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Environmental Protection
Agency

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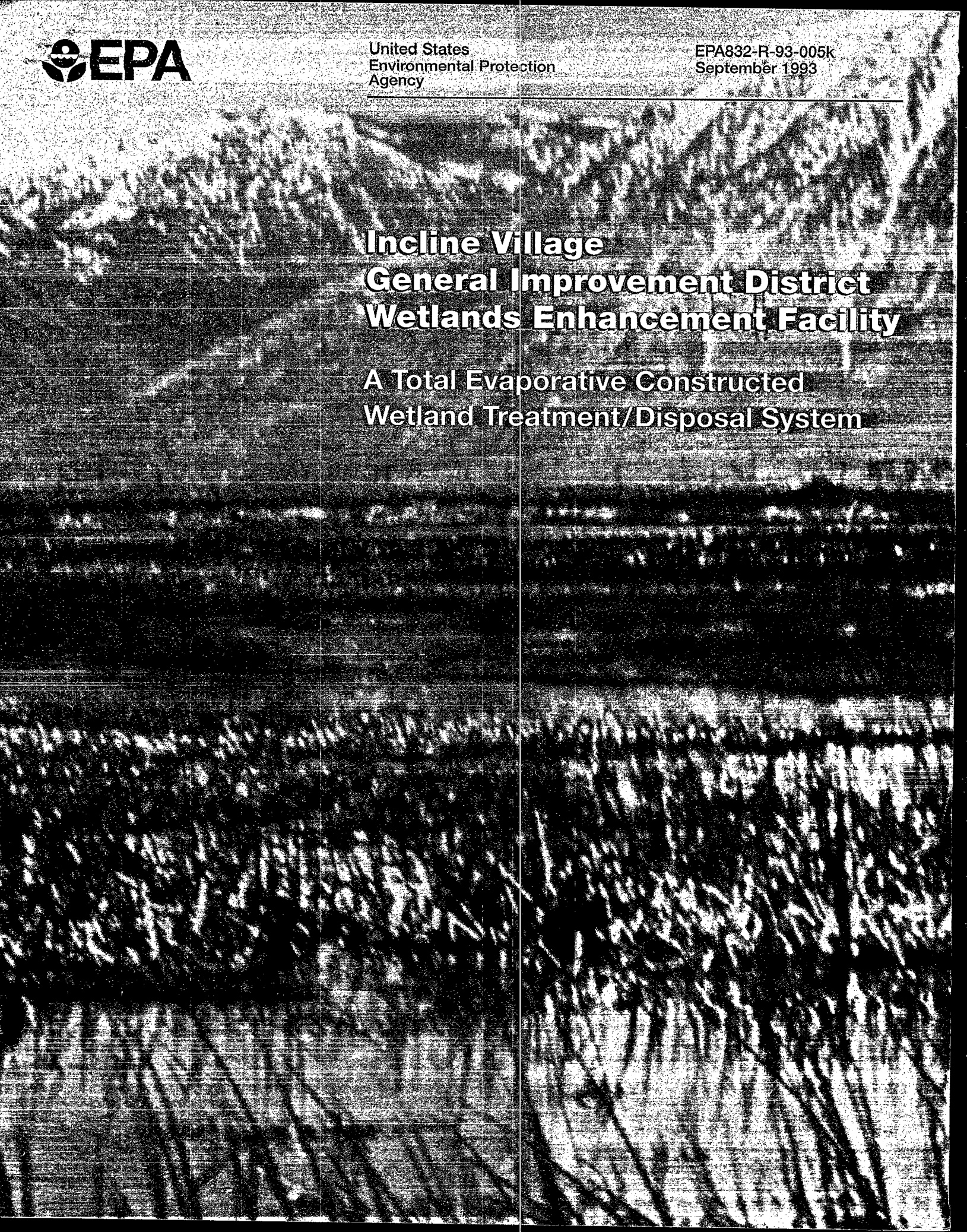


