8.0 RECOMMENDATIONS

The results of this study suggest that effluent-dependent waters would benefit from innovative thought in how they are established, managed, and regulated. Expectations for these ecosystems to function in a manner similar to a natural perennial stream may be incorrect, and accordingly, regulatory programs designed to protect human health and the environment may need to be implemented differently in effluent-dependent waters.

The importance of developing alternative approaches for the management of effluent-dependent waters is growing. Environmental projects are underway and others are envisioned in the arid West, especially the Southwest, where effluent is being contemplated as a source of water to support habitat restoration or rehabilitation efforts. In some cases, the *only* source of water available for these projects is treated effluent. To support these projects and at the same time support existing environmental benefits already achieved with the addition of effluent to otherwise dry riverbeds, the development of alternative approaches to manage water quality in these systems is recommended. **Chapter 6** of this report identifies existing approaches or ideas that could be used to develop these alternative management approaches. Additional approaches could be developed from the collective efforts of water quality practitioners, including both regulatory and non-regulatory stakeholders.

Developing alternative approaches to the management of effluent-dependent waters can help communities address multiple but intertwined issues associated with these often urban-based waters. Examples of these issues include flood control, ecosystem restoration or rehabilitation, irrigation needs, water conservation, threatened and endangered species, and public values such as providing minimum in-stream flows, meeting water quality expectations, maintaining riparian systems, and even creating recreational opportunities.

Given the diverse and potentially conflicting issues associated with effluent-dependent waters, the WQRP provides an opportunity to bring together diverse interests to conduct research and develop innovative ideas for managing these systems. With this opportunity in mind, and using the Habitat Characterization Study as a foundation, the authors provide the following general recommendations:

- Implement research projects to refine our understanding of how effluent-dependent ecosystems develop and function and develop innovative approaches for managing water quality in these waters.

- Establish a continuing research program to allow the development of a long-term research strategy.

- Increase outreach efforts to water quality practitioners.

The following sections provide additional discussion regarding the importance of each of these recommendations.

8.1 RESEARCH TO REFINE UNDERSTANDING OF EFFLUENT-DEPENDENT WATER ECOSYSTEMS

A key finding of the Habitat Characterization Study is the recognition that effluent-dependent waters represent a distinct class of waters. The authors believe that this recognition warrants the establishment of a designated use that is specifically applicable to these waters. This designation would provide a basis for the establishment of criteria and standards that not only recognize the limitations existing in these effluent-created ecosystems, but also the benefits of effluent discharge as manifested in the terrestrial component of the ecosystem. If a use could be established that allows consideration of the entire ecosystem rather than just the water column, the benefits to the riparian community, including wildlife, could be significant.

As stated in **Chapter 1** of this report, the Habitat Characterization Study was commissioned to characterize effluent-dependent water habitats, with the findings of this effort intended to provide a foundation for future WQRP research. As is true with many research endeavors, the results of any given project often lead to the creation of many new questions or directions for research. This project has been no different.

As a result of this study it is apparent that the research needs for effluent-dependent waters are numerous. Potential research topics range from large-scale, holistic ecosystem studies, to chemical-specific or species-specific studies. Results from holistic or chemical-specific studies are likely to be applicable to a regional area (e.g., the arid West), while species-specific studies may have only local interest or use. In addition to the technical questions highlighted by the Habitat Characterization Study, the authors believe that this project also has highlighted a number of important research needs involving water quality standards policies and implementation procedures and how they are applied to effluent-dependent waters. Accordingly, the following sections highlight some of the areas of research contemplated by the WQRP for the future.

8.1.1 Ecosystem Studies

8.1.1.1 Biological Criteria Applicable to Effluent-Dependent Waters

Biological criteria are useful for evaluating the health of the aquatic community; however, with regards to effluent-dependent waters what constitutes a "healthy" community is typically based on the characteristics of natural perennial waters. As discussed in **Chapter 5**, a combination of physical and chemical factors provides the template upon which the aquatic community exists. This template is dynamic. For that reason, it is important to establish reasonable expectations for the effluent-dependent community given that the aquatic community present on any given day exists because of the effluent and removing the effluent would typically result in a dry riverbed.

