Geothermal Resources Council Transactions, Vol. 28, August 29 - September 1, 2004

Milgro Nursery Geothermal Greenhouses Newcastle, Utah

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Keywords
Newcastle, Utah, direct use, greenhouses

ABSTRACT

After purchasing property near the community of Newcastle, Utah in 1992, over the course of the next ten years and continuing today, Milgro Nursery began installing one of the most successful commercial greenhouse operations in the country. Initiated as a potential opportunity for business expansion beyond an established base in southern California, Milgro's Newcastle operation started as one geothermally heated 200,000-ft^2 (1.86 ha) facility in the high, semi-arid Escalante Valley. The first facility used geothermal water at temperatures approaching 190ºF (88ºC) from one 500-ft deep (150-m) production well, pumped through a plate-type heat exchanger for a closed-loop heating system, and re-injected into the geothermal aquifer via one injection well. Today, Milgro's Newcastle facility consists of four production wells, two injection wells, and 1.14 million ft^2 (~ 26 ac. [10.5 ha]) of covered growing areas. Milgro presently produces more than five million potted plants and eight million stems of cut flower per year from their Newcastle facility.

Introduction

Newcastle is a rural farming community located about 30 miles (48 km) west of Cedar City, Utah along the southeastern edge of the Escalante Valley in Iron County (Figure 1). The Christensen Brothers accidentally discovered the Newcastle geothermal resource, a low- to moderate-temperature hydrothermal system, in 1975 during test pumping of an irrigation well. Subsequently, several geothermal greenhouse operators drilled production wells and opened commercial businesses at Newcastle. In 1992, Milgro Nursery, Inc. (Milgro), a California-based floral greenhouse operator (founded in 1980) became interested in the Newcastle area as an opportunity to expand their business using the geothermal water for space heating. Their initial facility, located in Oxnard, California, was approximately 120,000 ft^2 (1.11 ha) contained on 40 acres (16 ha). Milgro has since expanded the California operation to 800,000 ft^2 (7.43 ha) currently.

Milgro became interested in the Newcastle, Utah area in the early 1990s for business expansion, as they needed additional production space to accommodate an increasing demand for their product. Because the cost of land and other resources near Milgro's Oxnard facility limited expansion, the Newcastle area afforded an attractive alternative that included excellent growing conditions with:

- a high desert (5,300 ft [1,615 m] elevation) with mostly cloud-free days,
- good quality irrigation water, and
- a source of geothermal heat

Milgro purchased 300 acres (120 ha) at Newcastle in 1992 along with water rights for both hot and cold sources. The property purchased extends across both the geothermal system and the shallow, cold regional ground-water aquifer. Construction of the first greenhouse range (200,000 ft^2 [1.86 ha]) began in July 1993 and was completed the following September in time to plant the first Christmas poinsettia crop. Milgro has built four greenhouses since then, creating a total production area of about 1 million ft^2 (9.3 ha) at their main Newcastle facility.

In 1998, additional greenhouse space, detached from the main facility, was purchased from Mark Hildebran, adding 52,000 ft^2 (0.48 ha) of covered area and 8 acres (3.2 ha) of land. In 1999, Milgro purchased Utah Natural Growers greenhouse adding 84,000 ft^2 (0.78 ha) and 110 acres (44.5 ha) of land. Also in 1998, Milgro purchased 100 acres (40.5 ha) of adjacent property, closer to the geothermal source, eastward of their main facility. This affords the opportunity to develop higher temperature geothermal water.

Milgro's total covered area at Newcastle currently includes about 26 acres (10.5 ha), enabling Milgro to expand product lines and extend growing seasons. In their May 2003 issue, *Greenhouse Grower* rated Milgro as the 11th largest greenhouse complex in the United States.

