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Report on the Use of Wetlands for Municipal Wastewater Treatment and Disposal

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REPORT ON THE USE OF WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT AND DISPOSAL

Submitted to:

SENATOR QUENTIN N. BURDICK, CHAIRMAN
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

Prepared by:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER
OFFICE OF MUNICIPAL POLLUTION CONTROL

October, 1987

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Abstract

This document contains a recent Agency report which reviews current knowledge of the use of both natural and constructed wetlands for municipal wastewater treatment and disposal, including the extent and circumstances of this practice, and summarizes the regulatory issues involved in response to a request by the Honorable Quentin H. Burdick, Chairman of the U.S. Senate Committee on Environment and Public Works. Additional information and guidance concerning projects in which wetlands play a role in the treatment and disposal of municipal wastewater effluent more recently issued by the Office of Water to supplement the report is provided as an attachment to the original report.

Contents

REPORT ON THE USE OF WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT AND DISPOSAL

I. INTRODUCTION

Wetlands were once regarded as wasted land. It is now clear that they provide irreplaceable benefits to people and the environment. Wetlands provide natural flood prevention and pollutant filtering systems and contribute significantly to ground water recharge. Many sport fish, migratory waterfowl, furbearers, and other valuable wildlife live and breed in wetlands.

Freshwater, brackish, and saltwater wetlands have inadvertently served as natural water treatment systems for centuries. Because of their transitional position in the landscape between terrestrial and aquatic ecosystems, some wetlands have been subjected to wastewater discharges from both municipal and industrial sources. Wetlands have also received agricultural and surface mine runoff, irrigation return flows, urban stormwater discharges, leachates, and other sources of water pollution. The impacts of such discharges on different wetlands has been quite variable.

It is only in the past few decades, however, that the planned use of wetlands for meeting wastewater treatment and other water quality objectives has been studied and implemented. The functional role of wetlands in water quality improvements has been identified as a compelling argument for wetland preservation and in some cases for their creation. A number of studies over the last few years have found evidence that wetlands are able to provide a high level of wastewater treatment. However, concern has also been expressed regarding the possible harmful effects of toxic materials and pathogens in wastewaters, and the long-term degradation of wetlands due to the additional nutrient hydraulic loadings from wastewater discharges.

Due to these concerns, as well as other factors, there has been considerable interest in using constructed (or artificial) wetlands for wastewater treatment. Constructed wetlands are engineered systems that have been designed and constructed to employ wetland type vegetation to assist treating wastewater in a more controlled environment than occurs in natural wetlands.

This report reviews current knowledge of the use of both natural and constructed wetlands for municipal wastewater treatment and disposal. The extent and circumstances of this practice are reviewed and summaries of the regulatory issues involved as well as EPA policies are presented.

II. WETLAND TREATMENT SYSTEMS

A. Natural Wetlands

The term "wetlands" is a relatively new expression, encompassing what for years have simply been referred to as marshes, swamps, bogs, and so on. Wetlands occur in a wide range of physical settings at the interface of terrestrial and aquatic ecosystems.

Wetlands are defined by Federal regulatory agencies as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. They are vegetated systems, ranging from marshes to forested swamps. Wetlands occur in a wide range of natural settings and encompass a diversity of ecosystem types, while exhibiting a wide array of primary functions and values such as providing wildlife habitat, ground water recharge, flood control, water quality enhancement and recreational opportunities (See Attachment A). For regulatory purposes almost all natural wetlands are considered waters of the United States.

Wetlands appear to perform to at least some degree all of the biochemical transformation of wastewater constituents that take place in conventional wastewater treatment plants, in septic tanks and their drain fields, and in other forms of land treatment. The submerged and emergent plants, their associated microorganisms, and the wetland soils are responsible for the majority of the treatment effected by the wetland. (See list of some recent detailed references in Attachment B.)

The use of natural wetland treatment systems is limited to providing further treatment of secondary effluent to meet downstream water quality standards. (Any applicable water quality standards for the wetland itself must be met near the point of discharge to the wetland.) Usually the objective is to reduce the concentration of Biochemical Oxygen Demand (BOD), Suspended Solids (SS), and the nutrients nitrogen and phosphorus in secondary effluent. Most natural wetlands can effectively remove BOD, SS and nitrogen from secondary effluents. However, phosphorus removal capability varies among individual wetlands and depends largely on site-specific factors, especially soil type.

Other pollutants of concern in secondary effluent may also be removed in a natural wetland. Removal and die-off rates of pathogens from wastewater discharged into wetlands have been reported as very high in some places, but highly variable in others. However, the variable numbers of coliform bacteria and salmonella (which are routinely used as indicators of human pathogens but are also produced by wildlife) greatly complicate monitoring for human pathogens in wetlands which receive wastewater discharges. The levels of many of the inorganic and organic compounds present in wastewater are greatly reduced as they pass through wetlands. At least initially heavy metals appear to be mainly removed by sorption to wetland soils and sediments, although long-term studies have not been conducted to determine exactly how they are cycled or lost. It appears that many of the organic compounds that are removed by wetlands are degraded by microbial activity associated with the wetlands soil, sediment and vegetation.

While it appears that many wetlands have some capacity for improving water quality of wastewater, runoff, or industrial discharges, some wetlands are clearly not appropriate for continuous day-in/day-out use as a part of a wastewater disposal or treatment system. The potential for altering the biotic communities of natural wetlands when including them in wastewater management is of great concern to EPA and groups interested in preserving existing wetlands.

The major costs and energy requirements associated with a natural wetlands treatment system are involved with preapplication treatment, land costs, minor earthwork, and the wastewater distribution system. In addition to the need for monitoring to assure the maintenance of the wetland biota, operational problems which may need to be considered include a potential for increased breeding of mosquitos or flies, odor development, and maintenance of any flow control structures.

Proposed physical modification of a natural wetland to allow wastewater application require a permit from the Army Corps of Engineers (under section 404 of the Clean Water Act) and review under the National Environmental Policy Act.

B. Constructed Wetlands

The use of constructed wetlands for wastewater treatment seeks to take advantage of many of the same principles that apply in a natural system, but does so within a more controlled environment. Small-scale wetlands have been created expressly for the purpose of providing wastewater treatment, while some large-scale systems have been implemented with multiple-use objectives in mind, such as using treated wastewater effluent as a water source for the creation and restoration of marshes for wildlife use and environmental enhancement.

Constructed wetlands treatment systems can be established almost anywhere including on lands with limited alternative uses. This can be done relatively simply where wastewater treatment is the only function sought. They can be built in natural settings, or they may entail extensive earthmoving, construction of impermeable barriers, or building of containment such as tanks or trenches. Wetland vegetation has been established and maintained on substrates ranging from gravel or mine spoils to clay or peat. Some systems are set up to recycle at least a portion of the treated wastewater by recharge of the underlying ground water. Others act as flow-through systems, discharging the final effluent to surface waters.

Constructed wetlands have diverse applications and are found across the country and around the world. They can be designed to accomplish a variety of treatment objectives. The influent to various constructed wetlands treatment systems ranges from raw wastewater to secondary effluent.

The advantages of constructed wetlands are many, and include: flexibility in site location; optimized size for anticipated waste load; potential to treat more wastewater in a smaller area than is possible with natural wetlands; less rigorous preapplication treatment, and no alteration of natural wetlands. Concurrently, there are some disadvantages to using constructed wetlands for treatment relative to natural systems. The cost and availability of suitable land and the construction costs for grading the site are added expenses. In addition, the sites are unavailable for use in treatment during the construction period, and reduced performance can generally be expected during the period in which vegetation becomes established. Other possible constraints are the costs of plant biomass harvesting and disposal if required and the fact that artificial wetlands, like their natural counterparts, provide breeding habitat for nuisance insects or disease vectors, and may generate odors. When toxics are a significant component of the municipal wastewater to be treated, adequate pretreatment should be provided to avoid problems of bioaccumulation in wildlife (particularly waterfowl) attracted to the site.

III. NUMBER AND TYPES OF WETLAND TREATMENT SYSTEMS

Under appropriate conditions, both natural and constructed treatment systems have achieved high removal efficiencies for BOD, suspended solids, nutrients, heavy metals, trace organic compounds as well as natural die-off of pathogens from wastewater. More that 25 wetland-related municipal wastewater treatment projects have been at least partially funded by EPA construction grants funds, involving projects in essentially all regions of the country (see Figure I which depicts the locations of many of the wetland-related treatment projects in the U.S. and Canada). However, rather than a single concept for the involvement of wetlands in wastewater treatment, there are a number of approaches whereby wastewater and wetlands have or could be effectively combined as a part of water quality management projects. These include:

__Natural Wetlands for Wastewater Disposal__ .... In many areas natural wetlands serve as the receiving water for permitted discharges of treated wastewater. More than 400 such discharges exist in the southeastern States alone, while there are another 100 or more in the Great Lakes States. In addition much of the runoff from both rural and urban areas in many parts of the country receives considerable "treatment" as it passes through natural wetlands prior to entry into ground water, estuaries, streams and lakes. However, any use of natural wetlands for treatment purposes requires extensive pre-project review to ensure that the wetland ecosystem is not unacceptably altered.

