

# Lake County Success

## Generating Environmental Gains With Geothermal Power

By Mark Dellinger, Administrator, Lake County (CA) Sanitation District,  
and Eliot Allen, Principal, Criterion/Planners Engineers (Portland, OR)

October 2004 will mark the 7<sup>th</sup> anniversary of the world's first wastewater-to-electricity system in Lake County, California, where geothermal productivity at The Geysers is being enhanced with effluent injection. Since its startup in 1997, the system has earned international recognition as one of the geothermal industry's most successful injection programs, with approximately 77 megawatts (MW) of effluent-based power generating capacity created to date.

Equally important are the system's significant environmental benefits, which demonstrate how geothermal resource development can simultaneously produce environmental gains as well as renewable power. The premise of Lake County's effort is that geothermal development can achieve stronger public acceptance and

support through synergistic local partnerships that not only mitigate, but also produce net gains.

### Project History

In the 1980s, the Lake County Sanitation District (LACOSAN) found its wastewater systems in need of upgrades because of growth pressures and aging infrastructure. At the same time, The Geysers geothermal power generation operations began to experience productivity declines with power plant steam usage exceeding the steam field's natural recharge rate. The geothermal heat source remained constant, but injection of additional water was needed to convey the geothermal heat to steam production wells.

A cooperative effort between LACOSAN and The Geysers steam field and power op-

erators was launched in 1990 to identify potential injection water sources. The resulting investigation concluded that injection of community wastewater effluent into The Geysers deep geothermal reservoir could achieve two critical objectives. First, it would provide a continuous supply of steamfield recharge water to help mitigate Geysers productivity declines. Second, it would provide an effluent disposal method that would be environmentally superior to conventional surface water discharge or land irrigation methods.

After the effluent injection concept emerged, stakeholders formed a public/private partnership to confirm project feasibility and pursue implementation. This core group included LACOSAN, the Northern California Power Agency (NCPA), Calpine Corp., Unocal Corp., and Pacific Gas & Electric Co. (PG&E). Calpine has since

### Lake County Injection System Awards

- National Council for Environmental Sustainability, 1999 Award of Environmental Achievement
- California State Association of Counties, 1998 Challenge Award of Merit
- California Governor's, 1998 Environmental and Economic Award of Recognition
- Water Reuse Association of California, 1998 Award of Merit
- California Municipal Utilities Association, 1997 Resource Conservation Award
- Geothermal Resources Council 1997 Special Achievement Award



*Dedication of the Lake County System's first phase on Oct. 16, 1997. Initial delivery rate was approximately 5,400 gpm of injected fluid.*

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acquired the Unocal and PG&E interests in The Geysers.

Project groundbreaking occurred in October 1995, and after two years of construction an initial 30-mile pipeline connecting two LACOSAN wastewater treatment plants to The Geysers was dedicated in October 1997. The connected plants included LACOSAN's Southeast Regional

Wastewater Treatment Plant in Clearlake, and the agency's treatment plant in the community of Middletown. This initial \$45 million phase was cost-shared by LACOSAN, The Geysers operators, and six state and federal agencies, including the U.S. Department of Energy, California Energy Commission, California State Water Resources Control Board, U.S. Economic

Development Administration, U.S. Bureau of Land Management, and U.S. Environmental Protection Agency.

