Middlebury Elementary

By MiddZEST

Context

Building

Systems

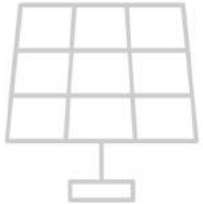
Energy

Finance

Affordable Efficiency

Inspirational Beacon

Experiential Collaboration



Visible Engineering

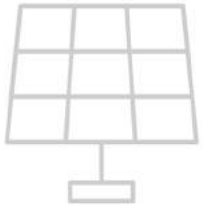
Resilient Design

Design Goals

Affordable Efficiency

Inspirational Beacon

Experiential Collaboration



Visible Engineering

Resilient Design

Design Goals

Affordable Efficiency

Experiential Collaboration

Inspirational Beacon

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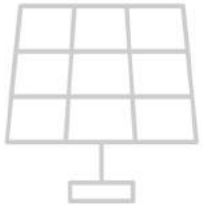
Resilient Design

Design Goals

Affordable Efficiency

Inspirational Beacon

Experiential Collaboration



Visible Engineering

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Design Goals

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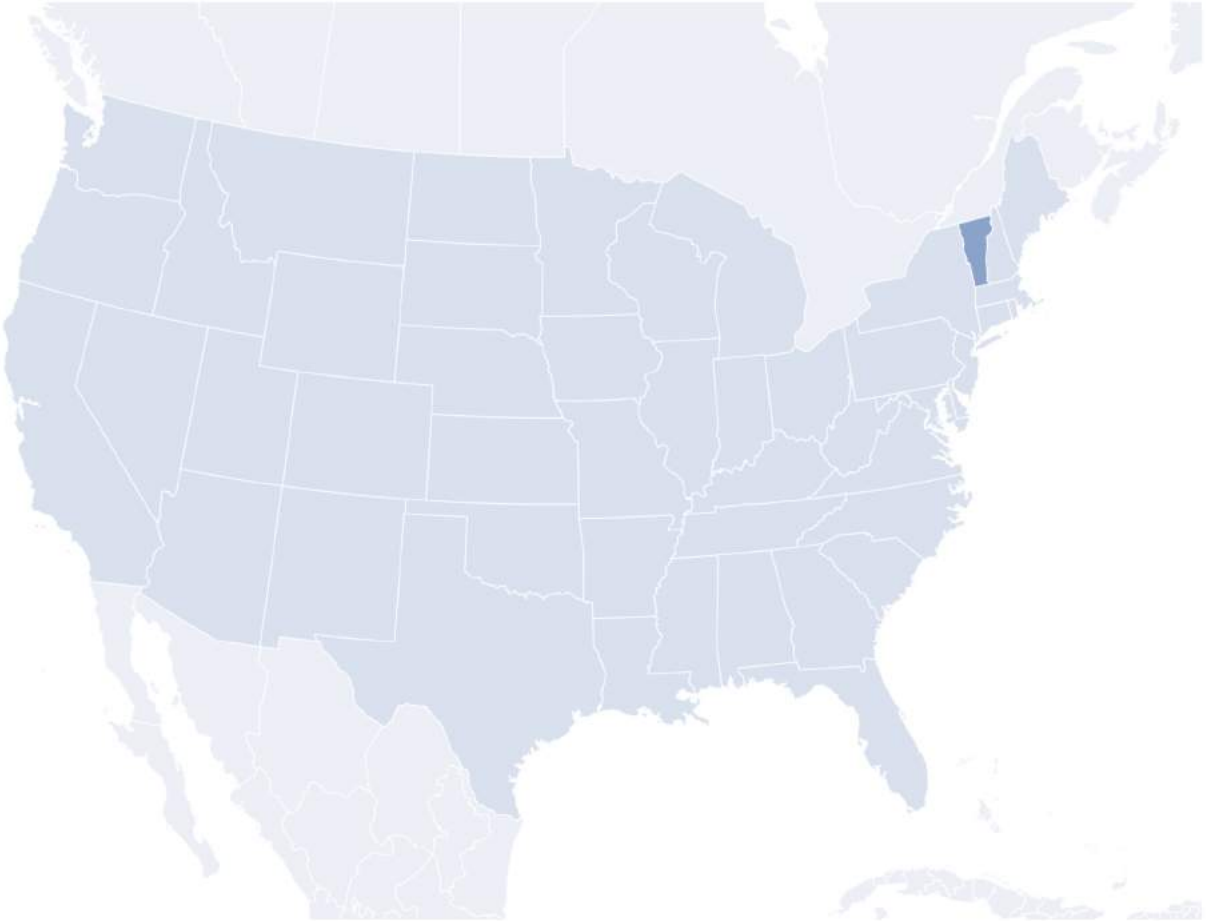
Resilient Design

