BIOCRITERIA PROGRAM

QUALITY ASSURANCE PROGRAM PLAN

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SUMMARY

The Arizona Department of Environmental Quality (ADEQ) Water Quality Division (WQD) has prepared this Quality Assurance Program Plan (QAPrP) as outlined in our agency's *Quality Management Plan* (QMP, ADEQ reference number EQR-0001), dated October 1, 1999. The QMP has been developed in accordance with the American National Standard, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs,* ANSI/ASQC E4-1994. This is a national consensus standard that addresses more specifically how a quality system is implemented within an environmental agency and its programs. The standard covers activities such as direct measurements, data generation, environmental modeling, compilation of data from the literature or electronic media, and data supporting the design, construction and operation of environmental technology.

ADEQ's QMP explains the overall quality management system as it applies to environmental data generation and monitoring activities for the agency. The purpose is to insure that all of the environmental programs produce environmental measurements that are of known quality with appropriate documentation. The results of the environmental measurements must be of a type and quality required for its intended use which can include: scientific studies, monitoring, compliance and enforcement activities, litigation, or regulatory decisions.

This QAPrP is intended to provide both the managerial and technical staff with the information required to develop and execute a Quality Assurance Project Plan (QAPjP) or Sampling and Analysis plan (SAP) for the Biocriteria Program.

Future QA project and sampling and analysis plans will be developed in accordance with this QAPrP. A compendium of approved administrative and field Standard Operating Procedures (SOPs) may be used in conjunction with this QA Program Plan.

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ACRONYMS

A&W	Aquatic and Wildlife
ADEQ	Arizona Department of Environmental Quality
COC	Chain-of-Custody
DQA	Data Quality Assessment
DQO	Data Quality Objective
EPA	Environmental Protection Agency
FSN	Fixed Station Network
HSAS	Hydrologic Support and Assessment Section
IBI	Index of Biological Integrity
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QC	Quality Control
QMP	Quality Management Plan
S&A Plan	Sampling and Analysis Plan
SEM	Stream Ecosystem Monitoring
SOP	Standard Operating Procedure
SWMS	Surface Water Monitoring & Standards (Unit)
TMDL	Total Maximum Daily Load
TSA	Technical System Audit
USGS	U.S. Geological Service
WQD	Water Quality Division

QUALITY ASSURANCE PROGRAM PLAN (QAPrP)

1.0 PURPOSE

To document the Quality Assurance, Quality Control, and other technical activities to be implemented to ensure that the results of Arizona Department of Environmental Quality program operations are of the type and quality needed for intended use by the Environmental Protection Agency (EPA). This QAPrP will provide sufficient detail to demonstrate that:

- the program's regulatory, technical and quality objectives are identified and agreed upon;
- the intended measurements, data generation, or data acquisition methods are appropriate for achieving program objectives;
- assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- any limitations on the use of the data will be identified and documented.

The development, review, approval, and implementation of the QAPrP is part of the Environmental Protection Agencies mandatory Quality System.

2.0 SCOPE

This document applies to all personnel and activities performed by the Biocriteria Program element of the Arizona Department of Environmental Quality (ADEQ), Water Quality Division (WQD).

3.0 REFERENCES

R9QA/03.1 - EPA Region 9 Requirements for Quality Assurance Program Plans.
Fixed Station Network (FSN) Procedures Manual for Surface Water Quality Monitoring

4.0 DEFINITIONS

Quality Assurance (QA) - An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client. (R9QA/03.1)

Quality Control (QC) - The overall system of technical activities that measures the attributes and performance of a process, item or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. (R9QA/03.1)

Quality Assurance Project Plan (QAPjP) - A QA plan for an activity (project) with a specified start and stop requirement and specific location (as opposed to a program which encompasses one or more projects at multiple locations and usually does not have the stated time or result constraint imposed on a project).

5.0 QAPrP MAIN ELEMENTS

The Biocriteria Program QAPrP is composed of four main elements covering the entire program from planning, through implementation, to assessment as follows:

Group A: Program Management (Para. 5.1)

Group B: Data Generation and Acquisition (Para. 5.2)

Group C: Assessment and Oversight (Para. 5.3)

Group D: Data Validation and Usability (Para. 5.4)

