

## **APPENDIX B**

### **REGULATORY FRAMEWORK AND REFERENCE CONDITION APPROACH**

This appendix presents details about applicable Montana Water Quality Standards (WQS) and the general and statistical methods used for development of reference conditions.

#### **B.1 TMDL Development Requirements**

Section 303 of the Federal Clean Water Act (CWA) and the Montana WQA (Section 75-5-703) requires development of TMDLs for impaired water bodies that do not meet Montana WQS. Although water bodies can become impaired from pollution (e.g. flow alterations and habitat degradation) and pollutants (e.g. nutrients, sediment, and metals), the CWA and Montana State Law (75-5-703) both require TMDL development for waters impaired only by pollutants. Section 303 also requires states to submit a list of impaired water bodies to EPA every two years. Prior to 2004, EPA and DEQ referred to this list as the 303(d) List.

Since 2004, EPA has requested that states combine the 303(d) List with the 305(b) report containing an assessment of Montana's water quality and its water quality programs. EPA refers to this new combined 303(d)/305(b) report as the Integrated Water Quality Report. The 303(d) List also includes identification of the probable cause(s) of the water quality impairment problems (e.g. pollutants such as metals, nutrients, sediment or temperature), and the suspected source(s) of the pollutants of concern (e.g. various land use activities). State law (MCA 75-5-702) identifies that a sufficient credible data methodology for determining the impairment status of each water body is used for consistency; the actual methodology is identified in DEQ's Water Quality Assessment Process and Methods (DEQ 2006b). This methodology was developed via a public process and was incorporated into the EPA-approved 2000 version of the 305(b) report (now also referred to as the Integrated Report).

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data shows that the water body or stream segment is failing to achieve compliance with applicable WQS (Montana Water Quality Act; Section 75-5-103(11)). A "threatened water body" is defined as a water body or stream segment for which sufficient credible data and calculated increases in loads show that the water body or stream segment is fully supporting its designated uses but threatened for a particular designated use because of either (a) proposed sources that are not subject to pollution prevention or control actions required by a discharge permit, the nondegradation provisions, or reasonable land, soil, and water conservation practices or (b) documented adverse pollution trends (Montana WQA; Section 75-5-103(31)). State Law and Section 303 of the CWA require states to develop all necessary TMDLs for impaired or threatened water bodies, as of now there are no threatened water bodies within the Middle and Lower Big Hole TPA.

A TMDL is a pollutant budget for a water body identifying the maximum amount of the pollutant that a water body can assimilate without causing applicable WQS to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in

units of mass per time, such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources in addition to natural background sources and must incorporate a margin of safety and consider influences of seasonality on analysis and compliance with Water Quality Standards (WQS).

To satisfy the Federal CWA and Montana State Law, TMDLs will be developed for each water body-pollutant combination identified on Montana’s 2006 303(d) List of impaired waters in the Middle and Lower Big Hole TPA. State Law (Administrative Rules of Montana 75-5-703(8)) also directs Montana DEQ to “...support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for water bodies that are subject to a TMDL...”. This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing Federal, State, or local regulations.

## **B.2 Applicable Water Quality Standards**

WQS include the uses designated for a waterbody, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the high quality of a waterbody. The ultimate goal of this TMDL document, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards are met. Water quality standards form the basis for the targets described within each pollutant section of the document. Pollutants addressed in this Water Quality Planning Framework include: sediment, nutrients, metals, and temperature. This section provides a summary of the applicable water quality standards for each of these pollutants.

### **B.2.1 Classification and Beneficial Uses**

Classification is the assignment (designation) of a single or group of uses to a waterbody based on the potential of the waterbody to support those uses. Designated Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of “uses” of state waters including growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana WQA directs the Board of Environmental Review (BER) (i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (ARM 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example, as a public drinking water supply; however, the quality of that waterbody must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or non-point source activities or pollutant discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water’s classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally misclassified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed or made less stringent.