Design Goals



Location

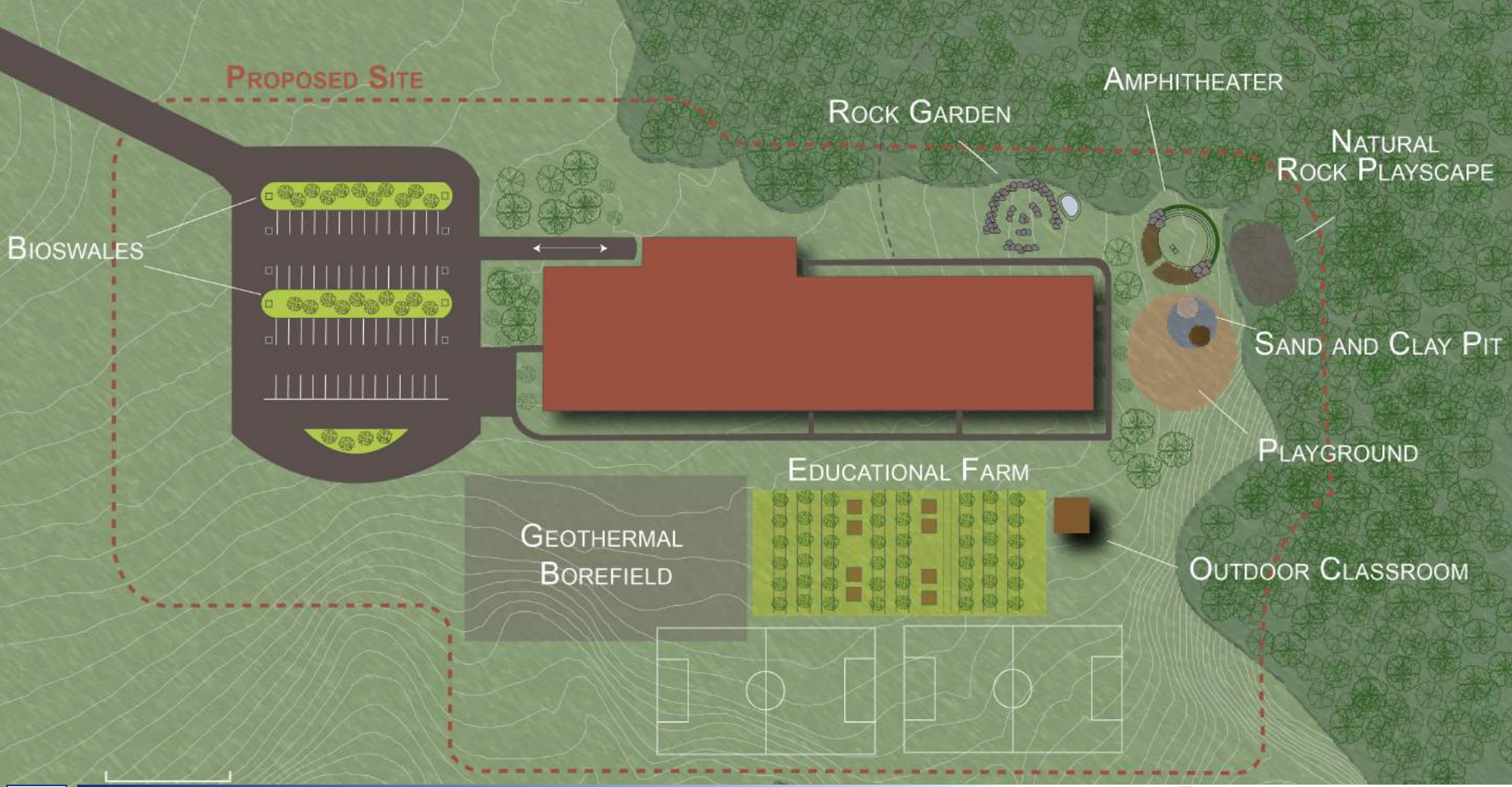
Location


Town Square
Mary Hogan Elementary
Middlebury Union High School
Middlebury Union Middle School
1/2 mi Radius
Middlebury Elementary
N
0.6mi

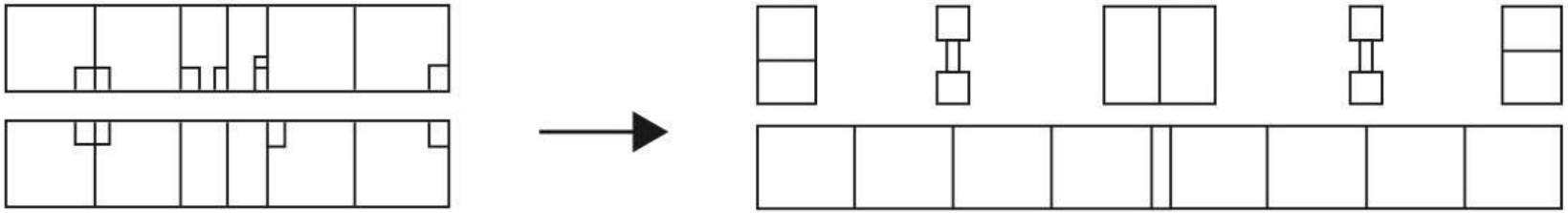
Location


Middlebury Union
Middle School
Jeffrey Murdock
Nature Preserve
Middlebury
Elementary
N
0.3mi

Location


Proposed Site
Rock Garden
Amphitheater
Natural Rock Playscape
Bioswales
Sand and Clay Pit
Playground
Educational Farm
Geothermal Borefield
Outdoor Classroom

