

Kelly Farm Demonstration Wetland

A project to expand wastewater reuse opportunities and enhance environmental quality in the Santa Rosa area

City of Santa Rosa

Subregional Water Reclamation System

Kelly Farm Demonstration Wetland was constructed in 1989 to study the benefits of tertiary-treated municipal wastewater (reclaimed water) for wetland creation and restoration. Wetland creation and restoration are integral parts of the City of Santa Rosa's plan to expand the existing recycled water reuse system. The expanded reuse system is planned to include a combination of agricultural irrigation and restored and protected habitat in the Laguna de Santa Rosa and nearby watersheds.

Design Concepts and Objectives

Maximizing reclaimed water reuse was the primary objective developed by the City of Santa Rosa for the expansion of the reclamation system. Although wetlands are employed throughout the world as a low-cost method of treating raw or primary treated sewage, the Santa Rosa Subregional Water Reclamation System produces fully treated water that is suitable for many reuses. Therefore, treatment of (removal of water quality constituents from) reclaimed water was not a primary objective of wetland reuse. The concept of a demonstration project was developed because reclaimed water reuse for the purpose of providing wetland habitat is a relatively new concept that required a limited but full scale test prior to widespread implementation in the Santa Rosa area. The Kelly Wetland was therefore designed and constructed to meet the following objectives:

- Identify design criteria such that fish and wildlife benefits are maximized.
- Determine how the natural biological processes of a wetland affect the quality of reclaimed water.
- Evaluate the impact of the reclaimed water on the wetland.
- Provide wildlife and water quality data to key regulatory agencies, public groups and individuals.

The results from study of the Kelly Wetland project indicate the high degree of suitability of reclaimed water for habitat restoration and that significant wildlife benefits are produced. Based on these results, nearly 1,000 acres of habitat that is similar to Kelly Wetland could be for created or restored in the Laguna and nearby watersheds.

Operations and Monitoring Information

Year Built: 1989 Project Area: 21.5 acres

No. of Cells: 5 Marsh Area: 11.6 acres

Flow Range: 0-150 gallons per minute =
0-0.2 million gallons per day

Monitoring Program Summary:

- Bird and mammal use monitored monthly
- Vegetation growth monitored seasonally
- Water quality monitored biweekly
- Flow monitored continuously

Habitat Types at the Kelly Wetland

Wetlands that are of high value to wildlife typically include a variety of habitat and the Kelly Wetland was designed to provide diverse habitat types. The habitat types that are present at the Kelly Wetland include the following:

- **Open Water** – Open water areas attract resident and migratory waterfowl. The open water areas provide resting areas for water birds. Shallow water provides feeding habitat for wading and dabbling birds, and deep water provides feeding habitat for diving ducks.
- **Emergent Wetland** – Rooted aquatic plants that extend above the water surface typically grow in areas where water depth is less than three feet. The plants provide cover (protection from predators and heat) for birds and fish. As a result, nesting occurs amongst the emergent vegetation. Seeds from the plants also provide food for birds, and growth on the plant stems provide food for fish.
- **Riparian Vegetation** – Trees and shrubs on the immediate shore of a wetland provide nesting and roosting habitat for birds. Island habitat can provide a nesting area that is relatively predator-free. Riparian vegetation also provides food and shade.
- **Upland Vegetation** – Trees and shrubs in the vicinity of a wetland provide habitat for birds and mammals that can use the wetland as a source of food.

The Kelly wetland was constructed to provide a small-scale version of large natural wetlands that include many variations of each of these habitat types. The figure at left is a plan of the Kelly Wetland that show the direction of water flow, islands and vegetation.

Cell 1 was designed to provide primarily open water habitat. Emergent vegetation is limited to the shoreline by water depth. Reclaimed water is introduced to Cell 1 from a nearby transmission pipeline. From Cell 1, water flows to Cell 2, which is approximately 50 percent open water. Cell 3 is dominated by vegetation. An island is located in Cell 2 and Cell 3 for habitat diversity. Flow from Cell 3 mixes with runoff from the adjacent irrigation depending on the season.

Vegetation and Wildlife

Upland, riparian and emergent vegetation was planted at the Kelly Wetland to accelerate the development of high quality habitat. Eight native upland and riparian tree and shrub species were planted. They are Valley oak, willow, box elder, hawthorn, poplar, dogwood, Oregon ash, and elderberry. Survival and growth of the upland vegetation has been excellent.

Emergent vegetation was planted in Cells 1, 2, and 3. California tule was planted in areas of appropriate depth through these cells and in controlled study areas. Tule is preferred in wetland habitat because it provides the highest quality food and habitat. Other wetland plant species (such as cattails and duckweed) were introduced in just a few locations for natural propagation.

Initially, just a few introduced species were present; in 1992, 62 wetland plant species were present in the wetland.

