PROCEDURES FOR ASSESSING WATER QUALITY STANDARDS ATTAINMENT FOR THE STATE OF NEW MEXICO CWA §303(d) /§305(b) INTEGRATED REPORT:

COMPREHENSIVE ASSESSMENT AND LISTING METHODOLOGY (CALM)

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

TABLE OF CONTENTS

Appendices

LIST OF COMMON ACRONYMS

4Q3	4-Day, 3-Year Low Flow
APs	Assessment Protocols
ATTAINS	EPA's Assessment, TMDL Tracking and Implementation System
AU	Assessment Unit
CALM	Comprehensive Assessment and Listing Methodology
CDX	Central Data Exchange
CHL-A	Chlorophyll *a*
CWA	Clean Water Act
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
HP	Hydrology Protocol
LM	Listing Methodology
MASS	Monitoring, Assessment, and Standards Section
M-SCI	Mountain Stream Condition Index
MDL	Method Detection Limit
NHD	National Hydrographic Dataset
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statues Annotated
NPDES	National Pollutant Discharge Elimination System
PAH	Poly Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PQL	Practical Quantification Limit
QA	Quality Assurance
QAO	Quality Assurance Officer
QC	Quality Control
QAPP	Quality Assurance Project Plan
RBP	Rapid Bioassessment Protocols
ROD	Record of Decision
SDL	Sample Detection Limit
SEV	Severity of Ill Effects
SLD	State Laboratory Division
SOPs	Standard Operating Procedures
SQUID	Surface water QUality Information Database
SSC	Suspended Sediment Concentration
STORET	STOrage and RETrieval System
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
USGS	United States Geological Survey
WQCC	New Mexico Water Quality Control Commission
WET	Whole Effluent Toxicity
WQC	Water Quality Criterion
WQS	Water Quality Standard
WQX	Water Quality Exchange

1.0 ASSESSMENT PROCESS OVERVIEW

Pursuant to Section 106(e)(1) of the federal Water Pollution Control Act (Clean Water Act or CWA), 33 U.S.C. § 1251 et seq. [1], the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) has established appropriate monitoring methods, quality assurance/quality control (QA/QC) procedures, and listing methodologies in order to compile and analyze data on the quality of the surface waters of New Mexico[2]. The SWQB has developed and implemented a water quality monitoring strategy for surface waters of the state in accordance with the New Mexico *Water Quality Act* (NMSA 1978, §§ 74-6-1 to -17).[3] The monitoring strategy establishes methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used toward three basic monitoring objectives to: develop water quality-based controls, evaluate the effectiveness of such controls, and conduct water quality assessments (NMED/SWQB 2016a).

From approximately 1998 to present, the SWQB has primarily utilized a rotating basin system approach to water quality monitoring similar to several other states (WERF 2007). Using this approach, a select number of watersheds are monitored for two years with an established return frequency of approximately eight years (NMED/SWQB 2016a). Revisions to the schedule are necessary based on staff and monetary resources that fluctuate on an annual basis. It should also be noted that a watershed is not necessarily ignored during the years in between sampling. The rotating basin strategy is supplemented with other data collection efforts such as data from United States Geological Survey (USGS) water quality monitoring stations and other external sources that meet SWQB's QA/QC requirements. The SWQB has revised their approaches to monitoring and total maximum daily load (TMDL) prioritization in accordance with the Unites States Environmental Protection Agency's (EPA's) "New 303(d) Vision" program (EPA 2013a).

The SWQB maintains current quality assurance and quality control plans that cover all monitoring activities. This document, called the *Quality Assurance Project Plan* (QAPP), is updated and approved annually by the EPA. When an intensive survey is completed, all data are checked against QA/QC measures identified in the QAPP and assessed to determine whether designated uses detailed in the current *State of New Mexico Standards for Interstate and Intrastate Surface Waters* (http://www.env.nm.gov/swqb/Standards/) are being met. Therefore, these methodologies cover the decision-making process for both listing and de-listing causes of impairment. In New Mexico, surface water data are assessed according to this document and associated appendices – referred to as the comprehensive assessment and listing methodology or "CALM." This document was previously referred to as the "Assessment Protocol." The name was changed to better align with similarly-named EPA guidance documents and other states' titles for their respective listing methodologies. The results of application of New Mexico's listing methodologies are then made available to the public through the *State of New Mexico CWA §303(d) /§305(b) Integrated Report* (Integrated Report). Use attainment decisions are summarized by assessment unit (AU) in New Mexico's Integrated List, which is Appendix A of the Integrated Report and the primary focus of the report. The intent is to prepare the Integrated Report by April 1st of every even-numbered calendar year as required by the CWA. Category 5 water bodies on the Integrated List (see Section 4.0 for category definitions) constitute the *CWA §303(d) List of Impaired Waters*.

Although EPA does not officially approve individual state's listing methodologies, they do provide review and comment and consult the protocols when reviewing New Mexico's draft Integrated List. The CALM is updated every odd-numbered calendar year, and is generally based on current EPA

[1] Full text at https://www.gpo.gov/fdsys/browse/collectionUScode.action?collectionCode=USCODE. Summary at https://www.epa.gov/laws-regulations/summary-clean-water-act.
[2] All available at https://www.env.nm.gov/swqb/
[3] http://public.nmcompcomm.us/nmnxtadmin/NMPublic.aspx.

assessment guidance. For development of the 2018 Integrated Report and List, the EPA recommends that states follow the 2006 Integrated Report guidance (EPA 2005), which is supplemented by biennial memoranda regarding development of the 2008, 2010, 2012, 2014, 2016, and 2018 Integrated Reports (EPA 2006a, 2009, 2011, 2013b, 2015, and draft 2017, respectively).

Assessment results are tracked and maintained by water body or AU (WERF 2007). The EPA first suggested the use of the term "assessment unit" in their 2002 listing guidance (EPA 2001). AUs can represent a single lake or reservoir, or miles of a stream reach or river. AUs are generally defined by various factors such as hydrologic or watershed boundaries, water quality standards (WQS) found in 20.6.4 New Mexico Administrative Code (NMAC), geology, topography, incoming tributaries, surrounding land use/land management, etc. Assessment units are designed to represent surface waters with assumed homogenous water quality (WERF 2007). With respect to 40 CFR 130.2, New Mexico's use of the term "assessment unit" is equivalent to "water quality-limited segment." New Mexico specifically defines the term "segment" within the state water quality standards at 20.6.4.7.S(2) NMAC. In New Mexico, there are generally many AUs within a water quality standard segment (20.6.4.97 through 20.6.4.899 NMAC).

The EPA listing and reporting guidance requires states to organize their respective lists by AUs and electronically report specific assessment information to the EPA's Assessment, TMDL Tracking and Implementation System (ATTAINS). The NMED's Information Technology Bureau merged SWQB's in-house water quality database (NMEDAS) with assessment information previously housed in New Mexico's version of the EPA's Assessment Database (ADB) during the 2014 listing cycle. The merged Oracle-based Surface water Quality Information Database (SQUID) now houses attainment data as well as SWQB-collected chemical, biological, and habitat data used to make attainment decisions. SQUID is also used to generate New Mexico's Integrated List and upload attainment data directly to EPA ATTAINS[4].

ATTAINs was significantly re-designed, with input from states, for the 2018 listing cycle forward. Part of the re-design included nationwide standardization of a variety of database fields, including parameter names/causes of impairment, probable sources, water body types, etc. SQUID was updated accordingly to accommodate these changes. As a result, some of the previous terminology in the Integrated List has been modified. Notable modifications will be further explained in the preface to the Integrated List.

Assessment of quantitative data creates the basis of designated use attainment decisions. These assessments are based on data that reasonably reflect current surface water quality conditions given sampling limitations. These data are compared to current EPA-approved WQS for the state of New Mexico (20.6.4 NMAC) regardless of what WQS were in effect at the actual time of sampling. Data types may include chemical/physical, biological, habitat, bacteriological, or toxicological data. The bulk of the data used for assessments are data collected by the SWQB during rotational water quality surveys. The SWQB will also utilize data collected by other entities (partially listed below), provided the entity's sampling methods and data analysis procedures meet QA/QC requirements as detailed in the most recent QAPP. Appendix A contains data quality and rigor information for aquatic life use determinations.

In general, previously assessed datasets will not be re-assessed unless there are more recent data to add to the assessment dataset (i.e., these assessment conclusions will be carried over onto the new draft list). All readily available data that were not assessed for a previous listing cycle will first be collated and assessed (Figure 1.1). Assessment conclusions will be compared to the conclusions of

[4] https://www.epa.gov/waterdata/assessment-and-total-maximum-daily-load-tracking-and-implementation-system-attains

the previous list. If they have not changed for a given water quality parameter within a particular AU, the conclusions of the current assessment will carry over to the current list. If the current assessment indicates a change in attainment status, the new data for that particular water quality parameter at that site will be combined with the most recent five years of data (WERF 2007).

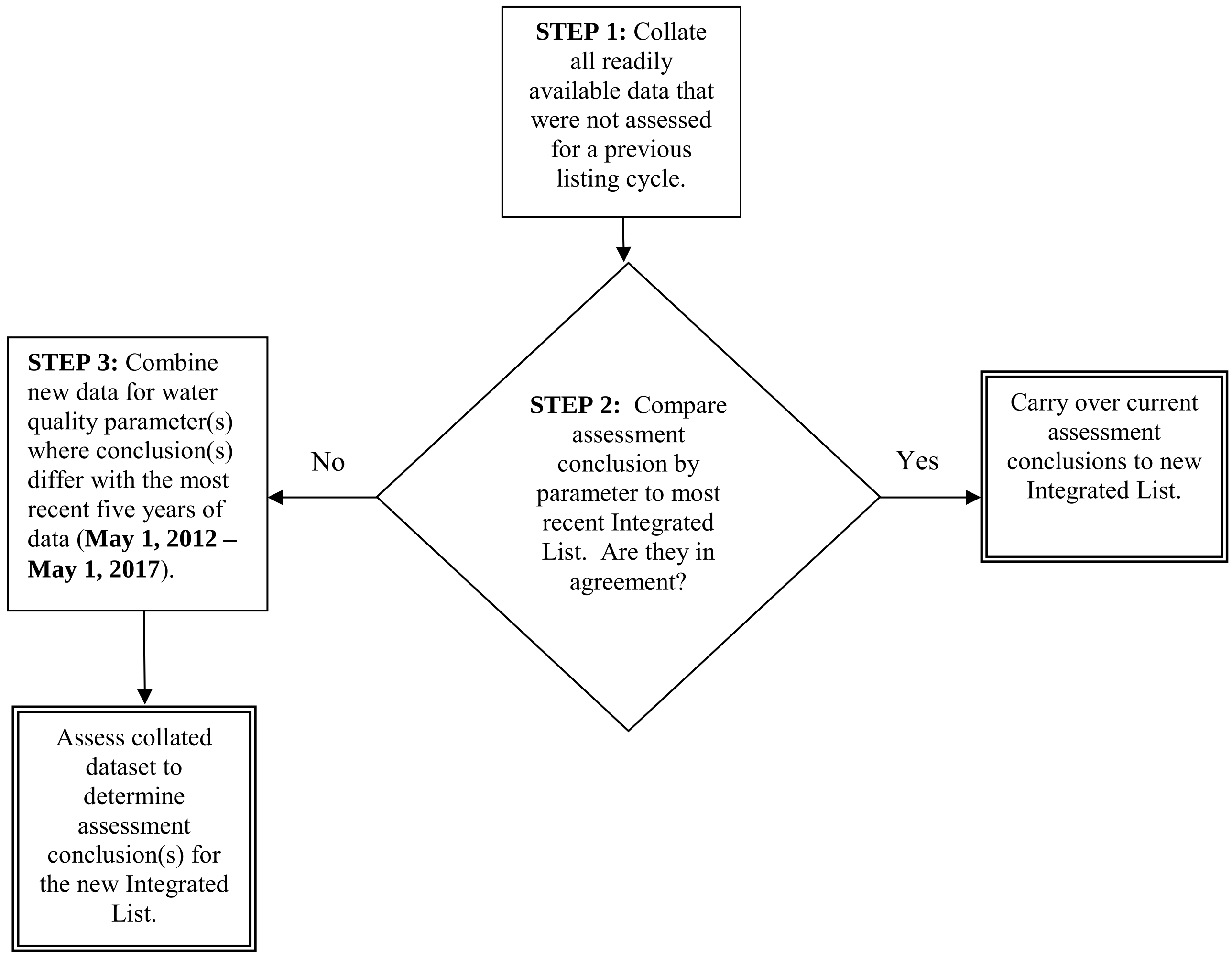


Figure 1.1. Decision process for determining assessment dataset

The specific years of data to use are defined from the date data were collated for the upcoming listing cycle, typically May 1 of the year before the list is due. For example, verified and validated data from May 1, 2012 through May 1, 2017, would be collated for development of the draft 2018 Integrated List. This collated dataset will primarily form the basis of final impairment decision. Data older than five years must meet data requirements and will only be considered on a case by case basis for the following reasons:

- No newer data exists for the waterbody segment/parameter or the existing data does not meet the requirements of this listing methodology;
- The data are part of a larger dataset or long term monitoring which includes data younger than five years old for the same waterbody/parameter; or
- Information or rationale is provided with the data to show that the data reflects current conditions and adheres to acceptable protocols.

Data older than five years may also be used when necessary to determine historical natural conditions if the data meets the QA requirements in place at the time of its collection.

The CWA requires that water quality standards protect designated uses during critical conditions such as years with below average stream flow. This distinction is important because it would not satisfy the intent of the CWA to use data collected in non-drought conditions to draw a conclusion of no impairment when available data collected during low flow conditions indicate impairment. Recent data may take precedence over older data if new data indicate a change in water quality or the older data fail to meet data quality requirements. If there was a temporary disturbance, such as a wildfire, or unintentional spill or discharge, and several consecutive years of data before and after the disturbance are available, the SWQB may also consider data trends when determining attainment status. This is consistent with recommendations in EPA guidance (EPA 2005). If there are only data greater than five years old available for a particular assessment unit, the assessment conclusions based on these older data will be carried over to the next list without being re-assessed until more current data are available to assess.

The Integrated Report and List are opened for a minimum 30-day public comment period. Response to Comments are prepared by SWQB and submitted to the EPA for review. The SWQB also updates and submits the Record of Decision (ROD) document. The ROD is an additional, non-required document that SWQB provides to EPA, NMED personnel, and the public that explains when and why a particular cause of impairment was added to or removed from the Integrated List. All the above-mentioned documents developed and maintained by the SWQB are available on the SWQB web page: http://www.env.nm.gov/swqb/.

Outside sources of available data are solicited via public notice, usually at the same time as the CALM revisions, for a minimum 30-day period before the draft Integrated List of surface waters is prepared (see Section 5.0 below). All data submissions from outside sources will be reviewed by the SWQB Quality Assurance Officer (QAO) to ensure the suitability of the QA/QC procedures under which the data were collected. Specifically, submitted documentation associated with the dataset will be reviewed to determine: (1) if there is documentation of QA/QC procedures that, at a minimum, meet the QA/QC requirements described in the SWQB's most recent QAPP; and (2) if there is reasonable evidence or assurance that these procedures were followed. See https://www.env.nm.gov/swqb/DataSubmittals/ for additional information.

Data meeting QA/QC requirements received through this solicitation may be used to confirm a listing of impairment, confirm the absence of impairment, or initiate a new listing of impairment of a particular AU. Data that do not meet these requirements may be used for screening purposes to determine if additional data collection is warranted. Other water quality related data (e.g., habitat conditions, field observations, and fish communities) are also solicited and may be useful for characterizing water quality conditions and for water quality standards development and refinement. Data packages submitted after the solicitation period and/or related to other watersheds in the state may be considered during development of subsequent Integrated Lists.

Quality data sources could include, but are not limited to, the following. These data would need to meet QA/QC requirements to be used for assessment, as stated above. Provisional data shall not be used to make designated use support determinations:

- Chemical/physical, biological, habitat, and bacteriological data collected by the SWQB during watershed surveys or other recent studies using SWQB's standard operating procedures or otherwise accepted methods;

- Chemical/physical, biological, habitat, and bacteriological data collected by other organizations (including citizen and volunteer groups), contractors, tribes, or individuals during watershed surveys or other recent studies using SWQB's standard operating procedures or otherwise accepted methods;

- Chemical/physical, biological, habitat, and bacteriological data collected by the USGS;

- Chemical/physical, biological, habitat, and bacteriological data collected by EPA or their contractors as part of National Aquatic Resources Survey (NARS);

- In-stream (i.e., receiving water) data collected during National Pollutant Discharge Elimination System (NPDES) storm water or effluent permit monitoring efforts;

- In-stream water quality data from other NMED bureaus such as the Drinking Water Bureau (DWB), Ground Water Quality Bureau (GWQB), or the Department of Energy (DOE) Oversight Bureau.

2.0 DATA USABILITY AND QUALITY DETERMINATIONS

2.1 Data Management Rules

2.1.1 Data qualifiers and validation codes

The SWQB's in-house water quality database (SQUID) houses water and fish tissue chemical data, as well as biological and habitat data. These data are available upon request. This database also contains lab data qualifiers and internal validation codes that are added during the data validation process. Validated chemical/physical data collected by the SWQB are uploaded to EPA's Water Quality Exchange (WQX) database. Any data with a qualifier code or data validation code that are used in an assessment should be noted in the assessment documentation. Refer to the current version of the QAPP for the current definition of all data qualifier and data validation codes.

- Lab Qualifier Codes – In the past, sets of qualifier codes have varied between the individual sections at the State Laboratory Division (SLD). The SWQB has encouraged SLD to determine a unified set of codes that will be reported consistently by all SLD sections. Standard lab qualifier codes for SLD and contract labs, as well as the SWQB data validation codes are defined in the most recent QAPP. All data flagged as "rejected" during internal laboratory QA procedures will not be used for assessment purposes. Other flagged results are usable provided the appropriate caveats are documented in the assessment files and uncertainties in the data are discussed.

  Results from samples that are flagged by the laboratory as "below the minimum quantification or reporting limit" (generally referred to as minimum reporting limit or MRL in SQUID) may only be used during the assessment process if the MRL is less than the applicable water quality criterion (WQC) or numeric threshold being assessed. For this listing methodology, the following terms related to analytical method sensitivity are considered synonymous: "quantitation limit," "reporting limit," "level of quantitation," and "minimum level." Parameters detected above the method detection limit (MDL) but below the MRL are typically flagged with a J qualifier that indicates any reported quantitative concentration is an estimate. The concentration is estimated because the concentration being detected is below the lowest quantifiable concentration on the calibration curve. There is certainty as to the detection of the chemical but uncertainty as to the exact concentration. These reported values may be used in an assessment when the J flagged data is part of a summed parameter. Otherwise, J flagged data will not be assessed. For example, it is common laboratory practice to include J flagged values for individual when summing congeners to determine total PCB concentration using EPA Method 1668A, B or C congener methods.

  Results from samples that are flagged by the laboratory as "exceeded holding time" will be considered estimates and may be used during the assessment process unless the result is deemed "rejected" based on best professional judgment in accordance with the QAPPs and SOPs. Method holding times are different for each sample parameter. Sample analysis after the allowable holding time for a sample or sample set may be a result of laboratory oversight, delayed sample shipment, need for reanalysis, or poor planning. The data validator will take into account the nature of the analysis, the extent of the noncompliance (e.g., considering the method holding time limit, whether the holding time was exceeded for one day vs. one month, and stability of the parameter in question), the sample matrix, any supporting data, and the purpose and goals of the sampling and analysis program (EPA 2002d). From the EPA's perspective, the time and expense associated with the sample collection and processing is forfeited when data exceeding the holding time are rejected even though the analytical results may in fact be accurate and usable (EPA 2002e). Therefore, data exceeding holding time may be considered for use in assessments, but any listings as a result of these qualified data will be noted as Category 5c – needing more data (see Section 4.0 for details).

- SWQB Data Validation Codes (internal) – The SWQB validates all data for a particular water quality survey. Internal data validation procedures are detailed in the most recent QAPP. All data with internal SWQB validation codes will still be used for assessment purposes except data flagged as "rejected" (typically R1, R2, R3, or RB1 data validation codes).

2.1.2 Duplicates and compliance monitoring sampling data

There may be cases where there are multiple data values on the same day at the same station within a one-hour period. For the purposes of assessment, these are considered duplicate samples and the maximum (or minimum if the criterion is expressed as a minimum) value should be used in the assessment dataset. Examples include when QA/QC duplicates or multiple compliance monitoring samples for human health criteria are taken within a one-hour time frame. Assessing the maximum/minimum value of duplicate samples guarantees that any criterion exceedence is considered, thus avoiding the risk of incorrectly disregarding an exceedence (i.e., Type II error).

2.1.3 Continuous recording equipment (thermographs, data loggers, and sondes)

Periodic instantaneous data do not provide information on maximum or minimum daily parameter values, duration of exceedences, or diurnal fluctuations of water temperature and DO. These aspects of water quality are pertinent to aquatic life use. Because of the limitations of grab data and the increasing availability data loggers and sondes to collect long-term datasets, assessments using data logger and sonde datasets are preferred.

The SWQB has been deploying thermographs in streams and applying the temperature assessment protocol since 1998. Continuously recording temperature data loggers (i.e., thermographs) are relatively inexpensive, readily available, and provide an extensive multiple-day record of hourly temperatures over the period when temperatures are generally highest. Monitoring staff program thermographs to record at least hourly (typically 15-minute data), and deploy them long enough to capture the summer season maximum temperature. The use of continuous data is more technically sound than simply applying percentages to limited instantaneous temperature data and allows consideration of magnitude, frequency and duration into water quality monitoring and listing methods. The use of thermographs eliminates the biases introduced when using instantaneous data to assess water quality parameters with significant diurnal fluctuation. Starting with the 2010 listing cycle, the temperature listing methodology covers all temperature assessment scenarios, including procedures for both instantaneous grab and thermograph data for all types of aquatic life uses in either lotic (e.g., streams or rivers) or lentic (e.g., lake or reservoir) water bodies (see Appendix B).

The SWQB has been deploying multi-parameter sondes at select stations since 2000. In addition, DO and specific conductance data loggers have been deployed in recent years. Monitoring staff program these devices to record, at least hourly, dissolved oxygen (DO), pH, specific conductance, temperature, or turbidity values for a minimum of three days (72 hours). Based on the success of the thermograph-based listing methodology, additional large dataset listing methodologies were developed to address parameters with known diurnal fluxes, namely DO and pH (Appendices E and F, respectively). Starting with the 2012 listing cycle, these protocols cover all assessment scenarios, including procedures for both instantaneous grab and sonde data for all types of aquatic life uses in either lotic (e.g., streams or rivers) or lentic (e.g., lake or reservoir) water bodies.

2.1.4 Limited datasets

As stated above, SWQB also uses thermographs, multi-parameter sondes, and data loggers to generate large datasets for temperature, pH, DO, specific conductance, and turbidity. Regarding chemical data, the SWQB strives for a minimum of four to twelve data points for core parameters such as metals and nutrients during rotating watershed surveys to make designated use determinations. Resource constraints typically limit data collection for radionuclides and organic parameters to four sampling events over a two-year monitoring period. The actual number of data points collected depends upon available resources, specific water quality concerns in the watershed, and the hydrologic characteristics of a given water body during the particular survey year. For example, the SWQB has observed an increasing number of streams with very low to no flow as the survey year progresses from March through October. The EPA does not recommend the use of rigid, across the board, minimum sample size requirements in the assessment process (EPA 2009). Target sample sizes should not be applied in an assessment methodology as absolute exclusionary rules (EPA 2003, 2005). The use of limited datasets is acceptable to the EPA, as limited financial, field, and laboratory resources often dictate the number of samples that can be collected and analyzed (EPA 2002a).

Generally, a minimum of two data points for field and chemical parameters is necessary to apply the procedures in Section 3.0 in order to determine and confirm attainment status for an associated AU parameter pair. The primary purpose of requiring two data points is to protect against the occurrence of false positives. During the survey year, the SWQB monitoring staff review data as they are received from the laboratory. As needed, staff investigate questionable results by contacting laboratory personnel directly to confirm the results and/or scheduling appropriate modifications to survey sampling plans in order to acquire a minimum of four seasonally-distributed data points for each parameter sampled.

Impairment listings based on only two available data points will be noted as Category 5c and prioritized for additional data collection until there are at least four total data points to confirm the assessment conclusion(s). If data from no or only one sampling event are available ($n \leq 1$) to assess an applicable designated use, there are insufficient data to determine attainment status for that particular designated use. The use will be noted as "Not Assessed" on the list. If there are no data at all, the AU would fall under category 3a (i.e., no data). If data from one sampling event do not exceed any applicable criteria, the AU would fall under Category 3b (i.e., limited data, no exceedences). If data from the one sampling event exceedence one or more applicable criteria, the AU will be assigned Category 3c (i.e., limited data, exceedences) and the parameter(s) of concern will be noted in the AU Comments field. Additional data will be collected as resources allow in order to determine attainment status. See Section 4.0 for a description of the categories described above.

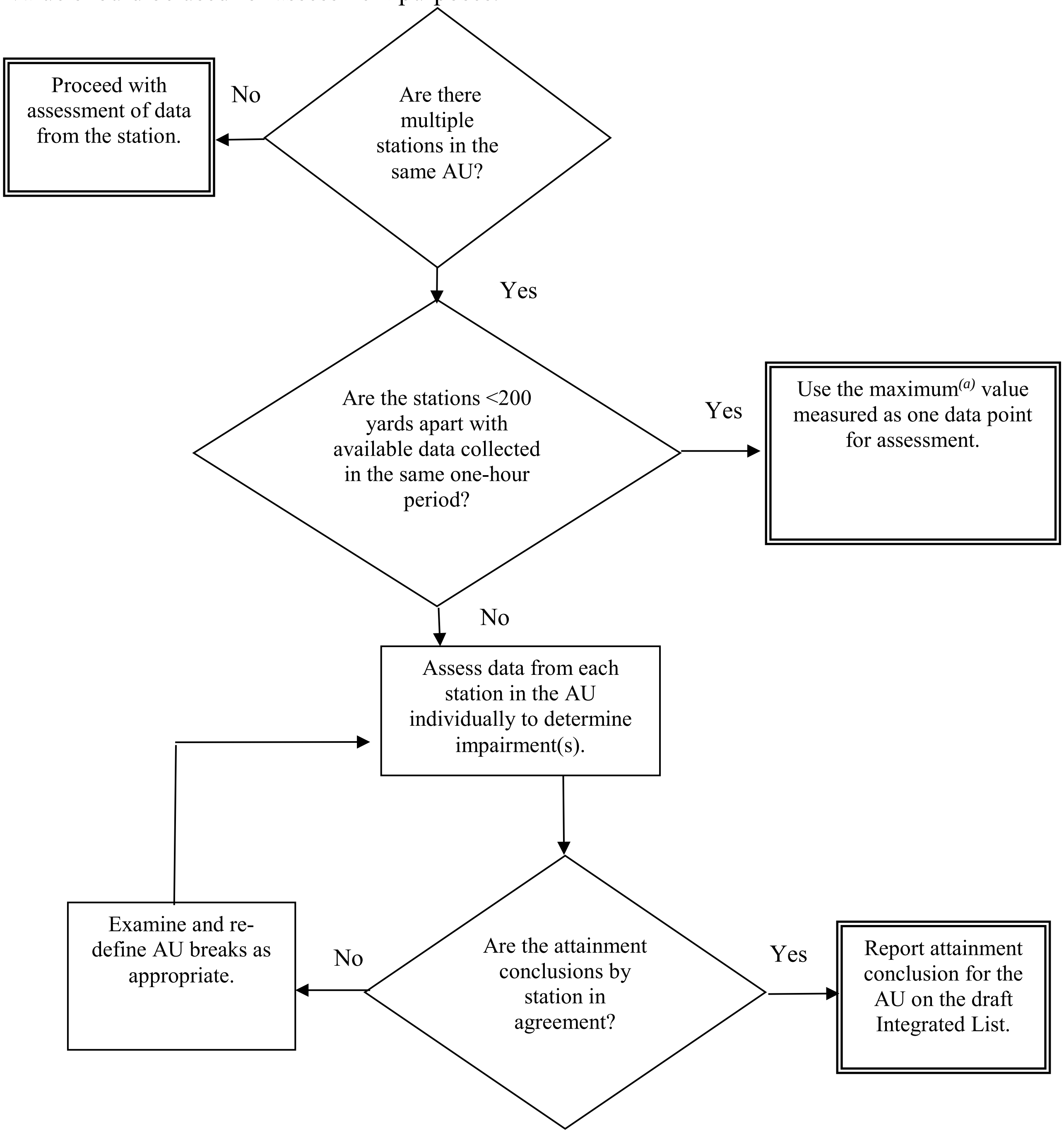
2.1.5 Application of WQS during low flow conditions

In terms of assessing designated use attainment in ambient surface waters, the WQS apply at all times under all flow conditions unless a flow qualifier is specified in a particular section of the WQS. Therefore, data collected during all flow conditions (except data collected during unstable conditions when assessing for chronic aquatic life use — see section 3.1.2.2 below for additional details), including low flow conditions, will be used to determine designated use attainment status during the assessment process.

2.1.6 Multiple stations in one assessment unit

As stated in Section 1.0 above, AUs are designed to represent waters with assumed homogenous water quality (WERF 2007). Section 1.0 also describes the relationship between AUs and "segments" as defined in 20.6.4.7.S(2) NMAC. The SWQB typically does not have the resources to establish more than one monitoring station in any particular river or stream AU during rotational watershed surveys, but there are occasions where more than one station with available data (typically chemical/physical data) is either established by the SWQB or some other data collection agency.

When this occurs in rivers or streams, the assessor will first assess data from each station individually to determine impairment(s) (Figure 2.1). Assessment units with homogenous landscape features are likely to have homogenous water quality. However, multiple stations within an AU may indicate otherwise due to point source discharges and/or lack of adequate, or no, best management practices (BMPs) that address non-point source pollution. If conflicts arise and the attainment conclusions for every station in the AU are not in agreement (i.e., either all **Fully Supporting** or all **Not Supporting**), the AU as currently defined may not represent homogeneous water quality. In this case, the AU breaks should be examined and may be split appropriately, including special consideration of NPDES point source discharges or non-point source BMPs. The data will then be re-assessed based on the newly-defined AUs. In the rare event that there are two or more stations less than one tenth of a mile (approximately 200 yards) apart, and data for the same parameter are collected within a one-hour time frame from these stations, these data are considered replicates for the purpose of assessment and the maximum (or minimum if criterion is expressed as a minimum) value should be used for assessment purposes.



NOTES: [a] or minimum if criterion is expressed as a minimum value.

Figure 2.1. Decision process for multiple stations in same assessment unit

When multiple stations exist on a lake or reservoir (e.g., one "shallow" and one "deep" station), they are usually sampled on the same day or within the same seven-day period. The applicable listing methodology shall be applied to the shallow and deep station datasets separately. If one or both datasets indicate impairment, the impairment conclusion for the AU is **Not Supporting**. If there are conflicting assessment conclusions, it will be noted in the Record of Decisions. The approach in this section is applicable to all impairment determination procedures detailed in this document, as well as all appendices unless otherwise stated.

2.1.7 Blank-correction for constituents measured using ultra-low level procedures

When a constituent concentration is determined using an ultra-low level method which recommends blank-correction (such as EPA Method 1668A, B, or C for analysis of PCBs), the result will first be blank-corrected using the procedures in the method (preferred) assuming adequate data are available to perform the recommended procedure. Other acceptable, documented blank-correction procedures will be considered when the procedures recommended in the method are not used, and the resulting data will be used for assessment if approved by the SWQB QAO. These blank-corrected values will then be compared against New Mexico's WQS to determine impairment.

2.1.8 Non-representative data

Non-representative data include data collected within the mixing zone of a discharge. In addition, data collected during or immediately after temporary catastrophic events influencing the waterbody that are not representative of normal conditions are typically not used to make CWA §303(d) listing decisions. For example, biological or habitat data collected soon after scouring storm flows which indicate the temporary diminished presence of aquatic life or chemical data collected immediately after accidental spills would not be a basis upon which to list a water body as impaired.

For example, wildfires can produce significant water quality changes that may impact fish and other aquatic organisms, drinking water supplies and wastewater treatment systems. These impacts are cumulative as a result of pollutants mobilized by the fire, chemicals used to fight the fire, and the post-fire response of the surrounding environment. Responses include immediate / short-term responses as well as long-term (decade or more) impacts.

The magnitude of the effects of fire on water quality is primarily driven by fire severity (how much of the fuel is consumed) and fire intensity (how hot the fire burned) coupled with subsequent seasonal weather events (e.g., monsoon rainfall). In other words, the more severe the fire, the greater the amount of fuel consumed, the more nutrients released, and the more susceptible the watershed is to erosion of soil and nutrients into the stream, which could negatively impact water quality. In addition, fire intensity affects the formation of hydrophobic soils that repel water and increase the probability of storm water runoff in the watershed. In New Mexico, severe fires most commonly occur on forested lands managed by the U.S. Forest Service (USFS). They have a special taskforce known as the Burned Area Emergency Response (BAER) Team who are responsible for undertaking rapid post-fire assessments. BAER is an emergency program whose purpose is to identify potential threats to life, property and infrastructure, along with potential threats to water quality and recreational resources, wildlife, vegetation, fisheries, and cultural resources. Additional information regarding wildfires and their impacts on water quality in New Mexico is available at: https://www.env.nm.gov/swqb/Wildfire/.

In New Mexico, wildfires have become more frequent in recent years. In addition, some have occurred mid-way through the SWQB's rotational watershed surveys, making it impossible to continue monitoring impacted AUs that particular survey year due to unsafe conditions, restricted access, or severe flooding. If the planned sampling in a particular AU was less than 50% complete based on the Sampling and Analysis Plan (SAP), this AU will be noted as "Not Assessed" and scheduled for additional data collection as resources, access, and recovery allow. These additional data will be collated with data from the original sampling year, and assessed for the subsequent draft Integrated List.

Data collected during or immediately after fires, floods or other catastrophic events will generally not be used to make attainment decisions if the data are not representative of conditions prior to the event or new stable conditions. When determining if an event is considered substantial enough to impact or alter the conditions that existed prior to the event, the following factors should be considered: severity of event, size of the affected area, distance of sampling sites from the event, hydrology, geomorphic effects that include soil types and slope. In the absence of data that characterize the conditions before an event, the SWQB will work with all available resources to try and determine those conditions.

Catastrophic events may be considered as a basis for listing in instances where nonattainment of standards arises from an irreversible source of pollutants. The decision regarding whether or not data collected during or after an event are representative of normal conditions, as well as a determination of irreversibility, will be evaluated in collaboration with stakeholders and EPA Region 6, on a case by case basis, as each event is unique with varying severity and longevity of impacts.

2.1.9 Temporary water quality standards

During New Mexico's 2013 triennial review of water quality standards, the WQCC adopted a temporary standards provision at 20.6.4.10 Section F NMAC. Per Subsection (3), designated use attainment as reported in the Integrated Report shall be based on the original applicable standard and not on any temporary standard.

2.2 Data Quality Levels

As stated in Section 1.0 above, data must, at a minimum, meet the QA/QC requirements described in the SWQB's most recent QAPP to be considered for development of the Integrated Report. In some cases, more than one type of data may be used to determine aquatic life use attainment. It is recognized that not all data are of equal quality or rigor. The tables in Attachment A describe defined levels of data quality for each data type that may be used to determine aquatic life support. These tables contain both elements of data quality as well as quantity. These tables are adapted from the *Consolidated Assessment and Listing Methodology: Towards a Compendium of Best Practices* guidance document (EPA 2002a), as modified with respect to the SWQB's standard operating procedures (SOPs). Tables for determining the level of data quality for biological, chemical/physical and habitat data types are included in Appendix A. It is important to evaluate data quality when an assessment performed with more than one data type results in conflicting use attainment decisions (see Section 3.1.5 for more detail). These tables are included only for aquatic life use determinations because it is the only use for which multiple data types are currently recognized and utilized.

3.0 INDIVIDUAL DESIGNATED USE SUPPORT DETERMINATIONS

The WQS are a triad of elements that work in concert to provide water quality protection. These three elements are: designated uses, numeric and narrative criteria, and an antidegradation policy. Designated uses are the defined uses of a particular surface water body. Each water body will have one or more designated uses. For example, Domestic Water Supply is a designated use. Designated use definitions and their assignment to various stream segments in New Mexico can be found in the *Standards for Interstate and Intrastate Surface Waters (*20.6.4 NMAC). The New Mexico Water Quality Control Commission (WQCC) adopted numeric and narrative criteria to protect these designated uses. There are both segment-specific criteria (detailed in 20.6.4.97 through 20.6.4.899 NMAC) and designated use-specific criteria (detailed in 20.6.4.900 NMAC) in New Mexico's WQS. All references to narrative or numeric criteria throughout this document refer to criteria found in 20.6.4 NMAC. The antidegradation policy ensures that existing uses[5] and levels of water quality necessary to protect these uses will be maintained and protected (20.6.4.8 NMAC).

