

organic
AEI Team 10-2013

ASCE Charles Pankow Foundation Annual
Architectural Engineering Student Competition

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April 3, 2013

Reading, PA

Population **88,082**

Among **poorest cities** per capita in the U.S.*

Bottom 15% in state academic performance*

*2010 United States Census

How can you improve a community?

“**Education** is the most powerful weapon which you can use to **change the world.**”

-Nelson Mandela

How can **team organic** improve Reading, PA?

Provide a high-performance educational facility that serves as a symbol and serves as an **educational tool** to **improve quality of life**

Presentation outline:

Project **Overview**

Detailed **Integration**

Structural Design

Construction

Conclusions & **Lessons Learned**

AEI Goals

“To improve the performance of building design”

- Integration
- Collaboration
- Communication

Efficient Engineering

Collaboration Software:

- Revit
- Navisworks

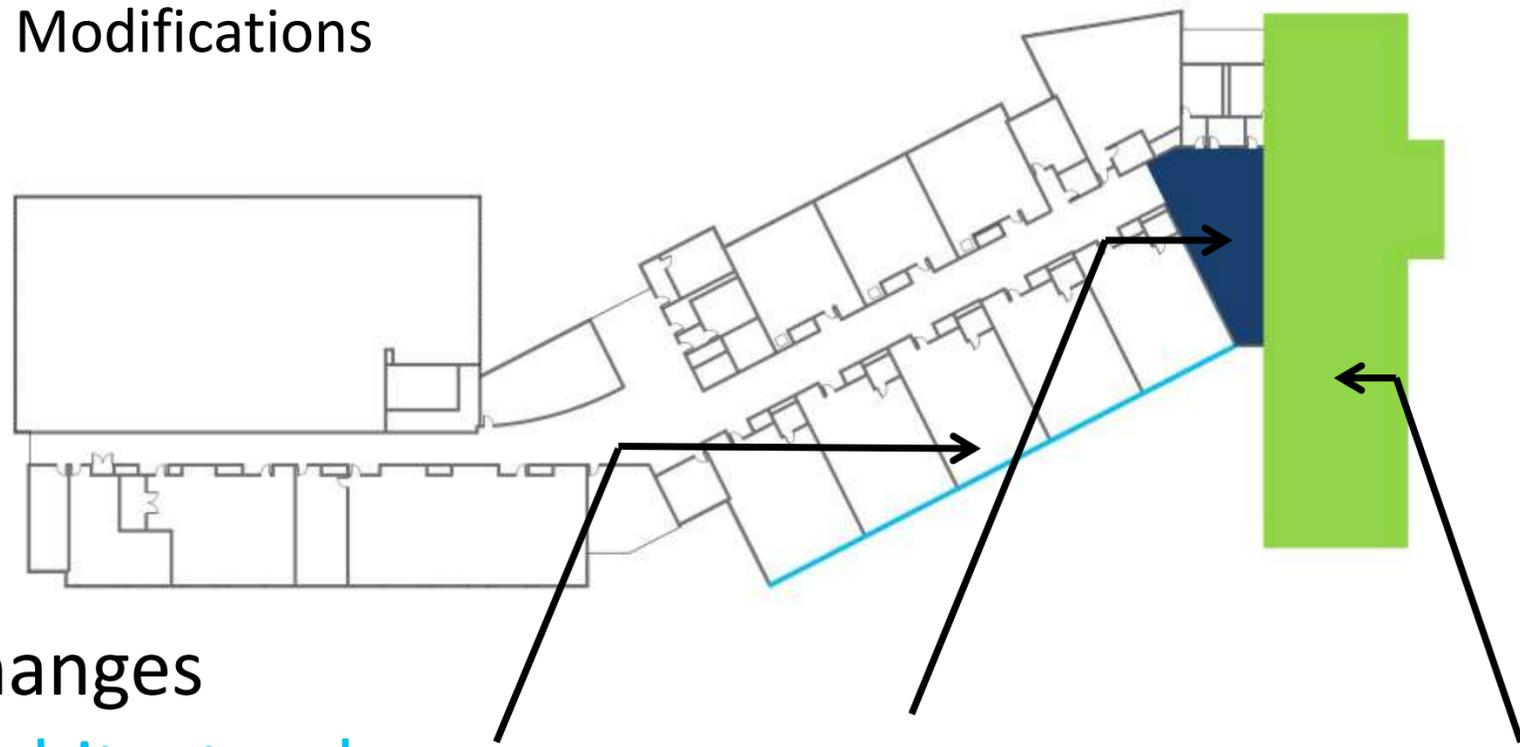
Team Approach

“Building is greater than the sum of its parts”

Strengthen Community

Energy efficiency
Community Hub
Safety & Security
Realistic Budget
Building as a Teaching Tool

Floor Plan with Highlighted Modifications

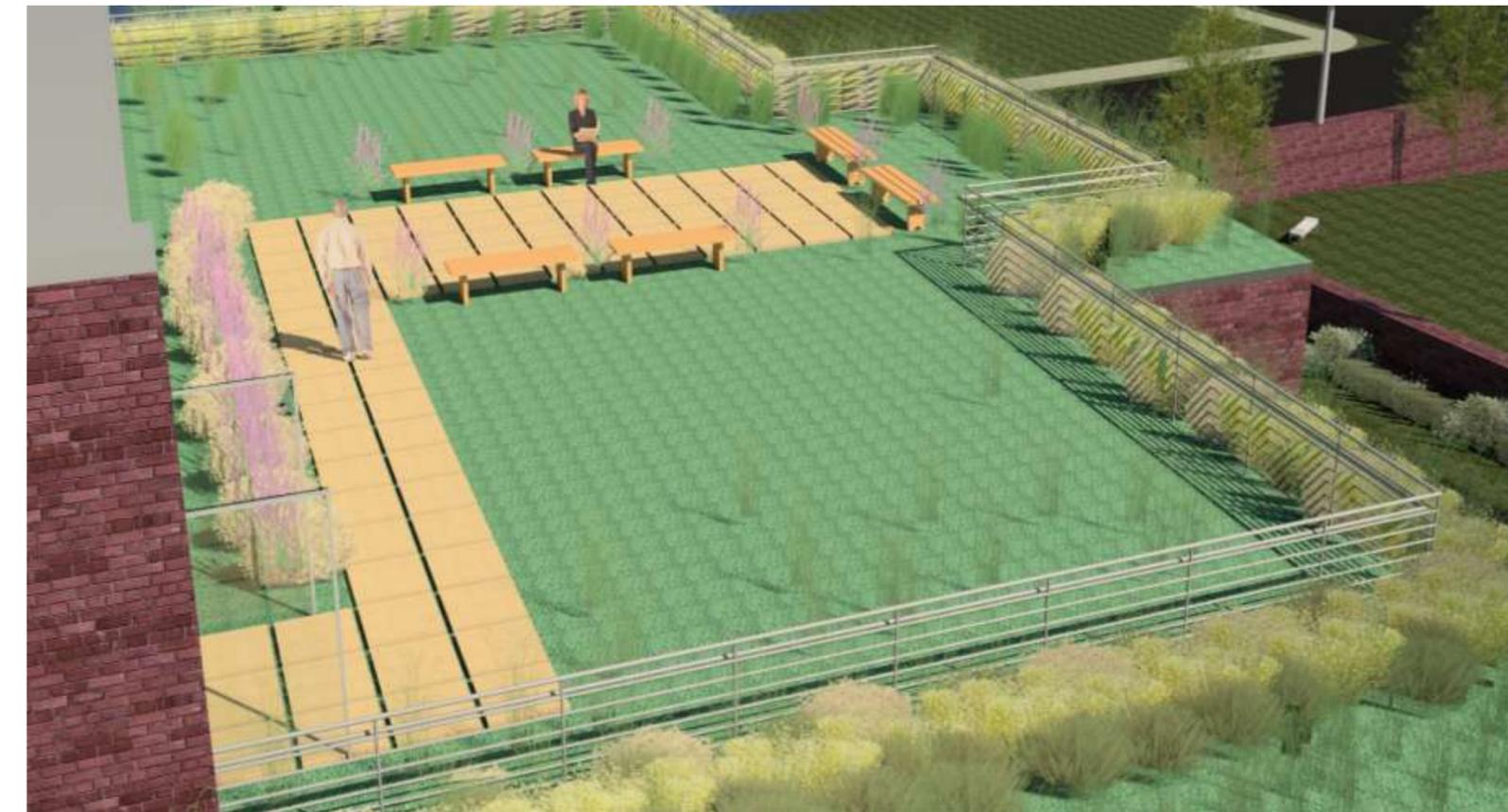
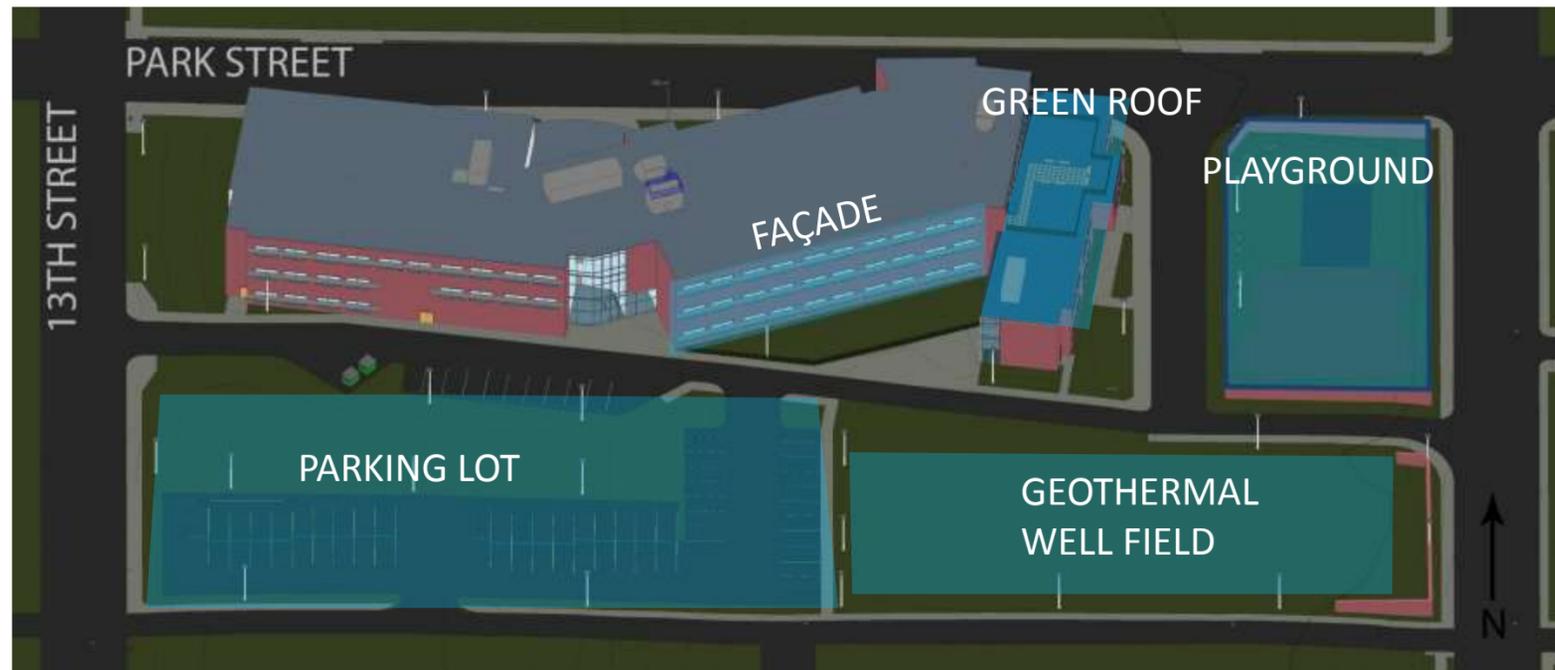


Changes

Architectural: façade, group instruction space, green roof

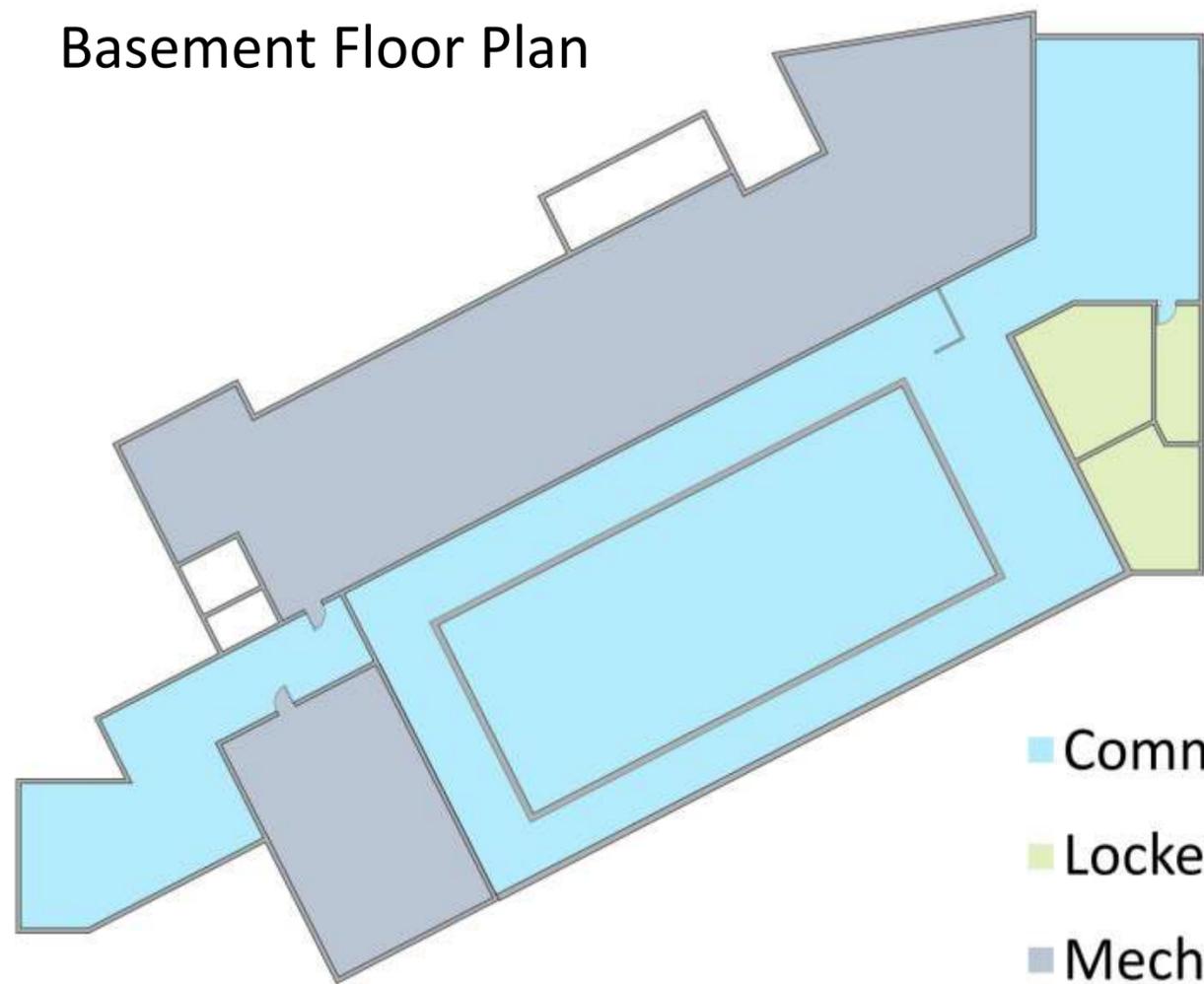
Site: playground w/ security wall, parking lot, well field

Architectural & Site **Modifications**



Green Roof

Basement Floor Plan



- Community Pool
- Locker Rooms
- Mechanical Room

Community Pool

Design Advantages

Same Building Footprint as Original Design

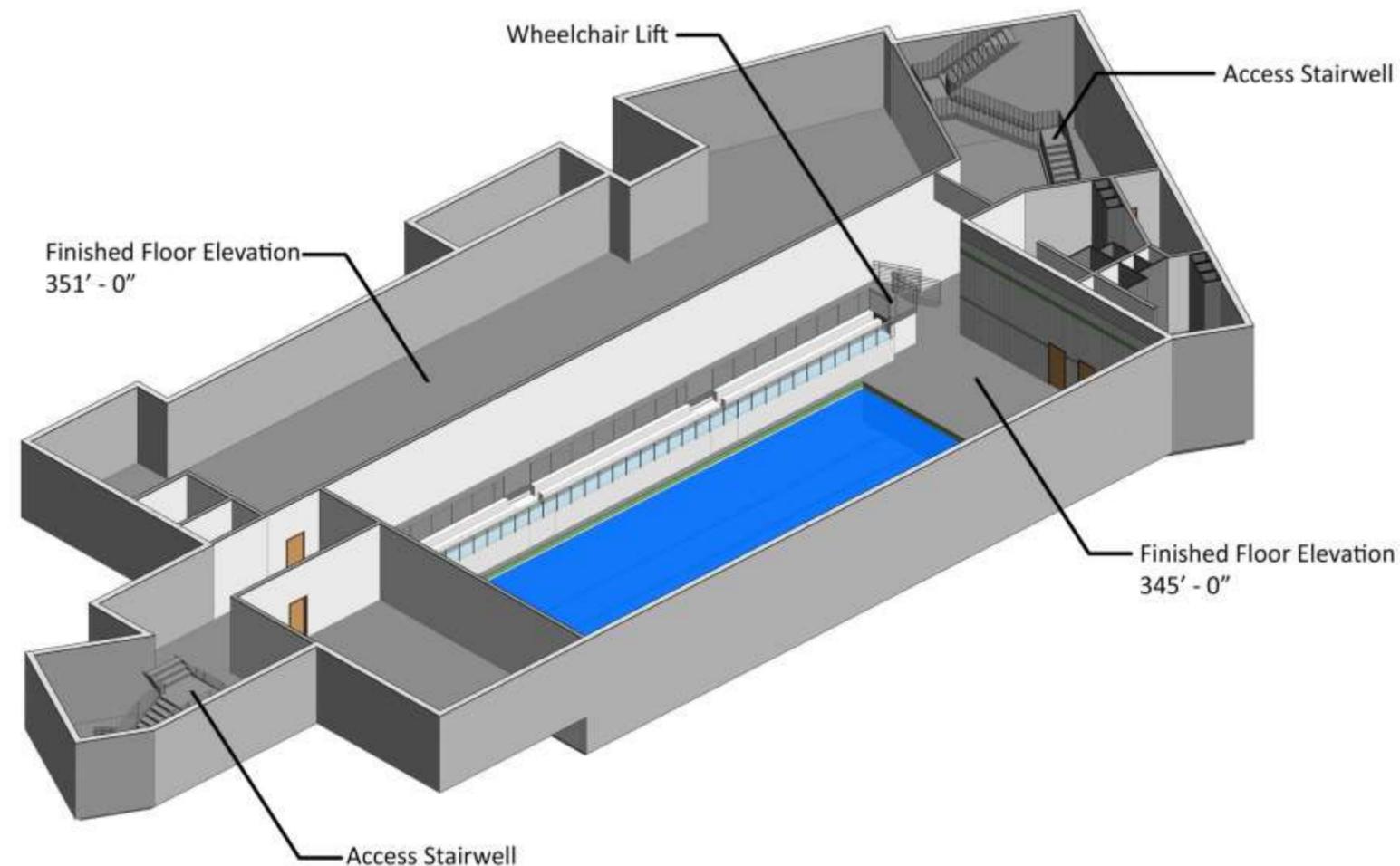
- Decreases impermeable square footage
- Increases usable site space

Cost Effective

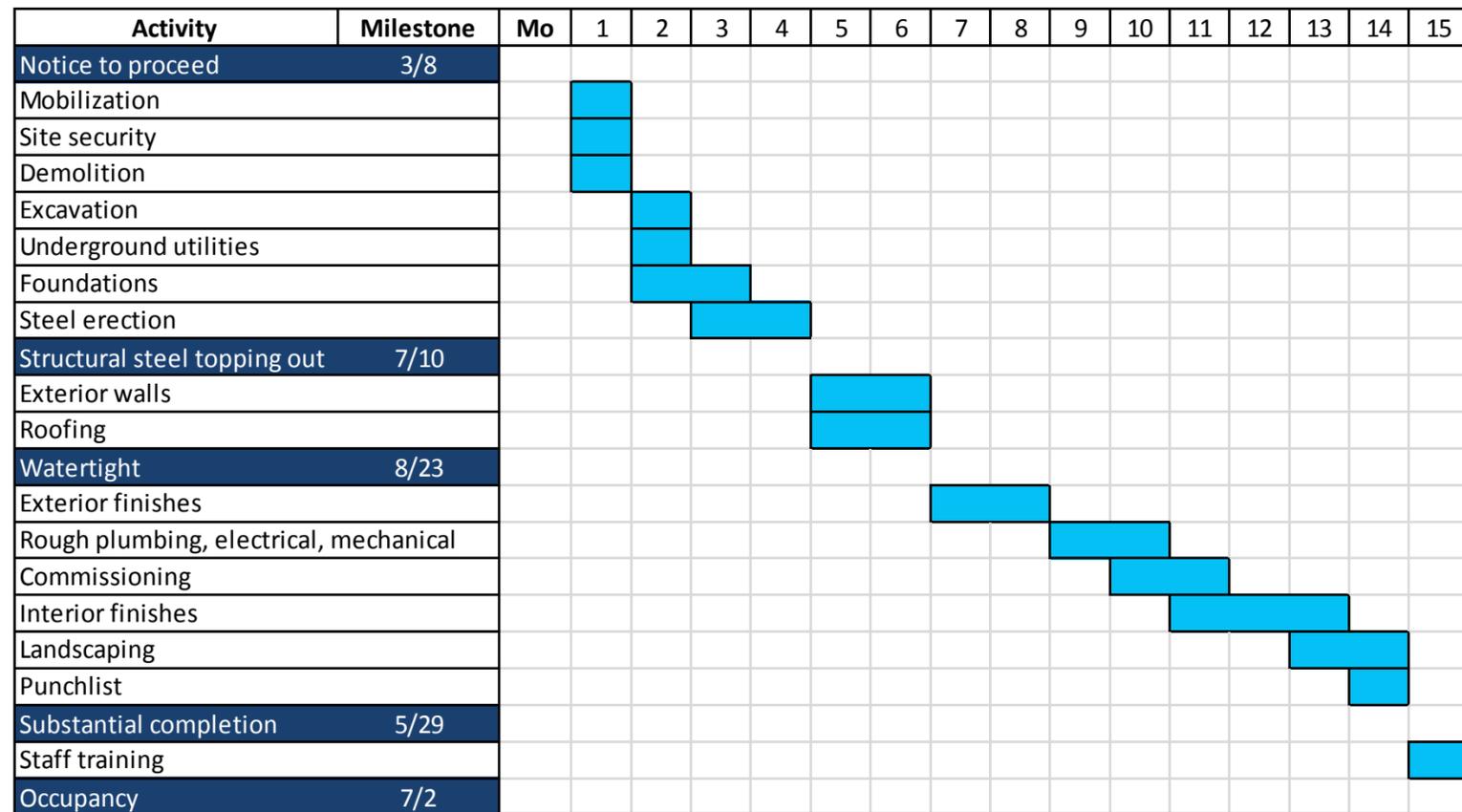
- Separate building would yield greater cost

Central Location

- Community spaces w/ secure entrances



Construction Overview



Delivery method: **Design-build**

Contract type: **GMP**

Cost analysis:

\$18,568,000

\$225.25/SF

Milestone **Schedule:**

Notice to proceed **3/8**

Steel topping out **7/10**

Watertight **8/23**

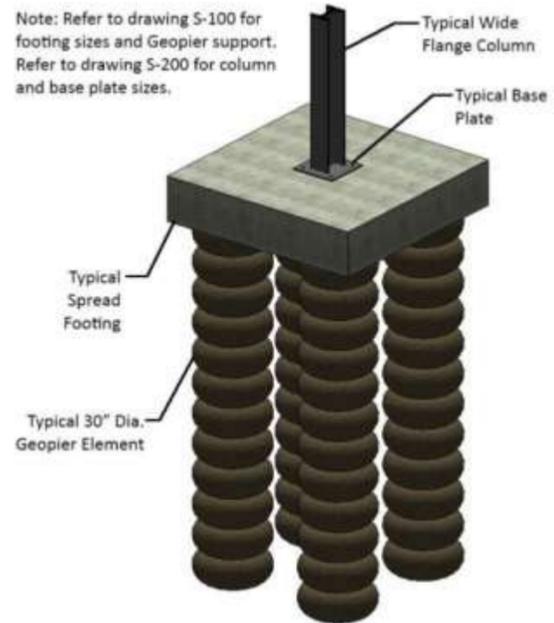
Substantial completion **5/29**

Occupancy **7/2**

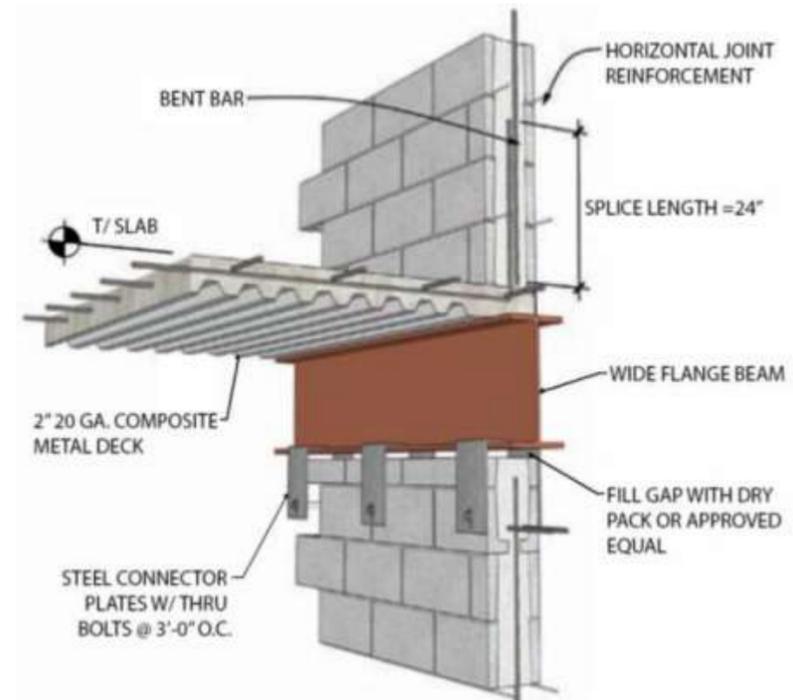
READING ELEMENTARY SCHOOL CONSTRUCTION BUDGET				
SF: 82,433		YEAR: 2013		
CATEGORY	DESCRIPTION	COST	COST/SF	% OF ORIG. CONTRACT
A. Substructure	A10 Foundations	\$200,526.52	\$2.43	1.49%
	A20 Basement Const	\$792,473.48	\$9.61	5.87%
B. Shell	B10 Superstructure	\$2,098,250.00	\$25.45	15.54%
	B20 Exterior Enclosure	\$1,307,574.00	\$15.86	9.68%
	B30 Roofing	\$564,278.00	\$6.85	4.18%
C. Interiors	C10 Interior Const	\$1,436,344.00	\$17.42	10.64%
	C20 Stairs	\$287,268.80	\$3.48	2.13%
	C30 Interior Finishes	\$1,149,075.20	\$13.94	8.51%
D. Services	D10 Conveying	\$76,947.00	\$0.93	0.57%
	D20 Plumbing	\$705,347.50	\$8.56	5.22%
	D30 HVAC	\$2,039,095.50	\$24.74	15.10%
	D40 Fire Protection	\$294,963.50	\$3.58	2.18%
	D50 Electrical	\$1,577,413.50	\$19.14	11.68%
E. Equipment & Furnishings	E10 Equipment	\$259,696.13	\$3.15	1.92%
	E20 Furnishings	\$86,565.38	\$1.05	0.64%
F. Special Construction & Demolition	F10 Special Const	\$106,000.00	\$1.29	0.79%
	F20 Selective Building Demolition	\$520,985.78	\$6.32	3.86%
Subtotal		\$13,502,804.29	\$163.80	100.00%
Time Adj. Factor		\$303,813.10	\$3.69	2.25%
Add-Alternate (Pool)		\$1,597,569.30	\$19.38	11.83%
General Conditions		\$1,340,743.00	\$16.26	9.93%
Taxes		\$810,168.26	\$9.83	6.00%
Fee		\$675,140.21	\$8.19	5.00%
Bonds & Insurance		\$337,570.11	\$4.10	2.50%
TOTAL		\$18,567,808.27	\$225.25	