Incline Village General Improvement District Wetlands Enhancement Facility

A Total Evaporative Constructed Wetland Treatment/Disposal System

BACKGROUND

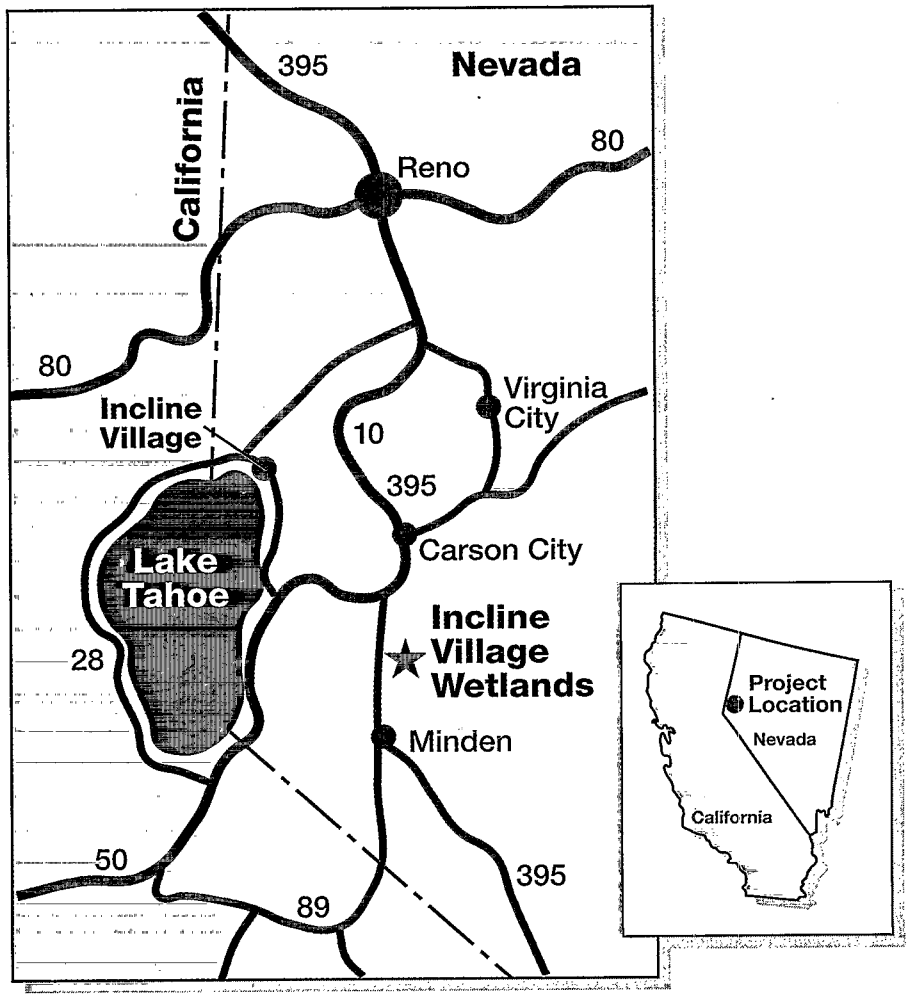
Incline Village, Nevada, uses a constructed wetland for disposal of secondary effluent. Starting with an existing, mineralized, warm-water wetland near Minden, Nevada, the Incline Village General Improvement District developed a system which uses natural processes both to renovate wastewater and benefit wildlife. With this system, Incline Village can meet several goals to protect the environment:

- dispose of treated effluent effectively and economically
- expand the existing wetland habitat for wildlife
- provide an educational experience for visitors

Until 1975, effluent treated at the Incline Village General Improvement District's 3.0-mgd activated sludge plant was exported from the Lake Tahoe Basin and discharged into the Carson River during the winter and used for irrigation of hay fields during the summer.