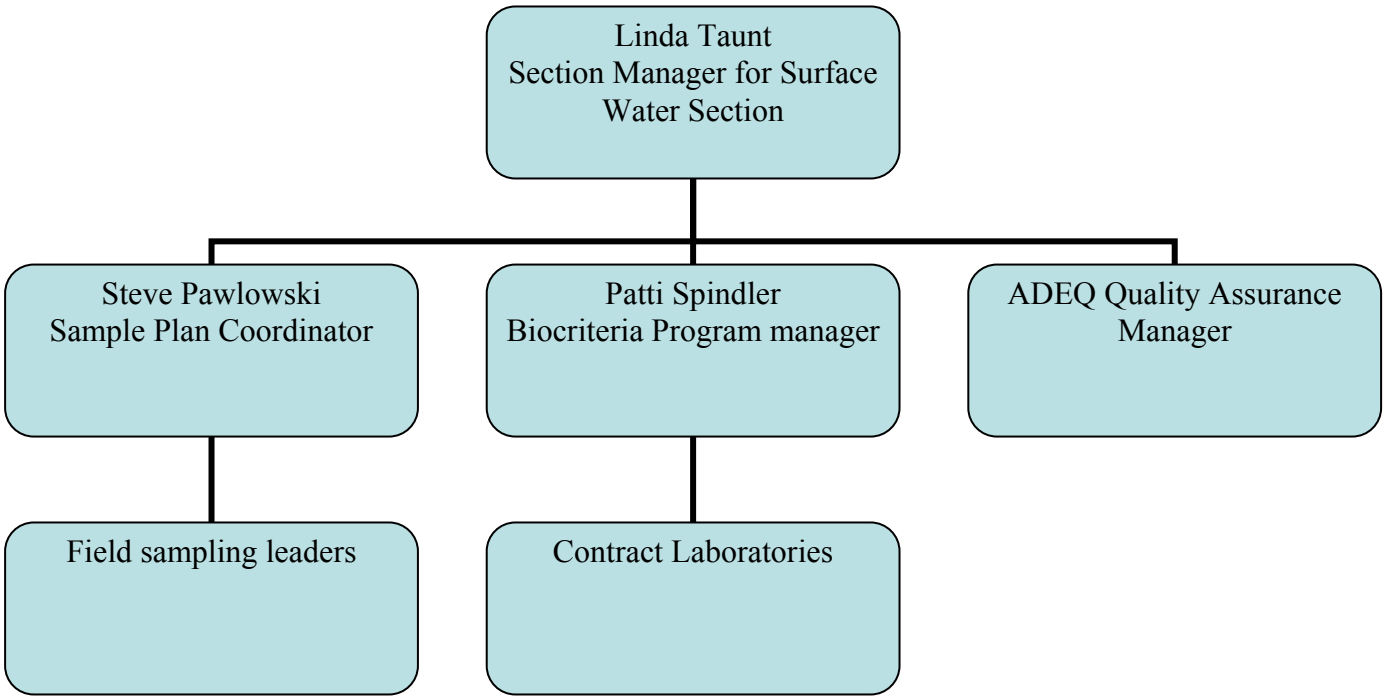
5.1 Group A: Program Management, Organization, and Planning Documentation

5.1.1 Program/Task Organization (Individuals listed are active in these roles in 2005)

Function	Individual	Organization	Title	**Role/responsibility**
Section Manager	Linda Taunt	ADEQ/WQD/ HSAS	Section Manager	Has the overall responsibility for direction, and any changes, in the scope of work for the program. The Section Manager will also oversee scheduling and management of all technical and non-technical aspects of the program.
Program Quality Assurance Manager	Julie Hoskin	ADEQ QA/QC Unit	Supervisor	Will ensure that all aspects of the program meet ADEQ QA/QC objectives. This includes review of documents, reports, plans, schedule and communications. In addition the Program QA Manager directs and manages the in-house QA resources and reviews QA/QC plans, sample plans and trains personnel on QC requirements. This manager is independent of direct data generation activities.
Program Manager	Patti Spindler	ADEQ/WQD/ HSAS/SWMS	Biocriteria Program Manager	Responsible for project implementation, and to guarantee that technical, and scheduling objectives are achieved successfully. The Program Manager coordinates all biocriteria program activities, and provides technical guidance to staff and management. The Program. Manager communicates to the Section Manager and will be the primary

				point of contact for the program.
Sampling Design	Steve Pawlowski	ADEQ/WQD/ HSAS/SWMS	SWMS Unit Manager	Creates the annual Sample Plan design statewide and for two watersheds by coordinating water and biological sampling needs, staff assignments, schedules and budgets.
Field Sampling Leaders	Lee Johnson, Lin Lawson, Kyle Palmer, Doug McCarty, Sam Rector, Patti Spindler, Roland Williams	ADEQ/WQD/ HSAS/SWMS	SWMS Staff	Responsible for on-schedule completion of assigned biological sampling field work with strict adherence to biological and SEM habitat data collection SOP's. All staff are QA managers in this area of primary data generation.
Lab Analysis	EcoAnalysts, Inc.	Contract Laboratory	President and Lab Manager	Processes benthic macroinvertebrate samples, determines taxonomic identifications of specimens, records taxonomic names and abundances on bench sheets and in a database, performs QC evaluations of adherence to lab SOP's, and produces lab reports for ADEQ.
Data Analysis	Patti Spindler	ADEQ/WQD/ HSAS/SWMS	Biocriteria Program Manager	Responsible for data entry, processing, database development and management, and data QC throughout the data analysis process.
Reporting	Patti Spindler	ADEQ/WQD/ HSAS/SWMS	SWMS Staff	Responsible for all aspects of document production including: data interpretation, in-house and outside technical reviews, editing and publishing ADEQ documents.

Biocriteria Program Organizational Chart



5.1.2 Planning Documentation

The Quality Assurance Program Plan for biological sampling will be kept on-file at ADEQ. This document will be updated as needed. Quality Assurance Project Plans and Sample Plans are created on an annual or as-needed basis. For example, the Ambient Surface Water Quality Monitoring Plan is prepared annually and references this Biocriteria QAPP and the Surface Water Procedures QAPP Manual. In addition, Quality Assurance Project Plans are prepared for grant-funded projects (eg.a REMAP grant) or other research projects which involve data collection.

Annual Sample Plans should reference the Biocriteria QAPP if biological sample collection will occur as part of the sampling activities. Annual sample plans are reviewed by Surface Water Monitoring and Standards Unit staff and are approved by the SWMS Unit Manager and the Hydrologic Support and Assessment Section Manager.

Quality Assurance Project Plans are usually prepared for grant funded projects. These project specific plans should reference the Biocriteria QAPP if biological sample collection will occur. These Project plans are usually peer reviewed by the grantor agency (eg. REMAP projects receive reviews from three science peers). Project plans are approved by the ADEQ Water Quality Division Director, and the QA Officer and Project Officer of the granting agency.

