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AGRICULTURAL WATER QUALITY INDEX

Field Handout

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The Agricultural Water Quality Index

Introduction

The Agricultural Water Quality Index (AWQI) is an assessment tool designed for use in agroecosystems. Most existing environmental indices and assessment tools focus on the stream channel and/or riparian zone (the area between the channel and active land use). In contrast, the AWQI places an emphasis on land use and soil types that play a significant role in hydrologic cycles and water quality characteristics within the watershed.

The AWQI is designed to be used by agricultural technicians with limited experience in aquatic ecology; however, it does assume a reasonable background in soil characteristics. This index is intended for use during the active growing season (approximately mid-May through September). The purpose of the index is two-fold; to describe the level of vulnerability or potential environmental impact a particular farming operation may have to the stream environment, and to provide direction in developing farm management strategies that work to stabilize or improve water quality.

The following are condensed instructions that are designed to assist the farmer, field technician, or agricultural consultant that may be performing the assessment. A more technical version of the AWQI is available to individuals seeking additional background information or more detail involving individual metrics within the index.

The AWQI is divided into two major sections. Part I is a physical inventory of the site to be assessed. This information is standard to many aquatic studies and allows for some comparison among sites. Additionally, conditions that may significantly affect aquatic biota are documented. Seasonal variations (current temperature and recent weather events) as well as observations that relate to local conditions are helpful to fully understand the relationship between land use and water quality. Although the first section is not scored, it does provide important information that supports the second portion of the index.

Part II of the AWQI is composed of three general categories plus an optional fourth category. Each of the first three categories is subsequently broken down into three to five *metrics* or statements that describe an existing habitat condition. The first category, *Land Use And Soil Characteristics*, involves features outside of the immediate riparian zone that impact water movement through the watershed. These features include soils and land forms, current land use, and the soil and surface condition, which will collectively influence the pathway water follows as it migrates toward the stream.

The second category, *The Riparian Zone*, is intended to evaluate the ability of the riparian area (or zone) to filter sediment, nutrients, and stormwater as well as provide sufficient shade, woody debris, and organic carbon to the stream channel.

The third category involves the *Stream Channel* itself. These metrics describe the amount of water in the channel during base flow conditions as well as the streams response to rain and runoff events. Channel sinuosity and structure are metrics that describes both the type of

streambed materials available (such as rock, cobble, sand, or woody debris) as well as the stream's ability to capture and retain materials for processing by stream biota.

An additional and optional category consists of one metric, which is a qualitative measure of existing *Aquatic Macroinvertebrates*. The goal of this final metric is to identify the presence or absence of tolerant versus intolerant species along with a relative measure of species diversity. This metric requires specific sampling equipment, knowledge of sampling methodologies, and a basic knowledge of aquatic macroinvertebrate taxonomy.

Following each category is a discussion of the metric scores. These discussions indicate how scores are related to the watershed and include suggestions that efficiently increase water quality protection. In many instances the necessary corrective action to improve the aquatic environment is made obvious by the metric score itself.

Metric scores from the second section of the index are given in two forms, a numeric value and a level of potential impact or vulnerability to impact (1-4). The vulnerability levels are as follows.

- *Level one* for optimal conditions. The stream environment is insignificantly impacted by local conditions.
- *Level two* for somewhat less than optimal conditions that exist without serious impacts to the stream environment.
- *Level three* denotes marginal or significant potential for impact to the stream environment.
- *Level four* describes poor conditions with the greatest level of vulnerability or impact.

The numeric score provides a more accurate description for each respective metric and a means to evaluate the effects of changing farm management strategies. Anticipated management changes can be re-scored against existing conditions to predict future outcomes to the stream environment. Total scores for each of the three categories should be placed in the appropriate box at the base of the individual score charts that follow each category.

PART I. Physical Inventory Of The Sampling Location

The physical inventory data sheet is generally self-explanatory. However, several areas that may require additional explanation are listed in more detail below.

Station Identifier

The station information is identical on all data sheets and requires sufficient information to describe the station and location where the assessment was conducted, date and time of assessment, and the investigators responsible for the quality and integrity of the data. The intent of good location information is to help identify access to the station for repeat visits.

Site Location/Map

To complete this phase of the bioassessment, a photograph may be helpful in identifying station location and documenting habitat conditions. A hand-drawn map is useful to illustrate major landmarks or features of the channel morphology (orientation, vegetative zones, and buildings, to name a few) that might be used to aid in data interpretation.

Stream Characterization

Stream Subsystem: Note if the stream is perennial or intermittent, or where tidal influences on the stream will alter the structure and function of stream communities. Perennial streams flow all year long while intermittent streams typically flow only during wet seasons.

Stream Origin: Note the origin of the stream under study, if it is known. As the size of the stream or river increases, include the origin of additional tributaries as they occur.

Watershed Features

Subsequent assessments within the same watershed will require verification of possible changes in land use; however, features such as soil types and slope will remain constant and need not be re-described.

Predominant Surrounding Land Use Type: Document the prevalent land-use type in the watershed of the station, noting any other land uses in the area which, although not predominant, may potentially affect water quality. This documentation may be accomplished by a careful visual inspection of the area or by using current land use information that has been compiled by local agriculture and/or natural resource agencies.

Local Watershed Nonpoint-Source Pollution: Describe potential nonpoint-source pollution problems in the watershed or any other compromising factors that may affect water quality. You should include feedlots, constructed wetlands, septic systems, dams and impoundments, mine seepage, etc.

Local Watershed Erosion: The existing or potential detachment of soil within the local watershed (the portion of the watershed or catchment that directly affects the stream reach or station under study) and its movement into the stream is noted. Erosion can be rated through visual observation of watershed and stream characteristics. Note any point sources of pollution that are present in the area and any turbidity observed during water quality assessment below.

Riparian Vegetation

The riparian zone serves to protect the stream from excessive runoff that adds sediment and nutrients to the active channel. Accepted buffer widths are variable and based on land use, soil types, and slope. The vegetation within the riparian zone is documented here as the dominant type and species, if known.

In-stream Features

Proportion of reach represented by stream form types: The proportion represented by riffles, runs, and pools should be noted to describe the channel and flow diversity of the reach.

