Geothermal Installations at Richard Stockton College and NJ Regulations

Northeast Region Geothermal Workshop

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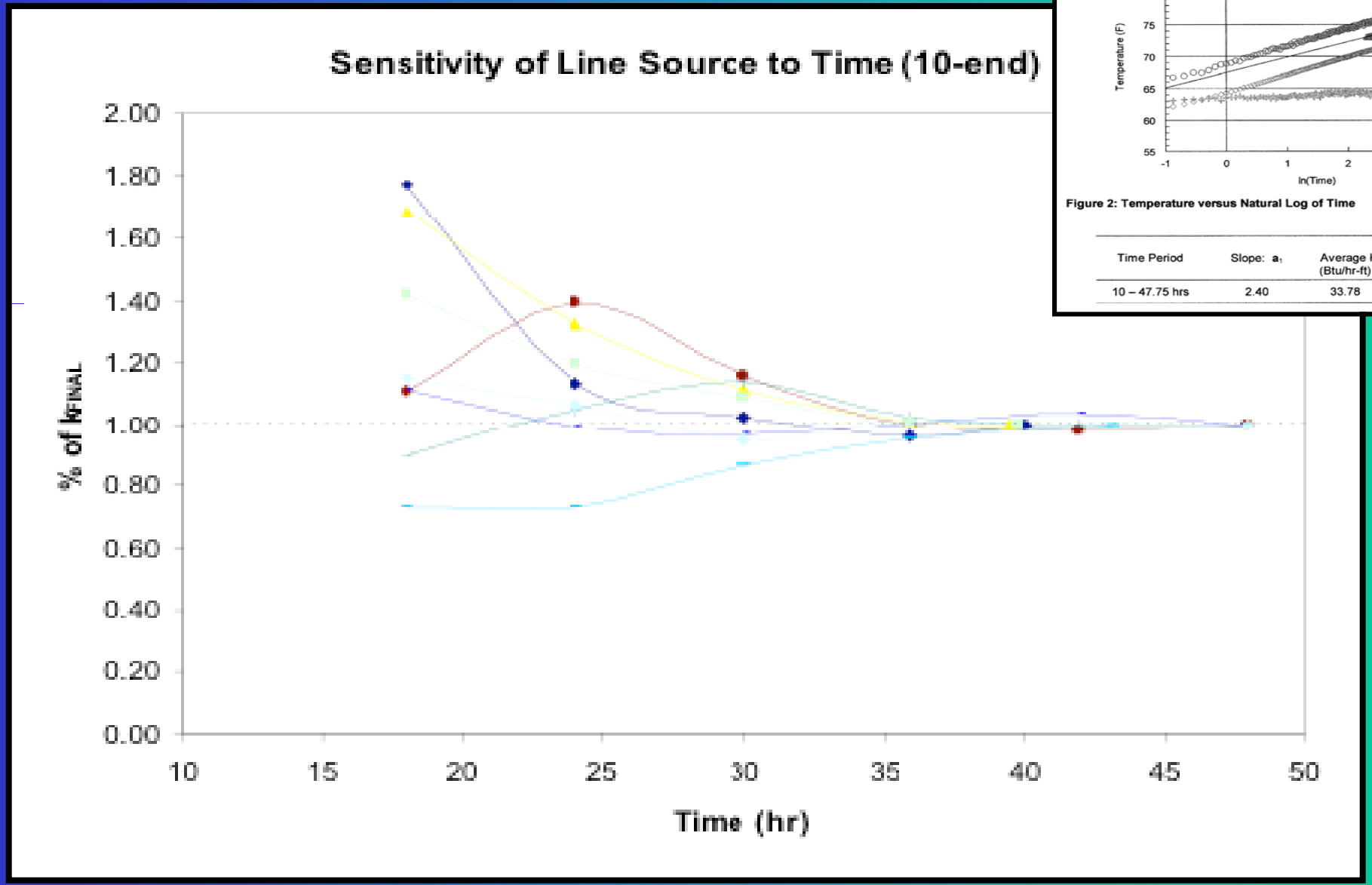
Grout

Type	Thermal Conductivity "K" (BTU/H-ft-°F)	Cost per Foot (for 6" Bore)	Ease of Use	Sealant Performance	New Jersey Regulations
Bentonite (30% Solids)	0.48	$0.30	*****	*****	Unconsolidated Formations only
Thermally Enhanced Grout #85 (Mix 111)	0.85 (1.11)	$1.15	***	****	Unconsolidated
Fine Sand (Wet)	1.35	$0.78	*****	*	Not Permitted
High Capacity Cementitious Thermally Enhanced Grout	Up to 1.40	$1.65	**	*****	Unconsolidated or Consolidated Formations

Comparison of typical systems with medium and high efficiency GHP's

Project type	Size (ft^2)	Cooling Capacity (tons)	CO_2 reduction	CO_2 reduction (kg/kW_c)
1 - Commercial office	5,600	25	19% - 34%	156-255
2 - Commercial office	160,000	500	41% - 46%	177-201
3a - College cluster housing (10 month occupancy)	23,000	30	38% - 45%	75-91
3b - College cluster housing (12 month occupancy)	23,000	30	43% - 50%	167-198
4 - College classrooms	20,000	75	19% - 26%	63-87
5 - College classrooms	80,000	300	18% - 26%	51-73
6 - College classrooms	25,000	100	17% - 31%	85-159
7 - Middle school (ages 11-13)	140,000	350	29% - 42%	136-192
8 - Elderly care facility	560,000	180	28%-34%	120-144
9 - Single family residence	2,000	5.5	48%	220

Thermal Conductivity Test



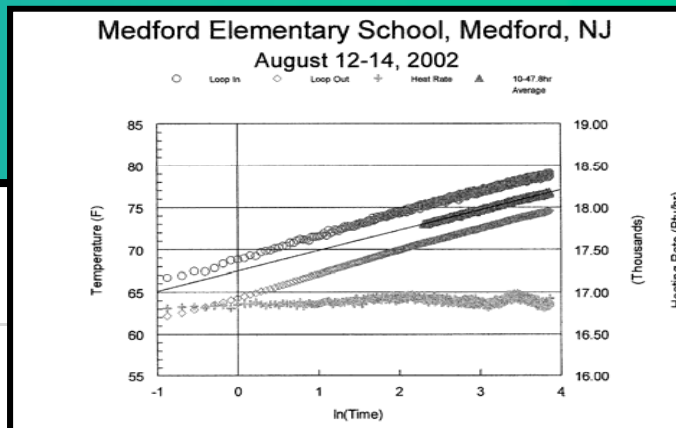
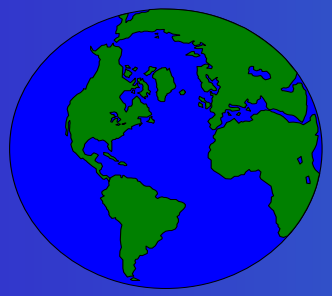