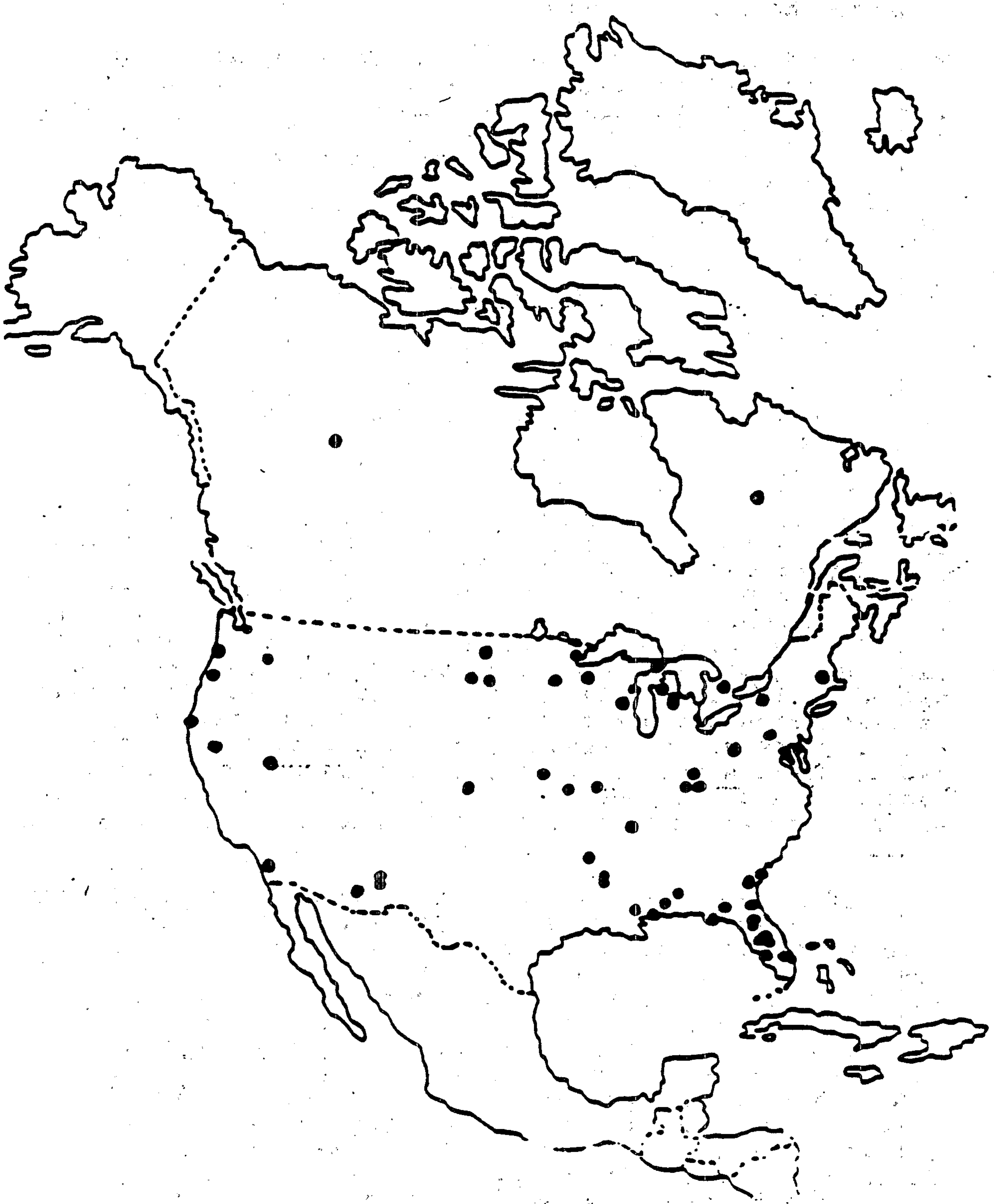
__Wetland Enhancement, Restoration, or Creation__ .... In the more arid parts of the country it is not uncommon for wastewater effluents to serve as the water supply used to create, maintain, restore, or enhance wetlands. In some cases wastewater effluent is the sole or major water source for valuable wetland habitat (e.g., the Mt. View Sanitary District project near Martinez CA, built as an alternative to a deepwater outfall into Suisun Bay; the Bitter Lake National Wildlife Refuge near Roswell, NM, which depends on the Roswell sewage treatment plant effluent as its main supply of freshwater). Considerable opportunity may exist for treating and utilizing wastewater effluents, drainage water, runoff, or other sources as a water supply to enhance or restore existing wetlands that are stressed due to lack of an adequate water supply or other reasons. However, some serious environmental problems have occurred in such situations where proper management practices were not observed (e,g., the Kesterson National Wildlife Refuge in Merced County, California, which received extremely high levels of selenium in the agricultural drainage water from the western San Joaquin Valley).

__Natural Wetlands for Wastewater Treatment or Reclamation__ .... A number of engineered treatment systems in Michigan, Wisconsin, Florida, Oregon, and elsewhere effectively utilize the capabilities of natural wetlands to provide part of the treatment. These systems attempt to achieve wastewater treatment in a manner that minimizes ecological disturbance. Typically, the only construction activity in the wetland involves the installation of a system for applying secondarily treated effluent in a dispersed manner and monitoring stations. Such systems require pretreatment of the wastewater, and are usually used to provide for nutrient removal or high level effluent polishing to protect downstream water quality.

__Constructed Wetlands for Wastewater Treatment__ .... The use of constructed treatment systems involving wetland vegetation for treating municipal and industrial wastewater, urban stormwater, agricultural runoff, acid mine drainage, leachates and other sources of contaminated water shows great promise, in part due to a greater opportunity for process control and less chance for causing adverse environmental effects. In some cases wetland systems have been built and operated to treat high loadings of higher strength wastewater in as small an area as possible (e.g., Santee and Gustine, CA; Collins, MS; Benton, KY; Listowel, Canada). In other cases such systems have been built to simulate natural wetlands, receiving relatively low loadings of pretreated effluents for further polishing while enhancing wildlife habitat and other wetland values (e.g., Arcata, CA; Incline Village, NV; Harriman, NY).

Constructed wetlands are currently being used quite extensively to treat acid mine runoff. Over 100 wetlands have been constructed in Ohio, Pennsylvania, Maryland and West Virginia alone by mining companies to help treat acid mine runoff. The Bureau of Mines is currently facilitating the monitoring and evaluation of many of these sites.

Figure I. Location of Some Known Wetland Wastewater Treatment Projects.



IV. STANDARDS AND PERMIT REQUIREMENTS

A. Requirements for Discharge

The Clean Water Act, together with EPA's implementing regulations, governs the discharge of wastewater to waters of the United States, including any wetlands which are considered waters of the United States (40 CFR Part 122.2). Municipal discharges to those wetlands which are considered waters of the United States, must meet minimum technology requirements and conform with State water quality standards. The exact level of treatment required for any discharge is specified in its National Pollutant Discharge Elimination System (NPDES) Permit issued by EPA or an authorized State.

1. Minimum Technology Requirements

All municipal wastewater treatment systems, except for certain ocean discharges and aquaculture systems, must achieve the degree of effluent reduction attainable through the application of secondary treatment prior to discharge to waters of the U.S. (including almost all natural wetlands). Secondary treatment is most often defined as attaining an average effluent quality for both five-day Biochemical Oxygen Demand (BOD_5) and Suspended Solids (SS) of 30 milligrams per liter (mg/L) in a period of 30 consecutive days, an average effluent quality of 45 mg/L for the same pollutants in a period of 7 consecutive days and 85 percent removal of the same pollutants in a period of 30 consecutive days. Although this definition is based upon the performance of a large number of properly operating wastewater treatment plants of various types, EPA's secondary treatment regulation does not require the use of any of these specific technologies to achieve the effluent limits, only that the limits be achieved.

The Clean Water Act and its implementing regulations do provide for relaxing some aspects of the definition of secondary treatment under certain circumstances. The most notable case is when Waste Stabilization Ponds (WSP) and Trickling Filters (TF) are used as the principal biological treatment process. When this is so, the facility may be considered as achieving treatment equivalent to secondary treatment if it achieves average BOD_5 and SS of 45 mg/L during a 30 day period, average BOD_5 and SS of 65 mg/L during a 7 day period, and 65% removal of these pollutants. Where WSP's are used the State may further adjust upward the SS limit for treatment equivalent to secondary treatment to reflect the effluent quality achieved within a specific geographical area. This provision allows differing geographical/climatic conditions which effect WSP performance to be taken into account.

Permit limits for WSP's or TF's may only be adjusted where violation of water quality standards will not result. In attempting to understand how an average SS level in excess of 45 mg/L could be considered equivalent to secondary treatment (average SS of 30 mg/L) it is important to remember that the SS contained in WSP effluent are largely the result of the biological treatment process occurring in the pond and are quite different from the SS in raw wastewater. WSP effluent SS are, for the most part, algae, which occur widely in natural water bodies. Thus, depending upon the water body, a WSP effluent high in SS may not pose an undue burden.

2. Water Quality Standards

In addition to meeting minimum technology requirements, discharges to waters of the United States must comply with applicable State water quality standards. Very few States have established separate water quality standards for wetlands and EPA has not yet developed water quality criteria specifically for wetlands. An internal EPA task force recently concluded that the lack of EPA water quality criteria for wetlands and the resulting absence of State water quality standards for wetlands is one of the most serious impediments to a consistent national policy on use of wetlands for wastewater treatment or discharge.

