 10th:_____
10th - 11th:_____
11th - 12th:_____
12th - 13th:_____
13th - 14th:_____
14th - 15th:_____

Sum:_____

Mean:_____

Length (m) Of Individual Riffles, Pools, And Runs:

1st Riffle:_____	1st Pool:_____	1st Run:_____
2nd Riffle:_____	2nd Pool:_____	2nd Run:_____
3rd Riffle:_____	3rd Pool:_____	3rd Run:_____
4th Riffle:_____	4th Pool:_____	4th Run:_____
5th Riffle:_____	5th Pool:_____	5th Run:_____
6th Riffle:_____	6th Pool:_____	6th Run:_____
7th Riffle:_____	7th Pool:_____	7th Run:_____
8th Riffle:_____	8th Pool:_____	8th Run:_____
9th Riffle:_____	9th Pool:_____	9th Run:_____
10th Riffle:_____	10th Pool:_____	10th Run:_____
11th Riffle:_____	11th Pool:_____	11th Run:_____
12th Riffle:_____	12th Pool:_____	12th Run:_____
13th Riffle:_____	13th Pool:_____	13th Run:_____
14th Riffle:_____	14th Pool:_____	14th Run:_____
15th Riffle:_____	15th Pool:_____	15th Run:_____
Sum:_____	Sum:_____	Sum:_____

* For riffles, runs, and pools note distance from start at beginning of feature. For bends, log jams, etc., note center-point.

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Station Features Continued:

DISTANCE FROM START (m)	STREAM FEATURE (Bend, Riffle, Pool, Run, Log Jam, etc.) *	LENGTH (m)
0		

TRANSECT MPCA

Field Number:_____ Date (mm/dd/yy):_____ Transect Number (1-13):_____

Crew:_____ Distance from Start (m):_____

Stream Width (m):_____ Channel Type (circle one): Riffle Pool Run

Channel Position (fifths of wetted stream width and deepest point, 0 = rightbank *)	**1/5**	**2/5**	**3/5**	**4/5**	**Deep**
Water Depth (cm)					
Depth of Fines and Water (cm)					
Embeddedness of Coarse Substrates (nearest 25%)					

Check Dominant Substrate Type in Quadrate:

Channel Position (fifths of wetted stream width and deepest point, 0 = rightbank *)	**1/5**	**2/5**	**3/5**	**4/5**	**Deep**
Bedrock (solid slab)					
Boulder (basketball or bigger)					
Rubble/Cobble (tennis ball to basketball)					
Gravel (BB to tennis ball)					
Sand (gritty, visible, < BB)					
Silt					
Clay					
Detritus					
Other (specify)					

Note Amount Observed on Quadrate:

Channel Position (fifths of wetted stream width and deepest point, 0 = rightbank *)	**1/5**	**2/5**	**3/5**	**4/5**	**Deep**
Algae (attached & filamentous., nearest 5%)					
Macrophytes (nearest 5%)					

Cover for Fish: *Percent length of transect* ***(over at least 10 cm water depth)*** *with:*
___Undercut Banks ____Overhanging Vegetation ____Woody Debris ____Boulders
___Submergent Macrophytes ____Emergent Macrophytes ____Other (specify):_____

Bank Erosion: *Length (nearest 0.1 m) of bare soil,* ***within 5 m of waters edge****, along transect:*
LEFT BANK *: _____(m) RIGHT BANK *: _____ (m)

Riparian Land Use: *Dominant land use* ***within 30 m of stream edge*** *(along transect):* ***(L / R) ****
___/___Cropland ___/___Pasture ___/___Barnyard ___/___Developed ___/___Exposed Rock
___/___Meadow ___/___Shrubs ___/___Woodland ___/___Wetland ___/___Other (specify):_____

Riparian Land Use: *Dominant land use* ***from 30 to 100 m of stream edge*** *(along transect):* ***(L / R) ****
___/___Cropland ___/___Pasture ___/___Barnyard ___/___Developed ___/___Exposed Rock
___/___Meadow ___/___Shrubs ___/___Woodland ___/___Wetland ___/___Other (specify):_____

Riparian Buffer Width: *Length (nearest meter) of undisturbed land use along transect,* ***within 10 m of stream:***
LEFT BANK *: _____(m) RIGHT BANK *: _____ (m)

Canopy/Shading (Densiometer reading, note #/17 that are shaded):

___Center Upstream ___Center Left ___Center Downstream ___Center Right ___Left Bank * ___Right Bank *

* Right Bank and Left Bank identified while facing downstream.

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VISIT SUMMARY MPCA

LOCATION INFORMATION ==========

Field Number:_____ Date (mm/dd/yy):_____ Stream Name:_____

Location:_____ County:_____

Visit Result (circle one): Reportable - Replicate - Other (explain)_____

GPS File Name:_____ Type of GPS Fix: ☐ 2D ☐ 3D PDOP:_____
(only if GPS taken during visit)

Data Source:_____ Project:_____

FIELD WATER CHEMISTRY ==========

Time (24 hr clock):_____ Air Temp.(°C):_____ Water Temp.(°C):_____

Conductivity (umhos@25°C):_____ Dissolved Oxygen (mg/l):_____

Turbidity (ntu):_____ pH:_____ Stream Flow (m^3/s):_____

Transparency Tube (cm):_____ Water Level: ☐ Normal ☐ Below_____(m) ☐ Above_____(m)

LAB WATER CHEMISTRY ==========

Collection Time (field sample):_____ Collection Time (field duplicate):_____

CHANNEL CHARACTERISTICS ==========

Transect Spacing (m):_____ Station Length (m) (from stream features form):_____

Channel Condition (check appropriate box):

☐ Natural Channel ☐ Old Channelization ☐ Recent Channelization ☐ Concrete Channel

Mean Distance Between Bends (m):_____ Mean Distance Between Riffles (m):_____

Total Length (Sum) of All (m): Riffles:_____ Pools:_____ Runs:_____

Total Number of: Riffles:_____ Pools:_____ Runs:_____ Bends:_____ Log Jams:_____

COMMENTS/NOTES: _____

_____

_____

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