5.1.3 Background

The purpose of the Biocriteria Program is to create a bioassessment tool and conduct bioassessments by which to better assess the biological integrity of surface waters. The general authority for developing biocriteria comes from the objective statement in Section 101(a) of the Clean Water Act; to restore and maintain the chemical physical, and biological integrity of the nation's waters. Legal authority also comes from Section 304(c)(2)(B) which requires states to adopt numeric water quality criteria for toxic pollutants for which EPA has published criteria. Where numeric toxicity criteria are not available, states should adopt criteria based on biological assessments. ADEQ has pursued development of a bioassessment program following USEPA guidance provided in the Rapid Bioassessment Protocols (Barbour et al., 1999).

5.1.4 Program Description

ADEQ began development of its Biocriteria Program in 1992 with a statewide reference site sampling network and creation of a standard operating procedures manual (Meyerhoff and Spindler, 1994). Classification of streams with similar macroinvertebrate communities was performed using the statewide biological monitoring data. The elevation based classification system consists of two broad macroinvertebrate regions and community types: 1) a warm water community located at <5000' and a cold water community located at >5000' (Spindler, 2001). All small to medium sized, wadeable, non-effluent dependent, perennial streams located in these regions, with a few exceptions, are predicted to have the same general macroinvertebrate community type. Indexes of Biological Integrity (IBI) were then developed for our warm water and cold water communities, utilizing our statewide network of reference data (Gerritsen and Leppo, 1998; Leppo and Gerritsen, 2000).

ADEQ's cold and warm water Indexes consist of several metrics or key attributes of the benthic macroinvertebrate community which best distinguish impairment from the reference condition. The **cold water IBI** consists of seven metrics selected for their ability to discriminate impairments in cold water streams located at >5000' elevation: total taxa richness, Diptera taxa richness, intolerant taxa richness, Hilsenhoff Biotic Index, percent composition by Plecoptera (stoneflies), percent composition by scrapers, and scraper taxa richness. The **warm water IBI** consists of nine metrics which best discern impairment in warm water streams located at <5000' elevation: total taxa richness, Ephemeroptera taxa richness (mayflies), Trichoptera taxa richness (caddisflies), Diptera taxa richness, percent composition of Ephemeroptera (mayflies), percent composition by the dominant taxon, percent Hilsenhoff Biotic Index, percent composition by scrapers, and scraper taxa richness. The metrics are calculated from a list of species and their abundances and the total IBI score is an average of the metric scores. The macroinvertebrate community is then rated as attaining the aquatic life use when a sample IBI score is greater than or equal to the 25th percentile of reference scores, inconclusive when a sample IBI score falls between the 10th and 25th percentile of reference score, or not attaining when the sample IBI score falls below the 10th percentile of reference scores. Procedures for calculating the Indexes are provided in Appendix A and the IBI scoring thresholds are shown in Table 1.

Table 1. Macroinvertebrate IBI thresholds for wadeable, perennial streams of Arizona

Macroinvertebrate bioassessment result	Index of Biological Integrity Score	
	Cold water	Warm water
Greater than the 25th percentile of reference condition	≥ 90	≥ 50
Between the 10th and 25th percentile of reference condition	86 – 89	42 - 50
Less than the 10th percentile of reference condition	≤ 85	≤ 42

Sample collection: Macroinvertebrate samples continue to be collected annually during the spring index period (April-June) for ambient water quality assessment purposes. The samples are collected from wadeable, perennial streams in two surface water basins per year, using standard operating procedures provided in Appendix A and in accordance with ADEQ's Draft Comprehensive Monitoring Strategy (ADEQ, 2005). In general, macroinvertebrate samples are collected and composited from 3- 1m^2 areas of riffle habitats at each site, using a D-frame kick net. Samples are only minimally processed to remove large debris and sand in the field. Samples are preserved with 99% isopropyl alcohol on-site. Samples are held in chain of custody from time of collection until delivery to the taxonomy laboratory, as per chain of custody and shipping procedures contained in the Macroinvertebrate Sampling and Analysis Procedures in Appendix A.

Laboratory analysis: Preserved samples are sorted, enumerated (500 minimum count) and identified to genus or species level for the insects and levels specified in the Macroinvertebrate procedures manual for all other taxa groups. General lab procedures are listed in the macroinvertebrate procedures in Appendix A. There is no maximum holding time for preserved macroinvertebrate samples, however ADEQ requests that lab analyses be completed within 6 months of sample delivery.

5.1.5 Data Quality Objectives

Bioassessments are used for determining biological integrity in perennial, wadeable streams and to determine compliance with a narrative biocriterion. To ensure data quality, biocriteria field and laboratory QC procedures listed in Table 2 are used. In addition, the following data quality criteria shall be applied for assessment purposes:

1. Precision – Studies of variability of IBI scores within reference sites across replicates or years will be conducted periodically. Target is standard deviation of <10 points.
2. Accuracy – Laboratory SOPs shall be followed such that a target of 90% sorting efficiency and 90% taxonomic accuracy is achieved for each batch of samples analyzed by our taxonomy lab.
3. Bias – Sampling bias shall be avoided by using a D-frame dip net with a standard mesh size. Only riffle habitats are sampled.