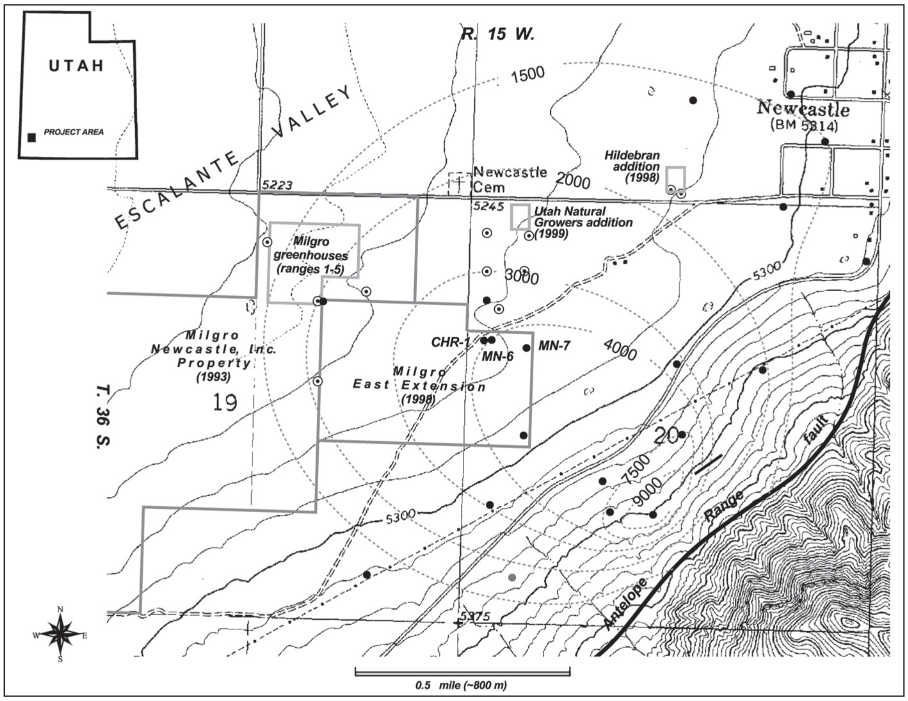

Figure 1. Newcastle geothermal area showing Milgro's property, greenhouses, drill holes, and wells. Heat-flow contour lines (dotted) are from previous studies (values reported in milliwatts per square meter). Production and injection wells are shown as bullseye symbols. Exploratory drill holes are shown as smaller dots. Base map from USGS Newcastle, Utah 7.5-minute quadrangle (1:24,000).

Currently, Milgro produces more than five million potted plants and eight million stems of cut flower per year. In addition, Milgro recently purchased Royal Van Zanten North America and now produces chrysanthemum cuttings commercially, one of Milgro's largest crops.

Site Characteristics

Newcastle is located along the southeast edge of the Escalante Valley (a desert) in southwestern Utah where, at an elevation of roughly 5,300 ft (1,615 m), greenhouse heating requirements are substantial. The region is agricultural, mainly producing crops of alfalfa, corn, and potatoes. Conditions can be summarized as follows:

- Winter nighttime temperatures commonly drop into single digit (Fahrenheit) range, and occasionally dip below zero.
- Because the region is a high desert, sunlight is abundant throughout the year.
- The desert environment also results in overall low humidity.
- Deep valley-fill alluvial deposits contain clean water in a regional aquifer.

The relatively harsh conditions outside, however, combined with the presence of the geothermal system, allow Milgro to create almost any growing environment inside.

- Overall cool temperatures, high sunlight, and geothermal energy allow Milgro to heat the greenhouse environment cost-effectively rather than using high-cost air conditioning to cool.
- Although the site is in a semi-arid desert, within the confines of the greenhouses, Milgo can easily create humidity. Whereas in a humid environment, it is virtually impossible to remove humidity.
- Abundant sunlight in the high desert allows more cost-effective control of crop lighting. It is much easier and much less expensive to block than to create it.

Geothermal Resource

The geothermal resource is described as a "blind" system with no obvious surface manifestations, such as hot springs or fumaroles, to suggest that a geothermal system is present at depth. The water in the Christensen Brothers' discovery well was near boiling and reportedly flashed to steam when pumped to the surface. Subsequent studies by the University of Utah, Department of Geology and Geophysics (Chapman and others, 1981), the Utah Geological Survey (UGS) (Blackett and Shubat, 1992) and the University of Utah Research Institute (Ross and others, 1990; 1994) defined a buried zone of suspected geothermal upflow along the nearby Antelope Range fault that they postulate as the source of the hot water.

Studies also defined a shallow aquifer that channel the outflow of geothermal fluids into the subsurface of the Escalante Valley (Figure 1). Geothermal production wells, typically 500 feet (150 meters) deep, tap the geothermal fluid in this unconfined aquifer. The fluids cool by conduction and probably mix with shallow groundwater at the system margins. A maximum temperature of 266°F (130°C) was measured in a 1981 geothermal exploration well drilled by UNOCAL (CHR-1), which penetrated the geothermal aquifer (outflow plume). Exploratory drilling in the summer of 2001 in the same location as CHR-1, however, yielded lower temperatures (243°F [117°C]). Production wells at the greenhouses generally yield fluids in the range of 167°F to 203°F (75°C to 95°C). Chemical signatures or "geothermometers" suggest maximum resource temperatures of about 266°F (130°C).