Descriptions of Montana’s surface water classifications and designated beneficial uses are presented in **Table B-1**. All water bodies within the Middle and Lower Big Hole TPA are classified as either A-1 or B-1 (see **Section 3.1, Table 3-1** for individual stream classifications).

**Table B-1. Montana Surface Water Classifications and Designated Beneficial Uses**

<b>Classification</b>	<b>Designated Uses</b>
<b>A-CLOSED CLASSIFICATION:</b>	Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection.
<b>A-1 CLASSIFICATION:</b>	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities.
<b>B-1 CLASSIFICATION:</b>	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
<b>B-2 CLASSIFICATION:</b>	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
<b>B-3 CLASSIFICATION:</b>	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
<b>C-1 CLASSIFICATION:</b>	Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
<b>C-2 CLASSIFICATION:</b>	Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

**Table B-1. Montana Surface Water Classifications and Designated Beneficial Uses**

<b>Classification</b>	<b>Designated Uses</b>
<b>C-3 CLASSIFICATION:</b>	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply.
<b>I CLASSIFICATION:</b>	The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

### **B.2.2 Standards**

In addition to the Use Classifications described above, Montana’s WQS include numeric and narrative criteria as well as a nondegradation policy.

Numeric surface WQS have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular WQB-7 (DEQ 2006a). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival, and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.) and in statute (75-5-303 MCA). Changes in water quality must be “non-significant” or an authorization to degrade must be granted by the Department. However, under no circumstance may standards be exceeded. It is important to note that waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the waterbody.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term “Narrative Standards” commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface WQS. The General Prohibitions are also called the “free from” standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a waterbody. Uses may be

impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi, and algae.

The standards applicable to the list of pollutants addressed in the Middle and Lower Big Hole TPA are summarized, one-by-one, below. In addition to the standards below, the beneficial use support standard for a A-1 and B-1 streams, as defined above, can apply to other conditions, often linked to pollution, limiting aquatic life. These other conditions can include impacts from dewatering/flow alterations, impacts from habitat modifications, or impacts from excess algae.

**Sediment**

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in **Table 3-2**. The relevant narrative criteria do not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a condition in which any increases in sediment above naturally occurring levels are not harmful, detrimental or injurious to beneficial uses (see definitions in **Table B-2**).

**Table B-2. Applicable Rules for Sediment Related Pollutants.**

<b>Rule(s)</b>	<b>Standard</b>
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
	The maximum allowable increase above naturally occurring turbidity is: 0 NTU for A-closed; 5 NTU for A-1, B-1, and C-1; 10 NTU for B-2, C-2, and C-3)
17.30.602(17)	“Naturally occurring” means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.

**Table B-2. Applicable Rules for Sediment Related Pollutants.**

Rule(s)	Standard
17.30.602(21)	“Reasonable land, soil, and water conservation practices” means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

**Turbidity**

The allowable changes in turbidity (above natural) is a rather small 5 or 10 nephelometric turbidity units (NTU), see table above. The likely direct effects of increased turbidity are on recreation, aesthetics and drinking water supplies. Indirectly increased turbidity can be linked to an increased pathogen potential, total recoverable metals concentration, and increased total suspended sediment. Turbidity cannot be equated with other parameters. Turbidity is a measure of light scatter in water. Suspended or colloidal solids like phytoplankton, metal precipitates or clay may cause the light scatter. In some cases it may be a useful and easily measured surrogate for total suspended solids (TSS) but only after paired flow and seasonal (full hydrograph) turbidity and TSS data have been collected and a statistically significant correlation exists.

**Nutrients**

The narrative standards applicable to nutrients elsewhere in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.). The prohibition against the creation of “*conditions which produce undesirable aquatic life*” is generally the most relevant to nutrients. Undesirable aquatic life includes bacteria, fungi, and algae.

