

# **Renewable Energy Workshop**

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## **GeoEnergy**

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**Nebraska Public Power District**  
*"Always there when you need us"*

# Topics of Discussion

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- The Advantages of a GSHP System
  - System Technology
    - How a ground source heat pump system works
  - Considerations/Regulatory
  - Installation methods – vertical loop ground heat exchanger
    - Types of ground heat exchangers
  - Costs and Potential Savings
    - GSHP vs. Alternative System
  - Where to Get Assistance
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# GeoEnergy:

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**“Using the energy in the earth to heat and cool buildings”**

Other names for GeoEnergy:

- Geothermal, GeoExchange, **Ground Source Heat Pumps (GSHP)**, Ground Coupled Heat Pumps, Earth Coupled Heat Pumps, Pond Coupled Heat Pumps, Open Loop Heat Pumps
    - Not to be confused with the generation of electricity using hot water from the earth, which is also known as Geothermal
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# GSHP Advantages

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- Energy Efficient
    - GSHPs are 300 - 400% efficient
      - Compare to Air Source Heat Pumps (200%)
      - Compare to Gas Furnace/Boiler (93%)
    - Reduces Heating and Cooling Costs 25 - 40%
  - Lower Maintenance Costs
    - Ground Heat Exchanger piping is virtually maintenance free and has long life
    - Heat pumps are located indoors, protected from the elements
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# GSHP Advantages

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- Less Space Required for Mechanical Equipment
    - No cooling tower required
    - No boiler required (usually)
      - Frees up space to be used for other purposes
  - Low Noise
    - No noisy units sitting outside
  - Lifecycle Savings
    - Less costly to operate over the life of the heating and cooling system
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# GSHP Environmental Advantages

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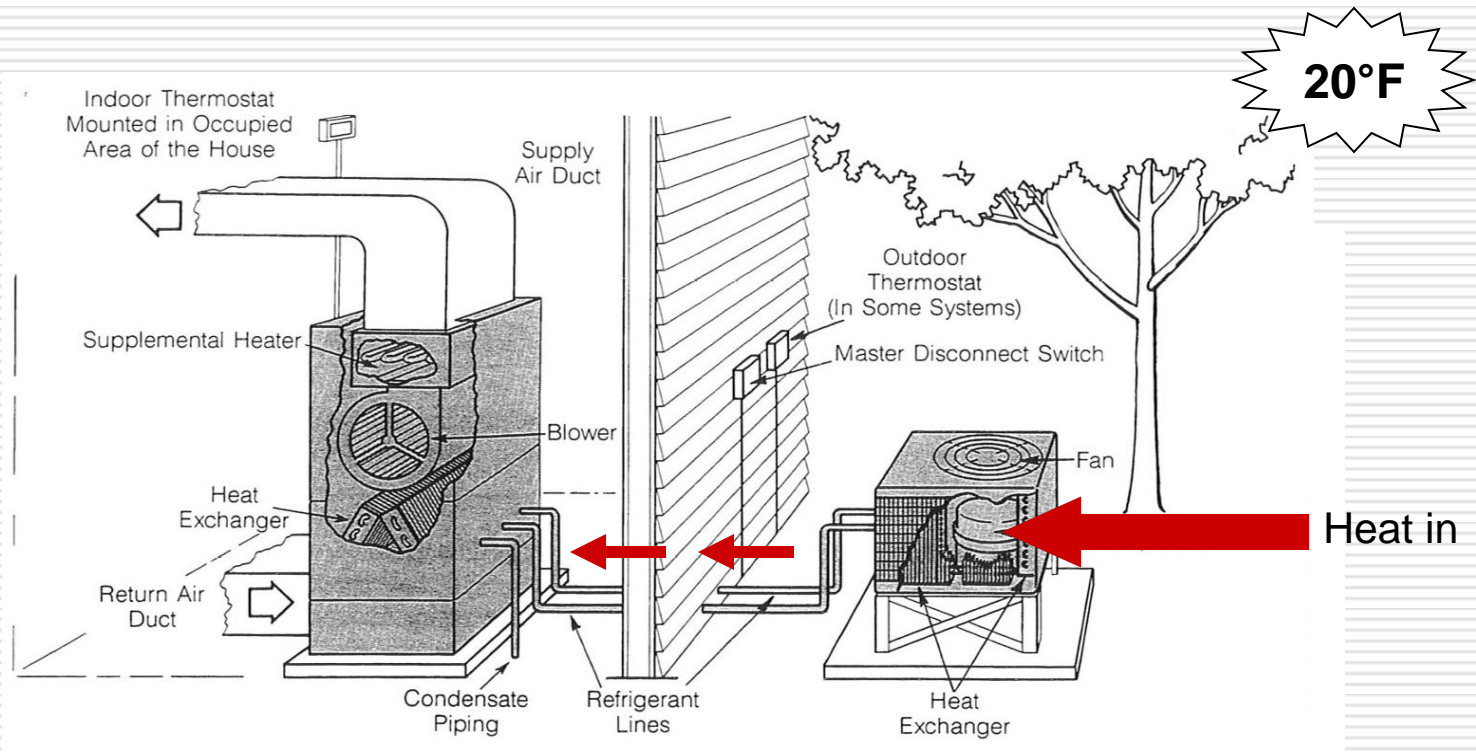
- Cuts Air Emissions
  - No Local Emissions
  - No Volatile or Toxic Fluids
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# How a Ground Source Heat Pump System Works

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- Compare to residential air-source heat pump system
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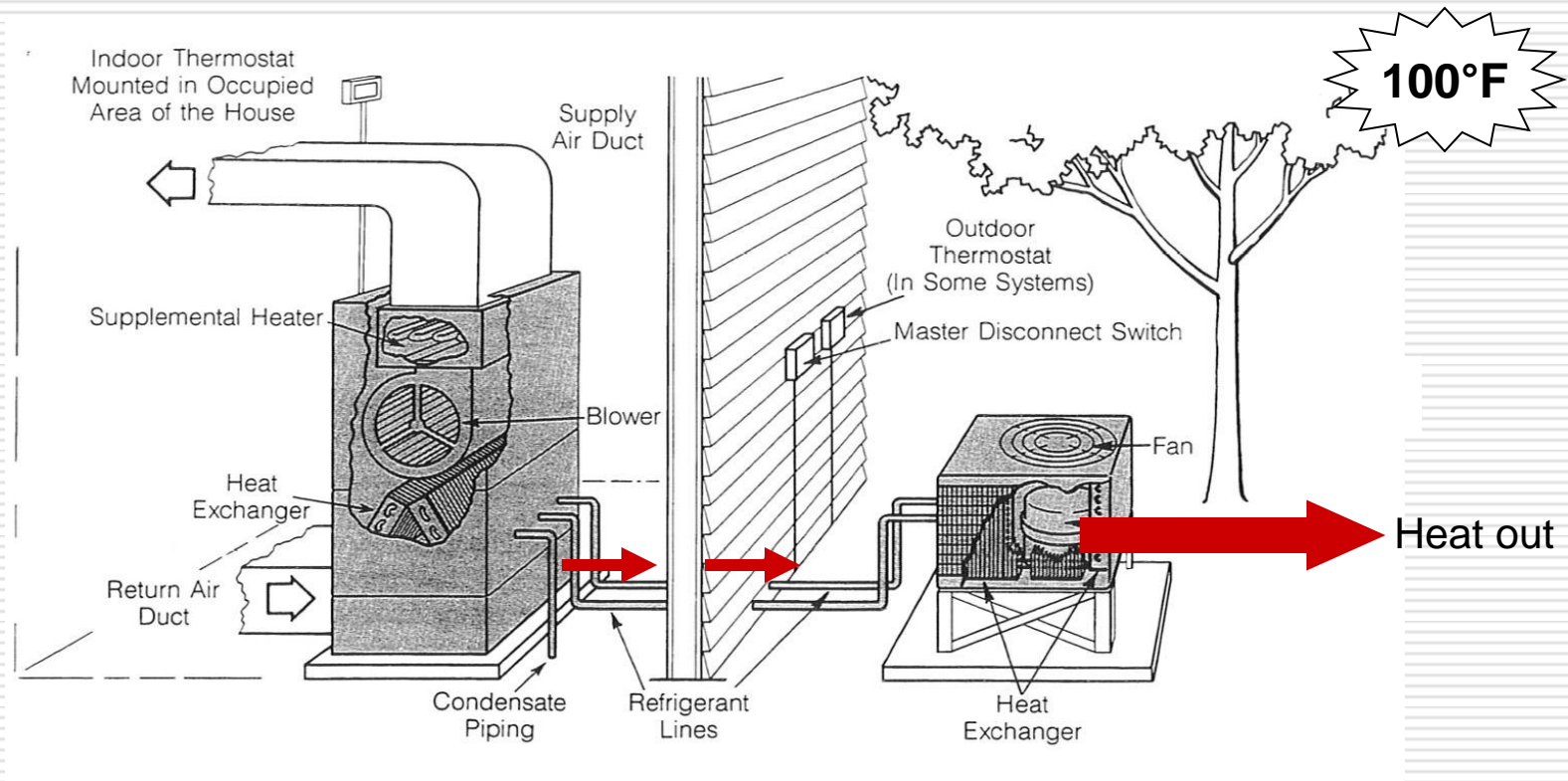
# Air-Source Heat Pump System