WQS segments described in 20.6.4.97 through 20.6.4.899 NMAC are further divided into AUs for use impairment determination and linked to the National Hydrographic Dataset (NHD) for national electronic reporting requirements. AUs are stream reaches, lakes, or reservoirs defined by various factors such as hydrologic or watershed boundaries, WQS, geology, topography, incoming tributaries, surrounding land use/land management, etc. Assessment units are designed to represent waters with assumed homogenous water quality (WERF 2007). As stated in Section 1.0, data collected at representative stations during the SWQB water quality surveys along with acceptable external data form the basis of use support determinations for each AU. Stream or river AUs are typically no more than 25 miles in length, unless there are no tributaries or land use changes to consider along the reach. Multiple stations in one AU warrant special consideration as detailed in Section 2.1.6 above.

Numerous classified segments in the water quality standards include only perennial waters, without specifically identifying which reaches are perennial. For example, the description of 20.6.4.109 NMAC states, "…all other perennial reaches of tributaries to the Rio Puerco…" Therefore, non-perennial reaches of these tributaries do not fall under this WQS segment. If the perennial nature of a stream reach is unclear, the Hydrology Protocol (HP) can be used as described in New Mexico's Water Quality Management Plan (WQCC 2011) to determine whether a particular AU is perennial, and therefore included in this classified segment, or non-perennial and therefore subject to the designated uses and criteria in 20.6.4.98 NMAC. Such a determination does not require a use attainability analysis (UAA). If a non-perennial AU is found to be ephemeral, then the UAA process must be followed as described in 20.6.4.15.C NMAC to place the AU under 20.6.4.97 NMAC in the Integrated Report.

The following subsections provide guidelines used to interpret available data. These guidelines will be used to make determinations of use support for each designated use in each AU, utilizing the previously described datasets. Some level of flexibility is built into these guidelines to account for uncertainties such as the natural variability of water quality, the lack of extensive data necessary to make more definitive assessments, and the transitory nature of many pollutants. Each designated use has one or more tables with specific requirements for determining use attainment based on the type of data being evaluated. When determining aquatic life use support, each type of data is first evaluated separately. Guidance on how to reconcile two or more data types with differing aquatic life use attainment determinations, as well as guidance on how to handle assessment units where both cause and response variables are determined to be impaired, is found in Section 3.1.6. In

[5] "Existing use" (defined at 20.6.4.7 NMAC Subsection Y) means "a use actually attained in a surface water of the state on or after November 28, 1975, whether or not it is a designated use." An existing use may be identified by SWQB staff or other sources based on observation, data, and/or documentation.

addition to the following subsections, several specific listing methodologies for temperature, excessive nutrients, DO, pH, sedimentation/siltation (this habitat variable is also referred to as "stream bottom deposits"), and turbidity to assess aquatic life use attainment have been developed. These protocols are detailed in Appendices B through H, respectively.

Integrated listing guidance from EPA recommends the following use attainment categories (EPA 2005 and subsequent biennual guidance): **Fully Supporting, Not Supporting, Insufficient Information,** and **Not Assessed.** For every AU detailed in the Integrated List, an attainment category is assigned to every designated use as stated in the applicable section of 20.6.4 NMAC, or identified existing use. New Mexico does not use the **Insufficient Information** category because it is redundant with **Not Assessed**, meaning if there are insufficient data to assess, the AU is not assessed.

A determination of **Fully Supporting** or **Not Supporting** should not be made in the absence of data. It is understood that any assessment may involve some level of best professional judgment (BPJ). However, evaluations based on BPJ, literature statements, or public comments without data to support the decision shall not be the only basis for a listing or de-listing. To those AUs for which there are no available data that meet the QA/QC requirements for any criteria within an applicable designated or existing use, a designation of **Not Assessed** will be assigned that use.

3.1 Assessing Aquatic Life Use (ALU) Support

Use assessment decisions should consider and integrate, whenever possible and appropriate, results of various data types. These include biological, chemical/physical, and toxicological data. Data quality associated with these types can be found in Appendix A.

3.1.1 Biological data

In 2010, the WQCC adopted the following General Criteria (20.6.4.13.M NMAC):

> *Biological integrity: Surface waters of the state shall support and maintain a balanced and integrated community of aquatic organisms with species composition, diversity and functional organization comparable to those of natural or minimally impacted water bodies of a similar type and region.*

Prior to the 2012 listing cycle, benthic macroinvertebrate sampling had been the primary form of biomonitoring utilized by New Mexico. The extensive data set generated through these sampling efforts was a crucial component towards development of numeric translators for both narrative biological and sediment water quality standards. The SWQB also monitors fish assemblages and algae in an increasing number of water bodies to improve understanding of these biological communities, improve numeric translators for narrative nutrient standards, and better assess potential impairment to aquatic communities.

3.1.1.1 Benthic macroinvertebrate communities

Two biological assessment approaches utilizing benthic macroinvertebrate communities are currently used in New Mexico for determining aquatic life use attainment, namely the reference site approach (i.e., comparing an individual water body to an appropriate individual reference site), and the reference condition approach (i.e., comparing an individual water body to a reference condition for class or group of water bodies to which that water body belongs). Currently, New Mexico has only defined a reference condition for wadeable, perennial streams in the Mountain ecoregions. Wadeable, perennial streams located outside of the Mountain ecoregions continue to be assessed using the reference site approach from the original Rapid Bioassessment Protocol (RBP) (Plafkin et al. 1989) as modified by Jacobi (2009) when a suitable reference site has been identified and sampled as well. The SWQB does not apply either method to large non-wadeable rivers, lakes and reservoirs, or non-perennial streams at this time.

Reference Site Approach

After the study site is selected, a specific reference site must be selected for comparison. The first step in determining a reference site is to identify a pool of best available sites in the same geographic region that have the lowest amount of anthropogenic impacts to the stream's ecosystem. The reference and study sites should share analogous characteristics, to the extent possible, such as elevation, gradient, geology, hydrology, watershed size, in-stream habitat, and riparian vegetation. In particular, characteristics that cannot change over time should be used as primary attributes of similarity between reference and study sites. For this reason, the study site and the reference should at a minimum be in the same ecoregion (Griffin et. al 2006).

Based on identification and enumeration of the benthic macroinvertebrates present in the two samples, biological response indicators (i.e., benthic macroinvertebrate metrics) are calculated and compared between the two sites. Under this approach, the reference site serves as a quantitative control or yardstick to which a site may be compared and evaluated. The eight metrics and scoring criteria New Mexico uses for the reference site approach are recommended in Plafkin et al. (1989) Figure 6.3-4 as modified in Jacobi (2009), excluding the Standing Crop and Community Loss metrics. The ratio between the score for the study site and the reference site provides a percent comparability measure for each study site. The study site is therefore assessed on the basis of its similarity to the reference site and its apparent potential to support an acceptable level of biological health. The resulting score is placed in a condition category based on percent of reference: Non Impaired (>83%), Slightly Impaired (54-79%), Moderately Impaired (21-50%), Severely Impaired (<17%). Sites in any of the impaired condition categories are considered to "Not Supporting" with respect to aquatic life use (see Table 3.3). Plafkin et al. (1989) recommends leaving 4% between each category to account for subjective judgment as to correct placement. Sites falling between >79 and ≤83% are considered "Not Assessed" until a second sample can be taken. These sites will be listed as "Not Supporting" if a second sample within a 5-year period confirms a value in this range. Figure 3.1 provides two examples using the reference site approach.

Metrics	Fish Creek 10 m abv confluence with Trout Creek Reference Site	Sunshine Creek immed abv USGS gage 0123456 Study Site 1	Falls Creek 5m abv conflence with Rock Creek Study Site 2
Diversity [Shannon Weiner (Log Base 2]	4.42	2.60	3.78
Total No. of Taxa	42	35	39
Total No. of EPT Taxa	7	4	6
Ratio EPT/EPT + Chironomidae	0.445	0.202	0.355
Ratio of Scrapers/Scrapers + Filterers	0.432	0.667	0.520
Ratio of Shredder/Total No. of Ind.	0.043	0.408	0.225
Percent Dominant Taxa	18.7	38.9	20.2
Hilsenhoff Biotic Index	5.7	5.7	5.4
% Comparison to Reference			
Total No. of Taxa	100	83	93
Total No. of EPT Taxa	100	57	86
Ratio EPT/EPT + Chironomidae	100	45	80
Ratio of Scrapers/Scrapers + Filterers	100	154	120
Ratio of Shredder/Total No. of Ind.	100	948	523
Hilsenhoff Biotic Index	100	100	106
Bioassessment Score (based on Plafkin et al 1989 Figure 6.3-4, as modified by Jacobi 2009)			
Diversity [Shannon Weiner (Log Base 2]	6	4	6
Total No. of Taxa	6	6	6
Total No. of EPT Taxa	6	0	4
Ratio EPT/EPT + Chironomidae	6	2	6
Ratio of Scrapers/Scrapers + Filterers	6	6	6
Ratio of Shredder/Total No. of Ind.	6	6	6
Percent Dominant Taxon	6	2	4
Hilsenhoff Biotic Index	6	6	6
Total	48	32	44
Bioscore % Comparison to Reference		**66.7**	**91.7**
ATTAINMENT STATUS ---->		**Non Support**	**Full Support**

Figure 3.1. Examples of reference site approach to determine attainment

<u>Reference Condition Approach</u>

The reference condition approach expands on the original RBP methods to acknowledge the reality of a wider range of aquatic conditions that reflect more than minimal impacts, including historic and dominant land and water use activities (Barbour et al. 1999, Stoddard et al. 2006). This broader concept of reference condition allows for the definition of reasonable and attainable targets or goals by class or group in order to assess potential impairment to the aquatic community at a larger number of study sites.

In order to determine reference condition, data from a continuum of reference to stressed sites in the ecoregion(s) of interest must be available. SWQB has been collecting benthic macroinvertebrate data since 1979. The formal process of developing numeric biological translators began in 2002 with assistance from the EPA and Tetra Tech, Inc. In 2006, SWQB, in collaboration with Drs. Jacobi and Tetra Tech, Inc., developed a regional Mountain Stream Condition Index (M-SCI) to determine aquatic life use attainment for the Mountain biological region which consists of Ecoregions 21 and 23 (Southern Rockies and AZ/NM Mountains) (Jacobi et al. 2006, Griffith et al. 2006). This approach is similar to the approach currently utilized in Wyoming and Colorado.

The M-SCI was developed based on reference condition as determined by a number of reference sites. The Jacobi et al. (2006) report describes indices for three classes (bioregions) of streams based on elevation and watershed size. However, the SWQB uses only the High Small (elevation and watershed, respectively) Index applied to the Mountain biological region which consists of Ecoregions 21 and 23 (Southern Rockies and AZ/NM Mountains). The available dataset, stream classification system, and reference site selection process did not sufficiently partition the variability and select an adequate number of sites to define the reference condition and a departure from this condition for the other biological region. Application of the High Small SCI in the report places study reaches in the same condition category for all tested streams in the Mountain region regardless of elevation or watershed size. Therefore, the SWQB applies the "High Small SCI" in the report to determine Aquatic Life Use attainment of all wadeable, perennial streams in the Mountain region, and refers to this as the M-SCI. Any study site within approximately 20 kilometers of the boundary of ecoregions 21 and 23 should be compared to the definitions for the various ecoregions to determine the proper bioregion designation for that site.

The M-SCI is composed of twelve individual metrics from five metric categories, representing community and species attributes such as Taxonomic Composition, Taxonomic Richness, Tolerance, Habit, and Functional Feeding Group. Individual metrics are listed in Table 3.1. For additional descriptions of these twelve metrics, see Plafkin et al. 1989, Barbour et al. 1999, and Jacobi et al. 2006.

Table 3.1 Metrics included in the M-SCI by metric categories

TAXONOMIC COMPOSITION	TAXONOMIC RICHNESS	TOLERANCE	HABIT	FUNCTIONAL FEEDING GROUP
Shannon Diversity (log_2)	Ephemeroptera Taxa	% Sensitive EPT	Clinger Taxa	% Scraper
Pielou's Evenness	Plecoptera Taxa	% Intolerant	Sprawler Taxa	Scraper Taxa
% Plecoptera			Swimmer Taxa	

M-SCI scores are normalized according to the formulas in Table 3.2 utilizing the 95th percentiles associated with each metric. Each metric is first calculated and normalized. All metrics are then summed and averaged to produce an M-SCI score between 0 and 100. The resulting score is then placed in a condition category of Very Good (100 – 78.36), Good (78.35 – 56.71), Fair (56.70 – 37.21), Poor (37.20 – 18.89), or Very Poor (18.90 – 0) based on the distribution of reference site scores. Sites with M-SCI ranking of poor or very poor are considered to **Not Supporting** with respect to aquatic life use. Sites falling in the fair range are considered **Not Assessed** until a second sample can be taken. These sites will be listed as **Not Supporting** if a second sample within a 5-year period confirms a value in this range.

Table 3.2. Metric formulas and 95th percentiles for calculating the M-SCI score

METRIC	95th PERCENTILE	FORMULA[a]
Shannon Diversity (log_2)	3.89	if $X > X_{95,}$ score = 100 if $X \leq X_{95,}$ score = $100 \times X/X_{95}$
Pielou's Evenness	0.50	
% Plecoptera	26.67	
Ephemeroptera Taxa	7.00	
Plecoptera Taxa	7.00	
% Sensitive EPT	78.46	
% Intolerant	57.17	
Clinger Taxa	17.00	
Sprawler Taxa	6.00	
Swimmer Taxa	4.00	
% Scraper	43.78	
Scraper Taxa	4.00	

NOTES: [a] X = metric value; X_{95} = 95th percentile of respective metric

Table 3.3 explains how to interpret macroinvertebrate data to assess aquatic life use support. Biological regions outside of the Mountains region will be assessed using the RBP approach as detailed in Plafkin et al. (1989) until SCIs can be developed for the Xeric and Plains regions. Additional data are needed to determine the specific pollutant or "pollution" of concern. If one or more pollutant(s) are identified, IR Category 5a is assigned and the identified pollutant(s) are listed as cause(s) of impairment. If a form of "pollution" (for example, flow alteration by EPA's definition) and no concurrent pollutant(s) are determined to be the reason for the biological impairment, IR Category 4c may be assigned. Otherwise, the AU is assigned IR Category 5c (more data needed). See Section 4.0 for more detail.

Table 3.3. Interpreting benthic macroinvertebrate data to determine Aquatic Life Use Support in wadeable, perennial streams

TYPE OF DATA	FULLY SUPPORTING	NOT ASSESSED [c]	NOT SUPPORTING	NOTES
Macroinvertebrate assemblages in Ecoregions 22, 24, 25, and 26[a]	Reliable data indicate functioning, sustainable macroinvertebrate assemblages not modified significantly beyond the natural range of reference condition (>83% of reference site(s)). [a]	Reliable data indicate macroinvertebrate assemblages might be modified beyond the natural range of reference condition (≤83% and >79% of reference site(s)). [a]	Reliable data indicate macroinvertebrate assemblage with moderate to severe impairment when compared to reference condition (≤79% of reference site(s)). [a]	Reference condition is defined as the best situation to be expected within an ecoregion. Reference sites have balanced trophic structure and optimum community structure (composition & dominance) for stream size and habitat quality.
Macroinvertebrate assemblages in Ecoregions 21 and 23 using M-SCI[b]	Reliable data indicate functioning, sustainable macroinvertebrate assemblages not modified significantly beyond the natural range of reference condition (> 56.7 score).	Reliable data indicate macroinvertebrate assemblages might be modified beyond the natural range of reference condition (≤56.7 and >37.2 score).	Reliable data indicate macroinvertebrate assemblage with impairment when compared to reference condition (≤37.2 score).	

NOTES:
[a] Percentages are based on Plafkin et al. (1989).
[b] Percentages based on Jacobi et al. (2006).
[c] List as **Not Supporting** if a second sample within a 5-year period confirms value in this range.

3.1.1.2 Algae composition and blooms

Algae are an important biological component of surface waters as they provide a food source for fish and other organisms. Although some forms of algae are toxic, algae do not have to be toxic to be considered a harmful nuisance. Nontoxic algae can reproduce, or bloom, at such a high rate that they reach concentrations that reduce the amount of available oxygen, which can result in fish kills and other detrimental impacts to aquatic organisms. Likewise, some algae have spines or other protrusions that may cause fish kills simply by getting caught in or otherwise irritating fishes' gills.

New Mexico has been collecting periphyton and phytoplankton community data from select streams, lakes, and reservoirs since about 1975. Periphyton is an assemblage of organisms that grow on underwater surfaces and includes a complex matrix of algae and heterotrophic microbes including bacteria, fungi, protozoa, and other organisms (Allaby 1985). Phytoplankton is the assemblage of free-floating, photosynthetic organisms, including diatoms, desmids, and dinoflagellates. Periphyton and phytoplankton data from lentic systems have also been collated and explored as response variables for the nutrient lake and reservoir assessment protocol (see Appendix D). Nutrient protocols for large rivers are under development.

Blue-green algae (also known as cyanobacteria) are one of the largest and oldest groups of photosynthetic bacteria and form a portion of the planktonic community in New Mexico surface waters. Blooms can be blue, bright green, brown or red and may appear as green paint floating on water or washed on shore, foam or scum, or mats on the surface of fresh water lakes and ponds. Some blooms may not affect the appearance of the water but as algae in the blooms die, the water may have a noticeable odor. As single cells, large colonies and filaments, blue-green algae grow in a wide variety of conditions and can become the dominant algae in nutrient-rich lakes, ponds, and slow-moving streams when water is warm and stagnant. Some forms, but not all, can produce toxins that are poisonous to humans, fish, and wildlife that ingest water contaminated with the toxins. Additional information regarding blue-green algae can be found on the SWQB website at:
https://www.env.nm.gov/swqb/documents/swqbdocs/BlueGreenAlgae/BlueGreenAlgaeFAQ.pdf.

Prymnesium parvum, a golden alga found worldwide in estuarine waters and in some freshwater bodies that have relatively high salt content, had its first confirmed freshwater blooms in North America in the Pecos River basin in Texas in 1985. This microscopic flagellated alga is a relatively new invasive species and has appeared in some waters of New Mexico where salinity and nutrient conditions provide suitable habitat for periodic blooms. Physicochemical conditions, including excessive nutrients, can stimulate growth of *P. parvum* which can produce toxins that cause significant fish and bivalve (i.e. clams and mussel) kills resulting in ecological and economic harm to the affected waterbodies; however there is no evidence these toxins harm other wildlife, livestock or humans. Research is under way to better understand, detect and manage *P. parvum* blooms. Additional information regarding this toxic golden alga can be found on the SWQB website at:
https://www.env.nm.gov/swqb/documents/swqbdocs/GoldenAlgae/GoldenAlgaeFactSheet.pdf.

New Mexico’s water quality standards do not contain any specific criteria related to the presence of toxic algae or fish kills. The SWQB currently does not list water bodies as impaired due to these occurrences. Documented occurrences are noted in AU Comments on the Integrated List and the corresponding Record of Decision entries for these particular waterbodies. The SWQB will also continue to post information regarding these blooms on our web site.

3.1.1.3 *Fish assemblages*

The SWQB has been collecting fish community data from select streams, lakes, and reservoirs since 2000. The SWQB has collated available data to begin exploring the feasibility of biological assessment techniques using fish assemblages in select water body types. Cold water streams tend to be lacking in variety of species, making development of fish assemblage-based biological assessment challenging. Therefore, biological assessment development efforts will initially be focused cool and/or warm water streams.

3.1.2 Chemical/physical data

WQS Section 20.6.4.900 NMAC provides numeric criteria related to various chemical/physical parameters. Table 3.4 explains how to interpret chemical/physical grab data relative to these standards to assess aquatic life use support. This table is divided into conventional parameters, which includes field measurements as well as major ions and nutrients, and toxic substances such as trace metals and priority pollutants. Refer to the appropriate water quality standard segment number (20.6.4.97 through 20.6.4.899 NMAC) of the WQS for numeric criteria for conventional chemical/physical parameters that may differ from those listed in 20.6.4.900 NMAC.

Conventional parameters monitored to determine aquatic life use support include: temperature, turbidity, pH, DO, specific conductance (SC), and total phosphorus (TP) (Table 3.4).

Assessment protocols for temperature, DO, and pH, are found in Appendices B, E, and F respectively. Prior to the 2005 triennial review of water quality standards, New Mexico had established segment-specific numeric turbidity values for all water quality standard segments detailed in 20.6.4 NMAC. In 2005, the WQCC amended the water quality standards to remove all the segment specific turbidity values and revise the turbidity subsection under the General Criteria section (20.6.4.13.J NMAC). Because of this water quality standards change, an interim protocol with numeric translators for turbidity was developed to assess turbidity data from listing cycles 2006, 2008, and 2010. The SWQB has since developed a revised turbidity assessment protocol for the 2012 cycle forward. Sedimentation/siltation and turbidity assessments are described in Appendices G and H, respectively. All other parameters are detailed in Table 3.4 and discussed below.

3.1.2.1 *Hardness-dependent metal criteria*

Hardness-dependent acute and chronic aquatic life criteria for metals are calculated using the hardness-dependent equations in 20.6.4.900.I NMAC. Hardness values from the same sampling event are required for the assessment of hardness-dependent metals. However, in EPA's April 30, 2012, triennial review approval letter[6], EPA disapproved the hardness-dependent equations for total recoverable aluminum in waters when concurrent pH is less than 6.5. According to EPA, the previously approved CWA 304(a) aquatic life criteria for dissolved aluminum are the applicable water quality criteria for purposes of the CWA in waters when concurrent pH is below 6.5. Therefore, the benchmark to be used to determine aluminum exceedences will be 87 ug/L when concurrent pH is less than 6.5.

[6] https://www.env.nm.gov/swqb/documents/swqbdocs/Standards/2012/WQS2010-EPAApprovalLetter.pdf

Assessment units (AUs) determined to be impaired prior to the 2018 listing cycle due to exceedences of the previous dissolved aluminum criteria when concurrent pH was greater than 6.5 will be delisted with a delisting rationale of "WQS no longer applicable." If total recoverable aluminum data are not available to assess, an AU Comment will be added indicating the change in WQS and need to prioritize the collection of total recoverable aluminum data.

20.6.4.900 NMAC.J(1)(e) states that total recoverable aluminum criteria are based on samples that were filtered to minimize mineral phases. The SWQB's study of this issue concluded that a filter of 10 µm pore size minimizes mineral-phase aluminum without restricting amorphous or colloidal phases (NMED/SWQB 2012). Therefore, if the turbidity of a sample is less than 30 NTU, no filtration is needed to minimize mineral phases. Samples from waters with turbidity greater than 30 NTU must be filtered with 10-µm disposable in-line capsule filters (rather than paper filters that are designed for use in plate or funnel-type filter holders) prior to analysis in order to determine impairment.

Total aluminum results less than the applicable water quality criterion may be used for assessment in the absence of concurrent turbidity data because filtering the sample prior to analysis would only lower the result even further below the applicable criterion.

Table 3.4 Interpreting chemical/physical data to assess Aquatic Life Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Conventional parameters** (e.g., specific conductance, total phosphorus[(a)])			All **temperature, pH**, and **DO** listing methodologies are described in Appendices B, E, and F respectively. Sampling biases in these parameters (such as diel flux) should be addressed by sampling with continuously-recording sondes, data loggers, and thermographs during the specified index period whenever possible.
A) 2 to 10 samples	**A**) For any one pollutant, no more than one exceedence of the criterion.	**A**) For any one pollutant, more than one exceedence of the criterion.	
B) >10 samples	**B**) For any one pollutant, criterion exceeded in <10% of measurements.	**B**) For any one pollutant, criterion exceeded in ≥ 10% of measurements.	**Sedimentation/siltation (habitat)** and t**urbidity** assessments are described in Appendices G and H, respectively.
•**Toxic substance** (e.g., priority pollutants, ammonia[(b)], chlorine, metals[(c)], cyanide) ≥ 2 samples	For any one pollutant, no more than one exceedence of the **acute** criterion, and no more than one exceedence of the **chronic** criterion in three years.	For any one pollutant, more than one exceedence of the **acute** criterion, or more than one exceedence of the **chronic** criterion in three years.	The **chronic criterion** shall be applied to either 1) the arithmetic mean of the analytical results of consecutive-day samples when available, or 2) the result of individual grab samples. Samples should be taken during hydrologically stable conditions to be representative of the averaging period (see Section 3.1.2.2 below for additional discussion).

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

(a) Only for segment-specific total phosphorus values. Otherwise, see the nutrient listing methodologies in Appendices C and D.

(b) New Mexico's WQS require consideration of the presence of salmonids to assess against acute ammonia criteria, and the presence of fish in early life stages to assess against chronic ammonia criteria. To apply Table K of 20.6.4.900 NMAC for assessment purposes, all waters designated as high quality cold water aquatic life (HQCWAL) or cold water aquatic life (CWAL) will be assumed "Salmonids Present," while all other aquatic life (AL) uses will be assumed "Salmonids Absent." If actual or historic fisheries documentation indicates the presence of salmonids, the "Salmonids Present" column will be used regardless of the designated AL use. To decide whether to apply Table L or M 20.6.4.900 NMAC for assessment purposes, "Fish Early Life Stages" will be assumed present from November 1 to June 30 for HQCWAL and CWAL. "Fish Early Life Stages" will be assumed present from March 1 to August 31 for all other AL uses. If actual fisheries documentation generated during the time of ammonia sample collection, or historic fisheries documentation generated during the same date in a previous year, indicate the presence of early life stages outside of these date ranges, the criteria in Table L of 20.6.4.900 NMAC will be applied regardless of the date of collection. If the applicable uses translate to different criteria values, the most stringent criteria is used per 20.6.4.11 NMAC Subsection F.

(c) See section 3.1.2.1 for additional information on assessment of hardness-dependent metal criteria.

3.1.2.2 Assessing chronic aquatic life WQS

The acute and chronic aquatic life criteria established in the WQS are based upon the nationally recommended criteria developed by the EPA (EPA 2006b). The acute criteria are intended to protect against short-term effects and are derived from tests of lethality or immobilization. The chronic criteria are intended to protect against long-term effects and are derived based upon longer term tests that measure survival, growth or reproduction. The EPA recommends a one-hour averaging period for the acute criteria and a four-day averaging period for the chronic criteria. That is, the 4-day average exposure of aquatic life to a pollutant should not exceed the chronic criterion (EPA 1994).

During the 2000 and 2001 SWQB intensive watershed surveys, the sampling regime generally consisted of two consecutive days of sampling in the spring, three days in the summer, and three days in the fall in order to gather consecutive day data. Starting with the 2002 SWQB intensive watershed surveys, the sampling regime was adjusted to sample once per month over an eight-month period in order to 1) better characterize the waterbody throughout the annual hydrograph, and 2) acquire data points that are more likely to be statistically independent with respect to time. Because of this sampling scheme, consecutive-day data are usually not available to calculate 4-day averages. Few states and tribes are obtaining composite data over a 4-day sampling period for comparison to chronic aquatic life criteria due primarily to budget and staff time constraints. The EPA believes that 4-day composites are not an absolute requirement for evaluating whether chronic criteria are being met (EPA 1997). Grab and composite samples can be used in water quality assessments if taken during stable conditions (EPA 1997). Available sample results should be representative of average conditions over the 4-day period for assessment of chronic aquatic life.

New Mexico has developed a three-step process for assessing attainment of chronic aquatic life criteria based on two or more samples after the dataset has been assembled following the rules in Sections 2.1.2 and 2.1.6 above (Figure 3.2). The first step is to average the results of any samples collected within a 4-day period. These averaged data as well as any individual grab samples are then assessed against the chronic aquatic life WQS. If a datum to be averaged was reported as less than the MRL and the WQC is greater than this limit, the MRL will be used to calculate the average value. If the WQC is less than the MRL, this datum would not be used for assessment (see section 2.1.8).

If two or more samples represent an exceedence of a given criterion, these data are evaluated to determine if the samples were collected during hydrologically stable conditions considered to be representative of the 4-day averaging period; this process is detailed below. If conditions were unstable during the time of sampling, the data are not assessed. If sample collection methodology was specifically designed to capture data from storm flow events (e.g., through the use of single stage or automated samplers deployed to capture storm events only), these data should not be used to assess chronic aquatic life criteria. Note that the above statements and data process only apply to chronic criteria and that all grab samples will be used to assess acute criteria regardless of hydrologic conditions.

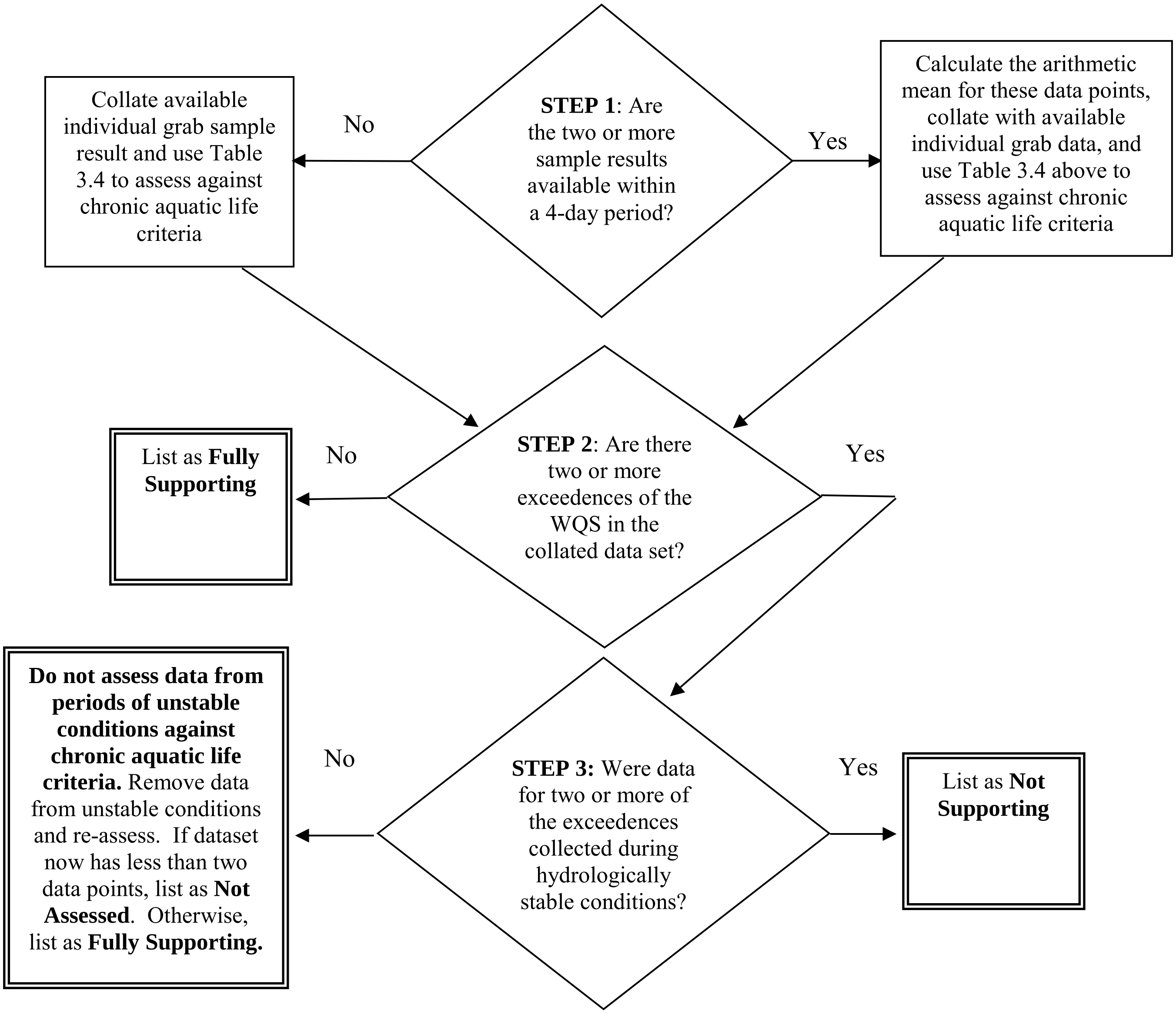


Figure 3.2 Decision process for assessing against chronic aquatic life criteria

Determining the representativeness of a sample is a qualitative assessment and is addressed primarily in the sample design, through the selection of sampling sites, and through use of procedures that reflect the project goals and environment being sampled (NMED/SWQB 2016b). These procedures ensure that a given sample represents a characteristic of a population, in this case the water in a given AU at the time of sampling. The assessment of chronic aquatic life criteria adds an additional constraint that the sample(s) must be representative of a 4-day period. As such, these samples must be collected during periods when the water is well mixed and reasonably expected to represent conditions during the averaging period. Specifically, lakes or reservoirs, as stated in 20.6.4.14.C(3) NMAC, will be assessed for attainment of criteria for toxic pollutants using data that were collected during periods of complete vertical mixing. With respect to stream or river chronic aquatic life assessments, grab samples are deemed representative for this application when there is an absence of contextual information indicating unstable hydrologic conditions. Examples of contextual information to be considered include but are not limited to: 1) stream flow measurements or flow rating, 2) precipitation, 3) location of point source discharges in relationship to the monitoring site, and 4) the occurrence of a chemical spill or other unusual event (EPA 2005).

Specifically, if there are two or more exceedences of applicable chronic aquatic life criteria based on grab or arithmetic mean data, the SWQB will consider the following information to determine whether conditions were stable at the time of data collection:

- Point source discharge records in the reach or immediately upstream (if one or more point source discharges provide a significant contribution to the receiving water)
- Field notes and weather records regarding precipitation and runoff
- Flow measurements taken at the time of sampling
- Flow condition rating recorded at the time of sampling
- Gage station records (when available)
- Land uses in the vicinity
- Records of chemical spills or other unusual events
- Historic patterns of pollutant concentrations when available

If readily available contextual information indicates that the pollutant concentration and the stream flow likely remained generally constant over a four-day period surrounding the sampling event, the SWQB will conclude that the result of the grab sample, or the average of multiple day sampling events, is valid for assessing chronic aquatic life criteria.

Alternatively, these data will not be used for assessing attainment of chronic aquatic life criteria when contextual data indicate unstable conditions. Examples of unstable conditions may include, but are not limited to, samples being collected during:

- A precipitation event with runoff lasting shorter than 4-days
    - NOTE: If the data were collected during several days of high flow, the sample would be assumed representative of the 4-day average condition to assess chronic aquatic life uses. If continuous gage data are available, the procedure in the below paragraph would be performed vs. making assumptions about the longevity of the storm event
- The first flush of a precipitation event
- A short-lived but high flow monsoon event

One way to determine stable conditions is to examine the coefficient of variation (CV). When exceedences occur at or near a continuous flow gaging station and mean daily flow data are available, a stream may be considered hydrologically stable if the CV of the mean daily flow for a 4-day period surrounding the sampling collection is at or below 0.2. The CV is determined by dividing the standard deviation of the values by the mean of the values. This is a common statistical method to evaluate variability in datasets relative to the mean, and 0.2 is a common threshold number below which data are considered to have minimal variability (ADEQ 2008).

The 4-day window that produces the lowest CV should be determined instead of always using a predetermined number of days before or after the sampling event. See Table 3.5 below for an example using available gage data for a grab sample collected on 8/2/07. In this example, the CV of the mean daily flows from 7/30/07 to 8/2/07 produced the lowest CV and is below 0.2, so this 4-day period surrounding the sampling event is determined to be stable. The hydrologic stability inference is about the entire 4-day period vs. just the sampling event. Utilizing the mean daily flow from 7/31/07 to 8/3/07 produces a CV of 0.22.

Table 3.5 Example of stable flow determination using gage data

Date	**Mean Daily Flow (cfs)**	**Mean [a]**	**Standard Deviation (SD) ***	**CV (SD / Mean) [a]**
7/30/07	6.0	**7.7**	**1.3**	**0.17**
7/31/07	7.5			
8/1/07	9.2			
8/2/07	**8.1**			
8/3/07	12.0			
8/4/07	11.3			

NOTES: [a] for mean daily flow data collected 7/30/07 – 8/2/07

If one or more point source discharges provide a significant contribution to the receiving water, the facility discharge record(s) should be reviewed to determine whether flow and associated pollutant discharges were relatively consistent during the four-day period when the exceedence occurred. Other evidence concerning unstable flow or pollutant discharges can be provided by the facility.