EPA is now beginning to look into the feasibility of developing water quality criteria and numerical or narrative biological quality maintenance criteria for wetlands, which would serve as the basis for establishing separate State water quality standards for wetlands. Some activity has been initiated in this area. For example, EPA is hosting a scientific workshop later this year to help prepare a research plan for developing water quality standards for wetlands. This workshop will explore the feasibility of a two-fold approach to water quality standards for wetlands, addressing both chemical water quality and biological integrity of these ecosystems. Chemical water quality standards would aim to protect wetlands and the fish and wildlife that use them from water pollution. The objective of standards for biological integrity would be to address impacts from activities that physically alter wetlands so that ecosystem processes are impaired (e.g., discharges of dredge and fill material).

A related project is being planned to improve State programs under Section 401 of the Clean Water Act for certifying that discharges into wetlands and other aquatic sites comply with existing water quality standards. The programs of States that have particularly effective or innovative approaches to their responsibilities under Section 401 will be reviewed in detail. Subsequently, other States will be encouraged to adopt and build upon the best approaches that are identified. Both efforts have significant potential for improving the level of protection for wetlands habitat. However, the availability of funding for the actual development of water quality standards for wetlands is contingent upon budget decisions for FY 89 and beyond.

In lieu of separate wetland standards some States have simply applied water quality standards for adjacent streams or lakes to wetlands. These water quality standards are often inappropriate for wetlands because wetlands are vastly different ecosystems. Research has shown that wetlands can effectively provide additional removal of pollutants from secondarily treated wastewater prior to its entering a stream or lake without significant impact on the wetland itself. Thus many wetlands can, without harm, accept higher loadings of nutrients and SS from municipal wastewater than can many streams or lakes. This, of course, assumes that contaminated materials are not contained in the SS at levels that would be harmful to fish and wildlife, or would pose threats to human health. Water quality standards for wetlands need to reflect these concerns.

There are a number of cases where advanced polishing by natural wetlands has been recognized in State-issued NPDES permits. In these cases the permit calls for the wastewater entering the wetland to meet secondary treatment limits and the water quality standards for the wetland while the water flowing out of the wetland into an adjacent stream must meet more stringent water quality standards for the adjacent stream.

In some cases permits contain seasonal variations in discharge requirements. For example, a higher level of nutrient removal may be required during the summer than during the winter. Natural wetlands may be well suited to meeting such seasonal requirements since their peak pollutant removal and transformation capacity occurs during the summer growing season.

The State of Florida, in 1986, established standards for the use of wetlands for treatment. These standards are considerably more complex than conventional water quality standards. Florida's wetland standards include design criteria and regulation at three levels: effluent limits; standards to be met within the treatment wetland;

and standards for discharge from the wetland to downstream water bodies. The Florida standards contain traditional physical and chemical parameters as well new "wetland biological quality" standards. Thus the standards recognize and allow wetland treatment capacity to be used while at the same time protecting the unique values and functions of wetlands and the water quality standards of the receiving waters.

However, Florida is the only State having such standards at present. In most cases the NPDES permitting authority must review the use of wetlands systems to achieve downstream water quality standards on a case-by-case basis. This situation has led to different findings in similar situations where questions have been raised concerning the use of natural wetlands for providing advanced treatment of secondary effluents.

B. Section 404 Permit Requirement

Generally proposals to use natural wetlands for wastewater treatment involve some alteration of the wetland, such as building dikes. It is generally necessary to obtain a permit for the discharge of dredged or fill material from the Army Corps of Engineers (or appropriate State Agency) under Section 404 of the Clean Water Act before such construction would be allowed.

Regulations established by EPA under Section 404(b)(1) are primarily intended to protect existing wetland values. The Corps or State review for the Section 404 permit will require determination that the impacts of dredged or fill material on the wetland do not constitute significant degradation; that there are no practicable, environmentally preferable alternatives; that unavoidable impacts have been minimized; and that unavoidable impacts are mitigated through practicable compensatory actions. An additional determination by the Corps also requires that the proposed wetland alteration is in the public interest. The proposed modification will also require a review under the National Environmental Policy Act (NEPA), consideration of other applicable Federal laws and executive orders (such as the Endangered Species Act), and any applicable State laws governing wetland filling or other alteration.

V. EPA APPROACH

A. Natural Wetlands

EPA regulates wastewater discharges to those natural wetlands which are considered waters of the United States through the Clean Water Act NPDES permit program. Municipal discharges to such wetlands must meet minimum technology-based requirements and conform with applicable State water quality standards. In the current absence of separate water quality criteria or State water quality standards for wetlands, EPA considers a conservative case-by-case approach, often combined with pilot testing, to be most appropriate for evaluating the use of natural wetlands for municipal wastewater discharge and treatment.

A recent internal EPA Task Force concluded that natural wetlands should continue to be viewed primarily as protected water bodies, and that, in the absence of water quality criteria for wetlands, it is not possible to broadly identify conditions where they could be safely regarded as part of the "treatment system". Therefore, the agency continues to review requests for treatment systems involving discharges (treated to secondary or equivalent to secondary levels) to natural wetlands using a conservative, case-by-case approach. For example, EPA's Region IV (in Atlanta) has prepared a Freshwater Wetlands for Wastewater Management Handbook (EPA 904/9-85-135) which provides guidance for such case-by-case evaluation.

B. Constructed Wetlands

EPA encourages the use of constructed (artificial) wetland systems through the innovative and alternative technology provisions of its construction grants program. Constructed wetland treatment systems can often be an environmentally acceptable, cost-effective, treatment option particularly for small communities. This technology also has the advantage of expanding wetland-type habitats, although these systems rarely achieve the same level of biological complexity as natural wetlands systems, and their ecological values are correspondingly less than for natural systems.

In general, current EPA regulatory and construction grants policies create fewer problems for consideration of constructed wetlands as a treatment option. In those cases where the constructed wetlands systems are designed, built and operated for the purpose of wastewater treatment, the constructed wetlands treatment systems are not considered waters of the U.S. (40 CFR Part 122.2). As a result some constructed wetland systems are currently being used to treat primary effluents to meet secondary or advanced treatment requirements in a number of locations across the country. Operational controls can be designed to closely regulate flow, application rate, and detention time to meet desired seasonal variations in operation and treatment needs. Plant species can be selected and utilized on various bases such as nutrient uptake efficiency, ease of culturing or harvesting, value as biomass, etc.

C. Construction Grants Eligibility

As with other land treatment systems, land purchases for constructed wetland treatment systems are clearly eligible for funding under the construction grants program. The eligibility of natural wetlands for funding, however, remains a more complicated issue due to the case-by-case approach which is necessary in determining eligibility. Still, under certain limited circumstances natural wetlands may be considered eligible for grant funding. Such projects must involve the wetlands in meeting more stringent downstream water quality requirements, and must be found to be both cost-effective and environmentally sound. In addition, the facility must have a current NPDES permit that reflects minimum treatment technology and State water quality requirements into and out of the wetlands. As noted above, these proposals must be reviewed on a case-by-case basis and may require a Section 404 permit.

VI. RECOMMENDATIONS

A. Action by the Congress

We do not believe that any legislative changes are necessary at this time to provide additional authorities concerning wetlands for wastewater treatment and disposal.

B. Action by EPA

EPA is taking a number of actions which may help resolve the questions regarding the extent to which natural wetlands may be used to help treat municipal wastewater. The most important of these is EPA's exploration of water quality criteria for wetlands. The first step is to examine the current scientific data and possible approaches, and to develop a research plan to fill in the missing information. A key component to developing appropriate criteria is additional information on the response of wetland ecosystems to various types and rates of discharges. In addition, EPA will encourage and (when funds are available) participate in monitoring current wetland wastewater treatment sites to determine the fate of toxics and their impact on wildlife using the system; and the differences in ecological functions of constructed versus natural wetlands. Currently, use of constructed, rather than natural, wetlands is generally preferred by EPA when projects for wastewater treatment are proposed.

U. S. ENVIRONMENTAL PROTECTION AGENCY

REGION IV - ATLANTA, GEORGIA

FRESHWATER WETLANDS FOR WASTEWATER MANAGEMENT

ENVIRONMENTAL ASSESSMENT

HANDBOOK

September 1985

CTA Environmental, Inc.

Gannett Fleming Corddry and Carpenter, Inc.

2.3 OVERVIEW OF WETLAND FUNCTIONS AND VALUES

Wetlands have many important roles in the maintenance of ecosystems and watersheds. The terms function and value are often used together to describe or characterize a wetland. Wetland functions are the inherent processes or capabilities of wetlands. Most of the values of wetlands relate directly to these functions: for example, the water quality enhancement functions of wetlands are one of their great values. Some wetland values, such as visual-cultural values, are somewhat independent of wetland function. Typically the functions and values of wetlands are interrelated.

The following 16 functions and values of wetlands summarized in Table 2-2 are widely accepted.