Site Plan



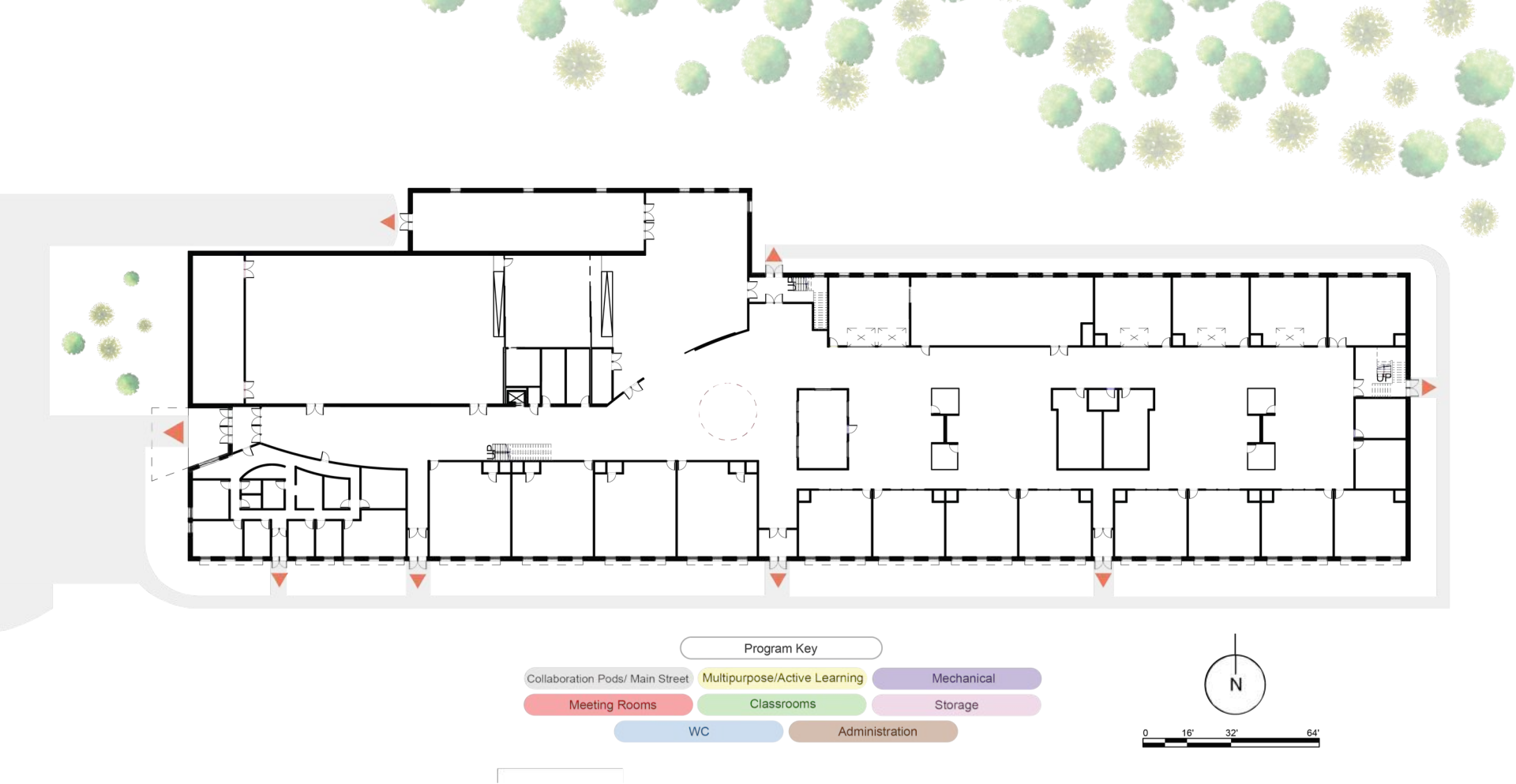
Traditional Hall

Class Neighborhoods

Mary Hogan Design

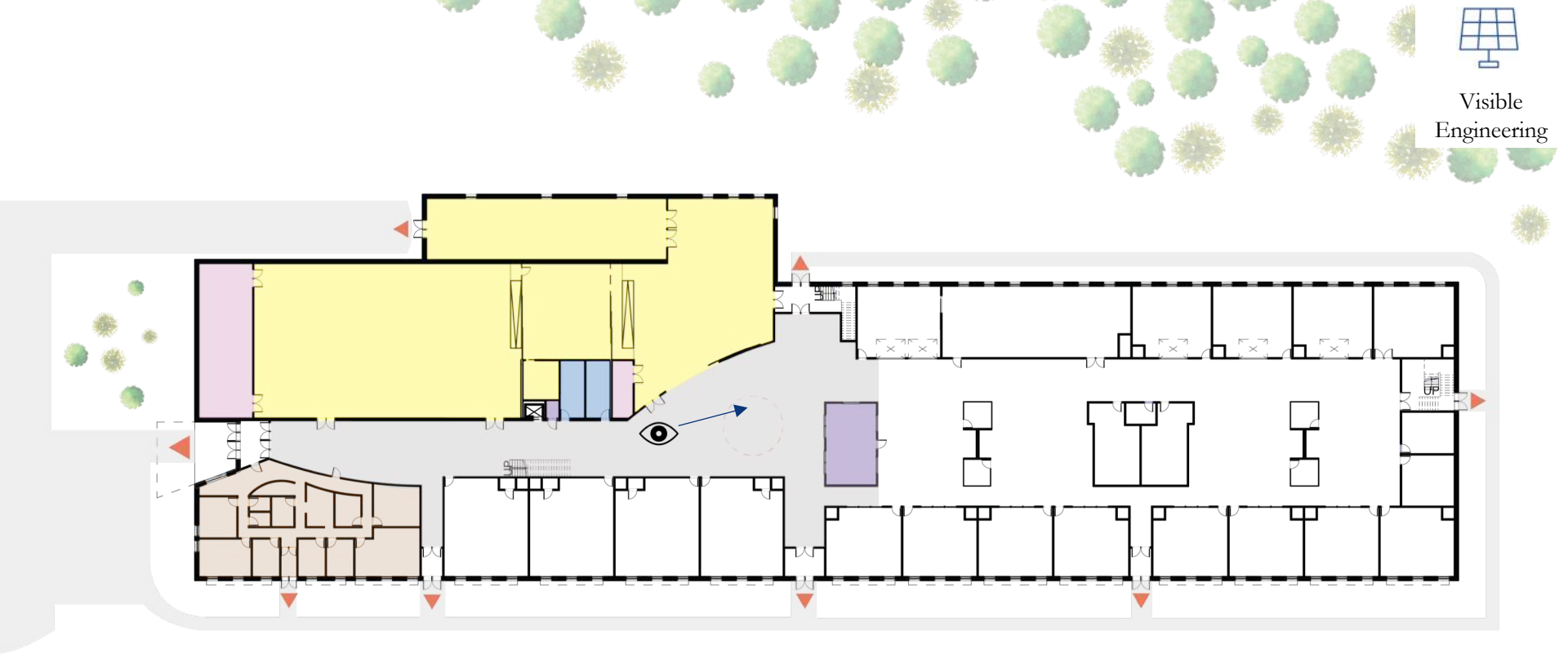
Middlebury Elementary Design

Design Considerations


UP
UP
UP
Program Key
Collaboration Pods/ Main Street
Multipurpose/Active Learning
Mechanical
Meeting Rooms
Classrooms
Storage
WC
Administration
N
0
16'
32'
64'