## Heating Mode



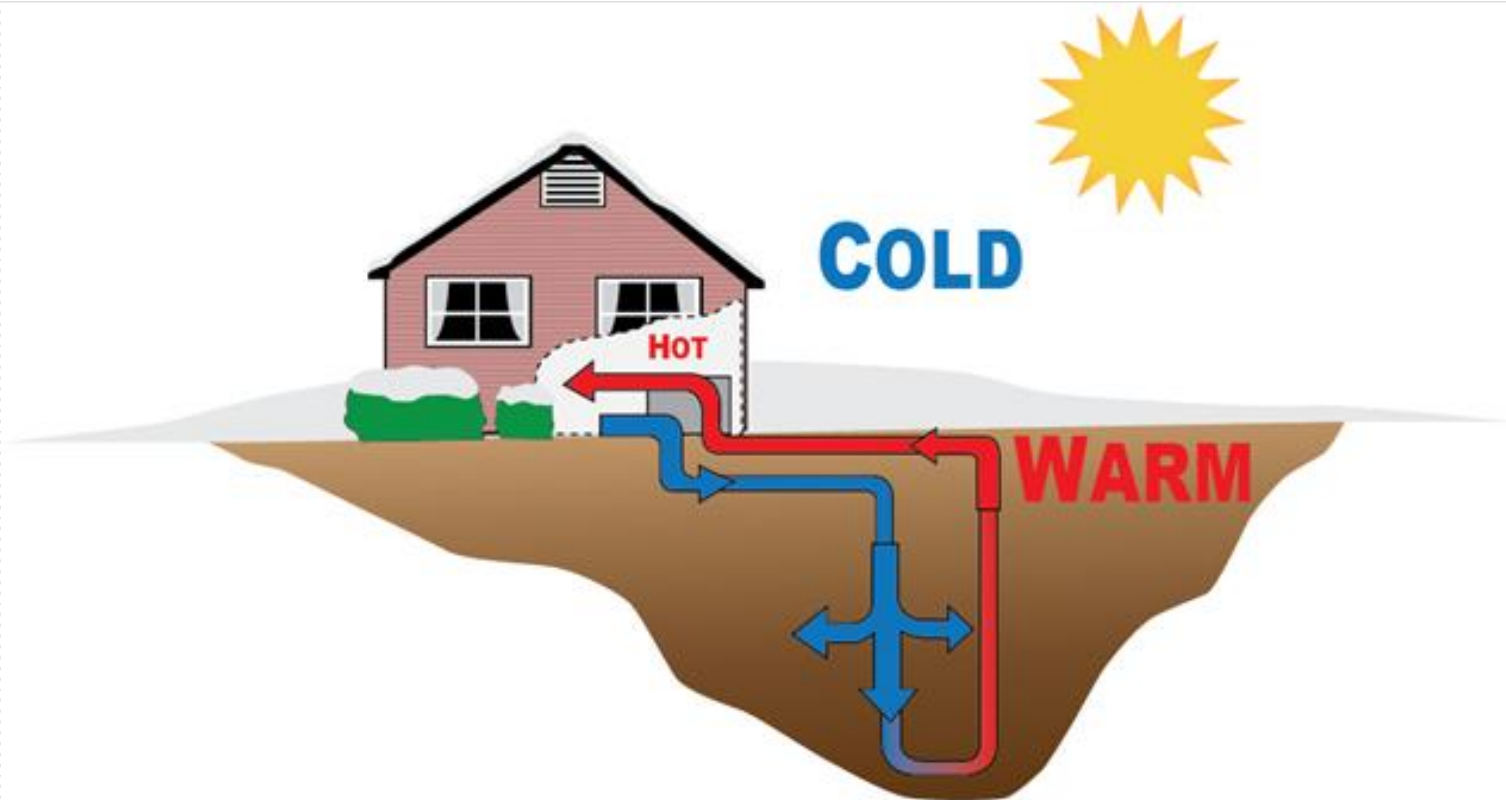
# Air-Source Heat Pump System



## Cooling Mode

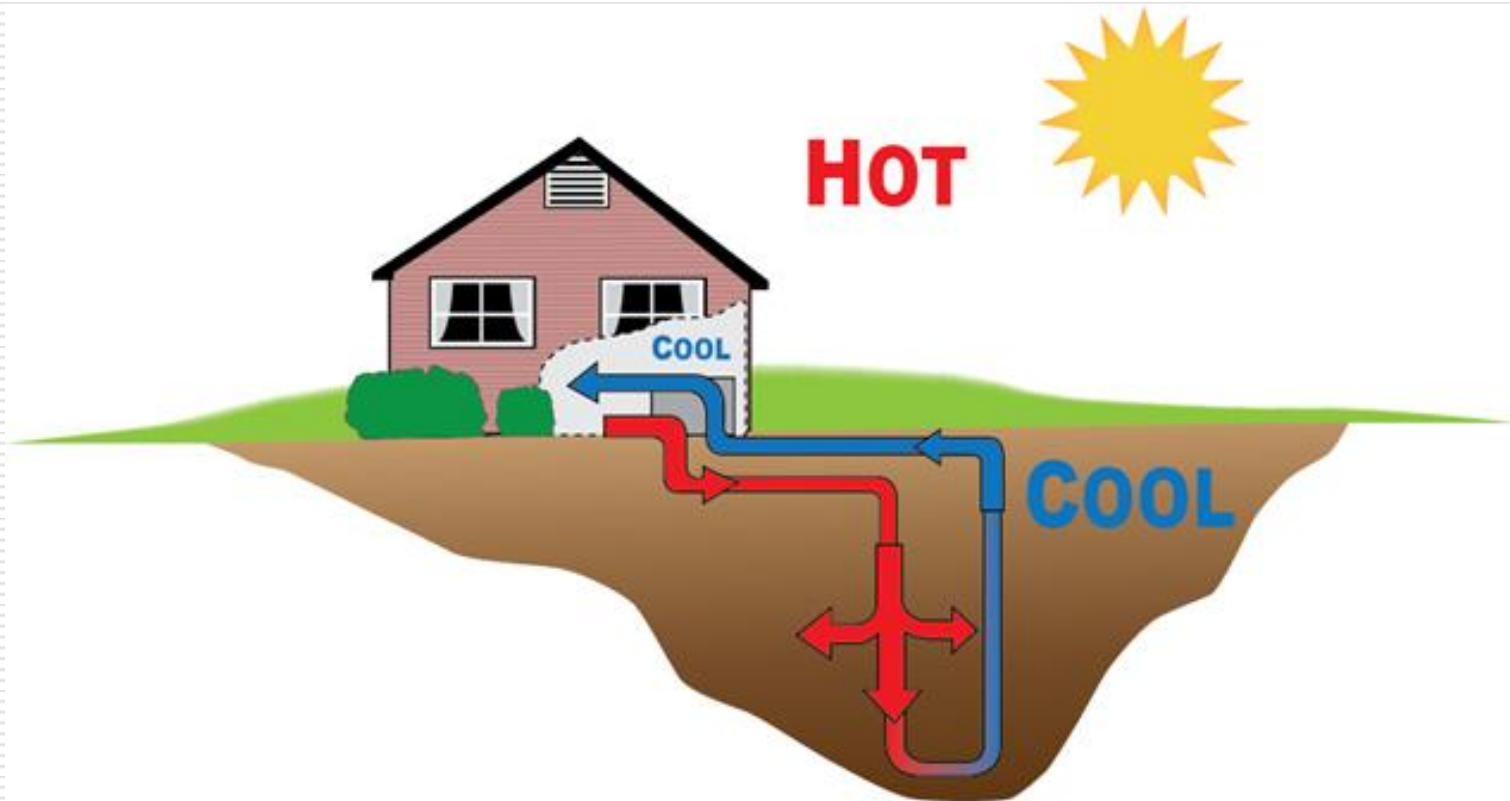
# Ground Source Heat Pump System

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# Ground Source Heat Pump System

