PROCEDURES FOR ASSESSING USE ATTAINMENT FOR THE STATE OF NEW MEXICO INTEGRATED CLEAN WATER ACT §303(d) /§305(b) WATER QUALITY MONITORING AND ASSESSMENT REPORT:

ASSESSMENT PROTOCOL

NOTE: This version includes the April 8, 2008, addendum in Track Changes

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

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1.0 ASSESSMENT PROCESS OVERVIEW

Pursuant to Section 106(e)(1) of the federal Clean Water Act (CWA), the Surface Water Quality Bureau (SWQB) has established appropriate monitoring methods (NMED/SWQB 2007a), quality assurance/ quality control (QA/QC) procedures (NMED/SWQB 2007b), and assessment methodologies in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the *New Mexico Water Quality Act* (NMSA 1978), the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the State (NMED/SWQB 2005). 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 to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments.

From approximately 1998 to 2007, 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 intensively monitored each year with an established return frequency of approximately eight years. Revisions to the schedule may be occasionally 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 intensive sampling. The rotating basin program will be supplemented with other data collection efforts such as the funding of long-term United States Geological Survey (USGS) water quality gaging stations for long-term trend data.

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 certified annually by United States Environmental Protection Agency (USEPA) Region 6 (NMED/SWQB 2007b). When an intensive survey is completed, all data are checked against QA/QC measures identified in the QAPP and assessed to determine whether or not designated uses detailed in the current *State of New Mexico Standards of Interstate and Intrastate Surface Waters* (NMWQCC 2007) are being met. In New Mexico, surface water data are assessed according to this document -- *Procedures of Assessing Standards Attainment for the State of New Mexico Clean Water Act Integrated §303(d) /§305(b) Water Quality Monitoring and Assessment Report* (otherwise known as the “assessment protocol”). The results are then made available to the public through the *State of New Mexico Clean Water Act Integrated §303(d) /§305(b) Water Quality Monitoring and Assessment Report* (otherwise known as the “Integrated Report”). The Integrated List which details individual water bodies can be found in Appendix B of the Integrated Report. The purpose of this document is to detail the decision process that the SWQB employs to determine whether or not designated uses are being attained in surface waters of the state. Therefore, these protocols cover the decision making process for both listing and de-listing.

USEPA does not officially approve individual state’s assessment protocols, but USEPA does provide review and comment on the protocols, and consults the protocols when reviewing the state’s draft Integrated List. The assessment protocol is periodically updated and is generally based on current USEPA assessment guidance (USEPA 2005, 2006). For development of the 2008 Integrated Report and List, USEPA recommends that states follow the 2006 Integrated Report guidance (USEPA 2005) as supplemented with the memorandum regarding development of the 2008 Integrated List and Report (USEPA 2006).

Similar to other states, summary assessment data are housed in the USEPA-developed Assessment Database version 2.1.4 (ADB v.2.1.4) by “assessment unit” (WERF 2007). USEPA first suggested the use of this term in their 2002 listing guidance (USEPA 2001). This term is also utilized in ADB. USEPA listing guidance documents recommend that states organize their respective lists by assessment units and house the information in ADB (USEPA 2001, 2003, 2005, 2006). Assessment units can represent a single lake or reservoir, or several miles of a stream reach or river. Assessment units are designed to represent 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 20.6.4.6.ZZ NMAC. In New Mexico, there is generally a one-to-many relationship between the term water quality standard segment (20.6.4.97 through 20.6.4.899 NMAC) and assessment unit.

Use attainment decisions are then summarized by assessment unit in the *State of New Mexico Integrated CWA §303(d)/ §305(b) Report*. This report is prepared every even numbered calendar year as required by the CWA. Category 5 assessment units on this Integrated List (see Section 4.0 for category definitions) constitute the *CWA §303(d) List of Impaired Waters*. The Integrated List portion of the Integrated Report is opened for a minimum 30-day public comment period. Response to Comments are prepared by SWQB and submitted to USEPA Region 6 for review. SWQB also updates and submits the Record of Decision (ROD) document. The ROD is an additional, non-required document that SWQB provides to USEPA and the public, which explains why and when a particular assessment unit (AU), was added to and, if applicable, why and when it was removed from Category 5 of the Integrated List. An outline of the basic assessment process that SWQB Project Leaders and the Assessment Coordinator follow when performing assessments is contained in Appendix B. All the above-mentioned documents developed and maintained by the SWQB are available on the SWQB web page: http://www.nmenv.state.nm.us/swqb/swqb.

Assessment of monitoring data form the basis of designated use support decisions. These assessments are based on data that reasonably reflect current ambient surface water quality conditions. These data are compared to current USEPA-approved water quality standards (WQS) for the state of New Mexico (20.6.4 NMAC) regardless of what WQS were in effect at the actual time of sampling. Since 1998, SWQB has intensively surveyed watersheds in the state on an approximately 8-year rotational basis. Data types may include chemical/physical, biological, habitat, bacteriological, or toxicological data. In general, data collected by SWQB during these intensive water quality surveys is combined with all readily available data collected during the same reporting cycle by other entities partially listed below, provided the organization's sampling methods and data analysis procedures meet state QA/QC requirements as detailed in the most recent QAPP. This collated data set forms the basis of impairment decisions.

Additional current data will be considered in the analysis, particularly available data from the critical condition of the individual parameter of concern, because the CWA requires water quality standards be protective of designated uses during critical conditions such as years with below average stream flow. This distinction is important to mention because it would not meet 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 indicates impairment. Similar to most states (WERF 2007), SWQB only uses data collected in the most recent five years prior to the listing cycle for which it was assessed. Additional data between 5 and 10 years old may also be considered for large mainstem rivers, such as the San Juan River, Rio Grande, and Pecos River (which tend to have greater amounts of outside data) so that the entire range of hydrologic conditions can be examined. Recent data take precedence over older data if new data indicate a change to water quality or the older data fail to meet data quality requirements. If several consecutive years of data are available and the most recent data are less than applicable numeric water quality criteria, SWQB may also consider data trends when determining impairment if the data indicate a clear pattern of recovery after a temporary disturbance. This is consistent with recommendations in USEPA guidance (USEPA 2005).

Outside sources of available data are solicited via public notice of a minimum 30-day period before the draft Integrated List of surface waters is prepared. To be considered for development of the Integrated List, data must, at a minimum, meet the QA/QC requirements described in the SWQB's most recent QAPP, with particular emphasis on ensuring that the analytical methods used meet the requirements specified in the analytical methods section of the QAPP, that the methods of data collection were the same as or comparable to those included in the state's Standard Operating Procedures (SOPs) referenced throughout this QAPP, and that the QC criteria used to verify and validate the data were the same or similar to those listed in the SWQB Field Quality Control Sampling Summary and the SWQB Data Verification and Validation Procedures detailed in the QAPP. Quality data 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 of lesser quality may be used for screening purposes. Other water quality data collected (e.g., habitat conditions, field observations, macroinvertebrate, fish communities) 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:

- NMED SWQB chemical/physical, biological, habitat, bacteriological, or toxicological monitoring data collected during intensive watershed surveys using approved or otherwise accepted quantitative methods;

- Chemical/physical data from recent studies by NMED or other organizations, contractors, or individuals;

- USGS water quality data that has met USGS QA/QC requirements (i.e., provisional data shall not be used to make designated use support determinations);

- Benthic macroinvertebrate, fish community, and/or fish tissue data collected by NMED or other organizations, contractors, or individuals;

- EPA-recognized protocols such as Environmental Monitoring and Assessment Program (EMAP), Rapid Bioassessment Protocols (RBP), or other biological/habitat data collected by NMED and other organizations, contractors, or individuals that meets QA/QC requirements;

- National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Report (DMR) data and in-stream monitoring data collected during NMED effluent monitoring efforts;

- NPDES storm water permit compliance monitoring data;

- In-stream water quality data from other NMED bureaus such as the Drinking Water, Ground Water, and/or the Department of Energy (DOE) Oversite bureaus;

- Citizen or volunteer monitoring data that meet the above QA/QC requirements.

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2.0 DATA USABILITY AND QUALITY DETERMINATIONS

2.1 Data Management Rules

2.1.1 Data qualifiers and validation codes

SWQB has developed an in-house water quality database to house ambient chemical water, sediment, and fish tissue data as it is collected in the field and/or received from the State Laboratory Division (SLD) or contract laboratories. This database also contains lab data qualifiers as well as internal validation codes that are added during the data validation process (NMED/SWQB 2007a). Chemical/physical data collected by SWQB are eventually uploaded to the national STORET, soon to be replaced by USEPA's WQX database. The current version of STORET does not have a standard lab remark code field. Per suggestion of the STORET user's group, SWQB has put user-defined information on data qualifiers and internal validation codes into STORET/WQX field entitled "Results Comments." Any data with a qualifier code or data validation code that is used in an assessment should be noted. Refer to the current version of the QAPP for the current definition of all data qualifier and data validation codes as they periodically may change.

- Qualifier codes (lab) – In the past, sets of qualifier codes have varied between the individual sections at State Laboratory Division (SLD) and these codes have changed between years. 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 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.

  There are instances when a statistic such as a mean must be calculated to determine impairment according to a specific assessment procedure. In these cases when there are values reported as "less than" a quantification limit, the Kaplan-Meier method (Helsel 2005) should be used to calculate descriptive statistics such as the mean, median, or percentile. Concentrations detected below the quantification limit but above the method detection limit (MDL) are typically flagged with a "J" qualifier that indicates the reported concentration is an estimated concentration. The concentration is reported as estimated because the concentration being detected is below the lowest concentration on the calibration curve. There is certainty as to the identification of the chemical but uncertainty as to the reported concentration. These values may be used in an assessment.

  Results from samples that are flagged by the laboratory as "exceeded holding time" will be considered estimates and will be used during the assessment process unless the result is deemed "rejected" based on best professional judgment. Method holding times are different for different sample parameters. 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 (for example, 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 (USEPA 2002d). From USEPA'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 (USEPA 2002e). Therefore, data exceeding holding time may be considered for use in assessments.

- Data validation codes (internal) – SWQB validates data after all data for a particular intensive water quality survey are received from SLD. 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 R, R1, R2, R3, or R4).

2.1.2 Duplicates and compliance monitoring sampling data

There may be cases where there are multiple data values on the same day. For example, compliance monitoring of human health criteria requires that three samples be consecutively collected (separated by at least 15 minutes) during the same sampling event at the same location (NMED/SWQB 2003 Work Element 10). Results that indicate two or three exceedences of data taken in this manner will be counted as one exceedence of the criterion for use attainability determinations.

2.1.3 Continuous recording equipment (thermographs and sondes)

Prior to 1998, water temperature was measured once during each site visit and designated use support status related to temperature criteria was determined by applying a percent-of-exceedences formula to these instantaneous temperature data. Periodic instantaneous temperature data do not provide information on maximum daily temperatures, duration of excessive temperatures, or the diurnal and seasonal fluctuations of water temperature. These aspects of temperature are pertinent to aquatic life use. Continuously recording temperature data loggers (i.e., thermographs) are now readily available and provide an extensive multiple-day record of hourly temperatures over the critical time period when temperatures are generally highest.

The SWQB has been deploying thermographs and applying the temperature assessment protocol since the 2000-2002 CWA §303(d) listing cycle (see Appendix C). This protocol, specific to high quality coldwater aquatic life (HQCWAL) and coldwater aquatic life (CWAL) categories, was developed by a multi-agency workgroup. It is more technically sound than simply applying percentages to limited instantaneous temperature data and better incorporate magnitude and duration concerns into water quality monitoring, assessment, and standards development. This protocol eliminates the biases introduced when using instantaneous data to assess water quality parameters with significant diurnal fluctuation. Based on the success of this effort, the SWQB has developed additional large data set protocols to address other parameters with known diurnal fluxes, such as pH and dissolved oxygen (see Appendices F and G). These protocols are used to assess pH and dissolved oxygen data for potential impairment when large data sets are available through the use of multi-parameter, continuously recording devices (i.e., sondes). SWQB typically deploys sondes for seven days and set to record hourly dissolved oxygen, pH, specific conductance, temperature, and turbidity values.

If sonde or thermograph data are not available, and to determine temperature impairment for marginal coldwater and warmwater aquatic life uses, the methods detailed in Table 3.4 are applied to determine impairment. SWQB is in the process of reconvening a multi-agency workgroup to develop appropriate temperature assessment protocols for non HCWAL and CWAL uses.

2.1.4 Limited data sets

While SWQB practice does not require a specific minimum sample size to make use attainment decisions, a minimum of two data points for field and chemical parameters is necessary to apply the procedures in Section 3.0 of this protocol. Through the current rotating watershed survey strategy, SWQB strives for a minimum of eight chemical data points for core parameters such as metals and nutrients to make designated use determinations. SWQB also use thermographs and multi-parameter sondes as stated above to generate large data sets for temperature, pH, dissolved oxygen, specific conductance, and turbidity. USEPA does not recommend the use of rigid, across the board, minimum sample size requirements in the assessment process. Target sample sizes should not be applied in an assessment methodology as absolute exclusionary rules (USEPA 2003, 2005). The use of limited data sets is acceptable to USEPA and commonly used in other states as limited financial resources, and both limited field and laboratory staff resources, often dictate the number of samples that can be collected and analyzed (USEPA 2002a). In New Mexico, SWQB is allocated a specific number of work time units (referred to as "WTUs") from the State Laboratory Division (SLD) each year which cover the costs of chemical analyses. SLD performs the vast majority of chemical analyses for SWQB. SLD supports several state agencies and therefore has a limited capacity to fulfill water and soil analyses. Therefore, factors such as laboratory capacity, and SWQB staff and financial resources (for items such as field supplies and travel expenses) result in limited sample size.

2.1.5 Application of WQS during low flow conditions

Data collected during all flow conditions, including low flow conditions (i.e., flows below the 4Q3), will be used to determine designated use attainment status during the assessment process. 4Q3 values are to be utilized as minimum dilution assumptions for developing discharge permit effluent limitations. In terms of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions, unless a flow qualifier is specified in a particular section of the WQS rule. The intent of the CWA would not be met if some entity would suddenly, for example, be allowed to dump pollutants into a stream in violation of a WQS simply because the stream was currently below some pre-established low flow value.

2.1.6 Assessing chronic aquatic life WQS when composite data are unavailable

During the 2000 and 2001 SWQB intensive watershed surveys, the sampling regime 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 survey, the sampling regime was adjusted to sample once per month over an eight-month period in order to 1) better characterize the waterbody throughout most of the 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 budgetary and staff time constraints. USEPA believes that 4-day composites are not an absolute requirement for evaluating whether chronic aquatic life criteria are being met when determining use attainment status. Therefore, USEPA affords states and tribes the flexibility to define how they will assess use attainment when 4-day composite data are not available (USEPA 1997, 2005). If consecutive day data are not available, the results of individual grab samples will be utilized as explained in the assessment tables (Section 3.0). Individual grab samples used to assess chronic aquatic life criteria should be taken during stable conditions to be representative of the averaging period. **Representativeness** is the degree to which data accurately and precisely represent a characteristic of a population. This is a qualitative assessment and is addressed primarily in the sample design, through the selection of sampling sites, and procedures that reflect the project goals and environment being sampled (NMED/SWQB 2007b).

As stated in Paragraph 3 of Subsection C of 20.6.4.14, attainment of criteria for toxic pollutants will be assessed during periods of complete vertical mixing in lakes and reservoirs. With respect to stream and river chronic aquatic life assessments, grab samples are deemed representative for this application when there is an absence of contextual information indicating unstable conditions. Examples of contextual information to be considered include, but are not limited to: 1) stream flow, 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 ~~more than~~ two **or more** exceedences of applicable chronic aquatic life criteria based on grab data, SWQB will look at 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
- Gage station records (when available)
- Land uses in the vicinity
- Records of chemical spills or other unusual events; and
- Historic patterns of pollutant concentrations when available

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

Alternatively, this result would not be used for listing decisions related to chronic aquatic life uses when contextual data indicated unstable conditions. Examples of evidence 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 after 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

When exceedences occurred at or near a continuous flow gaging station and mean daily flow data are available, the stream may be considered stable if the coefficient of variation (CV) in the flow records for the 3 days before the sampling event and 3 days after the sampling event is at or below the 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 ~~.02~~ **0.2** is a common threshold number below which data are considered to have minimal variability. See table 1.1 below for an example using available gage data for a grab sample collected on 8/2/07. In this example, the CV is below 0.2 so data collection on 8/2/07 was determined to be during stable conditions with respect to assessing chronic aquatic life criteria.

Table 2.1 Example of Stable Flow Determination using Gage Data

Date	Flow (cfs)	Mean	Standard Deviation (SD)	CV (SD / Mean)
7/30/07	176			
7/31/07	180			
8/1/07	265			
8/2/07	**242**	**205.4**	**34.8**	**0.17**
8/3/07	205			
8/4/07	180			
8/5/07	190			

2.1.7 Impairment due solely to naturally occurring conditions

If an assessment unit is impaired solely due to naturally occurring conditions (i.e., there are absolutely no human-caused influences or sources), the surface water will not be listed as impaired if there is sufficient evidence that anthropogenic activities are not and have not contributed to the impairment. Geology, geomorphology, hydrology and characteristics of the pollutant are an example of factors to be considered when establishing whether an exceedence was due solely to natural conditions or if there was some potential contribution for human activities. Water bodies that are suspected of being impaired due solely to natural causes, but which lack sufficient data to make this determination, will be placed in impairment category 5C with a note that additional information is needed. Water bodies that are shown to be impaired solely due to natural conditions will be placed in impairment category 4N on the Integrated List. To be placed in this category, SWQB must have evidence that anthropogenic activities are not and have not contributed to the impairment. See section 4.0 below for additional information regarding impairment categories.

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

When a constituent concentration is determined using ultra-low level methods (such as USEPA Method 1668A for PCBs or USEPA Method 1669 for trace metals), the data will first be blank-corrected using the procedures recommended in the method assuming adequate data are available to perform the recommended procedure. These blank-corrected values will then be compared against New Mexico's WQS to determine impairment.

2.2 Data Quality Levels

2.2.1 Aquatic life use data types

It is recognized that not all data of a certain type are of equal quality or rigor. The following tables describe defined levels of data quality or confidence for each type of data recognized for use in making aquatic life support determinations. 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 (USEPA 2002a). Tables for determining the level of confidence for biological, habitat, chemical/physical, and toxicological data types are presented. It is necessary 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. While data quality tables are not available for other designated uses, it is possible to apply the general guidelines to other data to determine if they are of sufficient quality to support use designations. For example, the table for chemical/physical determinations may be used to assign a level of confidence to data used for making a determination of drinking water supply use attainment.

Tables 2.1 through 2.4 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. Level 4 represents data of the highest rigor and the highest level of confidence while Level 1 represents the lowest acceptable level of confidence. Information of data confidence is housed in ADB v.2.1.4.

2.2.2 Contact use data type

Pathogen data are used to determine use support for Primary Contact and Secondary Contact designated uses. ADB v.2.1.4 also houses information on pathogen data quality levels. Pathogen data typically consists of fecal coliform and/or E. coli data. The CALM guidance does not contain any examples of data quality criteria to discern low to excellent data quality (USEPA 2002a). Currently, the only data type used to make contact use attainment decisions in New Mexico is pathogen data because there are no contact use water quality standards for non-pathogen data. Therefore, there cannot be conflicting contact use attainment conclusions from various types of data as there can be in aquatic life use attainment decisions, therefore, this protocol does not need to include criteria to evaluate pathogen data quality.

Table 2.2 Hierarchy of bioassessment approaches for evaluation of aquatic life use 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 assessment
4 EXLNT	Generally two assemblages, but may be one if high data quality; regional (usually based on 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 assessment

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

Table 2.3 Hierarchy of habitat assessment approaches for evaluation of aquatic life use 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; conducted with bioassessment; 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 commensurate with biological sampling; assessment may be regional or site-specific	Moderate precision and sensitivity; professional scientist performs survey or provides oversite and training
4 EXLNT	Assessment of habitat based on quantitative measurements of in-stream parameters, channel morphology, and floodplain characteristics; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during 1-2 seasons; spatial coverage broad and commensurate with biological sampling; assessment may be regional or site-specific	High precision and sensitivity; professional scientist performs survey and assessment

Table 2.4 Hierarchy of chemical/physical data levels for evaluation of use 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 up stream 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 monitoring data	Moderate spatial and temporal coverage: • Bimonthly or quarterly sampling at fixed stations • 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 • 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 EXLNT	All of the following: • Water quality monitoring using composite samples, series of grab samples, and continuous monitoring devices • Limited 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 • 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

NOTE: *See section 2.1.6 for additional information.

Table 2.5 Hierarchy of toxicological approaches and levels for evaluation of aquatic life use attainment

LEVEL OF INFO	TECHNICAL COMPONENTS	SPATIAL/TEMPORAL COVERAGE	DATA QUALITY
1 LOW	Any one of the following: • Acute or chronic WET for effluent dominated channel • Acute ambient water	1 ambient water sample tested in an assessment unit or site	Unknown/Low; minimal replication used; laboratory quality or expertise unknown
2 FAIR	Any one of the following: • Acute and chronic WET for effluent dominated channel	2 ambient water samples tested in an assessment unit or site on 2 different dates	Low/moderate; little replication used within a site; laboratory quality or expertise unknown or low
3 GOOD	Any one of the following: • Acute and chronic WET for effluent dominated system • Acute or chronic ambient water	3 ambient water samples tested in an assessment unit or site on 3 different dates	Moderate/high; replication used; trained personnel and good laboratory quality
4 EXLNT	Both of the following: • Acute and chronic ambient water	$\geq$ 4 tests in total based on samples collected in a assessment unit or site on 4 different dates	High; replication used; trained personnel and good lab quality

3.0 INDIVIDUAL DESIGNATED USE SUPPORT DETERMINATIONS

Water Quality Standards (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 has several 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* published in the New Mexico Administrative Code (NMAC) at 20.6.4 NMAC (NMWQCC 2007). The New Mexico Water Quality Control Commission (NMWQCC) adopted numeric and narrative criteria to protect these designated uses. There are both water quality standard 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 document. All references to narrative or numeric criteria throughout this document refer to state-adopted criteria found in 20.6.4 NMAC. The antidegradation policy ensures that existing uses[1] and levels of water quality necessary to protect these uses will be maintained and protected (20.6.4.8 NMAC).

WQS segments defined in 20.6.4 NMAC are further divided into assessment units (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. As stated in Section 1.0, data collected at representative stations during SWQB water quality surveys along with outside data form the basis of use support determinations for each AU. Stations are chosen to reflect current ambient conditions of 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.

SWQB typically does not have the resources to establish more than one monitoring station in any particular **perennial** AU during rotational watershed surveys, but there are occasions where more than one station with available data (typically chemical/physical data) are either established by SWQB or some other data collection agency. When this occurs, the assessor will first verify that the current AU break is appropriate (i.e., representing homogeneous reaches to the extent practicable). If it is not, the AU may be split appropriately. When data from multiple stations are used to assess a single AU, the data should be from ~~stations and~~ sampling events that are ~~1) spatially independent (generally more than 200 meters apart), and 2)~~ temporally independent (~~generally~~ collected at least seven days apart). ~~If one or both of these conditions are not met,~~ **If multiple samples are available at one station within a seven-day period, they are counted as one sample for that one-week period. With respect to determining impairments:**

1) the maximum value from the non-independent sampling events will be used to assess against

acute aquatic life and E. coli criteria, and

2) the ~~data~~ **average value** from the non-independent ~~stations~~ **sampling events** ~~should be averaged before application of the assessment procedures.~~ **will be used to assess against all other numeric criteria. If there are values below the detection limit in the data set that must be averaged, a value of ½ of the detection limit will be used (Gilbert 1987). To be conservative, use the lowest measured hardness value for the data set being averaged to**

[1] "Existing use" (defined at 20.6.4.7(Y) NMAC) 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.

determine the appropriate hardness-dependent chronic aquatic life criterion (see 20.6.4.900.I.2).

