Presentation Outline

- Project Team
- Project Overview
- Existing Mechanical Systems
- Proposed Redesign
- Mechanical Depth
- Electrical Breadth
- Construction Management Breadth
- Cost and Energy Savings
- Summary and Conclusion

Coppin State University Physical Education Complex
Kaylee Damico – Mechanical Option
April 12th, 2011

Presentation Outline

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Coppin State University Physical Education Complex
Kaylee Damico – Mechanical Option
April 12th, 2011

Project Team

Owner: Maryland Stadium Authority
Architect: Cochran, Stephenson & Donkervoet
Construction Manager: Gilbane
Mechanical Engineer: James Posey Associates
Electrical Engineer: Diversified Engineering
Structural Engineer: Hope Furrer Associates
Civil Engineer: Site Resources

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Project Overview

Project Site

- New Main Entrances for University
- Adjacent track and field and other sporting fields

Architecture

- 246,000 GSF $136 million
- 1-4 stories
- LEED Silver Certification

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Project Overview

Project Site

- New Main Entrances for University
- Adjacent track and field and other sporting fields

Architecture

- 246,000 GSF $136 million
- 1-4 stories
- LEED Silver Certification

Specialty Spaces

- 4,100 seat Arena
- 8-lane NCAA regulation pool
- Dance Studio
- Auxiliary Gym
- Fitness Center

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Existing Mechanical Systems

Air Systems

- 14 Variable Air Volume AHUs
  - Single zone and multiple zone
- 2 Energy Recovery Units
- 1 Pool Dehumidification System

Presentation Outline

- AHU-1: Level 1 Shops
- AHU-2: Level 1 Offices
- AHU-3: Level 2 Offices
- AHU-4: Level 3 Offices
- AHU-5 & 6: Arena
- AHU-7: Concessions
- AHU-8: Level 3 Coach Offices
- AHU-9 & 10: Auxiliary Gym
- AHU-11: Classrooms & Dance Studio
- AHU-12: Multipurpose Room
- AHU-13: Fitness Area
- AHU-14: Heating Unit for Shops
- PDU-1: Pool
- ERU-1 & 2: Locker Rooms

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Existing Mechanical Systems

Air Systems

- 14 Variable Air Volume AHUs
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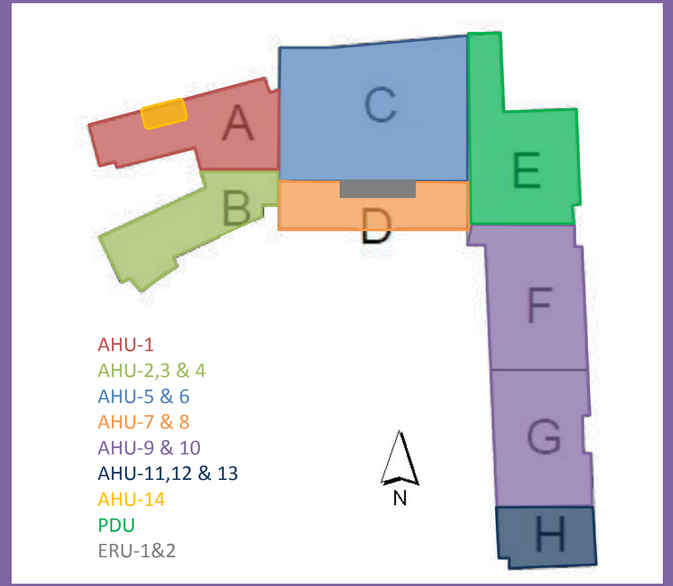