A discharge permit issued in 1975 required either more stringent treatment standards or a year-round, land-based disposal system. In 1979, a facility plan funded by the U.S. Environmental Protection Agency (EPA) and prepared by CH2M HILL recommended meeting a zero surface discharge standard by using land application during the growing season and constructed wetland enhancement during the remainder of the year. Local agency reviews and public hearings were held, and the wetland concept was finally approved in 1982. The project was designed by the environmental engineering firm, Culp • Wesner • Culp, with technical assistance from Dr. Robert Kadlec of the Wetlands Research Group. The design was completed in 1983 and construction was finished in November 1984.

The Incline Village Wetlands Enhancement Facility is located south of Carson City, Nevada, about 10 miles east of Lake Tahoe.



SITE DESCRIPTION

A 20-mile pipeline carries the treated effluent from the treatment plant to the Wetlands Enhancement Facility. Constructed wetland cells, berms, a flood dike, and a distribution ditch are the main components of the system. The 770-acre site is made up of several distinct areas:

- constructed wetlands
- natural warm-water wetlands
- seasonal storage/waterfowl areas
- effluent storage area
- upland area

Eight constructed wetland cells are the primary disposal area for the treated effluent. There is no surface discharge from the wetland disposal area because of evaporative water losses. Each cell has a deep channel down its center that discourages growth of emergent vegetation and furnishes a landing area for waterfowl. Islands within this channel serve as nesting sites.

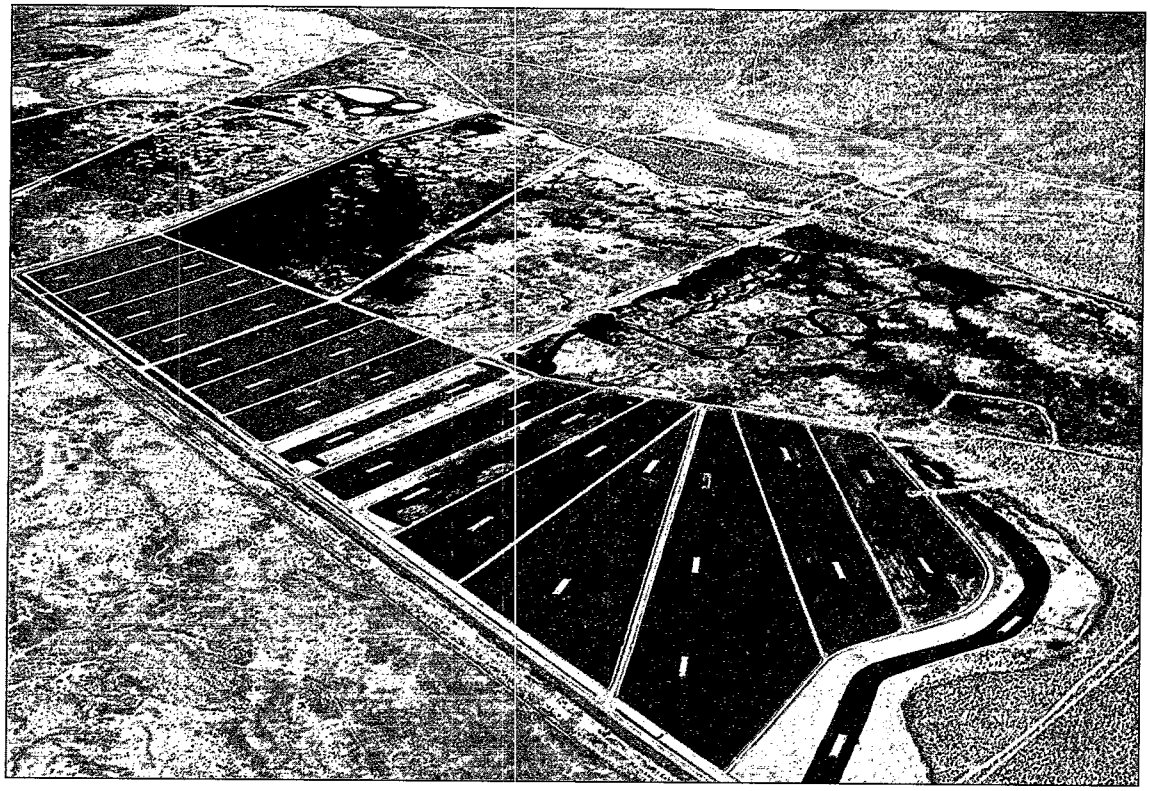
The natural warm-water wetland provides a natural habitat for plants and animals and is not part of the disposal process.