As part of a U.S. Department of Energy-sponsored program to assist locating a production well to supply a proposed, small-scale geothermal power plant, two exploratory (thermal-gradient) boreholes were drilled in the fall of 2001 on Milgro properties (Blackett, 2004). Temperature-depth measurements recorded in exploratory drill holes MN-6 and MN-7 (Figure 1) were about 10 percent below the anticipated results for this part of the geothermal field. The maximum temperatures recorded were:

- 239.0°F (115.0°C) in drill hole MN-6 at 335 ft (102 m), and
- 243.1°F (117.3°C) in drill hole MN-7 at 335 ft (102 m).

MN-6 was an offset to the original UNOCAL drill hole – CHR-1. Drill hole MN-7 was located near the eastern boundary of Milgro's property, about 500 ft (152 m) southeast of MN-6.

One of the unique geological characteristics of Milgro's Newcastle property is the fact that there are two very clean fresh water wells located relatively close (300 yards [274 m]) to the geothermal wells. The water has a pH of about 7.0 and conductivity of less than .5 mmhos/cm.

System Description

Milgro has nine available geothermal wells. Seven wells were developed for production (four were acquired as part of property purchases, although two of these are not used). Two injection wells are used to dispose of discharge geothermal water. Water temperatures coming out of the different wells vary from 170°F to 240°F (77ºC to 116ºC). Wells individually produce up to 1,500 gallons per minute (95 l/s). Wells are drilled to depths ranging from 500 to 1,000 feet (150 to 300 m), and completed generally using 16" slotted casing. The production zone usually lies at depths of 300 to 600 feet from the surface. Heating is distributed through a series of pumps, actuated valves, forced air heaters, EPDM tubing and aluminum fin tubing.

Milgro's heating system, within their main complex (Figures 2 and 3), was originally designed to yield a 70°F (39ºC) temperature drop from inlet to discharge. In actual practice, however, they have commonly experienced temperature drops of 85°F (47ºC). The initial design of the system was based upon the use of plate heat exchangers to isolate the heating system from the geothermal fluid. However, due to slow system response time, these heat exchangers were removed from the system in 1995. Since that time, because of its relatively benign nature (approximately 1,100 ppm TDS, pH 8), geothermal water has been used directly in the heating equipment. Disposal of the hot water is accomplished through forced injection (Geo-Heat Center, 2003).

Milgro uses a variety of methods to cool the greenhouses. They take advantage of the generally cool, dry outside air to ventilate the ranges naturally. Shade cloth is used throughout the facility to reduce the amount of solar insolation. Micro-mist

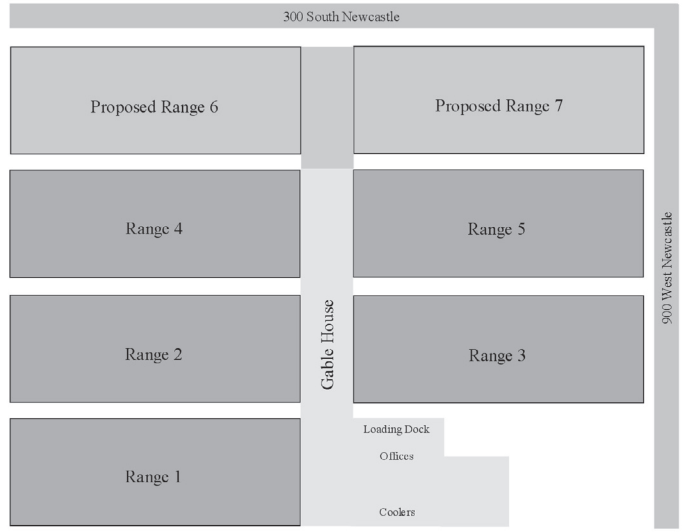

Figure 2. Schematic plot plan of Milgro's primary greenhouse complex at Newcastle. Total project area is about ¼ mile square.

