Consolidated Assessment and Listing Methodology: Surface Water Quality Assessment in Kentucky, The Integrated Report

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

Effective Date: June 15, 2015
Revision No: N/A
Document Control No: DOWSOP03036

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Document Revision History

Date of Revision	Page(s) Revised	Revision Explanation

Suggested Citation: Kentucky Division of Water (KDOW). 2015. Consolidated assessment and listing methodology: surface water quality assessment in Kentucky, the Integrated Report. Kentucky Department for Environmental Protection, Division of Water. Frankfort, Kentucky.

Abbreviations, Acronyms and Definitions

ADB: Assessment Data Base- used to manage assessment determinations and associated water body information.

AKGWA: Assembled Kentucky Ground Water- unique identity code for springs.

ATTAINS: Assessment and TMDL Tracking and Implementation System- EPA system for national reporting of assessed water bodies.

BMU: Basin Management Unit- hydrological unit of associated water bodies defined for resource management.

CAH: Cold Water Aquatic Habitat- habitat that is capable of supporting indigenous coldwater aquatic life or self-sustaining or reproducing trout populations year-round.

CALM: Consolidated assessment and listing methodology. This is guidance procedures as it is often referred to for the assessment and listing as required by the Clean Water Act, Sections 303(d) and 305(b).

CAS #: Chemical Abstract Number- unique numeric identification for chemicals assigned by Chemical Abstract Services.

CCR: Consumer Confidence Report- annual compliance report for domestic drinking water finishers; compliance based on federal and state codes that set maximum contaminant levels for various pollutants.

Conventional Pollutant: Pollutants readily treatable by municipal sewage treatment plant. These are: biological oxygen demand; fecal coliform; oil and grease; pH; and total suspended solids. These pollutants part of the broader list of nonpriority pollutants.

CWA: Clean Water Act- established by Congress in 1972, with subsequent amendments, to restore and maintain the chemical, physical and biological integrity of the nation's water bodies.

DBI: Diatom Bioassessment Index- multimetric index used to detect responses to pollutants by the diatom community.

DMR: Discharge Monitoring Report- required reporting of discharged pollutants relative to limits under the NPDES (National Pollutant Discharge Elimination System) program.

DO: Dissolved oxygen – available oxygen in the water column and used by aquatic organisms that breath under water.

DOW: Kentucky Division of Water – agency of the Department for Environmental Protection, Energy and Environment Cabinet.

DEP: Kentucky Department for Environmental Protection, Energy and Environment Cabinet.

DFWR: Kentucky Department of Fish & Wildlife Resources, Tourism, Arts & Heritage Cabinet

DU: Designated Use – appropriate, beneficial uses of the aquatic resources, e.g., streams, lakes and springs, along with water quality standards to manage these resources.

DWS: Domestic Water Supply – water body source used to produce water for human (domestic) consumption.

EDAS: Ecological Data Application System – database used to manage biological, physical and chemical data.

EPA: U.S. Environmental Agency

EPT: Ephemeroptera, Plecoptera, Trichoptera – three orders of aquatic insects that generally are indicative of good water quality.

Evaluated Data: Examples include, data not collected in-stream such as discharge data from a permitted facility like a municipal wastewater treatment plant or observational information. Data not collected under proper SOP or environmental conditions may be evaluated, but not used alone to make a designated use assessment decision that would result in a TMDL.

FSA: U.S. Farm Services Agency

GIS: Geographic Information System – designed to capture, analyze, manage and present spatial or geographical information.

GLI: Great Lakes Initiative- agreement between EPA and Great Lakes states to a plan to restore the health of the Great Lakes.

GNIS: Geographic Names Information System – a database containing names and location information about physical and cultural features in the USA.

Hg-guidance: Guidance for Implementing the January 2001 methylmercury water quality criterion.

HUC: Hydrologic Unit Code – numeric sequence used to identify a river, reach of river or area of drainage.

IR: Integrated Report – comprises the 305(b) report of a state's inventory of aquatic resources and assessed waters and the 303(d) list of impaired water bodies and segments.

KAR: Kentucky Administrative Regulation – regulations that include the Commonwealth's water quality standards.

KIBI: Kentucky Index of Biotic Integrity – multimetric index calibrated to detect changes to the fish community to physical and chemical disturbances.

KORA: Kentucky open records act – act provides for the access to documents that comply with the conditions of the law.

KPDES: Kentucky Pollutant Discharge Elimination System – permitting program authorizing the discharge of pollutants to water bodies; this is the delegated National Pollutant Discharge Elimination System under the CWA Section 402.

MBI: Macroinvertebrate Bioassessment Index – multimetric index calibrated to detect changes to the aquatic insect community to physical and chemical disturbances.

MCL: Maximum Contaminant Level – the level of a contaminant in drinking water below which there is no expected adverse health effects.

MP: Mile Point – used to describe an assessment unit of a stream in the Integrated Report.

Monitored Data: Data collected in-stream or in-lake and appropriate to utilize for making designated use assessment decisions. Data used for initial designated use assessment is preferred not t be older than five years, but older data will be considered on an individual basis. Qualities to consider for older data are type of data (biological or water quality grab samples, including bacteria) that may be considered still relevant and likely to correlate to current environmental conditions.

NHD: National Hydrography Dataset – digital database of surface waters used to make GIS maps. Used in the Integrated Report to geospatially display assessment units and aquatic inventory.

Nonpriority Pollutant: Pollutants not on the priority pollutant list. Examples of those pollutants are ammonia, nutrients, iron, dissolved oxygen, pH and temperature.

ORSANCO: Ohio River Valley Water Sanitation Commission – interstate commission authorized by Congress in 1948 to control and abate pollution in the Ohio

River Valley. The commission comprises the six Ohio River mainstem states and tributary states of New York and Virginia.

OSRW: Outstanding State Resource Water – water bodies and segments afforded the designated use of OSRW based on support of federal threatened or endangered species, water quality and biological qualities, or unique features as provided in water quality standards.

PCBs: Polychlorinated biphenyls – synthetic industrial organic compound. The compound is composed chlorine and a bipheyl (two benzene rings).

PCR: Primary Contact Recreation – recreation where full body contact with the water is expected.

Pollutant: Examples of pollutant are: a solid waste; dredged spoil; sewage; chemical wastes; radioactive materials; temperature; industrial; municipal; and agricultural waste discharged into a water, Clean Water Act (CWA) (Section 502[6]).

Pollution: The definition of pollution under the CWA (Section 502[19]): *The man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.*

Priority Pollutant: List of 126 (currently) pollutants that are organic compounds or that are toxic pollutants (e.g., metals) as defined in Section 307 of the Clean Water Act. See Appendix D for the toxic parameters.

QAPP: Quality Assurance Project Plan – the planning, procedures, quality assurance and control, and project evaluation documentation.

RA: Relative Abundance – numbers of a particular type of organism as a percentage of the total number of organisms.

SCR: Secondary Contact Recreation – recreation where partial body contact with the water, excluding contact with the head, is expected.

SOP: Standard Operating Procedure – document whereby the methods of particular processes are described and expected to be routinely followed.

STORET: Acronym stands for STOrage and RETrieval, this is an EPA Data Warehouse

SU: Standard Unit – a common unit of measurement, e.g., US customary units.

TDS: Total Dissolved Solids – all inorganic and organic substance suspended in a liquid. Examples of TDS are calcium, magnesium, potassium, chloride and phosphates.

TMDL: Total Maximum Daily Load – calculation of the amount *load* of a pollutant that a stream can assimilate daily without exceeding a certain criterion.

TKN: Total Kjeldahl-nitrogen – measure of organic nitrogen and ammonia in water.

TNI: Total Number of Individuals – a metric based on numbers of individuals, e.g., percentage of worms (Oligochaeta).

TP: Total Phosphorus – all forms of phosphorus in a sample (orthophosphate, organic phosphate and condensed phosphates).

TSI: Trophic State Index – the biological condition of a water body, defined by ` biomass, often algal biomass.

TSS: Total Suspended Solids – all suspended solids, determined by weight of solid residue.

TVA: Tennessee Valley Authority – manage one dam project in the Commonwealth.

USACE: United States Army Corps of Engineers – manage 18 dam projects (15 entirely intrastate) in the Commonwealth.

USGS: United States Geological Survey – federal research and resource monitoring agency.

UT: Unnamed Tributary – tributary that has no official name according to GNIS.

WAH: Warm Water Aquatic Habitat – surface water and habitat capable of supporting indigenous warmwater aquatic life.

WQS: Water Quality Standards – define the objectives and goals of a water body by setting designated uses and criteria to protect the uses; also an antidegradation policy to protect existing uses and high quality waters.

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Scope and Applicability

This CALM (Consolidated Listing Methodology) or standard operating procedure (SOP) provides the steps and processes for making designated use (DU) support assessments on water bodies as required by the Clean Water Act (CWA) Section 305(b). This SOP is utilized for streams, large (boatable) rivers, lakes and reservoirs which are assessed utilizing applicable water quality criteria found in the Energy and Environment Cabinet's administrative regulations.

Executive Summary

This CALM describes the procedures for assessing water bodies under Section 305(b) of the CWA. The goal of this document is to provide guidance for those procedures and the resources necessary to carryout the processes for assessment of the designated uses applicable to the Commonwealth's aquatic resources. Additionally, this SOP was written as a general guide to provide background and insight to interested parties within the area of environmental management and planning relative to the Division of Water (DOW) monitoring and assessment programs.

The CALM begins with a background on the DOW's water quality monitoring programs and an overview of the Commonwealth's demographics, those particularly related to aquatic resources. The development of basin-level aquatic resource inventory and classification scheme received considerable attention to detail due to the essential need for precise cataloging of assessments and building the required foundation to present the results required for resources assessed. That is followed by an overview of the application of water quality standards (WQS) for aquatic resources and how use support determinations are made relative to water quality criteria. Addressed are the procedures necessary to assist in assuring data management, sufficiency, credibility and quality. Then assessment procedures are presented based on a DU approach. This approach includes procedures for applying numeric criteria, interpretation and application of narrative criteria in concert with response data and implementing the criteria to make use assessment decisions. Supporting information is found in several appendices and referenced sources.

Personnel Qualifications

The DOW personnel performing assessments must meet their minimum position classification requirement as determined by the Kentucky Personnel Cabinet. In practice, those performing assessments often possess specialized knowledge in the areas of aquatic biology, chemistry, stream, and lake ecology. The use of GIS programs and databases is a necessity in the assessment process. Familiarity in application and implementation of WQS and the regulatory programs involved with the CWA Section 402 are necessary.

Chapter 1. Introduction

The IR is prepared by the DOW, Department for Environmental Protection (DEP), for submittal to the U.S. Environmental Protection Agency (EPA) to fulfill requirements of sections 303(d), 305(b) and 314 of the Federal Water Pollution Control Act of 1972 (P.L. 92-500), as subsequently amended (commonly referred to as the Clean Water Act). Section 305(b) of the Act requires states to assess and report current water quality conditions to EPA every two years.

The DOW has followed the EPA's guidance to incorporate sections 303(d) and 305(b) into an *Integrated Report*. This reporting format provides the framework and methods that contribute to unifying the reporting elements of these two sections of the CWA: Section 305(b) – the elements for water quality assessment and Section 303(d) – the listing of water bodies and (stream) segments that require a Total Maximum Daily Load (TMDL) be calculated for the pollutants contributing to impairment. When released, the IR is in two volumes. Provided in Volume I is an overview of the Commonwealth's water resources, select demographic, physiographic and ecoregional statistics, monitoring and planning, and water quality assessment. Volume II contains the EPA-approved list of those water bodies and segments that are impaired for one or more DU and require a TMDL for the pollutants that exceed WQS. Additional principle components of Volume II are the status for TMDLs under development, future monitoring plans in watersheds associated with impaired water bodies or segments, public notice plans for TMDLs and a list of water bodies and segments under consideration for delisting.

The DOW utilizes the assessment database (ADB) to store water body and segment assessments and to aid in producing the various narrative and statistical tables that are presented in the IR, Volume I. The ADB has been modified to meet the particular needs of DOW. It contains assessment information such as geographic information and unique identification tags used to produce reach index maps to provide an atlas of assessed water bodies and segments.

The DOW operates its primary monitoring programs under a five-year rotating watershed management approach implemented in 1998 (Figure 1-1). The major basins that comprise the five basin management units (BMU) are listed below and illustrated in Figure 1-2:

- Kentucky River BMU;
- Salt River and Licking River BMU
- Upper Cumberland River and 4-Rivers BMU;
- Green River – Tradewater River BMU; and
- Big Sandy River – Little Sandy River and Tygarts Creek BMU.

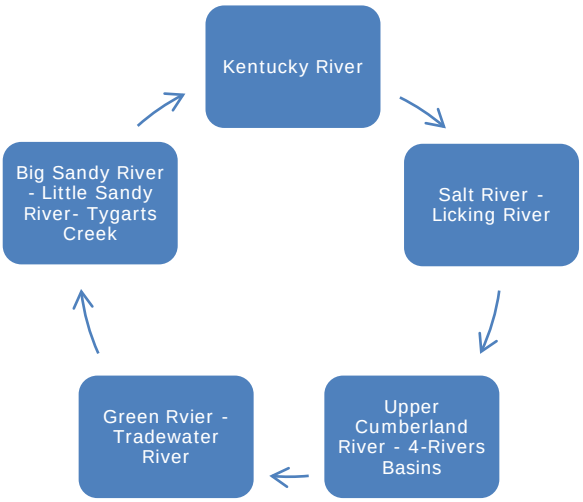

Figure 1-1. Rotation sequence for basin management units.

Each one of these BMUs contains minor tributaries to the Ohio River, with the exception of that portion of west Kentucky that drains directly to the Mississippi River. Monitoring of the Ohio River mainstem is accomplished by the Ohio River Valley Water Sanitation Commission (ORSANCO) and the assessments of the river are reported in their 305(b) report; that report may be found at http://www.orsanco.org/ under the title Biennial Assessment of the Ohio River. As each member state is an active participant of the ORSANCO programs that carryout its mission of managing the water quality in the Ohio River, the monitoring and assessment of DUs on the Ohio River are deferred to ORSANCO. Where ORSANCO's assessment methodologies differ from the DOW's, the DOW methodology takes precedent. The assessment procedures for ORSANCO are located in the aforementioned biennial report. The segments not supporting any assessed DU and require a TMDL are subsequently listed in Volume II of the Kentucky IR.

Reporting Frequency

Each 305(b) cycle is produced biennially and most typically the focus of each report is on two BMUs. In addition to the written IR published each biennium, an electronic-only update is usually submitted to EPA in each intervening year; this electronic update is included in the biennial report. For example, the 2011 electronic update was part of the 2012 305(b) cycle.

Public Participation

The public, including other agencies and nongovernmental organizations, are provided opportunities to participate in data submission and review of the draft 303(d) list of waters that do not meet one or more designated uses according to data results. On an ongoing basis, outside data may be submitted for consideration in making assessment decisions. Those data are subject to evaluation of application on the same level of rigor applied to

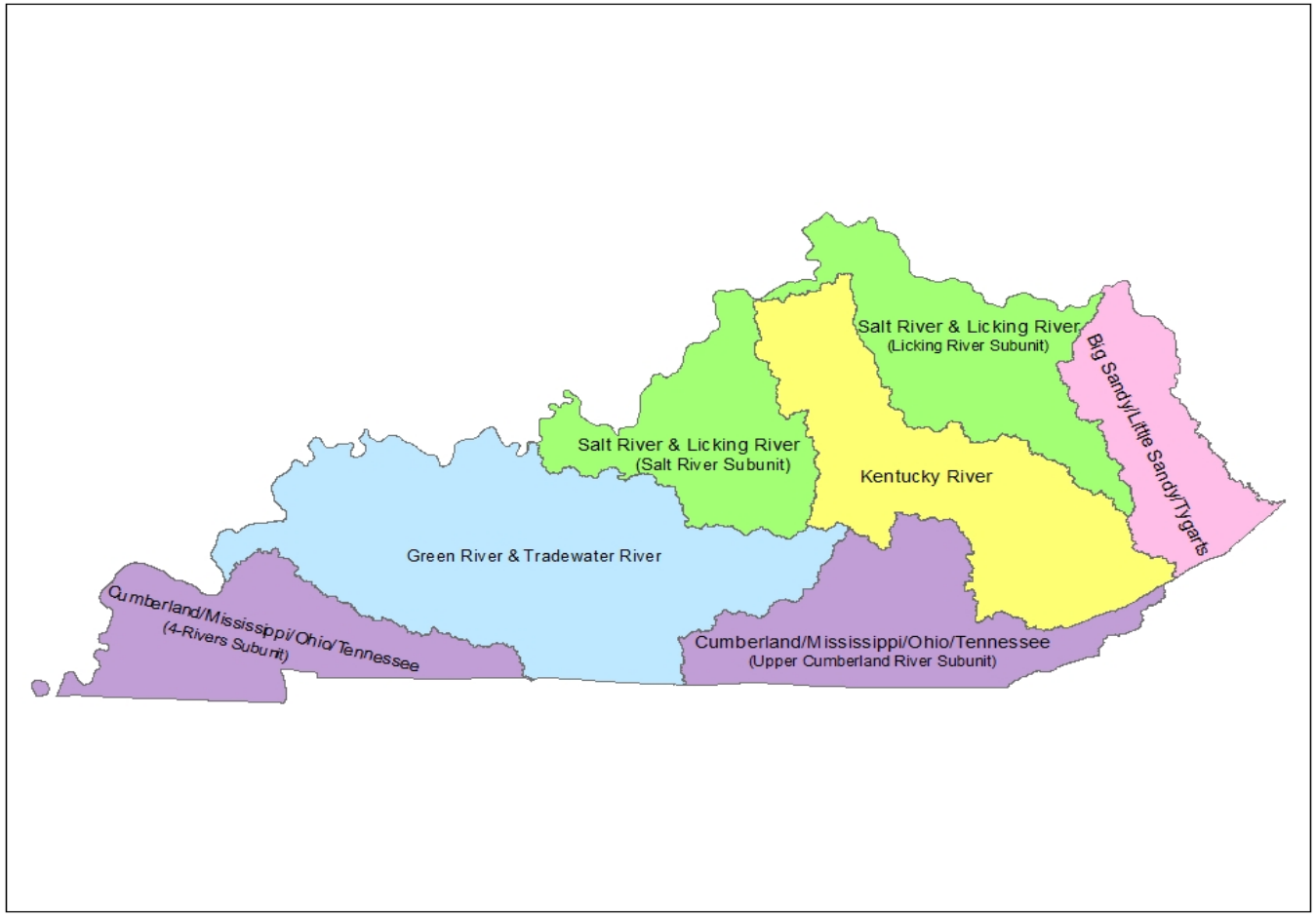

Figure 1-2. Kentucky basin management units (BMU).

the DOW. The agency's SOPs and monitoring guidance can be accessed at: http://water.ky.gov/Pages/QualityAssurance.aspx where links can be followed to specific topics and resources. However, data that may not meet minimum QA requirements can be considered for review, providing screening results for directing internal, public or other agency monitoring with the goal of generating data that can be used for assessment decisions.

Once the 303(d) list of waters that require a TMDL is drafted, the list goes out for public review and comment on the DOW webpage. A notice is posted on the DOW webpage (http://water.ky.gov/Pages/default.aspx) under the *News & Events* dropdown tab. The public review and comment period runs 60 days as required by Kentucky statute (KRS Chapter 224.70-150, http://www.lrc.ky.gov/Statutes/chapter.aspx?id=38337).

1.1 Water Resources and Select Demographics of Kentucky

The IR Volume I contains background information and basic water resource and demographic statistics in order to give context for all resources and accurately report statistical information derived from water quality assessment. This information is then applied by the appropriate geographic area or unit. An overview of the Commonwealth's demographic and physiographic statistics is contained in Table 1-1.

