5.0 REGULATORY SYSTEMS AND TOOLS FOR CONSIDERATION

The findings from the Habitat Characterization Study discussed in **Chapter 3** coupled with the **Chapter 4** discussion concerning the value of water in the arid West provide the basis for the presentation of regulatory issues in this chapter. Accordingly, the discussion that follows first provides an overview of how water quality regulatory programs are currently being implemented in effluent-dependent waters. Subsequent to this overview is a presentation of alternative regulatory frameworks that could be developed to take advantage of effluent as an important water resource in arid West watersheds. Developing an alternative framework would allow for consideration of the value of water as a resource while at the same time providing basic protection for effluent-dependent ecosystems.

5.1 EXISTING REGULATORY SYSTEM

Regulation of effluent discharge from wastewater treatment facilities is implemented through the establishment of NPDES permits (**Appendix L**). The quality of effluent discharged from a wastewater treatment facility is dependent on two key factors: (1) technology-based standards established by federal NPDES regulations; and (2) water quality-based standards. Technology-based standards are similar for wastewater treatment facilities. In contrast, water-quality based standards are dependent upon the water quality standards applicable to the waterbody to which the effluent is discharged.

Section 303 of the Clean Water Act grants states and tribes the responsibility for establishing water quality standards, but any standards adopted by states or tribes are subject to EPA approval. State or tribal water quality standards consist of the following three key elements:

- *Designated Uses* – Describe the existing or potential beneficial uses associated with each state or tribal waterbody. Examples of designated uses include broadly applicable uses such as aquatic life protection and recreation, but also more narrow applications such as navigation, public water supply, agriculture, and industry. Generally speaking, use designation should be based on the chemical, physical, and biological characteristics of a waterbody.

  As part of the Habitat Characterization Study an inventory of designated use classifications established in arid West states was developed (**Appendix M**). Arizona is the only arid West state that has established a use classification that specifically recognizes effluent-dependent waters. However, this classification is limited to aquatic life protection.

- *Ambient Water Quality Criteria (AWQC)* – Numeric or narrative pollutant-specific criteria established to protect designated uses. AWQC are used for several regulatory purposes, including protection of beneficial uses and derivation of NPDES effluent limitations. States and tribes have the option either to use the AWQC recommended by EPA or to establish their own water quality criteria based upon some scientifically defensible method. However, if states or tribes adopt alternative criteria, both the criteria and method of derivation are subject to EPA approval.

The applicability of the AWQC developed by EPA to effluent-dependent waters is often questioned for several reasons: (1) the AWQC are derived primarily from standardized toxicity tests (i.e., uniform types of water and laboratory exposure conditions, conditions not representative of in-stream ambient conditions) (2) the AWQC are developed using aquatic species that may not be representative of the biota in arid streams of the West; and (3) as reported in this study, effluent-dependent and ephemeral waters in the arid West share a set of unique biotic, hydrologic, and geochemical characteristics that are generally distinct from waters in more mesic areas of the United States.

Even with these important differences, a review of water quality criteria established by arid West states, shows that (1) the adopted water quality criteria are often similar to the EPA-recommended AWQC (**Appendix M**); and (2) the water quality criteria established to protect aquatic life in effluent-dependent waters are often no different than criteria established to protect a coldwater trout fishery (**Appendix M**). Thus, there has been minimal effort expended to adjust criteria to take into account differences in species composition.

- *Antidegradation Policy* – Procedures that will be implemented by the state or tribe to maintain and protect existing water quality as measured by water quality criteria. Antidegradation provisions can be implemented under a variety of water quality programs. For wastewater dischargers, antidegradation provisions are invoked when establishing effluent limitations in NPDES permits; specifically, the NPDES permit writer must establish effluent limitations in the permit that will maintain and protect existing water quality.

NPDES permits are required for any point source discharge, including treated effluent, to a waterbody under the jurisdiction of the Clean Water Act. Effluent limitations are based on the water quality standards established for the waterbody receiving the discharge. Limitations are derived based on the dilution capabilities of the receiving water. For example, if a wastewater facility discharges to a perennial stream (the 7Q10 is always greater than zero), then the effluent limitation can take into account the dilution capabilities of the receiving water. The exact effluent limitation will be based on a series of calculations that consider in-stream flow volume, effluent characteristics, and the water quality standard of the receiving water. In some instances, the calculated effluent limitation is also based on the establishment of a mixing zone, which allows for some potential chronic toxicity near the discharge point, but no acute toxicity is allowed. The resulting effluent limitations where there is substantial flow in the receiving water can be several times higher than the water quality standard.

> ***7Q10*** – The lowest average flow for a seven-day period that is expected to occur once every 10 years. The 7Q10 flow is used to allocate the discharge of toxic substances to a stream. 7Q10 flows are typically obtained from USGS .

Establishing effluent limitations where there is the possibility of dilution or establishment of a mixing zone is standard for many areas of the United States where discharge to perennial waters is possible. However, effluent limitations contained in NPDES permits issued for discharges that create effluent-dependent waters are established in a very different manner.

> ***Mixing Zone*** – an allocated impact zone below an effluent discharge point where water quality criteria can be exceeded as long as acutely toxic conditions are prevented (EPA 1991).

By definition, an effluent-dependent water creates perennial flow where, prior to the discharge, the flow was either ephemeral or intermittent. Under natural conditions (i.e., pre-discharge), the 7Q10 of such a system would be zero. In addition, because insufficient natural flow would be present without the discharge, establishment of a mixing zone is not allowed under existing interpretations of mixing zone regulations (EPA 1994). As a result of these conditions, effluent limitations established in a NPDES permit issued for a discharge creating an effluent-dependent water are based only on the water quality standards of the receiving waterbody. In other words, the water quality standard adopted by the state or tribe becomes the effluent limitation in the permit. Thus, for NPDES permits established for effluent-dependent waters, the expected level of treatment required for the wastewater facility that creates an effluent-dependent water can be substantially higher than the level of treatment required for that same facility if it were to discharge to a perennial water.

