



Public Building Commission of Chicago
BUILDINGChicago / Greening the Heartland 2014
Creating Extraordinary Results Through Integrative Design



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October 1, 2014

Acknowledgements/Credits

Chicago Public Schools

Principal Marti

Public Building Commission of
Chicago

Additional members of the team:

Jacobs/Ryan – landscape architect

Terra Engineering – civil engineer

F.H.Paschen/S.N.Nielsen -
contractor

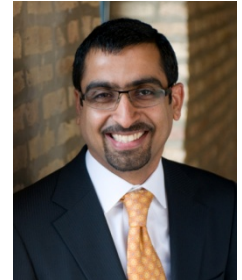


Introduction

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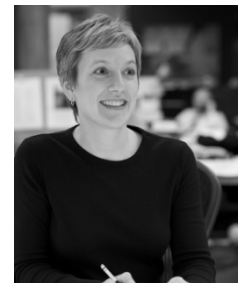


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Course Objectives

- Encourage collaborative thinking beyond expectations. Develop new mindset.
- Leverage integrated design to reduce first cost while improving ongoing efficiency.
- Implement an integrative design process in context of a prototype based design process
- Show how synergies between architectural, mechanical, lighting and site design can improve environmental performance



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Course Agenda

1. Integrative Design Process
2. Public Building Commission Program
3. Audience mini-charrette
4. Sarah E. Goode STEM Academy
5. Comparison with similar building
6. Conclusions
7. Audience discussion



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Preliminary Questions

- *How many of you are Architects? Engineers? Landscape Architects? Owners?*
- *How many of you have experience with integrative design process? Yes/No*
- *How many have felt that integrative design process led to better outcomes?*
- *How many felt it was easy? Hard?*
- *Paired share on experiences, or what you hope to learn in this session*



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Characteristics of an Integrative Design Process

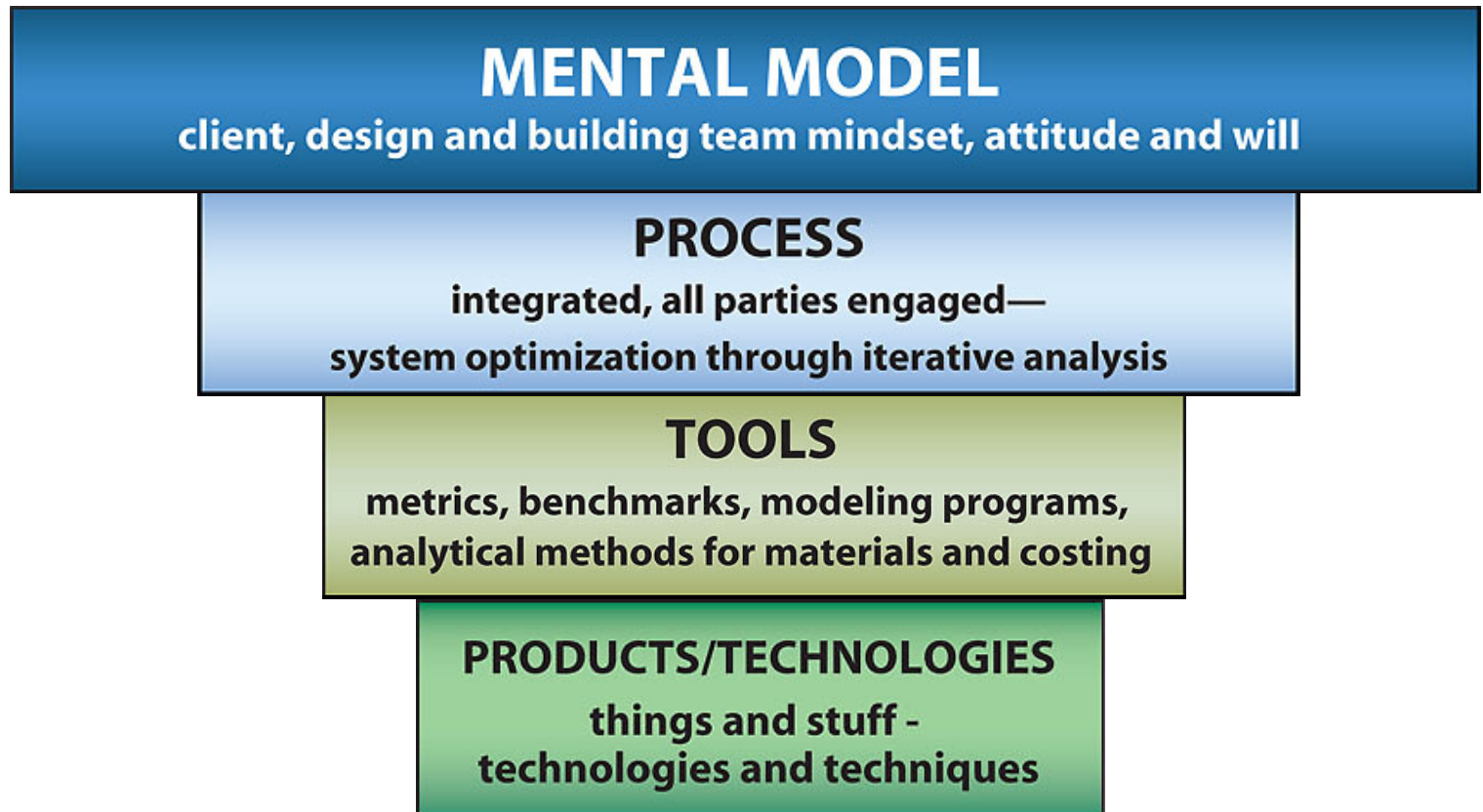
Everybody Engaging Every Issue Early

- Intentional process
- Discover interrelationships and synergies
- More and earlier analysis than typical practice
- Question conventional assumptions
- Iterative analysis
- Everyone working together



Stepping Stones to Integrative Design

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Concept by Bill Reed and Barbra Batshalom



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Shifting the Way We Think

From a linear process to



an interactive process to



an interdisciplinary process to



**a whole systems
process**

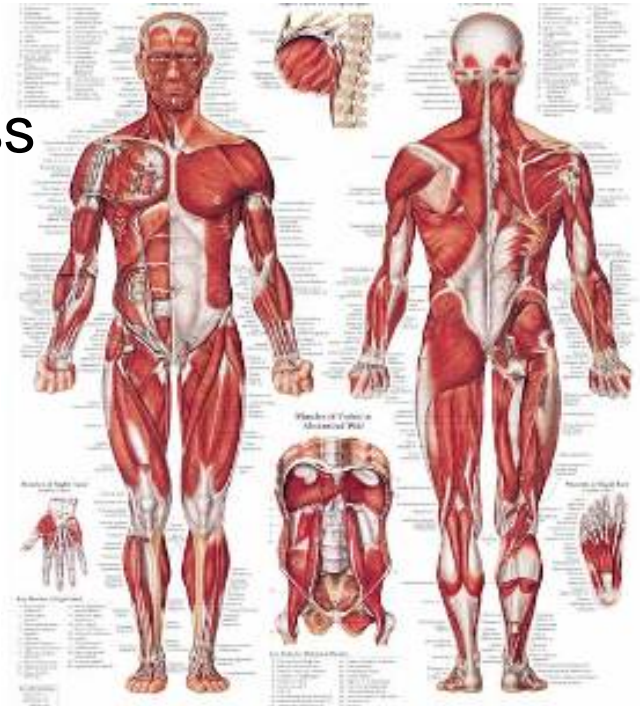


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Building as an Organism

Systems Integration:

- Understand relationships among systems
- Not a set of component parts
(Optimization in isolation)
- Holistic, non-linear process
- Downsize or eliminate
systems





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A Whole Systems Integrative Process

Tunneling through the cost barriers -
Optimize the system, not the parts

How?

- Take advantage of systems interactions
- Eliminate silos
- Use modeling/analysis tools

