KLAMATH FALLS DOWNTOWN REDEVELOPMENT GEOTHERMAL SIDEWALK SNOWMELT

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INTRODUCTION

The Klamath Falls, Oregon, downtown has seen a period of decline over the past 20 years as businesses have moved to new suburban shopping centers. Downtown business owners and the Klamath Falls Downtown Redevelopment Agency are working to reverse that trend with a Downtown Streetscape Project intended to make the downtown a more pleasant place to work and do business. The visible elements of the project include new crosswalks with brick pavers, wheelchair ramps at sidewalk corners, new concrete sidewalks with a consistent decorative grid pattern, sidewalk planters for trees and flowers, and antique-style park benches and lighting fixtures (Figure 1). A less visible, but equally valuable feature of the project is the plastic tubing installed under the sidewalks, wheelchair ramps and crosswalks, designed to keep them snow and ice free in the winter. A unique feature of the snowmelt system is the use of geothermal heated water on the return side of the Klamath Falls Geothermal District Heating System, made possible by the recent expansion of the district heating system.

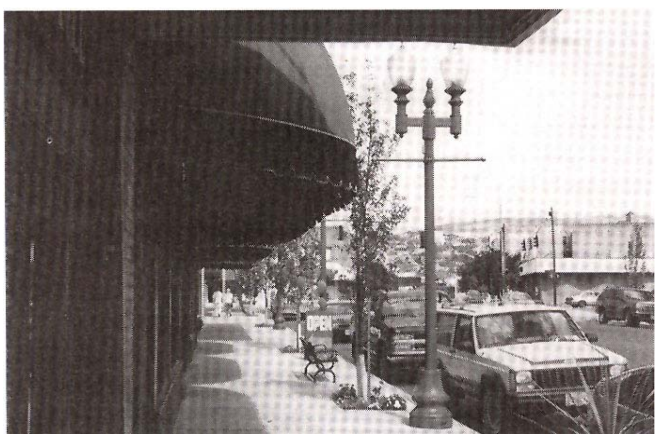

Figure 1. View of a completed section of the Streetscape Project.

HISTORICAL BACKGROUND

The Klamath Falls area has had a long history of geothermal heat utilization, beginning with Indian use of the natural hot springs. With the growth of the city, many wells were drilled to utilize the geothermal resource. Notable examples include: over 500 private homes and small businesses, the White Pelican Hotel (1911, burned in 1926, replaced with Balsiger Ford 1928, building still geothermal heated), Klamath Union High School (1930), the Esplanade Street ramp and bridge (1948), Oregon Institute of Technology campus (1964), Merle West Medical Center (1977), and the Klamath Falls Geothermal District Heating System (1983).

Geothermal District Heating System

In 1976, the Geo-Heat Center investigated the feasibility of developing a geothermal district heating system to serve the Klamath Falls downtown (Lienau, 1991). Options investigated included a limited system to serve 14 government buildings only, a larger system to serve 110 buildings in the downtown core area, and an even larger system including street snowmelt for the downtown. In 1980, the district heating system was installed, with the specific objective of providing heat to the government buildings, but with the expectation of future expansion. The system began operation in 1983. Most of the system was shut down in 1986 due to system leaks. The defective distribution piping was replaced in 1990, and the system has been operational since.

The district heating system consists of two production wells, a geothermal water transmission pipeline, a heat exchanger and pumping facility, and a closed-loop heating water delivery system. Geothermal water is pumped from the ground at about 215°F, conveyed to the heat exchanger building at the County Museum, circulated through a plate-and-frame heat exchanger, and discharged back to the geothermal aquifer at about 180°F. On the secondary side of the heat exchangers, water in the district heating loop is heated to about 180°F and pumped to the district heating customers. The system was designed for a 40° ΔT, with water returned from the customers to the heat exchanger at 140°F.

The system was designed to meet the estimated load of 14 government buildings, with some limited capacity for expansion. Actual observation of the operation of the 11 buildings that were connected showed the system peak load to be much less than anticipated, requiring only about 5-10% of design thermal capacity. Faced with available capacity and revenues not sufficient to meet operation and debt service costs, the city, in 1992, began marketing the district heating system to other buildings in the downtown area (Rafferty, 1993). To date, an additional 10 facilities (12 buildings) have connected to the system.