If multiple stations have been sampled within an AU during a seven-day period, they are counted as one sample for that one-week period and handled in the same manner described above. Stations bracketing NPDES point source discharges warrant special consideration of the AU breaks and any available discharge monitoring data.

Because this data rule is yet to be automated and is potentially time consuming, a screening technique may be employed for a given parameter if there is no existing listing and all detected values are below the applicable water quality criteria for that particular parameter. If this is the case, a note should be added to the Comments section of the appropriate Assessment Form to indicate why these data rules were not employed. Otherwise, the maximum and average values must be documented and assessed according to the above rule.

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 data sets. 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 is found in Section 3.1.4. In addition to the following subsections, several specific assessment protocols for temperature, sedimentation/siltation (also referred to as "stream bottom deposits") in perennial wadeable streams, excessive nutrients in perennial wadeable streams, dissolved oxygen, and pH have been developed. These protocols are included in appendices C through G.

In previous New Mexico §305(b) reports and §303(d) lists, five designated use determinations were possible according to earlier versions of the SWQB assessment protocol: Full Support, Full Support Impacts Observed, Partial Support, Not Supported, or Not Assessed. These determinations were modified from recommendations in the §305(b) report guidance (USEPA 1997). Guidance from USEPA recommends the following use attainment categories (USEPA 2001, USEPA 2002a, USEPA 2003, USEPA 2005): **Fully Supporting, Not Supporting, Insufficient Information, and Not Assessed.** For every assessment unit detailed in the Integrated List, one of these four categories is assigned to every designated use as stated in the applicable section of 20.6.4 NMAC, or identified existing use.

A determination of Fully Supporting or Not Supporting should not be made in the absence of monitored data. It is understood that any assessment, particularly when using biological and/or habitat data, may involve some level of best professional judgment (BPJ). However, evaluations based solely on professional judgment, literature statements, or public comments without reliable 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 monitored data that meet the QA/QC requirements described in the SWQB's most recent QAPP 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 Support

Use assessment decisions should consider and integrate, whenever possible and appropriate, results of various monitoring data types. These include biological, habitat/stream channel condition, chemical/physical, and toxicological monitoring data. Data quality associated with these types can be found in Section 2.2.1.

3.1.1 Biological data

Currently benthic macroinvertebrate sampling is the primary form of biomonitoring utilized by the state of New Mexico. SWQB also monitors fish assemblages and algae in an increasing number of streams. To determine impairment, the assessment approach is based on the concept of comparing the actual conditions of a specific stream with a reference condition, or a reference stream, to determine attainment of the applicable Aquatic Life Use. This approach is consistent with USEPA guidance. SWQB has only developed and utilized the below reference condition or reference stream approaches for wadeable, perennial streams at this time. The below is not applied to large non-wadeable rivers, lakes and reservoirs, or non-perennial streams.

When the Rapid Bioassessment Protocol (RBP) method was first introduced, the concept of reference condition was typically limited to pristine streams (Plafkin et al. 1989). This concept was updated 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 to assess potential impairment to the aquatic community. SWQB is in the process of developing a Human Disturbance Gradient through GIS and by on-site verification through the use of the Site Condition Class Verification and Probable Source Field sheet to better determine reference conditions following methods modified from Drake (2004). SWQB is also reassessing and refining current biological monitoring and habitat assessment protocols to determine appropriate numeric thresholds and eventually propose numeric biological criteria.

SWQB has been collecting benthic macroinvertebrate data since 1979. The formal process of developing biological criteria began in 2002 with assistance from USEPA Region 6 and Tetra Tech, Inc., Ecological Services Division. As of 2006, New Mexico, in collaboration with Drs. Jacobi and Tetra Tech, has 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 three indices based on elevation and watershed size. However, these results are only applicable to the Mountain biological region as the reference site selection process only included streams in the Mountain region for SCI model development. SWQB plans on revising the report in early 2008 to reflect this fact. The High Small (elevation and watershed, respectively) SCI in the current report appears to place study reaches in the same condition category for all tested streams in the Mountain region. Therefore, the M-SCI (High Small SCI in the Jacobi et al [2006] report) should be used to determine Aquatic Life Use attainment in the Mountain region. 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 ecoregion designation for that site.

The M-SCI is composed of metrics from five categories representing community and autecological attributes including Taxonomic Composition, Taxonomic Richness, Tolerance, Habit, and Functional Feeding Group. Individual metrics are listed in Table 3.1.

Table 3.1 Metrics included in the M-SCI

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. The resulting score is then placed in a condition category of Very Good (100 – 78.35), Good (78.35 – 56.70), Fair (56.70 – 37.20), Poor (37.20 – 18.90), Very Poor (18.90 – 0).

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

METRIC	95th PERCENTILE	FORMULA
Shannon Diversity (log_2)	3.89	if $X > X_{95,}$ score = 100 if $X \le X_{95,}$ 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: 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 Barbour et al. (1989) until SCIs can be developed for the Xeric and Plains regions. New Mexico will be adding additional data from Ecoregions 22, 24, 25, and 26 in 2007 – 2008 to develop these additional regional SCIs. Based on the results of the initial report, these ecoregions will probably be combined such that New Mexico will consist of three biological regions, Mountains, Plains, and Xeric. This approach is similar to SCI development for Wyoming and Colorado and generally follows the Level II ecoregions (Commission for Environmental Cooperation. 1997, 2006).

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

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
Macroinvertebrate assemblages in Ecoregions 22, 24, 25, and 26 using RBP Index	Reliable data indicate functioning, sustainable macroinvertebrate assemblages not modified significantly beyond the natural range of reference condition (>83% of reference site(s)).*	Reliable data indicate macroinvertebrate assemblage with moderate to severe impairment when compared to reference condition (≤79% of reference site(s)). *	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	Reliable data indicate functioning, sustainable macroinvertebrate assemblages not modified significantly beyond the natural range of reference condition (> 56.70 score). **	Reliable data indicate macroinvertebrate assemblage with moderate to severe impairment when compared to reference condition (<56.70 score). **	

NOTE: *Percentages are based on Plafkin et al. (1989). The 4% gap allows for some best professional judgment.
** Percentages based on Jacobi et al. (2006).

An expanded assessment protocol for sedimentation/siltation (also referred to as "stream bottom deposits") that incorporates benthic macroinvertebrate monitoring and assessment can be found in Appendix D. This protocol was also developed for and only applies to wadeable, perennial streams at this time.

3.1.2 Chemical/physical data

Table 3.4 explains how to interpret chemical/physical data to assess aquatic life use support. Refer to WQS Section 20.6.4.900 NMAC for numeric criteria related to various chemical/physical parameters. Refer to the appropriate water quality standard segment number (20.6.4.97 through 20.6.4.806 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, dissolved oxygen, specific conductance, and total phosphorus. Expanded assessment protocols for temperature for high quality coldwater and coldwater aquatic life uses when thermograph data are available, and large data set protocols for dissolved oxygen (DO), and pH, are found in Appendices C, F, and G respectively. Table 3.4 will be applied to available grab data to determine potential impairment.

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 NMWQCC amended the WQS rule. The amendments included removing all the segment specific turbidity values and revising the turbidity subsection under the General Criteria section to read (20.6.4.13.J NMAC):

> ***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. Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity. However, limited-duration activities necessary to accommodate dredging, construction or other similar activities and that cause the criterion to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and all appropriate permits and approvals have been obtained.

The language from the second sentence on in the above subsection was added specifically to protect waters from limited-duration turbidity-causing activities, not to guide impairment determinations. The intent of the new language was not to restrict SWQB's ability to develop appropriate WQ standards and assessment protocols to ensure that aquatic life is being protected from the effects of excess turbidity. Therefore, SWQB plans to propose changes to this provision to clarify the intent during the next triennial review (tentatively scheduled for fall 2008). SWQB also plans to develop an assessment protocol that focuses on impacts to biota for the 2010 listing cycle. SWQB considered and rejected the idea of simply using the pre-2005 turbidity values as numeric translators per each aquatic life use category because the previous turbidity values were inconsistently assigned per aquatic life use category, and the biological basis for the previous values was unclear. Once the new assessment protocols are developed, SWQB will assess available turbidity data from 2003 on to determine turbidity impairments for development of the 2010 Integrated List.

In the interim, SWQB will retain historic turbidity listings that were determined using the pre-2005 turbidity criteria and the methods in Table 3.4 on the Integrated List, with a footnote noting the change in water quality standards and the subsequent need for a change in assessment protocols.

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., pH, temperature, DO, specific conductance, turbidity*, total phosphorus) **A)** 1 to 7 samples **B**) > 7 samples	**A**) For any one pollutant, no more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in <15% of measurements.	**A**) For any one pollutant, more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in ≥ 15% of measurements.	Biases in DO, pH, and temperature sampling (such as diurnal flux) should be addressed by sampling with continuously-recording sondes and thermographs whenever possible.** The index period for temperature assessments of MCWAL and WWAL is June – August. Turbidity exceedence attributable to natural causes are not considered exceedences of the criteria.
•**Toxic substance** (e.g., priority pollutants, ammonia***, chlorine, metals)	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 the arithmetic mean of the analytical results of consecutive-day samples. Consecutive-day samples are often not available. When this is the case, to the results of individual grab sample will be used to determine whether an exceedence has occurred. Individual grab samples used to assess chronic aquatic life criteria should be taken during stable conditions to be representative of the averaging period (see Section 2.1.6 for additional discussion).

NOTES:

*See above paragraphs regarding the change in turbidity standards. The use of percentages to determine potential turbidity impairment only applies to data assessments that were completed prior to the 2006 listing cycle.

**See appendices C, F, and G.

***New Mexico's WQS now require consideration of the presence of salmonids to assess against acute ammonia criteria, and the presence of fish 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 HQCWAL or CWAL will be assumed "Salmonids Present," while all other 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, use the most stringent criteria per 20.6.4.11.F NMAC.

3.1.3 Toxicological data

Table 3.5 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…" Toxicity is 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 (USEPA 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. Fish and other vertebrates are sensitive to many compounds such as those similar to their waste material, namely ammonia or ammonium complexed molecules. Although ammonia is toxic to invertebrates, not all invertebrates are as sensitive as fish species. Similarly, invertebrates are generally more sensitive to pesticides than fish are. Toxicological data for New Mexico can be downloaded from http://www.epa.gov/earth1r6/6wq/ecopro/watershd/monitrng/toxnet/index.htm.

While toxicity is a valuable indicator, it is just the first step towards identification of a water quality concern. The particular pollutant(s) leading to the toxicity must be identified in order to take the next steps, such as development of total maximum daily load (TMDL) planning documents to develop a plan to correct the problem. In past surveys, the SWQB collected water or sediment samples that were subject to the USEPA toxicity tests during the survey year for a particular watershed, while concurrently sampling surface waters for a variety of chemical constituents. 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, SWQB will evaluate available benthic macroinvertebrate data using the factors in Table 3.3.

Table 3.5 Interpreting toxicological data to assess Aquatic Life Use Support

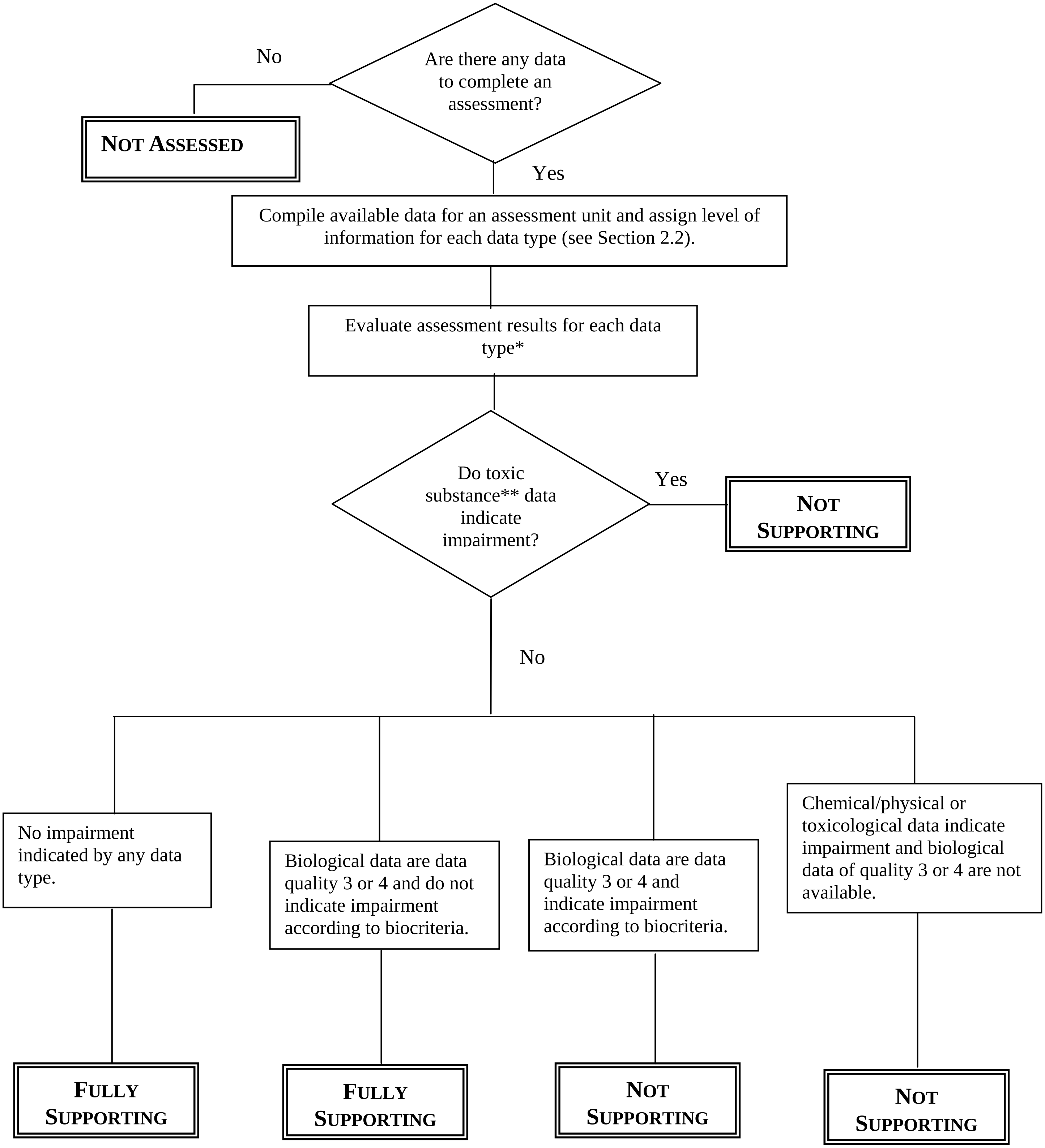
TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Acute and/or chronic toxicity testing**	Significant effect noted in no more than one acute water test as compared to controls or reference conditions, and in no more than one chronic water test in three years as compared to controls or reference conditions.	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 USEPA procedures documents for acute and chronic toxicity testing in water (USEPA 2002b, 2002c). Reference controls will be used to compensate for possible toxic effects from naturally occurring conditions (i.e. high salinity). If there are toxicity testing results 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 USEPA guidance, USEPA considers fish or shellfish consumption advisories and 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), USEPA 2005). The vast majority of New Mexico's current fish consumption advisories are based on mercury levels in fish (NMDOH 2001). There are also a few listings for PCBs in fish tissues:
(http://www.nmenv.state.nm.us/swqb/advisories/index.html). Fish tissue advisories for other parameters of concern may be forthcoming. Therefore, all water bodies listed in the advisory are listed as impaired due to either "Mercury in Fish Tissue" or "PCBs in Fish Tissue" on the Integrated List. The Integrated List will be updated whenever the advisory is revised.

3.1.5 Conflicting 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 more than two data types are available for assessment, a weight-of-evidence approach should be adopted. This approach should consider data type, quality, and quantity in reaching a final aquatic life use determination. Generally, data types with higher data quality should be given more weight. Once numeric biological translators or biocriteria are fully developed for the state of New Mexico, biological data may be given greater weight than other data types depending on the parameter of concern in making use support determinations when data quality levels are comparable, with the exception of toxic chemical data. Figure 3.1 displays a generalized flowchart for considering different data types when determining aquatic life use support. The ultimate goal is to develop specific, regional macroinvertebrate indices to identify non-toxicant stressor such as turbidity and sedimentation. 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.



NOTES: * Per Tables 3.3 through 3.5. **See Table 3.4 for description of toxic substances.

Figure 3.1 Generalized flowchart for determining Aquatic Life Use Support

3.2 Assessing Domestic Water Supply Use Support

Table 3.6 explains how to interpret chemical/physical data to assess domestic water supply use support Refer to Subsections B and J of 20.6.4.900 NMAC of the Water Quality Standards for the numeric criteria for domestic water supply.

Table 3.6 Interpreting chemical/physical data to assess Domestic Water Supply Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Toxic substance** (e.g., radionuclides*, priority pollutants, metals)	For any one pollutant, no exceedence of the criterion.	For any one pollutant, one or more exceedence of the criterion.	
•**Nitrate**	No exceedence of the criterion.	One or more exceedences of the criterion.	

NOTES:
*When radionuclides are analyzed using EPA Method 900.0 (recommended), 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. Also, the WQ criteria in 20.6.4.900.J 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.

3.3 Assessing Primary and Secondary Contact Use Support

Table 3.7 explains how to interpret bacteriological data to assess recreational contact use support . Refer to Subsection B under the appropriate stream segment number and to Subsections D and E of 20.6.4.900 NMAC of the Water Quality Standards for criteria to determine use support for primary and secondary contact recreation. The associated water quality criteria for contract use support was changed from fecal coliform to E. coli during the 2005 triennial review of New Mexico's water quality standards. Assessment units determined to be impaired prior to the 2006 listing cycle due to fecal coliform data will continue to be noted as impaired for fecal coliform, with a note indicating the change in water quality standards and need to collect E. coli data. There is no direct translator available to convert fecal coliform data to E. coli data.

Table 3.7 Interpreting bacteriological data to assess Contact Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•Bacteria **A)** 1 to 7 samples **B**) > 7 samples	**A**) No more than one exceedence of the single sample criterion. **B**) Single sample criterion is exceeded in <15% of samples and/or geometric mean criterion is met	**A**) More than one exceedence of the single sample criterion. **B**) Single sample criterion exceeded in ≥ 15% of measurements and/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). New Mexico replaced fecal coliform criteria with *E. coli* criteria during the 2005 triennial review process.

3.4 Assessing Irrigation Use Support

Table 3.8 explains how to interpret chemical/physical data to assess irrigation use support. Refer to Subsections C and J of 20.6.4.900 NMAC of the Water Quality Standards for the numeric criteria for the protection of irrigation use.

Table 3.8 Interpreting chemical/physical to assess Irrigation Use Support

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Toxic substance** (e.g., metals)	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)** 1 to 7 samples **B**) > 7 samples	**A**) For any one pollutant, no more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in <15% of measurements.	**A**) For any one pollutant, more than one exceedence of the criterion. **B**) For any one pollutant, criterion exceeded in ≥ 15% of measurements.	These are segment-specific criteria included in a few individual water quality standard segments based on flow qualifiers.

3.5 Assessing Livestock Watering Support

Table 3.9 explains how to interpret chemical/physical data to assess livestock watering use support. Refer to Subsections F and J of 20.6.4.900 NMAC of the Water Quality Standards for the numeric criteria for the protection of livestock watering.

Table 3.9 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)** 1 to 7 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) > 7 samples	**B**) For any one pollutant, criterion exceeded in <15% of measurements.	**B**) For any one pollutant, criterion exceeded in ≥ 15% of measurements.	
•**Toxic substance** (e.g., radionuclides*, priority pollutants, metals)	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	

NOTES:
*When radionuclides are analyzed using EPA Method 900.0 (recommended), 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. Also, the WQ criteria in 20.6.4.900.J 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.

3.6 Assessing Wildlife Habitat Use Support

Table 3.10 explains how to interpret chemical/physical data to assess wildlife habitat use support. Refer to Subsection 20.6.4.900.G NMAC of the Water Quality Standards for narrative criteria and Subsection 20.6.4.900.J NMAC for numeric criteria for the protection of wildlife habitat use.

Table 3.10 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)	For any one pollutant, no more than one exceedence of the criterion.	For any one pollutant, more than one exceedence of the criterion.	

3.7 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 (20.6.4.11.G NMAC). Because human health criteria proposed by the USEPA are presumed to have a duration of a year or more (USEPA 2005), and were generally established to protect for human lifetime exposure periods, SWQB believes it is appropriate to extend the percentage-based assessment approach to these criteria. Table 3.11 explains how to interpret chemical/physical data to determine if these criteria are met. Refer to Subsection 20.6.4.900.J NMAC of the Water Quality Standards for the numeric criteria for related to human health.

Table 3.11 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) 1 to 7 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) > 7 samples	**B**) For any one pollutant, criterion exceeded in <15% of measurements.	**B**) For any one pollutant, criterion exceeded in ≥ 15% of measurements.	

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4.0 ASSESSMENT UNIT CATEGORY DETERMINATIONS FOR INTEGRATED LIST

The determination of use support using Section 3.0 and other specified protocols are then combined to determine the overall water quality standard attainment category for each AU (USEPA 2001). The unique assessment categories for New Mexico are described as follows (see also Figure 4.1):

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.

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. **No reliable monitored data and/or information to determine if any designated or existing use is attained.** AUs are listed in this category where data to support an attainment determination for any use are not available, consistent with requirements of the assessment and listing methodology.

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

   A. **TMDL has been completed.** AUs are listed in this subcategory once all TMDL(s) have been developed and approved by USEPA 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 5A (see below) until all TMDLs for each pollutant have been completed and approved by USEPA.

   B. **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 130.7(b)(i),(ii), and (iii), AUs are listed in this subcategory where other pollution control requirements required by local, state, or federal authority are stringent enough to implement any water quality standard (WQS) applicable to such waters.

   C. **Impairment is not caused by a pollutant.** AUs are listed in this subcategory if a pollutant does not cause the impairment. For example, USEPA considers flow alteration to be “pollution” vs. a “pollutant.”

   N. **Impairment is caused solely due to natural conditions.** AUs are listed in this subcategory if the impairment is due solely to natural conditions. These waters are still protected by antidegradation provisions, and decisions regarding discharges or activities in the watershed that could increase the pollutant of concern must consider these waters to be “impaired.” To be placed in this category, SWQB must have evidence that anthropogenic activities are not contributing to the impairment.

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 into the following categories:

   A. **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 USEPA.

   B. **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 inappropriate, or if available data indicate background processes are causing criteria exceedences. After additional reviews of available data and the water quality standard are conducted, a Use Attainability Analysis (UAA) will be developed and submitted to USEPA for consideration, or the AU will be moved to Category 5A and a TMDL will be scheduled.

   C. **Additional data will be collected before a TMDL is scheduled.** AUs are listed in this category if there is not enough data to determine the pollutant of concern or there is not adequate data to develop a TMDL. For example, AUs with biological impairment will be listed in this category until further research can determine the particular pollutant(s) of concern. When the pollutant(s) are determined, the AU will be moved to Category 5A and a TMDL will be scheduled. If it is determined that the current designated uses are inappropriate, it will be moved to Category 5B and a UAA will be developed. If it is determined that “pollution” is causing the impairment (vs. a “pollutant”), the AU will be moved to Category 4C. AUs that are <u>suspected</u> 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. If evidence becomes available to show that anthropogenic activities are not and have not contributed to the impairment, these AUs will then be moved to Category 4N.