3.1.2.3 Assessing human health criteria

Human health is not defined as a designated use according to the current version of 20.6.4 NMAC. Instead, human health criteria apply to all waters with a designated, existing or attainable aquatic life use. Human health criteria for persistent toxic pollutants as identified in 20.6.4.900.J NMAC also apply to all tributaries of waters with a designated, existing, or attainable aquatic life use (20.6.4.11.G NMAC). Refer to Subsection 20.6.4.900.J NMAC for the numeric criteria related to human health. Human health criteria proposed by the EPA are presumed to have exposure durations of a year or more (EPA 2005), and were generally established to protect for exposure over the period of a human lifetime so a percentage-based assessment approach is appropriate when the sample size is greater than 10 samples. Table 3.6 explains how to interpret chemical/physical data to determine if these criteria are met.

Table 3.6 Interpreting chemical/physical data to assess human health criteria

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Toxic substance** (e.g., cyanide, PAHs, pesticides, PCBs, metals)			
A) 2 to 10 samples	**A)** For any one pollutant, no more than one exceedence of the criterion.	**A)** For any one pollutant, more than one exceedence of the criterion.	
B) >10 samples	**B**) For any one pollutant, criterion exceeded in <10% of measurements.	**B**) For any one pollutant, criterion exceeded in ≥ 10% of measurements.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

3.1.3 Toxicological data

Table 3.7 explains how to interpret toxicological data to assess aquatic life use support. Refer to 20.6.4.13.F NMAC for the narrative general standards which states "Surface waters of the state shall be free of toxic pollutants from other than natural causes in amounts, concentrations or combinations which affect the propagation of fish…" Results from ambient toxicity testing are a valuable indicator for assessing and protecting against impacts on water quality and designated uses caused by the aggregate toxic effect of pollutants. Contaminants may flow directly from industrial and municipal waste dischargers, may come from polluted runoff in urban and agricultural areas, or may collect in the sediments. Toxicity evaluations can be used to assess the type and extent of degraded water quality (EPA 2002a). Acute toxicities of substances are determined using at least two species, one vertebrate and one invertebrate, tested in whole effluent and/or ambient stream water as well as a series of dilutions. The reason for two distinctly different species is to account for the diverse species that inhabit waterbodies. In general, fish and other vertebrates are sensitive to many compounds such as those similar to their waste material, namely ammonia or ammonium complexes. Although ammonia is toxic to invertebrates, not all invertebrates are as sensitive as fish species in general. Similarly, invertebrates are generally more sensitive to pesticides than fish. Toxicological data for New Mexico can be downloaded from: https://www.epa.gov/regionallabs/epa-region-6-laboratory-biomonitoring-lab.

While ambient toxicity testing results are a valuable indicator, they are only the first step towards identification of a water quality concern. These listings are noted as Category 5C (see Section 4.0) because the particular pollutant(s) leading to the toxicity must be identified in order to take the next steps, such as development of TMDL documents to develop a plan to address the problem. In past surveys, the SWQB collected water and sediment samples that were subjected to the EPA toxicity tests during the survey year for a particular watershed, while concurrently sampling surface waters for a variety of chemical constituents. The SWQB has found that where there is nothing in the chemical data to indicate the source of toxicity, a false positive result from the toxicity test must be considered. There are also instances where toxicity tests fail in receiving waters due to a known issue with an upstream discharger. Once the permittee corrects the issue/malfunction, repeat toxicity testing is necessary to determine whether the impairment still exists. For these reasons, repeat toxicity testing is necessary to verify that the water is correctly listed due to acute or chronic toxicity. In the event that re-testing again provides a conclusion of non-support, the SWQB will evaluate available benthic macroinvertebrate data using the factors in Table 3.3.

Table 3.7 Interpreting toxicological data to assess Aquatic Life Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Acute and/or chronic toxicity testing**	Significant effect noted in no more than one acute water test as compared to controls or reference conditions, and in no more than one chronic water test in three years as compared to controls or reference conditions.	Significant effect noted in more than one acute water test as compared to controls or reference conditions, or in more than one chronic water test in three years as compared to controls or reference conditions.	Significant effect refers to a statistically significant difference in a primary endpoint as defined in the latest EPA procedures documents for acute and chronic toxicity testing in water (EPA 2002b, 2002c). Reference controls will be used to compensate for possible toxic effects from naturally occurring conditions (i.e. high salinity). If toxicity testing results are from multiple years, the most recent results will be used to make the final impairment determination for the reasons stated in Section 3.1.3.

3.1.4 Fish consumption advisories

Per guidance, the EPA considers fish or shellfish consumption advisories with supporting fish tissue data to be existing and readily available data that demonstrate non-attainment of CWA goals stating that waters should be "fishable" (CWA Section 101(a)(2), EPA 2000, EPA 2005). The EPA also acknowledges that in some cases, fish and shellfish consumption advisories may not demonstrate that a section 101(a)(2) "fishable" use is not being attained in an individual segment when, for example, a state uses a higher fish consumption value in determining the need for an advisory compared to the value used in establishing water quality criteria for the protection of human health (EPA 2000, EPA 2005). Therefore, all water bodies for which an advisory has been issued are listed as impaired due to the specific fish tissue contaminant on the Integrated List except in cases where there is a consumption advisory due to mercury but fish tissue data indicate the methylmercury criterion of 0.3 mg/kg in fish tissue is not exceeded. In acknowledgement of the need for data to support the listing, the impairment listing will be applied to the AU where fish tissue data are available, noting that, especially for stream/river AUs, the advisory may include different geographic extents.

The majority of New Mexico's current fish consumption advisories are based on mercury levels in fish (NMDOH et al. 2010); however, there are also listings for PCBs, DDT, or some combination thereof, in fish tissues. The current fish consumption advisory, as well as additional information on how New Mexico develops these advisories, can be found at: http://www.env.nm.gov/swqb/advisories/. Fish tissue advisories for other parameters of concern may be forthcoming. The Integrated List will be updated whenever the advisory is revised.

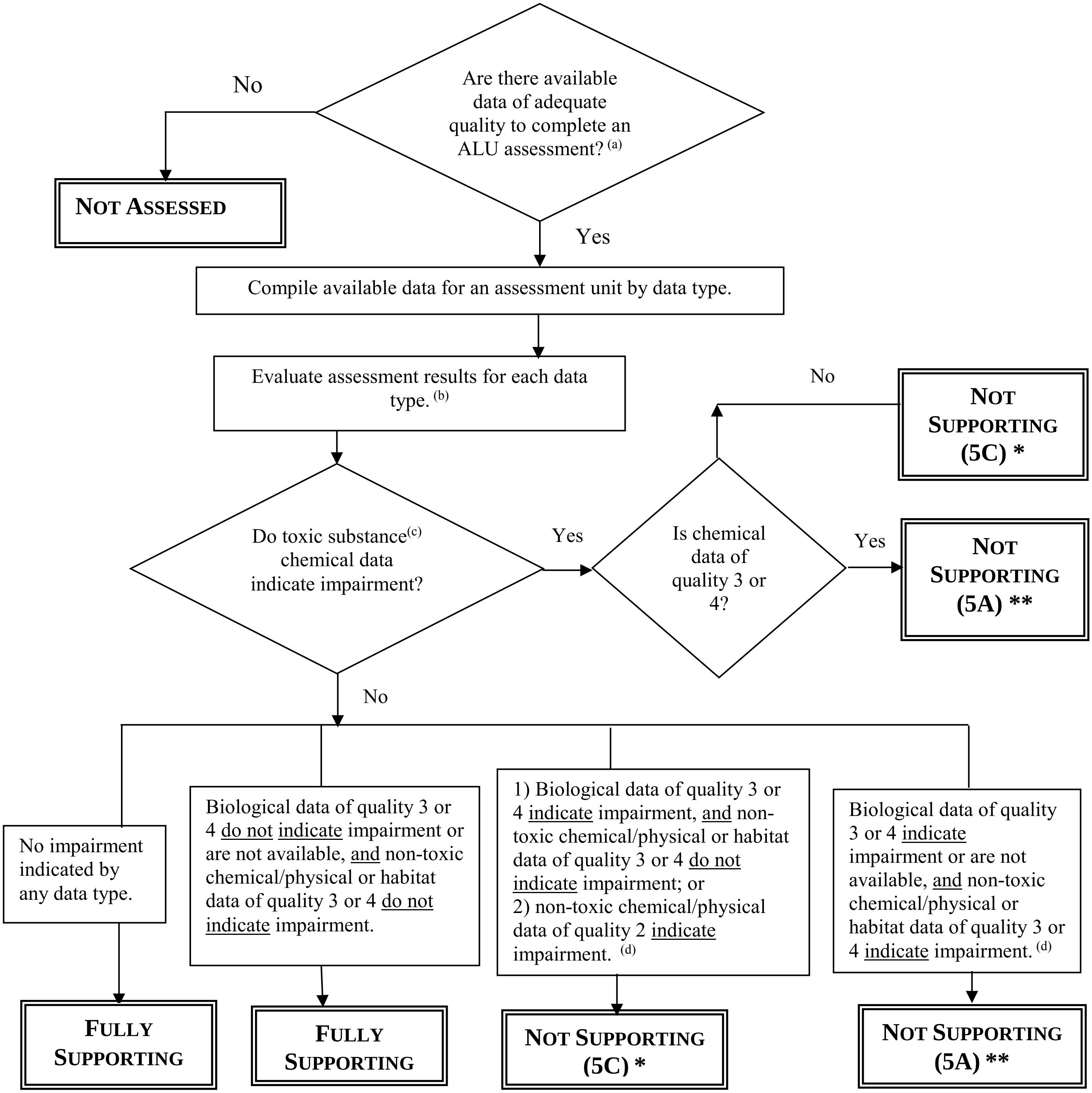
3.1.5 Special considerations for lake data

Lentic waterbodies in New Mexico have historically been, and continue to be, studied using the methods and approaches specified in the *Clean Lakes Program Guidance Manual* (EPA 1987). For purposes of consistency and comparability, classic limnological methods for water quality standards attainment continue to be used in monitoring practices. For purposes of this document, the term "lake" shall include natural lakes as well as reservoirs, impoundments, and any other human-made lentic waterbodies.

Lake water quality surveys should at least contain a station in the deepest portion of the lake. Additional sample locations may be needed if the reservoir is large, contains multiple arms with multiple inflows, or the lake is divided by narrow connectors resulting in pools with unique characteristics. Additional stations may be established as needed to evaluate conditions of concern. During periods of lake stratification, 20.6.4 NMAC requires depth-integrated composite samples for assessment of toxic pollutants (e.g., organic compounds, ammonia, metals, cyanide, radionuclides, etc.). Water quality measurements taken at intervals are averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of criteria per 20.6.4.14.C(3) NMAC. When multiple stations exist on a lake, they are usually sampled on the same day or within the same seven-day period. The applicable listing methodology shall be applied to the shallow and deep station datasets separately. If one or both datasets indicate impairment, the impairment conclusion for the AU is **Not Supporting**. If there are conflicting assessment conclusions, it will be noted in the Record of Decision.

3.1.6 Conflicting or duplicative aquatic use support determinations

For aquatic life use assessments, it is possible that data of differing types may lead to differing use attainment determinations for the same assessment unit. For example, there may be chemical/physical data that indicate **Not Supporting** and biological data that indicate **Fully Supporting**. If two or more data types are available for assessment, a weight-of-evidence approach is adopted when conventional parameter data (for example, non-toxic substances such as temperature, pH, or specific conductance), or habitat parameters such as sedimentation/siltation, indicate impairment. This approach considers data type, quality, quantity, and confidence of assessment methods in reaching a final aquatic life use determination. Data types with higher data quality are given more weight (see Appendix A for data quality descriptions). Typically, data quality of level 3 or 4 are used to make listing determinations. Chemical/physical data with quality level 2 may be used to list as impaired under IR Category 5c (e.g., needs more data to confirm). Chemical/physical of data quality 1, and biological or physical data of quality 1 or 2, will not be used to make designated use attainment decisions. Figure 3.3 displays a generalized flowchart for considering different data types and their quality when determining aquatic life use support. Biological assessments provide an integrated assessment of ecological health and have the potential to provide a direct measure of the designated goal of providing for the protection and propagation of aquatic life uses, especially when evidence of impairment due to non-toxic chemical/physical parameters is weak or based on low data quality. In the case of toxic substance chemical data (e.g., priority pollutants, ammonia, chlorine, metals, cyanide), the weight-of-evidence approach is not applied.



NOTES: * Additional data are needed to determine the specific pollutant or "pollution" of concern. If a form of "pollution" (for example, flow alteration by EPA's definition) and no concurrent pollutant(s) are determined to be the reason for the biological impairment, IR Category 4c may be assigned. Otherwise, the AU is assigned IR Category 5c (more data needed). See Section 4.0 for more detail.

** TMDL or TMDL alternative ready to be scheduled for the cause(s) of impairment. See Section 4.0.

[a] Data quality determined per Appendix A. Chemical/physical of data quality 1, and biological or habitat data of quality 1 or 2, will not be used to make designated use attainment decisions.

[b] Per Tables 3.3 through 3.6, and referenced associated appendices.

[c] Toxic substances include parameters such as priority pollutants, ammonia, chlorine, metals, cyanide (Table 3.4).

[d] Data quality determined per Appendix A. Data collected via SWQB SOPs are generally between data quality 3 and 4.

Figure 3.3 Generalized flowchart for determining Aquatic Life Use Support

In addition, if there are one or more causal variables (such as nutrients, temperature, or turbidity) as well as related response variables (such as DO, pH, or benthic macroinvertebrate) identified, the AU will be listed for the causal variable(s). For example, if an AU is determined to be impaired due to excessive nutrients following the procedures in Appendix C for streams or D for lakes or reservoirs, the AU will be listed for nutrients vs. the individual response variables. However, if only the response variable with established water quality criteria has been identified as impaired, the AU will be listed for that particular variable.

3.2 Assessing Domestic Water Supply Use Support

Table 3.8 explains how to interpret chemical/physical data to assess domestic water supply use support. Refer to 20.6.4.900.B and 20.6.4.900.J NMAC for numeric domestic water supply criteria.

Table 3.8 Interpreting chemical/physical data to assess Domestic Water Supply Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Toxic substance** (e.g., radionuclides[a], priority pollutants, metals, cyanide) •**Nitrate** ≥ 2 samples	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

[a] When radionuclides are analyzed using SM7110 B or EPA Method 900.0 (recommended, and equivalent to SM7110 B according to SLD), gross alpha and gross beta results generated using an Am-241 reference and a Sr/Y-90 reference, respectively, will be used for purposes of assessing standards attainment because these references are prescribed in the method description. If the information is not available for the type of reference used to generate a reported value, the highest value available will be assessed. Also, the water quality criterion in 20.6.4.900.J NMAC is for "adjusted gross alpha." Gross alpha data must be adjusted by subtracting contributions from natural uranium, as well as any measured special nuclear and by-product material, as called for in the definition in 20.6.4.7.B NMAC. To convert uranium concentrations reported in ug/L to pCi/ug a conversion factor of 0.67 is used. In the absence of U-mass to correct for adjusted gross alpha, U-238 can be used because this is the most common form of uranium radiation in the natural environment. In the event that negative values are reported for special nuclear materials are reported, zero will be substituted for purposes of adjusting gross alpha radiation.

3.3 Assessing Primary and Secondary Contact Use Support

Table 3.9 explains how to interpret bacteriological data to assess recreational contact use support. Refer to Subsection B under the appropriate WQS segment number (20.6.4.97 – 20.6.4.899 NMAC) and of 20.6.4.900 NMAC Subsections D and E for numeric primary and secondary contact use criteria.

Table 3.9 Interpreting bacteriological data to assess Contact Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Bacteria **A)** 2 to 10 samples **B**) > 10 samples	**A**) No more than one exceedence of the single sample criterion. **B**) Single sample criterion is exceeded in <10% of samples or geometric mean criterion is met.	**A**) More than one exceedence of the single sample criterion. **B**) Single sample criterion exceeded in ≥ 10% of measurements or geometric mean criterion is not met.	The monthly geometric mean shall be used in assessing attainment of criteria when a minimum of five samples is collected in a 30-day period (20.6.4.14.B NMAC).

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

3.4 Assessing Irrigation Use Support

Table 3.10 explains how to interpret chemical/physical data to assess irrigation use support. Refer to 20.6.4.900.C and 20.6.4.900.J NMAC for numeric irrigation use criteria.

Table 3.10 Interpreting chemical/physical to assess Irrigation Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Toxic substance (e.g., metals) ≥ 2 samples	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	
•Salinity parameters (e.g., total dissolved solids, sulfate, chloride) **A)** 2 to 10 samples **B**) > 10 samples	**A**) For any one pollutant, no more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in <10% of measurements.	**A**) For any one pollutant, more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in ≥ 10% of measurements.	Salinity parameters are segment-specific criteria included in a few individual WQS segments based on flow qualifiers.

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

3.5 Assessing Wildlife Habitat Use Support

Table 3.11 explains how to interpret chemical/physical data to assess wildlife habitat use support. Refer to 20.6.4.900.G NMAC for narrative criteria and 20.6.4.900.J NMAC for numeric criteria with respect to wildlife habitat use.

Table 3.11 Interpreting chemical/physical data to assess Wildlife Habitat Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Toxic substance** (e.g., PCBs, DDT, cyanide, chlorine, metals) ≥ 2 samples	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

3.6 Assessing Livestock Watering Support

Table 3.12 explains how to interpret chemical/physical data to assess livestock watering use support. Refer to 20.6.4.900.F and 20.6.4.900.J NMAC for the numeric livestock watering use criteria.

Table 3.12 Interpreting chemical/physical data to assess Livestock Watering Use Support

TYPE OF DATA*	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Conventional parameters** (e.g., nitrite + nitrate) **A)** 2 to 10 samples	**A**) For any one pollutant, no more than one exceedence of the criterion.	**A**) For any one pollutant, more than one exceedence of the criterion.	
B) > 10 samples	**B**) For any one pollutant, criterion exceeded in <10% of measurements.	**B**) For any one pollutant, criterion exceeded in ≥ 10% of measurements.	
•**Toxic substance** (e.g., radionuclides[(a)], priority pollutants, metals) ≥ 2 samples	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 for details.

[(a)] When radionuclides are analyzed using SM7110 B or EPA Method 900.0 (recommended, and equivalent to SM7110 B according to SLD), gross alpha and gross beta results generated using an Am-241 reference and a Sr/Y-90 reference, respectively, will be used for purposes of assessing standards attainment because these references are prescribed in the method description. If the information is not available for the type of reference used to generate a reported value, the highest value available will be assessed. Also, the water quality criterion in 20.6.4.900.J NMAC is for “adjusted gross alpha.” Gross alpha data must be adjusted by subtracting contributions from natural uranium, as well as any measured special nuclear and by-product material, as called for in the definition in 20.6.4.7.B NMAC. To convert uranium concentrations reported in ug/L to pCi/ug a conversion factor of 0.67 is used. In the absence of U-mass to correct for adjusted gross alpha, U-238 can be used because this is the most common form of uranium radiation in the natural environment. In the event that negative values are reported for special nuclear materials are reported, zero will be substituted for purposes of adjusting gross alpha radiation.

3.7 Assessing Fish Culture, and Public or Industrial Water Supply Uses

Per applicable assessment unit, all Fish Culture, Public Water Supply, and Industrial Water Supply designated uses have been assigned "Not Assessed" because no numeric criteria apply uniquely to these uses (see 20.6.4.900.A NMAC). The Rio Grande from Cochiti Pueblo boundary to Rio Pueblo de Taos (20.6.4.114 NMAC) includes public water supply radionuclide concern levels for monitoring and disclosure only. Available data will be compared to these concern values and noted in the AU Comments on the Integrated List.

3.8 Assessing Numeric Criteria Under Multiple Use Designations

40 CFR 131.11(a)(1) addresses instances where there are different water quality criteria for a particular parameter for two or more uses applicable to an AU. In these cases, the criteria used to make the final impairment decision for the AU should support the most sensitive use. In New Mexico, 20.6.4.11.F NMAC correspondently states:

> ***Multiple Uses****: When a surface water of the state has more than a single designated use, the applicable* <u>*numeric*</u> *criteria shall be the most stringent of those established for such water.*

For example, surface waters with both wildlife habitat and livestock watering designated uses are assessed against the lower 0.77 µg/L wildlife habitat total mercury criterion instead of only the 10 µg/L livestock watering criterion to make a total mercury impairment determination.

4.0 ASSESSMENT UNIT CATEGORY DETERMINATIONS FOR INTEGRATED LIST

The determination of individual use support using Section 3.0 and other specified protocols are combined to determine the overall WQS attainment category for each AU (EPA 2001, Figure 4.1).

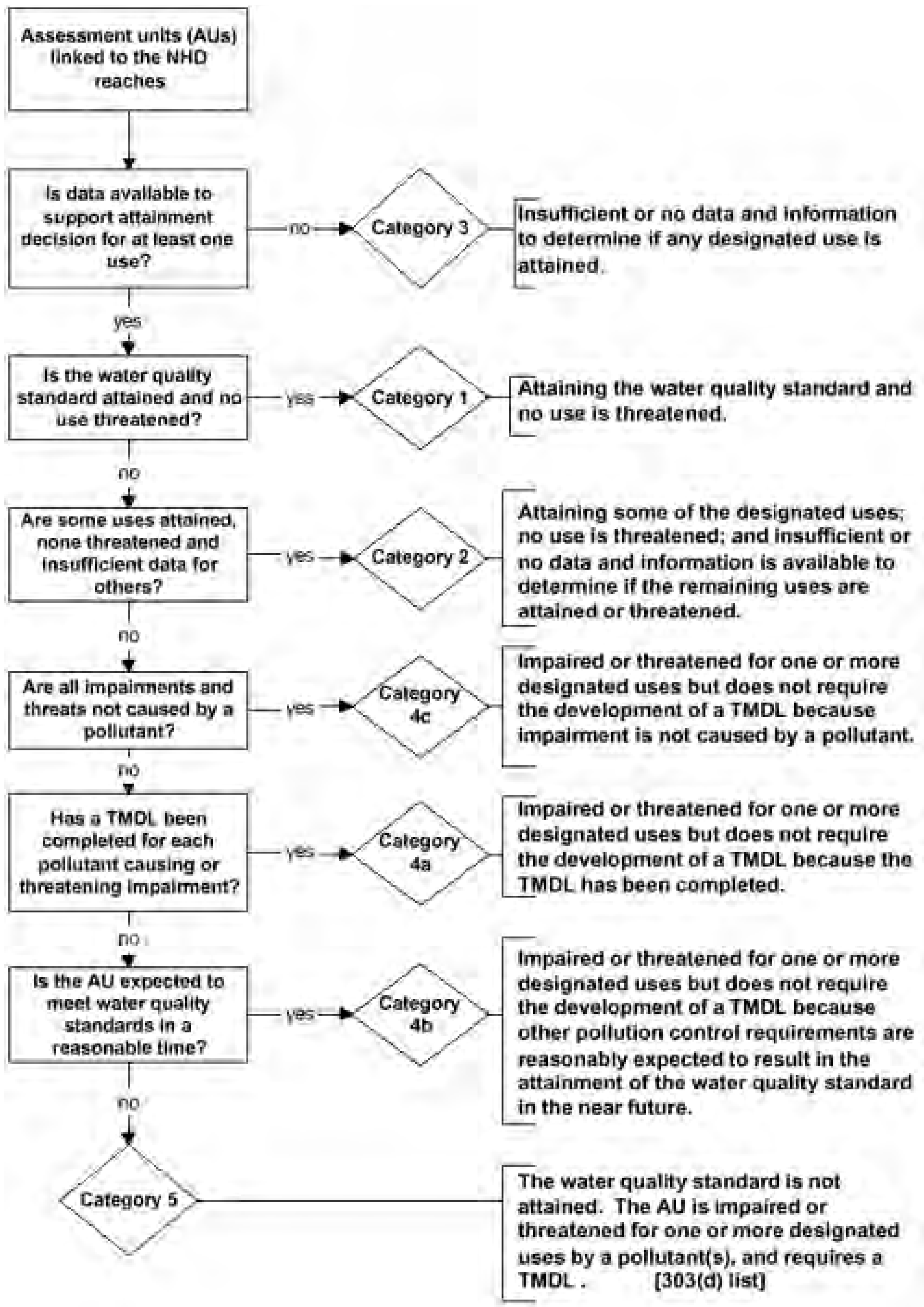


Figure 4.1. Attainment category logic (EPA 2001).

Several states, including New Mexico, further divide the EPA's recommended integrated reporting categories. New Mexico's specific reporting category interpretations are described below.

1. **Attaining the water quality standards for all designated and existing uses.** AUs are listed in this category if there are data and information that meet all requirements of the assessment and listing methodology and support a determination that the water quality criteria are attained based on numeric and narrative water quality criteria that were tested.

2. **Attaining some of the designated or existing uses based on numeric and narrative parameters that were tested, and no reliable monitored data are available to determine if the remaining uses are attained or threatened.** AUs are listed in this category if there are data and information that meet requirements of the assessment and listing methodology to support a determination that some, but not all, uses are attained based on numeric and narrative water quality criteria that were tested. Attainment status of the remaining uses is unknown because there is no reliable monitored data with which to make a determination.

3. **Insufficient or no reliable data and/or information to determine if any designated or existing use is attained.** AUs are listed in this category where sufficient data to support an attainment determination for any use are not available, consistent with requirements of the assessment and listing methodology. In order to relay additional information to stakeholders including SWQB staff, Category 3 is further broken down in New Mexico into the following categories:

   3a. **No data (n = 0) available**. AUs are listed in this subcategory when there are no available data to assess. These are considered high priority for follow up monitoring.

   3b. **Limited data (n = 1) available, no exceedences**. AUs are listed in this subcategory when there are no exceedences of any applicable criteria in the limited data set. Their priority for follow up monitoring depends on the parameter and concentration (for example, measurements near the criteria would increase the priority for additional sampling).

   3c. **Limited data (n = 1) available, exceedence(s)**. AUs are listed in this subcategory when there are exceedences of one or more applicable criteria in the limited data set. These are considered high priority for follow up monitoring.

4. **Impaired for one or more designated uses, but does not require development of a TMDL because:**

   4a. **TMDL has been completed and approved.** AUs are listed in this subcategory once all TMDL(s) have been developed and approved by the WQCC and the EPA that, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the impairment of an AU, the AU remains in Category 5 (see below) until all TMDLs for each pollutant have been completed and approved by the WQCC and the EPA.

   4b. **Other pollution control requirements are reasonably expected to result in attainment of the water quality standard in the near future**. Consistent with the regulation under the CWA section 130.7(b)(i),(ii), and (iii), AUs are listed in this subcategory where other pollution control measures required by local, state, or federal authority are stringent enough to implement any WQS applicable to such waters. Details regarding the specific documentation and timeline needed to propose a Category 4b listing can be found in Appendix I.

4c. **Impairment is not caused by a pollutant.** AUs are listed in this subcategory if available data and information demonstrate that the use impairment is not associated with one or more pollutants, and is attributable only to other types of "pollution" (e.g., flow or habitat alteration). For example, if the narrative biological water quality criterion found at 20.6.4.13.M NMAC is demonstrated to not be met due to pollution and no concurrent pollutant(s) are identified, the AU may be assigned Category 4c.

5. **Impaired for one or more designated or existing uses**. The AU is not supporting one or more of its designated uses because one or more water quality standards are not attained according to current water quality standards and assessment methodologies. **This category constitutes the *CWA §303(d) List of Impaired Waters*.** In order to relay additional information to stakeholders including SWQB staff, Category 5 is further broken down in New Mexico into the following categories:

5a. **A TMDL is underway or scheduled.** AUs are listed in this category if the AU is impaired for one or more designated uses by a pollutant. Where more than one pollutant is associated with the impairment of a single AU, the AU remains in Category 5a until TMDLs for all pollutants have been completed and approved by the EPA.

5b. **A review of the water quality standard will be conducted.** AUs are listed in this category when it is possible that water quality standards are not being met because one or more current designated uses are not attainable, or if available data indicate background processes are causing criteria exceedences. After additional reviews of available data and the water quality standard are conducted, either a UAA will be developed and submitted to the EPA for consideration, or the AU will be moved to Category 5a and a TMDL will be scheduled. AUs in this category usually also have additional data needs as well.

5c. **Additional data will be collected before a TMDL is scheduled.** AUs are listed in this category if there is not enough data and information to determine the specific pollutant of concern (for example, AUs with biological impairment but inadequate data to determine the cause of this response), complete a weight-of-evidence assessment, or when an impairment decision is based on less than four data points for chemical/physical parameters. When the causal pollutant(s) are determined or adequate data are available to confirm the listing ($n \geq 4$ for chemical/physical parameter or complete weight-of-evidence assessment), the AU will be moved to Category 5a and a TMDL will be scheduled. If it is determined that the current designated uses are not attainable, the AU will be assigned Category 5b. AUs that are suspected of being impaired due solely to natural causes, but which lack sufficient data to make this determination, will be placed in Category 5c with a note that additional information is needed.

5-alt. Alternative restoration approach is in progress or under development. EPA created this optional subcategory as an organizing tool to clearly articulate which impaired water bodies have or will have alternative approaches to attain WQS (EPA 2015). The alternative restoration approach needs to clearly demonstrate how the WQS will be achieved. The description of the alternative restoration approach and the waters to which it applies will be included during public review of the draft Integrated Report, so that the public has an opportunity to view the proposed alternative restoration approaches. Additional details on what must be included in the description are found in EPA's listing guidance (EPA 2015).

This present reporting approach was developed in response to a recent National Research Council (NRC) report and a desire to provide a clearer summary of the nation's water quality status and management actions necessary to protect and restore them (NRC 2001, EPA 2001, WERF 2007). With a few additions and minor changes in terminology, the information requested in the *Integrated Listing* guidance (EPA 2001) and Consolidated Assessment and Listing Methodology guidance (EPA 2002a) were previously suggested in earlier section 305(b) reporting guidance (EPA 1997). The earlier guidance formed the basis of previous SWQB listing methodology.

Assessment information is housed in the SWQB's in-house database SQUID. This database was designed to implement suggestions in the *Integrated Listing* guidance (EPA 2001, EPA 2005, EPA 2006a, 2009, 2011, 2013b, 2015, draft 2017), and to provide a means to directly upload New Mexico's use attainment information to the EPA's ATTAINs database. SQUID is first populated with AU information, associated designated uses, comments, and any supporting documentation. Individual use attainment decisions (i.e., **Fully Supporting**, **Not Supporting**, or **Not Assessed**) are then assigned for each AU based on assessment of data following these listing methodologies. SQUID then automatically determines the integrated reporting category for each AU based on the information entered for each applicable use.

Section 303(d)(1) of the CWA requires states to establish a priority ranking for AUs determined to be impaired, and to schedule TMDL development in accordance with the priority ranking. New Mexico expresses this ranking, including indicating which waters bodies are targeted for TMDL development in the next two years, in the form of an estimated TMDL completion year per the EPA's recommendation (EPA 2005). This information is housed in SQUID and reported under "TMDL Date" for all AU-pollutant pairs noted as **Not Supporting** on the Integrated List. If a TMDL has already been completed and approved, the EPA approval date is displayed.

5.0 PUBLIC PARTICIPATION

The listing methodologies are periodically revised based on new EPA guidance, changes to the WQS, and the need to clarify various assessment procedures for staff. When the protocols are revised, a draft is first sent to the EPA for initial review and comment. If significant changes to the overall assessment procedures and/or format of the document are being proposed, the SWQB also releases a public comment draft to solicit public review and comment. For example, a draft of this listing methodology was opened for a 30-day public comment period from April 12 to May 11, 2017. Consequent revisions to the main listing methodology are noted in the revision history below. See individual appendices for revisions histories related to those respective methodologies.

The final version of this protocol is provided to the EPA Region 6, who then considers the listing methodologies in its review and approval of Category 5 waters in the Integrated Report. The listing methodology is also posted on the SWQB website: http://www.env.nm.gov/swqb/protocols/.

REVISION HISTORY:

2014 listing cycle – Pre-public comment: Moved aquatic life use data quality tables from main document to attachment. Added description of SQUID (SWQB's merger of ADB and NMEDAS databases). Added link to new data submittal website. Added information regarding assessment of hardness-dependent metals criteria (specifically, clarified that samples from waters with turbidity greater than 30 NTU must be filtered with 10-µm disposable in-line capsule filters prior to analysis). Minor revision to wording in Figure 3.3 - Generalized flowchart for determining Aquatic Life Use Support. Added protocols for determining nutrient impairment in lakes/reservoirs, and for proposing IR Category 4b. **Post- public comment:** Several minor wording and flowchart clarifications. Revisions to Limited Dataset section and associated addition of Integrated Report subcategories 3A and 3B. Added description of reference site approach to Bioassessment section. Clarified when Category 5C would be assigned. Additional clarification to Figure 3.3, clarified relationship between Data Quality Levels (Attachment A) and aquatic life use attainment decisions when conflicting conclusions from various data types, and indicated SWQB's general data quality level.

2016 listing cycle – Pre-public comment: Moved List of Common Acronyms (previously Appendix A) to the beginning of Main AP. Moved Data Quality Levels (previously Attachment A) to Appendix A. Re-named all appendices Added section regarding wildfire. Clarified assessing when multiple applicable numeric WQC for the same parameter. Added additional clarification to Integrated Report category descriptions. Removed reference to "unclassified" segments to match proposed triennial review clarification.

2018 listing cycle – Pre-public comment: Changed "Assessment Protocol" to "Listing Methodology" throughout. Clarified how to handle data reported below the MRL when data are part of an additive parameter, and when MRL is greater than the applicable WQC. Clarified when J flagged data would be used. Added additional information regarding non-representative data, and when data older than five years would be assessed. Clarified the relationship between temporary standards and the Integrated Report listing process. Added IR Category 5-alt, and expanded IR Category 3 to 3a, 3b, and 3c to better explain handling of n=1. Changed Tables 3.4 to 3.12 from "1 to 10" to "2 to 10" because n=2 is a minimum data requirement for assessment. Updated impairment determination logic in Table 3.8 for consistency with other assessment tables. **Post-**

public comment: Clarified that this document was previously referred to as the "Assessment Protocol." Added the following footnote to Tables 3.4 – 3.12 to refer the reader to the appropriate section detailing the handling of limited datasets (n=1) with respect to assessment: "* Less than 2 samples = not assessed. See Section 2.1.4 for details." Clarified how SWQB will assess aluminum in waters with concurrent pH < 6.5 in Section 3.1.2.1. Based on this additional discussion, SWQB will also delist old dissolved aluminum listings for waters with concurrent pH >6.5 because the dissolved aluminum criterion is no longer applicable as stated in this revised section.

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APPENDIX A

AQUATIC LIFE USE (ALU) DATA QUALITY TABLES

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Tables 1 through 3 classify the data level or rigor of a data type by its technical components and describe the level of effort (spatial or temporal coverage) necessary to achieve each level as defined by EPA with minor modifications specific to the SWQB's standard operating procedures and hydrologic environment (EPA 2002). Level 4 represents data of the highest rigor and the highest level of quality while Level 1 represents the lowest level of quality. Although the table structures imply that data at Level 2 (Fair) level of information, for example, would have the technical components, spatial/temporal coverage, and data quality listed for that data level, it is possible to have different levels of information for each of the three components. SWQB's current standard MASS rotational survey levels are bolded in each table, and are a combination of Levels 3 and 4 depending on specific survey needs detailed in the associated Field Sampling Plan. Typically, data quality of level 3 or 4 is used to make listing determinations. Chemical/physical data with quality level 2 may be used to list as impaired under IR Category 5C (e.g., needs more data to confirm). Chemical/physical of data quality 1, and biological or physical data of quality 1 or 2, will not be used to make designated use attainment decisions.