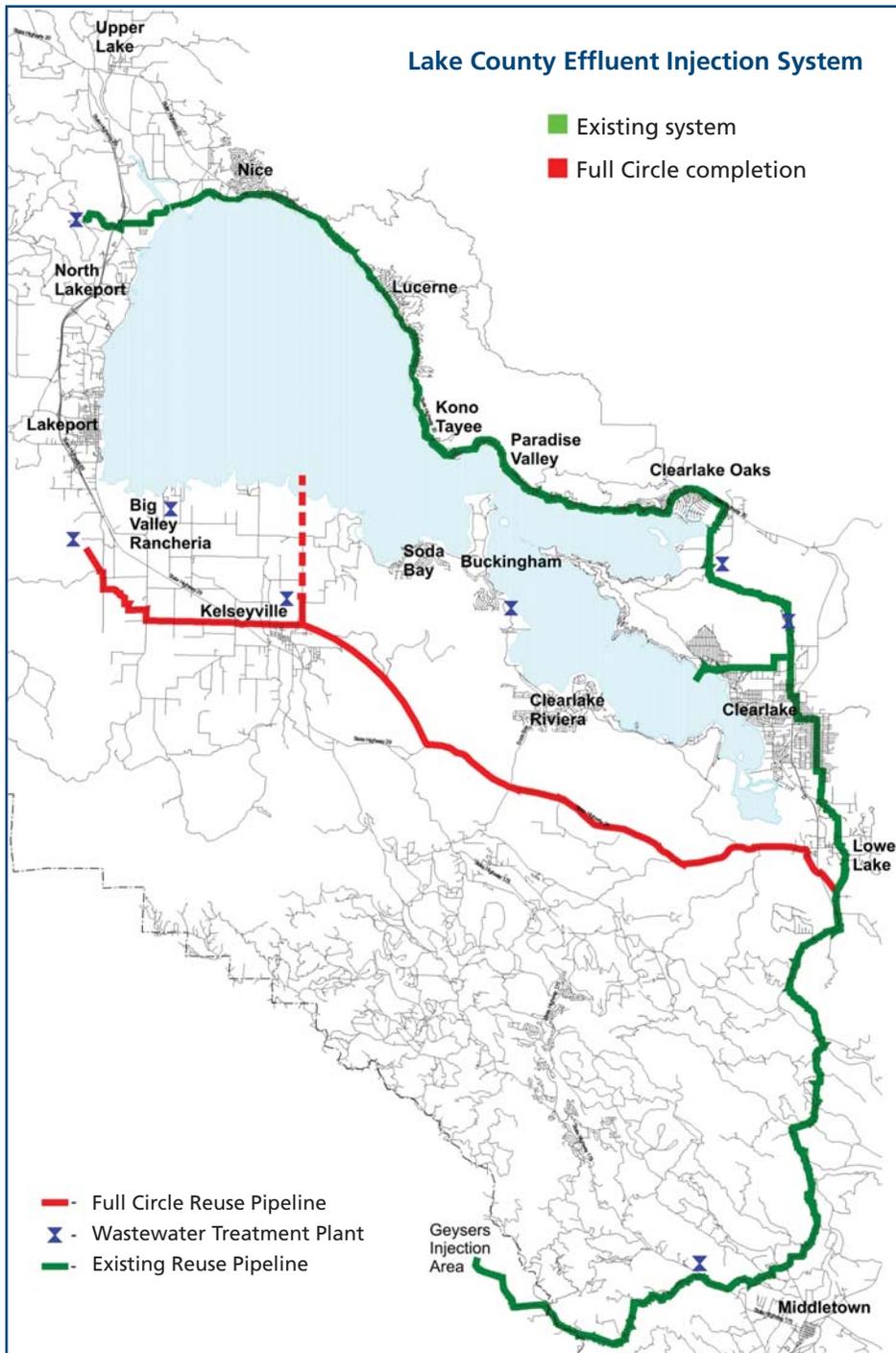
A second phase to expand the system began in 1999 with a 20-mile extension of the effluent pipeline to two additional wastewater treatment plants. This was a cooperative effort between LACOSAN and the Clearlake Oaks County Water District. The \$30 million extension to the Clearlake Oaks Treatment Plant and LACOSAN's Northwest Regional Treatment Plant was completed in 2003 with many of the same funding partners as in phase one of the project.

LACOSAN and The Geysers operators entered into a 25-year agreement for cooperative operation and maintenance (O&M) of the effluent injection system. Under a joint operating committee comprised of the partners, LACOSAN is responsible for its treatment plants and the effluent pipeline to a point of delivery at the steam field boundary in Bear Canyon, after which NCPA and Calpine manage and maintain the distribution of water to injection wells located in the southeast portion of The Geysers. LACOSAN pays an annual O&M cost share equivalent to the cost of conventional effluent disposal, while the industry partners pay remaining O&M costs based on the fluid quantity they each receive at their injection wellheads.