Figure 2: Temperature versus Natural Log of Time

Time Period	Slope: a_1	Average Heat Input (Btu/hr-ft)	(W/ft)	Thermal Conductivity (Btu/hr-ft-°F)
10 – 47.75 hrs	2.40	33.78	9.90	1.12

COP = 4.0 ***(Heating)***

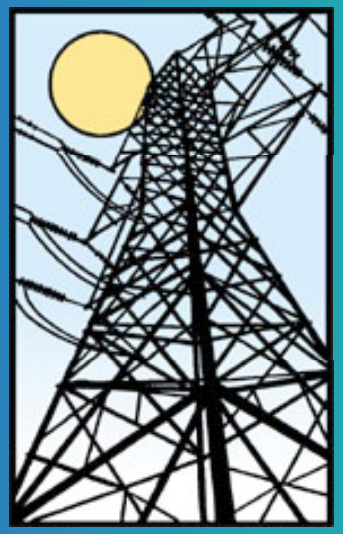


3 - Units

Geothermal Heat Pump

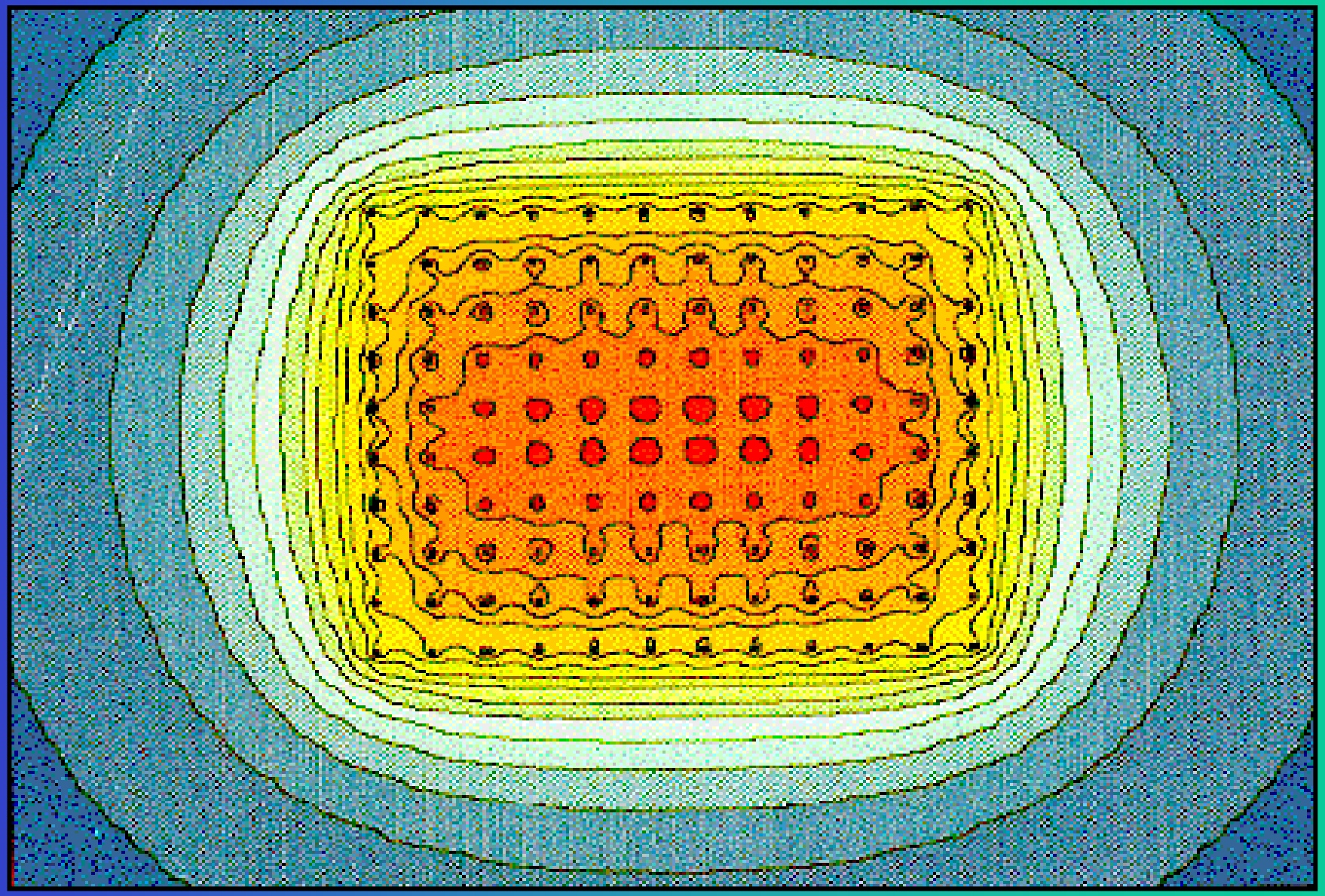
4 - Units

1 - Unit



New GWSHP's with R-410A have COP's of 5.0 and EER's of 30.0

Richard Stockton College BTES Heat Store



Case Study:

Richard Stockton College

- Public four-year comprehensive college in Pomona, NJ with ~ 8000 full-time equivalent students;
- Gross floor area:
  - **400,000** sq. ft.
- Installed heat pump capacity:
  - **1,400 tons (1,700 in 1995)**