This change in reporting 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, USEPA 2001, WERF 2007). With a few additions and minor changes in terminology, the information requested in the *Integrated Listing* guidance (USEPA 2001) and CALM guidance (USEPA 2002a) were previously suggested in earlier 305(b) reporting guidance (USEPA 1997). The earlier guidance formed the basis of previous SWQB assessment protocols.

Assessment information is housed in ADB v.2.1.4 (RTI 2005). This database was designed to help states implement suggestions in the Integrated Listing guidance (USEPA 2001, USEPA 2005, USEPA

2006). The database is first populated with AU information, associated designated uses, comments, and any supporting documentation. Individual designated use attainment decisions (i.e., Full Support, Non Support, Not Assessed) are then entered for each AU. ADB v.2.1.4 then automatically determines the water quality standards attainment category for each AU based on the information entered for each applicable designated use.

Section 303(d)(1) 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 a scheduled TMDL completion date per USEPA's recommendation (USEPA 2005). This information is housed in ADB v.2.1.4 and reported on the Integrated List under "TMDL Schedule" for all individual Category 5A waters.

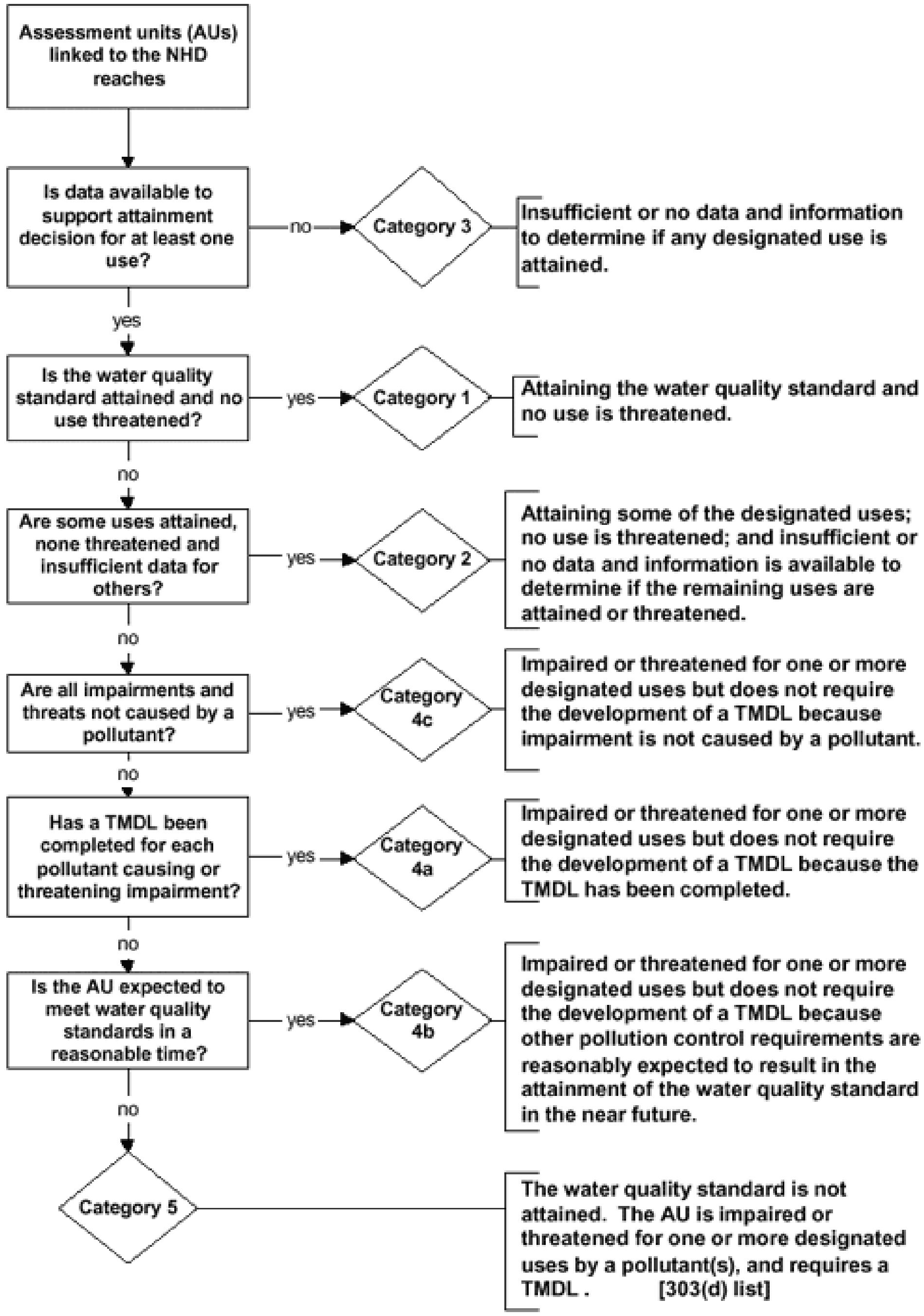

Figure 4.1. Generalized summary of logic for attainment categories (USEPA 2001). Category 5 was further expanded into categories 5A, 5B, and 5C.

5.0 PUBLIC PARTICIPATION

The assessment protocols are periodically revised based on new USEPA guidance, changes to the New Mexico Water Quality Standards, and the need to clarify various assessment procedures for staff. When the protocols are revised, a draft is first sent to USEPA Region 6 for initial review and comment. If significant changes to the overall assessment procedures and/or format of the document are being proposed, SWQB also releases a public comment draft to solicit public review and comment. For example, a draft of this assessment protocol was opened for a 30-day public comment period beginning on November 14, 2007. Eight sets of comments were received from stakeholders around the state. Comments were considered and incorporated as appropriate. Response to Comments were prepared by SWQB and provided to the parties who commented and USEPA Region 6.

The final version of this protocol is provided to USEPA Region 6. USEPA considers the assessment protocols in its review and approval of Category 5 waters in the integrated report. The assessment protocol is also posted on the SWQB website:
http://www.nmenv.state.nm.us/swqb/protocols/index.html.

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APPENDIX A

LIST OF COMMON ACRONYMS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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LIST OF COMMON ACRONYMS

4Q3	4-Day, 3-Year Low Flow
ADB	Assessment Database
AU	Assessment Unit
CALM	Consolidated Assessment and Listing Methodology
CWA	Clean Water Act
DO	Dissolved Oxygen
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
NMWQCC	New Mexico Water Quality Control Commission
NPDES	National Pollutant Discharge Elimination System
PAH	Poly Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PQL	Practical Quantification Limit
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RBP	Rapid Bioassessment Protocols
ROD	Record of Decision
SDL	Sample Detection Limit
SLD	State Laboratory Division
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
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WET	Whole Effluent Toxicity
WQS	Water Quality Standard

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APPENDIX B

DATA ASSESSMENT PROCEDURE AND FORMS

NOTE: This version includes the April 8, 2008, addendum in Track Changes

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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Introduction:

Comprehensive assessments of watershed surveys or other monitoring projects to determine designated use attainment status on an assessment unit basis are performed after all field data have been collected, all laboratory data have been received, and all data have been verified and validated in accordance with the most recent version of the Quality Assurance Project Plan (QAPP). In general, the Project Coordinator from the Monitoring and Assessment Section (MAS) Stream Studies Team performs the chemical/physical and E. coli data assessments while members of the MAS Biological Assessment Team perform the biological, sedimentation, and large dataset assessments (i.e., assessments using sonde and/or thermograph data). Members of the MAS Nutrient & Lakes Team perform stream nutrient assessments as well as chemical/physical and E. coli lake assessments. The Assessment Coordinator performs ambient toxicological assessments. The Assessment Coordinator and TMDL writers verify assessments. During verification of assessments, it is assumed that all relevant data have been compiled and that the data validation process or any other QA procedures were correctly performed.

This outline is to be used in conjunction with the *State of New Mexico Procedures of Assessing Standards Attainment for the Integrated §303(d) /§305(b) Water Quality Monitoring and Assessment Report* (Assessment Protocols), and is intended to detail the general steps that occur during the assessment process for each of the main categories of data. This outline will be updated and expanded as new and revised assessment protocols are developed and implemented.

I. Assessment Procedures Common to All Data Types:

A. Pre-Assessment: Data Collation and QA

1. Ensure that all field data and lab data from the survey have been received and uploaded into the appropriate water quality database and/or spreadsheet template.
2. Validate and verify the data per the most recent version of the *Quality Assurance Project Plan (QAPP)* – found at http://www.nmenv.state.nm.us/SWQB/MAS/index.html.
3. After any necessary changes to the appropriate database based on the QA Checklist and you have entered all Data Validation codes have been entered into the database, inform the Database Manager that the dataset is ready for upload to STORET/WQX.
4. Search for any readily available sources of outside data (such as recent water quality from active USGS stream gages [http://waterdata.usgs.gov/nwis], USFS data, EPA National Survey data [http://www.epa.gov/owow/streamsurvey/web_data.html], etc.) to incorporate into the assessment. If there are any USGS water quality gages in any assessment units in the study, download the last five years of data from the expected date of listing from NWIS: http://waterdata.usgs.gov/nwis. For example, when preparing assessments for Integrated List year 2008, download data from 2003-2007. Contact current USGS cooperative agreement contact (ask MAS Program Manager for current contact info) to acquire any provisional water quality data from the recent year. Ask SWQB WPS watershed lead if he/she is aware of any other entities collecting water quality data in the study area. Ask MAS staff if they are aware of any other entities collecting water quality data in the study area.
5. Determine whether data qualities of these additional data sources are sufficient to incorporate into assessments. (NOTE: USGS data downloaded from NWIS are assumed to meet SWQB data quality requirements). To be considered for development of the Integrated List, these data must, at a minimum, meet the QA/QC requirements described in SWQB's QAPP with particular emphasis on ensuring that the analytical methods used

meet the requirements specified in Section 2.4 of this QAPP, that the methods of data collection were the same as or comparable to those included in the Standard Operating Procedures (SOPs) referenced throughout this QAPP, and that the QC criteria used to verify and validate the data were the same or similar to those listed in Table 2.4 and Appendix B of the QAPP. If uncertain, consult with the QA Officer or Assessment Coordinator.

6. If outside data are of adequate quality for assessment, collate into assessment spreadsheet and merge with SWQB data in the spreadsheet, including a Data Source column. If the data are not of adequate quality, document why and keep in assessment folder.

B. Assessment

1. Download the latest version of the Assessment Protocols – found at http://www.nmenv.state.nm.us/SWQB/MAS/index.html. If in doubt, consult with Assessment Coordinator.
2. Download latest version of the EPA-approved WQS (20.6.4 NMAC) – found at. http://www.epa.gov/waterscience/standards/wqslibrary/nm/index.html. If in doubt, consult with Standards Coordinator.
3. Start an electronic Administrative Record folder (i.e., assessment packet) for your assessments by creating a directory on your hard drive to house all assessment documentation (Ex: Jemez 2005 Assessments -- to include MSExcel data spreadsheets, assessment forms, etc.)
4. Follow below assessment procedures by Data Type (see below sections).
5. Complete and print the Assessor's Worksheet (Attachment B-2).
6. Submit signed hardcopy of completed Assessor's Worksheet, and electronic copies of completed assessment forms and all supporting information (i.e., the electronic Administrative Record folder from step B1) to the Assessment Coordinator. Specifically, submit the following <u>electronic</u> files:
    - All completed Assessment Forms
    - Any supporting data spreadsheets used during the assessment procedure
    - Any supporting data called for on the Assessment Form

C. Assessment verification

1. Retrieve assessment packet (as described in B3) for <u>all</u> data types from the Assessment Coordinator.
2. Retrieve up-to-date <u>sample tracking spreadsheet</u> from \SWQB Public\MAS Core Documents\ or the survey lead(s) to identify any data holes.
3. Ensure available data were accurately assessed in accordance with the most recent Assessment Protocols and EPA-approved WQ standards.
4. Verify that the forms were filled out correctly by verifying correct WQS reference, correct assignment of stations to assessment units, and checking all calculations and impairment conclusions.
5. If discrepancies arise or assessments were not properly performed, discuss any proposed changes to the assessment with the original assessor.
6. Revise assessment forms as necessary.
7. Complete and print the Assessment Verification Worksheet (Attachment B-3).
8. Submit signed hardcopy of the Assessment Verification Worksheet, and electronic copies of the sample tracking spreadsheet, completed assessment forms and all supporting information (i.e., the final electronic Administrative Record) to Assessment Coordinator for inclusion on the upcoming draft Integrated List and eventual filing in the Administrative Record and the project binder.

II. Specific Assessment Steps by Data Type

A. Chemical/Physical and E. coli Grab Data

1. Export all field and lab data from the WQ dbase using the "Export Data" functions.
2. ***Exceedence Report in WQ dbase: Use as an initial screen only because the current reliability of the Exceedence Report is questionable.*** *If you know that no one else is on the database, run the Exceedence Report for your study and save as an *.RTF (rich text format) file in the newly created directory. If others are using the database, ask the Database Manager to run the exceedence reports for you and send you the *.RTF file to avoid locking up the database. If data are changed (as a result of QA), if assessment units are split, if stations are re-assigned to a different assessment unit, etc., the report must be re-run and re-saved.Review the Exceedence Report against the most current EPA-approved version of 20.6.4 NMAC to ensure that the data are being evaluated against the correct water quality criteria. If you use the information in the Exceedence Report to make assessment conclusions, include the *.RTF file in the electronic Administrative Record folder that will be submitted to the Assessment Coordinator.*
3. Fill out the **Summary Chemical/Physical and E. coli Assessment Form** for chemical/physical, bacteriological, organic, and pesticide data (Attachment B-1 and MAS Core Documents) for each assessment unit. Include <u>comments</u> and <u>notes</u> regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.
4. Determine use attainment status based on applicable tables in the most recent version of the Assessment Protocols, utilizing MSExcel functions such as autofilter and sort. Include <u>comments</u> and <u>notes</u> regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.

   a. <u>Hardness-dependent metals</u>: When all metals results are **<u>below</u>** the quantification limit, there is no need to calculate the hardness-dependent metals criteria, and the Exceedence Ratio field on the **Summary Chemical/Physical and E. Coli Assessment Form** should be filled in with "BLW QL" for "below quantification limit." When there are metals results **above** the quantification limit, **a screening level using the lowest measured hardness value in the data set to calculate hardness-dependent criteria may first be employed to determine the potential for any exceedences in the data set. If <u>any</u> measured values are above the associated criteria determined in this way, the assessor must** calculate appropriate hardness-dependent metals criteria for the sampling event(s) using concurrently-collected hardness and the formulas in 20.6.4.900 NMAC (see the hardness-dependent calculator spreadsheet in \SWQB Public\MAS Core Documents). **If concurrently-collected hardness data are not available, the lowest available hardness value within a seven-day period of the sample collection date may be used with a note in the Comments section of the appropriate Assessment Form explaining why concurrently-collected data were not used. If no hardness data (or adequate data to calculate hardness) are available within a seven-day period of the sample collection date, it is permissible to use conservative hardness estimates determined by qualified natural resources agencies or entities as**

appropriate for that water body. This deviation must be noted on the appropriate Assessment Form. Generate a spreadsheet that details the station, date/time, hardness, hardness-dependent criteria, and sample result. This spreadsheet must be included as part of the electronic record.

b. pH, temperature, and fish life stage dependent ammonia: When all ammonia results are **below** the quantification limit, there is no need to determine the pH, temperature, and life stage -dependent ammonia criteria, and the Exceedence Ratio field on the **Summary Chemical/Physical and E. Coli Assessment Form** should be filled in with "BLW QL" for "below quantification limit." When there are ammonia results **above** the quantification limit, determine the appropriate ammonia criteria for the sampling event(s) using Tables K through M of 20.6.4.900 NMAC, and the notes in Table 3.4 of the main assessment protocol. Generate a spreadsheet that details the station, date/time, pH, temperature, appropriate criteria, and sample result. This spreadsheet must be included as part of the electronic record.

c. Nitrate as N vs. Nitrite+Nitrate in 20.6.4.900 NMAC: Because data are generally reported from the State Laboratory Division (SLD) as Nitrite+Nitrate (N), and nitrite is generally negligible, the Nitrite+Nitrate (N) results can assessed against the Domestic Water Supply criterion of 10 mg/L expressed as "Nitrate as N" in 20.6.4.900 NMAC.

5. Fill out an **Individual Chemical/Physical Assessment Form** (Attachment B-1 and MAS Core Documents) by assessment unit for any parameter either a) determined to be "Non Support" or b) previously listed as "Non Support" on the most recent CWA 303(d)/305(b) Integrated List (http://www.nmenv.state.nm.us/swqb/MAS/index.html). These forms are extremely important because they constitute the primary record for both new listings and de-listings. Include comments and notes regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.

B. Ambient Toxicological Data

NOTE: The data utilized for these assessments are downloaded from EPA's toxicological program. It is therefore assumed that these data are thoroughly validated and verified before EPA uploads them to this site.

1. Download the most recent New Mexico toxicological data at http://www.epa.gov/earth1r6/6wq/ecopro/watershd/monitrng/toxnet/nm.pdf. This website collates all EPA toxicological tests performed in New Mexico for SWQB and EPA Region 6 over the years in one place.
2. Determine use attainment status based on the applicable table in the most recent version of the Assessment Protocol.
3. Fill out **Ambient Toxicity Monitoring Assessment Form** (Attachment B-1 and MAS Core Documents) for each assessment unit for which there are data. Include comments and notes regarding extraordinary field conditions that may have influenced results, etc., in the Comments section of this form.

C. Biological/Habitat Data

1. Determine Level III ecoregion.
2. Determine appropriate reference site for percent fines comparisons.
3. Determine percent fines (% of pebble count with intermediate axis < 2mm) for both the study site and the reference site.
4. If study site is in Ecoregion 21 or 23, determine M-SCI score.
5. If study site is in Ecoregion 20, 22, 24, 25, or 26, determine RBP index for both the study site and reference site.
6. Fill out **Sedimentation/Siltation (Stream Bottom Deposit) Assessment Form** (Attachment B-1 and MAS Core Documents) by station according to the most recent version of the **Sedimentation/Siltation (Stream Bottom Deposits) Protocol for Wadeable Perennial Streams** appendix in the Assessment Protocol. Include comments and notes regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.
7. If there is more than one station in the AU, repeat all steps above and fill out a new form.

D. Nutrient Data

1. Collate all data necessary to apply the weight-of-evidence approach detailed in the most recent version of the **Nutrient Assessment Protocol for Wadeable Perennial Streams** appendix in the Assessment Protocol.
2. Fill out **Level II Nutrient Assessment Worksheets** and **Level II Nutrient Assessment Forms,** (Attachment B-1 and MAS Core Documents) as necessary according to the protocol (NOTE: Level I Nutrient Assessment Forms are completed before August to indicate where Level II is needed – see Appendix E nutrient protocol for details). Include comments and notes regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.
3. If there is more than one station in the AU, repeat all steps above and fill out a new form.

E. Large Data Sets

Thermograph data:

1. Locate and collate available thermograph MS Excel files in \SWQB PUBLIC\Gary S Public\.
2. Determine the aquatic life use (ALU) of the water body being assessed (see 20.6.4 NMAC).
3. Use the "Conditional Formatting" option or other MS Excel functions to assess the data. If the ALU is high quality coldwater or coldwater, assess data using the most recent **Temperature Assessment Protocol** appendix in the Assessment Protocol. Otherwise, use Table 3.4 of the main Assessment Protocol.
4. Fill out **Temperature Data Logger (Thermograph) Assessment Form** (Attachment B-1 and MAS Core Documents). Include comments and notes regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.
5. If there is more than one station in the AU, repeat all steps above and fill out a new form.

Sonde data

1. Locate available sonde MS Excel files in \SWQB PUBLIC\Gary S Public\.
2. Assess data using the most recent **Large Data Set Assessment Protocol** appendix of the Assessment Protocol**.**
3. Fill out **pH and Dissolved Oxygen Sonde Data Assessment Form** (Attachment B-1 and MAS Core Documents). Include comments and notes regarding extraordinary field conditions that may have influenced results, Data Validation flags, the need for AU splits, questionable designated uses, etc., in the Comments section of this form.
4. If there is more than one station in the AU, repeat all steps above and fill out a new form.
5. Provide copy of complete assessment forms to Nutrient & Lakes Team for nutrient assessments.

Attachment B-1: Assessment Forms

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Page of Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used**:** _____ Date of WQS used: _____

Summary Chemical|Physical and E.coli Assessment Form

Study Year|Study Name: _____

1. Name of assessment unit (stream reach) in the SWQB WQ database or 303d|305b list:
_____
2. Segment number from NM WQ standards: _____
4. All designated uses from NM WQ standards: _____
5. Sites used for assessment: _____
6. Evaluation of data compared to applicable uses, expressed as a ratio of exceedences / total number of samples (**Bold** the use(s) and associated criteria being assessed. When the lowest applicable criterion is exceeded and multiple criteria apply, must also document the exceedence ratio for the next lowest applicable criterion until there are "0 / #"):

KEY: DWS = domestic water supply, **IRR** = irrigation, **LW** = livestock watering, **WH** = wildlife habitat, **AL** = aquatic life, **HH** = human health, **DL ABV WQS** = Detection limit greater than WQS, **NA** = not applicable, **BLW QL** = below quantification limit, **NO DATA =** no data available, **S.A**. = see attached spreadsheet

METALS:

Pollutants	Designated Use(s) [1,2]	Numeric Criteria	Exceedence Ratio(s)
Aluminum, Dissolved	AL chronic | AL acute | IRR	87 | 750 | 5000 µg/L	_____
Ammonia, total	Based on life stages, pH, and temperature (see 20.6.4.900.L NMAC and Table 3.4 of main Assessment Protocol)	See attached spreadsheet for any applicable criteria for any results above the quantification limit	_____
Antimony, dissolved	DWS | HH	5.6 | 640 µg/L	_____
Arsenic, dissolved	DWS | HH | IRR | AL chronic | LW | AL acute	2.3 | 9.0 | 100 | 150 | 200 | 340 µg/L	_____
Boron, dissolved	IRR | LW	750 | 5000 µg/L	_____
Cadmium, dissolved	AL chronic[3] | AL acute[3] | DWS | IRR | LW |	**S.A**. | **S.A**. | 5 | 10 | 50 | µg/L	_____
Chromium, dissolved	DWS | IRR | AL chronic[3] | AL acute[3] | LW	100 | 100 | **S.A**. | **S.A**. | 1000 µg/L	_____
Cobalt, dissolved	IRR | LW	50 | 1000µg/L	_____
Copper, dissolved	AL chronic[3]| AL acute[3] | IRR | LW | DWS	**S.A**. | **S.A**. | 200 | 500 |1300µg/L	_____
Lead, dissolved	AL chronic[3]| DWS | LW | AL acute[3] | IRR	**S.A**. | 50 | 100 | **S.A**. | 5000 µg/L	_____
Mercury, total	WH | DWS | LW	0.77 | 2 | 10 µg/L	_____
Mercury, dissolved	AL chronic | AL acute	0.77 | 1.4 µg/L	_____
Nickel, dissolved	DWS | AL chronic[3]| AL acute[3] | HH	100 | **S.A**. | **S.A**. | 4600 µg/L	_____
Selenium, dissolved	DWS | LW | IRR[4] | HH	5.0 | 50 | _____ | 4200 µg/L	_____
Selenium, total recoverable	WH | AL chronic | AL acute	5.0 | 5.0 | 20 µg/L	_____
Silver, dissolved	AL acute[3]	**S.A**. µg/L	_____
Thallium, dissolved	DWS | HH	1.7 | 6.3 µg/L	_____
Vanadium, dissolved	IRR | LW	100 | 100 µg/L	_____
Zinc, dissolved	AL chronic[3]| AL acute[3] | IRR | DWS | LW | HH	**S.A**.| **S.A**. | 2000 | 7400 | 25000 | 26000 µg/L	_____
_____	_____	_____	_____

[1] Per 20.6.4.11.G NMAC, human health criteria listed in 20.6.4.900.J NMAC shall apply to any waters with aquatic life use. For waters with **limited aquatic life use** (20.6.4.97 and 20.6.4.128), only the persistent (P) human health criteria apply.
[2] Chronic AL criteria do not apply to **limited aquatic life** use as stated in 20.6.4.97 and 20.6.4.128.
[3] Hardness-dependent criteria calculated using equations (see 20.6.4.900.I NMAC). Attach spreadsheet for any applicable criteria for any results above the quantification limit
[4] Applicable criterion depends on presence of sulfate (see 20.6.4.900.C NMAC – note units are in **mg/L**).

