

STREAM DATA ANALYSIS PROTOCOLS

BUMP data collection on streams began in November of 1998. In order to provide a structural framework for data analysis and interpretation within the confines of the OWQS, the program uses the Use Support Assessment Protocols (USAP) promulgated into rule in Oklahoma Administrative Code (OAC) 785:46-15. A detailed explanation of the relationship between the USAP and the data collected on streams and rivers as part of the BUMP is presented below. This explanation is broken down into 8 subsections: Data Requirements, Default Protocols, Assessment of Fish and Wildlife Propagation Support, Assessment of Primary Body Contact Recreation Support, Assessment of Public and Private Water Supply Support, Assessment of Agriculture Support, Assessment of Aesthetics Support, and Assessment of Human Health Support (fish consumption). The latest USAP is included with this document as Appendix A and should provide greater insight into exactly how use support determinations were made for this report. In addition, OAC 785:45 (Oklahoma Water Quality Standards) and the justification document for the USAP can be obtained by contacting the OWRB/Water Quality Programs Division at (405) 530-8800 or through accessing the documents on the OWRB web page at: <http://www.state.ok.us/~owrb/rules/Rules.html>.

Data Requirements. USAP divides the number of stream miles that can be represented by a single site/station (or spatial coverage) into two categories—non-wadable and wadable streams. Sites/stations can be representative of no more than 25 stream miles on non-wadable streams and 10 stream miles on wadable streams. These limitations can be adjusted based upon existing data, distance between monitoring sites, sources of pollution, and the influence of major hydrological features, such as major tributaries and dams (delineated by 12-digit waterbody identification segments). A definition of what constitutes a wadable and non-wadable stream is not outlined in the USAP, so OWRB staff use federal guidance as well as best professional judgment. Federal 305 (b) guidelines say that no monitoring site/station can be representative of more than 25 stream miles on large streams and rivers. Furthermore, in areas where topography and land use are relatively homogeneous and there are no other significant influences, a single monitoring station can be representative up to 50 to 75 stream miles. Therefore, only two firm guidelines are currently available for determining the spatial coverage of a monitoring site/station:

- 1) The spatial coverage can not extend outside the 12-digit segment in which the monitoring site/station is located except in those instances where it is determined that it is reasonable to do so (e.g., the segment break is not caused by a major hydrological influence).
- 2) No monitoring site/station can be representative of more than 25 stream miles (in some instances, monitoring sites/stations may be representative of up to 50 stream miles with a scientifically defensible justification).

Accordingly, spatial coverage for the 2004 - 2005 BUMP report on streams will be limited to these two guidelines. The spatial coverage is subject to change dependent upon the language of the latest version of USAP.

USAP sets two limitations on temporal coverage. First, data used in assessments must be collected such that decisions are not biased towards either critical-flow, base-flow, or high-flow conditions. This report uses data collected during all seasons. Secondly, stream data that is more than five years old cannot be used to assess support unless no other data exists or a

scientifically defensible reason can be brought forth justifying the use of older data. This report uses no data collected before November of 1998.

USAP also sets data requirements on the number of samples needed and the magnitude of criteria exceedance for toxicants and dissolved oxygen before a use support determination can be made. The minimum number of samples required to assess use support for all general water quality variables is ten (10). This minimum number of samples is not applicable if data from samples already collected ensures that the use will not be supported. In other words, if a 25% percent exceedance is required to designate a use as not supporting and three (3) of the first five (5) samples collected were in exceedance of the criteria, then sampling can discontinue because you are assured of having >25% of the minimum number of samples exceeding the criteria. The BUMP program collects at least ten samples per year on all general water quality parameters with the exception of bacteria, organics and metals. Toxicants (metals and organics) require a minimum of five (5) samples to determine use support, however, less than 5 samples can be used to determine if a use is partially supported or not supported. Furthermore, if at least 2 sample concentrations of a toxicant exceed the criteria prescribed in the OWQS by two or more orders of magnitude, then the use is determined to be “not supporting”.