4. Bias – Samples are sorted in the laboratory with a dissecting scope; no field sorting is conducted.
5. Sampling interferences shall be avoided; sampling shall not be conducted during high flow events. Sampling shall occur during the spring index period (April-June).
6. Completeness – A target of ten reference sites is the objective for sampling from each surface water basin each monitoring year for maintenance and updating of the IBIs.
7. Samples shall only be collected from appropriate habitats. For purposes of meeting the ADEQ narrative biocriteria standard, the following sampling site conditions must be met: wadeable, perennial, riffle/run habitat, heterogeneous substrates, sampled during the spring index period (April-May for warmwater streams and May-June for coldwater streams).
8. Decisions to be made using biological data - The ADEQ Indexes of Biological Integrity are the primary tool for analyzing macroinvertebrate data for purposes of 305b assessments of the aquatic life use. Since the new narrative biocriterion uses the 25^{th} percentile of reference condition as the threshold value for meeting the aquatic life use standard, the warmwater and coldwater 25^{th} percentile value is used for making decisions about whether the use is being adequately protected. A sample IBI score must be greater than or equal to the 25^{th} percentile of reference IBI threshold to comply with the narrative biocriteria standard. When a sample IBI score is less than the 10^{th} percentile of reference condition, the sample has exceeded the standard and is impaired. When a sample IBI score falls between the 10^{th} and 25^{th} percentile of reference score, the result is inconclusive and a verification sample is required. If the verification sample IBI score falls below the 25^{th} percentile, the biocriteria standard is exceeded. ADEQ sampling and analysis methods must be followed for valid bioassessments.

Table 2. ADEQ Biocriteria field and laboratory QC procedures and performance characteristics.

Procedure	Performance Characteristic	Description
Sampling device (field)	Precision - repeatability in a habitat	We have shown good repeatability in studies of variability within sites sampled over multiple years. These samples had low variability of site IBI scores (standard deviation of 6.5 points on a 100 point scale) for replicate spring, riffle samples within a site.
	Bias - exclusion of certain taxa (mesh size)	The D-frame sampler is outfitted with a 500μ mesh size net opening, which retains organisms of a consistent size for identification and excludes very small specimens of early larval instars which are difficult to identify.
	Performance Range	The D-frame dip net is an efficient sampler for use in Arizona streams, as it can be used in large or small streams with variable habitats and substrate sizes.
	Interferences - matrix/physical	The D-frame sampler functions well in a variety of water depths and velocities, without limitation.

	limitations	
Sampling method (field)	Precision - variable metrics or measures among replicate samples at a site	Measurement error is quantified by replicate sampling at 10% of our sampling sites each year. Samples are processed and analyzed separately and their metrics and IBI score compared to obtain a measure of the method precision. This is an estimate of the precision of the entire method which includes variability due to small-scale spatial variability within a site, operator consistency and bias, and laboratory consistency.
	Bias - exclusion of certain taxa (mesh size) or habitats	Only Riffle habitats are sampled. Pools are excluded. We exclude organisms smaller than 500μ.
	Performance range - limitations in certain habitats or substrates	Method is currently limited to only riffle habitats of wadeable, perennial streams. Intermittent and ephemeral streams, effluent dependent waters and lakes are excluded waterbody types. Bedrock/travertine dominated substrates, wetlands, pool dominated streams, and sand dominated habitats are excluded.
	Interferences - high river flows, training of personnel	Sampling is limited to low flow conditions, which are more suitable for sampling than during high flows. Our sampling SOPs recommend sampling a minimum of 4 weeks after a bankfull flood has occurred. Methods have not yet been developed for large river sampling.
	Bias - efficiency of locating small organisms in sample transfer	The sieve is carefully rinsed after straining a sample to obtain every specimen visible to the naked eye. Then the sieve is washed prior to leaving a sample site. All samples are sorted in the laboratory using 6-10X powered dissecting scopes.
	Performance range - sample preservation and holding time	Samples are preserved with isopropanol and a capful of formalin in the field. Formalin is used for better preservation in the Arizona heat.
	Interferences – Rainfall	Field sorting is not part of our routine SOPs, so rainfall is not limiting.
	Accuracy - of sample transfer process and labeling	Our contract laboratory follows sorting and labeling procedures according to their Laboratory SOP to prevent labeling errors.
Laboratory sample processing	Precision - split samples	Duplicate samples are collected at the rate of 10% of the total # of samples during each year's index period. We do not currently compare taxonomy from different laboratories.

	Bias - sorting certain taxonomic groups or organism size	Large specimens are removed first from the entire sample for best identifications. All organisms retained by the 500μ mesh sieve are identified utilizing a Caton Tray and subsampling procedures outlined in the Laboratory SOP manual.
	Interferences - equipment	A Caton Tray and specific subsampling SOPs are used to limit errors associated with subsampling.
	Accuracy - sorting method, lab equipment	Sorting efficacy is checked for 10% of the samples processed by our contract lab. A second sorter checks a sorted subsample to ensure that the target of 90% sorting efficiency is met.
Taxonomic enumeration	Precision - split samples	We do not currently conduct split sample analyses between two different laboratories.
	Bias - counts and identifications for certain taxonomic groups	Our taxonomy lab provides a minimum 500 count of insects per sample, which accounts for approximately 90% of the taxa present in the sample, missing only those that are rarely occurring in the sample.
	Interferences - appropriateness of taxonomic keys	The taxonomy lab uses the most current southwestern, western and North American taxonomy keys for identification of Arizona samples.
	Sensitivity - level of taxonomy related to type of stressor	A standard taxonomic effort is required for various macroinvertebrate groups, with insect identifications to genus or species level and midges identified to family level (Appendix A).
	Accuracy - identification and counts	A quantitative check of taxonomic accuracy is provided on 10% of the samples processed by our contract lab. A second taxonomy analyst re-identifies a subsample of specimens to ensure that the target of 90% accuracy is met. Taxonomy laboratory quality control procedures for sorting and taxonomic identifications are provided in Appendix A.

5.1.6 Training

5.1.6.1 Initial Biological Sample Collection Training

All biological sampling personnel shall attend an initial ADEQ Bioassessment Program training event conducted by ADEQ personnel. This training will cover field and laboratory methods of collecting and analyzing biological samples and habitat data (SEM field forms) and data analysis procedures. The training will consist of a classroom session and a hands-on training in the field. This requirement applies to both ADEQ and non-ADEQ personnel. The Arizona Department of Health Services "Environmental Sampling Workshop" presents introductory material about conducting bioassessments, but does not substitute for the ADEQ

Bioassessment training for those who will be performing sampling and analysis activities.