Table 1-1. Atlas of Kentucky's water resources and profile of select demographic and physiographic statistics atlas of Kentucky

State population, 2012[1]	4,380,415
Surface area (square miles)	40,409
Number of counties	120
Number of major physiographic regions	5
Number of level III ecoregions	7
Number of level IV ecoregions	25
Number of major basins	12
Number of USGS[2] 8-digit HUC[3]	42
Number of stream miles (1:24,000 NHD[4])	90,962
Number of stream-formed border miles (Big Sandy River, Tug Fork, Mississippi River and Ohio River)	983
Number of publicly owned lake and reservoir surface acres (estimated)	229,500
Three largest reservoirs by surface acres	
Kentucky Lake (Kentucky portion)	57,103
Cumberland Lake	47,623
Barkley Lake (Kentucky portion)	42,780
Wetland acres (approximation)[5]	324,000

[1]US Census Bureau
[2]United States Geological Survey
[3]Hydrolgic unit code
[4]National hydrography dataset
[5]*The state of Kentucky's environment: 1994 status report*. The Kentucky Environmental Commission, 1995.

1.2 Overview: Water Quality Standards

Kentucky WQS are part of the Kentucky Administrative Regulations. Current copies of the water quality regulations are found on the Legislature's Kentucky Administrative Regulations Titles webpage (http://www.lrc.state.ky.us/kar/titles.htm). The regulations pertinent to water quality for assessment are found in the Title 401 Energy and Environment Cabinet, Department for Environmental Protection, Chapter 10 (http://www.lrc.ky.gov/kar/TITLE401.HTM). These criteria form the underpinning to determine if water quality conditions are adequate for support of the applicable beneficial DUs as they apply to water bodies.

1.2.1 Designated Uses

All water bodies in Kentucky have assigned certain DUs for the management and goal of attaining a minimum level of water quality. DUs are promulgated in 401 KAR 10:026 and the implementing (enabling) criteria are in 401 KAR 10:031. The following are applicable DUs:

- warm water aquatic habitat (WAH)
- cold water aquatic habitat (CAH)
- primary contact recreation (PCR)
- secondary contact recreation (SCR)
- domestic water supply (DWS)
- outstanding state resource water (OSRW)

With the exception of CAH and OSRW, the remaining DUs apply by default to all water bodies. OSRW is a state-defined DU for water bodies that support federally listed threatened or endangered aquatic species or may support an excellent biological community (e.g., waters that are in the exceptional/reference reach categories in 401 KAR 10:030). Below is a description of each DU.

<u>Cold Water Aquatic Habitat</u>
As defined in 401 KAR 10:001, CAH is designated for water bodies that support a self-sustaining or reproducing trout population on an annual basis. All water bodies that support the CAH are listed in regulation (401 KAR 10:026). There are implementing criteria specific to CAHs; however, where there are no specific criteria to CAH, those criteria promulgated for WAH apply.

<u>Warm Water Aquatic Habitat</u>
WAH applies to the majority of water bodies in the Commonwealth – those not designated as CAH. The applicable definition of WAH is aquatic habitat capable of supporting indigenous warmwater life.

<u>Primary Contact Recreation</u>
PCR is the DU for water bodies in the Commonwealth with the implementing criteria to manage water quality for the protection of human health against primarily pathogenic-induced gastrointestinal illnesses during the recreation season of May 1 through October 31.

The bacterium *Escherichia coli* (*E. coli*) is a commonly used indicator organism to monitor water quality for safe swimming conditions. *E. coli* are bacteria found in the guts of warm-blooded organisms, including humans. The presence of *E. coli* indicate there is likely waste from warm-blooded organisms present in the water body and with it the expectation of various pathogenic viruses, parasites and pathogenic strains of bacteria, including *E. coli*. A criterion for pH applies to this DU during the recreation season. This criterion provides protection to the bather from extremes of both acidic and basic conditions.

Secondary Contact Recreation

SCR is the DU for water bodies in the Commonwealth with the implementing criteria to manage water quality for the protection of human health against primarily pathogenic gastrointestinal illnesses and maintain a safe range for pH; these criteria apply to this DU year-round. Fecal coliforms are bacteria found in the guts of warm-blooded organisms and are the indicator used to monitor the water quality for safe boating and wading, or any form of recreation that does not include full-body immersion. The pH criterion protects against extremes of water quality with regard to acidic and basic conditions. Additional criteria exist to protect the beneficial DU from such conditions including nuisance algal blooms and nuisance aquatic macrophytes that may result from eutrophication and floating scum.

Domestic Water Supply

This DU applies to all waters in the Commonwealth; however, the enabling criteria that implement this DU are only applied at the point of withdrawal. The human health criteria that apply are found in 401 KAR 10:031 (Section 6). These criteria were developed to protect water quality for human consumption.

Outstanding State Resource Water

This DU provides additional measures for maintenance of habitat quality, including water quality, for the protection of federally threatened or endangered species that inhabit the OSRW. Additionally, select water bodies that have water quality and habitat that support a diverse fish or macroinvertebrate community and rate *excellent* on either the fish or macroinvertebrate biological community multimetric index (http://water.ky.gov/Pages/SurfaceWaterSOP.aspx) may be proposed for designation as an OSRW. Other qualities or attributes that qualify a water body for OSRW designation are found in WQS, 401 KAR 10:031 Section 8 (http://www.lrc.ky.gov/kar/401/010/031.htm). In addition to the listing of special waters in regulation, a webpage was created to facilitate access to all special waters (http://eppcapp.ky.gov/spwaters/); this webpage is organized into 12 river basins and by designation. However, final authority for determination of whether a water body has a special DU or category is through WQS procedures that encompass a formal promulgation of any given water body with an exception, certain OSRWs. Waters that are determined to support a federal threatened or endangered species are typically afforded OSRW protection through enabling language found in 401 KAR 10:031 Section 8(1)(a)3. Both designated and candidate OSRW are published on the DOW's webpage at: http://eppcapp.ky.gov/spwaters/, so this is often the most up-to-date source of OSRW listings that include candidate water bodies or segments.

1.2.1.1 Fish Consumption

The quality of fish flesh needed for human consumption is a desired goal set forth in WQS. While fish consumption is not a DU it is strongly implied in WQS, particularly 401 KAR 10:031 Sections 2 and 6. As such, the U.S. EPA agrees and requires the assessment results of fish tissue residue monitoring be reported in Section 305(b) of the CWA under the fish consumption use.

1.3 Overview of the Monitoring Programs and Principle Data Types Generated

The DOW has the primary responsibility of monitoring and assessing the Commonwealth's water resources and regulating the permitting of facilities and industries that discharge via point sources to waters of the Commonwealth. Given the DUs established for Kentucky's waters provide a management framework for water bodies, there are necessary monitoring programs essential for recognizing the effectiveness of CWA programs such as Section 402, KPDES (Kentucky Pollutant Discharge Elimination System) and Section 401, Water Quality Certification. The monitoring programs aid in the identification of other sources of pollutants such as non-point sources that may be addressed through other CWA programs, for example Section 319. The DOW has a number of monitoring programs designed to determine the condition of water quality statewide for DU assessment and reporting. Those programs generate in-stream monitored biological and water quality data based on various indicators. Table 1.3-1 highlights the monitoring programs and those indicators commonly integrated into each program.

Biological Indices

The DOW's biological monitoring program has a long history in aquatic resource monitoring used to determine the health and long-term water quality of stream and river resources. Biological monitoring was implemented in the 1970s with significant refinement of the program as more research led to the development of biological multimetric indices (for more information visit http://water.ky.gov/Pages/SurfaceWaterSOP.aspx). The development of these metrics and associated criteria resulted in a regional reference reach approach with the identification of bioregions. Two of the three indices are used as primary tools to make assessment decisions for aquatic life use in headwater and wadeable streams; however, the algae index is only used in a supplemental role for assessment determination. Additionally, these multimetric indices are an integral component for the interpretation of aquatic life narrative criteria in WQS, 401 KAR 10:031 Section 4 (http://www.lrc.ky.gov/kar/401/010/031.htm).

Macroinvertebrates

Macroinvertebrates have been used extensively in water quality monitoring and impact assessment since the early 1900s. Today, macroinvertebrates are used throughout the world in water quality assessment as environmental indicators of biological integrity to describe water quality conditions or health of the aquatic ecosystem and to identify causes (pollutants) of impairment. This indicator community is relatively sedentary, spending a significant portion of their life cycle in the aquatic environment. Various populations of a

Table 1.3-1. Water body resources and monitoring programs.

	Long-term ambient Surface Water[a]	Rotating Surface Water[a]	Targeted Biological Monitoring[b, c]	Reference Reach[b]	Probabilistic Bio-survey[d]	Lake Monitoring[e]	Ground-water & Springs Monitoring[a]
Wadeable Streams (1st-5th order)		X	X	X	X		
Large (boatable) Rivers	X	X	X				
Lakes/Reservoirs						X	
Groundwater							X
Swamps/Wetlands[f]	--	--	--	--	--	--	--

[a]Indicators: chemical (priority and nonpriority pollutants) and bacteria.
[b]Indicators: macroinvertebrates, fish, algae, chemical (nonpriority pollutants), habitat.
[c]Includes some wadeable streams over 250 mi^2 where wadeable and associated with ambient water quality stations.
[d]Indicators: macroinvertebrates, chemical (nonpriority pollutants), habitat.
[e]Indicators: chemical (nonpriority pollutants), fish kills, macrophytes, algae.
[f]Monitoring methodology under development.

community are dependent on multiple habitats for support of the different consumer levels throughout the food web (herbivores, omnivores, and carnivores) and, significantly, many sensitive taxa live in or on the sediments of streams (benthos); sediments may be a sink for environmental contaminants. These characteristics and habits make this a key indicator group of their environment.

The Kentucky Macroinvertebrate Bioassessment Index (MBI) was developed using the reference reach approach across the different ecoregions of the Commonwealth. The index scaling was set to differentiate between reference (those least impacted headwater and wadeable streams) conditions and increasing gradients of watershed disturbance. Development of the individual indices that respond to observed and measured physical and chemical impacts across the Commonwealth resulted in the recognition of three bioregions. Each bioregion is defined by watershed physical, chemical and hydrological characteristics that support communities of aquatic insects adapted to those characteristics and qualities particular to a bioregion.

Fishes

The evaluation of fish community structure is an important component of biological monitoring providing a reliable assessment. The Kentucky Index of Biotic Integrity (KIBI) was developed based on reference conditions, tolerances, and community feeding structure of the species present. Note that in terms of the KIBI, headwater streams are defined as less than 6-mi^2 and wadeable streams are those streams 6-mi^2 or greater, up to about 200 mi^2 (DOW 2003). A transition zone exists between 6 and 10 mi^2 for classifying some streams as either headwater or wadeable streams. Familiarity with the bioregions and best

professional judgment is necessary to determine the correct classification of streams within this zone.

Advantages of using fish as biological indicators include their widespread distribution, utilization of a variety of trophic levels, stable populations during summer months, and the availability of extensive life history information (Karr et al. 1986).

Algae

Algae (primarily diatoms) communities are important water quality indicators, particularly as it relates to trophic status (nutrient or organic enrichment) and toxic conditions. This indicator group is critical to the food web of streams, beginning the process of primary production through photosynthesis. The Diatom Biotic Index (DBI) may be used in conjunction with macroinvertebrate or fish multimetric indices to add greater resolution to the information considered when assessing the biological integrity of headwater and wadeable streams. The DBI is not used to make independent assessment determinations, requiring further calibration of the indices for independent applicability.

1.3.1 DOW Monitoring Programs

1.3.1.1 Ambient Program

The primary objectives of the ambient monitoring program are to establish current conditions and long-term records and trends for water quality, biological health, and fish tissue residue in the state's major watersheds. Sub-objectives are identified as determining: 1) the quality of water in OSRWs; 2) background or baseline water quality conditions in streams not impacted by discharges; 3) the extent to which point and non-point sources affect trophic state of lakes and reservoirs; and 4) the water quality of major inflow tributaries to lakes and reservoirs.

There are 72 primary water quality stations throughout the Commonwealth that are monitored on a monthly or bimonthly frequency. Primary water quality stations are monitored monthly during a given BMU water-year (one year out of five), and those stations outside of the current water-year BMU are monitored bimonthly. These stations are located at mid- and lower watershed reaches of United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC) basins. Station locations also occur near the inflow and outflow of major reservoirs, for example Green River Reservoir in the Green River basin. Rotating watershed stations are monitored for the same suite of water quality parameters as the primary stations, but are established to provide monitored data in smaller watersheds for a variety of reasons, such as: 1) TMDL development; 2) characterizing and monitoring reference watersheds; 3) monitoring waters that receive permitted discharge (for instance from a municipal wastewater treatment plant) to characterize upstream and downstream water quality; and 4) characterizing water quality conditions in certain intense use landscapes, such as urban, agricultural or resource extraction (mine) areas.

1.3.1.2 Reference Reach Program

In the 1970s the DOW had biosurvey programs based on qualitative evaluation of the community composition. With time, greater understanding of the ecology of aquatic systems opened the door to development of multimetric indices. Development of such aquatic indices became an area of emphasis for aquatic resource agencies at the federal, state and local levels as an improved management tool with national and regional approaches. These approaches incorporate standardized, technically sound methods appropriate to the prevailing physiographic and ecoregional conditions.

The DOW-refined multimetric indices were developed based on a regional reference approach. There are three of them, the MBI, the KIBI and the DBI. Data led to the combining of similar Level IV Ecoregions that had common community structure and responses to gradients of perturbations; these combined ecoregions form bioregions. Four bioregions resulted from the development of the MBI and six for the KIBI. These waters do not represent pristine conditions (i.e., they contain anthropogenic and natural gradients of disturbance) rather they represent what is believed to be the best examples of high quality water and biological integrity in each of the four (or six) identified bioregions. Through this effort a network of streams, or stream reaches that represent reference biological conditions, have been identified throughout the Commonwealth. These stream reaches are listed in WQS, 401 KAR 10:030. One to three biological communities (macroinvertebrates, fishes, or algae) are sampled per biosurvey. When only one community is used to make an aquatic life use support determination, either macroinvertebrates or fishes are monitored, typically the former.

1.3.1.3 Probabilistic Survey

A biosurvey utilizing probabilistic or randomly located sample sites in headwater and wadeable streams was initiated with the assistance of EPA's technical support group in Corvallis, Oregon. Kentucky's approach is to sample macroinvertebrates once at 50 sites in each BMU per five-year cycle. In 2004 nutrients and additional chemical water quality variables were added to the suite of indicators within this program. These additional data aid in the development of numeric nutrient criteria, provide a more comprehensive knowledge of what ambient water quality variable concentrations are in each BMU, and increase the confidence of each aquatic life use assessment. This program allows DOW to report on aquatic life use support in headwater and wadeable streams on a BMU and statewide scale over the five-year watershed cycle. Section 305(b) use support determinations using probabilistic biosurvey program data are made only on segments directly monitored; however, the DOW extrapolates use support for each BMU providing current and historic use support trends, detection of changes in condition of aquatic resources over time and a means to gage general effectiveness of various pollution control programs and projects. This program is important both on the statewide level as well as national level, as indicated by EPA's nationwide probabilistic monitoring efforts in wadeable streams, lakes and reservoirs, large rivers and survey of wetlands.

1.3.1.4 Lake and Reservoir Monitoring Program

The lake and reservoir monitoring program began in the early 1980s as part of the CWA Section 314 Clean Lakes Program. Currently DOW monitors nearly all significant publicly owned lakes and reservoirs in the state (approximately 105 water bodies). Many of the USACE reservoirs and Kentucky Lake, a Tennessee Valley Authority (TVA) project, are monitored by those respective agencies in partnership with DOW, meeting each agency's data requirements.

Chemical (nonpriority pollutants) water quality variables and chlorophyll *a* are analyzed to determine current trophic state status of each of these lakes and reservoirs. Monitoring occurs three times during the growing season, spring (April – June), summer (July – September) and fall (October – November) to capture the seasonal variability; an overall Trophic State Index (TSI) score is calculated from the combined seasonal data. By monitoring these resources every five years trends in water quality can be measured; the TSI trend information is a reporting element of Section 305(b). This program collects data sufficient to determine aquatic life and secondary contact recreation DU support status. The majority of these resources have use restrictions that are listed in the annual *Kentucky Fishing & Boating Guide* published by the Kentucky Department of Fish and Wildlife Resources (DFWR). Recreational swimming is not allowed in most reservoirs managed or owned by the DFWR. Only in those reservoirs with a designated swimming area and with an on-duty qualified lifeguard is swimming allowed. Given the nearly all inclusive swimming restrictions, PCR is not assessed for in nearly all DFWR-owned or managed reservoirs.

Chapter 2. Reporting Framework and Initial Procedures for Assessment

An assessment unit is a length (e.g., stream or spring run) or area (e.g., springs, lakes and reservoirs) of a water body assessed for DU support. Before considering the primary objective of DU assessment, considerable background information of the hydrologic management framework, basic hydrologic scale for reporting considerations and the many sources of metadata that are required to establish assessment units is necessary. Without attention to detail of these hydrologic units of scale, the procedures for establishing assessment units and multiple sources for obtaining and deriving the metadata necessary for data management and support, the reporting of the plethora of information would be nearly impossible. Cross-platform communication for integration from assessment unit data and storage, to reporting and translation of the results into narrative, tabular and geographical indexing and mapping, are all dependent on the supporting metadata.

2.1 The Hydrological Framework for Monitoring and Assessment

All river miles and water bodies are cataloged by the USGS into hydrologic units, which are numeric codes of varying length representing drainage basins or watersheds. This system does not follow political boundaries since aquatic systems do not necessarily begin or end with those boundaries. However, for readily achievable management goals, to support the

regulatory structure, and for reporting purposes, it is necessary to define the miles of streams and acres of water bodies in each of these hydrologic units within state boundaries. Also, it is of benefit to have a common system of cataloging hydrologic features that follows the same rules and procedures throughout the country. This system provides a context for water quality data applications and reporting that forms a basis for use on differing scales as needed that are not only applicable on local and state scales, but on regional and national scales.

This cataloging system first divides large basins, for example the Atlantic or Gulf of Mexico, into more exclusive drainage basins. This system of hydrologic divisions was adopted as reporting units for national assessment by the EPA. The hydrologic units are presented as hydrologic unit codes (HUC), with a cataloging system progression that becomes more exclusive of aquatic resources, and by extension to geography; different sized HUCs are denoted by the number of digits; the larger the number of digits, the smaller the drainage basin they represent. For larger level management and state 305(b) reporting purposes, the DOW uses the 6- or 8-digit HUC; however, for more localized application, the use of 11-, 12- or 14-Digit HUCs may be necessary.

In addition to being the size used for 305(b) purposes, the 8-digit HUC has also been used for planning and implementation of regional monitoring programs and reporting of those results. For example, the probabilistic biological monitoring program and the ambient water quality network design use the framework provided by the 8-digit HUC scale. It is at the 8-digit HUC level that significant divisions occur in large watersheds. For instance the Kentucky River basin consists of five HUC, the three river forks (North, Middle and South) constitute the upper basin, mid-basin of the mainstem and the lower basin of the mainstem each represented by 8-digit HUC that comprise the principle tributary systems of the basin. Using a scale that goes to the 8-digit HUC resolution, the following are elements of that accounting system (e.g., 05130101); Figure 2.1-1 represents an example of a particular HUC.

- The first two digits are known as a hydrologic region.
- The aggregation of the first four digits represents a hydrologic subregion.
- Two more digits result in a 6-digit HUC, an aggregation of watersheds known as hydrologic accounting units.
- An 8-digit HUC is referred to as a cataloging unit.