Floor Plan

Visible Engineering



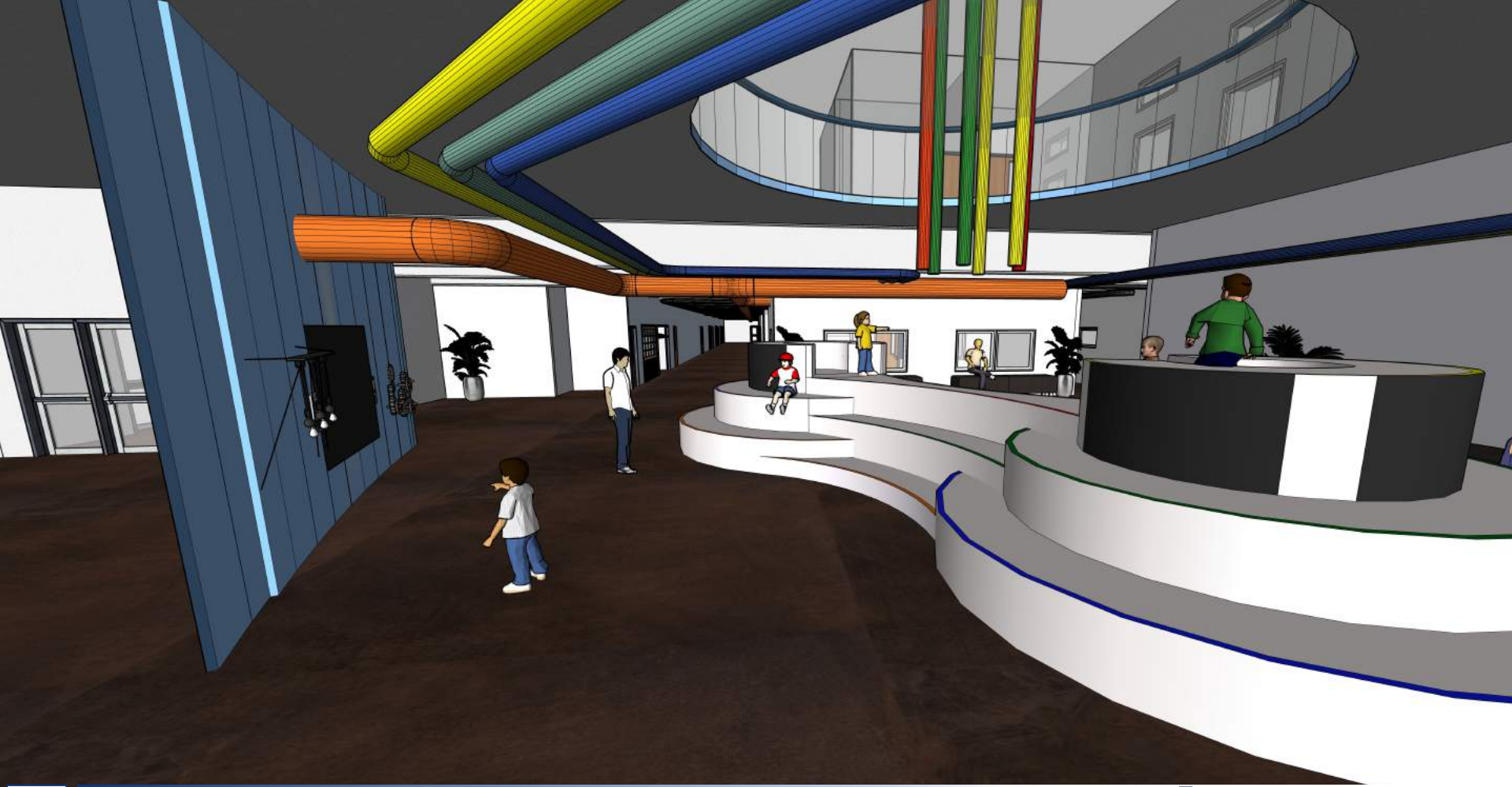
Program Key

Collaboration Pods/ Main Street	Multipurpose/Active Learning	Mechanical
Meeting Rooms	Classrooms	Storage
WC	Administration	

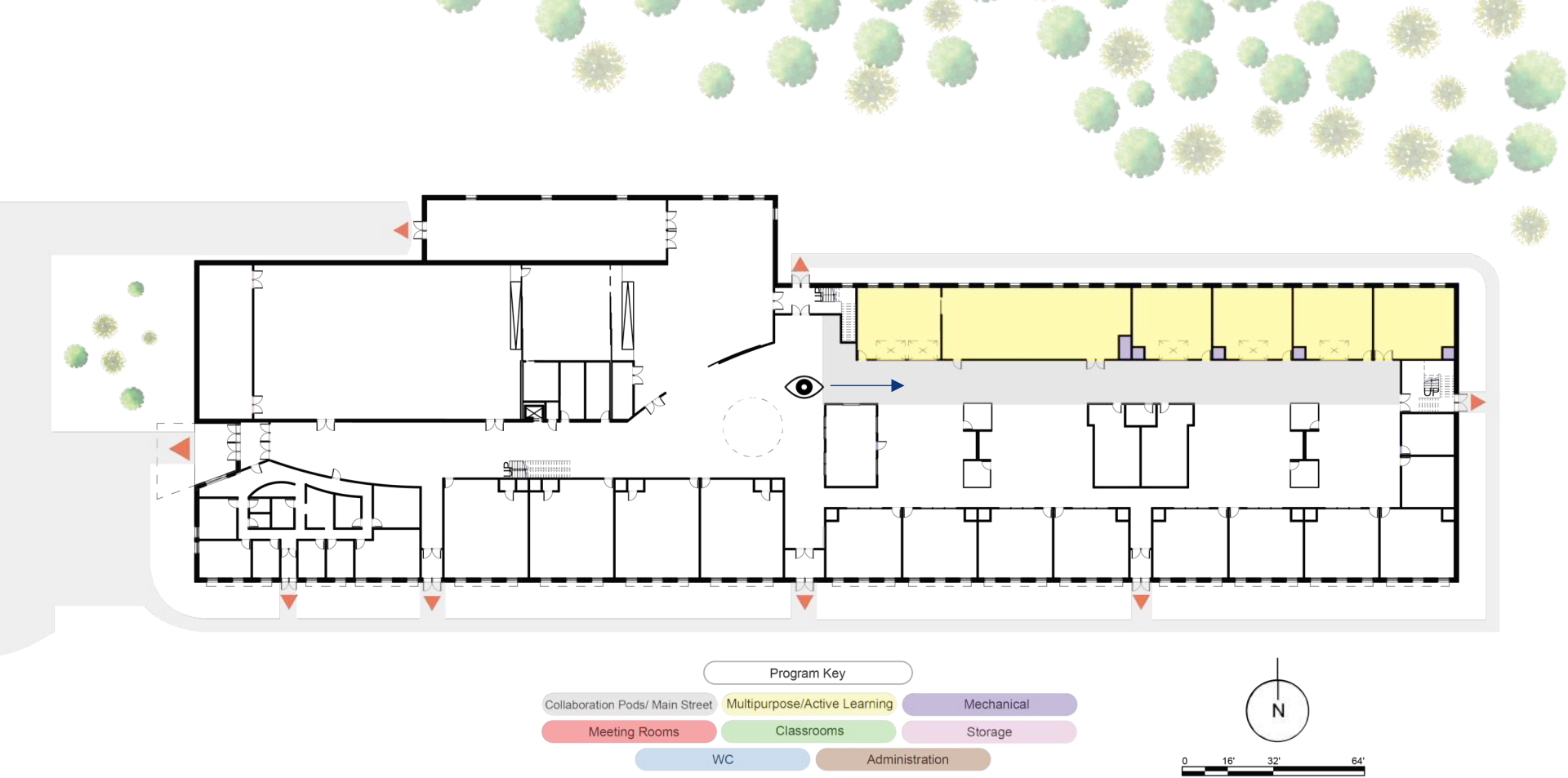
N

0 16' 32' 64'