OTHER:

Pollutant	**Designated Use(s)**	**Numeric Criteria**	**Exceedence Ratio(s)**
Cyanide, weak acid dissociable	AL chronic | WH | AL acute | DWS | HH	5.2 | 5.2 | 22.0 | 700 | 220000 µg/L	_____
E. coli	Primary or Secondary Contact	_____ cfu/100mL	_____
Nitrite + nitrate (N)	DWS | LW	10 | 132 mg/L	_____
Temperature (grab)	_____	Celsius	
pH (grab)	_____		
DO (grab)	_____	mg/L	
_____	_____	_____	_____
_____	_____	_____	_____

RADIONUCLIDES:

Pollutant	**Designated Use(s)**	**Numeric Criteria**	**Exceedence Ratio(s)**
Adjusted gross alpha	DWS | LW	15 | 15 pCi/L	_____
Radium 226 +228	DWS | LW	5 | 30.0 pCi/L	_____
_____	_____	_____ pCi/L	_____
_____	_____	_____ pCi/L	_____

8260 ORGANICS (Volatiles) -- Assess any pollutants with results above the quantification limit.

Pollutant	**Designated Use(s)**	**Numeric Criteria**	**Exceedence Ratio(s)**
_____	_____	_____ µg/L	_____
_____	_____	_____ µg/L	_____

8270 ORGANICS (Semi-volatiles) -- Assess any pollutants with results above the quantification limit.

Pollutant	**Designated Use(s)**	**Numeric Criteria**	**Exceedence Ratio(s)**
_____	_____	_____ µg/L	_____
_____	_____	_____ µg/L	_____

8081 PESTICIDES (Organochlorides) -- Assess any pollutants with results above the quantification limit.

Pollutant	**Designated Use(s)**	**Numeric Criteria**	**Exceedence Ratio(s)**
_____	_____	_____ µg/L	_____
_____	_____	_____ µg/L	_____

Additional comments about the assessments: _____

Revised 18 January 2008 (LG)

Page of Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Individual Chemical/ Physical Data or E.coli Assessment Form

Study Year/Study Name: _____

1. Name of assessment unit (stream reach) in the SWQB WQ database or 303d/305b list: _____
2. Segment number from NM WQ standards: _____
3. Parameter*: _____
4. Designated use(s) and associated criteria: _____
5. Evaluation of data, expressed as a ratio of exceedences/number of samples:

Station(s) used in assessment	Spring	Summer	Fall	Outside source #1	Outside source #2	Exceedence Ratio
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

6. Outside data source #1: _____
7. Outside data source #2: _____
8. What is the use support designation according to the SWQB Assessment Protocol:

☐ Full support

☐ Not supported

Additional comments about the assessment:

_____

--Attach data used to make impairment determination. Any data qualifier codes from either the lab or SWQB must be included.
*If parameter is **Adjusted Gross Alpha**, include documentation regarding how the data were corrected.

Revised 4 January 2008 (LG)

Page of Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Ambient Toxicity Monitoring Assessment Form

Study Year/Study Name: _____

1. Name of assessment unit (stream reach) in the SWQB WQ database or 303d/305b list:

_____

2. List all ambient water toxicity monitoring test with significant differences compared to control:

Station(s) used in assessment	Date of test	Acute or chronic[a] test?	Number of tests with significant difference
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

What is the use support designation according to the SWQB Assessment Protocol:

☐ Full support

☐ Not supported

Additional comments about the assessment:

_____

[a]Chronic test durations are 7 days, while acute tests are 4 days according to USEPA Region 6.
-- Attached printout of data related to this from http://www.epa.gov/earth1r6/6wq/ecopro/watershd/monitrng/toxnet/nm.pdf

Revised 4 January 2008 (LG)

 Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Sedimentation/Siltation (Stream Bottom Deposit) Assessment Form

Study Name and Year: _____

Assessment Unit: _____

Station ID:	Lat.:	Long.:	Watershed Area:	Elevation:	Ecoregion:
_____	_____	_____	_____	_____	__
Reference Station ID:	Lat.:	Long.:	Watershed Area:	Elevation:	Ecoregion:
_____	_____	_____	_____	_____	__

Circle ecoregion (Level III):
21 – Southern Rockies 22 – NM/AZ Plateau 23 - AZ/NM Mountains 24 - Chihuahuan Desert
25 – Western High Plains 26 – Southwestern Tablelands

Comments: on Reference Site selection and/or Study Site

Percent Fines at Station: __ Percent Fines at Reference: __ **%Increase**: ____

If ecoregion 21 or 23:
M-SCI Bio Score at Station: __
If ecoregion 22, 24, 25, or 26:
RBP Bio Score at Station:__ RBP Bio score at Reference: __ **RBP Bio Score as a % of Ref: __**

What is the use support designation according to the SWQB Assessment Protocol:

Biological / **Physical**	**Impaired (Non Support)** RBP Index < 79% of ref [1] M-SCI Score < 56.70 [2]	**Non-impaired (Full Support)** RBP Index > 84% of ref [1] M-SCI Score > 56.70 [2]
Non-Support Percent Fines >28% increase over reference	☐ Non-Support	☐ Full Support
Full Support Percent Fines <27% increase[3] over reference	☐ Full Support (Sedimentation/Siltation); ☐ Non-Support (Unidentified Biological Impairment)[4]	☐ Full Support

[1] RBP Index should be used in Ecoregions 22, 24, 25, and 26. RBP Index score based on Plafkin et al. (1989). The 4% gap allows for some best professional judgment.
[2] M-SCI should be used in Ecoregions 21 and 23. M-SCI and Score based on Jacobi et al. (2006).
[3] Raw percent values of ≤20% fines (pebble counts) at a study site should be evaluated as fully supporting regardless of the percent attained at the reference site.
[4] Reduction in the relative support level for the aquatic life use in this particular matrix cell is probably not due to sediment. It is most likely the result of some other impairment (temperature, D.O., pH, toxicity, etc.), alone or in combination with sediment. Label as Category 5C on the Integrated §303(d)/305(b) list to indicate that further study is needed.

Additional comments about the assessment: _____

*Attach associated pebble count and benthic macroinvertebrate raw or summary data / metrics.

Revised 4 January 2008 LG)

Page of Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Temperature Data Logger (Thermograph) Assessment Form

Year/Watershed: _____

Assessment Unit: _____

Station name: _____ **STORET ID:** _____

Lat: N _____ **Lon:** W _____

Thermograph file name: _____

WQS segment: 20.6.4. ___ **Aquatic Life use:** _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____ n (Jun – Aug) = _____

Criterion: ____**°C** **Exceedences:** n = _____;_____**%** **Exceedences (Jun-Aug)** n = ____;_____%

Maximum recorded: ____°C

HQCWAL: > 3 °C above criterion? ☐ no ☐ yes

CWAL: > 4 °C above criterion? ☐ no ☐ yes

n =_____; **n (Jun-Aug) =** _____;_____ %

HQCWAL: Criterion exceeded > 4 consecutive hours for > 3 consecutive days? ☐ no ☐ yes
CWAL: Criterion exceeded > 6 consecutive hours for > 3 consecutive days? ☐ no ☐ yes
All other designated uses: > 15% exceedences (Jun – Aug)? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Comments: _____

 Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

pH and Dissolved Oxygen Sonde Data Assessment Form

Year/Watershed: _____

Assessment Unit: _____

Station name: _____

STORET ID: _____

Lat: N _____ **Lon:** W _____ **Elevation:** ____ m

WQS segment: 20.6.4. ___ **Designated use:** _____

Sonde data file name: _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____

---

pH Assessment

Criterion range: ☐ 6.6 – 8.8 ☐ 6.6 – 9.0 ☐ Other (specify)

Minimum recorded: _____ **Maximum recorded:** _____ **≥ 0.5 units above criterion?** ☐ no ☐ yes

Number of data points outside criterion: ___ **% data points outside criterion:** ____

Maximum contiguous duration outside criterion: ___ hours

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Dissolved Oxygen Assessment

Applicable value: ☐ coldwater (early life stages) 8.0 mg/L; 95% **OR** 85%

☐ coldwater (other life stages) 6.0 mg/L; 90% **OR** 75%

☐ warmwater (all life stages) 5.0 mg/L; 90% **OR** 75%

Combined instantaneous minimum: _____ mg/L; ____ % saturation Exceedences: n = ___ ; ____ %

Percent saturation instantaneous minimum: _____ Exceedences: n = ___ ; ____ %

Combined values exceeded for > 3 hours contiguously? ☐ no ☐ yes

Minimum % saturation exceeded for > 3 hours contiguously? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Information pertinent to nutrient assessment:

Below DO concentration minimum? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

> 120% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

< 75% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

Comments:_____

Revised 4 January 2008 (LG)

Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Level II Nutrient Assessment Worksheet

Sonde: Use the *Protocol for Assessment of Large pH Data Sets* and the *Protocol for Assessment of Dissolved Oxygen Data Collected with Continuous Recording Devices* to assess pH and D.O. if multiple day Sonde data are available. Attach Assessment Form. If sonde data are not available, use grab sample data to calculate an exceedence ratio for pH, local D.O. percent saturation, and D.O. concentration.

Site Location: _____	
Multiple-day Deployment	**Grab Samples**
Assessment of dissolved oxygen:	D.O. % saturation exceedence ratio: _____
☐ Supporting ☐ Not supporting	
Assessment of large pH datasets :	D.O. minimum exceedence ratio: _____
☐ Supporting ☐ Not supporting	
DO fluctuations > 3mg/L: ☐ Yes ☐ No	pH exceedence ratio: _____
Notes: _____	

Nutrient Survey Water Chemistry: attach updated nutrient report from SWQB database and calculate the exceedence ration for the entire assessment unit.

Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Ecoregion/ALU Threshold (see Table 1): _____	Ecoregion/ALU Threshold (see Table 1): _____
Exceedence Ratio: _____	Exceedence Ratio: _____
Notes: _____	

Algal Sampling: record results of chlorophyll *a*.

Ecoregion chlorophyll *a* threshold value in µg/cm^2 (see Table 4): _____
Chlorophyll *a* (µg/cm^2): _____
Notes: _____

Benthic Diatoms (OPTIONAL): see notes on following page.

Date: _____ Sample method: _____
Reference site: _____
Stream Condition Index (SCI) Score: _____
Notes: _____

Algal Bioassays (OPTIONAL): Attach results.

Date collected: _____	Limiting nutrient: _____
Algal productivity: ☐low ☐moderate ☐moderately high ☐high	
Notes: _____	

NOTES: Total Nitrogen is calculated by adding Total Kjeldahl Nitrogen plus Nitrate + Nitrite. In the event that Nitrate + Nitrite or Total Kjeldahl Nitrogen are below the detection limit, a value of one half the detection limit will be used (Gilbert 1987).

Put NA (not available) in boxes for parameters that were not collected. Benthic diatom indicators will be added to the assessment once the index is developed and threshold values are verified for New Mexico.

Comments:______

Revised 4 January 2008 (LG)

Page of | Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Level II Nutrient Assessment Form (using Threshold Values)

Assessment Unit: _____	
Site Location(s): _____	
	Ecoregion: _____
	Aquatic life Uses: _____

An Assessment Unit will be determined to be not supporting if **three or more** of the following indicators are present (if not all of the indicators have been measured, the presence of two of the following indicators will be assessed as not supporting). Check all indicators that exceed the threshold values below.

- ☐ Total nitrogen is above the ecoregion/ALU threshold in >15% of samples
- ☐ Total phosphorus is above the ecoregion/ALU threshold in >15% of samples
- ☐ Dissolved Oxygen threshold is exceeded
  - (☐) determined to be **not supporting** using the assessment protocol for Data Collected with Continuous Recording Devices
  - (☐) >15% of grab samples exceeded 120%
  - (☐) >15% of grab samples are below the applicable standard
- ☐ pH threshold is exceeded
  - (☐) determined to be **not supporting** using the assessment protocol for large pH data sets
  - (☐) >15% of grab samples exceeds appropriate criterion
- ☐ The Algal Bioassay indicates moderately high or high algal production
- ☐ Chlorophyll *a* ecoregion threshold is exceeded

Check One:	☐ Fully supporting	☐ Not supporting
Notes: _____		

Comments:______

Revised 4 January 2008 (LG)

Page of Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Level II Nutrient Assessment Form (using a Reference Site)

Assessment Unit: _____	
Site Location(s): _____	
Reference Site: _____	
	Ecoregion: _____
	Aquatic life Uses: _____

If the study reach is believed to have naturally high productivity because of geology, flow regime, or other natural factors, a reference site approach may be used. An Assessment Unit will be determined to be **not supporting** if **two or more** of the following indicators of the study site are notably different from those of the reference site. If the number of samples from each site is sufficient (n is >4), then the rank-sum test (a.k.a. Wilcox or Mann-Whitney test) will be used to test if there is a high (>75%) probability that the study site is different than the reference site. If the number of measurements is ≤4, then best professional judgment utilizing the general guidelines in the table from the "notes" section below will be used to determine if the parameters are different at the sites.

Indicator	Reference Site	Study Site
D.O. saturation exceedence ratio*	_____	_____
pH exceedence ratio*	_____	_____
DO concentration exceedence ratio*	_____	_____
Total nitrogen exceedence ratio	_____	_____
Total phosphorus exceedence ratio	_____	_____
Chlorophyll *a* concentration	_____	_____
Algal Bioassay algal production	_____	_____

* the exceedence ratio for large data sets refers to the number of days with exceedences divided by the number of full days that the sonde was deployed, not the number of data points. Use grab sample data if multiple day Sonde data is not available for both sites.

Check One:	☐ **Fully supporting**	☐ **Not supporting**
Notes: _____		

NOTES: Put NA (not available) in boxes for parameters that were not collected.Complete and attach a Level II Nutrient Assessment Worksheet for the reference site as well as the study site.

The table below provides general guidelines of what constitutes a “difference” between the reference and study site for parameters with < 5 measurement.

Indicator	Reference Site	Study Site
D.O. saturation exceedence ratio	_____	> 1 exceedence more then reference
pH exceedence ratio	_____	> 1 exceedence more then reference
DO concentration exceedence ratio	_____	> 1 exceedence more then reference
Total nitrogen exceedence ratio*	_____	> 1 exceedence more then reference*
Total phosphorus exceedence ratio*	_____	> 1 exceedence more then reference*
Chlorophyll *a* concentration	_____	≥20% difference
Algal Bioassay algal production	_____	≥ 1 classification higher than reference

* Also consider how much greater the concentrations are at the study site, and how close the concentrations are to the detection limit (d.l.). If one or both of concentrations are <2 times the detection limit (d.l.), then a value of 4 times the reference site concentration would be considered “different”. If the concentrations are >2 times the d.l. then a value 2 times the reference concentration would be considered “different.”

Comments:______

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Attachment B-2: Assessor's Worksheet

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Assessor's Worksheet

Study Name: _____ **Year:_____**

Assessor:_____ **Date of assessment completion: _____**

Specific data type covered by this worksheet (circle all that apply):

☐ **Chem/Physical** ☐ **Bio/Hab** ☐ **Large Data Set** ☐ **Nutrient**

Step 1: Data collation and verification/validation

Were all applicable data verification and validation steps completed for the SWQB data identified above in accordance with the procedures described in the most recent SWQB QAPP?

☐ Yes ☐ No ☐ N/A Date of QAPP used: _____

Were all readily-available data, quality data identified and collated prior to assessment of data (example – USGS data)?

☐ Yes ☐ No

> If so, were these outside data checked for quality? To be considered for development of the Integrated List, these data must, at a minimum, meet the QA/QC requirements described in the SWQB's *Quality Assurance Project Plan for Water Quality Management Programs 2007* (QAPP), with particular emphasis on ensuring that the analytical methods used meet the requirements specified in Section 2.4 of this QAPP, that the methods of data collection were the same as or comparable to those included in the Standard Operating Procedures (SOPs) referenced throughout this QAPP, and that the QC criteria used to verify and validate the data were the same or similar to those listed in Table 2.4 and Appendix B of the QAPP.
>
> ☐ Yes ☐ No Comment: _____

Step 2: Completion of assessment per data type

Are all data identified above assessed according to applicable instructions in most recent Assessment Protocol as assessed against the most recent WQS for each Assessment Unit in the study?

☐ Yes ☐ No Date of Assessment Protocol(s) used: _____
Date of WQS used: _____

If not, explain why (data not available for all AUs, etc.): _____

Are applicable forms completely filled out?

☐ Yes ☐ No

Are required data detailed at bottom of assessment forms attached and/or provided electronically?

☐ Yes ☐ No If not, explain why:

<u>Step 3: Completeness of forms (fill out relevant subsection for data type(s) circled in intro)</u>

A. Chemical/Physical Data –

Did you fill out the Summary Chemical/Physical Assessment Form for each AU for which there are available data?

☐ Yes ☐ No

Did you fill out separate Individual Chemical/Physical Assessment Forms for data regarding any <u>existing</u> WQ impairment listing from the most recent Integrated Clean Water Act §303d/§305b list?

☐ Yes ☐ No ☐N/A (no previous impairment listings)

Did you fill out separate Individual Chemical/Physical Assessment Forms for any <u>new</u> WQ impairment determinations?

☐ Yes No ☐N/A (no new impairment listings)

B. Biological/Habitat Data–

Did you fill out the Sedimentation/Siltation (Stream Bottom Deposit) Assessment Form for each AU for which there are available data?

☐ Yes ☐ No

C. Large Data Sets (Thermograph and Sonde)–

Did you fill out the Temperature Data Logger (Thermograph) Assessment Form for each AU for which there are available data?

☐ Yes ☐ No

Did you fill out the pH and Dissolved Oxygen Sonde Data Assessment Form for each AU for which there are available data?

☐ Yes ☐ No

D. Nutrient Assessment Set Data --

Did you fill out Level I Nutrient Assessment Forms for each AU for which there are available data?

☐ Yes ☐ No

Did you fill out the applicable Level II Nutrient Assessment Worksheet for each AU for which there are available data?

☐ Yes ☐ No

- -

COMPLETION OF ASSESSMENT PROCESS

After the above steps have been completed, save and print the worksheet, attach all assessments and applicable supplemental information, sign below, and give the electronic Administrative Record (via your public directory) and worksheet to the Assessment Coordinator.

I acknowledge that the assessment process for the above data type has been completed in accordance with the most recent EPA-approved WQ standards (20.6.4 NMAC) and the most recent Assessment Protocols.

______________________________ _______________

Assessor's Signature Date

Attachment B-3: Assessment Verification Worksheet

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Assessment Verification Worksheet

Study Name: _____ **Year:_____**

Assessor:_____ **Date of assessment completion: _____**

Assessment verifier:_____ **Date of assessment verification:_____**

Specific data type covered by this worksheet (check all that apply):

☐ **Chem/Physical** ☐ **Bio/Hab** ☐ **Large Data Set** ☐ **Nutrient**

NOTE: During verification of assessments, it is assumed that all relevant data have been compiled and that the data validation process or any other QA procedures were correctly performed.

Step 1: Verify most recent WQS and Assessment Protocols were utilized

Were the most recent EPA-approved applicable WQS used for these assessments?
☐ Yes ☐ No Date of WQS used: _____

Were the most recent SWQB Assessment Protocols used for these assessments?
☐ Yes ☐ No Date of Assessment Protocol(s) used: _____

If no to either of these, data assessments must be re-done if the changes to either the applicable WQS or Assessment Protocols would result in different impairment conclusions based on application of the same data. Discuss with Assessor and Assessment Coordinator.

Step 2: Verify correct application of assessment protocols

Are all data identified above correctly assessed according to instructions in most recent Assessment Protocol?
☐ Yes ☐ No

If not, were appropriate corrections made on the applicable Assessment Form?
☐ Yes ☐ No

Were these corrections discussed with the original data assessor?
☐ Yes ☐ No

Step 3: Verify completeness of forms

Are applicable forms completely filled out?
☐ Yes ☐ No If not, discuss deficiencies with original data assessor.

Are required data detailed at bottom of assessment forms attached and/or provided electronically?
☐ Yes ☐ No If not, acquire from original data assessor.

A. Chemical/Physical Data –

Are there separate Summary Chemical/Physical Assessment Forms for each AU for which there are available data?

☐ Yes ☐ No

Are there separate Individual Chemical/Physical Assessment Forms for data regarding any existing WQ impairment listing from the most recent Integrated Clean Water Act §303d/§305b list?

☐ Yes ☐ No ☐ N/A (no existing impairment listings)

Are there separate Individual Chemical/Physical Assessment Forms assessment forms for any new WQ impairment listings?

☐ Yes ☐ No ☐ N/A (no new impairment listings)

B. Biological/Habitat Data–

Are there separate Sedimentation/Siltation (Stream Bottom Deposit) Assessment Forms for each AU for which there are available data? ☐ Yes ☐ No

Are site characteristics (such as watershed area and elevation) comparable between reference and study site?

☐ Yes ☐ No If not, discuss with assessor and Bio/Hab Team survey lead.

C. Large Data Sets (Thermograph and Sonde)–

Are there separate Temperature Data Logger (Thermograph) Assessment Forms for each AU for which there are available data?

☐ Yes ☐ No

Are there separate pH and Dissolved Oxygen Sonde Data Assessment Forms for each AU for which there are available data?

☐ Yes ☐ No

D. Nutrient Assessment Set Data --

Are there separate Level I Nutrient Assessment Forms for each AU for which there are available data?

☐ Yes ☐ No

Are there separate applicable Level II Nutrient Assessment Worksheet for each AU for which there are available data?

☐ Yes ☐ No

- -

COMPLETION OF ASSESSMENT VERIFICATION PROCESS

After the above steps have been completed, save and print the worksheet, attach all assessments and applicable supplemental information, sign below, and give the electronic Administrative Record (via your public directory) and worksheet to the Assessment Coordinator.

I acknowledge that the assessment verification process for the above data type has been completed.

______________________________ ______________

Assessment Verification Signature Date

APPENDIX C

TEMPERATURE ASSESSMENT PROTOCOL FOR HIGH QUALITY COLDWATER AND COLDWATER AQUATIC LIFE

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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RATIONALE FOR DEVELOPMENT OF TEMPERAURE ASSESSMENT PROTOCOL:

Prior to 1998, water temperature was routinely measured once during each site visit, and designated use support status related to temperature criteria was determined by applying a percent-of-exceedences formula to these instantaneous temperature data. Periodic instantaneous temperature data do not provide information on maximum daily temperatures, duration of excessive temperatures, or the diurnal and seasonal fluctuations of water temperature. These aspects of temperature are pertinent to aquatic life use. Continuously recording data loggers (i.e., thermographs) are now readily available and provide an extensive multiple-day record of hourly temperatures over the critical time period when temperatures are generally highest. The percent-of-exceedences formula previously used with instantaneous temperature data is inappropriate for assessment of thermograph data and was not designed for that purpose.