Finally, USAP gives guidance on the treatment of practical quantification limits (PQL), or detection limits. A PQL is the minimum value that a particular test or instrument can “read-to” with an acceptable level of confidence. If a value is determined to be less than the PQL, then it is generally reported as a “less than value” (e.g., variable data point “x” = <2.0 mg/L). In other words, the test or the instrument cannot deliver a value less than the PQL without introducing statistically significant uncertainty to the data. Moreover, when analyzing the data, data point “x” cannot be assigned a value of 2.0 mg/L or 0.0 mg/L because staff would be making an arbitrary determination that would assuredly be either an under estimation or an over estimation of the “true” value. Consequently, the OWRB staff assigns a value that is fifty percent of the PQL (“x” would equal 1.0 mg/L).

Default Protocols. USAP outlines the procedures for determining whether a set of data points for a particular variable **support**, **partially support**, or **do not support** a particular beneficial use. These protocols are constructed around two distinct types of numerical variables — short term averages and long term averages. In each case, samples collected for the range of water quality parameters are analyzed and aggregated in different ways.

Short-term average numerical variables measure variables with exposure periods of less than seven days (e.g., turbidity or a sample standard for chlorides). In other words, the set of samples that is being analyzed considers each sample as a separate entity. For example, **each** turbidity sample collected monthly from January through December is considered a unique sample, and consequently, every sample is not aggregated into a single sample for analysis but is considered a fraction of the whole. Use support determination for short-term numerical variables requires a three-step process:

1. Each sample exceeding the prescribed criterion or screening level for a particular variable is identified,
2. The number of samples exceeding the prescribed criterion or screening level is divided by the total number of samples collected to obtain a percent exceedance, and
3. The percent exceedance is compared to a range of prescribed percent exceedances to determine use support. The prescribed percent exceedances are:
 - i) Supporting — less than or equal to ten percent (10%),
 - ii) Partially supporting — greater than 10% but less than twenty-five percent (25%),

iii) Not supporting — greater than or equal to 25%.

Long-term average numerical variables measure variables with exposure periods of greater than or equal to seven days (e.g., yearly mean standard for chlorides). In other words, the **entire** set of samples that is being analyzed is considered a unique entity. For example, chloride samples collected monthly from January through December are aggregated through the calculation of a geometric mean. Use support determination for long-term numerical variables requires a three-step process:

- 1) Samples for a particular variable are aggregated into a geometric mean
- 2) The geometric mean is compared to the prescribed criterion or screening level
- 3) Use support is determined to be supporting if the mean is less than the prescribed criterion or screening level or not supporting if the mean is greater than the prescribed criterion or screening level.

Because the long-term average compares only one value (the geometric mean) to the prescribed criterion or screening level, it cannot be considered partially supporting. In most instances, at least ten samples are required to calculate a geometric mean. Furthermore, geometric means are calculated on a two-year rolling average using the most recent data available.

A particular change to this year's report is the addition of the language "but is impaired per the CPP" when a beneficial use is determined to be partially supporting. The data produced by the BUMP is used to help develop Oklahoma's Integrated Report, which is a USEPA required report classifying all water bodies based on impairment status. Although the USAP is the guiding document for use support attainment decisions; the State also uses the Continuing Planning Process (CPP) document as required by the USEPA. Its methodology section is mostly a reiteration of the USAP, however it does address areas where the USAP is silent or does not fully meet reporting requirements. Once such area is the use of "partial support" which is not a valid reporting endpoint for use attainment. The CPP classifies water bodies as "impaired" or "not impaired". Subsequently, for reporting purposes, those waters classified as "supporting" by the USAP are classified as "not impaired", and those waters classified as "partial supporting" or "not supporting" by the USAP are classified as "impaired".