## Current Operations

The system now collects effluent from a total of four wastewater treatment plants serving 22,000 persons and 360 businesses in 10 Lake County communities. This represents approximately 85 percent of all effluent produced in the county. In addition, pipeline capacity makeup water is drawn from Clear Lake to maximize injection flows during the system's early years of operation. As local communities grow over time, their increased effluent flows will gradually displace the lake makeup water. In this way, the geothermal injection system provides long-range capacity for local growth and economic development without the necessity of periodic disposal facility expansions and attendant environmental disturbances.

The system currently employs eight pump stations to move approximately 2.8



billion gallons of water annually through 53 miles of pipeline with a total elevation gain of 1,970 feet to injection wellheads in The Geysers. The system is controlled by NCPA staff at their Geysers steam field control facility, and by LACOSAN staff at the agency's Northwest and Southeast Regional Treatment Plants.

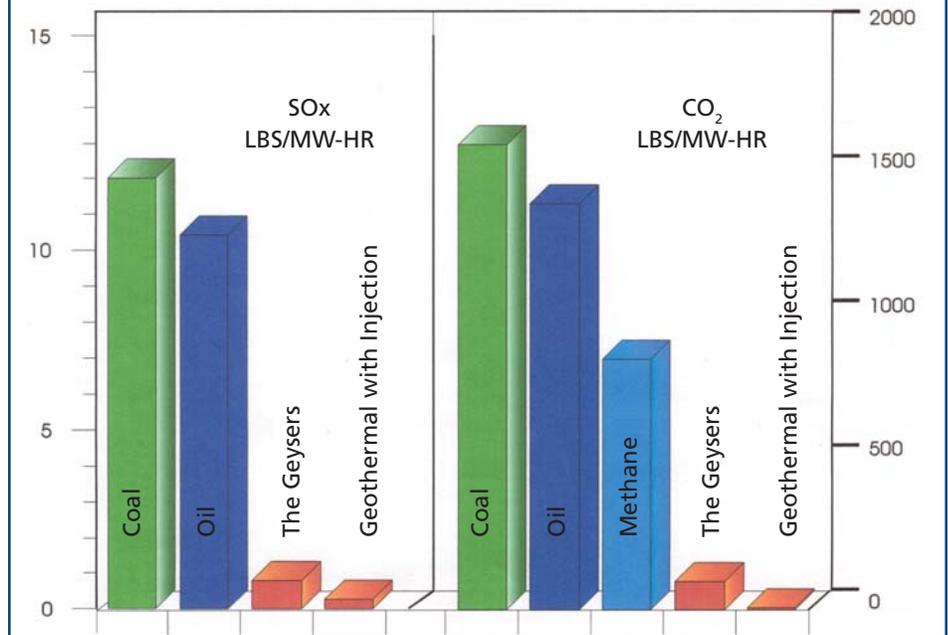
The injection system is significantly increasing steam reserves in the southeast portion of The Geysers, and helping to extend reservoir life and resulting power generation. NCPA and Calpine estimate that the Lake County system now supports approximately 77 MW of power generation capacity that would otherwise be unavailable if wastewater was disposed of in a conventional manner. (Assuming an energy price range of 4 to 5 cents per kilowatt-hour, and a capacity factor of 95 percent, the injected effluent is providing an increased yearly revenue stream ranging from \$25 million to \$32 million. Ed.).

## Environmental Benefits

Aside from the system's injection and power generation success, it is especially distinguished by significant environmental benefits concurrently created for stakeholders. In this way, it represents a strategic model of using geothermal development to address local environmental problems and create environmental gains for local communities. The underlying concept is that geothermal resource development either has a need and/or a by-product that can be coupled in a positive way with local stakeholders to create an environmental opportunity.

For Lake County, the most important environmental beneficiary has been Clear Lake, which is California's largest body of freshwater. It dominates the life of the local region in both economic and environmental terms. For years, Clear Lake water quality suffered from hydraulic overloading of wastewater systems that annually discharged millions of gallons of treated and untreated sewage into the lake. This problem has been eliminated with the disposal capacity provided by the effluent injection system. The result has been valuable water quality improvements for drinking water systems that use lake water, and for the wildlife and recreation values that are keys to the local economy.

