GEOTHERMAL:

Environmental and Water Resources Concerns

Andrew Stone, Executive Director
American Ground Water Trust

INFORMATION – AWARENESS – EDUCATION

American Ground Water Trust

(501(c)(3) non-profit

RESPONSE TO NEED FOR GEOTHERMAL EDUCATION

AGWT: GEOTHERMAL EDUCATION & TRAINING PROGRAMS

2010 and 2011 – 50 SCHEDULED EVENTS

2010 GEOTHERMAL

(WA, MD, MI, MN, FL, IL, NJ, AZ, CT, SC)

2010 LOOP INSTALLATION (partnership - ClimateMaster)

(TX, GA, FL, NC, SC, IL, KY, MN, NH, OR, TN, VA, CA, UT, PA)

April 19, Boxborough

2011 GEOTHERMAL

(NC, TN, VA, PA, MA, NM, TX, MO, OH, NJ, OR, WI)

2011 LOOP INSTALLATION (partnership - ClimateMaster)

(FL, AL, TX, AZ, NV, PA, IN, SC, CO, MO, AK, NY, IA, OH)

WE MUST KEEP CONTAMINANTS AWAY FROM THE WATER TABLE

"Geothermal heat pumps are the most energy efficient means of heating and cooling buildings in most areas of the United States"

US General Accounting Office

"Relatively simple precautions will ensure that any environmental impact is negligible."

Manual On Environmental Issues Related To Geothermal Heat-pump Systems,
EPA 430B 97028, September 1997

CONCERNS WITH INSTALLATION, OPERATION AND DE-COMMISSIONING

- Surface disturbance
- Surface contaminant migration
- Inter-aquifer flow (bedrock fracture connections)
- Borehole placement near wells and septics
- Water withdrawals (aquifer demands)
- Discharge of thermally changed water
- Thermal alteration of bedrock and/ or groundwater
- Chemical compounds in closed loop circuits

THREE SETS OF LOOPS IN A GEOTHERMAL SYSTEM

- Circulation of fluids in sub-surface loops
- Circulation of refrigerant in heat-exchange unit
- Circulation of heat in distribution system
- [Circulation of hot water from desuperheater]

BACKGROUND: GEOTHERMAL

GEOTHERMAL

"A rose by any other name would smell as sweet"

Romeo & Juliet, Act 2 Scene 2, William Shakespeare

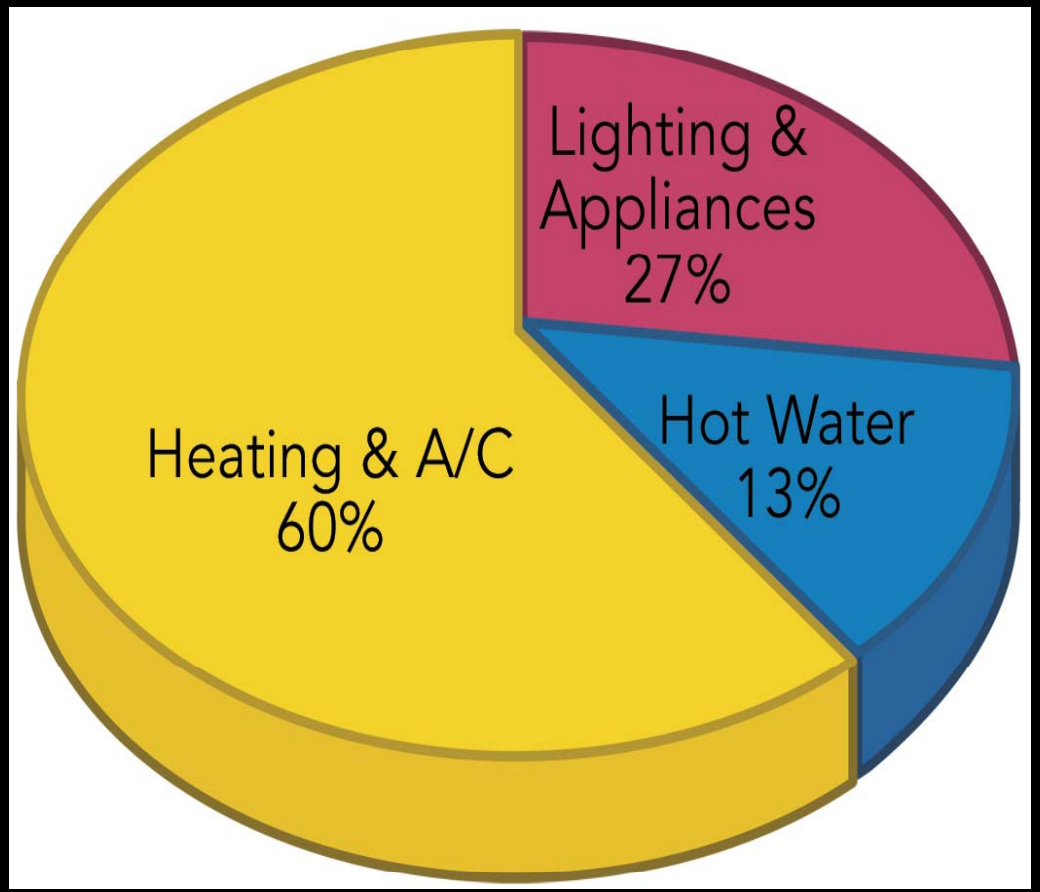
Geothermal
Geo-exchange
Geothermal Heat Pumps
Earth Coupled Heating & Cooling
Ground Source Heating & Cooling