So that the reader will fully understand how use support was determined for our rivers and streams for the various beneficial uses assigned to them a short discussion of the OWQS beneficial uses and the Use Support Assessment Protocols (USAP) is included below.

Assessment of Fish and Wildlife Propagation (FWP) Support. The FWP beneficial use utilizes five different water quality variables to assess use support: dissolved oxygen (D.O.) concentration, toxicants, hydrogen ion activity (pH), turbidity, and biological criteria. Only one variable needs to exceed the assessment protocol for the beneficial use to be partially supported or not supported.

The OWQS 785:45-5-12(g)(1) in a table entitled "Dissolved Oxygen Criteria" prescribes three screening levels for D.O. in streams. Streams are categorized in Appendix C of the OWQS as habitat limited aquatic communities (HLAC), warm water aquatic communities (WWAC), cool water aquatic communities (CWAC), and trout fisheries (TF). The prescribed screening level for each of the categories is: HLAC—4.0mg/l (April 1—June 15) and 3.0 mg/L (June 16—May 31); WWAC—4.0mg/l (June 16—October 15) and 5.0 mg/L (October 16—June 15); and CWAC and

TF—5.0mg/l (June 1—October 15) and 6.0 mg/L (October 16—May 31). The protocol for short-term average numerical parameters is used to assess the level of support.

Numerical criteria is prescribed for toxicants in OWQS 785:45-5-12(g)(6)(G) in a table entitled “Numerical Criteria for Toxic Substances”. To determine use support, the protocol for short-term average numerical parameters is used. Sample values must be compared to both acute and chronic criterion. Both criterions need not be exceeded for the variable to be partially supported or not supported.

A numerical range for pH of 6.5 to 9.0 units is prescribed in 785:45-5-12(g)(3) for all aquatic classifications. The protocol for short-term average numerical parameters is used to assess the level of support.

Screening limits are established for turbidity in OWQS 785:45-5-12(g)(7)(A)(i) and (iii). CWAC are assigned a criterion of 10 Nephelometric Turbidity Units (NTU), and all other stream communities are assigned a criterion of 50 NTU. The protocol for short-term average numerical parameters is used to assess the level of support. In OWQS 785:45-5-12(g)(7)(C), it is stated that numerical criteria for turbidity “apply only to seasonal base flow conditions”. Therefore, those measurements that are taken above seasonal base flow are not included in determining support. To determine seasonal base flow, the average discharge for the sampling day is compared to the median flow of the three months surrounding the sampling day. If the station is not part of the USGS stream-flow monitoring program but has an upstream or downstream stream-flow station in close proximity, that station is used to determine whether the station in question is at seasonal base flow. If no proximal stream-flow station exists, stream-flow monitoring stations on other waterbodies that are in close geographical proximity were used to determine whether the station in question is at seasonal base flow. Because discharge data is not yet available from October of 2001 through September of 2002, use support determinations based on turbidity data are provisional and assessments related to turbidity may be subject to change. Therefore, all turbidity assessments are provisional. Changes will be reported in an addendum to this report. Furthermore, to assist staff in the determination of seasonal base flow at stations that do not have continuous discharge measurements, the OWRB is now collecting discharge measurements at all but four of the permanent monitoring stations. To supplement base flow determination staff uses several anecdotal methods. These methods are only used in concert with another method when determining if base flow conditions existed when the sample was taken. In one method, staff determines flow condition visually by noting whether the flow is minimal, light, moderate, high, or stormwater. Also, beginning in 2002, staff began noting the presence or absence of a periphyton line as well as the color and texture of the periphyton. In most instances, if a periphyton line has been established, flow has not exceeded that level in at least seven days.