The seasonal storage/waterfowl areas store excess water during periods of low evaporation and high rainfall. They are dry during summer and fall, except for a small ponded area fed by warm-water springs. Three islands in this area provide nesting habitat for waterfowl. Each of the islands was planted to provide food, screened areas, and trees for birds.

The 2.8-million-gallon effluent storage area is used only during high flows or heavy rainfall. The 200-acre upland area is used to dispose of effluent by spray irrigation during extended rainy weather.

A resident population of Canada geese use the berms and islands for nesting.

Wetland treatment cells with islands were constructed around the existing warm-water wetlands.



OPERATIONS AND MANAGEMENT

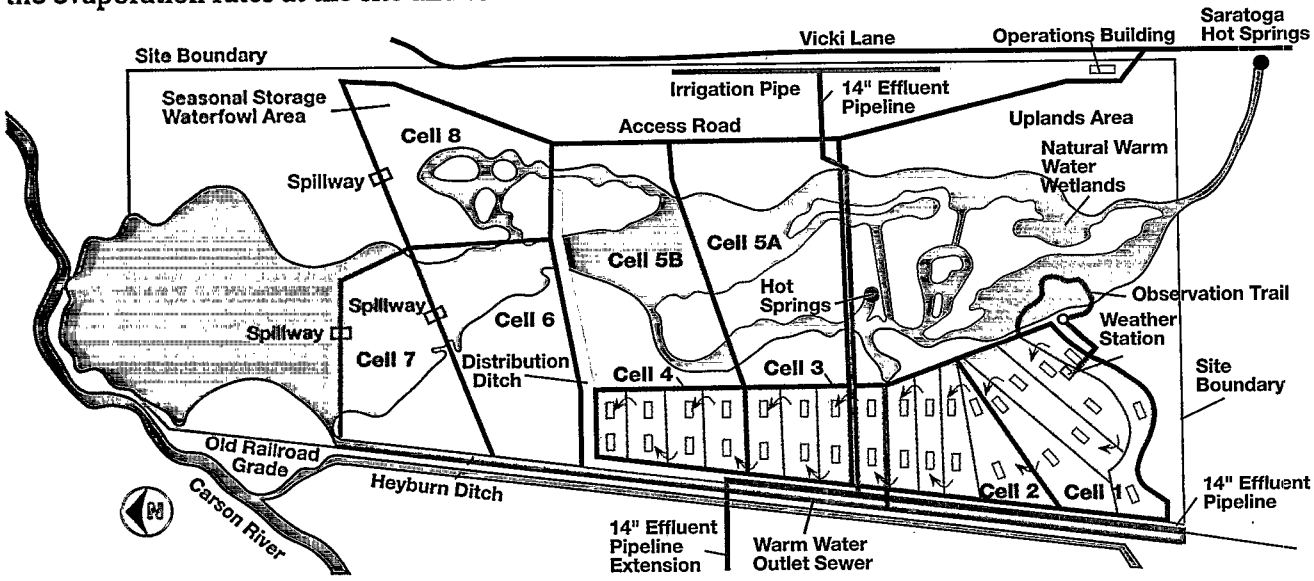
The treated effluent passes through the 390-acre system of wetland cells and is disposed of through evaporation, transpiration (evaporation through plants), and percolation (seepage through soil). The system works in harmony with the existing warm-water wetlands, adapts well to year-round fluctuations in weather and temperature, and meets state and EPA water-quality requirements while avoiding surface discharge to the Carson River.