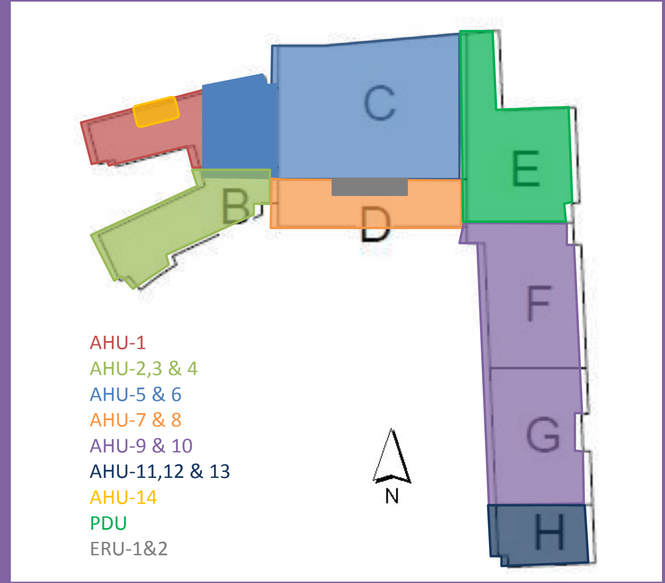
Existing Mechanical Systems

Air Systems

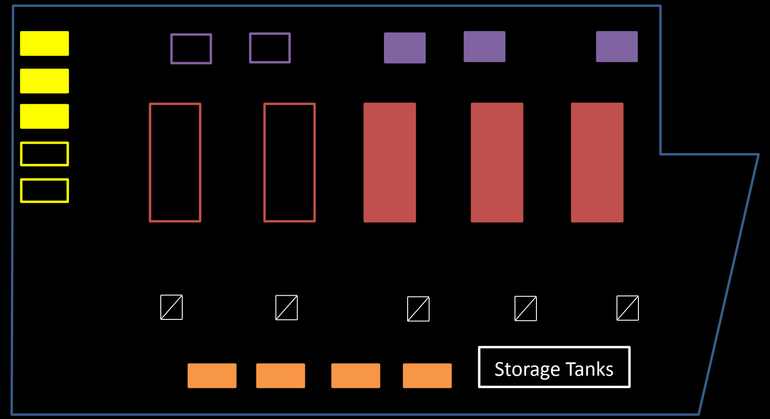
- 14 Variable Air Volume AHUs
  - Single zone and multiple zone
- 2 Energy Recovery Units
- 1 Pool Dehumidification System

Central Plant

- Two 500 ton chillers
- 1000 ton cooling tower



Existing Mechanical Systems



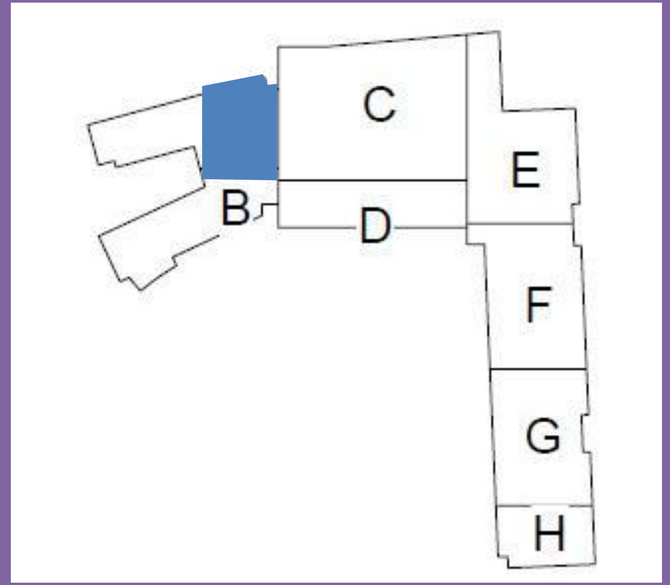
Boilers
Primary Heating Water Pumps
Secondary Heating Water Pumps
Variable Flow Heating Water Pumps
Pressure Relief

Air Systems

- 14 Variable Air Volume AHUs
  - Single zone and multiple zone
- 2 Energy Recovery Units
- 1 Pool Dehumidification System

Central Plant

- Two 500 ton chillers
- 1000 ton cooling tower
- Three dual fuel 250HP boilers
- Primary-Secondary system
- Space for future expansion



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- **Proposed Redesign**
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Proposed Redesign

Design Objectives

- More efficient mechanical systems
- Lower Overall Energy Usage
  - Lower Emissions