Additionally, biological criteria have been promulgated into rule for all but four ecoregions. As fish data are collected on streams throughout the state, an assessment of biological health will be presented in this report. The application of biological criteria requires a three-step process. First, various metrics (e.g., # of sunfish species) are determined on the raw collection data (i.e., species and numbers of each species). From these metrics, an index of biological integrity (IBI) is calculated. Finally, the IBI score is compared to regionally developed scoring ranges, and the site is placed into 1 of 3 biocriteria categories—fully supporting, undetermined, or not supporting. For those regions where biological criteria have yet to be developed, the data are presented in this report, but the site evaluation is left as undetermined.

Assessment of Primary Body Contact Recreation (PBCR) Support. The PBCR beneficial use utilizes 2 different bacteriological classes and one bacteriological species to assess use support: fecal coliform (FC), *Escherichia coli* (*E. coli*), and enterococci (Ent.). The assessment is performed by using the long-term average numerical protocol to compare to a prescribed geometric mean and by using a modified version of the short-term average numerical protocol to compare each sample to a prescribed screening level. The prescribed geometric means (GM) and screening levels (SL) are: FC—GM of 400 colony forming units/mL (cfu/mL) and SL of 400 cfu/mL; *E. coli*—GM of 126 cfu/mL and SL of 235 cfu/mL in scenic rivers and 406 cfu/mL in all other waters; and Ent.—GM of 33 cfu/mL and SL of 61 cfu/mL in scenic rivers and 406 cfu/mL in all other waters. For *E. coli* and Ent., both the SL (only one sample exceedance is necessary) and the GM must be exceeded for the use to not be supported. If all of the samples meet the SL or the GM is met, the use is supported. In the case of FC, the use may only be supported if the GM is met and no greater than 25% of the sample concentrations exceed the SL. If either the GM is exceeded or greater than 25% of the sample concentrations exceed the SL, the use is not supported for FC. In no instance is the PBCR beneficial use partially supported. Furthermore, PBCR support is only determined from samples collected during the recreational season from May 1 through September 30 of each year. Only one variable needs to violate the assessment protocol for the beneficial use to be not supported.

Assessment of Public and Private Water Supply (PPWS) Support. The PPWS beneficial use utilizes toxicant concentrations to assess use support. For purposes of this report, only metals are considered in the toxicant category. Only one variable needs to violate the assessment protocol for the beneficial use to be partially supported or not supported. Organics are currently being collected at some stations and will be used in the 2003 assessment. In previous reporting years, total coliform bacteria were used to determine use support. This was done in error. The criterion of 5,000 cfu/mL in the OWQS is only applied at the water supply intake point and is not to be applied throughout the waterbody.

Numerical criteria for metals is established in OWQS 785:45-5-10(1) and (6). The short-term numerical average protocol is used to determine use support for both sets of criterion. If a substance has different numerical criteria listed in both tables, the most stringent criterion takes precedence. Furthermore, criteria in both tables need not be exceeded for the use to be partially supported or not supported.

Assessment of Agriculture (AG) Support. The AG beneficial use utilizes three variables to assess use support: total dissolved solids, chlorides, and sulfates. Numerical criteria for both yearly mean standards and sample standards are located in Appendix F of OAC 785:45. The yearly mean standard for each variable is compared to the geometric mean of the samples using a long-term average numerical protocol. The sample standard for each variable is compared to the each sample using a short-term average numerical protocol. Use support assessment for each variable requires a three-step process:

- 1) The sample standard and yearly mean standard for the six digit management segment which encompasses the monitoring must be located in Appendix F of OAC 785:45;
- 2) The geometric mean of the samples is compared to the yearly mean standard (if the geometric mean exceeds the yearly mean standard, the use is not supported and no further analysis is necessary);
- 3) If the geometric mean meets the yearly mean standard, the sample standard is compared to each sample and percent exceedance is calculated (depending on the percent exceedance, the variable is supporting, partially supporting, or not

supporting). Regardless of the criteria in Appendix F of OAC 785:45, if all TDS samples are less than 750 mg/L and all chloride and sulfate samples are less than 250 mg/L, the AG beneficial use is supported. Only one variable needs to violate the assessment protocol for the beneficial use to be partially supported or not supported.

