Central High School

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Mechanical Breadth
- GCHP Sizing / Layout
- Energy Savings

Acoustical Breadth

Construction Breadth

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ADAM BROWN MECHANICAL OPTION SPRING 2014

CENTRAL HIGH SCHOOL

MID-ATLANTIC REGION

ADAM BROWN MECHANICAL OPTION SPRING 2014

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ADAM BROWN MECHANICAL OPTION SPRING 2014

- Central High School
  - 1st floor renovation
  - 2nd floor addition
- Location - Mid Atlantic Region
- Size - 322,000 sq. ft.
- Project Cost - $84 million
- Completion - February 2015

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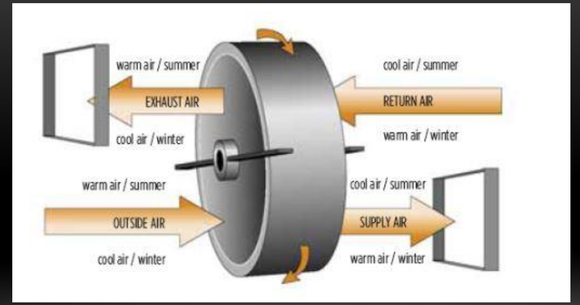
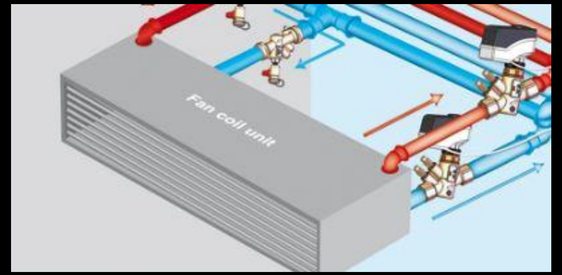


- Heating Water System
  - 1 natural gas boiler
- Chilled Water System
  - 2 air cooled chillers



- Air Handling Units
  - 20 DOAS units
  - Energy recovery wheels
- 4 pipe fan coil units

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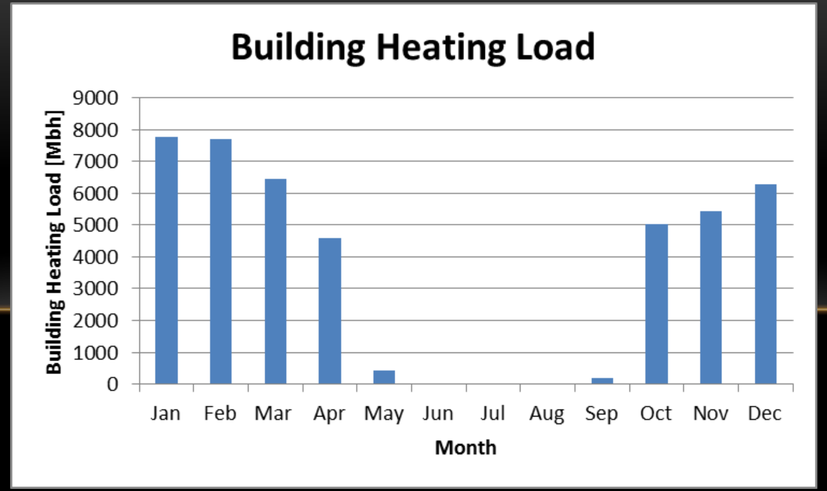
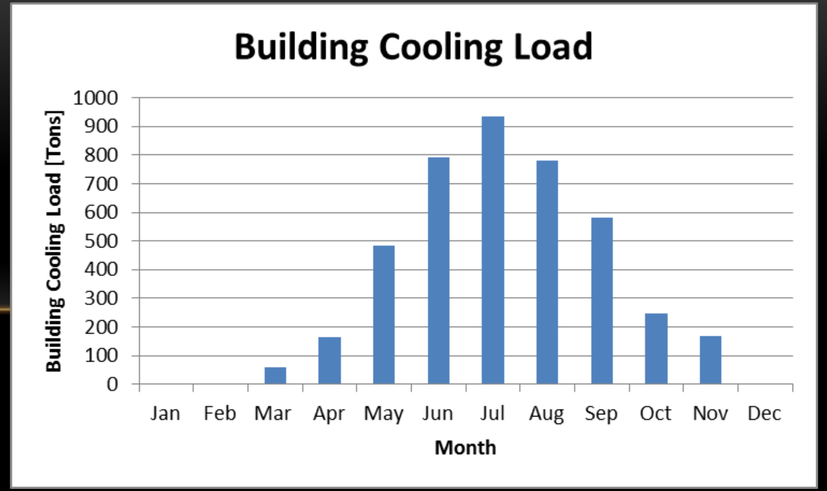


