HUMAN HEALTH SCIENCE BLDG GEO HEAT PUMP SYSTEMS

May 20, 2010

Principal Investigator

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Oakland University

Source Heat Pumps Demo Projects

This presentation does not contain any proprietary confidential, or otherwise restricted information.

Project Overview

- **Timeline**
  - Geothermal ground array bid package: April 2010
  - Geothermal ground array construction: Summer 2010
  - Main building construction begins: June 2010
  - Substantial completion: Summer 2012
  - Performance monitoring & reporting: 2012 through 2014
- **Budget**
  - Total project: $9,778,930
  - DOE share $2,738,100
  - Awardee share $7,040,830
- **Barriers** *(No funds received yet)*
  - Lack of experience with: Geothermal projects of this size, VRF heat pumps, large solar thermal systems, & desiccant cooling
- **Architect / Engineer:** Smithgroup
- **Construction Manager:** Christman Company
- **Geothermal Specialist:** Strategic Energy Solutions

Geothermal Heat Pump Demonstration

Utilize a ground sourced heat pump HVAC system.

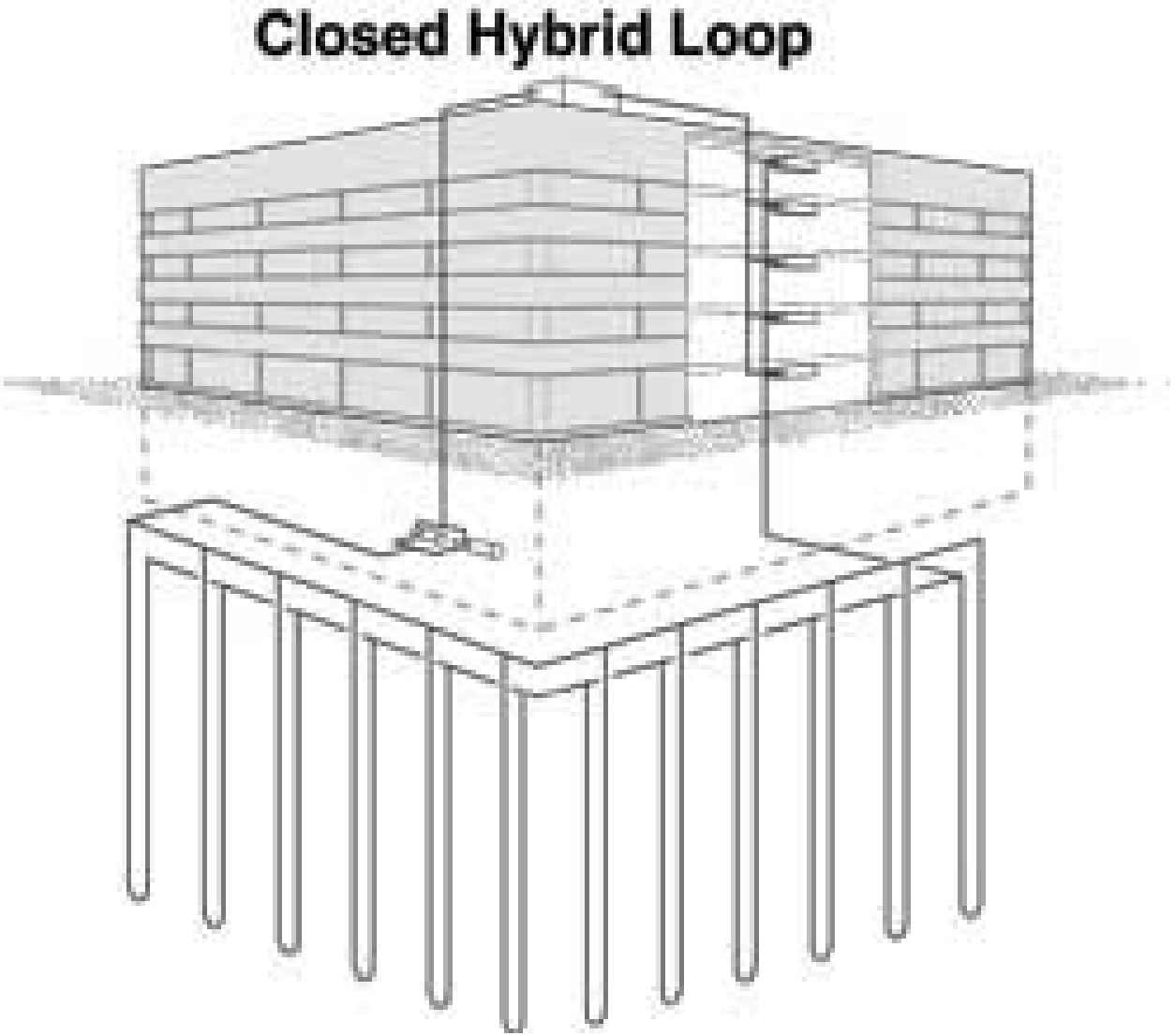
Variable Refrigerant Flow Technology

Utilize variable refrigerant flow (VRF) heat pumps, allows for less compressors and enhanced internal heat recovery.