Estimated length of stream surveyed: This information is important if variable length reaches are surveyed and assessed. Indicate the length of the stream that was surveyed.

High water mark (feet): Estimate the vertical distance from the wetted channel to the peak overflow level, as indicated by debris hanging in riparian or floodplain vegetation, and deposition of silt or soil. In instances where bank overflow is rare, a high water mark may not be evident.

Inorganic substrate compounds: The difference between silt and fine sand may be difficult to identify in the field. As a general rule, sand will have a somewhat coarse or gritty texture when rubbed between your fingers while silt will be smoother.

Physical Characterization/Water Quality Field Data Sheet

Stream Name		Location	
Station #	River Mile	Stream Class	
Lat	Long	River Basin	
Storet #		Agency	
Investigators			
Form Completed By		Date	AM PM Reason For Survey
Site Location/Map	Draw a map of the site and indicate the areas sampled. Identify natural features, structures and land use		

Stream Characterization	Subsystem Classification <input type="checkbox"/> Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Tidal	Stream Type <input type="checkbox"/> Coldwater <input type="checkbox"/> Warmwater
Weather Conditions	Now <input type="checkbox"/> storm (heavy rain) <input type="checkbox"/> rain (steady rain) <input type="checkbox"/> showers (intermittent) <input type="checkbox"/> % cloud cover <input type="checkbox"/> clear/sunny	Past 24 Hours <input type="checkbox"/> storm (heavy rain) <input type="checkbox"/> rain (steady rain) <input type="checkbox"/> showers (intermittent) <input type="checkbox"/> % cloud cover <input type="checkbox"/> clear/sunny
	Has there been a heavy rain in the last 7 days? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Air Temperature °C Other	

Riparian Zone/In-stream Features	Predominant Surrounding Land Use <input type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Other <input type="checkbox"/> Residential Local Watershed NPS Pollution <input type="checkbox"/> No Evidence <input type="checkbox"/> Some Potential Sources <input type="checkbox"/> Obvious Sources Canopy Cover <input type="checkbox"/> Partly Open <input type="checkbox"/> Partly Shaded <input type="checkbox"/> Shaded High Water Mark	Local Water Erosion <input type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy Estimated Stream Width Estimated Stream Depth <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool Velocity Estimated Reach Length Channelized <input type="checkbox"/> Yes <input type="checkbox"/> No Dam Present <input type="checkbox"/> Yes <input type="checkbox"/> No
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Riparian Vegetation (18 meter buffer)	Indicate the dominant type and record the dominant species present <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous Dominant species present
--	---

Aquatic Vegetation	Indicate the dominant type and record the dominant species present <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Free Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae Dominant species present Portion of the reach with vegetative cover %
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Sediment/Substrate	Odors <input type="checkbox"/> Normal <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Anaerobic <input type="checkbox"/> None <input type="checkbox"/> Other Oil <input type="checkbox"/> Absent <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Profuse	Deposits <input type="checkbox"/> Sludge <input type="checkbox"/> Sawdust <input type="checkbox"/> Paper Fiber <input type="checkbox"/> Sand <input type="checkbox"/> Relict Shells <input type="checkbox"/> Other Looking at stones which are not deeply embedded, are the undersides black in color? <input type="checkbox"/> Yes <input type="checkbox"/> No
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Water Quality	Temperature °C Specific Conductance Dissolved Oxygen pH Turbidity WQ Instrument Used	Water Odors <input type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other Water Surface Oils <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Globs <input type="checkbox"/> Flecks <input type="checkbox"/> None <input type="checkbox"/> Other Turbidity (if not measured) <input type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Opaque <input type="checkbox"/> Water color <input type="checkbox"/> Other
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Inorganic Substrate Components (should add to 100%)			Organic Substrate Components (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	>256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64mm (0.1"-2.5")		Marl		
Sand	0.06-2mm (gritty)				
Silt	0.004--0.06 mm				
Clay	<0.004 mm (slick)				

PART 2. The Agricultural Water Quality Index

Metric #1. Hydrologic Soil Group And Landform (1a and 1b) requires a description of the dominant or average hydrologic soil classification and slope for approximately 500 yards adjacent to the riparian zone. The hydrologic soil classifications are as follows (USDA 92).

- Group A soils which have low runoff potential and high infiltration rates even when wet. They consist chiefly of sands and gravel's and are well to excessively drained.
- Group B soils have moderate infiltration rates when wet and consist chiefly of soils that are moderately deep to deep, moderately to well drained, and moderately to moderately course textures.
- Group C soils have low infiltration rates when wet and consist chiefly of soils having a layer that impedes downward movement of water with moderately fine to fine texture.
- Group D soils have high runoff potential, very low infiltration rates, and consist chiefly of clay soils.

Soil groups are defined in county soil survey maps, by physical examination, a description may exist with state or local agencies in a digital format for Geographic Information System (GIS) application. Slope can be measured in the field or using United States Geological Survey (USGS) topographical maps.

Use Metrics 1a and 1b if there is a change in slope from approximately 200 to 500 yards outside of the riparian zone and average the results into one score. If slope is constant for the entire 500 yards, only the latter (question 1b) is necessary and should be used to describe the slope for the full 500 yards.

Metric #2. Land Use – One To 500 Yards Adjacent To The Riparian Zone records a description of dominant or shared land uses that exist along the riparian zone.

Metric #3. Soil And Surface Conditions describes the soil structure and the condition of the soil surface. Use a shovel to examine the top 10-14 inches of soil for the given characteristics that determine soil structure. In addition, examine the surface of the soil for evidence of crusting or soil sealing that occurs in the presence of frequently disturbed soil. A soil manual may provide some initial assistance with soil descriptions.

Metric #4. Riparian Zone Width is the distance between the edge of the stream bank and the beginning of existing land use.

Metric #5. Riparian Zone Completeness describes breaks or potential weak points along the riparian continuum that may negate the buffering characteristics of the riparian vegetation. These breaks may appear as cattle paths, game trails, drives, or gullies formed by significant erosion. Any sudden change in the riparian vegetation that results in an area where the riparian width is significantly less should be scored as a break.