5.1.6.2 Refresher Training

All biological sampling personnel shall attend the ADEQ Bioassessment Program sampling refresher training, every two years. The refresher training includes discussion of all topics identified in the QAPP and SOP's, and field demonstration and participation by all staff in biological sampling techniques and conducting habitat assessments.

5.1.6.3 Revisits to Sampling Sites

The biological sampling trainer will periodically conduct sampler bias and precision studies through duplicate sampling events between pairs of monitoring crews. The trainer will also conduct field audits for new samplers through revisits of sampling sites to determine that among-crew precision of new sampling teams is within acceptable limits (<10% error in IBI scores and habitat scores).

5.1.7 Documents and Records

The Biocriteria Program has produced several technical reports and a database including the following:

1. Spindler, P.H. 1996. Using Ecoregions for explaining macroinvertebrate community distribution among reference sites in Arizona, 1992. Arizona Department of Environmental Quality OFR 95-7. Phoenix, AZ.
2. Gerritsen, J. and E.W. Leppo, 1998. Development and testing of a biological index for warmwater streams of Arizona. Tetra Tech, Inc. Owings Mills, MD.
3. Leppo, E.W. and J. Gerritsen, 2000. Development and testing of a biological index for coldwater streams of Arizona. Tetra Tech, Inc. Owings Mills, MD.
4. Spindler, P.H., 2001. Macroinvertebrate community distribution among reference sites in Arizona. Arizona Department of Environmental Quality OFR 00-05, Phoenix, AZ.
5. ADEQ, 2004. Arizona Ecological Database Application System (EDAS v.3.2) in ACCESS format.

5.1.7.1 Report Storage and Retention

1. Technical reports are housed in the Biocriteria Program files and archives.
2. The EDAS database is maintained on the Biocriteria Program PC and backed up monthly onto the network drive and diskette.
3. Watershed Bioassessment Reports will be incorporated into the annual targeted watershed ambient monitoring report for each basin and will be stored accordingly in each basin file.
4. Other Biocriteria studies and related water quality standards research will be stored within the Biocriteria Program files
5. The retention period for these records has not yet been determined, however all of these documents and records are used regularly over a course of 5-10 years, so they should be kept within the active SWMSU program files for the foreseeable future.

6. The site files shall also contain lab reports, Fixed Station Network (FSN) field forms, QC forms, chain-of-custody forms, calibration logs, and other materials, as indicated in the surface water SOP.

5.1.7.2 Reference Specimen Collection Storage

The ADEQ Biocriteria Program macroinvertebrate voucher specimen collection shall be maintained permanently in the laboratory at the Phoenix ADEQ office. The ADEQ taxonomist has prepared the collection by preserving a few specimens of each macroinvertebrate taxon in a 5 ml vial with a solution of 70-80% isopropanol containing a rite-in-the-rain paper label which includes taxon name, site id/stream name, date collected, habitat sampled, and collector name (ADEQ). New specimens are added when new taxa are encountered, when needed to refresh degraded specimens, and to ensure that there is replicate material from different locations around the state. The Biocriteria Program Coordinator will ensure that the isopropanol solution is checked and refreshed annually. The voucher specimen collection is maintained for several reasons: 1) The voucher collection supports all the research and reports produced by the Department, 2) To periodically perform inter-laboratory taxonomy QC checks on the voucher specimens, 3) Other laboratories study the ADEQ voucher collection for QC purposes, and 4) To use the voucher collection for occasional in-house taxonomic identifications, training and internal study purposes.

5.1.7.3 Updated Procedures

The Biocriteria Program Coordinator will be responsible for ensuring the appropriate program personnel have the most current approved version of the Biocriteria QAPrP. The Biocriteria Program Coordinator will distribute the Biocriteria QAPrP, SOP's, implementation guidance document and any updates at the biennial Biocriteria training seminar. The QAPrP, SOP's and implementation guidance document will be stored in the SWMSU Unit QAPrP file.

5.1.7.4 Biological Sample Plan

The biological sample plan will be included in the annual surface water sample plan for the targeted watershed monitoring in two basins each year. Biological sampling methods are described in the Biological SOP and will be referenced for all sampling events. All macroinvertebrate samples shall be accompanied by Stream Ecosystem Monitoring (SEM) field forms which contain all of the macroinvertebrate sample and habitat information needed. Analysis of samples shall follow protocols for calculating the warm water or cold water Indexes of Biological Integrity, as indicated in the Biological SOP's.

5.1.7.5 Annual Bioassessment Report, External Parties

The following guidance is provided for external parties who plan to conduct bioassessments. This guidance was prepared for NPDES permitees, but also applies to other groups who would like to coordinate data sharing with ADEQ and/or apply the ADEQ Indexes of

Biological Integrity to assess attainment of the Biocriteria water quality standard. The guidance consists of the following bioassessment recommendations:

1. Bioassessment should occur concurrently with ambient water monitoring

2. A bioassessment survey plan containing sample dates, locations of background and study sites, sampling personnel and qualifications, name and location of contract laboratory, biological and habitat sampling protocols and method of analysis, should be completed and submitted to ADEQ by December 31st each year.

3. ADEQ sampling and analysis protocols should be followed as closely as possible, using the most updated Quality Assurance Program Plan.

4. Laboratory protocols should follow ADEQ procedures in the ADEQ Biocriteria QA Program Plan.

5. The bioassessment report should be submitted to ADEQ for review. The report should contain: an executive summary, introduction, study area descripton including maps and photos, methods, results and discussion, literature cited, and appendices with complete taxa lists and copies of completed field forms for each site. The results and discussion section should cover a physical characterization of the sites, a habitat assessment, water quality, fish & wildlife, macroinvertebrates, and long term trends at the study sites.