Geothermal and carbon footprint

Heating: 50 - 70% over traditional systems

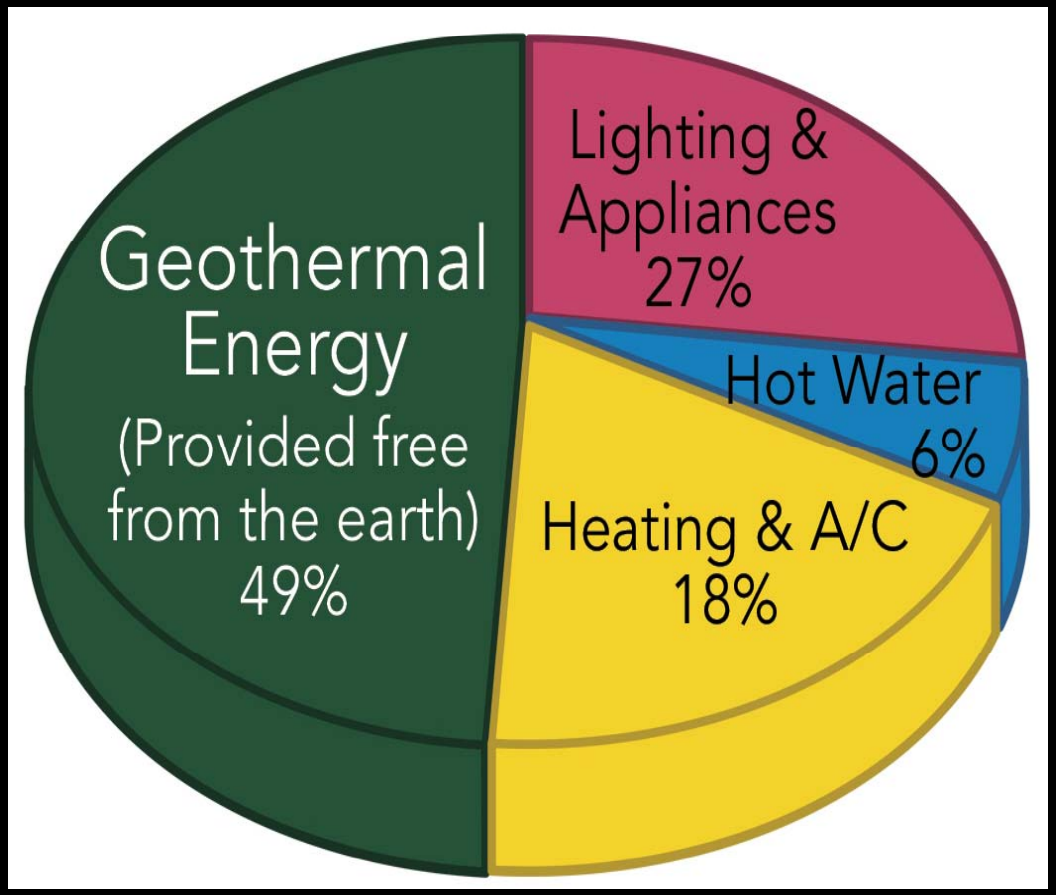
Cooling: 20 - 40% over available A/C units

Residential Energy
Conventional System



Over 70% of the energy consumed by a typical home is used to meet thermal loads

Residential Energy
Geothermal Heat Pump System



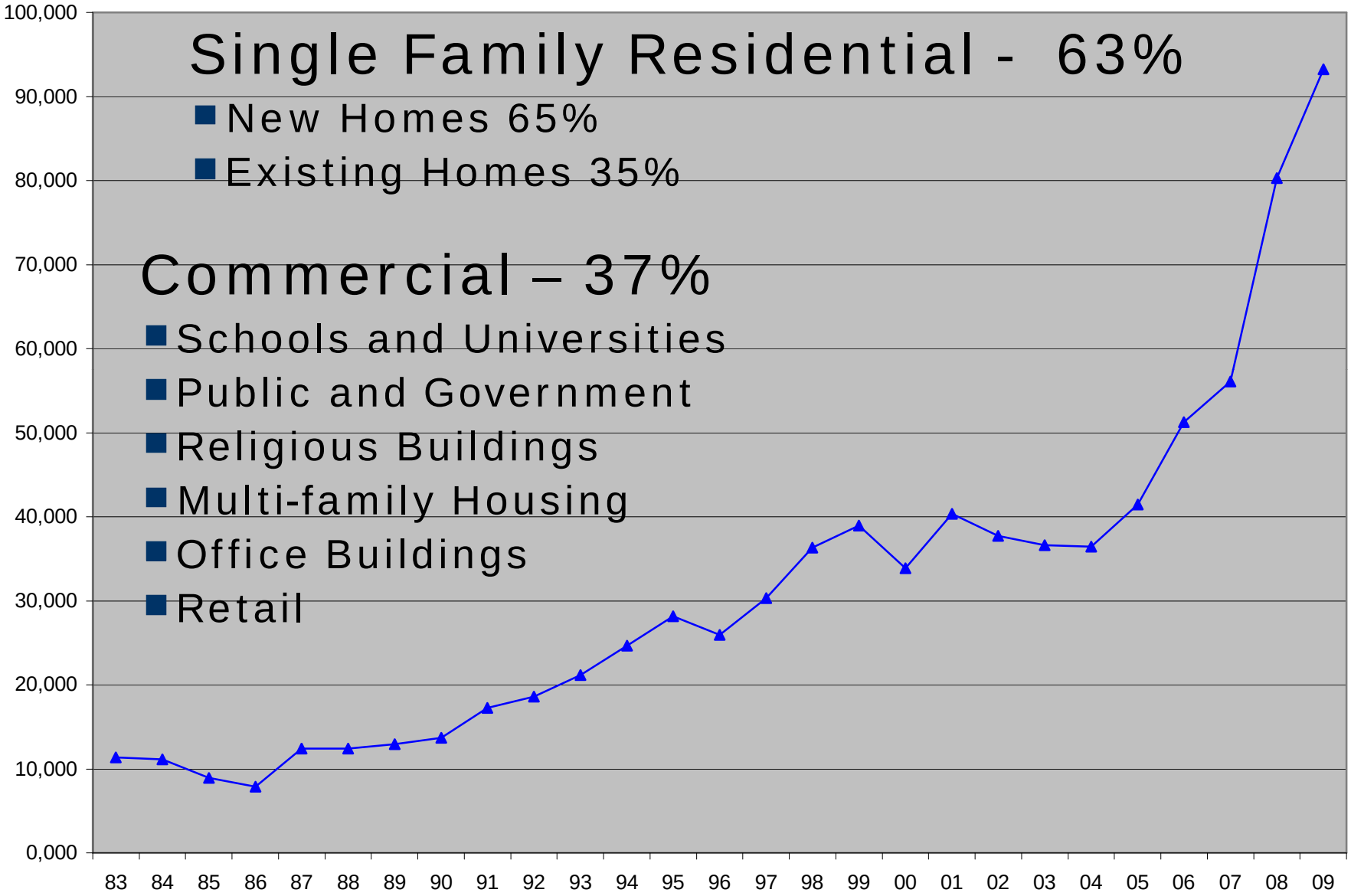
Total site energy consumption is cut in half