Table 1. Bioassessment data levels for evaluation of ALU attainment

LEVEL OF INFO	TECHNICAL COMPONENTS	SPATIAL/TEMPORAL COVERAGE	DATA QUALITY
1 LOW	Visual observation of biota; reference conditions not used; simple documentation	Limited monitoring; extrapolation from other sites	Unknown or low precision and sensitivity; professional biologist not required.
2 FAIR	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; identifications to family level	Low to moderate precision and sensitivity; professional biologist may provide oversight
3 GOOD	**Single assemblage usually the norm; reference conditions may be site specific, or composite of sites; 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; identifications to genus and species level**	**Moderate precision and sensitivity; professional biologist performs survey or provides training for sampling; professional biologist performs identification**
4 EXCELLENT	Generally two assemblages, but may be one if high data quality; regional (usually based on index sites) **reference conditions used; biotic index (single dimension or multi metric index)**	Monitoring during 2 sampling seasons*; broad coverage of sites for either site-specific or watershed assessments; identifications to genus and species level; conducive to regional assessments using targeted or probabilistic design	High precision and sensitivity; professional biologist performs survey and identification

NOTES: *Seasons are defined as October – December, January – March, April – June, and July – September.

Table 2. Chemical/physical data levels for evaluation of ALU attainment

LEVEL OF INFO	TECHNICAL COMPONENTS	SPATIAL/TEMPORAL COVERAGE	DATA QUALITY
1 LOW	Any one of the following: • Water quality monitoring using grab sampling • Water data extrapolated from upstream or downstream station where homogeneous conditions are expected • BPJ based on land use data, location of sources	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 flow (critical hydrological regimes) • Data are >5 years old and likely not reflective of current conditions	Approved QA/QC protocols are not followed or QA/QC results are inadequate Methods not documented Inadequate metadata
2 FAIR	Any one of the following: • Water quality monitoring using grab sampling • Rotating basin surveys involving single visits • Synthesis of existing or historical information on fish tissue contamination levels • Screening models based on loadings data (not calibrated or verified) • Verified volunteer data	Moderate spatial and temporal coverage: • Bimonthly or quarterly sampling at fixed stations, or few data points (n<2 for organics and radionuclides, n<4 for all other) • Sampling during a key period (e.g. fish spawning seasons, high and/or low flow) • Stream basin coverage, multiple sites in a basin	Low precision and sensitivity QA/QC protocols followed, QA/QC results adequate Approved SOPs used for field and lab; limited training Adequate metadata
3 GOOD	Any one of the following: • Water quality monitoring using grab sampling • **Rotating basin surveys involving multiple visits or automatic sampling** • Calibrated models (calibration data <5 years old) • Limited use of continuous monitoring instrumentation	**Broad spatial and temporal coverage of site with sufficient frequency and coverage to capture acute events:** • **Monthly sampling during key periods (e.g. critical hydrological regimes and fish spawning seasons); multiple samples at high and low flows; grab sample n = 2-4 for organics and radionuclides, 4 – 8 for all others)** • **Period of sampling adequate to monitor for chronic concerns*** • Lengthy period of record for fixed station sites (sampling over a period of months)	Moderate precision and sensitivity QA/QC protocols followed, QA/QC results adequate Approved SOPs used for field and lab Adequate metadata
4 EXCELLENT	All of the following: • **Water quality monitoring** using composite samples**, series of grab samples, and continuous monitoring devices** • Follow-up sediment quality sampling or fish tissue analyses at sites with high probability of contamination	Broad spatial coverage (several sites) and temporal (long-term, e.g. 5-years) coverage of fixed sites with sufficient frequency and coverage to capture acute events, chronic conditions, and all other potential chemical/physical impacts: • Monthly sampling during key periods (e.g., spawning, critical hydrological regimes) including multiple samples at high and low flows • **Grab sample** n>5 for radionuclides and organics, **>8 for all others; continuous monitoring (e.g. use of thermographs, sondes, or similar devices)**	**High precision and sensitivity** **QA/QC protocols followed, QA/QC results adequate** **Approved SOPs used for field and lab; samplers well trained** **Adequate metadata**

NOTES: *See section 3.1.2.2 for additional information. The same data levels are used to make all designated use attainment decisions.

Table 3. Habitat data levels for evaluation of ALU attainment

LEVEL OF INFO	TECHNICAL COMPONENTS	SPATIAL/TEMPORAL COVERAGE	DATA QUALITY
1 LOW	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 not required.
2 FAIR	Visual observation of habitat characteristics and simple assessment; use of land use maps for characterizing watershed condition; reference conditions pre-established by professional scientist	Limited to annual visits non-specific to season; generally easy access; limited spatial coverage and/or site-specific studies	Low precision and sensitivity; professional scientist not involved, or only by correspondence
3 GOOD	**Visual-based habitat assessment using SOPs; may be supplemented with quantitative measurements of selected parameters; data on land use may be compiled and used to supplement assessment**	**Assessment during single season usually the norm; spatial coverage may be limited sampling or broad and usually commensurate with biological sampling; assessment may be regional or site-specific**	**Moderate precision and sensitivity; professional scientist performs survey or provides oversight and training**
4 EXCELLENT	**Assessment of habitat based on quantitative measurements of in-stream parameters, channel morphology, and floodplain characteristics; usually 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 broad and commensurate with biological sampling; assessment may be regional or site-specific	High precision and sensitivity; professional scientist performs survey and assessment

REVISION HISTORY:

2016 listing cycle – Moved from Main AP Attachment A to separate appendix. Removed toxicological data level table because SWQB does not make impairment decisions based on toxicological testing. Clarified that chemical/physical of data quality 1, and biological or habitat data of quality 1 or 2, are not used to make designated use attainment decisions.

2018 listing cycle – Minor clarifications added to first paragraph.

REFERENCES:

U.S. Environmental Protection Agency (EPA). 2002. Consolidated Assessment and Listing Methodology (CALM): Towards a compendium of best practices. Office of Wetlands, Oceans, and Watersheds. Washington, D.C

APPENDIX B

TEMPERATURE LISTING METHODOLOGY

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to excessive water temperature in streams, rivers, lakes, and reservoirs. This protocol is not applicable to ephemeral streams and wetlands because the research and implementation procedures necessary have not been investigated or developed by the Surface Water Quality Bureau (SWQB).

1.0 Introduction

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount 1969). Behnke and Zarn (1976), in a discussion of temperature requirements for endangered western native trout, recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°Celsius (C), but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the aquatic community. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species. SWQB prepared a comprehensive summary of temperature thresholds for sensitive salmonids found in New Mexico as part of the 2009 triennial review of water quality standards process (NMED/SWQB 2009).

2.0 Data Collection Procedures and Considerations

For rivers and streams, thermograph datasets with a maximum one-hour frequency interval take precedence over grab data in all cases and are required to confirm temperature impairment determinations prior to TMDL development. Data loggers are deployed and the data reviewed following the guidelines specified in the SWQB’s Standard Operating Procedures (SOPs), available at http://www.nmenv.state.nm.us/swqb/SOP/. This includes locating the thermograph in the shade when possible, but the primary consideration is to place the logger in a location such that it will remain submerged for the duration of the data recording period while not becoming buried in sediment or covered with debris. Temperature data from periods where the record indicates that the data logger was exposed or buried will be censored and not used for assessment.

Thermograph data for assessment will ideally be collected from late May through late September for any aquatic life use because in order for a stream/river thermograph dataset to be used to determine full support, it must include the portion of the year with the highest temperatures. This usually occurs between early June and early September in New Mexico, depending on the site elevation, aspect, topography, and adjacent vegetation. Ensuring that the warmest portion of the year was captured can be easily discerned by plotting the data and observing a seasonal temperature increase from late spring through summer followed by a gradual decrease in temperature towards autumn. For example, if the period of record starts at some low point, rises to a high point and then descends to a low point, the data would be considered assessable for either full or non-support (Figure 1). Alternatively, if the plotted dataset does not capture the summer season maximum temperature, the dataset could only be used to determine non-support because even though the dataset did not cover the entire warm season, additional data would not change the non-support determination (Figure 2).

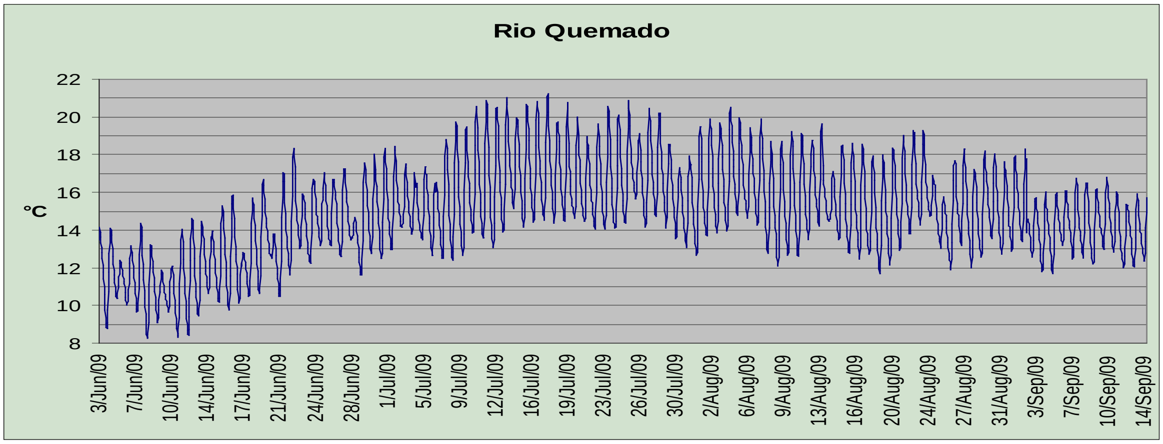

Figure 1. Example of assessable dataset for full support determination (adequate duration and includes summer season maximum temperature less than applicable maximum criterion of 23°C)

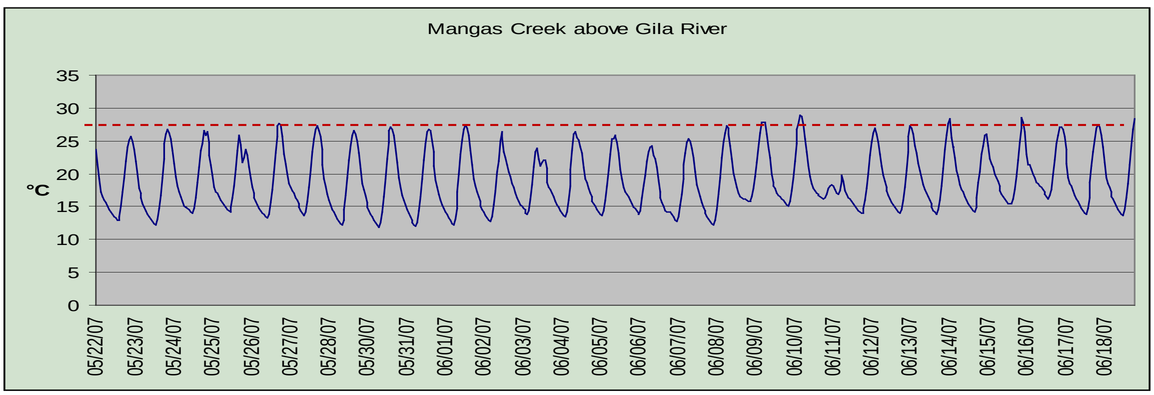

Figure 2. Example of assessable dataset for non-support determination (applicable segment-specific maximum criterion of 28°C is exceeded on more than one day in this limited duration dataset)

For lakes and reservoirs, data are collected at one-meter intervals up to 30 meters depth or the top one third of the lake, whichever is greatest as specified in the SWQB SOPs. After 30 meters or the top one third of the lake, measurements are collected every five meters. Measurements are taken at the surface to within one meter of the bottom of the lake or to the maximum depth allowed by current equipment (75m).

3.0 Assessment of Temperature Data to Determine Aquatic Life Use Support

Numeric temperature criteria per aquatic life use (ALU) are summarized in Table 1, and detailed in Section 20.6.4.900.H NMAC (https://www.env.nm.gov/swqb/Standards/). The “4T3 temperature” is defined as the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days, and the “6T3 temperature” is defined as the temperature not to be exceeded for six or more consecutive hours in a 24-hour period on more than three consecutive days (20.6.4.7.A NMAC).

Table 1. New Mexico's default temperature criteria by ALU (from 20.6.4.900.H NMAC)

AQUATIC LIFE USE	MAXIMUM (°C)[a]	4T3 (°C)	6T3 (°C)
High Quality Coldwater (HQCWAL)	23	20	
Coldwater (CWAL)	24		20
Marginal Coldwater (MCWAL)	29		25[b]
Coolwater (CoolWAL)	29		
Warmwater (WWAL)	32.2		
Marginal Warmwater (MWWAL)	32.2		
Limited	No default established		

NOTES: [a] Unless segment-specific maximum temperature criteria exist in 20.6.4.97 - 20.6.4.899 NMAC; default 4T3 and 6T3 values are not applicable in these cases per 20.6.4.900.H(1)(2)(3).
[b] With the exception of segment 20.6.4.114 NMAC, which contains a segment-specific 6T3 of 22°C.

For streams and rivers, the chronic numeric temperature standard is based upon the 4T3/6T3 and applies only to the HQCWAL, CWAL, and MCWAL unless otherwise identified in segment-specific temperature criterion. Continuous data are needed to determine the 4T3/6T3 in streams and rivers. A determination of non-support is made if the measured 4T3 or 6T3 exceeds an applicable 4T3 or 6T3.

The acute numeric temperature standard is defined as the maximum instantaneous temperature, unless otherwise identified in a segment-specific temperature criterion. A determination of non-support is made if the maximum temperature criterion is exceeded on more than one day during the same calendar year and the daily maximum temperatures are not statistical outliers from the maximum daily temperatures measured during the calendar year. An outlier is defined as a temperature greater than the 75^{th} percentile (Q3) of the measured daily maximum temperatures plus three times the inter-quartile range (IQR). The IQR is defined as the difference between the 25^{th} percentile (Q1) and Q3 (Tukey 1977, Seo 2006). This approach is intended to 1) reduce the influence from autocorrelation of continuous data, 2) demonstrate the repeatability of an observation and 3) take into consideration potential anomalies in the thermograph data set due to extreme air temperatures deviating from seasonal norms, other anomalous events such as runoff from catastrophic fire areas, or instrument errors. A generalized flowchart for assessing thermograph data in rivers and streams is provided in Figure 3.

For lakes and reservoirs, the SWQB generally does not deploy thermographs and 20.6.4.14.C(3) NMAC dictates assessment of lake data. The assessor examines the profile for the presence of a thermocline (greater than 1°C change per meter). If present, temperature measurements taken within the epilimnion (above the thermocline) are averaged. If absent (i.e., the lake is well mixed), measurements taken from the upper one-third of the depth profile are averaged. Therefore, the "grab" sample used to assess is actually an average value. This average value is assumed equivalent to and compared against the 4T3/6T3 criterion as opposed to the applicable ALU maximum criterion (unless there is a segment-specific maximum) to be the most protective of aquatic life. In addition, the upper one-third of a lake is usually considered well-mixed, and fish and other aquatic life have potential refugia. For example, they can move deeper if surface temperatures are higher depending on depth and conditions of the lake.

The assessment procedures for each ALU with applicable temperature criteria for both water types are detailed in Tables 2 – 6 below.

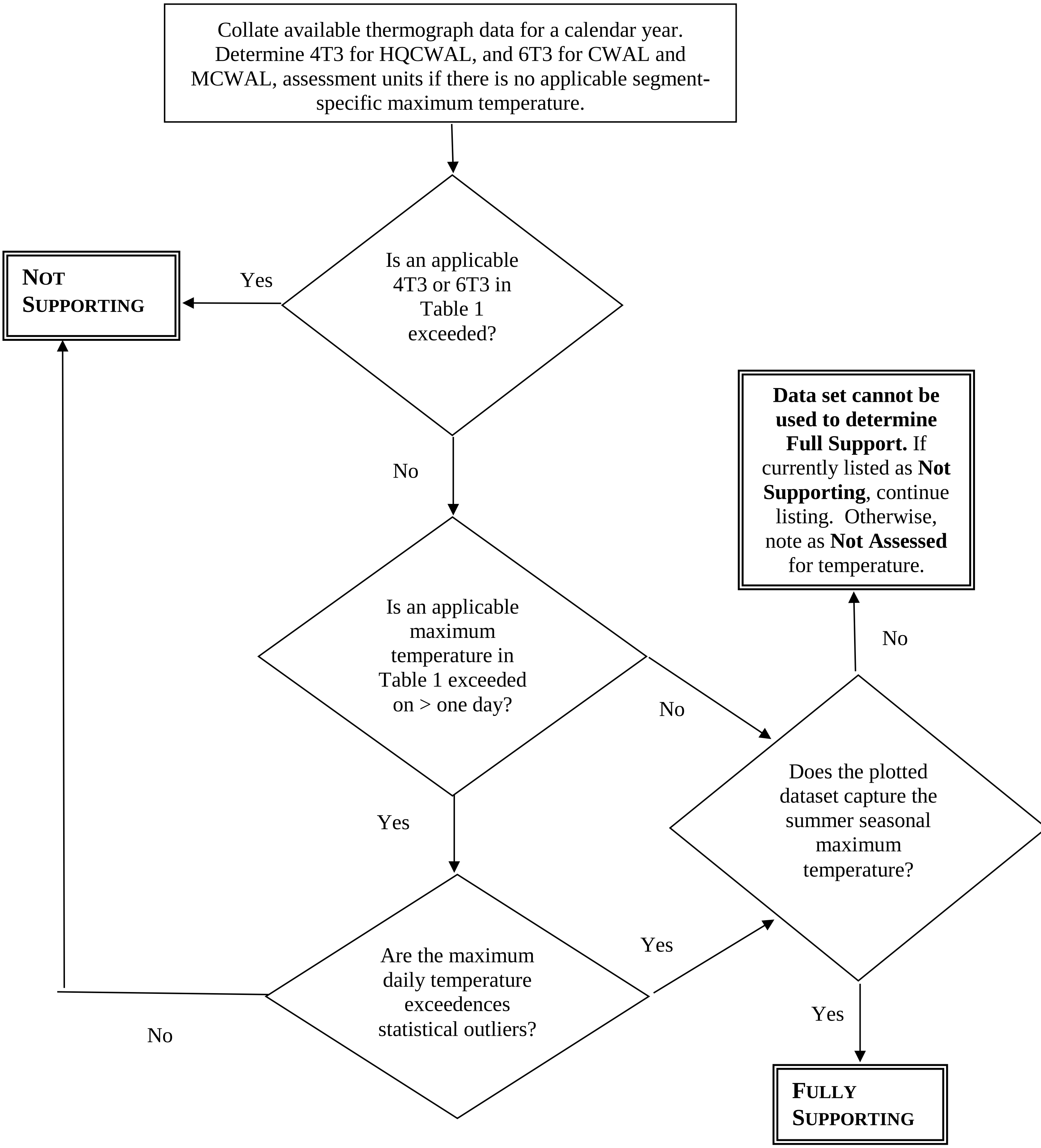

Figure 3. Generalized flowchart for assessing thermograph data in rivers and streams

Table 2. Assessing temperature data to determine HQCWAL Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Instantaneous (grab) temperature data** **A)** Rivers or streams **B**) Lakes or reservoirs	**A)** Not assessable (cannot determine fully supporting with grab data only) **B)** No temperature measurement greater than 20.0°C[b] (or the segment-specific maximum temperature).	**A)** More than one temperature measurement greater than 23.0°C (or the segment-specific maximum temperature) [a] **B)** One or more temperature measurements greater than 20.0°C[b] (or the segment-specific maximum temperature).	[a] IR Category 5C – needs thermograph data to confirm. [b] Because lake temperature measurements are averaged over the epilimnion or the upper 1/3 of the water column, the measured value is assumed be equivalent to the 4T3 value and thus this criterion is used when there is not a segment-specific maximum. See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling.
•Thermograph data (≤one-hour frequency interval)	Maximum daily temperatures do not exceed 23.0°C (or the segment-specific maximum temperature), on more than one day during the calendar year and 4T3 does not exceed 20.0°C if there is no segment-specific maximum temperature. [c]	Maximum daily temperatures exceed 23.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year and are not outliers**,** or 4T3 exceeds 20.0°C if there is no segment-specific maximum temperature.	[c] Plotted dataset must capture the summer season maximum temperature.

Table 3. Assessing temperature data to determine CWAL Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Instantaneous (grab) temperature data **A)** Rivers or streams **B**) Lakes or reservoirs	**A)** Not assessable (cannot determine fully supporting with grab data only). **B)** No temperature measurement greater than 20.0°C [b] (or the segment-specific maximum temperature).	**A)** More than one temperature measurement greater than 24.0°C (or the segment-specific maximum temperature). [a] **B)** One or more temperature measurements greater than 20.0° C [b] (or the segment-specific maximum temperature).	[a] IR Category 5C – needs thermograph data to confirm. [b] Because lake temperature measurements are averaged over the epilimnion or the upper 1/3 of the water column, the measured value is assumed be equivalent to the 4T3 value and thus this criterion is used when there is not a segment-specific maximum. See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling.
•Thermograph data (≤one-hour frequency interval)	Maximum daily temperatures do not exceed 24.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year, and 6T3 does not exceed 20.0°C if there is no segment-specific maximum temperature. [c]	Maximum daily temperatures exceed 24.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year and are not outliers, or 6T3 exceeds 20.0°C if there is no segment-specific maximum temperature.	[c] Plotted dataset must capture the summer season maximum temperature.

Table 4. Assessing temperature data to determine MCWAL Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Instantaneous (grab) temperature data **A)** Rivers or streams **B**) Lakes or reservoirs	**A)** Not assessable (cannot determine fully supporting with grab data only) **B)** No temperature measurement greater than 25.0°C[b] (or the segment-specific maximum temperature).	**A)** More than one temperature measurement greater than 29.0°C (or the segment-specific maximum temperature). [a] **B)** One or more temperature measurements greater than 25.0°C[b] (or the segment-specific maximum temperature).	[a] IR Category 5C – needs thermograph data to confirm. [b]Because lake temperature measurements are averaged over the epilimnion or the upper 1/3 of the water column, the measured value is assumed be equivalent to the 6T3 value and thus this criterion is used when there is not a segment-specific maximum. See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling. [c] Plotted dataset must capture the summer season maximum temperature. [d] With the exception of segment 20.6.4.114 NMAC, which contains a segment-specific 6T3 of 22°C.
•Thermograph data (≤one-hour frequency interval)	Maximum daily temperatures do not exceed 29.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year, and 6T3 does not exceed 25.0°C if there is no segment-specific maximum temperature. [c] [d]	Maximum daily temperatures exceed 29.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year and are not outliers, or 6T3 exceeds 25.0°C if there is no segment-specific maximum temperature.	

Table 5. Assessing temperature data to determine CoolWAL Aquatic Life Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Instantaneous (grab) temperature data** **A)** Rivers or streams **B**) Lakes or reservoirs[c]	**A)** Not assessable (cannot determine fully supporting with grab data only) **B)** No temperature measurement greater than 29.0°C [b] (or the segment-specific maximum temperature).	**A)** More than one temperature measurements greater than 29.0°C (or the segment-specific maximum temperature). [a] **B)** One or more temperature measurements greater than 29.0°C[b] (or the segment-specific maximum temperature).	[a] IR Category 5C – needs thermograph data to confirm [b] See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling. [c] Plotted dataset must capture the summer season maximum temperature.
•**Thermograph data** (≤one-hour frequency interval)	Maximum daily temperatures do not exceed 29.0° C (or the segment-specific maximum temperature) on more than one day during the calendar year. [c]	Maximum daily temperatures exceed 29.0°C (or the segment-specific maximum temperature) on more than one day during the calendar year and are not outliers.	

Table 6. Assessing temperature data to determine WWAL or MWWAL Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Instantaneous (grab) temperature data** **A)** Rivers or streams	**A)** Not assessable (cannot determine fully supporting with grab data only)	**A)** More than one temperature measurements greater than 32.2°C (or the segment-specific maximum temperature) [a]	[a] IR Category 5C – needs thermograph data to confirm [b] See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling. [c] Plotted dataset must have a discernible seasonal peak and must cover the entire recommended deployment period in order to determine Fully Supporting.
B) Lakes or reservoirs	**B)** No temperature measurement greater than 32.2°C[b] (or the segment-specific maximum temperature)	**B)** One or more temperature measurements greater than 32.2°C[b] (or the segment-specific maximum temperature)	
•**Thermograph data**(≤one-hour frequency interval)	Maximum daily temperatures do not exceed 32.2°C (or the segment-specific maximum temperature) on more than one day during the calendar year. [c]	Maximum daily temperatures exceed 32.2°C (or the segment-specific maximum temperature) on more than one day during the calendar year and are not outliers.	

REVISION HISTORY:

2014 listing cycle – Clarified data requirements for thermograph datasets to be assessable (removed 72-hour minimum); clarified that no 4T3 or 6T3 applies when segment-specific maximum exists, except for 20.6.4.114 NMAC; various minor word changes and clarifications.

2016 listing cycle – Added temperature criteria table and clarified use of segment-specific maximum temperatures when assessing data. Added additional description of lake data collection and assumption that averaged values are equivalent to 4T3/6T3.

2018 listing cycle – Changed "Assessment Protocol" to "Listing Methodology." For thermograph data, added provision regarding when there is only one day where the temperature exceeds the applicable maximum temperature criterion to demonstrate repeatability of observation and account for the autocorrelation of time series data. Also, added a provision to test for outliers in a temperature dataset. Added a generalized assessment flowchart for assessing thermograph data in rivers and streams. Clarified that stream/river impairment determinations based on grab data must be confirmed with thermograph dataset prior to TMDL development.

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APPENDIX C

NUTRIENT LISTING METHODOLOGY FOR PERENNIAL STREAMS AND RIVERS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to excessive nutrients in perennial streams and selected river segments. This assessment is only applied to perennial streams and selected river segments at this time because the research used to develop this listing methodology is based upon data and information collected from these waterbody types.

This protocol was developed to support interpretation of the *State of New Mexico Standards for Interstate and Intrastate Surface Waters* narrative standard for nutrients found at 20.6.4.13 NMAC (https://www.env.nm.gov/swqb/Standards/):

> ***E. Plant Nutrients:*** *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state.*

Nutrients are essential for proper functioning of ecosystems. However, excess amounts of nitrogen and phosphorus can cause undesirable aquatic life (e.g., community composition shifts or toxic algal blooms) and/or result in a dominance of nuisance species (e.g., excessive and/or unsightly algal mats, both attached and detached, or surface algal scums). Unfortunately, the magnitude of nutrient concentration that constitutes "excess" is difficult to determine because natural nutrient concentrations vary widely and interact with many biological and physical variables. Nutrient pollution results in a continuum of undesirable effects depending on numerous factors. For example, nutrient concentrations that would not cause a problem in rapidly flowing, well-shaded headwater streams can create major algae blooms in lower gradient, slow moving streams and rivers with little or no forest canopy.

In 2015 and 2016, the Surface Water Quality Bureau (SWQB) collaborated with Tetra Tech, Inc., EPA Region 6, and EPA's National Nutrient Criteria Program Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS) program on a project to revise nutrient impairment thresholds in New Mexico. This project follows EPA's nutrient criteria guidance (EPA 2010) and Empirical Approaches for Nutrient Criteria Derivation (EPA 2009). Statistical analyses of available state and regional data were conducted to refine nutrient thresholds using defined reference conditions, relationships between cause and response variables and a verified classification system. The resultant candidate thresholds were evaluated by SWQB staff, and the selected thresholds were used to revise this nutrient listing methodology.

The 100+ page report (Jessup et al. 2015) detailing the N-STEPS effort is available at http://www.nmenv.state.nm.us/swqb/Nutrients/. The SWQB also generated and posted a shorter document which summarizes the steps taken to determine the candidate thresholds, and SWQB's logic regarding final threshold selection (NMED/SWQB 2016).

Exclusions

This methodology is not applicable to the following water body types because 1) the necessary research and implementation procedures have either not been investigated by the SWQB or are not yet developed, or 2) a methodology specific to the water body type resides elsewhere:

- Lakes or reservoirs
- Select large rivers (low gradient, non-wadeable)
- Intermittent streams which includes water bodies under 20.6.4.98 or 20.6.4.128 NMAC

- Ephemeral streams which includes water bodies under 20.6.4.97 or 20.6.4.128 NMAC
- Wetlands or playas

A separate nutrient listing methodology for lakes and reservoirs (Appendix D of the Listing Methodologies) is available at: http://www.nmenv.state.nm.us/swqb/protocols/. Additional information on nutrient threshold development is available on the SWQB's website at: http://www.nmenv.state.nm.us/swqb/Nutrients/.

For nutrient assessment purposes, the following systems are exempt from this protocol:

1. Rio Grande below Cochiti Reservoir,
2. Pecos River from the Texas border to Sumner Reservoir, and
3. Canadian River from the Texas border to Conchas River.

The SWQB is distinguishing these rivers by defining systems that cannot be effectively assessed with thresholds developed from the N-STEPS analyses, due to a variety of channel characteristics including water depth and velocity, substrate characteristics, and highly altered flow regimes. As a result, the relationships defined using these analyses are not expected to translate to these systems. Additional data collection and analysis is needed to develop thresholds for these systems.

Although the San Juan River, Animas River, and portions of Rio Chama and the Gila River were exempt from the previous nutrient assessment protocol, these rivers will be assessed with this revised listing methodology because these reaches have channel characteristics similar to the N-STEPs streams. Also, stations from some of these reaches were used in the N-STEPs analyses to derive impairment thresholds (refer to Section 2.0 for more information on N-STEPs project).

1.0 Introduction

Nutrient pollution can be described as excess amounts of nitrogen and phosphorus and the associated high algal biomass. Nutrient impairment occurs when algae and other aquatic vegetation (macrophytes) interfere with designated uses such as domestic water supply or aquatic life. Algal blooms can produce toxins harmful to human and animal uses, and can also cause taste and odor problems in drinking water supplies. One of the most expensive problems caused by nutrient enrichment is increased treatment required for drinking water.

The variables referred to in this document are measurable water quality parameters that can be used to evaluate the degree of eutrophication in perennial streams and applicable rivers. Eutrophication is the process by which a body of water becomes enriched with nutrients that stimulate the growth of aquatic plant life. During the day, aquatic vegetation produce oxygen, sometimes leading to supersaturation. At night, however, excessive algal growth can deplete dissolved oxygen in the waterbody through respiration and decay of dead algal cells and other organic matter. Low dissolved oxygen concentrations and increased diel fluctuations can cause shifts in community composition and in severe cases, the death of other organisms such as macroinvertebrates and fish. Eutrophication can be a natural incremental process for a water body, but human activities may greatly enhance the process to the detriment of aquatic life (Art 1993).

Enrichment from excess nutrient levels in streams may lead to loss of diversity and native taxa; changes in algae, aquatic plant, invertebrate, and fish community structure; and subsequent loss of ecosystem function. Nutrient enrichment can also lead to excessive phytoplankton growth that can reduce light penetration and consequently limit the growth of submerged aquatic plants in slow moving waters, decreasing available habitat and shelter for certain fish and their prey (Sand-Jensen et al. 2000). A direct effect of nutrient enrichment in streams can be a dominance of nuisance filamentous benthic algae during the peak summer growing season, which can alter the flow environment and negatively impact the physical benthic habitat used by both stream invertebrates and vertebrate organisms (Welch et al. 1989, Chessman et al. 1992) and cause a subsequent shift in community composition towards less desirable aquatic life compared to natural conditions. For example, excessive nutrients can lead to shifts in the dominant benthic macroinvertebrate community composition from more pollution sensitive species such as mayflies, stoneflies, and caddisflies to more pollution tolerant (and less desirable) species such as aquatic worms, midge fly larvae, and pouch snails (Sabater et al. 2005; Miltner and Rankin 1998).

Nutrient enrichment results in excessive growth of primary producers as well as certain heterotrophic microorganisms, which increases the metabolic activities of surface waters and can lead to a depletion of dissolved oxygen (DO) (Mallin et al. 2006). Because algal biomass above nuisance levels often produces large diel fluctuations in DO concentration (daily delta DO), as well as associated maximum rates of productivity (Pmax) and respiration (Rmax), these response variables are often used as indicators of nuisance levels of algal biomass. While nutrient enrichment may benefit the growth and reproduction of certain fish species in the short term, the ecological consequence of excessive nutrients can have detrimental impacts on stream ecosystems, especially through the reduction in DO levels which would exclude or reduce more sensitive taxa (Stockner et al. 2000). In addition, excess algae growth could reduce or eliminate critical food sources and protective habitat, further impacting survivorship of sensitive species such as trout.

2.0 Nutrient Scientific Technical Exchange Partnership & Support (N-STEPS) Project Summary

Narrative criteria must be translated to numeric thresholds to develop consistent impairment determination protocols, National Pollutant Discharge Elimination System (NPDES) permit limits, and total maximum daily load (TMDL) targets loading capacities. Revision of thresholds and the associated listing methodology was needed to better define nutrients from “other than natural causes,” and link nutrient concentrations with the impairment of designated uses.

The N-STEPS analysis consisted of two major approaches: reference conditions and stressor-response relationships. The reference condition approach derived candidate thresholds from distributions of nutrient concentrations from least disturbed sites which are the best estimate of “natural” conditions. Stressor-response analyses derived candidate thresholds by defining the relationships between total nitrogen (TN) or total phosphorus (TP) concentrations (i.e., causal variables) and response variables and determining the level of the causal variable that corresponds to a change in the response variable.

Diatom and benthic macroinvertebrate metrics, diel dissolved oxygen (DO), and chlorophyll *a* (chl-a) concentrations were the response variables explored in the N-STEPS analysis. Response variables represent the relative integrity of the aquatic community and indicate when designated aquatic life uses are protected, thereby prohibiting “undesirable aquatic life” or “dominance of nuisance species.” DO is an applicable, indirect response variable and was used as a surrogate for nuisance algae because increases in algae biomass lead to increases in benthic chl-a concentrations which are correlated with several diel DO metrics, specifically minimum DO, daily delta DO, and Pmax. Daily delta DO is defined as the difference between the maximum and minimum DO concentration within a 24-hour period. In the N-STEPS analysis, all three of these DO metrics were correlated to each other as well as to chl-a concentrations and a variety of benthic macroinvertebrate indices.

The steps used to identify nutrient thresholds for perennial streams and rivers in New Mexico included:

1. Selecting and evaluating data
2. Defining the human disturbance gradient
3. Forming site classes
4. Developing frequency distributions of least disturbed sites
5. Evaluating estimated stressor–response relationships
6. Synthesizing multiple thresholds (and identifying the most appropriate for NM waters)

These steps are based on the EPA guidance for developing numeric nutrient thresholds and criteria (EPA 2009, 2010). The details of each step are available in summary form or in entirety in separate documents available on the SWQB web site (NMED/SWQB 2016 and Jessup et al. 2015, respectively): http://www.nmenv.state.nm.us/swqb/Nutrients/.

Data were collected between 1990 and 2012 within New Mexico and the same ecoregions in surrounding states through SWQB and national monitoring programs, including the National Rivers and Streams Assessment (NRSA), the Wadeable Streams Assessment (WSA), and Environmental Monitoring and Assessment Program (EMAP). A geographic information system (GIS) analysis of sites and their catchments was conducted to characterize environmental conditions for use in disturbance gradient designations and site classification.

The reference site and human disturbance gradient analysis of 542 sites resulted in 31% of sites being identified as least disturbed (i.e., reference or near reference) sites. Analyses of least disturbed sites were used to determine site classes based on nutrient conditions and landscape classification variables such as geology, land slope and ecoregion. For nitrogen, concentrations were associated with average catchment (i.e., watershed) land slope, and three TN classes were identified as TN Flat, TN Moderate, and TN Steep (Table 1, Figure 1).

