

ENVIRONMENTAL RESOURCE CONSERVATION:

RIPARIAN SYSTEM ENHANCEMENT THROUGH WATER RECLAMATION¹

Ronald LaRosa²

Abstract.--A proposed project would provide for the establishment of 2,000 native trees over 4 ha. (10 ac.) of floodplain. These public lands would be irrigated with wastewater from a planned water reclamation facility. The irrigation regime would be based on data from ongoing reclamation projects in the San Diego region.

INTRODUCTION

One of the most sensitive environmental resources in San Diego is the riparian or streamside woodland. Comprised of some five representative tree or tall shrub species, this plant community has been adversely affected by land-use development. Even where woodlands have been spared by open space easements or low-density development, environmental impacts include degradation through disturbances, clearing of understory vegetation, and interruption of continuous tree cover necessary for the systems' use as wildlife corridors.

Streamside vegetation occurs in areas subject to over- and/or underground water flows and can be seen in both inland and coastal drainages within the San Diego region. Species such as elderberry, willow and cottonwood (see table 1 for specific names) are common to woodlands occurring in these mesic or moist habitats (Sands 1977). Along the coast, sycamore and coastal oak replace species adapted to the montane climates of higher elevations.

One resource value of a dense woodland growing along a watercourse (intermittent or year-round) is in the habitat afforded various species of animals which live in, among, and under the vegetation. Where surface water is available year-round, an even greater diversity of fauna can be supported in addition to the trees and shrubs which provide food, nesting sites, and roosting cover.

These biological zones are so critical to diverse wildlife populations, for watersheds, and as aesthetic open spaces, that they have been the

¹Paper presented at the California Riparian Systems Conference. [University of California, Davis, September 17-19, 1981].

²Ronald LaRosa is Associate Water Quality Biologist, San Diego County Department of Public Works, San Diego, Calif.

Table 1.--Representative riparian woodland species in the San Diego region.

	Common name
<u>Quercus agrifolia</u>	Coast live oak
<u>Platanus racemosa</u>	California sycamore
<u>Populus fremontii</u>	Fremont cottonwood
<u>Heteromeles</u> <u>arbutifolia</u>	Christmasberry (Toyon)
<u>Sambucus mexicana</u>	Elderberry
<u>Salix hindsiana</u>	Sandbar willow

subject of extensive environmental legislation and local ordinances. In the San Diego region, the most effective measure yet developed to conserve these woodlands is the creation of open space easements and other withholding of development rights. To date no major effort has been made to create or enhance riparian woodland by establishing native trees and shrubs which would be irrigated until their root systems could utilize groundwater.

An environmental enhancement plan at the Naval Ocean Systems Center, Point Loma, resulted in the upland (not streamside) planting of 1,000 irrigated trees and shrubs. In addition, the USDI Forest Service in San Diego County annually installs thousands of seedlings without irrigation. However, these are not riparian system restoration efforts, as drought-tolerant species are planted in upland locations.

Water is a requisite for riparian woodland. Whether on or near the surface, soil moisture must be sufficient to carry the trees and shrubs through summer months and seasonal tropical dry winds. However, even with available water, continued intensive grazing by livestock, followed by repeated flooding can eliminate riparian vegetation and prevent recolonization of the woodland species. The trees give way to grasses which are in turn succeeded by weedy plants. In other

instances, introduced tree species such as *Eucalyptus* can out-compete native trees. This combination of factors has led to the loss and degradation of streamside vegetation along most of the Escondido Creek drainage and is particularly evident on county-owned lands in the floodplain east of the San Elijo Lagoon, a regional park and ecological reserve (fig. 1).