Metric #6. Riparian Zone Vegetation describes existing plant diversity within the riparian zone. A good mix of trees, shrubs, herbaceous, and grassy vegetation will maximize sediment filtering and nutrient assimilation capabilities within the riparian zone and provide woody debris and organic carbon leaf and plant litter to the stream channel.

Metric #7. Channel Flow Status characterizes hydrologic stability during base flow conditions. High scores should be given to streams that retain enough water at base flow to cover substrate materials in the active channel. Poor scores result when channel substrates are mostly or completely exposed. Look for evidence of dried algae or macroinvertebrate stone cases on exposed rocks and logs. Note if the stream is known to be perennial or intermittent.

Metric #8. Flow Stability differs from Channel Flow Status in that it describes flow stability as it relates to hydrologic responses from precipitation events. Stream systems with poor flow stability (sometimes called “flashy”) react suddenly and sometimes violently to rain events. These streams typically have stream banks with a band of exposed soil beginning at the surface of the water. High scores describe streams with thick vegetation to the water’s edge while flashy streams have bare soil as previously described.

Metric #9. Channel Sinuosity describes the extent of channel meandering through the riparian zone. Meandering streams typically have greater flow diversity in pools and riffles and are more efficient in diffusing stream power during high water events than straight channels. Straight channels tend to have more laminar flows, uniform substrate materials, and low aquatic plant and animal diversity.

Metric #10. Channel Structure describes both the presence and absence of hard substrate materials and the ability of these materials to trap and retain coarse and fine organic materials. Hard substrates and good retention capabilities are critical for facilitating nutrient cycling and carbon transformation processes that maintain good water quality.

Metric #11. (Optional) Aquatic Macroinvertebrates serve as excellent indicators of overall stream conditions. The stream channel should be sampled in proportion to the substrate materials represented with a standard D-frame or aquatic kick net. As an example, if substrate materials are 80% sand and 20% gravel, 80% of the sampling effort should be made in sandy areas and 20% in gravel areas. Macroinvertebrates need to be identified to a minimum of the taxonomic level order or family. Scores place an emphasis on diversity stoneflies, mayflies, and caddis flies representing high water quality indicators. Systems dominated by midge flies (Chironomidae) usually indicate poor stream environments.

Metrics And Scoring

The following metrics are to be applied against the average conditions that exist at each survey site. Circle an appropriate numerical score within each category that best fits local conditions.

Land Use And Soil Characteristics

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 1a. Hydrologic Soil Group and Landform 1-200 yards outside of the immediate riparian zone.	0-5% slope and in hydrologic soil group A	0-5% slope and in hydrologic soil group B or >5-10% slope in hydrologic soil group A	0-5% slope and in hydrologic soil group C or >5-10% slope and in hydrologic soil group B or >10-15% slope and in hydrologic soil group A	Hydrologic soil group D or >5% up to 10% slope and in hydrologic soil group C or >10% and up to 15% slope and in hydrologic soil group B or > 15% slope and in hydrologic soil group A
SCORE	24 - 30	16 - 23	8 - 15	0 - 7

Note: Question 1b may not be necessary if the average slope for the given survey site is consistent from the edge of the riparian zone out to approximately 500 yards. If both metrics are necessary, average the two scores into one and record in the Soil Group and Landform portion of the Land Use And Soil Characteristics Summary following Metric 3.

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 1b. Hydrologic Soil Group and Landform 200-500 yards	0-5% slope and in hydrologic soil group A	0-5% slope and in hydrologic soil group B or >5-10% slope in hydrologic soil group A	0-5% slope and in hydrologic soil group C or >5-10% slope and in hydrologic soil group B	Hydrologic soil group D or >5% up to 10% slope and in hydrologic soil group C or

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
outside of the immediate riparian zone.			or >10-15% slope and in hydrologic soil group A	>10% and up to 15% slope and in hydrologic soil group B or > 15% slope and in hydrologic soil group A
SCORE	24 - 30	16 - 23	8 - 15	0 - 7

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 2. Land use approximately one to 500 yards beyond the immediate riparian zone (modified from Petersen 1992)	Generally undisturbed, consisting of forest and/or wetland. Interruptions or modifications to the natural setting from residential dwellings or agriculture are rare. Vegetative cover is complete with no unnatural breaks or bare spots	Permanent pasture/hay mixed with woodlots and/or swamps with few mixed row and small grain crops. Vegetative cover may have a few breaks or bare spots. Occasional modifications for residential dwellings or agricultural dwellings.	Consisting of a mixture of row crops, small grains, and pasture/hay or an increase in suburban characteristics (multiple housing units in close proximity). Vegetative cover may contain many weed and/or brush species. May have some bare areas.	Land use is dominated by row crops or is largely urban or suburban in nature. Vegetative cover may have many breaks or bare areas. The lowest end score would be a paved area or compacted bare soil.
SCORE	24 - 30	16 - 23	8 - 15	0 - 7

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 3. Soil and Surface Conditions (outside of the riparian zone)	Surface open or loose, even when wetted. Large strong granules, crumbs or sand particles. Many root channels and earthworm burrows and other voids in the soil. No gleying or mottling.	Surface open or loose, small or weak granules or crumbs or sand particles. Some root channels and earthworm burrows. May have orange or bright mottles	Surface crusted however easy to break Or Structure very fine and very weak or is sub-angular blocky to blocky. May have mottles or gleying	Surface crusted and hard to break Or Bulk soil massive or puddled. No evidence of granules or crumbs. No root channels or earthworm burrows. Contains mottling and/or gleying. The

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
				most undesirable extreme is a paved area or a compacted bare crusted area.
SCORE	24 - 30	16 - 23	8 - 15	0 - 7

Land Use And Soil Characteristics Summary

While land use has a dramatic effect on water movement through a landscape, natural geomorphic features such as soil types and slope are not options that can be changed by man. However, these features are essential forces that define hydrologic processes and are strongly influenced by land use management. Poor scores for soil types do not indicate a poor quality soil. These scores do, however, suggest a greater vulnerability to surface runoff than higher scores. This vulnerability increases with an increase in slope and/or land use that involves frequent soil disruption. Soil types that are susceptible to surface runoff may exaggerate the effects to a stream due to increases in slope or patterns of land use that reduce soil structure.