Design Components

- Ground Source Heat Pump System
- Heat Recovery Chiller
  - Electrical Redesign of MCC
  - Construction Reorganization

Presentation Outline

- Project Team
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- **Mechanical Depth**
  - **GSHP**
  - HRC
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Mechanical Depth - GSHP

Site

- Soil Type
  - Resistance
  - Depth Allowed

Paleozoic basic igneous rock

Mechanical Depth - GSHP

$$L_c = \frac{q_a \cdot R_{ga} + [q_{lc} - 3.142 \cdot W_c] \cdot [R_p + PLF_m \cdot R_{gm} + R_{gd} \cdot F_{sc}]}{t_g - \left[\frac{t_{wi} - t_{wo}}{2}\right] - t_p}$$

Unit	EWT (°F)	GPM	Total Cooling Capacity (MBH)	Power (kW)	EER
50PSW360	50	70	304.6	12.43	24.5

Site

- Soil Type
  - Resistance
  - Depth Allowed

Calculations

- Only Zones A and B
- 55 bores at 4

Equipment

- 5 water to wa
  - Each with
- Reverse Retu
- Polyethylene

# of Bores:	Tota Rate (GP	s of et)	Piping Efficiency (20% P.G.):
11			High Efficiency
10			High Efficiency
9			High Efficiency
8			High Efficiency
7			High Efficiency
6			High Efficiency
5			High Efficiency
4			High Efficiency
3			High Efficiency
2			High Efficiency
1			High Efficiency

Paleozoic basic igneous rock

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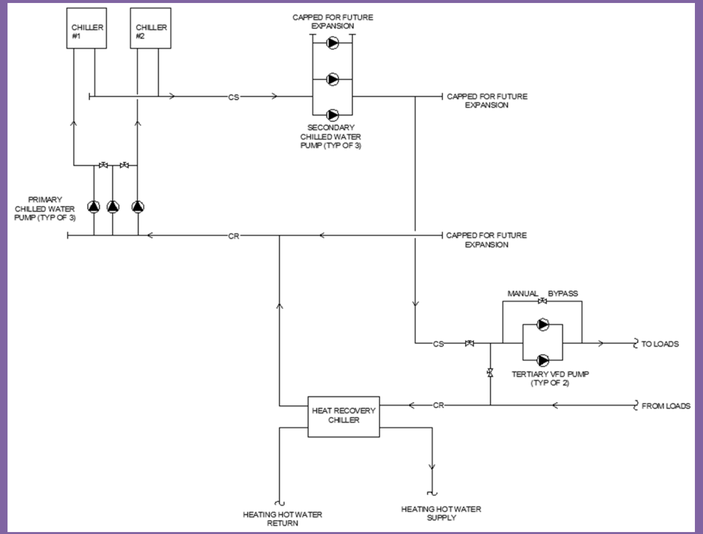
Mechanical Depth - HRC

Sizing

- Hourly loads
- Available heating hot water
- HRC can handle 52% of load

Reheat Load (MBH) ·1000 = GPM·500·ΔT

Reheat Load = 3500 MBH ΔT = (140°F - 120°F) = 20°F



Mechanical Depth - HRC

Unit	GPM	Input Power (kW)	Heating (MBH)	Cooling (MBH)
TGZ120A	209	109.5	2094.5	1720.9

Equipment	Manufacturer	Model	Gross Output (MBH)
Dual Fuel Boilers	Cleaver Brooks	CEW200	6695
Condensing Boiler	Weil-McClain	UG-310	289