Tule growth in the Kelly Wetland has been extremely rapid. The graphs above show the rate at which the number of stems increased and the length that each stem increased during the summer of 1990. Plant growth was measured on a group that was planted as single stems and a group that was planted as clumps of stems. Growth of clumped-stem plants was much greater than that of single-stem plants. Each plant has added an average of 5 new stems per month. At this rate, the plant stem density that is characteristic of a mature wetland would be attained in roughly 20 months. This information will be used to determine the planting density versus planting cost in other wetlands that are planned for construction by the City of Santa Rosa.

Birds and mammals have colonized the Kelly Wetland. Mink and otter reside in the wetland. Other mammals such as skunk, deer, rabbit, fox and raccoon visit the wetland to feed on the abundant crayfish. Bird use of the wetland is extensive. The number of bird species observed has increased each year, and 84 species were observed in 1991. The types of birds observed using the wetland include great and snowy egrets; great blue and green-backed herons; mallard, teal and common merganser ducks; coots; grebes; red-shouldered, red-tailed and sharp-shinned hawks; killdeer; black-shouldered kite; northern harrier; American kestrel; barn, cliff, tree, violet-green, Northern rough-wing swallows, Vaux swift; Belted kingfisher; California quail; Marsh wren; and a variety of song birds and migratory fowl.

Mosquito fish are abundant in the wetland. They serve to control the mosquito larvae, which would otherwise reproduce in large numbers in the wetland. The Marin-Sonoma Mosquito Abatement District regularly monitors mosquito growth in the wetland and typically finds no larvae. The District uses Kelly Wetland as their local year-round source of mosquito fish for transplantation to problem areas.

The type and number of wildlife that use the Kelly wetland are determined, in part, by the habitat that is found at the wetland. For example, the water level in the wetland is maintained at a constant level. Water level could be varied in Cells 2 and 3 to provide additional habitat for wading birds. Cells 2 and 3 were designed with large shallow areas that would be exposed or nearly exposed to provide habitat for wading and dabbling birds.

Water Quality

The reclaimed water produced by the Santa Rosa Subregional Water Reclamation System that is supplied to the wetland meets all State and federal standards and therefore would not be expected to adversely affect wildlife at the wetland. However, reclaimed water contains constituents that could be toxic, accumulate in organisms, or overstimulate growth of aquatic life. Therefore, the chemical monitoring of water, sediment and biological quality have been a priority at Kelly. The objective of the monitoring program has been to evaluate the impact of reclaimed water on the wetland.

Inorganic growth nutrients in reclaimed water that is discharged to streams can stimulate excessive algal growth, which can, in turn, deplete oxygen from the water. One such nutrient, ammonia, is also potentially toxic. The Kelly Wetland has proven to be exceptionally effective in the removal of ammonia and nitrate, as shown in the graph below. The graph shows the average summertime concentration of ammonia and nitrate in wetland influent and at established

monitoring locations through the wetland. The wetland does not remove significant amounts of phosphorus. Phosphorus in discharges to local streams does not appear to cause algal blooms.

An intensive program was undertaken to evaluate accumulation of toxic substances in the plants, animals and sediment at Kelly Wetland. Toxic substances (i.e. plant levels in the plants, animals or sediment in the wetland. A few metals were found at slightly elevated levels in clams that were deployed in the wetland for the purpose of calculating bioaccumulation. Investigations are ongoing to determine if these metals have an adverse effect; preliminary results suggest no adverse effects are occurring.

Flow

Flow is monitored at Kelly Wetland continuously at several locations. The purpose of collecting the flow monitoring data is two-fold. First, it provides a basis for interpreting the water quality data. Scientists studying Kelly Wetland are developing a relationship between flow rate and nitrogen removal. Second, the flow data provide an indication of the quantity of water that is lost via evaporation and evapotranspiration (loss via plant uptake). In light of the Santa Rosa Subregional Water Reclamation Systems' effort to maximize reuse and minimize dependence on discharge to the Laguna and Russian River, evaporation of reclaimed water for irrigation fields and wetlands is considered beneficial. Knowledge of the evaporation potential in wetlands assists the Subregional System plan for water use and consumption. Water use benefits can then be compared to the cost of constructing and operating the wetland.

Flow monitoring data collected at the Kelly Wetland indicated that the wetland plants at Kelly greatly increase water consumption. Evaporation from a water surface such as a pond, results in the loss of approximately 2.5 feet per year. The wetland plants at Kelly increase this to approximately 22 million gallons per year. The evapotranspiration from wetlands is greater than that from irrigated pasture because wetlands use water year round.

The Future of Created Wetlands

The Santa Rosa Subregional Water Reclamation System intends to continue operation and monitoring at the Kelly Wetland. Construction of additional wetlands is being planned with the input of interested individuals and agencies, and based on the Kelly Wetland study results. The wetland program will provide environmental enhancement and maximum reclaimed water reuse for the Santa Rosa area.

Habitat Type	Acreage
Freshwater Marsh	8.5
Open Water	3.1
Seasonal Wetland	0.8

Annual Grassland	5.2
Riparian Woodland	1.0
Riparian Shrub	1.0
Oak Woodland	1.9
Total	21.5

Date	Maximum # Observed in 1 Day	# of Species
August 1989	754	44
August 1990	1,223	43
December 1990	900	46
October 1991	9,719	84