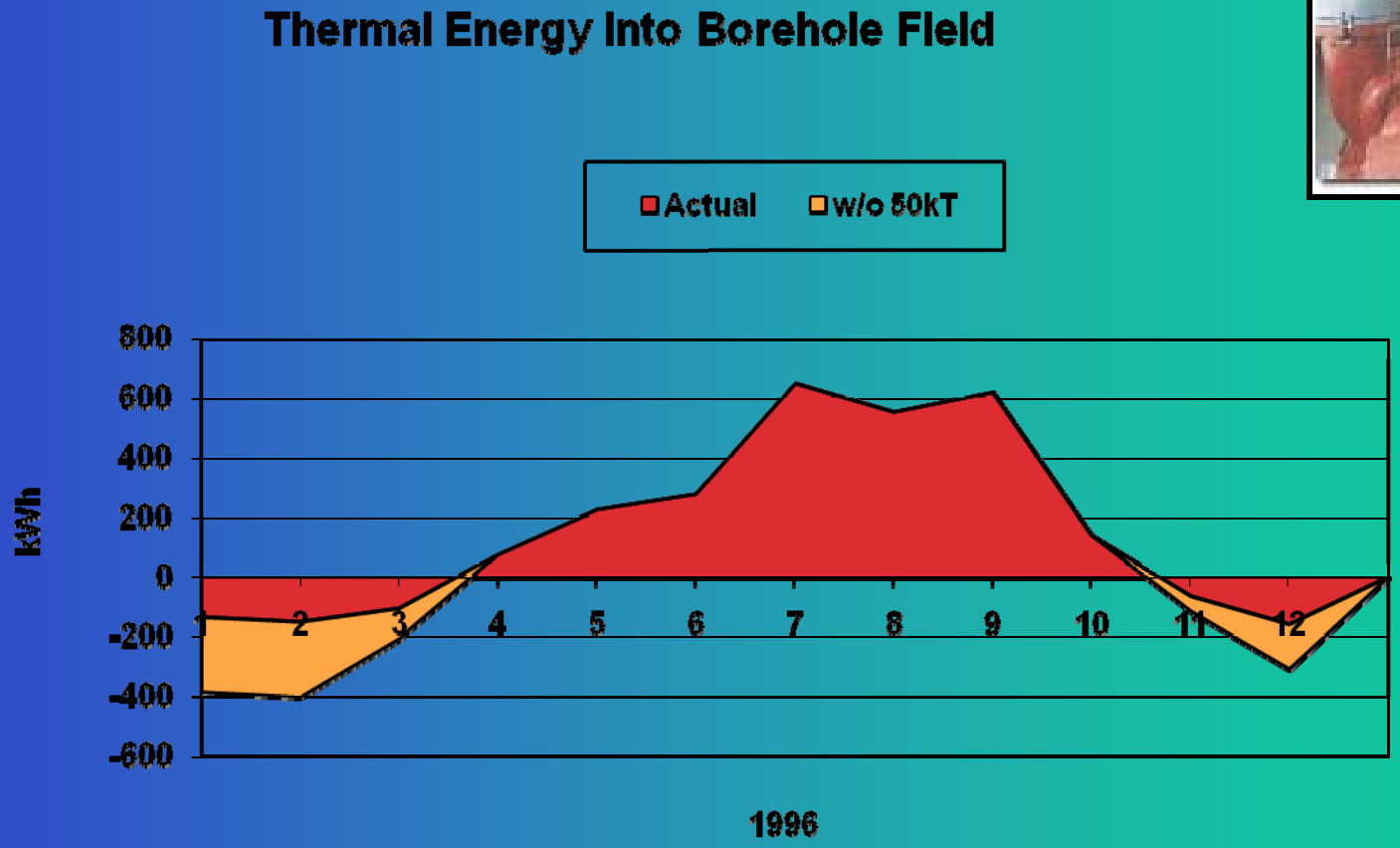
Richard Stockton College

Borehole Field Data

- Type:
  - vertical, closed-loop w/ central well field
- No. of boreholes:
  - 400
- Borehole depth:
  - 425 ft.
- Total heat exchanger length:
  - 340,000 ft.
- Borehole length/ton:
  - 121 ft/ton
- Circulating fluid:
  - water
- Flow rate through ground loop:
  - 4,000 gpm (max.)