engineering **systems** overview

Hybrid Masonry Walls

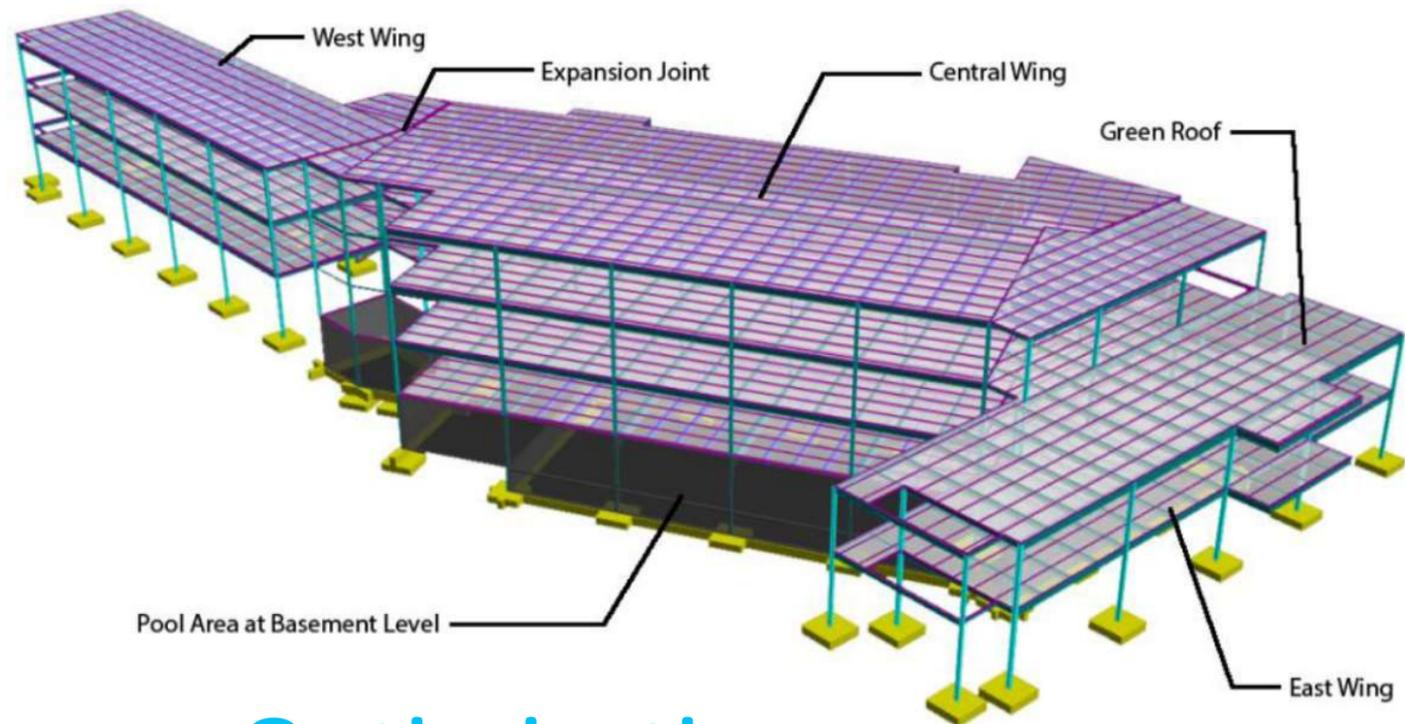


Geopiers

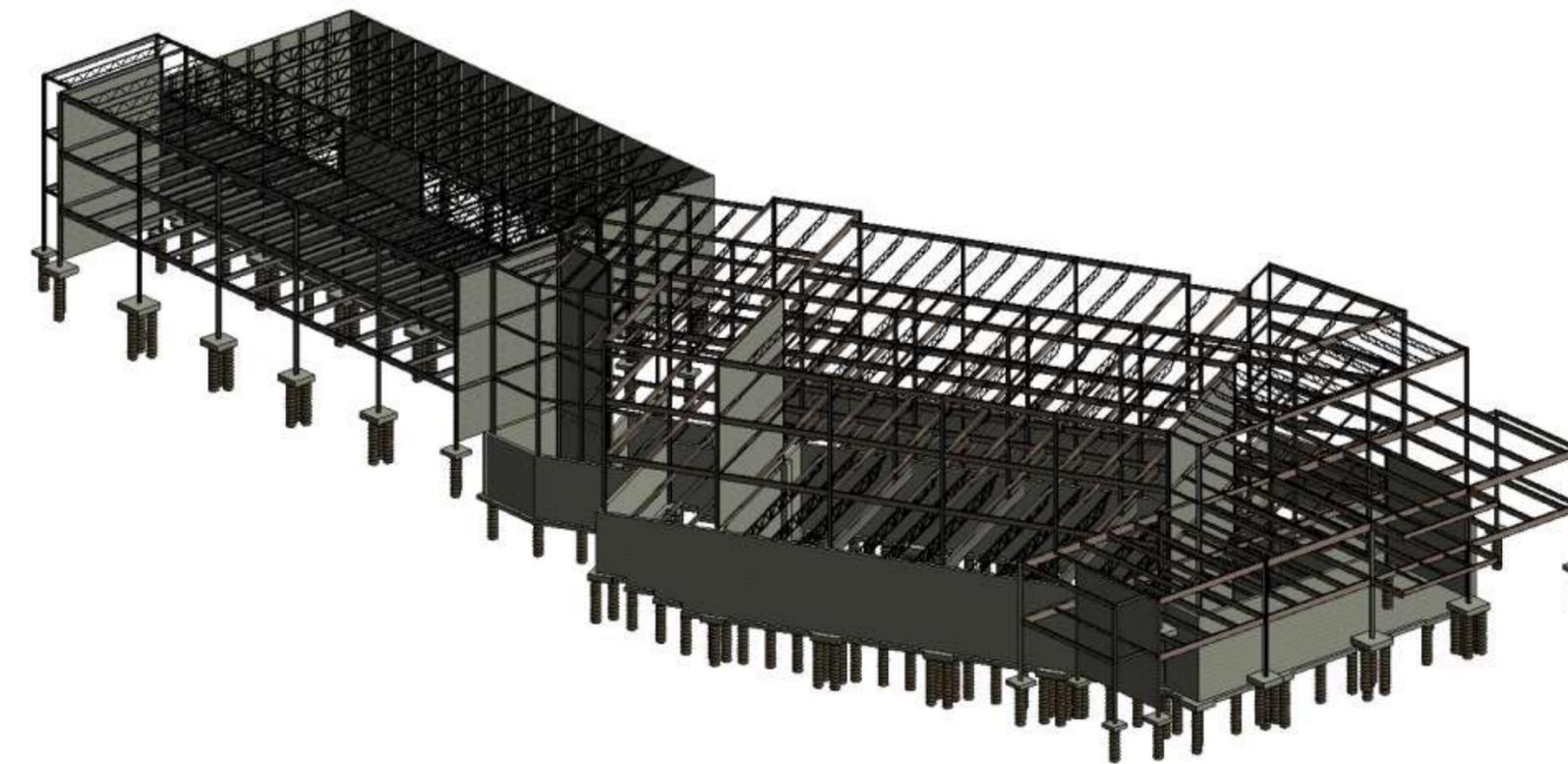


Structural Summary

Composite Steel Framing



Design Optimization



Building Information Modeling

System Innovation

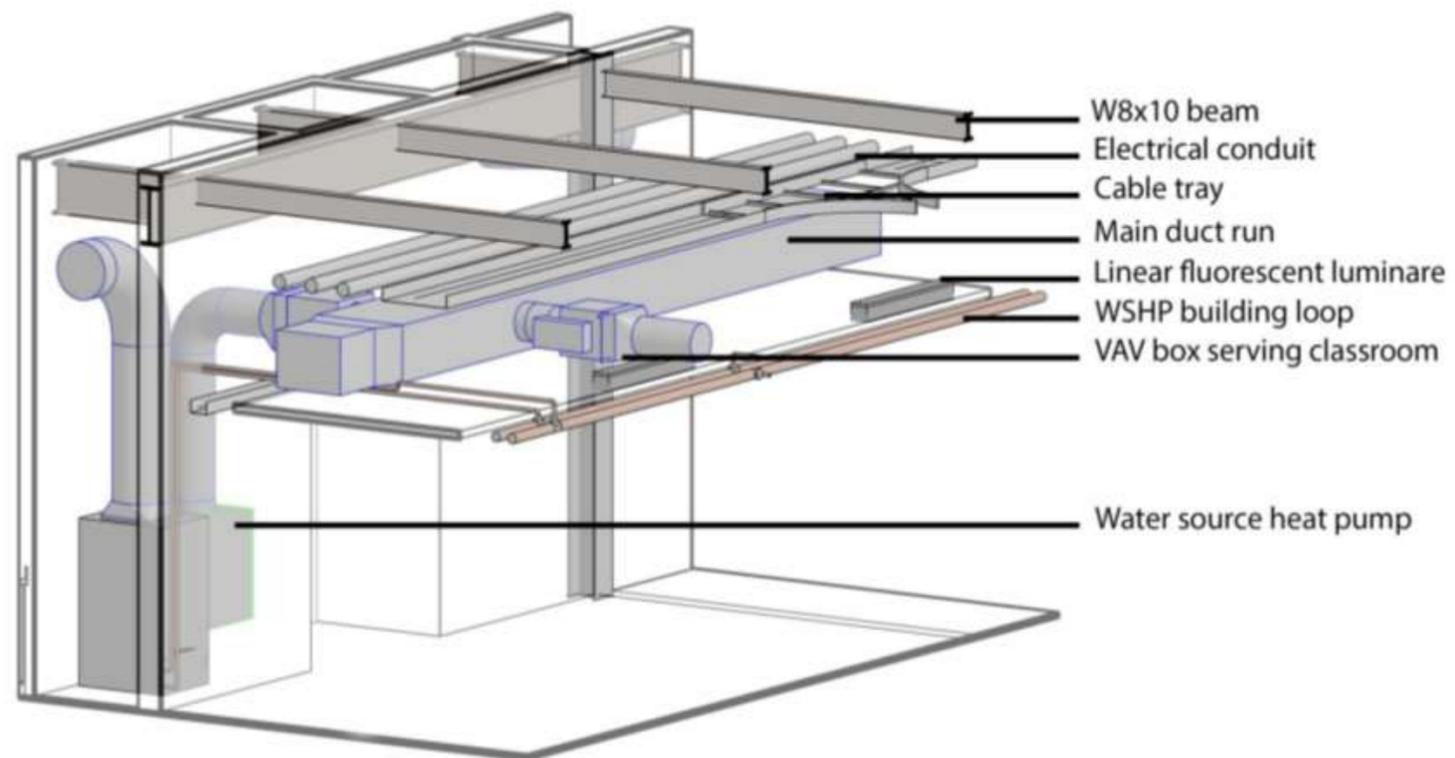
estimated energy use

Energy	Design	Median Building ¹
Energy Performance Rating (1-100)	73	50
Energy Reduction (%)	21%	0%
Source Energy Use Intensity (kBtu/ft ² /yr)	161	204
Site Energy Use Intensity (kBtu/ft ² /yr)	57	72
Total Annual Source Energy (kBtu)	12,443,900	15,663,400
Total Annual Site Energy (kBtu)	4,380,100	5,513,300
Total Annual Energy Cost (\$)	\$ 112,800	\$ 142,000
Pollution Emissions		
CO2-eq Emissions (metric tons/yr)	536	675
CO2-eq Emissions Recution (%)	21%	0%

¹Median Building energy results from www.energystar.gov

High **Performance**

Mechanical Summary

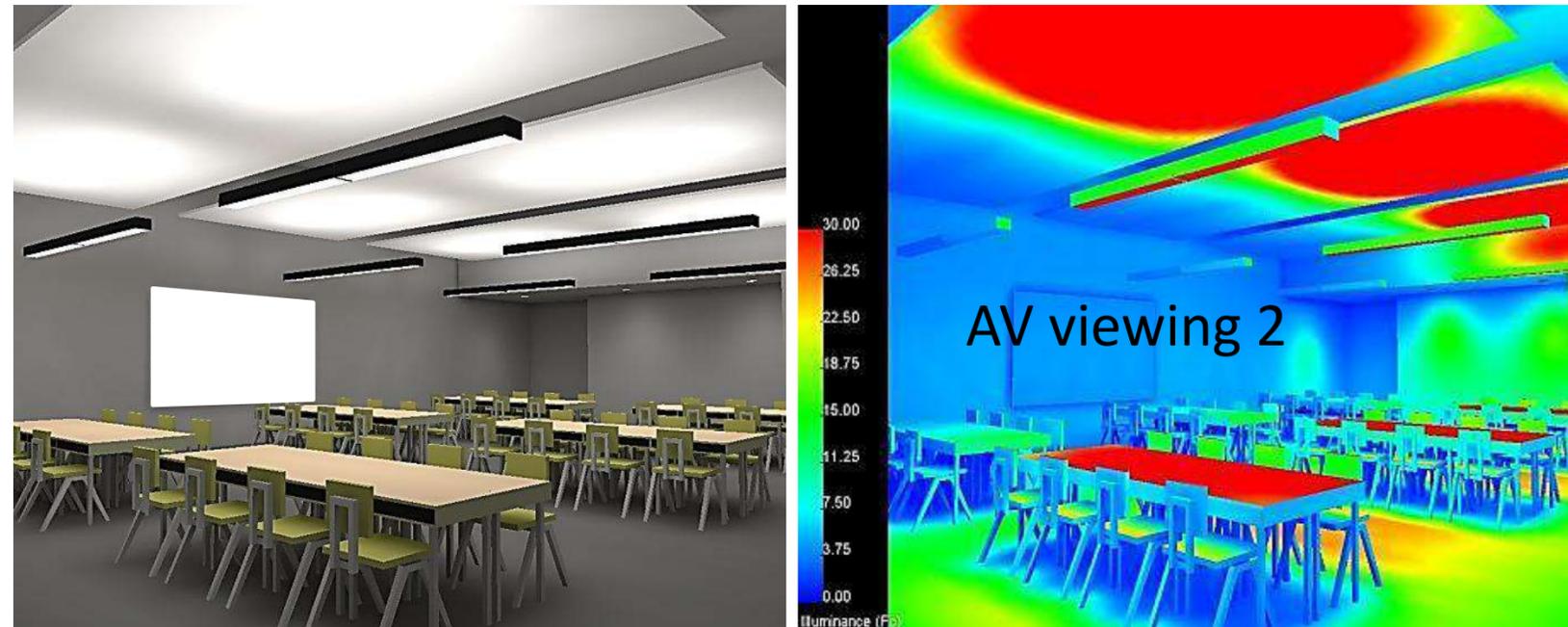


Collaborative Layout



Flexible Design

Lighting/Electrical Summary



- DALI lighting control
- Passive infrared occupancy sensors
- Closed loop proportional photosensors
- Dual-fuel emergency generator
- Automatic transfer switch
- I.D. card swipe
- Site lighting

Orientation	Room quantity	Dim zone	Annual energy savings (KWh)	Total annual energy savings (KWh)	Total annual cost savings
SE	15	2	84	420	\$58.80
		3	278	1,390	\$194.60
		4	332	1,660	\$232.40
NW	12	2	100	400	\$56.00
		3	341	1,364	\$190.96
		4	348	1,392	\$194.88
NE	7	2	307	921	\$128.94
		3	331	993	\$139.02
		4	344	1,032	\$144.48
S	5	2	291	291	\$203.79
		3	348	348	\$243.60
		4	341	341	\$238.70

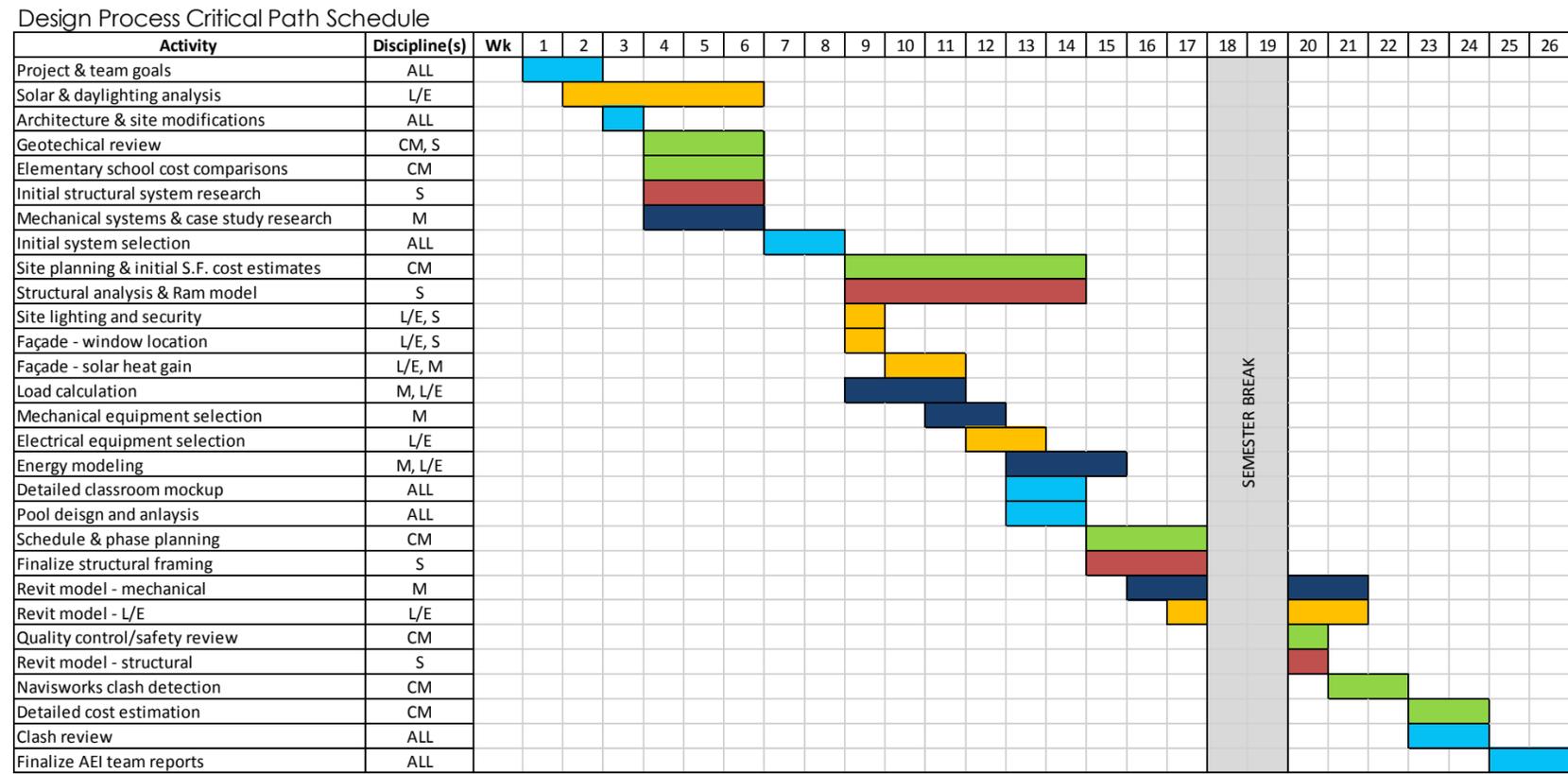
Table 17: Total energy savings by façade orientation and dim zone

Comfort and Productivity

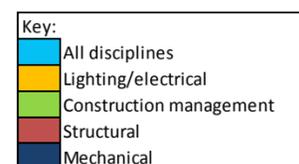
Safety and Security

Reduced Energy Consumption

Integration

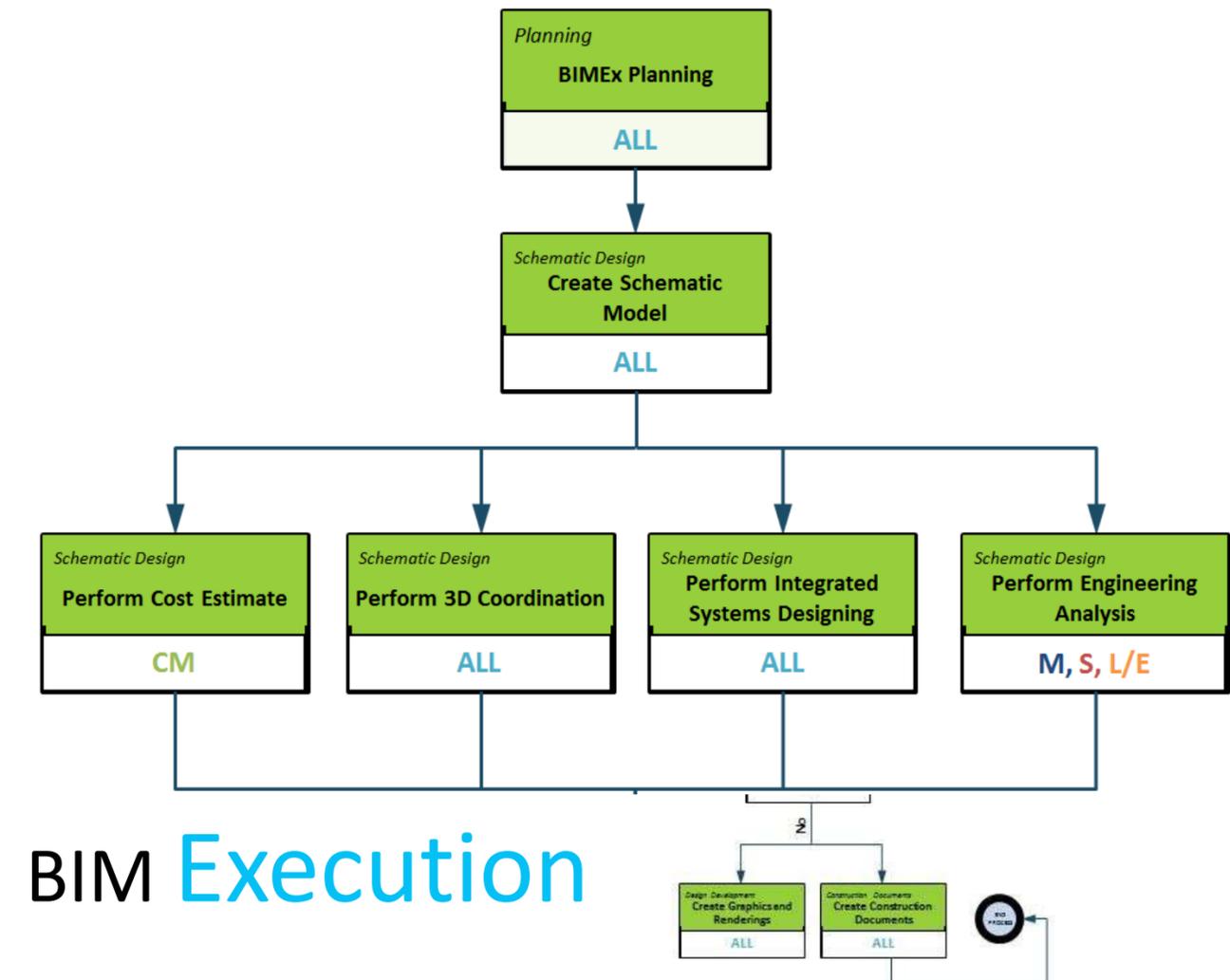


Team Schedule

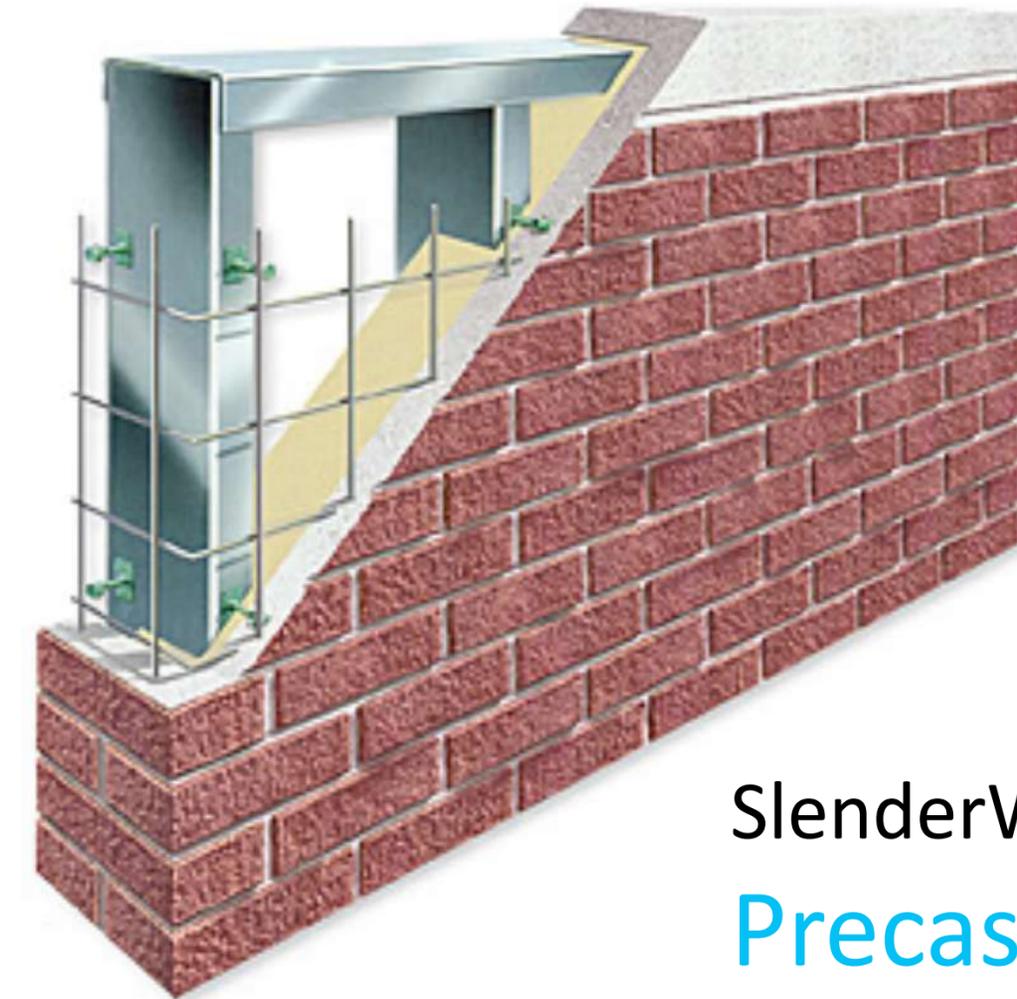


BIM Uses

Priority	Goal Description	BIM Uses
HIGH	Integrated building design	Worksharing, Central models
HIGH	Integrated model	Revit
HIGH	Minimal clashes	Navisworks
HIGH	Structural design/modeling	RAM, Revit
HIGH	Energy modeling	Green Building Studio, Revit
HIGH	Quantity takeoffs	Revit
HIGH	Cost estimating	Revit
HIGH	Project documentation	Revit
HIGH	Presentation graphics	3ds Max, Navisworks, Revit
MED	Lighting calcs	Elumtools
LOW	Renderings	3ds Max, Navisworks



BIM Execution



SlenderWall
Precast Panel

Precast Panel Façade System

Structural

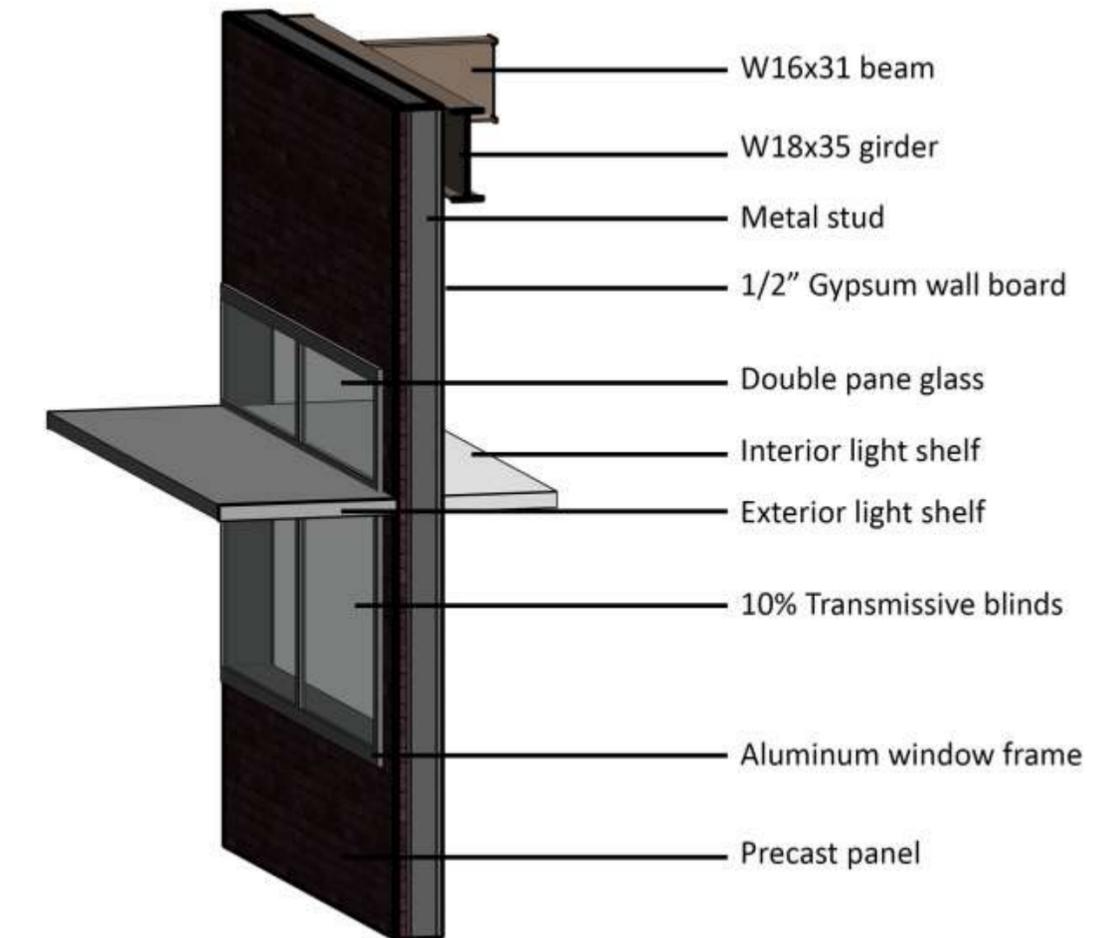
- Lightweight
- Isolated stud connections