5.2 ALTERNATIVE REGULATORY APPROACHES: WORKING WITHIN THE CLEAN WATER ACT AND IMPLEMENTING REGULATIONS

An original objective of the Habitat Characterization Study was to establish a habitat classification scheme for arid West effluent-dependent waters. This objective was based on the assumption that it would be possible to use the results of the 10 study area characterizations to classify stream types according to site-specific characteristics. However, the results from this study suggest that a more appropriate approach for habitat classification would be to focus on the establishment of a separate designated use for effluent-dependent waters rather than attempt to classify specific habitat types on the basis of the 10 study areas. This shift in thinking is based on the finding of common physical, chemical, and biological characteristics associated with the stream ecosystem created by the discharge of effluent (refer to **Chapter 3**).

While there certainly are differences among study areas with regards to the dominant riparian species or physical characteristics such as geology, these differences do not lend themselves well to the existing regulatory framework. Moreover, the current study evaluated only 10 study areas and the degree to which a classification scheme based on these 10 study areas would be applicable to other effluent-dependent sites in the arid West is unknown. Ultimately, site differences, which may be important with regards to the establishment of water quality criteria, could be addressed by the development of site-specific criteria.

Chapter 3 presents an overview of the characteristics of the effluent-dependent stream ecosystem, including a summary of the following key factors that define the uniqueness of these systems:

- The simple introduction of running water to a streambed is a profound disturbance, the scale of which depends upon several geomorphic and hydrologic conditions at the point of discharge. For example, channel gradient, substrate, and complexity are inherited from pre-discharge conditions and may not be appropriate for the flow regime created by effluent-dependent discharge.

- The physical limitations of effluent-dependent water habitat are determined not just by the physical dynamics resulting from the interaction between the effluent discharge and receiving channel, but by other existing physical limitations imposed on the system by multiple stressors (e.g., channel modifications, bridges, and other sources of discharge.
- The frequency, duration, and location of natural flow (e.g., the natural frequency of storm flows) in the river system likely influences biological expectations, both aquatic and terrestrial.
- Treatment levels are not necessarily a good predictor of expectations for aquatic community characteristics.
- Except during stormwater runoff or seasonal flow events, in-stream water quality is primarily or entirely a result of effluent quality.
- Riparian terrestrial characteristics are a reflection of the physical template resulting from in-stream flow characteristics (natural and effluent-driven).
- Terrestrial vegetation and associated wildlife benefit from the creation of effluent-dependent waters, especially where little or no flow occurs upstream of the discharge.

Chapter 4 describes the realities of the value of water in the West. Water is not only a resource that is used for activities ranging from public water supply and recreation to agriculture, it is in essence a commodity that can be bought, sold, leased or traded.

Section 5.1 of this chapter describes the existing regulatory framework under which the wastewater facilities that create effluent-dependent waters are permitted and how this scenario differs from the permitting scenario for facilities that discharge to perennial streams. These differences, coupled with the marketable value of water in the West, are in and of themselves significant drivers for recommendations for developing an alternative approach to the implementation of water quality regulations on effluent-dependent waters. However, when two additional factors are added to the mix, then the need for an alternative regulatory approach is appears to be even greater. These factors include: (1) physical limitations imposed on these systems by numerous stressors either related to the discharge itself or external factors such as urban development; and (2) the positive ecological response associated with the riparian community.

The remainder of this chapter focuses on options for an alternative regulatory framework and how these options can support other efforts to manage water resources and implement watershed-based programs such as ecological restoration.

5.2.1 Establishment of a Designated Use Specific to Effluent-Dependent Waters

The foundation for the establishment of water quality standards is the designation of beneficial uses for each surface water under the jurisdiction of the Clean Water Act. Because failure to properly define beneficial uses can lead to inappropriate regulatory outcomes, the EPA has recognized the importance of correctly establishing beneficial uses as follows:

> "States are required to designate uses considering, at a minimum, those uses listed in section 303(c) of the Clean Water Act (i.e., public water supplies, propagation of fish and wildlife, recreation, agriculture and industrial purposes, and navigation). However, flexibility inherent in the State process for designating uses allows the development of subcategories of uses within the Act's general categories to refine and clarify specific use classes. *Clarification of the use class is particularly helpful when a variety of surface waters with distinct characteristics fit within the same use class, or do not fit well into any category. Determination of non-attainment in waters with broad use categories may be difficult and open to alternative interpretations. If a determination of non-attainment is in dispute, regulatory actions will be difficult to accomplish*" (emphasis added)" (EPA 1994).

Recognition that there are distinct classes of waters is an important but often ignored element of the establishment of water quality standards. Interestingly, EPA has recognized that ephemeral and effluent-dependent waters represent distinct classes of waters, as follows:

> "Water quality criteria are toxicity based values, usually chemical specific. The criteria are based on toxic effects to a broad taxonomic group and do not consider the types of water bodies, such as semi-arid ecosystems, they may be applied to. Aquatic life criteria, when implemented as part of the water quality standards, are meant to be protective of aquatic life. These standards are applied to specific waterbodies through designated uses. *For this rulemaking, EPA assumes that States correctly define designated uses and the specific waterbodies to which those uses apply. EPA agrees that ephemeral streams and effluent dominated waters are distinct classes of waters.* If a State feels an aquatic life use designation is appropriate for these waterbodies, then the aquatic life criteria will apply to protect that use. If not, then they will not apply" (emphasis added) (National Toxics Rule, 57 Federal Register, pg. 60878, December 22, 1992).