Most waters of Montana are protected from excessive nutrient concentrations by narrative standards. The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/l) and total phosphorus (20 ug/l upstream of the confluence with the Blackfoot River and 39 ug/l downstream of the confluence) as well as algal biomass measured as chlorophyll *a* (summer mean and maximum of 100 and 150 mg/m<sup>2</sup>, respectively) have been established. Additionally, numeric human health standards exist for nitrogen (**Table B-3**), but the narrative standard is most applicable to nutrients as the concentration in most water bodies in Montana is well below the human health standard and the nutrients contribute to undesirable aquatic life at much lower concentrations than the human health standard.

**Table B-3. Human Health Standards for Nitrogen for the State of Montana.**

Parameter	Human Health Standard (µL) <sup>1</sup>
Nitrate as Nitrogen (NO <sub>3</sub> -N)	10,000
Nitrite as Nitrogen (NO <sub>2</sub> -N)	1,000
Nitrate plus Nitrite as N	10,000

<sup>1</sup>Maximum Allowable Concentration.

### **Metals**

Numeric criteria for metals in Montana include specific standards for the protection of both aquatic life and human health. As described above, acute and chronic criteria have been established for the protection of aquatic life. The criteria for some metals vary according to the hardness of the water. The standards for cadmium, copper, chromium (III), lead, nickel, silver and zinc vary according to the hardness of the water. These standards have an inverse relationship to toxicity (decreasing hardness causes increased toxicity). The applicable numeric criteria for the metals of concern at a hardness of 25 mg/L in the Middle and Lower Big Hole River TPA are presented in **Table B-4**. Narrative standards within the General Prohibitions [ARM 17.30.637 (c)(d)] apply to metals associated with stream sediment. They state “State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: (c) produce odors, colors, or other conditions as to which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; and (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant, or aquatic life;

The human health standards for iron and manganese are secondary maximum contaminant levels that are based on aesthetic water properties such as taste, odor, and the tendency of these metals to cause staining. Neither iron nor manganese is classified as a toxin or a carcinogen. Therefore, narrative standards adopted for these metals state that concentrations “must not reach values that interfere with the uses specified in the surface and ground water standards” (Circular DEQ-7 DEQ 2008). The secondary Maximum Contaminant Levels (MCLs) for iron and manganese, 300 ug/L and 50 ug/L respectively, serve as use support “guidance” together with consideration of the number, degree, and timing of exceedences and the concentrations of these metals likely to occur after conventional treatment. If the data indicates that the human health guidance values for iron and manganese would be consistently exceeded after conventional treatment, use of the water body for drinking water is considered impaired for these constituents. If most of the iron and manganese are in the particulate phase, they can be removed by conventional treatment. Diurnal sampling of dissolved and total Fe and Mn in the Big Hole River has indicated a high percentage of both elements is associated with particulate matter (Wenz 2003). Therefore, for the purposes of this TMDL document, the secondary MCL guidance values for iron and manganese are not applied and are not considered in the evaluation of water quality data. The chronic aquatic life standard of 1,000 µg/L for iron is considered applicable and is used as the metals target for iron.

It should be noted that recent studies have indicated some metals concentrations vary through out the day because of diel pH and alkalinity changes. In some cases the variation can cross the standard threshold (both ways) for a metal. Montana water quality standards are not time of day dependent.

**Table B-4. Montana Numeric Surface Water Quality Standards for Metals.**

Parameter	Aquatic Life Standards		Human Health Standards
	Acute (µg/L) (1)	Chronic (µg/L) (2)	Surface Water (µg/L) (1)
Arsenic (TR)	340	150	10
Cadmium (TR)	0.52 @ 25 mg/l hardness (3)	0.097 @ 25 mg/l hardness (3)	5
Copper (TR)	3.79 @ 25 mg/l hardness (3)	2.85 @ 25 mg/l hardness (3)	1,300
Iron (TR)	---	1000	300(4)
Lead (TR)	13.98 @ 25 mg/l hardness (3)	0.545 @ 25 mg/l hardness (3)	15
Mercury (TR)	1.7	0.91	0.05
Zinc (TR)	37 @ 25 mg/l hardness (3)	37 @ 25 mg/l hardness (3)	2,000
(1) Maximum allowable concentration.			
(2) No four-day (96-hour) or longer period average concentration may exceed these values.			
(3) Standard is dependent on the hardness of the water, measured as the concentration of CaCO <sub>3</sub> (mg/L), and ranges			
(4) Secondary maximum contaminant level guidance for aesthetic water properties such as taste and odor.			
Note: TR = Total Recoverable			

Hardness-based standards for aquatic criteria are calculated using the following equation and are used for determining impairment:

Chronic = exp. {mc[ln(hardness)]+bc} where mc and bc are values from **Table B-4**.