Table 1. Site classes for TN

Site Class	Description
TN Flat	Sites with average catchment land slopes less than <15%
TN Moderate	Sites with average catchment land slopes from 15% to 32%
TN Steep	Sites with average catchment land slopes > 32%

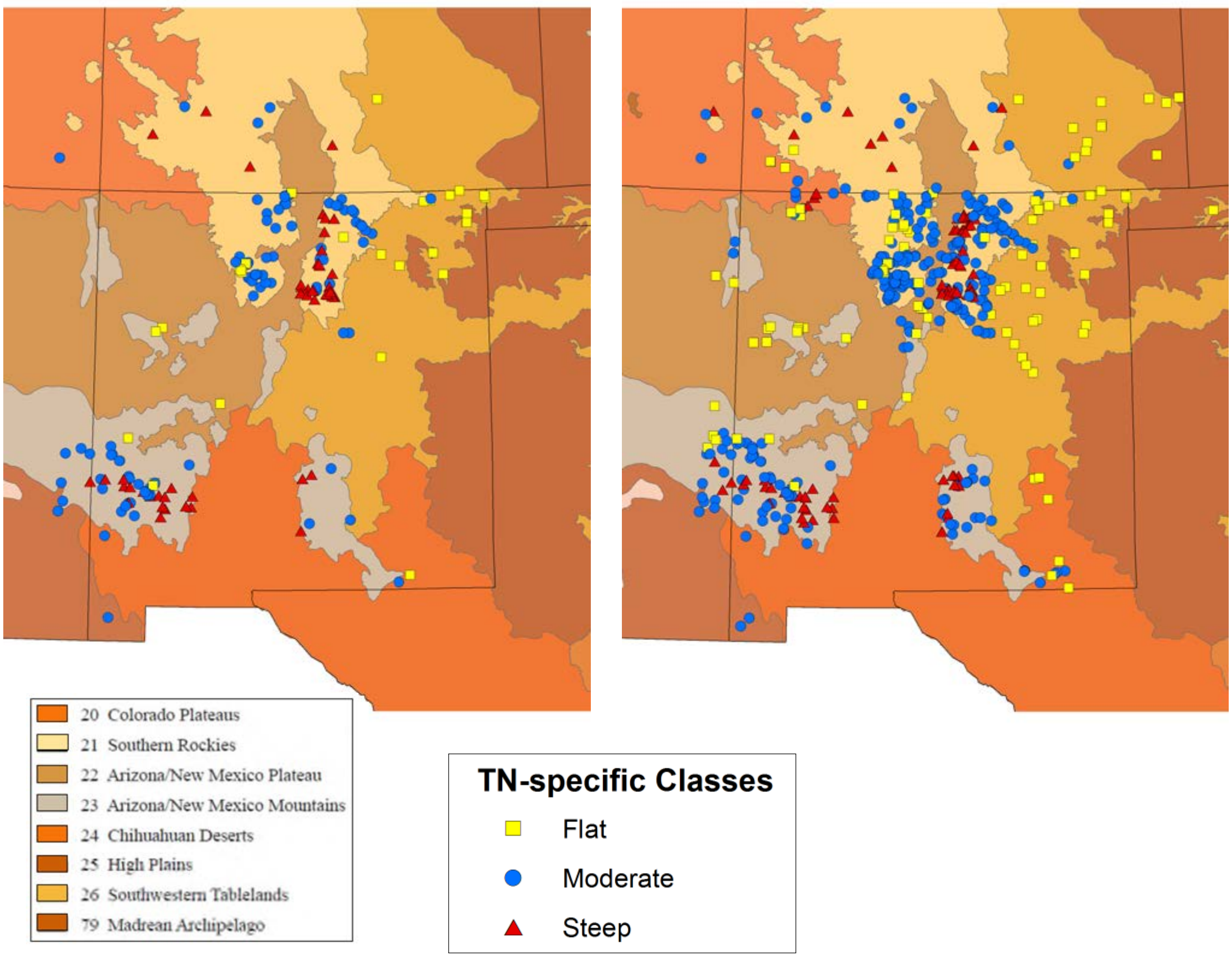

Figure 1. Least disturbed sites (left) and all sites (right) by the TN-specific site classes (from Jessup et al. 2015).

For phosphorus, the concentration of TP in soil and volcanic geology were important in addition to average catchment land slope, resulting in three different nutrient classes identified as TP High-Volcanic, TP Flat-Moderate, and TP Steep (Table 2, Figure 2).

Table 2. Site classes for TP (and delta DO)

Site Class	Description
TP High-Volcanic	All sites in the San Antonio and Conejos, the Upper Gila, Upper Gila-Mangas, San Francisco, and Mimbres basins. In the Upper Gila basin, it excludes sites in the Diamond, Taylor and Beaver Creek sub-basins (HUCs 150400010404, 150400010406, 150400010402, 150400010403, 150400010305, and 150400010302).
TP Flat-Moderate	Sites with average catchment land slopes ≤ 29% average land slope that are not in the TP High-Volcanic site class. Also includes sites in three drainages of the Jemez basin, the Vallecitos, Pajarito, and Sulphur/Redondo sub-basins (HUCS 130202020204, 130202010204, and 130202020202).
TP Steep	Sites with average catchment land slopes > 29% that are not in the TP High-Volcanic site class.

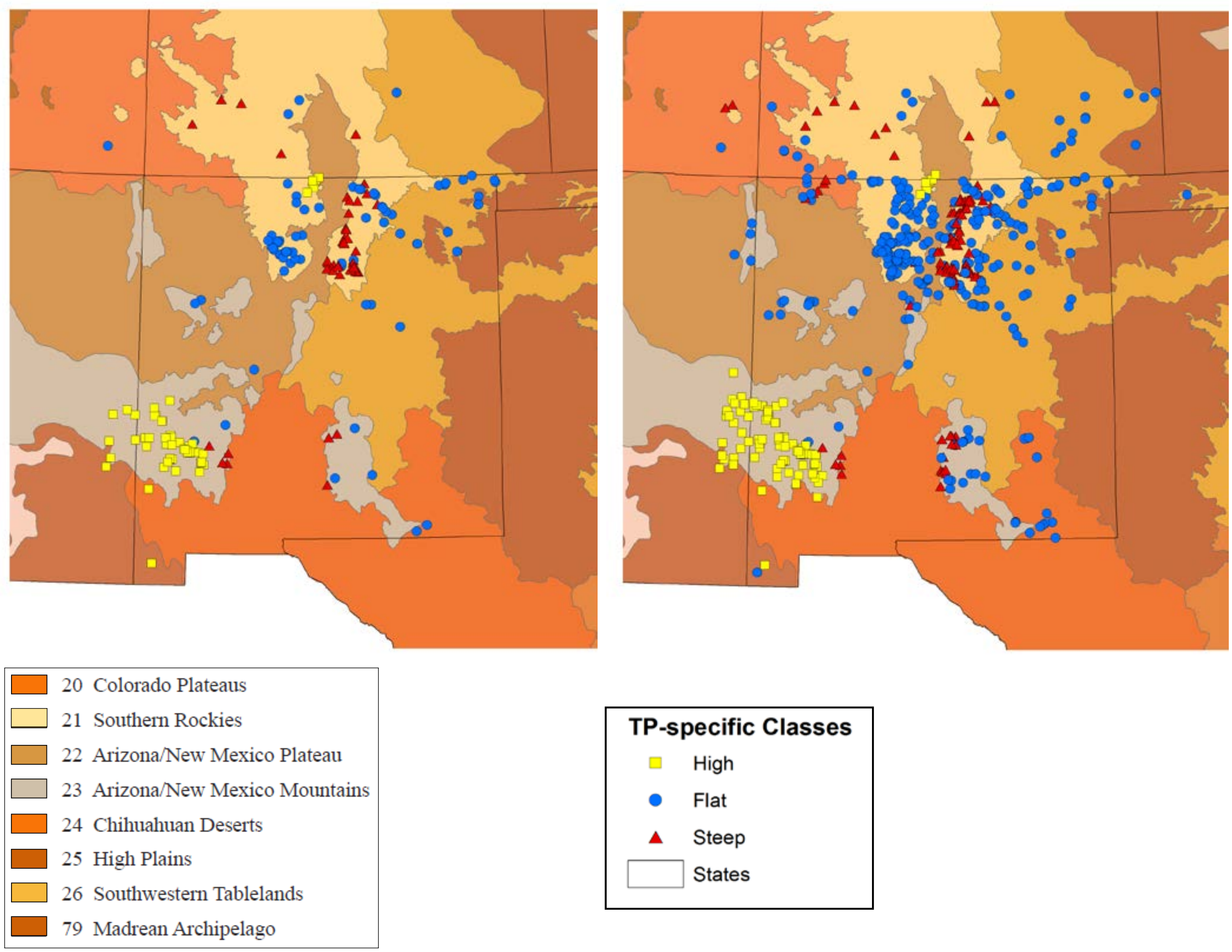

Figure 2. Least disturbed sites (left) and all sites (right) by the TP-specific site classes (from Jessup et al. 2015). Sites noted as "Flat" in the legend include the entire TP Flat-Moderate class.

Frequency distributions of nutrient conditions in least disturbed sites were used to derive TN and TP candidate thresholds for each site class. Correlation and other multivariate techniques supported the major linkages between nutrient concentrations, chl-a, diel DO, diatoms, and macroinvertebrates. Although chl-a relationships supported some causal linkages between nutrients and DO, the relationships between nutrient concentration and chl-a were too weak and inconsistent to support its use as indicator of nutrient impairment (Jessup et al. 2015). Multiple regression interpolations and change-point analysis for macroinvertebrates, diatoms, and diel DO in response to nutrient concentrations resulted in multiple candidate TN and TP thresholds in each site class.

For each site class combination, candidate thresholds were evaluated against stressor-response analyses to select the impairment thresholds shown in Tables 3 and 4. NMED chose the 90th quantile to represent a starting point for candidate thresholds. Ultimate quantile selection for threshold development is dependent upon the data used to develop the quantiles, the certainty that these data accurately reflect reference condition, and the best alignment of the quantile with the benthic macroinvertebrate and diatom change point analyses to provide assumed protection of the applicable designated aquatic life use(s). Selecting a quantile in the upper boundary of the reference population (in this case, between the 75th and 90th depending on the site class and parameter) provides confidence to the listing methodology. See NMED/SWQB 2016 for additional detail on threshold selection. The TN and TP upper assessment threshold, defined as the 90% confidence interval (CI) of the 90th quantiles by site class (i.e., the very upper limit of the quantile analysis), are also included in Table 3 and used in this protocol as detailed in Section 3.0. The selected daily delta DO response thresholds in Table 4 will be applied by TP site class because daily delta DO was significantly correlated with TP; therefore, TP site classes were used to determine appropriate delta DO thresholds (Jessup et al. 2015).

Table 3. TN and TP causal thresholds by site class

Site Class	Parameter	Threshold (mg/L)	Upper Assessment Threshold (90% confidence interval of 90th quantile) (mg/L)
TN Flat	TN	0.65	0.85
TN Moderate	TN	0.37	0.51
TN Steep	TN	0.30	0.34
TP High-Volcanic	TP	0.084	0.114
TP Flat-Moderate	TP	0.061	0.069
TP Steep	TP	0.030	0.053

Table 4. DO response thresholds by site class

Site Class	Parameter	Threshold (mg/L)
TP High-Volcanic	Daily delta DO	5.02
TP Flat-Moderate	Daily delta DO	4.08
TP Steep	Daily delta DO	1.79

NOTES: Daily delta DO is defined as the difference between the maximum and minimum DO concentration within a 24-hour period

3.0 Assessment Data

Nutrient and DO long-term datasets are collected during regular SWQB watershed surveys following SWQB's Standard Operating Procedures (SOPs) (http://www.nmenv.state.nm.us/swqb/SOP/). Algal biomass above nuisance levels often produces large diel fluctuations in DO. Accordingly, diel DO data are collected using continuous recording devices (sondes or DO data loggers) to observe diel fluctuations as opposed to the "snapshot" that grab data provide. After all data are received from the lab or field staff, validated/verified, and upload to SWQB's in-house database (SQUID), nutrient and DO data are download via a series of SQUID assessment reports. TN and TP site classes will be determined with assistance from NMED's IT Department and housed in SQUID.

3.1 Long-term dissolved oxygen data

Sonde deployments are preferably done during the respective site biomonitoring index period (BIP).[1] Assessments of DO are made with a minimum of 72 hours of sonde or DO logger data, collected preferably during the BIP, with a maximum interval of one hour between data points. The window between scouring events (typically occurring June – August) and the end of the BIP can be restrictive and result in data gaps. To address this and enable collection of data needed to complete nutrient assessments, long-term DO datasets may be collected before the BIP when concurrent benthic macroinvertebrate sampling is not needed. In these cases, data collection must occur at least two weeks into the growing season as defined in Table 5 and six weeks since the last scour event.

Table 5. Biomonitoring and growing seasons for New Mexico ecoregions

Class	Level 3 Omernick Ecoregion	Growing Season	Biomonitoring Index Period (BIP)	Permissible Sonde Start Date[(a)]
Mountain >7500 ft	22 & 23	July 1-Oct 15	Aug 15-Oct 15	July 15
Mountains <7500 ft & Plateau	20, 21, 22 & 23	Jun 15-Nov 1	Aug 15-Oct 15	July 1
S. Deserts and Plains	24, 25, 26, & 79	May 15-Nov 15	Aug 15-Nov 15	June 1

***NOTES**: [(a)] First allowable collection sample initiation date for nutrient assessments.*

3.2 Total nitrogen and total phosphorus data

There is no numeric criteria or definition of "total nitrogen" in 20.6.4 NMAC. An approved method for total nitrogen (TN) is not listed in 40 CFR Part 136, but is usually taken to mean the sum of Total Kjeldahl Nitrogen (TKN) and Nitrate+Nitrite (NO3+NO2). Therefore, the SWQB determines "TN Calculated" as the sum of NO3+NO2 and TKN for nutrient assessments. If either TKN or NO3+NO2 is unavailable for a particular sampling event, TN Calculated is noted as a "missing data point" with respect to this listing methodology.

The TKN and NO3+NO2 minimum quantifiable limits, referred to as minimum reported limits (MRLs) in SQUID, are added together to determine the "TN Calculated MRL." For this listing methodology, the following terms related to analytical method sensitivity are considered synonymous:

[1] See https://www.env.nm.gov/swqb/SOP/10.0SOP-NutrientSampling2014.pdf for additional BIP discussion.

“quantitation limit,” “reporting limit,” “level of quantitation,” and “minimum level.” If either TKN or NO3+NO2 are reported as below the MRL, the respective MRL value is used to determine the TN Calculated value that will be compared against the appropriate threshold. If both TKN and NO3+NO2 are reported as below the MRL, the resultant TN Calculated value is noted as “below the MRL.” The respective TP and TN data MRLs for a particular sampling event must be equal to or less than the threshold in order to be useful for assessment. Figure 3 details how to determine whether or not available TN Calculated data can be used for assessment based on the relationship between the MRLs and the applicable TN threshold.

Since the MRL reported by the SWQB’s regular laboratory (the State Laboratory Division or SLD) for EPA Method 351.2 (TKN) is greater than the TN thresholds (MRL = 0.5 mg/L), an analysis with a lower detection limit was needed. In 2016, SWQB began concurrently analyzing samples for TN using the persulfate digestion method (TPN, APHA Method 4500-N-C in APHA et al. 2012) which was necessary to apply this listing methodology because TPN has a MRL well below all the TN thresholds (MRL = 0.01 mg/L). Method 4500-N-C is listed as an approved method under the Standard Methods for the Examination of Water and Wastewater (2012) and is therefore acceptable for use in the assessment of ambient waters per 20.6.4.14 NMAC. Methods 351.2 (TKN) and 353.2 (Nitrate+Nitrite) are EPA approved methods for NPDES permit reporting and certification and will continue to be used for analysis of permitted discharge samples. Concurrent TPN data per method 4500-N-C and TN Calculated data from SLD are available for SWQB’s 2016 survey year.

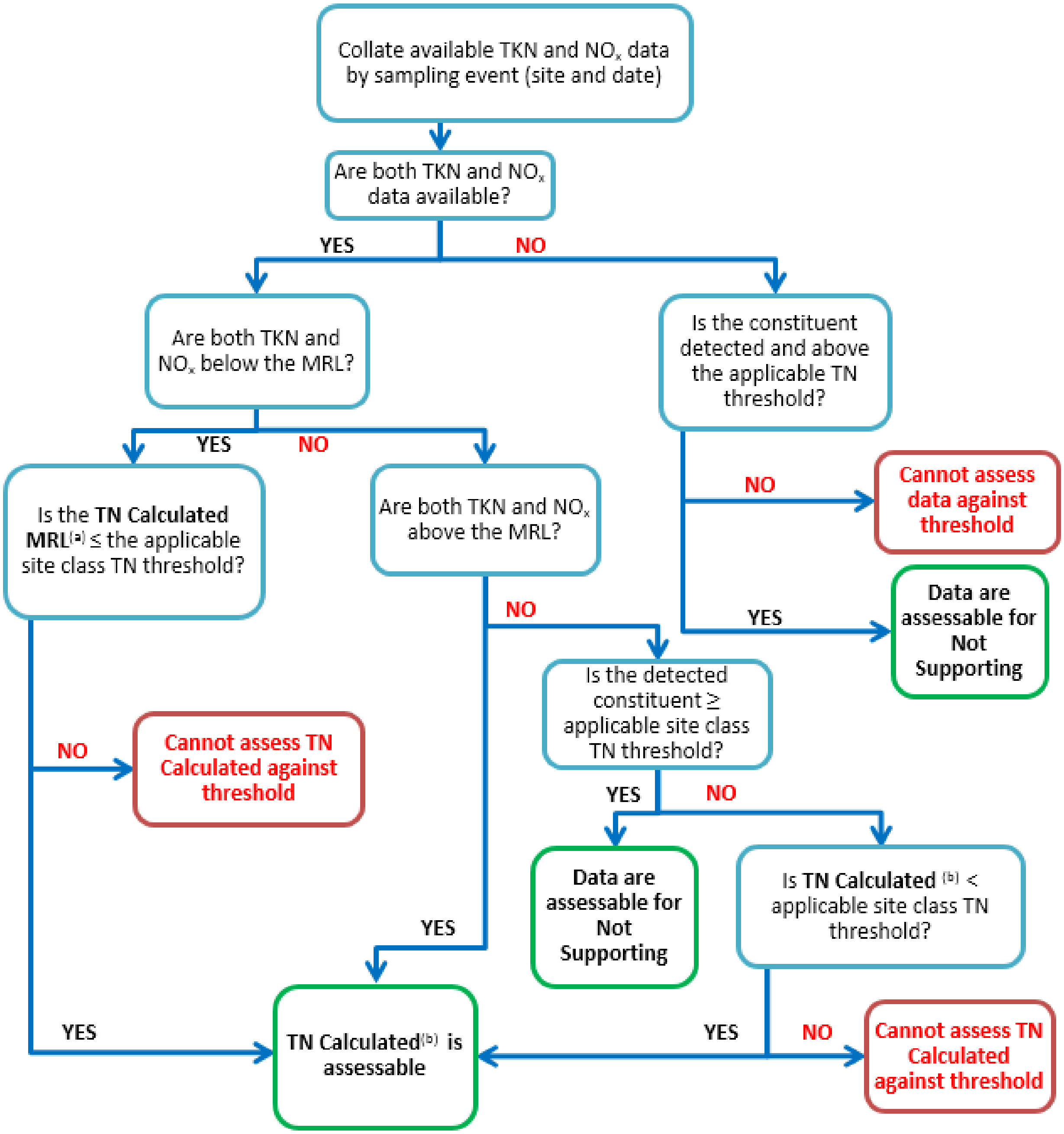

Figure 3. Generalized flowchart for calculating and determining TN Calculated data usability

NOTES: Total Kjeldahl Nitrogen = TKN; Nitrate+Nitrite = NO3+NO2 = NOx.
[(a)] TN Calculated MRL = the TKN MRL + the NOx MRL
[(b)] TN Calculated = TKN + NOx. For either, use the MRL if reported as non-detect.

If concurrent TPN and TN Calculated data are available, usable, and detected above their respective MRLs, the highest TN value will be used. If concurrent data are usable and TN Calculated is at the MRL, the TPN value will be used. If concurrent data are usable and both the TN Calculated and TPN are reported at the MRL, the lower value will be used.

4.0 Assessment Procedure

To determine if there is nutrient impairment in a stream reach, two levels of assessment are performed in sequential order (Figure 4). The first step considers causal indicators alone (TN and TP), and the second step considers a response indicator if the TN or TP causal thresholds are exceeded but the respective upper 90% confidence interval are not.

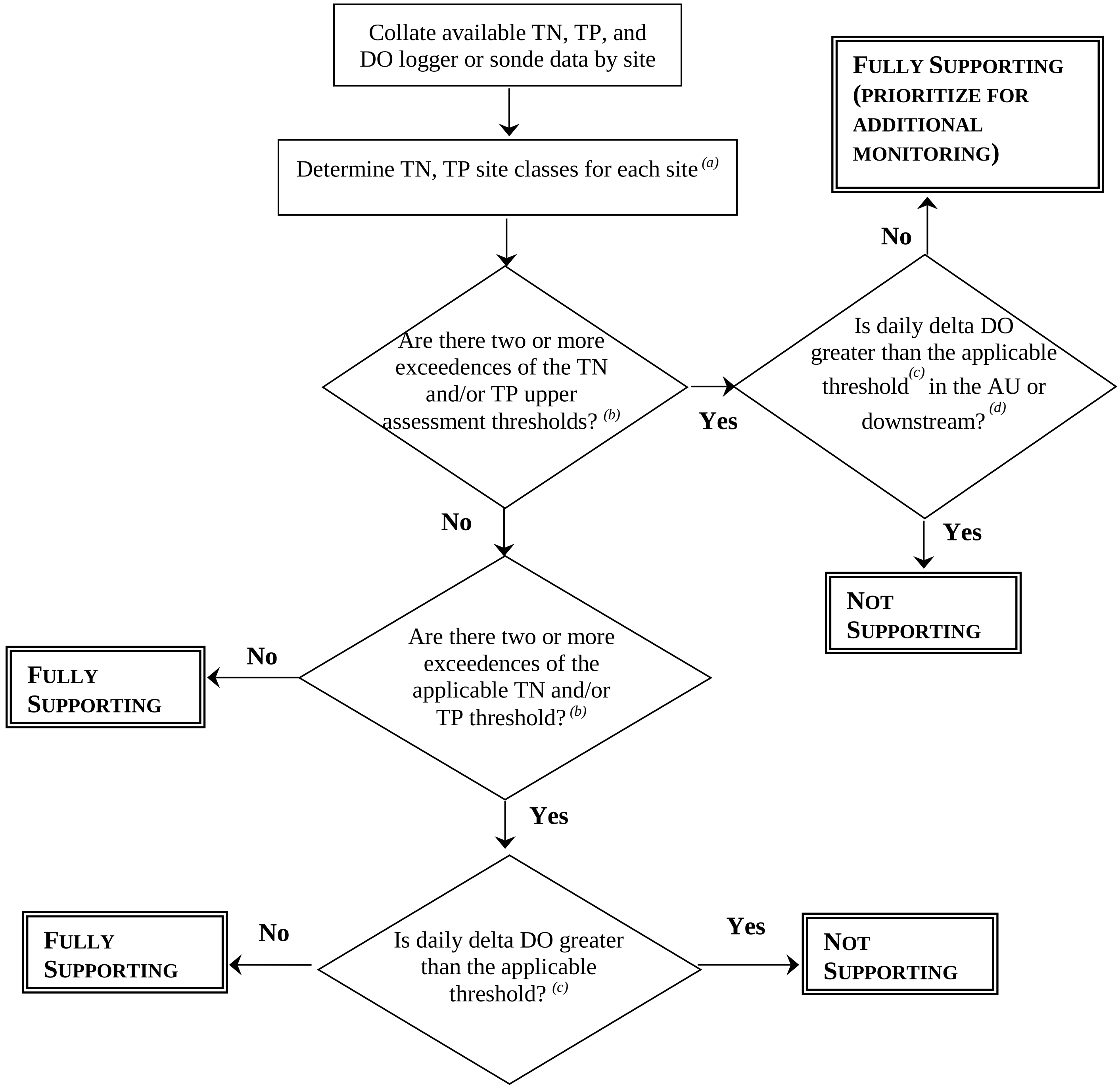

Figure 4. Generalized flowchart for determining nutrient impairment

<u>**NOTES**</u>:

[a] Based on Table 1 and 2.
[b] Based on Table 3. Upper assessment threshold is defined as the upper 90% confidence interval of the 90th percentile by site class.
[c] Based on Table 4.

[(d)] Before any potential influence from incoming major tributaries. Data must be from a perennial downstream AU that falls within the scope of this protocol (i.e., not an exempted river, or lake/reservoir).

TN and TP concentrations are first compared to the applicable upper assessment thresholds shown in Table 3 as described in the assessment flowchart (Figure 4) and Table 6. If enrichment is indicated, the assessor determines if there is a response in either the AU or downstream by comparing available daily delta DO data to the applicable threshold per Figure 4 and Table 7. If a response is documented, the assessment unit (AU) is noted as **Not Supporting** for nutrients. If not, it is noted as **Fully Supporting** (prioritized for additional sampling as resources allow) because the high nutrients do not appear to be resulting in either an immediate or downstream effect. This first step of screening for high nutrient values at the upper boundary of the threshold and considering downstream AU responses is necessary because the displacement of effects from excessive nutrient input is a common and challenging problem with nutrient impairment determinations. For example, excessive point or non-point nutrient inputs that result in TN or TP levels well above their respective thresholds in an upstream AU may not result in excessive algal growth and concurrent DO impacts in that particular stream reach due to substrate type or shading (e.g., a sandy stream bed that is not conducive to algal growth). In these cases, a downstream stream reach with a more conducive substrate or exposure can experience excessive vegetative growth that will take up the nutrients and result in low in-stream TN and TP values. A goal of the nutrient listing methodology is to correctly identify the AU where the nutrient input(s) are occurring in order to address this displacement effect. Potential displacement effects may be further explored during subsequent total maximum daily load (TMDL) development.

If the 90% confidence interval of the applicable threshold is not exceeded, TN and TP are then compared to the applicable threshold in Table 3 per Figure 4 and Table 6. If enrichment is not indicated for TN or TP, the AU is noted as **Fully Supporting** for nutrients. If enrichment is indicated for TN and/or TP, available daily delta DO data are compared to the applicable threshold per Figure 4 and Table 7. If a response is not indicated by the daily delta DO, the AU is noted as **Fully Supporting** for nutrients; however, if a response is indicated, the AU is noted as **Not Supporting** for nutrients.

Water quality criteria for DO concentrations are found in 20.6.4.900 NMAC. DO concentration will additionally be assessed as a separate parameter, following the procedures detailed in the DO Listing Methodology (https://www.env.nm.gov/swqb/protocols/, Appendix E). If DO concentration and nutrients are both determined to be **Not Supporting** via their respective listing methodologies, the AU will be listed for nutrients because the minimum DO is a response to excessive nutrients.

There are a few instances of segment-specific TP criteria in 20.6.4.101 - 20.6.4.899 NMAC. These will not be used to determine impairment of the narrative nutrient criteria found at 20.6.4.13.E. TP will additionally be assessed as a separate parameter in these cases, following the procedures detailed in Section 3.1 of the main Listing Methodology (https://www.env.nm.gov/swqb/protocols/).

Table 6. Interpreting nutrient causal data

TYPE OF DATA*	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
•**Nutrients** (total nitrogen or total phosphorus[(a)])			
A) 2 to 10 samples	**A**) No more than one exceedence of the threshold value.	**A**) More than one exceedence of the threshold value.	Applicable thresholds are found in Table 3.
B) >10 samples	**B**) Threshold value exceeded in < 10% of measurements.	**B**) Threshold value exceeded in ≥ 10% of measurements.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 Main Listing Methodology (CALM) for details.

[(a)] Segment-specific TP criteria in 20.6.4.101 - 20.6.4.899 NMAC will not be used to determine impairment of the narrative nutrient criteria found at 20.6.4.13.E.

Table 7. Assessing daily delta DO response data

TYPE OF DATA	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
• **DO** Continuously recorded data (≥72 hours, ≤ one-hour frequency interval)	Daily delta DO is less than or equal to the applicable threshold.	Daily delta DO is greater than the applicable threshold.	Applicable thresholds are found in Table 4, using TP site classes.

NOTES: Daily delta DO is defined as the difference between the maximum and minimum DO concentration within a 24-hour period.

If there are multiple sites in the AU and the assessment results are not in agreement, the AU as currently defined may not represent homogeneous water quality. In this case, potential AU breaks will be examined. If none can be determined, the assessment for the downstream station will be given priority because water flows downhill.

<u>REVISION HISTORY</u>:

2012 listing cycle - Substantially re-organized protocol.

2014 listing cycle – Pre-Public Comment: Changed terminology from "Level 1 Nutrient Assessment" to "Nutrient Screening," and "Level 2 Nutrient Assessment" to "Nutrient Assessment." Full Support determinations from Nutrient Screenings are now considered preliminary and must be confirmed once all laboratory data are available. Changed data requirement to clarify that all Level 2 Nutrient Survey parameters – TN/TP, DO and pH sonde data (>72 hours), and chlorophyll *a* data – collected at the same station are required in order to perform a full Nutrient Assessment. Changed the chlorophyll *a* indicator to whether or not the upper limit of the threshold range is exceeded. Added clarification on how to assess multiple chlorophyll *a* samples when available. **Post Public Comment:** Minor wording clarifications/revisions. Clarified how the assessment approach addresses the "…*from other than natural* …" portion of the WQS. Changing wording in Table 6 to more clearly explain how multiple chlorophyll *a* samples are assessed.

2016 listing cycle – Revised to indicate that all indicators must be available to determine Full Support while Non Support can be determined with a partial dataset. Revised to include alternative collection time (two weeks into the growing season), and alternative Dissolved Inorganic Nitrogen calculation in the absence of useable TKN data. Added discussion of Future Direction and status of collaborative threshold revision project with EPA. Removed pH as a response variable based on analyses done as part of this project by (Ben Jessup, personal communication) combined with the lack of demonstration as a useful indicator in nutrient assessments completed between 2004 and 2014.

2018 listing cycle – Pre-Public Comment: Complete re-write to incorporate revised TN, TP, and delta DO thresholds based on stressor-response analyses completed collaboratively with Tetra Tech, Inc., EPA Region 6, and the EPA Office of Water Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS) program. Removed alternative TN calculation using Dissolved Inorganic Nitrogen in the absence of useable TKN data based on rarity of occurrence and consistency with how missing data are handled in other listing methodologies. Term "assessment protocol" changed to "listing methodology" throughout. Changed Table 6 from "1 to 10" to "2 to 10" because n=2 is a minimum data requirement for assessment (added related footnote). Added discussions on persulfate digestion TPN method, how to handle MRLs above the application threshold, and how to assess concurrent TN Calculated and TN persulfate data. **Post Public Comment** Clarified why certain river segments are assessable using this revised listing methodology. Added additional description of quantile selection to the N-STEPS section in 2.0. Added an additional assessment step of verifying the presence of a downstream response when the upstream AU response is not documented due to displacement effects. Revised to note that it is necessary to document nutrient enrichment with a concurrent response (either in the AU or downstream AU) to determine impairment. Added additional information on persulfate digestion TPN method.

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APPENDIX D

NUTRIENT LISTING METHODOLOGY FOR LAKES AND RESERVOIRS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

Nutrient impairment occurs when algae and other aquatic vegetation (macrophytes) interfere with designated uses such as recreation, water supply, or aquatic life. Excess amounts of nitrogen and phosphorus can cause increases in undesirable aquatic life (e.g., community composition shifts or toxic algal blooms) and/or result in a dominance of nuisance species (e.g., excessive and/or unsightly algal mats or surface plankton scums). Excessive algal growth may cause anaerobic conditions resulting in fish kills or loss of sensitive species.

With the recognition of the pervasiveness and potential severity of nutrient-related problems comes the need to accurately monitor and assess nutrient impairment. This document establishes an assessment protocol for determining the nutrient impairment status of lakes and reservoirs. While a few lakes have segment specific numeric criteria for total phosphorus (TP), New Mexico currently has no general numeric criteria for nutrients. The narrative criterion in *State of New Mexico Standards for Interstate and Intrastate Surface Waters* found at 20.6.4.13 NMAC (available at: https://www.env.nm.gov/swqb/Standards/) states:

> *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state.*

This document will be used to determine if a lake or reservoir is meeting the narrative criterion. Impairment threshold values are used to translate the narrative criterion into quantifiable endpoints. Threshold values are derived from water quality standards (WQS), Surface Water Quality Bureau (SWQB) analyses of existing data, or published literature. Nutrient enrichment indicators, including TP, total nitrogen (TN), and chlorophyll *a* (chl-a), are compared to threshold values to determine impairment. To address the "*from other than natural causes*" portion of the criterion, designated or assigned aquatic life use is used to classify sites in order to define reference conditions that account for New Mexico's complex landscape and high biodiversity. If a water body is determined to be impaired, it will be added to the Integrated Clean Water Act §303(d)/§305(b) List of Assessed Waters (Integrated List) as impaired.

This protocol is a dynamic document and subject to refinement as more data are collected and analyzed, enabling more precise classification of lentic systems and clearer definition of the relationships between nutrient concentrations, indicators, and impairments of New Mexico lakes and reservoirs. In the event that new data indicate that the threshold values presented in this document are inaccurate and/or if new standards are adopted, the threshold values will be adjusted accordingly.

This protocol is <u>not</u> applicable to the following water body types:

- Perennial, wadeable streams (see Appendix C of the Assessment Protocols)
- Wetlands and playas

A separate nutrient assessment protocol for perennial, wadeable streams (Appendix C of the Assessment Protocols) is available at: https://www.env.nm.gov/swqb/protocols/. Additional information on nutrient threshold development is available on the SWQB website at: http://www.nmenv.state.nm.us/swqb/Nutrients/.

1.0 Introduction/Background

The presence of some aquatic vegetation is normal in lakes and reservoirs. Algae and macrophytes provide habitat and food for other aquatic organisms. However, excessive aquatic vegetation is not beneficial to most aquatic life and may change the associated community structure. High nutrient concentrations may promote an overabundance of algae and floating or rooted macrophytes. The types and amounts of aquatic vegetation often reflect the level of nutrient enrichment. Algae are either the direct (excessive periphyton mats or surface plankton scums) or indirect (diurnal swings of dissolved oxygen and pH as well as high turbidity) cause of most problems related to excessive nutrient enrichment. In addition, algal blooms can cause taste and odor problems in drinking water supplies. One of the most expensive problems caused by nutrient enrichment is increased treatment required for drinking water. Blooms of certain types of blue-green (cyanobacteria) and golden (*Prymnesium* spp.) algae can produce toxins that are detrimental to fisheries in addition to animal and human health (Graham *et al.* 2016).

Limited increases in primary productivity (e.g., aquatic plants or algae) can increase the abundance of aquatic life such as invertebrates and fish in lakes and reservoirs. Alternatively, excessive plant growth and subsequent decomposition can limit aquatic populations by decreasing dissolved oxygen (DO) concentrations as plant respiration and decomposition of dead vegetation consumes DO. Lack of DO stresses aquatic organisms and can cause fish kills; even relatively small reductions in DO can have adverse effects on both invertebrate and fish communities. Nocturnal respiration can cause oxygen depletion in waters with high primary productivity and low aeration rates. Development of anaerobic conditions due to oxygen depletion alters a wide range of chemical equilibria, may mobilize certain pollutants, and generates noxious odors (EPA 1991).

The variables referred to in this document are measurable water quality parameters that can be used to evaluate the degree of eutrophication in lakes and reservoirs. The parameters consist of causal variables (TN and TP concentrations) and response variables (algal biomass determined by chlorophyll a (chl-a) concentration, % cyanobacteria, DO concentration, and pH). The typically large watershed-to-lake size ratio of many impoundments in arid landscapes can have great influence on both nutrient loading and biomass production. Additionally, low and middle elevation lakes and reservoirs in New Mexico may have naturally high levels of productivity due to nutrient loading, long growing seasons, and high temperatures. Many other factors come into play in lentic systems, including size and depth of the lake, residence time of the water, and geology of the surrounding area. Additional factors will be noted during monitoring to aid in interpretation of measured variables.

Available information does not allow identification of definitive and broadly-applicable water quality thresholds beyond which a particular designated use is always impaired in all water bodies. For the most part, nutrient-related impacts are gradational (chronic) rather than characterized by sharp transitions (acute). Furthermore, lakes and reservoirs are complex biogeochemical systems subject to many site-specific factors that affect responses to nutrient loading. Another challenge is the relatively small number of studies designed to identify nutrient-related thresholds of designated use impairment. Despite these challenges, the basic relationship between nutrient enrichment and use impairment in lakes and reservoirs is recognized.

2.0 Development of the Numeric Thresholds

This assessment approach considers multiple lines of evidence to make a final impairment determination. The abundance of confounding factors and indirect and fluctuating nature of the relationships between these factors make the use of a single variable for assessment challenging. Because of this, a suite of indicators is used in a weight-of-evidence approach to provide a more comprehensive and defensible assessment. The nutrient assessment is based on quantitative measures of both causal and response variables (EPA 2010).