The original distribution loop was routed down an alley between Klamath Avenue and Walnut Street, about 1-1/2 blocks south of Main Street. The Ross Ragland Theater, a non-profit community theater, was able to secure grant funding for extending the distribution lines about four blocks to the theater. The line extension crosses Main Street at Eighth, providing a source of geothermal heat near the center of the

10-block downtown portion of Main Street. Six of the new service connections have been made along that line extension, and that line extension made the Main Street sidewalk snowmelt possible.

Downtown Redevelopment

Concurrent with the city effort to add customers to the geothermal district heating system, a group of downtown business owners started an effort to beautify and revitalize the downtown core. This effort led to the establishment of a tax-increment financing district to fund improvements, and a downtown streetscape plan. The streetscape was envisioned to include decorative sidewalk pattern, tree planters, antique-style light fixtures, park benches, and brick crosswalks. Street and sidewalk snowmelt was briefly considered; but, initial estimates led to the conclusion that it was too expensive. The first block considered for the streetscape project, the "demonstration block", was to be the 800 block of Main Street, coincidentally adjacent to the new district heating main extension.

Reconsideration of the feasibility of geothermal sidewalk snowmelt led to the conclusion that with the sidewalks and crosswalks already torn up for the streetscape project, the extra cost of the snowmelt system was manageable. The snowmelt system enhances the project with several benefits, including:

- Elimination of cost and inconvenience of snow and ice removal.
- Reduced wintertime liability exposure from slick sidewalks.
- Reduced mess and inconvenience in buildings from tracked-in sand, salt and slush.
- Elimination of damage to sidewalks and brick pavers from freeze-thaw cycles.

The individual property owners will be responsible for the operating cost of the snowmelt system, about $0.25 per square foot of sidewalk per year. Each business owner was also responsible for the cost of the sidewalk concrete in front of his building; but, the installation cost of the snowmelt system was carried by the redevelopment agency. The added value of the snowmelt system was instrumental in encouraging full participation by the business owners in the redevelopment project.

SNOWMELT DESIGN

The required heat load for snowmelt will vary tremendously depending on the air temperature, wind, snowfall rate, and how much snow accumulates. For the downtown Klamath Falls Main Street sidewalks and crosswalks, the snowmelt is a convenience, not a necessity. The design objective was to provide a reasonable level of performance, while limiting installation and operation costs and load on the district heating system. The variables in the snowmelt design are climate, available snowmelt loop temperature and flow, tube depth, and tube spacing.

Klamath Falls is located east of the Cascade Mountain Range, at an elevation of 4100 feet. The climate is moderated by on-shore flow from the Pacific Ocean, 120 miles to the west. Average annual snowfall is about 30 inches. Average December and January temperatures are right around freezing. Northeast air flow can bring cold Arctic air into the area, with temperatures as low as -30°F; but, the temperature seldom goes below 0°F. In a typical year, there are about 120 hours below 15°F. Typically there is little wind coincident with extremely cold temperatures.

The snowmelt system was designed to maintain a slab surface temperature of 38°F at 15°F air temperature and 5-mph wind speed. This requires about 85 Btu/hr/ft^2. By comparison, the Esplanade Street ramp and bridge snowmelt system, installed in 1948, is operating successfully at about 58 Btu/hr/ft^2 (Thurston, et al., 1995).

Heat for the snowmelt system will be provided from the return main of the Klamath Falls Geothermal District Heating System. The district heating return water will be pumped from the return main at 140°F, through a plate-and-frame heat exchanger, and back into the return main downstream. The snowmelt loop will contain a propylene glycol/water mix, supplied to the snowmelt grid at a maximum temperature of 130°F.

Tube Depth and Spacing

The civil engineer responsible for the redevelopment sidewalk design was adamant that the snowmelt tubing not be placed in the concrete sidewalk slab. Placement under the slab minimizes the impact of the snowmelt tubing on the integrity of the sidewalk, and allows removal of a section of sidewalk without damaging the tubing. The greater tubing depth also results in greater percentage back losses and more temperature drop between the tube and the sidewalk surface. The design compensates for varying tubing depth by adjusting the tube spacing and flow rates as a function of tube depth. Tubing under the sidewalks is placed at a depth of about 6 inches below the slab surface, 14 inches on center. Under the cross-walks, the tubing depth is about 10 inches, and the tubes spacing is reduced to 8 inches on center (Figures 2 and 3). The tubing was continually pressurized with water during construction to assure that any damage to the tubing would be evident prior to placement of the concrete.

