

aquatic biological communities that inhabit ephemeral systems of the arid West. In addition to a literature search on ephemeral streams, field studies will be conducted and will include data collection on the aquatic species that colonize ephemeral streams following precipitation or snowmelt events. An evaluation of aquatic communities in ephemeral streams as a function of the duration of water present in the ephemeral stream will also be conducted. This project will be completed in late 2006.

Implementation Guidance document — This document is under development and will include a summary of findings of AWWQRP research, as well as other related research, and will discuss these findings in the context of water quality standards program implementation as it is being carried out by the states and EPA. This document is being prepared with all water quality standards practitioners in mind, not just dischargers who must comply with the myriads of state and federal water quality standards regulations, but also state regulators, who are often searching for practical and innovative ways to develop and implement water quality standards within the bounds of Clean Water Act and its implementing regulations. This project will be completed in late 2006.

AWWQRP Structure

The following provides a description of the structural elements established for the AWWQRP.

Research Agenda — Selection of research activities to fund is based on the Research Agenda established by Project participants. Periodically updating this agenda is critical to the success of the Project since it provides a mechanism to ensure that research activities are conducted in a coordinated fashion. For example, experience with the completed and ongoing research projects has illustrated the benefits of linking projects, that is, data generated and synthesized in one research project can provide the foundation for subsequent projects. Based on the findings of funded projects, the AWWQRP Research Agenda recently was refined to guide the development and implementation of the next round of research projects to be funded by the AWWQRP. In the future, it is expected that completion of additional research projects or changes in regulatory drivers will require further refinement of the Research Agenda.

Public Outreach — Public outreach has proven to be an important vehicle for sharing information regarding the AWWQRP and generating discussion on the goals and objectives of the Project. Most outreach efforts have ranged from formal oral presentations based on accepted abstracts to informal discussions with agency representatives. Several of the oral presentations have included the submission of a manuscript for publication as part of the conference proceedings. Other opportunities to share information through society or regional newsletters and publications are taken advantage of when available. The AWWQRP will continue to watch for and take advantage of such opportunities to publicize the Project and share research results.

Research Collaboration — Water quality research is not unique to the AWWQRP. Organizations, e.g., WERF and federal agencies, e.g., the EPA and Army Corps of Engineers, routinely conduct research on various elements of water quality from generating empirical data for establishment of national AWQC to developing methods for implementing programs to control pollutants. While the idea of conduct-

ing water quality research is not unique, the focus of the AWWQRP on conducting water quality research activities on ephemeral and effluent-dependent waters is unique.

One means to maximize the benefit of expenditures on research is to implement research activities jointly with other entities – with and without sharing of funds. As the AWWQRP matures, the opportunity and demand for cooperative relationships – both financial and time-related – are expected to grow. Many of these cooperative relationships may be beneficial to furthering the purpose of the Project.

Research Implementation — The completion of research projects results in additional information that can be used in a regulatory context. While individual projects may discuss results in such a manner, e.g., Habitat Characterization Study, the results of the individual projects should be linked together in a manner that is useful to regulators. The linking of this information is best suited to implementation or guidance document(s) that are applicable to arid West streams, e.g., ephemeral or effluent-dependent streams. Accordingly, where appropriate, the AWWQRP will create these documents to provide a forum for the synthesis and application of research results to regulatory questions.

Research Continuation — To date, research conducted under this Project has shown that the need for continued research in ephemeral and effluent-dependent waters is great. It is critical that we improve our understanding of these unique aquatic ecosystems so that appropriate beneficial uses and criteria are established for these watercourses. As part of its public outreach effort, the AWWQRP will look for opportunities to establish a source of long term funding that will not only allow the funding of long-term projects to enhance our understanding of arid West ecosystems, but allow the development of a long-term research strategy that looks beyond the current end of the Project. Having a secure funding source will allow the AWWQRP to conduct long-term planning and consider the development of long-term cooperative relationships with other research entities or facilities.



*Santa Cruz River downstream from the Nogales International Wastewater Treatment Plant
Nogales, Arizona*

Additional Project Information

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Summer 2006

Arid West



Water Quality Research Project



The AWWQRP

Project Background

The Arid West Water Quality Research Project (AWWQRP or "Project") began as an idea in the early 1990's out of concerns regarding the applicability of national water quality criteria to western ephemeral and effluent-dependent waters. Two key issues were originally identified: (1) national water quality criteria were based on aquatic species and flow regimes not necessarily representative of ephemeral and effluent-dependent streams; and (2) the methods provided by the U.S. Environmental Protection Agency (EPA) to modify national water quality criteria for use in effluent-dependent and ephemeral streams were not readily applicable primarily because of the lack of basic data on organisms of importance in these arid West waters (note: throughout this document references to the arid West include both arid and semi-arid areas). With these concerns in mind, efforts were initiated to demonstrate the need for the establishment of a program for the development of standards and criteria applicable to the arid West, similar to regional programs established for the Great Lakes and coastal marine waters.