**Table B-4. Coefficients for Calculating Metals.**

Parameter	Ba (acute)	Bc (chronic)
Cadmium	-3.924	-4.719
Copper	-1.700	-1.702
Lead	-1.46	-4.705
Zinc	0.884	0.884

Note: If hardness is <25 mg/L as CaCO<sub>3</sub>, the number 25 must be used in the calculation. If hardness is equal or greater than 400 mg/L as CaCO<sub>3</sub>, 400 mg/L must be used for the hardness value in the calculation.

**Temperature**

Montana’s temperature standards were originally developed to address situations associated with point source discharges, making them somewhat awkward to apply when dealing with primarily nonpoint source issues. In practical terms, the temperature standards address a maximum allowable increase above “naturally occurring” temperatures to protect the existing temperature regime for fish and aquatic life. Additionally, Montana’s temperature standards address the maximum allowable decrease or rate at which cooling temperature changes (below naturally occurring) can occur to avoid fish and aquatic life temperature shock.

For waters classified as A-1 or B-1, the maximum allowable increase over naturally occurring temperature (if the naturally occurring temperature is less than 66° Fahrenheit) is 1°F. In the naturally occurring range of 66-66.5°F, an increase can not exceed 67°F. If the naturally



occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5° F [ARM 17.30.622(e) and ARM 17.30.623(e)]. A 2°F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F. A 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F.

### **B.3 Reference Conditions**

#### **B.3.1 Reference Conditions as Defined in DEQ’s Standard Operating Procedure for Water Quality Assessment (2006b)**

DEQ uses the reference condition to evaluate compliance with many of the narrative WQS. The term “reference condition” is defined as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, the reference condition reflects a waterbody’s greatest potential for water quality given historic land use activities.

DEQ applies the reference condition approach for making beneficial use-support determinations for certain pollutants (such as sediment) that have specific narrative standards. All classes of waters are subject to the provision that there can be no increase above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids sufficient to create a nuisance or render the water harmful, detrimental, or injurious. These levels depend on site-specific factors, so the reference conditions approach is used.

Also, Montana’s WQS do not contain specific provisions addressing nutrients (nitrogen and phosphorous), or detrimental modifications of habitat or flow. However, these factors are known to adversely affect beneficial uses under certain conditions or combination of conditions. The reference conditions approach is used to determine if beneficial uses are supported when nutrients, flow, or habitat modifications are present.

Waterbodies used to determine reference condition are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. Reference condition also does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology, and other natural physiochemical differences. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology due to human activity. Therefore, reference conditions should reflect minimum impacts from human activities. A reference approach attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil, and water conservation practices. DEQ realizes that presettlement water quality conditions usually are not attainable.

Comparison of conditions in a waterbody to reference waterbody conditions must be made during similar seasons and/or hydrologic conditions for both waters. For example, the Total Suspended Solids (TSS) of a stream at base flow during the summer should not be compared to the TSS of reference condition that would occur during a runoff event in the spring. In addition,

a comparison should not be made to the lowest or highest TSS values of a reference site, which represent the outer boundaries of reference conditions.

The following methods may be used to determine reference conditions:

### **Primary Approach**

- Comparing conditions in a waterbody to baseline data from minimally impaired waterbodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the waterbody in the past.
- Comparing conditions in a waterbody to conditions in another portion of the same waterbody, such as an unimpaired segment of the same stream.