Place land use scores in the appropriate box below each respective category. Consult the *Recommendations* section for the highest of the three scores listed to determine possible farm management changes that will minimize potential impacts to the stream environment.

Metric #1 Soil Group And Landform	Metric #2 Land Use	Metric #3 Soil Surface Condition	Recommendations
Level 4			Land cannot tolerate a continuous crop. Set to forest, permanent pasture, or long rotations. Avoid or minimize row crops. Use minimum or no-till with additions of organic matter/crop residue. Badly eroded land may require complete renovation. In addition, follow recommendations for Level 2 and 3 categories.
Level 3			Be alert as some precaution is needed. If in continuous row crop, rotate to a non-row crop. Use minimum or no till where tillage is required. In addition, follow recommendations for Level 2
Level 2			Have soils tested to determine if lime or fertilizer additions are needed. Examine vegetative cover. If cover is sparse, interseeding is needed.
Level 1			No special precautions or new management schemes are needed based on this assessment.

Total Land Use And Soil Characteristics Score _____ (Metrics 1+2+3)

Land Use And Soil Characteristics Adjustment Factor

Agricultural lands that have been exposed to recent increases or decreases in conservation tillage practices will reflect changes to the soils hydrologic characteristics over time. While the total land use score (above) reflects current conditions, the following metric is an adjustment factor that reflects the potential change to soil hydrologic conditions and potential impact to the stream environment. The Crop and Tillage Practice metric below provides a potential adjustment to the Land Use and Soil Characteristics score in the chart above and, therefore, a method of evaluating the effects of various farm management practices. Add the *adjustment factor* score to the Land Use and Soil Characteristics Score listed above for a Land Use and Soil Characteristics Score (adjusted).

Farm Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4

Farm Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Crop And Tillage Practices (Adjustment Factor).	Long term rotation with minimal row cropping and maximal hay and/or pasture. Mixed farm uses including crop production and pasture. Minimum or no-till where applicable.	Short term crop rotation with conservation or no till practices.	Some crop rotation with standard tillage practiced.	Intensive row crop monoculture with intensive tillage.
SCORE	5	0	-5	-10

Total Land Use And Soil Characteristics Score (Adjusted) _____

(Metrics 1+2+3 plus the Adjustment Factor)

The Riparian Zone

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 4. Riparian Zone Width (from stream to edge of field).	Marshy or woody riparian zone 100 to 150 feet or more.	Marshy or woody riparian zone varying from 50 to 99 feet.	Marshy or woody riparian zone from 20 to 49 feet.	Marshy or woody riparian zone essentially absent or less than 20 feet.
SCORE	16 - 20	11 - 15	6 - 10	0 - 5

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 5. Riparian Zone Completeness (Petersen 1992).	Riparian zone intact to nearly intact with infrequent breaks occurring at intervals greater than 165 feet.	Incidental breaks in the riparian zone at approximately 100-164 foot intervals.	Breaks in the riparian zone frequent with some gullies and scars occurring every 100 feet.	Riparian zone has frequent breaks in the vegetation with deeply scarred gullies along its length.
SCORE	16 - 20	11 - 15	6 - 10	0 - 5

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 6. Riparian Zone Vegetation.	Riparian vegetation consists of trees, shrubs, herbaceous species, and grasses. Maximum canopy potential is achieved with native plant species.	Riparian vegetation has sustained some degree of alteration. Some degree of canopy cover less than the maximum potential exists. At least one of the four categories of plants is missing or very limited.	Riparian vegetation has been altered with at least two of the four categories missing. Obvious gaps in the canopy exist, and the potential to supply organic material and woody debris to the stream channel has been significantly reduced.	Riparian vegetation has been severely altered with an abundance of only one or none of the four plant categories present. Organic material and woody debris is not realistically available to the stream channel or has been replaced with agricultural commodities or used as pasture.
SCORE	16 - 20	11 - 15	6 - 10	0 - 5

Riparian Zone Scores

Place the Riparian Zone Width score in the appropriately box within its respective category below. If the Land Use score (from the previous section) was a level 3 or 4, shift to the next higher level of vulnerability and refer to the *Recommendations* listed to the right in the same row. As an example, if the Riparian Zone score is 17 (level 1) and the Land Use score was 14 (level 3), refer to the level 2 Riparian Zone Width *Recommendations*. No adjustments are necessary if Riparian Zone Width score falls into a level 4 category or if Land Use scores fall into a level 1 or 2 category. All recommendations assume that the condition and completeness of the riparian zone is of high quality. In all cases, changes in land use may require increases in riparian zone width.

Metric #4 Riparian Zone	Recommendations
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Width	
Level 4	Riparian zone widths need to be increased to a minimum of 100 feet in areas containing hydrologic soil groups A or B and slopes <10% and up to 165 feet for hydrologic soil groups C or D. Where slopes exceed 10% an additional 50 feet may be necessary, especially if land use involves frequent tilling and/or occasional row crops or if slope exceeds 10%. Refer to level 1 riparian characteristics (metric #6) as a guide to riparian zone reconstruction.
Level 3	Riparian zone widths need to be doubled or tripled in areas containing hydrologic soil groups A or B with slopes <10% with an additional 50 feet for areas containing hydrologic soil groups C or D. An additional 50 feet may be necessary where slopes exceed 10%, especially if land use involves frequent tilling and/or occasional row crops. Refer to level 1 riparian characteristics as a guide to riparian zone reconstruction.
Level 2	Riparian widths may be adequate if located within hydrologic soil group A with less than a 10% slope or hydrologic soil group B with less than a 5% slope. An additional 50 feet is necessary for areas containing hydrologic soil groups C or D or where slopes exceed 10% or where land use involves frequent tilling and/or occasional row crops.
Level 1	No special recommendations are needed based on this assessment. However, changes in existing land use may require increases in current riparian zone widths.

Place the Riparian Zone Completeness score in the appropriately box below, following the same pattern of scoring instructions as previously given with respect to the Land Use score. All recommendations assume an adequate Riparian Zone Width. If not adequate, these recommendations must be performed in conjunction with the Level 1 Riparian Zone Width description from Metric #4.