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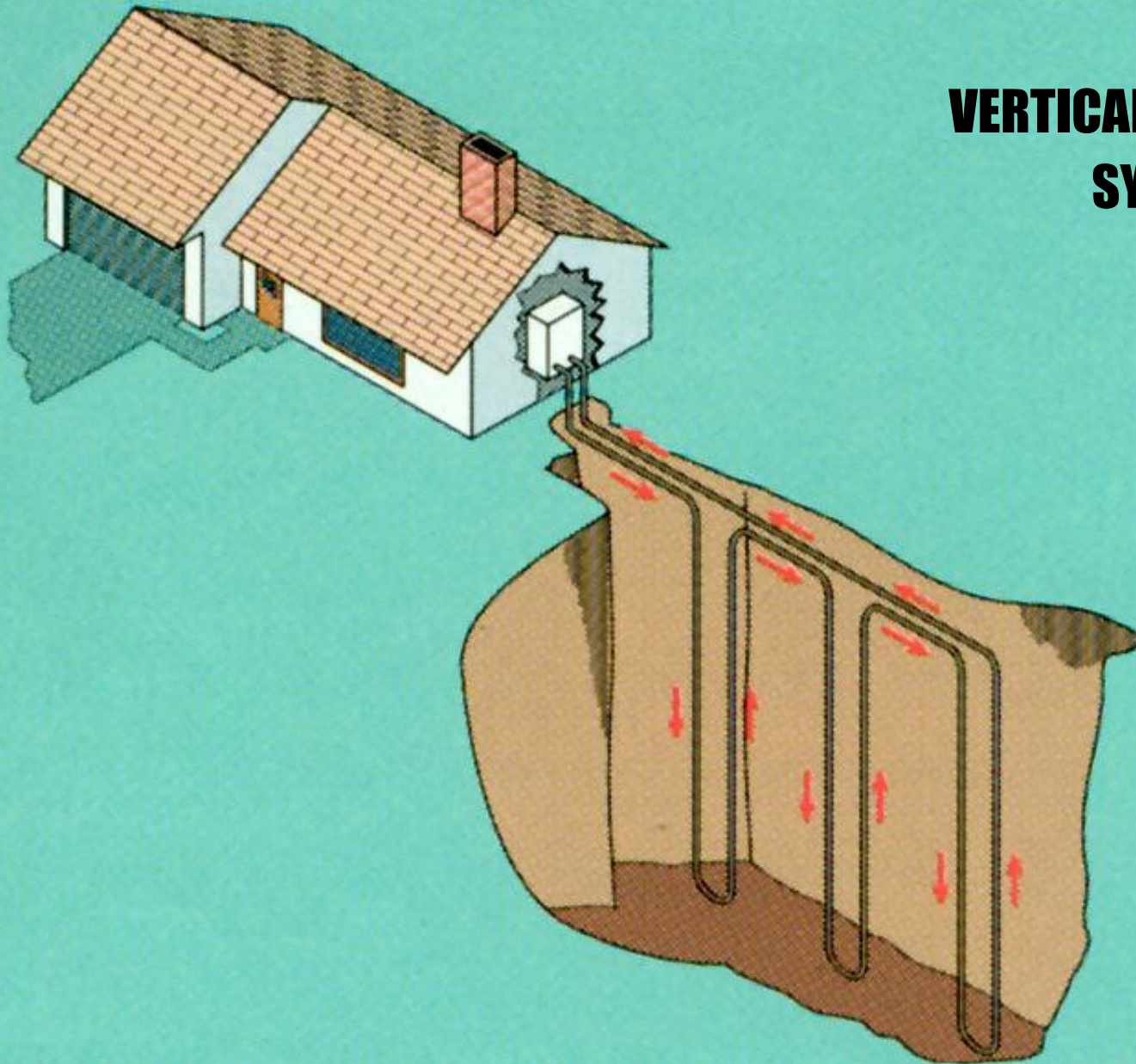
# Variations of GSHP Systems

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- Closed Loop
  - Vertical
  - Horizontal
    - Slinky
  - Pond
- Open Loop
  - Pump and Reinject
  - Single Well

Note: There are critical design details associated with each of these types of systems. Retaining the help of a design expert is highly recommended, and usually required by law in a commercial application!

## **VERTICAL LOOP SYSTEM**

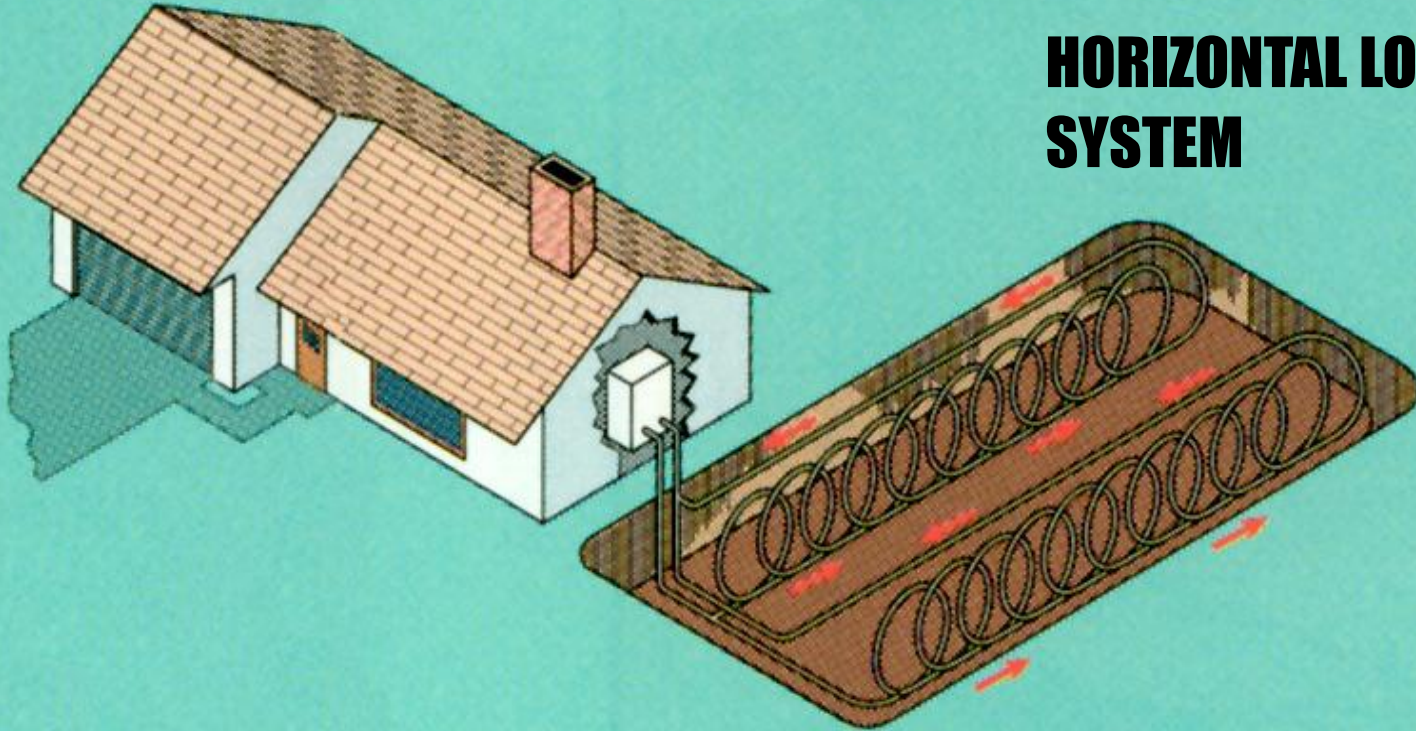


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Source: International Ground Source Heat Pump Association