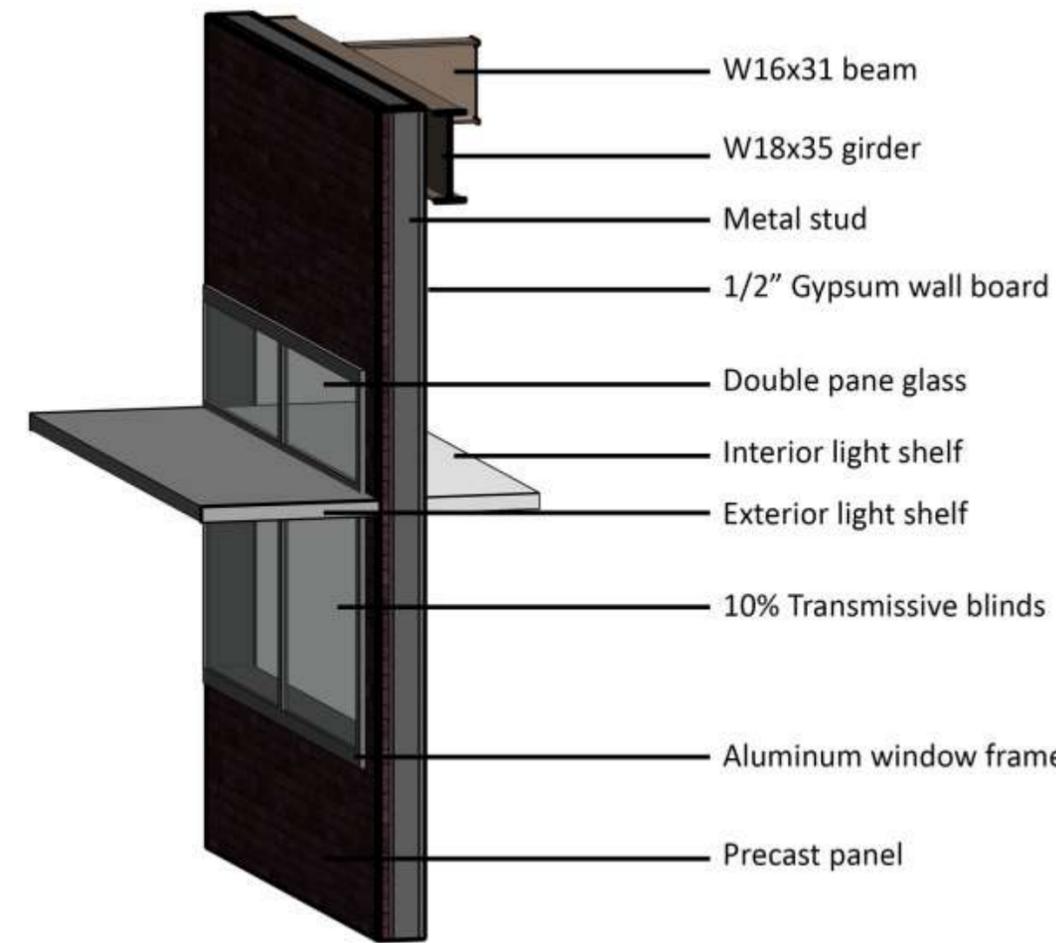
Mechanical

- Thermal transfer reduction
- R-21

Construction

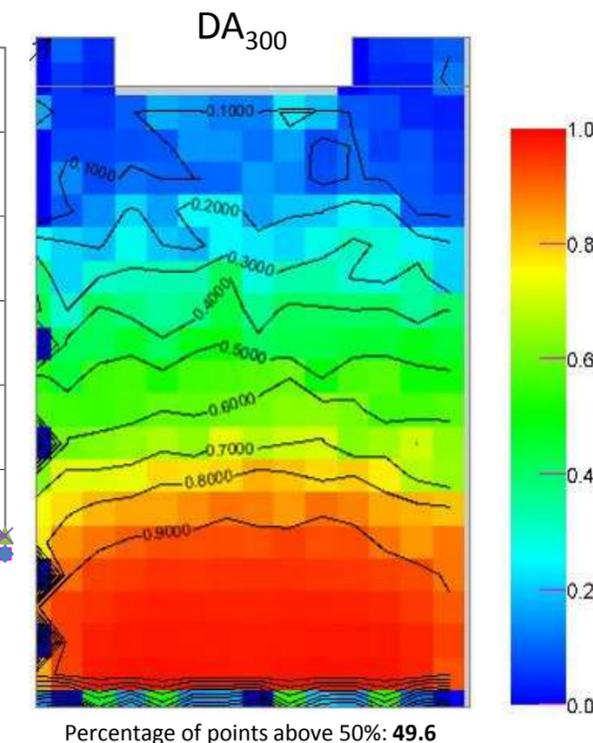
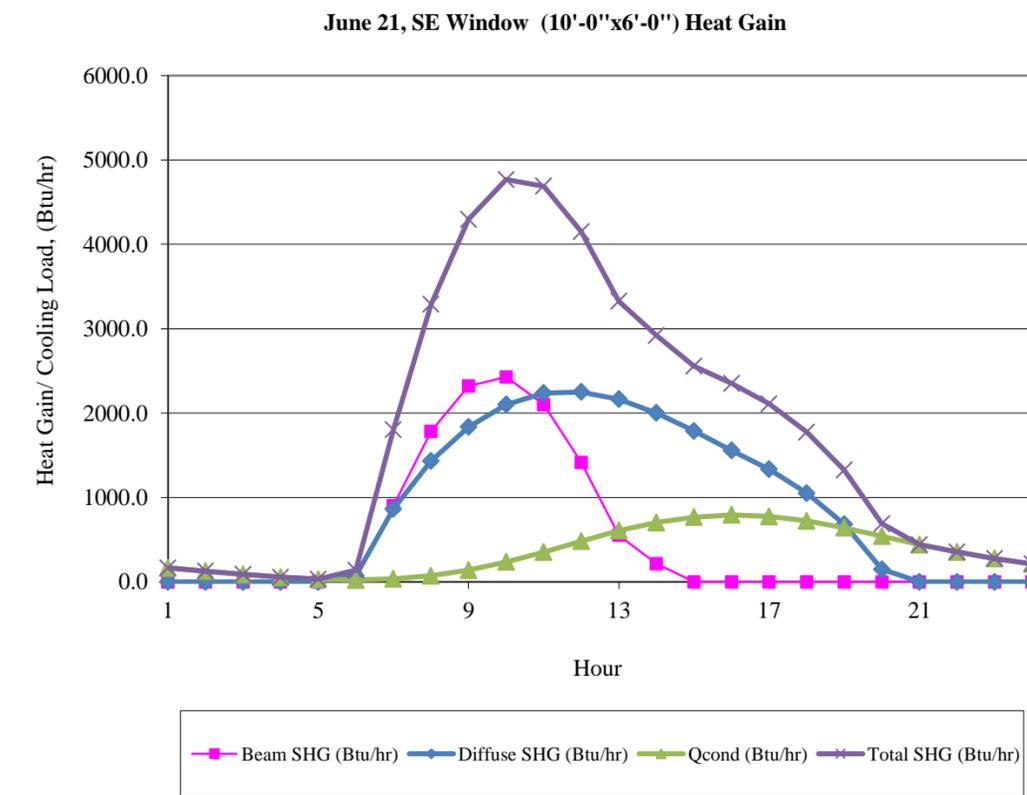
- Cost
- Schedule
- Safety

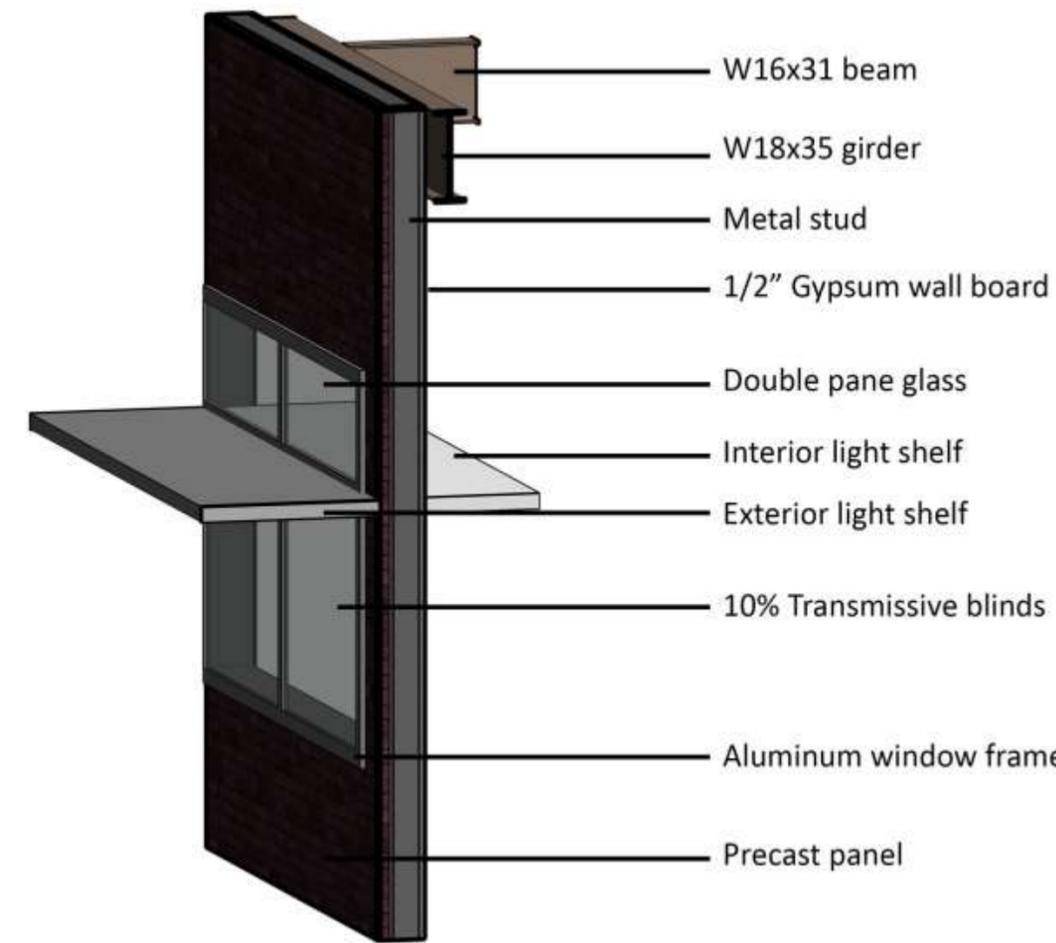




Daylighting and Energy Efficiency

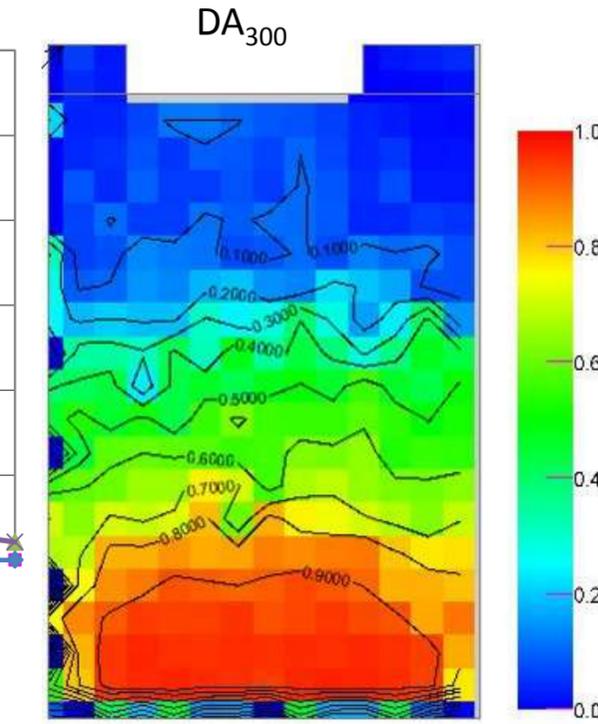
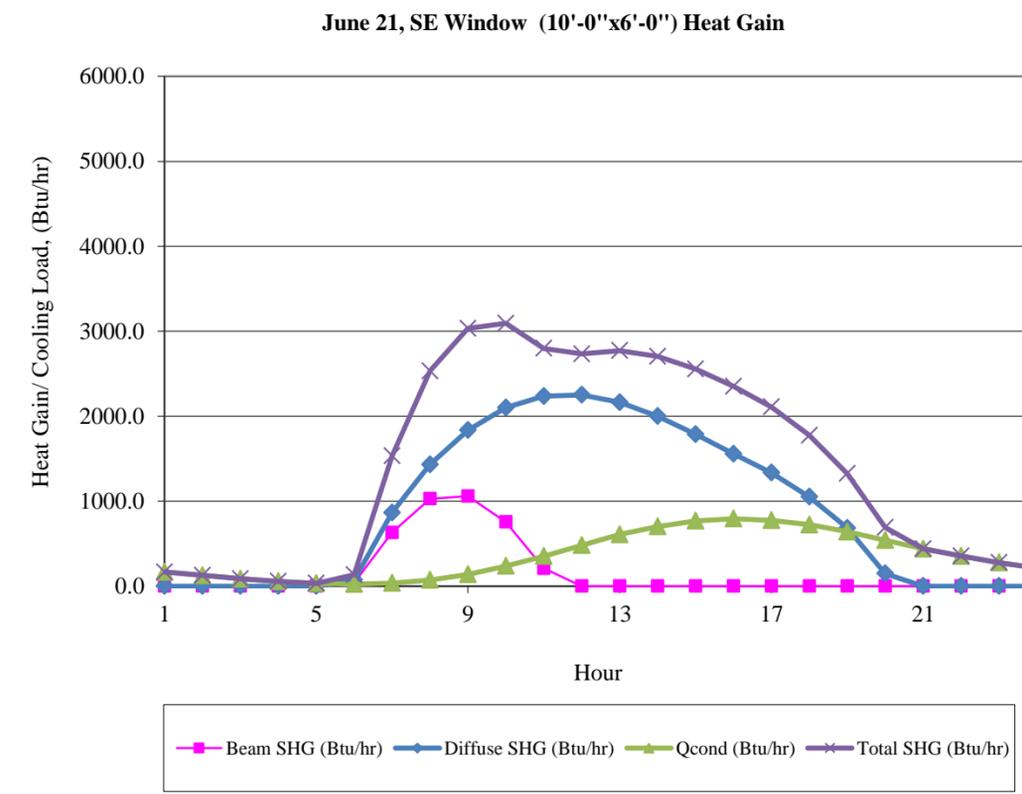
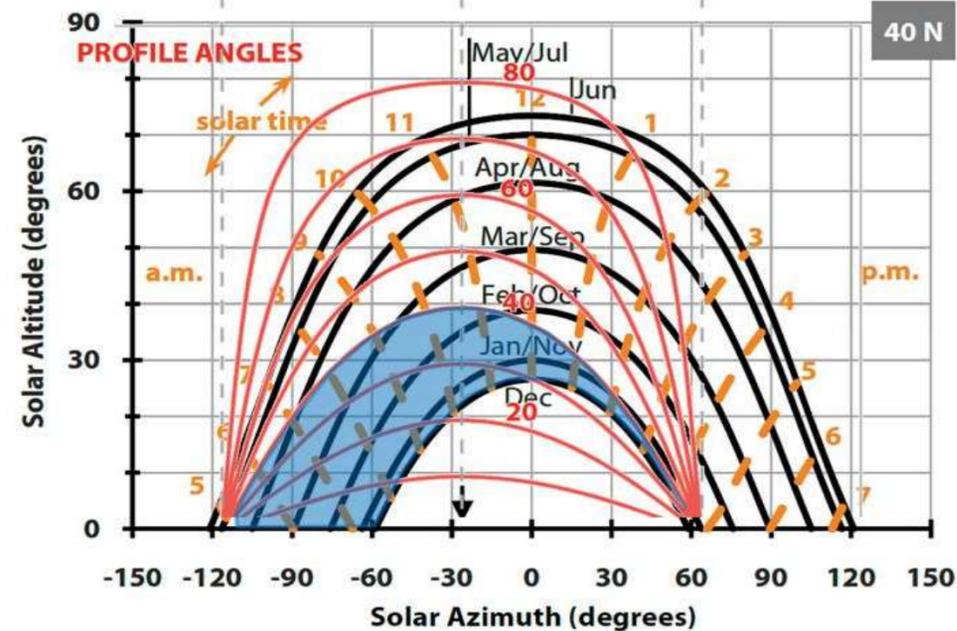
- Untreated window aperture



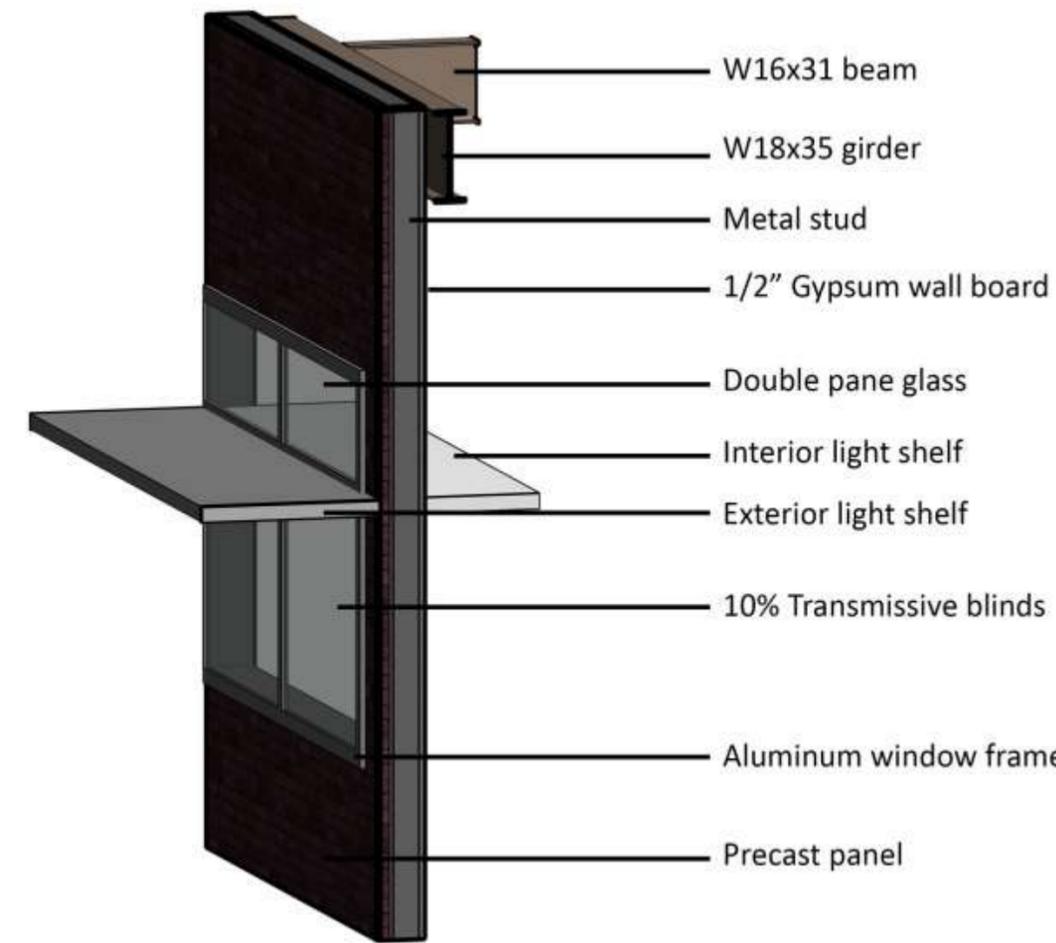


Daylighting and Energy Efficiency

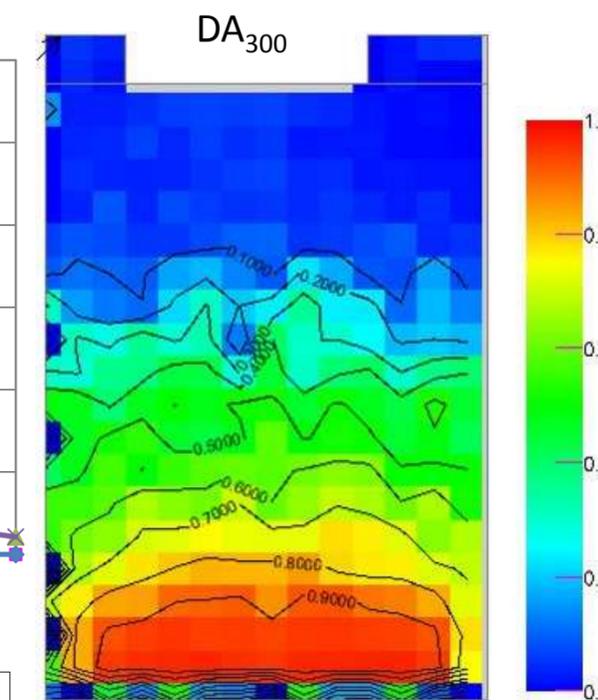
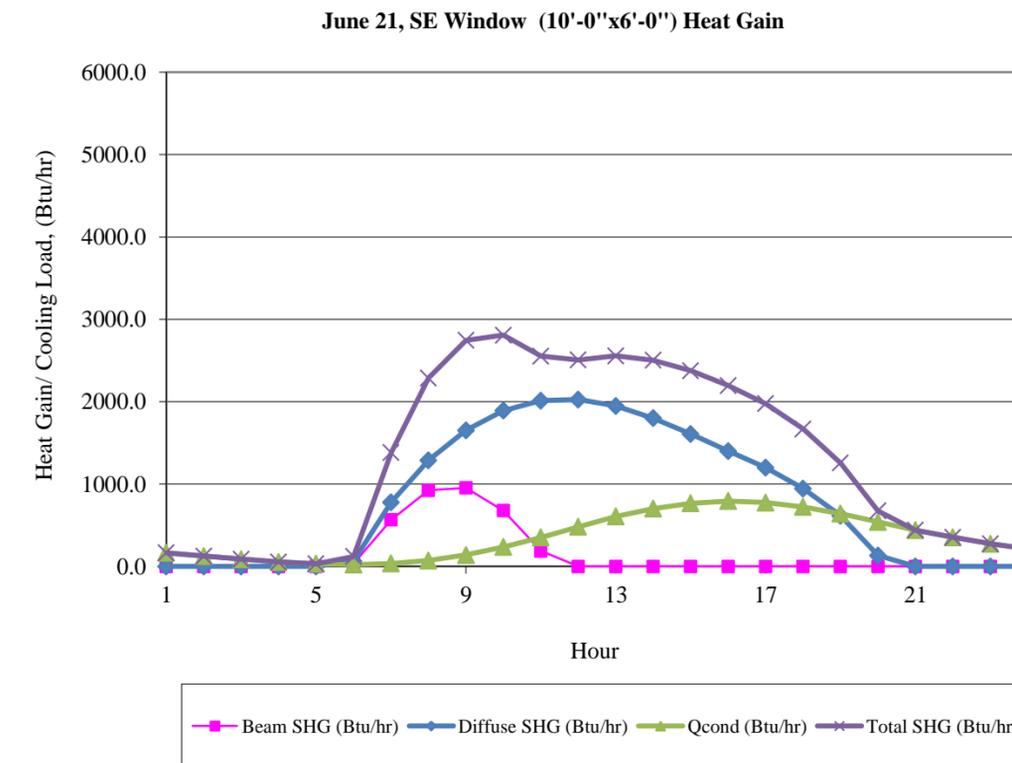
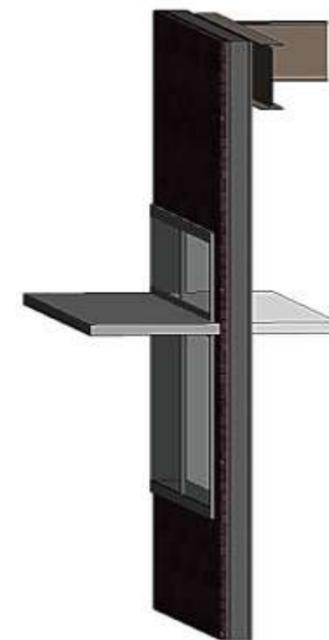
- Exterior light shelf