6. Macroinvertebrate analyses should contain: a list of taxa and abundances, the calculated warm or cold water IBI score, the benthic habitat score, and graphs indicating a comparison of reference and study site IBI scores for the current year, changes in the reference and study IBI scores over a permit period and changes in the reference and study site habitat scores or habitat values over the permit period.

7. The first bioassessment shall be subject to a quality assurance review to be conducted by ADEQ. The voucher specimens from the laboratory should be submitted to ADEQ for a quality control review of the taxonomic identifications by the ADEQ contract taxonomist. Major revisions should be incorporated into the final bioassessment report.

8. External parties shall collect, QC check and maintain voucher specimen collections for each sampling site or stream following methods in the ADEQ Biocriteria QA Program Plan.

5.2 Group B: Data Generation and Acquisition

5.2.1 APPENDIX A: ADEQ Macroinvertebrate Sampling and Analysis Procedures (Lawson, L. ed., 2005).

5.2.2 APPENDIX B: ADEQ Habitat Assessment Procedures (Lawson, L. ed., 2005).

5.3 Group C: Assessment and Oversight Elements

5.3.1 Assessments and Responsive Actions

The following QA assessments will be periodically conducted by the ADEQ QA/QC Unit for the Biocriteria program as described below. Both the program staff and staff from the QA/QC Unit will participate in the various quality assurance assessments.

5.3.1.1 Data Quality Assessment (DQA)

Data Quality Assessments (DQAs) involve data validation activities which use the Validation, Verification and Data review reports in Section D of this document. The use of these reports standardizes the data validation process.

ADEQ currently uses only one laboratory for macroinvertebrate taxonomic identifications. In the future, ADEQ may contract with more than one laboratory. Criteria for selecting a laboratory will be developed at that time by the Biocriteria Program personnel and the ADEQ QA/QC Unit.

An in-depth DQA review and data validation for the analytical results performed by the ADEQ QA/QC Unit can be triggered two ways: 1) At the request of Biocriteria program staff, the raw data would be requested from the laboratory as part of the analytical results being submitted to the ADEQ QA/QC Unit and 2) the ADEQ QA/QC Unit may randomly select analytical results that the Biocriteria program has already received. The goal of the ADEQ QA/QC Unit is to review and validate 10% of the analytical results that are submitted to the ADEQ.

Problems identified through a DQA may trigger the need for a technical system audit to identify technical problems or a management system review to determine management deficiencies. Any documentation resulting from a DQA will be maintained in the project files.

5.3.1.2 Data Quality Audits

The data quality audit process is an assessment tool used to evaluate the documentation of the data generated for a given project. This assessment primarily involves the ADEQ QA/QC Unit evaluating the completeness of the documentation of field and analytical procedures and the QC results. It usually involves following the paper trail accompanying the database from sample collection and custody to analytical results and entry into a database. This technique is commonly used to verify the process involved in entering data residing in large regulatory databases.

The results of a DQA can be used by Biocriteria program staff in two ways: First, it can be used in making recommendations for changes in the design and performance of data collection efforts and in the use and documentation of QC procedures and secondly, the results can be used as a guide for the planning and acquisition of supplemental data for the project area as well as for other potentially related projects.

Problems identified through this assessment process may trigger the need for a technical system audit to identify technical problems or a management system review to determine management deficiencies. Any documentation resulting from a DQA will be maintained in the project files.

5.3.1.3 Laboratory Audits

Laboratory audits are audits of laboratory operations either in "real-time" (while the samples are under analysis) or performed after the analysis has been completed. Laboratory audits will consist of an on-site visit to the laboratory and the observation of analytical practices when possible. Project records and laboratory SOPs will be reviewed and the findings will be documented. A laboratory audit will be conducted to determine and document whether laboratory practices and analytical procedures used are consistent with the project areas QA project plan or SAP. Audits will be conducted by the ADEQ QA/QC Unit or the Biocriteria Program Manager. All laboratory auditing activities will produce a written report. Laboratory audits can be requested by Biocriteria program staff.

A draft report will be prepared by the ADEQ QA/QC Unit on the completion of the observation phase of the audit. The draft report will be sent to the individual responsible for the submittal of the samples to the laboratory. Comments will be requested from the sampler prior to completion of the audit report by the ADEQ QA/QC Unit. Written comments will be provided to the ADEQ QA/QC Unit as appropriate from the sampler. The ADEQ QA/QC Unit will then complete the final audit within thirty (30) calendar days of receipt of comments or by a mutually agreed upon alternative date. Copies of the final audit report, with recommendations of corrective actions, will be sent to the Biocriteria Program Manager for review and storage in the project files. Additional copies will be distributed as appropriate.

Corrective actions will be taken, if necessary, to assure that the environmental measurements will be of a known quality and will be sufficient for their intended purpose. The request for corrective actions will originate from Biocriteria program staff and will be transmitted to the laboratory through the ADEQ QA/QC Unit with their assistance. This would apply to the

biological laboratory on contract. The frequency of laboratory audits will be determined by the Biocriteria Program Manager and the ADEQ QA/QC Unit.

5.3.1.4 Field Audits

Field audits are conducted to critically review and appraise field sampling activities. Field audits can consist of either 1) an on-site visit to the sampling location and observation of sampling practices or 2) repeat habitat and water quality measurements collected on the same date at a sample location. The Project QA Manager records any deviations from standard sampling SOPs under scenario #1 and findings are documented. Under scenario #2, two teams collect habitat, water quality measurements and percent similarity is calculated with the aim of minimizing errors to 10% differences. Follow-up discussion of methods or training is provided to remedy any problems. The primary intention of such audits is to ascertain whether the QA project plan or Sampling and Analysis Plan procedures are being followed.