8.1.1.2 Nutrient Dynamics in Effluent-Dependent Waters

A strong push is underway nationally to adopt nutrient criteria on all waters jurisdictional under the Clean Water Act. Current EPA guidance does not distinguish effluent-dependent waters from

natural perennial waters. Research is needed to establish appropriate nutrient limits for effluent-dependent waters. Examples of research questions include, how do nutrients benefit the riparian community supported by the effluent? Also, if benefits are identified, should these benefits be recognized by the establishment of alternative criteria?

8.1.1.3 Relationship Between Levels of Wastewater Treatment and the Aquatic Community

Research is needed to further understand the relationship between increased treatment levels and aquatic community expectations. Often treatment upgrades are implemented to achieve benefits to aquatic life in the receiving waters. However, because confounding factors, often associated with physical limitations, are active in these systems, the treatment upgrade may not result in the expected benefit.

8.1.1.4 Fate and Transport of Pollutants in Arid West Waters

As stated in **Chapter 5**, any alternative approach developed for regulating pollutants in effluent-dependent and ephemeral waters to take advantage of the net ecological benefits perceived from the discharge of effluent must consider the potential presence and export of bioaccumulative pollutants. It is recommended that the WQRP conduct studies to understand the fate and transport of such pollutants in both created systems and ephemeral waters. Examples of transport pathways to be evaluated include bioaccumulation through the food chain, transport downstream and discharge into aquifers.

8.1.1.5 Whole Effluent Toxicity Test Procedures Applicable to Arid West Waters

Develop standard toxicity test organisms that have been acclimated to the natural water quality stress caused by the ionic structure of arid West waters. Such stress is frequently mistaken for pollutant toxicity when using standard whole effluent toxicity test organisms that were cultured under very different ionic conditions. Or, alternatively, modify the whole effluent toxicity test procedures to account for non-pollutant stresses.

8.1.1.6 Effluent-Dependent Water Demonstration Project

Implement a demonstration project that studies the creation of an aquatic ecosystem from the time that discharge of treated effluent begins. A key benefit of this type of study would be the ability to quantify changes in the aquatic and terrestrial communities over time. Incorporated into this project would be specific studies on physico-chemical dynamics, aquatic and riparian community establishment, and system evolution.

8.1.2 Effluent-Dependent Water Use-Specific Policies and Procedures

Effluent-Dependent Water Designated Use. Establish a standard beneficial use category for "modified streams" to formally recognize effluent-dependent streams. Develop tools for evaluating use attainment that consider multiple uses including urban uses and recognition of ecological benefits. An effluent-dependent water use would differ from traditional uses by

recognizing that the "use" of the effluent-dependent water extends out of the water column into the terrestrial ecosystem supported by the effluent discharge.

8.1.2.1 Performance-Based NPDES Permitting

Develop a permitting approach for effluent-dependent waters that moves away from the traditional approach of setting effluent limitations to develop non-traditional performance-based standards or outcomes. This non-traditional permitting approach would require the development of new approaches for evaluating compliance through the use of performance-based standards rather than effluent limitations.

8.1.2.2 Development of Minimum Water Quality Expectations for Effluent-Dependent Waters

Establish default water quality criteria for streams designated as effluent-dependent based on technology-based limits, anti-backsliding, anti-degradation regulations associated with the protection of existing uses, and concerns for limiting bioaccumulative chemicals of concern. Water quality-based criteria needed to protect human consumption and exposure also could be developed, as necessary.

8.1.3 Ecosystem Evaluation Methods and Habitat Restoration Studies

8.1.3.1 Methods for Evaluating the Physical Ecology of Arid Riparian Zones

One finding from this study is that although there are a few classification schemes that have been proposed for arid West riparian systems (**Appendix B**), none are especially useful. There is little point in classifying riparian habitat health if the classification does not suggest a remedial direction. In part, the problem emerges because the physical ecology of the stream has not been well coupled to the biotic health of the riparian system in a direct causal manner. There is a deficit of ecological theory for arid Western streams useful to regulatory assessment that cannot be filled without additional research.

Accordingly, it is recommended that research be conducted to develop a physical ecological model that fully describes arid West riparian zones adjacent to effluent-dependent waters. Such a study would begin with the chemistry, hydrology, hydrogeology and geomorphology of the stream, perturbed by introduced stressors appropriate to wastewater discharges. The interaction of the physical template with the riparian plant and animal communities would be quantified. The model would examine the adjustments and feedback cycles of human and ecological significance, (i.e., a particular regulatory, permitting or other facility operation period, as modified by the growing periods and recovery rates of the biotic community).