Table 2-2. Primary Wetland Functions and Values

<u>Geomorphology</u>

- Erosion control

<u>Hydrology/Meteorology</u>

- Flood control
- Saltwater intrusion control
- Groundwater supply
- Microclimate regulation

<u>Water Quality</u>

- Water quality enhancement

<u>Ecology</u>

- Habitat for threatened and endangered species
- Waterfowl breeding and habitat
- Wildlife habitat
- Freshwater fish (and some marine species)
- Aquatic productivity
- Nutrient/material cycling

<u>Cultural Resources</u>

- Harvest of natural products
- Recreation and aesthetics

2.3.1 Geomorphology

Erosion Control. Located between watercourses and uplands, wetlands help protect uplands from erosion. Wetland vegetation can reduce shoreline erosion in several ways, including: (1) increasing stability of the sediment through binding with its roots, (2) dampening waves through friction and (3) reducing current velocity through friction. These processes reduce turbidity and thereby improve water quality. Rich, alluvial soils, which build up in wetlands, also contribute to productivity.

Wetland vegetation has been successfully planted to reduce erosion along U.S. waters. While most wetland plants need calm or sheltered water for establishment, they will effectively control erosion once established. Willows, alders, ashes, cottonwoods, poplars, maples and elms are particularly good stabilizers. Successful emergent plants in freshwater areas include reed canary grass, reed, cattail, and bulrushes. Sediment deposition in freshwater wetlands also acts to decrease siltation in downstream systems such as estuaries.

2.3.2 Hydrology/Meteorology

Flood Control. Wetlands temporarily store flood waters and thus reduce downstream losses of life and property. Since destruction from floods in the U.S. runs from $3 to $4 billion each year, the damage-diminishing function of wetlands is vitally important.

Rather than having all flood waters flowing rapidly downstream and destroying private property and crops, wetlands slow the flow of water, store it for some time and slowly release stored waters downstream. In this way, flood peaks of tributary streams are desynchronized and all flood waters do not reach the mainstem river at the same time. This function becomes more important in urban areas, where development has increased the rate and volume of surface water runoff and the potential for flood damage (U.S. FWS 1984).

Saltwater Intrusion Control. The flow of freshwater through wetlands creates groundwater pressure that prevents saltwater from invading public water supplies. This is important only where freshwater wetlands interface with an estuarine environment (U.S. FWS 1984).

Groundwater Supply. There is considerable debate over the role of wetlands in groundwater recharge. Recharge potential of wetlands varies according to numerous factors, including wetland type, geographic location, season, soil type, water table location and precipitation. Depressional wetlands like cypress domes in Florida and prairie potholes in the Dakotas may contribute to groundwater recharge. Floodplain wetlands also may do this through overbank water storage (U.S. FWS 1984). As a result, the protection of this function could be a factor in addressing current and future water supply problems.

Microclimate regulation. Although less is known about the role of wetlands in regulating climatic conditions than about many other wetlands functions, available data indicate this may be a significant wetland function. In some cases wetlands appear to modify air temperatures, affect localized precipitation and maintain global atmospheric stability. Most available information concerning the modification of air temperatures and regional precipitation is pertinent for Florida wetlands, which comprise such a large percentage (30%) of the state. It has been suggested that thunderstorm activity could decrease in Florida as a result of draining wetlands, thereby modifying water budgets (EPA 1983).

2.3.3 Water Quality

Water Quality Enhancement. Wetlands act as natural water purification mechanisms. They remove silt, and filter out and absorb nutrients and many pollutants such as waterborne toxic chemicals.

Water quality enhancement is dependent on wetlands soils, vegetation, flow through-time, water depth and related processes. Many communities throughout the United States, including more than 400 communities in the Southeast, have benefitted from the capabilities of wetlands to enhance water quality by incorporating wetlands into their wastewater management systems (EPA 1983).

2.3.4 Ecology

Habitat for Threatened and Endangered Species. More than 20 percent of all the plant and animal species on the Federal Endangered or Threatened Species list are dependent on wetlands for food and/or habitat. Fifteen wetlands dependent species on the federal list are found only in the Southeast. Additionally, each state has a list of protected species and many of these in each state are wetlands dependent: Alabama - 25 species; Florida - 31 species; Georgia - 6 species; Kentucky - 14 species; Mississippi - 14 species; North Carolina - 8 species, South Carolina - 13 species; Tennessee - 13 species (EPA 1983).

Waterfowl Breeding and Habitat. Over 12 million ducks nest and breed annually in northern U.S. wetlands. This area, when combined with similar habitats in the Canadian prairies, accounts for 60 to 70 percent of the continent's breeding duck population. Waterfowl banded in North Dakota have been recovered in 46 states, 10 Canadian provinces and territories, and 23 other countries. Some 2.5 million of the 3 million mallards in the Mississippi Flyway and nearly 100 percent of our 4 million wood ducks spend the winter in flooded bottomland forests and marshlands throughout the South.

Bottomland forested wetlands of the South are primary wintering grounds for North American waterfowl areas, as well as important breeding areas for wood ducks, herons, egrets and white ibises. Even wild turkeys nest in bottomland hardwood forests. Other common bird inhabitants include barred owls, downy and redbellied woodpeckers, cardinals, pine warblers, wood peewees, yellowthroats and wood thrushes (U.S. FWS 1984).

Wildlife Habitat. Wetlands provide food and shelter for a great variety of furbearing animals and other kinds of wildlife. Louisiana marshes alone yield an annual fur harvest worth $10 to $15 million (U.S. FWS 1984).

Muskrats, beavers and nutria are the most common fur bearers dependent on wetlands. Muskrats are the most wide ranging of the three, inhabiting both coastal and inland marshes throughout the country. In contrast, beavers tend to be restricted to inland wetlands, with nutria limited to coastal wetlands of the South. Other wetland-utilizing furbearers include otter, mink, raccoon, skunk and weasels. Other mammals also frequent wetlands, such as marsh and swamp rabbits, numerous mice, bog lemmings and shrews. Larger mammals may also be observed. Black bears find refuge and food in shrub wetlands in South Carolina, for example (U.S. FWS 1984).

Turtles, snakes, reptiles and amphibians are all common residents of wetlands in the Southeast. Alligators range from Florida to North Carolina to the north, and Texas to the west.

Freshwater Fish. Many of the 4.5 million acres of open water areas found in inland wetlands are ideal habitat for such sought after species as bass, catfish, pike, bluegill, sunfish, and crappie.

Most freshwater fishes can be considered wetland-dependent because: (1) many species feed in wetlands or upon wetland-produced food; (2) many fishes use wetlands as nursery grounds and (3) almost all important recreational fishes spawn in the aquatic portions of wetlands. Bottomland hardwood forests of the South serve as nursery and feeding grounds for young warmouth and largemouth bass, while adult bass feed and spawn in these wetlands. River swamps in Georgia produce 1,300 pounds of fish per acre. The bottomlands of the Altamaha River in Georgia are spawning grounds for the hickory shad and blueback herring. Southern bottomland forested wetlands are also the home of the edible red swamp crayfish, which burrow down to the water table when flooding waters recede (U.S. FWS 1984).

Aquatic Productivity. Wetlands are among the most productive ecosystems in the world. Wetland plants are particularly efficient converters of solar energy. Through photosynthesis, plants convert sunlight into plant material or biomass and produce oxygen as a by-product. This biomass serves as food for a multitude of animals, both aquatic and terrestrial. For example, many waterfowl depend heavily on seeds of marsh plants, while muskrat eat cattail tubers and young shoots.

Generally, direct grazing of wetland plants is limited, so the vegetation's major food value is produced when it dies and fragments, forming detritus. This detritus forms the base of an aquatic food web which supports higher consumers. Wetlands can be regarded as the farmlands of the aquatic environment, producing great volumes of food annually. The majority of non-marine aquatic animals depend, either directly or indirectly, on this food source (U.S. FWS 1984).

Nutrient and Material Cycling. Implicit in the discussion of several other wetland functions and values is the importance of wetlands to downstream ecosystems. Wetlands that are hydrologically connected to surface waters often serve as an important source of nutrients and organic matter. Wetlands serve to break down organic matter, such as dead vegetation, and to cycle nutrients so these materials are useable in downstream ecosystems. This function is essential to many freshwater and marine organisms in downstream waters and estuaries (Day 1981).

2.3.5 Cultural Resources

Harvest of Natural Products. A variety of natural products are produced in freshwater wetlands, including timber, fish, water fowl, pelts and peat. Wetland grasses are hayed in many places for winter livestock feed. During other seasons, livestock graze directly in wetlands across the country. These and other products are harvested by man for his use and provide a livelihood for many people. The standing value alone of southern wetland forests is $8 billion. Conversion of bottomland forests to agricultural fields (e.g., soybeans) in the Mississippi Delta has reduced these wetlands by 75 percent.

Wetlands also support fish and wildlife for man's use. Commercial fishermen and trappers make a living from these resources. Many commercial species (catfish, carp and buffalo fish) depend on freshwater wetlands for habitat, nutrients or organic matter. Furs from beaver, muskrat, mink, nutria and otter yielded roughly $35.5 million in 1976. Louisiana is the largest fur-producing state, and nearly all furs come from wetland animals.

Many wetlands produce peat, a resource used mainly for horticulture and agriculture in the United States. Peat mining, however, destroys wetlands and their many associated values (U.S. FWS 1984).