Metric #5 Riparian Zone Complete ness	Recommendations
Level 4	Identify and eliminate sources of erosion. Restore eroded banks with appropriate vegetation. Refer to Level 3 and 4 recommendations under Riparian Buffer Widths.
Level 3	Modify and/or eliminate non-essential breaks in the riparian vegetation. Essential breaks in the vegetation need to be modified so that surface runoff flows away from the area of the break. Continue to observe riparian zone standards as described in the previous section.
Level 2	Modify essential breaks in the riparian vegetation so that surface runoff flows away from the area of the break. Continue to observe riparian zone standards as described in the previous section.
Level 1	No special recommendations are needed based on this assessment. Continue to observe riparian zone standards as described in the previous section.

Place the Riparian Zone Vegetation score in the appropriately box below, following the same pattern of scoring instructions as previously given with respect to the Land Use score. All recommendations assume an adequate Riparian Zone Width. If not adequate, these recommendations must be performed in conjunction with the Level 1 riparian zone width description in Metric #4.

Metric #6 Riparian Zone Vegetatio n	Recommendations
Level 4	Riparian vegetation needs to be re-established. One third of the riparian zone area nearest the stream should be planted with several large tree species at approximately 6-10 foot intervals. The middle third of the riparian zone should be planted with woody shrubs at 3-6 foot intervals while the remaining portion of the riparian zone should remain as undisturbed grasses with intermittent woody shrubs. Refer to the section on Riparian Zone Widths for the correct dimensions for

	existing soil types, land use, and land features.
Level 3	Riparian vegetation needs to be expanded to include the various forms listed above. Select species that will provide some degree of shade and stability to the stream channel.
Level 2	Areas where riparian vegetation has been altered should be selectively restored. Select species that will provide some degree of shade and stability to the stream channel.
Level 1	No special recommendations are needed based on this assessment. However, changes in current land use may require increases in riparian zone widths. Continue to monitor vegetation quality for changes due to high water or frequent flooding that may eliminate some forms of grasses, trees, or shrubs.

Total Riparian Zone Score_____ (metric numbers 4+5+6)

The Stream Channel

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 7. Channel Flow Status (from Barbour et al. 1997).	Water reaches the base of both banks with minimal or no channel substrates exposed.	Water reaches >75% of the active channel substrates or <25% of active channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in the channel and mostly present as standing pools.
SCORE	12 - 15	8 - 11	4 - 7	0 - 3

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 8. Flow Stability (at or near base flow).	Vegetation along the stream banks is complete nearly to the water's edge. Little or no evidence of frequent changes in discharge and/or stream velocity that scours stream bank vegetation. Channel retention devices (if present) mostly stable and extending laterally across the stream channel.	Some evidence of bank scour approximately eight to 4-8 inches above the water surface. Channel retention devices (if present) mostly stable and extending partially into the stream channel.	Bank scour evident 9-18 inches above the water surface. Channel retention devices (if present) tend to lay more against the stream bank rather than extending out into the active channel.	Bank scour severe (>20 inches) into the stream channel. Channel retention devices are generally absent from the active channel and/or may exist as woody debris jams along the stream bank above the active channel.

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
SCORE	12 - 15	8 - 11	4 - 7	0 - 3

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 9. Channel Sinuosity (from Barbour et al. 1997).	The bends in the stream increase the stream length 3 to 4 times longer than if it was a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel is essentially straight; waterway has been channelized for a long distance.
SCORE	12 - 15	8 - 11	4 - 7	0 - 3

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 10. Channel Structure (Retention Devices).	Channel structure comprised of rocks and/or logs firmly set in place in both the active channel as well as along the interface of the bank and channel area.	Channel structure comprised of rocks and/or logs however largely backfilled with sediment.	Channel structure loose; moving with floods.	Channel with few or no retention structures. Substrate materials dominated by sand and silt.
SCORE	12 - 15	8 - 11	4 - 7	0 - 3

Stream Channel Scores

Add total scores for the entire Stream Channel section (metrics 7-10) and place in the appropriate box below. Refer to the *Recommendations* section immediately to the right of the Stream Channel score for direction with future management strategies.

Stream Channel Scores	Recommendations
Level 4 (Scores 0-15)	Poor habitat that has resulted from riparian zone impairment, poor land use management and/or somewhat recent stream channelization. Re-establish adequate riparian widths and land use management strategies as described in previous sections. If the disturbance is not caused on site, maintain adequate riparian zone widths and appropriate land use management strategies to minimize additional sediment and nutrient inputs.
Level 3 (Scores 16-30)	Marginal habitat. Re-examine Land Use and Riparian Zone scores to identify possible causes of habitat loss. Identify possible weak areas from individual Stream Channel metric scores and adjust. If Land Use and Riparian Zone scores are in Level 1 or 2, determine the extent of impacts resulting from upstream land use. Increase protective measures where possible.
Level 2 (Scores 31-45)	Suboptimal habitat. Identify possible weak areas from individual Stream Channel metric scores and adjust where possible. If Land Use and Riparian Zone scores are in Level 1 or 2, determine the extent of impacts resulting from upstream land use.
Level 1 (Scores 46-60)	Optimal habitat. Continue to maintain adequate riparian zone widths and farm management practices that minimize impacts to the stream environment.

Total Channel Score _____ (metrics 7+8+9+10)

Cumulative Metric Score Results

Step 1. Add the Total Riparian Zone Score with the Total Land Use And Soil Characteristics Score (metrics 1-6) to form a *Total Land Use And Riparian Score* (0 to 150). Place this score in the appropriate space indicated in Figure 1. Place an *X* in the position along the horizontal scale labeled “Land Use And Riparian Score” that represents your *Total Land Use And Riparian Score*. From the *X*, draw a vertical line to the top of the colored chart.

Step 2. Place the Total Stream Channel Score (0-60 for metrics 7-10) in the appropriate space indicated in Figure 1. Place an X in the position along the vertical scale labeled “Channel Score” that represents your score results. From the X, draw a horizontal line to the right side of the colored chart.

Step 3. Circle the point where the two lines intersect.