In 1998, the New Mexico Environment Department Surface Water Quality Bureau (Bureau) initiated an effort to review current temperature criteria and to determine the most appropriate method to monitor and assess potential aquatic life use impairment due to elevated water temperature. This effort involved: 1) convening an interdisciplinary multi-agency workgroup to review existing scientific literature and US Environmental Protection Agency (EPA) guidance in order to recommend methods to assess current temperature criteria, and 2) development of a standard operating procedure for deployment of thermographs in each assessment unit during intensive water quality surveys.

The Bureau has been deploying thermographs and applying the following temperature assessment protocol since the 2000-2002 CWA §303(d) listing cycle. This protocol is more technically sound than simply applying percentages to limited instantaneous temperature data, and better addresses the intent of the Clean Water Act to use best available technology as well as incorporate magnitude and duration concerns into water quality monitoring, assessment, and standards development. This protocol addresses biases introduced when using instantaneous data to assess water quality parameters with significant diurnal fluctuation. Based on the success of this effort, the SWQB is exploring the steps necessary to potentially incorporate these changes into the water quality standards and to initiate additional efforts to address other parameters with known diurnal fluxes, such as pH and dissolved oxygen (NMWQCC 2007).

I. Introduction

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms that affect fish. 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°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 fishery. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species.

II. Historical Background

The Bureau convened a multi-agency workgroup to evaluate current temperature criteria and how the Bureau could best incorporate these criteria into its management activities. This exercise was undertaken as a result of changes in temperature monitoring procedures initiated by the Bureau in 1998, and the resulting data.

Prior to 1998, temperature monitoring by the Bureau was limited to instantaneous streamside measurements taken by a staff member conducting a water quality survey. This resulted in limited information concerning actual dynamics of temperature in New Mexico streams. During 1998, stream sampling surveys used a new device, the continuously-recording thermograph, to collect more complete temperature data. These devices may be deployed in streams for extended periods of time, and collect data at preset intervals. Bureau protocols for use of these devices (Attachment A) call for deployment during the critical summer period of June through August, with a data collection interval of one hour. These devices were first deployed in mid-July 1998.

Following deployment, devices were collected and data were downloaded and interpreted. Data review at that time indicated only one stream (Sulphur Creek) of more than 20 evaluated in 1998 had no exceedences of the 20°C standard. Many of these monitoring sites were established on what were considered to be minimally-impacted stream reaches. These preliminary results seemed to indicate that the streams evaluated had temperatures that may not support their coldwater fishery designated use.

Procedures for assessing designated use support were conducted using 1997 Bureau protocols. Under these protocols, all physical parameters, including temperature, were evaluated based on a percent-of-exceedences formula. Review of data generated by thermographs brought into question the usefulness of this method of evaluation, as it did not recognize a maximum allowable temperature. In response, the Bureau convened the Temperature Workgroup.

The Workgroup was comprised of representatives from the EPA Region 6, the US Department of Interior, Fish and Wildlife Service – New Mexico Ecological Services Field Office, New Mexico Department of Game and Fish – Conservation Services and Fisheries Management Divisions, and the Bureau. The Workgroup held four meetings beginning in December 1998. The Workgroup's task was to develop an assessment protocol for high quality cold water and cold water aquatic life designated uses that would evaluate designated use support status of New Mexico streams using detailed temperature data collected by the Bureau. The Workgroup was informed of implementation of new sampling procedures and given a general summary of preliminary results. It was the Bureau's wish that the Workgroup develop an assessment protocol independent of any data or *a priori* beliefs that could have been developed from a review of data collected. For this reason, the Workgroup was not given any specific thermograph data, nor were members made aware of specific data collection sites.

The Workgroup decided to conduct a literature review, and to base any recommendations on results of this review and internal discussions held with other agency or department staff. Information collected, that formed the basis for recommendations, is summarized in the below section.

III. Review of the EPA Criteria Document for Temperature

Following is a summary of temperature information from EPA's September 1988 document "*Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria*."

Preamble: Temperature standards are set to control thermal pollution, or the amount of heated wastes discharged into a waterbody. The following guidelines were developed by the EPA and published in "*Quality Criteria for Water, 1986"* (Gold Book).

Freshwater Aquatic Life

For any time of year, there are two upper limiting temperatures for a location (based on the important sensitive species found there at that time):

1. One limit consists of a maximum temperature for short exposures that is time and species dependent, and

2. The second value is a limit on weekly average temperature that:

    a. In the cooler months, will protect against mortality of important species if the elevated plume temperature is suddenly dropped to the ambient temperature, with the limit being the acclimation temperature minus two °C when the lower lethal threshold temperature equals ambient water temperature;

or

    b. In the warmest months, is determined by adding to the physiological optimum temperature (for growth) a factor calculated as 1/3 of the difference between the ultimate upper incipient lethal temperature and the optimum temperature for the most sensitive species that are normally present at that location and time;

or

    c. During reproductive seasons, the limit is the temperature that meets site-specific requirements for successful migration, spawning, egg incubation, fry rearing, and other reproductive functions of important species. These local requirements should supersede all other requirements when applicable;

or

    d. There is a site-specific limit that is found necessary to preserve normal species diversity or prevent appearance of nuisance organisms.

Upper and lower limits have been established for many aquatic organisms. Tabulations of lethal temperatures for fish and other organisms are available. Factors such as diet, activity, age, general health, osmotic stress, and even weather contribute to the lethality of temperature. Aquatic species, thermal acclimation state, and exposure time are considered critical factors.

Effects of sublethal temperatures on metabolism, respiration, behavior, distribution and migration, feeding rate, growth, and reproduction have been summarized by De Sylva (1969). Brett (1960) illustrated that inside the tolerance zone, there is a more restrictive temperature range in which normal activity and growth occur, and an even more restrictive zone inside that in which normal reproduction occurs.

The upper incipient lethal temperature and the LT50 (the highest temperature at which 50% of a sample of organisms can survive) for any given species are determined at that species' highest sustainable acclimation temperature. Generally, the lower end of temperature accommodation for aquatic freshwater species is 0°C.

The following requirements are currently considered necessary and sufficient for development of a protective temperature criteria definition:

1. Maximum sustained temperatures are consistent with maintaining desirable levels of primary and secondary productivity.

2. Maximum levels of metabolic acclimation to warm temperatures that permit return to ambient winter temperatures should artificial sources of heat cease.

3. Time-dependent temperature limitations for survival of brief exposures to temperature extremes, both upper and lower.

4. Restricted temperature ranges for various states of reproduction, including (for fish) gametogenesis, spawning migration, release of gametes, development of embryo, commencement of independent feeding (and other activities) by juveniles, and temperature required for metamorphosis, emergence, or other activities of lower forms.

5. Thermal limits for diverse species composition of aquatic communities, particularly where reduction in diversity creates nuisance growth of certain organisms, or where important food sources are altered.

6. Thermal requirements of downstream aquatic life (in rivers) where upstream diminution of a coldwater resource will adversely affect downstream temperature requirements.

The temperature-time duration for short-term maximum (STM) exposure, such that there is 50% survival, is expressed mathematically by fitting experimental data with a straight line on a semi-logarithmic plot. Time is shown on the log scale; temperature is on the linear scale. To provide for safety, an experimentally derived safety factor of 2°C is applied. In equation form, this is:

Equation 1. STM = (log(time)-a)/b

Where:

STM = short-term maximum temperature
$\log_{10}$ = logarithm to base 10 (common log)
a = intercept on "y" axis (or logarithmic axis) of the line fitted to experimental data that is available for some species from Water Quality Criteria 1972, Appendix II-C (USEPA, 1972).
b = Slope of the line fitted to experimental data and available for some species from Water Quality Criteria 1972, Appendix II-C (USEPA, 1972).
time = minutes

For extensive exposure, the maximum weekly average temperature (MWAT) is expressed as:

Equation 2. MWAT = OT + ((UUILT - OT)/3)

Where:

MWAT = maximum weekly average temperature.
OT = a reported optimum temperature for the particular life state or function.
UUILT = ultimate upper incipient lethal temperature (the upper temperature at which tolerance does not increase with increasing acclimation temperature)

One caveat in determining maximum weekly average temperature is that the limit for short-term exposure must not be exceeded. Some calculated values are available in the literature for species considered important in New Mexico.

EPA Calculated Values for Maximum Weekly Average Temperatures for Growth and Short-term Maxima for Survival of Juveniles and Adults During Summer Months are given in the following table.

Species	Growth[a]	Maxima[b]
Rainbow trout	19	24
Brook trout	19	24
Brown trout	--	25

[a]Calculated according to the maximum weekly average formula (Equation 2).
[b]Based on the short term maximum formula (Equation 1), with acclimation at the weekly average temperature for summer growth (does not indicate exposure period).

IV. Review of Other Literature References

Numerous literature references (Armour, 1991; USEPA, 1986) also recognize the concept of using short-term maxima and weekly average temperatures to protect for temperature effects on fisheries. Of primary importance are protections necessary to support reproducing populations of salmonids in stream segments designated as high quality coldwater aquatic life.

Armour (1991) cited the following findings for the calculated short-term maxima (STM) = (log of time - *a*)/*b*. Values for *a* and *b*, intercept, and slope of a line from experimental data, are taken from National Academy of Sciences, Water Quality Criteria (1972) for juvenile brook trout (*Salvelinus fontinalis*), where time = 120 min. This yields a calculated STM of 25.6°C (25.5°C for juvenile brown trout, *Salmo trutta*). To provide a margin of safety for all organisms, this value was reduced by 2°C, resulting in a calculated STM of 23.6°C.

This calculated STM value is consistent with data found in other literature. USEPA (1986) short-term lethal threshold for brook trout and rainbow trout (*Oncorhynchus mykiss*) is given as 24°C, after reduction by the 2°C safety factor. Grande and Andersen (1991) experimentally determined in controlled studies a LT50 for brook trout, brown trout, and rainbow trout to be 25.2°C, 26.2°C, and 26.6°C, respectively. Applying a safety factor of 2°C results in 23.2°C, 24.2 °C, and 24.6°C, respectively, which are similar to USEPA findings. Eaton (1995) developed a Fish Temperature Database Matching System (FTDMS) to document temperatures at which various species were found in natural settings. He reported a 95th percentile temperature (i.e. 95% of all individuals collected were found at temperatures below this value) of 22.3°C for brook trout, 24.1°C for brown trout, and 24.0°C for rainbow trout.

V. Workgroup Recommendations

Given the broad literature support for temperature evaluations employing a concept of short-term thermal maximum and long-term average value, the Workgroup recommended such an approach be applied in New Mexico. Because the current default criterion for high quality coldwater and coldwater aquatic life uses is 20°C, this value was used as the basis of the assessment protocol and can be considered the proposed temperature value that protects against chronic impacts. The instantaneous temperature values proposed below can be considered the values necessary to protect against acute impacts.

The specific recommendations from the Workgroup are as presented below. During reproductive seasons, temperatures must not impede successful migration, egg incubation, fry rearing, and other reproductive functions of target species. Sampling for assessment of these criteria will be accomplished using continuously recording thermographs with a maximum interval of one hour. Data will be collected from at least June through August.

A. Temperature in High Quality Coldwater Aquatic Life (HQCWAL)

Full Support — Instantaneous (hourly) temperatures do not exceed 3.0°C greater than the applicable temperature criterion, and temperatures do not exceed the applicable criterion for more than four consecutive hours in a 24-hour cycle for more than three consecutive days.

Non Support — Instantaneous (hourly) temperatures exceed 3.0°C greater than the applicable temperature criterion, or temperatures exceed the applicable criterion for more than four consecutive hours in a 24-hour cycle for more than three consecutive days.

B. Temperature in Coldwater Aquatic Life (CWAL)

Full Support	Instantaneous (hourly) temperatures do not exceed 4.0°C greater than the applicable temperature criterion, and temperatures do not exceed the applicable criterion for more than six consecutive hours in a 24-hour cycle for more than three consecutive days.
Non Support	Instantaneous (hourly) temperatures exceed 4.0°C greater than the applicable temperature criterion, or temperatures exceed the applicable criterion for more than six consecutive hours in a 24-hour cycle for more than three consecutive days.

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VI. Other Recommendations

Additional recommendations by the Workgroup:

- Language should be included in any future standard indicating temperature limits are established to protect the entire aquatic community, not just fish species. (NOTE: The term "fishery" was changed to "aquatic life use" during the 2005 triennial review).
- Additional data should be collected on varying stream types, thought to be representative of least impacted streams, to establish an expected or reference range of temperatures.
- Fish population data should be collected on reference streams in order to evaluate appropriateness of designated uses.
- The need for a regionalized temperature standard should be reviewed.
- This proposal should be evaluated over time, and a new standard criterion should be developed from this review that will eventually be proposed to replace the single-value temperature criterion currently specified in the New Mexico Surface Water Quality Standards.

The Bureau plans to re-convene the workgroup in 2008 to expand these magnitude and duration-based assessment approaches to cover other aquatic life uses (namely, marginal coldwater, warmwater, and marginal warmwater).

References:

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Brett, JR. 1960*. Thermal requirements of fish – three decades of study, 1940-1970. Pages 110-117 in C.M. Tarzwell, compiler. Biological problems in water pollution. US Department of Health, Education, and Welfare, Cincinnati, Ohio. 285 pp.

Eaton, J.G. et. al. 1995. A field information-based system for estimating fish temperature tolerances. Fisheries 20:10-18.

Grande, M. and S. Andersen. 1991. Critical thermal maxima for young salmonids. Journal of Freshwater Ecology 6(3): 275-279.

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United States Environmental Protection Agency (USEPA). 1972. Water quality criteria 1972. A Report of the Committee on Water Quality Criteria. National Academy of Sciences. Washington, D.C. 1972.

_______. 1986. Quality criteria for water: 1986. EPA 440/5-86-001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards. Washington, D.C.

* The date on the publication that DM Tarzwell edited is 1960, Brett's title conflicts.

Attachment A

New Mexico Environment Department/Surface Water Quality Bureau Protocol for Deployment and Evaluation of Long-term Thermographs

Monitoring Timing, Frequency and Duration

Monitoring for temperature should generally be conducted from June through August to be consistent with periods when incident solar radiation angles are high and ambient air temperatures are most likely to be at maximums. Knowledge of regional patterns is important if monitoring duration must be limited to periods shorter than the interval described above. Monitoring should always include the period of critical maximum expected temperatures.

When monitoring data are to be used to make assessments of designated use support maximums, duration and rate of temperature increase must be collected. For these purposes, the recording thermograph is the most useful tool. For a recording thermograph, monitoring frequency should be adequate to provide a realistic estimate of the maximum temperature and duration of criteria exceedences. If data are collected at too large an interval, maximum temperatures and durations are likely to be missed. **The SWQB maximum interval for monitoring for standards attainment, with a recording thermograph, is one hour.** Obviously, shorter intervals provide a more precise estimate of the duration of daily maximums. For this reason, shorter intervals may be used with no impact to data quality. However, this is a trade-off against data storage limitations. One approach to this problem is use of a pilot period of monitoring, with at least thirty-minute monitoring intervals, to determine how rapidly stream temperature may change. The need for a shorter monitoring interval is more important on smaller, coldwater streams than larger streams.

Monitoring Equipment

Thermographs must be waterproof and have a temperature range that is appropriate for the applicable standard. Devices should have a minimum temperature range of –5°C to 40°C, with minimum resolution and accuracy of ±0.5°C within this range. They should be capable of recording at a wide range of intervals with a minimum of no more than fifteen minutes and a maximum greater than two hours. The thermograph must be capable of direct download to a PC, creating a file that is exportable to currently available spreadsheet software.

Where to Monitor

Thermographs should be placed in stream locations that are representative of ambient stream conditions. For this reason, thermographs should not be placed in shallow riffles or in deep pools. Generally, the thermograph should be deployed in a transition between a riffle/run and a pool. If possible, the thermograph should be placed at the toe of a pool as it becomes more shallow, prior to entering a run or riffle. The thermograph should be placed such that under expected flow conditions it will be continuously submerged. If possible, the thermograph should be located under shading to eliminate direct solar gain.

Field Equipment

Actual situations encountered during thermograph deployment will vary. Consequently, this protocol offers only very general recommendations for thermograph deployment. Consideration should be given to the list of conditions in the section entitled “Where to Monitor.”

Typical equipment that should be available includes:

- plastic zip ties
- surveyors marking tape
- iron rebar stakes (minimum 18 inches)
- sledge hammer
- wire cutters and knife
- portable computer and interface, as needed by your equipment
- auditing thermometer
- timepiece
- field book or data sheets
- camera and film

Precautions against vandalism, theft, and accidental disturbance should be considered when deploying equipment. In areas frequented by the public, it is advisable to secure or camouflage equipment. Visible tethers are not generally advisable, since they attract attention. If such tethers are deemed necessary, they should be buried or hidden.

Quality Assurance and Quality Control

The following procedures must be followed to ensure that temperature data are of acceptable quality. These procedures document instrument accuracy, test for proper functioning during the deployment period, and set criteria for data acceptance.

Accuracy Testing and Recording

A National Institute of Standards and Technology (NIST) traceable thermometer, with a resolution and accuracy of 0.1°C or better, should be used to test thermograph accuracy prior to deployment. The NIST thermometer should be checked annually, with a minimum of two temperatures. If a NIST thermometer is not available, a good quality thermometer checked against an NIST thermometer may be used. This thermometer should also be checked annually, with a minimum of two temperatures.

Accuracy of the thermograph must be tested pre- and post-deployment, at a minimum of two calibration temperatures between 0°C and 25°C. SWQB accomplishes this by testing all thermographs annually during the off-season. Testing is done using a stable thermal mass, such as an ice water bath or other controlled water bath. The stable temperature of the insulated water mass allows direct comparison of the unit’s readout with that of the certified or checked thermometer. Accuracy should be within ±0.5°C. A log must be kept that documents each unit’s calibration date, test result, and the reference thermometer used.

Data Review and Reduction

Data will be retained in raw form without post-processing. Only data that meet quality control requirements may be used for comparison to numeric temperature criteria. Data are considered valid if the thermograph from which they were generated has passed its annual test.

All data will be reviewed for any obvious anomalies. Since these devices are left for long periods of time without supervision, they may be subject to external forces or conditions that may render some of the data questionable. Examples of such conditions may include being picked up by persons other than sampling personnel or being exposed to ambient air temperature as water levels drop below the sensor. These problems can be minimized through proper deployment of the devices and a complete data review to document anomalous or apparently unnatural data. Frequently, viewing a graph of the data is the best way to reveal obvious anomalies.

 Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

Temperature Data Logger (Thermograph) Assessment Form

Year/Watershed: _____

Assessment Unit: _____

Station name: _____ **STORET ID:** _____

Lat: N _____ **Lon:** W _____

Thermograph file name: _____

WQS segment: 20.6.4. ___ **Aquatic Life use:** _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____ n (Jun – Aug) = _____

Criterion: ____**°C** **Exceedences:** n = _____;_____**%** **Exceedences (Jun-Aug)** n = ____;_____%

Maximum recorded: ____°C

HQCWAL: > 3 °C above criterion? ☐ no ☐ yes

CWAL: > 4 °C above criterion? ☐ no ☐ yes

n =_____; n (Jun-Aug) = _____;_____ %

HQCWAL: Criterion exceeded > 4 consecutive hours for > 3 consecutive days? ☐ no ☐ yes
CWAL: Criterion exceeded > 6 consecutive hours for > 3 consecutive days? ☐ no ☐ yes
All other designated uses: > 15% exceedences (Jun – Aug)? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Comments: _____

Revised 4 January 2008 (LG)

APPENDIX D

SEDIMENTATION/SILTATION ASSESSMENT PROTOCOL FOR WADEABLE, PERENNIAL STREAMS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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Purpose and Applicability

This document establishes an assessment protocol for determining impairment due to excessive sedimentation/siltation (otherwise referred to as stream bottom deposits or SBD) in perennial, wadeable streams with representative riffle or run areas. This assessment is only conducted in wadeable perennial streams at this time because the existing research used to develop this assessment protocol 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 NMAC 20.6.4.13 (NMWQCC 2007):

> 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.

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

- Lakes, reservoirs, ponds, and playas
- Sand bed streams (generally defined as streams with a D84 of <2mm)
- Large rivers (non wadeable)
- Intermittent streams
- Ephemeral streams
- Wetlands

This assessment protocol is a dynamic document that will be refined as more data are collected, enabling better definition of relationships between sedimentation and associated biological indicators in New Mexico streams. New Mexico has several initiatives in place in order to better define reference condition by Level II ecoregions (Commission for Environmental Cooperation 1997, 2006) and plans to initiate a Sediment Workgroup starting in early 2008 to develop a revised sedimentation assessment protocol for future listing cycles.

I. Introduction

Clean stream bottom substrates are essential for optimum habitat for many fish and aquatic insect communities. Excessive fine sediment, or substrate fining, occurs when biologically-important habitat components such as spawning gravels and cobble surfaces are physically covered by fines (Chapman and McLeod, 1987). Substrate fining results in decreased intergravel oxygen and reduced or eliminated quality and quantity of habitat for fish, macro invertebrates, 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 (gravel, cobbles); and 3) community composition changes as substrate particle size changes from large (gravel, cobbles) to small (sand, silt, clay) (Waters, 1995).

Sediment loads that exceed a stream's sediment transport capacity often trigger changes in stream morphology (Leopold and Wolman, 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 accelerate erosion, reduce habitat diversity (pools, riffles, etc.) and place additional stress on the designated use.

This protocol is similar to the approach originally proposed by the State of Colorado (CDPH&E, 1998) and represents a simple, but quantitative, three-step assessment procedure for determining whether the narrative standard is being attained in a particular perennial stream reach by: 1) comparing changes or differences, if any, between the site of concern and a best available reference site or reference condition, 2) directly evaluating instream habitat by measuring the amount of fine particles (defined in NMAC 20.6.4.13 as 2 mm or less), and 3) verifying or confirming results obtained in number 2 by assessing and comparing benthic macroinvertebrate communities at the same sites. The State of Colorado has since modified their approach to determining impairment due to sedimentation (CDPH&E 2005).

II. Biological Monitoring by Reference Site or Condition

In order to properly assess a study site or stream reach for impairment due to excessive sedimentation, a specific reference site must be selected, or a reference condition empirically defined, for comparison. Then exposure and biological response indicators are measured and compared between the two sites. To assess for stream bottom deposits, the percent of fine substrate less than 2 mm, is the exposure indicator expressing the filling of interstitial space within the substrate, and the response indicator is the biological condition measured through macroinvertebrate community composition. Under this protocol, the reference site or condition serves as a quantitative control or yardstick to which a site may be compared and evaluated. Reference conditions are used to scale the assessment to the "best attainable" situation. This approach is critical to the assessment because stream characteristics vary dramatically across different regions (Barbour *et al.*, 1996), watersheds, or even stream segments. **The ratio between the score for the study site and the reference site (or condition) provides a percent comparability measure for each station**. The station of interest is then classified on the basis of its similarity to the reference condition and its apparent potential to support an acceptable level of biological health (Barbour *et al.*, 1999).

Reference Site Selection

The first step in determining a reference site is to identify a pool of best available sites in all geographic regions of New Mexico that have the lowest amount of anthropogenic impacts to the stream's ecosystem. Once the biological, physical, and chemical integrity of a reference site is determined to be of highest available quality, it can be compared to a similar survey site. The reference and study sites should share analogous characteristics, to the extent possible, such as elevation, gradient, geology, hydrology, watershed size, in-stream habitat (pools, substrate, etc), and riparian vegetation. If the study site is severely impaired such things as channel morphology, habitat, and streamside vegetation may be different from the reference site as a result of a departure from the reference condition. Characteristics that cannot change over time should be used as primary attributes of similarity between reference and study sites. Examples of similar attributes are elevation, geology, precipitation, gradient, etc. These characteristics of similarity between a reference and study site can be ensured through the use of ecoregion designations. Simply put, **the study site and the reference site need to be in the same ecoregion**. The Surface Water Quality Bureau (SWQB) primarily utilizes the ecoregion system developed for the United States Environmental Protection Agency (USEPA) by Griffith et al. (2006). SWQB has several initiatives in progress to further refine reference condition.