These efforts bore fruit with the establishment of the AWWQRP in 1995 as the result of a \$5,000,000 federal appropriation (Public Law 103-327) and the establishment of an Assistance Agreement between the EPA and Pima County Wastewater Management Department, Tucson, Arizona. The establishment of the Agreement provided a significant opportunity for Pima County, EPA Region 9 and others throughout the arid West to work cooperatively to conduct the scientific research necessary to develop appropriate water quality criteria and standards for the region and improve the scientific basis for regulating wastewater and stormwater discharges in the arid and semi-arid West.

Since the establishment of the AWWQRP, nine projects have been funded. As projects have been implemented and completed, the AWWQRP has shared Project results and their implications in a variety of forums. This outreach effort is leading to a broader understanding of water quality issues unique to the arid West and growing support for the establishment of a regional approach for the development and implementation of water quality standards. This growing support resulted in an additional federal appropriation of \$500,000 (Public Law 107-73) that is being administered separately as the "Phase II" AWWQRP grant. In addition, increased support of the AWWQRP also has been fueled by an increasing interest in recognizing the ecological benefit of effluent-supported riparian habitats in the West. Moreover, it is being recognized that as the cost of wastewater treatment climbs and the quality of effluent improves, the competition and value of treated wastewater will likewise increase to the extent that treated wastewater, which could be used to support riparian habitat and wildlife, will likely be diverted to other urban uses. This is especially a concern for areas of the arid West where riparian and wildlife habitats are already limited. Thus, an ongoing purpose of the AWWQRP is to provide critical data to support efforts to address these unique western water quality concerns and provide innovative solutions.

Project Purpose

The purpose of the AWWQRP is to conduct scientific research and disseminate scientific information on western ephemeral and effluent-dependent waters to help resolve issues of significance to both the regulated community and regulators at state, tribal and federal levels. To accomplish this purpose, research activities have focused on the following areas:

- Water quality criteria and standards for arid West habitats;



Program results could affect 17 western states

- Water quality criteria for chemicals of concern;
- Biological and ecological criteria and standards for arid West ecosystems;
- Whole effluent toxicity testing guidance for arid West waters; and
- Arid West water quality policy and implementation issues.

Project Organization

AWWQRP Office: The AWWQRP is directed and managed by the AWWQRP Office established within Pima County Wastewater Management (PCWMD), Tucson, Arizona.

EPA Region 9 Project Officer: The EPA Project Officer serves as the primary point of contact with the EPA and participates to the extent possible in Project meetings, especially those involving the direction and management of the Project.

Research Manager: Scientific management of the AWWQRP is the responsibility of the Research Manager. A contractor recruited according to Pima County procurement procedures provides this service. CDM has provided scientific management services for the AWWQRP since 2001.

Quality Assurance Consultant (QAC): The grant awards specify that the Project will comply with Quality Assurance requirements that are consistent with the EPA. Consequently, the Project has developed a Quality Assurance Project Plan (QAPP) that specifies how this will be done and retains an experienced investigator in quality assurance to review individual project work plans for compliance with the QAPP. Aquatic Consulting & Testing, Inc. has provided this service for the Project.

Regulatory Working Group (RWG): The RWG is comprised of a 15-member group of stakeholders representing both public and private interests. The RWG was established to ensure that the research undertaken by the AWWQRP has a sound regulatory basis, and that, to the extent practicable, the regulatory needs of arid West states are addressed by the Project.

Scientific Advisory Group (SAG): This advisory group is comprised of established scientists (e.g. aquatic toxicologists, terrestrial ecologists, etc.) from throughout the West with experience in water quality research and peer review of scientific and technical literature. The function of the SAG is to recommend research topics for study, to ensure



Santa Ana River
San Bernardino, California

that studies undertaken are designed appropriately, and to assist in the technical review of research products.

Completed/Ongoing Projects

Pre-Research Survey of Municipal NPDES Dischargers in the Arid and Semi-Arid West (Discharger Survey) — This research was implemented following an RWG recommendation that the Project survey as many arid West dischargers as possible to obtain information necessary to properly characterize arid West discharges and associated water quality concerns. A key finding of the resulting report, completed in March 2000, was that there was a general lack of data that effectively described effluent-dependent water habitats.

Habitat Characterization Study — Based on the findings of the Discharger Survey, the Habitat Characterization Study was commissioned for the purpose of characterizing the physical, chemical and biological characteristics of selected effluent-dependent waters (EDWs) across the arid West. It is believed that this effort represents the first attempt to focus data gathering efforts on this type of aquatic ecosystem. The final report was published in winter 2002.

Extant Criteria Evaluation — The primary focus of this project was to evaluate existing methods for generating federal ambient water quality criteria (AWQC), methods for site-specific modifications to criteria and, if appropriate, develop an approach for regional AWQC modification that takes into account the unique characteristics of ephemeral and effluent-dependent watercourses in the arid West. Four “model” AWQC, which represent different types of pollutants, were used as the basis for this evaluation: copper, selenium, diazinon and ammonia. The final report was completed with a limited publication in September 2003 and is expected to be published by the Society of Environmental Toxicology and Chemistry (SETAC) in 2007.