- Peak Heating Load – 7766 Mbh



- Peak Cooling Load – 934 Tons

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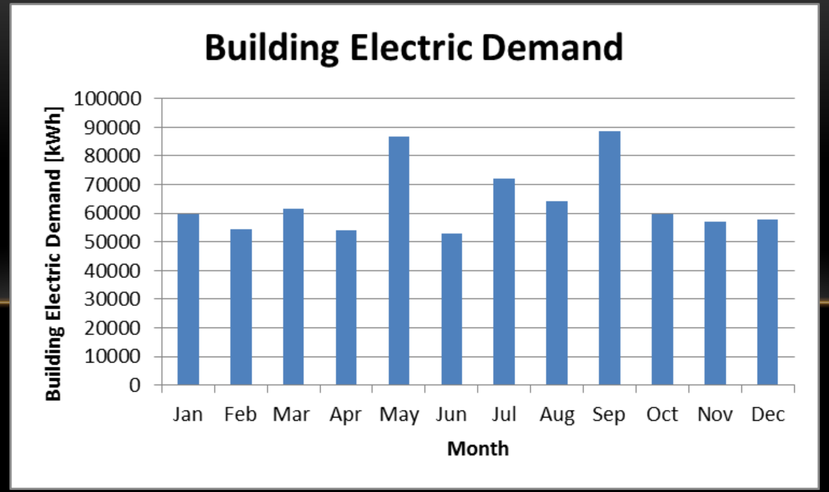
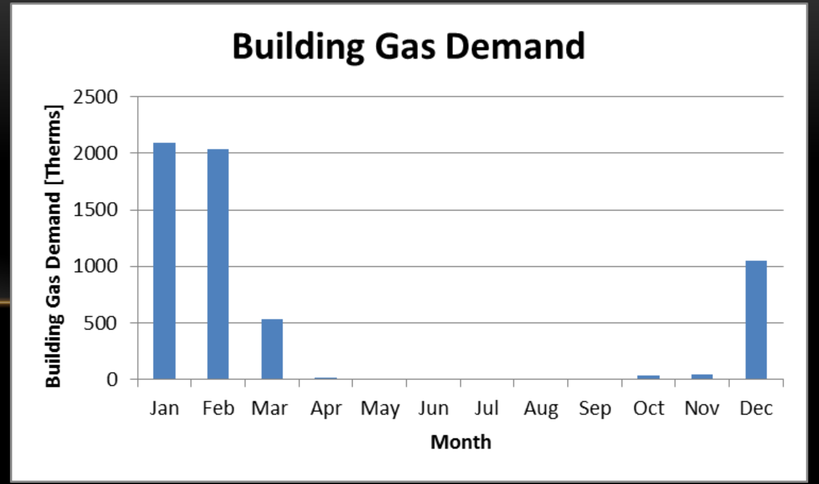


- Peak Electric Demand – 88681 kWh



- Peak Gas Demand – 2094 Therms

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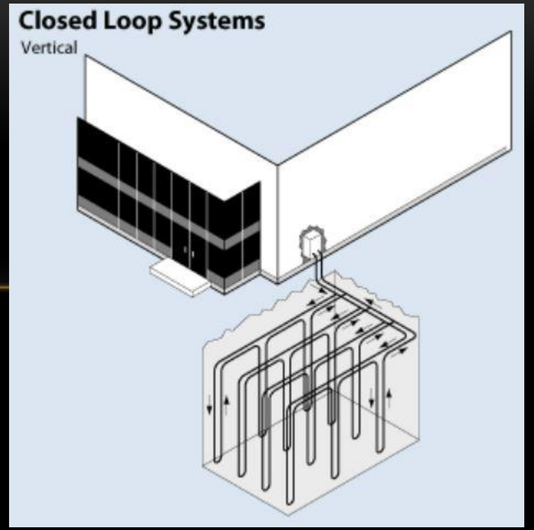
ADAM BROWN MECHANICAL OPTION SPRING 2014