Effluent flows from Cell 1 through Cells 2, 3, and 4 before overflowing to the distribution ditch. Overflows from Cells 3 and 4 are diverted to Cell 5 for storage and evaporation. Water that must be stored is held in Cells 6, 7, and 8.

Using weather instrumentation and monitoring equipment, plant operators determine rainfall, evapotranspiration and percolation rates, and groundwater quality. These data are used to estimate the evaporation rates at the site and to determine compliance with groundwater quality standards.

The size of the constructed wetland needed for evapotranspiration and percolation of effluent was determined by calculating several water balances for the site. Evaporation rates were estimated with the Penman method and were based on limited data available for the area. Subtracting the evapotranspiration and percolation from the rainfall yielded the net water loss from the site. Dividing the net water loss into the effluent volume gave an estimate of the required acreage.

Percolation is critical to successful operation of the project. At least 1.1 inches of percolation per month is required at the projected flow rate. If percolation occurs at this rate, only 175 acres are needed to treat the effluent. If percolation does not occur, as much as 450 acres would be required.



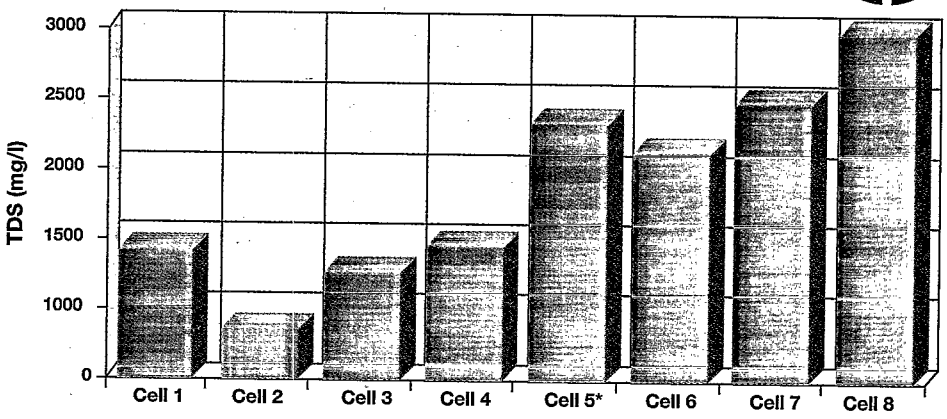
The Incline Village Wetlands Enhancement Facility includes a total of 770 acres of wetlands and uplands.

PERFORMANCE

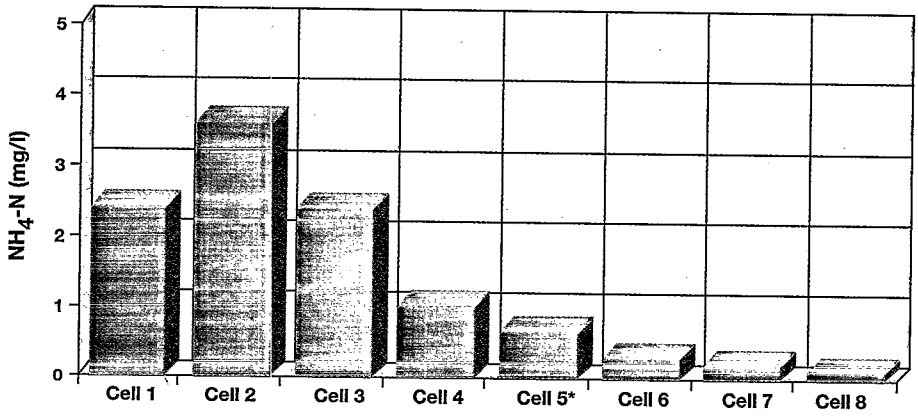
Because there is zero discharge to surface waters from the Incline Village Wetlands Enhancement Facility, no surface water quality criteria must be met. However, many parameters of regulatory interest are monitored in the wetland cells. Even though all surface water evaporates or is lost to percolation, water quality improvements can be observed as the water passes through the cells in a serial pattern.