Field sampling audit activities can be performed by ADEQ staff or a contractor. When a contractor is used, the audit will be under the supervision of the ADEQ QA/QC Unit. Requests for outside audits shall go through the ADEQ QA/QC Unit. All field auditing activities will result in the production of a written report. A draft of this report from the auditor is due within seven (7) calendar days of the completion of the observance phase of the audit. The draft will be sent for comments to the Biocriteria Program Manager. Written comments by the Biocriteria Program Manager or the sampler will be supplied to the ADEQ QA/QC Unit. Final reports generated by the ADEQ QA/QC Unit are to be completed within thirty (30) calendar days of receipt of the comments. Copies of the final report, with recommendations for corrective actions, will be stored in the project file. Additional copies will be distributed as appropriate.

Corrective actions will be taken by the program as necessary to assure that the environmental measurements will be of a known quality and will be sufficient for their intended purpose. The corrective actions will be adopted by staff within the Biocriteria Program and their contractors, as appropriate, so that future field sampling will be corrected for the project area in question.

5.3.1.5 Technical System Audits

Technical system audits will be conducted periodically to assess the sampling and analytical quality control procedures used to generate environmental data. The ADEQ QA/QC Unit or Biocriteria Program Manager may request a Technical System Audit (TSA). The TSA will consist of evaluation of various components of the sampling program, outlined in the table below.

Technical System Audit Report

Is staff training in bioassessment methods up to date?

Water testing instruments are properly maintained and calibrated?

Bioassessment equipment has been properly maintained and cleaned?

Proper field procedures are followed according to ADEQ Procedures manuals?

Field audit yielded acceptable results?

Laboratory audit yielded acceptable results?

QA/QC Manager signature and date

The TSA will be conducted by the ADEQ QA/QC Unit. Results of the audit will be prepared and submitted to the Biocriteria staff in the form of a written report. Written responses prepared by the Biocriteria Program Manager will be supplied to the ADEQ QA/QC Unit. Copies of the TSA Final Report, with recommendations for corrective actions, will be stored in the project file. Corrective actions will be taken by the Biocriteria program as necessary to assure that the environmental measurements will be of a known quality and will be sufficient to meet data quality objectives.

5.3.2 Reports to Management

Effective communications between all project personnel is an integral part of the quality

system. Planned reports provide a structure for apprising management of the project schedule, deviations from planned activities, the impact of the deviations, and the uncertainties in decisions based on the data. This section of the QAPrP identifies the requirements for the QA reports to management.

5.3.2.1 Data Quality Assessment

Data Quality Assessments will be conducted by the ADEQ QA/QC Unit. Results of DQA reports will be given to the Biocriteria Program Manager. Recommendations for improvements will be forwarded to the HSAS Section Manager.

5.3.2.2 Data Quality Audits

Data Quality Audits will be performed by the ADEQ QA/QC Unit. The goal of the ADEQ QA/QC Unit is to review and validate 10% of the submitted results. Results of DQAs will be given to the Biocriteria Program Manager. Recommendations for improvements will be forwarded to the HSAS Section Manager.

5.3.2.3 Audit of Laboratory Data Package

Laboratory audits will be conducted by the ADEQ QA/QC Unit at their discretion. Results of reports will be given to Biocriteria Program Manager. The final audit report with recommendations for any corrective actions will be forwarded to the HSA Section Manager.

5.3.2.4 Field Audits

Field audits will be performed by the ADEQ QA/QC Unit at their discretion. The goal of the QA/QC Unit is to review and validate 10% of the submitted results. Results of DQAs will be given to the Biocriteria Program Manager.

5.3.2.5 Technical System Audits

Field Audits will be performed by the ADEQ QA/QC Unit at their discretion. The goal of the ADEQ QA/QC Unit is to review and validate 10% of the submitted results. Results of DQAs will be given to the Biocriteria Program Manager. Recommendations for improvements will be forwarded to the HSAS Section Manager.

5.3.2.6 Corrective Actions

Corrective actions can be the result of situations involving field activities or laboratory activities. Review of Precision, Accuracy, Representativeness, Completeness, Comparability (PARCC) criteria can also indicate a need for corrective actions. Corrective actions will be taken as necessary to assure that the environmental measurements will be of a known quality and will be sufficient to meet the Program data quality objectives. Corrective actions will be adopted by Biocriteria program staff, laboratories, or contractors as appropriate.

Field corrective actions generally are the responsibility of the field sampler. Some corrective actions can be taken in the field. Problems can result from situations such as malfunctioning or broken field equipment, inability to access a surface water sampling site or well, or an inability to get samples into a laboratory before their holding time is exceeded. Regardless of the source of the problem or whether or not it can be corrected, it will be documented in the appropriate field forms. Corrective actions can include such items as performing additional decontamination of equipment, re-sampling, locating alternative sample sites or obtaining additional training of field personnel. Each corrective action will be documented with a description of the deficiency and the corrective action taken, and the person responsible for implementing the corrective action.

Laboratory corrective actions are the responsibility of the ADEQ QA/QC Unit for that laboratory. Problems can result from situations such sample labels that do not match chain-of-custody documents, insufficient preservation, missed holding times, duplicate sample criteria not met, or other conditions relating to the sample or laboratory. Some corrective actions will require the notification of the individual that submitted the sample. Other corrective actions may be internal to the laboratory and automatically implemented by laboratory personnel. Corrective actions will be documented as required by the ADEQ QA/QC Unit. The corrective action shall be described in the laboratory report sent to the individual that collected the sample.