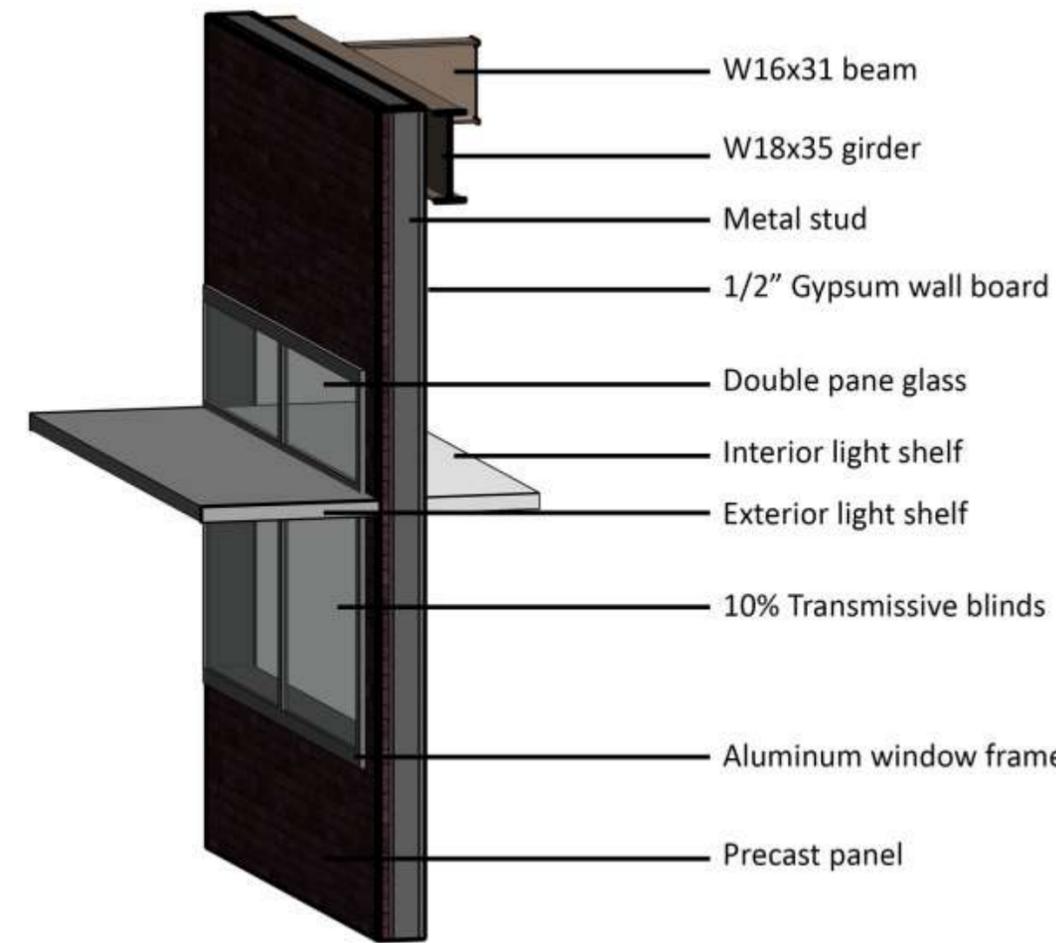
Daylighting and Energy Efficiency



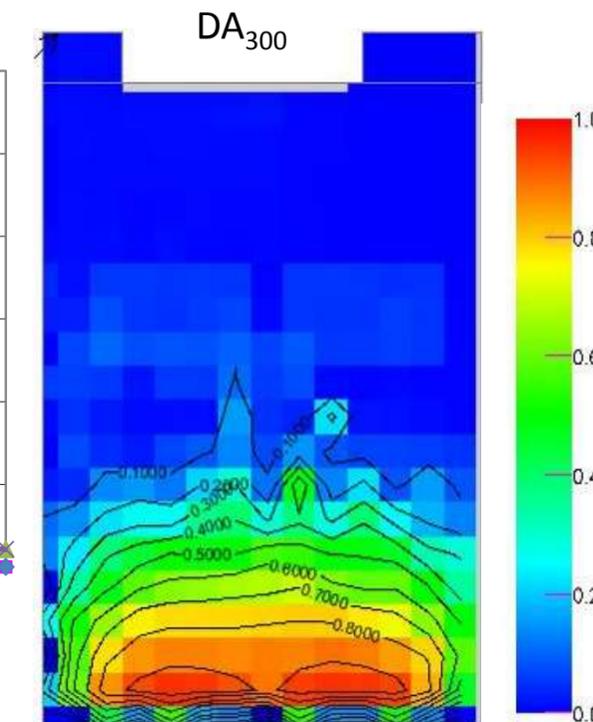
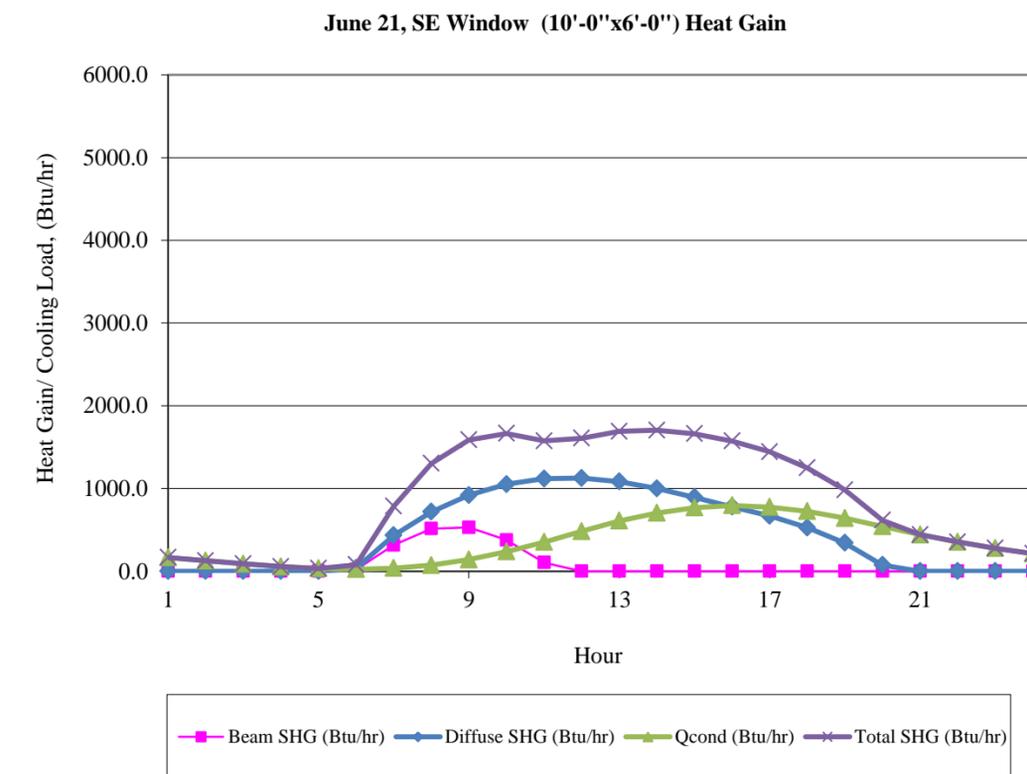
- Exterior light shelf
- Interior light shelf



Daylighting and Energy Efficiency

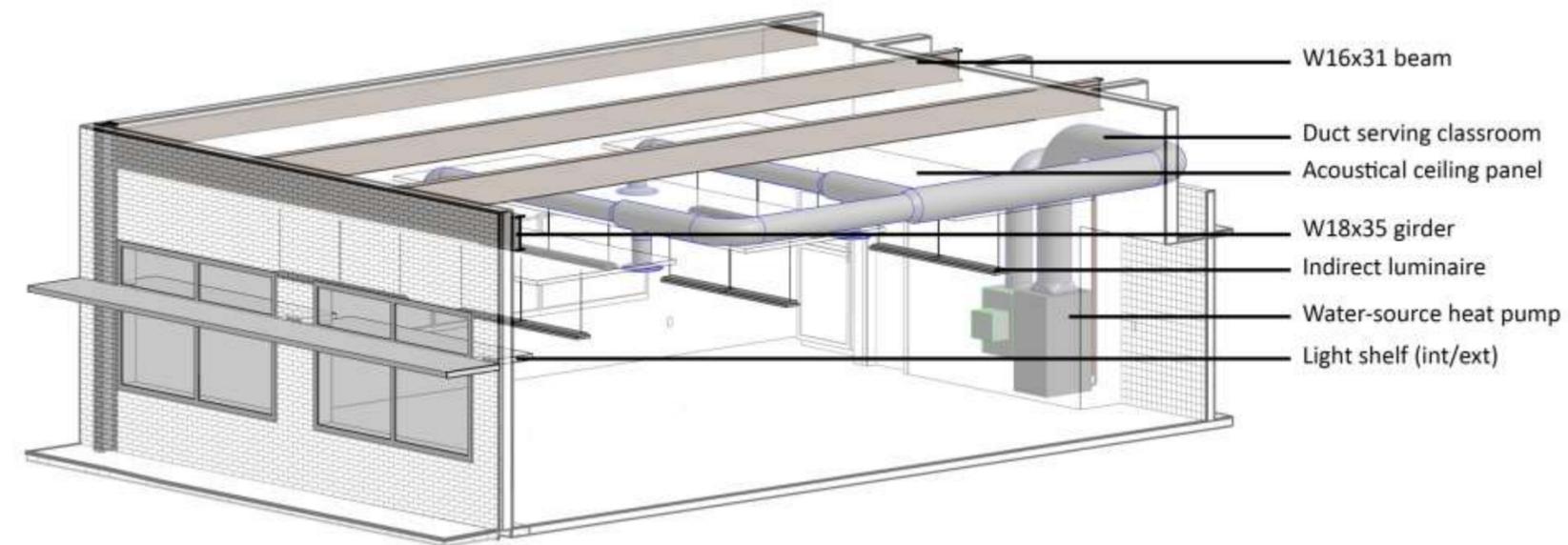


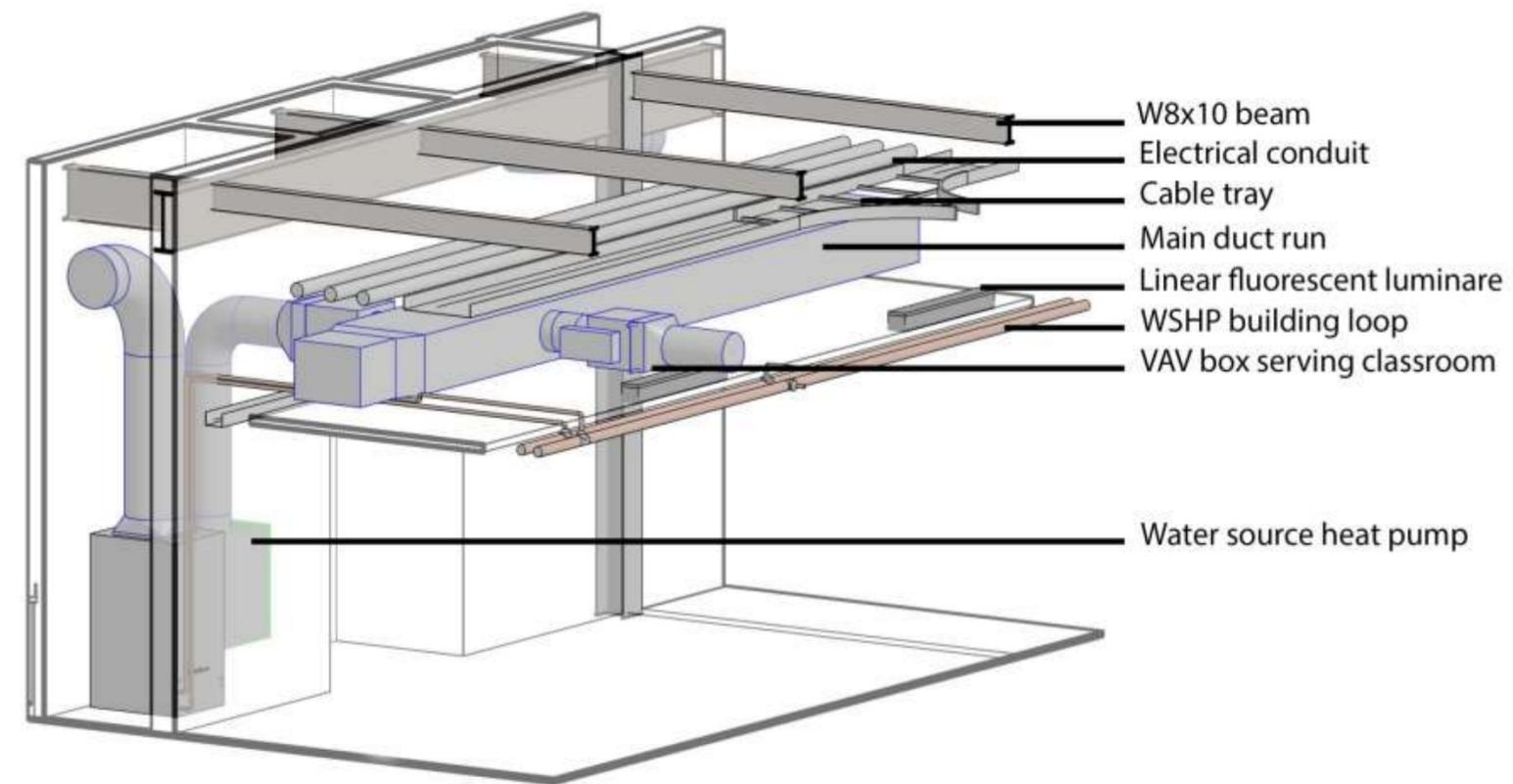
- Exterior light shelf
- Interior light shelf
- Interior blinds



Elementary School Classroom

- Building as a Learning tool
 - Exposed systems
- Ceiling panel benefits:
 - Acoustics
 - Light levels
- Flexible classroom layout





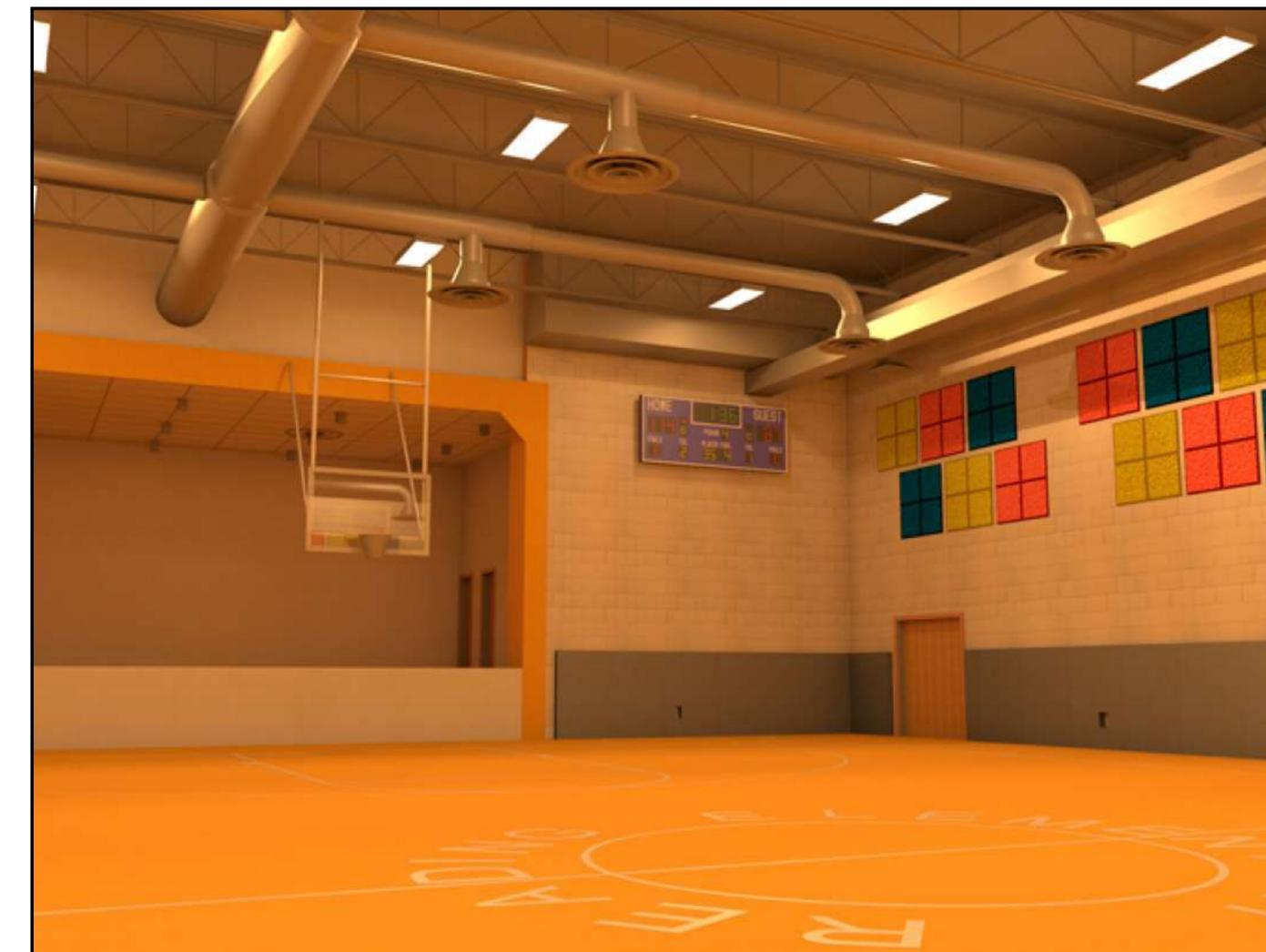
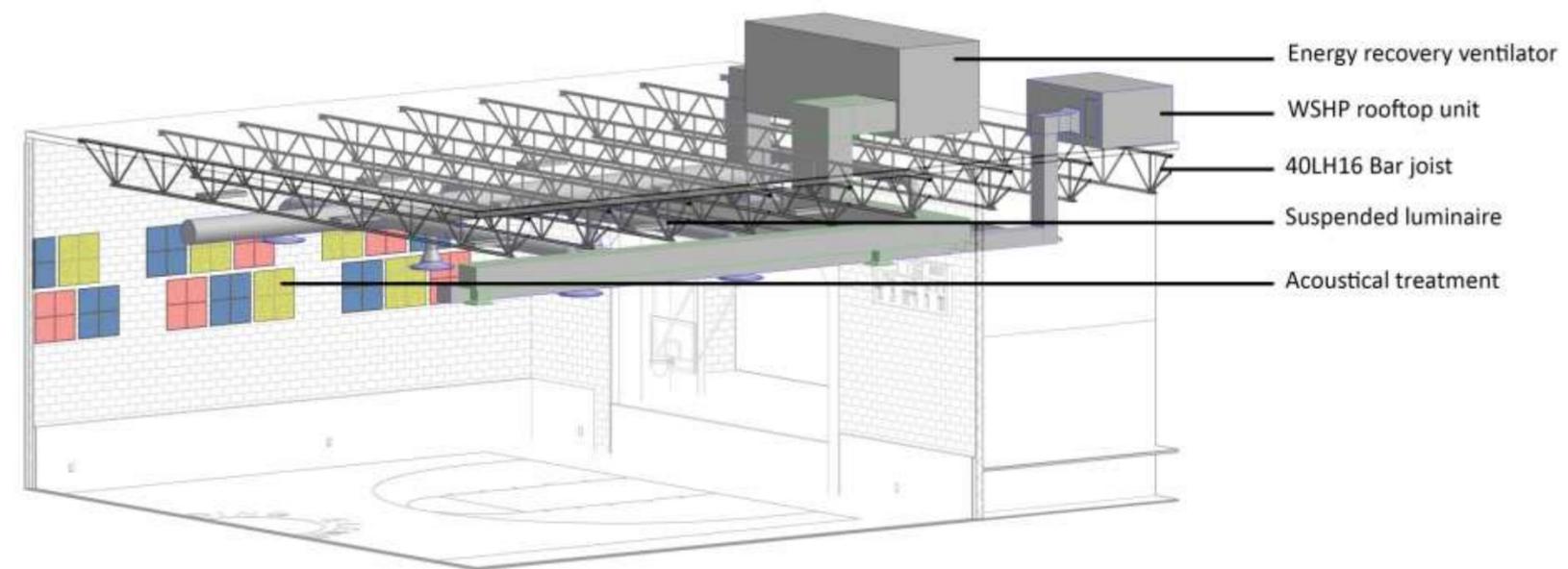
Elementary School Corridor

- Building as a Learning tool
 - Exposed systems
 - Color coding
- Interactive monitors display building performance
- Emphasizes interdisciplinary collaboration

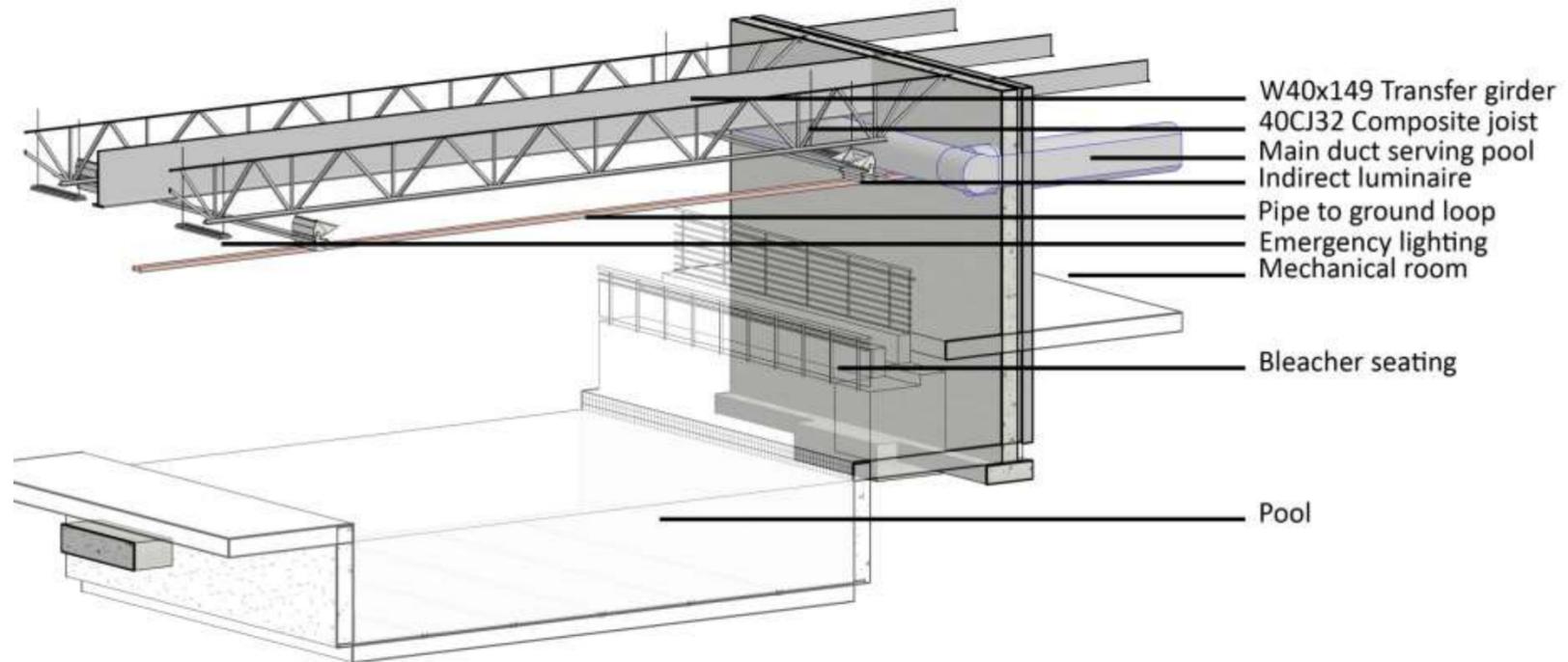


Multipurpose Area / Shelter

- Flexibility
- Community shelter per local Homeland Security department
- Isolation
 - Risk Category IV
 - Emergency power
 - Separate mechanical system



Community Pool



- Up-front engineering and architectural collaboration
- Ceiling space
 - Framing
 - Lighting
 - Ductwork
- Accessibility and logistics

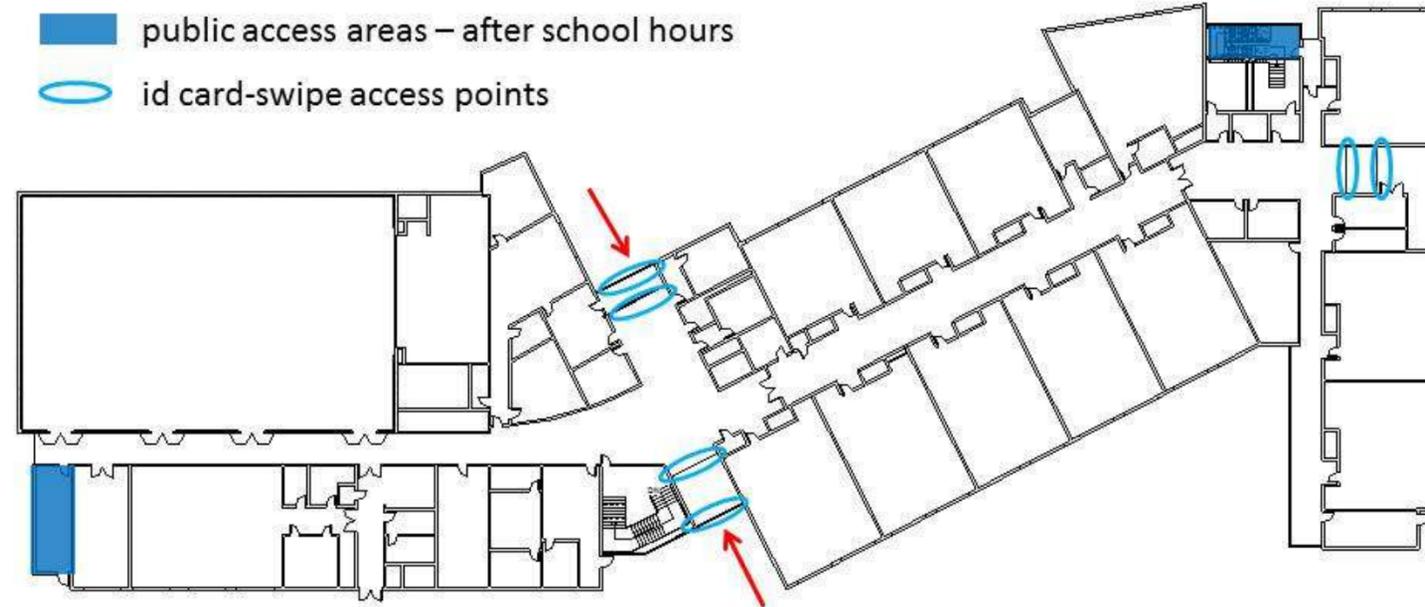


Playground Security

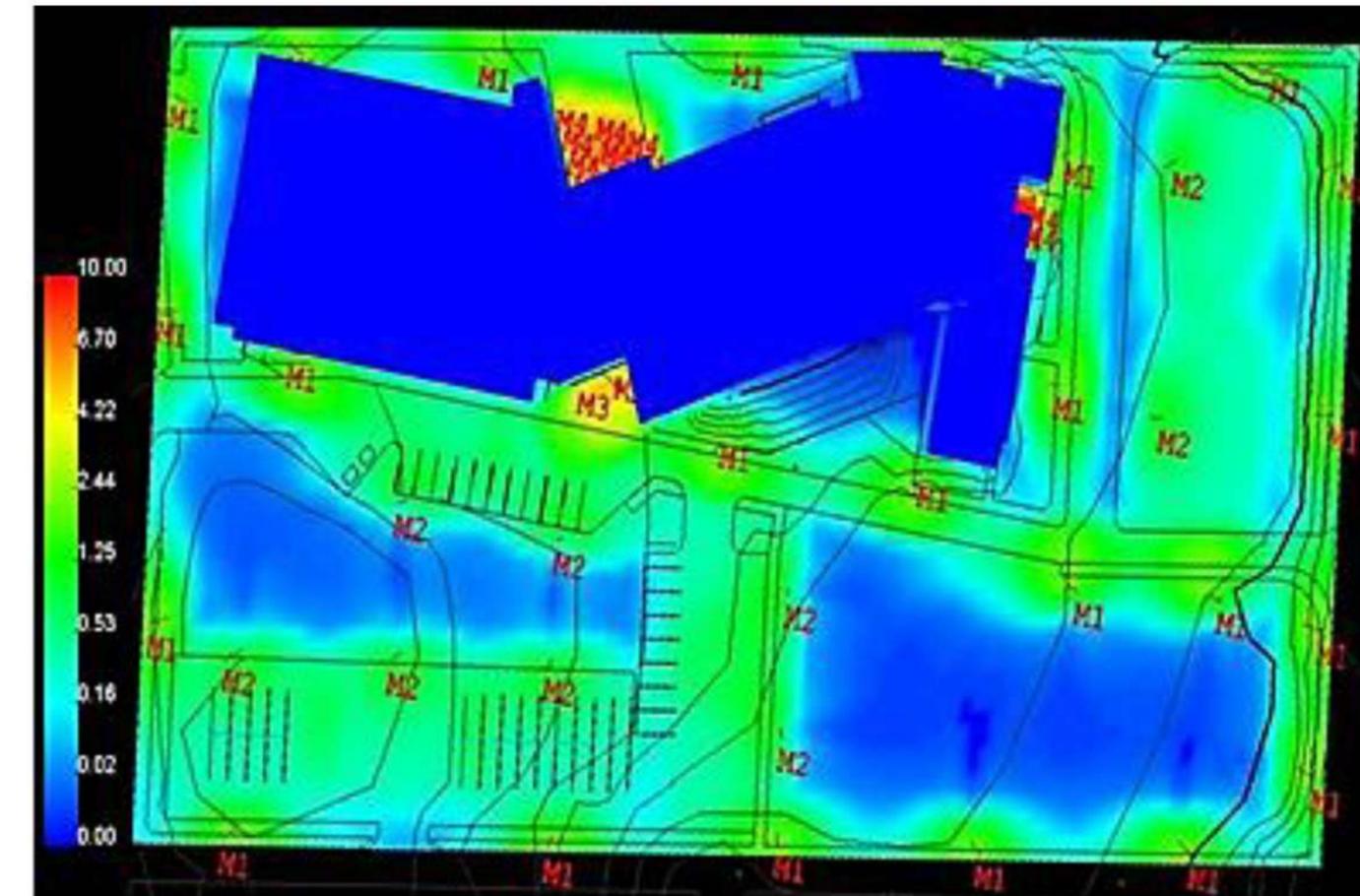


School Security

- public access areas – during school hours
- public access areas – after school hours
- id card-swipe access points