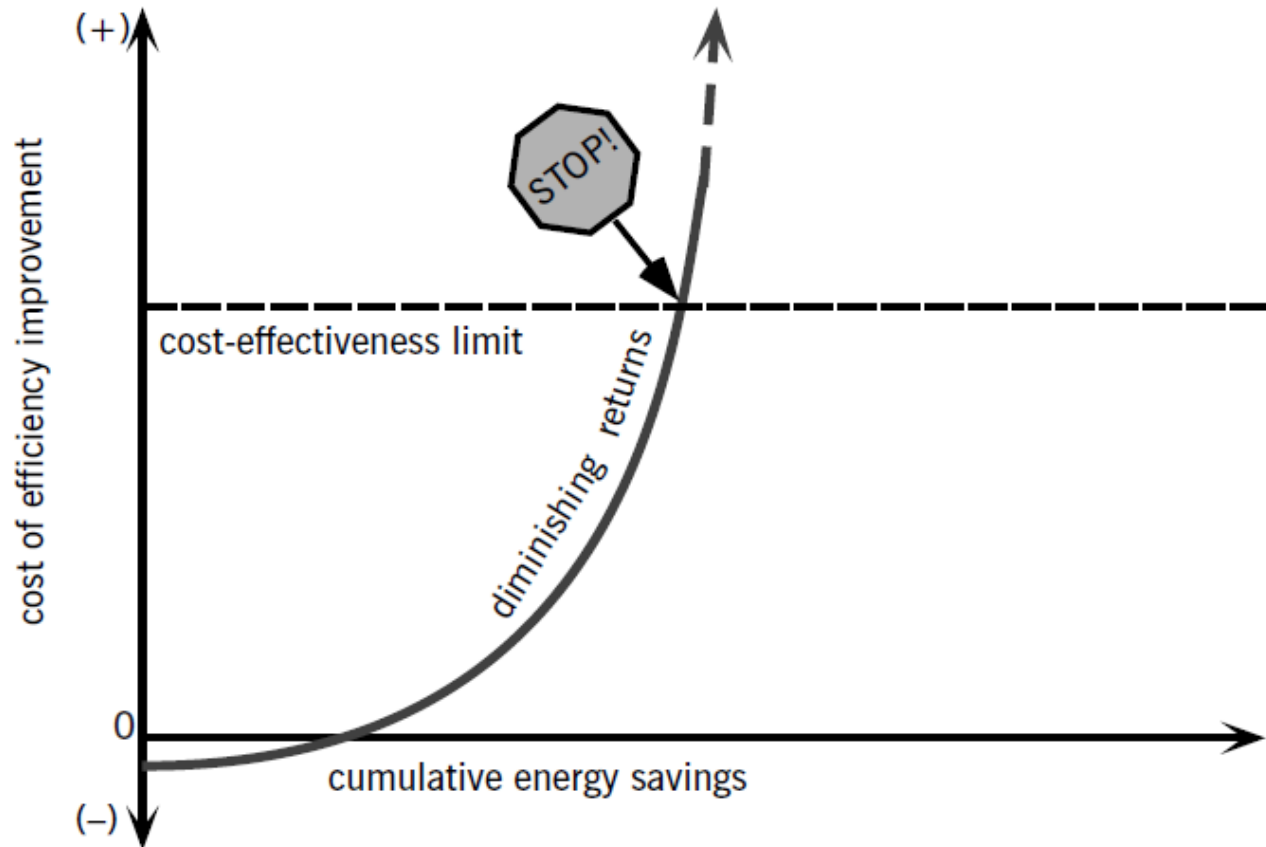
Goal –

Improve performance at lower first cost



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Diminishing Returns

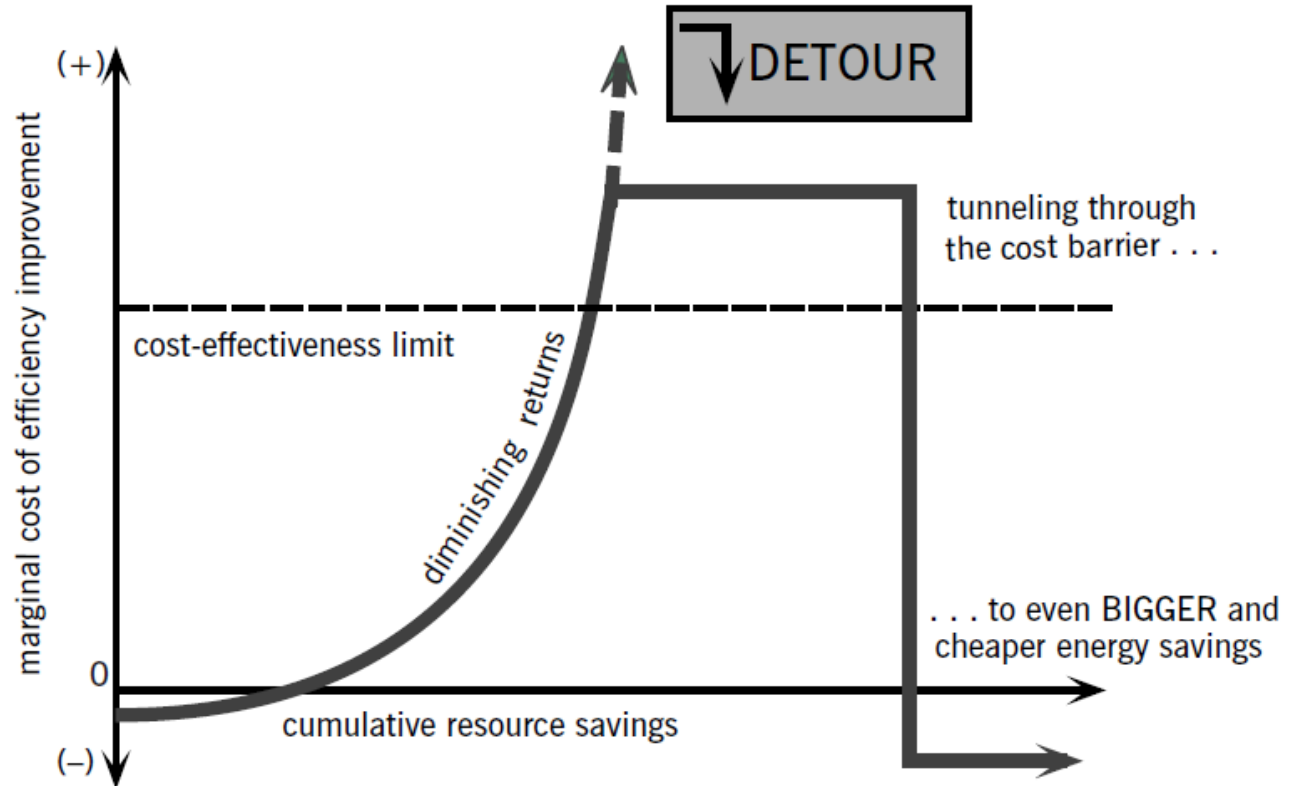


From Natural Capitalism by Lovins, Lovins and Hawken, 1999, Chapter 6



Tunneling Through the Cost Barrier

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Integrative Design Process

- Start with an Initial Charrette, but don't stop there
- Ongoing Team Meetings, Discussions, Research throughout design process
 - Iterative, makes use of tools, such as energy and lighting models
 - Interdisciplinary
 - Considers Whole systems – the project and systems within larger context



The Program

The Public Building Commission of Chicago

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Mission

The Public Building Commission of Chicago (PBC) is committed to client service and strong stewardship of public resources. The PBC plans, designs and builds facilities that reflect the highest standards of environmental and economic sustainability.

Vision

A built environment in which function, beauty and sustainability are inherent to every community; where physical surroundings inspire and support achievement of the individual goals of those who live, work and visit Chicago and Cook County; and, where people gather to share the common values that truly build our communities.



Daley Center, PBC Offices



The Program

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PBC manages a multi-year capital program -
Over \$2.6B in development authority

>4 Million SF of development

Over 100+ total projects

84 LEED-eligible (66 Certified to date):

- Public Schools
- Municipal – Firehouses/Police Stations/
Libraries
- Parks/Field Houses/Harbors
- Other Projects

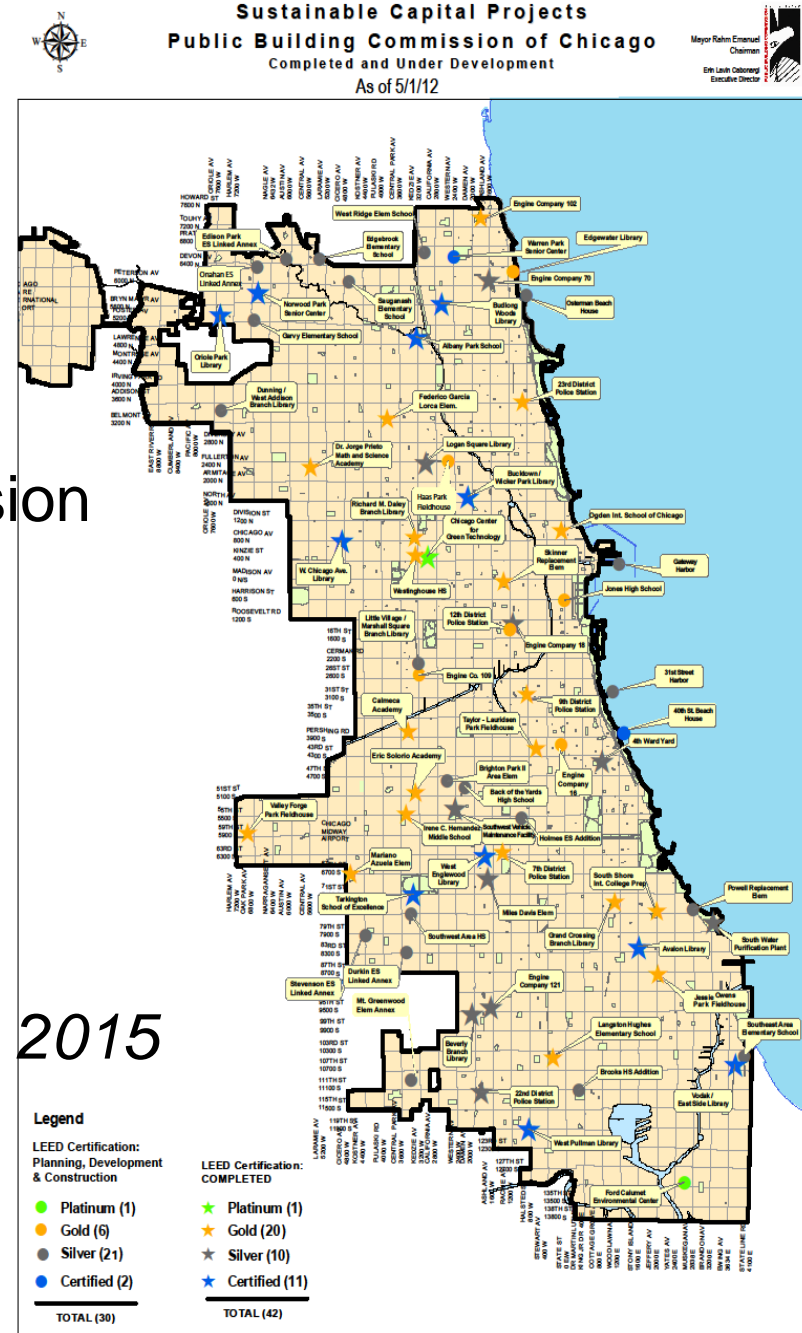


Context

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Public Building Commission
of Chicago
Chicago Public Schools
City of Chicago

- ✓ Aligned Goals
- ✓ Shared Commitment
- ✓ *Sustainable Chicago 2015*





Aligned Goals

From Green Medians to Sustainable Chicago 2015

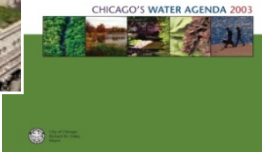
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-- 2000

-- 2002



-- 2004

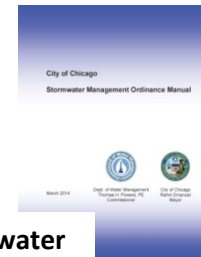


-- 2006



Green Alley
Program

-- 2008



Stormwater
Ordinance

-- 2010

-- 2012



-- 2014



Chicago
Standard



Green Urban
Design (2008)



2013

Retrofit
Chicago



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Aligned Goals

Program-wide: Make “green” routine
Excellent student experience / learning
environment
Use LEED to help meet goals





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The Evolving Prototype

- Chicago Public Schools Urban Model High School program – prototype design
- Minimum LEED Silver certification (LEED for Schools)
- Constraints – Design Standards



The Evolving Prototype

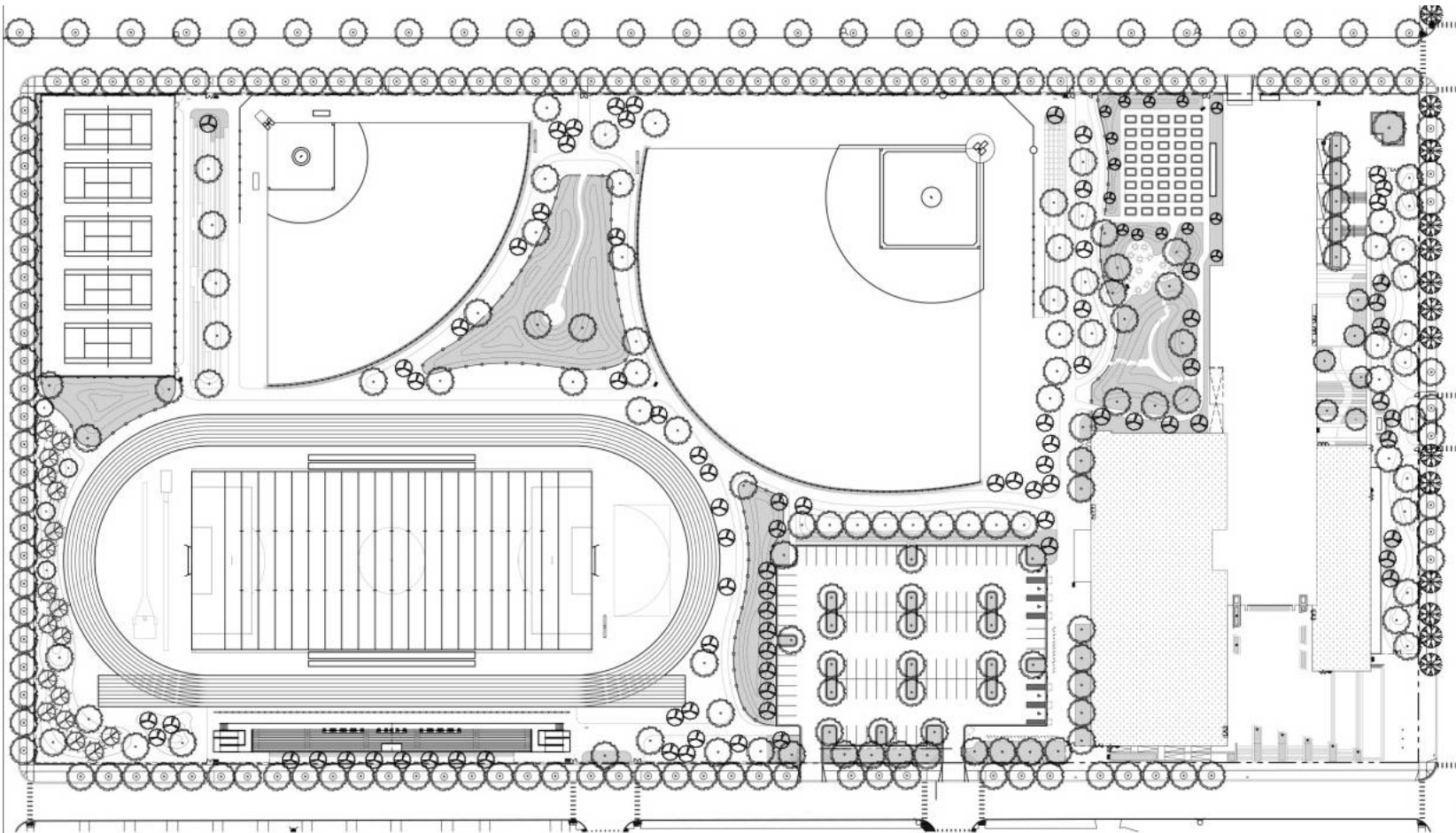
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Concept Transfer Package