USA ANNUAL INSTALLATIONS

100,000 to 120,000

- 45% horizontal closed loop
- 45% vertical closed loop
- 10% water-source open loops

North American Geothermal Industry Shipments



ClimateMaster

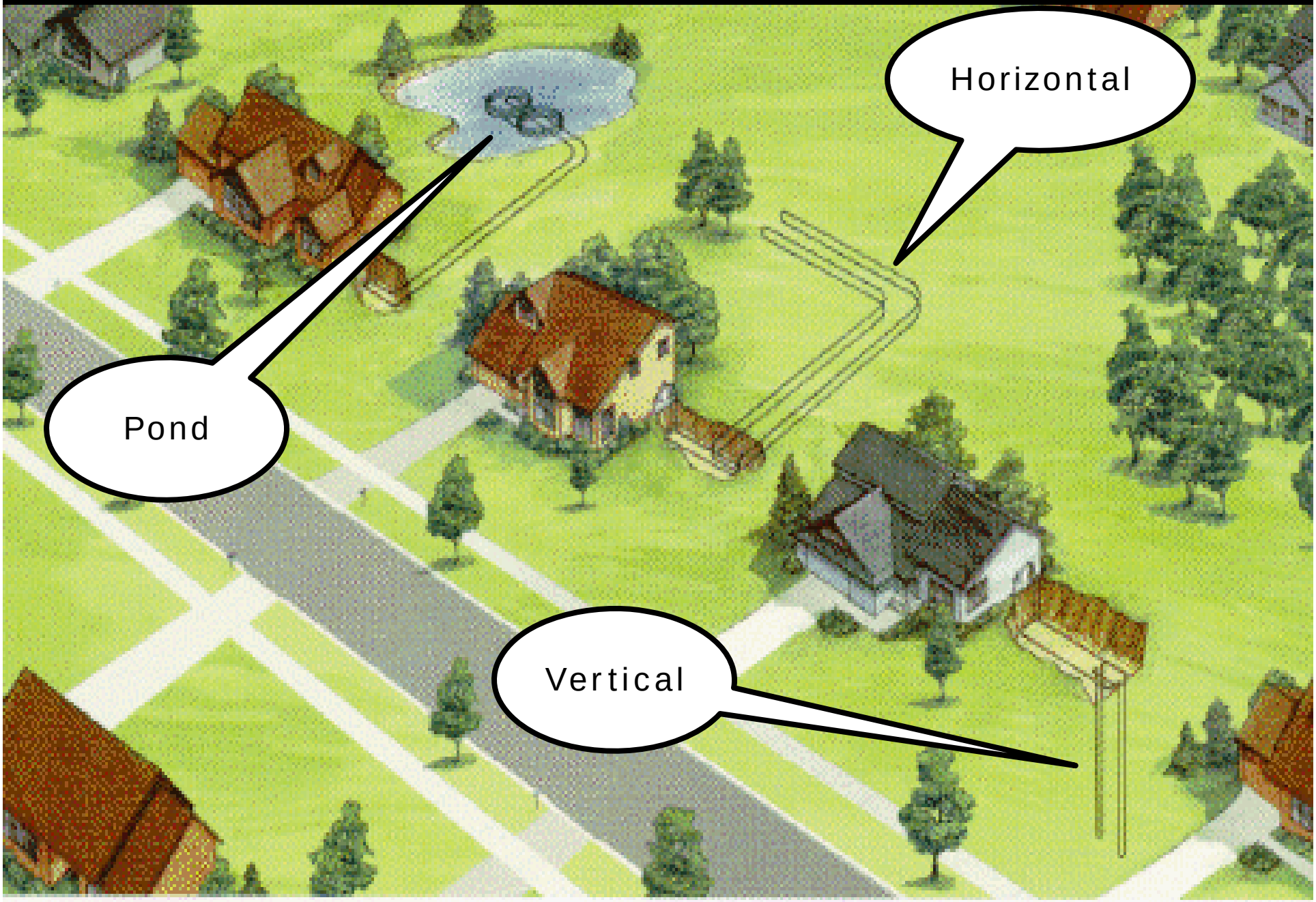
COUNTRIES USING GHP

Country	Number	
Switzerland	84,800	
Canada	92,600	
Germany	185,800	
Norway	275,000	
Sweden	371,700	
China	434,000	
USA	1,000,000	