It is necessary in preparing Section 305(b) of the IR that the political boundaries of the state are reflected in the resultant analyses, while bearing in mind water quality is not constrained by those boundaries. Table 1, Appendix A, segregates the HUC by BMU and reports the total stream miles per HUC; where a HUC is shared with another state, only the stream miles in Kentucky are reported.

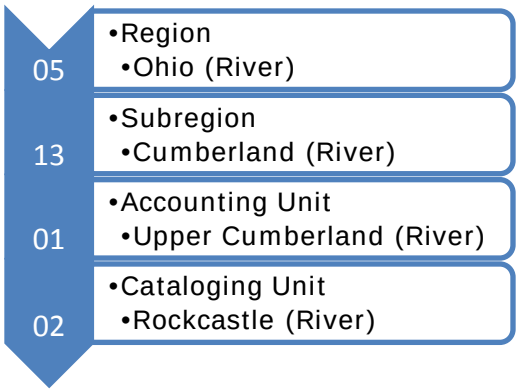

Figure 2.1-1. An example of the hydrological units accounting system developed by the U.S. Geological Survey. An 8 digit hydrologic unit code (HUC) is shown by accounting unit hierarchy.

2.2 Procedures for Procuring and Generating the Assessment Metadata: Unit Identification, Georeferencing, Tracking and Assessment Categorization

Each water body or segment (assessment unit) assessed becomes one individual record. It is essential to tag each assessment unit for ready identification, georeferencing (mapping), tracking (historic information and data), reporting and retrieval of the elements particular to an assessment unit.

A list of resources to aid in populating assessment forms for waters that have previously been monitored can be located at the below locations. For water bodies that have not been assessed, information on obtaining the needed information follows in Section 2.2.1.

- GIS layers of assessed water bodies and segments: http://gis.gapsky.org/watershed/;
- STORET database for water quality data (primarily chemical): http://www.epa.gov/storet/;
- Kentucky IRs: http://water.ky.gov/waterquality/Pages/IntegratedReport.aspx; and
- Kentucky Health Portal (under the water maps portal): http://watermaps.ky.gov.

Currently, biological data are warehoused in a non-web accessible database. Request for data of that type should come through a KORA (Kentucky Open Records Act) request made at: http://eec.ky.gov/Pages/OpenRecords.aspx.

2.2.1 Procedures and Information Sources to Populate the Assessment Form

The DU support decisions are documented for each assessment unit on an Assessment Form. Assessment forms are maintained on a DOW common drive under the folder entitled "Assessment Form_Master", accessible at: W:\ProgrammaticData\Clean_water_act\305b and an example is located in Appendix A. The assessment form follows and is presented in

sections by topical relevance. Stepwise, from top of the page to completion are the information fields for each assessment unit and the procedures to complete them.

305(b) Assessment Form
(Complete a form for each assessed segment)

Sample Year: _____
305(b) Cycle Year (DOW only): _____
Basin Management Unit: _____
Stream or Reservoir Name: _____

- The "Sample Year" is that year the samples were collected; if samples were collected over a period of years note the most recent year.
- The "305(b) Cycle Year" field will always be an even-year (fields with *(DOW only)* are those completed by the 305(b) Coordinator).
- The *Basin Management Unit* is one of five defined hydrologic management units (Figure 1-2).
- The *Stream or Reservoir Name* field should contain the official USGS geographic name. These are found on the 1:24,000 scale topographic maps. However, for those streams that were not named when the topographic maps were published there may be a recent official name given; the Geographic Names Information System (GNIS) is a database where official names are stored and is accessible at: http://geonames.usgs.gov/domestic/index.html. The National Hydrography Dataset (NHD) will often be a more convenient means to access the GNIS water body name; the NHD Layer is accessed via Geographic Information System (GIS) software. The Kentucky Geospatial server is the state repository for GIS data, including the NHD (national hydrography dataset), http://kygisserver.ky.gov/geoportal/catalog/main/home.page.
    - The following are the procedures employed as a means to identify streams without an official name.
        - If the stream discharges directly to a named stream (e.g., Stone Creek), then the unnamed tributary (UT) would follow this naming convention: UT of Stone Creek. When determining the stream length, the measure tool in GIS (ArcMap) should be used to follow the NHD flowline (or 1:24K USGS blue line (including intermittent) if no NHD flowline [blue] line exist) and the total stream length reported in miles to the nearest 0.1 mile (if the measurement is at 0.05 mile, or close (±0.01 mi), report to the nearest 0.05 mile). If the UT forks, by convention the fork that is greatest in length is followed upstream to its endpoint (blue [including intermittent] line); this constitutes the UT.
    - The mile point where the UT discharges into the receiving stream is attached to the UT name to facilitate the identification of the UT, for example UT of Stone Creek-1.5.

- The same procedures apply to an UT of UT of Stone Creek. In this example, the UT of UT of Stone Creek is identified by mile points that go from the named receiving stream to the mile points of the mouths of intervening UT(s), ultimately to the stream mile point receiving direct discharge from the UT of interest. This example is written as UT of UT of Stone Creek-1.5-0.8
- For reservoirs and lakes, naming procedures similar to those for streams apply. If no name occurs on the USGS 1:24,000 quadrangle, consult the NHD Lakes Layer; another resource is the GNIS (http://geonames.usgs.gov/domestic/index.html) database. If there is no official name then one should provide a description similar to UT convention for streams. For example, if the dam is at mile point 25 on the major tributary, name it Unnamed Reservoir (or Lake, as appropriate) (UR/L) of Brown River-25.0.
- For springs please access the same references as mentioned for streams and lakes to acquire the name. If a name does not exist, please use the convention for streams and reservoirs. For example, Unknown Spring (US) of Lubber Creek-10.5.

The next section of the assessment form ties the naming protocols into an alphanumeric identity that is necessary to both track and identify segments. The first entry of this section is determined by using information from the two entries that follow it. The "ADB ID #" is so placed to be in a prominent location.

ADB ID # (DOW only)**:** KY_____

GNIS ID: _ _ _ _ _ _ **Segment #** (DOW only): _ _ **Stream Length (miles) (w/ in KY):** _____.___
(exclude reservoir miles)
Lake/Reservoir Area (acres):_____

- As stated, current GNIS IDs may be found at: http://geonames.usgs.gov/domestic/index.html. Another often more convenient means to access the GNIS ID is through the NHD via GIS. The prefix "KY" is added to all GNIS numbers.
  - For Springs, please use the AKGWA (Assembled Kentucky Ground Water) number for the ID. This number can be found on the DOW Springs Layer in ArcGIS.
- Segment number relates to a unique assessment segment for a given water body.
  - For streams, the downstream-most segment begins with Segment #01.
  - Lakes, reservoirs and springs (unless it is the outlet "run" from the spring being assessed, then it follows the convention for streams) are given a Segment #00.
- The segment number should be attached to the ADB ID # as follows: XXXXXX_01.
  - For an UT, the GNIS number of the receiving stream is utilized, followed by the mile point where the UT discharges.

        - For the example UT of Stone Creek, it would have assigned a GNIS number and segment number that when combined would read XXXXX-1.5_01.
- "Stream Length" is that length of stream found on the NHD at a 1:24,000 scale (all subsequent stream miles and water body acreage refers to that obtained from the NHD river mile datalayer at 1:24,000 scale). Use the length of the entire stream, not the length of the assessed segment, unless they are identical. The length of UTs must be manually determined by the measuring tool in GIS. Any portion of stream that has been hydrologically altered by creating a pond or reservoir via dams affects the stream length.
    - Subtract the distance inundated by the reservoir from the total stream length. Note the subtracted distance below the stream length entered. For mouth of streams discharging to a large river that shows backwater extending into the mouth of the stream, deduct that distance as well. The USGS topographic 1:24,000 scale and the "Named Lakes" datalayer are the preferred standards, used to determine the extent of reservoir backwater. The FSA digital orthographic imagery (1-m scale) may be helpful in certain cases where the standard datalayers present questionable or incomplete information.
        - All stream assessments exclude the lake or reservoir portion of a stream, including backwater extending upstream.
- Populate the reservoir or lake acres for publically accessible ponds, reservoirs and lakes with information established in ADB.
    - For newly created lakes or reservoirs the acreage is determined based on the reported normal pool elevation obtained through the DFWR.

The next section of the assessment form identifies the stream location, length (reach), the corresponding coordinates to NHD stream miles, sample location(s), major river basin and the USGS cataloging unit (8-digit HUC in this case), and dates associated with the assessment.

USES Assessed (tick all that apply)**:** Aquatic Life (20WAH) ____ (20CAH) ____; Fish Consumption (21) ____;

Primary Contact Rec. (42) ____; Secondary Contact Rec. (44) ____; Drinking Water (50) ____; OSRW (316)

Receiving Water: _____

Assessment Reach: **Downstream/Upstream MP:** ___.__ **to** ___.__ **Segment Length:** ____.__

Downstream Lat. (dd.ddddd): ____._____ **Long.** (dd.ddddd): **-** ____.____

Upstream **Lat.** (dd.ddddd): ____._____ **Long.** dd.ddddd): **-**____._____

Downstream/Upstream Description: _____ to _____

Sample Site Mile Point: _____.____ **Lat.** (dd.ddddd): ____._____ **Long.** (dd.ddddd): **-**____._____

Topographic Map Name (1:24K) (sample location): _____

Major Basin (circle one)**:** Big Sandy; Little Sandy; Tygarts; Licking; Salt; Green; Tradewater; Upper Cumberland; Lower Cumberland; Kentucky; Mississippi; Ohio; Tennessee

USGS (8-digit) Cataloging Unit: _____ **County(s)** (sample site)**:** _____

Station ID: _____ **Sampling Date:** Start: ____-____-____; End: ____-____-____ (mm-dd-yy)

Assessment Date (DOW use only)**:** ____-____-____ (mm-dd-yy) **Data Type:** Monitored or Evaluated (circle)

- Tick all DU that will be (or carryover from previous assessment) assessed for a water body or segment.
- Identify the receiving water body of the stream, lake or reservoir.
- The sample site information should be entered and this information will typically be provided by the person that did the field work and made the preliminary assessment.
- Once an assessment reach or segment is determined enter that information in the appropriate fields.
- Record all coordinates in decimal degrees to five decimal places.
    - These coordinates will come from GIS via the NHD mile point layer; that layer should be zoomed to a scale of 1:4,000 or greater resolution when determining the coordinates.
- The downstream and upstream description delineates the segment's upper and lower boundaries by geographic reference. These will typically be at the mouths of tributary streams, backwaters, headwaters, city limit, break in buffer zone integrity, etc.
- Note the USGS 1:24,000 topographic quadrangle name(s) of the sample location(s).
- Identify the major river basin.
- Enter the USGS 8-digit HUC.
- Enter the county or counties, sample location only.
- The Station ID refers to either that assigned for EDAS, EPA STORET or another identifier used to associate data with a sample location.
- The sampling date applies to the data used to make the current assessment.
    - Often for segments with historic data those dates will be noted below this line for reference purposes.
- The assessment date is for the final assessment for the segment or water body, completed by the 305(b) coordinator.
- Identify whether the data are monitored (in-stream data) or evaluated (e.g., Discharge Monitoring Reports (DMRs) from the KPDES program or monitored data older than five years).
    - Exercise caution when using *evaluated* data; recognize the associated limitations such as low confidence in the data or if the data are generally old enough (>5 years) to raise questions about their current relevance.

The next section relates to assessment of the aquatic life (warm water or cold water) DU. This DU assessment may be made with chemical, biological and habitat data; however,

habitat results are used only as supplemental information, for example identification of pollutants affecting the biological community such as sedimentation/siltation and/or the lack of functional in-stream habitat types.

Community Score: MBI ____.__; KIBI _____.__; DBI _____.__ **Number of sites:** _____

Biological Integrity (circle one)**:** Excellent Good Fair Poor

Trophic State Index: _____; (circle one): Oligotrophic; Mesotrophic; Eutrophic; Hyper-eutrophic: **Trend** (circle one): ↑ ↓ ↔

Aquatic Life (AL) Use Support Table (tick all that apply)

Aquatic Life	Full	Partial	Non-support	Full but Threatened	Level of Info 1 - 4
Habitat					
Biological					
Chemical					
Toxicity					

USE Support, AL (DOW only)**:** Full Partial Support Non-support Full but Threatened

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
(*Note: At least one Source Code must be assigned to each Cause Code*) Kentucky Division of Water – 09-18-2008

- If biological community data are available and used in the assessment, record the score(s) appropriate to the multimetric index.
- The number of sample locations of a segment should be recorded, commensurate with Station ID's.
- Based on the score of the index or indices, report the overall biological integrity.
- The TSI (trophic state index) should be calculated and reported for lakes and reservoirs, along with the general trend of the water body TSI.
- In the Aquatic life use support table, tick all rows that are applicable.
    - Partial support and Full but Threatened carries the same programmatic weight as non-support (i.e., both require a TMDL).
- The "Level of Info 1-4" column relates to the rigor of the data associated with temporal, spatial, frequency and types of data (e.g., toxic, non-toxic or toxic + non-toxic parameters).
    - This information is found in *Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates (1997)*, Section 3.2 and may be accessed at http://water.epa.gov/type/watersheds/monitoring/guidelines.cfm and Consolidated Assessment and Listing Methodology-Toward a Compendium of Best Practices (http://water.epa.gov/type/watersheds/monitoring/calm.cfm) and synthesized in Tables 1 – 3, Appendix B along with code definitions in Table 1, Appendix C. While updates have occurred since the 1997 guidance

specific to the IR format, important information used in the assessment and reporting procedures are relevant in this guidance.

- Circle the overall DU support determination.
- All assessment codes related to the level of information are found at http://water.epa.gov/type/watersheds/monitoring/guidelines.cfm under *Supplement (Volume 2, Section 1)* and in Tables 1 – 3, Appendix B and Table 1, Appendix C.
- The cause (pollutant) should be identified when relevant. These have corresponding numeric codes located in Table 1, Appendix D.
- The source code relates the pollutant to suspected or known sources of the pollutant. This list is modified by grouping sources into categories to increase efficiency, see Table 2, Appendix D.

The following section of the form provides for reporting the assessment of fish consumption and the remaining DU. This is accomplished in a similar fashion as the aquatic life use by associating causes with suspected sources. Fish consumption, primary and secondary contact recreation DU and drinking water DU are based on human health criteria in WQS.

Fish Consumption (21)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

Primary Contact Recreation (swimming) **(42)**

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

Secondary Contact Recreation (44)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____

Drinking Water (50)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

The next section is the listing and assessment table where each segment or water body is categorized by DU and the support or non-support of WQS for each.

Assessment Category (DOW use only)

Category	Definition	**Uses** (circle all that apply)
1	All designated uses for water body Fully Supporting.	20WAH 20CAH 21 42 44 50 OSRW
2	Assessed designated use(s) is/are Fully Supporting, but not all designated uses assessed.	20WAH 20CAH 21 42 44 50 OSRW
2B	Segment currently supporting use(s), but 303(d) listed & proposed to EPA for delisting.	20WAH 20CAH 21 42 44 50 OSRW
2C	Segment with an EPA approved or established TMDL for the following use(s) now attaining Full Support. TMDL approval #_____.	20WAH 20CAH 21 42 44 50 OSRW
3	Designated use(s) has/have not been assessed (insufficient data).	20WAH 20CAH 21 42 44 50 OSRW
4A	Segment with an EPA approved or established TMDL for the following listed use(s) not attaining Full Support. TMDL approval #_____	20WAH 20CAH 21 42 44 50 OSRW
4B	Non-support segment with an approved alternative pollution control plan (e.g., BMP) stringent enough to meet full support level of all uses within a specified time.	20WAH 20CAH 21 42 44 50 OSRW
4C	Segment is not meeting Full Support of assessed use(s), but this is not attributable to a pollutant or combination of pollutants.	20WAH 20CAH 21 42 44 50 OSRW
5	TMDL is required.	20WAH 20CAH 21 42 44 50 OSRW
5B	Segment does not support designated uses based on evaluated data, but based on KY listing methodology, insufficient data are available to make a listing determination. No TMDL needed	20WAH 20CAH 21 42 44 50 OSRW

- Each assessed DU of a water body or segment is categorized using the appropriate Assessment Category; categories 1 and 2 are self-explanatory.
- Category 3 is only used where data exist for an assessment unit, but are insufficient for assessment.
- Categories 2B, 2C (state-defined categories) and 4A water bodies and segments require an EPA-approved TMDL with an associated unique TMDL identification number from EPA's ATTAINS (Assessment and TMDL Tracking and Implementation System) database before the associated DU can be assigned to it.
- Category 4B has specific, restrictive requirements that must be met: specifically this category requires an EPA-approved plan in-lieu of TMDL development.
- Category 4C is uncommonly used given the requirement for populating it with a water body or segment that is not supporting a DU due to natural conditions or pollution (excludes pollutants, see Category 5 below). A straightforward example might be a stream where WAH is not supported due to *flow alteration* that has resulted in water diverted from the natural channel to a created canal. Listing a DU in this category may require still greater scrutiny including ecological, physical or chemical information to rule out impairment is a result of a known pollutant. An example might be a stream segment below a dam. Chemical data does not indicate a reported water quality parameter that exceeds water quality standards, and any habitat perturbations are result of physical alterations such as stream flow, sinuosity and bedrock due to scouring below the dam. The biological community scores a less than *good* (meets expectations); examination of the community structure is

indicative of a filtering community rather than a diverse collector-gatherer community that would naturally occur given unregulated flow (no dam) conditions. Here, flow alterations, lack of diverse substrate and niches and a shift from heterotrophic ecology to autotrophic ecology are the causes of the result. In this scenario, removal of the dam or modifications to dam management and habitat restoration is what may restore the natural community.

- Category 5 is for a segment or water body that is not supporting one or more DU based on a pollutant and requires development of a TMDL.
- Category 5B is a state-established category to accommodate those water bodies and segments where in-stream data is not known to exist, but DMR data indicate one or more pollutants are not meeting permit requirements at a magnitude and frequency that reasonably indicates in-stream DU is not being met. An actual example is a package treatment plant discharge that greatly exceeds the limit for *E. coli* by an order of magnitude on some ongoing frequency. This may result in PCR use assigned to this category. This often highlights facilities that need immediate inspection and could result in the collection of in-stream data. Segments in this category do not require a TMDL.

Assessment Information Source: (circle/insert all that apply)

DOW	DOW	University	Federal	State	Other
Amb. WQ	Reservoir	EKU	ACE	DFWR	ORSANCO
Amb. Bio.	GDW	Morehead SU	EPA	KGS	MSD
WBM	NPS	Murray SU	TVA	SNPC	LFUCG
Bac-t	Fish Tissue	UK	USFS	TN	Volunteer
IS	PWS	UL	USF&WS	VA	
RR	DMR	WKU	USGS	WV	
FO	TMDL				
ProbMon					

The above table on the assessment sheet is for data source tracking. All contributors of data used to make an assessment decision should be identified.

Once the assessment form is filled out, any physiochemical sampling data used to make assessment decisions should be submitted as a data table on a separate piece of paper and electronically provided to the 305(b) coordinator. Include the following:

- The name or identification number of sampling station(s).
- The physiochemical data, including the dates the samples were taken, as well as data qualifiers and flags.
- Explanations of any flags or data qualifiers.
- Make notation if pH was measured in the laboratory rather than in-situ.
- Specify non-detections and the corresponding detection limit (e.g., ‘Non-detect at 0.1 mg/L’ or ‘< 0.1 mg/L’).
- Highlight any sampling result that exceeds an applicable water quality criterion.
- Explain all highlights in a footnote to the data table; if acute or chronic criteria apply specify which were exceeded.

- Compute the percentage of samples exceeding applicable water quality criteria, and note the percentage in a footnote to the table.