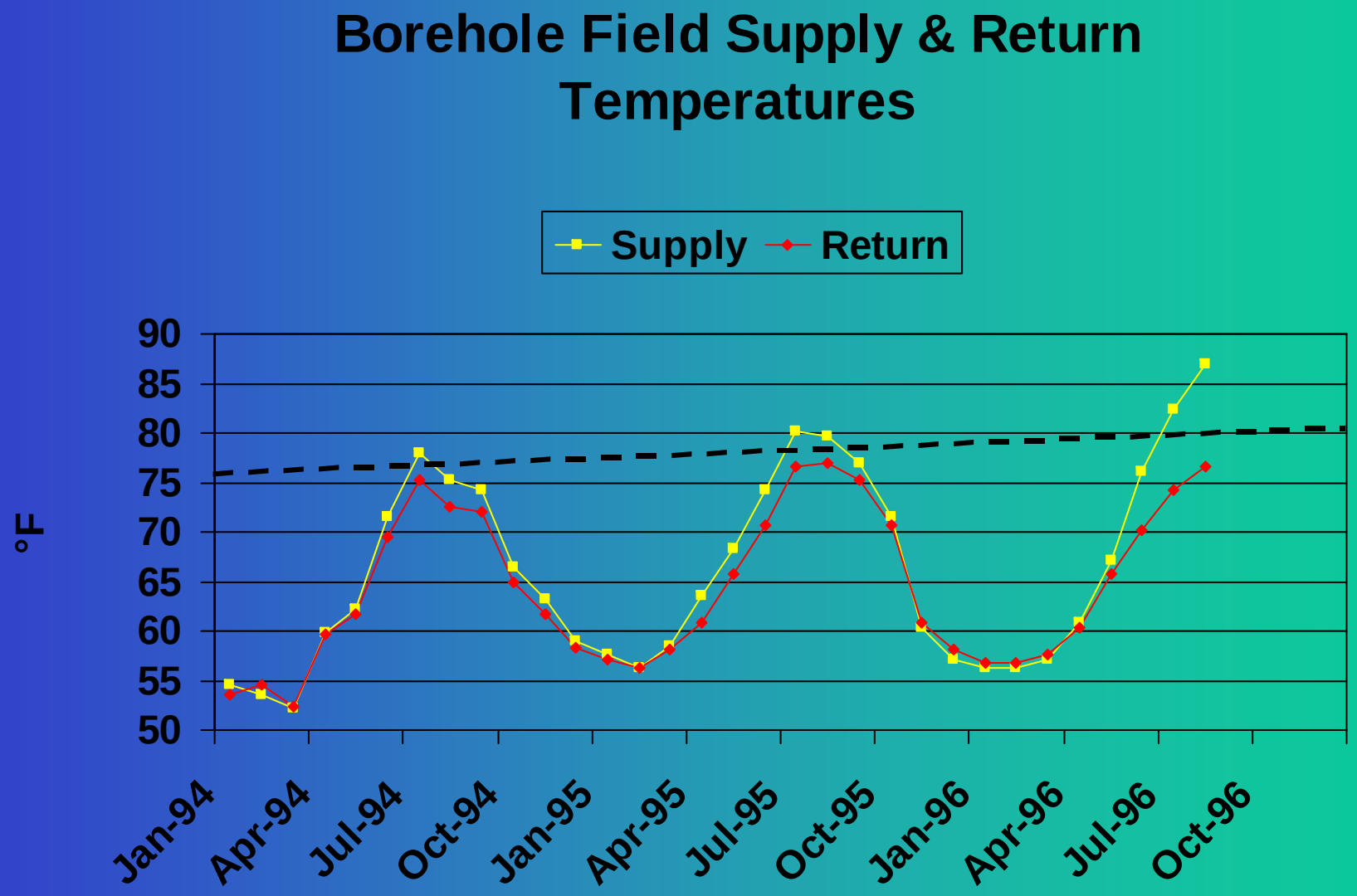
Richard Stockton College

Well Field Performance



Richard Stockton College

Borehole Field Performance



Cost Comparison with Current Rebate & Credits

	Actual project	W/Today's rebate
HVAC Capital Cost (Premium)	$1,627,477	$1,627,477
Parking Lot (Credit)	- $135,000	- $135,000
Library Addition (Credit)	- $600,000	- $600,000
A & S Building Well Field (Credit)	- $300,000	- $300,000
Net Premium	$592,477	$592,477
Rebate	$1,100,000	$900,000
Annual Operating Cost Savings*	$126,047	$126,047
Simple Payback w/o Rebate	4.6 Years	4.6 Years
Simple Payback w/ Rebate	+ $507,523	+ $307,523

* - Difference between GWSHP and Replacement RTU's.