- Goals
  - REDUCE energy demand
  - REDUCE environmental impact
  - INCREASE maintainability

- Proposal
  - Ground Coupled Heat Pump System
    - Heat Pumps
    - Packaged ERUs
    - Hydronic Pumps



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ADAM BROWN MECHANICAL OPTION SPRING 2014

- Vertical Bore Layout
- Well Field
  - Increase depth of well
  - Decrease amount of wells

Cooling Load [Tons]	Well Capacity [ft/Ton]	Depth of Well [ft]	Number of Wells
934	200	400	500

- Oversize Well Field
  - 1000 Tons
  - Soccer Field
  - Future capacity
  - No supplemental boiler / cooling tower

Well Coverage [ft^2]	Number of Wells	Total Coverage [ft^2]	Soccer Field Area [ft^2]
314	500	157080	202213

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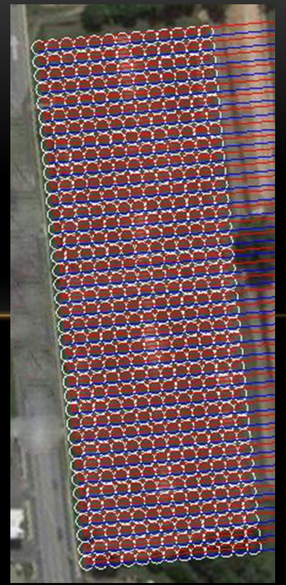

- Well Field Layout
  - 38 rows
  - 13 wells per row
  - Reverse return

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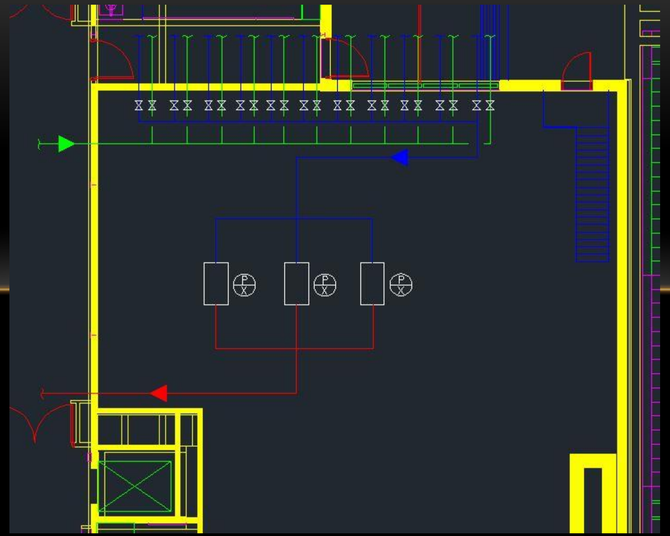
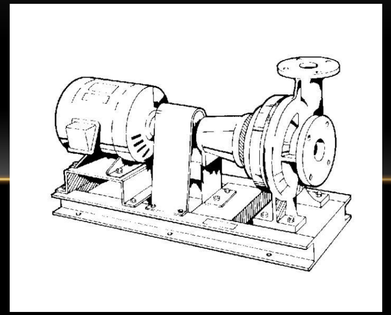


- Individual runs
  - Emergency shutoff
- 3 VFD pumps
  - 2 primary pumps
  - 1 redundant
- Increase maintainability

Central High School

ADAM BROWN MECHANICAL OPTION SPRING 2014

Pump Selection	
Manufacturer	Bell & Gossett
Model	Series 1510
Flow Rate [gpm]	1000
Head [ft]	200
Impeller Diameter [in]	8
RPM	3550
HP	60