With regards to the establishment of aquatic life uses, EPA has specifically encouraged the establishment of uses that best define what can actually be attained in a given type of waterbody. Moreover, defining attainability is not necessarily linked to original habitat conditions (i.e., returning all jurisdictional waters back to a pre-settlement condition):

> "It has never been the intention of the water quality standards program to bring all waters to a pristine condition or necessarily to set standards based on original habitat conditions. In the first instance, some waters are naturally of "poor" quality, and in the second, man has changed the environment and there are instances where an attempt to correct or control some sources of pollution either simply cannot be effected or would

cause more environmental damage to correct than to leave in place" (48 Federal Register pp. 51409-51410, November 8, 1983, Appendix to Water Quality Standards Regulation, Final Rule).

Federal regulations currently recognize at least three basic stream types: perennial, intermittent, and ephemeral (see 40 CFR 131.10(g)(2)). This recognition is also discussed in federal water quality standards guidance (e.g., EPA 1994) and often acknowledged in state water quality standards. However, although these stream types are routinely acknowledged by definition in federal guidance or state regulations, rarely is guidance provided or criteria established that are specific to these different stream types.

The results of this study suggest that there is a scientific basis for consideration of an additional stream type that is as distinct as a perennial, intermittent, or ephemeral stream. This additional stream type could be referred to as a "modified stream," (i.e., a stream, which is naturally intermittent or ephemeral, where effluent is the primary or only source of non-stormwater flow). These streams are "modified" in the following key ways:

- The discharge of effluent may result in erosion and channel incision, creating an aquatic habitat with decreasing potential nearer the point of discharge.
- The flow is primarily or completely derived from effluent during much of the year and the in-stream water quality should be expected to be similar to the quality of the effluent.
- Urban and public expectations for flood and erosion control may nullify the expected gains from improved treatment levels; as a result, prospects for returning the watercourse to a natural or pre-disturbance condition are low or non-existent.
- Other sources of discharge to the stream (e.g., stormwater outfalls and agricultural return flows) influence the modified stream in their own ways.
- Water resource projects (e.g., diversions, upstream storage reservoirs) have significantly affected the natural flow regime of the modified stream, especially in urban areas.

While any one of the above ways in which a stream is "modified" is sufficient to impact the aquatic community, the reality is that these modifications often occur in various combinations. The fact that a combination of factors simultaneously influences these watercourses raises important questions with regard to how water quality standards are established and implemented in modified systems. It is telling that upgrades to high levels of treatment appear to have resulted in little change in taxonomic richness; only changes in the types of organisms present have occurred (refer to **Chapter 3**).

If taxonomic richness remains low regardless of treatment, what would be an appropriate measure for defining attainment in a modified stream? Simply upgrading a wastewater treatment facility does not appear to be sufficient to produce a waterbody that meets expectations for a non-impacted aquatic community (based on traditional measures of what constitutes an unimpacted community). Even with improved water quality (e.g., reduced nitrogen), resulting from more costly forms of treatment, the aquatic community does not necessarily become more like a "natural" community. Regardless of this fact, water quality programs continue to focus on treatment facilities as the primary answer or means to achieve in-stream expectations. In so doing, water quality control efforts have been focused on only specific components of the stream ecosystem rather than looking at the big picture (i.e., the need for a watershed approach that addresses other limiting factors such as habitat).

At this point, it is important to recognize that, although the benefits of higher levels of treatment may not appear to be manifested in the aquatic biological community of the receiving water, higher levels of treatment may have unrecognized benefits, especially involving the removal of bioaccumulative pollutants. These pollutants (e.g., mercury, dichlorodiphenyltrichloroethane [DDT] and polychlorinated biphenyls [PCBs] receive special attention because they are persistent, bioaccumulative substances that can build up in the food chain to levels that are harmful to human and ecosystem health (e.g., see www.epa.gov/pbt). The importance of removal of these chemicals of concern cannot be diminished and must be considered when developing any alternative framework for water regulation in effluent-dependent waters.

The recognition that effluent-dependent waters, as modified habitats, may require a different approach to managing water quality has been recognized for almost a decade. In 1992, EPA Region 9 published its Interim Final *Guidance for Modifying Water Quality Standards and Protecting Effluent Dependent Ecosystems* (EPA 1992). This was the first attempt to address these ecosystems on a specific basis by recognizing their uniqueness. This document also established the term "net ecological benefit," a concept that recognized the potential value of having wastewater discharged to an otherwise dry riverbed [Note: For the purposes of this discussion it has been assumed that the addition of water to an otherwise dry riverbed is a "benefit." The authors acknowledge that preservation of naturally ephemeral channels can likewise be beneficial. However, in an urban environment such preservation may not always be practical (refer to **Chapter 3** for additional discussion on this issue].

In 1993, EPA prepared its *Supplementary Guidance on Conducting Use Attainability Analyses on Effluent Dependent Ecosystems* (EPA 1993). The purpose of this document was to provide guidance to states on what constitutes net ecological benefit as follows:

> "An important consideration in developing water quality standards for effluent-dependent water bodies is that discharges may promote restoration of habitat suitable for formally indigenous species. Effluent flows may enable maintenance of certain forms of aquatic life, wildlife, and riparian or wetland habitat, even if water quality criteria necessary to protect fishable/swimmable uses are not readily attainable. Where water quality criteria are not met, State/dischargers may consider removal of the effluent instead of additional treatment. If removal of the effluent would cause more environmental damage than allowing it to continue, the discharger may be able to demonstrate that the effluent is providing a Net Ecological Benefit. Examples of such benefits include the following:
>
> - Provision or enhancement of habitat or food sources for native or threatened/endangered aquatic species, or migratory waterfowl

- Provision or enhancement of habitat or food for terrestrial native or threatened/ endangered species

- Enhancement or restoration of riparian values (e.g., increased species diversity, growth of vegetation and improved wildlife/bird habitat)

- Preservation of existing riparian or aquatic habitat that could not be supported without effluent flow

- Restoration of aquatic and riparian values lost due to human activities (prior to new effluent discharge)

- Enhancement of water quality resulting in conditions conducive to ecosystem restoration and/or preservation

- Improvement or creation of habitat capable of supporting fish or allowing migration of anadramous species

- Restoration of species diversity in aquatic ecosystems" (EPA 1993).