### **Secondary Approach**

- Reviewing literature (e.g. a review of studies of fish populations, etc., that were conducted on similar waterbodies that are least impaired).
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the waterbody's fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information, etc.).

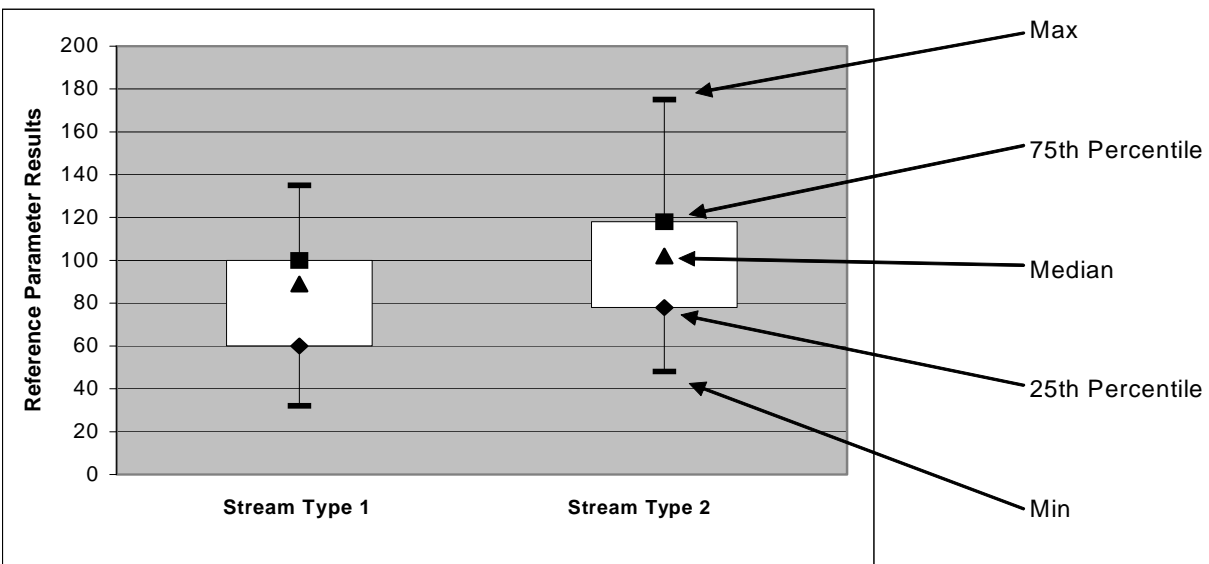
DEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there are no regional data. DEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

### **B.3.2 Use of Statistics for Developing Reference Values or Ranges**

Reference value development must consider natural variability as well as variability that can occur as part of field measurement techniques. Statistical approaches are commonly used to help incorporate variability. One statistical approach is to compare stream conditions to the mean (average) value of a reference data set to see if the stream condition compares favorably to this value or falls within the range of one standard deviation around the reference mean. The use of these statistical values assumes a normal distribution, whereas water resources data tend to have a non-normal distribution (Hensel and Hirsch 1995). For this reason, another approach is to compare stream conditions to the median value of a reference data set to see if the stream condition compares favorably to this value or falls within the range defined by the 25<sup>th</sup> and 75<sup>th</sup> percentiles of the reference data. This is a more realistic approach than using one standard deviation since water quality data often include observations considerably higher or lower than most of the data. Very high and low observations can have a misleading impact on the statistical summaries if a normal distribution is incorrectly assumed, whereas statistics based on non-normal distributions are far less influenced by such observations.

**Figure B-1** is an example boxplot type presentation of the median, 25<sup>th</sup> and 75<sup>th</sup> percentiles, and minimum and maximum values of a reference data set. In this example, the reference stream results are stratified by two different stream types. Typical stratifications for reference stream data may include Rosgen stream types, stream size ranges, or geology. If the parameter being measured is one where low values are undesirable and can cause harm to aquatic life, then measured values in the potentially impaired stream that fall below the 25<sup>th</sup> percentile of reference data are not desirable and can be used to indicate impairment. If the parameter being measured is one where high values are undesirable, then measured values above the 75<sup>th</sup> percentile can be used to indicate impairment.