*Comparative gaseous emission data for power generation illustrates the clean air benefits of not only geothermal energy, but effluent-derived geothermal steam as well.*

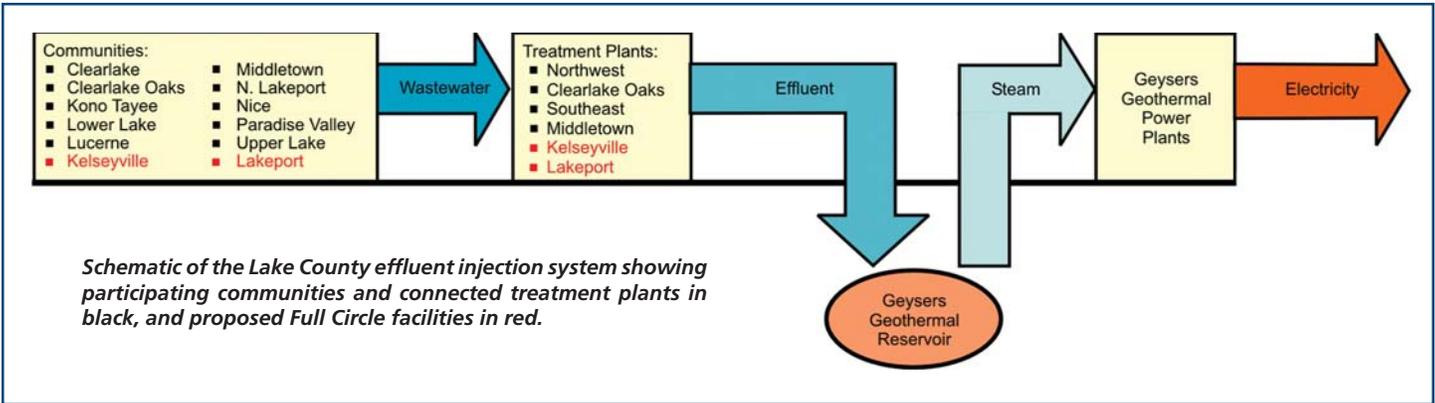


*Lake County effluent pipeline construction used existing rights-of-way wherever possible to minimize environmental disturbance. Pipeline diameters ranged from 16 to 20 inches, using PVC, welded steel, and ductile iron pipe.*

Effluent disposal through injection has also avoided the water quality stresses associated with conventional surface water discharge of treated effluent. In this way, the geothermal injection system is protecting the outflow of Clear Lake to Cache Creek, which serves downstream domestic, agricultural and recreational uses in Yolo County and the Sacramento River Valley.

Another unique environmental feature of the system are wetlands that are used to "polish" the effluent prior to delivery to The Geysers. This system component was developed on Lyons Creek, adjacent to LACOSAN's Northwest Regional Wastewater Treatment Plant north of Lakeport. After secondary treatment at this plant, effluent moves through 10 acres of

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constructed wetlands to remove nutrients and reduce turbidity prior to being pumped to The Geysers. The wetlands represent a major restoration of riparian habitat in the Lyons Creek drainage, and are now home to a multitude of wildlife species. The wetlands include trails and interpretive signage, and are frequently used for environmental education classes, bird watching and hiking.

For The Geysers operators, the system's effluent-derived steam helps the environment by producing less contaminants that require abatement. According to