For seven years, nitrogen and phosphorus levels have been reduced in the water, even during the winter. Nutrients in the last cells display only 2 to 3 percent of the concentration values in the incoming wastewater effluent.

The effect of evaporation can be seen in the increases of total dissolved solids (TDS) and chloride ion as water moves through the cells. The evaporites in the original desert soils are rearranged by water movement, with increases in concentrations in the downstream cells. However, there is no evidence of a continuing buildup of these ions in the downstream cells. Apparently, transport of solutes from upstream to downstream cells has reached a balance with other processes.



The concentration effect of evaporation can be seen in the increase of total dissolved solids as water moves through the cells.



The concentration of ammonium nitrogen is reduced as the water flows through the cells.

Wetlands Design Criteria

Flow, Average Annual .....1.66 mgd
Flow, Maximum Daily.....2.68 mgd

Influent Quality

Suspended Solids.....20 mg/l
BOD_5.....20 mg/l
TDS.....240 mg/l
Total Phosphorus as P.....6.5 mg/l
Total Nitrogen as N .....25 mg/l

Constructed Wetland Area

Cell 1.....37.9 acres
Cell 2.....33.2 acres
Cell 3.....27.3 acres
Cell 4.....23.4 acres
Cell 5 (overflow area) .....117.3 acres
Cells 6 & 7 (floodplain area) .....105.6 acres
Cell 8 (seasonal storage).....42.5 acres

Wetland Depth

Emergent Marsh .....0.5 feet
Open Water.....2.0-3.0 feet

ANCIILARY BENEFITS

Plant Communities

Vegetation is essential to the success of the wetland. Plants increase evapotranspiration by as much as 20 percent in the summer and improve water quality. Wetland vegetation includes rush meadow, three-square bulrush, tule cattail, and willow thickets. Upland vegetation consists primarily of sagebrush, rabbitbrush, greasewood, and salt grass, which tolerate the alkaline soils. Floodplain vegetation includes rabbitbrush and salt grass, plants which can exist in saline, silty loam, and clay soils.

Project implementation has allowed existing plant species to flourish. Careful planting of hundreds of trees and bushes added a new component to the ecosystem, with taller vegetation providing new perching and nesting areas for hawks and eagles.

The yellow-headed blackbird prefers nesting in the emergent marsh areas.

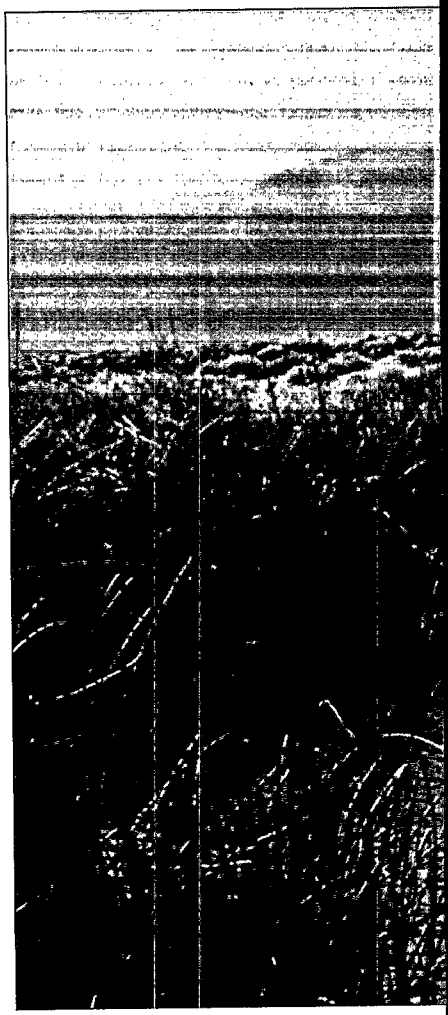
Wildlife Habitat

The wetlands provide three types of wildlife habitat: permanent wetlands, seasonal wetlands, and uplands.