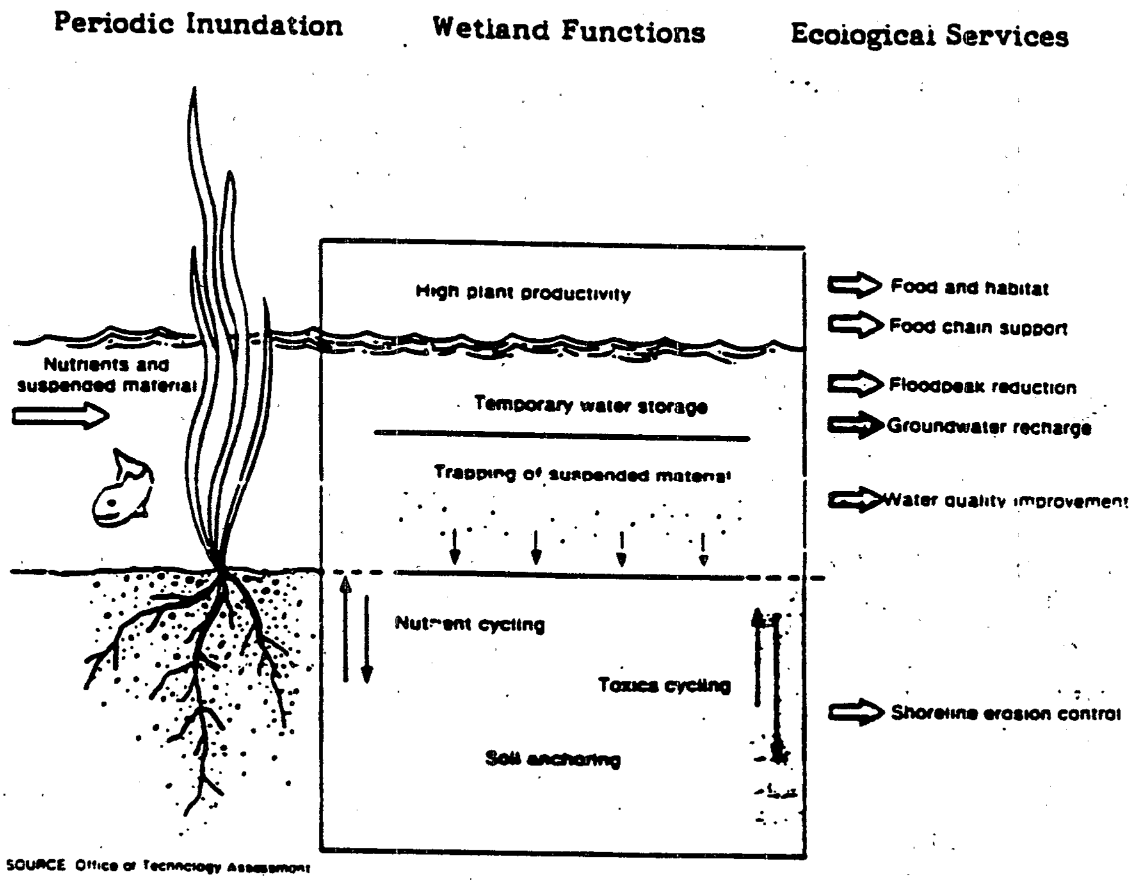
Recreation and Aesthetics. Many recreational activities take place in and around wetlands. Hunting and fishing are popular sports. Waterfowl hunting is a major activity in wetlands, and big game hunting is also important locally.

Other recreation in wetlands is largely non-consumptive: hiking, nature observation and photography, swimming, boating and ice-skating. Many people simply enjoy the beauty and sounds of nature and spend their leisure time walking or boating in or near wetlands observing plant and animal life. The aesthetic value of wetlands is extremely difficult to evaluate or place a dollar value upon. Nonetheless, it is very important. In 1980 alone, 28.8 million people (17 percent of the U.S. population) took special trips to observe, photograph or feed wildlife.

Figure 2-3 graphically depicts many of the major wetlands functions and values. These functions and values are important to the use of wetlands for wastewater management for several reasons. First and foremost, they provide the basis for water quality standards and the nondegradation of existing uses Existing uses, as represented by the list of beneficial wetland functions and values, must be clearly identified and protected by a wastewater management plan incorporating wetlands.

While few wetlands will exhibit all 16 attributes listed, the existing values must be identified for each prospective site. Not only do these functions and values serve as a basis for regulatory considerations, they also impact site screening, engineering design, operation and monitoring of a prospective wetlands discharge. Wastewater management objectives must be considered in light of environmental protection. The Handbook emphasizes the importance of wetlands functions and values in each of the three major subject areas addressed: institutional, scientific and engineering considerations.

Figure 2-3. Relationship Between Wetland Functions and Values.



SOME RECENT DETAILED TECHNICAL REFERENCES

U.S. EPA, September 1985. Freshwater Wetlands for Wastewater Management Environmental Assessment Handbook. EPA 904/9-85-135. U.S. EPA Region IV, Atlanta, GA. 474pp.

U.S. EPA, 1983. The Effects of Wastewater Treatment Facilities on Wetlands in the Midwest. Technical Report. EPA 905/3-83-002. U.S. EPA Region V, Chicago, IL. 264pp.

U.S. EPA/U.S F&WL Service, 1984. The Ecological Impacts of Wastewater on Wetlands, An Annotated Bibliography. EPA 905/3-84-002. 300pp.

Bastian, R.K. and J. Benforado, In Press. Water Quality Functions of Wetlands: Natural and Manmade System. IN: D. Hook (ed) Proceedings of the International Symposium on Ecology and Management of Wetlands. Croom Helm LTD, Beckenham, Kent. UK

Brinson, M.M. and F.R. Westall, 1983. Application of Wastewater to Wetlands. Rpt. No. 5, Water Research Inst., Univ. of North Carolina, Raleigh, NC. 26pp.

Godfrey, P.J., E.R. Kaynor, S. Pelczarski and J. Benforado (eds.), 1985. Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Co., New York, N.Y. 473pp.

Hammer, D.E. and R.H. Kadlec, 1983. Design Principles for Wetland Treatment Systems. EPA 600/2-83-026. 243pp.

Horwitz, E.L., 1978. Our Nation's Wetlands, An Interagency Task Force Report Coordinated by the President's Council on Environmental Quality. CPO, Washington, D.C. 70pp.

Kadlec, R.H., June 1987. Using Wetlands to Mitigate the Water Quality of Sewage Effluent. IN: Nix, S.J. and P.E. Black (eds). Proceedings of the Symposium on Monitoring, Modeling, and Mediating Water Quality, AWRA, Bethesda, MD. pp. 415-427.

Kadlec, R.H. and J.A. Kadlec, 1979. Wetlands and Water Quality. IN: Wetland Functions and Values: The State of Our Understanding. AWRA, Bethesda, MD. pp.436-456.

Mudroch, A. and J.A. Capobianco, 1979. Effects of Treated Effluent on a Natural Marsh. JWPCF 51(9):2243-2256.

Nichols, D.S., 1983. Capacity of Natural Wetlands to Remove Nutrients from Wastewater. JWPCF 55(5):495-505.

Nixon, S.W. and V. Lee, In Press. Wetlands and Water Quality: A Regional Review of Recent Research in the U.S. on the Role of Freshwater and Saltwater Wetlands as Sources, Sinks, and Transformers of N, P and Heavy Metals. Prepared by the Univ. of Rhode Island for the U.S. Army Corps of Engineers, WES, Vicksburg, MS.

Reddy, K.R. and W.H. Smith (eds.), 1987. Aquatic Plants for Water Treatment and Resource Recovery. Magnolia Press, Inc., Orlando, FL. 1032pp.

Zedler, J.B. and M.E. Kentula, 1985. Wetlands Research Plan, November 1985. U.S. EPA ERL-Corvallis, OR. 118pp.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 2 1987

THE ADMINISTRATOR

Honorable Quentin N. Burdick
Chairman, Committee on Environment
and Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

I am pleased to forward to you our report on the use of wetlands for municipal wastewater treatment and disposal, prepared in response to your May 4, 1987 request.

The report indicates that there are a number of approaches whereby wastewater and natural or constructed wetlands may be effectively combined as a part of water quality management projects. Almost all natural wetlands are waters of the United States and discharges to these wetlands must comply with Clean Water Act requirements. Such wetlands may be used to provide nutrient removal or high level effluent polishing for municipal wastewater discharges. On the other hand some constructed wetlands are designed and built for the express purpose of treating municipal wastewater. Such wetlands are not waters of the United States and may be used to comply with the minimum technology requirements of the Clean Water Act. Land purchases for constructed wetlands treatment systems, and under certain limited circumstances natural wetlands, are eligible for funding under the construction grants program.

We do not recommend any legislative changes at this time. However, the Agency is taking actions which may help resolve the questions regarding the circumstances under which natural wetlands may be used to help treat municipal wastewater.

Please do not hesitate to contact me if you have any further questions.

Sincerely,

~~Lee~~ M. Thomas

... BASTIAN:...final:10/8/87:ID#8765H

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
WASHINGTON, DC 20510-6175

May 4, 1987

Mr. Lee Thomas
Administrator
Environmental Protection Agency
401 M St S.W.
Washington, D.C. 20460

Dear Mr. Thomas:

I recently learned that the Environmental Protection Agency has considered the option of using wetland areas for disposal or treatment of municipal sewage.