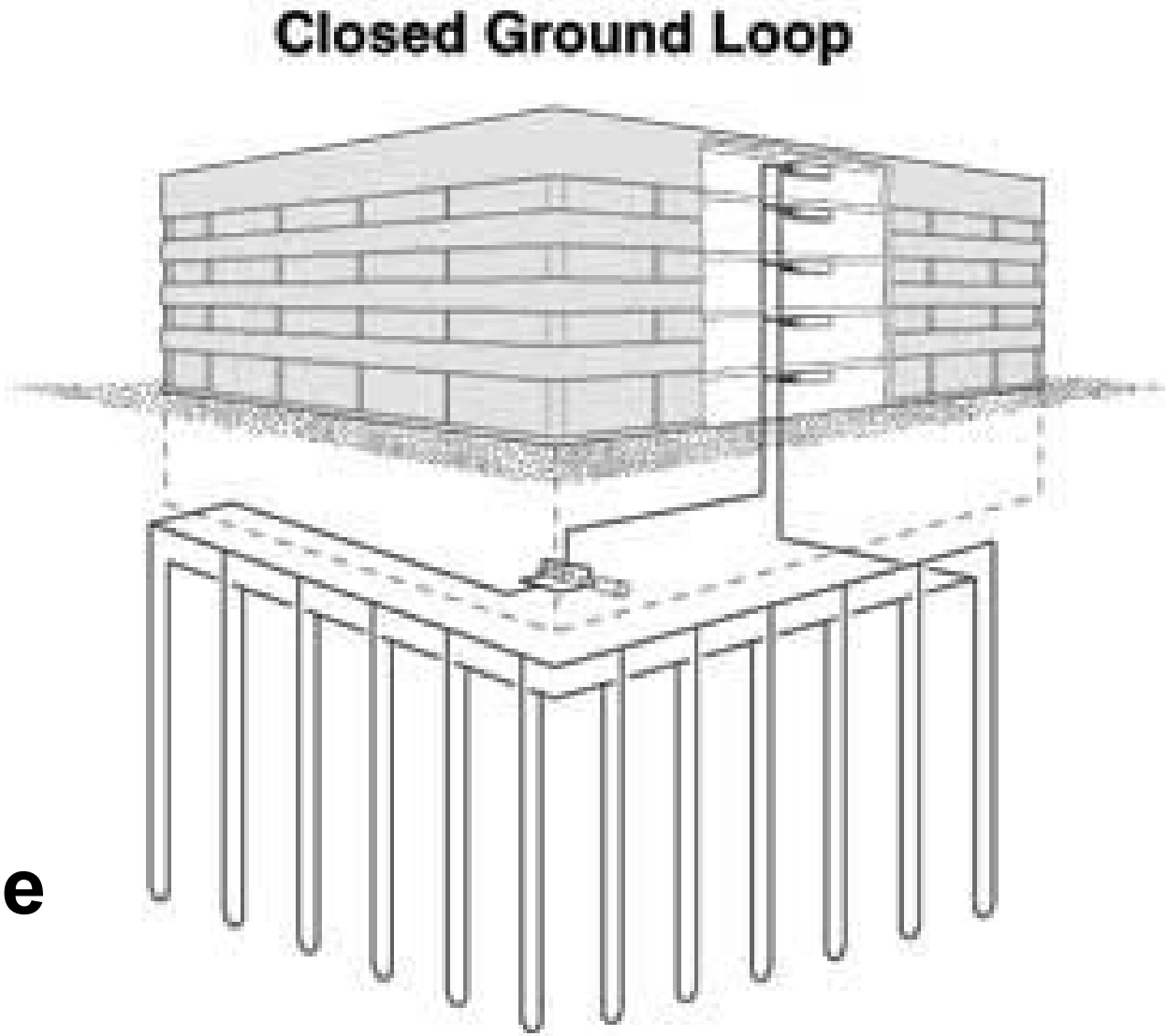
Solar Thermal Desiccant Dehumidification

Dedicated outdoor air supply units will utilize a thermally regenerated desiccant dehumidification section. A large solar thermal system along with a natural gas backup boiler will provide the thermal regeneration energy.