Town Square



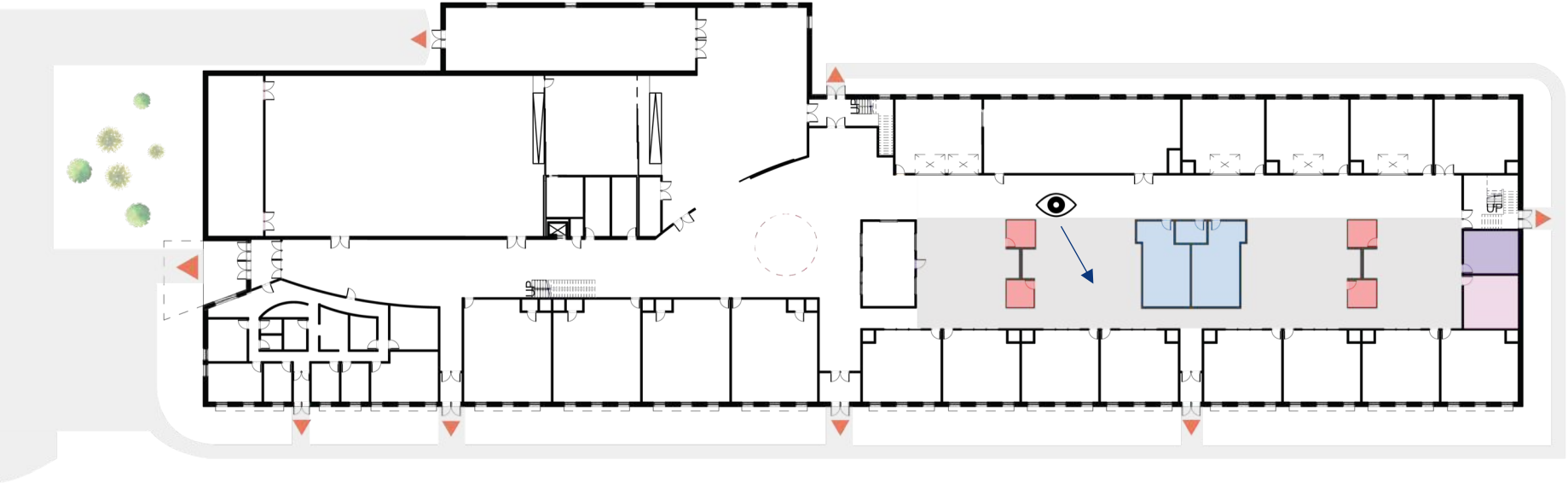
Town Square


UP
UP
UP
Program Key
Collaboration Pods/ Main Street
Multipurpose/Active Learning
Mechanical
Meeting Rooms
Classrooms
Storage
WC
Administration
N
0
16'
32'
64'

Main Street

Main Street

Experiential Collaboration



Program Key

Collaboration Pods/ Main Street	Multipurpose/Active Learning	Mechanical
Meeting Rooms	Classrooms	Storage
WC	Administration	

N

0 16' 32' 64'