Chapter 3. Data Requirements and Assessment of Designated Uses for Section 305(b) Reporting

This chapter addresses the consideration of data sources, a necessary level of data quality and rigor, data sufficiency and the data types applicable for the various DU assessed. Table 3-1 provides a synoptic view of the DU and the core indicators that are used to determine use support. These topics and procedures lead to application of WQS to monitored data for DU assessment.

3.1 Data Sources

The DOW monitors and collects the majority of data used to develop the 305(b) and 303(d) lists. In addition to the overview of water resource monitoring programs provided in Section 1.3, the DOW accepts data from a number of local, university, state and federal partners. The following are external sources of data, with the particular BMU of focus for assessment driving the likelihood of a given local partner providing data. Other data sources are considered as they become available. Data without proper quality assurance is typically used for screening purposes.

- Kentucky Department for Fish & Wildlife Resources
- Kentucky Department for Natural Resources
- Kentucky Geological Survey
- Kentucky State Nature Preserves Commission
- Lexington-Fayette Urban County Government
- Louisville Metropolitan Sewer District
- Northern Kentucky Sanitation District #1
- Ohio River Valley Sanitation Commission (ORSANCO)
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- Universities: Eastern Kentucky, Kentucky, Louisville, Morehead State, Murray State and Western Kentucky

Table 3-1. Designated uses of Kentucky waters and the indicators used to assess designated use support.

Use	Aquatic Life	Primary or Secondary Contact Recreation	Fish Consumption[a]	Drinking Water[b]
Core Indicators	*Stream:* 1-2 biological communities: macroinvertebrates, and fishes[c] Dissolved oxygen Temperature pH Specific conductivity/TDS Chemical Parameters (i.e., priority and nonpriority) Sedimentation *Lake/Reservoir:* Dissolved oxygen Temperature pH Specific conductivity/TDS Parameters (nonpriority) Fish kills	*Stream:* Pathogen indicators: fecal coliform; *E. coli* pH *Lakes/Reservoir:* Pathogen indicators: fecal coliform or *E. coli* pH	Methylmercury Mercury PCBs Phenol Other fish consumption chemicals of concern found in water quality standards	Inorganic chemicals Organic chemicals Pathogen indicators: fecal coliform; *E. coli*
Supplemental Indicators	*Streams:* Diatom Flow *Lake/Reservoir:* Trophic State Index (TSI) Secchi depth Nuisance macrophytes Nuisance macroscopic algal growth Nuisance algal blooms	Nuisance macrophytes Nuisance macroscopic algal growth Nuisance algal blooms Suspended sediment (TSS) Odor Human toxic or behavioral response Debris Unnatural oil slick	N/A	Odor Taste Treatment problems caused by poor water quality

[a]Implied designated use per 401 KAR 10:031 Sections 2 and 6.
[b]All core indicators are based on "at the tap" Consumer Confidence Report received from the domestic water supplier.
[c]Biological communities are utilized in headwater and wadeable streams; assessment of boatable streams most often rely on chemical indicators only.

3.2 Data Sufficiency, Credibility and Quality

Data quality is of paramount importance for making 305(b) and 303(d) listing decisions. This is due to the fact that an incorrect data assessment may result in a listing error of a water body or segment. Should a water body not be listed as not supporting when that is the case, there are consequences to that decision just as there are when assessing a water body as not supporting its uses when it is. In the case of incorrectly assessing a non-supporting DU as supporting, this action may lead to potential human health risks and ecological impairment that go unaddressed, or be delayed. Likewise, incorrectly assessing a supporting DU may result in increased costs to regulated entities, communities and individual landowners.

The DOW's data are collected under Division-approved SOPs (http://water.ky.gov/Pages/SurfaceWaterSOP.aspx) applicable to the water quality parameters and biological communities per test or study. Quality assurance project plans (QAPP) are developed defining the minimum data quality and sufficiency. Data from sources outside of the DOW must be collected under the DOW's SOP or a particular agency's SOP that at least meet the minimum quality assurance and control requirements to the applicable DOW SOP. Volunteer data may be used by the DOW for assessment purposes, but those data must be collected under SOP that is at least equivalent to the applicable DOW SOP and a DOW-approved QAPP. Volunteer data not meeting quality objectives may be used for screening purposes.

Because of the complexity of making DU assessment determinations, a minimum level of rigor for data quality is necessary to provide reasonable assurance that the correct assessment decision has been reached. Figure 3.2-1 illustrates data sources, the assembly of data types by DU applicability and a decision point to assure data are of sufficient rigor to make a 305(b) assessment. These steps help to ensure that scientifically valid and informed conclusions are reached and provide a level of rigor and consistent processes that provide for legal defense of the final results. As science advances and WQS are updated, these changes can affect future assessments made on water bodies previously assessed under earlier water quality criteria. For example, conditions may change between the time of the assessment and the monitoring for TMDL development occurs; in such a circumstance the resource could now support the DU. If this occurs, just cause for delisting the 303(d) listed water body can be presented to EPA during the IR submission.

Information is presented in Tables 1 – 3, Appendix B to help determine whether sufficient data exist to make an assessment. The data hierarchies (U.S. EPA 2002, 1997) should be followed when determining the sufficiency of data and the appropriateness of their use. The Level of Information considers factors such as spatial/temporal coverage, data types and technical components.

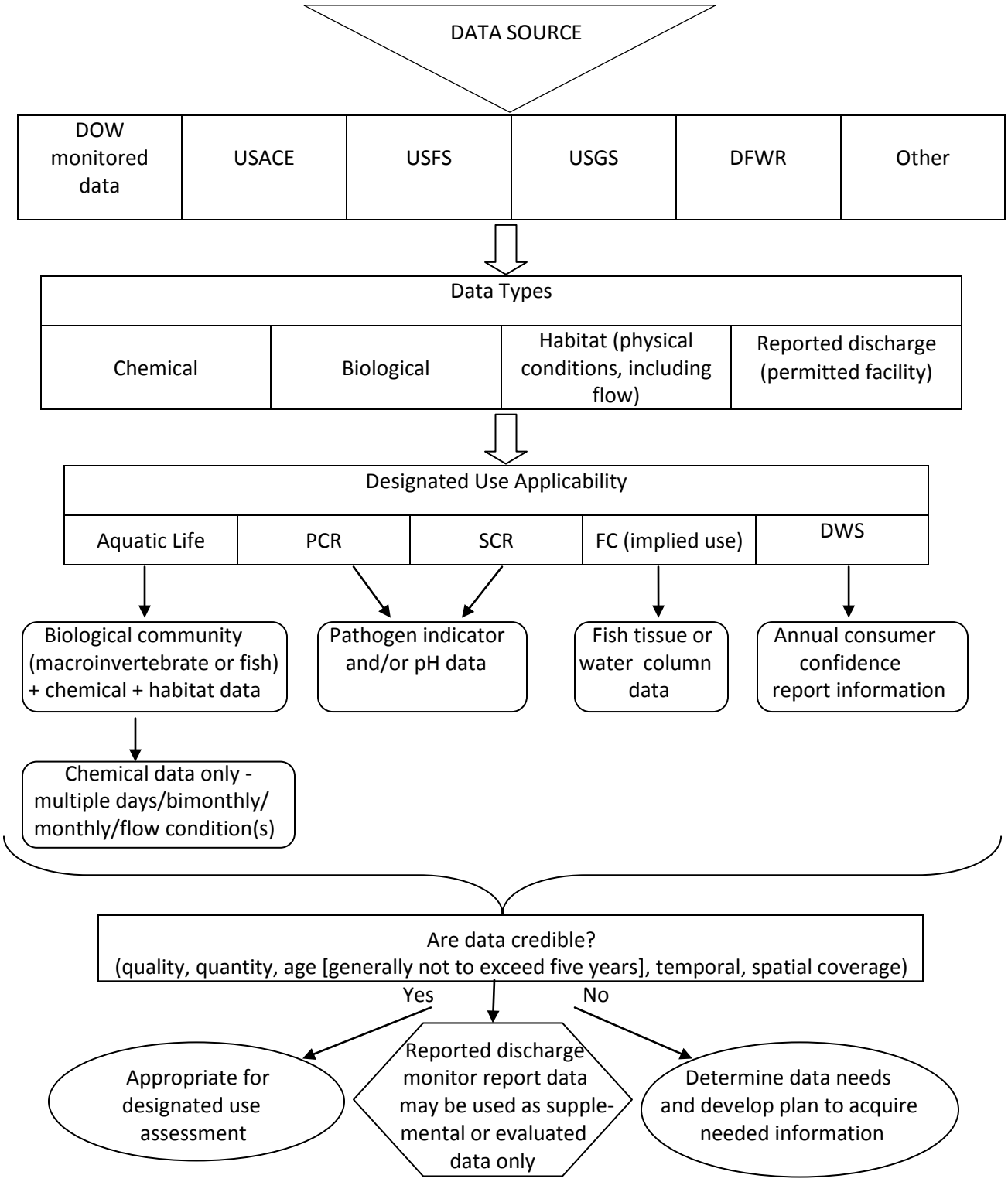

Figure 3.2-1. Sufficient and credible data determination procedures.

3.3 General Assessment Elements and Aquatic Life Use Assessment

Biological Information

Assessment of WAH or CAH is collectively termed aquatic life use. WQS provide criteria for the maintenance of the health and function of aquatic habitats. For a biosurvey investigation where only macroinvertebrates were collected, headwater streams are those that drain less than 5-mi^2; however, the cutoff for headwater streams for fishes is less than 6-mi^2. The MBI calibration defined wadeable streams as those draining 5-mi^2 (6-mi^2 considering fishes) or more, up-to approximately 250-mi^2 in drainage area (for fish use of the KIBI in catchment areas in the extreme range of its recommended use [>200 to 300 mi^2] must be done so with caution (DOW 2003). All watershed areas as previously defined may be adjusted slightly for individual watersheds where there is sound best professional judgment basis.

Large non-wadeable streams, or those generally greater than 250-mi^2, are assessed under different procedures and presented in the next subsection (C*hemical Information*). Assessment decisions involving headwater and wadeable aquatic life use attainment are primarily made using biological data obtained from monitoring programs within the DOW and agencies that meet data required rigor (e.g., USFS, USACE and USGS). Collection and especially taxonomic determination of biological communities requires considerable applied training or academic background with experience. Data analysis is then completed to assess whether the community composition represents a healthy environment. Also interpretation of additional information discerned from the functional structure of that community (i.e., the relationships between habitat disturbance gradient, pollutants and community composition and function) often provide insights by comparing the community present to the expected community for the water body type under evaluation. There are numbers of reasons biological data are important in making level-of-support decisions for aquatic life use. Biological communities (indicators) integrate conditions of their environment and thus serve as good long-term indicators of the environment (physical, chemical and habitat) they live in. The indicators for biology-based assessments are outlined in Table 3.3-1. The two indices used to make bioassessment support determination are incorporated into WQS by reference in 401 KAR 10:030 (http://www.lrc.ky.gov/kar/401/010/030.htm). Level of use support is dependent on the indicator community health and integrity as related directly to each multimetric index score narrative, along with chemical data and supplemental habitat evaluation information.

The DOW has enhanced its WQS through classifying uses of water bodies for aquatic life uses via tiering. Biological data can determine whether the CAH or WAH aquatic life use is met, and also determine the quality and system integrity of water bodies based on the results of biological community integrity. The biological multimetric indices, along with WQS developed to provide protection for qualities of aquatic resources in the Commonwealth, provide a strong program to not only assess level of use support, but to recognize and protect those water bodies and segments that exceed water quality conditions required to support the default uses. This is accomplished through categorization of Exceptional Water

in the Antidegradation Policy adopted in WQS, 401 KAR 10:030 (http://www.lrc.ky.gov/kar/401/010/030.htm). Additionally, the aquatic life DU, OSRW, has specific water quality criteria to enhance protection of those water bodies with high water quality and biological integrity (401 KAR 10:031).

Table 3.3-1. Biological criteria for assessment of cold or warm water aquatic habitat (headwater and wadeable streams) use support.[a]

Indicator	Fully Supporting	Partial Support	Non-support
Algae[b]	Diatom Bioassessment Index (DBI) Classification of excellent or good; biomass similar to reference/control.	DBI classification of fair; increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor; biomass very low (toxicity), or high (organic enrichment).
Macroinvertebrates	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high EPT, sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in relative abundance of sensitive taxa. Some alterations of functional groups (shift to mostly generalists) evident.	MBI classification of poor; EPT low, total number of individuals of tolerant taxa very high. Most functional groups missing from community.
Fishes	Kentucky Index of Biotic Integrity (KIBI) excellent or good; presence of uncommon, endangered or species of special concern.	KIBI fair. For example, reduction of native species, reduced darter, madtom and sculpin diversity and increased tolerant species.	KIBI poor, very poor, or no fish. Dominant community of tolerant individuals, loss of intolerant species

[a]Acronyms used in this table: EPT= Ephemeroptera, Plecoptera, Trichoptera; RA= relative abundance; TNI- total number of individuals.
[b]Indicator used in a supplemental capacity with fish or macroinvertebrate data; it is not used alone to make final use assessment decisions.

Chemical Information

The physical and chemical criteria adopted by the DOW into WQS are found in 401 KAR 10:031 (http://www.lrc.ky.gov/kar/TITLE401.HTM). These criteria are used to assist in the identification of pollutants that, when exceeded, may negatively affect biological

communities. In addition to the aquatic biocommunity indices, the core and supplemental chemical indicators are found in Table 3-1. These criteria may be used to assess aquatic life use alone as long as a sufficient number of samples are collected and the data are applied only to the spatial extent the monitoring rigor allows. Assessments have been made utilizing chemical data since the enactment of the CWA. In the early period, development of biological community quality and integrity indices had not occurred and the significant challenge of the time was controlling and abating chemical pollutant discharges to the aquatic environment. Currently, while biological multimetric indices are available for headwater and wadeable streams, chemical data are the primary tool to assess water quality in large rivers, often called boatable streams, in addition to manmade lakes and reservoirs. Chemical criteria encompass two classes of chemical parameters, priority and nonpriority pollutants. Examples of toxic pollutants (subset of priority pollutants) are mercury, methylmercury, benzene and DDT; a comprehensive list is available at: (http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=bd1b7f7d8f632c20259961d792e72b2e&rgn=div5&view=text&node=40:30.0.1.1.23&idno=40). Examples of nonpriority pollutants are pH, dissolved oxygen (DO) (low concentration), specific conductivity and temperature. The supporting documentation for national recommended chemical criteria are found at http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm and applicable criteria to Kentucky's aquatic habitats are located in 401 KAR 10:031 (http://www.lrc.ky.gov/kar/401/010/031.htm).

When biological community data are collected, at a minimum, in-situ nonpriority pollutant data are obtained with a multiparameter meter using EPA-approved sensor measurement methodologies (temperature, DO, percent DO saturation, pH, specific conductivity). In nearly all cases the DOW collects and has analyzed nutrients (nitrite + nitrate, ammonia, TKN, TP, total organic carbon) along with total suspended solids, chlorine, sulfate and alkalinity. Together, biological and chemical data provide a robust dataset for assessment.

Nonpriority pollutants and a suite of many priority pollutants are collected for analyses at the DOW's ambient water quality stations. The priority pollutants include metals at those ambient stations. Water quality parameter data are collected with the necessary frequency to assess aquatic life use support for nonpriority and priority (including toxic criteria) pollutants. Assessment methods for the applicable DU follow in Section 3.3.1.

3.3.1 Assessment Elements and Procedures

Assessment decisions are made with as many suitable data types as available; however, the majority of water bodies monitored and assessed for the first time have only one dataset consisting of biological community information coupled with one-time chemical grab samples and in-situ multi-parameter (DO, pH, specific conductivity and temperature) probe data for nonpriority water quality parameters. It is biological community data that provide the substantial rigor and evidence needed to make level-of-support decisions using datasets

with limited collection frequency. Adhering to Section 3.2 is critical in minimizing data error and thus reaching sound conclusions in decision making.

Once data are quality assured, the data must be categorized as either *monitored* or *evaluated*. The DOW prefers to make DU support decisions using in-stream data. Additionally, data (i.e., chemical data and biological data [the biological data may still be useful given those data represent an integration of biological, chemical and physical habitat conditions]) older than five years should generally not be used to make a use support decision (U.S. EPA 1997), unless it can be determined the data are still representative of current conditions. The greatest source of evaluated data is generated via the use of KPDES Discharge Monitoring Reports (DMR). The facilities where evaluated data are typically obtained through DMR are small dischargers, those that discharge up to 50,000 gallons per day; these facilities tend to have more frequent permit exceedences as opposed to larger dischargers. The majority of discharges from those systems occur in small watersheds with a 7Q10 (the lowest 7-day average flow that occurs on average once every 10 years) low-flow of zero. The age of DMR datasets utilized are no more than five years old when making the provisional non-support decisions. The DOW created the 305(b) Assessment

Category 5B to use with data of this type. The extrapolation of the DMR data to make an assessment may trigger follow-up inspection of the facilities. It would be inappropriate to use evaluated data to make a full support decision given the data are discharge results only.

Multimetric biological index results provide a tested, reliable foundation from which to make assessment decisions. Chemical data alone generally require more datasets to meet the minimum Level of Information (rigor) that include the frequency and temporal components necessary to detect exceedence of criteria and meet guidance for chemical-based use support decisions. Below are general examples of both data types that meet the level of rigor discussed:

- results from a biosurvey of one to two biological communities (fish or macroinvertebrates);
- a nonpriority pollutant standard that is exceeded once in conjunction with biological community score that has a narrative rating of fair, poor or very poor;
- nonpriority pollutant parameters monitored at least during key periods (e.g., spring or summer) or sampling over a period of months; or
- priority pollutant, provided monitored data are sufficient to capture the needed frequency, duration and magnitude.

The following section provides specific guidance necessary to assign Level of Information ratings with water body system type codes (Tables 1 – 3, Appendix B) to datasets when making concluding use-support assessment decisions.

3.3.2 Substantial and Reliable Data: Required Minimum Level of Information and Assessment

Once the data sufficiency and credibility are established, the monitored data rigor will meet an Information Level found in Tables 1 – 3 of Appendix B with a numeric interpretation of the narrative ranging from one to four, four being the greatest level of rigor. Each table contains three components for consideration when making the Level of Information decision for a dataset. These are: 1) technical components; 2) spatial/temporal coverage; and 3) data quality.

For illustrative purposes, most program data generated or obtained by the DOW for biological and habitat-based (Table 1 and 2, Appendix B) assessment is at Level of Information equaling three; however, some datasets reach a Level of Information of four (Table 1 and 2, Appendix B). Generally, habitat evaluations generated by the DOW equal a Level of Information of three.

Biological monitoring programs in the DOW typically include one-time grab samples of chemical data, this results in a Level of Information of two (Table 3, Appendix B); whereas, ambient monitored data produced through the Primary Stations network result in a Level of Information equaling three (Table 3, Appendix B). For third-party data a QAPP is important for the determination of the appropriate Level of Information the data represent. A decision tree is provided for assessments both with and without biological community data (Figure 3.3.2-1).

<u>Biology (Headwater and Wadeable Streams)</u>
The qualities required to achieve one of the four levels of information when making aquatic life use assessment decisions is found in Table 1, Appendix B. Use of at least one community, either macroinvertebrates or fishes, is required for synoptic (general overview) and probabilistic monitoring bioassessment. For assessment based on one monitored biological community the DOW utilizes a professional biologist, and thus the Level of Information is three when one community is collected. Often a Level of Information of four is obtained as the DOW generally collects both fishes and macroinvertebrates. Table 3-1 provides an overview of the primary and secondary indicators that are used in aquatic life use support assessment.

<u>Chemical</u>
Along with biological community data, the DOW includes chemical data as a monitoring component in all headwater and wadeable stream programs for aquatic life use assessment. Streams that are considered boatable or non-wadable may routinely have only chemical data. The minimum dataset for headwater and wadeable streams normally collected include temperature, pH, DO, percent DO saturation and specific conductivity. In addition, the DOW often collects a more comprehensive dataset that includes TP, nitrite + nitrate, TKN, ammonia, TSS, sulfate, chlorine, alkalinity and hardness.