It is notable that these examples of net ecological benefit are primarily focused on the ecosystem, rather than a specific component of the ecosystem. Moreover, several of the examples consider ecosystem functions (e.g., provision of food resources for terrestrial species). The Habitat Characterization Study was initiated for the purpose of documenting the physical, chemical, and biological characteristics associated with case study examples of effluent-dependent waters in the arid West. As a result of this data gathering effort, many of the elements of what could constitute a net ecological benefit have been observed at the 10 study areas (e.g., substantially increased terrestrial community supported by effluent, wildlife supported to some degree by food resources generated by the adjacent aquatic community, and enhancement and restoration of riparian values lost as a result of human activities).

The regulatory framework within which the net ecological benefit concept was originally established envisioned the preparation of a use attainability analysis to justify the lowering of one or more water quality standards because one or more of the use attainability provisions at 40 CFR 131.10(g) had been met [typically 40 CFR 131.10(g)(3)] (**Appendix L**). This approach assumed that the designated uses of the effluent-dependent water were appropriately set in the beginning. Based on the findings of this study, it may be more appropriate to establish an aquatic life and wildlife beneficial use specifically designed for modified streams rather than use the traditional use attainability approach to evaluate attainment. This approach would be in accordance with EPA's water quality standards guidance, which states that:

> "...flexibility inherent in the State process for designating uses allows the development of subcategories of uses within the Act's general categories to refine and clarify specific use classes. Clarification of the use class is particularly helpful when a variety of surface waters with distinct characteristics fit within the same use class, or do not fit well into any category. Determination of non-attainment in waters with broad use categories may be difficult and open to alternative interpretations. If a determination of

non-attainment is in dispute, regulatory actions will be difficult to accomplish" (EPA 1994).

Under this scenario, modified streams would be considered a separate class of streams with unique characteristics that "do not fit well into any category." Criteria would be developed that would allow states or tribes to categorize streams as "modified." The principals of net ecological benefit could be incorporated into this categorization to recognize the benefits of having water flowing in what otherwise would be a dry or mostly dry riverbed. These benefits would be identified and used as the basis for implementing a water quality management program focused on optimizing the overall benefits of the resource rather than the more traditional approach, which focuses efforts on only one or a few components of the resource.

The chemical-specific and whole effluent toxicity criteria established to protect the aquatic life and wildlife use in the 10 streams evaluated for this study were often no different than the criteria applied to nearby naturally perennial waters (**Appendix M**). Some locations had adopted site-specific or category-specific aquatic life criteria to address specific constituents (e.g., the South Platte River has site-specific dissolved oxygen criteria, and Arizona, which recognizes effluent-dependent waters as a distinct class of waters, has established water quality criteria specific to such waters). None of the 10 study areas have applicable biological criteria. However, because of the prevailing view and practice that similar chemical-specific and whole effluent toxicity criteria should be applied to both naturally perennial and effluent-dependent waters, one must assume that as states develop biological criteria programs there will be an expectation that the biological communities of effluent-dependent waters should be similar to the communities of nearby naturally perennial streams.

Regardless of the approach used to adopt aquatic life and wildlife criteria, the primary purpose behind these criteria is to support the establishment of a propagating biological community that meets some ideal. This ideal (e.g., measured as taxonomic richness or composition), has not been established for any effluent-dependent water. However, levels of treatment continue to be improved to meet increasingly strict end-of-the-pipe water quality standards and the expectation remains that improved treatment will push the aquatic community towards the ideal. Unfortunately, as indicated by data collected from the 10 study areas, increasing levels of treatment do not appear to be accomplishing any specific or consistent goal.

The traditional approach to water quality regulatory programs is a focus on the establishment of designated uses and water quality criteria to protect those uses. Because most states or tribes have

Recognition of Distinct Classes of Waterbody Types Aquatic and Wildlife Uses in Arizona

Uses and general procedure to calculate water quality criteria:

- Aquatic and Wildlife (coldwater) – majority of water quality criteria are the same as EPA-recommended AWQC.
- Aquatic and Wildlife (warmwater) – Using EPA recalculation procedure, AWQC recalculated to remove coldwater species.
- Aquatic and Wildlife (effluent-dependent) – Using EPA recalculation procedure, AWQC recalculated on the basis of list of species present in Arizona effluent-dependent waters.
- Aquatic and Wildlife (ephemeral) – Alternative criteria calculation method developed, specific to ephemeral streams using ephemeral water taxa list.

not recognized effluent-dependent waters or modified streams as a distinct class of water, the same criteria that apply to a cold or warmwater stream typically apply to the effluent-dependent water. Although states have the option to work within the existing water quality standards process to establish separate uses and criteria for these waters, an alternative regulatory approach to environmental protection in effluent-dependent waters could be implemented through the NPDES permitting process.

5.2.2 Implementation of Performance-Based Regulatory Approach for NPDES Permits in Effluent-Dependent Waters

Water quality criteria are established to protect the designated use, and, as such, it is critical that uses be appropriately defined to ensure that the established criteria actually accomplish their intent. As discussed above, establishment of an aquatic life use envisions more than just numbers of species or species composition. It also envisions a functioning ecosystem that supports wildlife. While this concept is not often the explicit basis for the establishment of aquatic life criteria, it is contemplated in discussions associated with biological criteria and very importantly the net ecological benefit concept.

It is particularly notable that the net ecological benefit guidance as considered by EPA recognized the supportive role that created aquatic habitat could have on riparian and wildlife resources. This same guidance also noted some key limitations that must be considered before the benefits gained from improved riparian and wildlife resources could be acknowledged. These limitations included the following (EPA 1993):

- Effluent discharges may not produce or contribute to concentrations of pollutants in tissues of aquatic organisms or wildlife that are likely to be harmful to humans or wildlife through food chain concentration. This element would support EPA and USFWS concerns regarding minimizing persistent, bioaccumulative chemicals in the environment.