I have a particular interest in plans to use wetland areas for disposal of sewage from the City of Devils Lake in my home State of North Dakota. While I understand that the wetlands disposal option is no longer under active consideration in the case of the City of Devils Lake, I am interested in, and concerned about, the general question of the use of wetland areas for sewage disposal or treatment.

I would like you to prepare a report on the general subject of use of wetlands for municipal sewage disposal and discharge and related activities.

Your report should provide a full assessment of the extent and circumstances of this practice, summarize the legal issues involved, review the Agency's policy with regard to this practice, and provide recommendations of actions which should be taken by the EPA or the Congress to address this issue.

Please provide this report to my office within thirty days. If you are unable to prepare this report within this time period, please contact Mr. Bob Davison (224-7189) or Mr. Jeff Peterson of the Environment and Public Works Committee staff (224-7069).

Thank you for your cooperation in this important matter.

Sincerely,

Quentin N. Burdick
Chairman

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 20 1988

OFFICE OF WATER

MEMORANDUM

SUBJECT: Use of Wetlands for Municipal Wastewater Treatment and Disposal

FROM: Rebecca W. Hanmer, Acting Assistant Administrator for Water (WH-556)

TO: Water Division Directors, Regions I - X

This memorandum provides information and guidance concerning projects in which wetlands play a role in the treatment and disposal of municipal wastewater effluent. Attached you will find **OW Guidance to Supplement the October 1987 Burdick "Report on the Use of Wetlands for Municipal Wastewater Treatment and Dipsosal"**, as well as a copy of the Burdick report.

The report was prepared by the Office of Water at the request of Senator Quentin N. Burdick, Chairman of the Senate Committee on Environment and Public Works, to attempt to provide a full assessment of the extent and circumstances of the use of wetlands for municipal wastewater treatment and disposal, a summary of the legal issues involved, a review of pertinent agency policy, and recommendations of actions which need to be taken by EPA or the Congress to address this issue. The supplemental guidance was developed to summarize a number of internal agency issues addressed during preparation of the report, and to provide some general guidance.

The following are the Headquarters contacts on this matter who had the lead in their respective offices for preparation and review of the report. Please feel free to contact them if you have any questions: Karen Tarnow (382-5686) on my immediate staff, Bob Bastian (382-7378) in OMPC, John Meagher (382-5043) in OWP, Steve Bugbee (475-9539) in OWEP, Nandan Kenkeremath (382-7700) in OGC.

Attachments

cc: CG Branch Chiefs
Water Permits/Compliance Branch Chiefs
Section 404 Coordinators
Regional Counsels

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

September 20, 1988

OFFICE OF WATER

SUBJECT: OW Guidance to Supplement the October 1987 Burdick "Report on the Use of Wetlands for Municipal Wastewater Treatment and Disposal"

When Are Wetlands Waters of the United States?

The definition of waters of the U.S. under 40 CFR Part 122.2 includes most wetlands. Wetlands which are adjacent to other waters of the United States (other than wetlands) are automatically waters of the U.S. In addition, other wetlands (often called "isolated wetlands") are waters of the U.S. if their use, degradation or destruction would or could affect interstate or foreign commerce. Some examples of an adequate interstate commerce connection are if the wetlands are or could be used by interstate or foreign travelers for recreational or other purposes, contain or could contain fish or shellfish which could be sold in interstate or foreign commerce, or are or could be used for industrial purposes by industries in interstate commerce. In addition, isolated wetlands that are or could be utilized by migratory waterfowl are regulated as waters of the U.S.

As discussed below, constructed wetlands which are designed, built and operated as wastewater treatment systems are in general excluded from the definition of "waters of the U.S." (see 40 CFR 122.2, exclusion for waste treatment systems). Pending additional rulemaking, the decisions of whether these waste treatment systems are considered waters of the U.S. must be made on a case-by-case basis.

When Can Natural Wetlands Be Used For Effluent Polishing?

Almost all natural wetlands are waters of the U.S. Municipal discharges to those wetlands which are considered waters of the U.S. are, therefore, subject to the provisions of the Clean Water Act and must meet minimum technology requirements and conform with all applicable State water quality standards including the "free froms" and other narrative standards. Thus, nothing less than secondary effluent (or equivalent to secondary effluent where trickling filters or waste stabilization ponds are used) may be discharged to a natural wetland. If State water quality standards applicable to the wetland require more stringent or additional effluent limitations; they too must be met at the point of discharge to the wetland. However, under circumstances where secondary (or equivalent to secondary) effluent limitations are met and all State water quality standards applicable to the wetland are also met, if more stringent water quality criteria apply to a downstream surface water body, natural wetlands can be used to provide additional assimilation of conventional and nonconventional pollutants. In limited situations natural wetland treatment systems could provide certain communities, especially small communities, with alternatives to more costly and complex advanced treatment plants. However, effluent found to contain potentially harmful levels of toxins should not be discharged to natural wetlands or any constructed wetlands serving habitat functions.

<u>Case-By-Case Evaluation of Proposed Natural Wetland Treatment Systems</u>

Some natural wetlands can provide advanced effluent polishing for conventional and nonconventional pollutants on a seasonal if not year-round basis without damage to their ecological functions and values. The Office of Water and several Regional Offices have been looking into many of the technical and administrative issues associated with such practices for several years. However, in the absence of appropriate water quality criteria for wetlands it is impossible to broadly identify the conditions under which they can safely function as part of the treatment system. When such practices are allowed, a comprehensive monitoring system must be in place. At a minimum, the monitoring program should be designed to help avoid harmful accumulations of toxic materials present in trace amounts in the wastewater and to detect changes in the plant and animal communities due to changes in water flow and characteristics caused by the wastewater discharge.

Therefore, proposals for treatment systems involving discharge of secondary (or equivalent to secondary) effluent to natural wetlands that are to provide additional treatment to the effluent to meet higher downstream treatment requirements for conventional and nonconventional pollutants should be reviewed by the Regions on a case-by-case basis. The Region's wetlands protection staff should be consulted on all such cases. Region IV's **Freshwater Wetlands for Wastewater Management Handbook** (EPA 904/9-85-135; September 1985) provides one source of guidance for such case-by-case evaluations.

Proposals to use natural wetlands for effluent polishing may involve some alteration of the wetland, such as building dikes. Such construction activity may require a Section 404 permit, review under the National Environmental Policy Act, consideration of other applicable Federal laws and executive orders (such as the Endangered Species Act), and any applicable State laws governing wetland filling or other alteration.

Natural Wetlands Treatment Systems NPDES Permit Requirements

All effluent discharges into wetlands which are waters of the U.S. require a National Pollutant Discharge Elimination System (NPDES) permit. Municipal NPDES permits must contain minimum technology-based limits and conform with all applicable State water quality standards including the "free froms" and other narrative standards. In those cases where a natural wetland will be used either on a seasonal or year-round basis for effluent polishing, the NPDES permit must contain secondary (or equivalent to secondary) effluent limits consistent with 40 CFR Part 133, plus any additional limits and/or monitoring requirements necessary to protect the wetlands and achieve water quality standards for the wetlands, adjacent and downstream waters. These water quality-based limits must be implemented in the NPDES permit at the point of discharge into the wetlands (i.e., at end-of-pipe). In addition to meeting water quality standards in the wetlands, the end-of-pipe water quality-based limits necessary to achieve adjacent and downstream water quality standards may be established based on the degree of effluent "polishing" provided by the wetlands.

There are a number of cases where effluent polishing by natural wetlands has been recognized in State-issued NPDES permits. See, for example, the attached case summaries for the Houghton Lake, MI and Cannon Beach, OR projects.

Construction Grants Eligibility of Natural Wetlands

Under certain limited circumstances the acquisition of a natural wetland which will serve to polish municipal wastewater effluent may be eligible for construction grant funding. A determination as to eligibility can be made only after a thorough case-by-case evaluation has shown that the natural wetland alternative is both cost effective and environmentally sound. The latter determination must be made in consultation with the Region's wetland protection staff. In the case of Houghton Lake, MI, pond treated secondary effluent is applied to state-owned wetlands on a seasonal basis to achieve phosphorus and ammonia removal while the wetland is maintained open and acceptable for public access. On the other hand, at Cannon Beach, OR, natural wetlands, which were purchased as a construction grant eligible component, receive secondary pond effluent on a seasonal basis to meet seasonal advanced treatment requirements for BOD and SS prior to discharge to the receiving stream.

Such funding is only available where the management of the wetlands is recognized in a NPDES permit as the method for achieving downstream water standards. This management may occur beyond the discharge point, which would be the discharge to the wetlands itself. In addition, the NPDES permit must require that discharges into the wetlands must meet secondary (or equivalent to secondary) treatment limits and any limits based on water quality standards for the wetlands before funding can be made available.

Natural wetlands treatment systems can be funded as either innovative or alternative technology under provisions of the Innovative and Alternative Technology program, depending upon the experience with the type of wetland system to be used.

When Can Constructed Wetlands Be Used For Wastewater Treatment?