Aquatic life uses (i.e., coldwater, warmwater) are generally defined by water temperatures and other characteristics that are known to support the growth or propagation of certain aquatic species. Assessment of the DO and pH indicators is dependent upon the designated aquatic life use, associated numeric criteria, and established procedures for assessing DO and pH, respectively. For assessment of the other indicators (i.e., TN, TP, chl-a, and cyanobacteria), New Mexico's lakes and reservoirs are grouped into three categories based on their designated aquatic life use(s) or assigned lake type. The lake groups include coldwater (COLD), warm water (WARM), and sinkholes (SINKHOLES). All reservoirs and high-elevation lakes with high quality coldwater aquatic life (HQCWAL) or coldwater aquatic life (CWAL) designated uses are assigned to the COLD group, while those with marginal CWAL, warmwater aquatic life (WWAL), or marginal WWAL designated uses are assigned to the WARM group. Sinkhole lakes are classified separately from other lakes and reservoirs because they are groundwater-fed, which results in unique chemical properties, and, in general, they are more influenced by the surrounding geology than adjacent land use.

Some lakes do not fit directly into one of the three lake groups. Specifically, New Mexico's coolwater aquatic life use designation was not in effect when data analyses and threshold development for this assessment protocol occurred. There are currently seven reservoirs that are designated in 20.6.4 NMAC with a coolwater aquatic life use. There are also six lakes with dual WWAL and CWAL designated uses. Given that these lakes do not fit directly into one lake group, lakes and reservoirs with coolwater or dual CWAL/WWAL uses were assigned a lake group based on the dominant fish community in the water body. The dominant fish community for these lakes was determined by examining fish community composition data and/or discussions with New Mexico Department of Game and Fish personnel. Figure 1 contains a generalized flowchart for assigning the appropriate lake group. Table 1 indicates the lake group assignments for thirteen water bodies with coolwater or duel aquatic life uses.

There are a few instances of segment-specific TP criteria in 20.6.4.97 - 20.6.4.899 NMAC. These will not be used to determine impairment of the narrative nutrient criteria found at 20.6.4.13.E. TP will additionally be assessed as a separate parameter in these cases, following the procedures detailed in Section 3.1 of the main Listing Methodology https://www.env.nm.gov/swqb/protocols/).

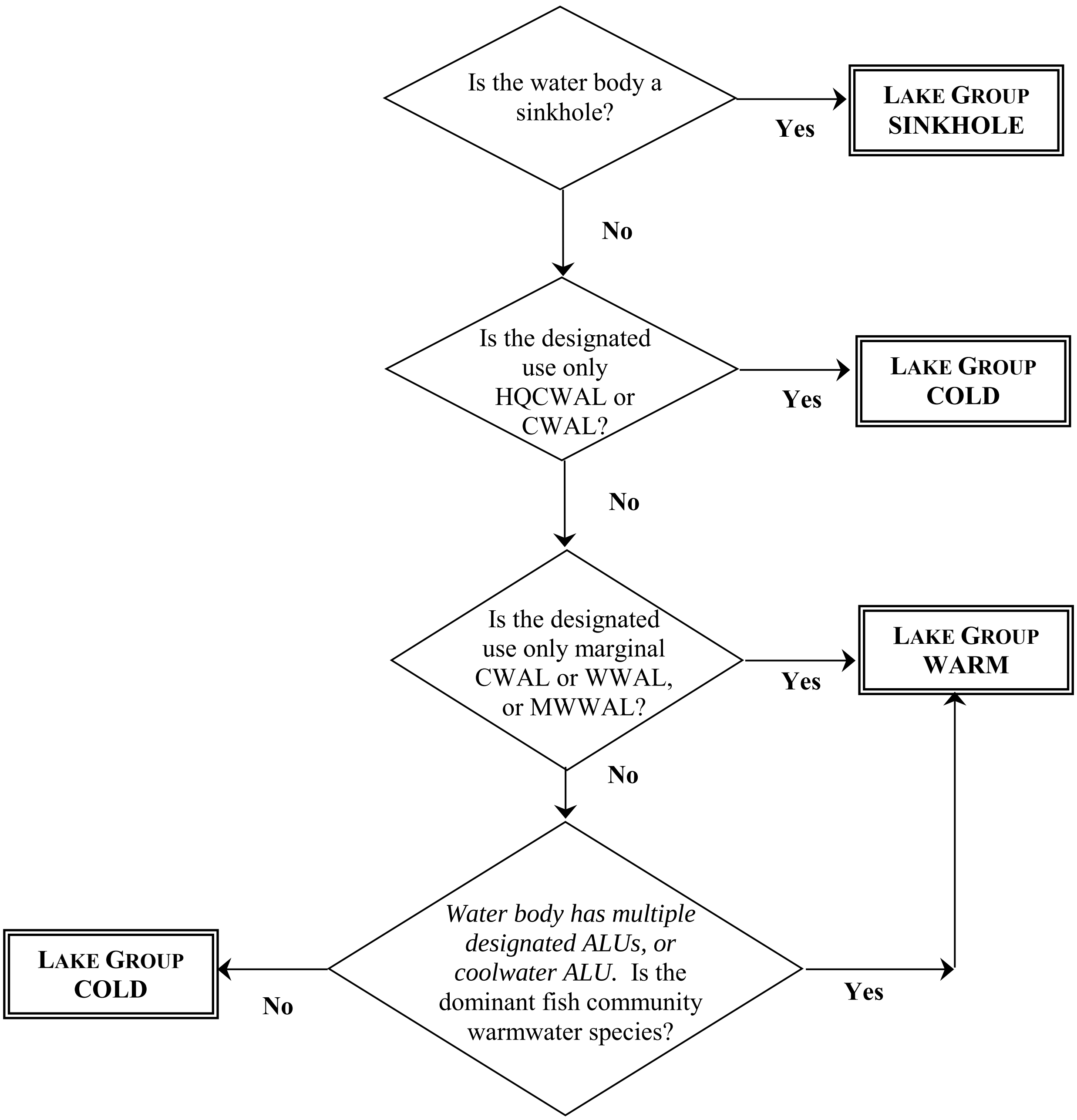

Figure 1. Generalized flowchart for determining lake group assignments

Table 1. Lake group assignments for evaluating TN, TP, chl-a, and cyanobacteria

Reservoir or Lake	Designated Aquatic Life Use(s)	Assigned Lake Group
Abiquiu Reservoir	CWAL/WWAL	COLD
Bill Evans Lake	CoolWAL	WARM
Charette lakes	CWAL/WWAL	WARM
Clayton Lake	CoolWAL	WARM
Jackson Lake	CoolWAL	WARM
Lake Farmington	CWAL/WWAL	WARM
Monastery Lake	CoolWAL	COLD
Navajo Reservoir	CWAL/WWAL	COLD
Quemado Lake	CoolWAL	WARM
Ramah Lake	CWAL/WWAL	WARM
Santa Rosa Reservoir	CoolWAL	WARM
Springer Lake	CoolWAL	WARM
Storrie Lake	CWAL/WWAL	WARM

Potential nutrient enrichment indicators for TN, TP, algal biomass, % cyanobacteria, as well as Secchi depth were collated from SWQB analyses, other state agency examples, or published literature. The indicators and respective threshold values selected for New Mexico lakes, reservoirs, and sinkholes are listed in Table 2. This selection was based on best professional judgment with respect to New Mexico's ecoregions. Additional information on all of the candidate thresholds is provided in Table 3.

Table 2. Nutrient-related impairment threshold values for New Mexico's lakes and reservoirs

	CAUSAL VARIABLES		RESPONSE VARIABLES			
Lake Group	**TP (mg/L)**	**TN (mg/L)**	**chl-a (µg/L)**	**% Cyano-bacteria[a]**	**DO[g] (mg/L)**	**pH[g]**
COLD	≤ 0.03 [b]	≤ 0.9[c]	≤ 7.5 [b]	≤ 38% [c]	*See NMAC for applicable DO and pH criterion*	
WARM	≤ 0.04[c]	≤ 1.4[c]	≤ 11[d]	≤ 38% [c]		
SINKHOLE	≤ 0.025 [e]	≤ 1.42 [e]	≤ 3.5[f]	-		

NOTES:

a. *The cyanobacteria thresholds are expressed as a percentage of the total algae count.*
b. *Boundary between mesotrophic and eutrophic lakes (Nürnberg 1996).*
c. *Threshold values were derived from change point and regression tree analyses of water quality data from New Mexico (Scott and Haggard 2011).*
d. *Thresholds for Kansas Central Plains & SW Tablelands (Dodds 2006).*
e. *75th percentile of NM sinkhole lake data.*
f. *Thresholds between oligotrophic and mesotrophic lakes (Nürnberg 1996).*
g. *DO and pH criteria are based on the designated aquatic life use(s) of the lake as assigned in 20.6.4.900.H NMAC.*

Table 3. Candidate impairment thresholds from SWQB analyses and literature review

	CAUSAL VARIABLES		RESPONSE VARIABLES			SOURCE	
Lake Group	**TP (mg/L)**	**TN (mg/L)**	**Secchi Depth[a] (m)**	**chl-a^ (µg/L)**	**% Cyano-bacteria**	**Organization/ Author**	**Method of threshold derivation**
COLD candidate thresholds							
NM Coldwater ALU	0.03	0.5	1.5	2.3	-	NMED SWQB	Median of lake group
NM Coldwater ALU	-	-	3	6	21%	NMED SWQB	75th percentile of lake group
NM Coldwater ALU	0.04	0.9	-	-	38%	Scott and Haggard (2011)	Changepoint analysis
ID Mountain	0.015	0.28	-	1.8		ID DEQ	75th percentile of reference
AZ Coldwater	0.70	1.2	1.5-2.0	5-15	>50%	Arizona DEQ	AZ trophic index
mesotrophic-eutrophic boundary	0.030	0.65	2	7.5	-	Nürnberg (1996)	Literature review
WARM candidate thresholds							
Warmwater ALU	0.04	0.6	1	3.2	-	NMED SWQB	Median of lake group
Warmwater ALU	-	-	1.8	10	31%	NMED SWQB	75th percentile of lake group
Warmwater ALU	0.04	1.41	-	-	38%	Scott and Haggard (2011)	Changepoint analysis
ID Xeric	0.048	0.514	-	7.79	-	ID DEQ	75th percentile of reference
AZ Warmwater	0.13	1.7	0.8-1.0	25-40	>50%	Arizona DEQ	AZ trophic index
KS Central Plains & SW Tablelands	0.044	0.70	1.2	11	-	KSU & KS Dept. of Health & Env.	Median of best 1/3
SINKHOLE candidate thresholds							
Sinkhole lakes	0.025	1.42	6	-	-	NMED SWQB	75th percentile of sinkhole lakes
oligotrophic-mesotrophic boundary	0.01	0.35	4	3.5	-	Nürnberg (1996)	Literature review

Secchi depth was included as a separate response variable in the initial lake nutrient assessment protocol (2014) but removed during the 2016 listing cycle. This water clarity measurement is affected by algae, soil particles, as well as other materials suspended in the water. Although Secchi depth can be used as an indicator of algal abundance and general lake productivity, high concentrations of non-algal suspended materials such as clay or organic matter can increase turbidity and weaken the relationship between Secchi depth and chlorophyll production (Lee 1995). If reduced Secchi depth is due to increased algal levels, there should be a concurrent increase in chl-a concentration. Non-algal turbidity is a prominent characteristic of many impoundments in arid Western States (EPA 2000). The amount of non-algal suspended material can be influenced by weather (i.e., rain, strong winds) in the days before sampling. Secchi depth is also influenced by time of day (10 am to 2 pm being ideal), but constraining lake sampling in this way is not possible.

Secchi depth will continue to be measured, and remains an influential measurement because it is used to estimate the extent of the euphotic zone and thus where to take phytoplankton samples.

3.0 Assessment Procedures

The following parameters are used as indicators in the assessment: nutrient concentrations (TP and TN), chl-a, cyanobacteria, DO, and pH. The interpretation for each set of indicators is given below.

3.1 Total nitrogen and Total phosphorus concentrations

TN is not a 40 CFR Part 136 regulated parameter, but is usually taken to mean the sum of Total Kjeldahl Nitrogen (TKN) and Nitrate+Nitrite (NO3+NO2). Therefore, the SWQB typically calculates TN as the sum of TKN plus NO3+NO2 for nutrient assessments. If either TKN or NO3+NO2 is unavailable for a particular sampling event, TN Calculated is noted as a "missing data point" with respect to this listing methodology.

The TKN and NO3+NO2 minimum quantifiable limits, referred to as minimum reported limits or MRLs in SQUID, are added together to determine the "TN Calculated MRL." If either TKN or NO3+NO2 are reported as below the MRL, the respective MRL value is used to determine the TN Calculated value that will be compared against the appropriate threshold. If both TKN and NO3+NO2 are reported as below the MRL, the resultant TN Calculated value is noted as "below the MRL." The respective TP and TN data MRLs for a particular sampling event must be equal to or less than the threshold in order to be useful for assessment.

Compare the TN or TP concentration to the threshold values in Table 2. The information in Table 4 is used to interpret TN and TP data to determine if enrichment is indicated.

Table 4. Interpreting nutrient causal data

TYPE OF DATA*	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
•**Nutrients** (total nitrogen or total phosphorus) **A)** 2 to 10 samples	**A**) No more than one exceedence of the threshold value.	**A**) More than one exceedence of the threshold value.	Applicable thresholds are found in Table 2.
B) >10 samples	**B**) Threshold value exceeded in < 10% of measurements.	**B**) Threshold value exceeded in ≥ 10% of measurements.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 Main Listing Methodology (CALM) for details.

3.2 Chlorophyll *a* or cyanobacteria

In lakes and reservoirs, phytoplankton community composition and biomass are useful parameters in monitoring changes in water quality. Chl-a concentration is used as a surrogate for phytoplankton biomass and is generally the most appropriate variable to monitor (EPA 2000). Chl-a levels along with Secchi depths and TP are the measurements most commonly used to characterize the trophic status of lakes and reservoirs.

Cyanobacteria (sometimes referred to as blue-green algae) can be toxic under certain conditions and are considered nuisance species (Graham *et al.* 2016). The dominance of cyanobacteria and probability of toxic algal blooms increases with eutrophication (Dodds 2006), so the proportion of these taxa can be a useful indicator to evaluate nutrient loading and nuisance algal growth. The thresholds are expressed as a percentage of the total phytoplankton count and are intended to identify cyanobacteria dominance. The information in Table 5 is used to interpret data from phytoplankton samples and to determine if enrichment is indicated.

Table 5. Interpreting chlorophyll *a* or cyanobacteria response data

TYPE OF DATA	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
• **Chlorophyll *a* or cyanobacteria**			
A) 1 sample	A) chl-a concentration or cyanobacteria percentage is less than the applicable threshold value.	A) chl-a concentration or cyanobacteria percentage is greater than the applicable threshold value.	Applicable threshold values for chlorophyll *a* and cyanobacteria are found in Table 2.
B) ≥2 samples	B) Exceedence rate ≤ 10% of measurements, or one or no exceedences of the applicable threshold value.	B) Exceedence rate > 10% of measurements with at least two exceedences of the applicable threshold value.	

3.3 Dissolved oxygen data

Dissolved oxygen criteria are based on the designated aquatic life use(s) of as detailed in 20.6.4.900.H NMAC (Table 6). DO measurements taken at intervals are averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of DO criteria. DO data are assessed following the procedures detailed in the DO Listing Methodology (https://www.env.nm.gov/swqb/protocols/, Appendix E). The information in Table 7 is used to interpret DO data and to determine if nutrient enrichment is indicated.

Table 6. Criteria for dissolved oxygen concentration (20.6.4.900 NMAC)

Aquatic Life Use	DO Criterion*
High Quality Coldwater Coldwater Marginal Coldwater	6.0 mg/L
Coolwater Warmwater Marginal Warmwater	5.0 mg/L

NOTES: * Listing based on data points when concurrently-measured percent saturation was greater than or equal to 90% will be further examined to determine the site-specific reason for the high percent saturation.

Table 7. Interpreting DO response data

TYPE OF DATA	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
• **DO data**	DO is "Fully Supporting" according to the *Dissolved Oxygen Listing Methodology.**	DO is "Not Supporting" according to the *Dissolved Oxygen Listing Methodology.**	See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling.

NOTES: * Available at https://www.env.nm.gov/swqb/protocols/, Appendix E.

3.4 pH Grab Data

The criteria for pH are based on the designated aquatic life use(s) of as detailed in 20.6.4.900.H NMAC (Table 8). pH measurements taken at intervals are averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of pH criteria. Data for pH are assessed according to the *pH Listing Methodology* (https://www.env.nm.gov/swqb/protocols/, Appendix F). The information in Table 9 is used to interpret pH data and to determine if enrichment is indicated.

Table 8. Criteria for pH (per 20.6.4.900 NMAC)

Aquatic Life Use	pH Range
High Quality Coldwater Coldwater	6.6 to 8.8
Marginal Coldwater Coolwater Warmwater Marginal Warmwater	6.6. to 9.0

Table 9. Interpreting pH response data

TYPE OF DATA	DOES NOT INDICATE ENRICHMENT	INDICATES ENRICHMENT	NOTES
• **pH data**	pH is "Fully Supporting" according to the *pH Listing Methodology.*.*	pH is "Not Supporting" according to the *pH Listing Methodology.*.*	See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling.

NOTES: * Available at https://www.env.nm.gov/swqb/protocols/, Appendix F.

ANALYSIS AND INTERPRETATION:

The threshold values selected for New Mexico lakes, reservoirs, and sinkholes listed in Table 2 are applied in a weight-of-evidence approach to assess data collected at the deep station. The SWQB strives to collect the full suite of causal and response indicators during nutrient surveys. Occasionally, data may be missing for a particular indicator due to equipment malfunction, sampling complications, or lab analysis errors. While the full suite of parameters must be monitored in order to determine Fully Supporting using this assessment protocol, it is permissible to determine Not Supporting using a partial dataset as detailed below.

Compare each available indicator to the associated impairment threshold using Tables 4 – 9 to determine which variables indicate potential nutrient enrichment. Indicators of nutrient concentrations (TP and TN) are considered causal variables. chl-a, % cyanobacteria, pH and DO indicators are considered response variables.

A lake or reservoir is **Fully Supporting** with respect to New Mexico's narrative nutrient standard if (1) all indicators were collected, 2) one or none of the variables (causal or response variables) indicate enrichment, or (3) total nitrogen or total phosphorus indicate enrichment, but there was no indication of a biological response to elevated nutrients (i.e., no response variables indicate enrichment). A lake or reservoir is **Not Supporting** if (1) *at least* one causal variable and one response variable indicate enrichment, or (2) if response variable chl-a and another response variable (% cyanobacteria, DO, or pH) indicate enrichment. This second scenario is to account for situations in which the lake is receiving a significant nutrient load, but the nutrients are quickly being assimilated into the biomass of the lake, hence low nutrient concentrations but undesirable effects (refer to example "Lake Two" in Table 10).

When multiple stations exist on a lake or reservoir (e.g., one "shallow" and one "deep" station), they are usually sampled on the same day or within the same seven-day period. The nutrient assessment protocol shall be applied to the shallow and deep station datasets separately. If one or both datasets indicate impairment, the impairment conclusion is **Not Supporting**. If there are conflicting assessment conclusions, it will be noted in the assessment record. In addition, the full suite of parameters must be monitored in order to determine **Fully Supporting** using this assessment protocol (see Section 3.0 for more information).

Figure 2 provides a generalized flowchart of the assessment procedure. Table 10 provides some examples of how nutrient assessments will be conducted following these rules.

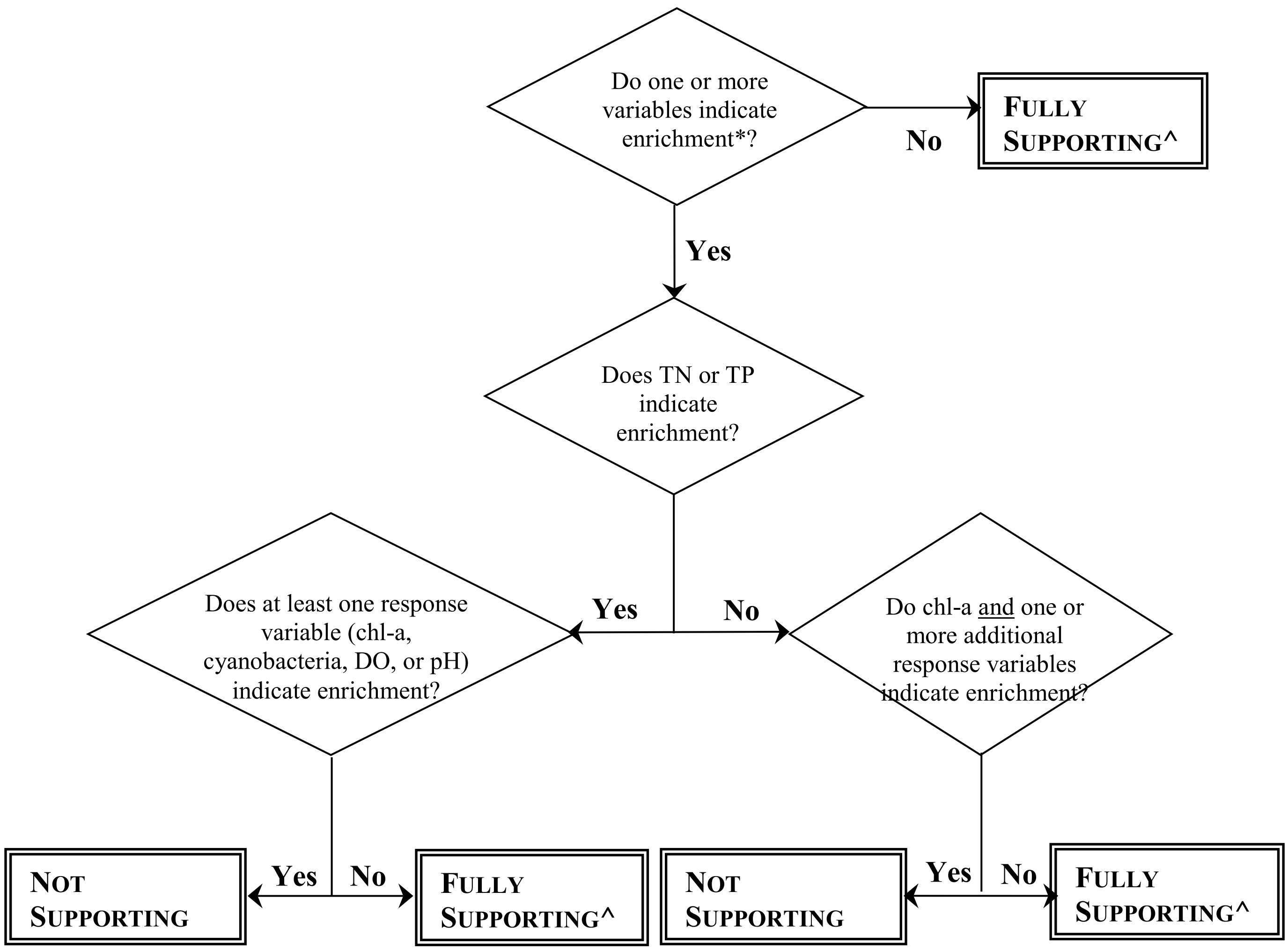

Figure 2. Generalized flowchart for determining nutrient impairment in NM lakes and reservoirs

NOTES: *Enrichment is determined using Tables 4-9.
^ All indicators must be sampled to determine Fully Supporting.

Table 10. Examples of lake and reservoir nutrient assessments*

Indicators	Lake One *COLD*	Lake Two *COLD*	Lake Three *WARM*	Lake Four *WARM*	Lake Five *SINKHOLE*
TP (mg/L)	0.015	0.03	0.02	**0.051**	**0.032**
TN (mg/L)	0.249	0.45	0.29	**2.06**	**2.69**
Chlorophyll *a* (µg/L)	0.28	**15.4**	**12**	**23**	0.4
% Cyanobacteria	**50**	30	24	5	7.4
DO impairment per DO AP	**Yes^**	**Yes**	No	No	No
pH impairment per pH AP	No	No	No	No	**Yes**
Nutrient Impairment Determination	Full Support^	**Non Support**	Full Support	**Non Support**	**Non Support**

NOTES: *Actual lake nutrient assessments will typically have two to ten values for each indicator. Tables 4 – 9 are used to interpret data. Excursions of the applicable threshold values are **bolded and underlined**.

^In this example, DO would be noted as impaired per the DO Assessment Protocol.

REVISION HISTORY:

2014 listing cycle – Pre Public Comment: Original. **Post Public Comment**: Minor edits and clarification to various sections, including DO assessment procedures and lake groups.

2016 listing cycle – Revised to indicate that all indicators must be available to determine Full Support while Non Support can be determined with a partial dataset. Removed application to deep station only. pH added as a response variable. Secchi depth was removed as a specific response variable (see details in Section 2.0). Added alternative Dissolved Inorganic Nitrogen calculation in the absence of useable TKN data.

2018 listing cycle – "Assessment Protocol" changed to "Listing Methodology." Minor wording clarifications. Addition of 2016 USGS cyanobacteria reference. Removed alternative TN calculation using Dissolved Inorganic Nitrogen in the absence of useable TKN data based on rarity of occurrence and consistency with how missing data are handled in other listing methodologies. Changed Table 4 from "1 to 10" to "2 to 10" because n=2 is a minimum data requirement for assessment (added related footnote).

REFERENCES:

Dodds, W.K., E. Carney and R.T. Angelo. 2006. Determining ecoregional reference conditions for nutrients, secchi depth and *chlorophyll a* in Kansas lakes and reservoirs. Lake and Reservoir Management 22(2):151-159.

Graham, J.L., Dubrovsky, N.M., and Eberts, S.M. 2016. Cyanobacterial harmful algal blooms and U.S. Geological Survey science capabilities: U.S. Geological Survey Open-File Report 2016–1174. Avaiable at: http://dx.doi.org/10.3133/ofr21061174.

Lee, G. F., A. Jones-Lee, and W. Rast. 1995. Secchi depth as a water quality parameter. G. Fred Lee & Associates. El Macero, CA.

Nürnberg, G.K. 1996. Trophic state of clear and colored, soft and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12(4):432-447.

Organization for Economic Cooperation and Development (OECD). 1982. Eutrophication of waters: Monitoring, assessment and control. Final report, Environment Directorate Cooperative Programme on Monitoring of Inland Waters (eutrophication control). 154 pp. Paris, France.

Scott, J.T. and B.E. Haggard. 2011. Analytical support for identifying water quality thresholds in New Mexico surface waters. University of Arkansas. Available at: https://www.env.nm.gov/swqb/Nutrients/IdentifyingWQThresholdsInNewMexico.pdf.

U.S. Environmental Protection Agency (EPA). 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. EPA-910-9-91-001. Seattle, WA.

_______. 2000. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs. First Edition. EPA-822-B00-001.

_______. 2010. Using stressor-response relationships to derive numeric nutrient criteria. EPA-820-S-10-001.

APPENDIX E

DISSOLVED OXYGEN LISTING METHODOLOGY

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to dissolved oxygen excursions in streams, rivers, lakes, and reservoirs. This protocol is not applicable to ephemeral streams and wetlands because the research and implementation procedures necessary have not been investigated or developed by the Surface Water Quality Bureau (SWQB).

1.0 Introduction/Background

Oxygen content in fresh waters is determined by several factors acting in concert. These factors include temperature, atmospheric pressure, salinity, turbulence, and photosynthetic activity of algae and plants in the water. Healthy aquatic systems have dissolved oxygen (DO) content that at least approaches 100% saturation[1]. Oxygen content may fall substantially below 100% saturation during the night when oxygen consumption coupled to the heterotrophic decay of organic matter, and other ecosystem respirations, reduce DO in the water column (Deas and Orlob 1999). The diel changes in DO content is normal, but can be particularly pronounced in systems with excessive nutrient enrichment and consequent algal and plant growth. See SWQB's Nutrient Listing Methodology (available at: https://www.env.nm.gov/swqb/protocols/) for more details.

Currently, New Mexico's criteria for DO are expressed only in units of mass per volume (mg/L). However, in certain circumstances such as high altitudes where atmospheric pressure is comparatively low or high air temperatures that reduce oxygen solubility (and particularly when these two conditions are both present), DO may be reduced so much so that the concentration-based criterion is physically impossible to attain. New Mexico's listing methodology considers concurrent percent saturation because this integrates several naturally-occurring factors that influence the amount of oxygen that water can contain. Specifically, the SWQB will further examine listing based on data points when concurrently-measured percent saturation was greater than or equal to 90% to determine the site-specific reason for the high percent saturation. Surrounding states have also incorporated percent saturation into their impairment determinations. For example, water quality criteria for DO concentration in Arizona are considered met if the measured DO percent saturation is equal to or greater than 90 percent. Arizona has incorporated this approach into their water quality standards (AAC 2013).

2.0 Data Collection Procedures and Considerations

Dissolved oxygen (DO) data from flowing waters typically exhibit a diel pattern that is usually at its lowest (i.e., most likely to have an excursion of the criteria) in the early morning in streams with excessive aquatic plant growth. For these reasons, continuous recording devices (sondes or data loggers) are used to record diel fluctuations, especially where excessive aquatic plant growth is suspected or evident.

SWQB typically deploys sondes or data loggers in streams and rivers to record DO, pH, specific conductance, temperature, and turbidity values over a specific period of time. When DO is the only parameter of concern, single parameter DO data loggers may be deployed instead of sondes. Both

[1] All references to saturation are defined as percent saturation at the local elevation, as opposed to global percent saturation (the percent saturation a given concentration would be at sea level).

sondes and data loggers are deployed and the data reviewed following the guidelines specified in SWQB's Standard Operating Procedures (SOPs, available at: http://www.nmenv.state.nm.us/swqb/SOP/). DO data from periods where the record indicates that the sonde or data logger was exposed or buried are censored and not used for assessment. Sondes or DO loggers should be used to collect DO data in order to observe a more complete picture of any diel fluctuations, as opposed to the "snapshot" that grab data provide; however, in some cases only grab data are available. For rivers and streams, sonde or data logger data sets deployed for ≥72 hours with a maximum one-hour frequency interval are preferred for assessment purposes, and required in order to determine Full Support of the applicable criteria. The likelihood of capturing adequate data to determine natural vs. anthropogenic influences to DO concentrations increases with increased sonde or data logger data, so longer deployments with interim equipment checks and data downloads are encouraged. DO listings based on grab data from streams or rivers will be noted as Category 5C (needing sonde or data logger data to confirm).

Reviewers of long-term data should make note of other factors that may cause DO excursions due to natural increases in biological oxygen demand (BOD), such as deciduous litter drop or post-fire stormflow events. If these conditions were present during collection, the data review should include a sampling event comment. The SWQB is exploring the feasibility of sonde deployment in lakes and reservoirs. If it is determined that sondes or data loggers can be safely deployed in this waterbody type and generate valuable data that can meet 20.6.4.14.C(3) NMAC, SWQB will develop a standard operating procedure and listing methodologies for lake continuous monitoring data.

3.0 Assessment Procedure

New Mexico DO criteria found in 20.6.4.900.H NMAC (available at: https://www.env.nm.gov/swqb/Standards/) are based on the aquatic life use designation (Table 1).

Table 1. New Mexico's DO criteria

Aquatic Life Use	DO Criterion*
High Quality Coldwater Coldwater Marginal Coldwater	6.0 mg/L or more
Coolwater Warmwater Marginal Warmwater	5.0 mg/L or more
Limited	No default established

NOTES: * Listing based on data points when concurrently-measured percent saturation was greater than or equal to 90% will be further examined to determine the site-specific reason for the high percent saturation.

Sonde or data logger data sets greater than 72 hours with a maximum one-hour frequency interval are required to assess with the continuously recorded data set assessment method in Table 2. If this resolution of sonde DO data is not available, the instantaneous grab method is used to determine attainment. Dissolved oxygen impairment listings determined from grab data from streams or rivers will be noted as Category 5C and prioritized for sonde or logger deployment to confirm the assessment.

Table 2. Determination of aquatic life use support using DO data

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Instantaneous (grab) DO data**			
A) Rivers or streams	**A)** Not assessable (cannot determine Fully Supporting with grab data only)	**A)** DO criteria excursions* in ≥ 10% of measurements, or more than one measurement if 2** to10 data points are available.	**A)** DO listings based on grab data will be noted as Category 5C (need sonde data to confirm).
B) Lakes or reservoirs	**B)** No DO criteria excursions^	**B)** 1 or more DO criteria excursions^	**B)** See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling^.
•**Continuously recorded DO data (≥72 hours, ≤one hour frequency interval)**	DO criteria excursion(s)* for less than four consecutive hours.	DO criteria excursions* for four or more consecutive hours.	If an AU is determined to be impaired for both excessive nutrients and DO following respective listing methodologies, the AU will be listed for the causal variable (nutrients) rather than the response variable (DO).

NOTES:
^ Lakes are typically sampled once in the spring and fall, and twice in the summer. DO measurements taken at intervals are averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of DO criteria.
* Listing based on data points when concurrently-measured percent saturation was greater than or equal to 90% will be further examined to determine the site-specific reason for the high percent saturation.
** Less than 2 samples = not assessed. See Section 2.1.4 Main Listing Methodology (CALM) for details.

REVISION HISTORY:

2014 listing cycle – Clarified concurrent minimum approach (i.e., ≥90% saturation = no excursion of criterion). Removed "Additional Thresholds Under Consideration" section (passed on to SWQB Standards and Reporting Team for evaluation). Clarified relationship between nutrient and DO assessments.

2016 listing cycle – Minor wording clarifications. Reduced grab data Non Support for lakes to 1 or more excursions because lakes are typically sampled once in the spring and fall, and twice in the summer; each seasonal sampling event is intended to be representative of the entire season. Changed ≥90% saturation = no excursion of criterion exclusion to further review of associated data vs. censoring of these data from the assessment dataset.

2018 listing cycle – "Assessment Protocol" changed to "Listing Methodology." Added reference to data logger. Removed reference to segment-specific DO criteria in 20.6.4.113 NMAC because they no longer exist. Changed Table 2 from "10 or fewer" to "2 to 10" because n=2 is a minimum data requirement for assessment (added related footnote).

REFERENCES:

Arizona Administrative Code (AAC). 2013. Title 18, Chapter 11, Supp. 08-4, Article 1, Water Quality Standards for Surface Waters. R18-11-109 (E)(3). Available at: http://www.azsos.gov/public_services/title_18/18-11.htm.

Deas, M.L. and G.T. Orlob. 1999. Klamath River Modeling Project. Project #96-HP-01. Assessment of alternatives for flow and water quality control in the Klamath River below Iron Gate Dam. University of California Davis Center for Environmental and Water Resources Engineering. Report No. 99-04. 236 pp.

APPENDIX F

pH LISTING METHODOLOGY

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to pH excursions in streams, rivers, lakes, and reservoirs. This protocol is not applicable to ephemeral streams and wetlands because the research and implementation procedures necessary have not been investigated or developed by the Surface Water Quality Bureau (SWQB).

1.0 Introduction/Background

The pH of a solution is a measure of its acidity or basicity and is calculated as the inverse log of the hydronium ion concentration ($pH = -\log_{10} [H_3O^+]$). In water, pH is a measure of the acid-base equilibrium resulting from various dissolved compounds and gases. A pH value of 7.0 is considered neutral. That is, at pH 7, the concentration of hydrogen ions ($[H^+]$) is equal to that of hydroxide ions ($[OH^-]$). The principal buffering system regulating pH in natural waters is the carbonate-bicarbonate system, composed of carbon dioxide (CO_2), carbonic acid (H_2CO_3), bicarbonate ion (HCO_3), and carbonate ion (CO_3). Gradual, non-linear deterioration of a waters ability to support aquatic life occurs as pH values depart from neutral. A range of pH values from 5.0 to 9.0 is not directly lethal to fish; however, the toxicity of some pollutants (e.g., ammonia) can be substantially affected by pH changes within this range (EPA 1986). At pH values above 9.0, fish have difficulty excreting ammonia across the gill epithelium.

In New Mexico, typical pH values in surface waters that are largely unaffected by anthropogenic disturbance vary approximately from 7.5 to 8.7. An exception, Sulphur Creek in the Jemez River watershed, has documented natural background pH values as low as 2.4 as a result of parent lithology and geothermal influences. Accordingly, segment-specific criteria have been established for this stream.

2.0 Data Collection Procedures and Considerations

An increase in pH values can result from the decrease of carbonic acid when carbon dioxide, carbonate, and bicarbonate are used by plants during photosynthesis. Thus, when high levels of nutrients lead to excessive plant productivity, pH values above 9.0 may occur during the daylight hours. During the night, when photosynthesis does not occur, the pH value drops. The result is a daily or "diel" fluctuation of pH values that lags behind the diel fluctuation observed in dissolved oxygen concentrations. Dissolved oxygen (DO) concentration is at its lowest in the early morning in areas of excessive aquatic plant growth. This is in contrast to the diel pattern of pH values, which are most likely to have an excursion of the criteria late in the day. For these reasons, it is best to use continuous recording devices (sondes) to record pH values, especially where excessive aquatic plant growth is evident.