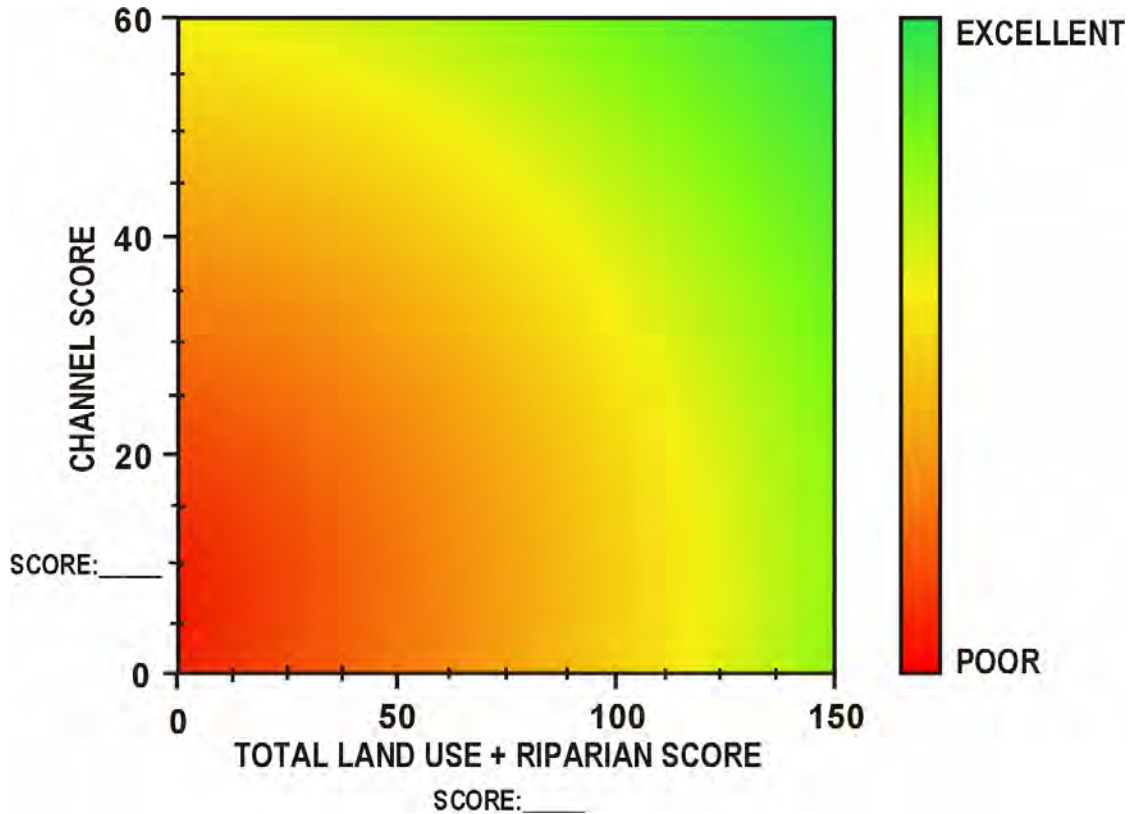


Figure 1. Cumulative score chart for the AWQI. Record the Total Land Use and Riparian Score in the appropriate blank and place an X where this score occurs on the horizontal axis. In similar fashion, record the Channel Score in the appropriate blank and place an X where this score occurs on the vertical axis. Draw a straight (vertical and horizontal) line from each X to the opposite side of the chart and circle the intersect of the two lines.

Both aquatic and terrestrial environments are multi-dimensional, highly dynamic systems that remain in a constant state of flux with temporal and spatial changes. Because of this variability, total scores need to be somewhat approximate when describing real environmental conditions to accurately communicate the constant yet subtle changes in nature. The AWQI utilizes a color gradient to represent final assessment results. An exact numerical score implies a precise condition that rarely if ever exists in environmental assessments, whereas the color gradient more accurately reflects environmental complexity. The color gradient in Figure 1 represents a continuum between very good conditions (green shades) to very poor conditions (orange to red shades) for Channel Scores. For Land Use And Riparian Scores, the color continuum represents a shared impact from upstream and adjacent conditions that are responsible for existing channel characteristics and the intensity of the potential to impact the stream environment.

The intersection of the two lines provides an estimation of the degree that the existing stream environment is due to upstream watershed conditions (line intersection is on the far right side of the figure). A degree of shared impact potential is described when the line intersection is between the extreme right and left margins of the figure. When the intersection is on the far left side of the chart, adjacent conditions could be largely responsible or impose a high potential for impairment to the stream environment. In general, the relative amount of potential impact to the stream from adjacent land use, soils, and riparian conditions is greater if the intersection is to the left and less if the intersection is to the right.

The color fields transected by the vertical line illustrate the intensity of a potential stream impact. Only a minimal potential to impact the stream exists if the line passes through green and/or yellow shades while a more serious potential exists if the vertical line crosses red or orange field.

As an example, if the Channel Score is 55 and the Land Use And Riparian Score is 145 (Figure 2, Example A), the intersection will occur in the green, upper right portion of the figure. The interpretation would be that stream conditions are good, as a result of upstream conditions, and adjacent characteristics offer little potential to impact the stream. If the Channel Score remains the same and the Land Use And Riparian Score is 40 (Figure 2, Example B), the intersection would communicate that stream conditions are good; however, there is a strong potential for impact from adjacent land use, soil, and/or riparian conditions.