When assessing constructed wetlands for municipal wastewater treatment a distinction should be made between those constructed wetlands designed, built and operated as wastewater treatment systems, and those constructed wetlands designed, built and operated to provide many of the functions and values of natural wetlands (e.g., wildlife habitat) in addition to providing wastewater treatment. This is necessary in order to help determine which wetlands are waters of the U.S. and, therefore, the degree of wastewater treatment that is necessary prior to placing the wastewater into the constructed wetland unit for further treatment. Generally, man-made bodies of water which are designed, built and operated as wastewater treatment systems are not waters of the U.S.

Constructed Wastewater Treatment Wetlands

Constructed wastewater treatment wetlands can be designed, built and operated as municipal wastewater treatment systems. See, for example, the attached case summary for the Gustine, CA project. These are highly engineered systems designed to maximize the treatment of municipal wastewater. Any other functions they may provide must be incidental to the treatment of wastewater. Through the Innovative and Alternative technology provisions of the construction grants program, EPA has been encouraging the use of constructed wastewater treatment wetlands. The construction costs for these systems, including land acquisition, have been and remain eligible for up to 75% construction grants funding.

Constructed wastewater treatment wetlands that are designed, built, and operated as wastewater treatment systems are generally not considered to be waters of the U.S. Thus the restrictions which apply to natural wetlands do not generally apply to such constructed wastewater treatment wetlands. Influent to these constructed wastewater treatment wetlands may range from raw wastewater to secondary effluent or better.

Constructed Multiple Use Wetlands

There are many constructed wetlands which are designed, built and operated to provide, in addition to wastewater treatment, functions and values similar to those provided by natural wetlands. See, for example, the attached case summaries for the Martinez, CA; Arcata, CA; and Incline Village, NV projects.

The Martinez project involves wetlands which provide only incidental treatment of secondary effluent from a regulatory point-of-view because they were constructed for the benefit of wildlife habitat as an alternative to a more expensive deepwater Bay outfall and diffuser. On the other hand, the Arcata project involves wetlands constructed to provide year-round wastewater treatment followed by a wetland discharge, in lieu of a Bay outfall and diffuser, through a pre-existing coastal wetland area managed as a wildlife sanctuary to help enhance wildlife habitat and overall Humboldt Bay area use. Finally, the Incline Village project involves wetlands designed for both effluent disposal into a non-discharging wetland and wildlife habitat enhancement.

Under certain circumstances such constructed multiple use wetlands may be considered waters of the U.S. and as such would be subject to the same protection and restrictions on use as natural wetlands. This determination must be made on a case-by-case basis, and may consider factors such as the size and degree of isolation of the constructed wetlands and other appropriate factors. Where such constructed multiple use wetlands are found to function as waters of the U.S., municipal discharges to such systems must be limited to secondary or equivalent to secondary effluents and any more stringent effluent requirements necessary to meet applicable water quality standards. The Region's wetlands protection staff should be consulted on all such cases.

Finally, in some cases a municipal wastewater discharge may be the sole water supply for a constructed multiple purpose wetland which becomes waters of the U.S. As long as the discharge to such a wetland continues, the wetland would continue to be considered waters of the U.S. However, aside from any contractual arrangements which may be entered into, a municipal discharger is not bound to supply water to the constructed wetland in perpetuity, even if the wetland achieves a high level of ecological complexity.

CANNON BEACH, OREGON
CASE SUMMARY

PROJECT TYPE: Use of seasonally operated natural wetlands to upgrade existing wastewater stabilization ponds treating the wastewater from a permanent population of 1,200 which swells with summer tourists to 4,000. The ponds provide secondary equivalent treatment (30 mg/l BOD and 50 mg/l SS as monthly averages) prior to stream discharge from November 1 through April 30. From May 1 through October 31, pond effluent is further treated in the wetlands system to achieve monthly average BOD and SS levels of 10 mg/l prior to discharge to Ecola Creek.

GRANT FUNDING: 75%, including 10% I/A grant awarded in 1982; eligible grant expenses included land acquisition costs. The capital costs and the operation and maintenance requirements were significantly lower than those of any of the conventional alternatives.

PRE-EXISTING SITUATION: Secondary treatment via three-cell stabilization pond system, followed by chlorination and discharge into a small tidal slough that drains into Ecola Creek. System incapable of meeting summer discharge requirements.

PROJECT EVOLUTION: The project as originally envisioned would have involved creation of a 15-acre constructed wetland within an existing natural wetland located adjacent to the secondary treatment ponds. After receiving an approved Section 404 permit, the 15 acre site was to be stripped of its existing vegetation and re-planted with bullrush, burreed, and wapatto to be harvested each fall. Concerns raised by the U.S. Fish & Wildlife Service and other resource agencies forced reconsideration of this proposal. It was determined that the adverse effects of redistributing and destroying most of the wetland could not be effectively mitigated by enhancement of waterfowl and aquatic species habitat, and that, if possible, the existing wetland should be used in its natural condition. The project as ultimately built uses the natural filtering capacity of the existing wetland vegetation.

PROJECT DESIGN: Enclosure of approximately 15 acres of existing alder/spruce/sedge wetland by earthen dikes 12 feet wide and 0.5 to 7 feet high (2.5 ft. average). Detention time in the wetland is approximately 10 days. Sections of the dike were intentionally made of gravel & cobbles to help alleviate the potential effects of flooding by allowing flood water from the nearby stream to flow through the treatment site to downstream areas.

NPDES PERMIT: Specifies seasonal discharge limitations of 10 mg/l BOD and SS as monthly averages at the point of the wetland discharge to the creek for the period May 1 to October 31; and specifies limitations at the point of the secondary treatment ponds' discharge to the creek for the period November 1 to April 30.

MONITORING: Conducted on the quality of lagoon influent, lagoon effluent (at Outfall #1), wetland influent, wetland effluent (at Outfall #2), and wetland background (in diversion ditch upgradient of wastewater introduction).

HOUGHTON LAKE, MICHIGAN
CASE SUMMARY

PROJECT TYPE: Upgrade of aerated ponds treating the wastewater from a seasonally variable population, averaging approximately 8,000, by establishment of a seasonally operated natural wetlands wastewater treatment/discharge system. The ponds provide secondary treatment as well as storage during the non-irrigation season. Unchlorinated secondary pond effluent is applied to the Porter Ranch peat lands of the Houghton Lake Wildlife Research Area from approximately May 15 to September 15. The project is required to achieve year-around monthly averages of 30 mg/l BOD, 4 mg/l CBOD, 20 mg/l SS, and 0.5 mg/l Total P, as well as a requirement of 0.5 mg/l NH_3-N (as N) from May 16 to October 15 for its two points of surface water discharge to Bear Creek and Dead Horse Creek which flow into the Muskegon River.

GRANT FUNDING: 75% grant awarded in 1977; no grant funds for land acquisition involved since the wetlands are State-owned and their use for the wastewater project is authorized through a special use permit issued by the Wildlife Division, Department of Natural Resources, State of Michigan. The capital costs and the operation and maintenance requirements of the wetland system were significantly lower than those of any available alternative.

PRE-EXISTING SITUATION: Individual household septic tanks with leach field drainage entering Houghton Lake. Secondary treatment via aerated ponds alone was incapable of meeting advanced treatment/discharge requirements. Discharge to Great Lakes watershed required phosphorus removal.

PROJECT EVOLUTION: The wetlands system was developed as a more cost-effective alternative to expanding existing seepage beds and upland irrigation system for disposal of secondary effluent while providing advanced treatment. Research and pilot scale testing provided background data; full scale (1.1 MGD design) system was constructed and placed in operation in 1978.

PROJECT DESIGN: Pond treated secondary effluent is distributed over a 16-week period each year across the width of the 1,500 acre sedge-willow/leatherleaf-bog birch peatland at a rate of about 1 MGD (not to exceed 2.5 MGD) through a series of 100 small gated openings in a 3,200 ft. irrigation pipeline system mounted on a wooded walkway across the wetland which is maintained by the wastewater authority.

NPDES PERMIT: Specifies seasonal (May 16 to October 15) ammonia nitrogen and fecal coliform limits and year-round BOD, CBOD, SS, and Total P requirements for the wetland discharges to the creeks and compliance with requirements of the DNR Wildlife Division's special use permit for applying secondary effluent to the stateowned wetland - including maintaining the wetland open and acceptable for public access.

MONITORING: Conducted on pond effluent (i.e., wetland influent), within wetland surface & ground water quality, wetland effluent discharges to Bear Creek and Dead Horse Creek, and downstream water quality; wetland hydrology, soils, vegetation & wildlife.

MARTINEZ, CALIFORNIA
CASE SUMMARY

PROJECT TYPE: Establishment by the Mt. View Sanitary District (MVSD) of a constructed wetland system with chlorinated secondary effluent to create a wetland environment for the benefit of wildlife and migratory waterfowl that would also improve water quality and avoid the building of an expensive deepwater outfall into Suisun Bay.

GRANT FUNDING: 75% grant awarded in 1974; no grant funds involved in land aquisition since the wetland area that was created as an alternative to a deepwater outfall was not considered to be an integral part of the treatment system in terms of the discharge permit issued by the Regional California Water Resources Control Board. The capital costs and operations and maintenance requirements were significantly lower than those of any available alternatives.