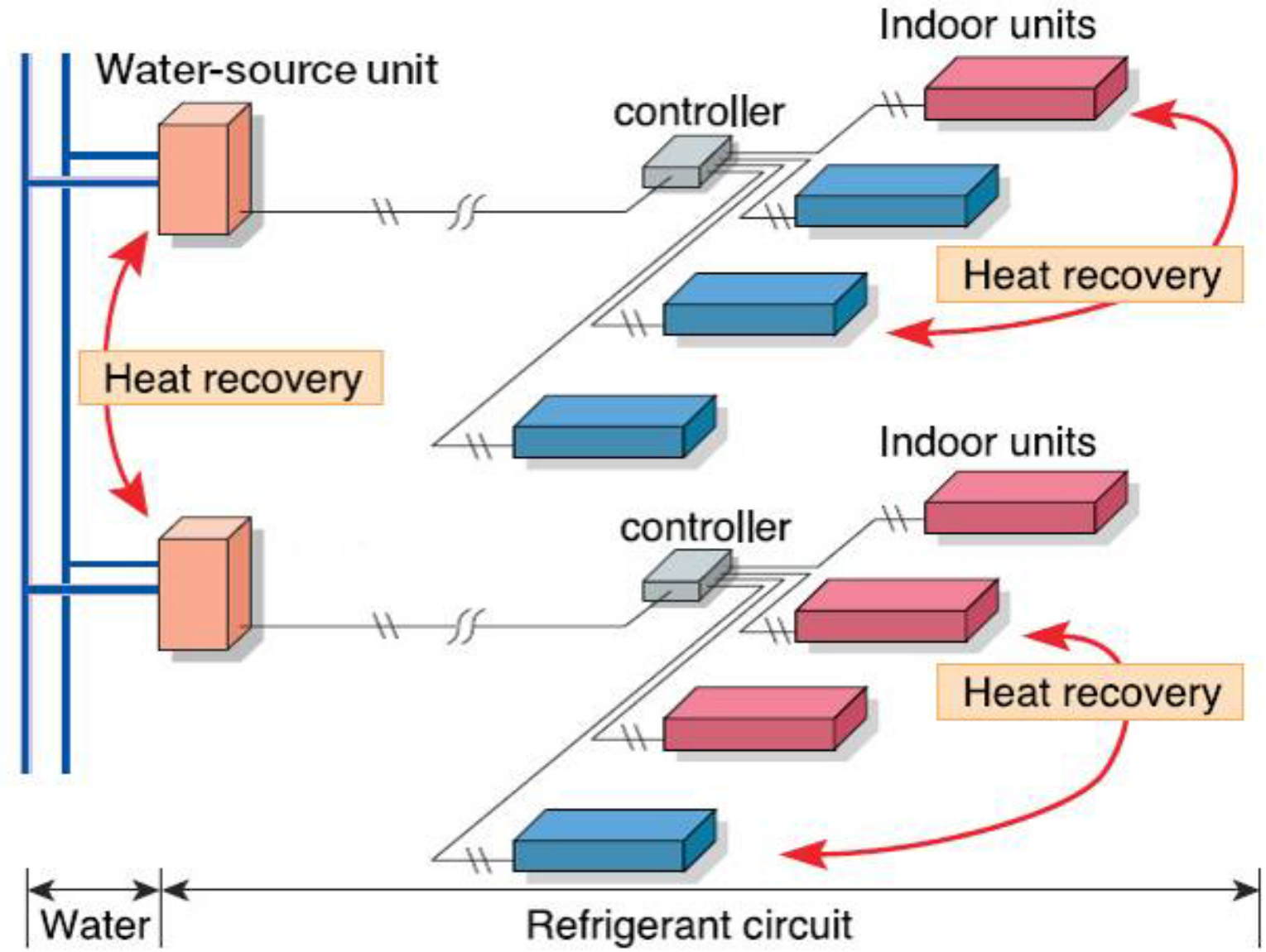
Original Concept



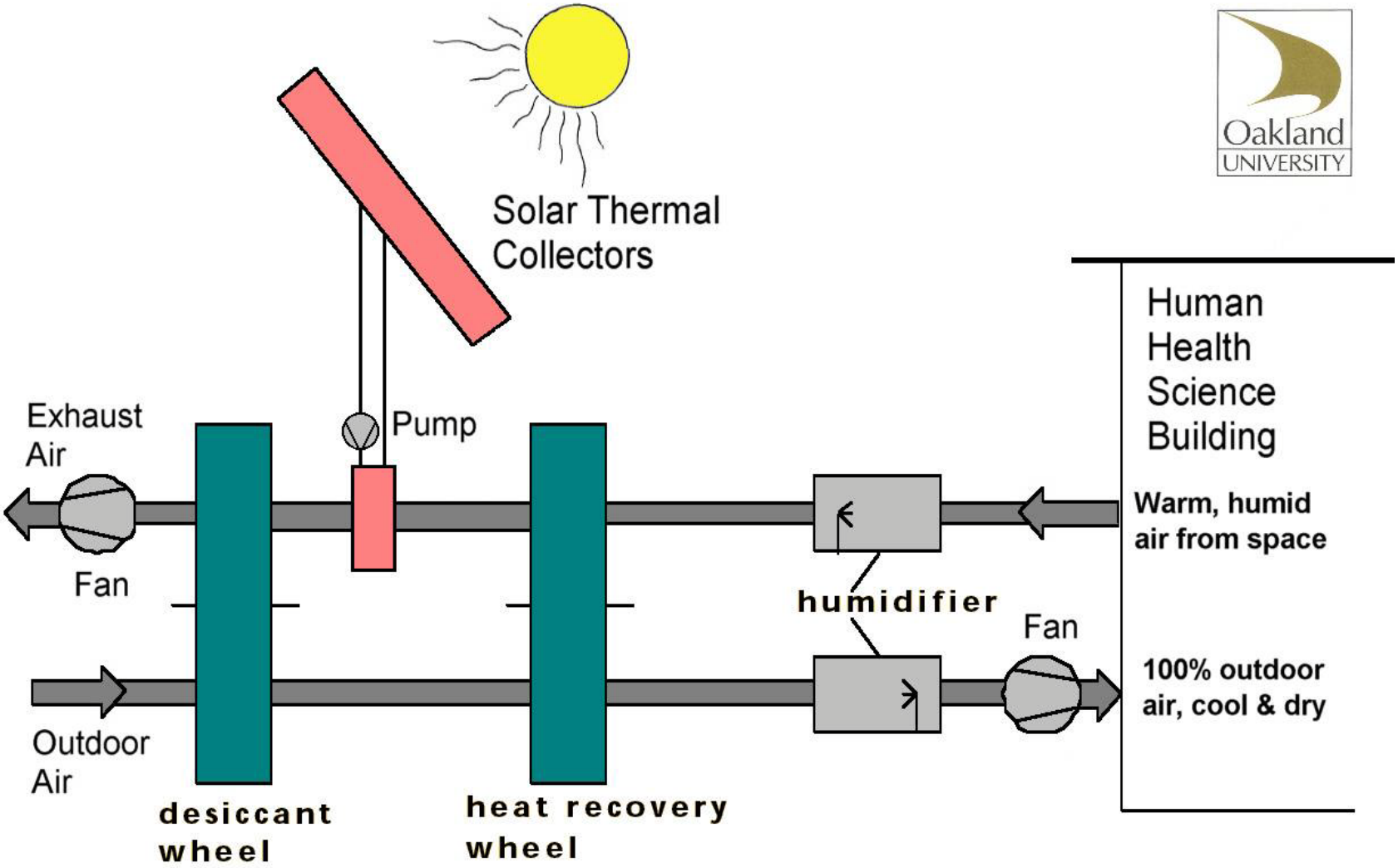
Water Only, No Antifreeze



Variable Refrigerant Flow

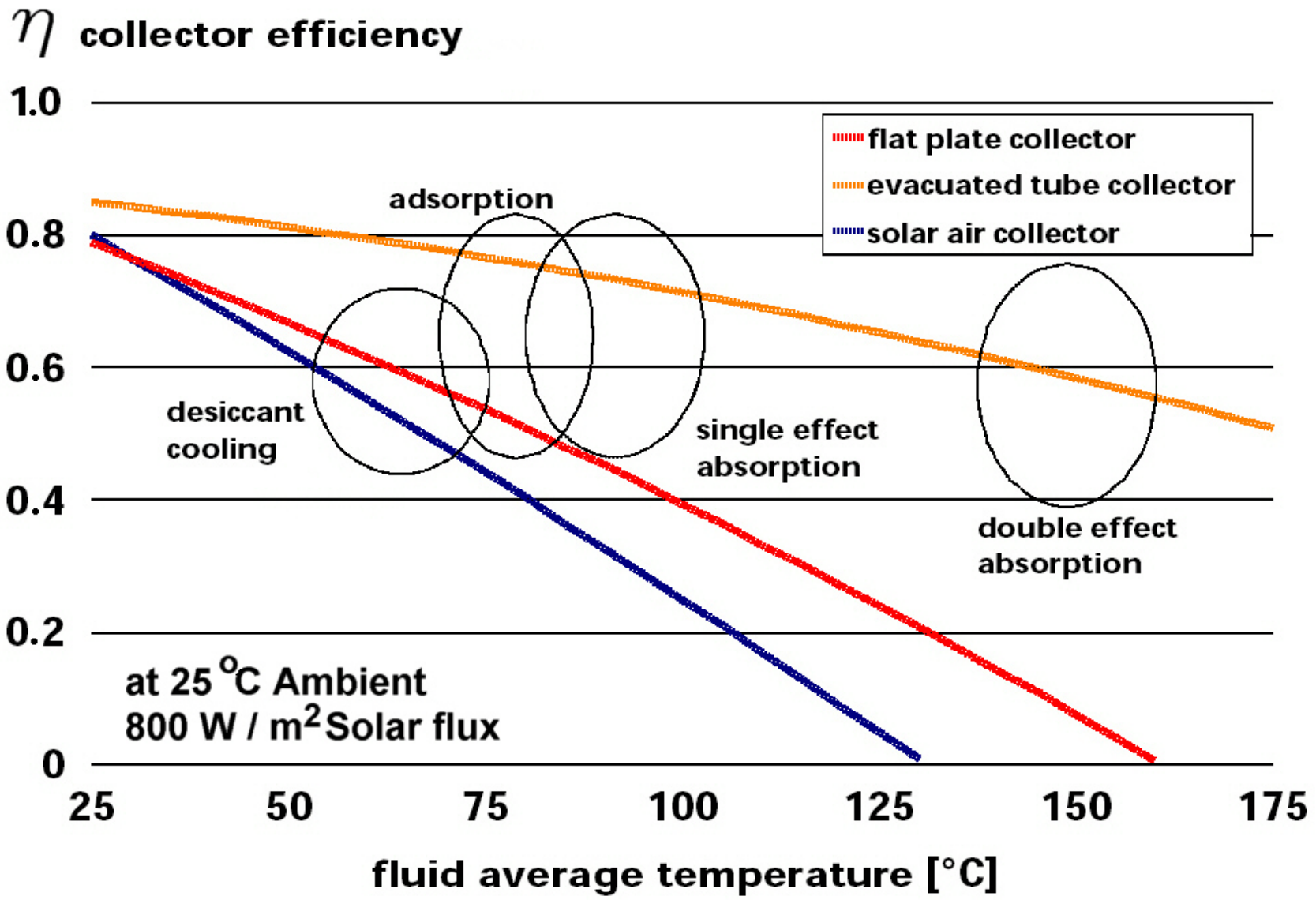