Collaboration Spaces

Collaboration Spaces

Collaboration Spaces

Experiential Collaboration

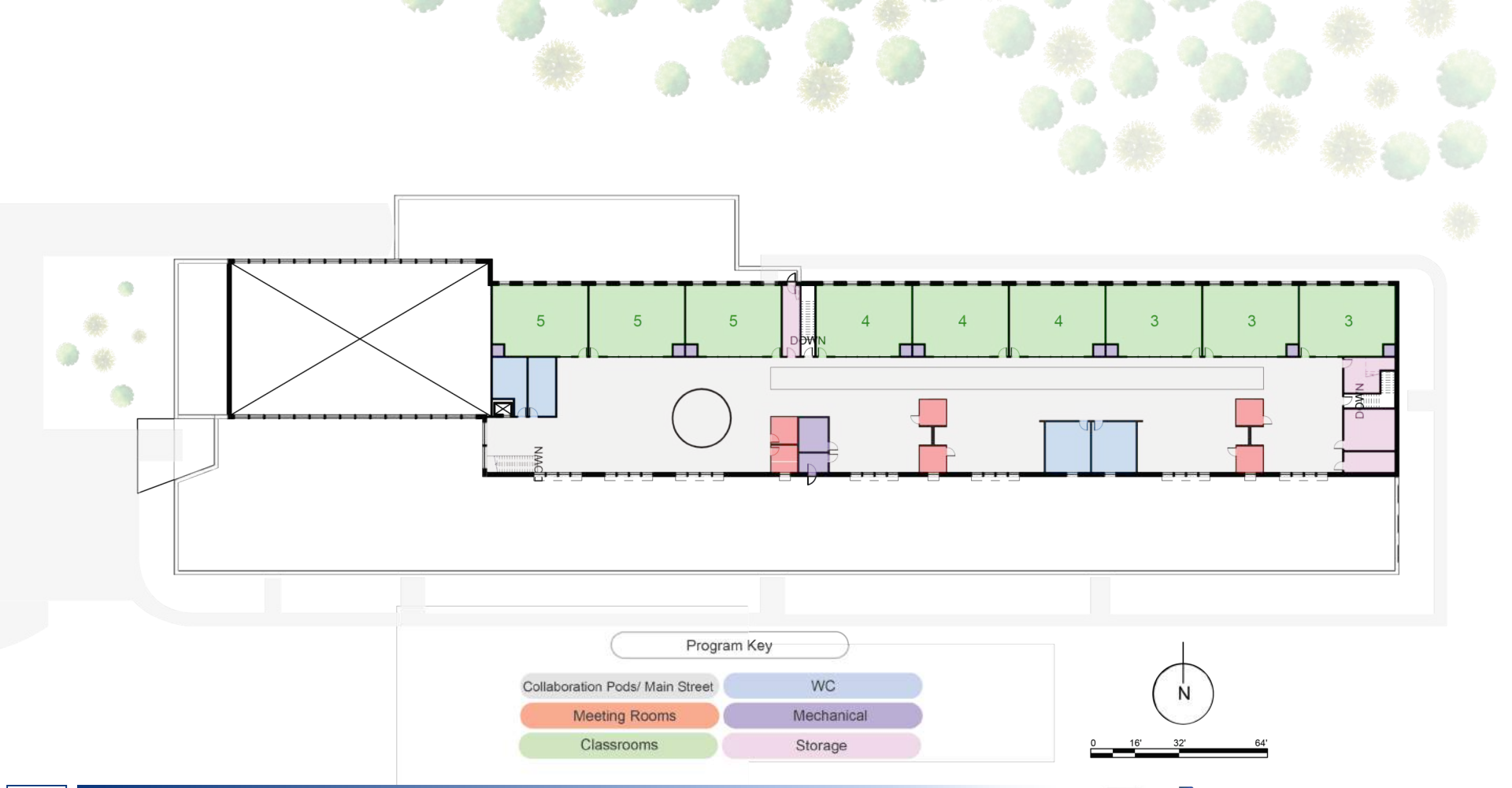
Classrooms

Classrooms

Classrooms

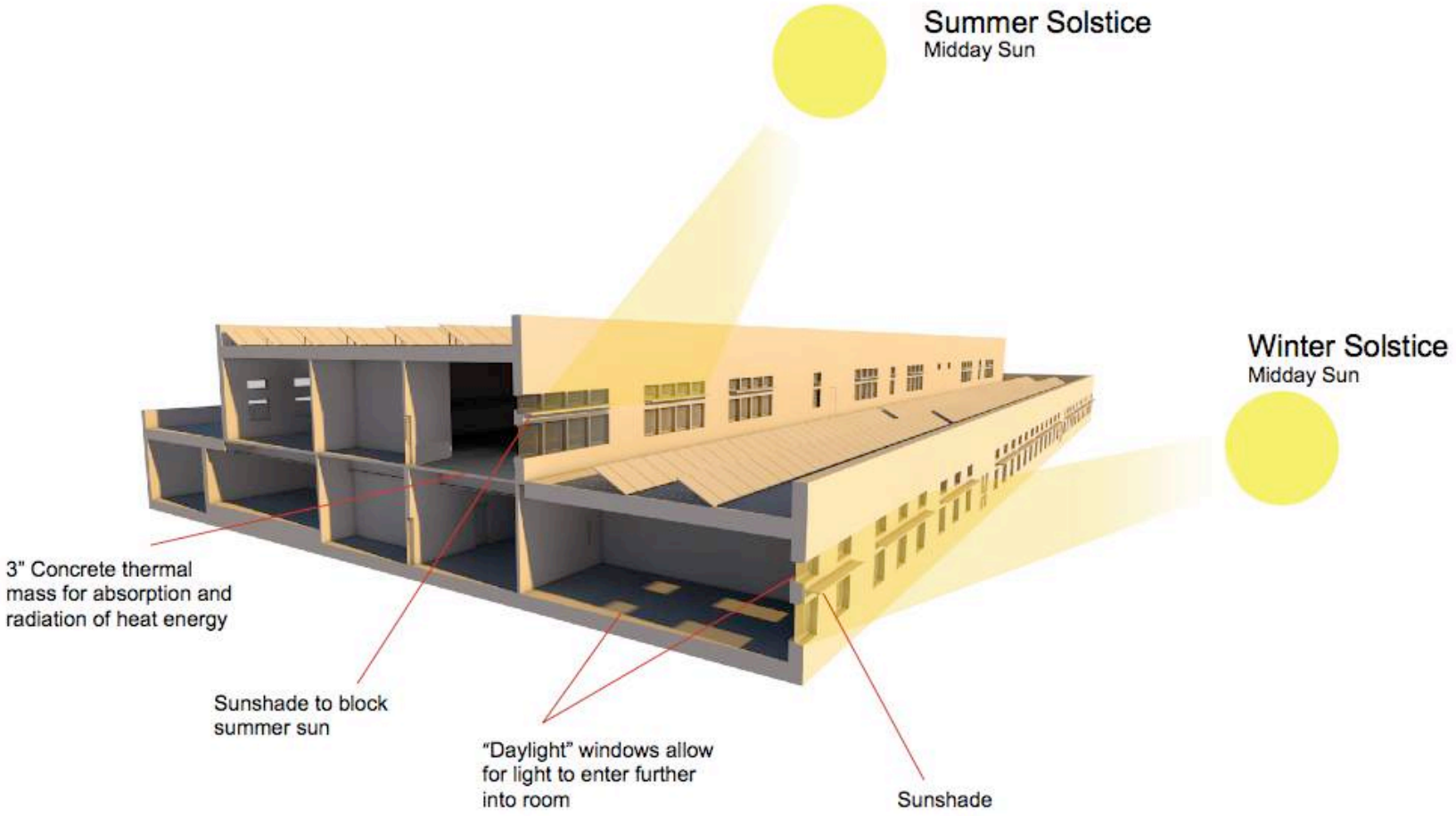
Classrooms

First Floor Plan

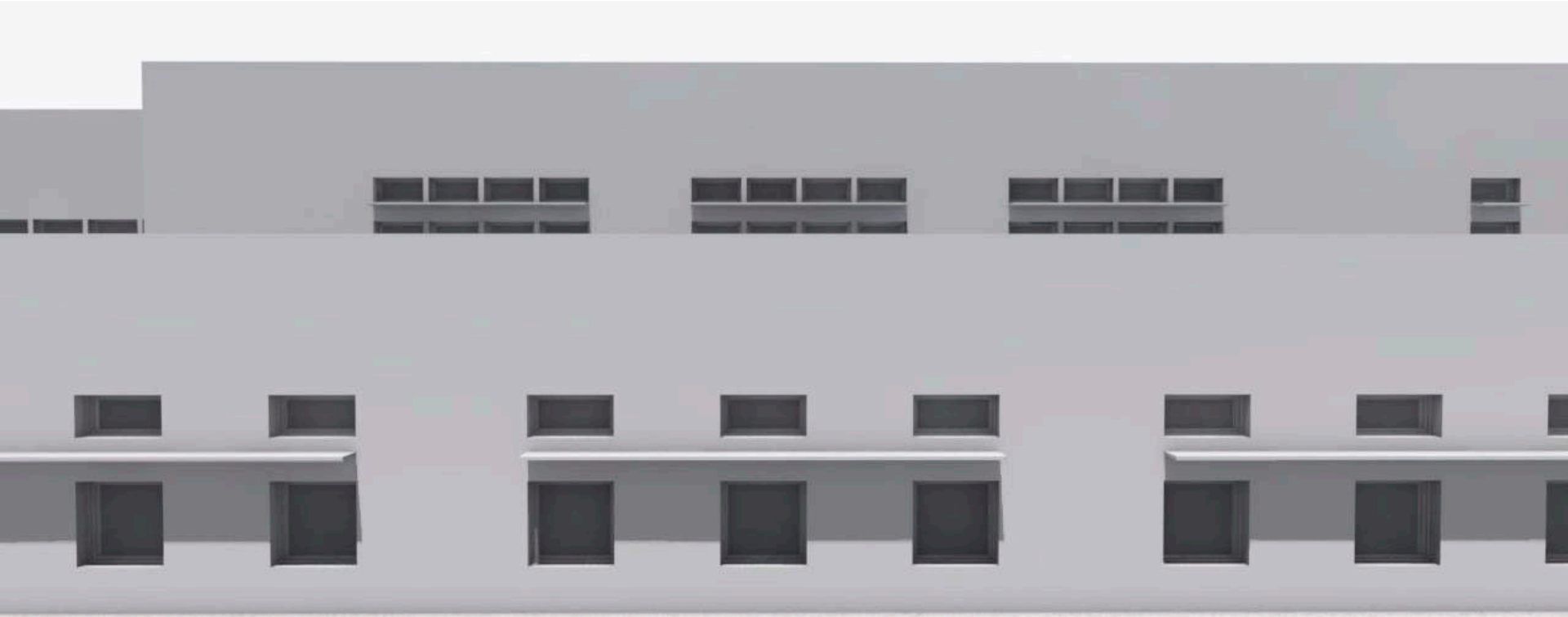


Second Floor Plan

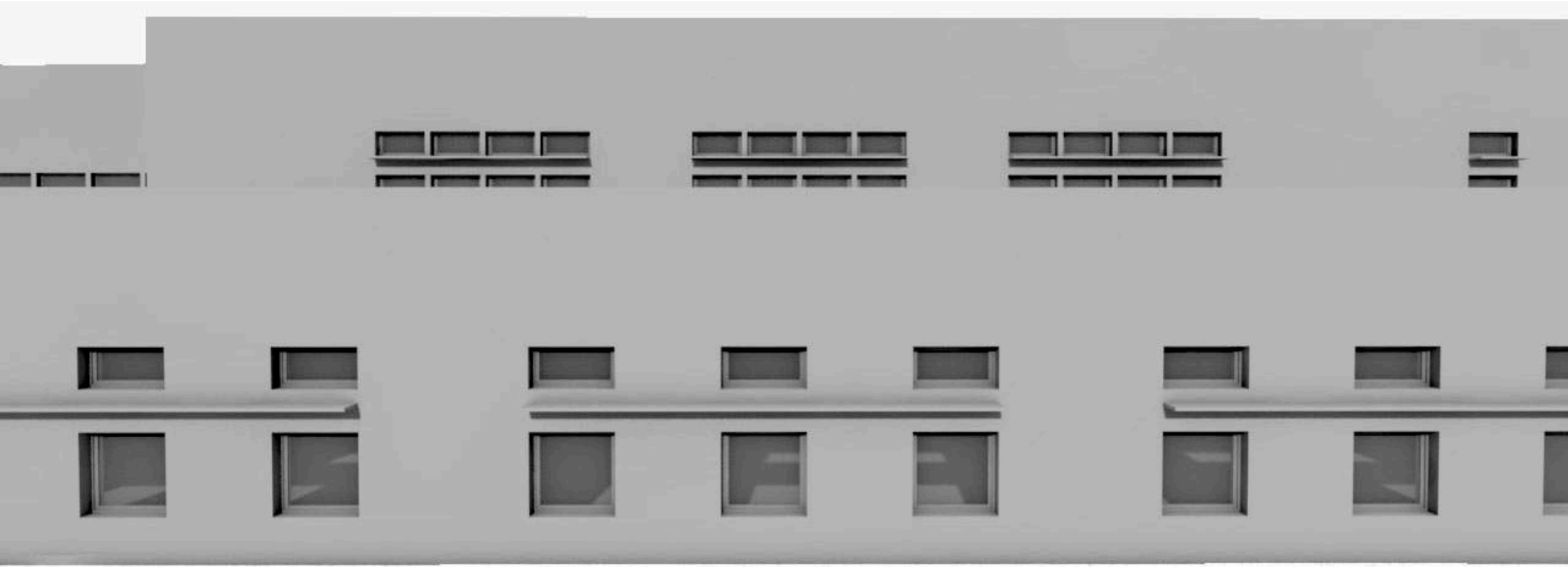
Exterior



Passive Strategies