PRE-EXISTING SITUATION/PROJECT EVOLUTION: The wetlands system was developed in 1974 by MVSD as an alternative to constructing a 15-inch diameter, 9,000 ft. long pipeline and outfall plus pumping facilities (1977 estimated capital costs were $2.8 million and $130,000/yr O&M) or abandonment of the existing treatment facilities and transport of untreated wastewater to a nearby community's treatment plant that would have to be expanded to handle the additional flow (1977 estimated costs to MVSD for conveyance of the wastewater and expansion of the treatment facilities were $6.9 million; MVSD's share of O&M costs were $230,000/yr).

PROJECT DESIGN: Conventional treatment preceeding the wetland involves comminution, primary and secondary sedimentation, high rate trickling filtration and effluent chlorination/dechlorination design to provide full secondary treatment of 1.6 MGD dry weather flow with a hydraulic capacity of 8 MGD wet weather flow. The wetland system was created on 20.3 acres of land that had previously been a brackish water marsh, but had been diked and drained early in the 1800's. The wetland was designed to provide maximum wildlife habitat while avoiding nuisance situations. Habitat types include open water mixed with stands of emergent vegetation, islands, areas covered by floating vegetation, and areas with cultivated wildlife foods, plus mud flats, levees, and adjacent land with grasses, brush and trees. The total plant flow passes through the wetland into Peyton Slough which discharges into Suisun Bay. When the project flow was 0.7 MGD there was a 10-day detention time in the wetland; land usage was 17 acres/MGD. At design capacity of the treatment plant, there will be a 5-day detention time using 12 acres/MGD.

NPDES PERMIT: Specifies discharge limitations of 30 mg/l BOD and TSS as monthly averages at the discharge from the high rate trickling filter following chlorination/dechlorination.

MONITORING: In addition to standard monitoring of the effluent quality from the conventional portion of the treatment plant, MVSD keeps track of the numbers and types of animals and plants supported by the wetland habitat, including numerous species of migratory waterfowl and shorebirds.

GUSTINE, CALIFORNIA
CASE SUMMARY

PROJECT TYPE: Upgrade of existing stabilization ponds with a design capacity of 1 MGD treating a relatively high strength wastewater (ranging between 300 and 3,000 mg/l BOD) from a small agricultural town, including both domestic and commercial sources - primarily from dairy products industries. The ponds serve as the pretreatment system for the constructed wetland cells to meet monthly average BOD and TSS levels of 30 mg/l prior to discharge to Los Banos Creek which flows into the San Joaquin River.

GRANT FUNDING: 75%, including 10% I/A grant and pilot testing awarded in 1986; no grant funds for land acquisition involved since city-owned land for the constructed wetland was available; a one-year pilot test program (using a 0.4 ha constructed cattail marsh) was undertaken to develop the final design criteria for the system. The capital and operations costs and energy requirements made the stabilization pond/constructed wetlands system considerably more cost-effective than any of the other alternatives considered.

PRE-EXISTING SITUATION: Advanced primary treatment via 14 stabilization ponds; discharge of final effluent to adjacent duck hunting clubs for land irrigation and wildlife was terminated by the adjacent land owners. Modified disposal operation involving discharge into Los Banos Creek could not consistently comply with secondary effluent limitations.

PROJECT DESIGN: Effluent taken from any of the last seven of 11 stabilization ponds, operated in series, is further treated in 24 constructed cattail marsh cells (each about 0.4 ha in size; 11.6 m wide, 337 m long) which are operated in parallel. Effluent from each cell flows over an adjustable weir which controls water depth in the cell. Detention time in the constructed cattail marsh cells can be controlled at 4 to 11 days.

NPDES PERMIT: Specifies discharge limitations of 30 mg/l BOD and TSS as monthly averages at the discharge to the creek and that the average daily discharge shall not exceed 1.0 MGD.

MONITORING: Conducted on water quality of influent, effluent, and receiving waters.

ARCATA, CALIFORNIA
CASE SUMMARY

PROJECT TYPE: Constructed polishing marshes operated to upgrade existing oxidation ponds with a design capacity of 2.2 MGD followed by effluent disposal into pre-existing coastal marshes that are now managed as a wildlife sanctuary and recreational area. Developed as an alternative to complete removal of the pond discharge from Humboldt Bay.

GRANT FUNDING: 75% grant, including 10% I/A funds, awarded in 1984. Total federal capital cost was about $4.6 million. No grant funds for land acquisition because land was city-owned.

PRE-EXISTING SITUATION/PRESENT EVOLUTION: Original plans developed in 1975 called for Arcata to be part of a $25 million Humboldt Bay Wastewater Authority (HBWA) regional treatment facility. Escalating costs (estimated at up to $50+ million by 1977) and local controversy over the regional system lead to alternative solutions being developed by members of HBWA. In 1977 Arcata proposed an alternative treatment and enhancement marsh/recreational lake system with discharge to Humboldt Bay. A pilot project partially funded by the Construction Grants Program began operation in 1980 to evaluate this concept as an alternative to complete phase out of the pond discharge from Humboldt Bay in accordance with the State Water Resources Control Board's "Bays and Estuaries Policy."

PROJECT DESIGN: Three 1-acre marshes were constructed as treatment marshes and operated in parallel to polish the oxidation pond effluent prior to effluent disposal into 31 acres of existing marshes (exclusive of a 17-acre recreational lake) managed as the Arcata Marsh and Wildlife Sanctuary to help enhance fish, shellfish, waterfowl, and other wildlife populations in the Humboldt Bay area. The polishing wetlands are operated at a depth of 0.5 m providing a theoretical residence time of about 189 days. The 31-acres of disposal wetlands are operated at a hydraulic loading of 0.07 MGD/acre as recommended for coastal conservancy marshes also help reduce BOD and ammonia levels while achieving some removal of phosphorus from the effluent leaving the polishing wetlands. Cattail and bullrush dominate the polishing marshes while a wide diversity of vegetation is present in the Arcata Marsh and Wildlife Sanctuary.

NPDES PERMIT: Preliminary project standards for BOD and SS (or NR - Non-Filterable Residue) established for monthly average (30 mg/l), weekly (45 mg/l), and daily (60 mg/l) samples were frequently exceeded by the pond effluent. The pilot marshes demonstrated that the project would meet these standards. The disposal marshes allowed the full system to meet NPDES requirements consistently, in spite of start-up problems associated with the conventional portion of the plant upgrades. Fecal coliforms were also greatly reduced by the polishing marsh during this period.

MONITORING: An integrated monitoring program developed during the pilot program is being continued to monitor the Arcata Marsh and Wildlife Sanctuary area for water quality, fish tissue residues, vegetation patterns, and various special studies in conjunction with Humbolt State University.

INCLINE VILLAGE, NEVADA
CASE SUMMARY

PROJECT TYPE: Establishment by the Incline Village General Improvement District (IVGID) of a constructed, nondischarging wetland system that was designed for both effluent disposal and wildlife habitat enhancement. The wetland system is part of a no-discharge wastewater treatment/disposal system initially being implemented as an alternative to providing nutrient removal prior to effluent discharges to the Carson River. The wetland system was put into operation in 1984. The wastewater treatment system serves a permanent population of about 8,000 which swells seasonally to about 15,000, treating a dry weather flow of approximately 1.6 MGD. Effluent is used to irrigate pasture from April 15 - October 1 until 1995 when the wetlands will be the sole disposal method and accomplish the goal of no direct discharge to the Carson River.

GRANT FUNDING: 85%, including 10% I/A grant, awarded in 1982; eligible grant expenses included land acquisition costs. The nondischarging system, which initially combines seasonal pasture irrigation with seasonal discharge to a constructed wetlands, was found to be the most cost effective alternative to nutrient removal for continued river discharge during winter and to eventually achieve the goal of no direct discharge to the Carson River.

PRE-EXISTING SITUATION/PROJECT EVOLUTION: IVGID, which is located on the north shore of Lake Tahoe, could not discharge its effluent into Lake Tahoe. Consequently the District pumped its secondary effluent out of the Lake Tahoe Basin via a 30 km pipeline and discharged to the Carson River. The effluent was used to irrigate pasture from April 15-October 1 and discharged to the Carson River during the winter. The wetlands concept was developed in response to an order from the Nevada Division of Environmental Protection prohibiting future direct discharges to the Carson River.

PROJECT DESIGN: The 906-acre project site's created wetlands contains four cells that can be operated in series or in parallel, but are normally operated in series. They include central channels and islands. Each cell is divided into four subcells. Separate outlets to the cells allow for individual management of each cell as required. Water depths in the created wetlands range from 15 cm to about 1 m. An overflow area receives all effluent in excess of the percolation and evapotranspiration capacity of the created wetlands. Seasonal storage (which contains an area of open water with three islands for wildlife use) is provided to store excess effluent during cool, wet seasons. Habitat enhancement includes the creation of entirely new permanent and seasonal wetlands. Bullrush and cattail are dominating the seasonal wetlands. The created wetlands also serve to expand a nearby warm water (spring fed) wetland area used extensively for migratory waterfowl.

NPDES PERMIT: No NPDES permit is currently required for this non-discharging system, although one may be obtained in the future to deal with any potential releases.

MONITORING: Very limited