- Heat Pump Selection
  - Carrier
  - Typical 1 – 3 ton units

- Energy Recovery Unit Selection
  - SEMCO
  - Packaged
  - Water to water source heat pumps
  - Enthalpy & Sensible wheels

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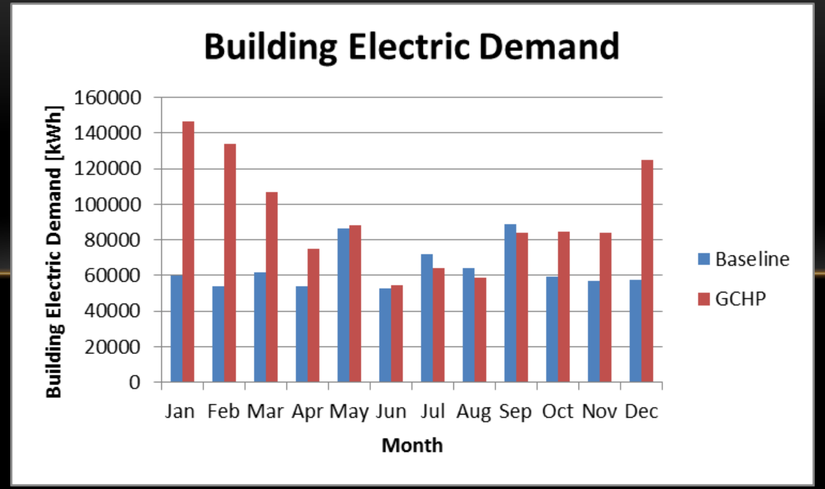

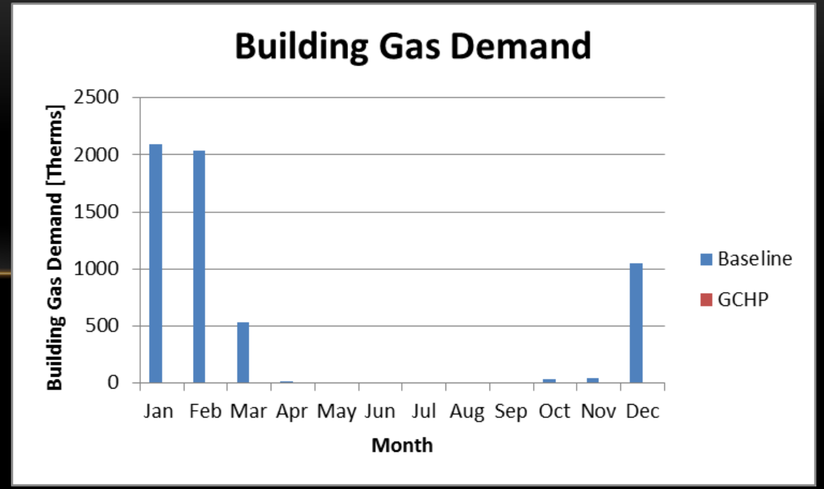

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ADAM BROWN MECHANICAL OPTION SPRING 2014

- Electricity increase 45%
- Energy decrease 35%
- Savings of $19074 per year

Energy Savings				
	Baseline		GCHP	
	Energy [10^6 Btu/yr]	Cost/yr [$/yr]	Energy [10^6 Btu/yr]	Cost/yr [$/yr]
Electricity	2623	85793	3771	70516
Gas	3221.9	3797	0	0
Total	5845	89590	3771	70516

Site & Source Energy		
	Baseline	GCHP
Electricity [kWh]	768528	1104826
Gas [kBtu]	3221945	0
Building [Btu/ft^2-yr]	18263	11782
Source [Btu/ft^2-yr]	35187	35350
Floor Area [ft^2]	320000	

Building Emissions		
	Baseline	GCHP
CO2 [lbm/yr]	1028013	1477859
SO2 [gm/yr]	9257	13308
NOX [gm/yr]	1772	2547

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Adjacent space			
Other enclosed or open-plan core learning space, therapy room, health care room and space requiring a high degree of acoustical privacy [a), b)]	**Common-use and public-use toilet room and bathing room [a)]**	**Corridor, staircase, office, or conference room [c), d)]**	**Music room, music performance space, auditorium, mechanical equipment room, [e)] cafeteria, gymnasium, or indoor swimming pool.**
50	53	45	60

[a)] These requirements do not apply to toilets opening only into the core learning space and used only by occupants of the core learning space.