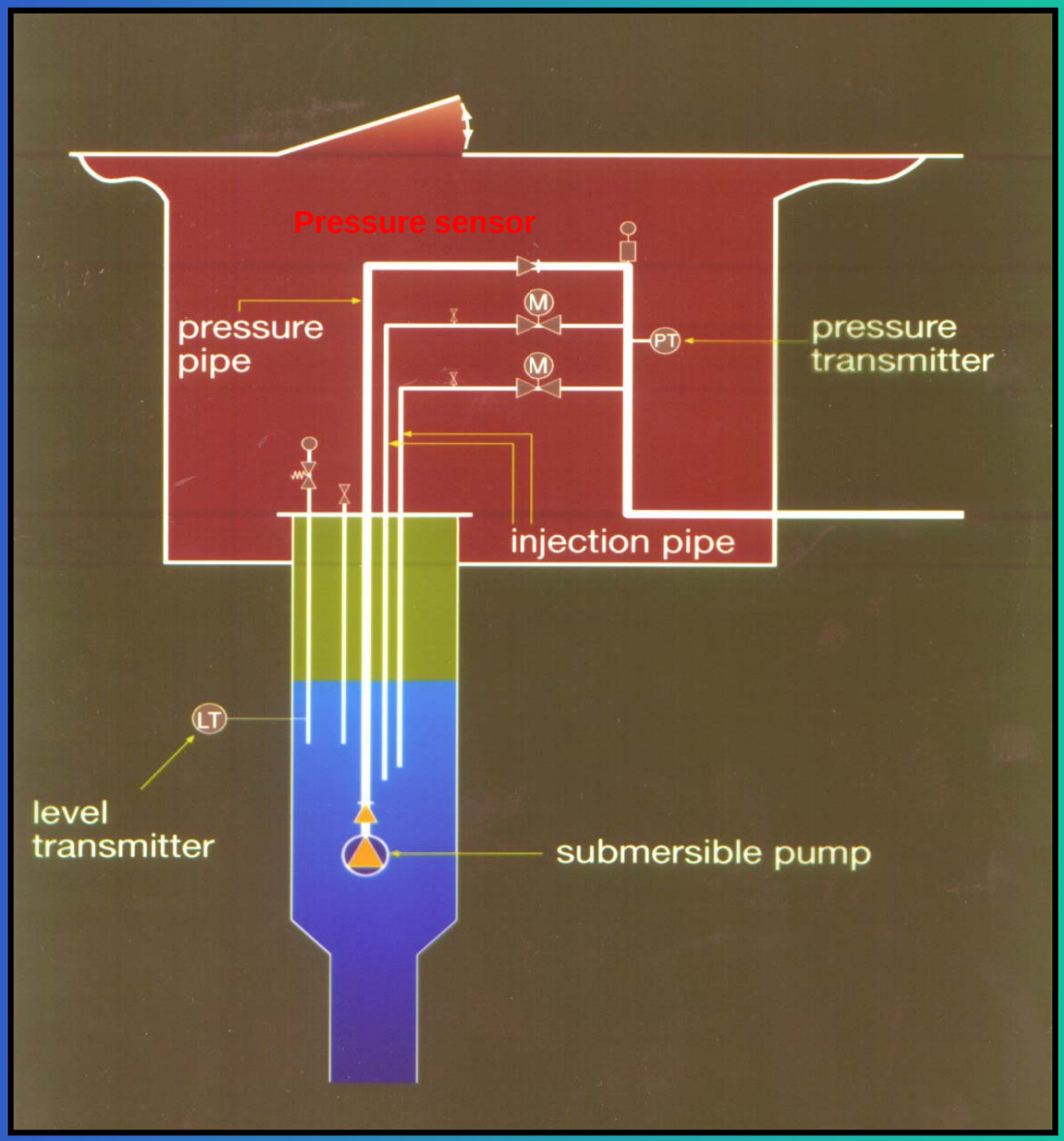
Richard Stockton College
ATES Project

Aquifer Systems

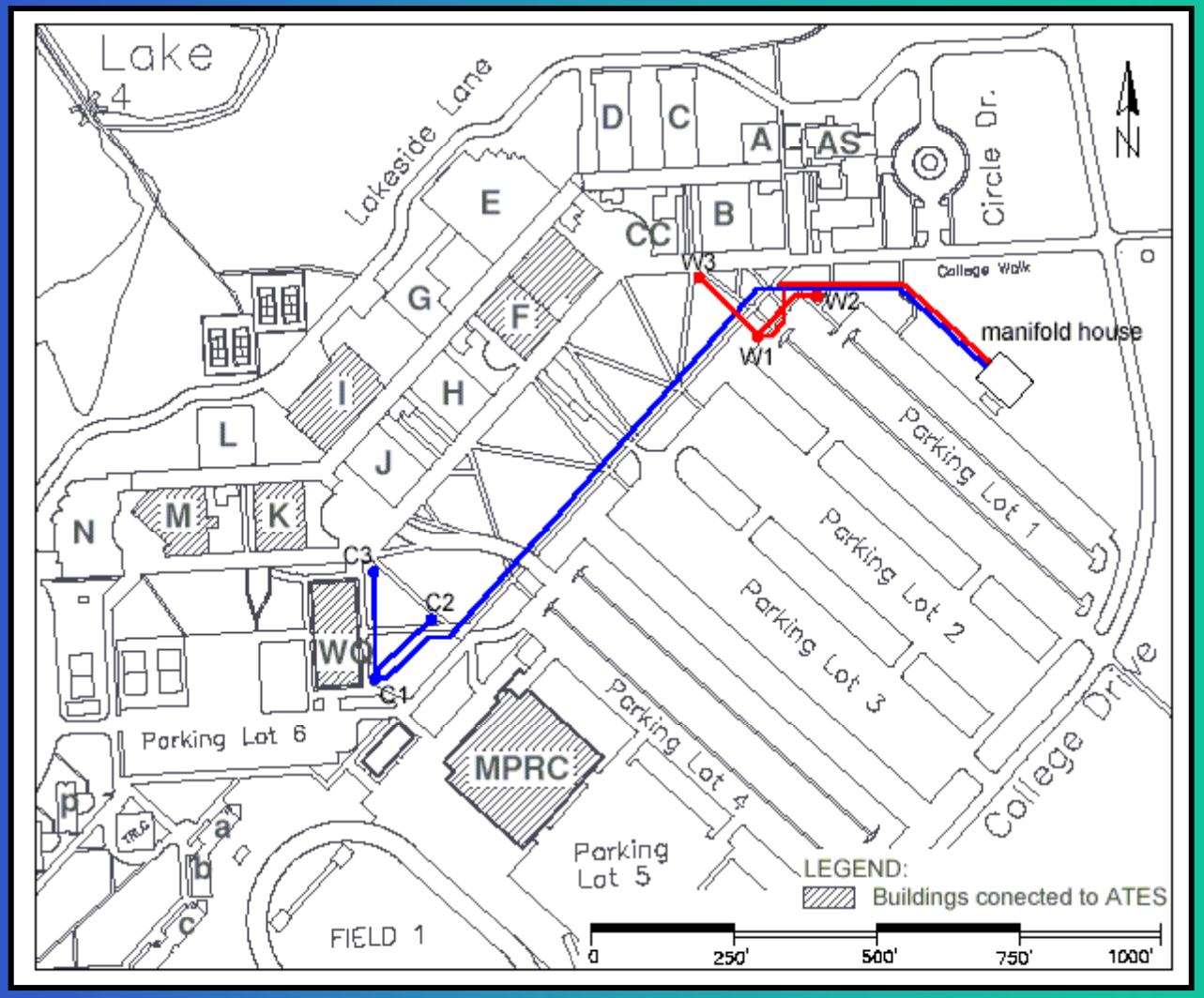
Example Wellhead

Aquifer Systems

Control and Protection

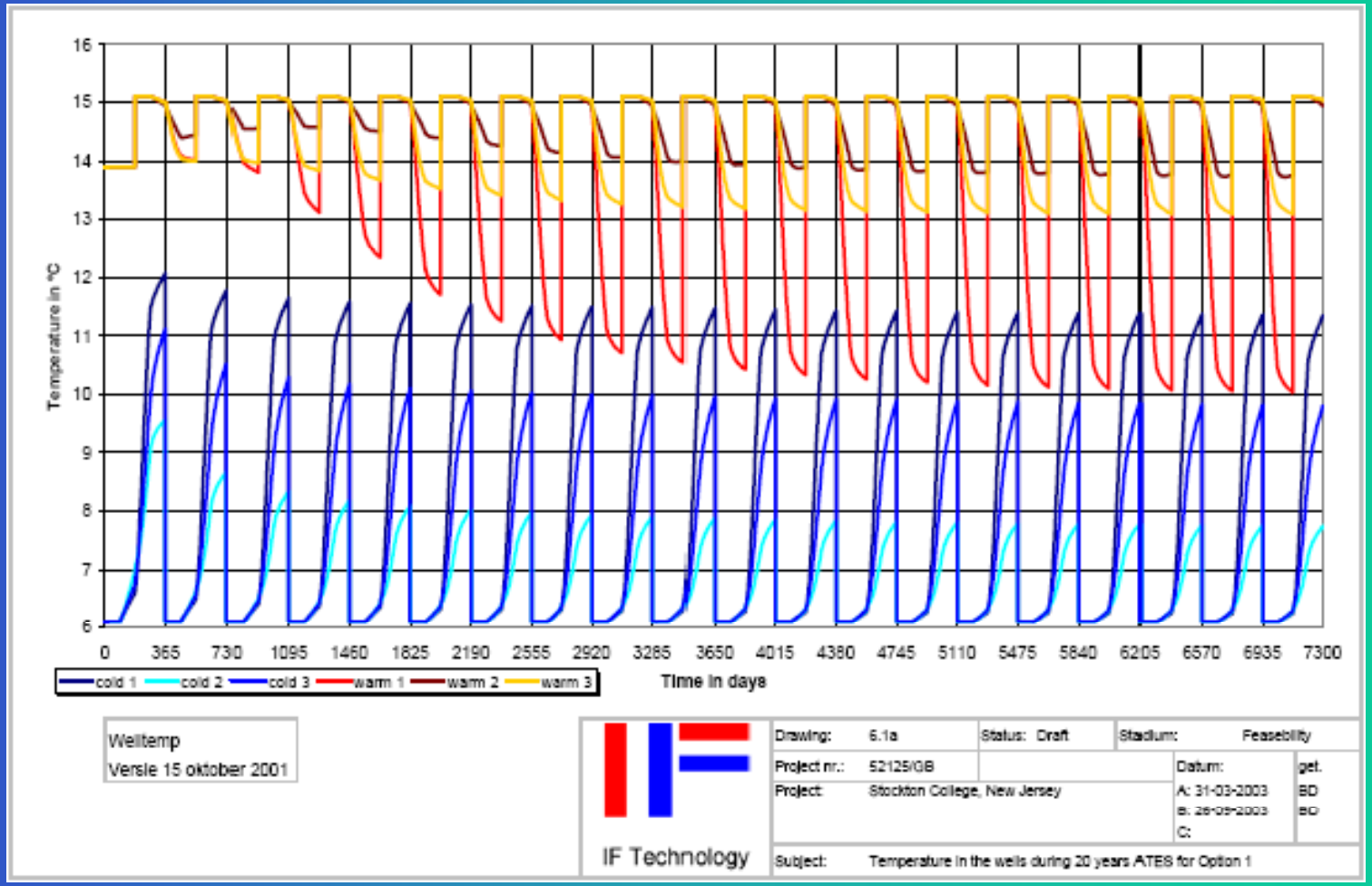


Site Plan


Lake
4
Lakeside Lane
Circle Dr.
College Walk
College Drive
N
D
C
A
AS
B
CC
E
G
F
H
I
J
L
M
K
N
W3
W2
W1
manifold house
C3
C2
C1
WC
Parking Lot 1
Parking Lot 2
Parking Lot 3
Parking Lot 4
Parking Lot 5
Parking Lot 6
MPRC
FIELD 1
a
b
c
p
LEGEND:
Buildings conected to ATES
0
250'
500'
750'
1000'