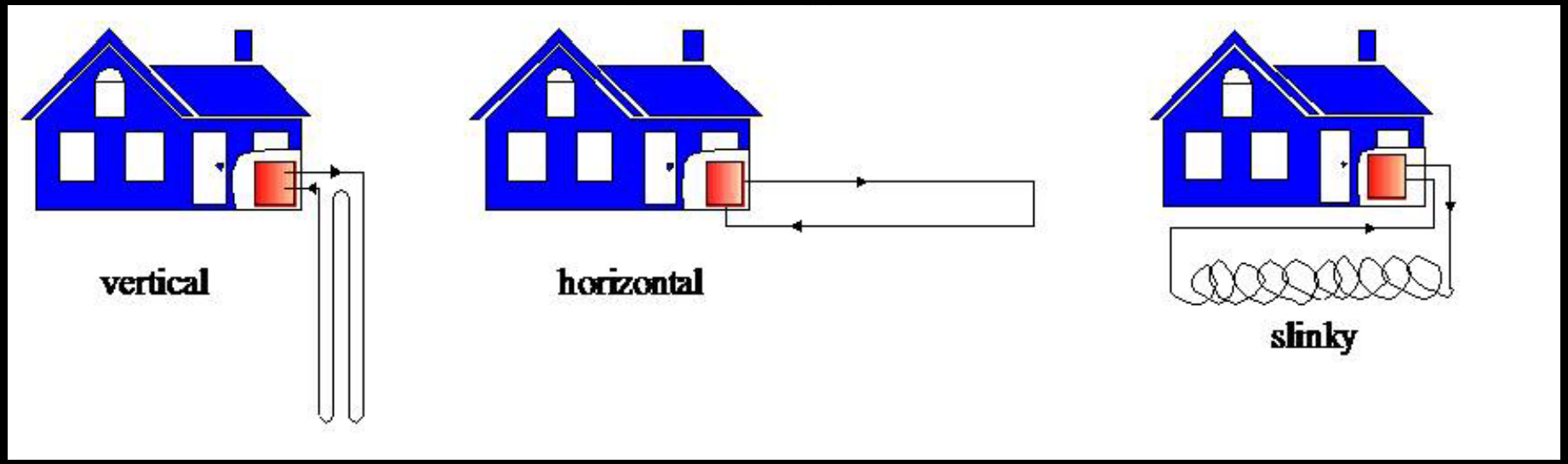
John Lund, Oregon Institute of Technology