When assessing DU support and nonpriority chemical data only comprise the dataset, the Level of Information should reach at least two. The minimum Level of Information needed

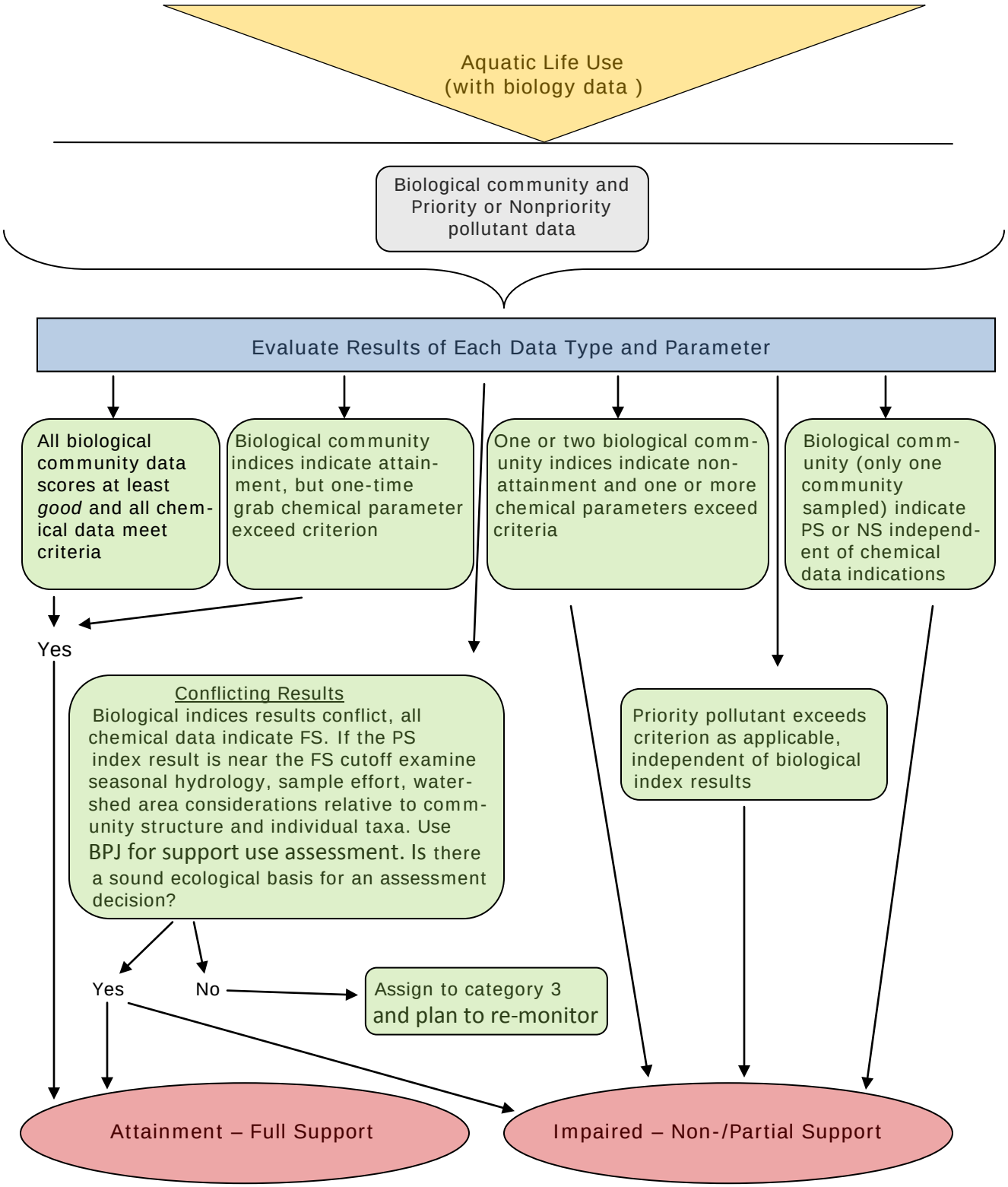

Figure 3.3.2-1. Decision tree for determination of assessment of the aquatic life designated use for monitored lotic waters.

for assessment of toxic pollutants must reach at least Level of Information three (Table 3, Appendix B).

Numeric Criteria

Nonpriority and Priority (i.e., the nontoxic parameters) pollutants are assessed by the DOW incorporating EPA guidance (U.S. EPA 2002, 1997). Water quality data are compared to criteria contained in Kentucky Water Quality Regulations (401 KAR 10:031). The segment fully supports WAH use when a pollutant criterion (e.g., dissolved oxygen, temperature and pH) is not met in 10 percent or less of the samples collected. Impaired, partially supporting, if any one criterion for these parameters is not met in greater than 10 – 25 percent of the samples. A segment is impaired, not supporting, if any one criterion is not met in greater than 25 percent of the samples (Table 3.3.2-1). Pollutants other than toxic criteria require at a minimum multiple samples collected during a month, bimonthly or quarterly for assessment. Appendix B, Table 3 offers guidance on decision making when considering assessment; the DOW requires a minimum of Level of Information of 2 be met in the absence of confirming biological data.

Table 3.3.2-1. Nonpriority and priority pollutants (excluding toxic pollutants) criteria assessment.

Level of Support	Fully Supporting	Impaired	
		Partially Supporting	Non-supporting
Percent of samples exceeded	≤10 %	>10 – 25 %	>25 %

Priority (i.e., the toxic parameters) pollutants are assessed by the DOW incorporating EPA guidance (U.S. EPA 2002, 1997). The DOW requires a minimum Level of Information of three be met to assess toxic parameters, per guidance (Appendix B, Table 3). For a list of the toxic subset of priority pollutants, please see Appendix D, Table 1. Generally, a minimum of quarterly samples over a three year period is needed to have sufficient frequency to pick up acute events.

Aquatic life is considered protected if acute and chronic criteria are not exceeded more than once every three years. A water body segment where an acute criterion is exceeded more than once within a three year period with at least quarterly sampling will be assessed not meeting the CAH or WAH DU (Appendix B, Table 3). It is impaired, partially supporting, if any one criterion is not met more than once but in 10 percent or less of the samples. The segment is impaired, not supporting, if criteria are exceeded in greater than 10 percent of the samples (Table 3.3.2-2).

Results are compared to chronic criteria using three years of bimonthly or more frequently collected data. Observations that equaled chronic criteria are not considered to exceed WQS. The segment is fully supporting CAH or WAH use if criteria are exceeded in no more than one sample over a three year period. Impaired, partially supporting if any criterion is not met in greater than one sample, but in 10 percent or less of samples. The segment is impaired, not supporting if any criterion is exceeded in greater than 10 percent of samples (Table 3.3.2-2). The assessment criteria were closely linked to the way state and federal water quality criteria were developed.

Table 3.3.2-2. Toxic pollutant criteria assessment.

	Fully Supporting	Impaired	
		Partially Supporting	Non-supporting
Number of Exceedences	No more than 1 in 3 years	More than 1 in 3 years, but less than 10 % of samples	More than 1 in 3 years and greater than 10 % of samples

While three years of quarterly or more frequent sample collections are preferred for toxic criteria assessment decisions, there are exceptions where less than three years of data may be considered. Assessment may occur in instances of overwhelming evidence of toxicity concerns where multiple samples are collected and a criterion is exceeded by a magnitude of concentration or frequency of excursions that indicate a toxic condition; thus, supporting a reliable impairment decision.

Narrative Criteria

While most water quality criteria in standards are numeric, there are certain standards based on narrative criteria (narrative criteria are implemented as are numeric criteria – both defined to be protective of the applicable DU). This includes nutrients, conductivity and minimum general criteria applicable to all surface water to protect the aesthetic and recreational qualities, and beneficial uses in general. Assessments are made in the following manner to protect against a (cultural) eutrophication problem.

The narrative **nutrient criterion**, 401 KAR 10:031 Section 1:

> *Nutrients shall not be elevated in a surface water to a level that results in a eutrophication problem*.

The guiding interpretation of the nutrient criterion is found in the definitions chapter of WQS, 401 KAR 10:001 Section 1(30):

> *"Eutrophication" means the enrichment of a surface water with nutrients nitrogen and phosphorus resulting in adverse effects on water chemistry and the indigenous aquatic community. Resulting adverse effects on water chemistry manifest by daily dissolved oxygen supersaturation followed by low dissolved oxygen concentrations and diurnal increase in pH. Resulting adverse effects on the indigenous aquatic community include:*
>
> *(a) Nuisance algae blooms;*
>
> *(b) Proliferation of nuisance aquatic plants;*
>
> *(c) Displacement of diverse fish or macroinvertabrate community by species tolerant of nutrient-enriched environments; or*
>
> *(d) Fish kills brought on by severe, sudden episodes of plant nutrient enrichment.*

A vital part of monitoring is that field personnel document all conditions that may be associated either with or potential degradation of the water body when collecting physical, chemical or biological data. This information is useful when interpreting data for application of narrative criteria. Algae blooms that negatively affect the aquatic habitat include potentially toxic blue-green blooms and macroalgae growth that smother benthic or physically obscure water column habitat. Proliferation of nuisance aquatic plants can have similar effects on the aquatic habitat, affecting spawning, displacing resident biota and the indigenous community structure. This proliferation of excessive algae and plant growth creates stressful environmental conditions. Some examples of excessive conditions that may result in nuisance conditions include the physical area of benthic algae coverage, sestonic algae creating obvious turbid conditions, floating algae, harmful algae blooms or macrophyte rafts.

Two important water quality response variables to nutrient stress (e.g., nitrogen and phosphorus) are DO and pH. These response variables are important data components when interpreting the nutrient criterion. DO concentrations that are unstable, having large swings involving supersaturation and concentrations falling below about 4.5 mg/L in a 24-hour period, coupled with increased pH, are indications of excess nutrient concentrations, persistence of such conditions may lead to eutrophic problems.

Since both DO and pH are important in the determination of increased or excess nutrient enrichment that could result in a (cultural) eutrophication problem, knowing the general time of day the data are collected is an important factor when interpreting nutrient related responses. For the DOW, nearly all sampling occurs between late morning and early evening, which is the time of greatest plant and algae use of carbon dioxide and the resultant release of oxygen. Excess nutrient enrichment conditions trigger a response in the concentration of diurnal (and diel) DO and a response in pH in the presence of excess

nutrients during the growing season (April through October). From late morning into early evening those two response variables often will result in the percent DO saturation exceeding approximately 105 percent coincident with elevated pH greater than 8.5 SU; these are general conditions associated with plant nutrient enrichment. Consideration of the macroinvertebrate community structure for nutrient-tolerant taxa and the related functional structure, or excessive algae/plant growth are additional important elements of the aquatic conditions to take into account when assessing a DU as less than fully supporting.

Minimum General Criteria

The narrative minimum general criteria, 401 KAR 10:031 Section 2:

> *Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:*
>
> *(a) Settle to form objectionable deposits;*
>
> *(b) Float as debris, scum, oil, or other matter to form a nuisance;*
>
> *(c) Produce objectionable color, odor, taste, or turbidity;*
>
> *(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;*
>
> *(e) Produce undesirable aquatic life or result in the dominance of nuisance species;*
>
> *(f)1. Cause fish flesh tainting.*
>
> *2. The concentration of phenol shall not exceed 300 μg/L as an instream value.*

(2) The water quality criteria for the protection of human health related to fish consumption in Table 1 of Section 6 of this administrative regulation are applicable to all surface water at the edge of the assigned mixing zones except for those points where water is withdrawn for domestic water supply use.

(a) The criteria are established to protect human health from the consumption of fish tissue, and shall not be exceeded.

(b) For those substances associated with a cancer risk, an acceptable risk level of not more than one (1) additional cancer case in a population of 1,000,000 people, or 1 x 10^{-6} shall be utilized to establish the allowable concentration.

Criteria for each of those general pollutants in Section 2(1)(a – f)1 are promulgated to protect basic water quality and aesthetics from degradation and any acutely toxic substance for which numeric criteria do not exist. Each of these general criteria is applied based on

the DU that may be negatively affected. Those criteria in *(a)*, *(b)*, and turbidity of *(c)* are primarily associated with PCR and SCR uses. The criteria found in *(d)* and *(e)* are applicable to aquatic life use, PCR and SCR *(f)1* and *2* to fish consumption. The taste and odor component is applicable to drinking water use.

These criteria are interpreted for assessment through methods and associated indicators particular to each applicable use. The criteria in *(a)*, *(b)*, and turbidity in *(c)* should be considered in the context of the ability to use a water body for swimming, paddle sports, general boating, and aesthetic enjoyment of the water body (i.e., PCR and SCR). The criteria in *(a)*, *(c)* (color and turbidity), *(d)* and *(e)* may be interpreted through biological community composition and chemical information. Color is associated primarily with water quality that may affect aquatic community composition as in some dystrophic lakes; whereas, odor and taste are qualities most often associated with domestic water supply use. Potable water sources that are negatively affected by nutrients and eutrophic conditions often result in taste and odor problems, requiring costly filtration processes to produce a palatable product; turbidity is often a concern in nutrient-enriched water bodies. Reoccurring seasonal conditions with these problems may lead to less than full support of the DWS use.

Protection against fish flesh tainting is provided through (Section 2(1)2 and 2(2)(a,b)). There is a numeric criterion for phenol in Section 2(1)(f)2 (CAS # [Chemical Abstract Number] 108952) of 300 µg/L, while Section 2(2)(a,b) refers one to criteria located in Section 6, Table 1 of Chapter 10:031 for specific numeric human health criteria to protect the resource for fish consumption.

<u>Aquatic Life</u>
Warm water aquatic habitat, 401 KAR 10:031 Section 4 (narrative criteria with guidance follow in this section, the numeric application is provided in section 3.3.2-1 *Numeric Criteria*, above).

Section 4. Aquatic Life. (1) Warm water aquatic habitat. The following parameters and associated criteria shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arboreous growth, agricultural, and industrial uses:

(c) Flow shall not be altered to a degree that will adversely affect the aquatic community;.

Flow is a critical element of the physical habitat; it determines the community composition that naturally inhabits lotic waters, as opposed to lentic-adapted aquatic communities. If flow is altered to some appreciable degree, chemical characteristics such as change to the REDOX (reduction-oxidation) potential, DO and temperature, may be adversely affected. In addition, the alteration of the flow regime can alter the trophic dynamics of streams and rivers. These conditions resulting from flow alterations, in turn, alter the indigenous biological community composition.

Water bodies and segments where the biological community index (particularly sensitive is the macroinvertebrate community) indicate less than a score of *good* may be impacted by altered flow, in addition to, or without, observed chemical impairments. Community composition relative to trophic structure is important in recognizing some flow regime related impairments. For example, in headwater or wadeable streams (generally 1st – 5th [be aware some 5th order streams function as an autotrophic system] Strahler stream order) a shift from the generally shredder-collector-gatherer functional taxa to the scraper-filterer taxa that more generally represent $\geq 6^{th}$ (and some 5th) Strahler stream order systems. Dams or other structures that restrict or otherwise modify the natural flow regime often result in a shift of the natural functional feeding species to those associated with filtering suspended fine particulate organic material most common to autotrophic, less erosional systems.

Results where flow and physical habitat alone (i.e., pollution rather than a pollutant, keep in mind sediment is a pollutant) are the only recognized contributors to impairment, this case will result in the aquatic life use assessed and assigned to category 4C. In this scenario, if an additional cause is a pollutant (e.g., DO) that exceeds the criterion, the segment or water body is placed in category 5; included in the causes of impairment on the assessment sheet are the pollutions, for example *Other flow regime alterations* (refer to Appendix D).

3. A successful demonstration concerning thermal discharge limits carried out pursuant to Section 316(a) of the Clean Water Act, 33 U.S.C. 1326, shall constitute compliance with the temperature requirements of this subsection. A successful demonstration assures the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife in or on the water into which the discharge is made;

(f) Total dissolved solids or specific conductance. Total dissolved solids or specific conductance shall not be changed to the extent that the indigenous aquatic community is adversely affected.

Specific conductivity is a surrogate measure of total dissolved solids (TDS) and is a common measure of pollutants that adversely affect the aquatic community at concentrations that exceed a natural range typical for conductivity/TDS of a water body. This pollutant affects many sensitive species of a healthy aquatic community, potentially resulting in a depauperate assemblage of taxa; especially sensitive are the mayflies (Ephemeroptera). The eastern portion of Kentucky that encompasses ecoregions 68, 69 and 70 is typically naturally low in TDS and therefore conductivity. In these ecoregions, as specific conductivity exceeds 300 µS/cm the MBI score will most often be below the *good* narrative rating indicating less than full support. Therefore, this is a breakpoint where conductivity should be listed as a pollutant when supported by a biological index score indicating the use is not supported. Other ecoregions outside eastern Kentucky where low conductivity may be naturally occurring are Ecoregions 73 and 74, known locally as the Jackson Purchase. For much of the remaining regions of the state conductivity is naturally higher due in large

extent to the geology; thus, aquatic communities are adapted to those local (regional) conditions. Evaluation of the community structure is warranted when investigating possible listing of conductivity as a pollutant (cause), especially if the mayflies are absent or poorly represented in the macroinvertebrate community. In the ecoregions outside of ecoregions 68, 69, 70, 73 and 74 caution should be exercised when tying the impairment to conductivity.

(g)Total suspended solids. Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected;
(h) Settleable solids. The addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities shall be prohibited.

The standard *g* contain the criterion to protect against TSS (total suspended solids) (e.g., mineral-based such as silt and clay), but may include organic materials. The ambient network provides data on a watershed and ecoregional scale to determine long-term ambient conditions for TSS from which to compare the test water body. The following are DU that are likely to be adversely affected by excess total suspended solids: (a) recreation (swimming); (b) aquatic life (potentially impacts light penetration and sestonic and benthic communities); and (c) drinking water supply (DWS producers may handle TSS without problem). Observation and/or measurement of total suspended solids are necessary to assess this criterion. Levels of TSS that are deemed to impact swimming, aquatic life or drinking water DU must be evaluated based on TSS results, observation and reports. Heavy, ongoing levels of turbidity that impact the water column perpetually with every rain and persists for some time thereafter could result in the listing of TSS, especially if a biosurvey finds sedimentation/siltation impacting the in-stream habitat; another impact under that scenario may be a reservoir where this condition impacts swimming.

TSS is often associated with, and more apparent through, the manifestation of *h*, settleable solids. The criterion for TSS is most often represented in a water body by bottom sediments of sand, clay and silt. To assess this standard, one should have two important pieces of information, the habitat rating and narrative, and observe the biological community structure (especially the benthic macroinvertebrates) if available. For stream (lotic) habitats pay attention to the frequency and presence of riffles, runs and pools with respect to habitat and sedimentation (settleable solids). Streams where pools are no longer deep and are either filled or partially filled with sediment taking away this habitat function are obvious indicators of excess sediments in the system – an indication of the inability for the stream to manage the excess sediment load. Additionally, riffles are the single most important habitat to healthy headwater and wadeable streams. As such, they are targeted for sample collection of macroinvertebrates and fish populations. If the riffles are sedimented-in, show beginning stages of, or are embedded, obstructing the diversity of micro-niches (habitats) for lotic communities, then each of these conditions are indicative of the pollutant sedimnets/siltation. Again, relative expectations to the type of system (high- or low gradient streams), ambient condition of supporting streams, and the use of the

reference conditions benchmark, should all be taken into consideration in data evaluation for assessment.