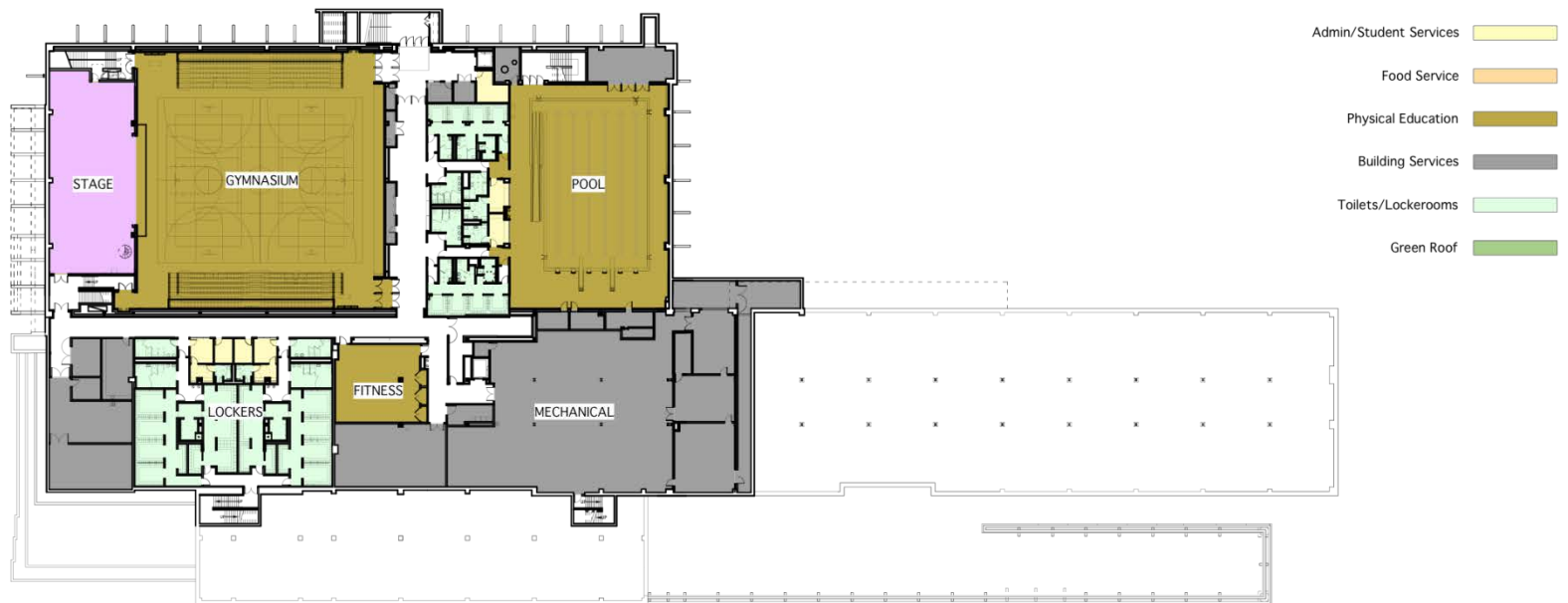
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Concept Transfer Package

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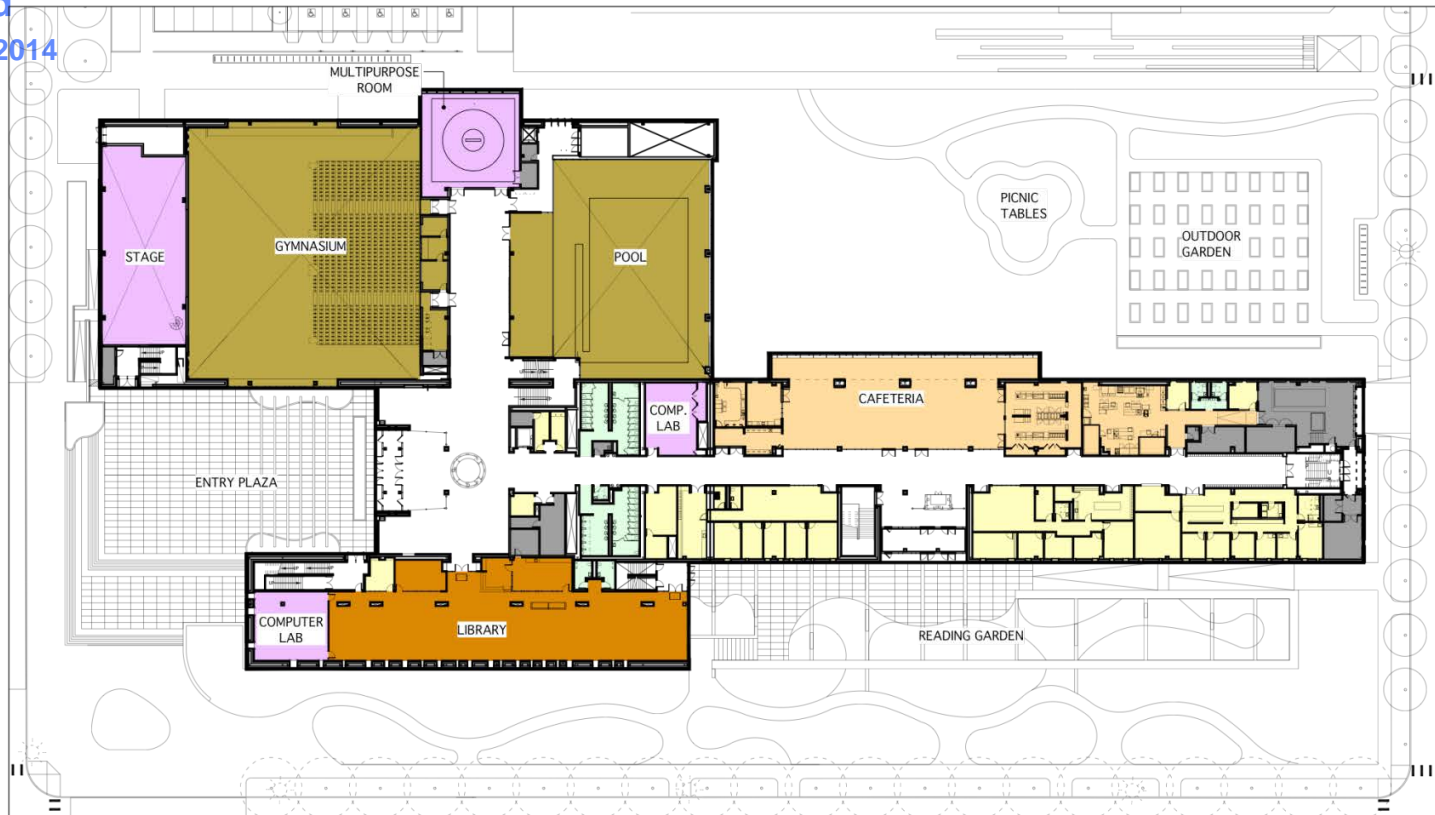


Lower Level Plan 



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- Core Academic
- Library
- Specialty/Arts
- STEM Laboratories
- Admin/Student Services
- Food Service
- Physical Education
- Building Services
- Toilets/Lockerrooms
- Green Roof