Additional or secondary characteristics that can be used to supplement and further refine the ecoregion similarity between reference and study sites are those that can be readily measured at each site such as stream type (Rosgen, 1996) and channel cross-sectional area. In other words, reference and study sites in the same ecoregion, having the same stream type (McGarrell, 1998) and cross-sectional area are extremely similar and can be readily compared. Use of these secondary characteristics in evaluating similarities for pairing of sampling sites needs further study. However, their use as an additional tool for evaluation of sites is encouraged (Barbour et al, 1999). These data can then be used in a statistical analysis to determine whether use of these characteristics is valid in site selection protocols.

In summary, the classification of streams based on ecoregions and stream type (Rosgen 1994, 1996) reduces the complexity of biological information and improves the resolution or sensitivity of biological surveys by partitioning or accounting for variation between sites. The best classification variables are those that are readily obtained from maps or regional water characteristics such as ecoregion, gradient, alkalinity, and hardness. Stream characteristics that are readily affected by human activities or occur as a biological response to physical conditions (i.e., land use, habitat condition, or nutrient concentrations) should not be used as classification variables (McGarrell, 1998; Barbour *et al;* 1999).

III. Physical Assessment

In order to assess the stream channel for excessive sedimentation that may damage or impair aquatic life and significantly alter the physical properties of the bottom, physical measurements of the stream bottom substrate must be made alongside measurements being made of the biological component. Percent fine measurements or other indicators of settled sediment should represent characteristics that can promote the best physical habitat or environment for aquatic life independent of chemical water quality. This concept is described in Figure 1 (Plafkin *et al.*, 1989), which shows the relationship between habitat and biological condition. More specifically, substrate which is sufficiently large and varied, and is not surrounded or buried by fines, appears to offer the best attributes for habitat suitability for many aquatic organisms adapted to such conditions.

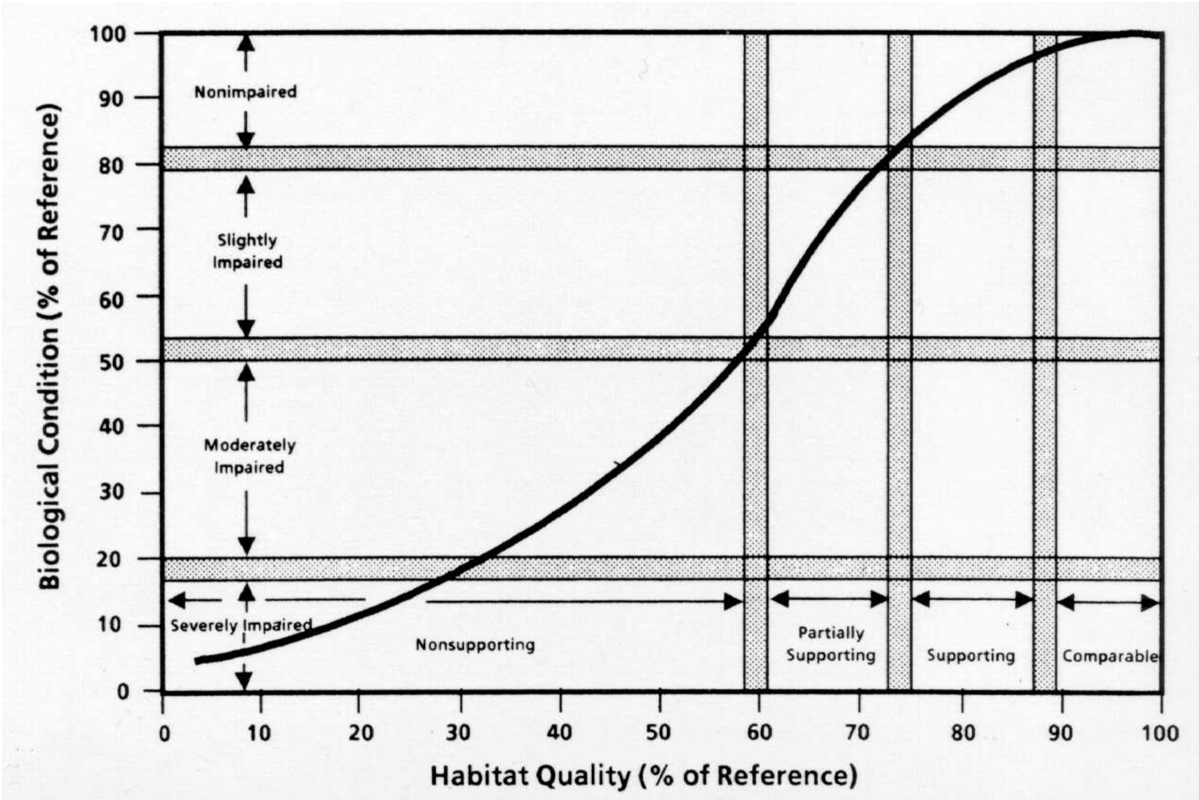

Figure 1. The relationship between habitat and biological condition (from Plafkin *et al.*, 1989).

In a study of 562 streams located in four northwestern states (namely Idaho, Oregon, Washington, and Wyoming), Relyea *et al.* (2000) suggested that changes to invertebrate communities as a result of fine sediment (2mm or less) occur between 20-35% fines throughout the reach. The most sensitive species were affected at 20% surface fines. This is the primary basis this protocol states that study sites with less than 20% fines should be considered non-impaired (fully supporting) with respect to sedimentation/siltation regardless of the percent fines determined at the reference site (Table 1, footnote 3). However this limit will be subject to review as more information is available. It is important to note some of the limitations of the data set used in the study, including that the sediment and benthic macroinvertebrate data were collected by several different methods, the sites were mainly first through fourth order streams, and 77% of the streams used in the study contained less than 30% fines. This study was expanded upon later to include 1139 western streams (Relyea 2005).

Chapman and McLeod (1987) suggest that geometric particle size and percent of the bed surface covered by fines should both be used to define habitat quality. These two criteria can be ascertained by performing a pebble count. The pebble count procedure provides not only particle size distributions (D50, D84, etc.) and percent class sizes (% sand, % cobble, etc.), but offers a relatively fast and statistically reliable method for obtaining this information. In addition, relatively rapid temporal and spatial comparisons can be made at a number of sites within a watershed. Although sufficient and varied sizes of stream bottom substrate are necessary for biological colonization, protection, and reproduction, its full potential may not be realized if the substrate surfaces are surrounded by fine sediment. In streams where the sediment load exceeds the transport capacity, the coarser particles often become surrounded or partially buried by fine sediment. Embeddedness quantitatively measures the extent to which larger particles are surrounded or buried by fine sediment (Mc Donald *et al*., 1991). Studies by Bjorn *et al.* (1974, 1977) concluded that approximately one-third embeddedness (33%) or less is probably the normal condition in proper functioning streams. Above this condition, however, insect populations decline substantially as habitat spaces become smaller and filled. By performing a pebble count, the substrate can be characterized as an aquatic habitat by quantifying fine sediment, which is compared to a reference site, and evaluated for impairment due to stream bottom deposits. Verification of impairment takes place when a stream site is biologically assessed as not attaining the designated use by sampling the macroinvertebrate community in the same location.

Pebble Count Procedure

The pebble count (Wolman, 1954) may be performed separately or as part of a larger stream inventory and assessment study (Rosgen, 1996). It is recommended that biological sampling and pebble counts always be performed concurrently to capture an accurate picture of the stressor and response, as the amount of fine substrate present and the biological community changes with stream flow and season. The intermediate axis of particles should be measured within the wetted perimeter of the channel and tallied using standard Wentworth size classes (Bunte and Abt, 2001) from 10 equidistant transects (10 particles/transect as a minimum) selected along a longitudinal stream section of the single habitat representative riffle being biologically sampled or evaluated. Habitat type must be documented. For application of this protocol developed for perennial wadeable non sand bed streams, the specific habitat sampled is representative riffle or run areas. Pebble counts may be recorded, tallied, and represented either by using the Riffle Count Tally Sheet (preferred), forms provided by Rosgen in the *Reference Reach* field book (Rosgen, 1998), or on a computer laptop at streamside using the *Reference Reach* (channel materials) software package (Mecklenberg, 1998) which can be downloaded from the State of Ohio Department of Natural Resources website (www.dnr.state.oh.us/odnr/soil+water/streammorphology.htm). These forms and additional information regarding pebble counts can be found in the NMED SWQB Standard Operating Procedures (NMED 2007a).

From the raw data, D35, D50, and D84 values can then be calculated along with percent composition values for six classes of channel materials ranging from fines (silt, clay, and sand) to bedrock. The percent fines (i.e., the percentage of measured particles <2mm in diameter) at the study site and the reference site are compared in accordance with Table 1. **Study sites showing fines of 20% or less should be considered non-impaired (fully supporting) with respect to sedimentation/siltation regardless of the percent fines** determined at the reference site. If the percent fines at the study site are lower than that of the reference site, one might consider using the study site as a new reference site provided that the other criteria mentioned previously for reference site nomination are equal or better.

Table 1. Degree of aquatic life use support affected by stream bottom deposits (sediment) evaluated by increases in percent fines relative to a reference site.[1] Adapted and modified from Figure 1, i.e. 100 - 90% = 0 - 10%).

Pebble Count Fines ≤ 2 mm (% increase over reference) [1]	**Degree of Aquatic Life Use Support (Presumptive [2])**
0 – 27%	Full Support, Comparable to Reference [1,3]
≥ 28%	Non-Support[1]

[1] Raw data values used for these percent comparisons between reference and study sites needs to meet adequate sampling size requirements.

[2] Biological assessment is necessary for confirmation and statistical database.

[3] Raw percent values of ≤20% fines (pebble counts) at a study site should be evaluated as fully supporting regardless of the percent attained at the reference site.

Optional Additional Procedures

If a “Rosgen” Level II classification is being performed in addition to the sediment protocol assessment, a separate pebble count analysis should be done to account for the larger bankfull widths, increased longitudinal distances, and multiple habitats used in various “Rosgen” protocols.

With respect to the pebble count procedure described in the sections above, SWQB has typically performed n=100 pebble counts for these sedimentation assessments (i.e., the intermediate axis of 100 substrate particles is measured and recorded). If there is a need to determine quantitative confidence levels and decrease the chance of Type I and Type II errors, a higher “n” pebble count is needed and can be determined as follows:

> In order to ascertain and/or evaluate increases in fines by pebble count methodology and its potential effect on aquatic life at the study (or impacted) site relative to the reference site, the following steps should be taken. First, download a copy of the pebble count software tool *Size-Class Pebble Count Analyzer V1 2001.xls* (651KB) by John Potyondi and Kristin Bunte from the US Forest Service’s Stream System Technology Center (aka “Stream Team”) website (www.stream.fs.fed.us) under their Download PDF Documents and Software Tools menu. Specific information concerning its use, application, sample size, data input, statistical analysis, and case studies are included in various document sections of the software and should be read prior to setting up a study and collecting any data. Next, select a reference site for each group of study sites being assessed or evaluated. Visit each reference site and collect the necessary biological samples (benthic macroinvertebrates) along with a

pebble count (n≈200-300) from the same habitat unit(s) that the biological samples were collected. Using the USFS pebble count software (preferably streamside at the reference site) calculate the percent fines (< 2 mm) encountered at the reference site under the data input tab. The percent fines can be also calculated using the *Reference Reach* channel materials software (Mecklenberg, 1998) package. Using the percent fines value at the reference site, determine the increase in percent fines needed at the study site to classify them as non-supporting (28% increase) according to Figure 1 and Table 1. This can be accomplished by multiplying the percent fines at the reference site by 1.28. Under the sample size tab in the software package, the sample sizes of both the reference and study sites can be estimated for statistical significance by filling in the worksheet provided which requires the following fields to be filled: 1) Type 1 error probability (use 0.1), 2) Type 2 error probability (use 0.2), 3) ratio of study site sample size to reference site sample size (1 is recommended, but unequal sample sizes can be used), 4) reference site percent fines or proportion (entered as a decimal percent i.e. 0.1 for 10%) , 5) and the study site percent fines or proportion (reference site fines plus 28%). Find the sampling number to cover a 28% increase. If the percent value for fines at the reference site is determined to be 20% or less, calculate the percent fines to be used in step 5 (study site fines or proportion) by choosing the greater value between either a 28% increase (reference fines multiplied by 1.28) or the percent increase obtained by using 21% as a raw fines percent at the study site(s). The program will then calculate an estimated reference and study site sample size necessary to determine whether an increase in fines of 28% is statistically valid at the 10% level of significance (90% confidence level). Once the statistical sampling size(s) of both the reference and study site has been determined, the data can be collected, entered, and compared under the analysis section of the software and then subsequently used according to Tables 1 and 3.

IV. Biological Assessment (Macroinvertebrates)

Since the narrative standard for bottom deposits is dependant on biological condition, the assessment of this physically-based narrative sedimentation criteria should be determined using a biological response variable that will link excess settled sediment levels to designated use attainment. New Mexico has chosen the community composition of macroinvertebrates as the most informative biological response in determining sedimentation impacts to aquatic life. Prior to collection of macroinvertebrates, a habitat assessment (Plafkin *et al.,* 1989; Barbour *et al.*, 1999) of the site should be performed using both visual observation and measurements made in association with any other studies (EMAP, representative pebble counts, Rosgen Level II or III, longitudinal profiles, etc.). This should include the quantification of fines for sediment assessment, but other information can be compared with the habitat information at the reference site to yield additional information as to other potential sources of use impairment other than sediment.

To utilize this protocol, benthic macroinvertebrates at the study site should be collected in a representative riffle area and may consist of either three quantitative samples using a Hess sampler or three composited kick samples (semi-quantitative) covering an area of approximately one meter for one minute. For valid biological comparisons to an individual reference site, sampling procedures should be identical between the reference and study site(s). Procedures for preservation, sorting, enumeration, identification, and analysis need to follow standard Surface Water Quality

Bureau and USEPA procedures (Barbour *et al.*, 1999; NMED 2007a).

Depending on the ecoregion of the study site, a benthic macroinvertebrate impairment determination utilizing either the Rapid Bioassessment Protocols (RBPs) or Mountain Stream Condition Index (M-SCI) as described in the main assessment protocol must be performed (see NMED/SWQB 2007b for additional details). Impairment determination procedures are presented in Tables 2 and 3 below. Application of the biological assessment or degree of impairment is a percentage comparison of the sum of selected metric scores at the study site compared to a selected reference site or condition. For example, a study site in ecoregion 24 achieving a biological assessment score greater than 83 percent of the reference site would be deemed non-impaired (full-support).

Table 2. Biological Integrity Attainment Matrix using the RBP Index [1] for Ecoregions 22, 24, 25, and 26

% Comparison to Reference Site(s)	**Biological Condition Category [2]**	**Attributes [1]**
>83%	Non-impaired (Full Support)	Comparable to best situation to be expected within ecoregion (watershed reference site). Balanced trophic structure. Optimum community structure (composition & dominance) for stream size and habitat quality.
79 – 54%	Slightly Impaired (Non Support)	Community structure less than expected. Composition (species richness) lower than expected due to loss of some intolerant forms. Percent contribution of tolerant forms increases.
50– 21%	Moderately Impaired (Non Support)	Fewer species due to loss of most intolerant forms. Reduction in EPT index.
<17	Severely Impaired (Non Support)	Few species present. Densities of organisms dominated by one or two taxa.

[1] RBP Index, percentages, and biological attributes are taken from Plafkin *et al.*, 1989. Percentage values obtained that are in between the above ranges will require best professional judgment as to the correct placement.

[2] New Mexico has combined all but the “non-impaired” category into “Non Support” per USEPA Region 6 suggestion.

Table 3. Biological Integrity Attainment Matrix using M-SCI [1] for Ecoregions 21 and 23

% Comparison to Reference Condition	Biological Condition Category [2]
>78.35	Very Good (Full Support)
78.35 – 56.70%	Good (Full Support)
56.70 – 37.20%	Fair (Non Support)
37.20 – 18.90%	Poor (Non Support)
<18.90	Very Poor (Non Support)

[1] M-SCI Index and percentages based on Jacobi et al. (2006).

[2] New Mexico has combined the "very good" and "good" categories into "Full Support," while the remaining categories are lumped into "Non Support."

V. Final Assessment: Combined Application of Physical and Biological Assessments

Upon completion of physical and biological assessments detailed above, a final assessment can be determined from the matrix in Table 4. This is accomplished by taking the increases between percent fines and matching it with the appropriate physical assessment use support category in the far left column. The physical assessment use category can then be matched with the biological assessment use category located on the top row to obtain a use support category for aquatic life use based on biological and physical indicators of increased stream bottom sediment.

It is noteworthy that under certain situations, the physical indicators (i.e., percent fines) may indicate full support, while the biological assessment may indicate non support. In these cases, factors other than sediment alone, such as extremes in pH, low oxygen, temperature, lack of stream flow, and toxicity, etc. may be responsible for a reduction in biological integrity at a particular site. In this case, the assessment unit should be listed under Category 5C with an impairment of "Benthic-Macroinvertebrate Bioassessments (Streams)" on the Integrated Clean Water Act §303(d)/305(b) list until the exact cause of impairment is determined. Potential causes of impairment such as those listed above will then be quantified by examining such things as chemical and physical data collected at or near the site in question.

Table 4. Final assessment matrix for determining aquatic life use support categories by combining physical and biological assessments as sediment indicators

Biological / Physical	**Impaired (Non Support)** RBP Index < 79% of ref [1] M-SCI Score < 56.70 [2]	**Non-impaired (Full Support)** RBP Index > 84% of ref [1] M-SCI Score > 56.70 [2]
Non-Support Percent Fines >28% increase over reference	☐ Non-Support	☐ Full Support
Full Support Percent Fines <27% increase[3] over reference	☐ Full Support (Sedimentation/Siltation); ☐ Non-Support (Unidentified Biological Impairment)[4]	☐ Full Support

[1] RBP Index should be used in Ecoregions 22, 24, 25, and 26. RBP Index score based on Plafkin et al. (1989). The 4% gap allows for some best professional judgment.

[2] M-SCI should be used in Ecoregions 21 and 23. M-SCI and Score based on Jacobi et al. (2006).

[3] Raw percent values of ≤20% fines (pebble counts) at a study site should be evaluated as fully supporting regardless of the percent attained at the reference site.

[4] Reduction in the relative support level for the aquatic life use in this particular matrix cell is probably not due to sediment. It is most likely the result of some other impairment (temperature, D.O., pH, toxicity, etc.), alone or in combination with sediment. Label as Category 5C on the Integrated §303(d)/305(b) list as described in the text above to indicate that further study is needed.

VI. Step by step Evaluation Procedure to Determine Impairment

1. Select study site(s) along with a comparable reference site or reference condition (depending on ecoregion determination).

2. Perform a bio survey of the benthic macroinvertebrate community at each reference in which a pebble count procedure is to be performed.

3. Do a pebble count evaluation at the reference sites. For application of this protocol, pebble counts must be done in the same habitat unit(s) where the macroinvertebrates were collected. If it is necessary to document confidence levels and reduce Type 1 and 2 error, it is necessary to determine the exact sample size (see page7) needed at each study site based on the evaluated sample size and determined percent fines at each reference site. This calculation should preferably be done streamside at the reference site using the pebble count analyzer software so that sufficient data can be collected with one visit. However, it is acceptable to do the calculations in the office, but realize that an additional visit to the stream may be required if your sample size is inadequate.

4. Perform a bioassessment of the benthic macroinvertebrate community at each study site, accompanied by collection of a pebble count of sufficient size to be statistically significant.

5. Compare the physical data between the study and reference sites by dividing the results obtained at the study site by that of the reference site to obtain percent “comparability.”

6. Compare the biological data between the study site and reference site (if using RBP index) or reference conditions (if using M-SCI) by dividing the results obtained at the study site by that of the reference site to obtain percent “comparability.”

7. Using the final assessment matrix (Table 4), locate the proper support cells for both the physical and biological percentages calculated in steps 5 and 6, and determine the final degree of support for the applicable aquatic life use.

VII. Future Development

The various support categories along with the ranges of percents used to quantify them are based on slight modifications of those used in EPA’s Rapid Bioassessment Protocols (Plafkin *et al.*, 1989) and the State of Colorado Sediment Task Force original sediment protocol (CDPH&E, 1998). They are intended to provide an initial base or reference point from which to proceed in the collection and interpretation of data regarding the adverse effects of sediment on biological communities in the State of New Mexico. As this guidance is applied and data from various sites are collected, it will be necessary to adjust the standards attainment matrices in terms of the percentage of reference conditions for physical stream bottom substrate “indicators” and biology. It is imperative to the validity, growth, and evolution of this document that the Surface Water Quality Bureau establish a proper database from which the valid statistical treatment may be employed to strengthen and adjust the matrix tables when deemed necessary through the addition of data generated from this protocol. Also, it is critical that the metrics (EPT, diversity, standing crop, shredders/total, etc.) used for evaluating the macroinvertebrate communities also undergo review in order to select those metrics that are most sensitive to changes or increases in stream bottom sediment. In addition, it may be prudent to engage the services of a statistician to review and strengthen these endeavors. SWQB has initiated the above items, and is planning to propose and implement several improvements to the sedimentation impairment determination protocol for development of the 2010 Integrated List.

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APPENDIX E

NUTRIENT ASSESSMENT PROTOCOL FOR WADEABLE, PERENNIAL STREAMS

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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I. Purpose and Applicability

This document establishes an assessment protocol for determining nutrient impairment status of wadeable perennial streams. While a few streams have segment specific numeric criteria for total phosphorus, 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* states that, "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" (NMWQCC 2007). Excess amounts of nitrogen and phosphorus can cause undesirable aquatic life (i.e. community composition shifts or toxic algal blooms) and/or result in a dominance of nuisance species (i.e. excessive and/or unsightly algal mats or surface plankton scums). 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 contact recreation, domestic water supply, or coldwater aquatic life.

This protocol will be used to determine if a stream reach (i.e., assessment unit) is meeting the narrative criterion. If an assessment unit is determined to be impaired, it will be added to the Integrated Clean Water Act §303(d)/§305(b) List of Assessed Waters as impaired, and a total maximum daily load (TMDL) planning document will be written. This protocol is a dynamic document that will be refined as more data are collected, enabling more precise classification of streams and definition of relationships between nutrient concentrations, indicators, and impairment in New Mexico streams.

II. Background

The presence of some aquatic vegetation is normal in streams. Algae and macrophytes provide habitat and food for aquatic organisms. However, excessive aquatic vegetation is not beneficial to most stream life and may change the aquatic community structure. High nutrient concentrations may promote an overabundance of algae and floating and 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 and high turbidity) cause of most problems related to excessive nutrient enrichment. In addition, algal blooms often cause taste and odor problems in drinking water supplies. Blooms of certain types of blue-green (cyanobacteria) and golden (*Prymnesium* spp.) algae can produce toxins that are detrimental to animal and human health. One of the most expensive problems caused by nutrient enrichment is increased treatment required for drinking water.