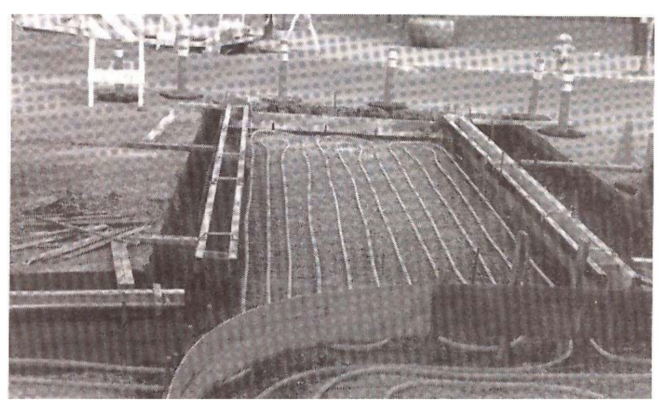

Figure 2. View of the tubing under a crosswalk.

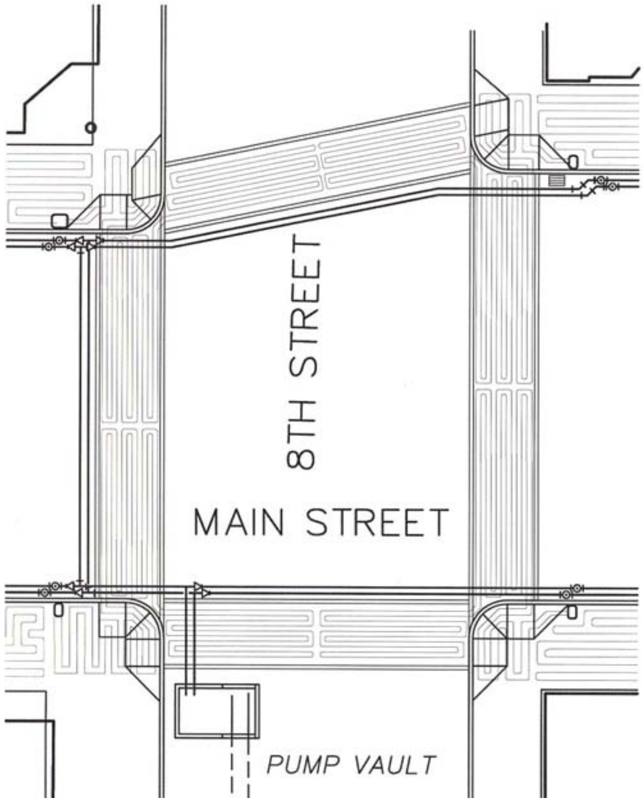

Figure 3. Details of the tubing layout.

Pump Vault

The entire snowmelt system, planned to extend for 10 blocks, will be operated from a single pump and heat exchanger vault. The system includes a plate-and-frame heat exchanger, a primary pump to circulate district heating loop return water through the heat exchanger, a snowmelt loop pump to circulate the snowmelt loop, and an expansion tank to pressurize and provide makeup water to the snowmelt loop. Both pumps are operated with adjustable frequency drives to provide variable pumping rate.

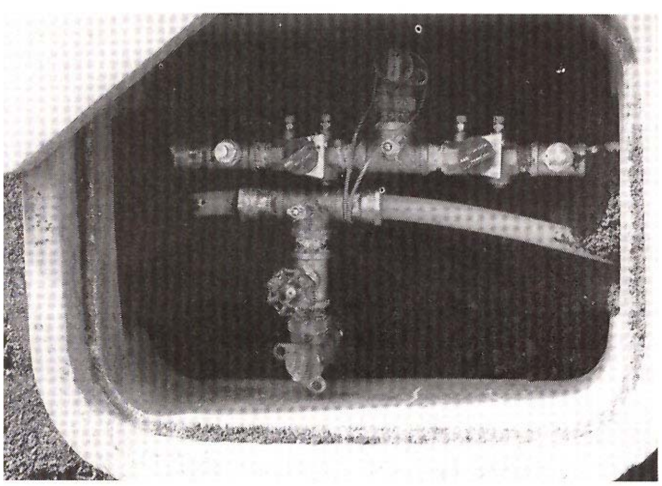

Figure 4. Balance valve and pressure-temperature test port.