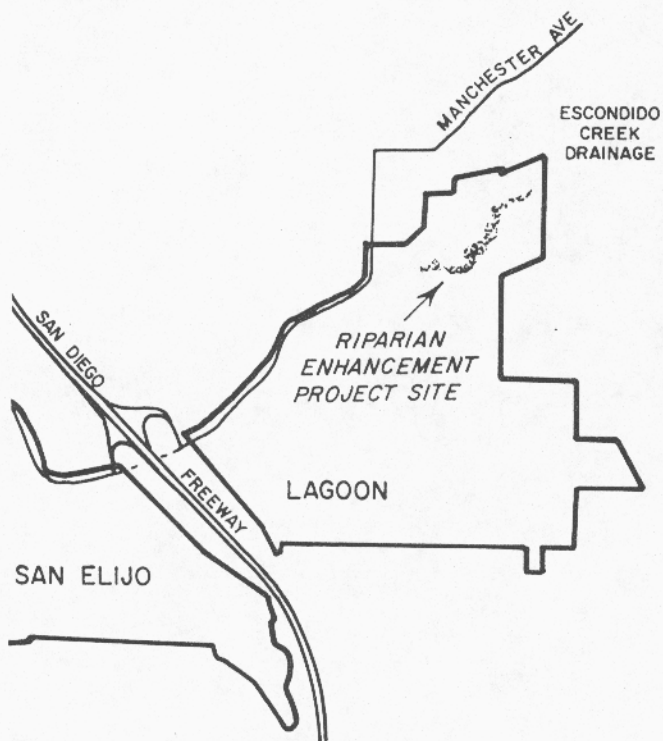


Figure 1.--Vicinity map and proposed project location, San Elijo Lagoon.

WATER RESOURCES AND RIPARIAN ENHANCEMENT

Although there are a number of drainages in San Diego County which could benefit from year-round reclaimed water flows³ and a wild area landscape plan, Escondido Creek--one candidate area--will be discussed here for the following reasons.

1. The drainage system has the greatest potential to enhance wildlife habitats within an established public park and ecological reserve.

2. The drainage system could accommodate a woodland landscape without jeopardy from flooding.

3. The drainage system could receive surface water from existing and/or proposed wastewater facilities.

³ Reclaimed water is the product of domestic wastewater treatment which is suitable for a beneficial/controlled use that would not otherwise occur.

4. The drainage system has extensive areas degraded by exotic vegetation, overgrazing, and erosion/sedimentation.

ENVIRONMENTAL DESIGN

Although this report discusses the environmental enhancement of a floodplain through water reuse,⁴ the interdisciplinary considerations of water quality planning, landscape architecture, environmental planning, hydrologic engineering, and woodland management are recognized.

The plan for the proposed environmental enhancement project would call for the installation of native shrubs and trees and provide year-round surface water to recreate the components of high-quality riparian systems. Figure 2 shows a conceptual schematic of the riparian woodland, including surface water and area subject to planned inundation.

Environmental design considerations in the enhancement plan include, but are not limited to,

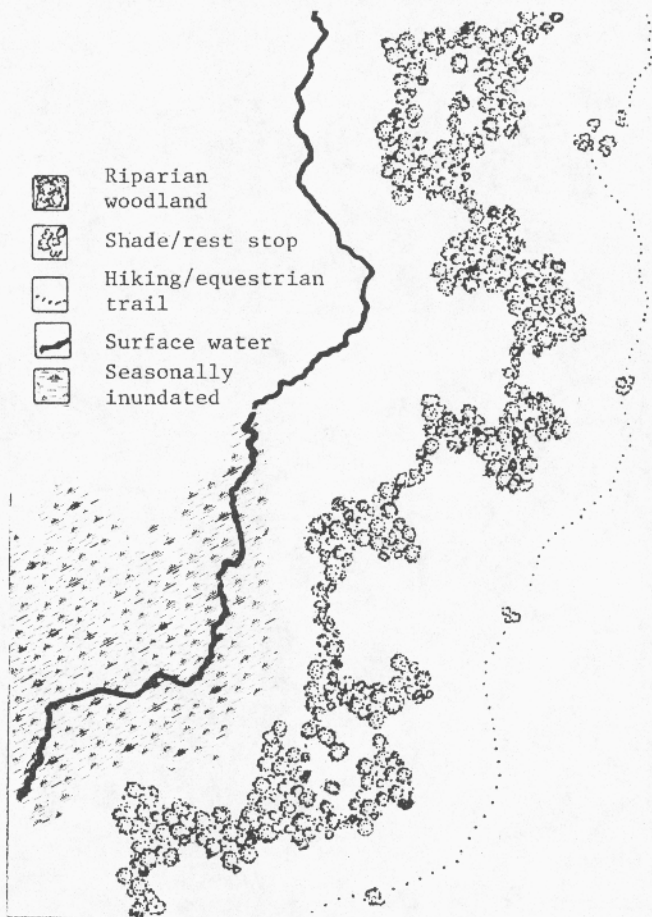


Figure 2.--Conceptual schematic plan.