Sizing

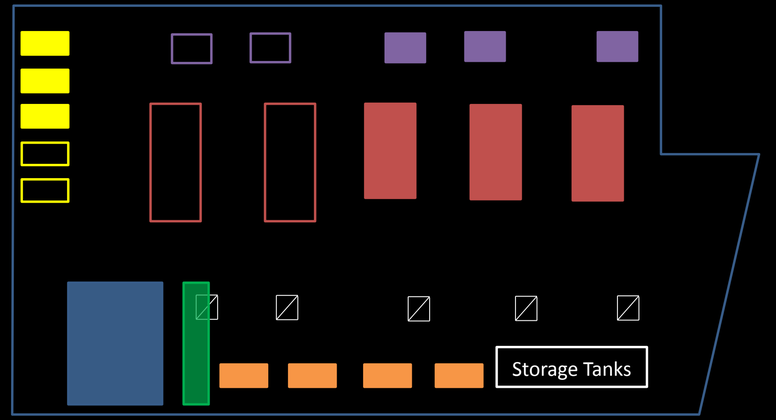
- Hourly loads
- Available heating hot water
- HRC can handle 52% of load

Equipment

- (2) McQuay Templifier HRC
- (5) Weil McLain Condensing Boilers
- Downsize existing Cleaver Brooks boilers

Reheat Load (MBH) / 1000 = GPM/500 ΔT

Reheat Load = 3500 MBH ΔT = (140°F - 120°F) = 20°F



Mechanical Depth - HRC

Where, Q = [illegible] 9kg of R134a

Unit	GPM	Input Power (kW)	Heating (MBH)	Cooling (MBH)
TGZ120A	209	109.5	2094.5	1720.9

Equipment	Manufacturer	Model	Gross Output (MBH)
Dual Fuel Boilers	Cleaver Brooks	CEW200	6695
Condensing Boiler	Weil-McClain	UG-310	289

Fan Ty				Motor HP
Roof Upblast	ACME PDU135	Direct	750	1/3

Sizing

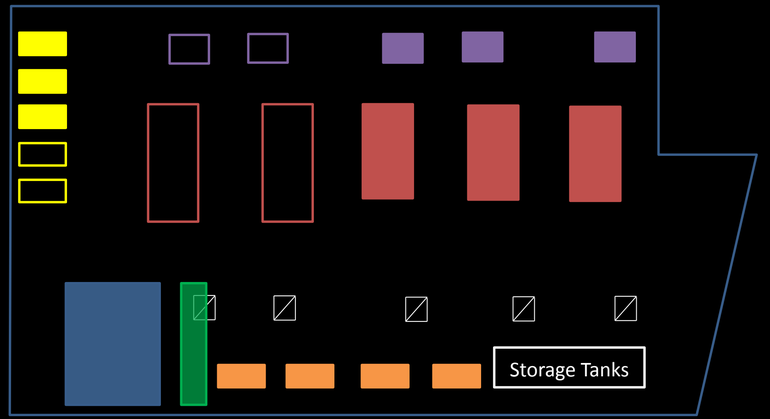
- Hourly loads
- Available heating hot water
- HRC can handle 52% of load

Equipment

- (2) McQuay Templifier HRC
- (5) Weil McLain Condensing Boilers
- Downsize existing Cleaver Brooks boilers

Refrigerant Leak Detection

- Exhaust 1400 CFM required for R-134a
- 2 Roof Upblast Fans



Boilers
Primary Heating Water Pumps
Secondary Heating Water Pumps
Variable Flow Heating Water Pumps
Pressure Relief

Heat Recovery Chillers
Condensing Boilers

Presentation Outline

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Electrical Breadth

Calculations

- Electrical Information
  - HP
  - KVA
  - FLA

Electrical Info of Equipment Added for HRC

Equipment Removed	HP	KVA	FLA
Boiler Blower Motor 1	10	11.14	14
Boiler Blower Motor 2	10	11.14	14
Boiler Blower Motor 3	10	11.14	14
Equipment Added			
New Boiler Blower Motor-1	7.5	8.4	10.1
New Boiler Blower Motor-2	7.5	8.4	10.1
New Boiler Blower Motor-3	7.5	8.4	10.1
Condensing Boiler Motor-1	1.75	2.0	2.4
Condensing Boiler Motor-2	1.75	2.0	2.4
Condensing Boiler Motor-3	1.75	2.0	2.4
Condensing Boiler Motor-4	1.75	2.0	2.4
Condensing Boiler Motor-5	1.75	2.0	2.4
HRC-1	23	25.8	31.1
HRC-2	23	25.8	31.1