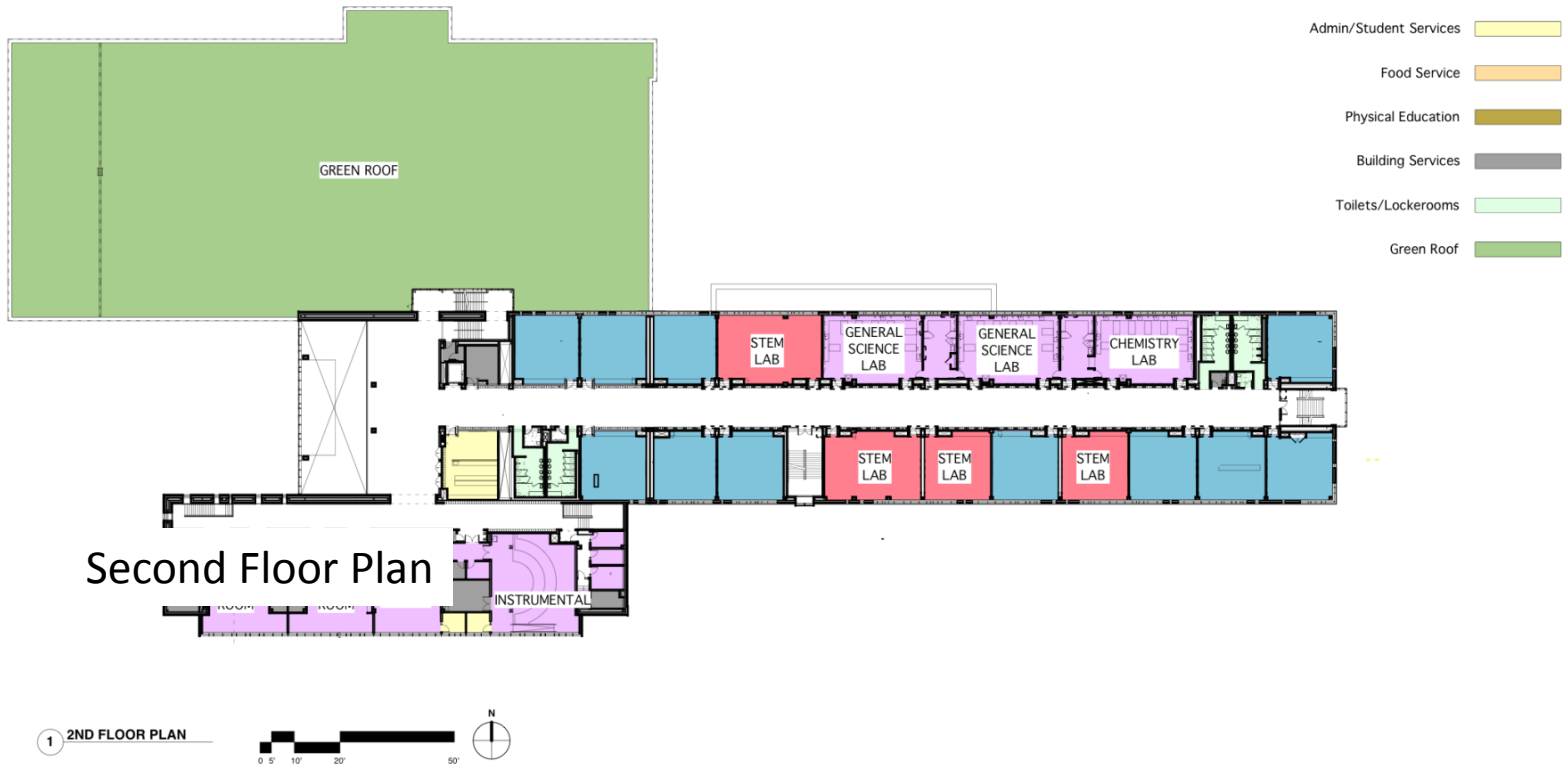
Main Level Plan





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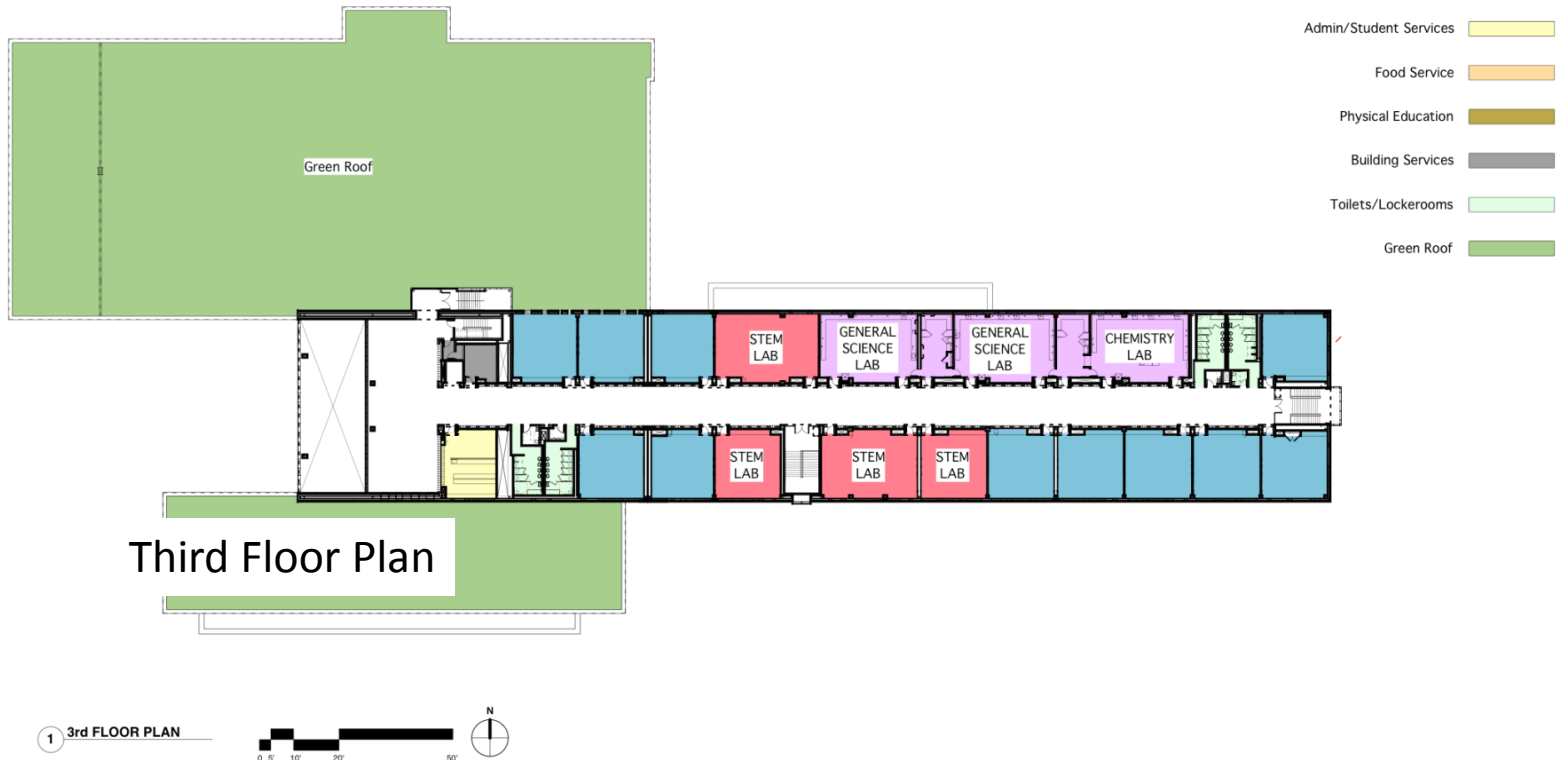
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Concept Transfer Package

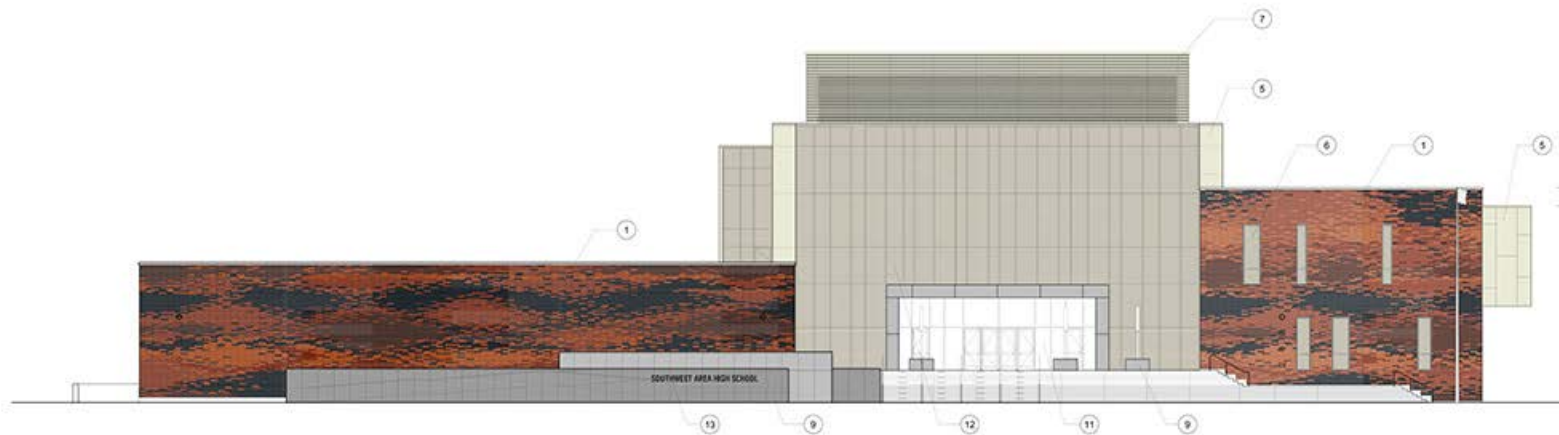
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West Elevation