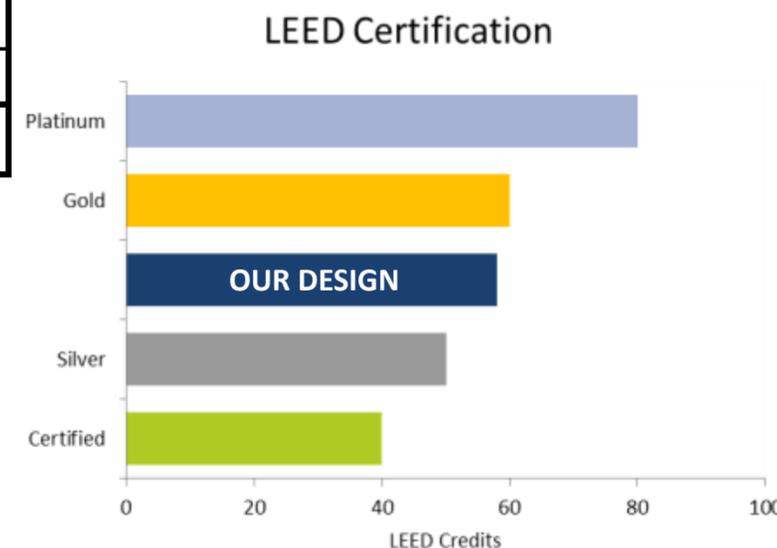


Site Security

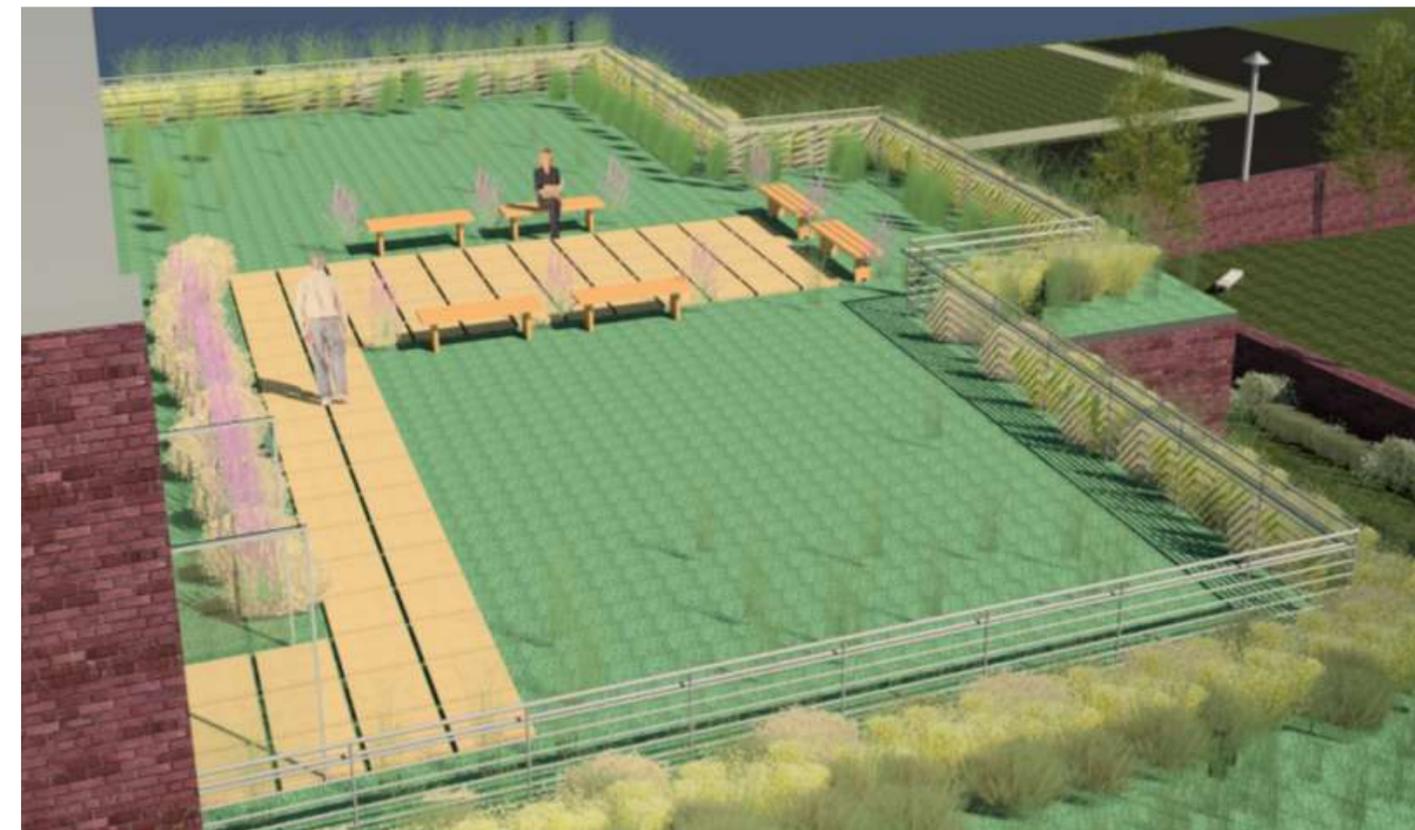


LEED Scorecard

	LEED Credits
Sustainable Sites (SS)	18
Water Efficiency (WE)	6
Energy & Atmosphere (EA)	15
Materials & Resources (MR)	4
Indoor Environmental Quality (IEQ)	13
Innovation in Design (ID)	2
Regional Priority (RP)	0
Total LEED Credits	58



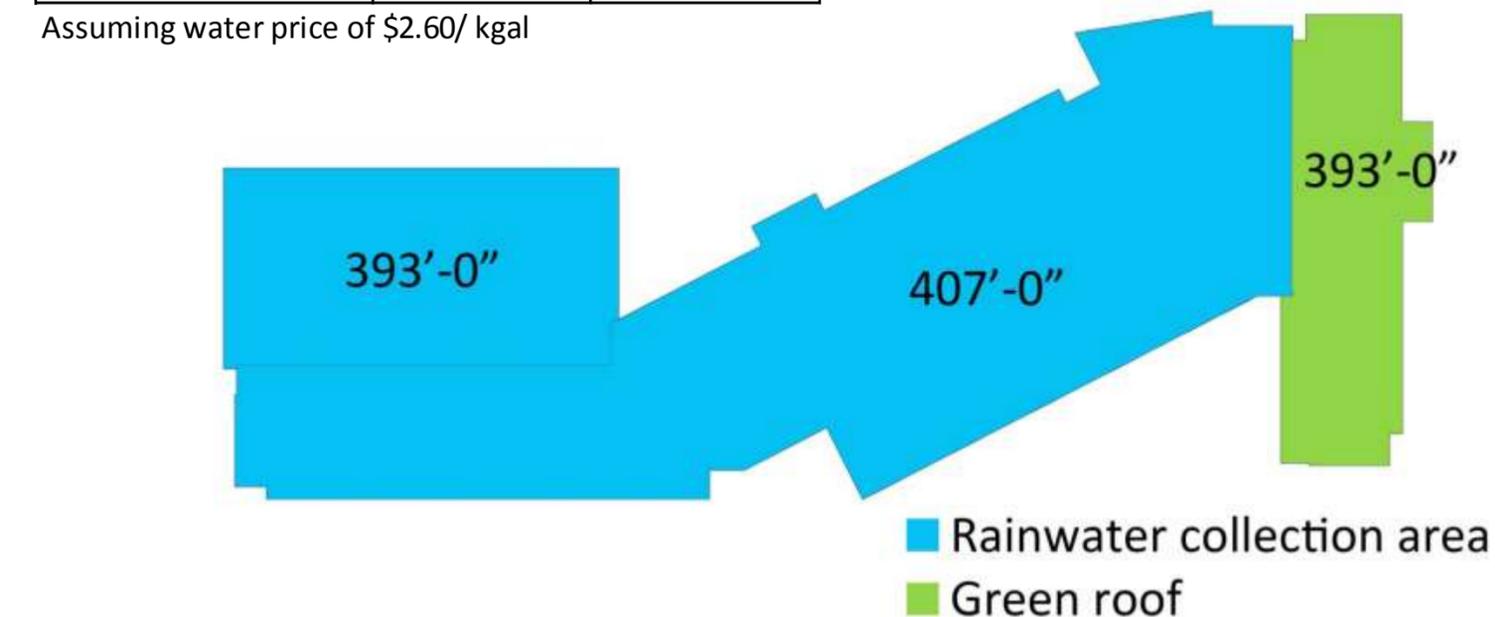
LEED / Sustainability



Water Usage and Costs

	Gal/yr	Annual Cost (\$)
Indoor	2,007,969	10,616
Rainwater Collected	612,397	1,592
Net Utility	1,395,572	9,024

Assuming water price of \$2.60/ kgal



Rainwater Collection

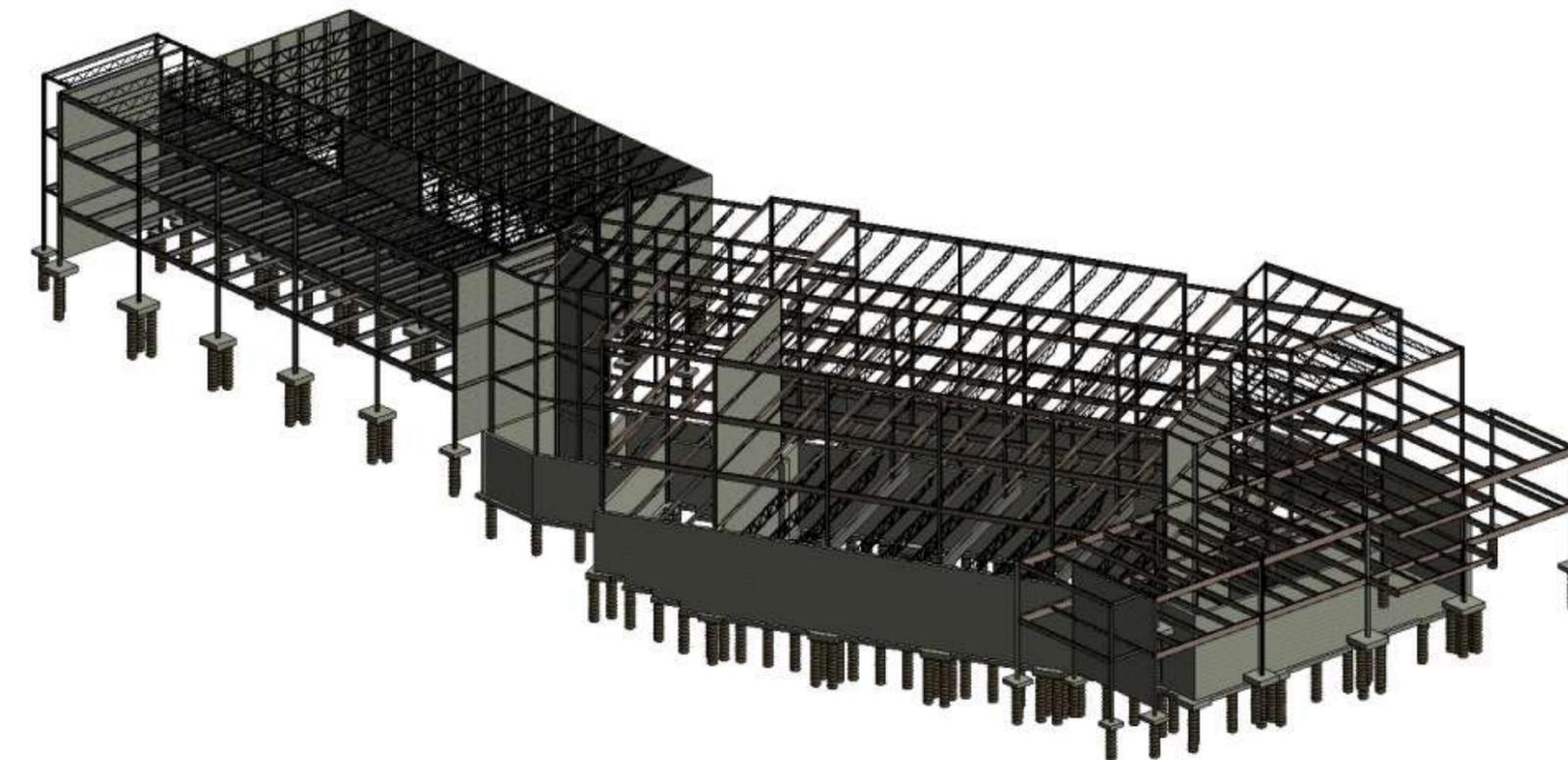
Structural Design

High
Performance

Innovation

Structural Goals

- **Innovative** and **Cost-Effective** Foundation
- **Optimized** Design of a Gravity Structural System
- **Innovative** and **Efficient** Lateral Force-Resisting System
- **Optimized** Design of a Shelter Facility
- **Building Information Model** Complete with All Structural Systems →

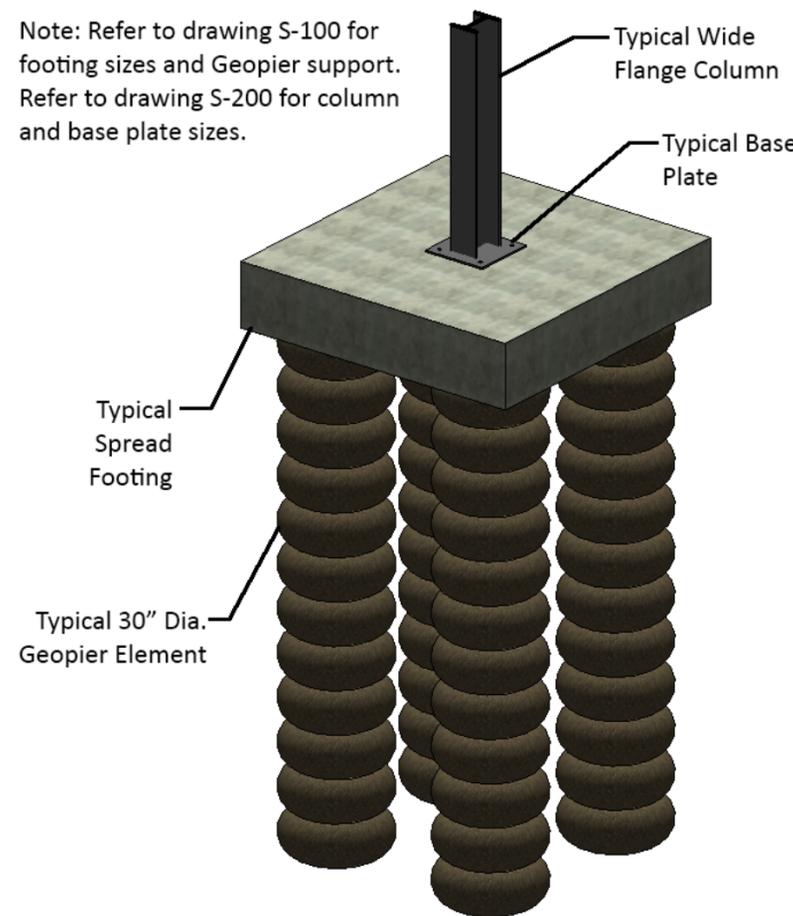


Efficiency

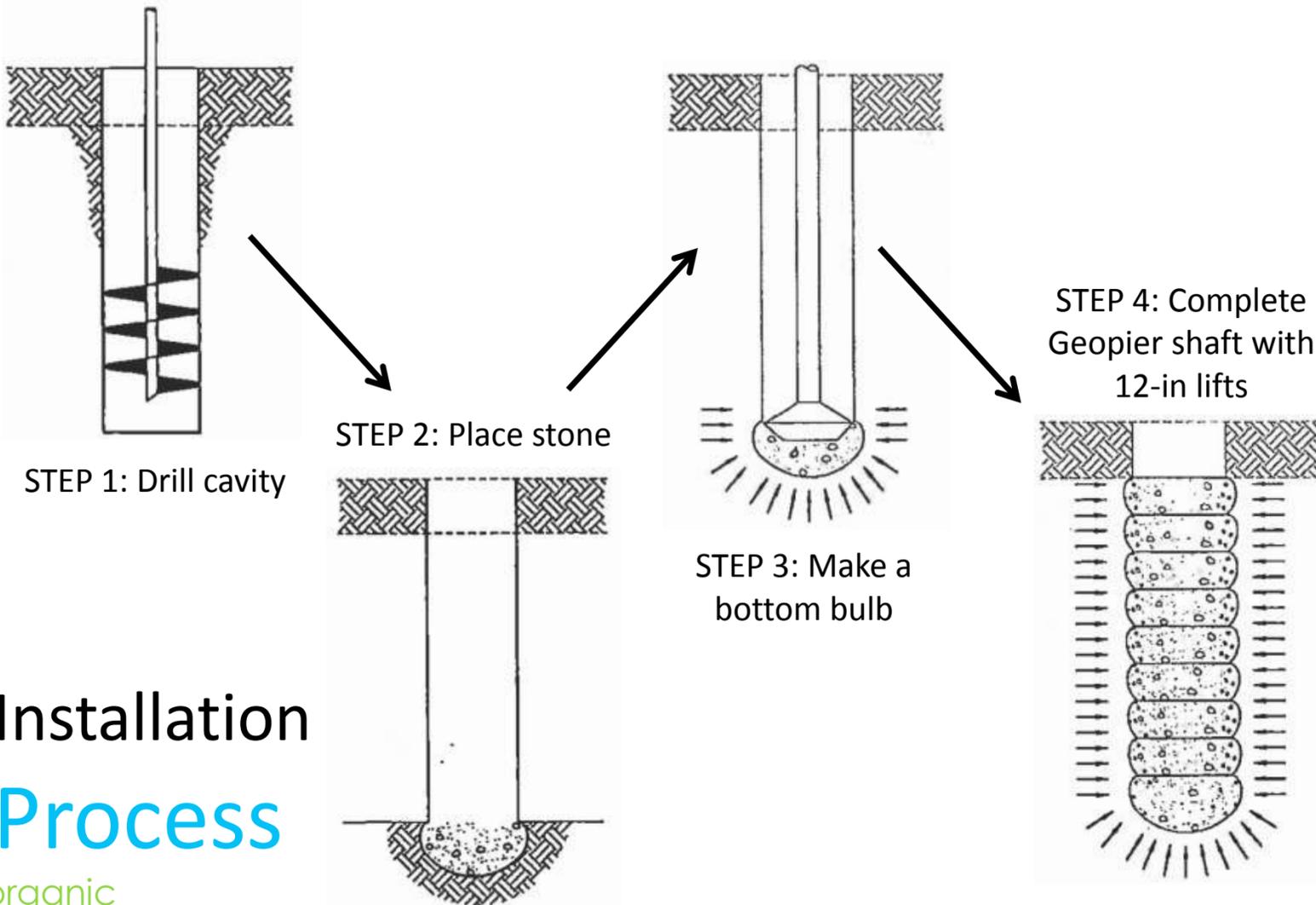
Constructability

Foundation Design Geopiers

Note: Refer to drawing S-100 for footing sizes and Geopier support. Refer to drawing S-200 for column and base plate sizes.



Installation Process
organic



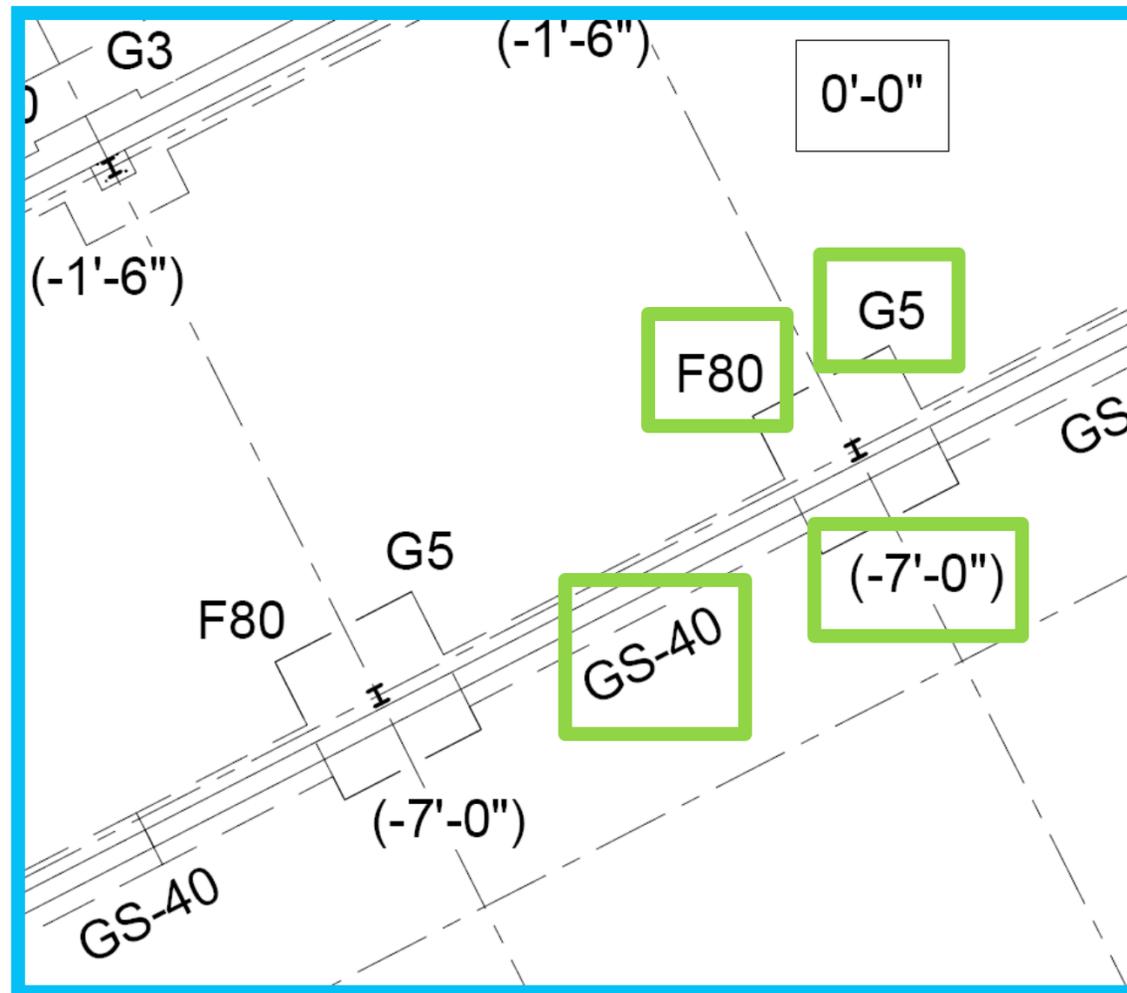
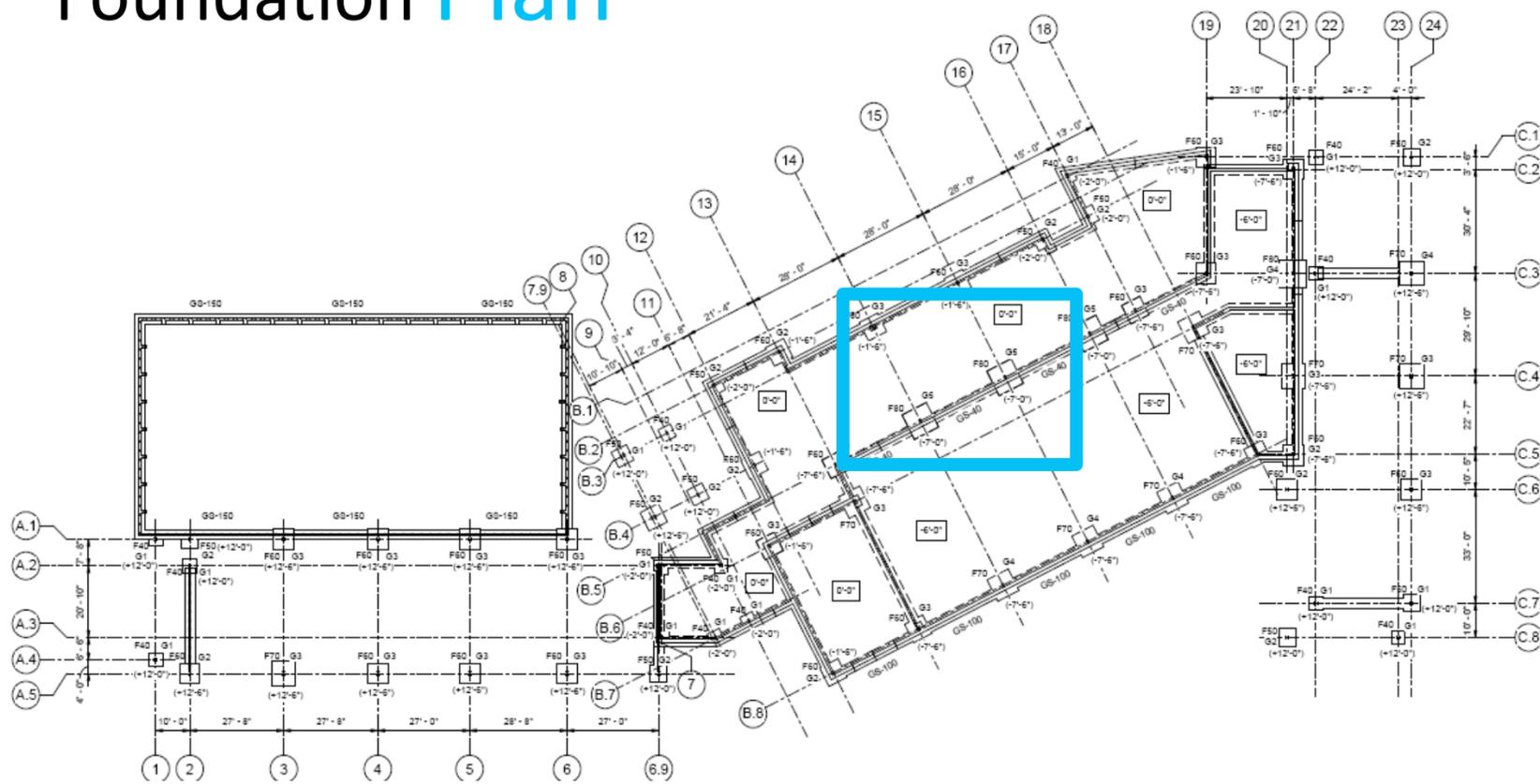
STEP 4: Complete Geopier shaft with 12-in lifts

Floor	Footing Location	Column Load (kips)			Footing Width B ft	Footing Length L ft	Footing Stress q_o ksf	RAP Capacity Q_{rap} kip	Est'd RAPs	Actual RAPs	RAP Dia d_{rap} in	RAP Depth Z_{rap} ft	RAP Mod. K_{rap} pci	Soil Mod. K_m pci	Stress Ratio R_s	Area Ratio R_a	Soil Stress q_m ksf	RAP Stress q_{rap} ksf	Settlement		
		Dead DL	Live LL	Total TL															UZ S_{uz} in	LZ S_{Lz} in	Total S_{total} in
Pool	B.5-13	102.5	73.4	176	6.0	6.0	4.9	70	2.5	3	30	11.0	175	6.95	25.2	0.41	0.45	11.3	0.45	0.06	0.51
	B.5-14	195.1	118.0	313	8.0	8.0	4.9	70	4.5	5	30	13.0	175	6.95	25.2	0.38	0.48	12.0	0.48	0.18	0.65
	B.5-15	195.2	118.0	313	8.0	8.0	4.9	70	4.5	5	30	13.0	175	6.95	25.2	0.38	0.48	12.0	0.48	0.18	0.65
B.5-16	174.7	114.7	289	8.0	8.0	4.5	70	4.1	5	30	13.0	175	6.95	25.2	0.38	0.44	11.1	0.44	0.16	0.60	
B.5-17	81.0	62.7	144	6.0	6.0	4.0	70	2.1	3	30	11.0	175	6.95	25.2	0.41	0.37	9.2	0.37	0.05	0.41	
B.6-13	124.2	78.6	203	7.0	7.0	4.1	70	2.9	3	30	12.0	175	6.95	25.2	0.30	0.50	12.6	0.50	0.10	0.60	
B.6-18	115.3	76.3	192	7.0	7.0	3.9	70	2.7	3	30	12.0	175	6.95	25.2	0.30	0.47	11.9	0.47	0.09	0.57	
B.8-13	124.5	55.3	180	6.0	6.0	5.0	70	2.6	3	30	12.0	175	6.95	25.2	0.41	0.46	11.5	0.46		0.46	
B.8-14	154.7	71.2	226	7.0	7.0	4.6	70	3.2	4	30	12.0	175	6.95	25.2	0.40	0.43	10.9	0.43	0.11	0.54	
B.8-15	154.5	71.1	226	7.0	7.0	4.6	70	3.2	4	30	12.0	175	6.95	25.2	0.40	0.43	10.8	0.43	0.11	0.54	
B.8-16	154.4	71.1	226	7.0	7.0	4.6	70	3.2	4	30	12.0	175	6.95	25.2	0.40	0.43	10.8	0.43	0.11	0.54	
B.8-18	96.9	48.2	145	6.0	6.0	4.0	70	2.1	3	30	11.0	175	6.95	25.2	0.41	0.37	9.3	0.37	0.05	0.42	
C.2-21	86.6	65.2	152	6.0	6.0	4.2	70	2.2	3	30	11.0	175	6.95	25.2	0.41	0.39	9.7	0.39	0.05	0.44	
C.3-19	92.5	72.4	165	6.0	6.0	4.6	70	2.4	3	30	11.0	175	6.95	25.2	0.41	0.42	10.6	0.42	0.05	0.48	
C.3-21	134.9	116.4	251	8.0	8.0	3.9	70	3.6	4	30	13.0	175	6.95	25.2	0.31	0.47	11.7	0.47	0.14	0.61	
C.4-21	109.5	88.8	198	7.0	7.0	4.0	70	2.8	3	30	12.0	175	6.95	25.2	0.30	0.49	12.3	0.49	0.10	0.59	
C.5-21	61.2	45.1	106	6.0	6.0	3.0	70	1.5	2	30	11.0	175	6.95	25.2	0.27	0.39	9.8	0.39	0.04	0.42	

Floor	Footing Location	Settlement		
		UZ S_{uz} in	LZ S_{Lz} in	Total S_{total} in
Pool	B.5-13	0.45	0.06	0.51
	B.5-14	0.48	0.18	0.65
	B.5-15	0.48	0.18	0.65