Summer Solstice Shading



Winter Solstice Shading

NFPA 101

National Electrical Code

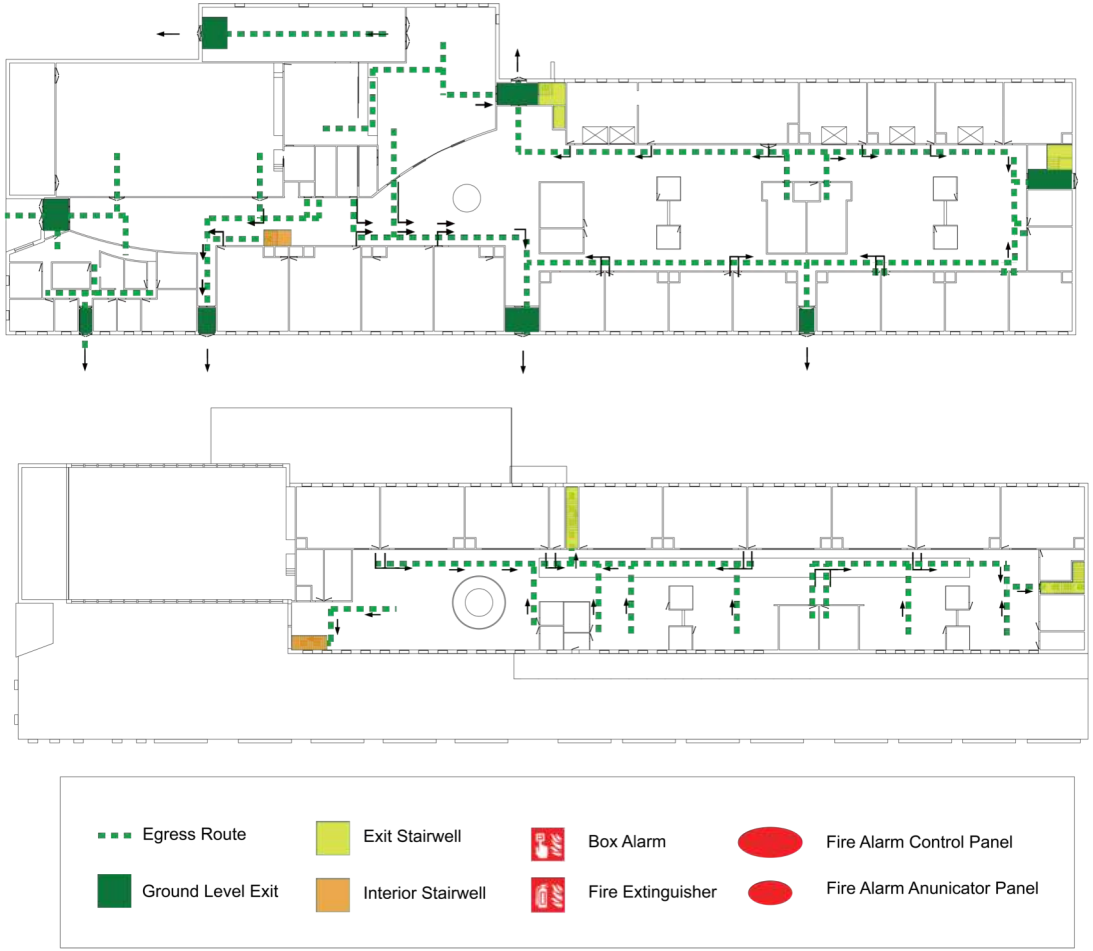
Uniform Plumbing Code

International Building Code

Vermont Accessibility Codes

ADA Compliant

Codes and Constructability



Resilient Design

NFPA 101

National Electrical Code

Uniform Plumbing Code

International Building Code