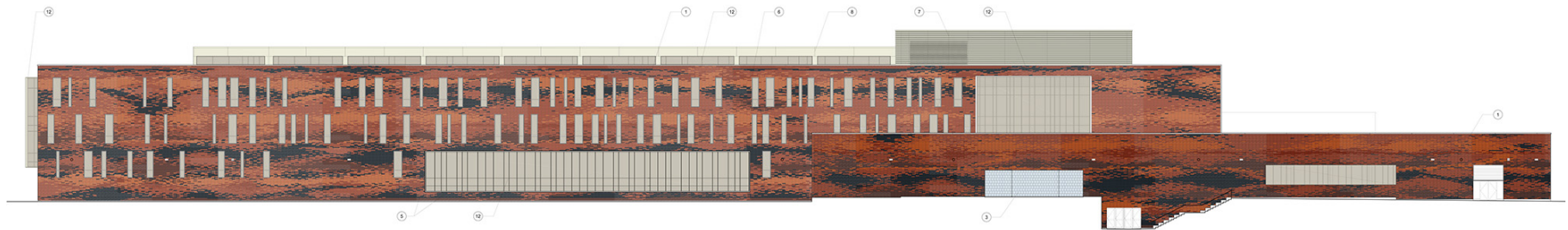


East Elevation

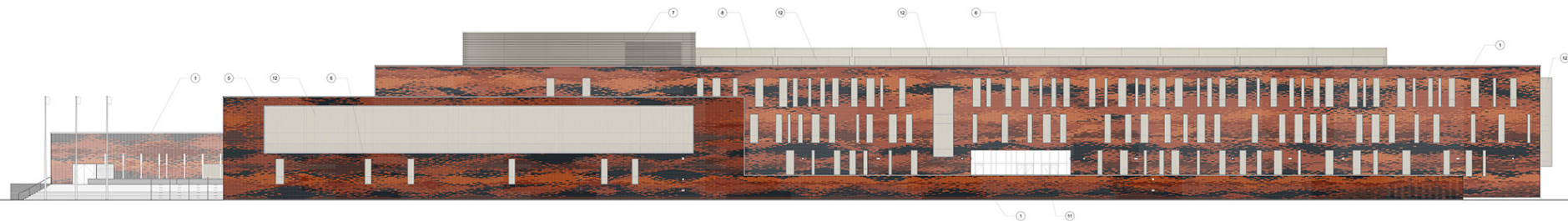


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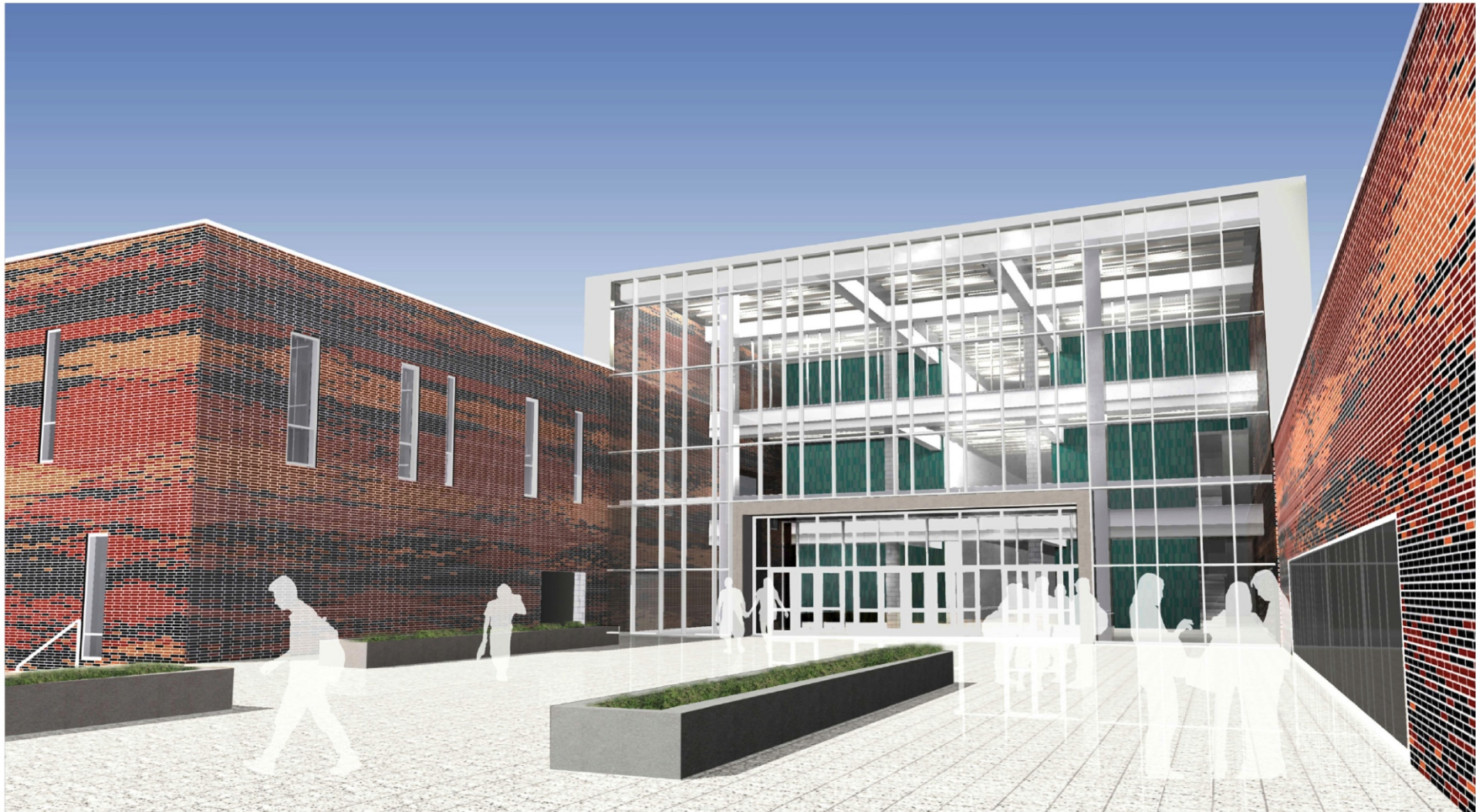
North Elevation



South Elevation



Concept Transfer Package





Sustainable Design / LEED Charrette

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Purpose of Initial Sustainable Design/LEED Charrette

- Understand what Sustainability means to stakeholders.
- Explore sustainable design goals, opportunities, interacting relationships.
- Identify further research.
- Develop LEED Checklist – Target points (Don't start here!!)



Charrette – Initial Discussion Points

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What would have you be able to say the project is sustainable?

What would make the project a success?



Charrette Notes

10

Is site fenced fr/ community?
 filter 100% of stormwater
 make sure handicap parking is exposed to sun in winter
 introduce turtles & frogs to site
 playground mfr that slices water - illustrates water input/control
 Create bird habitat @ green roof
 leads water
 make sure outdoor recreation facilities used year round
 Create ice skating rink, skate board park
 truth room - temperature sensors to show stratification, mechanical room visible
 materials visible - show where they come from - signage
 reduce amount of site lighting
 individual sport fields have own on/off switches
 trellises & plants @ parking lot
 PV parking lot canopies
 PV site lighting - to avoid electrical
 PV/wind site lighting
 solar trash compactor
 Use water from roof for water sculpture - physics demo

3

Reduce noise in a/c system

comfort
 first best fit for all three
 learning
 energy eff

Choose mat'ls that enhance healthy environment & that are durable
 a place that inspires students to make a difference in the world - in a good way
 Students take pride in the environment
 enhances interconnectivity -
 Community, students
 environment / community / learning
 improves ability of students to learn & changes their lives with respect to the community, the environment & themselves
 focus on passive solar heating/cooling/structures
 1st - will not change long term, therefore should be designed for efficiency
 easily maintained & sustained equipment
 reduce burden on landfill
 building continues to be used/useful for at least 100 years

6

provide just the illumination levels that are required
 lamps - high CRI, good color temp.
 CPS guidelines - water cooled chiller
 Use CO₂ sensors in gym, other large multi-tenant spaces, not classrooms
 occupancy sensor tied to HVAC system
 Design so that systems fail, signals that energy efficiency is maintained
 Explore micro-turbines - demand for waste heat??
 Capture NW winds w/ evergreens?
 Create layer of plants behind facade & bldg?
 Clean interior w/ plants?
 Small windows good for reducing interior noise levels
 window shading
 stack effect ventilation thru atrium - see Little Village users
 envelope - insulated a bit beyond code
 increase roof insul beyond code
 Consider envelope for heating + cooling season
 Intakes should be on north side

Good(e) Charrette Goals:

- Simplify Construction
- Increase Daylight
- Reduce Cost
- Implement Ground Source Heat Pump System
- Engage Community

Reduce noise in duct system

3

Comfort
Learning
Energy

Choose materials that enhance healthy environment

a place that inspires students to make a difference in the world - in a good way

enhances interconnectivity -

Community, Students
Improves ability of students to learn & engages them in respect to the community.

focus on passive solar heating/cooling/structure

1st - will not change long term, therefore

reduce burden on landfill

building continues to be used/useful for at least 100 years

provide for the illumination of the
hall and required
analysis - high CPT, energy efficient

CPS requires water control system

Use CPS sensors in gym, other large

high element storage and - atmosphere

CPS planning service tied to HVAC, lighting

Design so that, system, to, improve, that

Energy efficiency is maintained

Explore more turbines - demand for

light heat

Create layer of plants before facade & building?

Color, interior w/ plants?

Small windows good for reducing interior noise

Window shading

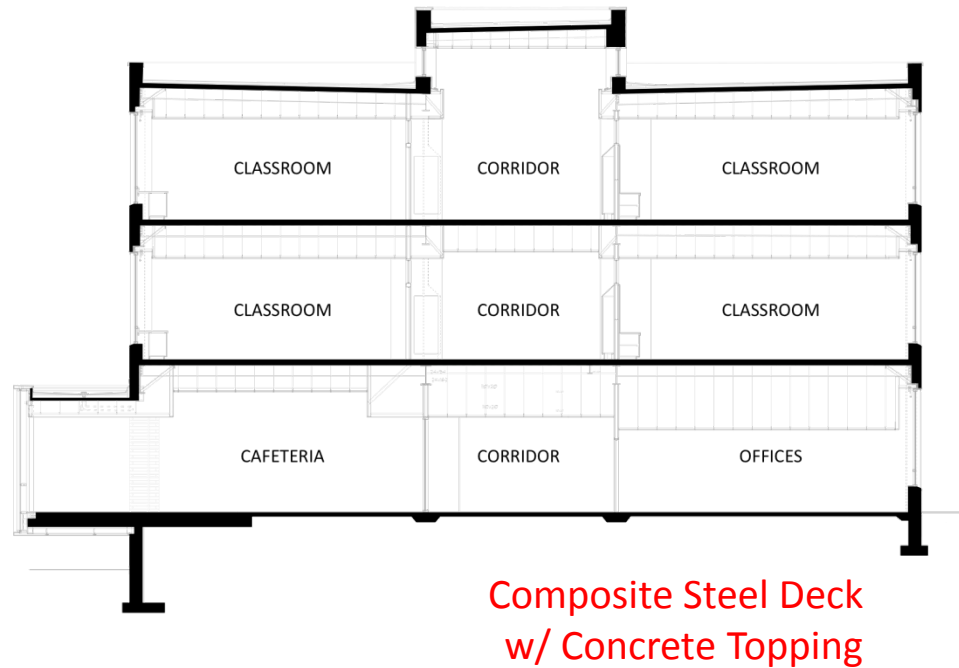
stack effect ventilation, thus driving - so little

envelope - insulated a bit beyond code

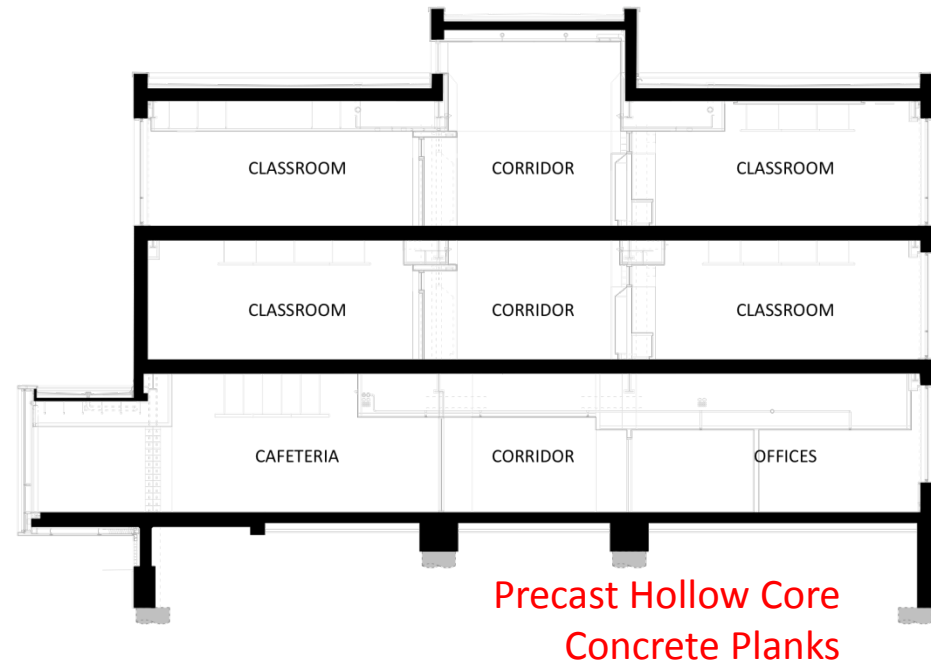
Consider envelope for heating & cooling season