Geopier Design

Foundation Plan



Comparison of Alternatives

- Compaction Grouting
- Excavation / Replacement
- Micropiles

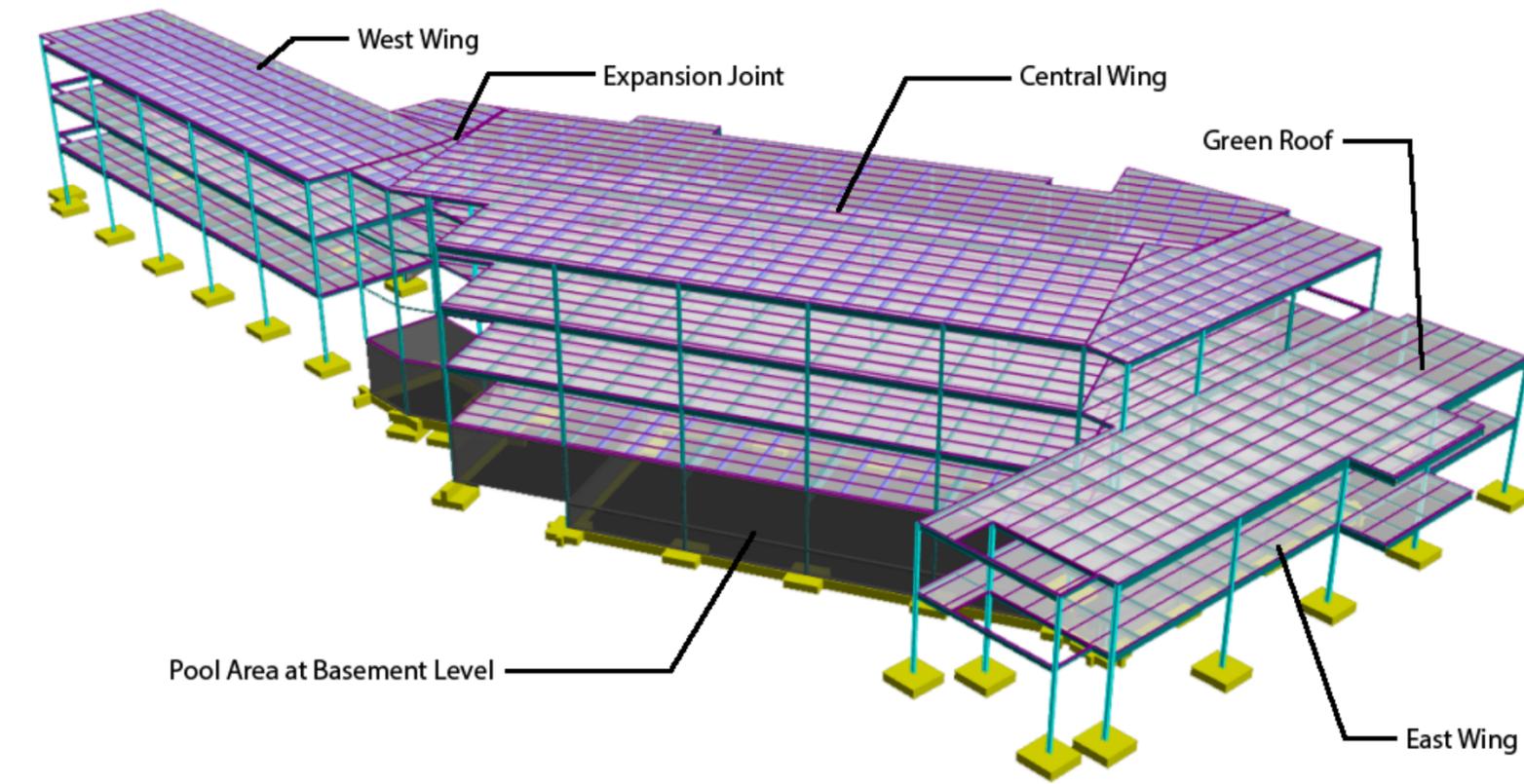
Foundation System	Excavation/Replacement	Micropiles	Geopiers
Estimated Cost	\$334,000 ^a	\$292,000 ^b	\$203,000 ^c

^aIncludes excavation, backfill, compaction, reinforced concrete (footings), and labor

^bIncludes steel piles, pile driving, concrete, and labor

^cIncludes drilling, ramming, aggregate, reinforced concrete (footings), and labor

RAM Model



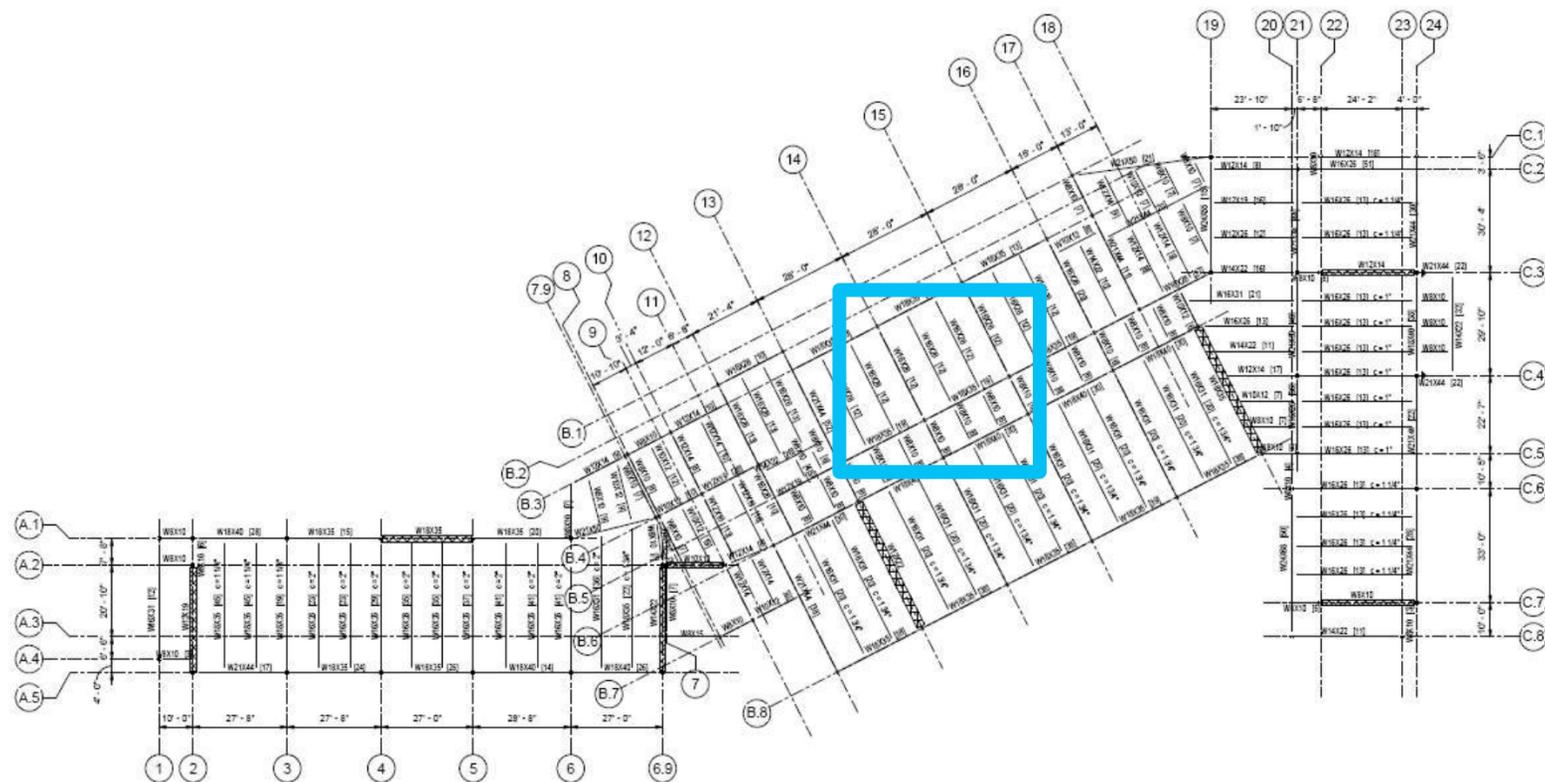
Framing Optimization

- Beam orientations and layout schemes
- Composite floor deck
- 3-span unshored construction
- Constructability criteria per industry publications
- Column sizes of W10 and larger



COLUMN LOCATIONS	A.1-1	A.1-2	A.1-3	A.1-4	A.1-5
ROOF T.O.S.					
406' - 10 1/2"					
THIRD FLOOR T.O.S.			W10X33	W10X33	
392' - 6 3/4"					
SECOND FLOOR T.O.S.	W10X33	W10X33			W10X33
378' - 6 3/4"					
FIRST FLOOR T.O.S.			W10X45	W10X39	
364' - 6 3/4"					

Design Spot Checks

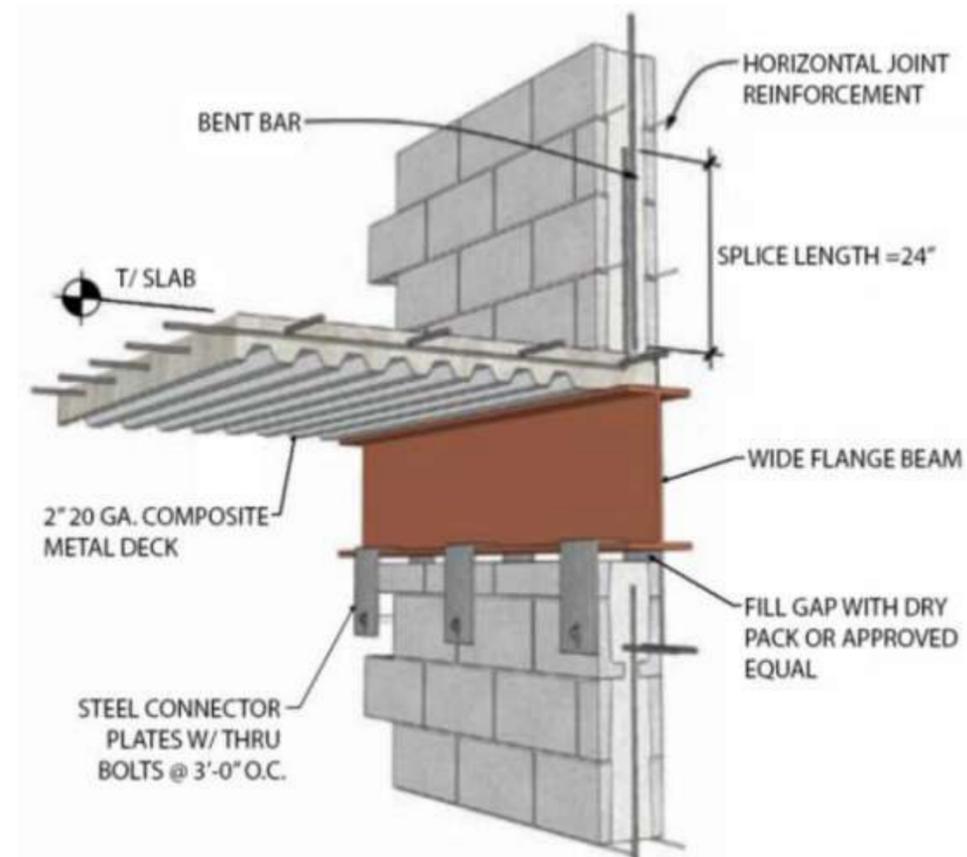
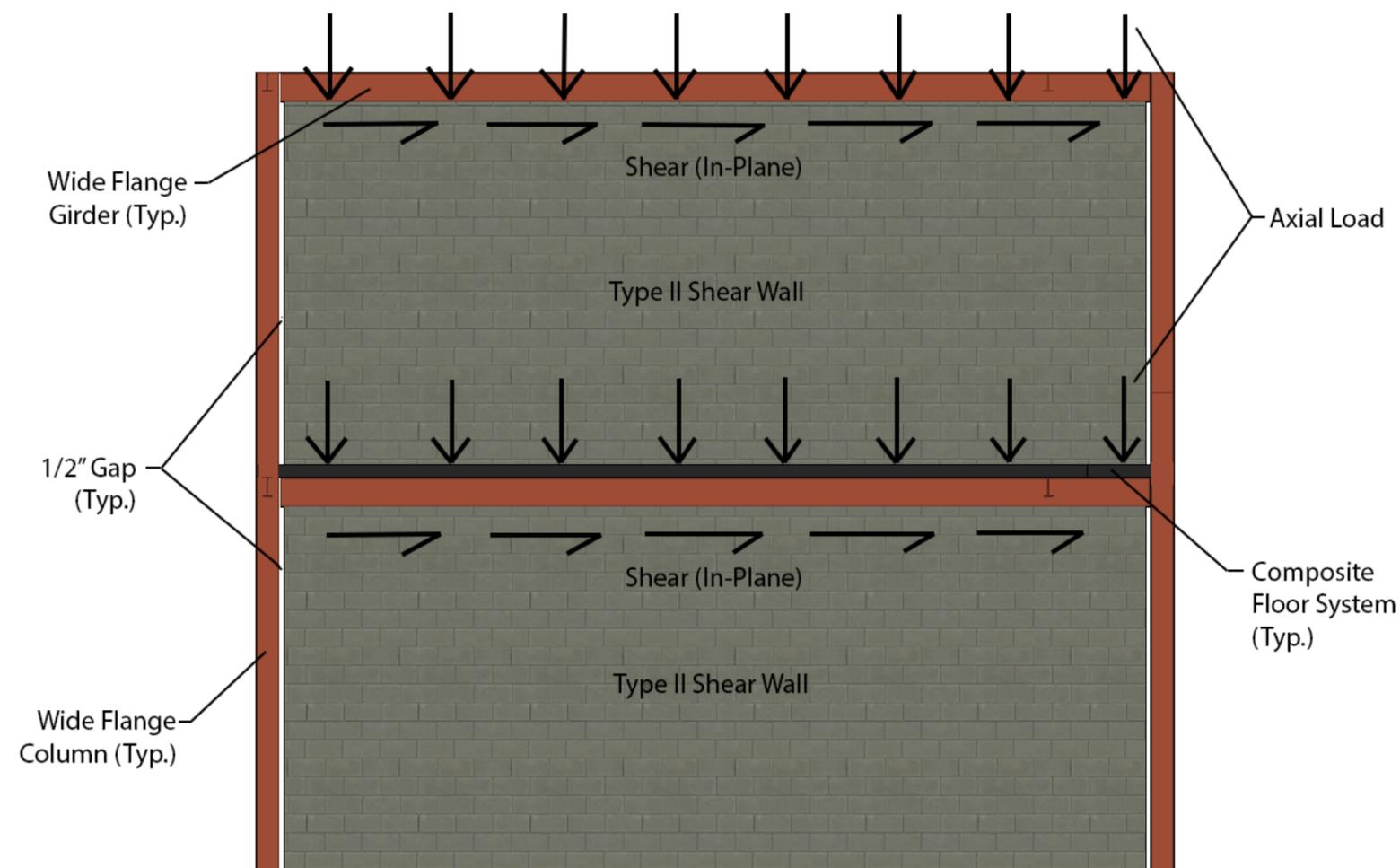


Typical Composite Beam Design (1st/2nd/3rd Floor Small Classroom)

RAM Design Output → W16x26 (12 studs)

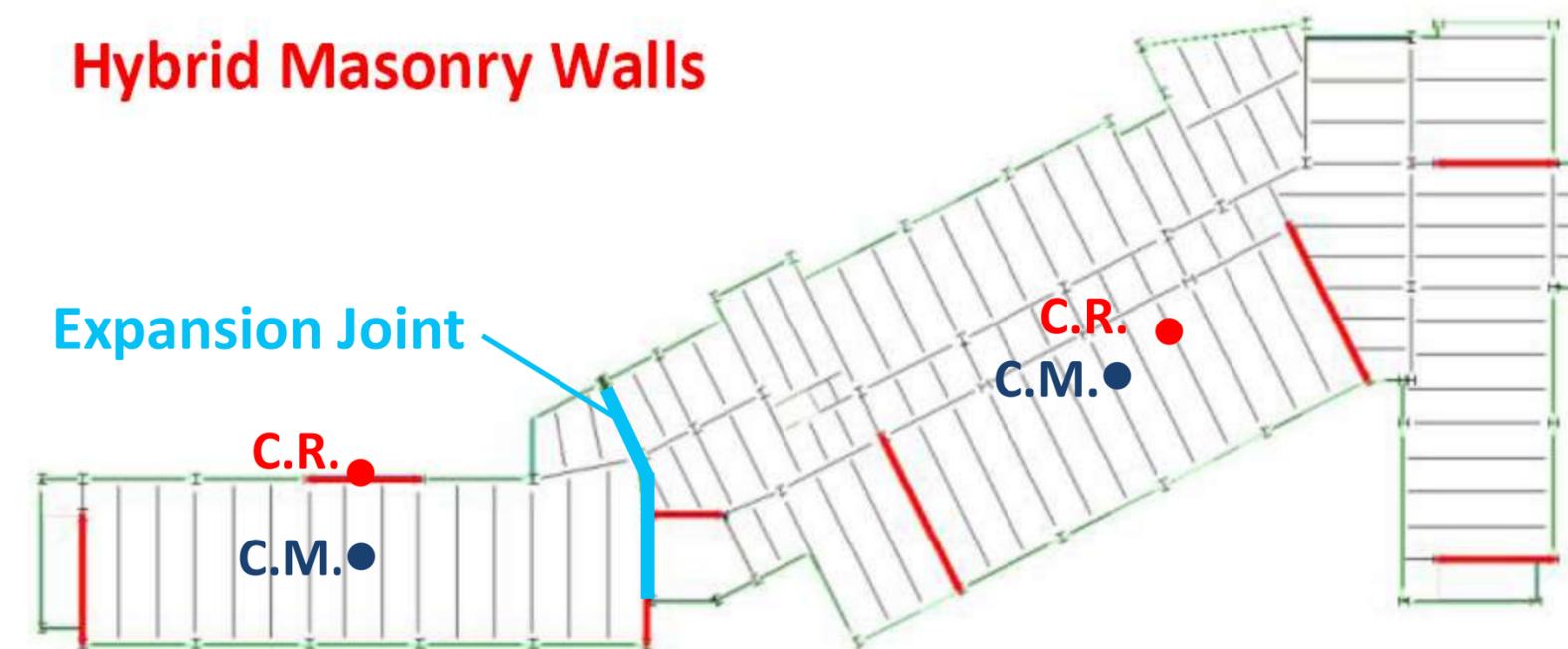
Hand Calculations → W16x26 (12 studs)

Lateral Design Hybrid Masonry Walls



Hybrid Masonry Walls

Expansion Joint



C.M. and C.R. < 20' apart

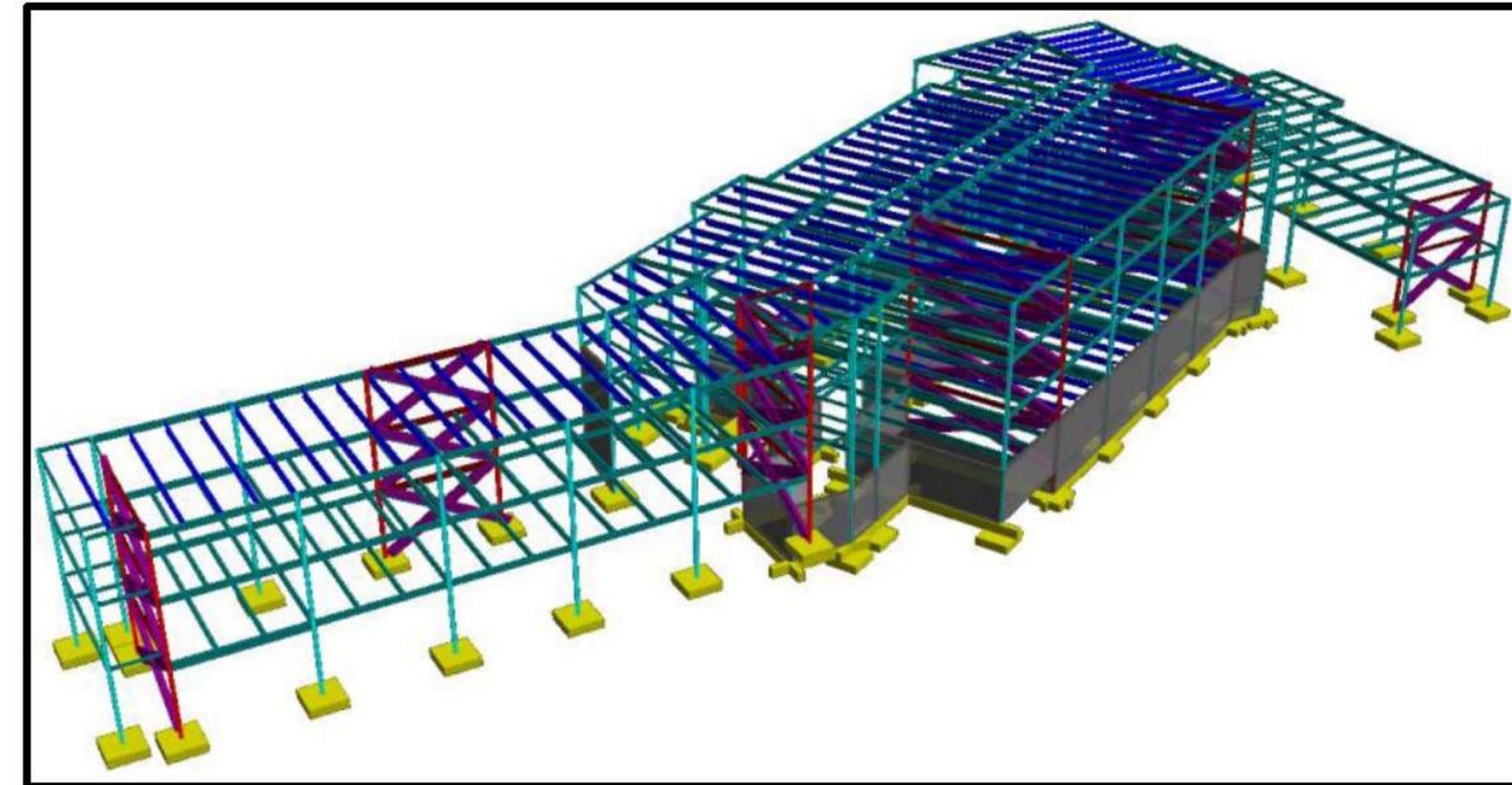
Modeling Methodology

- Personally recommended by David T. Biggs, PE – main developer of the hybrid masonry system
- First, solve for stiffness of the masonry shear wall
- Next, equate stiffness to that of steel cross bracing
- Finally, solve for necessary “equivalent brace” size

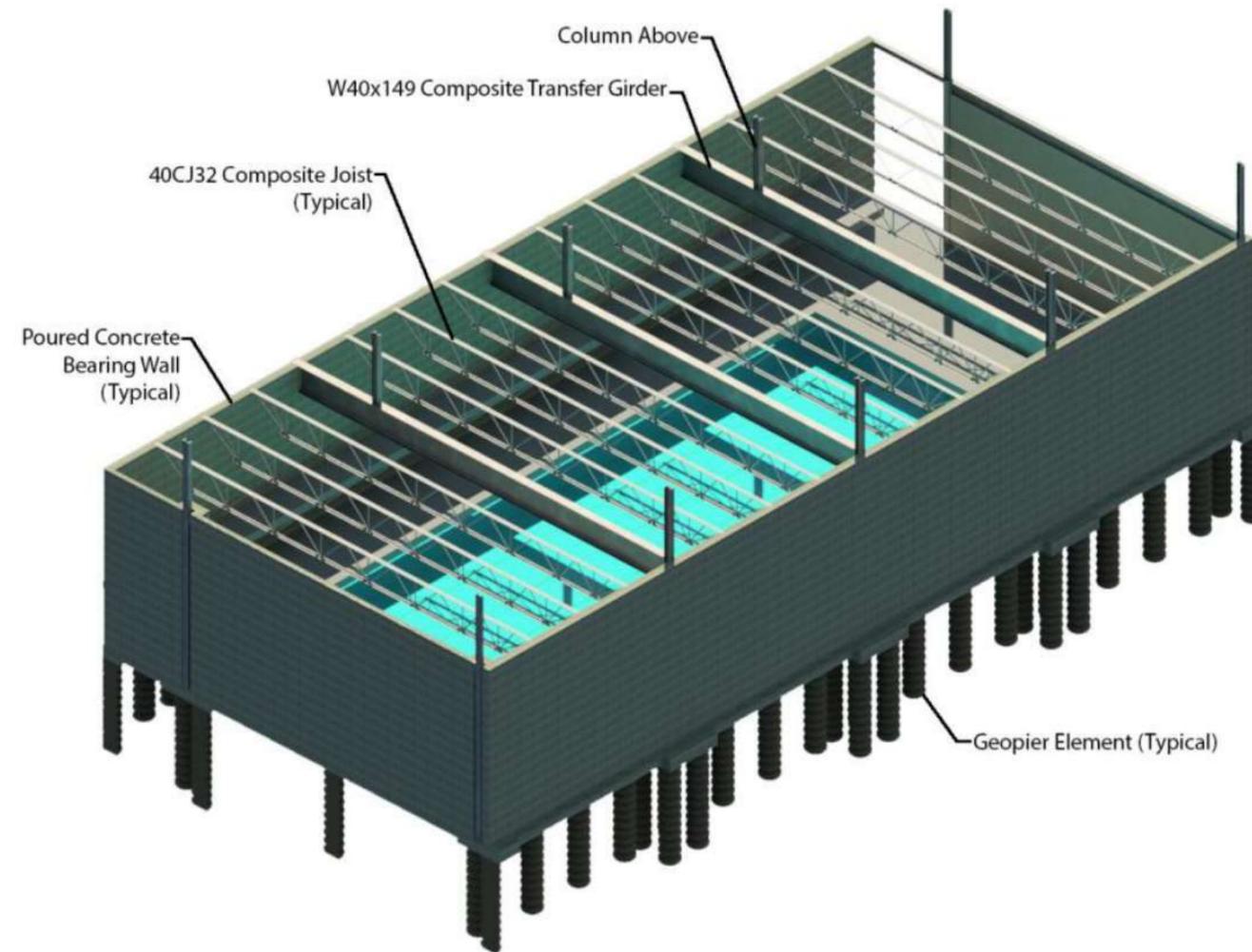
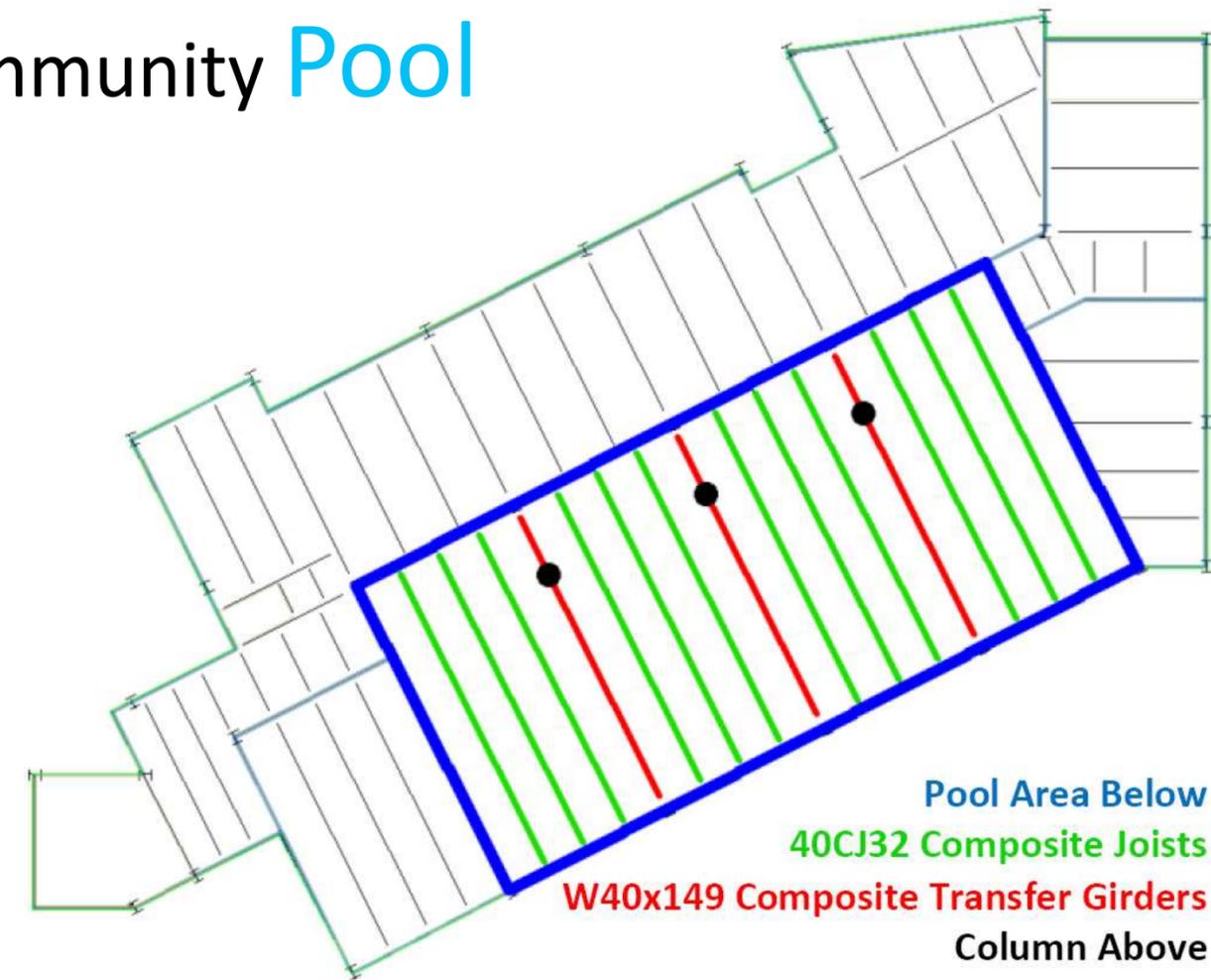
Bay Length (ft)	Brace Size
28'-0"	(2) W30x124
31'-4"	(2) W36x160
41'-4"	(2) W40x297