[b)] A 20 cm (8") concrete masonry unit wall having a surface weight density of at least 180 kg/m^2 painted and sealed on both sides, acoustically sealed at the entire perimeter and extending from the floor slab to the structural deck above, is an acceptable alternate assembly that conforms to the intent of 5.4.2.1.

[c)] For corridor, office, or conference room walls containing doors, the basic wall, exclusive of the door, shall have an STC rating as shown in the appropriate column in this table. The entrance door shall conform to the requirements of 5.4.2.4.

[d)] When acoustical privacy is required, the minimum composite STC rating, including the effects of doors, of the partitions around an office or conference room, shall be increased to 50.

[e)] The isolation between core learning spaces and mechanical equipment rooms shall have a STC rating of 60 or greater unless it is shown that the sound level in the mechanical equipment room combined with a lower STC rating can achieve the required sound level in the core learning space. In no case shall the design STC between such spaces be less than 45.

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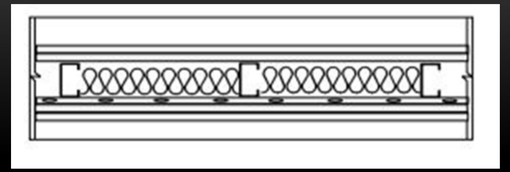

NRC TL #	Description	STC
TL-94-020	1 single layer of 1/2 in gypsum board 1 single layer of 1/2 in gypsum board 3.5 in steel studs at 16 in o.c. 3.5 in glass fiber insulation resilient channels at 24 in o.c. 1 single layer of 1/2 in gypsum board 1 single layer of 1/2 in gypsum board	60

- Heat Pump closet
  - Typical for classrooms
  - Achieves mitigation of sound through wall
  - Meets ANSI S12.60 standard

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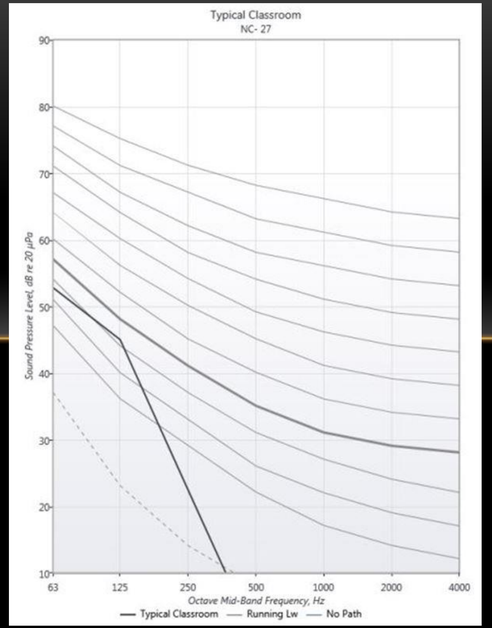

- NC 30 required
  - Low frequency issues
- Low Frequencies
  - Heat Pump emits most noise
  - Mitigate sound through ductwork
- NC 27 achieved

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	Cost [$]	Duration [days]	Coordination Issues
Closet	63878.58	19	2
Ceiling	60234.69	17	4

- Cost Difference of $3643.89
- Duration Difference of 2 days
- Coordination Issues Difference of 2

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- Goals
  - REDUCE energy demand
  - REDUCE environmental impact
  - INCREASE maintainability

- Conclusions
  - GCHP
    - REDUCED site energy
    - INCREASED environmental impact
    - INCREASED maintainability
  - Heat Pump Closet
    - MEETS ANSI standards
    - NOT feasible to construct

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Acknowledgements

Jacobs
SHW Group
Thesis Advisor
AE Faculty
Family & Friends
Classmates

THANK YOU!

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Questions?