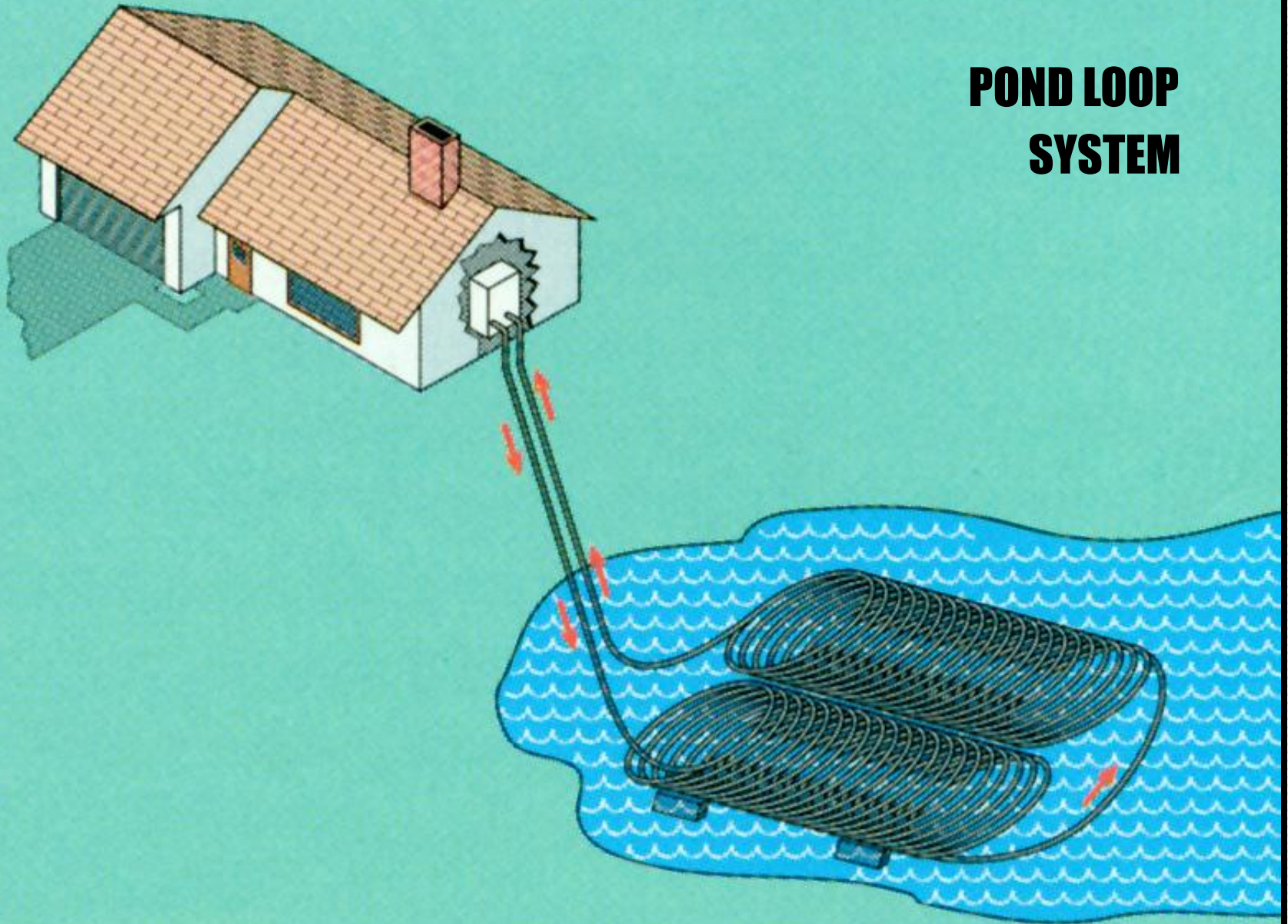
## **HORIZONTAL LOOP SYSTEM**



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Source: International Ground Source Heat Pump Association

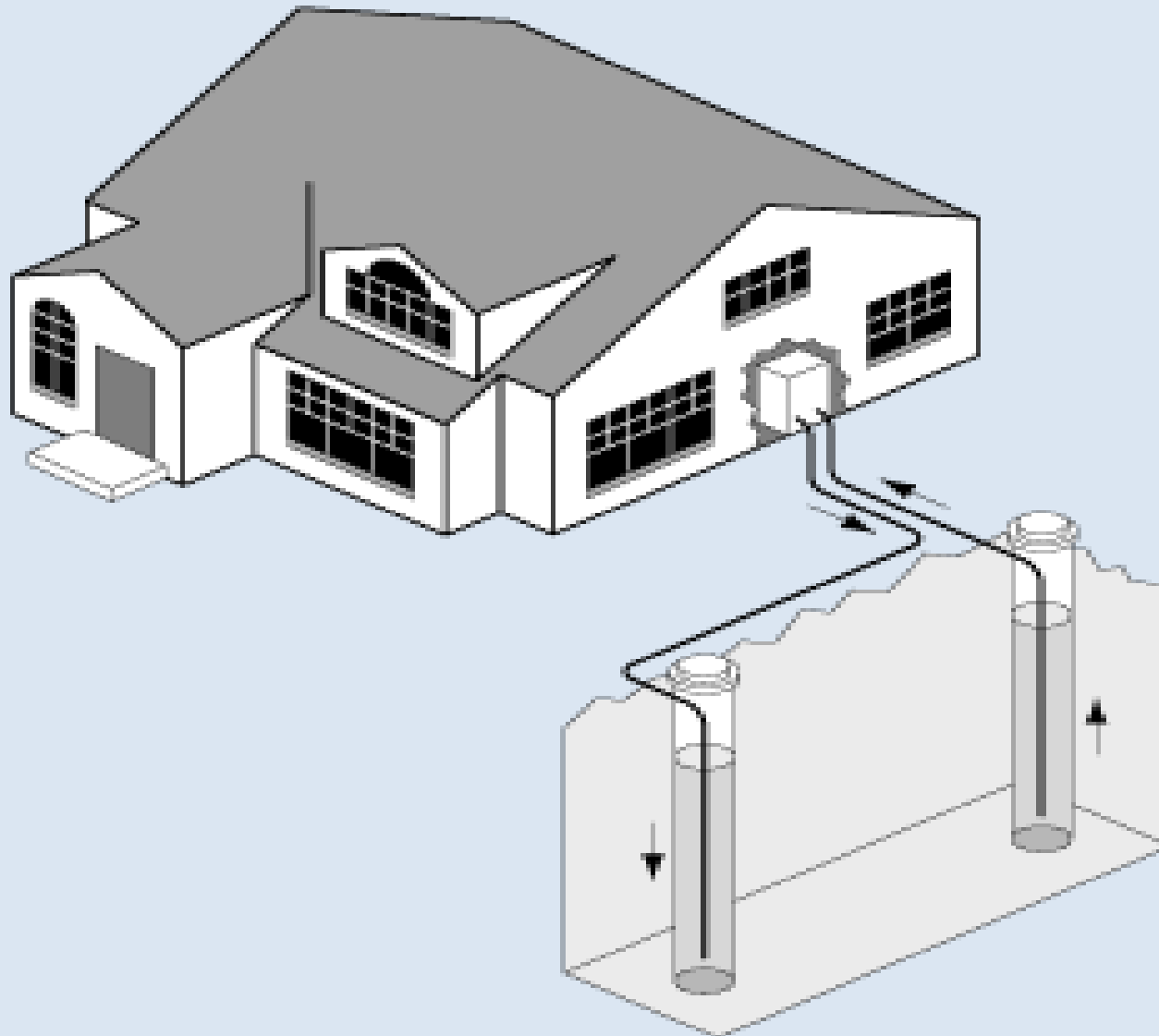
## POND LOOP SYSTEM



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Source: International Ground Source Heat Pump Association