Many types of aquatic and nonaquatic wildlife coexist at the site. Aquatic invertebrates such as insects, worms, snails, and crayfish eat algae and other plants and serve as food for larger organisms. Fish such as largemouth bass, black bullhead, green sunfish, mosquito fish, and carp were identified before construction and were transferred to several areas within the site.

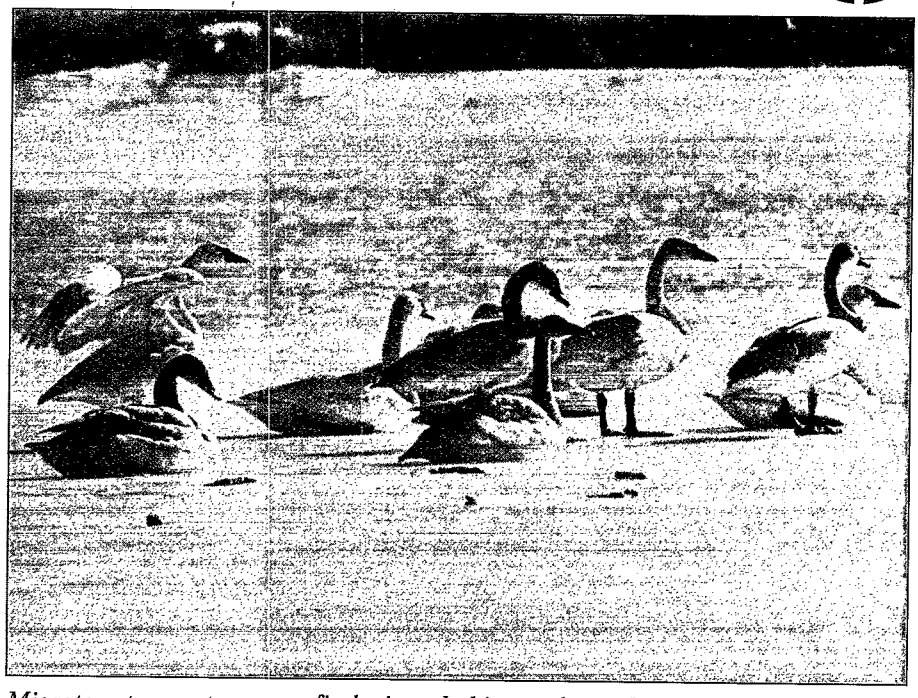
Birds occupying the site include ducks and geese, shore birds, raptors (hawks and eagles), and passerine (such as blackbirds). Many migratory species travel through the Carson Valley and nest on the islands in the seasonal storage/waterfowl area or the grassy areas along the edges of the cells. Animals common to the area include deer, coyote, skunk, mink, muskrat, rabbit, squirrel, chipmunk, and the western yellow-bellied racer.

The natural warm-water wetlands provide a year-round habitat when the constructed wetland cells are dry.