Lateral Analysis

Wing	Direction	Seismic Force-Resisting System	Response Modification Coefficient (R)	Deflection Amplification Factor (C_d)	Seismic Importance Factor (I_e)	Seismic Response Coefficient (C_s)	Design Force (k)	Elastic Analysis Drift (δ_{xe}) (in)	Adjusted Maximum Drift (δ_x) (in)
West	X	Intermediate Reinforced Hybrid Masonry Walls	4.0	2.5	1.25	0.049	65.9	0.12	0.24
	Y	Intermediate Reinforced Hybrid Masonry Walls	4.0	2.5	1.25	0.049	65.9	0.04	0.08
Central/ East	X	Intermediate Reinforced Hybrid Masonry Walls	4.0	2.5	1.25	0.049	224.7	0.15	0.30
	Y	Intermediate Reinforced Hybrid Masonry Walls	4.0	2.5	1.25	0.049	224.7	0.16	0.32

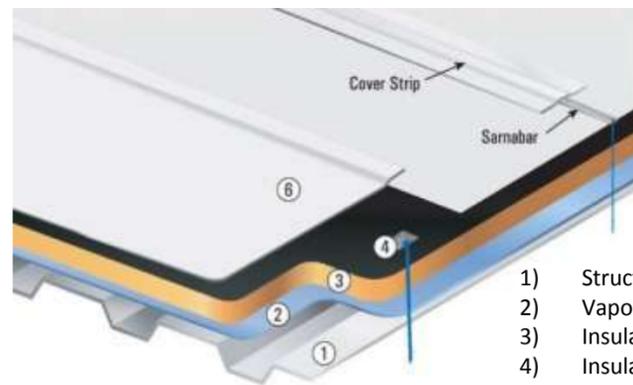


Community Pool

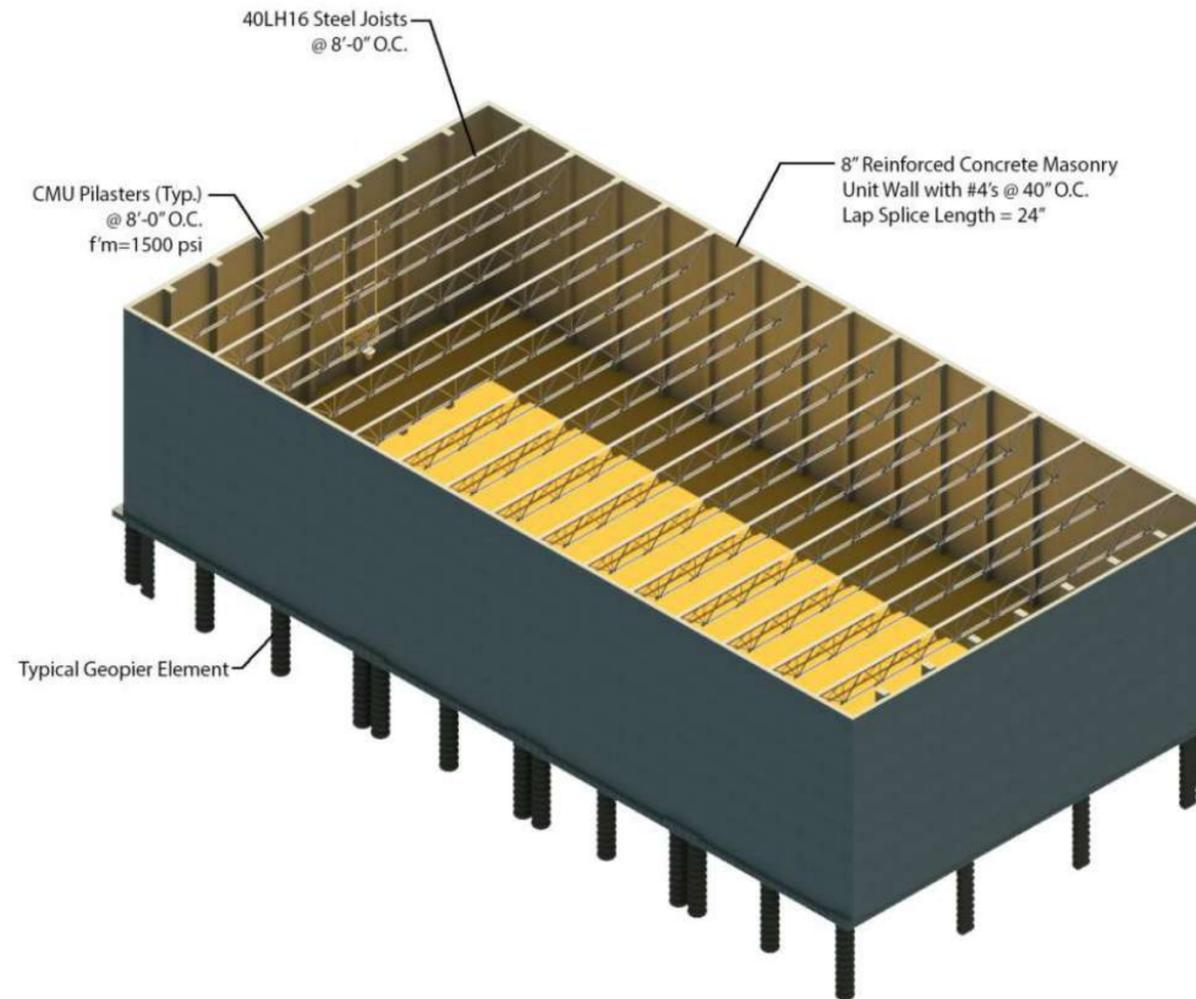
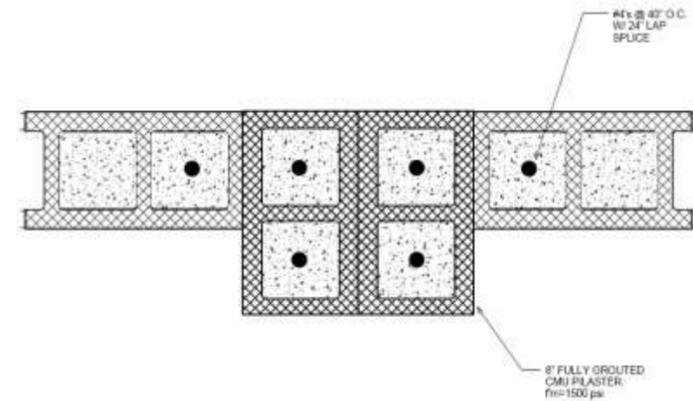


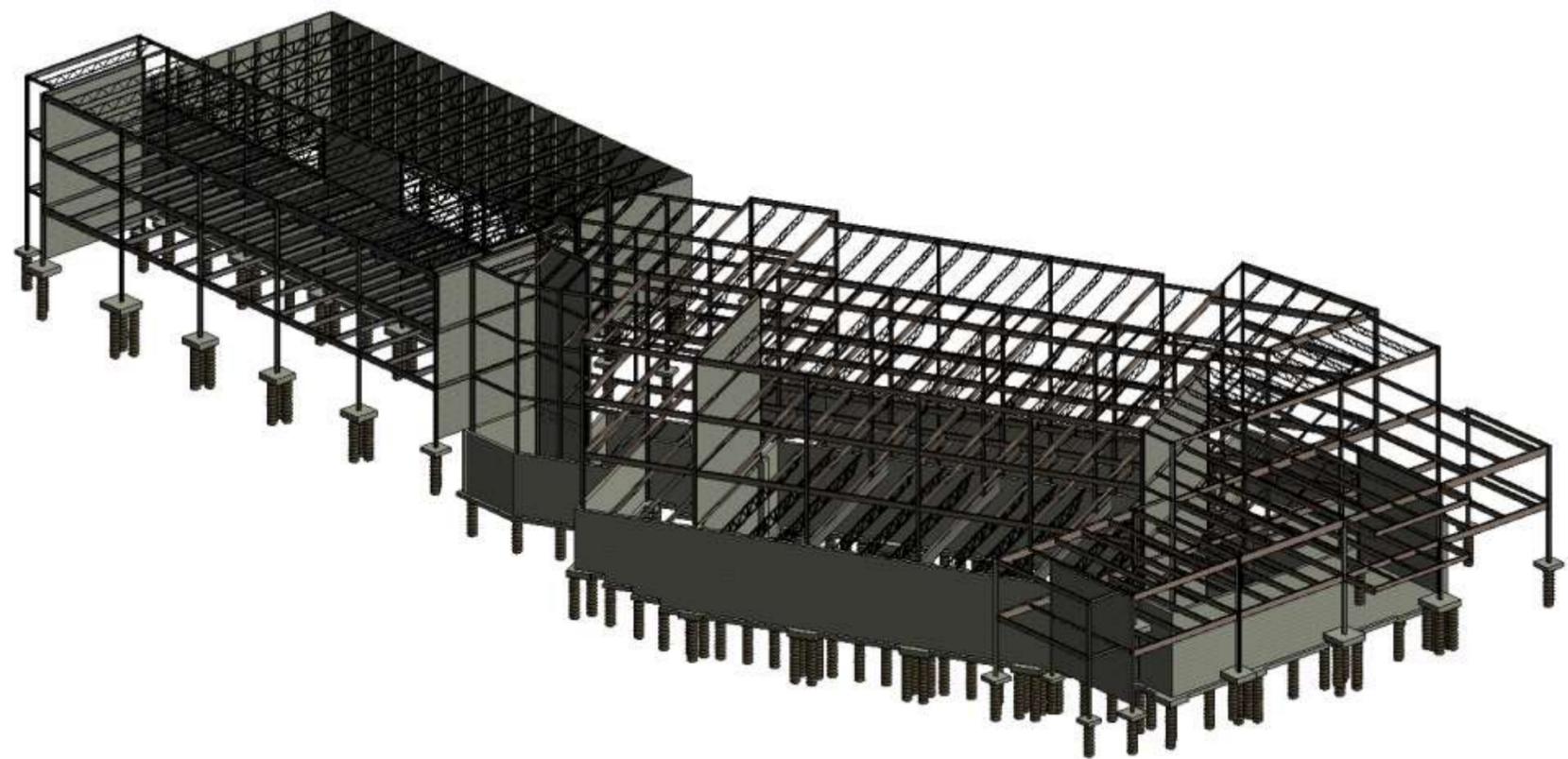
Multipurpose Area / Shelter

- Risk Category IV per ASCE 7-10
- Fully-grouted reinforced CMU walls with pilasters
- Engineered Roof System



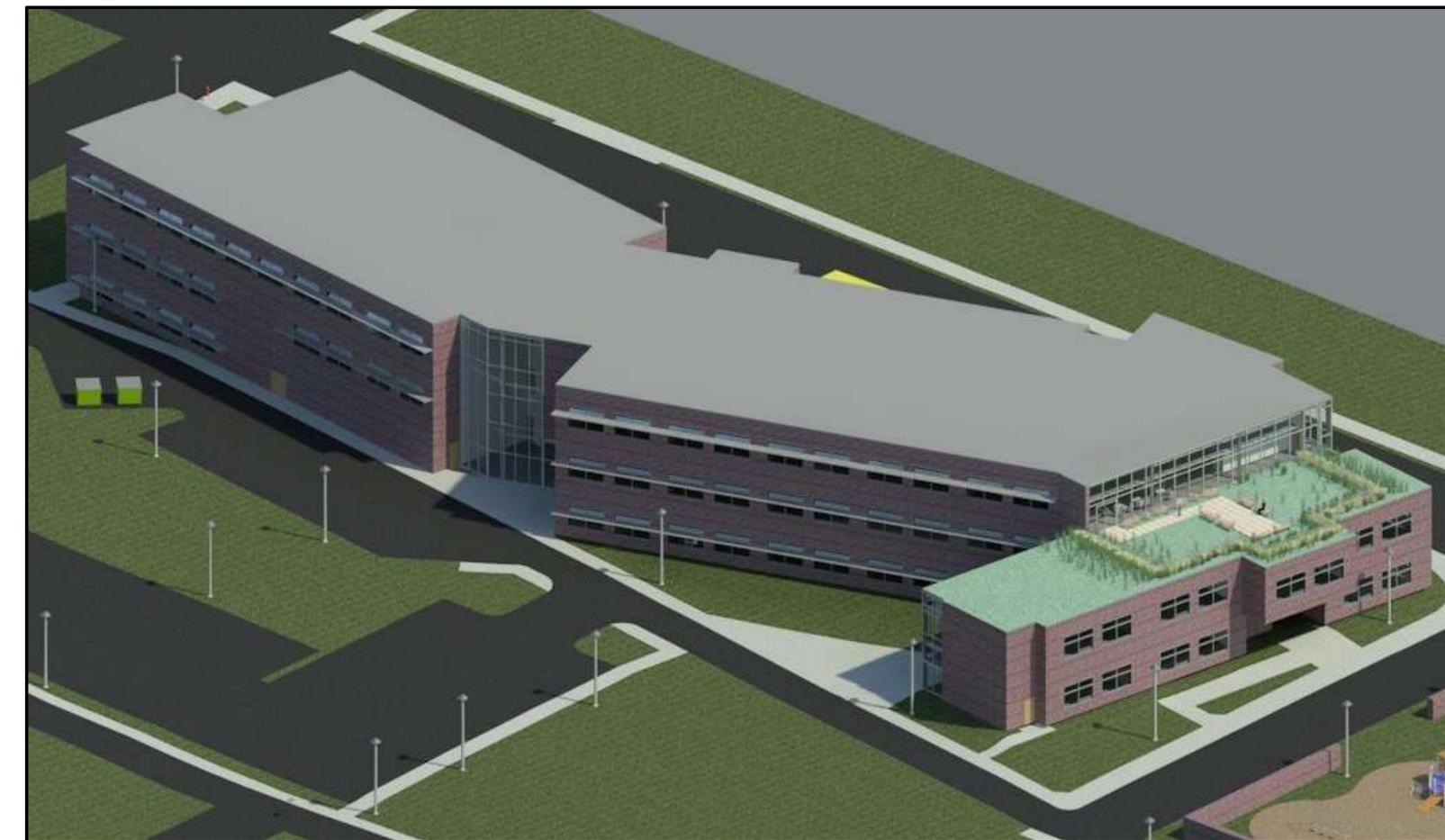
- 1) Structural Deck
- 2) Vapor Retarder
- 3) Insulation
- 4) Insulation Fastener
- 5) Gypsum Roof Board
- 6) Sarnafil Membrane





Conclusion / **Lessons Learned**

- ✓ Innovative and Cost-Effective Foundation
- ✓ Optimized Design of a Gravity Structural System
- ✓ Innovative and Efficient Lateral Force-Resisting System
- ✓ Optimized Design of a Shelter Facility
- ✓ Building Information Model Complete with All Structural Systems



construction management **overview**

Existing Site Plan



Construction Goals

Design a **cost-effective** facility to help the entire community grow

Plan for & **adapt** to issues of **safety** & **quality** throughout construction

Provide a safe & efficient environment for **end users**

Final Site Plan



Delivery Method

Cost

Cost Analysis:

\$18,568,000

\$225.25/SF

Pool Add-Alt: \$1,597,500

Square Foot Resources

Detailed Estimates

READING ELEMENTARY SCHOOL CONSTRUCTION BUDGET				
SF: 82,433		YEAR: 2013		
CATEGORY	DESCRIPTION	COST	COST/SF	% OF ORIG. CONTRACT
A. Substructure	A10 Foundations	\$200,526.52	\$2.43	1.49%
	A20 Basement Const	\$792,473.48	\$9.61	5.87%
B. Shell	B10 Superstructure	\$2,098,250.00	\$25.45	15.54%
	B20 Exterior Enclosure	\$1,307,574.00	\$15.86	9.68%
	B30 Roofing	\$564,278.00	\$6.85	4.18%
C. Interiors	C10 Interior Const	\$1,436,344.00	\$17.42	10.64%
	C20 Stairs	\$287,268.80	\$3.48	2.13%
	C30 Interior Finishes	\$1,149,075.20	\$13.94	8.51%
D. Services	D10 Conveying	\$76,947.00	\$0.93	0.57%
	D20 Plumbing	\$705,347.50	\$8.56	5.22%
	D30 HVAC	\$2,039,095.50	\$24.74	15.10%
	D40 Fire Protection	\$294,963.50	\$3.58	2.18%
	D50 Electrical	\$1,577,413.50	\$19.14	11.68%
E. Equipment & Furnishings	E10 Equipment	\$259,696.13	\$3.15	1.92%
	E20 Furnishings	\$86,565.38	\$1.05	0.64%
F. Special Construction & Demolition	F10 Special Const	\$106,000.00	\$1.29	0.79%
	F20 Selective Building Demolition	\$520,985.78	\$6.32	3.86%
Subtotal		\$13,502,804.29	\$163.80	100.00%
Time Adj. Factor		\$303,813.10	\$3.69	2.25%
Add-Alternate (Pool)		\$1,597,569.30	\$19.38	11.83%
General Conditions		\$1,340,743.00	\$16.26	9.93%
Taxes		\$810,168.26	\$9.83	6.00%
Fee		\$675,140.21	\$8.19	5.00%
Bonds & Insurance		\$337,570.11	\$4.10	2.50%
TOTAL		\$18,567,808.27	\$225.25	

COMPARABLE BUILDING COST ESTIMATES								
Data	Year	Location	S.F.	Price	Per S.F.	Location Factor	Time Factor	Adjusted S.F. Cost
D4 Estimate	2013	Reading, PA	82,433	\$17,376,074	\$210.79	1.00	1.00	\$210.79
R.S. Means Costworks	2012	Reading, PA	82,433	\$17,152,500	\$208.08	1.00	1.02	\$212.24
Clearview Elementary School	2002	Hanover, PA (Near York)	43,638	\$6,887,822	\$157.84	1.03	1.56	\$253.62
School Planning & Management	2011	National	75,000	\$14,800,000	\$197.33	0.99	1.06	\$207.08
School Planning & Management	2011	PA,NJ,NY	90,000	\$26,000,000	\$288.89	0.99	1.06	\$303.16
							AVG	\$237.38

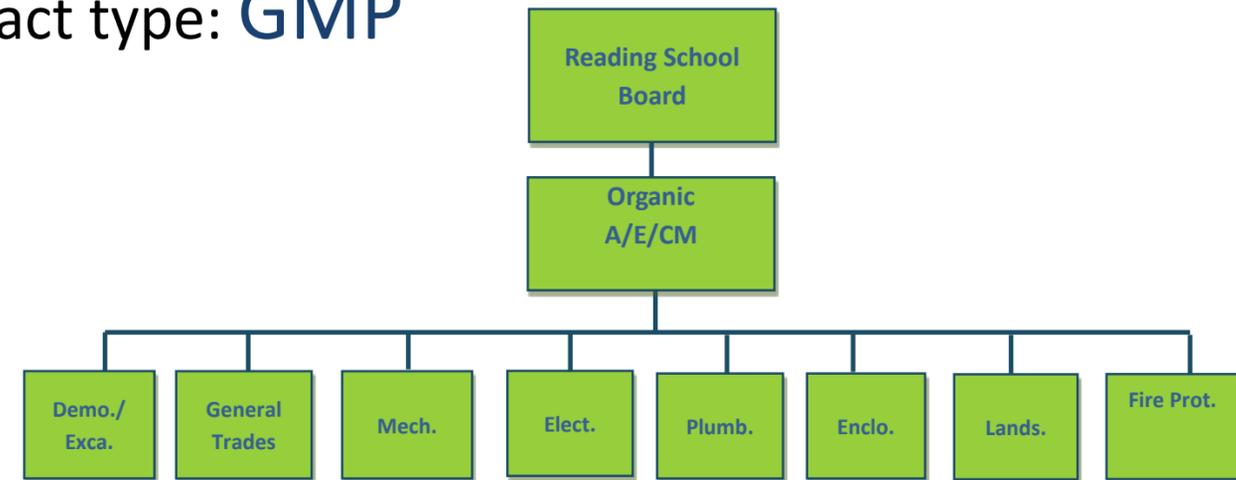
FUTURE POOL ADDITION ESTIMATE					CURRENT ADD-ALTERNATE DESIGN	
Item	Unit	Qty.	Cost/Unit	Cost	Item	Cost
Facebrick Building w/ CMU backup	S.F.	9,000	\$265.07	\$2,385,630.00	Structure	\$352,876.35
Bleachers	L.F.	120	\$55.50	\$6,660.00	Mechanical	\$173,341.76
Lockers	EACH	12	\$217.00	\$2,604.00	Electrical	\$120,607.22
Benches	EACH	6	\$180.00	\$1,080.00	Plumbing	\$118,609.64
Sound System	EACH	1	\$13,675.00	\$13,675.00	Architectural	\$832,134.33
Pool Lights	EACH	2	\$945.00	\$1,890.00		
Scoreboard	EACH	1	\$3,450.00	\$3,450.00		
			TOTAL:	\$2,414,989.00	TOTAL:	\$1,597,569.30

Façade Estimate					
Location	Façade Area (SF)	Cost/SF (Low)	Cost/SF (High)	Total Cost (Low)	Total Cost (High)
North	13791.35	\$25.00	\$40.00	\$344,783.75	\$551,654.00
South	11389.58	\$25.00	\$40.00	\$284,739.50	\$455,583.20
East	3821.54	\$25.00	\$40.00	\$95,538.50	\$152,861.60
West	3686.88	\$25.00	\$40.00	\$92,172.00	\$147,475.20
				\$817,233.75	\$1,307,574.00