⁴ Water reuse is the term used to describe the application of reclaimed wastewater for irrigation, groundwater recharge, industrial uses, recreation, or wildlife habitats.

existing wildlife populations and ecological systems, water resources, health and water quality requirements, hydraulics, and fluvial conditions, as well as funding sources for capital expenditures and maintenance/management. The riparian woodland must satisfy specific biological parameters if it is to provide high-quality habitats for diverse wildlife species. In addition, the woodland must incorporate elements of visual resource management in order to have value as aesthetic open space and greenbelt zone. A summary of these design considerations follows.

Wildlife Habitats

A woodland must include trees and shrubs which provide food (nuts, fruit, nectar, insects), nesting sites (hollows, cavities, etc.), and roosting/perching cover (upper- and under-story branches/foliage), as shown in figure 3. Vegetation must be sufficiently continuous, broad (deep), and dense to provide wildlife corridors or access routes (fig. 4). Trees and shrubs must be grouped to provide optimum habitat by providing a mixture of irregular edges and random openings in proximity to weedy sites and thickets. And last, plants must be irrigated for at least three growing seasons or until they can survive on groundwater and supplemental rainfall.

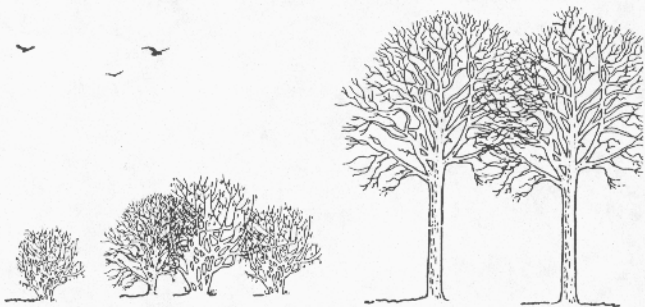


Figure 3.--Wildlife habitats provided by upper-story branches and understory cover of shrubs and small trees.

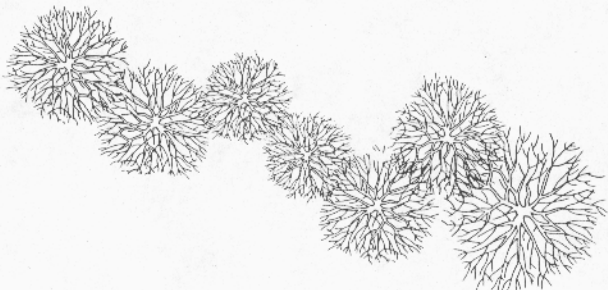


Figure 4.--Wildlife corridor provided by linear vegetative cover.

Visual Resource

Line, form, color, and texture must be provided by plant species; these should include evergreen and deciduous species with erect and procumbent forms, and columnar and round shapes (fig. 5). Groups of trees installed outside of

the primary woodland to provide shade for hikers and equestrian riders are designed to encourage use of recreational trails away from sensitive habitats.

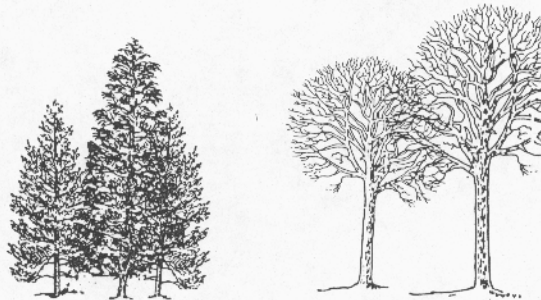


Figure 5.--Visual resource criteria include low-growing broad-leaved species, columnar evergreens, and deciduous round-headed trees.

Fluvial and Hydraulic Systems

In addition to planting trees and shrubs, a low dam is proposed to inundate a portion of the floodplain and create a marshland environment for diverse populations of wildlife including migratory and visiting birds, many of which are threatened species (table 2). Most of trees would be installed outside the floodway and further protected by an earthen bank or berm to avoid loss of irrigation systems and plants due to higher-than-normal flows (fig. 6).