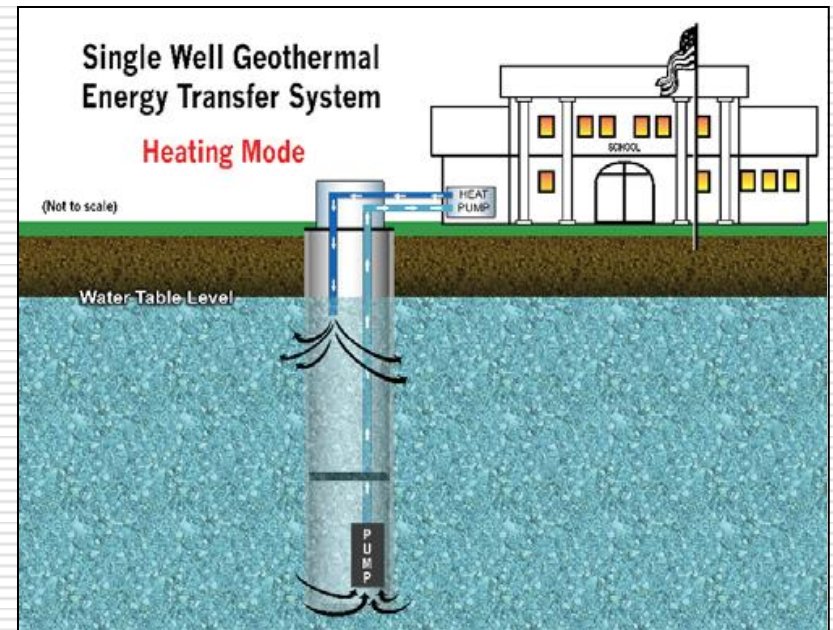
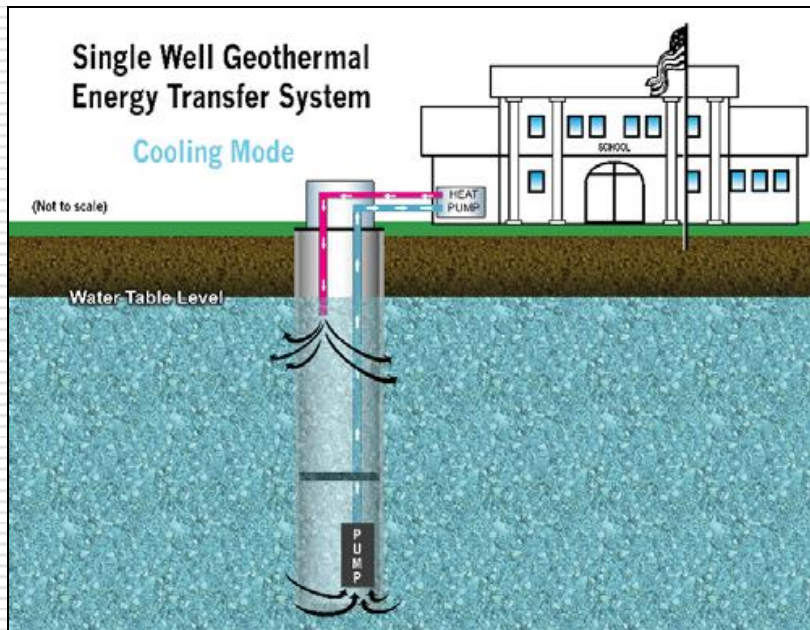
# Open Loop Systems





# Open Loop - Single Well

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# GSHP Considerations

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- First Cost
    - The cost difference to install a GSHP system versus an alternative system
  - Space Consideration
    - Need space for ground heat exchanger
      - Can be located under parking lots
  - Thermal Conductivity Test
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# GSHP Regulations

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- Ch. 12 of Title 178 (Water Well Standards)
    - Addresses installation requirements
      - Grouting, antifreeze, pipe materials, etc.
      - Note: Tom Christopherson (Nebraska Health and Human Services) indicated that this document will be revised in 2011 and will require high solids grout only
    - Prenotification
    - Distance from a Municipal Well
      - Governed by State Regulations
      - Usually not an issue, but must be checked
    - Registering of ground heat exchanger
  - Title 179 (Public Water Systems)
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# Typical GSHP Installation

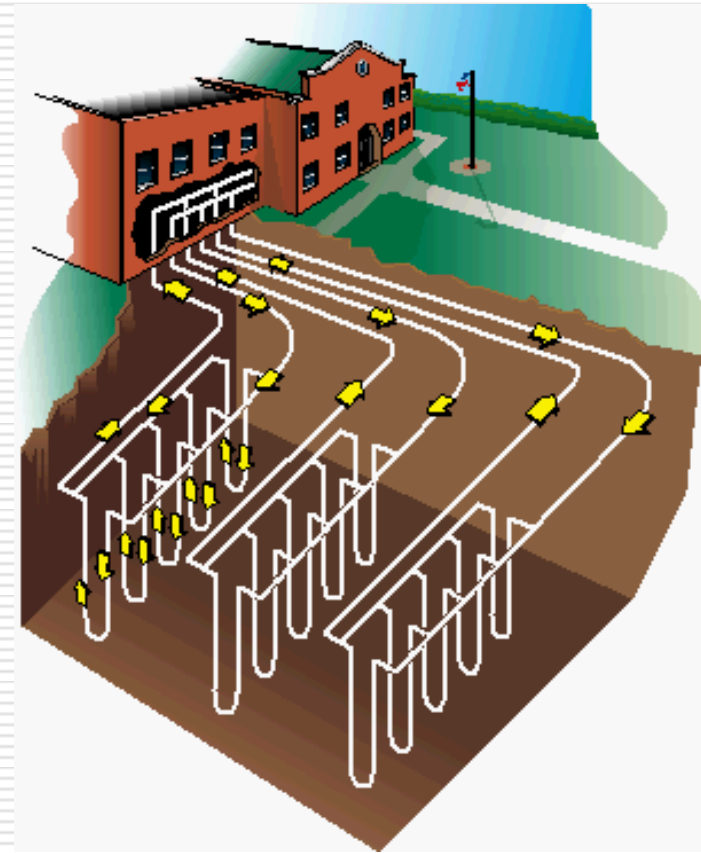
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## Outside Building:

- Ground heat exchanger (GHE)
  - Vertical loop GHE is most common
  - Polyethylene piping
  - 200-foot boreholes (typ.)