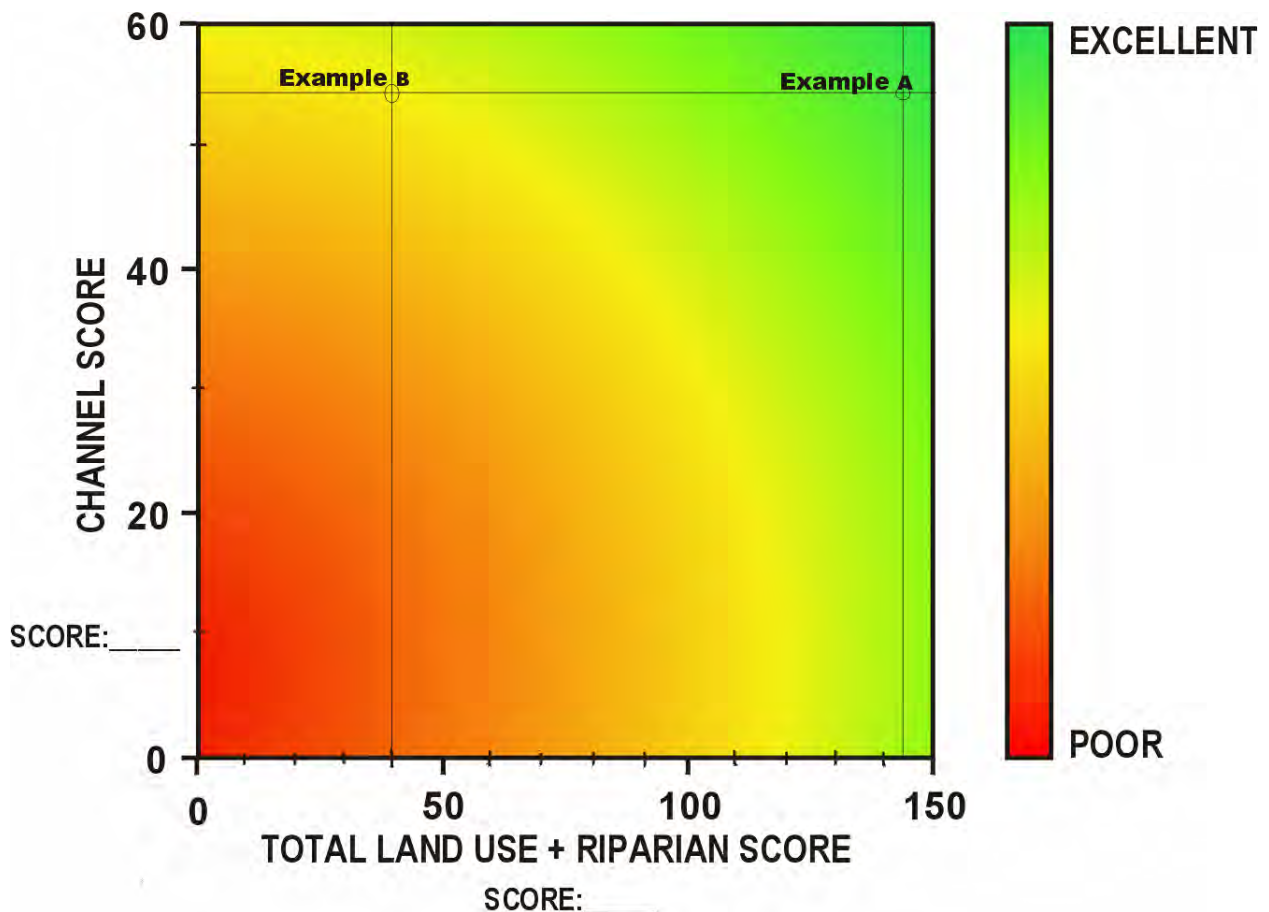


Figure 2. An example of a high Stream Channel Score with a high Land Use And Riparian Score (Example A) and a high Stream Channel Score with a poor Land Use And Riparian Score (Example B).

In reality an investigator will probably encounter conditions where both sets of scores are less than excellent. As an example, if the Channel Score is 35 and the Land Use And Riparian Score is 100 (Figure 3, Example C), the interpretation would conclude that stream conditions are marginal. While the upstream portion of the watershed contributes a substantial percent to current channel conditions, adjacent conditions also offer the potential (yellow bordering on orange) to contribute to existing channel conditions. Again, if the Channel Score remains 35 and the Land Use And Riparian Score is 60 (Figure 3, Example D), the interpretation would conclude that stream conditions are marginal and adjacent conditions have a strong potential to contribute along with upstream portions of the watershed. This latter conclusion is drawn by the position of the transect (degree of share responsibility) and by the colors transected by the vertical line (orange/red).