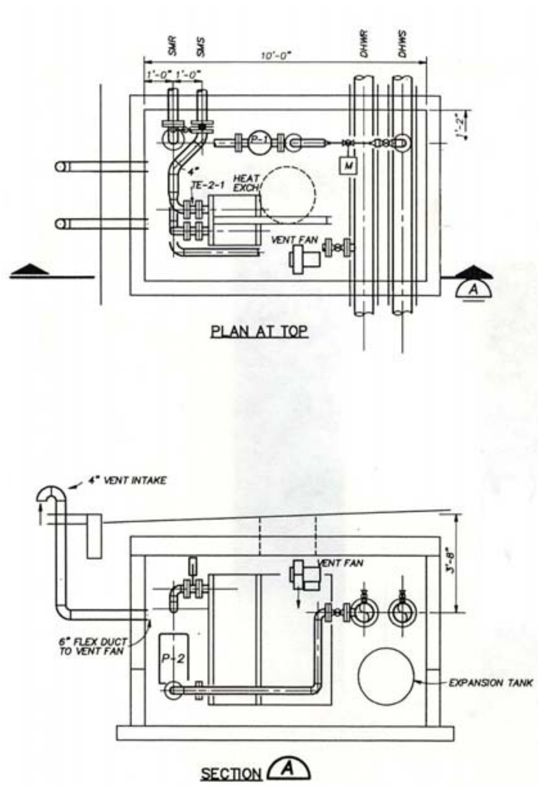

Figure 5. Sidewalk snowmelt service vault.

The flow of the snowmelt loop will be manually set based on the area of sidewalk served. Initially the system will serve three blocks. Flow will be increased as additional blocks are added. Balance valves and pressure-temperature test ports are provided at each snowmelt tubing loop to allow balancing between the loops (Figures 4 and 5). As the system is expanded, rebalancing will compensate for increased pressure drop along the snowmelt distribution mains.

Controls

The simplest controls for a snowmelt system are a manual ON-OFF switch. For this installation, while the geothermal heat is essentially "free", it costs money to run the pumps and operate the system. To offset those costs, the city has valued the geothermal energy at half the cost of natural gas. A spreadsheet energy use analysis showed an annual operation cost of \$0.90 /ft^2/year for uncontrolled operation all winter, compared to \$0.25 /ft^2/year for carefully controlled operation. Since the system will ultimately cover about 60,000 ft^2, it made sense to install automatic controls.

The basic control strategy will be to maintain a slab surface temperature of 38°F continuously throughout the winter. The heat stored in the warm slab should quickly melt snowfall even if the instantaneous heat requirement exceeds the system heating capacity. The control system will monitor outside air and sidewalk slab temperature, adjusting system operation accordingly. When air and slab temperatures both drop below 38°F, the pumps automatically start. When the system is on, the speed of the primary pump will be modulated to maintain the desired snowmelt loop supply temperature. The snowmelt loop temperature required to maintain the design slab temperature will vary with air temperature, wind and precipitation. The supply temperature set-point will be reset over a range of about 80°F to 130°F as required to maintain the desired slab temperature.

The control system will also provide monitoring of the operation of the snowmelt system and the geothermal district heating system main loop. On unusual conditions, the control system can dial-out over a phone line to notify maintenance staff.

PROJECT STATUS

Construction is currently complete on the 800 block of Main Street, and on the north side of the 600 and 700 blocks. Construction on the south side of the 600 block and a portion of the 700 block is expected to be complete within a few weeks. The system should be operational before the first major snowfall. Construction will continue next year as funds allow, with an ultimate goal of about 10 blocks on the system. Updates on system operation and construction will be reported periodically to the Geothermal Pipeline.

REFERENCES

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