## Inside Building:

- Circulating pumps
  - Anti-freeze fluid
- Heat pumps
- Outside air unit

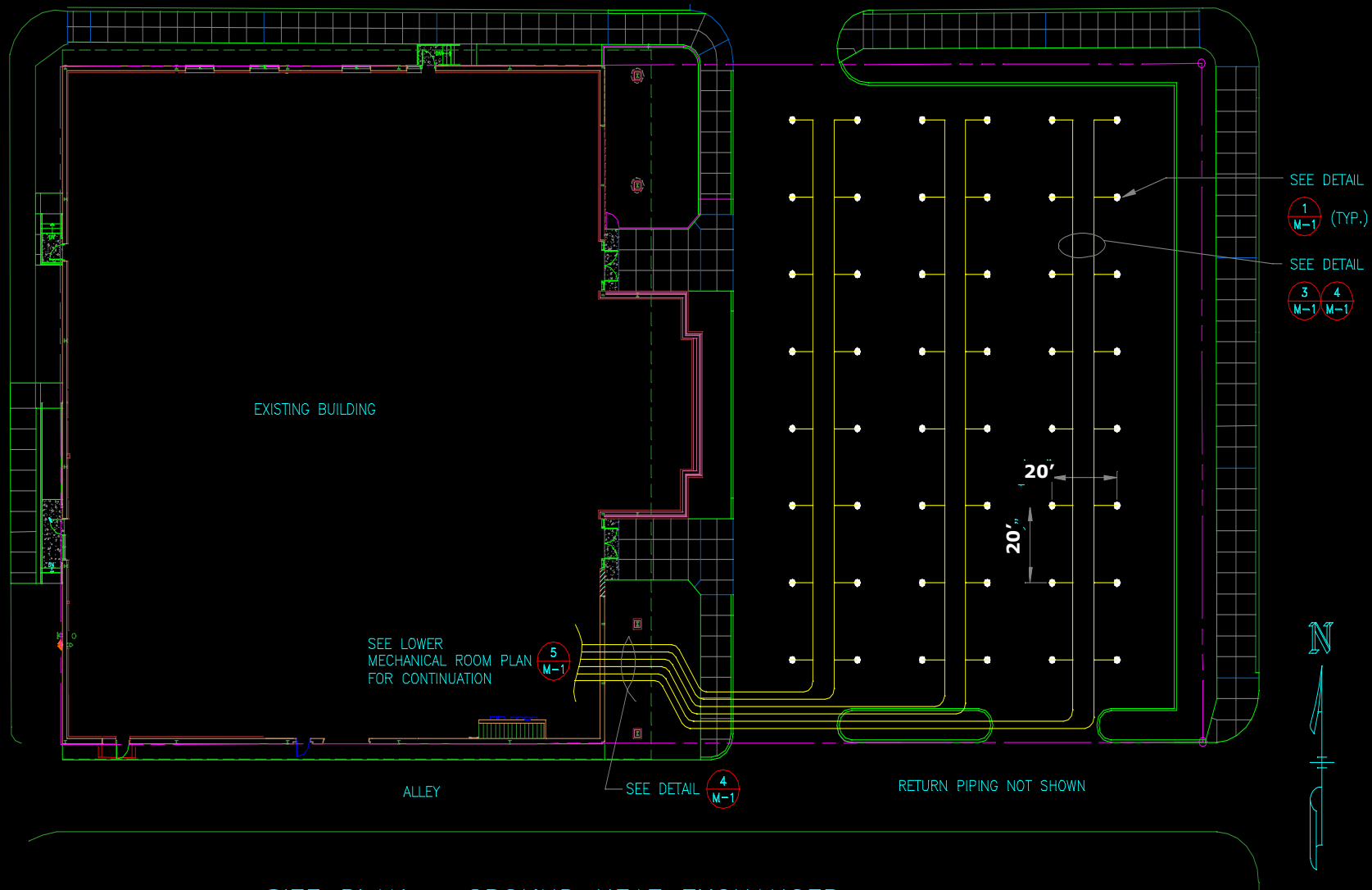


# Thermal Conductivity Test

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Provides valuable information used by the engineer in the design of a vertical ground heat exchanger. Recommended in the design of larger systems.



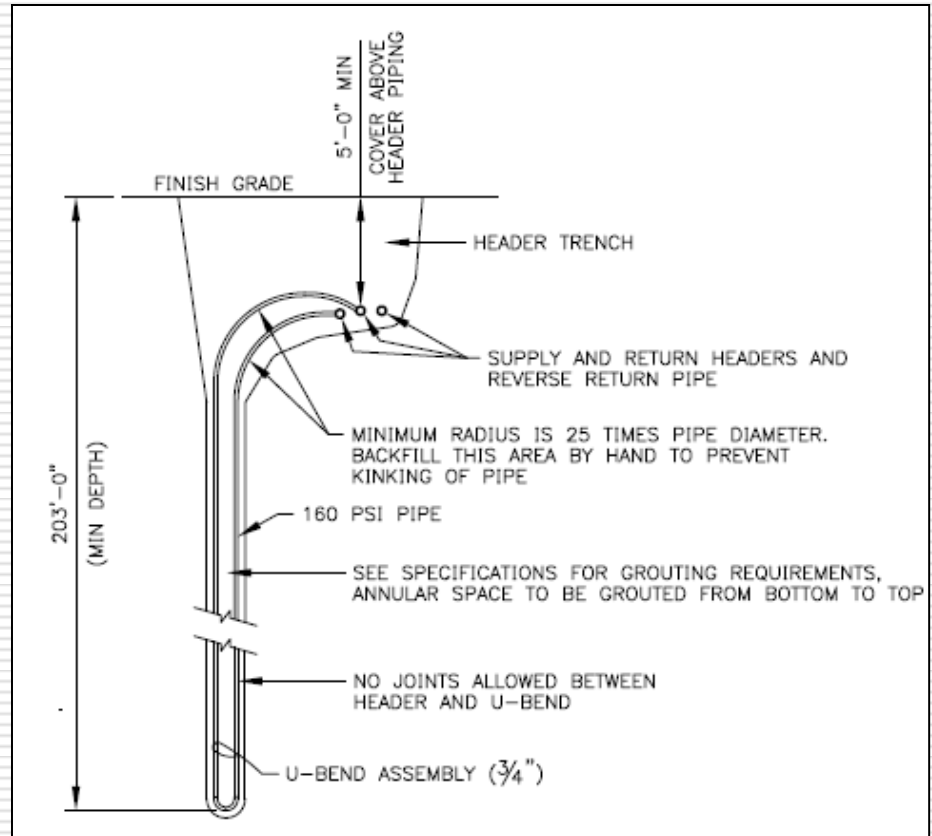
# SITE PLAN — GROUND HEAT EXCHANGER

1" = 20'-0"

# Installation of Ground Heat Exchanger



Well Drilling



Example Borehole Detail

# Installation of Ground Heat Exchanger

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Grout Rig



Recommend thermally enhanced grout – typically 4 parts of silica sand to 1 part bentonite mixed with water

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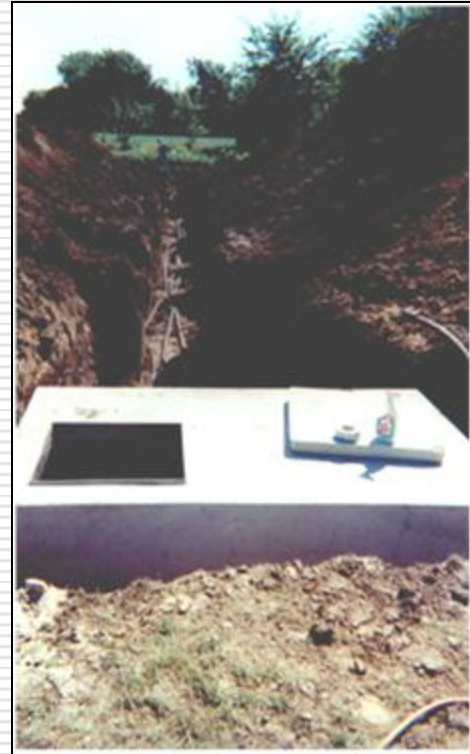
# Trench Showing Header Piping

# Installation of Ground Heat Exchanger

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Header Piping in Trench



Vault

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# Installation of Ground Heat Exchanger