- The analysis demonstrates that a continued discharge to the water body has not created and is not likely to cause or contribute to violations of downstream water quality standards or groundwater basins.

- All practicable pollution prevention programs, such as pretreatment and source reduction, are in operation. The discharger verifies that it has responded appropriately to previous and ongoing compliance actions.

These limitations are designed to ensure that (1) a minimum level of wastewater management and treatment is implemented, and (2) pollutants are not exported from the water column into the ecosystem through the food chain. The emphasis is on toxic chemicals, especially bioaccumulative chemicals of concern. Accordingly, from the standpoint of adopting appropriate criteria for modified stream systems, the focus should be on the management of these types of pollutants through pollution prevention and treatment.

The establishment of beneficial uses forms the cornerstone for the implementation of the Clean Water Act. Evaluating whether a surface water is in compliance with Clean Water Act provisions is based entirely on whether the beneficial uses established for that water body have been attained. Therefore, establishing appropriate beneficial uses and determining the means by which one measures attainment of those uses is a critical step in the process of establishing water quality standards.

Beneficial use attainment can be measured in many ways including through the use of surrogate measures. For example, states typically establish fecal coliform or *Escherichia coli* criteria as indicators for all pathogens that may be present in a surface water. Chemical-specific criteria, while directly measured, are really indirect measures of attainment because there typically is no direct cause and effect observed between the measurement and the use it was established to protect. Biological criteria are direct measures of aquatic life, but its use depends on correctly establishing what is attainable for a given water body.

States establish criteria as a means to measure attainment and ensure that the water body under question functions correctly to meet its beneficial uses. This can be straightforward and direct for uses such as domestic water supply. Water that contains toxic substances above some maximum concentration cannot function as a water supply source for human populations. However, the coupling of criteria to the beneficial use becomes more complicated when other types of uses are considered. For example, in most state water quality regulations, agricultural uses for water include two categories (e.g., livestock water and irrigation), because the different function of water associated with these uses requires protection from different types of pollutants. An even more relevant but important distinction occurs between warmwater and coldwater aquatic life. For this category of use, the regulations are established to preserve a set of conditions that have been determined necessary for the proper function of the habitat, broadly defined to include both physical and chemical factors.

EPA has recognized that when establishing appropriate beneficial uses for the protection of aquatic life, it can be appropriate to consider functional aspects of the aquatic system as follows:

> "Subcategories of aquatic life uses may be established on the basis of attainable habitat (e.g., coldwater versus warmwater habitat); *innate differences in community structure and function (e.g., high versus low species richness or productivity)*; or fundamental differences in important community components (e.g., warmwater fish communities dominated by bass versus catfish). Special uses may also be designated to protect particularly unique, sensitive, or valuable aquatic species, communities, or habitats...Data collected from biosurveys as part of a developing biocriteria program may assist States in refining aquatic life use classes by revealing consistent differences among aquatic communities inhabiting different waters of the same designated use. Measurable biological attributes could then be used to divide one class into two or more subcategories" (emphasis added) (EPA 1994).

In ecology, the term "function" has a very specific definition. Functional properties are those that transfer energy, nutrients, or biomass through or out of the ecosystem. For example, the hydrologic function of the stream ecosystem has functional importance in each of these transfer processes, supplying water for terrestrial animals, temperature regulation for fish, biomass removal within the plant community, and other factors (refer to **Chapter 3**). Each of these functions can be described with a set of parameters (defining the system) and variables (defining the condition of the system) that must remain within a certain range if biota can successfully use the ecosystem. If one was to understand each of these variables and how they function for the benefit of the stream biota, these variables could be established as standards and criteria to protect the aquatic life use that they define.

The results of the Habitat Characterization Study would suggest that according to criteria typically used to evaluate aquatic communities for the purpose of evaluating attainment, effluent-dependent systems would likely fail simply because of a lack of species richness or sufficient diversity in certain groups used as indicators of clean water. Increased treatment levels appear to have resulted in shifts towards increased numbers of aquatic organisms that are considered more "acceptable" (e.g., mayflies and caddisflies) but even within these groups, richness remains low as compared to natural perennial streams.

Lost in the discussion of whether or not the appropriate species are present is whether or not the ecosystem created by the effluent discharge is properly functioning. It may be more important to consider this aspect of evaluating use attainment than focusing on measures that are strictly associated with the well being of specific species. For example, biological endpoints that focus only on the aquatic resource rather than other elements of the stream ecosystem (e.g., riparian habitat, food resources for wildlife, and wildlife migration corridors) may be overly limiting and shortsighted. These other biological endpoints may be functioning well regardless of the species richness or composition of the aquatic community. Evaluating attainment using biological or alternative endpoints could form the foundation for a performance-based approach to environmental management of effluent-dependent waters.

Performance-based regulation is the use of "success criteria"" to define observable or measurable management or mitigation objectives for a given waterbody or watershed (Streever 1999). EPA Region 9's net ecological benefit guidance is an example of performance-based regulation. It accurately accounts for the dynamic forces that arise in response to more stringent permit limits. The policy abandons previous assumptions that "all things are equal" and "everything else will remain the same." Instead, the new policy causes all stakeholders to consider the most likely direct and indirect consequences of regulatory actions. More importantly, it emphasizes the need to measure success at the true endpoint: overall integrity of the aquatic ecosystem. However, to date the concepts identified in the EPA guidance have not been widely applied.

The Habitat Characterization Study provides evidence that although the aquatic communities of effluent-dependent waters do not appear to achieve high species richness even with additional effluent treatment, other benefits of the effluent are obvious. Benefits directly measured include increased extent and density of riparian vegetation and increased numbers of wildlife species. Assumed indirect benefits include the creation of wildlife corridors for the migration of wildlife populations and the transfer of energy from the aquatic community to the wildlife community, especially birds and bats, through the emergence and dispersal of aquatic organisms. None of these benefits is currently considered when implementing water quality programs through the issuance of NPDES permits. Instead the focus is on chemical-specific criteria with the assumption that more stringent criteria, and thus more stringent effluent limitations, will lead to a directly measured benefit to the aquatic community.