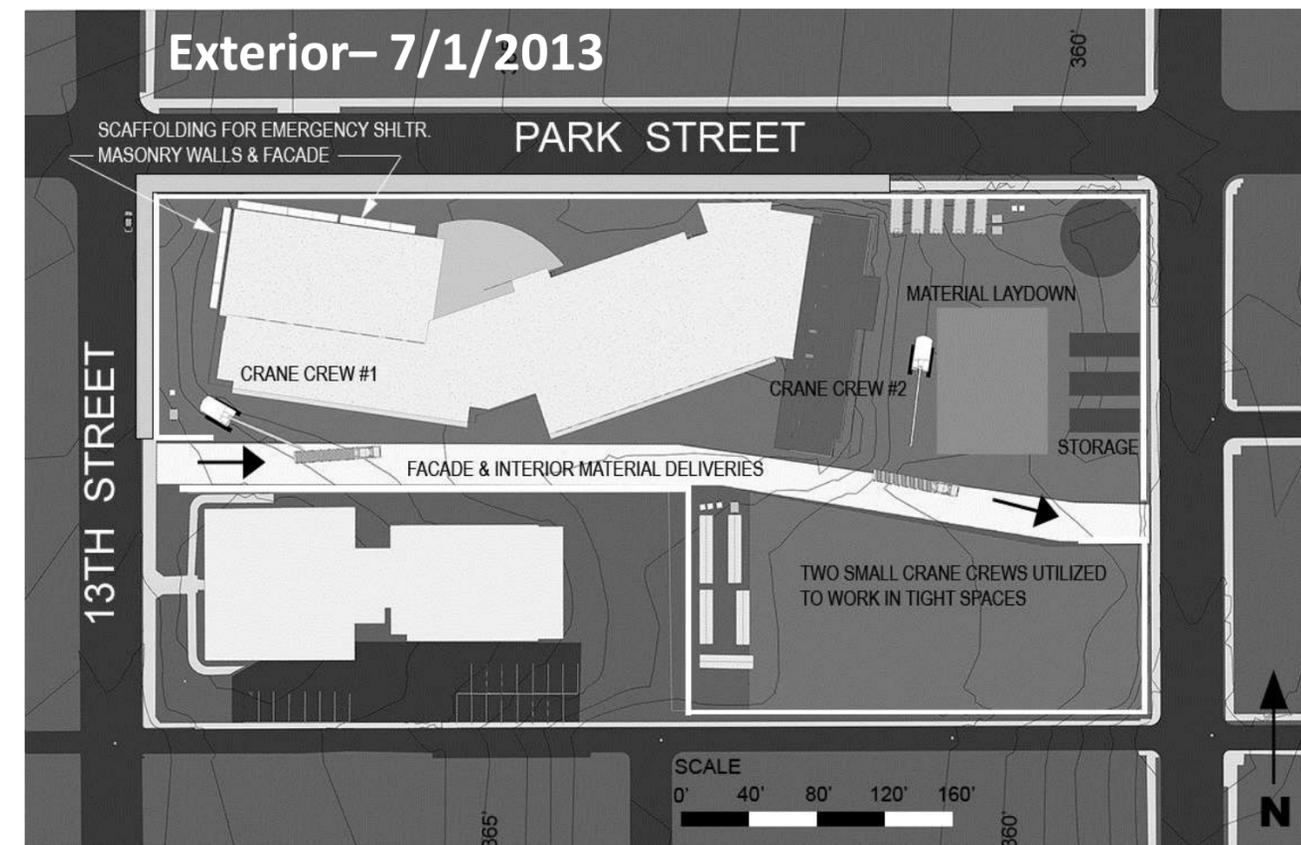
Delivery method: Design-Build

- PA Separations Act

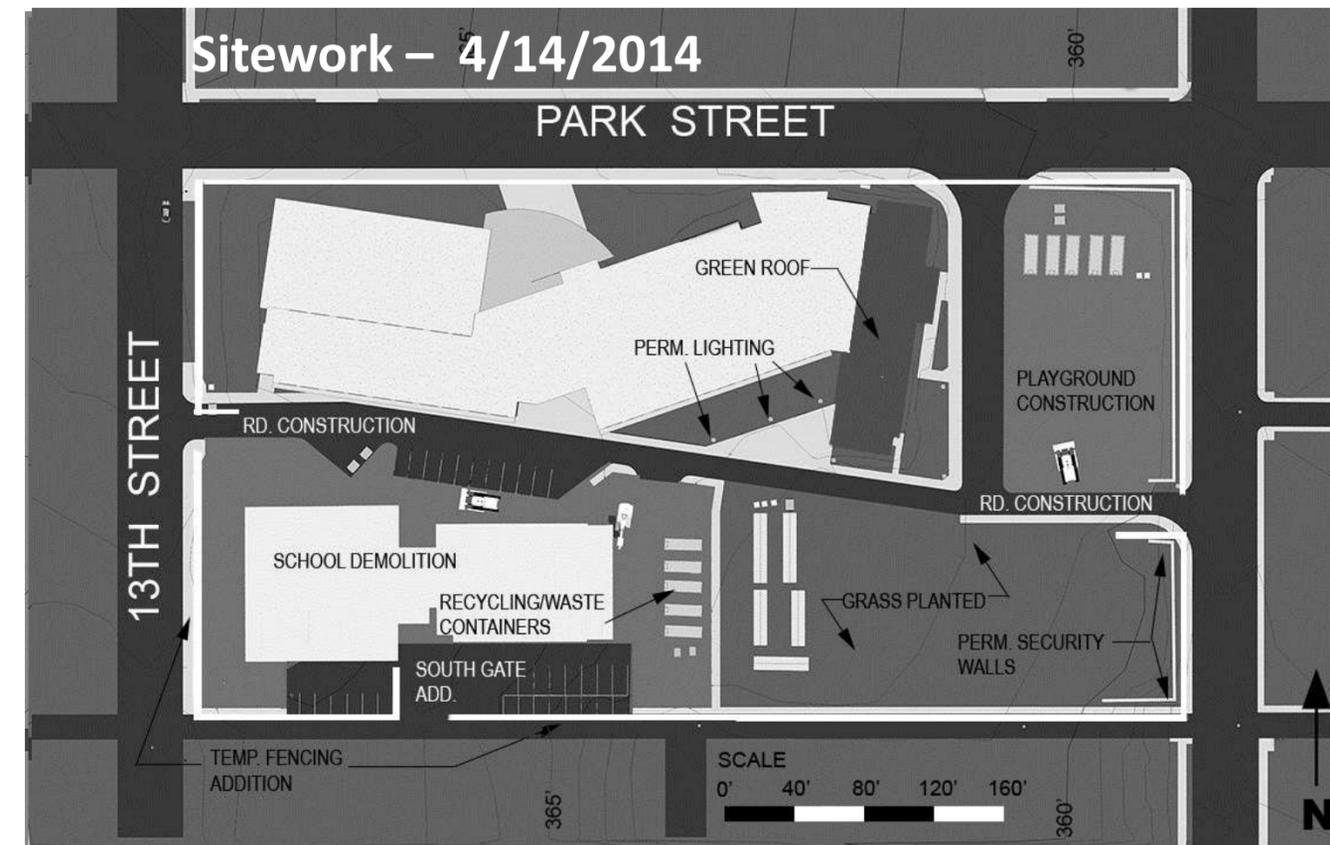
Contract type: GMP



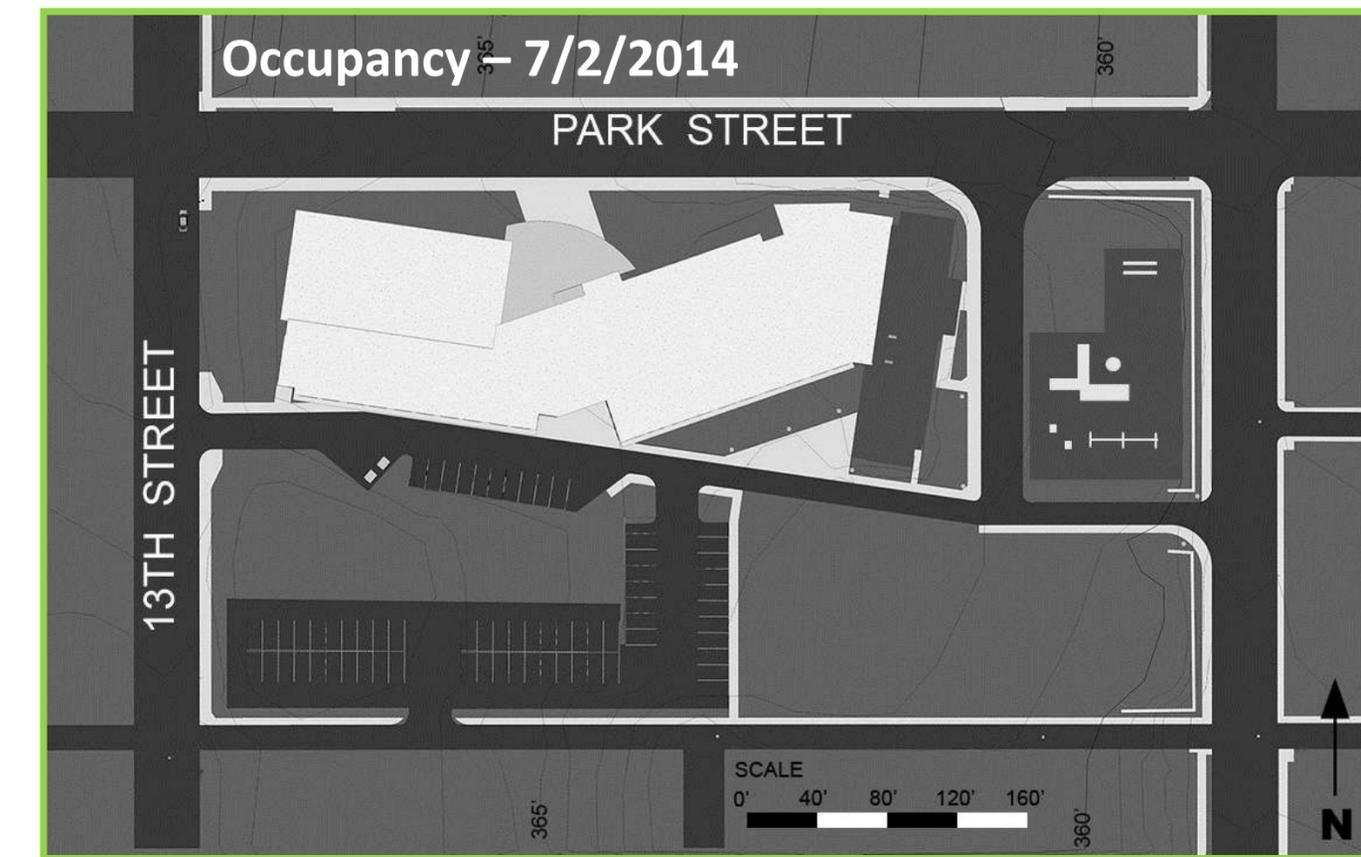
Project Phases/Site Utilization



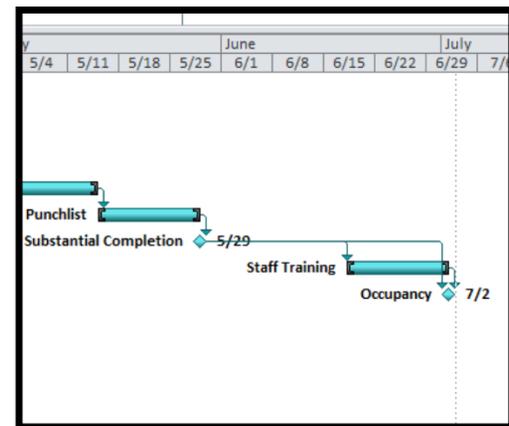
Focus: Establish site security



Focus: Falling debris, hazardous material



✓ **Organic** Construction Goal : adapt to safety and quality concerns



Water Usage and Costs

	Gal/yr	Annual Cost (\$)
Indoor	2,007,969	10,616
Rainwater Collected	612,397	1,592
Net Utility	1,395,572	9,024

Assuming water price of \$2.60/ kgal

estimated energy use

Energy	Design	Median Building
Energy Performance Rating (1-100)	73	50
Energy Reduction (%)	21%	0%
Source Energy Use Intensity (kBtu/ft ² /yr)	161	204
Site Energy Use Intensity (kBtu/ft ² /yr)	57	72
Total Annual Source Energy (kBtu)	12,443,904	15,663,393
Total Annual Site Energy (kBtu)	4,380,117	5,513,342
Total Annual Energy Cost (\$)	\$ 112,829	\$ 142,020
Pollution Emissions		
CO ₂ -eq Emissions (metric tons/yr)	536	675
CO ₂ -eq Emissions Recution (%)	21%	0%

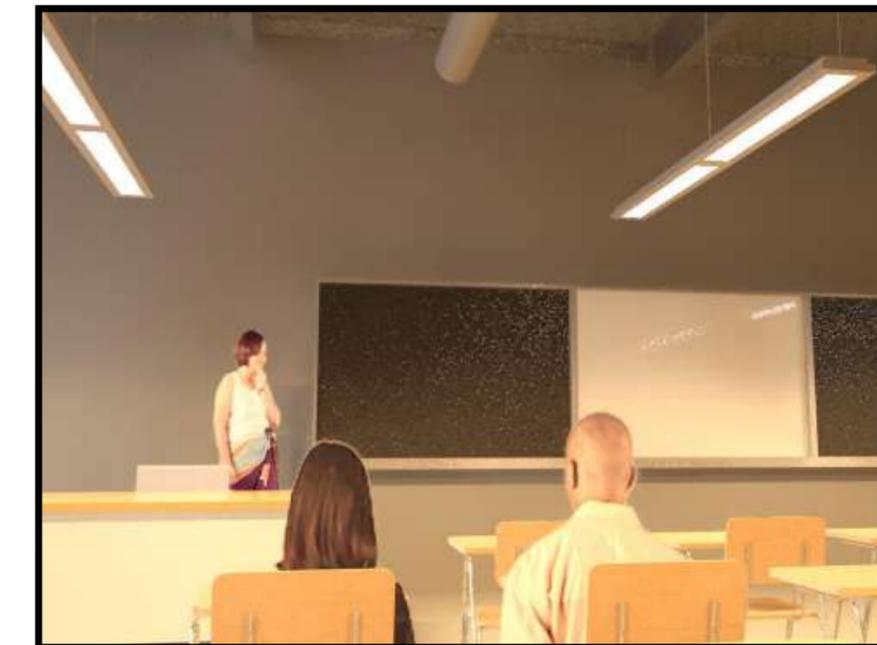
Transition Plan

Goals of Plan

1. Teach Facility Managers
2. Allow for Teacher Input
3. Let teachers contribute to safe design

Methods

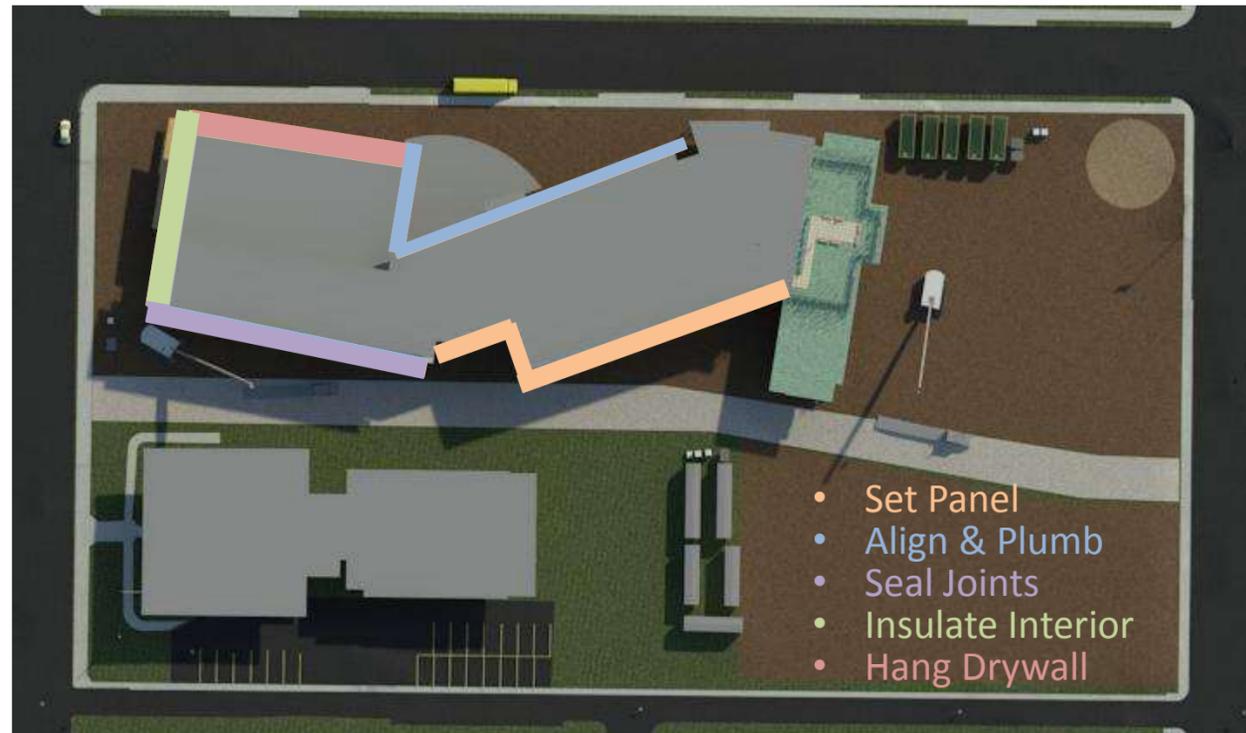
Facility Staff Training
 Teacher Feedback Results
 Virtual Mock-ups



Results

1. Natural Lighting
2. Accessible Outlets
3. Built in Shelving
4. Noise Separation
5. Wireless Connection

✓ **Organic** Construction Goal : **safe** and **efficient** environment for **end-users**



Area	1	2	3	4	5	6	7	8	9	10	11	12
A-N	Set Panel	Align & Plumb	Seal Joints	Insulate Interior	Hang Drywall							
A-W												
A-S												
B-S												
B-N												
C-N												
C-E												
C-S												

SIPS Schedule

- Approx. 140 Panels
- 1260 LF of Façade
- 8 Week Schedule

Detailed Activities Scheduling

Short Interval Production Scheduling (SIPS)

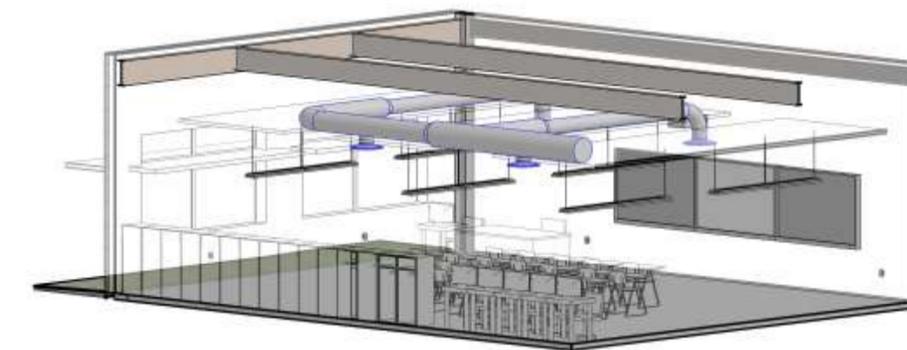
Attributes of SIPS

- Repetitive Work
- Learning Curve
- Quality/Safety Improvement

Matrix Scheduling (Parade of Trades)

- Similar Construction
- Number of Classrooms

Matrix Schedule



Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
134																													
135																													
136																													
141																													
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HVAC
Sprinkler Main
Plumbing
Lighting/Electrical
Sprinkler Branch
Ceiling Panels
Finish Drywall/ Paint
Millwork
Floor Finishes
Commissioning

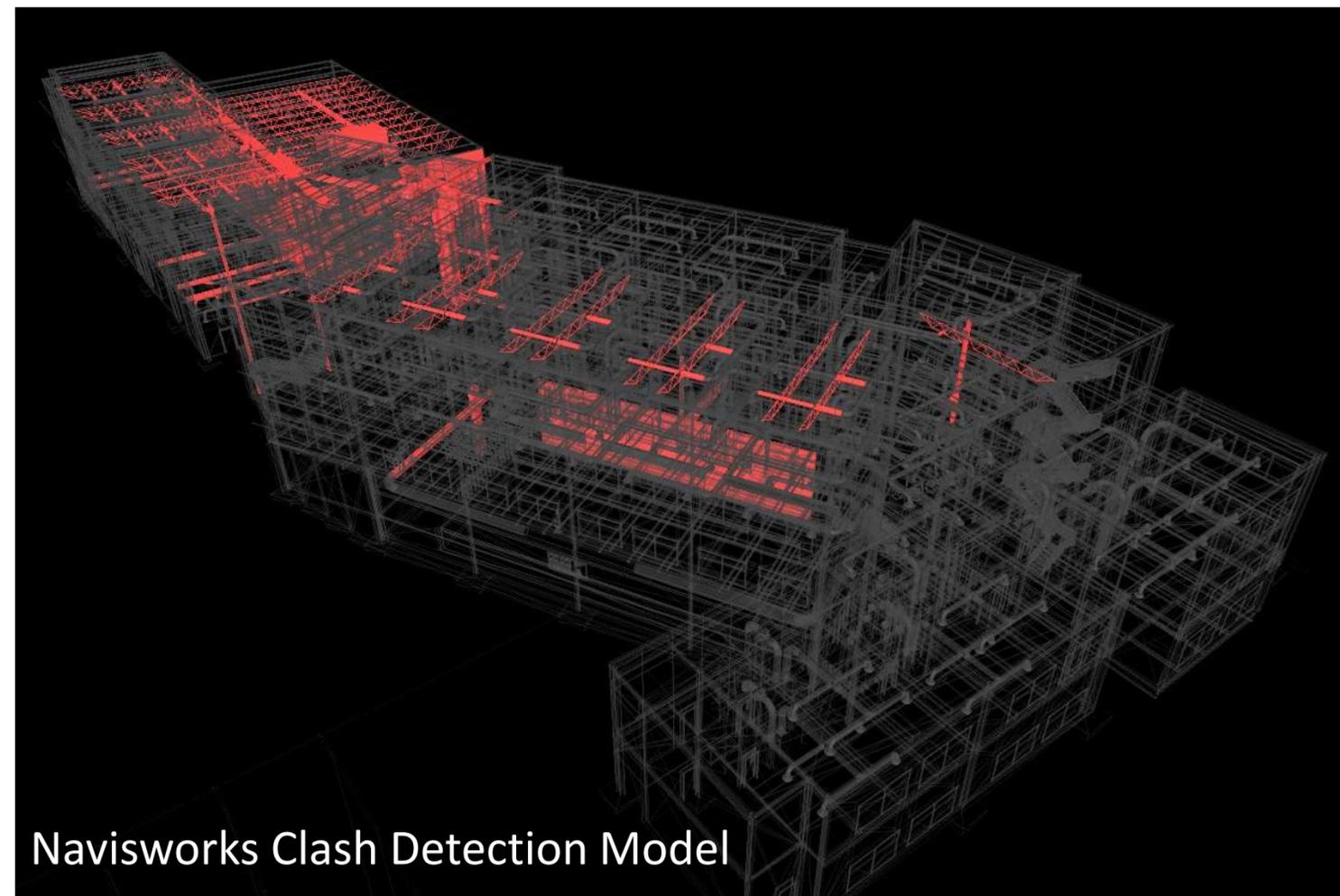
3D Applications

Clash Avoidance

- Discipline Collaboration
- Navisworks Analysis
- Implement Changes

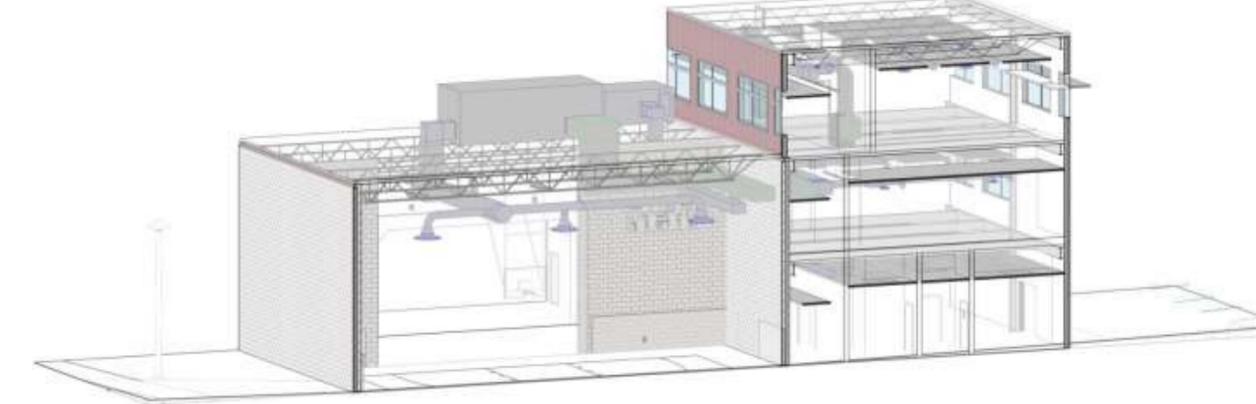
Constructability

- Spatial Orientation
- Potential Hazards

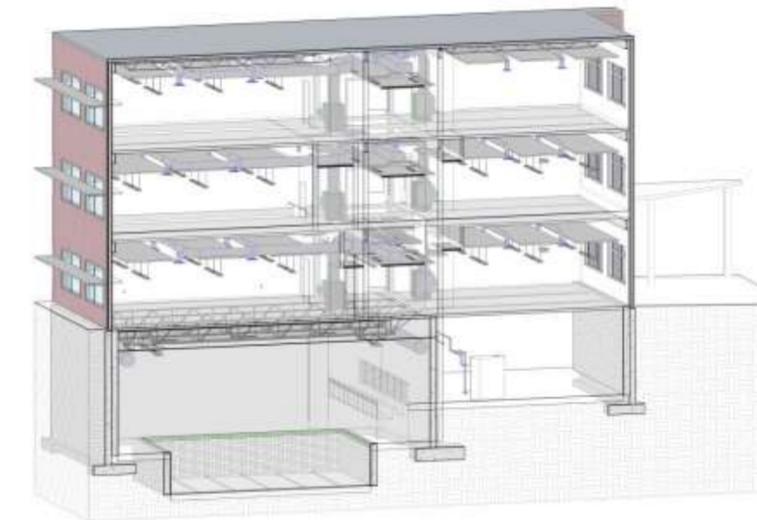


Navisworks Clash Detection Model

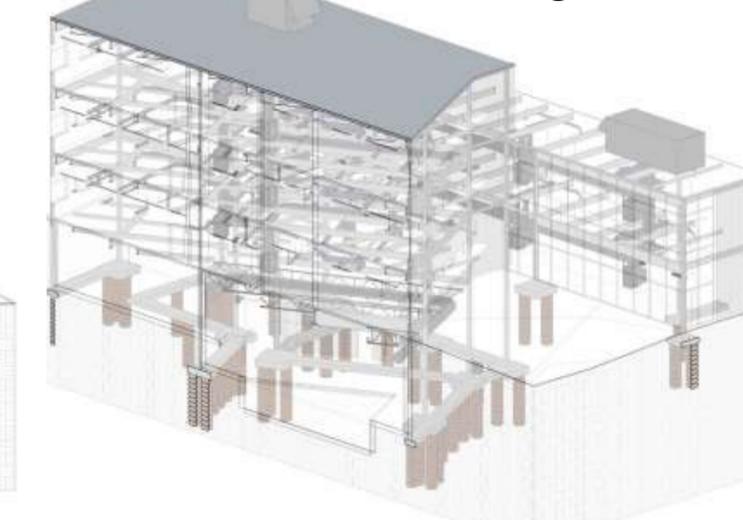
Multi-Purpose Room Section



Pool Section

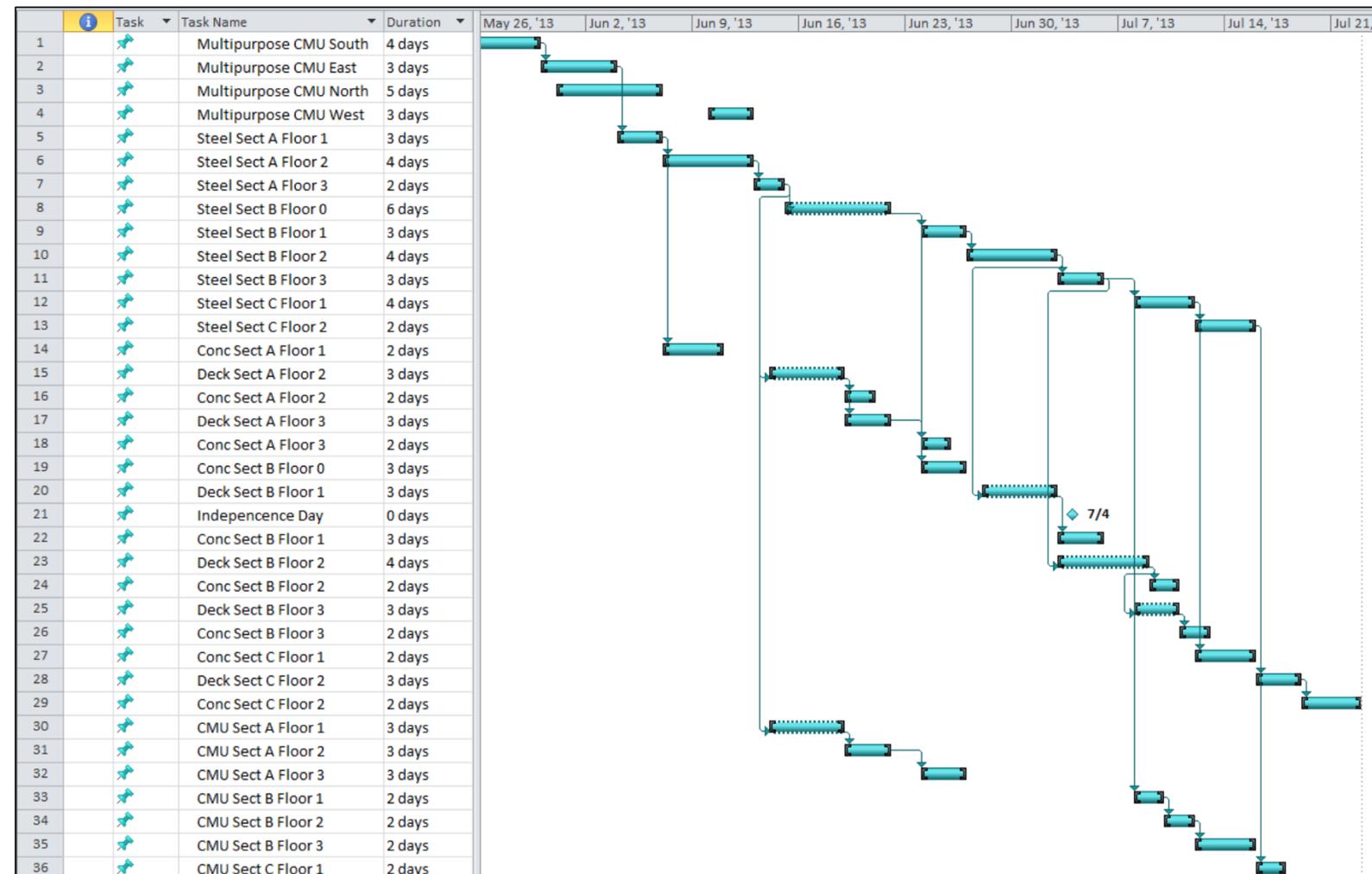


East Building Section





4D Modeling



Construction Sequencing Benefits

- Communicates schedule in an easily understandable manner
- Helps to determine constructability concerns and schedule clashes
- Provides a useful way to gauge progress during construction
 - Contractor planning
 - Owner reviews

Conclusions & Lessons Learned

Conclusions

Strengthen **Community**

Energy efficiency

- Community Hub
- Safety & Security
- Realistic Budget
- Building as a Teaching Tool

LEED Silver **Certification: 58 Credits**

energy reduction over median elementary school design

- High performance façade
- Geothermal energy
- Daylighting
- Controls



Conclusions

Strengthen **Community**

Energy efficiency

Community Hub

Safety & Security

Realistic Budget

Building as a Teaching Tool

Community **Hub**

Classrooms

Community Pool

Playground

Multipurpose Room



Conclusions

Strengthen **Community**

Energy efficiency

Community Hub

Safety & Security

Realistic Budget

Building as a Teaching Tool

Passive exterior **walls**

Site **lighting**

Card swipe access



Strengthen **Community**

Energy efficiency

Community Hub

Safety & Security

Realistic Budget

Building as a Teaching Tool

Realistic Design Approach

Competitive elementary school cost

Innovative and current design

Conclusions



Conclusions

Strengthen **Community**

Energy efficiency

Community Hub

Safety & Security

Realistic Budget

Building as a Teaching Tool

Highlighted **engineering systems**

Interactive display of building information



Lessons Learned

What did we learn to

“improve the performance of building design”?

Importance of weekly **coordination** meetings

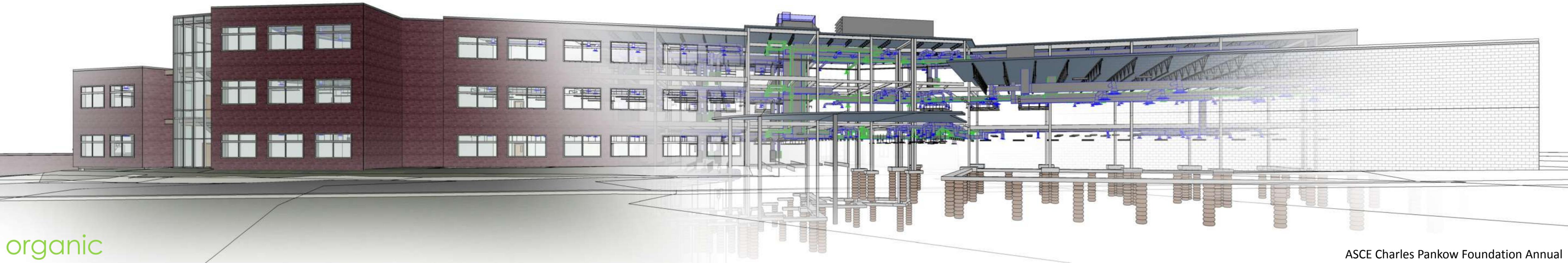
Design Build allows for **faster** decision process

Team **dynamic**: Respect & Critique

Absence of **Architect** on design team

Exposure to other discipline design **challenges**





organic
AEI Team 10-2013

ASCE Charles Pankow Foundation Annual
Architectural Engineering Student Competition

campisino fogarty hirlinger ramondo rosmell stremski walker

April 3, 2013