Habitat

Physical habitat is evaluated using qualitative and semi-quantitative measurements of both in-stream and riparian vegetation zone characteristics. This includes the extent and integrity of the riparian vegetative zone, stream macrohabitat, hydrologic function and morphologic characteristics based on stream type. Notation and possible photographic documentation of surrounding land uses, and a description of any observable sources of potential pollutants, should be included. Since this set of information is used only ancillary to biological or chemical in-stream data, an acceptable minimum Level of Information for consideration is 2 (Table 4, Appendix A).

Assessment Dataset

Once the suite of data available for consideration is compiled and the data quality, credibility and sufficiency are determined, the DOW makes the final assessment decision. Figure 3.3.2-1 illustrates the amalgamation of potential datasets to reach final use support assessment decision for aquatic life use. Boatable (non-wadeable) streams will normally only have chemical data, but the dataset will typically be multiyear with a collection frequency of monthly and bimonthly and contain a suite of both conventional and toxic pollutants.

Outstanding State Resource Waters

Those aquatic resources that support federally threatened or endangered species are promulgated with the DU of OSRW and the listed species identified on the Special Waters webpage (http://eppcapp.ky.gov/spwaters/). The loss or measured (e. g., using semi-quantitative transect methods) declining trend of one of these populations constitutes an impairment of use. Since most data obtained are USFWS contracted studies and typically not quantitative, statistical analysis is not typically an option. Documented mortality (e.g., recent mussel die-off as indicated by the [fresh] condition of empty shells) of individuals of the listed species that indicate an important population reduction, or absence, constitutes impairment. Additionally, to protect the federally listed population, the regulation states that existing habitat and water quality shall be maintained; therefore, water quality and habitat quality that were present at the time the water body was accepted for inclusion as an OSRW should, if available, be compared with future datasets to assure there is no decline. A measured important decline indicates impairment of the DU. Waters where previously unknown or newly listed populations of federally threatened or endangered species inhabit are automatically included in each triennial review of WQS.

Those OSRW that are listed under the permissible conditions in 401 KAR 10:031 Section 8(1) 1 and 2 are afforded the protection of sections 1 – 6 of 401 KAR 10:031 and 401 KAR 10:031(2)(a), at a minimum. As of 2015, only one OSRW is promulgated (as of 2015) due

to these provisions, Jessamine Creek, Jessamine County. Any applicable WAH or CAH criterion that exceeds the standard results in impaired listing for both WAH and OSRW.

OSRW that qualify via provisions in 401 KAR 10:031 Section 8(2)(b) that are listed as Exceptional Waters in 401 KAR 10:031, Section 1(2) shall have at a minimum DO maintained at 6.0 mg/L as a 24-hour average and instantaneous DO maintained at 5.0 mg/L. The non-attainment of the DO criterion constitutes impairment of the OSRW DU. Any applicable criterion to WAH or CAH that exceeds the standard result in the impaired listing of both WAH or CAH and OSRW.

Lakes and Reservoirs

Lakes and reservoirs are assessed for aquatic life use by measuring several chemical indicators, in conjunction with confirmed reported or observed fish kills or nuisance algae blooms. Those confirmed observed or reported conditions must be tied to general water quality conditions rather than a brief episodic (up to several days) event. Harmful algal blooms (HAB) are part of the nuisance algae blooms category. The DOW started monitoring for HAB in 2013 and has coordinated with the USACE, the state health department and other agencies as appropriate. Without EPA recommended safe drinking water MCLs in finished water for HAB-related toxins, the DOW currently considers the World Health Organization (WHO) threshold of 1 µg/L for microcystin as indication of safe levels in finished drinking water.

The lack of a community-based biological indicator is primarily due to the fact that these resources are most often manmade, thus supporting altered and unnatural biological communities such as benthic organisms that are often composed of tolerant species (e.g., Tubificidae, *Chironomus* spp., *Chaoborus* spp., *Glyptotendipes* spp.) that are capable of exploiting this often DO-stressed environment. Thus, the core and supplemental indicators shown in Table 3-1 are of utmost importance to assure water quality conditions are suitable for supporting sportfish and associated prey fishes. Healthy populations of these fishes are the primary management concern for aquatic life use in many of these habitats. With all downstream water bodies, the reservoir monitoring programs aids in the effort to ensure downstream (below dam) DUs are supported.

DO is a key indicator of the health of a lake or reservoir. Profiles of DO concentration are produced in every monitored lake or reservoir, along with percent DO saturation, pH and specific conductivity. Under seasonal sampling conditions, these water bodies are stratified from mid-spring and usually until the second-half of September. Those stratified water bodies supporting the use should always have a DO concentration at or above 4.0 mg/L throughout the epliminon (region of the trophogenic zone) and will exhibit a gradually decreasing DO concentration in the metalimnion. In a stratified lake, the hypolimnion overlays the profundal zone – this region is a concentrated area of decomposition containing the tropholytic zone – where DO depletion is common with increased carbon dioxide (CO_2) production. The pH and conductivity may increase with depth in many reservoirs due to the increased organic matter associated with the profundal habitat; however, there may be

lower pH in the profundal zone due to elevated CO_2, enhancing conditions favorable for carbonic acid production.

Trophic state in lakes and reservoirs is determined using the Carlson TSI (trophic state index) for chlorophyll *a*. Based on the TSI, lakes and reservoirs are ranked numerically according to increasing trophic state, the numeric ranges correspond to oligotrophic, mesotrophic, eutrophic, and hypereutrophic states. The growing season (April through October) average TSI value is used to rank each lake. For reservoirs with one sample station, the average growing season TSI is calculated. Lakes and reservoirs with multiple stations are calculated the same way, calculating each seasonal TSI per station, then average each station by itself, followed by averaging all station TSI values to get the water body TSI. The current and historic TSI (especially if it has increased and crossed trophic states) are both taken into account when assessing these water bodies. Increased TSI does not independently equate to non-supporting conditions, but over time may be symptomatic of cultural nutrient enrichment.

While it is often reasonable to make an integrated assessment for lakes and reservoirs, there are circumstances where one may need to divide the water body into sections or zones. For example, a particular embayment might exhibit markedly different water quality conditions from the rest. This result may trigger an embayment of a large lake to be assessed independently from the remainder of the water body.

3.4 Assessment of Primary Contact Recreation Use

Primary contact recreation use and associated criteria are developed to protect swimmers and other recreationalists who plan to expose themselves to full body immersion. Both fecal coliforms and *E. coli* are indicators of the likelihood for the presence of pathogens in a water body. Although both indicators are in the DEP regulations, *E. coli* is the preferred indicator because it has a stronger association with pathogenic agents and therefore it is the bacterium indicator regularly collected and analyzed by DOW for PCR use support. Currently, the DOW will assess PCR based on fecal coliform data; however, this criterion is planned to sunset and language to phase it out is anticipated during the 2015 triennial review of water quality standards.

The applicable criteria (401 KAR 10:031 Sections 2(1)(a – e) and 7(1)) in WQS apply to this DU from May 1 through October 31. Regulation 401 KAR 10:031 Section 2(1)(a – e) apply as noted in Section 3.3.2 “Narrative Criteria” above. The two numeric criteria applicable are bacteria (*E. coli*) and pH. Determination of use support based on bacteria follows:

<u>Single Sample Maximum Criterion</u>

- fully supported when the single sample maximum is not met in ≤20 percent of six monthly samples collected over the six month recreation period (if only five [minimum for assessment] monthly samples could be collected, than if the criterion is not met in two or fewer of the five samples it is considered fully supported);

- partially supported if the criterion is not met in >20 to 33 percent of those samples collected over the six month recreation period; and
- not supported if the criterion was not met in >33 percent of those samples collected over the six month recreation period.

<u>30-Day Geometric Mean Criterion</u>

- fully supported when the geometric mean of five samples collected during a 30-day period during the six month recreation period do not exceed the 30-day criterion;
- partially supported when the geometric mean of five samples collected over a 30-day period during the six month recreation period exceed the criterion; and
- not supported when the geometric mean of two sets of five samples collected in differing 30-day periods exceed the criterion of the six month recreation period.

In addition, the water quality parameter pH applies to PCR use. The criterion for pH may range between 6.0 – 9.0 SU, but cannot vary more than 1.0 SU over a 24-hour period. Where applicable, the criterion is applied to any water body to determine use support as follows:

- fully supported when the criterion is exceeded once, but in <10 percent of the samples during the recreation season;
- partially supported when the criterion is exceeded in >10 to 25 percent of samples collected;
- not supported when the criterion is exceeded in >25 percent of samples during the recreation season.

The narrative minimum general criteria, 401 KAR 10:031 Section 2, applicable to PCR follows:

> *Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:*
>
> *(a) Settle to form objectionable deposits;*
>
> *(b) Float as debris, scum, oil, or other matter to form a nuisance;*
>
> *(c) Produce objectionable color, odor, taste, or turbidity;*
>
> *(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;*
>
> *(e) Produce undesirable aquatic life or result in the dominance of nuisance species.*

Any material such as sediment, silt, turbidity (cloudy water), excess trash (either submerged or floating), oil slicks (unnatural), unpleasant odor, that form and have more than an ephemeral presence (i.e., has some persistence that is greater than two days) and precludes recreational activity associated with PCR (swimming/bathing) apply to this DU and may result in non-support. Section 2(1)(e) particularly applies to lakes and reservoirs, but equally applies to streams if conditions exist. Any lake or reservoir where swimming is not restricted (e.g., many DFWR managed water bodies prohibit swimming) that has rooted or floating aquatic plants or algae restricting reasonable access to open water for swimming may result in non-support of the PCR DU.

Regulation 401 KAR 10:031 Section 2(1)(d) has a human health component that if conditions are met results in non-support of this DU. An example of a condition applicable to the criterion is toxins produced at a level by blue-green algae (often considered a nuisance species) that may result in adverse human physiological or behavioral reactions.

3.5 Assessment of Secondary Contact Recreation Use

Secondary contact recreation use and associated criteria are in place to protect the recreationalist when activity does not involve full body emersion (e.g., incidental contact or wading). Pathogen-indicating bacteria, fecal coliforms, and pH are the principle indicators established to determine SCR support.

The applicable criteria (401 KAR 10:031 Sections 2(1)(a – e) and 7(2)) in WQS apply to this DU year-round. Regulation 401 KAR 10:031 Section 2(1)(a – e) apply as noted in Section 3.3.2 “Narrative Criteria” above. The two numeric criteria applicable are fecal coliforms and pH. Determination of use support based on fecal coliforms follows:

<u>Single Sample Maximum Criterion, minimum of six monthly samples collected during a calendar year for assessment</u>

- fully supporting when the criterion is exceeded in ≤20 percent;
- partially supporting if the criterion is exceeded in >20 to 33 percent of samples; and
- non-supporting if the criterion is exceeded in >33 percent of samples.

<u>30-Day Geometric Mean Criterion</u>

- fully supporting when the geometric mean of five samples collected during a 30-day period does not exceed the criterion;
- partially supporting when the geometric mean of five samples collected during a 30-day period exceed the criterion; and
- non-supporting when the geometric mean of two sets of five samples collected in differing 30-day periods exceed the criterion.

In addition, the water quality parameter pH applies to SCR use. The criterion for pH may range between 6.0 – 9.0 SU, but cannot vary more than 1.0 SU over a 24-hour period. The water body assessed for this water quality criterion follows:

- fully supporting when the criterion is exceeded once, but ≤10 percent of the samples during the recreation season;
- partially supporting when the criterion is exceeded in >10 to 25 percent of samples collected;
- non-supporting when the criterion is exceeded in >25 percent of samples.

The narrative minimum general criteria, 401 KAR 10:031 Section 2(1)(a – e) applicable to SCR follows:

> *Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:*
>
> *(a) Settle to form objectionable deposits;*
>
> *(b) Float as debris, scum, oil, or other matter to form a nuisance;*
>
> *(c) Produce objectionable color, odor, taste, or turbidity;*
>
> *(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;*
>
> *(e) Produce undesirable aquatic life or result in the dominance of nuisance species.*

Any form of material such as sediment, silt, turbidity (cloudy water), excess trash (either submerged or floating), oil slicks (unnatural), unpleasant odor, etc., that form and have more than an ephemeral presence (i.e., has some persistence that is greater than two days) that precludes recreational activity associated with SCR (e.g., paddlesports, boating, wading, fishing) apply to this DU and may result in non-support. Section 2(1)(e) listed above particularly applies to lakes and reservoirs (although uncommon to local streams it equally applies to those water body types if conditions warrant). Any lake or reservoir that has rooted or floating aquatic plants or algae restricting reasonable access or precludes a recreational activity such as fishing may result in non-support of the SCR DU.

Regulation 401 KAR 10:031 Section 2(1)(d) has a human health component that if met results in non-support of this DU. An example given in the previous section applies equally for SCR under conditions that may result in adverse human physiological or behavioral reactions.

3.6 Assessment of Fish Consumption

Fish consumption is not a DU per state regulation. However, there exists human health criteria in WQS for the protection of the population should they choose to catch or buy local

fish flesh for consumption. Examples of pollutants of concern are methylmercury and PCBs. Those core and supplemental indicator pollutants are identified in Table 3-1. Applicable criteria may be found in WQS 401 KAR 10:031 Sections 2 and 6.

In 2001 the EPA issued a national recommended criterion for methylmercury (greater than 0.3 mg/Kg) in fish tissue for the safe consumption of fish flesh. For purposes of assessment, the arithmetic average methylmercury concentration of the composite samples is compared to the criterion for exceedence of 0.3 mg/Kg methylmercury. Each trophic level is treated equally with no assumed proportion of consumption made. Determination of use support based on this pollutant follows:

- fully supporting when fish tissue residue is ≤0.3 mg/Kg;
- partially supporting when fish tissue residue is >0.3 mg/Kg to 1.0 mg/Kg; and
- non-supporting when fish tissue residue is ≥1.1 mg/Kg.

Composite filet samples of fish species are collected per SOP (http://water.ky.gov/Documents/QA/ProceduresforResectionofFishFilletsandHomogenizationofTissueSamples.pdf), concentrating on trophic levels 3 (e.g., bluegill, longeared sunfish, and crappie) and 4 (e.g., large- and smallmouth bass, walleye, sauger, muskie). Larger (older) individuals in a population are targeted for collection given they usually represent the greatest potential contamination of methylmercury. Each composite sample of fish are represented by the same species and are of similar size so that the smallest individual is no less than 75 percent of the total length of the largest individual (USEPA 2000).

The Food and Drug Administration (FDA) protocols for fish consumption advisories for PCBs are based on fish tissue residue concentrations which are triggered when tissue residue exceeds 0.2 mg/Kg. The ranges below are based on the FDA concentration limit that is recommended not to exceed the 0.2 mg/Kg and are utilized to determine whether the implied fish consumption use is fully supported or not. The concentrations at which various degrees of support follow:

- fully supported when the average of composite fish tissue samples is ≤0.2 mg/Kg;
- partially supported when the average of composite fish tissue samples is >0.2 mg/Kg to 1.0 mg/Kg; and
- not supported when the average of composite fish tissue samples is ≥1.1 mg/Kg.

3.7 Domestic Water Supply Use

The MCLs in WQS applicable to this use are found in 401 KAR 10:031. While this DU applies to all water bodies in the Commonwealth, the use is only implemented (via criteria, 401 KAR 10:031) at the point of water withdrawal by a public treatment facility. Public water systems are defined as those systems that have at least 15 service connections or regularly serve an average of 25 or more individuals (40 CFR 141.2)

(http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/pdf/CFR-2010-title40-vol22-sec141-2.pdf). In addition, the Commonwealth regulates facilities that are known as "semi-public" water systems. These serve more than three residences, but are smaller than public water systems.

This use is primarily assessed through compliance with the MCLs in finished water (Table 3-1). A treatment facility's finished product must meet all non-disinfectant by-product MCLs (because the DU is assessed for the source water quality) based on the annual average of the quarterly sample results. An exceedence or violation of an MCL reported in the CCR indicates less than full use support of the water body. The DOW considers four or five years for DU assessment. If available, the DOW will consider in-stream data and compare against the standards for DWS; gradations of use support assessment are as follows:

- fully supported if all MCLs are met as reported in the CCR or if all criteria are not met in ≤10 percent of samples collected from the point of withdrawal;
- partially supported if one MCL exceeds the criterion in the CCR or in-stream data at point of withdrawal exceeded any criterion in >10 – 25 percent of samples; and
- not supported if two or more MCLs exceed the criteria per the CCR or in-stream data at point of withdrawal exceed any criterion in >25 percent of samples.

3.8 Threatened Use Assessment Category

This category is used for water bodies that currently support the DU, but are not expected to in the future. This determination requires placing the water body into Category 5 (U.S. EPA 2005) and therefore on the 303(d) list requiring a TMDL, 40 CFR 130.7(b) (http://www.gpo.gov/fdsys/pkg/CFR-2007-title40-vol21/pdf/CFR-2007-title40-vol21-sec130-7.pdf). For the water body to be considered threatened, datasets must indicate a clearly declining aquatic community or water quality trend over time. Valid statistical methodology should be applied indicating the decline and show the projected trend will result in the water body not fully supporting the DU by the date of the next listing cycle (the listing cycle is every two years).

3.9 Determining Extent of Coverage for Use Assessment

In general, the more robust the dataset the greater the confidence will be when determining the extent of the assessment results. Determination of the extent of coverage of an assessment is variable and the following are some initial considerations:

- stream order or relative volume to area drained;
- data type, chemical only or biological and chemical;
- frequency of data collection;
- period of data record; and
- predominant land uses downstream, but especially upstream of the sample locations.

Ambient Water Quality – Aquatic Life, PCR and SCR

Stations monitored for chemical parameters only typically occur at the ambient network locations; however, some may have biological data. These stations are usually located in large watersheds, the mid-points and downstream lower drainage reaches of 8-digit HUCs. These stations are monitored for a robust set of parameters that are sampled frequently, monthly in the BMU-year and bimonthly during the four intervening years. Given the network is designed to provide data on a large scale, these assessment units typically are larger than streams monitored with a limited frequency. Assessment segments are determined based on downstream and upstream substantial tributaries. The substantial tributaries are those that discharge a volume deemed to contribute a quantity that alone has an influence on the water quality of the monitored stream. Another important consideration is large-scale habitat conditions, particularly areas of intense landuse practices that disturb substantial areas (e.g., cities, towns, resource extraction or agriculture).

Headwater and Wadeable Streams – Aquatic Life

Water bodies in this category are smaller watersheds, the largest approximating 250-mi^2 and most are smaller watersheds that typically are drained by streams that fall into 1st – 5th Strahler stream order (Strahler, 1952). Data obtained in the headwater and wadeable streams monitoring programs usually have biological community data and chemical data obtained from one-time sample events. Segments assessed with these datasets are necessarily relatively short. Biological data are typically sensitive to subtle changes in environmental conditions, particularly habitat integrity. Of particular consideration in headwater and wadeable streams is both in-stream habitat and riparian habitat corridor integrity. The smaller the watershed, typically the quicker the biological response to perturbations since these water bodies have smaller areas of in-stream habitats and the exposure of the biological community to disturbance gradients occurs rather quickly. This is contrasted to relatively large wadeable streams commonly of 4th and 5th Strahler order with greater in-stream habitat availability and greater flow that may buffer change in water quality and habitat integrity.

Because of this, a fully supporting or non-supporting headwater stream will necessarily be of a small assessment segment, but will likely be of significant length relative to watershed. Streams of all sizes should be canvassed via GIS to obtain the locations of any point source discharges (DOW GIS layers provide this type of information). DMR information should be reviewed if the data indicate less than full support and the determination is based on water quality chemistry data rather than primarily habitat perturbations. Most commonly, the assessment segment should begin and end at tributary mouths that are either draining a large watershed in relative area or contribute substantial flow relative to the receiving stream being assessed. Also, consider any tributaries that are assessed as less than full support and the landuses of tributaries in general, relative to the stream being assessed.