To resolve this apparent disparity between the implementation of water quality standards and the apparent benefits associated with the presence of the discharge, consideration could be given to implementing water quality standards differently for these created ecosystems. Human-caused conditions from all watershed activities limit ecosystem potential and if the focus remains solely on the level of treatment, considerable effort may be expended with little gain. Instead, if a net ecological benefit approach is used as a means to guide water quality management activities, with the goal being a more holistic approach (i.e., ecosystem management), additional benefits may be achieved. Using this approach, ecosystem performance becomes the measure of success rather than a specific effluent limitation.

Under a net ecological benefit approach, permittees, regulatory agencies, and other interested groups could work together to define appropriate biological and chemical endpoints that (1) maintain the existing use, (2) ensure anti-backsliding regulations are appropriately implemented, and (3) ensure that bioaccumulative chemicals of concern are not exported from the created ecosystem. This approach moves away from the tradition of implementing permits through effluent limitations, and instead provides the opportunity for dischargers and communities to work together to define ecosystem or watershed goals for the created habitat. These goals still may require implementing flood control activities to protect the community, but implementing such activities in a more ecosystem-friendly manner that considers other urban goals such as habitat restoration, recreational opportunities, meeting water rights obligations, or providing habitat for threatened and endangered species.

The use of alternative biological or chemical endpoints for evaluating attainment represents a performance-based approach for water quality management. Such an approach is not new to managing water quality under the Clean Water Act. Stormwater management and nonpoint source pollution control programs are examples of existing performance-based programs (see inset). Controls are based on the implementation of watershed-based water quality management strategies rather than specific

Wetland Protection: Example of Performance-Based Clean Water Act Program

Performance-Based Standards Definition: Performance standards are observable or measurable attributes that can be used to determine if a compensatory mitigation project meets its objectives. Performance standards are frequently called "success criteria."

Purpose: "Performance standards allow the Army Corps of Engineers to determine if the objectives of compensatory mitigation required by a Section 404 permit have been successfully fulfilled. Performance standards should generally reflect Corps of Engineers guidelines calling for a minimum of "one for one functional replacement" of wetlands unavoidably impacted by permitted activities. Performance standards also facilitate enforcement actions for projects that fail to comply with Section 404 permit conditions."

Examples of Performance-Based Standards

- 50 percent survival of planted trees, including replanting efforts, after two seasons
- 85 percent of the site vegetated by the planted species and/or naturally regenerated vegetation approved by regulatory agencies
- Less than 5 percent cover by nuisance and exotic plant species

effluent limitations. In addition, USACE is using performance-based outcomes to evaluate compliance under the Clean Water Act Section 404 program (Streever 1999) (see inset).

Implementation of a performance-based model for effluent-dependent waters may need to incorporate different objectives depending on whether the effluent-dependent water is existing or new. Existing effluent discharges must work within the confines of the existing ecosystem created by the discharge. For example, the effluent discharges in some of the 10 study areas evaluated for this project have existed for almost 50 years (e.g., the discharge to the Santa Cruz River from the City of Tucson, Arizona). Limitations may exist with regards to the types of performance-based outcomes that are realistic for these systems. In some cases, maintenance of an existing riparian system may be an appropriate outcome.

Phase II Stormwater Program: Performance-Based Management of a Point Source Discharge

The Phase II program, based on the use of federally enforceable NPDES permits, includes elements to achieve the following:

- encourage the use of general permits
- provide flexibility for regulated operators to determine the most appropriate stormwater controls
- include public education and participation efforts as primary elements of the small municipal stormwater sewer system (MS4) program
- attempt to facilitate and promote watershed planning and to implement the stormwater program on a watershed basis

A Phase II small MS4 operator is required to design its program so that it accomplishes the following:

- reduces the discharge of pollutants to the "maximum extent practicable" (MEP)
- protects water quality
- satisfies the appropriate water quality requirements of the Clean Water Act

Compliance with the technical standard of MEP requires the successful implementation of approved BMPs. The Phase II program considers narrative effluent limitations that require the implementation of BMPs and the achievement of measurable goals as the most appropriate form of effluent limitations to achieve the protection of water quality, rather than requiring that storm water discharges meet numeric effluent limitations.

Sources: EPA 2000a; EPA 2000b

In contrast to existing effluent-dependent waters, a proposal to initiate a new effluent discharge that creates a new effluent-dependent water would provide an opportunity to "design" the ecosystem that will develop as result of the discharge of effluent to what would otherwise be a dry riverbed. Under this scenario, not only may it be possible to "design" the receiving water, but it would be possible to develop performance outcomes or standards that are not only beneficial to the environment, but that support local public values.

It is important to recognize that a performance-based approach is not a replacement for minimum requirements for wastewater treatment (e.g., as codified at 40 CFR 122). Performance-based approaches are also not a means to avoid anti-backsliding requirements (i.e., reduce existing levels of wastewater treatment). Instead, a permitting approach that uses performance-based outcomes provides an opportunity to look beyond the end of the pipe to the watershed, ecosystem, habitat restoration, or whatever the public value or desire is for the local area. A decision-making process involving the public could be implemented for the purpose of evaluating whether public funds should be devoted to maximizing treatment of effluent or instead using some of those same funds to implement habitat improvement projects that would enhance riparian community benefits downstream of the discharge.