Some increases in primary productivity can increase the abundance of invertebrates and fish in streams. However, excessive plant growth and decomposition can limit aquatic populations by decreasing dissolved oxygen (D.O.) concentrations. Plant respiration and decomposition of dead vegetation consume D.O. Lack of D.O. stresses aquatic organisms and can cause fish kills. Nocturnal respiration can cause oxygen depletion in waters with high primary productivity and low aeration rates. Even relatively small reductions in D.O. can have adverse effects on both invertebrate and fish communities (USEPA 1991). Dissolved oxygen saturation levels of greater than 120% may be harmful to aquatic life (Behar 1996). Development of anaerobic conditions will alter a wide range of chemical equilibria and may mobilize certain pollutants and generate noxious odors (USEPA 1991).

The variables referred to in this document are measurable water quality parameters that can be used to evaluate the degree of eutrophication in streams. The variables consist of causal variables (nutrient concentrations), and response variables (algal biomass, pH, and D.O.). Relationships between these variables are not as tightly coupled in rivers and streams as they are in lakes. Many other factors come into play in lotic systems, including flow regime, channel morphology, bed composition, degree of shading, and grazing by invertebrates. Many of these factors will be noted during the nutrient survey to aid in interpretation of measured variables.

The highly variable flows and spatially interrupted nature of many streams in arid landscapes can have great influence on both nutrient loading and biomass production. In the arid southwest, low and middle elevation streams may have naturally high levels of productivity due to the long growing season, high temperatures, open canopy, and the consequential tight cycling of available nutrients (AZDEQ 1996, Fisher and Grimm 1983).

III. Nutrient Threshold Development Process

In February of 2002, the US Environmental Protection Agency (EPA) released nine nutrient water quality criteria documents. These documents contained EPA's recommended criteria for total phosphorus (TP) and total nitrogen (TN) for aggregate ecoregions. The criteria were derived using procedures described in the *Rivers and Streams Nutrient Criteria Technical Guidance Manual* (USEPA 2000). These aggregate ecoregion nutrient criteria were intended as a starting point for states and authorized tribes to develop more refined nutrient criteria.

Refinement of the recommended draft ecoregion nutrient criteria was conducted by Evan Hornig (EPA), a former USGS employee assisting states in EPA Region 6 with development of nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the U.S. Geological Survey (USGS), and the Surface Water Quality Bureau (SWQB) to create a regional dataset for New Mexico. The revised threshold values were calculated based on EPA procedures and the median for each Level III ecoregion (Omernik 2006).

A third round of analysis was conducted by SWQB/MAS to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) was combined with Archival STORET data for 1998, and 1999-2006 data from the SWQB in-house database.

Once the dataset was compiled, the data were divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For this project "rivers" were defined as systems that cannot be monitored effectively with methods developed for wadeable streams and generally have drainage areas greater than 2,300 square miles. The systems included in the "rivers" waterbody type and consequently exempt from this protocol are: 1) the San Juan River from below Navajo Reservoir to the Colorado border near Four Corners, 2) the Rio Grande in New Mexico, 3) the Pecos River from below Sumner Reservoir to the Texas border, 4) the Rio Chama from below El Vado Reservoir to the Rio Grande, 5) the Canadian River below the Cimarron River , 6) Rio Puerco below the confluence with the Rio San Jose, and 7) the Gila River below Mogollon. GIS was used to identify data from river sites as defined above.

Figure 1. Level III and IV Omernik ecoregions

Level III and IV Omernik ecoregions (Figure 1) as well as the designated aquatic life use were assigned to all stream sites using GIS coverages and the station's latitude and longitude. New Mexico has 7 aquatic life uses: high quality coldwater, coldwater, marginal coldwater, warmwater, marginal warmwater, aquatic life, and limited aquatic life. Aquatic life and limited aquatic life sites were removed from the dataset used in this analysis as they generally represent waters with ephemeral or intermittent flow, naturally occurring rapid environmental changes, high turbidity, fluctuating temperatures, low dissolved oxygen content or unique chemical characteristics and are not wadable perennial streams. The 5 other aquatic life uses were divided into 3 groups:

1. Coldwater (CW) – those segments having only coldwater uses (high quality coldwater or coldwater)
2. Transitional (T)– waterbodies with marginal coldwater or both cold and warmwater uses
3. Warmwater (WW) - waterbodies having only warmwater uses (warmwater or marginal warmwater)

Because of the limited area and number of sites in the Madrean Archipelago (79), Western High Plains (25), and Colorado Plateau (20) ecoregions, these data where grouped with the most similar ecoregions; the Madrean Archipelago with the Chihahuan Desert and the Colorado Plateau with the Arizona New Mexico Plateau. The Western High Plains had no stream data as the only surface waters are playas, therefore this ecoregion was not included in the analysis.

The stream data were divided first by ecoregion then by aquatic life use (ALU). When there were less than 60 data points in the warmwater group, these data were combined with the transitional group to form the Trans/WW group. The 50th percentiles (medians) were calculated for each parameter and ecoregion/aquatic life use group. The results are shown in **Table 1**. The total nitrogen value was calculated by adding the percentiles for TKN and N+N.

There was no difference in the TP threshold values for the coldwater and trans/ww groups in ecoregion 21. However, when examining the different level IV ecoregions there was a significant difference in the TP data from the volcanic and the other groups. This led to the development of a separate threshold value for the ecoregion 21 volcanic group. The threshold value was calculating by determining the median of the data from ecoregions 21g and 21h as well as 21j in the Jemez Mountains. The Grassland Parks (21j) of the Jemez Mountains were included in this group as they are of volcanic origin and have the characteristic higher background TP.

Table 1. Ecoregion and Aquatic Life Use Nutrient Thresholds for Streams (mg/L), using regional data and the 50th percentile (SWQB 2007).

	21-Southern Rockies		22-AZ/NM Plateau		23-AZ/NM Mountains		24-Chihuahuan Desert	26-SW Tablelands		
TN	0.25		0.35		0.25		0.53	0.38		
TP	0.02		0.05		0.02		0.04	0.03		
ALU	CW	T/WW (volcanic)	CW	T/WW	CW	T/WW	T/WW	CW	T	WW
TN	0.25	0.25	0.28	0.48	0.25	0.29	0.53	0.25	0.38	0.45
TP	0.02	0.02 (0.05)	0.04	0.09	0.02	0.05	0.04	0.02	0.03	0.03

IV. Assessment Procedure

The primary question to be answered is: **Is this reach impaired due to nutrient enrichment?** Nutrient impairment occurs where algal and/or macrophyte growth interferes with designated uses, thus preventing the reach from supporting these uses. Algal biomass is the most important indicator of nutrient enrichment, as algae cause most problems related to excessive nutrient enrichment. Algae and macrophytes may be a nuisance when 1) there are large amounts of rotting algae and macrophytes in the stream; 2) the stream substrate is choked with algae; 3) large diurnal fluctuations in D.O. and pH occur; and/or 4) there is a release of sediment-bound toxins.

This protocol uses a two-tiered approach to nutrient assessment. The two levels of assessment are used in sequential order to determine if there is excessive nutrient enrichment. If a Level I assessment indicates nutrient enrichment, a Level II assessment will be used to test this finding and provide more quantitative indicators. Level I is a screening level assessment that is observational with limited measurements. It is based on a review of available data, including on-site observations and measurements of chemical parameters. Level II is based on quantitative measurements of selected indicators. If these measurements exceed the numeric nutrient threshold values, indicate excessive primary production (i.e., large D.O. and pH fluctuation and/or high chlorophyll *a* concentration), and/or demonstrate an unhealthy benthic community, the reach is considered to be impaired. Both assessments use data that are collected during water quality and nutrient surveys and compiled on the Nutrient Survey Forms. These data, along with reports from the Surface Water Quality Bureau (SWQB) in-house water quality database, are used to complete the Nutrient Assessment Form and conduct the assessment.

SWQB has adopted a multi-indicator approach to conduct a more robust assessment and account for diverse lotic systems and dynamic nutrient cycling. Both cause and response variables are used. It is important to incorporate response variables into the assessment as ambient water column nutrient "concentrations cannot indicate supply because large biomass of primary producers may have a very high nutrient demand and render inorganic nutrient concentrations low or below detection" (Dodds and Welch 2000). The response variables of algal biomass, D.O., and pH are incorporated into the assessment. For D.O. concentration and pH, criteria are based on designated uses of an assessment unit, as indicated in the *State of New Mexico Standards for Interstate and Intrastate Surface Waters* (NMWQCC 2007) (**Table 2**).

Table 2. Criteria for dissolved oxygen concentration and pH

Designated Use	**Dissolved Oxygen**	**pH**
High Quality Coldwater Aquatic Life	6.0 mg/L	6.6 – 8.8
Coldwater Aquatic Life	6.0 mg/L	6.6 – 8.8
Marginal Coldwater Aquatic Life	6.0 mg/L	6.6 – 9.0
Warmwater Aquatic Life	5.0 mg/L	6.6 – 9.0
Marginal Warmwater Aquatic Life	5.0 mg/L	6.6 – 9.0

The assessment may use either a reference or threshold approach (USEPA 2000). For most streams, indicators will be compared to thresholds from published literature. If, however, the researcher feels that these thresholds are not appropriate for the class of stream being assessed, a reference site approach will be used. A suitable reference reach will be surveyed and indicators from the study reach will be compared to those of the reference reach rather than established thresholds. This is to account for streams that may have naturally high productivity because of regional geology, flow regime, or other natural causes.

A. Level I Nutrient Assessment

Level I Nutrient Assessment will use water quality data and field observations that have been compiled for each assessment unit. Data from the SWQB database, field sheets, and other readily available sources (such as USGS and NPDES permittees) should be utilized. These data are compiled on the Level I Nutrient Survey Form and used to complete the Level I Assessment Form. This assessment should be conducted during the summer, just prior to the nutrient and benthic macroinvertebrate index period (August 15 – November 15). The Level I assessment will be conducted at this time to utilize as much water quality survey data as possible and leave enough time to conduct the Level II Nutrient Survey at those sites that the Level I Assessment indicates the need. The following parameters are used in the Level I assessment:

Algae and Macrophyte Coverage:

Macrophyte is a general term that applies to many types of aquatic vegetation including flowering vascular plants, mosses, and ferns. Nutrients supplied from sediments combined with those in solution are usually adequate to meet nutritional demands of rooted aquatic plants, even in oligotrophic systems (Barko and Smart 1986). Macrophyte growth in streams is usually controlled by temperature, substrate characteristics, light limitation, or flow regimes. Phosphorus, nitrogen, and other nutrients may be taken up by submerged macrophytes from sediment, uncoupling rooted macrophyte growth from water column nutrient concentrations (Welch 1992). As bottom sediments act as the primary nutrient source for rooted macrophytes, they will not be used as indicators of nutrient enrichment. However, abundance of rooted macrophytes will be noted during nutrient surveys to explore their relationships with other variables.

Algae are non-vascular plants without true roots, stems, or leaves. They are mostly aquatic and range from tall stalks of kelp to fuzzy growths of green filamentous algae to microscopic, silica-encased diatoms. In the context of this document, “algae” refers to the visible growth of non-rooted aquatic vegetation attached to the stream substrate. The extent of algal coverage of a streambed can be an important indicator of algal biomass problems (USEPA 2000). As nutrient enrichment increases, the percent of streambed covered with algae increases (Welch et al. 1987, Lohman et al. 1992, Biggs 1996). The Level I assessment uses percent algal coverage as a qualitative indicator of algal biomass.

A visual estimate of the percent of both algal and macrophyte coverage will be recorded. Generally, this will be determined at each site once in the spring, summer, and fall as part of SWQB water quality surveys. Coverages of greater than 50% in any season may indicate nutrient enrichment. On the Nutrient Assessment Form, indicate if this 50% threshold is exceeded during any season.

Periphyton Abundance:

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). Periphyton is composed primarily of microscopic organisms, while algae noted in the percent coverage is mainly macroalgae. The extent of periphyton coverage of a streambed can be an important indicator of algal biomass problems (USEPA 2000). A rating of periphyton abundance will be recorded during the nutrient survey. The rating is from 0 to 5 as follows: **0)** rough with no apparent growth; **1)** thin layer of periphyton is visible (tracks can be drawn in the film with the back of your fingernail); **2)** 0.5 to 1 mm thick; **3)** 1 to 5 mm thick; **4)** 5 to 20 mm thick; and **5)** >20 mm thick. Periphyton thickness of >l mm (rating of >2) may indicate nutrient enrichment. On the Nutrient Assessment Form, indicate if the rating is greater than 2 during any season.

Anaerobic conditions:

Anaerobic conditions can be indicative of excessive plant growth and decay. Decomposition of organic material uses oxygen, and excessive decomposition can create anoxic conditions. Anaerobic decomposition that takes place in anoxic conditions produces hydrogen sulfide with an associated "rotten egg" smell and black color. Note on the Nutrient Assessment Form if an anoxic layer is found under rocks and/or in depositional areas.

Dissolved Oxygen and pH:

High rates of primary production can cause D.O. supersaturation and high pH during the day. Photosynthesis and respiration alter the amount of carbon dioxide (CO_2) in water, which affects pH. Photosynthesis removes CO_2 from water, which forces buffers to remove hydrogen ions, increasing pH. Respiration takes place at night (when photosynthesis does not occur) and adds CO_2 to water resulting in an increase in the number of hydrogen ions, thereby lowering the pH. Diurnal pH fluctuation will be greater in streams with low buffering capacity, so this may not be a responsive indicator in many NM streams. Dissolved oxygen deficit and high pH are the algal related problems most affecting aquatic life (Dobbs and Welch 2000). Unfortunately, it is difficult to test for D.O. deficit, as it usually occurs in the early morning after respiration has been occurring all night. Thus, D.O. percent saturation, which typically peaks in late afternoon, will be used as an indicator in the Level I Assessment. The data set should include all of the measurements taken in the Assessment Unit. Note on the Nutrient Assessment Form if any D.O. saturation readings are above 120%. Determine if any pH readings exceed 8.8 for high quality coldwater and coldwater aquatic life uses and 9.0 for marginal coldwater and warmwater aquatic life uses.

Water Chemistry:

Print out and attach the Nutrient Report from the SWQB water quality database. Use the data in the report to calculate the exceedence ratio for TN and TP. The exceedence ratio is the number of times that the TN or TP concentration is above the ecoregion nutrient threshold values (see Table 1), divided by the total number of samples in the data set. The data set should include all of the samples taken in the Assessment Unit, i.e. if more than one site occurs in the assessment unit, combine the data from all sites in calculating the exceedence ratio. It may also be helpful to calculate the exceedence ratio for individual sites in an assessment unit to determine where nutrient impairment and/or loading are occurring. Record the exceedence ratios for the entire dataset on the Level I nutrient Assessment Form. An exceedence ratio of >15% may indicate nutrient enrichment (NMED/SWQB 2007).

Analysis and Interpretation:

Record appropriate data on a **Level I Nutrient Assessment Form**. If **two or more** of the observations noted above indicate nutrient enrichment, a Level II Assessment should be conducted because attainment status is uncertain. If one or none of the above observations indicate enrichment, the assessment unit is considered to be Fully Supporting with respect to New Mexico's narrative nutrient standard.

B. Level II Nutrient Assessment

A Level II Assessment is based on quantitative measures of indicators. It is conducted if the Level I Assessment indicates potential nutrient impairment. The Level II Assessment uses data that will be collected during a Level II Nutrient or EMAP Surveys and compiled on the Level II Nutrient Survey or EMAP Forms.

Diurnal Cycles:

Algal biomass above nuisance levels often produces large diurnal fluctuations in D.O. and pH (Figure 1). Photosynthesis and respiration by dense algal mats commonly cause water quality criteria exceedences. Dissolved oxygen concentration, local D.O. percent saturation, and pH are all used as indicators of nuisance levels of algal biomass. The magnitude of diurnal swings in D.O. and pH will depend on several factors, such as turbulence (which affects aeration), light, temperature, buffering capacity, and the amount and health of algal and/or macrophyte biomass.

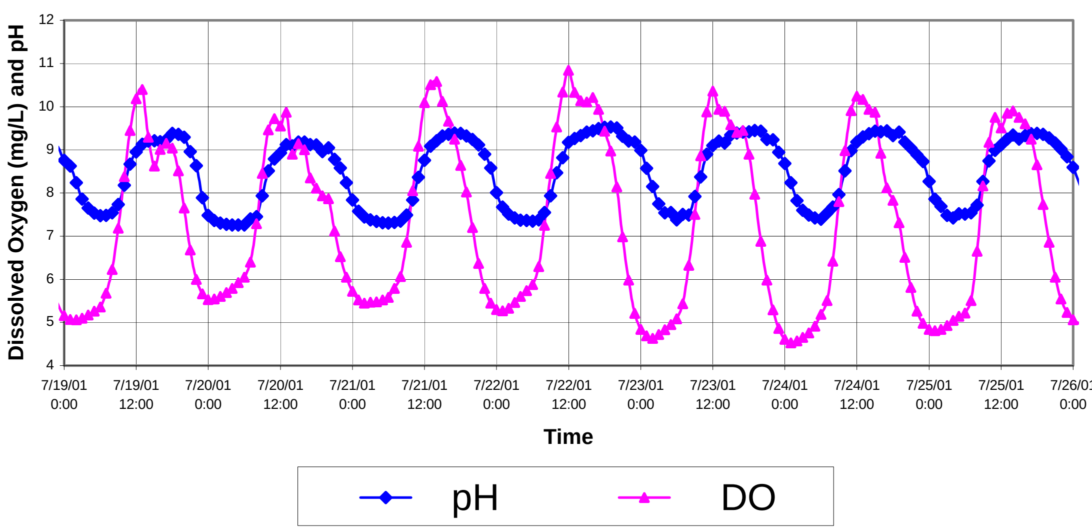

Figure 1. Diurnal patterns in dissolved oxygen and pH in East Fork Jemez, below La Jara Creek (July 18 - 26,2001)

Higher temperatures tend to enhance algal growth and may increase photosynthesis and respiration, resulting in greater variation in diurnal D.O. and pH values. Observe pre-dawn measurements for minimum D.O. concentrations and afternoon hours for maximum pH and D.O. percent saturation. Aquatic organisms are most affected by maximum pH and minimum D.O., rather than by daily means of these variables (USEPA 2000).

Assessment of D.O. and pH may be made with large sonde dataset or from grab samples. Grab sample assessments will only be used when a large sonde data set is not available. Large sonde datasets are generated by deploying a sonde (multi-parameter, continuous recording device) set to take hourly readings of D.O., pH, specific conductance, temperature, and turbidity for multiple days. These datasets provide a more robust assessment as the diurnal cycles of D.O. and pH are recorded over multiple dates and times. The *Protocol for Assessment of Large pH Data Sets* and the *Protocol for Assessment of Dissolved Oxygen Data Collected with Continuous Recording Devices* should be used to assess pH and D.O. data from a sonde (appendix in NMED/SWQB 2007). The D.O. thresholds presented in **Table 3** are based on both the designated use and the life stage present at the time of sampling. Based on these assessments, note on the Nutrient Assessment Form whether or not the designated use is being supported.

Table 3. Water Quality Threshold Values for Dissolved Oxygen

	Coldwater values		**Warmwater values**
	Early life stages (1 Nov - 31 Jul at ≥ 2750 m; 1 Nov - 30 Jun at < 2750 m)	**Other life stages**	**All life stages**
Combined Instantaneous Minimum	8.0 mg/L; 95% saturation	6.0 mg/L; 90% saturation	5.0 mg/L; 90% saturation
Local percent saturation instantaneous minimum	85	75	75

If a sonde was not deployed for multiple days, use field data from the water quality and nutrient surveys to calculate an exceedence ratio for pH, local D.O. percent saturation, and D.O. concentration. Be sure to use data from all of the sites in the assessment unit, not just the site where nutrient survey was conducted. For D.O. percent saturation, a threshold of 120% is used. For grab sample assessments, D.O. percent saturation is used in addition D.O. concentration as it tends to be collected during the day when D.O. is high and not during pre-dawn time period when low levels occur. The criteria for D.O. concentration and pH are based on designated use (see **Table 2**). For D.O., the criterion is 6 mg/L for coldwater aquatic life uses and 5 mg/L for warmwater aquatic life uses. The threshold value for pH is 8.8 for high quality coldwater and coldwater aquatic life uses and 9.0 for marginal coldwater and warmwater aquatic life uses. If an assessment unit has both warmwater and coldwater uses, the more stringent criterion should be used to be protective of all uses. An exceedence ratio of greater than 15% may indicate nutrient enrichment (NMED/SWQB 2007). Sondes will not be deployed if there is a high risk of damage to, or loss of, the instrument due to high flows or vandalism.

Water Chemistry:

Use the nutrient report from the SWQB water quality database. Print and attach a current report so that all available data are used. Record the TN and TP concentrations collected during the nutrient survey as well as the exceedence ratio for the entire dataset. Be sure to use data from all of the sites in the assessment unit, not just the site where nutrient survey was conducted, i.e. if more than one site occurs in the assessment unit, combine the data from all sites in calculating the exceedence ratio. The exceedence ratio is the number of times that the TN or TP concentration is above the nutrient threshold values (**Table 1**), divided by the total number of samples in the dataset. An exceedence ratio of >15% may indicate nutrient enrichment (NMED/SWQB 2007).

Algal Sampling:

In streams, benthic algae production and biomass are the most useful parameters in monitoring changes in water quality (USEPA 1991). Chlorophyll *a* concentration is used as a surrogate for algal biomass and is generally the most appropriate variable to monitor (USEPA 2000). Record the results of chlorophyll *a* concentration in µg/cm^2. If more than one chlorophyll *a,* record the average for each site visit. Do not average samples taken on different days.

In *Rapid Bioassessment Protocols (RBP) for Use in Streams and Wadeable Rivers* (USEPA 1999), nuisance levels of algal biomass are defined as: greater than 10 micrograms chlorophyll *a* per square centimeter (>10 µg/cm^2). EPA's *Nutrient Criteria Technical Guidance Manual for Rivers and Streams* lists a number of algal biomass thresholds ranging from 100 – 200 mg/m^2 (10 to 20 µg/cm^2) (USEPA 2000). SWQB measured the chlorophyll *a* concentration at reference sites in each of the ecoregions and calculated the 95th percentile for each ecoregion. These threshold values are shown in the **Table 4**.

Table 4. Chlorophyll *a* Ecoregional Threshold Values in µg/cm^2

21-Southern Rockies	22/20-AZ/NM Plateau	23-AZ/NM Mountains	24/79-Chihuahuan Desert	26/25-SW Tablelands
n = 32	n = 12	n = 18	n = 14	n =12
5	8	7	17	11

Benthic Diatoms (OPTIONAL COMPONENT UNDER DEVELOPMENT):

SWQB is currently in the process of developing a regional SCI and assigning tolerance values for diatom communities of New Mexico. Once a SCI has been developed for New Mexico and organism tolerance values are verified these biological indicators will be used in the weight of evidence nutrient assessment.

Algal Bioassays (OPTIONAL COMPONENT INCLUDED IF NECESSARY):

If stream observations indicate that algal biomass may be a problem and/or there is an NPDES permit that discharges within the assessment unit, a limiting nutrient analysis and algal growth potential test may be performed. Currently, researchers at the University of New Mexico (UNM) are conducting these analyses for SWQB.

The procedures for determining limiting nutrients and algal growth potential are outlined in *The Selenastrum capricornutum Prinz Algal Assay Bottle Test* (USEPA 1978) and *Biostimulation and Nutrient Assessment Workshop* (USEPA 1975). Results are given in dry weight measurements in accordance with the EPA procedure. Dry weight is used to define the Productivity Classification as described in **Table 5**. Moderately High Productivity and High Productivity may be indicative of nutrient enrichment.

Table 5. Productivity Classifications from algal bioassay results.