TYPES OF INSTALLATIONS

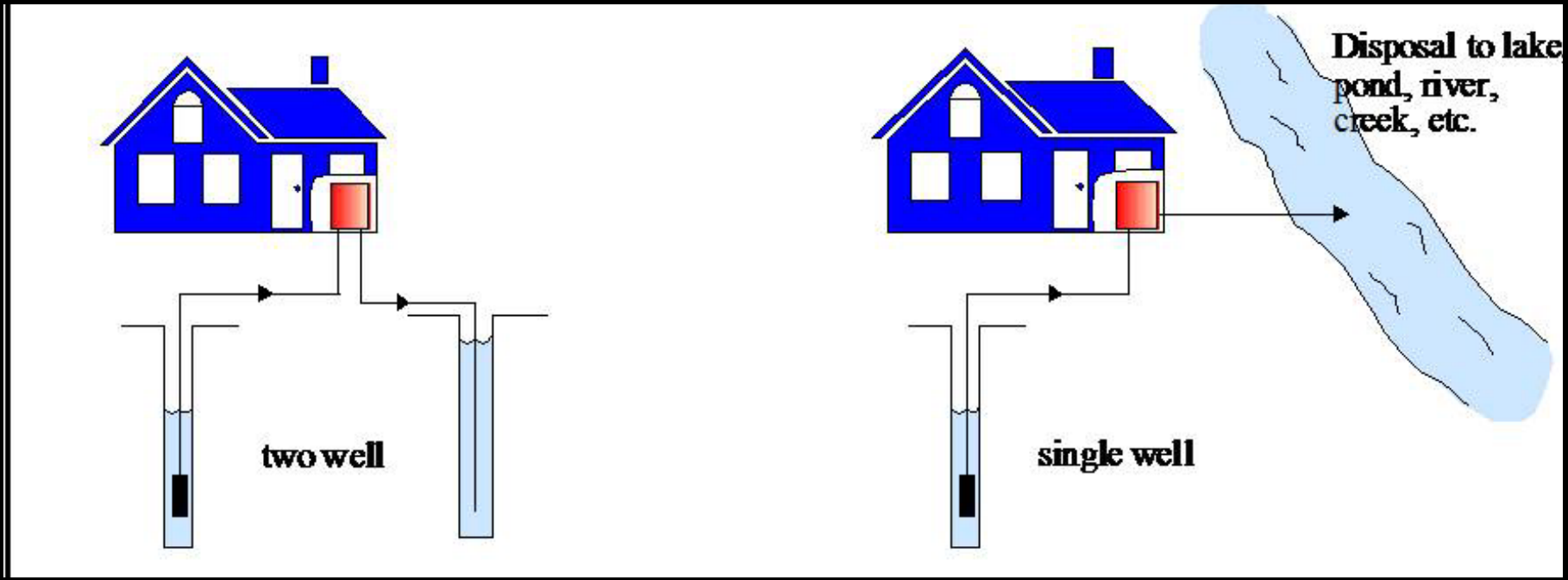
GEOTHERMAL INSTALLATIONS



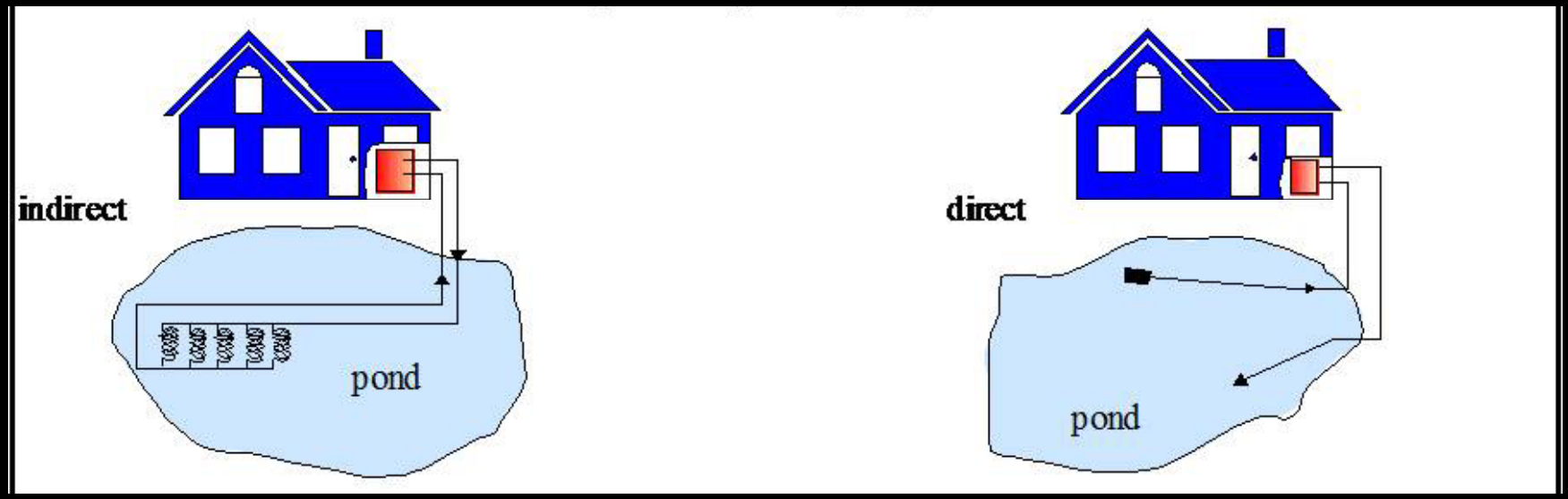
CLOSED LOOP SYSTEMS

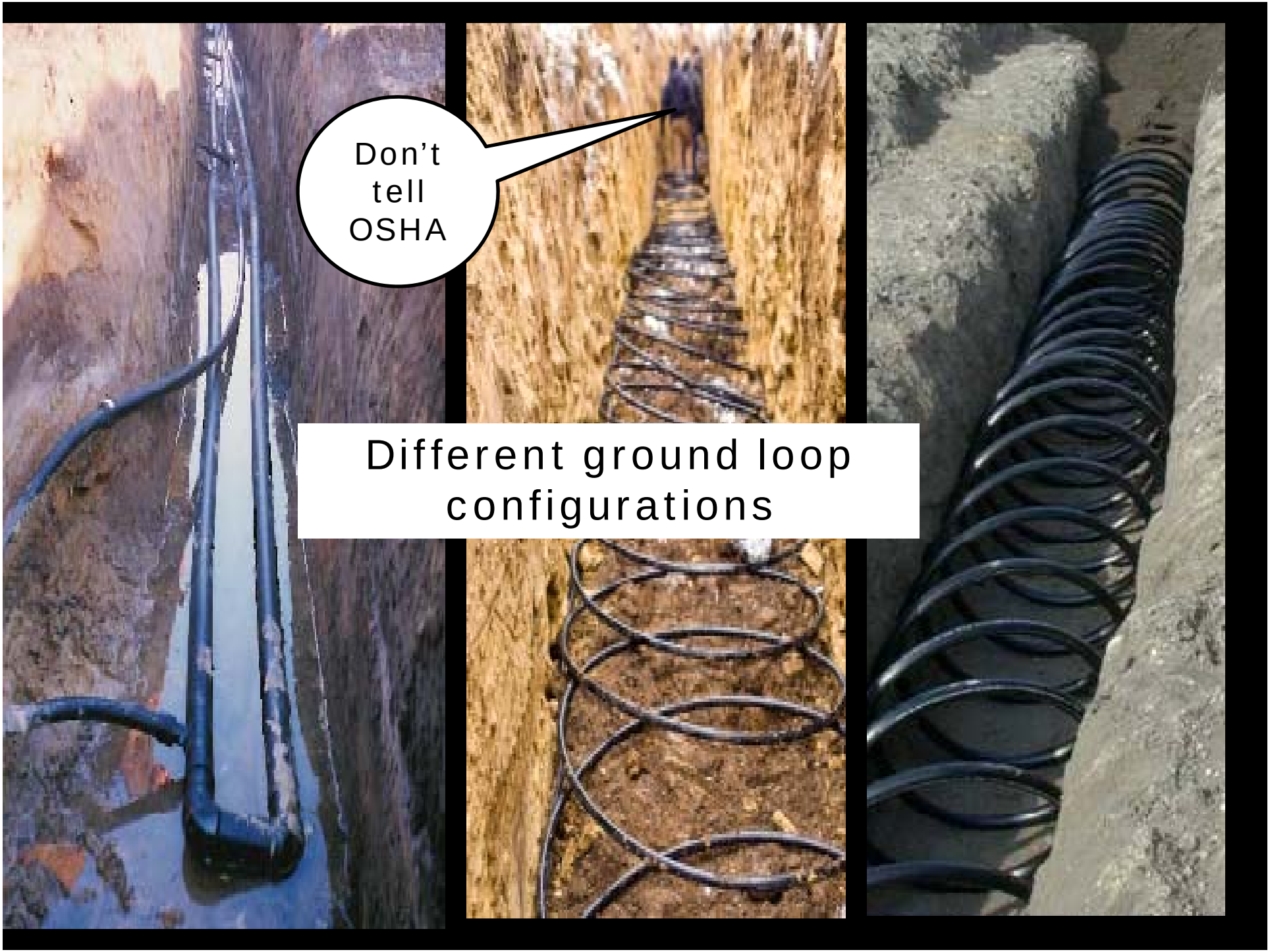


OPEN LOOP SYSTEMS



SURFACE WATER – LAKE OR POND HEAT PUMPS

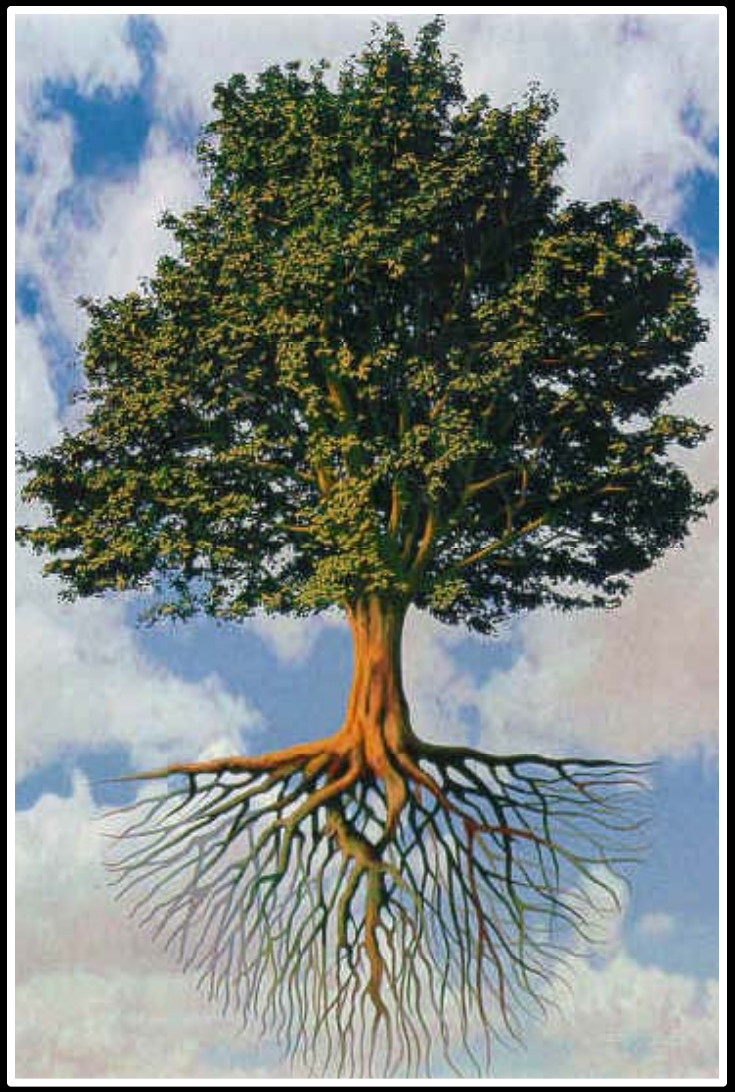



Don’t tell OSHA
Different ground loop configurations

Backfilling geothermal loop field

John Lund, Oregon Institute of Technology

Trees have roots



Animals dig

SEDIMENT FROM SITE WORK


Photograph – Baroid IDP

Straw bales keep well drilling slurry and rock fragments from spreading over existing landscape

A 200 ft well drilled to take 6 inch casing will create about 4 cubic yards

GROUND WATER QUALITY

Water quality concerns

CIRCULATION FLUIDS:

H20	Water
$K2CO_2$	Potassium carbonate
KOAc	Potassium acetate
NaCl	Sodium chloride
$CaCl_2$	Calcium chloride

