



# CITY OF DAYTON

## GEOTHERMAL FEASIBILITY STUDY

### I. EXECUTIVE SUMMARY

**Ground Source Geothermal Systems (GSGS)** have been used in many commercial and industrial buildings in the downtown Dayton business district since the early 1940s, taking advantage of the abundant water resources of the aquifer. The City of Dayton is located on one of the most productive aquifers in the country, with wells that yield as high as 3,000 gallons per minute. It is important to note that of the +60 buildings investigated in this geothermal study effort, over 30% were already using groundwater for their heat rejection medium.

#### **GSGS – Benefits**

Ground source geothermal systems use ground (well) water as a heat exchange medium where building energy is transferred to / from the water. *This allows for significant improvement in heating and cooling system operating efficiencies* versus using outdoor air (OA) as a heat exchange medium. The near constant temperature of groundwater can dramatically raise operating efficiencies with using 55 degree water in lieu of 0 degree air in the winter and 55 degree water versus 100 degree air in the summer as the heat exchange medium. Energy modeling of various building and system types, conducted as part of this study effort, shows ***potential annual energy savings (and carbon footprint reduction) ranged from 5% to 34% by utilizing geothermal systems.***

#### **District Geothermal Utility Option**

Also included in the scope of this study was determining the feasibility of creating a district geothermal utility to serve businesses and residences in downtown Dayton. Four main issues were evaluated: First, was identifying potential buildings that could use such a utility. Second, was developing realistic scenarios for well field(s) and distribution piping infrastructure. Third, was determining an acceptable method to discharge the used ground water. Fourth, was creating an appropriate groundwater utility rate that incorporates the initial capital investment plus ongoing utility operating expenses. The payback analysis for the District Geothermal Utility System showed that *the geothermal utility costs range from 4% to 70% higher than the expected annual energy cost savings generated.* This makes the District Geothermal Utility System option financially unfeasible.

#### **Conclusions**

Ground source geothermal systems have been a financially viable option to meet heating and cooling needs for buildings in Downtown Dayton. Such systems in downtown Dayton have been in use for many decades. The feasibility of using these systems remains for future building heating and cooling system upgrade projects as well as for new building construction projects. ***The financial analysis conducted in this study shows significant energy cost savings potential for Ground Source Geothermal System projects, producing savings in the range of 5 to 34 percent over more conventional systems.***

## II. INTRODUCTION

### A. GOAL AND OBJECTIVE

In May of 2010 the City of Dayton contracted with Heapy Engineering to complete a feasibility study to determine the economic viability and overall feasibility of the use of **Ground Source Geothermal Systems (GSGS)** to serve the downtown Dayton business district. Included in this analysis was the evaluation of the option to create a district geothermal utility to serve buildings in downtown. This district system would be in lieu of each building owner being required to install their own well(s) to serve their building.

The area of study for this project was primarily bounded to the north by State Route 4, to the west by Interstate 75, to the south by State Route 35 and to the east by Keowee Street, covering approximately 850 acres.

The City of Dayton encompasses 56.4 square miles, which is located on the Great Miami Buried Valley Aquifer System. The Great Miami Buried Valley Aquifer, averages 2 miles in width and 150 feet to 200 feet in depth. It was formed during the interglacial episodes of the Pleistocene Epoch and was subsequently filled with permeable sand and gravel deposits. The Dayton Region has more than 6,000 miles of rivers and streams to recharge this vast, 1.5 trillion gallon buried valley aquifer.

The City of Dayton is located on one of the most productive aquifers in the country, with wells that yield as high as 3,000 gallons per minute. In addition, the aquifer has been designated a sole source aquifer by the U.S. Environmental Protection Agency and is the principal source of drinking water for 1.6 million people.

### B. PROJECT SCOPE

The following tasks have been addressed by this study effort and are summarized in this report:

1. Complete a comprehensive assessment of approximately fifty existing buildings in the downtown business district through on-site visits and interviews.
2. Perform HVAC system assessments that calculate the potential energy savings and reduced carbon footprint for end users that convert their buildings to a ground source geothermal system.
3. Identify and evaluate general well location requirements and potential environmental concerns, including:
  - + *Discuss the need for decoupling the building loop from the ground source geothermal System*
  - + *Pro/con assessment of utilizing recharge wells versus the storm water system for groundwater discharge*
  - + *Evaluate the regulations and standards requirements for groundwater wells and their discharge*
4. Evaluate the potential infrastructure needed to create a district geothermal utility. The analysis will consider redundancy, reliability, maintenance cost, and billing associated with a district utility.
  - + *Identify and evaluate potential well field location(s), and the quantity of wells*
  - + *Pro/con assessment of various distribution loops and types*
  - + *Assess the electrical service requirements for the utility*
  - + *Develop potential routing for distribution to buildings*

5. Perform a district utility rate assessment.

+ *Develop an estimate of probable capital cost for well fields, distribution loop, and electrical infrastructure*

+ *Develop an estimate of probable operating cost, including maintenance, electrical, and billing services*

6. Develop estimates of probable renovation cost to retrofit or upgrade building HVAC systems to utilize geothermal groundwater systems, including:

+ *Estimate of probable cost using standalone geothermal system*

+ *Estimate of probable cost to connect to a district geothermal utility*

7. Discuss rebates, grants, and incentives to encourage owners to use geothermal systems.

8. Summarize findings in a final report

### **Acknowledgements**

The project team consisted of Heapy Engineering, Moody's of Dayton, and Weston Solutions.

**Moody's of Dayton** was a great resource for well design as they have an extensive knowledge of the Great Miami Buried Valley Aquifer. They also provided construction cost estimates for the well/pump installation.

**Weston Solutions** was responsible for the environmental impact assessment, which addressed general regulations and standards.

**Heapy Engineering** was responsible for overall project management and the remaining items of the above described project scope.

In addition to the project team, Heapy Engineering would like to thank the building owners that participated in the study and City of Dayton staff that dedicated their time and resources to the project.

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