5.2.3 Ecological Restoration or Rehabilitation

Implementation of a performance-based approach to water quality protection in effluent-dependent waters would benefit efforts by regulatory agencies, especially EPA, to guide implementation of Clean Water Act programs towards the concept of ecological restoration or rehabilitation (EPA 1995a, 1995b). A driving purpose behind new emphasis on ecological restoration or rehabilitation is an increasingly important need to implement water quality programs on a watershed basis, especially where the focus has only been on point source controls and there has been limited success in achieving Clean Water Act goals:

> "Over the last 23 years, the Clean Water Act has produced large improvements in the water quality of the nation's surface waters, most of which were achieved through reductions in pollutants from point sources. Despite these achievements, however, many surface water still have not attained CWA goals. Further reductions in pollutants from point sources likely will not achieve those goals, because factors that now limit attainment of those goals primarily are derived from land uses within a watershed which result in ecological degradation. To achieve significant additional improvements in the nation's waters will often require some type of ecological restoration" (EPA 1995a).

Ecological restoration is a term with many meanings often depending on an individual's beliefs or opinions regarding environmental protection. The U.S. Natural Resource Council defined ecological restoration as the return of an ecosystem to a close approximation of its condition prior to disturbance (U.S. Natural Resource Council 1992). EPA defines ecological restoration as "the restoration of chemical, physical and/or biological components of a degraded system to a pre-disturbance condition" (EPA 1995a). Both of these definitions emphasize restoring the ecosystem to some state prior to "disturbance." However, as is often pointed out accomplishing this goal can be difficult for several reasons: (1) little may be known about the characteristics and functions of the historic ecosystem; (2) key species may be lost; and (3) efforts to fully restore an ecosystem may be prohibitively expensive (Cooke and Jordan 1995). Moreover, as indicated by the ecologist, Jared Diamond, this goal may be difficult to reach because of differences in public values:

> "We've heard that the goal of restoration should be to recreate a natural community, or to recreate a self-sustaining community, or perhaps to preserve a community for posterity in essentially its natural state. This goal--this formulation of the goal--isn't itself a self-evident mandate, however. It's a choice based on values, and it is only one of many possible choices. We know that different people with different values would make different choices about the same site. And even if we adopt the goal of a natural community, it is important to recognize that this goal is extremely ambiguous and needs to be defined very carefully in order to be useful (Jared Diamond, quoted in Jordan et al. 1987)."

Another definition of what constitutes ecological restoration has been adopted by the Society for Ecological Restoration:

> "Ecological restoration is the process of assisting the recovery and management of ecological integrity. Ecological integrity includes a critical range of variability in biodiversity, ecological processes and structures, regional and historical context, and sustainable cultural practices."
> (Society of Ecological Restoration 1996).

This simpler definition does not presuppose that it is possible to return an ecosystem to a pre-disturbance condition. Instead, the focus is on recognition that restoration is a dynamic process that requires not only an understanding of ecological processes, but consideration of historical factors and cultural practices. This viewpoint is especially important when determining what the goal of restoration activities should be. For example, in some cases the historical river was perennial with dense stands of riparian vegetation, which are aesthetically pleasing to most. However, in other cases, the historical river was not something that the public may envision as the ideal riverine environment for their urban home (see inset).

Achieving a "pre-disturbance condition" will be difficult in an urban environment, especially given the number of arid West watersheds, which are hydrologically modified for the purpose of providing regional drinking water supplies and flood control. In this context, the goal may not be restoration *per se*, but rehabilitation to some specific state or condition. At a presentation made at a national symposium,

Historical Perspective of the South Platte River, Colorado (Excerpts from Harris 1995)

"Theodore Talbot, a trainee on Fremont's second expedition in 1824, wrote of the river's quality, 'Here the buffalo come to drink and stand during the heat of the day, adding their own excrement to the already putrescent waters. This compound, warmed for weeks by the blazing sun, makes a drink palatable to one suffering from intense thirst' (Talbot, 1844)."

"Stephan A. Long led an expedition up the South Platte River in 1820 and described the area as 'the Great American Desert, an area uninhabitable by people depending upon agriculture' (Benson, 1988)."

"Colonel McClure's description of the South Platte River during the early summer run-off period in 1867 was, 'The river rolls its turbid waters through the Platte Valley and makes no sign of life along its borders. It is shallow, wide, and muddy and broken by innumerable islands, treacherous and apparently useless. It doesn't even shirt its own banks with shrubs or timber' (McClure, 1867)."

"In 1846, Francis Parkman described the South Platte River near Denver as 'nothing but a dry bed of sand, into which the water had sank and disappeared' (Parkman, 1846)."

"The South Platte River historically was 'a raging torrent one moment and a dry bed of sand the next' (Silkenson, 1992). The name of the river comes from the French, and means 'dull' or 'shallow.' Early settlers described the river as 'too thin to plow, too thick to drink, a mile wide and an inch deep.'

"The historical health of the South Platte River was summarized in Michener's book, *Centennial* (1974):

> 'And finally there is the river, a sad, bewildered nothing of a river. It carries no great amount of water, and when it has some, it is uncertain where it wants to take it. No ship can navigate it, nor even canoe it with reasonable assurance. It is the butt of more jokes than any other river on earth, and the greatest joke is to call it a river at all. It's a sand bottom, a wandering afterthought, a useless irrigation, a frustration, and when you've said all that, it suddenly rises up, aprils out to a mile wide, engulfs your crops and lays waste your farms.'

Although Michener may have used poetic license in his description of the health of the South Platte River, his description is backed by historical record."

Using Ecological Restoration to Meet Clean Water Act Goals, Chicago, Illinois, participants William Jordan III and G. Dennis Cooke stated that rehabilitation is not necessarily the same as restoration. Rehabilitation refers to restoring certain aspects of a system, but it lacks the holistic and historic intent of restoration. Moreover, rehabilitation of an ecosystem is comparable to rehabilitation of a human after an injury. Essential structural and functional features are recovered, although the rehabilitated patient may never be exactly as before. Similarly, they state that rehabilitation of an ecosystem means the "repair and protection of ecosystem-level structure and function" (reported in EPA 1995b).