Electrical Info of Equipment Added for GSHP

Equipment Added	HP	KVA	FLA
HP-1	16.6	18.4	41.4
HP-2	16.6	18.4	41.4
HP-3	16.6	18.4	41.4
HP-4	16.6	18.4	41.4
HP-5	16.6	18.4	41.4

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Electrical Breadth

Calculations

- Electrical Information
  - HP
  - KVA
  - FLA

Scheduling

- Spares and spaces on previous MCC's

MCC-2 Partial Schedule
Electrical Info of Equipment Added for HRC

Main Bus: 600A | Volts: 480VAC | Phase: 3

Equipment Removed	HP	KVA	FLA
Boiler Blower Motor 1	10	11.14	14
Boiler Blower Motor 2	10	11.14	14
Boiler Blower Motor 3	10	11.14	14
Equipment Added			
New Boiler Blower Motor-1	7.5	8.4	10.1
New Boiler Blower Motor-2	7.5	8.4	10.1
New Boiler Blower Motor-3	7.5	8.4	10.1
Condensing Boiler Motor-1	1.75	2.0	2.4
Condensing Boiler Motor-2	1.75	2.0	2.4
Condensing Boiler Motor-3	1.75	2.0	2.4
Condensing Boiler Motor-4	1.75	2.0	2.4
Condensing Boiler Motor-5	1.75	2.0	2.4
HRC-1	23	25.8	31.1
HRC-2	23	25.8	31.1

Main Bus: 1200A | Volts: 480VAC | Phase: 3

Equipment Added	HP	KVA	FLA
HP-1	16.6	18.4	41.4
HP-2	16.6	18.4	41.4
HP-3	16.6	18.4	41.4
HP-4	16.6	18.4	41.4
HP-5	16.6	18.4	41.4

Electrical Breadth

Calculations

- Electrical Information
  - HP
  - KVA
  - FLA

Scheduling

- Spares and spaces on previous MCC's
- Installed and replaced with new equipment

Sizing

- Feeders sized for each addition

Feeders from HRC Equipment

Compartment #	Feeder Size
1BL	3#12+1#12G, 1/2" C
2BL	3#12+1#12G, 1/2" C
3BL	3#12+1#12G, 1/2" C
3M	3#8+1#10G, 1/2" C
4K	3#8+1#10G, 1/2" C
4M	3#8+1#10G, 1/2" C
5B	3#8+1#10G, 1/2" C
5D	3#8+1#10G, 1/2" C
5F	3#8+1#8G, 1" C
5J	3#8+1#8G, 1" C

Feeders from GSHP Equipment

Compartment #	Feeder Size
5BR	3#8+1#8G, 1"C
7HL	3#8+1#8G, 1"C
7HR	3#8+1#8G, 1"C
8DL	3#8+1#8G, 1"C
9G	3#8+1#8G, 1"C

MCC-2 Partial Schedule

New MCC-2 Partial Schedule

Main Bus: 600A		Volts: 480VAC	Phase: 3		
Vertical Bus: 300A			Wires: 3		
Compartment No.	Circuit Number	Name Plate	Load		
			HP	KVA	FLA
1BL	MCC2-1	Boiler #1 Blower Motor	10	11.14	14
2BL	MCC2-2	Boiler #2 Blower Motor	10	11.14	14
3BL	MCC2-3	Boiler #3 Blower Motor	10	11.14	14
3M	MCC2-26	SPARE	-	-	-
4K	MCC2-31	SPARE	-	-	-
4M	MCC2-32	SPARE	-	-	-
5B	MCC2-33	SPARE	-	-	-
5D	MCC2-34	SPARE	-	-	-
5F	MCC2-35	SPARE	-	-	-
5J	-	SPACE	-	-	-
Total Load: 349 KVA			Total Load: 443.1 Amps		
		Demand Factor:70%			