Algal Growth (mg dry wt./L)	**Classification**
0.00 – 0.10	Low Productivity
0.11 - 0.80	Moderate Productivity
0.81 – 6.00	Moderately High Productivity
6.10 – 20.00	High Productivity

Analysis and Interpretation:

Record appropriate data on a **Level II Nutrient Assessment Worksheet**. Compare each indicator to the associated threshold value. Note those indicators that exceed the threshold value on the **Level II Nutrient Assessment using Threshold Values** Form. If **three or more** indicators exceed the threshold, the assessment unit is determined to be not supporting.

If the study reach is believed to have naturally high productivity because of geology, flow regime, or other natural factors, a reference site approach may be used. Identify an appropriate reference reach for the study area and conduct a Level II Nutrient Survey of the reference reach near the same time that the study reach is surveyed. Whenever possible, select an existing survey site as a reference, as existing sites will have associated water quality data. Compare each indicator from the two sites, including algal biomass, and chemical and physical parameters, as well as benthic community composition, when appropriate. Use statistical tests to determine significant difference when feasible. When the number of samples from each site is sufficient (n is greater than 4), the rank-sum test (a.k.a. Wilcox or Mann-Whitney test) will be used to test if there is a high probability that the study site is different than the reference site. If the number of measurements is ≤4, then best professional judgment will be used to determine if the parameters are different at the sites (see notes on the **Level II Assessment using a Reference Site** Form for general guidelines). If indicators from the sites are in the same range, the assessment unit will not be listed. If, however, two or more indicators are substantially different, the assessment unit will be determined to be not supporting.

Page of Evaluator:

Date of Assessment: Date of Assessment Protocol used: Date of WQS used:

Level I Nutrient Assessment Form

Assessment Unit:	
Site Location:	
	Ecoregion:
	Aquatic Life Uses:

Algae and Macrophytes: mark **True** if the indicator is present during one or more seasons.

Percent algal cover is greater than 50%: True False
Percent macrophyte cover is greater than 50%: True False

Periphyton and Substrate: mark **True** if the indicator is present during one or more seasons.

0 - rough with no apparent growth, **1 -** thin layer of periphyton is visible, **2 -** thickness of 0.5-1 mm, **3 -** 1 mm to 5 mm thick, **4 -** 5 mm to 20 mm thick, **5 -** >20 mm thick Rating of the periphyton on coarse substrate is >2: True False
Anoxic layer present (black, H_2S layer): True False

D.O. Percent Saturation and pH: mark **True** if the indicator is present at any time
The pH criterion is 8.8 for high quality coldwater and coldwater aquatic life (CWAL) uses, and 9.0 for marginal coldwater and warmwater aquatic life (WWAL) uses.

D.O. percent saturation (local) is greater then 120%: True False
pH value is greater then 8.8 for CWF or 9.0 for WWF: True False

Water Chemistry: attach nutrient report from SWQB database.

Total Nitrogen (mg/L):	**Total Phosphorus (mg/L):**
Ecoregion/ALU Threshold (see Table 1):	Ecoregion/ALU Threshold (see Table 1):
Exceedence Ratio:	Exceedence Ratio:

Move to a Level II Assessment if two or more of the following occur:

- ____ Algae cover on stable substrate is >50%
- ____ Periphyton rating is >2
- ____ Anoxic layer is present
- ____ D.O. percent saturation (local) is greater then 120%
- ____ pH value is greater then appropriate criterion
- ____ Total nitrogen is above the ecoregion criterion or exceedence ratio is >15%
- ____ Total phosphorus is above the ecoregion criterion or exceedence ratio is >15%

Conduct Level II Assessment: Yes No – Reach is Full Support for nutrients

Level II Nutrient (Office) Assessment Worksheet

Sonde: Use the *Protocol for Assessment of Large pH Data Sets* and the *Protocol for Assessment of Dissolved Oxygen Data Collected with Continuous Recording Devices* to assess pH and D.O. if multiple day Sonde data are available. Attach Assessment Form. If sonde data are not available, use grab sample data to calculate an exceedence ratio for pH, local D.O. percent saturation, and D.O. concentration.

Site Location:	
Multiple-day Deployment	**Grab Samples**
Assessment of dissolved oxygen:	D.O. % saturation exceedence ratio:
Supporting Not supporting	
Assessment of large pH datasets :	D.O. minimum exceedence ratio:
Supporting Not supporting	
DO fluctuations > 3mg/L: Yes No	pH exceedence ratio:
Notes:	

Nutrient Survey Water Chemistry: attach updated nutrient report from SWQB database and calculate the exceedence ration for the entire assessment unit.

Total Nitrogen (mg/L)	**Total Phosphorus (mg/L)**
Ecoregion/ALU Threshold (see Table 1):	Ecoregion/ALU Threshold (see Table 1):
Exceedence Ratio:	Exceedence Ratio:
Notes:	

Algal Sampling: record results of chlorophyll *a*.

Ecoregion chlorophyll *a* threshold value in µg/cm^2 (see Table 4):
Chlorophyll *a* (µg/cm^2):
Notes:

Benthic Diatoms (OPTIONAL): see notes on following page.

Date:
Reference site:
Stream Condition Index (SCI) Score:
Notes:

Algal Bioassays (OPTIONAL): Attach results.

Date collected:	Limiting nutrient:
Algal productivity: low moderate moderately high high	
Notes:	

NOTES: Total Nitrogen is calculated by adding Total Kjeldahl Nitrogen plus Nitrate + Nitrite. In the event that Nitrate + Nitrite or Total Kjeldahl Nitrogen are below the detection limit, a value of one half the detection limit will be used (Gilbert 1987).

Put NA (not available) in boxes for parameters that were not collected. Benthic diatom indicators will be added to the assessment once the index is developed and threshold values are verified for New Mexico.

 Evaluator:

Date of Assessment: Date of Assessment Protocol used: Date of WQS used:

Level II Nutrient Assessment Form (using Threshold Values)

Assessment Unit:	
Site Location(s):	
	Ecoregion:
	Aquatic life Uses:

An Assessment Unit will be determined to be not supporting if **three or more** of the following indicators are present (if not all of the indicators have been measured, the presence of two of the following indicators will be assessed as not supporting). Check all indicators that exceed the threshold values below.

- ____ Total nitrogen is above the ecoregion/ALU threshold in >15% of samples
- ____ Total phosphorus is above the ecoregion/ALU threshold in >15% of samples
- ____ Dissolved Oxygen threshold is exceeded
  - (____) determined to be **not supporting** using the assessment protocol for Data Collected with Continuous Recording Devices
  - (____) >15% of grab samples exceeded 120%
  - (____) >15% of grab samples are below the applicable standard
- ____ pH threshold is exceeded
  - (____) determined to be **not supporting** using the assessment protocol for large pH data sets
  - (____) >15% of grab samples exceeds appropriate criterion
- ____ The Algal Bioassay indicates moderately high or high algal production
- ____ Chlorophyll *a* ecoregion threshold is exceeded

Circle One:	**Fully supporting**	**Not supporting**
Notes:		

Page of Evaluator:

Date of Assessment: Date of Assessment Protocol used: Date of WQS used:

Level II Nutrient Assessment Form (using a Reference Site)

Assessment Unit:	
Site Location(s):	
Reference Site:	
	Ecoregion:
	Aquatic life Uses:

If the study reach is believed to have naturally high productivity because of geology, flow regime, or other natural factors, a reference site approach may be used. An Assessment Unit will be determined to be **not supporting** if **two or more** of the following indicators of the study site are notably different from those of the reference site. If the number of samples from each site is sufficient (n is >4), then the rank-sum test (a.k.a. Wilcox or Mann-Whitney test) will be used to test if there is a high (>75%) probability that the study site is different than the reference site. If the number of measurements is ≤4, then best professional judgment utilizing the general guidelines in the table from the "notes" section below will be used to determine if the parameters are different at the sites.

Indicator	Reference Site	Study Site
D.O. saturation exceedence ratio*		
pH exceedence ratio*		
DO concentration exceedence ratio*		
Total nitrogen exceedence ratio		
Total phosphorus exceedence ratio		
Chlorophyll *a* concentration		
Algal Bioassay algal production		

* the exceedence ratio for large data sets refers to the number of days with exceedences divided by the number of full days that the sonde was deployed, not the number of data points. Use grab sample data if multiple day Sonde data are not available for both sites.

Circle One:	**Fully supporting**	**Not supporting**
Notes:		

NOTES: Put NA (not available) in boxes for parameters that were not collected.Complete and attach a Level II Nutrient Assessment Worksheet for the reference site as well as the study site.

The table below provides general guidelines of what constitutes a “difference” between the reference and study site for parameters with < 5 measurement.

Indicator	Reference Site	Study Site
D.O. saturation exceedence ratio		> 1 exceedence more then reference
pH exceedence ratio		> 1 exceedence more then reference
DO concentration exceedence ratio		> 1 exceedence more then reference
Total nitrogen exceedence ratio*		> 1 exceedence more then reference*
Total phosphorus exceedence ratio*		> 1 exceedence more then reference*
Chlorophyll *a* concentration		≥20% difference
Algal Bioassay algal production		≥ 1 classification higher than reference

* Also consider how much greater the concentrations are at the study site, and how close the concentrations are to the detection limit (d.l.). If one or both of concentrations are <2 times the detection limit (d.l.), then a value of 4 times the reference site concentration would be considered “different”. If the concentrations are >2 times the d.l. then a value 2 times the reference concentration would be considered “different”

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APPENDIX F

LARGE DISSOLVED OXYGEN DATASET ASSESSMENT PROTOCOL

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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Introduction

Most of the information available concerning oxygen requirements of fish is based on salmonids, although a substantial number of studies also involve warmwater species. The consensus that has emerged from the literature is that salmonids and other coldwater species are generally more sensitive to low levels of dissolved oxygen than warmwater species, and that early life stages (embryos and larvae) of all species have higher dissolved oxygen requirements than their respective adult stages. Although few data are available on the effects of reduced dissolved oxygen on benthic macroinvertebrates, "historical consensus states that, if all life stages of fish are protected, the invertebrate communities, although not necessarily unchanged, should be adequately protected" (USEPA, 1986) although there may be exceptions to this generalization.

Based on the above statements, this protocol recommends values for coldwater and warmwater aquatic life uses, as well as early life stages and other life stages.

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 content that at least approaches 100% saturation[1]. Oxygen content may fall substantially below 100% saturation during the night when respiration and oxidation of decaying organic matter exceed production from photosynthesis (Deas and Orlob, 1999). This type of situation is particularly pronounced in systems with excessive nutrient enrichment and resulting algal and plant growth.

Currently, New Mexico's criteria for dissolved oxygen are expressed only as mass per volume (mg/L). However, in certain circumstances, such as high altitude, where atmospheric pressure is comparatively low, or high temperatures that reduce oxygen solubility, criteria may be physically impossible to attain. For this reason, this assessment protocol proposes a combined assessment of both dissolved oxygen concentration (i.e., mg/L) and percent saturation, as this integrates several factors that influence the amount of oxygen that water can contain. Additionally, when the percent saturation drops too low, the resulting reduction of the oxygen tension gradient across the gill epithelium of a fish decreases the ease of oxygen diffusion from the water into the blood, with deleterious physiological effects (Davis, 1975). For this reason, this assessment protocol includes a minimum percent saturation value that is independent of oxygen concentration. Apparently, oxygen supersaturation has no negative impact on fish (Wiebe and McGavock, 1932), thus this protocol addresses only minimum saturation levels.

Procedures

Ideally, dissolved oxygen data should be collected using continuous recording devices (sondes) in order to observe diurnal fluctuations, as opposed to the "snapshot" that grab data provide. However, in some cases, grab sample data will be all that are available. In those cases, grab samples should be taken as near to sunrise as possible to ensure that the lowest concentration for a given day is recorded. Areas where excessive aquatic plant growth is evident should be prioritized for sonde deployment because diurnal fluctuations in dissolved oxygen concentrations will likely be greater due to variation in photosynthetic activity.

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[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).

Interstitial dissolved oxygen concentration may be substantially lower than that of the adjacent water column. In order to be protective of fish embryos and larvae that develop in the interstitial environment (e.g., salmonids), early life stages values are higher than those of other life stages (see Table 1). Early life stage values do not apply to the marginal coldwater aquatic life use, as this designated use is intended to protect cold season use of warm waters.

Early life stage values shall apply to data that are collected during the time period when early life stages are likely to occur in a given water body. The period of applicability for early life stages values shall be defined for high quality coldwater and coldwater aquatic life uses as 1 November through 31 July for elevations at or above 2750 m and 1 November through 30 June for elevations below 2750 m.

In Table 1, coldwater values apply to high quality coldwater, coldwater, and marginal coldwater aquatic life uses (with the exception, as noted above, that early life stages values do not apply to marginal coldwater aquatic life uses). Warmwater values include warmwater and limited warmwater aquatic life uses. All values are given in milligrams per liter (mg/L) and/or local percent saturation.

Table 1. Water Quality Values for dissolved oxygen

	COLDWATER VALUES		WARMWATER VALUES
	Early life stages (1 Nov - 31 Jul at ≥ 2750 m; 1 Nov - 30 Jun at < 2750 m)	**Other life stages**	**All life stages**
Combined Instantaneous Minimum	8.0 mg/L; 95% saturation	6.0 mg/L; 90% saturation	5.0 mg/L; 90% saturation
Local percent saturation instantaneous minimum	85	75	75

NOTE: When assessing data for the combined instantaneous minimum, only simultaneous data are considered. In other words, both the concentration and saturation values must fail to meet minimum values at the same time for an exceedence to occur. If the local percent saturation value falls below 85 during early life stages in coldwater streams or 75 at any other time or in warmwater streams, regardless of the corresponding concentration value, it shall be considered an exceedence.

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•**Dissolved oxygen – continuously recorded data** (e.g., sonde data)	All of the following must be met: 1) Combined instantaneous minimum values are not exceeded simultaneously for more than three consecutive hours, and 2) minimum saturation value is not below 85% (coldwater early life stages) or 75% (coldwater other life stages and warmwater all life stages) for more than three consecutive hours.	Any one of the following is met: 1) Combined instantaneous minimum values are exceeded simultaneously for more than three consecutive hours, or 2) minimum saturation value is below 85% (coldwater early life stages) or 75% (coldwater other life stages and warmwater all life stages) for more than three consecutive hours.	When available, biological assessment data shall be considered in determination of support status. When single excursions substantially below minimum values occur; when such excursions occur during a critical life cycle period, such as during spawn periods for coldwater fish species; or when severe events lead to fish kills (or other serious water quality impairment), best professional judgment and other available data will be used to determine aquatic life use support status.

NOTE: Information derived from analysis of dissolved oxygen data according to the above protocol may be useful for purposes other than determining support status. Included on the form used to document dissolved oxygen assessment from data collected with continuous data logging devices is a section for information that can be used as a screening tool for nutrient assessments (see attached form).

References:

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Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

pH and Dissolved Oxygen Sonde Data Assessment Form

Year/Watershed: _____

Assessment Unit: _____

Station name: _____

STORET ID: _____

Lat: N _____ **Lon:** W _____ **Elevation:** ____ m

WQS segment: 20.6.4. ___ **Designated use:** _____

Sonde data file name: _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____

---

pH Assessment

Criterion range: ☐ 6.6 – 8.8 ☐ 6.6 – 9.0 ☐ Other (specify)

Minimum recorded: _____ **Maximum recorded:** _____ **≥ 0.5 units above criterion?** ☐ no ☐ yes

Number of data points outside criterion: ___ **% data points outside criterion:** ____

Maximum contiguous duration outside criterion: ___ hours

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Dissolved Oxygen Assessment

Applicable value: ☐ coldwater (early life stages) 8.0 mg/L; 95% **OR** 85%

☐ coldwater (other life stages) 6.0 mg/L; 90% **OR** 75%

☐ warmwater (all life stages) 5.0 mg/L; 90% **OR** 75%

Combined instantaneous minimum: _____ mg/L; ____ % saturation Exceedences: n = ___ ; ____ %

Percent saturation instantaneous minimum: _____ Exceedences: n = ___ ; ____ %

Combined values exceeded for > 3 hours contiguously? ☐ no ☐ yes

Minimum % saturation exceeded for > 3 hours contiguously? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Information pertinent to nutrient assessment:

Below DO concentration minimum? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

> 120% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

< 75% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

Comments:_____

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APPENDIX G

LARGE pH DATASET ASSESSMENT PROTOCOL

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU

JANUARY 23, 2008

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Introduction

The pH of a solution is a measure of its hydrogen ion concentration and is calculated as the inverse log of the hydrogen ion concentration (pH = $-\log_{10}$ [H^+]). 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^-]). In natural waters, pH is a measure of the acid-base equilibrium resulting from various dissolved compounds and gases. The principal system regulating pH in natural waters is the carbonate system, composed of carbon dioxide (CO_2), carbonic acid (H_2CO_3), bicarbonate ion (HCO_3), and carbonate ion (CO_3).

There is no absolute pH range outside of which there are detrimental effects to freshwater aquatic life. Rather, gradual deterioration occurs as pH values move away 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 (USEPA, 1986). At pH values above 9.0, fish have difficulty excreting ammonia across the gill epithelium, but they are generally able to survive pH values up to 9.5 for 2-3 days (McKean and Nagpal, 1991). Benthic macroinvertebrates may be more sensitive to lower pH values than fish. A pH range from 6.5 to 9.0 appears to adequately protect both fish and benthic macroinvertebrates (USEPA, 1986).

In New Mexico, typical pH values in surface waters that are largely unaffected by anthropogenic disturbance vary approximately from 7.5 to 8.7. Some streams, depending on local geology, have documented natural background pH values as low as 3.0 (e.g., Sulphur Creek in the Jemez River watershed), but this is atypical on a statewide basis.

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 growth, 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 diurnal fluctuation of pH values that lags a few hours behind the diurnal fluctuation observed in dissolved oxygen concentrations. For this reason, it is best to use continuous recording devices (sondes) to record pH values where excessive aquatic plant growth is evident. If this is not possible, grab samples should be taken at the end of the day when pH values will be at their highest.

If exceedences of water quality criteria are to be detected, the use of grab samples for recording pH in areas of excessive aquatic plant growth poses a logistic problem when viewed with the need to also detect exceedences of the dissolved oxygen criterion. Dissolved oxygen is at its lowest (i.e., most likely to exceed criteria) in the early morning in areas of excessive aquatic plant growth. This is in contrast to the diurnal pattern of pH values, which are most likely to exceed criteria late in the day. This dilemma underscores the need to use sondes for collecting these kinds of data.

Recommendations

When continuously recorded pH data are available, instantaneous (hourly) pH values shall not be outside the range of the criterion for the water body in question in greater than 15% of the measurements, pH shall not exceed the range of the criterion for the water body in question for more than 24 contiguous hours, and pH shall never exceed 0.5 units above the upper limit of the criterion.

The following table shall be used to determine the degree of aquatic life use support.

TYPE OF DATA	FULLY SUPPORTING	NOT SUPPORTING	NOTES
•pH – continuously recorded data (e.g., sonde data)	All of the following must be met: 1) pH is outside the range of the criterion for the water body in question in <15% of measurements, 2) pH exceeds the range of the criterion by 0 to 0.5 units for less than 24 contiguous hours, and 3) pH is never 0.5 or more units above the upper limit of the criterion at any time.	Any one of the following is met: 1) pH is outside the range of the criterion for the water body in question in ≥ 15% of measurements, 2) pH exceeds the range of the criterion by 0 to 0.5 units for 24 or more contiguous hours, or 3) pH is 0.5 or more units above the upper limit of the criterion at any time.	Assessments shall be based upon floating 24-hour periods; data from partial 24-hour periods shall not be included in assessments in order to avoid skewing the percentage of exceedences. The only exception to this rule is if there is an instantaneous reading that exceeds 0.5 units above the upper limit of the criterion within the partial day data. When available, biological assessment data shall be considered in determination of support status. When single excursions substantially above the criteria occur; when such excursions occur during critical life cycle period, such as during spawn periods for coldwater fish species; or when severe events lead to fish kills (or other serious water quality impairment), best professional judgment and other available data will be used to determine aquatic life use support status.

References

McKean, C. J. and N. K. Nagpal. 1991. Ambient water quality criteria for pH. British Columbia Ministry of Environment, Water Quality Branch, Water Management Division. <http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/pH.html>

United States Environmental Protection Agency (USEPA). 1986. Quality criteria for water 1986. EPA 440/5-86-001. Office of Water, Washington, D.C.

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 Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

pH and Dissolved Oxygen Sonde Data Assessment Form

Year/Watershed: ______

Assessment Unit: _____

Station name: _____

STORET ID: _____

Lat: N _____ **Lon:** W _____ **Elevation:** ____ m

WQS segment: 20.6.4. ___ **Designated use:** _____

Sonde data file name: _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____

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pH Assessment

Criterion range: ☐ 6.6 – 8.8 ☐ 6.6 – 9.0 ☐ Other (specify)

Minimum recorded: _____ **Maximum recorded:** _____ **≥ 0.5 units above criterion?** ☐ no ☐ yes

Number of data points outside criterion: ___ **% data points outside criterion:** ____

Maximum contiguous duration outside criterion: ___ hours

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Dissolved Oxygen Assessment

Applicable value: ☐ coldwater (early life stages) 8.0 mg/L; 95% **OR** 85%
☐ coldwater (other life stages) 6.0 mg/L; 90% **OR** 75%
☐ warmwater (all life stages) 5.0 mg/L; 90% **OR** 75%

Combined instantaneous minimum: _____ mg/L; ____ % saturation Exceedences: n = ___ ; ____ %

Percent saturation instantaneous minimum: _____ Exceedences: n = ___ ; ____ %

Combined values exceeded for > 3 hours contiguously? ☐ no ☐ yes

Minimum % saturation exceeded for > 3 hours contiguously? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Information pertinent to nutrient assessment:

Below DO concentration minimum? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

> 120% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

< 75% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

Comments:_____

 Assessor: _____

Date of Assessment: _____ Date of Assessment Protocol used: _____ Date of WQS used: _____

pH and Dissolved Oxygen Sonde Data Assessment Form

Year/Watershed: ______

Assessment Unit: _____

Station name: _____

STORET ID: _____

Lat: N _____ **Lon:** W _____ **Elevation:** ____ m

WQS segment: 20.6.4. ___ **Designated use:** _____

Sonde data file name: _____

First data point: Date/Time

Last data point: Date/Time

Recording interval: 1 hr. **Data points:** n = _____

---

pH Assessment

Criterion range: ☐ 6.6 – 8.8 ☐ 6.6 – 9.0 ☐ Other (specify)

Minimum recorded: _____ **Maximum recorded:** _____ **≥ 0.5 units above criterion?** ☐ no ☐ yes

Number of data points outside criterion: ___ **% data points outside criterion:** ____

Maximum contiguous duration outside criterion: ___ hours

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Dissolved Oxygen Assessment

Applicable value:

☐ coldwater (early life stages) 8.0 mg/L; 95% **OR** 85%

☐ coldwater (other life stages) 6.0 mg/L; 90% **OR** 75%

☐ warmwater (all life stages) 5.0 mg/L; 90% **OR** 75%

Combined instantaneous minimum: _____ mg/L; ____ % saturation Exceedences: n = ___ ; ____ %

Percent saturation instantaneous minimum: _____ Exceedences: n = ___ ; ____ %

Combined values exceeded for > 3 hours contiguously? ☐ no ☐ yes

Minimum % saturation exceeded for > 3 hours contiguously? ☐ no ☐ yes

Use support designation: ☐ **Supporting** ☐ **Non-supporting**

Information pertinent to nutrient assessment:

Below DO concentration minimum? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

> 120% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

< 75% saturation? ☐ no ☐ yes If yes, maximum contiguous duration: ___ hours

Comments:_____