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Header Manifold

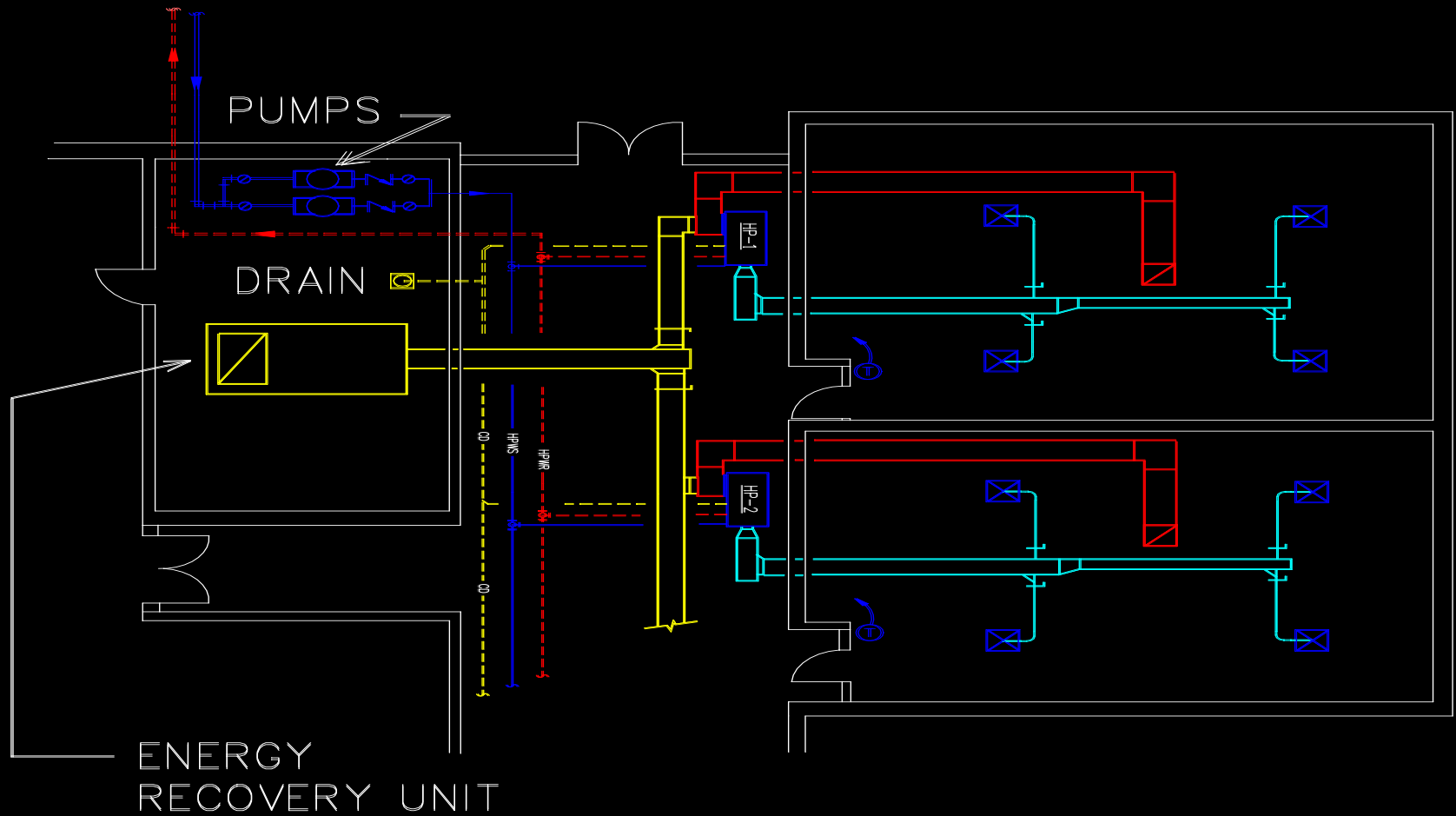


Purge Cart

After purging, propylene glycol antifreeze may be added. (20 – 30% is common)

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TO GROUND  
HEAT EXCHANGER



GROUND SOURCE HEAT PUMP SYSTEM  
INTERNAL COMPONENTS

# Inside Building

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Heat Pumps in Equipment Rm



Heat Pump Above Ceiling

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# GSHP Costs

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- The installation cost of any heating and cooling system varies, depending on:
    - Location
    - Size of building
    - Bidding climate
      - Material price fluctuations
      - Contractor availability and labor cost
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# GSHP Costs

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- It is best to compare costs of a GSHP system to another type of system:
    - For example, compare to a Water Source Heat Pump (WSHP) system with cooling tower and boiler
      - Heat pump equipment inside building is about the same
      - Determine cost difference between cooling tower and boiler option and the ground heat exchanger
        - The cost difference may not be as much as you think!
    - Must be designed both ways in order to determine the true cost difference.
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# GSHP Savings and Payback

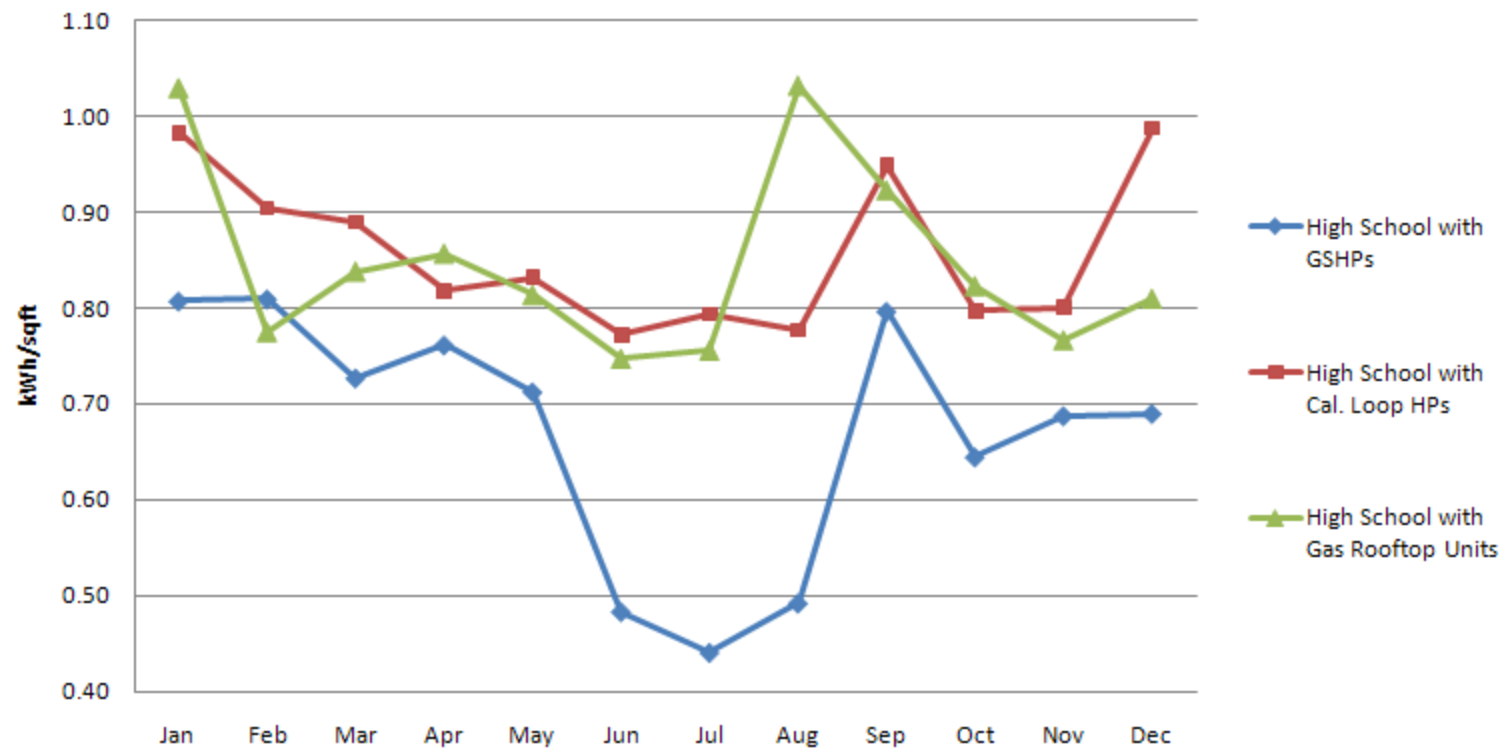
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- Typical savings are 25 – 40% of heating and cooling energy
  - Take the difference in installation costs, and then divide by the estimated savings, to obtain the number of years it will take to payback the cost difference.
  - Typical payback is 6 – 10 years
  - Tax incentives – Energy Policy Act of 2005
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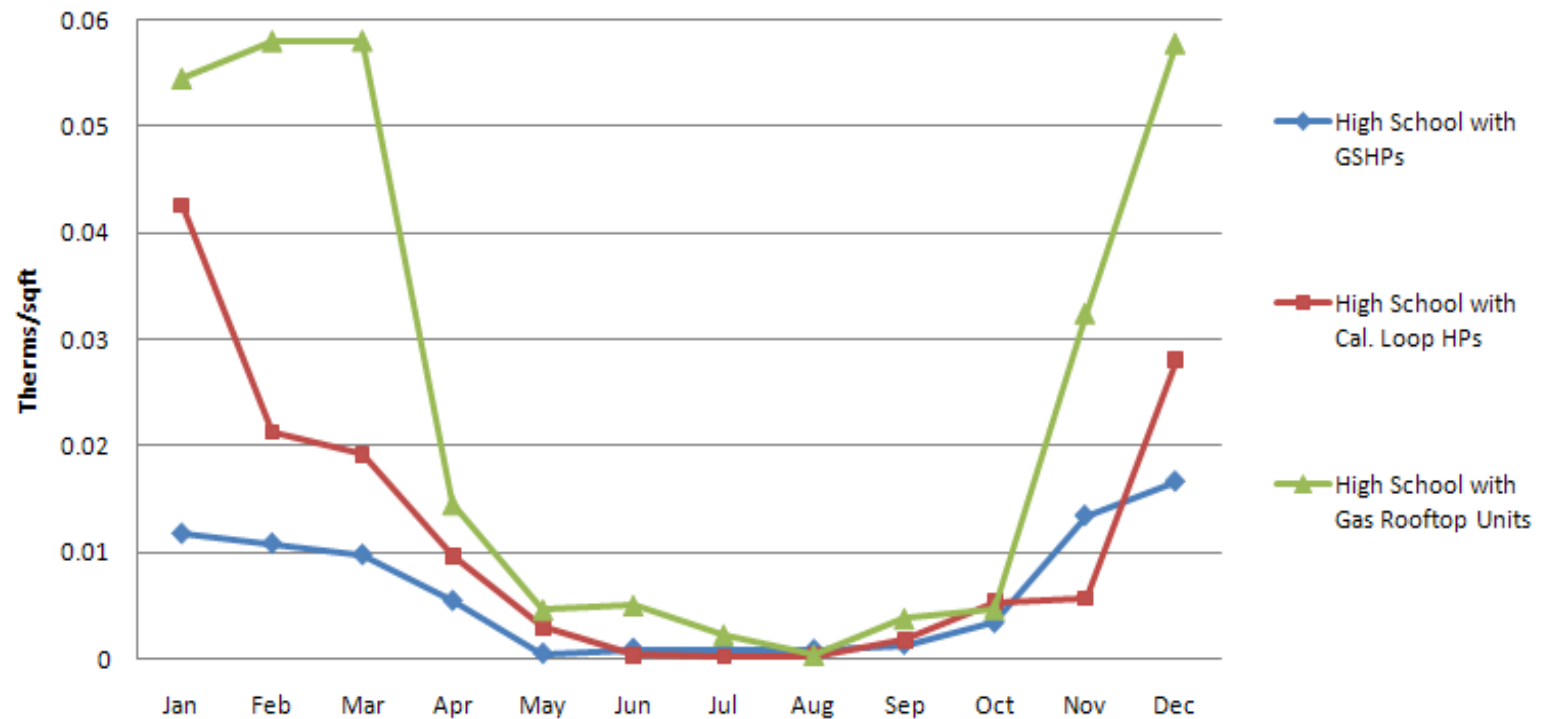
# Energy Usage Comparison