The use of a non-parametric statistical distribution for interpreting narrative WQS or developing numeric criteria is consistent with EPA’s guidance for determining nutrient criteria (EPA 2000). Furthermore, the selection of the applicable 25<sup>th</sup> or 75<sup>th</sup> percentile values from a reference data set is consistent with ongoing DEQ guidance development for interpreting narrative WQS where it is determined that there is “good” confidence in the quality of the reference sites and resulting information (DEQ 2004). If it is determined that there is only a “fair” confidence in the quality of the reference sites, then the 50<sup>th</sup> percentile or median value should be used, and if it is determined that there is “very high” confidence, then the 90<sup>th</sup> percentile of the reference data set should be used. Most reference data sets available for water quality restoration planning and related TMDL development, particularly those dealing with sediment and habitat alterations, would tend to be “fair” to “good” quality. This is primarily due to the limited number of available reference sites/data points available after applying all potentially applicable stratifications on the data, inherent variations in monitoring results among field crews, the potential for variations in field methodologies, and natural yearly variations in stream systems often not accounted for in the data set.



**Figure B-1. Boxplot Example for Reference Data.**

The above 25<sup>th</sup> – 75<sup>th</sup> percentile statistical approach has several considerations:

1. It is a simple approach that is easy to apply and understand.
2. About 25 percent of all streams would naturally fall into the impairment range. Thus, it should not be applied unless there is some linkage to human activities that could lead to the observed conditions. Where applied, it must be noted that the stream's potential may prevent it from achieving the reference range as part of an adaptive management plan.
3. About 25 percent of all streams would naturally have a greater water quality potential than the minimum water quality bar represented by the 25<sup>th</sup> to 75<sup>th</sup> percentile range. This may represent a condition where the stream's potential has been significantly underestimated. Adaptive management can also account for these considerations.
4. Obtaining reference data that represents a naturally occurring condition, as defined above in **Table B-4**, can be difficult, particularly for larger waterbodies with multiple land uses within the drainage. This is because all reasonable land, soil, and water conservation practices may not be in place in many larger water bodies across the region. Even if these practices are in place, the proposed reference stream may not have fully recovered from past activities, such as riparian harvest, where reasonable land, soil, and water conservation practices were not applied.
5. A stream should not be considered impaired unless there is a relationship between the parameter of concern and the beneficial use such that not meeting the reference range is likely to cause harm or other negative impacts to the beneficial use as described by the WQS in **Table B-2**. In other words, if not meeting the reference range is not expected to negatively impact aquatic life, cold water fish, or other beneficial uses, then an impairment determination should not be made based on the particular parameter being evaluated. Relationships that show an impact to the beneficial use can be used to justify impairment based on the above statistical approach.

As identified in (2) and (3) above, there are two types of errors that can occur due to this or similar statistical approaches where a reference range or reference value is developed: (1) A stream could be considered impaired even though the naturally occurring condition for that stream parameter does not meet the desired reference range or (2) a stream could be considered not impaired for the parameter(s) of concern because the results for a given parameter fall just within the reference range, whereas the naturally occurring condition for that stream parameter represents much higher water quality and beneficial uses could still be negatively impacted. The implications of making either of these errors can be used to modify the above approach, although the approach used will need to be protective of water quality to be consistent with DEQ guidance and WQS (DEQ 2004). Either way, adaptive management is applied to this water quality plan and associated TMDL development to help address the above considerations.