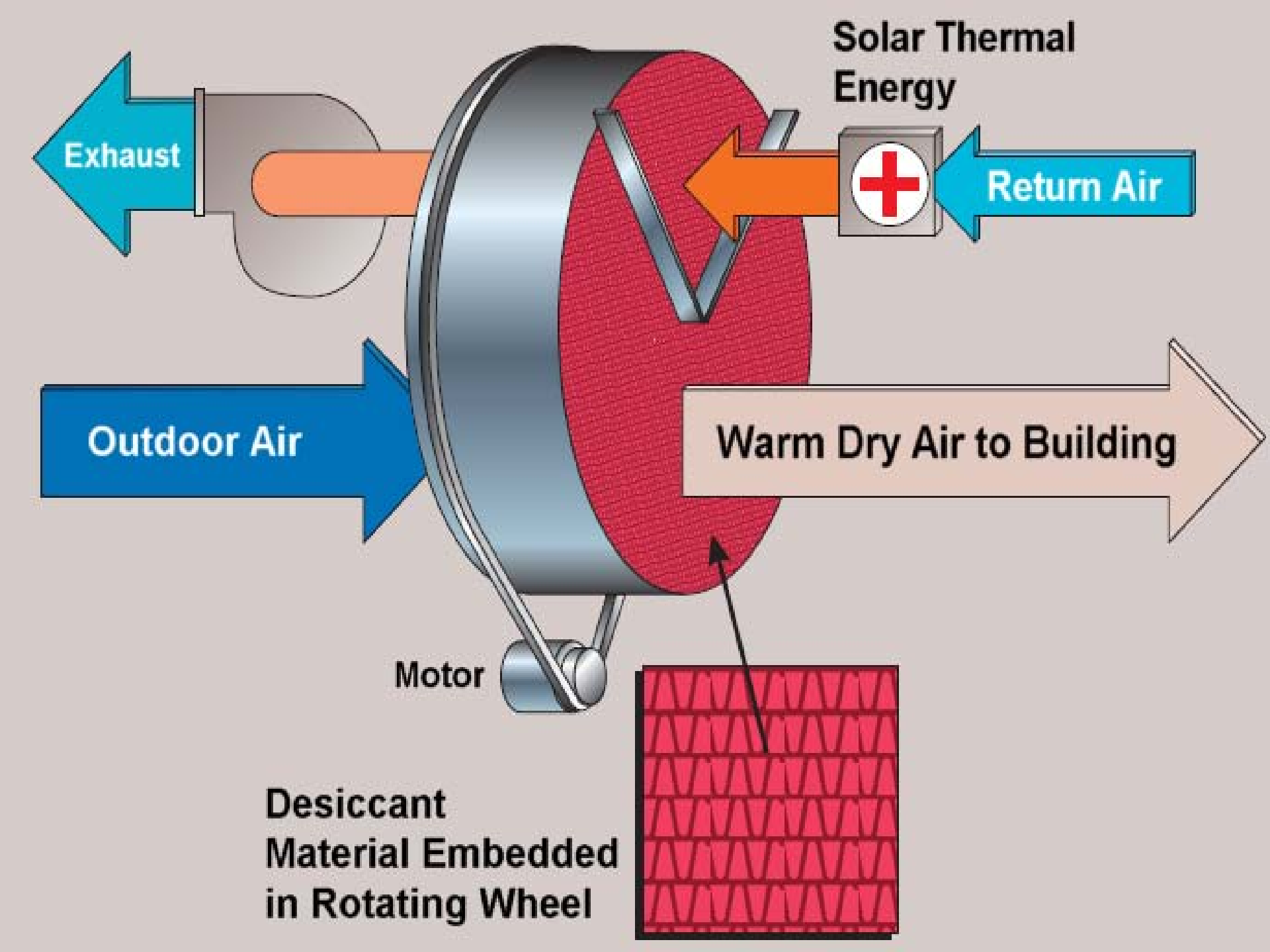
Solar Thermal Desiccant Cooling



Dedicated Outdoor Air Suppy Unit

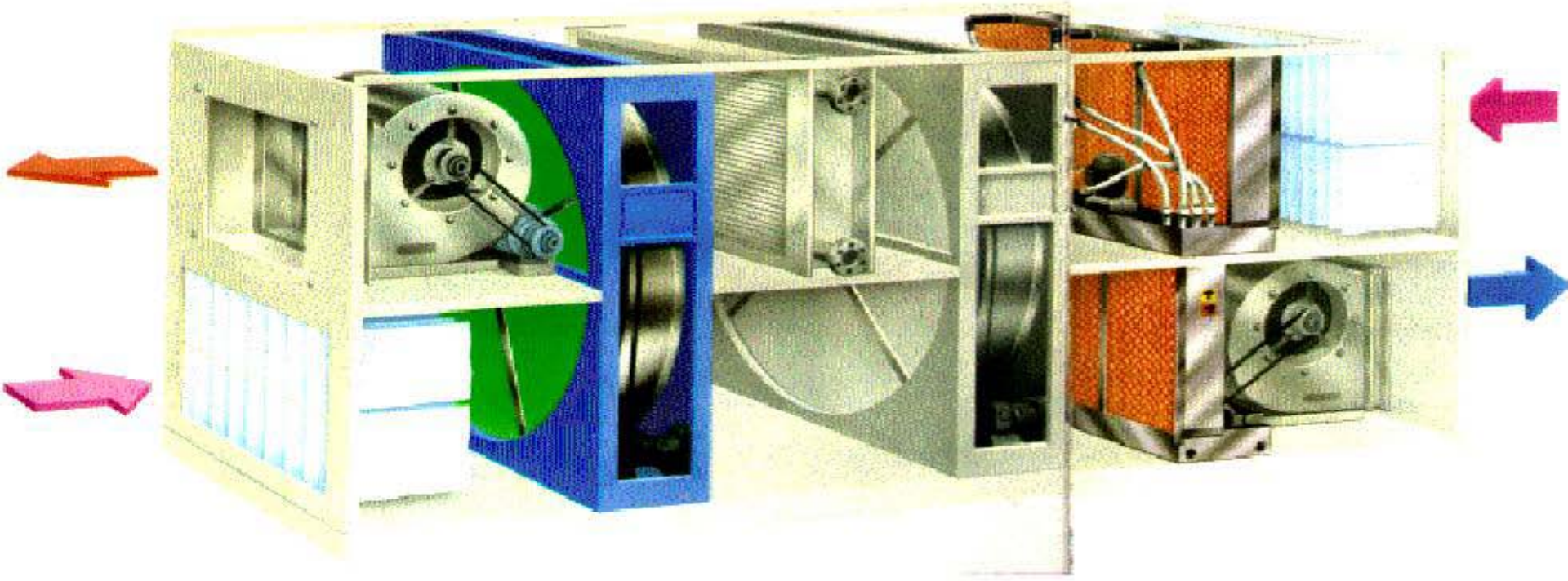
Choice of Thermally Activated Technology – Desiccant Cooling