Fish Consumption

Segments monitored for support determination for fish consumption are defined in a similar method as those reaches assessed using only chemical or bacteria data. Some large river fish species are relatively far ranging, which is significant when defining segments if this is the only use being assessed. Also, with the plethora of sources – especially for mercury that may reach the aquatic environment via multiple pathways including atmospheric deposition – relatively long reaches are typically defined when making these assessments, whether supporting or not. Significant tributaries are often used to determine the upstream and downstream termini, with less consideration given to habitat. In boatable streams that have locks and dams, the intervening pool between each is usually considered an assessment unit.

Drinking Water

Given this use is typically assessed utilizing finished water data supplied by PWS through the CCR and the DU is only implemented at point of withdrawal, the assessed source water segments are usually conservative. The assessment segments are typically taken from the point of withdrawal and extended upstream one mile. A few exceptions to that rule occur when multiple uses are assessed (e.g., fish tissue, aquatic life) in the same general area of PWS withdrawal points. Those segments are usually longer in order to accommodate other assessed uses that overlap the PWS withdrawal point. For reservoirs the assessment is generally applied to the water body.

Reservoirs and Lakes

Because these water bodies have considerable retention time relative to streams, water quality monitoring normally occurs at a single location (forebay) or at additional locations within major tributary arms (embayments) of large reservoirs. Data are normally collected to assess the aquatic life use and SCR, although infrequent bacteria samples may be collected; generally PCR is not assessed lacking sufficient frequency. Additionally, many of the reservoirs owned and managed by DFWR are posted as *no swimming* water bodies. The no swimming postings are not a result of impairment of the DU, but are a management and safety decision by the DFWR.

While normally the assessment unit is the reservoir or lake, under certain circumstance there could be reason to assess an embayment separately from the main lake if that embayment has water quality differing to the degree it warrants treatment as a separate assessment unit. Such conditions would likely only present itself in large, USACE or TVA reservoirs and may be most likely associated with excess nutrients that are near the tipping point of DU support, or are impaired.

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Appendix A

USGS HUC Reference Tables and Sample Assessment Form

Table 1. The U.S. Geological Survey 8 Digit HUC (hydrologic unit code) presented by basin management unit with stream miles as determined by the National Hydrography Dataset (NHD).

HUC Name	HUC Code	Stream Miles 1:24,000 Scale
Kentucky River BMU		
North Fork Kentucky	05100201	2872
Middle Fork Kentucky	05100202	1213
South Fork Kentucky	05100203	1533
Upper Kentucky	05100204	2644
Lower Kentucky	05100205	7809
Salt River – Licking River BMU		
Salt River Basin		
Silver – Little Kentucky	05140101	1376
Salt	05140102	3615
Rolling Fork	05140103	3645
Blue – Sinking	05140104	985
Licking River Basin		
Licking	05100101	7239
South Fork Licking	05100102	2331
Ohio Brush – White Oak	05090201	2087
Middle Ohio - Laughery	05090203	1044
Upper Cumberland – 4-Rivers BMU		
Upper Cumberland	05130101	4181
Rockcastle	05130102	1783
Upper Cumberland – Lake Cumberland	05130103	3439
South Fork Cumberland	05130104	808
Obey	05130105	223
4-Rivers		
Lower Cumberland	05130205	2790
Red	05130206	717

HUC Name	HUC Code	Stream Miles 1:24,000 Scale
Kentucky Lake	06040005	932
Lower Tennessee	06040006	2126
Lower Ohio	0514206	727
Lower Mississippi – Memphis	08010100	272
Bayou de Chien – Mayfield	08010201	2788
Obion	08010202	382
<u>Green – Tradewater BMU</u>		
Green		
Upper Green	05110001	6008
Barren	05110002	2647
Middle Green	05110003	2289
Rough	05110004	2439
Lower Green	05110005	2484
Pond	05110006	1955
Lower Ohio – Little Pigeon	05140201	1036
Tradewater		
Tradewater	05140205	2658
Highland – Pigeon	05140202	1148
Lower Ohio – Bay	05140203	1131
<u>Big Sandy – Little Sandy – Tygarts BMU</u>		
Big Sandy		
Tug	05070201	898
Upper Levisa	05070202	619
Lower Levisa	05070203	2167
Big Sandy	05070204	815

HUC Name	HUC Code	Stream Miles 1:24,000 Scale
Little Sandy		
Little Sandy	05090104	1888
Tygarts		
Little Scioto - Tygarts	05090103	1219

Below is an example of the 305(b) assessment form. Note: Due to formatting requirements of the document this form does not conform to the layout design in use.

305(b) Assessment Form
(Complete a form for each assessed segment)

Sample Year: _____

305(b) Cycle Year (DOW only): _____

Basin Management Unit: _____

Stream or Reservoir Name: _____

GNIS ID: __ __ __ __ __ __ **Segment #** (DOW only)**:** __ __ **Stream Length (miles) (w/in KY):**_____.___
(exclude reservoir miles)

Lake/Reservoir Area (acres):_____

ADB ID # (DOW only)**:** KY_____

USES Assessed (tick all that apply)**:** Aquatic Life (20WAH) ____ (20CAH) ____; Fish Consumption (21) ____;

Primary Contact Rec. (42) ____; Secondary Contact Rec. (44) ____; Drinking Water (50) ____

Receiving Water: _____

Assessment Reach: **Downstream/Upstream MP:** _____.____ to _____.____ **Segment Length:** _____.____

Downstream Lat. (dd.ddddd): ____._____ **Long.** (dd.ddddd): **-** ____._____

Upstream Lat. (dd.ddddd): ____._____ **Long.** (dd.ddddd): **-**____._____

Downstream/Upstream Description: _____ to _____

Sample Site Mile Point: _____.____ **Lat.** (dd.ddddd): ____._____ **Long.** (dd.ddddd): **-**____._____

Topographic Map Name (1:24K) (sample location): _____

Major Basin (circle one)**:** Big Sandy; Little Sandy; Tygarts; Licking; Salt; Green; Tradewater; Upper Cumberland; Lower Cumberland; Kentucky; Mississippi; Ohio; Tennessee

USGS (8-digit) Cataloging Unit: _____ **County(s)** (sample site)**:** _____

Station ID: _____ **Sampling Date:** Start: ____-____-____; End: ____-____-____ (mm-dd-yy)

Assessment Date (DOW use only)**:** ____-____-____ (mm-dd-yy) **Data Type:** Monitored or Evaluated (circle)

Community Score: MBI ____.__; KIBI _____.__; DBI _____.__ **Number of sites:** _____

Biological Integrity (circle one)**:** Excellent Good Fair Poor

Trophic State Index: _____; (circle one): Oligotrophic; Mesotrophic; Eutrophic; Hyper-eutrophic: **Trend** (circle one): ↑ ↓ ↔

Aquatic Life (AL) Use Support Table (tick all that apply)

Aquatic Life	**Full**	**Partial**	**Non-support**	**Full but Threatened**	**Level of Info 1 - 4**
Habitat					
Biological					
chemical					
Toxicity					

USE Support, AL (DOW only)**:** Full Partial Support Non-support Full but Threatened

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
(*Note: At least one Source Code must be assigned to each Cause Code*) Kentucky Division of Water – 04-18-2013

Fish Consumption (21)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

Primary Contact Recreation (swimming) **(42)**

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

Secondary Contact Recreation (44)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____

Drinking Water (50)

USE Support: Full Partial Support Non-support Full but Threatened (circle one)

Assessment Codes: _____

Cause Code: _____ **Source Code(s):** _____
Cause Code: _____ **Source Code(s):** _____

Assessment Category (DOW use only)

Category	Definition	**Uses** (circle all that apply)
1	All designated uses for waterbody Fully Supporting.	20WAH 20CAH 21 42 44 50 316OSRW
2	Assessed designated use(s) is/are Fully Supporting, but not all designated uses assessed.	20WAH 20CAH 21 42 44 50 316OSRW
2B	Segment currently supporting use(s), but 303(d) listed & proposed to EPA for delisting.	20WAH 20CAH 21 42 44 50 316OSRW
2C	Segment with an EPA approved or established TMDL for the following use(s) now attaining Full Support. TMDL approval #_____.	20WAH 20CAH 21 42 44 50 316OSRW
3	Designated use(s) has/have not been assessed (insufficient data).	20WAH 20CAH 21 42 44 50 316OSRW
4A	Segment with an EPA approved or established TMDL for the following listed use(s) not attaining Full Support. TMDL appr. #_____	20WAH 20CAH 21 42 44 50 316OSRW
4B	Nonsupport segment with an approved alternative pollution control plan (e.g., BMP) stringent enough to meet full support level of all uses within a specified time.	20WAH 20CAH 21 42 44 50 316OSRW
4C	Segment is not meeting Full Support of assessed use(s), but this is not attributable to a pollutant or combination of pollutants.	20WAH 20CAH 21 42 44 50 316OSRW
5	TMDL is required.	20WAH 20CAH 21 42 44 50 316OSRW
5B	Segment does not support designated uses based on evaluated data, but based on KY listing methodology, insufficient data are available to make a listing determination. No TMDL needed.	20WAH 20CAH 21 42 44 50 316OSRW

Assessment Information Source: (circle/insert all that apply)

DOW	DOW	University	Federal	State	Other
Amb. WQ	Reservoir	EKU	COE	DFWR	ORSANCO
Amb. Bio.	GDW	Morehead SU	EPA	KGS	MSD
WBM	NPS	Murray SU	TVA	SNPC	LFUCG
Bact	Fish Tissue	UK	USFS	TN	Volunteer
IS	PWS	UL	USF&WS	VA	
RR	DMR	WKU	USGS	WV	
FO	TMDL				
ProbMon					

Appendix B

Level of Information and Water Body System Codes

Table 1. Hierarchy of bioassessment approaches for evaluation of aquatic life use attainment based on resident assemblages (U.S. EPA, 1997).

Level of Info[a]	Technical Components	Spatial/Temporal Coverage	Data Quality[b]	WBS Codes[c]
1	Visual observation of biota; reference conditions not used; simple documentation	Limited monitoring; extrapolations from other sites	Unknown or low precision and sensitivity; professional biologist not required	310, 320, 350, 322
2	One assemblage (usually invertebrates); reference conditions pre-established by professional biologist; biotic index or narrative evaluation of historical records	Limited to a single sampling; limited sampling for site-specific studies	Low to moderate precision and sensitivity; professional biologist may provide oversight	310, 320, 322, 350
3	Single assemblage usually the norm; reference condition may be site-specific or composite of sites (e.g., regional); biotic index (interpretation may be supplemented by narrative evaluation of historical records)	Monitoring of targeted sites during a single season; may be limited sampling for site-specific studies; may include limited spatial coverage for watershed-level assessments	Moderate precision and sensitivity; professional biologist performs survey or provides training for sampling; professional biologist performs assessment	310, 315, 320, 321, 330, 331, 350
4	Generally two assemblages, but may be one if high data quality; regional (usually based on sites) reference conditions used; biotic index (single dimension or multimetric index)	Monitoring during 1-2 sampling seasons; broad coverage of sites for either site-specific or watershed assessments; conducive to regional assessments using targeted or probabilistic design	High precision and sensitivity; professional biologist performs survey and assessment	310, 315, 320, 321, 330, 331, 340, 350

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other water body types.
[a] Level of information refers to rigor of bioassessment, where 1 = lowest and 4 = highest.
[b] Refers to ability of the ecological endpoints to detect impairment or to differentiate along a gradient of environmental conditions.
[c] WBS (Water body System) Assessment Type Codes from Table 1-1.

Table 2. Hierarchy of habitat assessment approaches for evaluation of aquatic life use attainment (U.S. EPA, 1997).

Level of Info[a]	Technical Components	Spatial/Temporal Coverage	Data Quality[b]	WBS Codes[c]
1	Visual observation of habitat characteristics; no true assessment; documentation of readily discernable land use characteristics that might alter habitat quality; no reference conditions	Sporadic visits; sites are mostly from road crossings or other easy access	Unknown or low precision and sensitivity; professional scientist (biologist, hydrologist) not required	365
2	Visual observation of habitat characteristics and simple assessment; use of land use maps for characterizing watershed condition; reference condition pre-established by professional scientist	Limited to annual visits and non-specific to season; generally easy access; limited spatial coverage and/or site-specific studies	Low precision and sensitivity; professional biologist or hydrologist not involved or only correspondence	370
3	Visual-based habitat assessment using standard operating procedures (SOPs); may be supplemented with quantitative measurements of selected parameters; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during a single season usually the norm; spatial coverage may be limited or broad and commensurate; assessment may be regional or site specific	Moderate precision and sensitivity; professional biologist or hydrologist performs survey or provides oversight and training	375
4	Assessment of habitat based on quantitative measurements of instream parameters, channel morphology, and floodplain characteristics; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during 1-2 seasons; spatial coverage usually broad and commensurate with biological sampling; assessment may be regional or site-specific	High precision and sensitivity; professional biologist or hydrologist performs survey and assessment	380

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other water body types.
[a] Level of information refers to rigor of bioassessment where 1 = lowest and 4 = highest.
[b] Refers to ability of the habitat endpoints to detect impairment or to differentiate along a gradient of environmental conditions.
[c] WBS (Water body System) Assessment Type Codes from Table 1, Appendix C.

Table 3. Hierarchy of physical/chemical data levels for evaluation of aquatic life use attainment (modified from U.S. EPA, 2002 and 1997).

Level of Info[a]	Technical Components	Spatial/Temporal Coverage	Data Quality[c]	WBS Codes [d]
1	Any one of the following: • Water quality monitoring using grab water sampling • Water data extrapolated from an upstream or downstream station where homogeneous conditions are expected • Monitoring date >5 years old without further validation • Best professional judgment based on land use date, source locations	Low spatial and temporal coverage: • Quarterly or less frequent sampling with limited period of record (e.g., 1 day) • Limited data during key periods or at high or low flows (critical hydrological regimes)[b] • Data are >5 years old and are not reflective of current conditions	Unknown /Low	210, 220, 230, 240, 850, 150, 130
2	Any one of the following: • Water quality monitoring using grab water sampling • Rotating basin surveys involving multiple visits or automatic sampling • Synthesis of existing or historic information on fish contamination levels • Screening models based on loadings data (not calibrated or verified)	Moderate spatial and temporal coverage: • Bimonthly or quarterly sampling during key periods (e.g., spring/ summer months) • Fish spawning seasons, including limited water quality data at high and low flows • Short period of record over a period of days or multiple visits during a year or season • Data are <5 years old and there is high certainty that conditions have not changed since sampling	Low/ Moderate	210, 220, 222, 230, 240, 242, 260, 810, 180
3	Any one of the following: • Composite or a series of grab water sampling used (diurnal coverage as appropriate) • Rotating basin surveys involving multiple visits or automatic sampling • Calibrated models (calibration data < 5 years old)	Broad spatial and temporal (long term, e.g., ≥ 3 years) coverage of site with sufficient frequency and coverage to capture acute events: • Typically, monthly sampling during key periods(e.g., spring/ summer months, fish spawning seasons), multiple samples at high and low flows • Lengthy period of record (sampling over a period of months) • Data are <5 years old and there is high degree of certainty that conditions have not changed since sampling	Moderate /high	211, 222, 242, 250, 610

Level of Info[a]	Technical Components	Spatial/Temporal Coverage	Data Quality[c]	WBS Codes [d]
4	Follows defined sampling plan which includes the following elements: • Description of how sample is representative of target populaiton • Defined data quality objectives, including error rate, confidence interval, sample size	Broad spatial (several sites) and temporal (long-term, e.g., ≥ 3 years) coverage of site with sufficient frequency and coverage to capture acute events, chronic conditions, and all other potential P/C impacts • Monthly sampling during key periods (e.g., spring/ summer months, fish spawning seasons) including multiple samples at high and low flows • Fish spawning seasons including multiple samples at high and low flows • Continuous monitoring	High	231, 242, 250

NOTE Physical refers to physical water parameters (e.g., temperature, pH, dissolved oxygen, turbidity, color, conductivity).

[a] Level of information refers to rigor of physical/chemical sampling and analysis, where 1 = lowest and 4 = highest.

[b] Even a short period of record can indicate a high confidence of *impairment* based on P/C data; 3 years of data are not required to demonstrate impairment. For example, a single visit to a stream with severe acid mine drainage impacts (high metals, low pH) can result in high confidence of non-support. However, long-term .

[c] Refers to ability of the toxicity endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

[d] WBS (Water body System) Assessment Type Codes from Table 1, Appendix C.

Appendix C

Assessment Codes modified from the EPA Waterbody System

Table 1. Assessment type codes from the waterbody system (modified from U.S. EPA, 1997).

100 Qualitative (evaluated) assessment--unspecified[a]
110 Information from local residents
120 Surveys of fish and game biologists/other professionals
130 Land use information and location of sources
140 Incidence of spills, fish kills, or abnormalities
150 Monitoring data that are more than 5 years old
175 Occurrence of conditions judged to cause impairment (e.g., channelization, dredging, severe bank erosion)
176 Occurrence of conditions not judged to cause impairment (e.g., channelization, dredging,
severe bank erosion)
180 Screening models (desktop models; models are not calibrated or verified)
190 Biological/habitat data extrapolated from upstream or downstream waterbody
191 Physical/chemical data extrapolated from upstream or downstream waterbody

200 Physical/chemical monitoring[b]
210 Fixed-station physical/chemical monitoring, conventional pollutants only
211 Highest quality fixed-station physical/chemical monitoring, conventional pollutants; frequency and coverage sufficient to capture acute and chronic events, key periods, high and low flows
220 Non-fixed-station physical/chemical monitoring, conventional pollutants only
222 Non-fixed-station monitoring, conventional, during key seasons and flows
230 Fixed-station physical/chemical monitoring, conventional plus toxic pollutants
231 Highest quality fixed-station physical/chemical monitoring, conventional plus toxicants; frequency and coverage sufficient to capture acute and chronic events, key periods, high and low flows
240 Non-fixed-station physical/chemical monitoring, conventional plus toxic pollutants
242 Non-fixed-station physical/chemical monitoring, conventional plus toxicants, during key seasons and flows
250 Chemical monitoring of sediments
260 Fish tissue analysis
270 Community water supply chemical monitoring (ambient water)
275 Community water supply chemical monitoring (finished water)

300 Biological monitoring[b]
310 Ecological/habitat surveys
314 Exceptional waters
315 Reference reach waters
316 OSRW (Outstanding State Resource Waters)
320 Benthic macroinvertebrate surveys
321 RBP III or equivalent benthos surveys
322 RBP I or II or equivalent benthos surveys
330 Fish surveys
331 RBP V or equivalent fish surveys
340 Primary producer surveys (phytoplankton, periphyton, and/or macrophyton)
350 Fixed-station biological monitoring

360 Habitat assessment
365 Visual observation, usually at road crossings; professional not required
370 Visual observation, use of land use maps, reference conditions, professional not required
375 Visual observation, may quantify some parameters; single season typically; by professional
380 Quantitative measurements of instream parameters, channel morphology, floodplain; one or two seasons; by professional

400 Pathogen monitoring[b]
410 Shellfish surveys
420 Water column surveys (e.g., fecal coliform)
430 Sediment analysis
440 Community water supply pathogen monitoring (ambient water)
450 Community water supply pathogen monitoring (finished water)

600 Modeling[c]
610 Calibrated models (calibration data are less than five years old)

700 Integrated intensive survey[b] (field work exceeds one 24-hour period and multiple media are sampled)
710 Combined sampling of water column, sediment, and biota for chemical analysis
720 Biosurveys of multiple taxonomic groups (e.g., fish, invertebrates, algae)

Assessments Based on Data from Other Sources
800 Assessments based on data from other sources[c]
810 Chemical/physical monitoring data by quality-assured volunteer program
820 Benthic macroinvertebrate surveys by quality-assured volunteer program
830 Bacteriological water column sampling by quality-assured volunteer program
840 Discharger self-monitoring data (effluent)
850 Discharger self-monitoring data (ambient)
860 Monitoring data collected by other agencies or organizations (use the assessment comment field to list other agencies
875 Public water systems (PWS) reported data

Discrepancy in Aquatic Life Assessment Results[d]

900 Discrepancy in Aquatic Life Assessment Results
910 Discrepancy among different data types; aquatic life assessment is based on physical/chemical data
920 Discrepancy among different data types; aquatic life assessment is based on biological data
925 Discrepancy among different data types; aquatic life assessment is based on habitat data
930 Discrepancy among different data types; aquatic life assessment is based on toxicity testing data
940 Discrepancy among different data types; aquatic life assessment is based on qualitative (evaluated) assessment data

[a]Generally considered to be evaluated assessment types.
[b]Generally considered to be monitored assessment types.
[c]Considered to be monitored or evaluated assessment types depending on data quality and State assessment protocols.
[d]States are requested to use these codes to identify cases when biological, habitat, toxicity, and/or physical/chemical data show different assessment results.