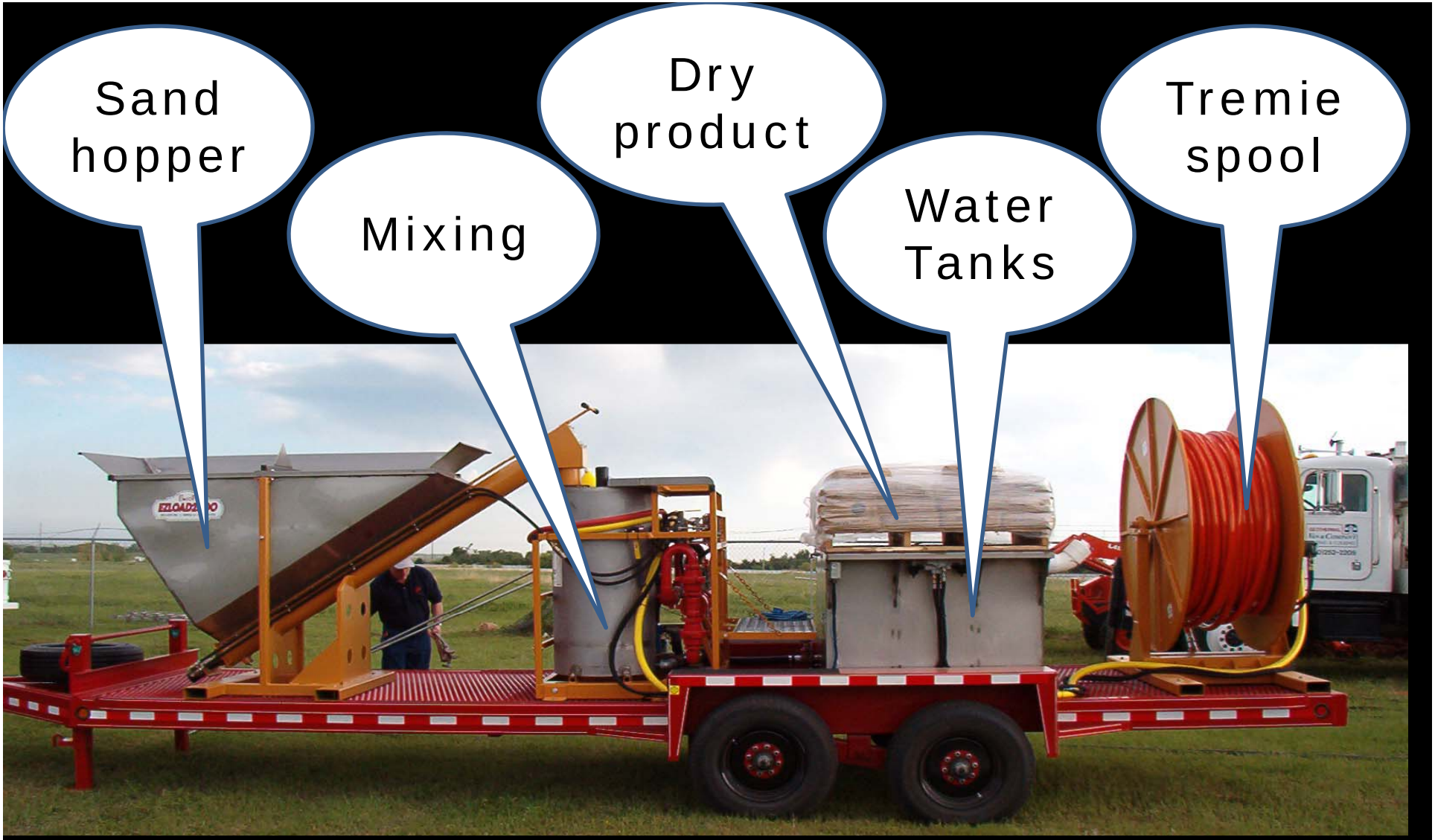
Ethanol
Methanol
Ethelene glycol
Propylene glycol (the good one!)

Need to consider, cost, toxicity, heat transfer properties and viscosity

CIRCULATION FLUIDS:

- 60 gallons of fluid needed for 5 tons of heat exchange
- Systems tested at 100psi, operated at 30psi
- Risk (if any) is at installation stage when loop is “filled”
- Horizontal installation base and back-fill material selection important
- Tracer wire in trench aids location
- Buried dig-safe beads can help avoid back-hoe disturbance
- Trenches can be flow conduits