Construction of this model would provide opportunity for research on the roles of various parameters associated with wastewater discharge and their influence on riparian systems. This approach, called long-term adaptive management research by USACE has been successfully implemented in river restoration projects nationwide. It has not yet been applied to effluent-

dependent streams, although results from many existing research and monitoring programs could potentially be adapted to these waters.

8.1.3.2 Impacts of EDWs on Invasive Species

Invasive species issues are of great significance in effluent-dependent waters because of ecosystem considerations discussed in **Chapter 3**. Changing flow duration, location, and frequency within a river, or otherwise altering the physical template of a reach will create a new ecological equilibrium that will clearly favor some plants and animals over others. In general, the native assemblage will be optimized by the dynamic conditions of an unregulated river; while the regulated flows of urbanized or altered watersheds favor a completely different biota (Stanford et al 1996). Examples of this phenomenon were observed on the Salt and Gila rivers (salt cedar) and the Santa Ana River (giant reed) where non-native species appeared to be more prolific in highly modified reaches of these rivers. Research could be designed to study the long-term changes in plant, avian and wildlife abundance and diversity associated with the creation of effluent-dependent waters.

8.2 ESTABLISHMENT OF A CONTINUING RESEARCH PROGRAM

To date, research conducted under this project has focused on developing an understanding of effluent-dependent waters (e.g., where are they, how have they developed, what are their physical, chemical and biological attributes?). Additional WQRP research is ongoing to develop an understanding of the link between existing national water quality criteria and protection of aquatic communities of effluent-dependent waters.

As should be apparent from the description of recommended future research topics provided above, the need for continued research in ephemeral and effluent-dependent waters is great. Moreover, the ongoing implementation of existing water quality programs under the Clean Water Act promises to result in more questions with regards to how water quality programs are implemented in these waters. For example, the number of surface waters listed as impaired and requiring the establishment of a TMDL is increasing rapidly. It is possible that a number of waters listed in the arid West have been classified as impaired simply because inappropriate designated uses or water quality criteria have been established. Research on appropriate uses and criteria for arid West streams can support evaluations of impairment.

The WQRP was originally established as a five-year program with $5,000,000 in funding. An additional $500,000 was authorized in 2001, which will extend the window for research. As already summarized in this chapter, we believe the need for research is great and significant environmental benefits can be achieved by a continued focused research effort on ephemeral and effluent-dependent waters. As suggested above, the questions of habitat or ecosystem science transcend single objective, individual grants. There is an enormous need for long-term monitoring of the hydrology and ecology of effluent-dependent streams. Because flow within arid West watersheds is so variable, to fully investigate some ecosystem questions some streams may require many more years of ecological monitoring than their non-arid equivalents. Implementing long-term monitoring studies requires secure funding over many seasons or years, the kind of support afforded other regional research programs (e.g., research conducted by the

U.S. Department of Agricultural Experimental Ranges and Forests in other parts of the West). To allow the development of a long-term research strategy and consideration for funding of extended field studies, it is recommended that the WQRP seek secure funding that will allow such long-term planning.

8.3 INCREASE OUTREACH TO WATER QUALITY PRACTITIONERS

Effluent-dependent waters directly or indirectly affect many organizations and individuals. Interest in the appropriate management of these created ecosystems has grown in the past decade, especially as (1) new national mandates have resulted in requirements for increased treatment levels at wastewater treatment plants, (2) implementation of efforts to restore or rehabilitate urban rivers gains momentum, and (3) the conflict among competing uses of water grows. With these varied interests in mind, the WQRP believes that the Habitat Characterization Study can serve as a basis for discussions among stakeholder groups – not to solve site-specific problems, but to serve as a catalyst to provoke discussion on how groups with varied interest and goals can work together to manage these ecosystems holistically. Key stakeholder groups include those described below.

8.3.1 Federal Regulatory Agencies

8.3.1.1 Environmental Protection Agency

EPA is responsible for implementing the Clean Water Act. Specific programs authorized under this Act may be delegated to other agencies (e.g., the Section 404 program to the USACE), or states and tribes (e.g., the NPDES permit program). However, states and tribes ultimately must have EPA approval for implementing water quality programs, especially if the selected approach is "different" from accepted methods established by EPA either through the promulgation of rules or adoption of policy.