Solar Thermal Energy
Exhaust
Return Air
Outdoor Air
Warm Dry Air to Building
Motor
Desiccant Material Embedded in Rotating Wheel

Exhaust Air

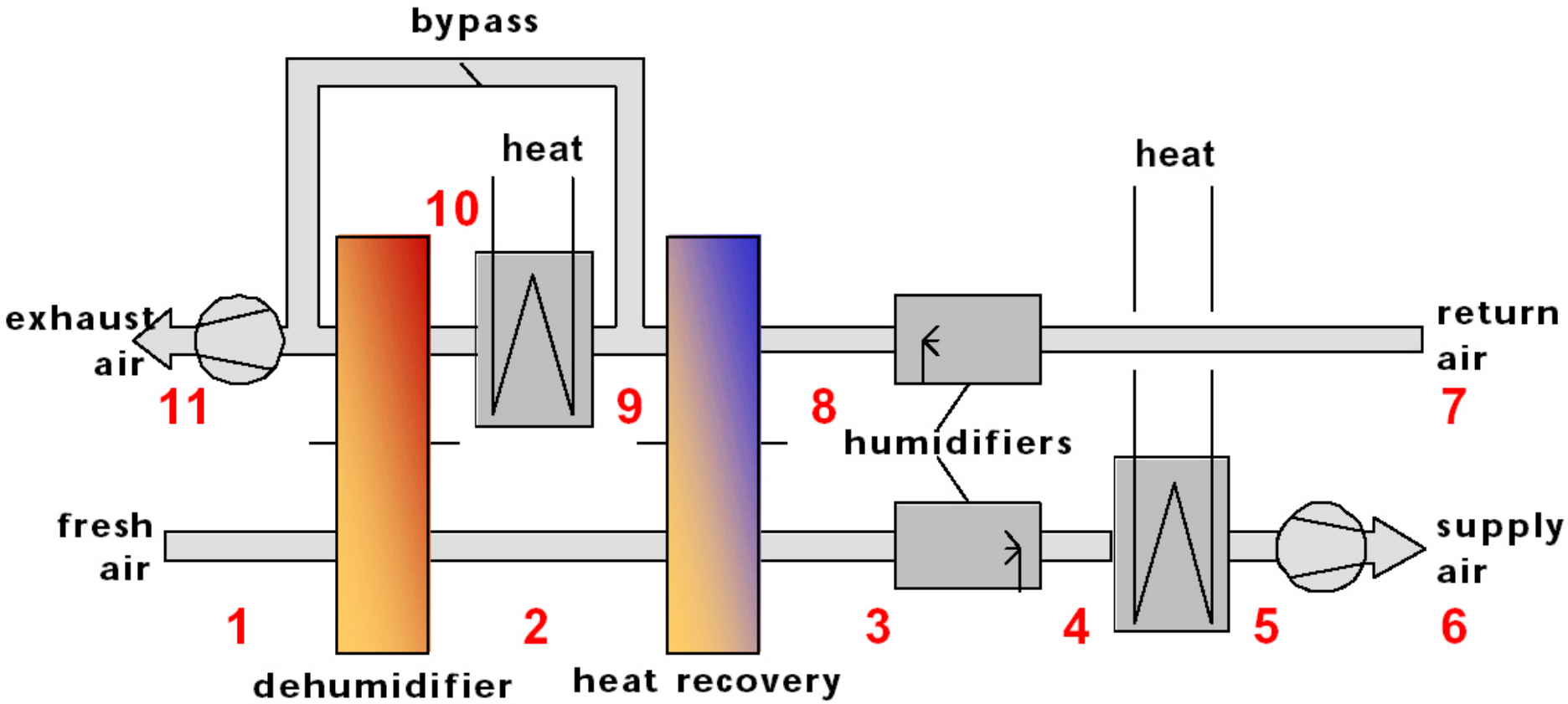
Exhaust from Space



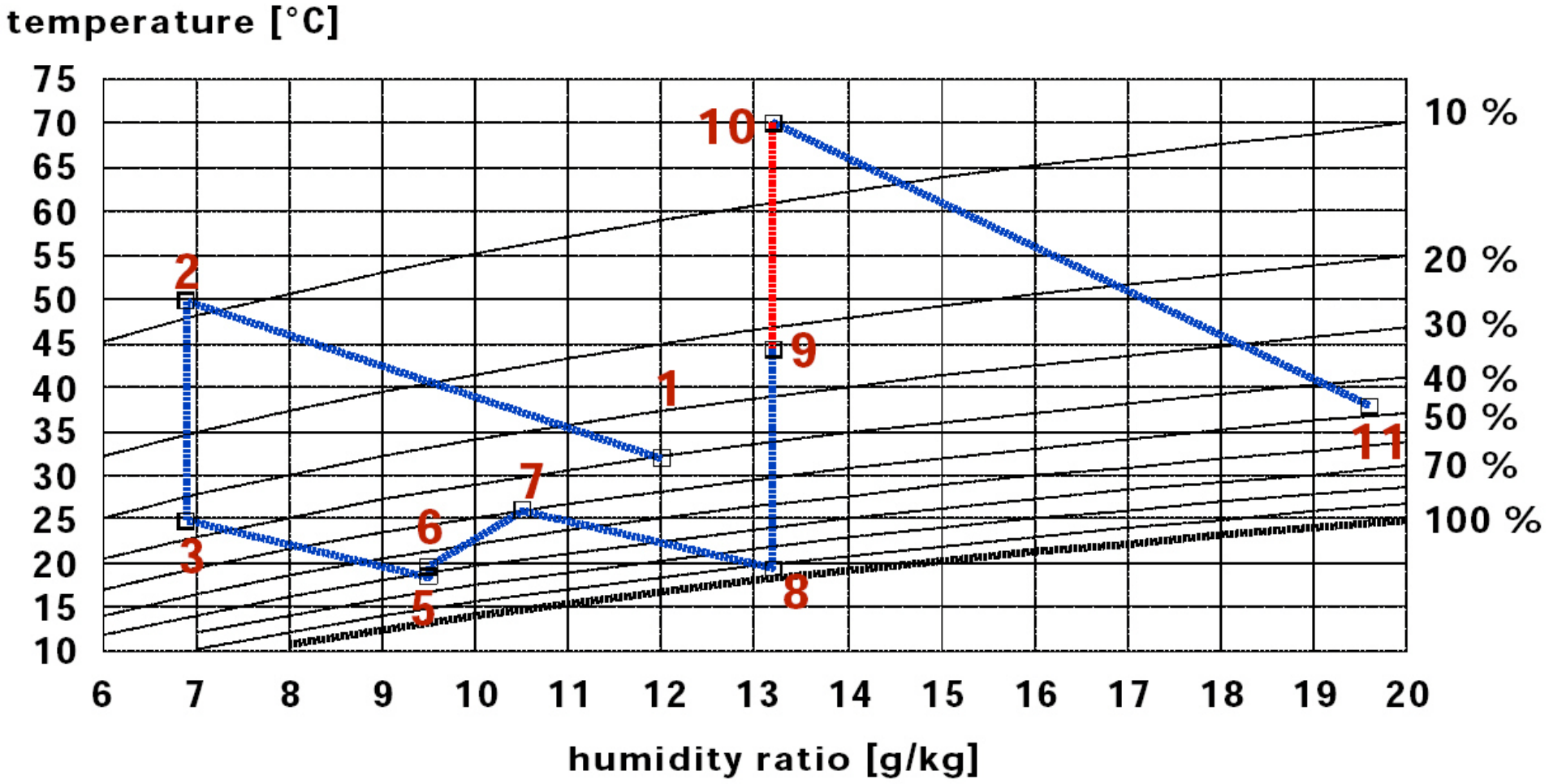
Outdoor Air Intake

Conditioned Air to Space

Technical Approach



Technical Approach



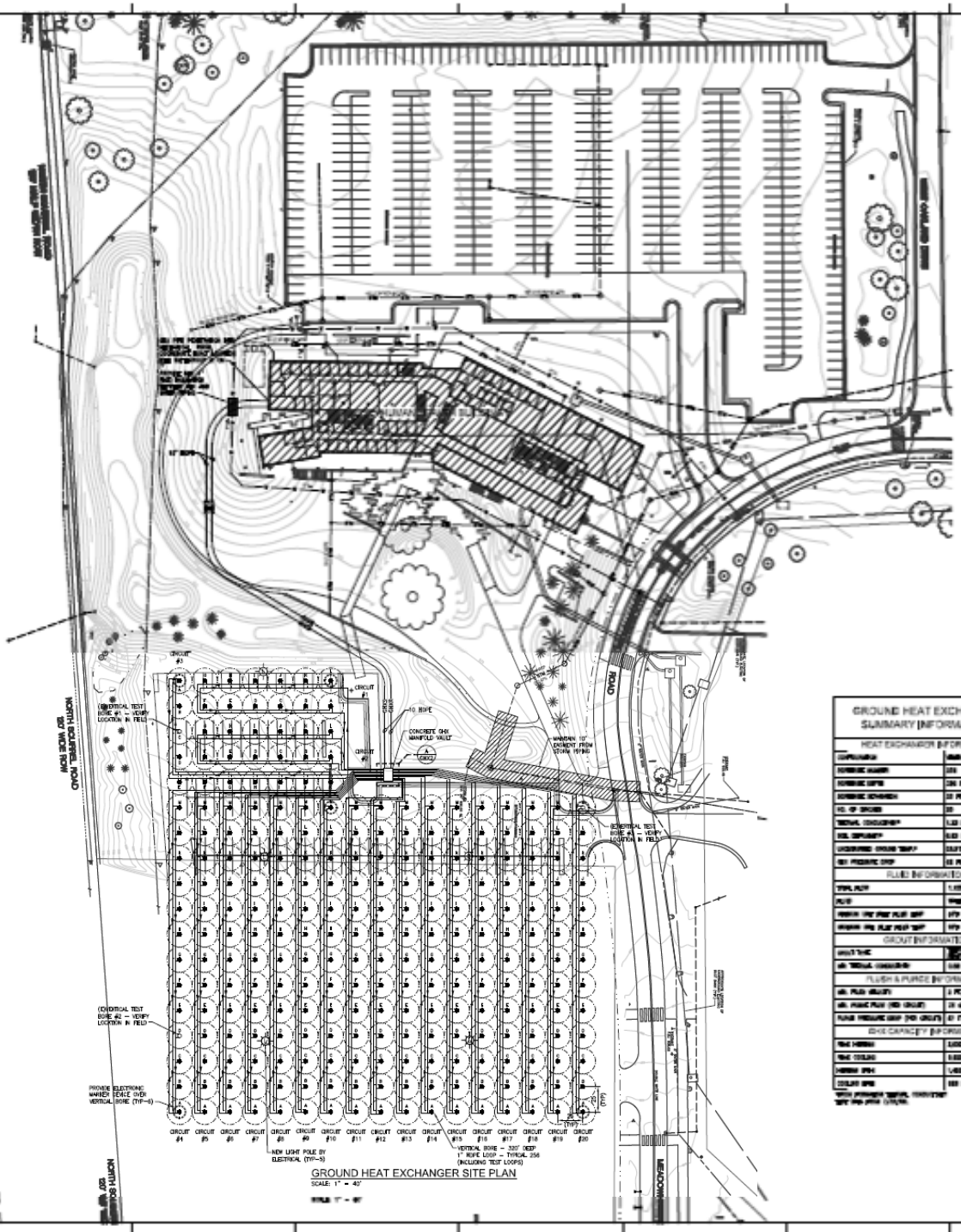
Geothermal Heat Pump Demonstration

HEAT EXCHANGER INFORMATION	
Configuration	Vertical Closed Loop
Borehole Quantity	256
Borehole Depth	320 feet
Borehole Separation	25 feet
Number of Circuits	20
Thermal Conductivity *	1.23 BTU / (hr-ft-deg F)
Soil Diffusivity	0.83 foot^2 / day
Undisturbed Ground Temperature *	53.0 deg F
GHX Pressure Drop	42 feet of head
FLUID INFORMATION	
Total Flow	1,225 GPM
Fluid	Water only
Minimum HP Unit Inlet Fluid Temp	40 deg F
Maximum HP Unit Inlet Fluid Temp	90 deg F