MCC-3 Partial Schedule

New MCC-3 Partial Schedule

Main Bus: 1200A		Volts: 480VAC	Phase: 3		
Vertical Bus: 600A			Wires: 4		
Compartment	Circuit	Name Plate	Load		
No.	Number		HP	KVA	FLA
5BR	MCC3-27	SPARE	-	-	-
7HL	MCC3-48	SPARE	-	-	-
7HR	MCC3-49	SPARE	-	-	-
8DL	MCC3-55	SPARE	-	-	-
9G	-	SPACE	-	-	-
Total Load: 1399 KVA			Total Load: 1808.95 Amps		
		Demand Factor:70%			

Presentation Outline

- Project Team
- P
- E ystems
- P
- M
- E
- C ment Breadth
- C gs
- S sion

Construction Management Breadth

Costs

- GSHP
  - Installation
  - Piping
  - Equipment
- HRC
  - Equipment

Equipment Costs for HRC

Equipment Removed	Cost
Boiler 1	$ 131,500.00
Boiler 2	$ 131,500.00
Boiler 3	$ 131,500.00
Equipment Added	
New Boiler -1	$ 129,650.00
New Boiler -2	$ 129,650.00
New Boiler -3	$ 129,650.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
HRC-1	$ 250,500.00
HRC-2	$ 250,500.00
Total Cost Added	**$ 527,945.00**

Equipment Costs for GSHP

Equipment Added	Cost
HP-1	$ 24,900.00
HP-2	$ 24,900.00
HP-3	$ 24,900.00
HP-4	$ 24,900.00
HP-5	$ 24,900.00
Total Cost Added	**$ 124,500.00**

Cost of Labor and Equipment for GSHP Installation

Length of Pipe (ft)	Man Power (ft/day/rig)	# of rigs	Days	Man Power Cost per linear foot	Piping Installation Cost	Renting rig ($/week)	Cost rigs	Total Price
22000	400	2	28	$24	$528,000	$4,500	$24,750	$ 552,750.00

Cost Polyethylene Pipe

Size (in)	# of Wells	Depth (ft)	Total Length (ft)	Price per 40'	Price per Size
3	30	400	12000	1.32	15840
2	15	400	6000	1.1	6600
1.25	10	400	4000	0.66	2640
				Total	**$ 25,080.00**

Construction Management Breadth

Equipment Costs for HRC

Equipment Removed	Cost
Boiler 1	$ 131,500.00
Boiler 2	$ 131,500.00
Boiler 3	$ 131,500.00
Equipment Added	
New Boiler -1	$ 129,650.00
New Boiler -2	$ 129,650.00
New Boiler -3	$ 129,650.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
Condensing Boiler	$ 6,499.00
HRC-1	$ 250,500.00
HRC-2	$ 250,500.00
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Equipment Costs for GSHP

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HP-3	$ 24,900.00
HP-4	$ 24,900.00
HP-5	$ 24,900.00
Total Cost Added	**$ 124,500.00**

Costs

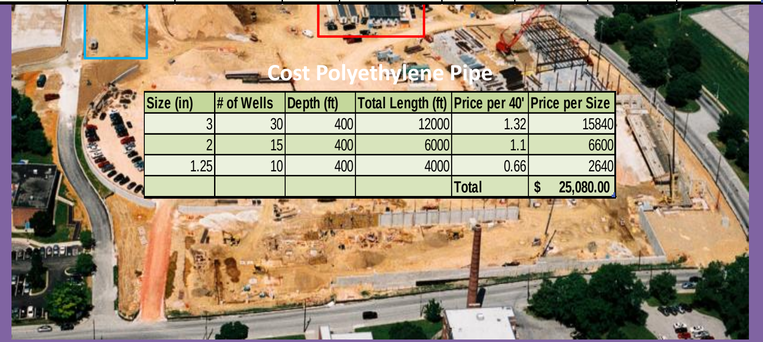
- GSHP
  - Installation
  - Piping
  - Equipment
- HRC
  - Equipment

Site

- Installed in adjacent parking lot
- Trailers can be moved
  - Excavation – Finishing Zone B