Intakes should be on north side

Structural System

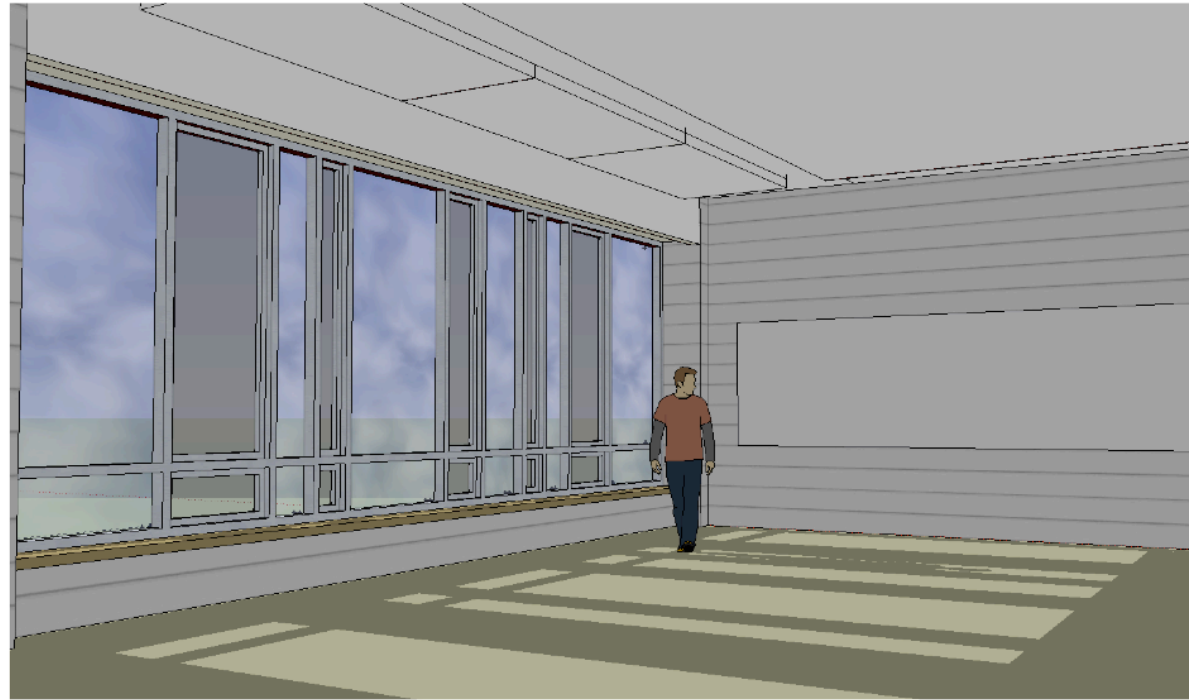


Sarah E. Goode Building Section



Prototype Building Section

Increase Daylight



**OPTION 2:
INTERIOR VIEW IN TYPICAL CLASSROOM**

41% Glazing Area



**BASE CONCEPT DESIGN:
INTERIOR VIEW IN TYPICAL CLASSROOM**

28% Glazing Area



**OPTION 1:
INTERIOR VIEW IN TYPICAL CLASSROOM**

35% Glazing Area

Study: Glazing Properties

Table 1: Cost and Energy Comparison							
Simulation Option	Glazing Area (% of Total Wall Area)	Electrical Energy		Gas Energy		Total Energy	
		Usage (kWh)	Cost (\$)	Usage (Therms)	Cost (\$)	Usage (10 ⁶ Btu)	Cost (\$)
Option 1 ^a	28%	941,500	30,214	62.04	1,220	3,833	31,434
Option 2 ^a	41%	918,377	29,471	72.86	1,433	3,862	30,904
Option 2 ^b - Scenario 1	41%	946,073	30,360	68.71	1,352	3,915	31,711
Option 2 ^b - Scenario 2	41%	944,431	30,307	69.06	1,358	3,913	31,666
Option 2 ^b - Scenario 3	41%	934,379	29,985	67.10	1,320	3,859	31,305



Prototype



Sarah E. Goode







HVAC System: Life-Cycle Cost Analysis

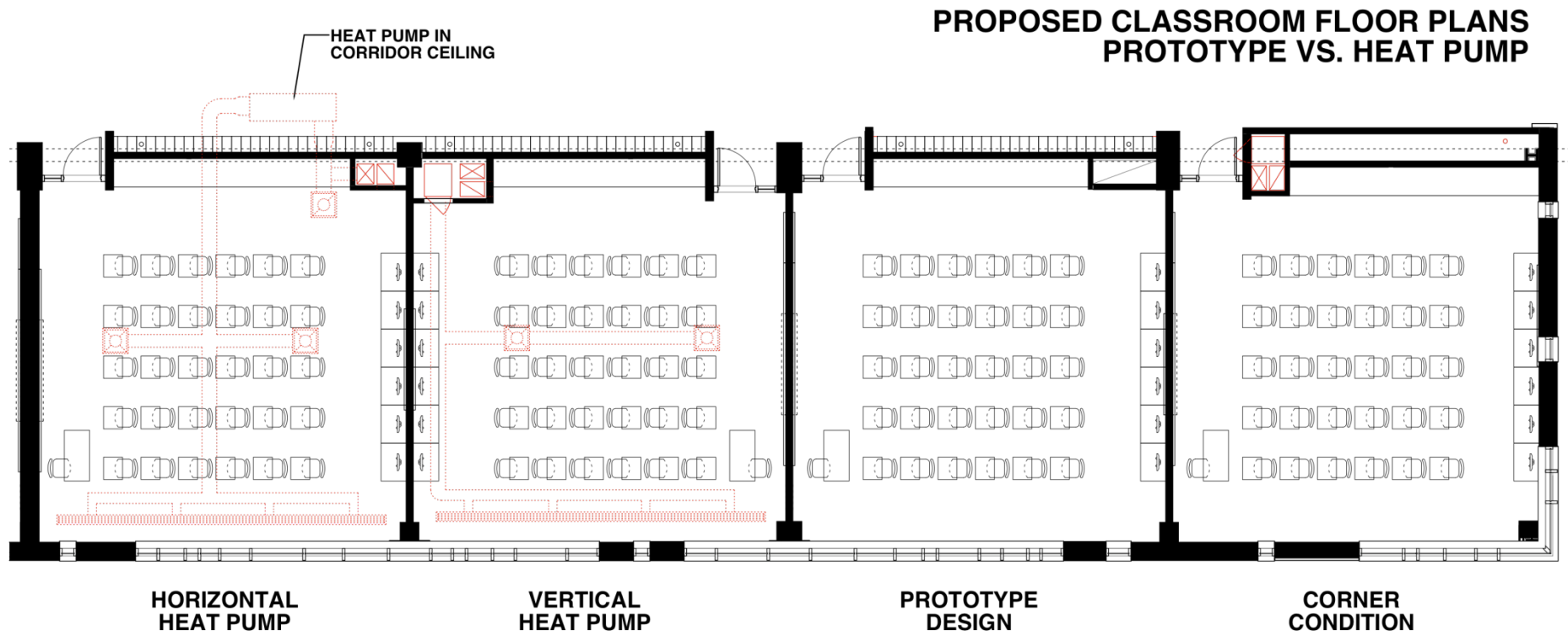
HVAC SYSTEM COMPARISON FOR SOUTH WEST AREA HIGH SCHOOL

	Equipment	Ashrae 90.1 Baseline Water Cooled VAV	Alternate 1 Air Cooled VAV	Alternate 2 Water Cooled VAV	Alternate 3 GSHP VAV	Alternate 4 GSHP	Responsibilities/Comments
1	ASHRAE 90.1 BASELINE						
2	Refrigeration	0.03					
3	Heat Recovery	0.004					
4	Heat ex. (Cooling Tower) (CFM)	0.73					
5	Chiller	0.03					
7	Heating Coefficient	0.40					
8	Heating Plant	Chiller/Boiler					
10	Cooling Plant	Water Cooled Chiller					
11	Energy Recovery						
12	LOAD DATA						
13	Conditioned Area	160,700	160,700	160,700	160,700	160,700	
14	Outside Air - Supply Air Flow (CFM)	15,000	15,000	15,000	15,000	15,000	
15	Heating Load (kBtu/h)						
16	Cooling Load (Tons)						
17	Zone Unit - Supply Air Flow (CFM)	15,000	15,000	15,000	15,000	15,000	
18	Heating Load (kBtu/h)						
19	Cooling Load (Tons)						
20	Pool Unit - Supply Air Flow (CFM)	15,000	15,000	15,000	15,000	15,000	
21	Heating Load (kBtu/h)						
22	Cooling Load (Tons)						
23	1st Floor Unit - Supply Air Flow (CFM)	80,000	80,000	80,000	80,000	80,000	
24	Heating Load (kBtu/h)						
25	Cooling Load (Tons)						
26	2nd Floor Unit - Supply Air Flow (CFM)	80,000	80,000	80,000	80,000	80,000	
27	Heating Load (kBtu/h)						
28	Cooling Load (Tons)						
29	3rd Floor Unit - Supply Air Flow (CFM)	167,000	167,000	167,000	167,000	167,000	
30	Heating Load (kBtu/h)						
31	Cooling Load (Tons)						
32	Outside Air Flow (CFM)	48,000	48,000	48,000	48,000	48,000	
33	Cooling Capacity (Tons)	400	300	300	400	400	
34	Heating Capacity (kW - Boiler)	6,000	3,700	3,700	2,000	2,000	
35							
36	Water Air Handling Unit	\$120,000	\$120,000	\$80,000	\$80,000	\$80,000	
37	Boiler Air Handling Unit	\$120,000	\$120,000	\$80,000	\$80,000	\$80,000	
38	1st Floor Air Handling Unit	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	
39	2nd Floor Air Handling Unit	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	
40	3rd Floor Air Handling Unit	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	
41	Pool Unit Air Handling Unit	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	
42	Outside Air Unit	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	
43	2nd Floor Air Unit						
44	Boiler						
45	Chiller						
46	Cooling Tower						
47	Heating Plant						
48	Water to Chiller (Distribution)						
49	Chiller to Water (Return)						
50	Water to Chiller (Distribution)						
51	Chiller to Water (Return)						
52	Outside Air Unit						
53	Water to Air Unit (Distribution)						
54	Air Unit to Water (Return)						
55	Water to Air Unit (Distribution)						
56	Air Unit to Water (Return)						
57	COST SUMMARY						
58	Total Equipment Cost			\$2,598,000	\$2,553,000	\$2,180,000	\$1,980,000
59	Total Installed Cost			\$7,794,000	\$7,659,000	\$6,540,000	\$5,940,000
60	Geo-Exchange Wells			N/A	N/A	\$2,000,000	\$1,700,000
61	Capital Cost (Note 2)			\$7,794,000	\$7,659,000	\$8,540,000	\$7,640,000
62	Federal Tax Credit (10% for Geothermal)			\$0	\$0	-\$854,000	-\$764,000
63	Total Cost of System to Owner			\$7,794,000	\$7,659,000	\$7,686,000	\$6,876,000
64	\$/sq ft			\$46.20	\$45.40	\$45.56	\$40.76
65	ENERGY SUMMARY						
66	Electric Consumption (kWh) - (Note 3)		1,007,516	1,000,746	971,117	885,189	735,811
67	Gas Consumption (THERMS) - (Note 3)		34,506	7,313	7,313	3,272	3,807
68	Annual Energy Cost		\$93,261	\$70,580	\$68,582	\$59,488	\$50,247
69	Performance Improvement		0.0%	24.3%	26.5%	36.2%	46.1%
70	LEED For Schools Points			4	5	8	10
71	ME TRICS						
72	\$/Sq.ft Energy Cost		\$0.55	\$0.42	\$0.41	\$0.35	\$0.30
73	Cooling (\$/ton)		375	482	482	475	359