Table 2.--Partial list of threatened species inhabiting Escondido Creek.

<u>Rare/Endangered Species</u> (federal and state statutes)	
California Least Tern	
Belding's Savannah Sparrow	
<u>Declining Blue List Species</u> (National Audubon Society)	
Marsh Hawk	Yellow Warbler
Sharp-shinned Hawk	Western Grebe
American Kestrel	Fulvous Duck
Cooper's Hawk	Bewick's Wren
Burrowing Owl	Bell's Vireo

Woodland Management

Water, in addition to nominal flows in Escondido Creek, will be required for the success of the proposed riparian enhancement project for the following reasons.

1. Seasonal runoff is subject to rainfall cycles and soil moisture would be insufficient to support the woodland during growing seasons.

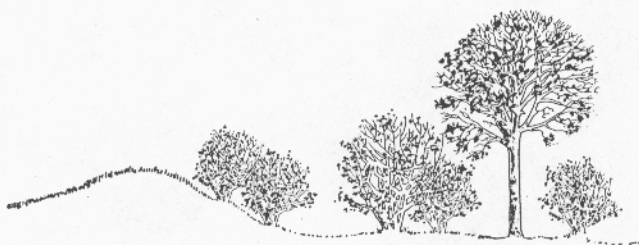


Figure 6.--Landscape profile showing earthen berm to protect plants from high-water flows.

2. Aquatic systems are dependent upon year-round flows for the maintenance of pools and other surface water.

3. Vegetation "weaned" from irrigation would be augmented by the establishment of more plants.

4. The nutrients in wastewater would provide the vigor for vegetation to overcome the handicaps of characteristically poor soils.

WASTEWATER RE-USE

A possible source of water to enhance a riparian system and/or create a riparian woodland habitat is the liquid wastes (sewage) processed by a water pollution control facility (WPCF). In the San Diego region, facilities which process liquid wastes and produce an effluent of sufficient quality to be applied for irrigation, wetland replenishment, industrial make-up water, and other uses are called water reclamation plants. Wastewater can be reused if it meets state and local health and water-quality requirements. In the San Diego region, these regulatory agencies include the California Department of Health Services (DHS), State Water Resources Control Board (SWRCB), and San Diego County Department of Health Services. The fundamental intent of wastewater reclamation requirements is to provide guidelines to establish acceptable levels of constituents (chemical, physical, bacterial and other biological properties) and to prescribe processes which insure reliability, such that the reuse of wastewater for specified purposes does not impose undue risks to public health.

Federal and State Regulations

Laws have been enacted to establish requirements for adequate planning, implementation, and management of water quality control. Relevant portions of both federal and state laws, plans, and policies pertaining to water quality planning and control of wastewater discharges are summarized below.

Federal Water Pollution Control Act

The Federal Water Pollution Control Act: 1) sets forth the national strategy for controlling

water pollution, including uniform effluent limitations, and requires states to set ambient water quality standards; 2) establishes various levels of water quality planning; and 3) sets up a National Pollutant Discharge Elimination System permit program.

National Environmental Policy Act of 1969

In general, this law directs the preservation of acceptable environments and the restoration of those that have been degraded.

Porter-Cologne Water Quality Control Act

The basic tenor of the Porter-Cologne Water Quality Control Act was set by a policy stating that the waters of the state shall be protected for use and enjoyment by the people of the state, and that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable; it further provides that the statewide program for water quality control can be most effectively administered regionally, within a framework of the SWRCB and the nine Regional Water Quality Control Boards (RWQCB). These agencies were established as the principal state agencies with primary responsibility for water quality control. SWRCB is responsible for formulating and adopting state policy for water quality control, including guidelines for long-range planning of groundwater and surface water and the use of reclaimed water. Each RWQCB must formulate and adopt, for its region, water quality control plans establishing such water quality objectives as in its judgment will ensure the reasonable protection of beneficial uses and the prevention of nuisance.