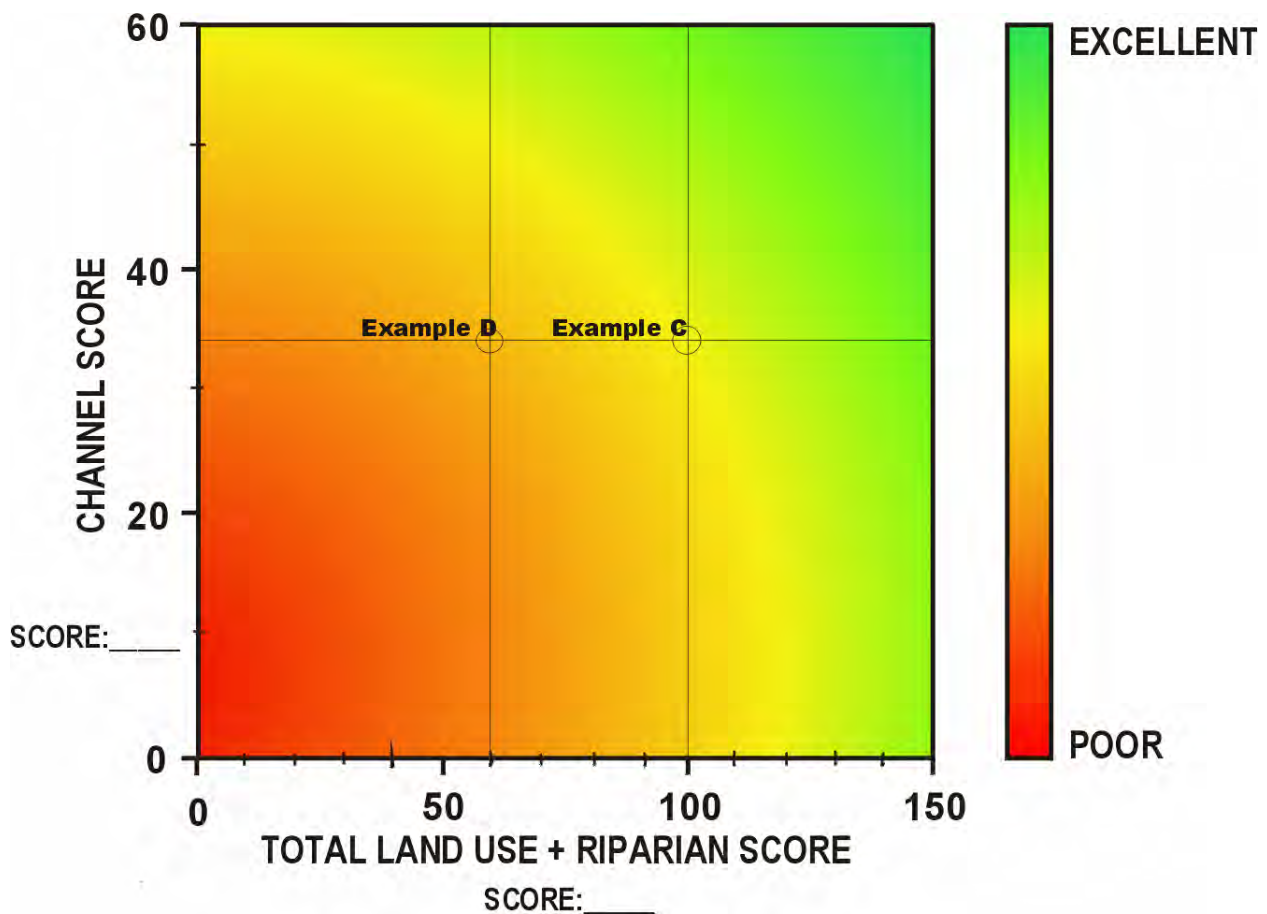


Figure 3. An example of a marginal Stream Channel Score with a fair Land Use And Riparian Score (Example C) and a marginal Stream Channel Score with a poor Land Use And Riparian Score (Example D).

Score Modifications

Once existing conditions have been scored and the results interpreted, potential modifications to current farm management strategies or changes to the riparian zone can be made within the index to project potential outcomes. This will allow the producer/land owner to make theoretical

changes using the AWQI index itself and extrapolate outcomes expressed as the potential to impact stream quality and, therefore, water quality. Add the adjustment score to the Total Land Use And Soil Characteristics Score and repeat Steps 1 and 3 under Score Results. Plot additional vertical lines in Figure 3 and compare with existing conditions as shown by the initial line plotted.

Aquatic Macroinvertebrates

The following metric is an optional check or method of validating the AWQI assessment process. An additional and optional category consists of one metric, which is a qualitative measure of existing *Aquatic Macroinvertebrates*. The goal of this final metric is to identify the presence or absence of tolerant versus intolerant species along with a relative measure of species diversity. This metric requires specific sampling equipment, knowledge of sampling methodologies, and a basic knowledge of aquatic macroinvertebrate taxonomy. If used, scores should be at approximately the same level as the Channel Scores listed above, specifically Metric #10. Strong discrepancies may indicate a need to re-examine some or all of the Stream Channel metrics or consider chemical contamination as a possible explanation.

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
Metric 11. Aquatic Macroinvertebrate.	Macroinvertebrate populations are very diverse. Several different orders including mayflies, stoneflies, and caddis are present with no specie being overly dominant in number. Stoneflies may not be normally found in warmwater streams or during warm summer months. 1-3 species dominate the sample population.	Macroinvertebrate populations are somewhat diverse; however, not all groups of high water quality indicator species are present. Stoneflies may not be normally found in warmwater streams or during warm summer months. 1-3 species dominate the sample population.	Only one group of high water quality indicators (EPT) are present while midge flies, amphipods, and/or isopods are dominant and may occur in large numbers	EPT are absent with variable to few other macroinvertebrates found. The entire number of species found may not exceed 5 with 1 or 2 being obviously dominant in number.

Habitat Parameter	Condition Category			
	Level 1	Level 2	Level 3	Level 4
SCORE	12 - 15	8 - 11	4 - 7	0 - 3

Appendix A

Macroinvertebrate Sampling Results

River/Stream _____ Site ID _____ Date ____ / ____ / ____ Time _____ AM PM
 Individuals Present (initials) _____

	Riffle/ Cobble	Core Depth	Fine Depth	Bank	Woody	Plant		Riffle/ Cobble	Core Depth	Fine Depth	Bank	Woody	Plant
ANNELIDA							Coleoptera						
Oligochaeta							Psephenidae						
ARTHROPODA							Elmidae						
ISOPODA (sow bugs)							Hydrophilidae						
AMPHIPODA (scuds)							Dytiscidae						
DECAPODA							Staphylinidae						
INSECTA							Diptera (flies)						
Ephemeroptera							Tipulidae						
Baetidae							Simuliidae						
Ephemerellidae							Chironomidae						
Isonychiidae							Tabanidae						
Heptageniidae							Empididae						
Leptophlebiidae							Ceratopogonidae						
Tricorythidae							Athericidae						
Ephemeridae							Culicidae						
Plecoptera							MOLLUSCA						
Perlidae							Gastropoda (snails)						
Pteranarcidae							Pelecypoda (clams)						
Taeniopterigidae													
Nemouridae													
Perlodidae													
Odonata													
Zygoptera (damselflies)													
Anisoptera (dragonflies)													
Hemiptera (true bugs)							Other (specify)						
Belostomatidae													
<i>Belastoma</i>													
Corixidae													
Notonectida													
Gerridae													
Megaloptera							Total Number of Taxa						
Sialidae							Number of Mayfly Taxa						
Corydlidae							Number of Stonefly Taxa						
<i>Nigronia</i>							Number of Caddisfly Taxa						
<i>Corydalis</i>							Percent Mayfly Comp.						
Trichoptera							Percent Caddis Comp.						
Glossosomatidae							Percent Contr. Dom. Taxon						
Limnephilidae							Percent Isopod, Snail, Leech						
Helicopsychidae							Percent Surface Air Breathers						
Brachycentridae							Ratio EPT:Chiron						
Molanidae													
Rhyacophilidae													
Hydropsychidae													
Percent (of total available substrate) represented in sample reach.	%	%	%	%	%	%							

of samples/habitat _____