* From formation thermal conductivity test data taken July 30, 2009

Geothermal Heat Pump Demonstration

GROUT INFORMATION	
Grout Type	Thermally Enhanced Bentonite
Minimum Thermal Conductivity	0.88 BTU / (hr-ft-deg F)
FLUSH & PURGE INFORMATION	
Minimum Fluid Velocity	2 feet / second
Minimum Purge Flow (per circuit)	75 GPM
Purge Pressure Drop (per circuit)	47 feet of head
GHX CAPACITY INFORMATION	
Peak Heating	2,000,000 BTU / hour (166 tons)
Peak Cooling	4,920,000 BTU / hour (410 tons)
Heating EFLH	1,455 hours
Cooling EFLH	929 hours



GROUND HEAT EXCHANGER SITE PLAN

SCALE: 1" = 40'

GROUND HEAT EXCHANGER NOTES

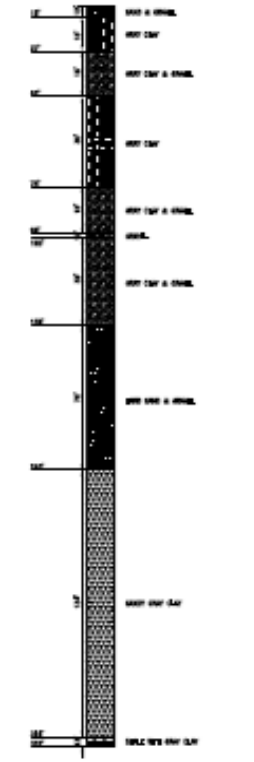
1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]

[illegible]

GROUND HEAT EXCHANGER SUMMARY INFORMATION

HEAT EXCHANGER INFORMATION	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
FLUID INFORMATION	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
GROUT INFORMATION	
[illegible]	[illegible]
[illegible]	[illegible]
FLUSH & PURGE INFORMATION	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
SYSTEM CAPACITY INFORMATION	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]