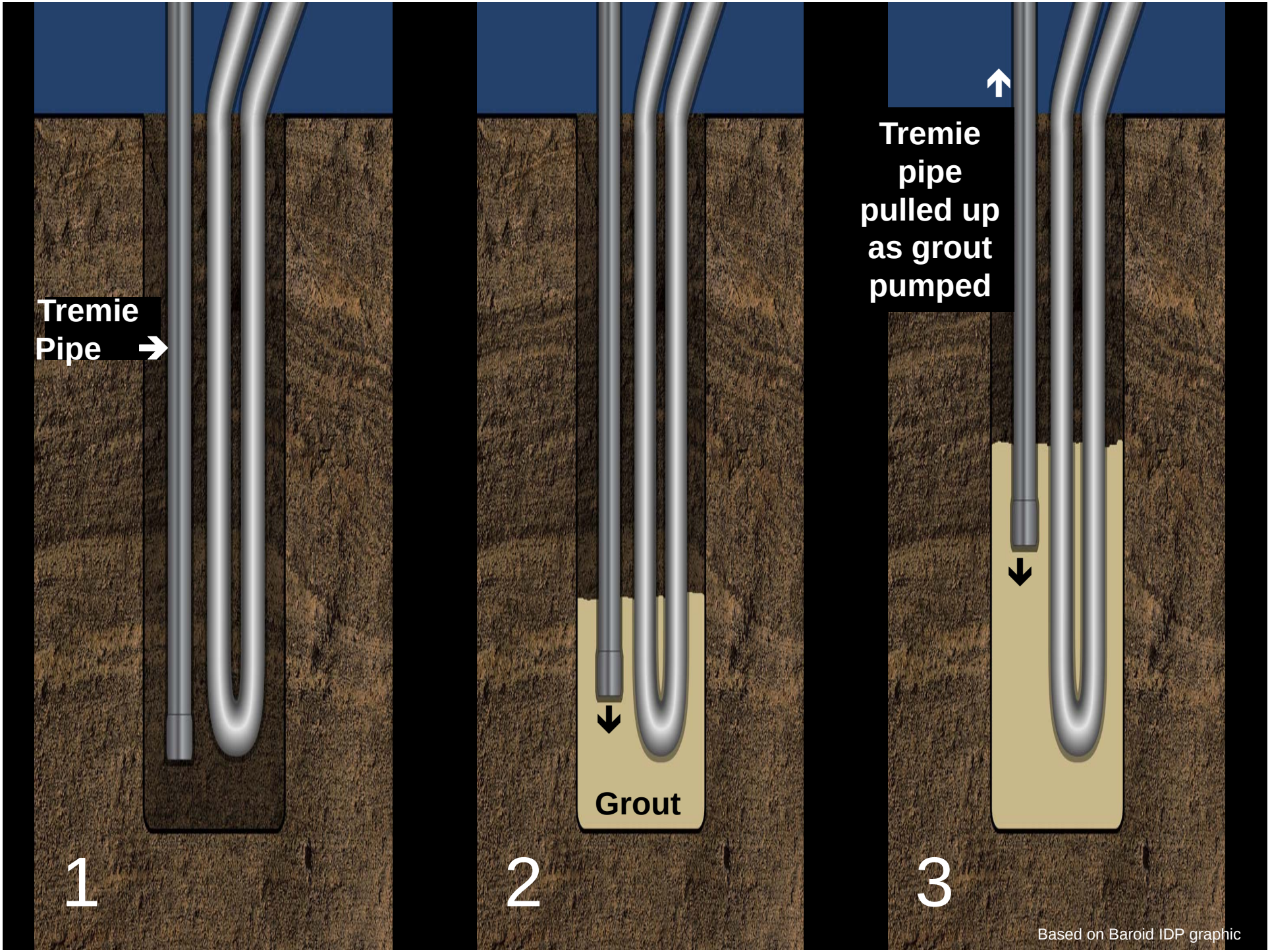
GROUT PLACEMENT

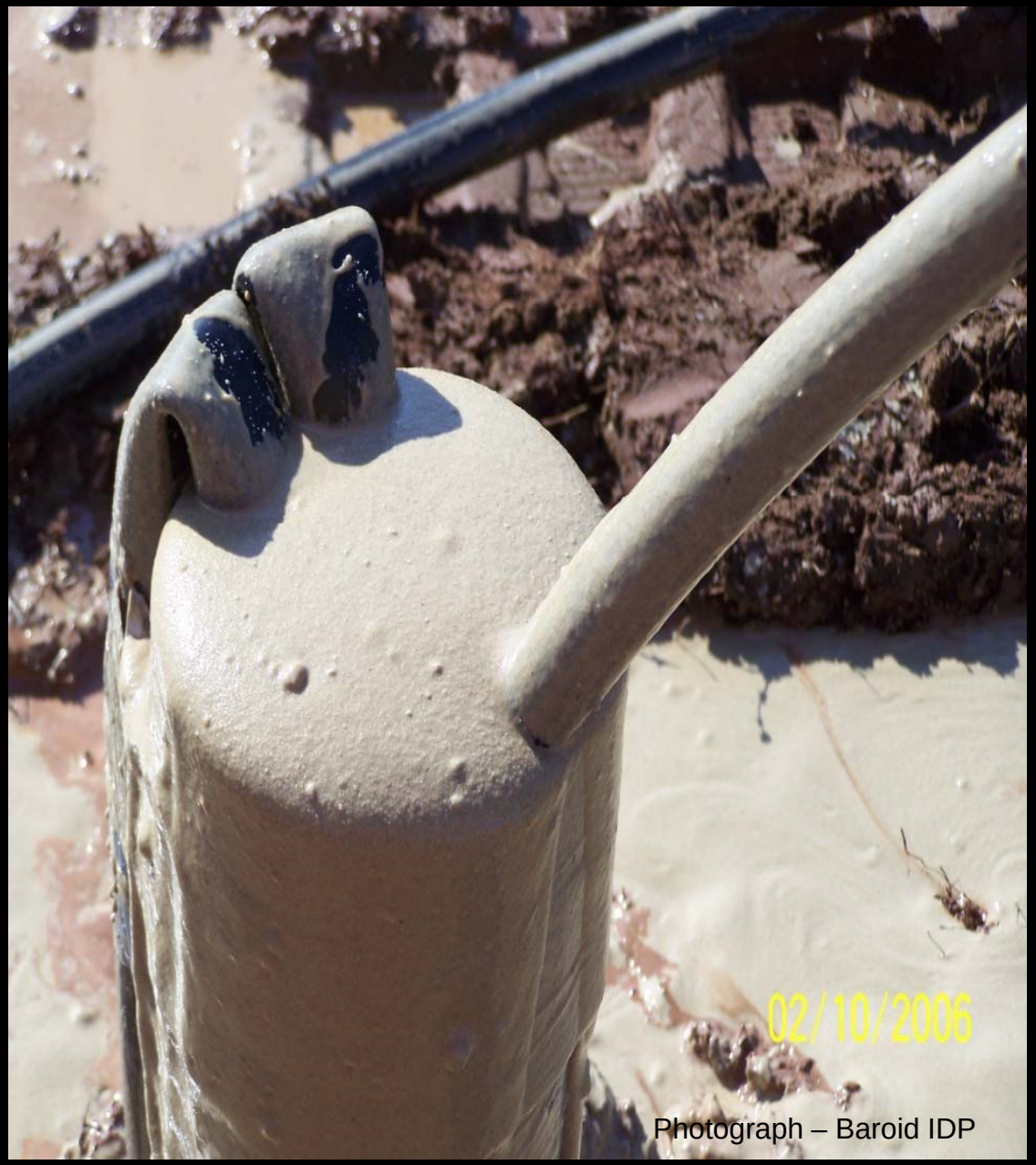


GROUTING SYSTEM FOR GEOTHERMAL INSTALLATIONS

Photograph - GeoPro

Bentonite and sand mixed to make thermally enhanced grout


Tremie Pipe
Grout
Tremie pipe pulled up as grout pumped
1
2
3
Based on Baroid IDP graphic



Photograph – Baroid IDP

Photograph 1 Baroid IDP

The GHPsRUS Project encourages the installation of geothermal heat pumps (GHPs) across the United States. The project supports the U.S. Department of Energy's goal of having one million GHPs installed each year by 2016