The Porter-Cologne Act addresses water reclamation and reuse through a policy in which the state has a primary interest in the development of facilities to reclaim water to supplement existing water supplies. Anyone proposing to reclaim or reuse wastewater must file a report with the RWQCB. After consulting with the DHS, the board may prescribe water reclamation requirements for either the individual reclaiming the water or the user, or both.

California Water Code

The California Water Code contains provisions controlling almost every consideration of water and its use.

California Environmental Quality Act of 1970

The California Environmental Quality Act of 1970 (CEQA) requires consultation with and comments from any governmental agency with jurisdiction or special expertise with respect to any environmental impact involved.

WATER RECLAMATION AND RIPARIAN SYSTEMS

A conventional wastewater system collects wastewater in sewers, transports it to a treatment plant, processes it, and then releases it into the ocean or evaporation ponds, or onto land. A reclamation facility instead treats the wastewater to a level suitable for reuse and then conveys it directly to the area of application.

The degree of treatment for reclaimed water depends on the intended use. Regulations covering this are issued by the DHS and are summarized in table 3. Most uses require at least second-level treatment, which is the minimum level required for discharge to surface waters. In addition, reclaimed water often must undergo coagulation and filtration to make it acceptable for many uses.

Although most reclaimed water in California is used to irrigate fodder crops, greenbelts, golf courses, orchards, and vineyards, its use in the creation of woodlands as part of a riparian system is the focus of this discussion.

SWRCB and RWQCB are encouraging reclamation projects which generally improve the beneficial use of water, e.g., those which create a new water supply, preserve recreational and aesthetic resources, or benefit fish and wildlife habitats (California Department of Water Resources 1979). However, reclamation is not universally feasible or practical. Even highly treated wastewater can contain more salts (defined as total dissolved solids [TDS] in milligrams per liter [mg/l] or parts per million [ppm]), nutrients, and other substances than freshwater. Water with high levels (1,000-1,500 mg/l) of dissolved salts or limiting constituents such as boron or heavy metals cannot be used to irrigate most crops. Although many species of riparian trees are salt-tolerant, water management plans for irrigation must consider salt build-up in root zones, changes in groundwater quality, and other impacts of wastewater reuse.

Reclaimed Water Irrigation Regime

Salts in irrigation water that can harm plants are classified as sodium-containing. Although these salts in wastewater can harm plants and be detrimental to the soil, they can also be removed. To prevent buildup in the root zone, enough water must pass through the soil profile to carry away dissolved minerals. The volume necessary to remove these salts--the leaching fraction, usually 5% to 20% of the applied irrigation--is beyond the quantity needed for plant growth. Although the problems of over-irrigation (loss of nutrients, saturated soils) can be alleviated by the additional nutrients in reclaimed water and the adaptability of most riparian species to water-logged soils, excess irrigation can create downstream impacts, in addition to being wasteful and costly (Dunne and Leopold 1978).

San Diego Case Studies

The San Diego County Department of Public Works has undertaken four limited water re-use projects which, among other objectives, provide reclaimed water to irrigate wild landscapes and woodlands. Although the circumstances of vegetative cover, irrigation volumes, and basin requirements differ among the sites, some general conclusions can be drawn.

Irrigation Uniformity.--More wastewater is generated, and therefore available, during summer months when plant growth and evapotranspiration are greatest. However, the problem of uniformly distributing reclaimed water to plants of varying size and water requirements must be overcome in order to avoid runoff (overwatering) or salt accumulation (underwatering).

Application Efficiency.--In San Diego, discharges of wastewater into moving water are not allowed due to regional health and basin plan requirements (Barry 1978). In some instances maximum use of wastewater is an objective; in every case, the irrigation regime has several goals, i.e., to fill the root zone for plant growth; to provide extra water for leaching salts; and to minimize poor distribution.

Table 3.--General water quality guidelines for uses of reclaimed water in California.

Beneficial Use	Criteria/Guidelines
Surface irrigation for orchards and vineyards	Primary plant effluent can be used provided that no fruit is harvested that has come in contact with the irrigation water or ground.
Nursery, golf course, freeway, wild landscape, woodland and landscape impoundment	An adequately disinfected, oxidized wastewater in which, at some location in the treatment process, the median number of coliform organisms does not exceed 23/100 ml. as determined from the bacteriological results of the last seven days for which analyses have been completed.