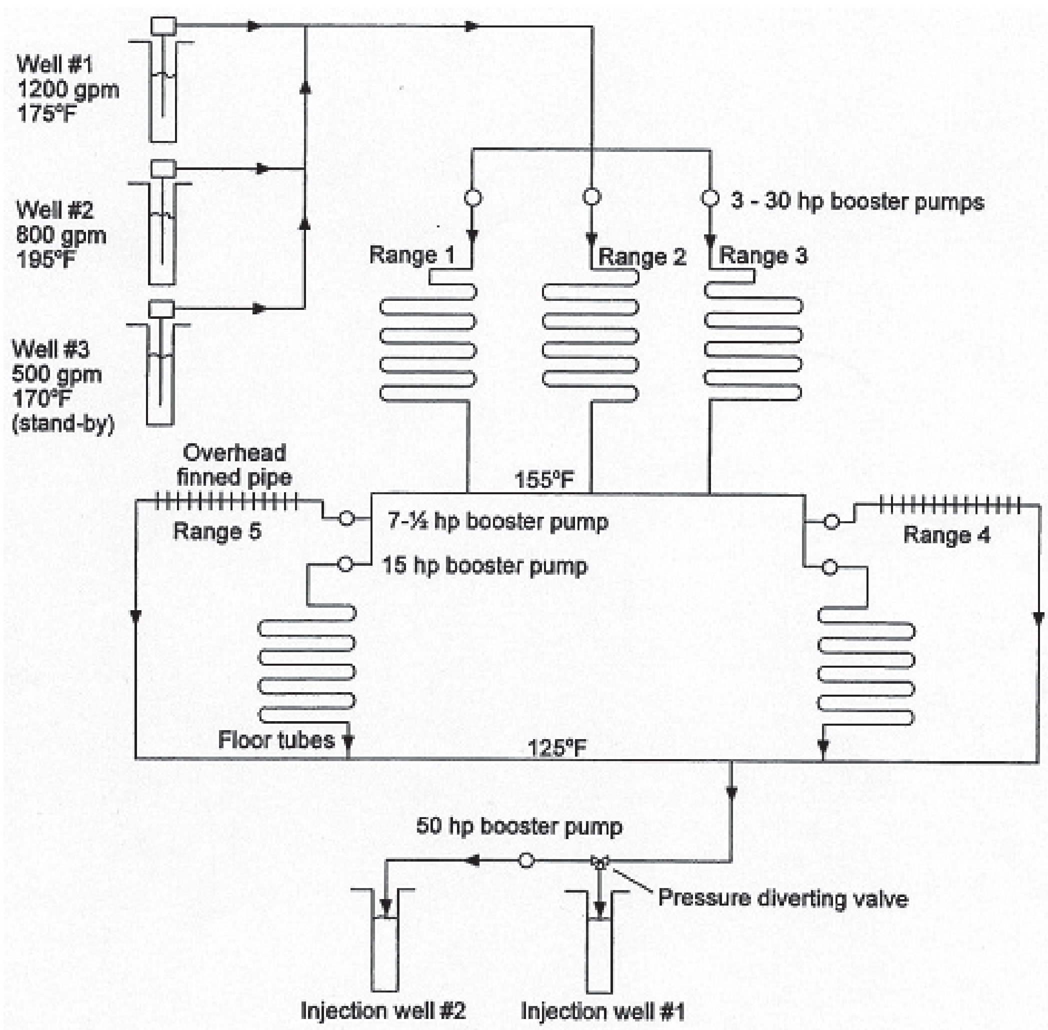

Figure 3. Schematic diagram showing Milgro's primary greenhouse geothermal heating system.

systems cool individual sections of crops, while pad and fan-type evaporative air-conditioners cool individual ranges.

Summary

Since building a geothermally heated commercial greenhouse business near Newcastle, Utah beginning in 1992, Milgro Nursery, Inc. has become one of the country's leading greenhouse growers. The property purchased in 1992 extends across the margin of the geothermal system and shallow groundwater aquifer providing both hot water for geothermal heating and cold water for irrigation. The combination of beneficial geothermal heat, high light, low-humidity, and cool outside temperatures allow Milgro to create nearly any desired growing conditions inside. Properties purchased subsequently will allow Milgro ample opportunities for future expansion.

Acknowledgements

The Utah Geological Survey provided resource information and reviews of the draft document. The Oregon Institute of Technology, Geo-Heat Center characterized technical and economic aspects of Milgro's facility in a recent bulletin article (Geo-Heat Center, 2003).

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