Evaluation of Whole Effluent Toxicity Testing as an Indicator of Aquatic Health — This project has been a collaborative research effort between the AWWQRP and the Water Environment Research Foundation (WERF, Project No. 03-ECO-2). WERF managed and directed the research project, and the AWWQRP, as a collaborative partner, contributed research funds and technical oversight. This pilot study evaluated the quality of data needed to determine relationships between chronic Whole Effluent Toxicity (WET) test results and instream biological condition. Benefits from this study included providing several data quality criteria for WET that should be considered along with test accep-

tance criteria to improve accuracy and defensibility of test results; demonstrated the importance of data quality factors and endpoint calculation methods in determining whether an effluent “passes” or “fails” its WET limit. The project was completed in 2006.

Evaluation of the Reliability of the Biotic Ligand Model (BLM) Predictions for Copper Toxicity in Waters Characteristic of the Arid West — The focus of this research project was a series of studies designed to further evaluate the reliability of the BLM to predict copper toxicity in arid West waters. Additionally, a series of tests to further evaluate the different roles of calcium vs. magnesium in controlling copper toxicity to invertebrates and fishes was also conducted.

Conclusions from this study further suggested that the BLM generates more appropriate and protective copper standards for waters with elevated hardness when compared to the hardness-based equation or Water-Effect Ratio (WER) approaches. Although the historical site-specific methods (hardness equation and WER) are useful for surface waters with low to moderate levels of hardness, the unique chemi-



Santa Fe River
Santa Fe, New Mexico

cal conditions of arid West streams require site-specific methods that account for the influences of all water quality variables (i.e., pH, dissolved organic carbon, alkalinity, and major ions). Therefore, the BLM offers an improved alternative to the hardness-based and WER approach for modifying copper criteria, particularly for situations where the current methods would be under-protective of sensitive aquatic life. This project was completed in 2006.

Ammonia Water Effect Ratio — Although the 1999 AWQC is not expressed as a function of hardness, some toxicity studies have suggested that ammonia toxicity may vary with hardness for both invertebrates and fish. Therefore, a simple empirical study was conducted as a “proof of concept” to determine whether hardness exerts a significant enough effect on acute ammonia toxicity to be used as a basis for deriving site-specific ammonia standards in hard, effluent-dependent waters.

This study supported the limited toxicity literature available which suggests that hardness (and/or related cations) may influence acute ammonia toxicity. However, these effects have been shown to be species-specific, and only valid for invertebrates, not fish. This study has also shown

that WERs >1 can be observed in effluent-dependent waters for both fish and invertebrates. The WERs found to be >1 may have been the result of a difference in ionic composition between the site and laboratory waters, but it is clear that the protective effect associated with these significant WERs was not due to hardness alone. Therefore, until these potential ion effects and/or mechanisms are better understood, it is difficult to predict whether a positive WER could be achieved for a given site without first conducting empirical tests. This project was completed in 2006.

Evaluation of EPA Recalculation Procedure and User's Guide for EPA Recalculation Procedure — This project used fundamental insights from previous AWWQRP efforts to evaluate the potential use and/or modification of the recalculation procedure with five chosen AWQCs based on resident species data from five pilot study streams. The Recalculation Procedure was used as a basis for comparing resident aquatic species lists to toxicity databases for ammonia, copper, zinc, aluminum, and diazinon.

Using EPA methods, species from the toxicity databases for the five criteria were added and deleted. This portion of the study included a sensitivity analysis on the effects of modifications of toxicity database size on the resulting recalculated criteria values.

A list of resident species common to the case study sites was compiled, including species common to arid West streams that would potentially be useful for new toxicity data development. These included genera often found in EDWs, for example:

- *Cyprinidae* (minnows, carps)
- *Centrarchidae* (sunfish, bass, etc.)
- Multiple midge genera
- *Callibaetis*, *Tricorhithodes* (mayflies)
- *Argia* (damselfly)

The possibility of generating a new minimum data requirement for toxicity database evaluation that is functionally equivalent to the current, nationwide, eight-family database “rule”, but more appropriate to protection of aquatic communities in arid west streams was evaluated. When applied to the various study sites, the recalculation procedure and development of site-specific criteria using these new data were generally less restrictive than the national criteria, especially for zinc and copper. Ammonia was the only compound not greatly affected by derivation of site-specific criteria since national criteria were derived from cold and warmwater specific databases. Furthermore, in most cases regional criteria are less restrictive than the national criteria.

To assist in the possible application of these methods, a User's Guide was prepared for the Recalculation Procedure to aid dischargers and permit holders in applying a Recalculation Procedure given the unique biological conditions often present in effluent-dependent waters. This document includes a discussion of the derivation of national AWQC and evaluation of the use of the WER method versus the Recalculation Procedure and Resident Species Procedure in effluent-dependent waters. Additionally, the User's Guide includes a discussion on the role of AWQC in regulating water quality via the NPDES program of the Clean Water Act. This project was completed in 2006.

Aquatic Communities of Ephemeral Stream Ecosystems — The focus of this recently initiated research project is on



Discharge from the WWTP into the Santa Cruz River
Tucson, Arizona