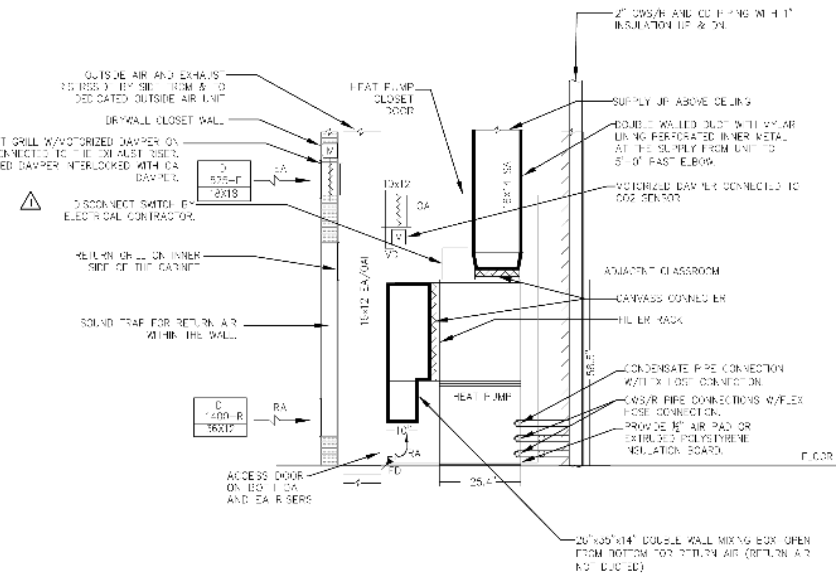
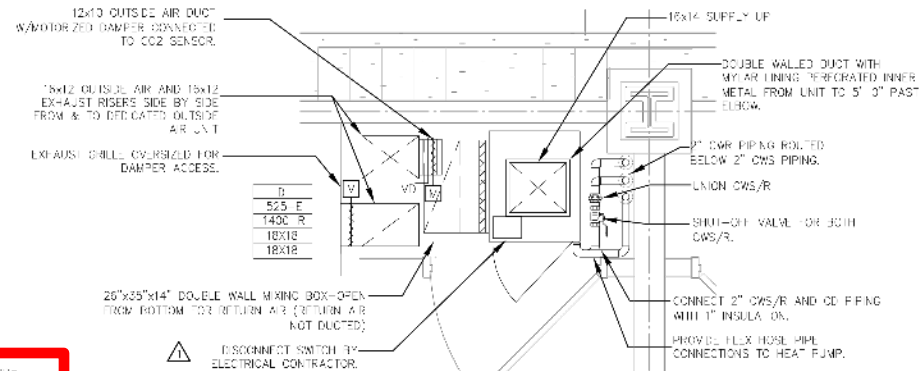
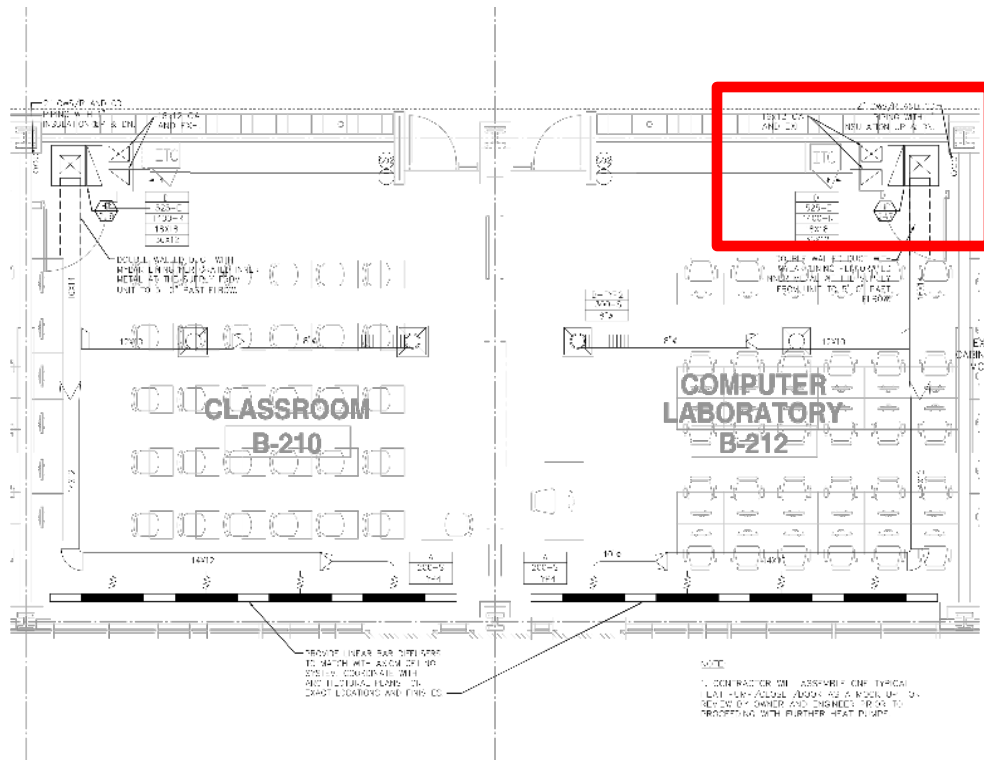
Ground Source Heatpump System



Ground Source Heatpump System



Ground Source Heatpump System



Ground Source Heatpump System



**Drilling wells for
geo-exchange system**

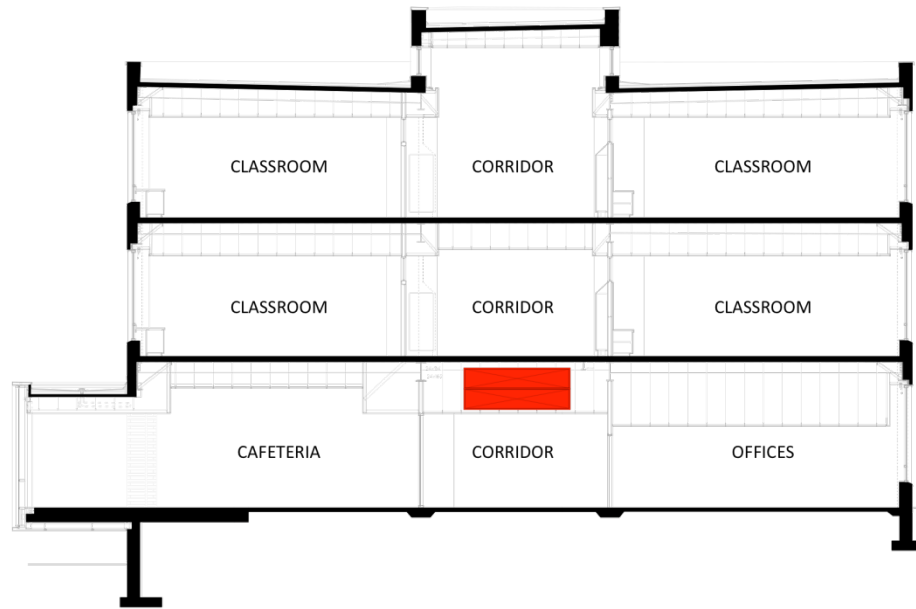
**Heatpump Closet
located in classroom**



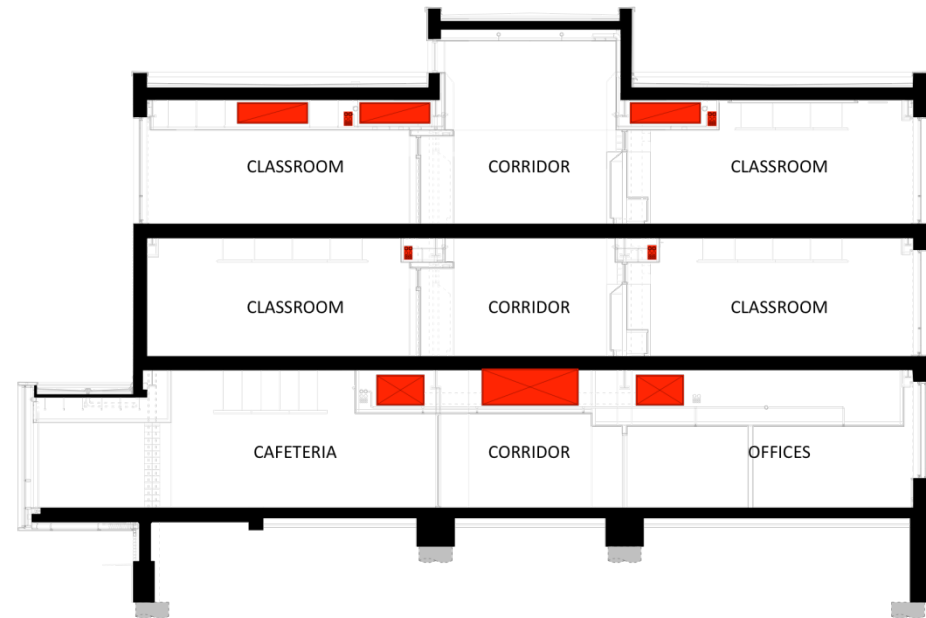
Ground Source Heatpump System

Areas of Intense Mechanical Coordination

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Sarah E. Goode Building Section



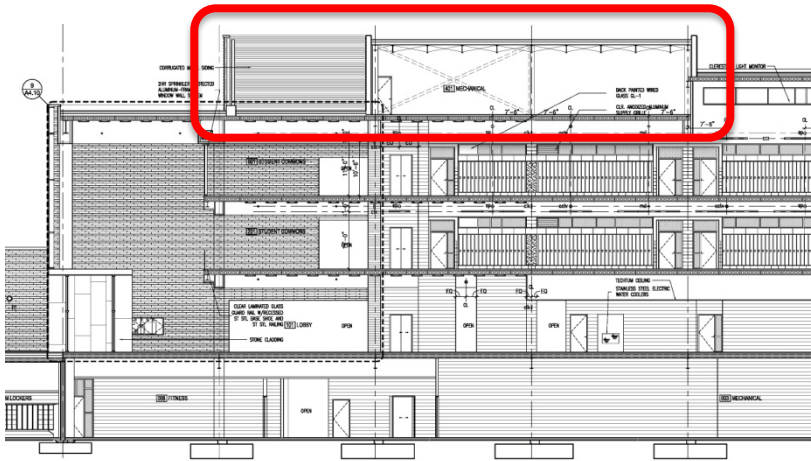
Prototype Building Section



Ground Source Heatpump System

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**Penthouse Eliminated
At Sarah E Goode**



Prototype Building Section



Sarah E Goode Solar Panels



Engage Community















Solar Water Heating



A wide-angle photograph of a large indoor swimming pool. The pool is filled with blue water and has several lanes marked by floating lane lines. The ceiling is a complex, high-arched structure made of blue-painted steel trusses. The walls are covered in blue and white square tiles. On the right wall, there is a large digital scoreboard displaying various statistics in red and white numbers. The pool deck is made of light-colored tiles, and there are metal railings and diving boards along the edges. The overall atmosphere is bright and modern.