Cost of Labor and Equipment for GSHP Installation

Length of Pipe (ft)	Man Power (ft/day/rig)	# of rigs	Days	Man Power Cost per linear foot	Piping Installation Cost	Renting rig ($/week)	Cost rigs	Total Price
22000	400	2	28	$24	$528,000	$4,500	$24,750	$ 552,750.00



Cost Polyethylene Pipe

Size (in)	# of Wells	Depth (ft)	Total Length (ft)	Price per 40'	Price per Size
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1.25	10	400	4000	0.66	2640
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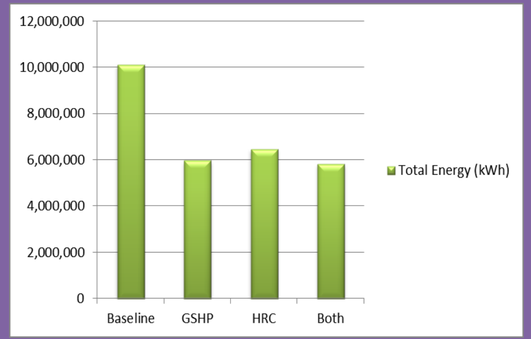
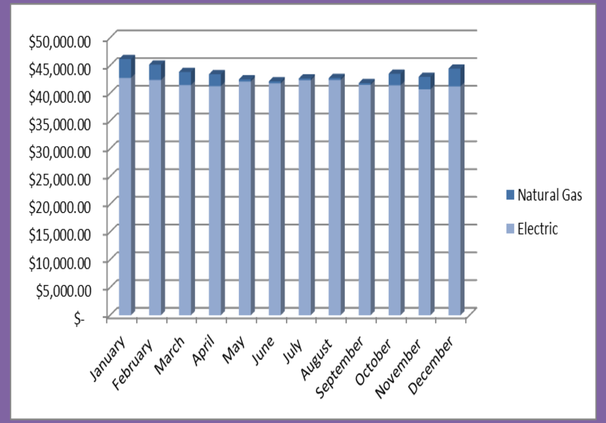
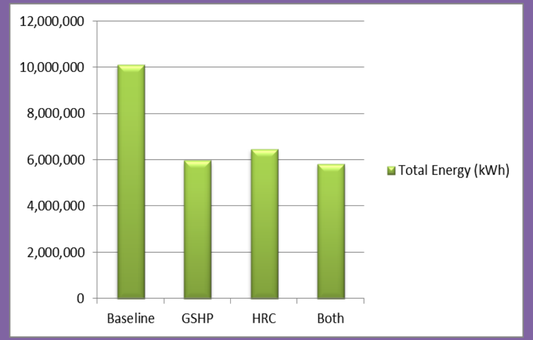
Cost and Energy Savings

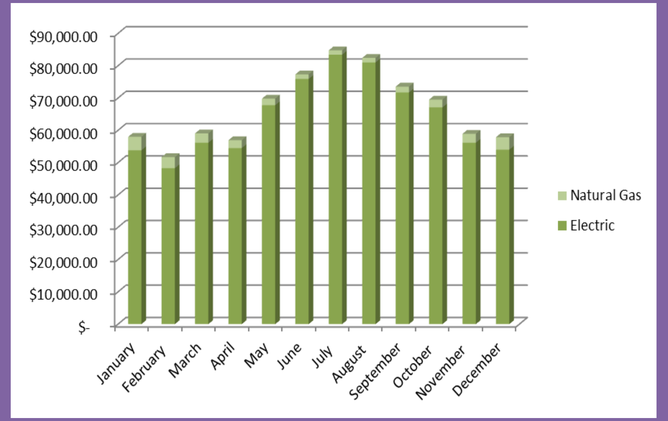


Cost and Energy Savings



Redesign Cost of Utilities





Baseline Cost of Utilities

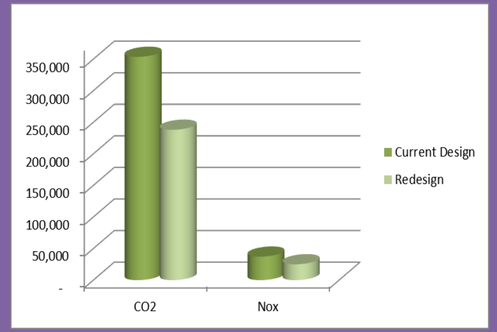
Cost and Energy Savings

Annual Emissions for Baseline

Pollutants	lb of Pollutant per 1000 cubic feet of Natural gas	Natural Gas per year (1000 cubic feet)	Amount of Pollutant per year (lb)
CO2	11.6	30,486	353,638
Nox	0.0164	30,486	500
Sox	1.22	30,486	37,193