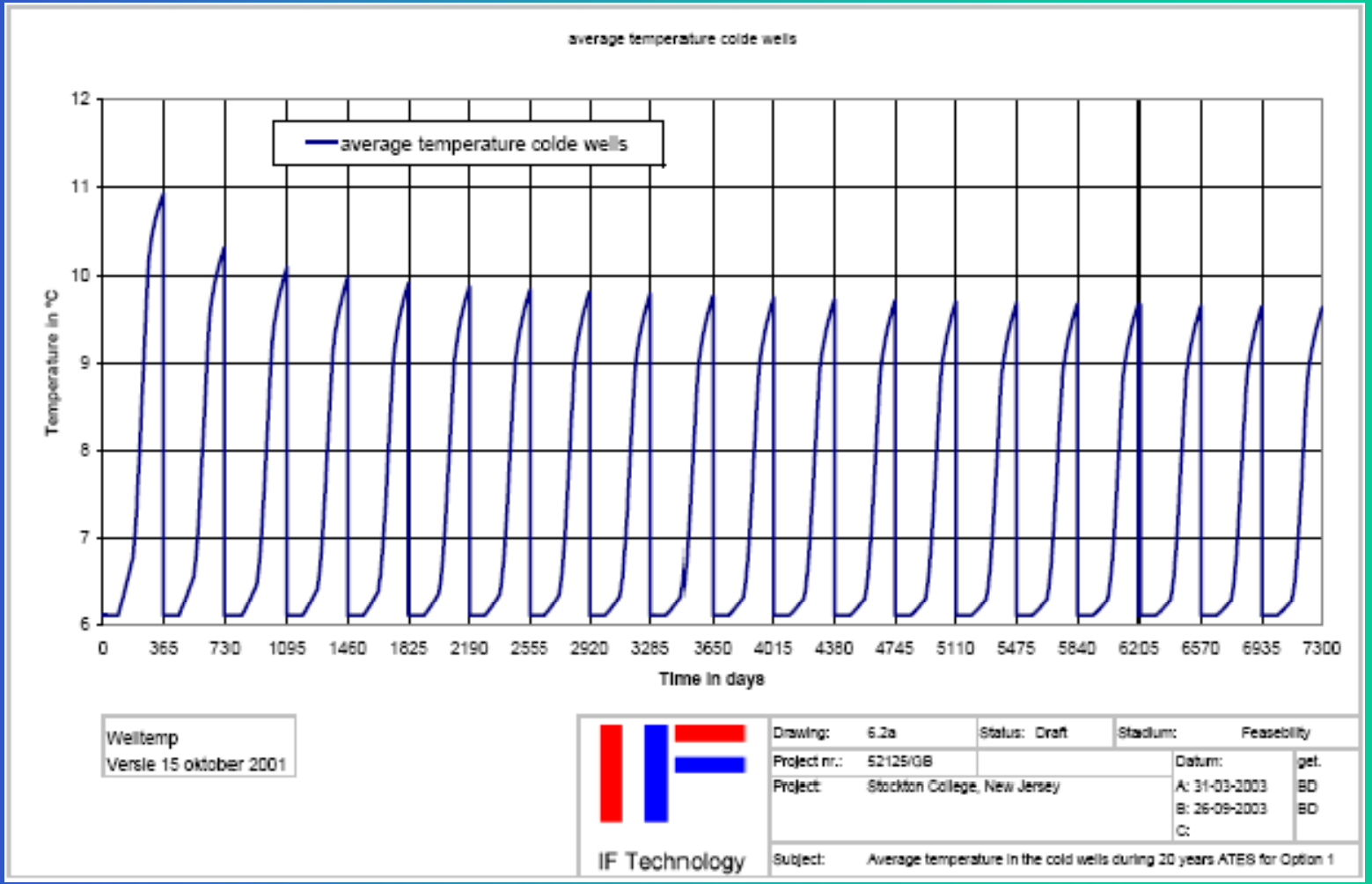
Richard Stockton College - ATES

Temperature in 3 cold and 3 warm for 20 Yrs

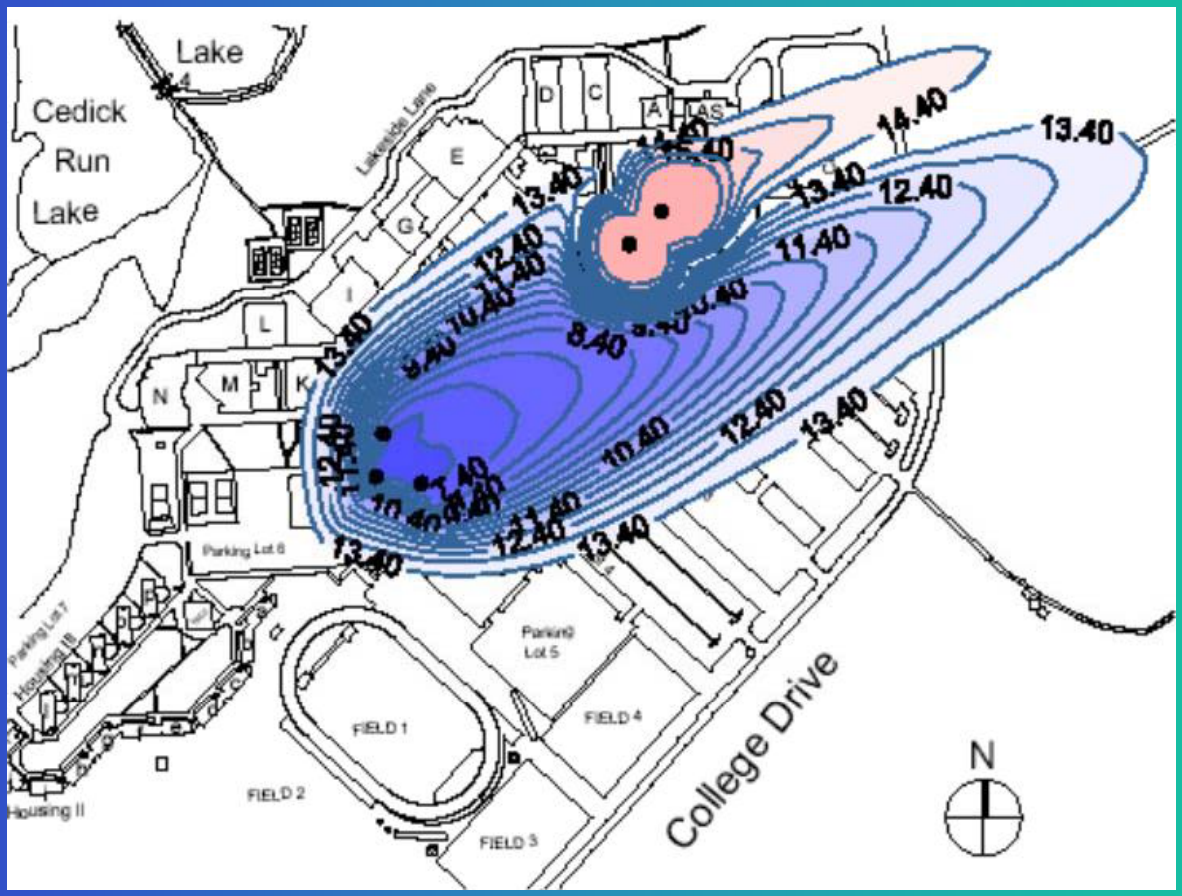


Richard Stockton College - ATES

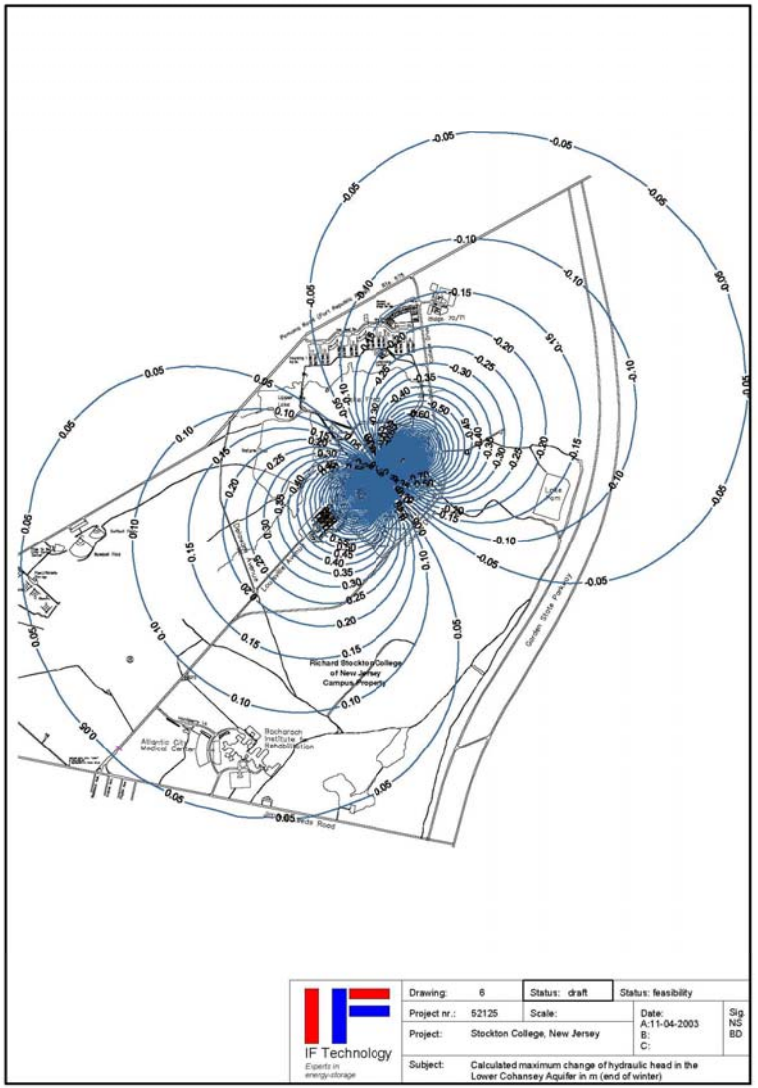
AverageTemperature of 3 cold wells for 20 Yrs



Isotherms after 20 years operation



Hydraulic Impact



Requirements for ATES

Aspect	Lower limit	Typical	Upper limit
Aquifer thickness (m)	2-5	25	None (partial use)
Aquifer depth (mbgs)	5 (injection pressure)	50	150 (economic)
Aquifer permeability	3 10exp-5	3 10exp-4	1 10exp-3
(m/s)			
Groundwater flow (m/d)	0	0.1	0.3
Static head (mbgs)	50	10	-5

Hydrogeologic Factors

- Stratigraphy
- Grain size distribution
- Structures and fracture distribution
- Aquifer depth and geometry
- Storage coefficient
- Permeability
- Degree of consolidation
- Thermal gradient
- Static head
- Natural ground water flow
- Direction of flow
- Water chemistry
- Leakage factor confining layers