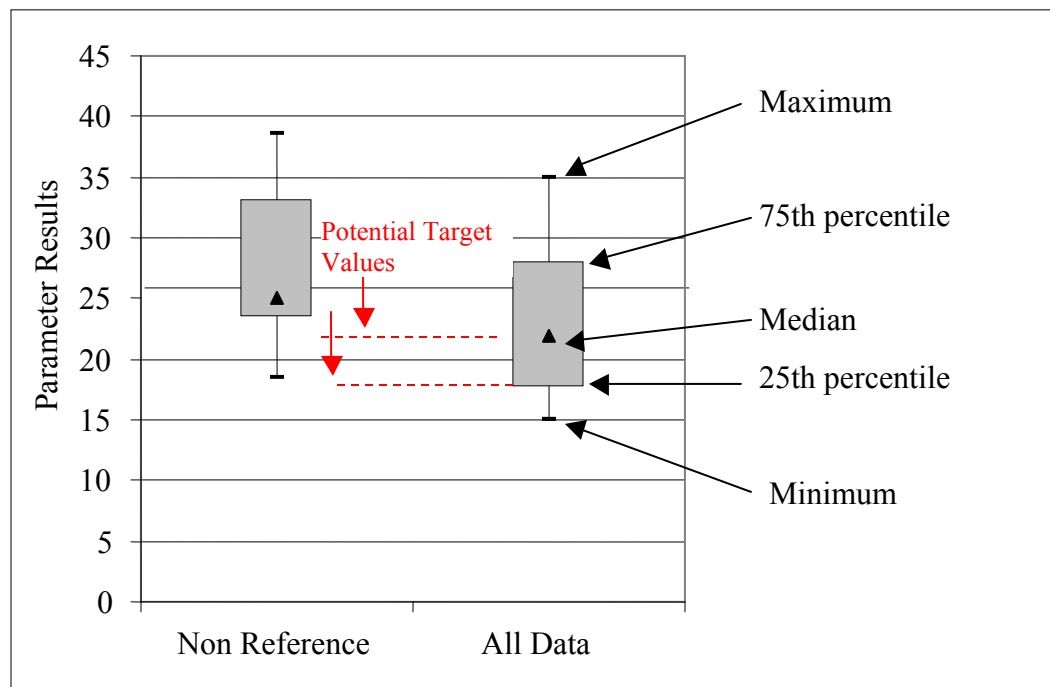
Where the data do suggest a normal distribution or reference data is presented in a way that precludes use of non-normal statistics, the above approach can be modified to include the mean plus or minus one standard deviation to provide a similar reference range with all of the same considerations defined above.

#### **Options When Regional Reference Data is Limited or Does Not Exist**

In some cases, there is very limited reference data and applying a statistical approach like above is not possible. Under these conditions the limited information can be used to develop a reference

value or range, with the need to note the greater level of uncertainty and perhaps a greater level of future monitoring as part of the adaptive management approach. These conditions can also lead to more reliance on secondary type approaches for reference development as defined in **Section B.1.3.1**.

Another approach would be to develop statistics for a given parameter from all streams within a watershed or region of interest (EPA 2000). The boxplot distribution of all the data for a given parameter can still be used to help determine potential target values knowing that most or all of the streams being evaluated are either impaired or otherwise have a reasonable probability of having significant water quality impacts. Under these conditions you would still use the median and the 25<sup>th</sup> or 75<sup>th</sup> percentiles as potential target values, but you would use the 25<sup>th</sup> and 75<sup>th</sup> percentiles in a way that is opposite from how you use the results from a regional reference distribution. This is because you are assuming that, for the parameter being evaluated, as many as 50% to 75% of the results from the whole data distribution represent questionable water quality. **Figure B-2** is an example of statistical distribution where higher values represent better water quality. In **Figure B-2**, the median and 25<sup>th</sup> percentiles represent potential target values versus the median and 75<sup>th</sup> percentiles discussed above for regional reference distribution. Whether you use the median, the 25<sup>th</sup> percentile, or both should be based on an assessment of how impacted all the measured streams are in the watershed. Additional consideration of target achievability is important when using this approach. Also, there may be a need to also rely on secondary reference development methods to modify how you apply the target and/or to modify the final target value(s). Your certainty regarding indications of impairment or non-impairment may be lower using this approach, and you may need to rely more on adaptive management as part of TMDL implementation.



**Figure B-2. Boxplot example for the use of all data to set targets.**

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