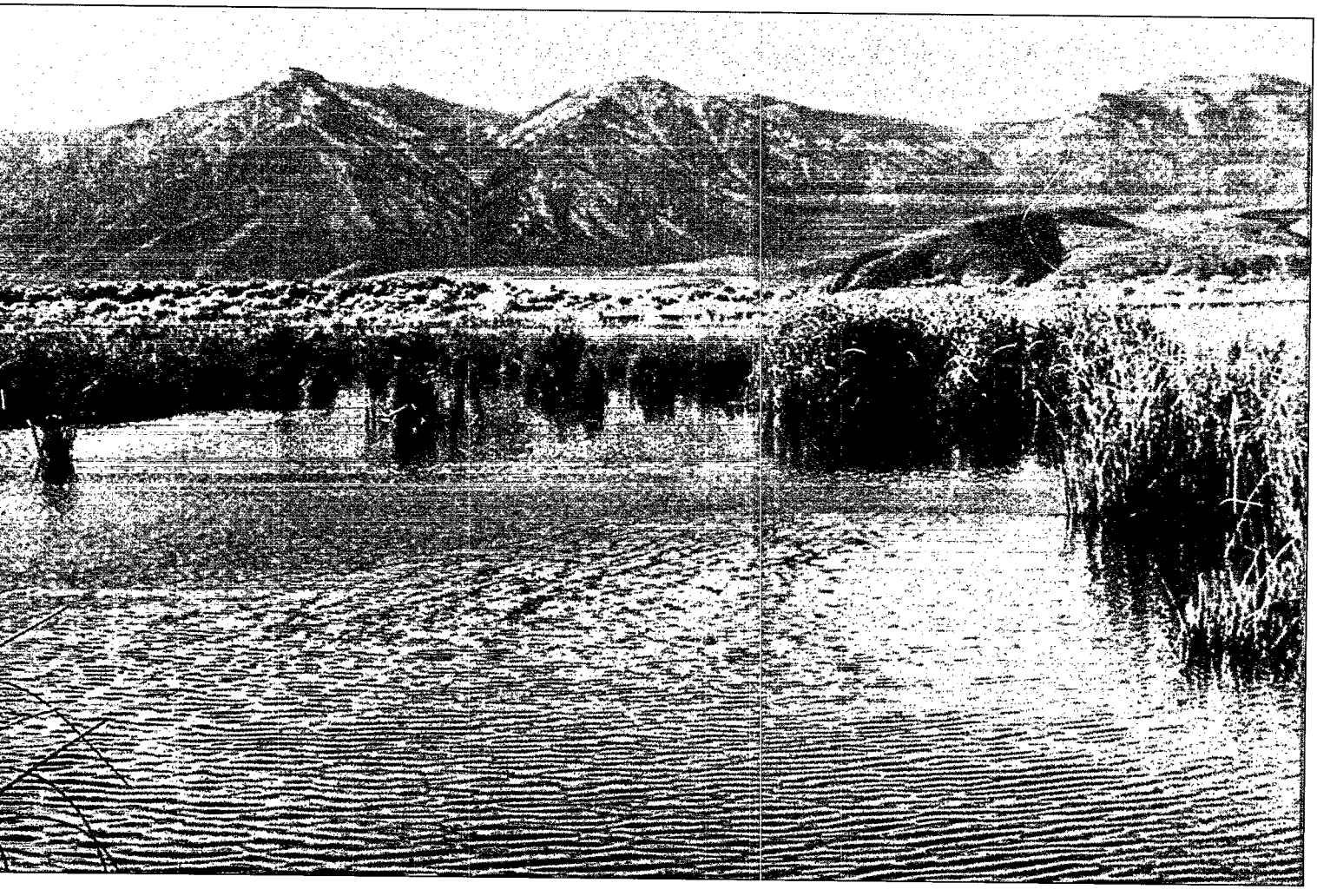


Recreational Uses

An observation area is provided at the operations building in the southeast corner of the site to encourage the public to enjoy and learn about man's use of his natural environment. Observation trails traverse the warm-water wetlands and created wetlands so that visitors may experience the diverse wildlife and vegetation at the site and see how the project operates.



Migratory trumpeter swans find winter habitat at the wetlands enhancement facility.



ACKNOWLEDGEMENTS

Incline Village General Improvement District

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Professional Staff

Robert A. Hunt, *General Manager*

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Don N. Richey,
Sr., Operations Superintendent

Grant Funding

U.S. Environmental Protection Agency,
Region 9

Nevada Division of
Environmental Protection,
Construction Grant Section

Design Team

CH2M HILL
Facilities Plan and Conceptual Design

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Richard Mishaga,
Environmental Scientist

Culp • Wesner • Culp, *Design*

Wetlands Ecosystem Research Group,
Wetlands Consultation

Robert Kadlec, Senior Consultant

This brochure was prepared by
CH2M HILL for the
U.S. Environmental Protection Agency.

Project Cost

Description	Amount
Engineering/Inspection	$623,493
Land	$772,503
Construction	$3,568,000
Total Project	$4,963,996

Innovative/Alternative grants funded 85 percent of the project.