DRILL LOG FROM VERTICAL TEST BORE #1

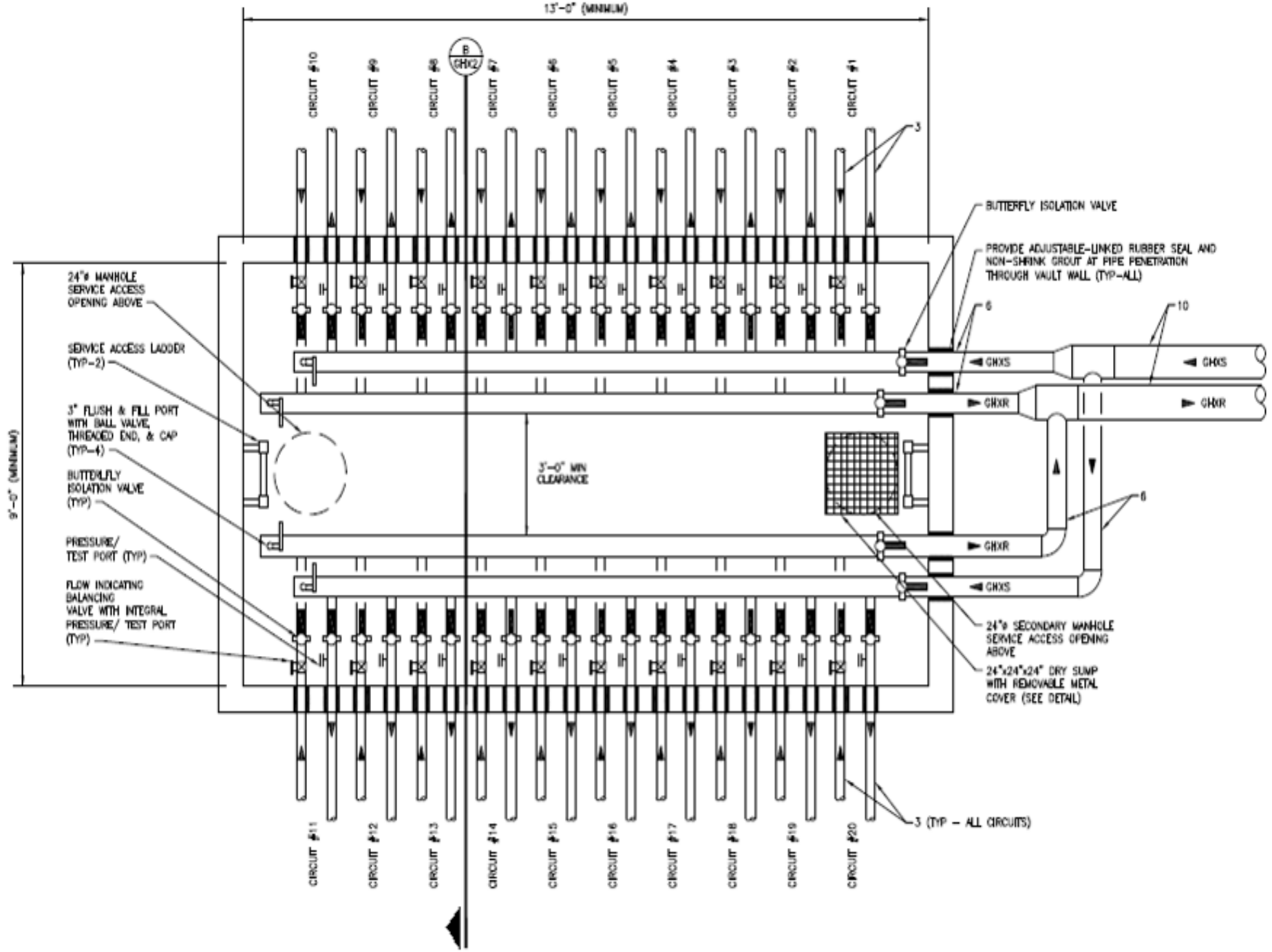
FORMATION THERMAL CONDUCTIVITY TEST

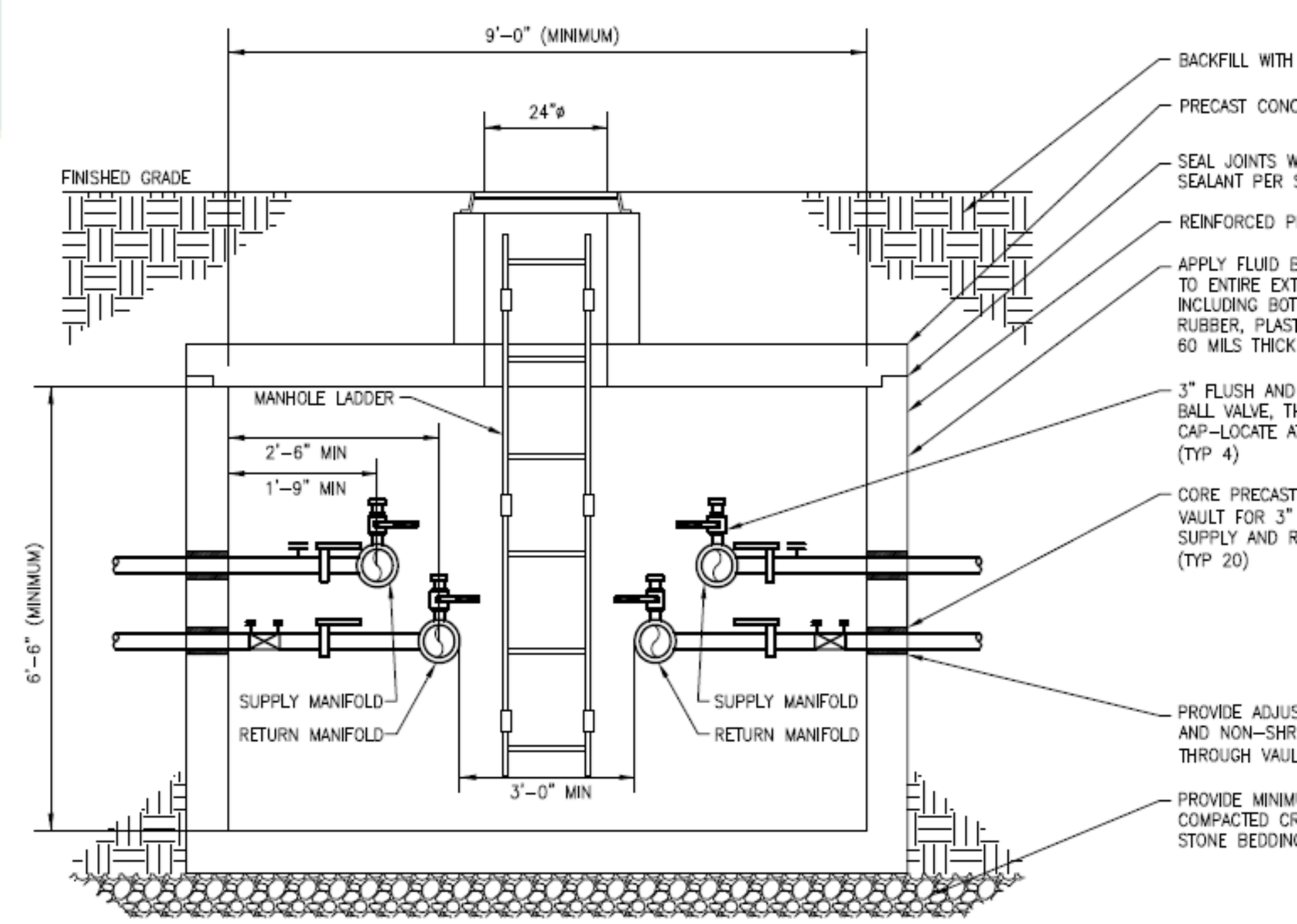
Know what's below. Call before you dig.

OAKLAND UNIVERSITY

HUMAN HEALTH BUILDING
GROUND HEAT EXCHANGER
SITE PLAN

GHX-1.0


13'-0" (MINIMUM)
9'-0" (MINIMUM)
B
GHX2
CIRCUIT #10
CIRCUIT #9
CIRCUIT #8
CIRCUIT #7
CIRCUIT #6
CIRCUIT #5
CIRCUIT #4
CIRCUIT #3
CIRCUIT #2
CIRCUIT #1
CIRCUIT #11
CIRCUIT #12
CIRCUIT #13
CIRCUIT #14
CIRCUIT #15
CIRCUIT #16
CIRCUIT #17
CIRCUIT #18
CIRCUIT #19
CIRCUIT #20
24"ø MANHOLE SERVICE ACCESS OPENING ABOVE
SERVICE ACCESS LADDER (TYP-2)
3" FLUSH & FILL PORT WITH BALL VALVE, THREADED END, & CAP (TYP-4)
BUTTERFLY ISOLATION VALVE (TYP)
PRESSURE/ TEST PORT (TYP)
FLOW INDICATING BALANCING VALVE WITH INTEGRAL PRESSURE/ TEST PORT (TYP)
3'-0" MIN CLEARANCE
BUTTERFLY ISOLATION VALVE
PROVIDE ADJUSTABLE-LINKED RUBBER SEAL AND NON-SHRINK GROUT AT PIPE PENETRATION THROUGH VAULT WALL (TYP-ALL)
GHXS
GHXR
24"ø SECONDARY MANHOLE SERVICE ACCESS OPENING ABOVE
24"x24"x24" DRY SUMP WITH REMOVABLE METAL COVER (SEE DETAIL)
3 (TYP - ALL CIRCUITS)
3
6
10


9'-0" (MINIMUM)
24"ø
FINISHED GRADE
MANHOLE LADDER
2'-6" MIN
1'-9" MIN
6'-6" (MINIMUM)
SUPPLY MANIFOLD
RETURN MANIFOLD
SUPPLY MANIFOLD
RETURN MANIFOLD
3'-0" MIN
BACKFILL WITH
PRECAST CONC
SEAL JOINTS W
SEALANT PER
REINFORCED P
APPLY FLUID
TO ENTIRE EXT
INCLUDING BOT
RUBBER, PLAST
60 MILS THICK
3" FLUSH AND
BALL VALVE, TH
CAP-LOCATE A
(TYP 4)
CORE PRECAST
VAULT FOR 3"
SUPPLY AND R
(TYP 20)
PROVIDE ADJUS
AND NON-SHR
THROUGH VAUL
PROVIDE MINIM
COMPACTED CR
STONE BEDDING

- **Three Test Bores – Geothermal Conductivity Tests Completed**
- **Geothermal System Design is Complete**
- **Geothermal Bid Package Issued**
- **Full Project Design 90% Complete**
- **Formal Ground Breaking in April 2010**

Project Management/Coordination

- **Geothermal Well Field to be Constructed & Completed by September 2010**
- **Site Work & Foundation Bid Package Due to be Issued in May 2010**
- **Full Construction Bid Package Due to be Issued in Summer 2010**
- **Substantial Completion by Summer 2012**
- **Three Full Years of System Monitoring & Reporting**

Project Summary

- **Innovative Project with Proven Technologies, but New the United States**
  - **Variable Refrigerant Flow Heat Pumps**
  - **Desiccant Dehumidification of Outdoor Air Ventilation with Solar Thermal Regeneration**
- **Large 400 Ton System**
- **USGBC LEED Building Gold or Platinum Rating**

Thank you

www.oakland.edu/energy

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