SWQB typically deploys sondes to record DO, pH, specific conductance, temperature, and turbidity values over a specific period of time. Sondes are deployed and the data reviewed following the guidelines specified in SWQB's Standard Operating Procedures (SOPs, available at: https://www.env.nm.gov/swqb/SOP/). Sondes should be used to collect pH data in order to observe a more complete picture of any diel fluctuations, as opposed to the "snapshot" that grab data provide; however, in some cases only grab data are available. For rivers and streams, sonde data sets deployed for ≥72 hours with a maximum one hour frequency interval are preferred for assessment purposes, and required in order to determine Full Support of the applicable criteria. The likelihood of capturing adequate data to determine natural vs. anthropogenic influences to pH concentrations increases with increased sonde data, so longer sonde deployments with interim equipment checks and data downloads are encouraged. pH listings based on grab data from streams or rivers will be noted as Category 5C (needing sonde data to confirm).

The SWQB is exploring the feasibility of sonde deployment in lakes and reservoirs. If it is determined that sondes can be safely deployed in this waterbody type and generate valuable data that can meet 20.6.4.14 NMAC.C(3) , SWQB will develop a standard operating procedure and listing methodologies for lake sonde data.

3.0 Assessment Procedure

New Mexico pH criteria found in 20.6.4.900.H (available at: http://www.nmenv.state.nm.us/swqb/Standards/) are based on the aquatic life use designation (Table 1). There are two segment-specific pH criteria (2.0 - 8.8) for Sulphur Creek (20.6.4.108 and 20.6.4.124 NMAC).

Table 1. New Mexico's pH criteria

Aquatic Life Use	pH Range
High Quality Coldwater Coldwater	6.6 to 8.8
Marginal Coldwater Coolwater Warmwater Marginal Warmwater	6.6. to 9.0
Limited	No default established

Sonde data sets greater than 72 hours with a maximum one hour frequency interval are required to assess with the continuously recorded data set assessment method in Table 2. If this resolution of sonde pH data is not available, the instantaneous grab method is used to determine attainment. pH impairment listings determined from grab data for streams and rivers will be noted as Category 5C and prioritized for sonde deployment to confirm the assessment.

Table 2. Determination of aquatic life use support using pH data

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Instantaneous (grab) pH data			
A) Rivers or streams	**A)** Not assessable (cannot determine Fully Supporting with grab data only)	**A)** pH is outside the criteria range in ≥ 10% of measurements, or more than one measurement if 2* to 10 data points are available.	**A)** pH listings based on grab data will be noted as Category 5C (need sonde data to confirm).
B) Lakes or reservoirs	**B)** No pH criteria excursions^	**B)** 1 or more pH criteria excursions^	**B)** See 20.6.4.14.C(3) NMAC for additional information regarding lake sampling.
•Continuously recorded pH data (≥72 hours, ≤one hour frequency interval)	pH criteria excursion(s) for less than four consecutive hours.	pH criteria excursions for four or more consecutive hours.	

NOTES: * Less than 2 samples = not assessed. See Section 2.1.4 Main Listing Methodology (CALM) for details.
^ Lakes are typically sampled once in the spring and fall, and twice in the summer. pH measurements taken at intervals are averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of pH criteria.

REVISION HISTORY:

2014 listing cycle – Minor clarifications.

2016 listing cycle – Removed pH 9.5 upper threshold because not supported in EPA's pH criteria guidance (EPA 1986). Reduced grab data Non Support for lakes and reservoirs to 1 or more excursions because lakes and reservoirs are typically sampled once in the spring and fall, and twice in the summer; each seasonal sampling event is intended to be representative of the entire season. Changed 24-hour floating average approach to more conservative 4 consecutive hour approach to better align with existing pH water quality standards and DO assessment protocol.

2018 listing cycle – "Assessment Protocol" changed to "Listing Methodology." Removed Table 2 note regarding pH as a nutrient response variable because pH is no longer a response variable in the nutrient listing methodology. Changed Table 2 from "10 or fewer" to "2 to 10" because n=2 is a minimum data requirement for assessment (added related footnote).

REFERENCES:

U.S. Environmental Protection Agency (EPA). 1986. Quality criteria for water 1986. Washington, D.C. Available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/upload/2009_01_13_criteria_redbook.pdf.

APPENDIX G

SEDIMENTATION/SILTATION LISTING METHODOLOGY FOR WADEABLE, PERENNIAL STREAMS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to excessive sedimentation/siltation (otherwise referred to as stream bottom deposits or SBD) in wadeable, perennial streams. This assessment is only conducted in wadeable perennial streams at this time because the research used to develop this listing methodology is based upon data and information collected in perennial streams.

This protocol was developed to support an interpretation of the *State of New Mexico Standards for Interstate and Intrastate Surface Waters* narrative standard for bottom deposits found at 20.6.4.13 NMAC (https://www.env.nm.gov/swqb/Standards/):

> ***A. Bottom Deposits and Suspended or Settleable Solids:***
> *(1) Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function, or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.*

In 2008, the Surface Water Quality Bureau (SWQB) Sediment Workgroup was formed to review the previous sedimentation/siltation listing methodology and recommend an approach for revision. As a result of workgroup discussions, the SWQB and the U.S. Environmental Protection Agency (EPA) Region 6 contracted with Tetra Tech, Inc. to develop sediment translators or thresholds. Tetra Tech, Inc. generally followed the steps provided in EPA's Framework for developing suspended and bedded sediment (SABS) water quality criteria (EPA 2006). To address the "*from other than natural causes*" portion of the criterion, Level IV ecoregions were used to classify and group sites to examine distributions and define reference conditions that account for New Mexico's varied associated geological and physiographic characteristics around the state. Several staff from Tetra Tech, Inc., EPA Region 6, and the SWQB worked as a team to complete this effort.

This effort included the identification of sediment characteristics that are expected under the range of environmental settings in New Mexico, especially in undisturbed or best available reference streams. The goal of this characterization was to enable SWQB to identify situations where sedimentation/siltation expectations are not met, using sediment indicators that show responsiveness to disturbance. Examining the relationships between biological measures and sediment indicators helped to identify where disturbance caused sediment imbalance and biologically-relevant habitat degradation. The results of these analyses led to quantitative, sedimentation indicator threshold recommendations for New Mexico perennial streams.

The 100+ page report (Jessup et al. 2010) detailing this effort, plus information on additional bedded sediment indictors as well as suspended sediment indicators, is available at https://www.env.nm.gov/swqb/Sedimentation/. The SWQB also generated a Sedimentation/ Siltation Thresholds Development Plan (NMED/SWQB 2011), which summarizes the seven steps taken to develop recommended bedded sediment thresholds, available at the same web site. For historical purposes, this plan includes an abbreviated description of the previous sedimentation listing methodology utilized during the 1998 – 2010 listing cycles as Attachment A.

<u>Exclusions</u>

This protocol is not applicable to the following water body types because the necessary research and implementation procedures have either not been investigated by the SWQB or are not yet developed:

- Lakes or reservoirs
- Large rivers (non wadeable)
- Intermittent streams which includes water bodies under 20.6.4.98 or 20.6.4.128 NMAC
- Ephemeral streams which includes water bodies under 20.6.4.97 or 20.6.4.128 NMAC
- Wetlands or playas

The SWQB is distinguishing rivers from streams by defining systems that cannot be monitored effectively with the biological and habitat methods developed for wadeable streams. These rivers also generally meet the Simon and Lyons (1995) definition of great rivers as those having drainage areas greater than 2,300 square miles (mi^2). There are many systems is in New Mexico that meet the great river definition but are suitable to wadeable stream monitoring methods due to the arid nature of the region. For sedimentation monitoring and assessment purposes, the systems included in the "Large Rivers" water body type, and consequently <u>exempt</u> from this protocol, are the non wadeable portions of the:

1. San Juan River from below Navajo Reservoir to the Navajo Nation boundary near Four Corners,
2. Animas River from the Colorado border to the San Juan River,
3. Rio Grande in New Mexico,
4. Pecos River from below Sumner Reservoir to the Texas border,
5. Rio Chama from below El Vado Reservoir to the Rio Grande,
6. Canadian River below the Cimarron River, and
7. Gila River below Mogollon Creek.

Fine sediment benchmarks in representative riffle areas were previously developed for the San Juan and Animas Rivers . In 2002, the SWQB received a grant to develop a protocol for the determination of sedimentation impairment in these rivers. The SWQB contracted with the U.S. Department of Agriculture (USDA) National Sedimentation Lab (NSL) to provide technical support on the project (Heins et al. 2004). The SWQB used the results of this study to develop a repeatable, quantitative assessment procedure for determining whether New Mexico's current narrative sedimentation standard is being attained in the San Juan and Animas rivers. The NSL study resulted in the determination of fine sediment benchmarks for representative riffles areas in Ecoregion 22 as well as various river reaches in the San Juan River basin. The SWQB used these benchmarks to establish one fine sediment threshold for the San Juan and Animas rivers, and compared the measured bed material characteristics of the stream reach of concern to this fine sediment threshold. This procedure was used to assess the San Juan and Animas rivers for development of the 2004-2006 Integrated List, and was applied to subsequent data collected during non-wadeable conditions with comparable sampling methods to determine potential sedimentation impairment in these rivers. This document and the entire NSL report is available at:
https://www.env.nm.gov/swqb/Sedimentation/.

1.0 Introduction/Background

Stream bottom substrate without excessive fine sediment filling the interstitial spaces provides optimum habitat for many fish and aquatic insect communities. Excessive fine sediment occurs when biologically-important habitat components, such as spawning gravels and cobble surfaces, are physically covered by fines (Chapman and McLeod 1987). Excessive fine sediment can result in decreased inter-gravel oxygen, as well as reduced or eliminated quality and quantity of habitat for fish, macroinvertebrates, and algae (Lisle 1989, Waters 1995). Chapman and McLeod (1987) found that bed material size is related to habitat suitability for fish and macroinvertebrates and that excess sediment decreased both density and diversity of aquatic insects. Specific aspects of sediment-invertebrate relationships can be described as follows: 1) abundance of certain invertebrate taxa is correlated with substrate particle size; 2) fine sediment reduce the abundance of sediment intolerant taxa by reducing interstitial habitat normally available in large-particle substrate (e.g., gravel or cobbles); and 3) community composition changes as substrate particle size changes from large to small (e.g., sand, silt, or clay) (Waters 1995).

Sediment loads that exceed a stream's sediment transport capacity often trigger changes in stream morphology (Leopold et al. 1964). Streams that become overwhelmed with sediment often go through a period of accelerated channel widening and streambank erosion before returning to a stable form (Rosgen 1996). These morphological changes can accelerate erosion, reduce habitat diversity (e.g., pools, riffles, etc.), and place additional stress on the designated aquatic life use.

Substrate characteristics may be considered impacted at a site if they are: 1) not similar to expectations for undisturbed sites in the same environmental setting; or 2) detectably affecting the biota. In the first case, substrate may be more fine, more coarse, more unstable, or more stable than expected under broadly-recognized, undisturbed conditions (i.e., reference or best available conditions) for that particular environmental setting. In the second case, biotic responses to disturbed substrates can be variable, but sub-optimal biotic conditions are often associated with unbalanced sediment.

Bedded sediments cannot be treated as introduced pollutants such as pesticides because they are not uniquely generated through human input or disturbance. Rather, bedded sediments are components of natural systems that are present even in pristine settings and to which stream organisms have evolved and adapted. Therefore, the detection of a sediment imbalance is more difficult than detecting an absolute concentration or percentage that represents a clear biological impact (Jessup et al. 2010).

The approach used to identify sedimentation/siltation thresholds for wadeable, perennial streams in New Mexico followed seven basic steps:

1. Review background information
2. Assemble datasets
3. Establish reference sites
4. Classify sites
5. Characterize sediments
6. Describe stressor–response relationships
7. Recommend thresholds or benchmarks

These steps are generally based on the EPA Framework for developing SABS water quality criteria (EPA 2006). The details of each step are available in summary form or in entirety in separate documents available on the SWQB web site (NMED/SWQB 2011 and Jessup et al. 2010, respectively): https://www.env.nm.gov/swqb/Sedimentation/.

Multiple sediment indicators and their responsiveness to site disturbance and effects on benthic macroinvertebrates were analyzed. The analysis used reference distributions, quantile regression, and change-point analysis, and resulted in the threshold recommendations for two bedded sediment indicators (Table 1) – % Sand & Fines (%SaFN) and log Relative Bed Stability calculated without bedrock (LRBS_NOR) -- in three sediment site classes, Mountains, Foothills, and Xeric areas (Table 2, Figure 1). The site classes are defined by Level III and IV ecoregions (Griffith et al. 2006) and distinguish sediment expectations across New Mexico. Site classes were identified through a principal components analysis (PCA) of environmental conditions and the bedded sediment indicators. The Foothills and Xeric site class definitions were modified slightly from Jessup et al. 2010 to further divide ecoregion 22 based on site characteristics used in the PCA (see NMED/SWQB 2011 for additional details). Site locations near sediment site class boundaries warrant additional scrutiny. Any study site within approximately twenty kilometers of these boundaries should be compared to the adjacent ecoregion definition within the bordering sediment site class to determine the appropriate ecoregion and associated bedded sediment site class designation for that particular site. Sediment site class assignments that deviate from Table 2 will be documented the SWQB's in-house database (SQUID).

Table 1. Bedded sediment indicators

Sediment Indicator	Description
Percent Sand & Fines (%SaFN)	**The percentage of systematically selected streambed substrate particles that are ≤2.0 mm in diameter from reach-wide pebble count.**
Log Relative Bed Stability (LRBS)	**A measure of the relationship of the median particle size in a stream reach compared to the critical particle size calculated to be mobilized by standardized fluvial stresses in the reach.** Median particle size is determined using a reach-wide pebble count (Peck et al. 2006). Critical particle size is calculated from channel dimensions, flow characteristics, and channel roughness factors (Kaufmann et al. 2008). The measure is expressed as a logarithm of the ratio of geometric mean to critical particle size.
LRBS_NOR	**RBS without bedrock or hardpan (log10).** This measure regards only the potentially mobile streambed particles in determining the geometric mean particle size, and improved associations between the bedded sediment measure and biological responses in the TetraTech analyses (Jessup et al. 2010).

Table 2. Definition of bedded sediment site classes

Site Class	Definition
Mountains	Ecoregions 21 and 23, ***except*** *21d, 23a, 23b and 23e*
Foothills	Ecoregions 21d, 22a, 22b, 22f, 23a, 23b, 23e and 79
Xeric	Ecoregions 20, 22, 24, 25, and 26, ***except*** *22a, 22b, 22f*
Ecoregion number	**Ecoregion Name***
20	Colorado Plateaus
21	Southern Rockies
21d	Foothill Woodlands and Shrublands
22a 22b 22f	San Luis Shrublands and Hills San Luis Alluvial Flats and Wetlands Taos Plateau
23	Arizona/New Mexico Mountains
23a	Chihuahuan Desert Slopes
23b	Madrean Lower Montane Woodlands
23e	Conifer Woodlands and Savannas
24	Chihuahuan Deserts
25	High Plains
26	Southwestern Tablelands
79	Madrean Archipelago

NOTES: * Additional written descriptions of level 4 ecoregions in New Mexico are available at: http://www.eoearth.org/view/article/51cbed847896bb431f692a14/.

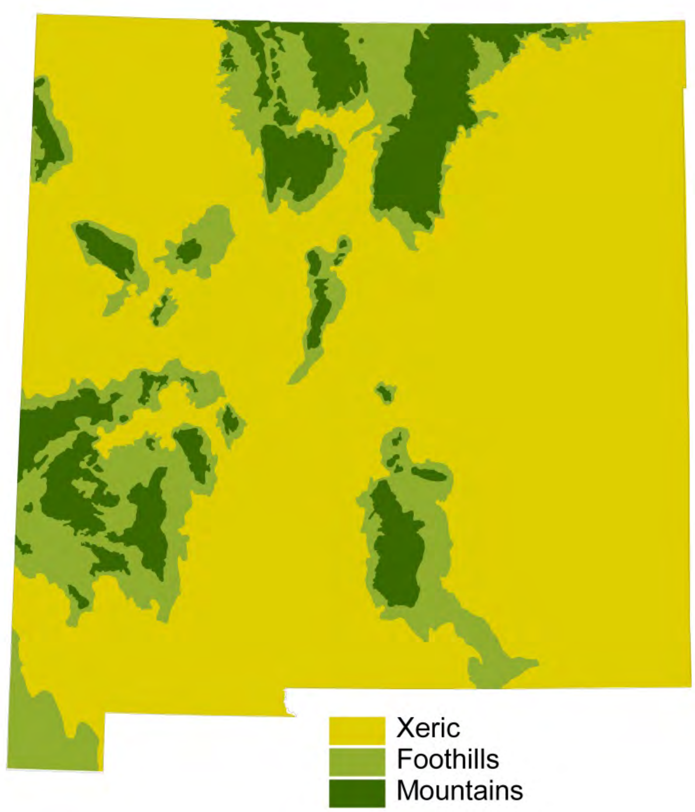

Figure 1. New Mexico Mountain, Foothills, and Xeric site class map

The recommended thresholds by site class resulted from a weight-of-evidence approach that considered multiple analytical approaches and the strength of each analysis. Corroborating evidence for selection of thresholds from reference conditions was found in the analysis of relationships between sediment and biological indicators. Biological effects are less direct indicators of required sediment conditions because the biota is affected by other environmental conditions, not just sediments (Jessup et al. 2010).

2.0 Assessment Procedure

To determine if there is excessive sedimentation/siltation in the study stream reach, two levels of assessment are performed in sequential order (Figure 2). The first level considers the simpler indicator of biological impairment, and the second level considers geomorphic impairment, as needed, when the first level threshold is exceeded.

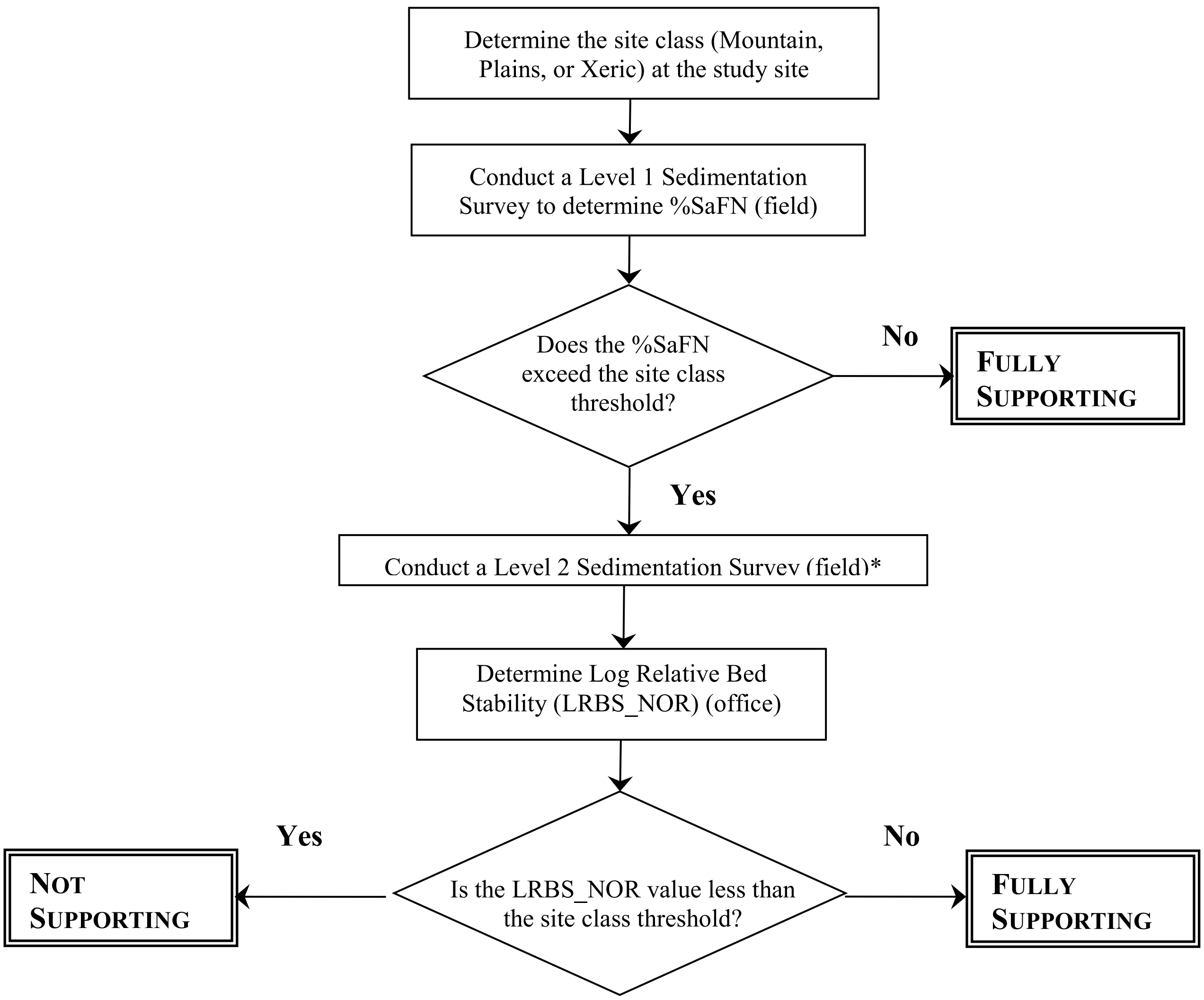

Figure 2. Generalized flowchart for determining sedimentation/siltation impairment

<u>NOTES</u>: * As stated in the SWQB's Standard Operating Procedures, Level 1 and Level 2 sedimentation surveys should be performed during the same site visit whenever possible to reduce the influence of seasonal variability, including flood/scouring events, large reservoir releases, etc.

The %SaFN sediment indicator is used in the Level 1 assessment because it is easily measured and related strongly with biological metrics. If the %SaFN indicates excessive fine sediment in the stream bed, a Level 2 survey is performed to collect the data necessary to calculate the LRBS_NOR value. This sediment indicator is a calculation that considers site-specific hydraulic potential for moving bed sediments, so that the observed amount of fine sediments are only considered impaired when the streambed is more easily mobilized and transported than expected. The LRBS_NOR measure is appropriate as a second-tier indicator because it is scaled to hydro-geomorphic factors of the individual sites, as well as to the broader site classes, thus allowing evaluation of the potential of the specific site in terms of retaining or flushing fine sediments. When used as a second-tier sediment indicator, LRBS_NOR helps explain whether high %SaFN were expected for a given site or are a result of disturbed conditions (Jessup et al. 2010). A two-level assessment approach is justified because sediment conditions relative to the fluvial potential are better estimates of system stability and imbalance than absolute measures of fine sediment concentration alone because they intrinsically account for site-specific natural settings. In contrast to LRBS_NOR, the %SaFN measure is an absolute quantity, which, except for natural variability captured by site classification, is more susceptible to natural variations (Jessup et al. 2010).

Another way to present how the two indicators are applied in a tiered approach is to consider the quadrants when the two indicators are graphed against one another (Figure 3).

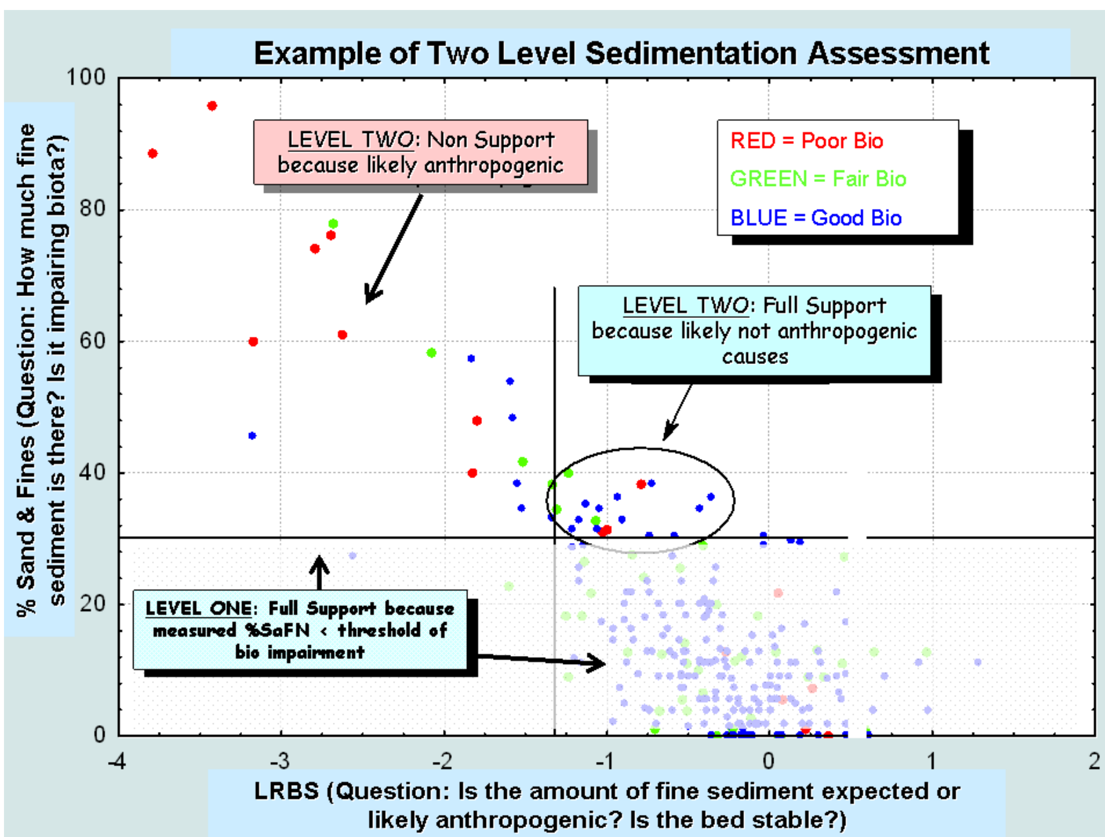

Figure 3. Graphical example of two indicator tiered assessment approach

For example, sites falling in the upper left quadrant represent **Non Support** (impaired) for sedimentation/siltation because they fail both the Level 1 and Level 2 thresholds (i.e., have both high %SaFN and low LRBS_NOR values). Sites in the other three quadrants are considered **Full Support** (unimpaired). Specifically, sites that fall in the lower quadrants are considered unimpaired because they have low %SaFN (passing the Level 1 threshold). These sites are considered unimpaired because the measured %SaFN values from the Level 1 survey are below the threshold for biological impairment. Observations in the upper right quadrant indicate potential impairment using the Level 1 (%SaFN) threshold, but are considered unimpaired based on the Level 2 (LRBS_NOR) threshold because LRBS_NOR values greater than the threshold suggests that the higher %SaFN values may be natural and therefore expected for those sites.

2.1 Level 1 Sedimentation Assessment

Level 1 sedimentation surveys are conducted during regular SWQB watershed surveys according to SWQB's Standard Operating Procedures (SOPs) (http://www.nmenv.state.nm.us/swqb/SOP/). These surveys are completed during stable low flow conditions, between August 15 and November 15. The %SaFN is calculated on-site based on the 105 particle count, and recorded on the appropriate field sampling sheet.

The %SaFN is an appropriate sediment indicator because it is essentially equivalent to New Mexico's definition of "…fine sediment particles (less than two millimeters in diameter)…" found at 20.6.4.13 NMAC. In a slight deviation from 20.6.4.13 NMAC, this listing methodology includes particles that are two mm in diameter to be conservative, and to match EPA's definition and TetraTech, Inc.'s analyses (Peck et al. 2006, Jessup et al. 2010).

Table 3. Percent Sand & Fines (Level 1) thresholds

Site Class	Measured % Sand & Fines	Number of particles ≤ 2mm diameter based on a 105 particle count
Mountain	< 20% Sand & Fines	< 21 particles
Foothill	< 37% Sand & Fines	< 39 particles
Xeric	< 74% Sand & Fines	< 78 particles

Level 1 Analysis & Interpretation

If the measured %SaFN is less than the applicable site class threshold in Table 3, the sediment survey and assessment is complete and the assessment unit is considered to be **Full Support** with respect to New Mexico's narrative sedimentation/siltation standard found at 20.6.4.13 NMAC. If the measured %SaFN is greater than the applicable site class threshold in Table 3, the assessment is inconclusive and a Level 2 sedimentation survey is conducted according to the procedures in SWQB's SOPs. As stated in the SOPs, Level 1 and Level 2 surveys should be performed during the same site visit whenever possible to reduce the influence of seasonal variability, including flood/scouring events, large reservoir releases, etc.

2.2 Level 2 Sedimentation Assessment

Data from the Level 2 sedimentation survey are used to calculate LRBS_NOR. Because fluvial site conditions are major determinants of the substrate conditions in stream channels, the critical particle size calculated from fluvial characteristics is a predictor of dominant and stable substrate conditions. In essence, the LRBS_NOR calculation is used to predict the expected sediment particle size that would be moved during a bankfull flow event. This expected or "critical" particle size is calculated from channel dimensions, roughness factors, and shear stresses (Kaufmann et al. 2008). The logarithm ratio of the measured particle size to the expected particle size is a measure of the relative stability of the stream bed.

In minimally disturbed streams, the measured geometric mean stream bottom particle size should trend towards the expected particle size (i.e., the size a stream is capable of moving as bedload at bankfull). Thus, LRBS_NOR values near zero indicate a stable stream bed, whereas increasingly negative values indicate excess fine sediment. For example, a LRBS_NOR value of -1 means that the measured geometric mean bedded sediment particle size is ten times (10X) finer than the expected particle size moving during bankfull flow events. Calculated LRBS values less than -3 indicate that the bed substrate may be moving even during low flow events.

LRBS_NOR was selected to be a sediment impairment indicator because this measure regards only the potentially mobile streambed particles in determining the geometric mean particle size and produces improved associations between the bedded sediment measure and biological responses when compared to the LRBS calculated with bedrock (Jessup et al. 2010). LRBS_NOR threshold values by site class are listed in Table 4.

Table 4. LRBS_NOR (Level 2) thresholds

Site Class	LRBS_NOR Units
Mountain	> -1.1
Foothill	> -1.3
Xeric	> -2.5

Level 2 Analysis & Interpretation

If the calculated LRBS_NOR is greater than the applicable site class threshold in Table 4, the assessment unit is regarded as **Full Support** with respect to New Mexico's narrative sedimentation/siltation standard found at 20.6.4.13 NMAC. If the calculated LRBS_NOR is less than or equal to the applicable site class threshold, the assessment unit is considered **Non Support**.

REVISION HISTORY:

2012 listing cycle – Protocol was substantially revised based on Jessup et al. (2010).

2014 listing cycle – Minor clarifications and re-formatting.

2016 listing cycle – Minor clarifications.

2018 listing cycle – "Assessment Protocol" changed to "Listing Methodology." Clarified application of Heins et. al 2004 study to waters in the San Juan River basin. Clarified potential re-assignment and documentation of sediment site class for a particular site.

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APPENDIX H

TURBIDITY LISTING METHODOLOGY FOR COLDWATER PERENNIAL STREAMS AND RIVERS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose and Applicability

This document establishes a listing methodology for determining impairment due to excessive turbidity in coldwater perennial streams and rivers. This protocol was developed to assess the first sentence of the *State of New Mexico Standards for Interstate and Intrastate Surface Waters* narrative criterion for turbidity found at 20.6.4.13 NMAC (available at: https://www.env.nm.gov/swqb/Standards/):

> ***Turbidity**: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water.*

Exclusions

This protocol is currently not applicable to the following water body types because the necessary research and implementation procedures have either not been investigated by the Surface Water Quality Bureau (SWQB) or are not yet developed. As resources allow, the scope will be expanded to include these water body types:

- Lakes, reservoirs, and playas;
- Intermittent streams;
- Ephemeral streams;
- Wetlands; and
- Stream segments with a coolwater (or dual coldwater and warmwater), warmwater, or marginal warmwater aquatic life designated use per the current version of 20.6.4 NMAC.

1.0 Introduction/Background

Prior to the 2005 triennial review of water quality standards, New Mexico had numeric turbidity criteria for certain aquatic life use. When these numeric criteria were removed, it became necessary to develop numeric translators or thresholds for the narrative criterion found at 20.6.4.13 NMAC in order to continue making turbidity impairment determinations. Water quality criteria for turbidity and total suspended sediments vary greatly among states. New Mexico is one of many states that do not have numeric criteria for turbidity or total suspended solids (EPA 2006). No other state examples for assessing narrative turbidity criteria in order to determine aquatic life use attainment for the purposes of Clean Water Act §303(d) listings could be found.

There is a recognized relationship between total suspended sediment (TSS) and turbidity in New Mexico (Jessup et. al 2010). New Mexico also has a narrative TSS criterion found at 20.6.4.13.A(2) NMAC. Turbidity and TSS data were collated and examined to determine potential sediment benchmarks or thresholds in New Mexico following EPA's guidance (EPA 2006). Unfortunately, data available at the time were not sufficient for identifying a biologically-based low-flow or high-flow turbidity or TSS threshold using this approach (Jessup et. al 2010). The SWQB hopes to revisit this approach as well as other potential approaches such as Schartz et. al (2008) in the future as resources allow.

The approach described below relies on the use of biotranslators to derive numeric thresholds for New Mexico's narrative turbidity criterion. A biotranslator is most simply obtained in controlled experiments that isolate a physical or chemical water quality parameter and determine a threshold level of that parameter above which a quantifiable attribute of an indicator organism is impaired. This approach has been used with a wide variety of fish species to define lethal doses (LD_{50}) and lethal concentrations (LC_{50}) values that have in turn, been used to establish water quality standards criteria for parameters such as temperature, dissolved oxygen, metals and organic compounds. In turbidity studies, a less well defined endpoint is usually determined based on observations of behavior and the resulting values are referred to as Effect Levels (EL).

To minimize the potential for the effects of bedded sediment to influence turbidity assessment, this protocol will consider primarily those biotranslators which have been developed from experiments on biota that isolated turbidity from other water quality parameters. These experiments used fish because the effects of turbidity in the water column can be observed as changes in feeding, growth, or social interactions. Benthic macroinvertebrate data from turbidity studies that controlled for effects from sedimentation and other parameters were also considered.

Several aquatic life uses, including High Quality Coldwater (HQCW), Coldwater (CW), Marginal Coldwater (MCW), Coolwater, Warmwater, and Marginal Warmwater, are defined in 20.6.4.7 NMAC. The correlation between temperature tolerance and turbidity tolerance is not well documented. Also, there is a wide variation in trophic levels among temperature classes of fish species. A correlation may exist between coldwater species and turbidity tolerance due to the fact that all coldwater species in New Mexico (with the exception of Southern redbelly dace) are salmonids, and salmonids are known to have low turbidity tolerances. A literature search was conducted to find turbidity tolerance biotranslators for fish species native to New Mexico. When data on native species were unavailable, well-established introduced species were considered. Additional, turbidity technical review documents from other western states were also reviewed (OR DEQ 2010).

1.1 Coldwater (including Marginal and High Quality) Species

Most coldwater species in New Mexico are generally considered "sensitive" to items such as increased siltation, temperature, turbidity, or lowered dissolved oxygen (Sublette et al. 1990, Zaroban et al. 1999), and tend to be greatly reduced in association with human disturbance (Karr et al. 1986). The most representative fish to use in determining the appropriate turbidity thresholds for stream segments assigned these aquatic life uses are salmonids. The majority of studies on turbidity in fish have been conducted with salmonids due to their economic importance and relatively low tolerance to elevated turbidity. Data on several species of salmonids indicate that at turbidities in the vicinity of 10 NTUs, reactive distance is halved, and passive feeding is replaced with an active feeding. This turbidity level, if maintained for a sufficient duration, results in impaired growth (Berg and Northcote 1985, Sweka and Hartman 2001, Newcombe 2003). Brown trout, a non-native species, are widespread throughout New Mexico. Reduced feeding was observed in brown trout at 7.5 NTUs (Bachman 1984) indicating that growth could potentially be impaired at lower turbidity levels. This suggests a long duration threshold of <10 NTUs is appropriate for waters with these aquatic life uses. Additional support for a threshold near 10 NTUs is provided in a study of benthic macroinvertebrates above and below clay-laden discharges from placer mines (Quinn et al. 1992). In this study, invertebrate densities were halved at turbidity levels between 0 and 7 NTUs. No physical effects of sediment were found on macroinvertebrates, indicating the observed reductions in densities were due to reduced food production as a result of reduced light transmission.