In terms of effluent-dependent waters, the term "rehabilitation" is certainly more applicable than the term "restoration." As apparent from this study and the previously completed Discharger's Survey (WQRP 2000), many of the effluent-dependent waters are located in urbanized environments where riverine systems have been greatly modified. Most of these modifications have been the result of local concerns regarding flood control and the regional need for a stable water supply for urban centers and agricultural activities. These modifications historically have superseded concerns for maintaining natural habitat, and as a result, natural riverine habitats have been fundamentally modified by factors unrelated to limitations associated with the effluent now serving as the source of perennial flow.

Regardless of the limitations imposed on many effluent-dependent waters by physical modifications to the system, the fact remains that the presence of water in what typically would be a dry riverbed provides an alternative and useful source of water in the already hydrologically modified environment. In many instances, this alternative water source provides the only opportunity for supporting aquatic and terrestrial habitats along rivers in urban environments. Given this set of conditions, it would seem that the oft-stated public goal to improve habitats along urban rivers could be linked in a positive manner to the apparent benefits obtained from the discharge of effluent (e.g., ecological benefits such as the support of ribbons of riparian habitat in an otherwise dry environment). However, any such effort may be better viewed as ecosystem rehabilitation rather than restoration.

Meyer (1997) recently published an essay describing the need to integrate stream ecological research with the concept of stream health, where a healthy stream is defined as "an ecosystem that is sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectations." Meyer (1997) goes on to state the following:

> "Stream ecologists who want their research to contribute to improving conditions in flowing waters require concepts like stream health, which will stimulate research in directions that will be more effective in restoring and preserving the unique organisms and ecosystems they study. Determining what is a healthy stream requires integration of stream ecology with disciplines such as economics and political science, because a concept of stream health must take into account the human attitudes and social institutions that are a part of the stream's societal watershed."

These ideas are closely related to the discussion that is beginning and needs to bear fruit with regards to effluent-dependent ecosystems. The many competing needs and uses for urban streams, where many effluent-dependent ecosystems are found, require an integration of stream ecology concepts with societal values.

Although not explicitly stated as the purpose for such activities, examples of efforts to link the concepts of ecological rehabilitation with the use of treated effluent, while incorporating societal values, are already ongoing in the arid West. For example, USACE has implemented projects in Phoenix and Tucson, Arizona that hope to result in the partial restoration of aquatic habitats formerly associated with the Salt and Santa Cruz rivers, respectively. In Tucson, efforts to restore habitats in the Santa Cruz River watershed are being led by the development of the Sonoran Desert Conservation Plan (SDCP), a Habitat Conservation Plan that will address a host of issues, biological and cultural, in an integrated manner (Pima County 2000) (see additional discussion in **Chapter 6**). As part of the SCDP, Pima County, Arizona is proposing to implement a number of projects to restore, rehabilitate, or even create habitat throughout the county planning area. In each of these proposed projects, the primary source of water is treated effluent.

5.2.4 Upgrade Wastewater Treatment or Implement Habitat Improvements: Consideration of Cost Effectiveness

Inherent in implementing an alternative approach to permitting in effluent-dependent waters is the need to consider costs versus benefits. Results from case studies on effluent-dependent waters in the arid West suggest that limitations to improvement in aquatic communities can be linked to habitat limitations rather than water quality limitations. These findings are not meant to be an argument against improved wastewater treatment; instead, they are meant to be an argument for consideration of cost per unit treatment per expected benefit in the resulting aquatic community. As conceptualized on Figure 5-1 in Chapter 5) of this document, increased treatment levels may lead to an increased likelihood that water may be diverted from a riverbed, resulting in the loss of aquatic habitat rather than improved habitat as was anticipated. Moreover, increased treatment may not result in any improvement in the aquatic community, simply because the expenditure on wastewater treatment upgrades did not attack the factor(s) limiting the aquatic community, which may be habitat driven rather than water quality driven.

In its guidance on ecological restoration, the EPA recognizes the importance of considering cost-effectiveness as follows:

> "selecting the most cost-effective techniques is critical to the success of any restoration project...The two primary economic reasons why restoration may be more cost effective than point source controls alone are that (1) restoration often has lower marginal costs (i.e., the incremental costs of removing an additional unit of pollutant) and (2) restoration provides a wider range of ecological benefits" (EPA 1995a).

Moreover, the issue of cost versus benefit must be addressed locally since the expected effectiveness of restoration efforts may vary from one location to another:

> "Some water quality problems (e.g., loss of habitat) are not amenable to a point source treatment approach at any cost; and some water quality problems cannot be reduced through any reasonable degree of restoration" (EPA 1995a).

In the arid West, municipalities frequently discharge treated effluent to ephemeral streams. Many of these streams would be completely dry during some part of the year but for the perennial flow from the WWTPs. Organisms living in or near such streams rely on continued discharges to maintain the aquatic and riparian habitat. The streams they live in are not merely effluent-dominated; they are effluent-dependent.

5.3 SUMMARY

The regulatory issues facing effluent-dependent waters are significant. Water quality standards setting and permitting processes may and will continue using existing traditional approaches. However, we believe that in time because of the increasing likelihood of a conflict between the value of water and the cost of treatment, less treated effluent will find its way back into watercourses, resulting in the potential loss of numerous effluent-dependent habitats in the arid West. Innovation in the application of the existing regulations, programs, and policies is needed to develop an alternative framework that will allow communities to determine what is the best end use of effluent in their communities, ranging from continued discharge to watercourses and maintenance of the created habitat or sold as a commodity to recoup treatment cost. Ultimately, it will be up to communities and consideration of quality of life issues and public values that will decide what is the best approach. However, to aid communities in making such decisions, we believe there is a critical need for the development of additional regulatory alternatives. With that need in mind, in the following chapter we discuss regulatory innovations, existing or envisioned, that could be applied to the regulation of effluent-dependent waters.