Annual Emissions for Redesign

Pollutants	lb of Pollutant per 1000 cubic feet of Natural gas	Natural Gas per year (1000 cubic feet)	Amount of Pollutant per year (lb)
CO2	11.6	20,530	238,148
Nox	0.0164	20,530	337
Sox	1.22	20,530	25,047



Emission Comparison in pounds of Pollutant

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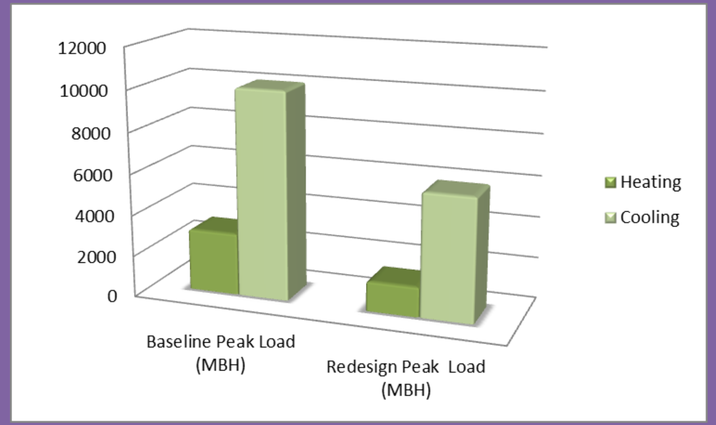
Summary and Conclusion

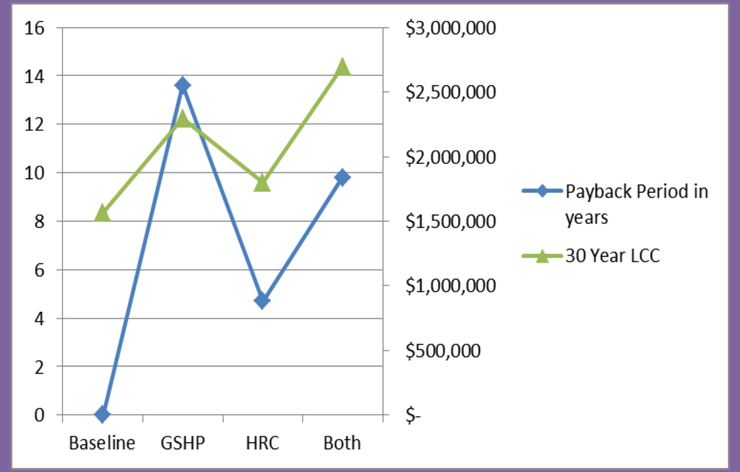


Summary and Conclusion

Suggestions to Owner

- **Definite Additions**
  - ✓ Heat Recovery Chiller
- **Possible Additional Savings**
  - ✓ Ground Source Heat Pump
- Implementing both can possibly increase LEED points

Owner's Discretion



30-Year LCC Details

	Initial Capital Cost	Discount Rate	Yearly Maintance	30-Year Life Cycle Cost (NPV)	Discounted Payback Period (years)
Baseline	$ 1,567,600.00	7%	$ 87,283	$ 9,130,491	0
GSHP	$ 2,293,202.00	7%	$ 90,976	$ 9,505,982	13.6
HRC	$ 1,799,600.00	7%	$ 98,625	$ 9,635,367	4.7
Both	$ 2,694,202.00	7%	$ 110,763	$ 10,049,383	9.8

Questions or Comments?

Special Thanks to:

- James Posey Associates
- Gilbane Company
- McClure Company
- Professors
- Family and Friends