Results from the Habitat Characterization Study suggest that effluent-dependent waters are unique, and as such we are recommending that these created ecosystems might be managed best by the use of methods that are "different" from routine approaches used in water quality management. This study can provide a foundation for discussions on created ecosystems and how environmental programs could be implemented in a manner that maximizes ecological benefits while at the same time meeting the goals of the Clean Water Act. With EPA participation in these discussions, support can be provided to states and tribes, the entities most likely to implement alternative approaches to water quality management in these waters.

8.3.1.2 U.S. Fish and Wildlife Service

USFWS has a significant role in the implementation of water quality programs. Not only is USFWS responsible for ensuring that federal actions do not result in negative impacts on species protected by the Endangered Species Act, but also for implementing plans to recover protected species.

USFWS interest in how effluent-dependent waters are managed should be high for two key reasons. First, USFWS must ensure that any alternative approaches adopted to manage water quality in these systems are not detrimental to protected species. However, at the same time, USFWS should be interested because creation of riparian habitat as a result of effluent discharge provides opportunity for the support of recovery plans for species that benefit from the creation of riparian communities and corridors.

8.3.1.3 U.S. Army Corps of Engineers

As indicated in **Chapter 5**, USACE is actively involved in riverine habitat restoration and rehabilitation projects. In the arid West, these planned or ongoing projects often depend upon treated effluent as a key source of water. As such, the discharge of effluent into what otherwise would be dry riverbeds provides opportunity for habitat restoration projects, especially in areas where water resources are limited.

8.3.2 States and Tribes

States and tribes have considerable responsibility for implementing Clean Water Act programs, especially if the state or tribe has been delegated responsibility for the NPDES permit program. This approach results in separate, independent water quality programs in each state and tribe. To implement these programs, states and tribes generally rely on federal guidance provided by the EPA.

Currently, recognition of effluent-dependent waters as distinct waterbody types is limited in state and tribal water quality standards. Moreover, implementation of any type of alternative permitting approach for these systems is non-existent. Although some states have expressed interest in developing alternative approaches for managing these systems, without federal support this interest will likely not be realized. This document provides a first step for interested states and tribes to work with their respective federal counterparts to move forward with the development of alternatives for managing effluent-dependent waters. Development of these alternatives can be coordinated with other state and tribal needs associated with water resource management, including flood control, water rights, and water conservation.

8.3.3 Wastewater Dischargers

8.3.3.1 Existing Dischargers

Many effluent-dependent waters exist and opportunities to optimize some factors that could benefit from engineering (e.g., morphology of the receiving water), are limited. Regardless, the presence of the effluent is still providing benefits, especially in the support of the riparian community. This document as well as future WQRP research can lend support to interested dischargers that seek alternative ways to manage the ecosystem created by the discharge. For example, if implementing habitat restoration activities can be shown to be more cost-effective than upgrades to wastewater treatment, then WQRP research can be used to support such efforts.

8.3.3.2 Future Dischargers

The findings from this study provide some critical insight into an area not typically considered when dischargers develop plans to discharge effluent to a dry riverbed. Results suggest that consideration of physical attributes of the receiving water prior to initiating discharge could enhance expectations for the aquatic community and establishment of riparian community. Development of a "designer" ecosystem would benefit from changes in policies that accept the benefits attained by the discharge of effluent. In this regard, effluent could be viewed as a valuable tool to achieve community benefits.

8.3.4 General Public

Effluent-dependent waters are often associated with urban areas. The general public, a key stakeholder in urbanized areas, has numerous concerns regarding how aquatic ecosystems are managed, especially with regards to flood control, water quality, and recreational opportunities. Increasingly, the public is interested in multiple uses (e.g., combining flood control strategies with the development of recreational opportunities). Where effluent is the primary source of water, additional opportunities envisioned in some communities include the establishment and maintenance of riparian habitats, which provide important recreational opportunities. As discussed elsewhere in this report, the concept of including public amenities in the design of created wetlands has become the norm; we believe a similar opportunity exists with effluent-dependent waters. This study as well as future WQRP research can support this opportunity by helping the public view urban rivers as something more than just conduits for effluent or floodwaters.

8.4 CLOSING COMMENT

The Habitat Characterization Study is only a beginning. The need for long-term scientific support for the western water issues identified in this report agrees with a scientific opinion that began over 100 years of federal research in the arid West. The West is different, said USGS director John Wesley Powell in 1878. Over the intervening period, the West has experienced many ecological changes forced by the lack of both water and understanding. We now have the tools and the opportunity to begin to supply that understanding and, with time, to become fully protective of all of our western waters.