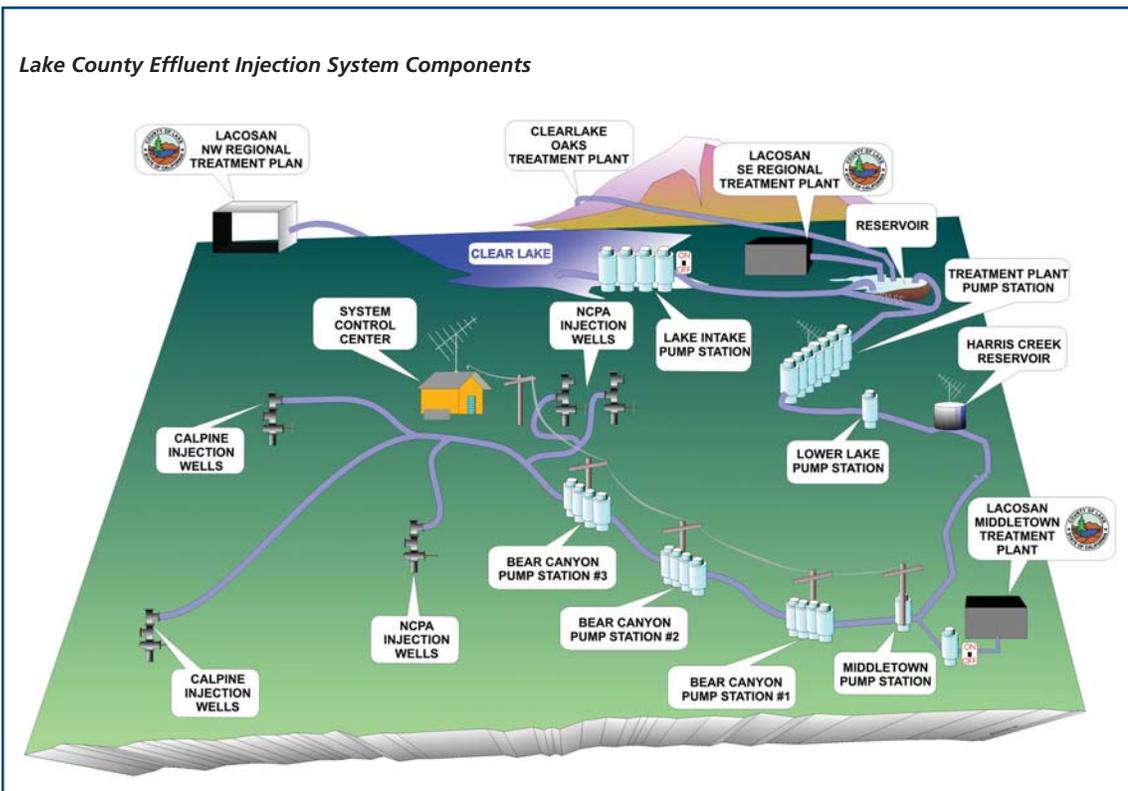
NCPA, the amounts of non-condensable gases normally found in Geysers steam have dropped notably since effluent injection commenced. Of these gases, hydrogen sulfide ( $H_2S$ ) is of greatest concern because it requires costly removal and landfilling after being separated into elemental sulfur. With effluent-derived steam producing less  $H_2S$ , abatement costs have declined, heavy truck traffic hauling sulfur on local roads has been reduced, and landfill life has been extended. Most importantly, the region enjoys improved air quality as a result of effluent injection.

## The Future

The system's success to date has prompted a third phase that will extend the effluent pipeline to the two remaining public wastewater treatment plants near Clear Lake, and potentially to other non-public treatment plants near the lake. Called "Full Circle," this final phase will completely surround Clear Lake with the effluent reuse system.

Successful completion of the Full Circle phase will ultimately remove all wastewater stresses to the lake basin, while increasing the reliability of geothermal power generation at The Geysers. The 20-mile Full Circle extension to the communities of Lakeport and Kelseyville will reduce the system's dependence on Clear Lake makeup water that is periodically unavailable because of drought or low-water conditions. In effect, as the recycled water injection system grows, freshwater supplies are being extended in the local watershed for other beneficial uses.

LACOSAN is currently preparing engineering plans and environmental reviews for the Full Circle phase, and is assembling cost-shared funding that can enable construction startup in 2005. When this phase is



fully implemented, LACOSAN and its Geysers partners will have a system that injects approximately 98 percent of all wastewater effluent produced in Lake County.