Appendix D

Causes (Pollutants) and Sources with ADB Codes

Table 1. Causes (pollutants) and assessment database codes used under Section 305(b) water quality assessment (modified from ADB).

Cause (Pollutant)	Cause Code
.alpha.-BHC	01
.alpha.-Endosulfan(Endosulfan 1)	02
.beta.-BHC	03
.beta.-Endosulfan (Endosulfan 2)	04
.delta.-BHC	05
1,1,1,2-Tetrachloroethane	06
1,1,1-Trichloroethane[1]	07
1,1,2,2-Tetrachloroethane[1]	08
1,1,2-Trichloroethane[1]	09
1,1-Dichloro-1,2,2-trifluoroethane	10
1,1-Dichloroethane[1]	11
1,2,3,4-Tetrachlorobenzene	12
1,2,4,5-Tetrachlorobenzene[1]	13
1,2,4-Trichlorobenzene[1]	14
1,2,4-Trimethylbenzene	15
1,2-Butylene oxide	16
1,2-Dibromo-3-chloropropane	17
1,2-Dibromo-3-chloropropane (DBCP)	18
1,2-Dichloroethane[1]	19
1,2-Dichloroethylene	20
1,2-Dichloropropane[1]	21
1,2-Diphenylhydrazine[1]	22
1,3-Butadiene	23
1,3-Dichloropropene	24
1,4-Dioxane	25
2,2'-Dichlorodiethyl ether	26
2,2'-Dichlorodiisopropyl ether	27
2,3,7,8-Tetrachlorodibenzofuran	28
2,3-Dichloropropene	29
2,4,5-TP (Silvex)[1]	30
2,4,5-Trichlorophenol[1]	31
2,4,6-Trichlorophenol	33
2,4-D[1]	34
2,4-Diaminotoluene	35
2,4-Dichlorophenol[1]	36
2,4-Dimethylphenol[1]	37
2,4-Dinitrophenol[1]	38
2,4-Dinitrotoluene[1]	39
2,5-Dichlorophenol	40
2,6-Dinitrotoluene	41
2-Acetylaminofluorene	42
2-Chloroethyl vinyl ether	43
2-Chloronaphthalene[1]	44
2-Chlorophenol[1]	45
2-Ethoxyethanol	46

2-Methoxyethanol 47
2-Methylnaphthalene 48
2-Methylpyridine 49
2-Nitrophenol 50
3,3'-Dichlorobenzidine[1] 51
3,3'-Dimethoxybenzidine 52
3,3'-Dimethylbenzidine 53
3,4-Dichlorophenol 54
3-Chlorophenol 55
4,4'-Isopropylidenediphenol 56
4,4'-Methylenebis 57
4,4-Dichloro-2-butene 58
4-Aminobiphenyl 59
4-Bromophenylphenyl ether 60
4-Chloro-3-methylphenol (3-methyl-4-chlorophenol) 61
4-Chlorophenol 62
4-Dimethylaminoazobenzene 63
4-Methylphenol 64
4-Nitrophenol 65
5-Nitro-o-toluidine 66
Acenaphthene 68
Acenaphthylene[1] 69
Acetaldehyde 70
Acetamide 71
Acetochlor 72
Acetonitrile[1] 73
Acrolein[1] 74
Acrylamide 75
Acrylonitrile 76
Alachlor 77
Aldicarb 78
Aldrin[1] 79
Alkalinity, Carbonate as CaCO3 80
Allyl alcohol 81
Allyl chloride 82
Alpha particles 83
Alum (aluminum sulfate) 86
Aluminum 87
Ambient bioassays – acute aquatic toxicity 88
Ambient bioassays – chronic aquatic toxicity 89
Amitrole 90
Ammonia (Un-ionized) 91
Amnesic shellfish poisoning (ASP) biotoxins 92
Aniline 93
Anthracene[1] 94
Antimony[1] 95
Arsenic[1] 96
Asbestos[1] 97
Atrazine 99

BOD, Biochemical oxygen demand 100
BOD, carbonaceous 101
BOD, nitrogenous 102
BOD, sediment load (Sediment Oxygen Demand) 103
Barium[1] 104
Benzal chloride 106
Benzene[1] 107
Benzidine[1] 108
Benzo(a)pyrene (PAHs) [1] 109
Benzo[a]anthracene[1] 110
Benzo[b]fluoranthene[1] 111
Benzo[g,h,i]perylene 112
Benzo[k]fluoranthene[1] 113
Benzoic Acid 114
Benzoyl chloride 115
Benzyl chloride 116
Beryllium[1] 117
Beta particles and photon emitters 118
Biphenyl 119
Bis(2-chloroethyl) ether[1] ..... N/A
Bis(2-chloroethoxy)methane 120
Bis(2-chloroisopropyl) ether[1] ..... N/A
Bis(2-chlormethyl) ether ..... N/A
Bis(2-ethylhexyl) phthalate[1] ..... N/A
Bis(2-chloro-1-methylethyl) 121
Bis(n-octyl) phthalate 122
Boron 123
Bromoform[1] 124
Butyl benzyl phthalate[1] 125
Butyraldehyde 126
Cadmium 127
Captan 128
Carbaryl 129
Carbofuran 130
Carbon Disulfide 131
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Cesium 133
Chemical oxygen demand (COD) 134
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Chloramines 136
Chlordane 137
Chloride 138
Chlorine 139
Chlorine dioxide (as ClO_2) 140
Chloroacetic acid 141
Chlorobenzene (mono) [1] 142
Chlorobenzilate 143
Chlorodibromomethane[1] 144
Chlorodifluoromethane 145

Chloroethane 146
Chloroform[1] 147
Chloromethyl methyl ether 148
Chlorophenyl-4 phenyl ether 149
Chloroprene 151
Chlorothalonil 152
Chlorpyrifos 153
Chromium (total) [1] 154
Chromium, hexavalent 155
Chromium, trivalent 156
Chrysene (C1-C4) [1] 157
Ciguatera fish poisoning (CFP) biotoxins 158
Cobalt 159
Color[1] 160
Copper 163
Creosote 164
Cresol (mixed isomers) 165
Cryptosporidium 166
Cumene 167
Cyanide 168
Cyanide (as free cyanide) 169
Cyanobacteria hepatotoxic microcystins 170
Cyanobacteria hepatotoxic nodularins 171
Cyanobacteria neurotoxic anatoxins 172
Cyanobacteria neurotoxic saxitoxins 173
Cyclohexane 174
DDD[1] 175
DDE[1] 176
DDT 177
DEHP (di-sec-octyl phthalate) 178
Dacthal 179
Dalapon 180
Debris/Floatables/Trash 181
Demeton 182
Di(2-ethylhexyl) adipate 183
Diallate 184
Diaminotoluene (mixed isomers) 185
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Dibenz[a,h]anthracene[1] 188
Dibenzofuran 189
Dibutyl phthalate[1] 190
Dichlorobenzene (mixed isomers) 191
Dichlorobromomethane[1] 192
Dichlorodifluoromethane 193
Dichloromethane 194
Dichlorotrifluoroethane 195
Dichlorvos 196
Dicofol 197

Dieldrin 198
Diethyl phthalate[1] 199
Dimethyl phthalate 200
Dinitro-o-cresol 201
Dinitrophenols[1] ..... N/A
Dinoseb 202
Dioxin (including 2,3,7,8-TCDD) 203
Diquat 204
Disulfoton 206
Diuron 207
Dyfonate (Fonofos or Fonophos) 208
EPTC 209
Endosulfan 210
Endosulfan sulfate[1] 211
Endothall 212
Endrin 213
Endrin aldehyde[1] 214
Enterococcus 215
Epichlorohydrin 216
Escherichia coli (*E. coli*) 217
Ethelyne dibromide 219
Ether, bis(chloromethyl) 220
Ethylbenzene[1] 221
Ethylene 222
Ethylene glycol 223
Ethylene oxide 224
Ethylene thiourea 225
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Foam/Flocs/Scum/Oil Slicks 235
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Gold 241
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Hydroquinone 258
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Iron 260
Isobutyraldehyde 261
Isophorone[1] 262
Isopropanol 263
Isosafrole 264
Kepone 265
Lead 267
Lindane 268
Linuron 269
Malathion 271
Maleic anhydride 272
Manganese 273
Mercury 274
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Methanol 276
Methoxychlor 277
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Methyl iodide 284
Methyl isobutyl ketone 285
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Mirex 289
Molinate 290
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N-Nitrosodiethylamine[1] ..... N/A
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Selenium, total recoverable 527
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[1]Pollutant tied to human health criterion only in regulation, 401 KAR 10:031
[2]Should only be used as last option when impairment exists and no pollutant can be identified

--Pollution—

Definition of pollution under the CWA (Section 502[19]): *The man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.*

The following is a list of measurements and categories considered pollution. There are ADB codes for these, but in and of themselves do not constitute a pollutant; therefore, they will not be included in a 303(d) listing, nor result in a TMDL.

Table 2. Pollution and assessment database codes used under Section 305(b) water quality assessment (modified from ADB).

Pollution	ADB Code
Abnormal fish histology (lesions)	67
Alteration in stream-side or littoral vegetative covers	84
Alterations in wetland habitats	85
Atlantic sea lamprey, *Petromyzon marinus*	98
Benthic macroinvertebrate bioassessments	105
Chlorophyll-a	150
Combination benthic/fishes bioassessments	161
Combined biota/habitat bioassessments	162
Dissolved oxygen saturation	205
Eurasion Water Milfoil, *Myriophyllum spicatum*	206
Estuarine bioassessments	218
Eurasian water milfoil, *Myriophyllum spicatum*	226
Excess algal growth	227
Fish passage barrier	228
Fish kills	229
Fishes bioassessments	230
Habitat assessment (streams)	243
Lake bioassessments	266
Low flow alterations	270
Non-native fish, shellfish, or zooplankton	313
Other anthropogenic substrate alterations	318
Other flow regime alterations	319
Periphyton (aufwuchs) indicator bioassessments	336
Secchi disk transparency	368
Suspended algae	387
Trophic state index	412
Zebra mussel, *Dreissena polymorph*	422
Abnormal fish deformities, erosions, lesions, tumors (DELTS)	445
Habitat assessment (lakes)	446
High flow regime	450
Aquatic plants - native	460
Fish advisory - no restriction	465
Sediment screening value (exceedence)	466
Bottom deposits	471

Non-native aquatic plants 312
Partial pressure of dissolved gases 330
Particle distribution (embeddedness) 331
Physical substrate habitat alterations 344
Taste and Odor 459
Bacterial slimes 477
Aquatic plants (macrophytes) 478
Aquatic algae 479
Aquatic macroinvertebrate bioassessments 492
Aquatic plant bioassessments 493
Lack of a coldwater assemblage 495
Changes in stream depth and velocity patterns 500
Loss of in-stream cover 501
Natural conditions (flow or habitat) 503
Direct habitat alterations 504
Invasive aquatic algae 505
Light attenuation coefficient 507
Electrical conductivity (EC) 508
Sodium Adsorption Ratio (SAR) 509
Algal growth potential (AGP) 514
Plankton count 515

Table 3. Probable sources of impairment to Kentucky rivers and streams.

Source Group	Source ID	Source
Agriculture		
	4	Animal feeding operations (NPS)
	5	Animal shows and racetracks
	6	Aquaculture (not permitted)
	7	Aquaculture (permitted)
	11	Auction barns & off-farm animal holding/management area
	30	Crop production with subsurface drainage
	31	Dairies (outside milk parlor areas)
	46	Grazing in riparian or shoreline zones
	73	Managed pasture grazing
	87	Non-irrigated crop production
	100	Permitted runoff from Confined Animal Feeding Operations (CAFOs)
	108	Rangeland grazing
	123	Specialty crop production
	143	Livestock (grazing or feeding operations)
	144	Crop production (crop land or dry land)
	156	Agriculture
	161	Pesticide application
	173	Manure runoff
	174	Unrestricted cattle access
	179	Lake fertilization
Non-Point Sources		
	8	Atmospheric deposition - acidity
	9	Atmospheric deposition - nitrogen
	10	Atmospheric deposition - toxics
	16	Cercla NPL (superfund) sites
	24	Commercial districts (industrial parks)
	26	Commercial districts (shopping/office Complexes)
	67	Land application of wastewater (non-agricultural)
	68	Land application of wastewater biosolids (non-agricultural)
	84	Municipal (urbanized high density area)
	92	On-site treatment systems (septic & similar decencentralized systems)
	97	Other spill related impacts
	107	Post-development erosion and sedimentation
	111	Residential districts
	122	Site clearance (land development or redevelopment)
	130	Unpermitted discharge (domestic wastes)
	131	Unpermitted discharge (industrial/commercial Wastes)
	133	Wastes from pets
	134	Waterfowl
	136	Wildlife other than waterfowl
	141	Non-point source
	146	Sources outside state jurisdiction or borders
	153	Wet weather discharges (non-point source)

	161	Pesticide application
	162	Watershed runoff following forest fire
	169	Unspecified urban stormwater
	171	Unspecified land disturbance
	175	Contaminated groundwater
	177	Urban runoff/storm sewers
	181	Runoff from forest/grassland/parkland
Habitat Impacts		
	19	Channel erosion/incision from upstream hydromodifications
	20	Channelization (canalization)
	21	Clean sediments
	36	Drainage/filling/loss of wetlands
	38	Dredging (e.g., for navigation channels)
	42	Flow alterations from water diversions
	44	Freshettes or major flooding
	51	Historic bottom deposits (not sediment)
	52	Hydrostructure impacts on fish passage
	71	Littoral/shore area modifications (non-riverine)
	72	Loss of riparian habitat
	125	Streambank modifications/destablization
	132	Upstream impoundments (e.g., PI-566 NRCS structures)
	157	Habitat modification - other than hydromodification
	163	Low water crossing
	187	Shallow lake or reservoir basin
Silviculture		
	43	Forest roads (road construction and use)
	101	Permitted silvicultural activities
	118	Silviculture - large scale (industrial) unpermitted forestry
	119	Silviculture harvesting
	120	Silviculture plantation management
	121	Silviculture reforestation
	137	Woodlot site clearance (majority of KY forestland in private ownership)
	138	Woodlot site management (sm. private tree farms)
	158	Siliviculture, fire suppression
	161	Pesticide application
	162	Watershed runoff following Forest Fire
	166	Silviculture activities
Resource Extraction		
	37	Dredge mining (e.g., coal removal from Big Sandy R. channel)
	2	Acid mine drainage
	22	Coal mining discharges (permitted)
	47	Hardrock Mining Discharges (Permitted)
	48	Heap-leach extraction mining
	56	Impacts from abandoned mine lands (inactive)
	82	Mine tailings
	83	Mountaintop mining

	93	Open-pit mining
	102	Petroleum/natural gas activities
	103	Petroleum/natural gas production activities (permitted)
	105	Placer mining
	114	Sand/gravel/rock mining or quarries
	126	Subsurface (hardrock) mining
	127	Surface mining
	159	Reclamation of inactive mining
	165	Coal mining
	172	Potash mining
	178	Coal mining (subsurface)
	186	Legacy coal extraction
Municipal Point Sources		
	23	Combined sewer overflows
	33	Discharges from biosolids (SLUDGE) storage, application or disposal
	34	Discharges from Municipal Separate Storm Sewer Systems (MS4)
	85	Municipal point source discharges
	86	Municipal point source impacts from Inadequate Industrial/Commercial Pretreatment
	99	Package plant or other permitted small flows discharges
	115	Sanitary sewer overflows (collection system failures)
	128	Total retention domestic sewage lagoons
	135	Wet weather discharges (point source and combination of stormwater,
		SSO or CSO)
Transportation		
	3	Airports
	12	Ballast water releases
	15	Cargo loading/unloading
	25	Commercial ferries
	49	Highway/road/bridge runoff (non-construction related)
	50	Highways, roads, bridges, infrastructure (new construction)
	112	Salt storage sites
	124	Spills from trucks or trains
	170	Unspecified unpaved road or trail
Industrial Sources		
	61	Industrial land treatment
	62	Industrial point source discharge
	63	Industrial thermal discharges
	64	Industrial/commercial site stormwater discharge (permitted)
	122	Site Clearance (land development or redevelopment)
Recreation Sources		
	95	Other recreational pollution sources
	45	Golf courses
	60	Impacts from resort areas (winter and non-winter resorts)

	91	Off-road vehicles
	106	Pollutants from public bathing areas
	181	Runoff from forest/grassland/parkland
Sediments		
	28	Contaminated sediments
	65	Internal nutrient recycling
	148	Sediment re-suspension (clean sediment)
	149	Sediment re-suspension (contaminated sediment)
Marina/Boating Sources		
	74	Marina boat construction
	75	Marina boat maintenance
	76	Marina dredging operations
	77	Marina fueling operations
	78	Marina-related shoreline erosion
	79	Marina/boating pumpout releases
	80	Marina/boating sanitary on-vessel discharges
	94	Other Marina/Boating On-vessel Discharges
	117	Shipbuilding, repairs, drydocking
	184	Marina related shoreline habitat degradation
Water Quantity or Withdrawal		
	13	Baseflow depletion from groundwater withdrawals
	113	Saltwater intrusion from groundwater overdrafting
	152	Transfer of water from an outside watershed
Permitted Sources (other)		
	1	Above ground storage tank leaks (tank farms)
	8	Atmospheric deposition – acidity
	9	Atmospheric deposition - nitrogen
	10	Atmospheric deposition - toxics
	27	Construction stormwater discharge (permitted)
	69	Landfills
	70	Leaking underground storage tanks
	109	RCRA hazardous waste sites
	146	Sources outside state jurisdiction or borders
	153	Wet weather discharges (non-point source)
	175	Contaminated groundwater
Inappropriate or Illegal		
Waste Disposal		
	54	Illegal dumps or other inappropriate waste disposal
	55	Illicit connections/hook-ups to storm sewers
	116	Septage disposal

	130	Unpermitted discharge (domestic wastes)
	160	Inappropriate waste disposal
	167	Unspecified domestic waste (e.g. straight-pipes)
Preferred over 167	168	Sewage discharges in unsewered areas
Other		
	17	Changes in ordinary stratification and bottom water hypoxia/anoxia
	39	Drought-related impacts
	57	Impacts from geothermal development
	65	Internal nutrient recycling
	92	**On-site treatment systems (septic & similar decencentralized systems)**
	140	Source unknown
	145	Natural conditions - water quality standards use attainability analyses needed
	147	Upstream source
	150	Forced drainage pumping
	151	Naturally occurring organic acids
	154	Upstream/downstream source
	155	Natural sources
	176	Rural (residential areas)
	180	Introduction of non-native organisms (accidental or intentional)
	185	Fire retardant slurry
	187	Shallow lake/reservoir basin