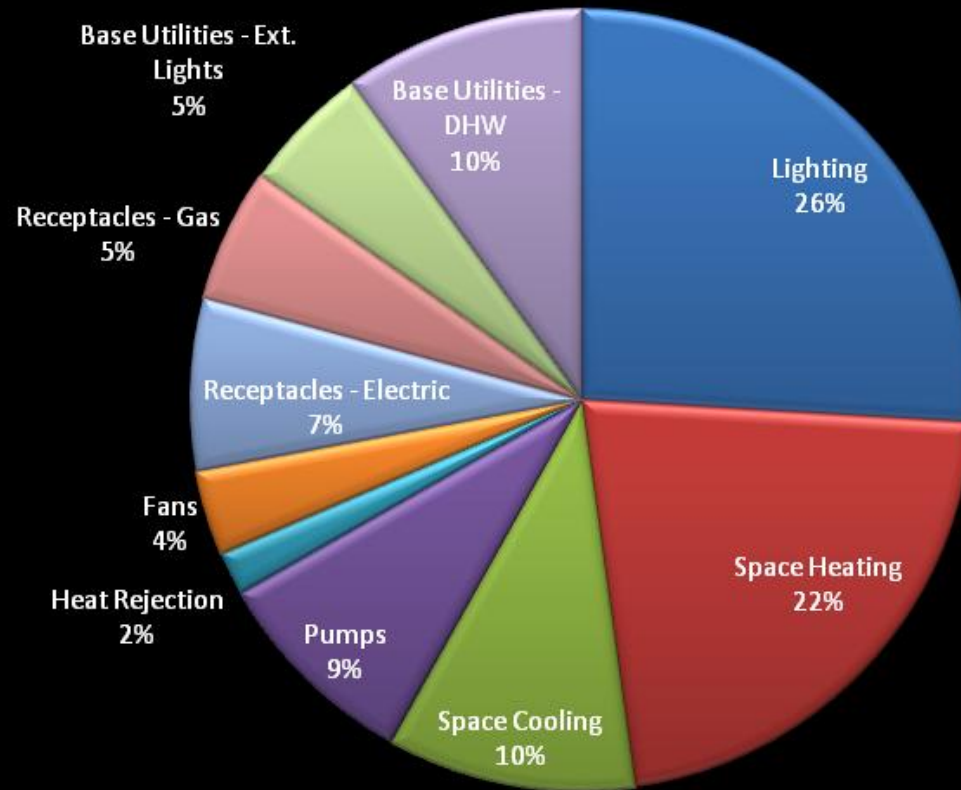




Energy Baseline

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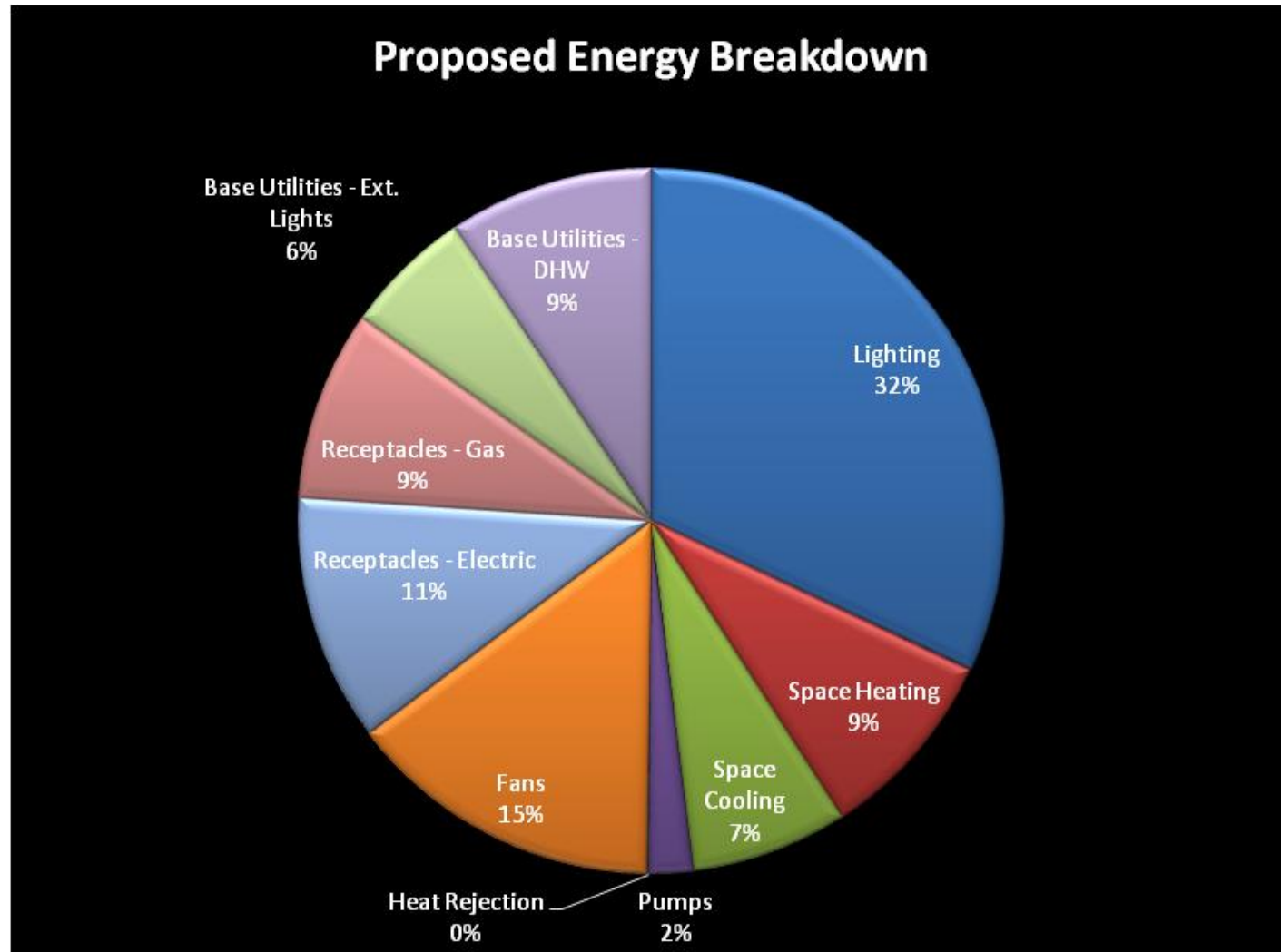
Baseline Energy Breakdown





Energy Proposed

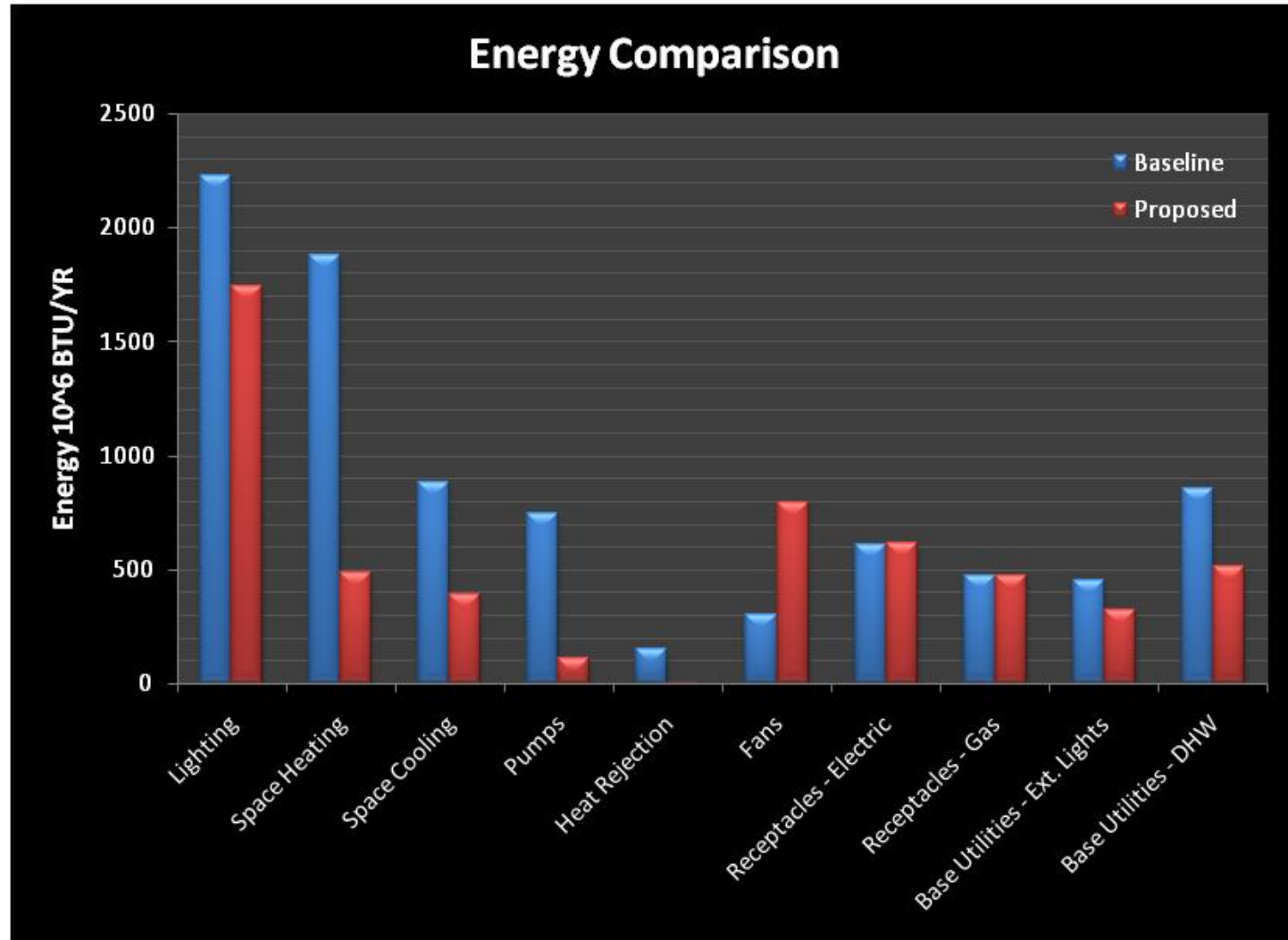
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Energy Comparison

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Sarah E. Goode vs. Evolving Prototype

A Side-By-Side Comparison: Cost

Goode	\$	62,452,000
BOTY	\$	63,822,440
	\$	(1,370,440) @ \$7/SF difference

Significant Scope Differences:

Masonry	Brick pattern regularized; Less quantity than prototype due to increase in windows and shorter building due to HVAC changes.
Steel / Miscellaneous Metals	Goode changed from concrete deck to steel deck with concrete top. Shorter building due to smaller HVAC ductwork. Eliminated Penthouse. BOTY stayed with precast plank. Penthouse required with standard HVAC
Spray Fireproofing and Insulation	Less Steel; less fireproofing.
HVAC	Smaller ductwork – VAV versus distributed heat pumps with dedicated outside air; Added acoustic insulation at classroom heat pump closets;
Geothermal wells	Boilers reduced from (3) 3,000 mbh to (2) 1,500 mbh; (1) 450 ton Chiller versus distributed heat pumps and geothermal pool dehumidification unit. Added geothermal wells – 170 wells at 450 feet deep each.

Sarah E. Goode vs. Evolving Prototype

A Side-By-Side Comparison: LEED

LEED Categories	GOODE	BOTYHS
Sustainable Sites	14	10
Water Efficiency	5	5
Energy and Atmosphere	12	8
Materials and Resources	7	7
Indoor Environmental Quality	16	10
Innovation	5	5
TOTAL	59	45
	Platinum	Gold

effort
research holistic green
efficiency focused support
collaborative high leverage
integrative cognitive leadership
cost ongoing synergies value receptive extraordinary
unstoppable design performance persistence
interrelationships communication first modeling process
champion out committed open innovative continuous
sustainable taking proved mindset engage
team belief quality

Questions





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