## Summary

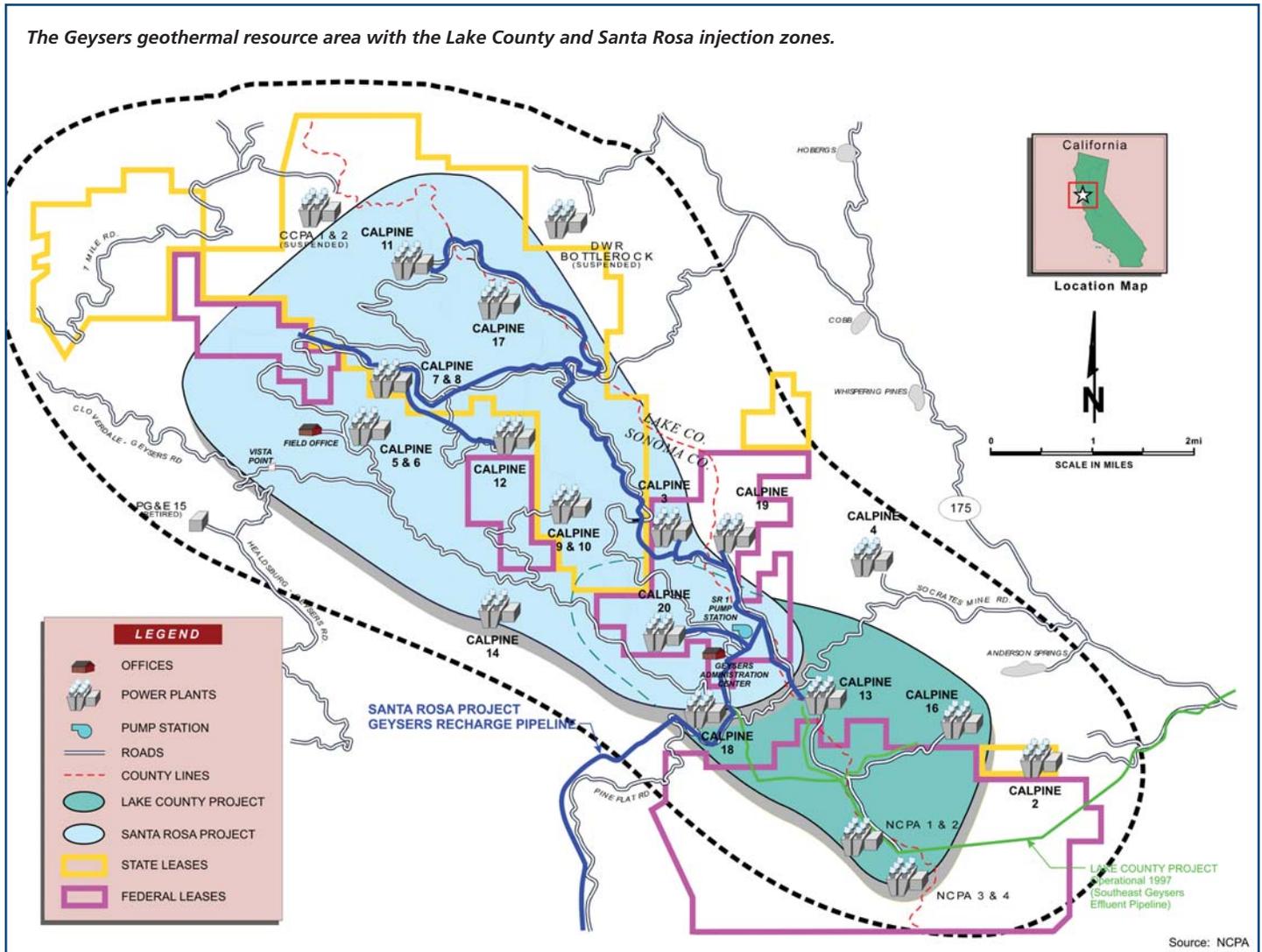
The award-winning Lake County effluent injection system is uniquely distinguished by its multiple dimensions, including 10 participating communities, 12 funding agencies, 3 joint operators, and most importantly, multiple societal benefits. In addition to the geothermal energy it produces, the system has shown how public/private collaboration can create significant environmental benefits that translate into valuable economic gains for affected communities. More people are at work today in a healthier environment in Lake County as a result of the effluent injection system. The system represents a model of development practices that can help foster greater acceptance and support for geothermal energy use worldwide.



Photos: Mark Dellinger

Treated effluent is "polished" in the Lyons Creek wetlands prior to pumping to The Geysers for injection. The wetlands now provide valuable habitat for wildlife and an "outdoor classroom" for environmental education. Interpretive signage explains the synergy between the wetlands and Geysers geothermal productivity.

The Geysers geothermal resource area with the Lake County and Santa Rosa injection zones.



Source: NCPA