Comparison of Three High Schools - Electricity Consumption

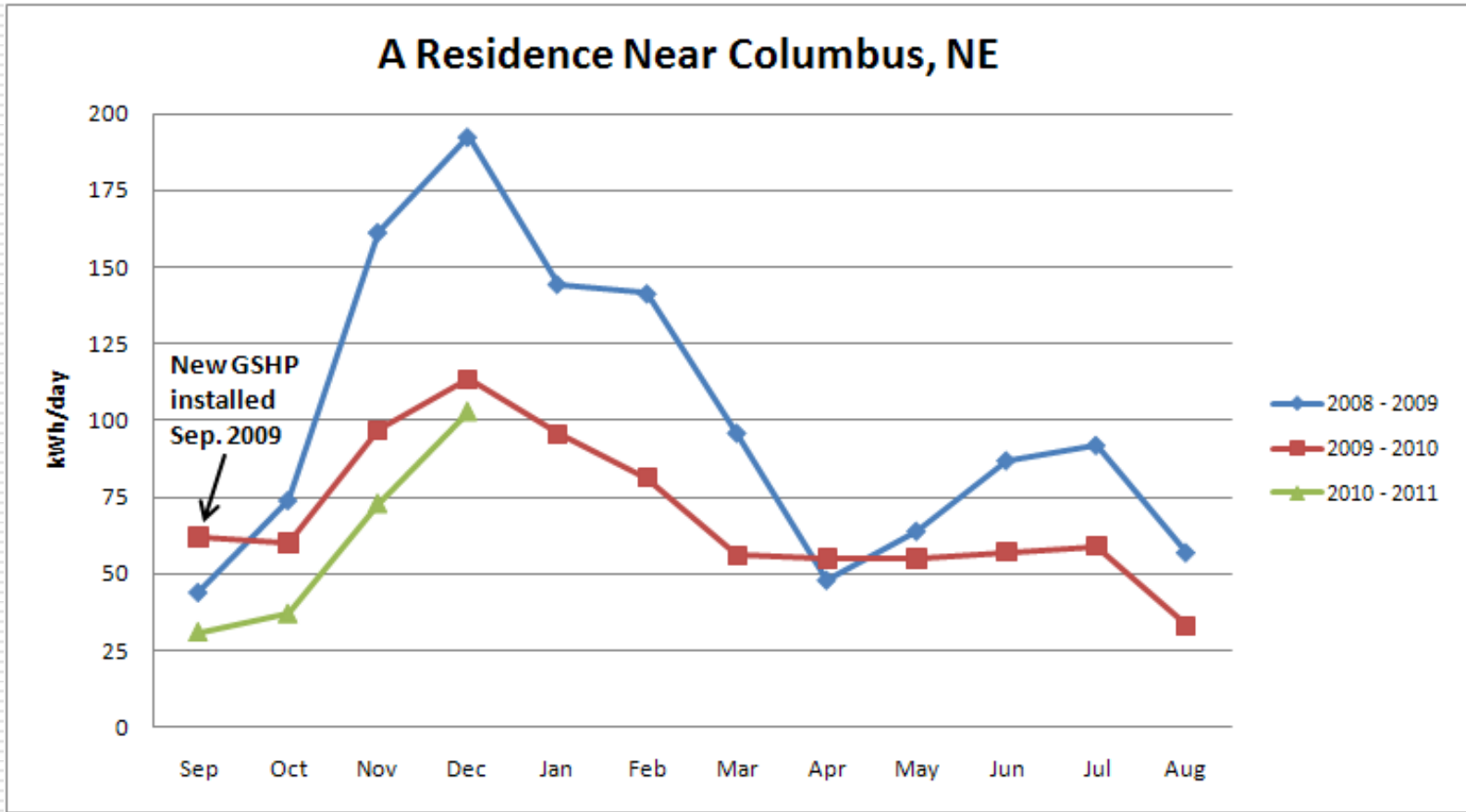


# Energy Usage Comparison

Comparison of Three High Schools - Natural Gas Consumption



# Energy Usage Comparison



# Where to go for help?

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- Local Heating and Air-Conditioning Contractor
  - Local Well Drillers
  - Engineering Consulting Firms
  - Local Utility personnel
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# Where to go for help?

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## ■ Before You Build/Renovate:

Commercial Structures: Nebraska state law requires that all commercial structures must be designed by an architect and/or professional engineer, with certain exceptions. Following are **some examples** of those exceptions:

### **Business (B) – Less than 3,000 sq. ft.**

This includes any part of a structure used for office, professional, or service-type transactions.

### **Factory Industrial (F-1, F-2) – Less than 5,000 sq. ft.**

This includes any part of a structure used for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as high-hazard or storage occupancies.

**See Handout**

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# Utility Incentives

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- Commercial/Industrial Lighting
  - High Efficiency Motor
  - Variable Frequency Drives
  - Commercial HVAC
  - HVAC System Optimization
  - Brochures Available
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- Benchmarking
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# Sources of Information

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## **International Ground Source Heat Pump Association (IGSHPA)**

- [www.igshpa.okstate.edu](http://www.igshpa.okstate.edu)

## **Geothermal Heat Pump Consortium**

- [www.geoexchange.org](http://www.geoexchange.org)

## **Department of Energy – Energy Efficiency and Renewable Energy**

- [www.eere.energy.gov](http://www.eere.energy.gov)

## **Nebraska Public Power District**

- [www.nppd.com](http://www.nppd.com) Steve Zach (402) 563-5472
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