Salt Management.--Where the protection of groundwater is mandated by health and water quality objectives, irrigation regimes must take into account all sources of infiltration (rainfall, upstream sources, wastewater application) and losses (evaporation, plant transpiration, runoff). The water budget must consider TDS in wastewater, dilution from precipitation, and concentration of salts--in the area of application and downstream--both seasonally and in the long-term (Engineering Science and PRC Tours 1982).

Riparian Woodland Proposal

Project Costs

Expenses associated with the riparian enhancement proposal (table 4) include capital improvements of \$82,000 and annual operation and maintenance costs of \$18,000. Although conservation projects typically have high operational costs in the short-term, expenses decrease significantly after five years, since plant replacement and major maintenance will have been completed.

Woodland Specifications

The overall design and biological parameters of the riparian woodland have been previously discussed. Specifically, the proposed plan recommends that oak and pine species (see table 1) be

Table 4.--Project costs for riparian enhancement over 4 ha. (10 ac.) of public land.

Project Planning and Design	
Architecture and engineering	\$9,500
Project review and environmental report	\$3,500
Permits	\$2,000
Total	\$15,000
Construction	
Soil amendments and irrigation system	\$7,500
Plant material	\$26,500
Plant and irrigation installation	\$33,000
Total	\$67,000
Total capital cost	\$82,000
Maintenance	
Irrigation system and water	\$2,750
Plant material (replacement at average 10%)	\$5,900
Labor (project management)	\$9,650
Total operation and maintenance cost (first year)	\$18,000
Total first-year project cost	\$100,000

planted on higher ground in sandy soil, in odd, random groupings of five- and 15-gallon sizes in a ratio of 3:1 respectively. Cottonwoods and sycamores would be planted in both open and dense groupings (at an installation rate of 100 containers per 0.4 ha. [1 ac.]) with a minimum of three-trees width and maximum of 40-trees width in total planting area. Twenty percent of the trees planted should be planted on 1.5-m. (5-ft.) centers to allow crowns to grow into each other (fig. 7). Willows should be installed adjacent to watercourse/surface water. The plan recommends that other shrubs (5-gal. size) be mixed in among edges of tree areas in odd, irregular groupings. Openings in dense plantings would vary from 0.2 to 0.6 ha. (0.5-1.5 ac.).

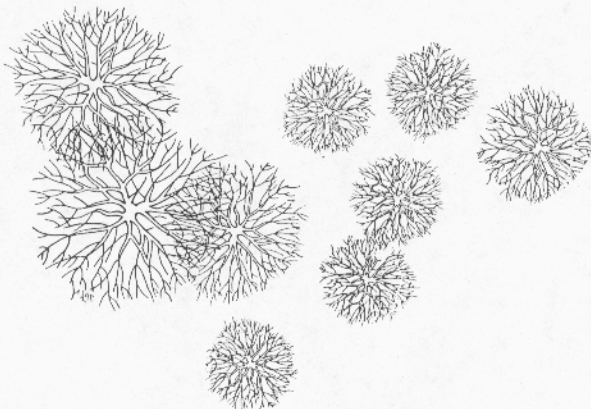


Figure 7.--Landscape specifications showing irregular groupings; plants installed to allow crowns to merge, shrubs mixed with trees.

LITERATURE CITED

- Barry, Joseph N. 1978. San Diego City/County water reuse study report. 89 p. Department of Public Works, County of San Diego, San Diego, Calif.
- California Department of Water Resources. 1979. Water reclamation: State-of-the-Art. Bulletin 189, California Department of Water Resources, Sacramento. 112 p.
- Dunne, T., and L. Leopold. 1978. Water in environmental planning. 819 p. W.H. Freeman and Company, San Francisco, Calif.
- Engineering Science and PRC Tours. 1981. Orange and Los Angeles Water reuse study. Issue paper on water quality. p. 7-13. In: Water Quality Workshop. [Orange, California, August 7, 1981]. 137 p. Engineering-Science and PRC Tours, Arcadia, Calif.
- Sands, Anne (ed). 1977. Riparian forests in California: their ecology and conservation. Institute of Ecology Pub. 15, University of California, Davis. 122 p.