Any corrective action requiring re-sampling will be considered a minor corrective action. All corrective action that requires a change to the existing QA project plan or SAP will be considered a major corrective action. A major corrective action will require modifications to the site sample plan which would require a review and approval for the modifications. All documentation resulting from a corrective action will be maintained in the project files.

5.4 Group D: Data Validation and Usability Elements

This section identifies the validation, verification, and data review process that is used to ensure sufficient data quality to meet the project DQOs.

5.4.1 Verification, Validation, and Data Review

Data validation activities ensure that laboratory data are accurate. Data verification involves verifying that overall sampling, lab analysis and database generation activities were conducted appropriately and as per the data quality objectives. Data review is conducted to ensure that data has been screened prior to entry into the EDAS database and data is of sufficient quality for water quality standards to be applied and for designated use support determinations.

5.4.1.1 Validation

The validation process involves review of laboratory taxonomic data to ensure that data meets measurement data quality objectives, prior to incorporation into ADEQ's EDAS biological database. The Project QA Manager will conduct data validation activities, which will be documented in the Data Validation Report below. The taxonomy laboratory on contract to ADEQ conducts most of the following quality control checks and ADEQ provides a review of these activities to validate the data package. A copy of the Validation Report will be included in the Biocriteria Program Laboratory Data Files.

- Chain-of-custody procedures were followed
- Sorting efficiency check of 90% is attained
- A minimum of 500 macroinvertebrates are identified for each sample
- Accuracy of taxonomic identifications is >90% with checks done by a second taxonomist on 10% of the annual batch of samples
- Precision of sample identifications and IBI scores is determined by comparison of duplicate samples, collected at a rate of 10% of the annual batch of samples
- Data entry of results from bench sheets to database files is correct

Laboratory DataValidation Report

Validation Report for Taxonomy Data Package (name and date)

Laboratory QC

Have any QC problems been identified in the laboratory quality control reports? What corrective action, if any, was taken?

Chain-of-Custody documentation

Have original Chain-of-Custody forms with ID numbers and laboratory receipt signatures been submitted?

Electronic laboratory data

Laboratory taxonomic data results have been provided for each biological sample submitted. The results are supplied electronically in database format, as specified by the Biocriteria Program Manager. Data has been entered correctly (10% check) from bench sheets to database files.

QC Summary: **Is the following information included?**

a. Duplicate samples have similar taxa list and IBI score

b. Record of Caton Tray proportion of sample analyzed

c. Minimum of 500 count per sample is recorded

d. List of new taxa and attributes is provided

e. Sorting efficiency check of 90% accuracy has been met

f. Taxonomic identification check on 10% of samples has yielded 90% accuracy

g. Have results been submitted within 6 months of sample delivery

Summary of laboratory communications or qualification on the dataset

Program QA Manager review, signature and date

5.4.1.2 Verification

Verification of data involves determinations that overall sample collection, lab analysis, and data entry procedures have been correctly followed and data quality objectives have been met. Verification activities involve determinations that the Standard Operating Procedures for collecting biological samples were correctly followed, that chain-of-custody procedures were followed, that laboratory data has been validated, and that general data quality objectives have been met. The Project QA Manager will conduct a data verification review for each annual dataset collected, to be documented in the Verification Report shown below. A copy of the Verification report will be filed in the Biocriteria Program files.

Biological Data Verification Report

Verification Report for Data Package (name and date)

Standard Operating Procedures

Were ADEQ SOP's followed during collection of biological samples? This includes correct habitat, index period, general sampling conditions and correct preservation of samples.

Chain-of-Custody followed by ADEQ and documentation provided by Laboratory?

Lab Result Validation

Were lab results produced for each sample submitted to the taxonomy lab? Was a Laboratory Validation report produced and lab data validated for Biocriteria Program use?

General Data Quality Objectives met

*Data quality objectives listed in section 5.1.5 and in Table 2 of this report have been met

*Recommendations for improvement if needed,

*A summary of all laboratory communications regarding QC problems or qualifications in the dataset is provided

Program QA Manager review, signature and date

5.4.1.3 Data Review

Data review is conducted to ensure that data has been screened prior to entry into the EDAS database and data is of sufficient quality for water quality standards to be applied and for designated use support determinations.

The field and laboratory data upload process is reviewed by the Project QA Officer to ensure that database quality control procedures have been followed. Determinations that the data is acceptable for scientific analyses, calculation of Indexes of Biological Integrity, biological assessments and other purposes are made as part of the data review by the Project QA Officer. The review will include the items described in the table below.

Data review will be conducted on each annual data package and will be documented in the Data Review Report shown below. A copy of this report will be included in the Biocriteria Program Data files.

Data Review Report

Data Review for Taxonomy Data Package (name and date)

Laboratory Data Validated (yes or no; if no provide comments on follow up actions)

Data Package Verified and Data Quality Objectives met (yes or no; if no provide comments regarding follow up actions)

Data Outliers

Data was reviewed for outlier values. Any outlier values are checked with the taxonomy laboratory and corrective actions taken.

Data uploads to EDAS

Electronic Dataset has been successfully uploaded into ADEQs Ecological Data Application System (EDAS) and quality control checks on the data upload completed.

Data is acceptable for data analysis and decision making

(QA Manager signature and date)

5.4.2 Reconciliation with Data Quality Objectives

Determinations that Data Quality Objectives have been met are documented in the Laboratory data Validation and Verification reports. Any quality control problems, data qualifications or laboratory communications are documented in the Validation, Verification, or Data Review Reports. Reconciliation actions with respect to data quality objectives are discussed in the Data Review Report. When the Data Review Report is completed, data are approved for data analysis and decision making purposes, which might include calculation of Indexes of Biological Integrity, biological assessments and other statistical analyses.

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