First Ave Elementary School

GeoExchange - Technology II

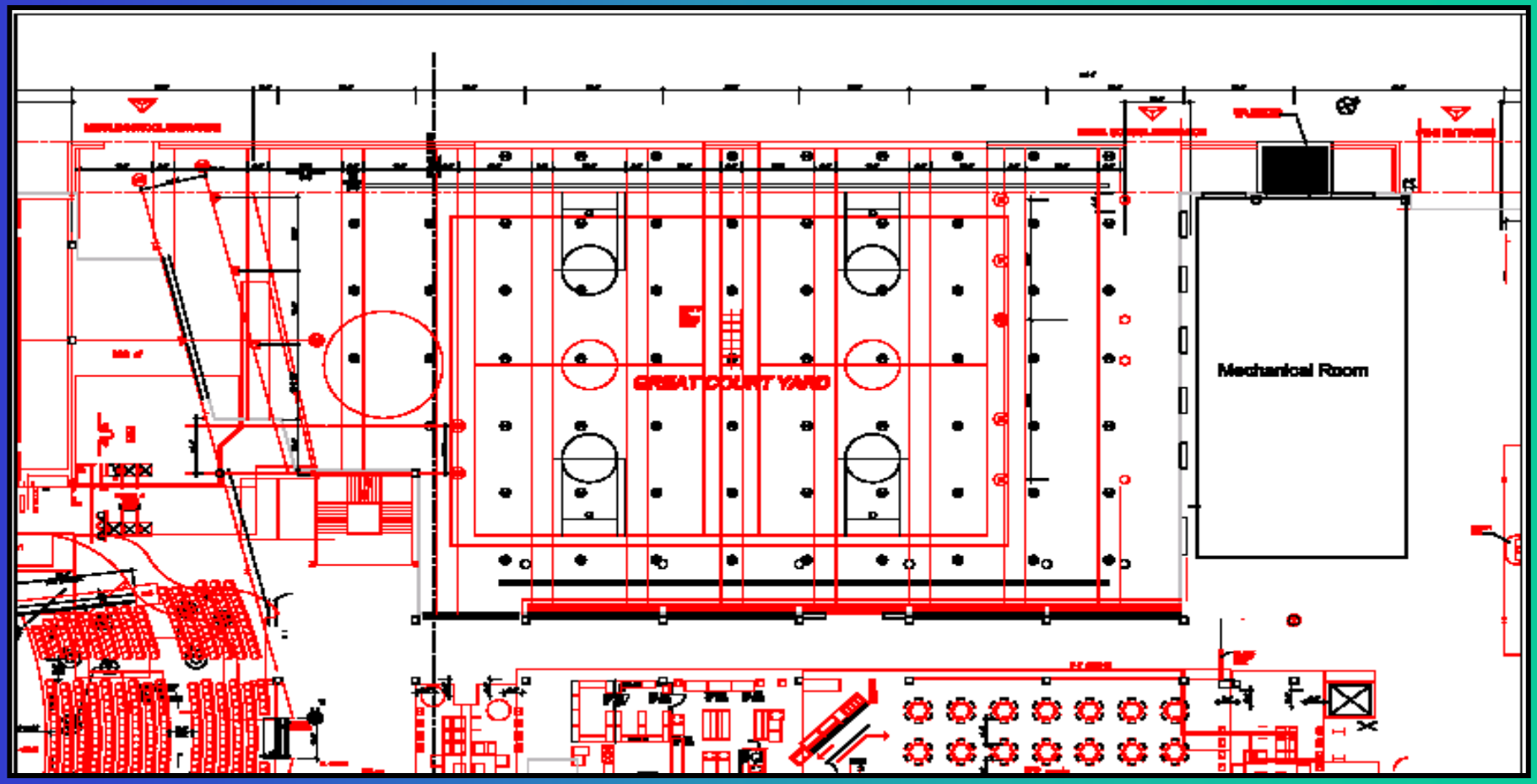
First Avenue School, Newark, NJ

Mechanical System Summary

Item	Value	Remarks
Building:		
heating load	0.543 MBtu/h (156 kW)	c
annual heating demand	313 MBtu (91.7 MWh)	c
cooling load	206 Tons (725 kW)	c
annual cooling demand	2,535 MBtu (743 MWh)	c
Heat Pumps:		
number of heat pumps	69	d
total cooling capacity	228 Tons (798 kW)	e
average COP heat pumps in heating mode	4.2	e
average COP heat pumps in cooling mode	5.6	e
minimum supply temperature evaporators in heating mode	26 °F (-3.3 °C)	
maximum supply temperature condensers in cooling mode	95 °F (35 °C)	
Vertical Ground Heat Exchanger System:		
maximum power heat pumps in heating mode	410 kBtu/h (120 kW)	
extraction of heat from VGHE's in heating mode	290 MBtu (85 MWh)	
maximum power heat pumps in cooling mode	2,900 kBtu/h (850 kW)	
rejection of heat to VGHE's in cooling mode	2,989 MBtu (876 MWh)	
Dry cooler:		
Extraction of heat to balance the borehole system	2,700 MBtu (791 MWh)	

First Avenue School, Newark, NJ

Borehole Layout



First Avenue School, Newark, NJ

Borefield Information

number of boreholes / vertical ground heat exchangers	70
depth boreholes / heat exchangers	450 ft (137 m) below surface
distance between boreholes / heat exchangers	16.5 ft (5 m)
heat transfer fluid	water / glycol
freezing point heat transfer fluid	14 °F (-10°C)
material piping	High Density Polyethylene (HDPE)

First Avenue School, Newark, NJ

Dry Cooler Information

number of dry coolers	1
number of fans	10
heat transfer fluid	water / glycol
freezing point heat transfer fluid	-13 °F (-25°C)
capacity	102 Tons (357 kW)
liquid in / out (at nominal capacity)	50 °F (10°C) / 40 °F (5°C)
dry bulb temperature (at nominal capacity)	32 °F (0 °C)
indication of dimensions	33 ft (10 m) x 8.3 ft (2.5 m) x 4.3 ft (1.3 m)
indication of total weight	3,000 kg
noise at 33 ft (10 m)	58 dB(A)
maximum total electric power fans	10 kW

First Avenue School, Newark, NJ

First Cost Analysis of Borehole w/Dry Cooler

Components	Investment
borehole system	$ 472,500.-
dry cooler system (including circulation pump and heat exchanger)	$ 85,000.-
piping in mechanical room (excluding circulation pumps)	$ 10,000,-
control borehole and dry cooler system	$ 95,000.-
contingency 10%	$ 66,250,-
total	**$ 728,750,-**

First Avenue School, Newark, NJ

Temperature Predictions