1.2 Coolwater Species

Smallmouth bass can be considered a coolwater aquatic life species based on temperature needs, and may be a useful indicator of limited to moderate disturbance based on "intermediate tolerance" to influencing variables such as increased siltation, temperature, turbidity, or lowered dissolved oxygen (Zaroban et al. 1999). Changes in smallmouth bass prey selection between round goby, golden shiner, and northern crayfish were noted at various turbidity levels between 0 and 40 NTUs. Although this study was not designed to directly test long-term feeding rates, a correlation revealed a negative relationship between turbidity and feeding rate with a significant difference between 0 and 5 NTUs (Carter et al. 2009).

1.3 Warmwater and Marginal Warmwater Species

Bluegill typically occupy warmwater aquatic life habitat and are native to New Mexico. Bluegill feeding activity was reduced approximately 20% at 60 NTUs relative to clear water conditions (Gardner 1981). A second warmwater species is the Largemouth bass, although this species is not native to New Mexico. No changes in feeding behavior were observed in Largemouth bass exposed to turbidities ranging from 0-37 NTU (Reid et al. 1999), indicating that an upper threshold for warmwater aquatic life habitat should be at least 37 NTUs and possibly higher. Conversely, other native New Mexican warmwater species such as the Sand shiner, Arkansas River shiner, Red shiner and Flathead chub, all showed little or no change in prey consumption rate at turbidities ranging from 0-1,000 NTUs, and prey consumption was enhanced in Arkansas River shiner as turbidity increased from 0-2,000 NTUs (Bonner and Wilde 2002).

2.0 Turbidity Thresholds for Perennial Streams with Coldwater (including Marginal or High Quality Coldwater) Designated Aquatic Life Uses based on Newcombe (2003)

Duration of exposure can vary greatly from study to study, making it difficult to compare results. In order to generate a larger dataset to develop a severity of ill effects (SEV) index that describes the combined effects of turbidity levels and duration of exposure on clear water fishes, Newcombe (2003) used the information cited in some of the above studies as well as others. Turbidity effects considered for the model include fish reactive distance, predator prey dynamics, egg and larval development growth rates, and habitat alteration effects. Newcombe (2003) assigned SEV scores to the results of the studies, and then regressed against water clarity measurements and exposure duration from literature to develop a log-linear regression (OR DEQ 2010).

Newcombe states that only data from fishes with one or more life stages intolerant of cloudy conditions, or those usually found in clear water systems that "…perhaps benefit from seasonal improvements in water clarity…" were available in sufficient quantities to develop the index. Coldwater (i.e., typically pollution sensitive) fishes in New Mexico clearly meet this definition, whereas coolwater fishes cover a wider range of pollution tolerances and there is no direct translation between temperature and turbidity tolerances. Therefore, Newcombe's SEV index is evidently applicable to coldwater aquatic life, including high quality and marginal designated uses. The limited availability of data for coolwater and warmwater fish species native to New Mexico, together with conflicting tolerances and needs for turbidity among species for which data are available, prevents derivation of a suitable biotranslator and SEV index for coolwater and warmwater aquatic life designations. Additionally, this assessment approach derived from the SEV index will not be applied to stream segments that list both a coldwater and a warmwater designated aquatic life use as these dual aquatic life use waters are currently under water quality standards review to determine the most appropriate aquatic life use designation. As resources and research allow, the SWQB hopes to be able to develop assessment approaches for coolwater and warmwater fishes in the future.

An SEV index value of 3.5 was selected to develop thresholds for turbidity assessment in New Mexico. This value corresponds to the boundary between conditions that produce changes in feeding and those that reduce growth rate and habitat size. SWQB's selection an SEV index value of 3.5 balances the potential for both type I and II error with respect to impairment listings, is conservative given the scale provided in Newcombe (2003), and addresses the goal of 20.6.4.13.J NMAC. Aquatic organisms are adapted to episodic disruptions in feeding, especially in southwest streams that experience intense localized precipitation events.

The power relationship between turbidity and duration for a severity index of 3.5 is given in Equation 1:

Equation 1. Relationship of NTUs and allowable duration for SEV = 3.5:

$$x = (37{,}382)*(y^{-1.9887}) \quad \text{or} \quad y = (199.2)*(x^{-0.5028})$$

where x = duration in hours and y = NTUs.

Solving Equation 1 for various NTUs and durations gives a range of turbidity thresholds for clear water fishes (Table 1 contains example values from use of these equations). If the turbidity threshold (y) is exceeded consecutively for more than the allowable duration (x), the water body is considered to have exceeded that particular turbidity threshold. Impairment thresholds were determined with a minimum duration (x) of 72 hours (three days) and a minimum turbidity threshold (y) of 7 NTUs. Sonde data that do not meet this minimum duration cannot be used to make final impairment or de-listing determinations.

Table 1. Turbidity impairment thresholds and durations at which ill effects (SEV = 3.5) are expected to occur in clear water fish, based on Newcombe (2003).

Turbidity Threshold (y) (NTUs)	Allowable Duration (x) (consecutive hours)	Allowable Duration (consecutive days)
23	72[(a)]	3
20	96	4
18	120	5
16	144	6
15	168	7
11	336	14
7	720[(b)]	30

NOTES:
[(a)]Turbidity levels above this duration will certainly impact feeding behavior while turbidity levels for shorter-duration turbidity excursions are unlikely to impair the growth and reproduction of aquatic life as required by New Mexico's narrative turbidity water quality criterion.
[(b)]Thresholds for duration longer than this result in turbidity values lower than supported by the literature review presented in section 1.0.

A graph of the relationship between turbidity and duration for a severity index of 3.5 within the turbidity thresholds in Table 1 is shown in Figure 1.

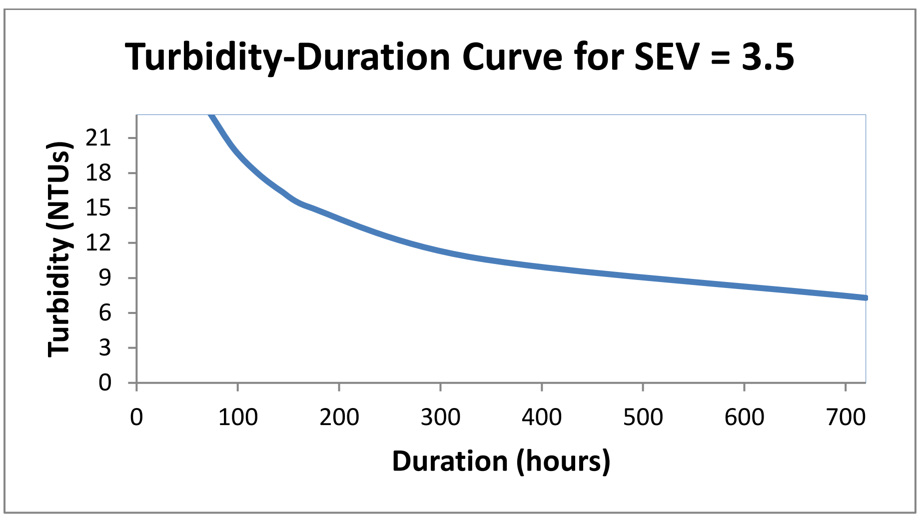

Figure 1. Relationship between turbidity and length of exposure for a SEV index of 3.5 with respect to New Mexico's narrative turbidity criterion, based on Newcombe (2003)

3.0 Assessment Procedure

The first step is to collate available grab and sonde turbidity data (Figure 1). The SWQB collects grab (instantaneous) turbidity measurements roughly once a month during water quality surveys. The SWQB typically deploys sondes for three to seven days set to record at least hourly dissolved oxygen, pH, specific conductance, temperature, and turbidity values. Only valid datasets as determined via application of the SWQB's standard operating procedures (SOPs, available at: https://www.env.nm.gov/swqb/SOP/) and quality assurance project plan (QAPP, available at: https://www.env.nm.gov/swqb/QAPP/) are used for assessment purposes.

<u>Sonde data</u>

If at least 72 hours (3 days) of sonde data are available, the sonde data are evaluated to determine impairment status. The likelihood of capturing high turbidity events increases with increased sonde deployment so longer sonde deployments are encouraged. The data are evaluated against impairment thresholds in Table 1 and attainment status is determined per Table 2 (see also Figure 1). If less than 72 hours of data are available, the data will only be evaluated to determine priority for subsequent sonde deployment. In other words, an impairment determination for turbidity using sonde data are only made if at least three days (≥72 hours) of continuous sonde data are available.

To evaluate a sonde dataset with sufficient data against the impairment thresholds, the maximum value for the entire sonde dataset is first determined. This value is then compared to the threshold associated with the closest duration listed in Table 1 by rounding up. For example, if there are 3.5 days of sonde data available, round up to the 4-day threshold in Table 1. If this impairment threshold is not exceeded, the assessment conclusion is **Full Support**. If this impairment threshold is exceeded, the sonde data are then scanned for consecutive intervals of elevated turbidity (i.e., turbidity values greater than the impairment threshold determined in the above paragraph). If any are found, a turbidity value is chosen that is just below the lowest measured value from the interval under consideration and Equation 1 is used to determine the allowable duration. If the consecutive turbidity readings last for a period exceeding the calculated allowable duration, the threshold has been exceeded and the conclusion is **Non Support**. Below are three examples. See also Figure 1:

> **<u>Example 1</u>**: The maximum value for a 7-day sonde deployment at a particular water quality station is 10.6 NTU. The impairment threshold of 15 NTU was not exceeded, as well as none of the shorter-duration thresholds in Table 1 because these thresholds are all greater than 15 NTUs. Therefore, the impairment conclusion is **Full Support**.
>
> **<u>Example 2</u>**: The maximum value for a 6-day sonde deployment at different water quality station is 36.0 NTU. This exceeds the 6-day threshold of 16 NTU, so the sonde data were then scanned for consecutive intervals of elevated turbidity greater than 16 NTU. An interval with turbidity values from 30.5 to 36.0 NTUs was found that lasted for 48 hours. Therefore, 30 NTUs was plugged into Equation 1 to determine the allowable duration of 43 hours. The consecutive elevated turbidity readings lasted 48 hours, which exceeded the calculated allowable duration, so the impairment conclusion is **Non Support**.
>
> **<u>Example 3</u>**: The scenario is the same as Example 2 above, but the elevated period only lasted for 12 hours. This does not exceed the calculated allowed duration of 43 hours, so the impairment conclusion is **Full Support**.

Grab data

If less than 72 hours of sonde data are available, grab data may be evaluated to determine either **Full Support** or to prioritize future sonde deployments. Only grab data collected during non-flood flows (i.e., generally under snowmelt or baseflow conditions) will be used. All flood flow samples (i.e., high flow in response to recent precipitation) will be removed from the dataset prior to assessment. This may be determined by either a corresponding flow condition rating of 2 or 3 as recorded on the SWQB Field Sampling Form or by analysis of available quantitative flow data. If there are at least four data points collected that are at least 21 days apart (to ensure temporal independence of the grab data), and all values are below the minimum impairment threshold of 7 NTU, the assessment unit (i.e., stream reach) will be determined to be **Full Support** for turbidity. If one or more data points exceed 7 NTU, the assessment unit will be prioritized for sonde deployment.

Table 2. Assessing turbidity data to determine HQCW, CW, or MCW Aquatic Life Use Support^

TYPE OF DATA	FULL SUPPORT	NON SUPPORT	NOTES
If sonde data are available			
STEP 1: Sonde Data[(a)]			
A) ≥ 72 hours (3 days) of data	**A)** No sonde data exceed impairment thresholds in Table 1 (Equation 1).	**A)** One or more data exceed impairment thresholds in Table 1 (Equation 1).	* If there are not enough sonde data to assess, move on to **Step 2**. If available sonde data exceed any impairment threshold(s), site will be prioritized for future minimum three-day (72 hour) sonde deployment.
B) < 72 hours (3 days) of data	**B)** Not Assessed*	**B)** Not Assessed*	
If <72 hours of sonde data			
STEP 2: Grab Data			
C) ≥ 4 samples and data ≥ 21-days apart	**C)** No measurements greater than 7 NTU.	**C)** Not Assessed**	** If available grab data exceed 7 NTU, site will be prioritized for future minimum three-day (72 hour) sonde deployment.
D) < 4 samples or data < 21-days apart	**D)** Not Assessed**	**D)** Not Assessed**	

NOTES: [(a)] As stated in Section 2.0, this assessment approach derived from the SEV index will not be applied to stream segments that list both a coldwater and a warmwater designated aquatic life use.

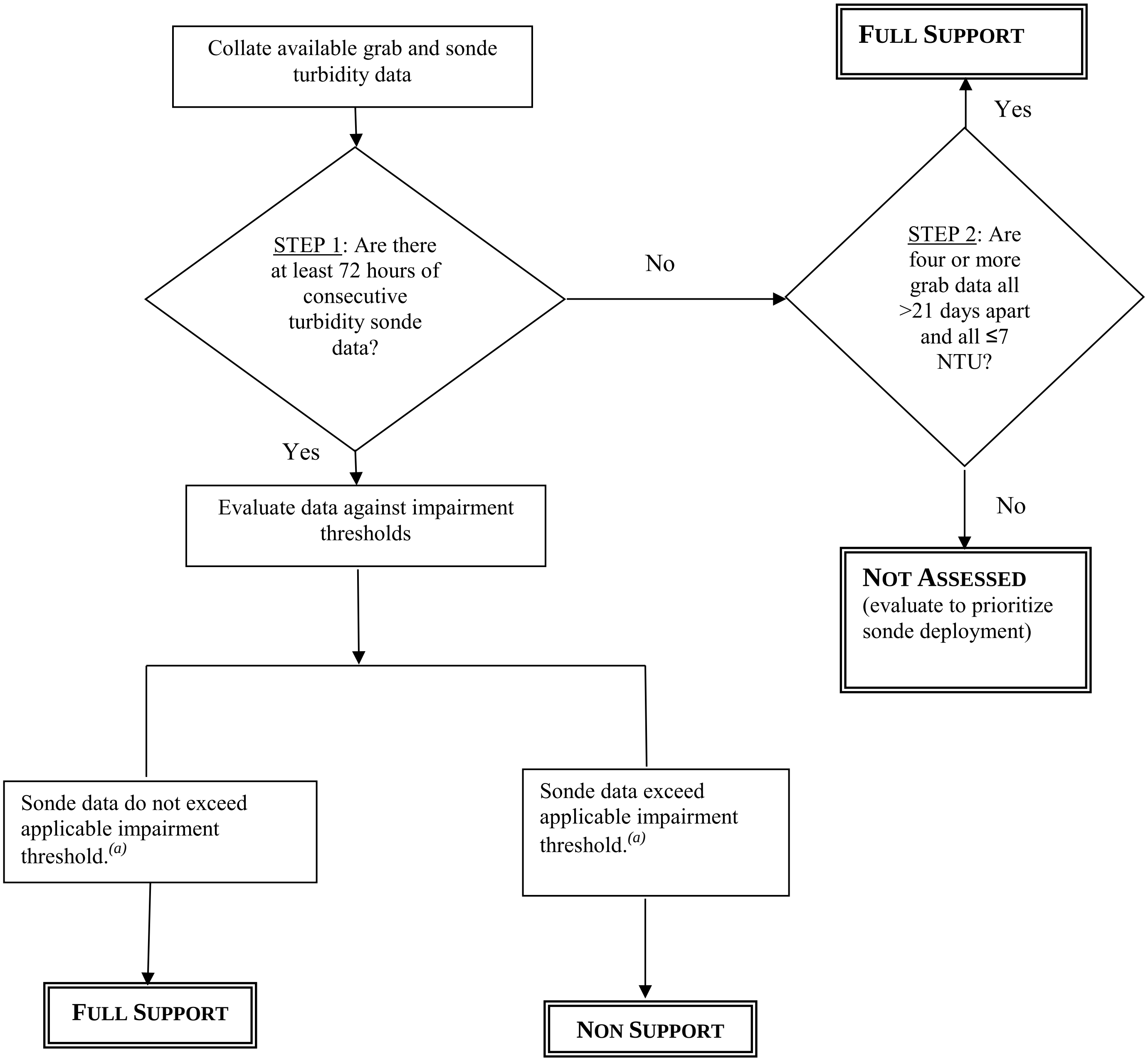

Figure 1. Generalized flowchart for determining turbidity attainment status

NOTES: [a] As determined by Equation 1 and Table 1.

REVSION HISTORY:

2012 listing cycle – Initial protocol using SEV translator approach.

2014 listing cycle – Removed application to coolwater aquatic life. Minor clarifications and re-organization.

2016 listing cycle – Minor clarifications/revisions. Added history of NM's turbidity and TSS criteria, and Tetra Tech analyses based on EPA's suspended and bedded sediments (SABS) guidance.

2018 listing cycle – "Assessment Protocol" changed to "Listing Methodology." Clarified that < 72 hours of sonde data cannot be used to make final impairment or de-listing determinations.

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APPENDIX I

PROCEDURE FOR CWA §303(D) /§305(B) INTEGRATED LIST CATEGORY 4B (NO TMDL REQUIRED) REQUESTS DEVELOPED BY THIRD PARTIES

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JUNE 14, 2017

Purpose

The New Mexico Environment Department Surface Water Quality Bureau (SWQB) has prepared this guidance document to assist stakeholders interested in submitting a justification for an Integrated Reporting Category 4b determination for an impaired assessment unit. Interested stakeholders are encouraged to first read through this document and then contact the SWQB to discuss the potential Category 4b requests prior to development of the submittal. The SWQB follows the same process when developing IR Category 4b demonstrations.

1.0 Introduction / Background

The State of New Mexico Clean Water Act (CWA) §303(d)/ §305(b) Integrated Report (IR) satisfies the statutory requirements of §§ 303(d), 305(b), and 314 of the federal Water Pollution Control Act [33 U.S.C. §§ 1251-1376 (2006)]. The IR also conveys basic information on water quality and water pollution control programs in New Mexico to the United States Environmental Protection Agency (EPA) and the United States Congress, as well as to the general public. The IR is first approved by the New Mexico Water Quality Control Commission (WQCC) and then submitted to EPA Region 6 by April 1 of every even numbered year.

The core of the IR is the CWA §303(d)/ §305(b) Integrated List. In accordance with EPA integrated listing guidance, New Mexico first determines Fully Supporting, Not Supporting, and Not Assessed for each individual designated use to then assign an IR category to every assessment unit (i.e., waterbody) on the Integrated List (USEPA 2001). IR determination is explained in Figure 1.

Assessment units that are assigned Category 5 constitute New Mexico's CWA §303(d) List of Impaired Waters. Section 303(d) and supporting regulations require states to develop a total maximum daily load (TMDL) for each impaired assessment unit-pollutant combination in IR Category 5. New Mexico further subdivides IR Category 5 to indicate whether 1) a TMDL should be developed as soon as possible (IR Category 5a), 2) the impaired waterbody needs to be evaluated to determine if changes to the standard may be appropriate (IR Category 5b), or 3) more data collection is necessary to complete and confirm the impairment (IR Category 5c). TMDLs establish pollution reduction goals and load allocations necessary for an impaired water to attain applicable water quality standards.

EPA regulations recognize that alternative pollution control requirements that are stringent enough, in place, and monitored may make the development of a TMDL unnecessary because both mechanisms would essentially achieve the same surface water quality goal. Specifically, TMDLs are not required if technology-based effluent limitations, more stringent effluent limitations, or other pollution control requirements (*e.g.*, best management practices) required by local, State, or Federal authority are stringent enough to implement an applicable water quality standard (WQS) (see 40 CFR 130.7(b)(1)) within a reasonable period of time.

If there is adequate information provided to ensure that pollution control requirements other than TMDLs are stringent enough to achieve an applicable water quality standard, these assessment unit-pollutant combinations may be assigned Category 4b on the Integrated List instead of

Category 5. Assessment units – pollutant combinations assigned Category 4b do not require TMDL development.

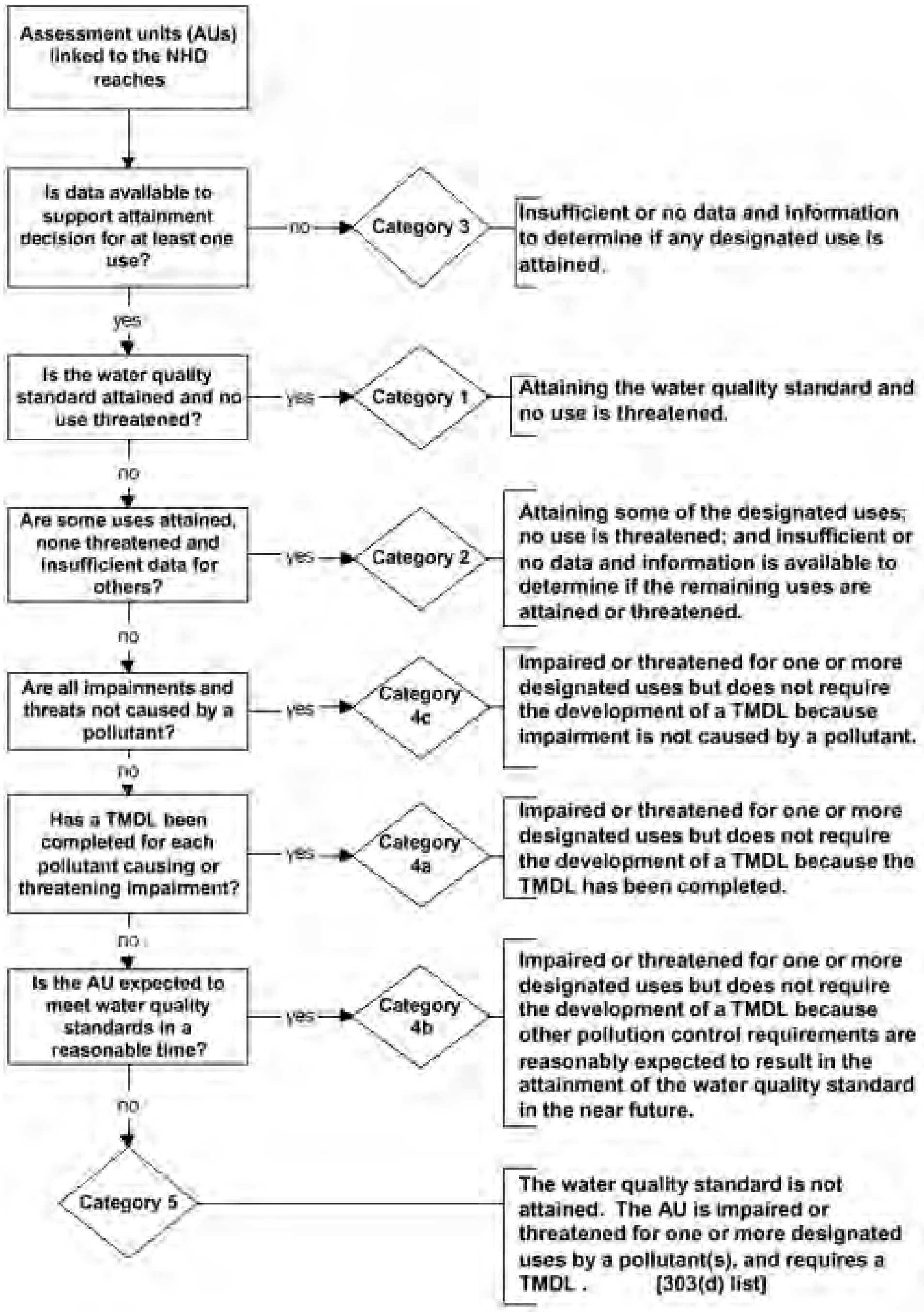

Figure 1. Generalized summary of logic for IR attainment categories (USEPA 2001)

In addition, States have the opportunity to assign impaired waters to IR Category 4b where controls sufficient to achieve water quality standards in a reasonable period of time are already in place. Specifically, controls relied on for IR Category 4b demonstrations do not always need to occur pursuant to binding legal authority (USEPA 2006). States may choose to rely on controls that have already been implemented where there is sufficient certainty that implementation will continue until WQS are achieved and will not be reversed. Because the controls are already in place and achieving progress, EPA may consider such controls to be requirements even if their implementation did not occur pursuant to a specific binding legal authority (USEPA 2006).

Watershed-based plans are also amenable to IR Category 4b provided they address the six IR Category 4b elements outlined in the 2006 IR guidance (USEPA 2005) as well as the nine elements outlined in national non-point source program guidance (USEPA 2013) for an acceptable watershed-based plan to address NPS (USEPA 2007, 2008). For an example of this scenario, see Texas' Plum Creek Watershed Protection Plan (PCWP 2008).

In New Mexico, the IR and TMDL documents are both incorporated into the Water Quality Management Plan and Continuing Planning Process (WQMP-CPP) by reference (NMWQCC 2011). As IR Category 4b demonstrations are part of the IR via their inclusion on the §303(d)/ §305(b) Integrated List (Appendix A of the IR), SWQB views these documents as part of the New Mexico WQMP-CPP. As such, IR Category 4b demonstrations and TMDLs have equal standing for EPA's development of NPDES permits as well as State Certification under §401 of the Clean Water Act (40 CFR 124.53(e)(1)). SWQB has renamed the TMDL webpage at to "List of TMDLs and TMDL Alternatives (IR Category 4b)" to draw attention to and create easy access to Category 4b demonstrations currently approved by the WQCC and the EPA: https://www.env.nm.gov/swqb/TMDL/List/.

2.0 Procedure

2.1 Required Documentation

New Mexico must submit any Category 4b demonstrations with their IR submission, and must work closely with EPA Region 6 to ensure that Category 4b demonstrations are adequate to support the decision not to include these impaired waters on the state´s § 303(d) list. The six required elements include:

1. Identification of assessment unit and statement of problem causing the impairment;
2. Description of pollution controls and how they will achieve water quality standards;
3. An estimate or projection of the time when WQS will be met;
4. Schedule for implementing pollution controls;
5. Monitoring plan to track effectiveness of pollution controls; and
6. Commitment to revise pollution controls, as necessary.

Attachment A describes in more detail the core information that must be submitted to SWQB and EPA Region 6 to support placing an assessment unit in Category 4b. The EPA has compiled a list of examples by control mechanism and pollutants of concern (Monschein and Reems 2009). EPA Region 6 may require additional information in order to demonstrate good cause not to include those assessment units on the list (40 CFR 130.7(b)(6)(iv)).

2.2 Process and Timeline

In New Mexico, the SWQB is responsible for developing and submitting the Integrated List by April 1 every even-numbered year. Stakeholders, including public or private agencies, institutions, or organizations, may request that the SWQB consider an impaired water for Category 4b provided they follow this procedure. The level of rigor necessary to support a Category 4b determination will vary depending on the complexity of the impairments and corresponding implementation strategies. Therefore, close and early coordination between first the SWQB and the submitter, and then the SWQB and EPA Region 6 will promote development and timely review of Category 4b demonstrations that successfully address each of the six elements detailed in Attachment A. The specific process and timeline for Category 4b requests is as follows:

1. To be considered in time for the next Integrated List, complete Category 4b requests should be submitted to SWQB by July 1 of odd-numbered years. This deadline is necessary to allow adequate time for SWQB/EPA Region 6 review, consultation, and revision (as needed) prior to public noticing of the draft Integrated List, which typically occurs in December of odd-numbered years.
2. The proposed Category 4b request must address the six elements detailed in Attachment A of this procedure.
3. SWQB will make the final decision regarding whether or not the Category 4b demonstration will be submitted as part of the draft Integrated List to EPA Region 6 following review and discussion of the request with the submitter to ensure the appropriateness and adequacy of the request.
4. The Category 4b demonstration must be a stand-alone document that will be available to the public during the public comment period for the entire Integrated List. The public should also be able to access supporting documentation via web links or other means.
5. The Category 4b request will be included as part of the draft Integrated List presentation to the New Mexico WQCC. If SWQB believes the Category 4b request may be contentious, SWQB may provide the Category 4b information to the WQCC earlier than this time for a separate discussion as to not hold up approval of the rest of the draft Integrated List.
6. Upon approval by the WQCC, the entire Integrated List, including Category 4b demonstrations and other supporting documentation, will be submitted to EPA for review. While reviewing the § 303(d) portion of the submitted list for approval (i.e., IR Category 5 waters), the EPA Region 6 evaluates the state's decision to place any impaired assessment unit-pollutant combinations in Category 4b since this is a removal of an impairment from the § 303(d) portion of the Integrated List, and will make the final determination of this action. Final Category 4b demonstrations will be posted to SWQB's Integrated List website.
7. For any Category 4b assessment unit – pollutant pair, a progress report must be submitted to SWQB no later than July 1 of every odd-numbered year until the assessment unit is removed from Category 4b. In order to continue placing an assessment unit-pollutant pair in Category 4b, the progress report must demonstrate that the six elements are still addressed and that adequate progress is being made towards the goal of water quality standard attainment. The SWQB

TMDL and Assessment Team will consult with EPA Region 6 to make this determination.

8. If the water quality standards are eventually attained according to the assessment of available data in accordance with New Mexico's most recent listing methodology, the assessment unit-pollutant pair can be removed from Category 4b and assigned either Category 1 or 2 accordingly. In addition, an assessment unit can be moved from Category 4b to Category 5 if the original Category 4b determination can no longer be supported.

REVISION HISTORY:

2014 cycle – Original.

2016 cycle – Minor revisions, reference additions, and clarification of EPA review process as well as NPDES permit ramifications related to IR Category 5 versus 4b. Changed IR Category 4b demonstration and progress report deadline from May 1 to July 1.

2018 cycle – "Assessment protocol" changed to "listing methodology.

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Attachment A

REQUIRED ELEMENTS FOR CATEGORY 4B DEMONSTRATIONS

The following list of required elements is taken largely from EPA's 2008 IR guidance (USEPA 2006). It provides a structure for submitting all the information the SWQB and EPA will need in order to determine if Category 4b is the correct determination.

All requests for Category 4b determinations on New Mexico's Integrated List must include the following six elements:

1. Identification of assessment unit and statement of problem causing the impairment;
2. Description of pollution controls and how they will achieve water quality standards;
3. An estimate or projection of the time when WQS will be met;
4. Schedule for implementing pollution controls;
5. Monitoring plan to track effectiveness of pollution controls; and
6. Commitment to revise pollution controls, as necessary.

Additional details for each of the six elements are provided below.

Category 4b demonstrations should be submitted as a stand-alone document. In situations where data and information for a Category 4b demonstration are contained in existing documents developed under separate programs (e.g., NPDES permit, Superfund Record of Decision), summarize relevant information in the Category 4b demonstration and reference the appropriate supporting documentation that provides that information. The supporting documentation should be included as part of the State's administrative record supporting the Category 4b determination.

1. Identification of Assessment unit and Statement of Problem Causing Impairment

1.1 Assessment Unit Description

The demonstration should identify the impaired assessment unit, including name, general location in the State, and State-specific location identifier (i.e., AU_ID).

1.2 Impairment and pollutant causing impairment

The demonstration should identify the applicable water quality standard(s) not supported for each assessment unit and associated pollutant causing the impairment.

1.3 Sources of pollutant causing impairment

The demonstration should include a description of the known and likely point, nonpoint, and background (upstream inputs) sources of the pollutant causing the impairment, including the potential magnitude and locations of the sources. In cases where some portion of the impairment may result from naturally occurring sources (natural background), the demonstration should include a description of the naturally occurring sources of the pollutant to the impaired assessment unit.

2. Description of Pollution Controls and How They Will Achieve Water Quality Standards

2.1 Water quality target

The demonstration should identify a numeric water quality target(s), which is a quantitative value used to measure whether or not the applicable water quality standard is attained. Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical contained in the water quality standard. The demonstration should express the relationship between any necessary reduction of the pollutant of concern and the attainment of the numeric water quality target.

In cases where the impairment is based on non-attainment of a narrative (non-numeric) water quality criterion, the Category 4b demonstration should identify one or more appropriate numeric water quality target levels or translators that will be used to evaluate attainment of the narrative water quality criteria. The Category 4b demonstration should also describe the basis for selecting these surrogates.

2.2 Point and nonpoint source loadings that when implemented will achieve WQS

The demonstration should describe the cause-and-effect relationship between the water quality standard (and numeric water quality target as discussed above) and the identified pollutant sources and, based on this linkage, identify what loadings are acceptable to achieve the water quality standard. The cause-and-effect relationship may be used to determine the loading capacity of the assessment unit for the pollutant of concern. However, a loading capacity may not be relevant in all circumstances. For example, a loading capacity would not be relevant in situations where the pollutant source will be completely removed. The demonstration should identify the loading capacity of the assessment unit for the applicable pollutant or describe why determination of the loading capacity is not relevant to ensure that the controls are sufficient to meet applicable water quality standards.

The demonstration should also contain or reference documentation supporting the analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling or data analysis.

2.3 Controls that will achieve WQS

The demonstration should describe the controls already in place, or scheduled for implementation, that will result in reductions of pollutant loadings to a level that achieves the numeric water quality standard. The demonstration should also describe the basis upon which the State concludes that the controls will result in the necessary reductions.

2.4 Description of requirements under which pollution controls will be implemented

The demonstration should describe the basis for concluding that the pollution controls are requirements or why other types of controls already in place may be sufficient, as discussed below.

As discussed in the 2006 IR guidance (USEPA 2005), EPA will consider a number of factors in evaluating whether a particular set of pollution controls are in fact "requirements" as specified in EPA´s regulations, including: (1) authority (local, state, federal) under which the controls are required and will be implemented with respect to sources contributing to the water quality impairment (examples may include: self-executing State or local regulations, permits, and contracts and grant/funding agreements that require implementation of necessary controls); (2) existing commitments made by the sources to implement the controls (including an analysis of the amount of actual implementation that has already occurred); (3) availability of dedicated funding for the implementation of the controls; and (4) other relevant factors as determined by EPA depending on case-specific circumstances.

Since the overriding objective of the IR Category 4b alternative is to promote implementation activities designed to achieve water quality standards in a reasonable period of time, for all of the factors listed above, EPA will evaluate each IR Category 4b alternative on a case-by-case basis, including in particular the existence of identifiable consequences for the failure to implement the proposed pollution controls. Depending on the specific situation, "other pollution control requirements" may be requirements other than those based on statutory or regulatory provisions, as long as some combination of the factors listed above are present and will lead to achievement of WQS within a reasonable period of time. For example, established plans of government agencies that require attainment of WQS within a reasonable period of time may qualify even when their components include incentive-based actions by private parties. States may also choose to rely on controls that have already been implemented where there is sufficient certainty that implementation will continue until WQS are achieved and will not be reversed. Because the controls are already in place and achieving progress, EPA may consider such controls to be requirements even if their implementation did not occur pursuant to binding legal authority.

3. Estimate or Projection of Time When WQS Will Be Met

EPA expects that assessment units impaired by a pollutant but not listed under § 303(d) based on the implementation of existing control requirements will attain WQS within a reasonable period of time. The demonstration should provide a time estimate by which the controls will result in WQS attainment, including an explanation of the basis for the conclusion.

The demonstration should also describe why the time estimate for the controls to achieve WQS is reasonable. EPA will evaluate on a case-specific basis whether the estimated time for WQS attainment is reasonable. What constitutes a "reasonable time" will vary depending on factors such as the initial severity of the impairment, the cause of the impairment (*e.g.*, point source discharges, in place sediment fluxes, atmospheric deposition, nonpoint source runoff), riparian condition, channel condition, the nature and behavior of the specific pollutant (*e.g.*, conservative, reactive), the size and complexity of the assessment unit (*e.g.*, a simple first-order stream, a large thermally stratified lake, a density-stratified estuary, and tidally influenced coastal assessment unit), the nature of the control action, cost, public interest, etc.

4. Schedule for Implementing Pollution Controls

The demonstration should describe, as appropriate, the schedule by which the pollution controls will be implemented and/or which controls are already in place.

5. Monitoring Plan to Track Effectiveness of Pollution Controls

The demonstration should include a description of, and schedule for, monitoring milestones to track effectiveness of the pollution controls. The demonstration should describe water quality monitoring that will be performed to determine the combined effectiveness of the pollution controls on ambient water quality. If additional monitoring will be conducted to evaluate the effectiveness of individual pollution controls, EPA encourages States to include a description of these efforts as well. The demonstration should identify how and when assessment results from the monitoring will be reported to the public and EPA.

6. Commitment to Revise Pollution Controls, as Necessary

The demonstration should provide a statement that the State commits to revising the pollution controls, as necessary, if progress towards meeting water quality standards is not being shown. Also, the demonstration should identify how any changes to the pollution controls, and any other element of the original demonstration, will be reported to the public and EPA.