Assessment of Aesthetics Support. With the exception of the numerical criterion of 0.037 mg/L of total phosphorus for Oklahoma scenic rivers and 70 Platinum-cobalt units for true color, the OWQS includes only narrative criteria for the aesthetics beneficial use. Furthermore, the USAP only addresses the effect of nutrients and true color. However, narrative criteria in OAC 785:45-3-2(c) requires that nutrients related water quality degradation cannot interfere with the maintenance of any beneficial use protected under OAC 785:46-13-3(a)(1). Because numerical nutrient criteria exists only for scenic rivers, assessments of nutrients on all other rivers and streams do not determine beneficial use support but whether a particular stretch of stream is nutrient-threatened. Therefore, these assessments of nutrients do not utilize any of the default protocols, but revolve around the use of a dichotomous key. The use of the key is a rather involved process and will not be verbally outlined in this report. Please refer to OAC 785:46-15-10 for a detailed discussion of the dichotomous key and how it is applied for use support determination.

The impact of nutrients on streams is related to the growth of phytoplankton. Phytoplankton are autotrophic which means that when light and consumables such as nutrients are available they can convert energy and grow. The available nutrients are total phosphorus and nitrite and nitrate (utilized as a combined nitrogen concentration). Several factors determine if the level of these compounds pose a threat to the health of the stream. Foremost, the size of the stream must be considered. Smaller streams (3rd order or less) tend to be more susceptible to nutrient impacts and, therefore, smaller concentrations have similar effects as larger concentrations in larger streams (greater than 3rd order). Depending on stream order, USAP has established preset threshold values for total phosphorus and nitrate/nitrite. If the two-year rolling median of the sample values exceeds the threshold, the following confounding factors are considered to determine if the excessive nutrients are threatening the health of the stream. The amount of time the nutrient is resident in the stream is proportional to the impact. Therefore, the slope of the topography around the station must be considered. Furthermore, phytoplankton is light dependent for growth. Consequently, light must be able to penetrate the surface of the water. For this reason, water clarity must be measured by using a nephelometric turbidity meter or a Secchi disk. Only turbidity readings taken at seasonal base flow are included when calculating the geometric mean. Logic states that low clarity will limit the impact of phytoplankton on the stream and that high clarity will increase the impact of phytoplankton. On smaller streams, available light is also measured by percent canopy shading. An option to the dichotomous key is the use of Carlson's Trophic State Index (TSI) value (Carlson, 1977) on non-wadeable streams. The mean of sestonic chlorophyll-a data is used to calculate the TSI using the equation: **$TSI = 9.81 \times \ln(\text{chlorophyll-a}) + 30.6$** . A TSI value of 62 or greater indicates that a nonwadeable waterbody is nutrient threatened.

In 2002, A numerical criterion of 0.037 mg/L of total phosphorus was set for all waterbodies designated as Oklahoma Scenic Rivers. These rivers include the Barren Fork River, Flint Creek, the Illinois River, Lee Creek, Little Lee Creek, and the Mountain Fork River above Broken Bow Reservoir. The current USAP requires that a multi-step process for support determination. First of all, three-month rolling geometrics are calculated for the most immediate 5 years of data available. This data, when possible, should include high flow monitoring events. Once the geometric means are calculated a short-term protocol is used for final assessment. If

less than 10% of the three-month geometric means are below 0.037, the station is supporting, but if more than 10% are above the criterion, the station is not supporting.

Assessment of Human Health Support. A new beneficial use was created in 1999 dealing with fish consumption and is housed under the Human Health criteria. The new use deals with fish consumption bans and states that waters that the DEQ has issued a fish consumption ban on will be considered as not supporting its fish consumption use. Currently the BUMP has sampled several waters to determine fish consumption use support but will not report results until the 2003 report.