Vermont Accessibility Codes

ADA Compliant

Codes and Constructability

Resilient Design

NFPA 101

National Electrical Code

Uniform Plumbing Code

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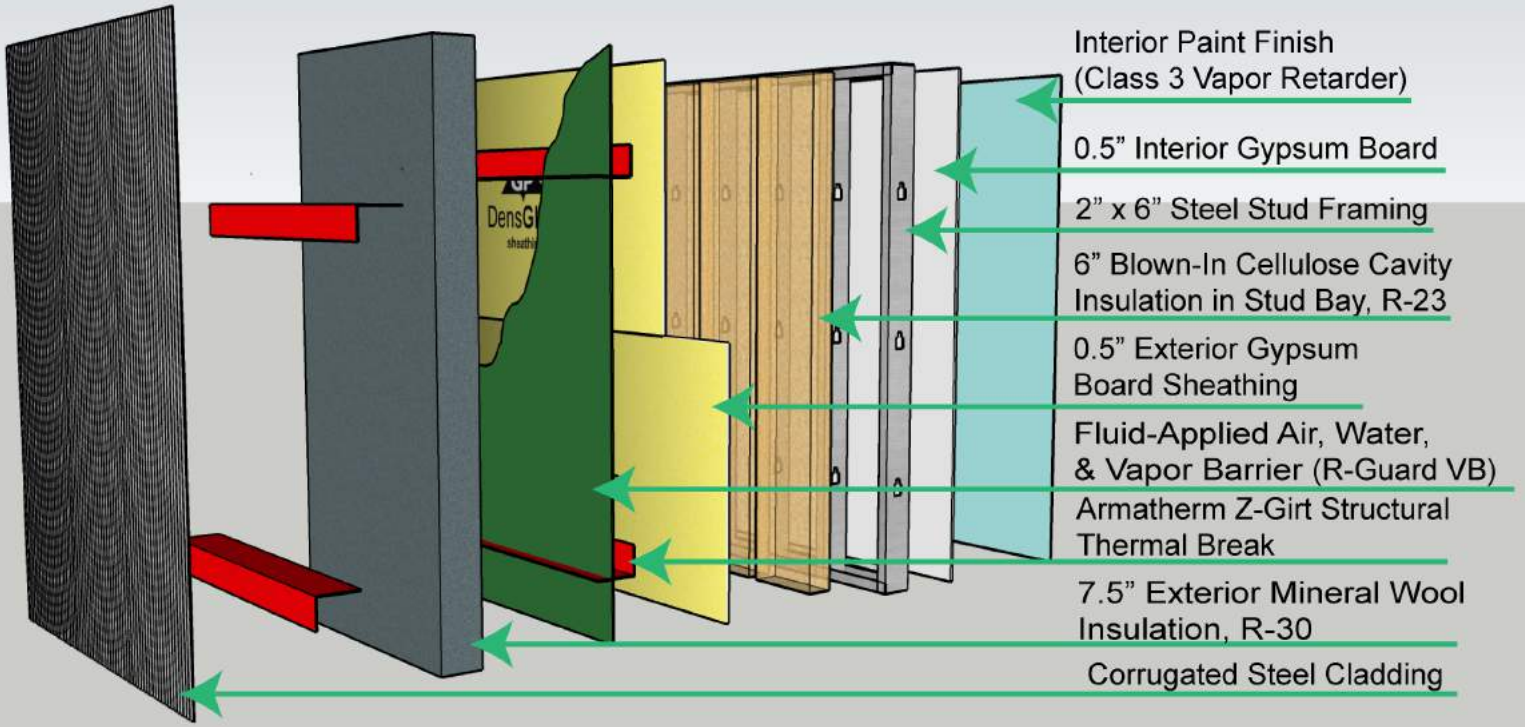
Vermont Accessibility Codes

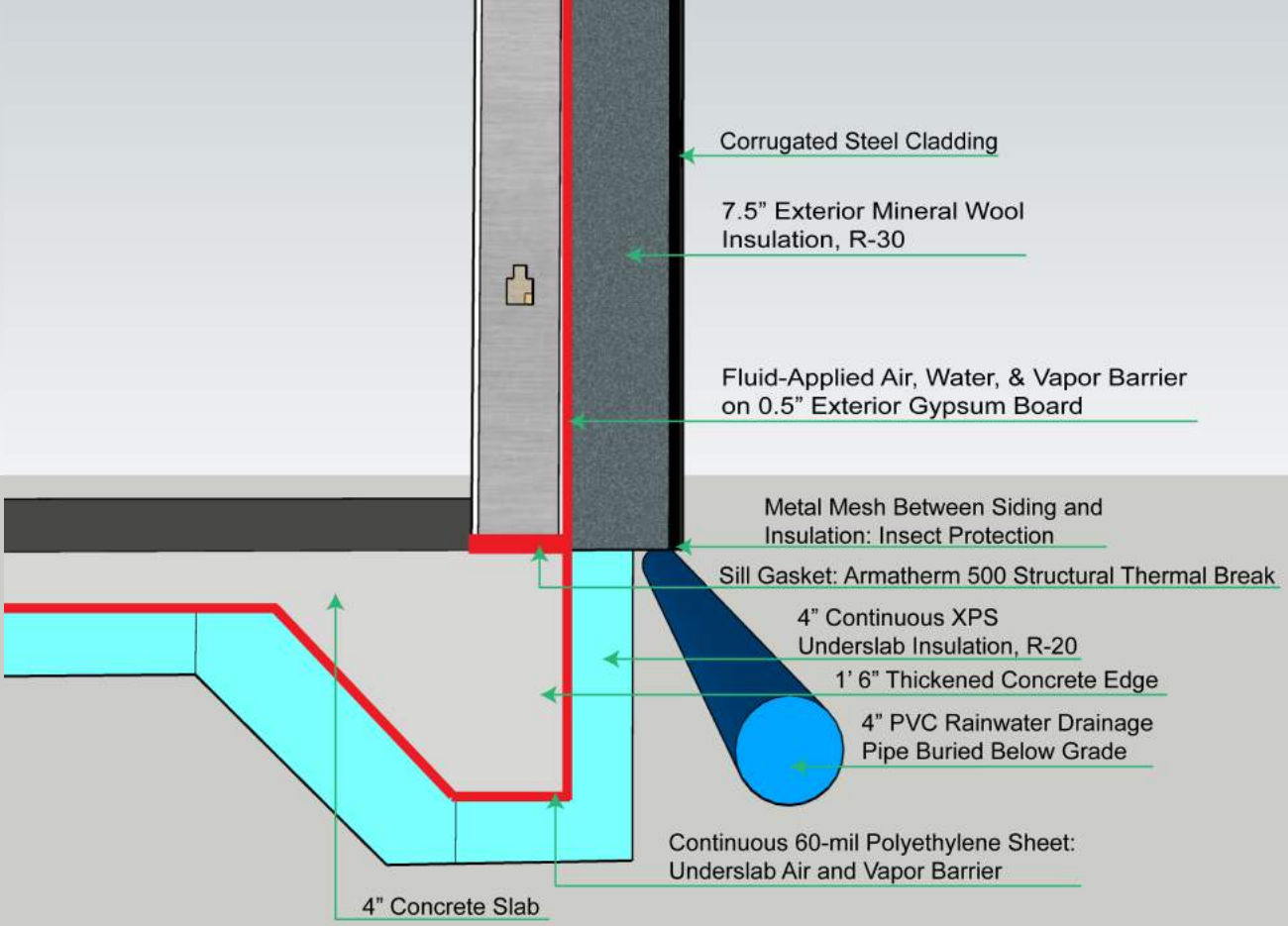
ADA Compliant

Codes and Constructability

Resilient Design

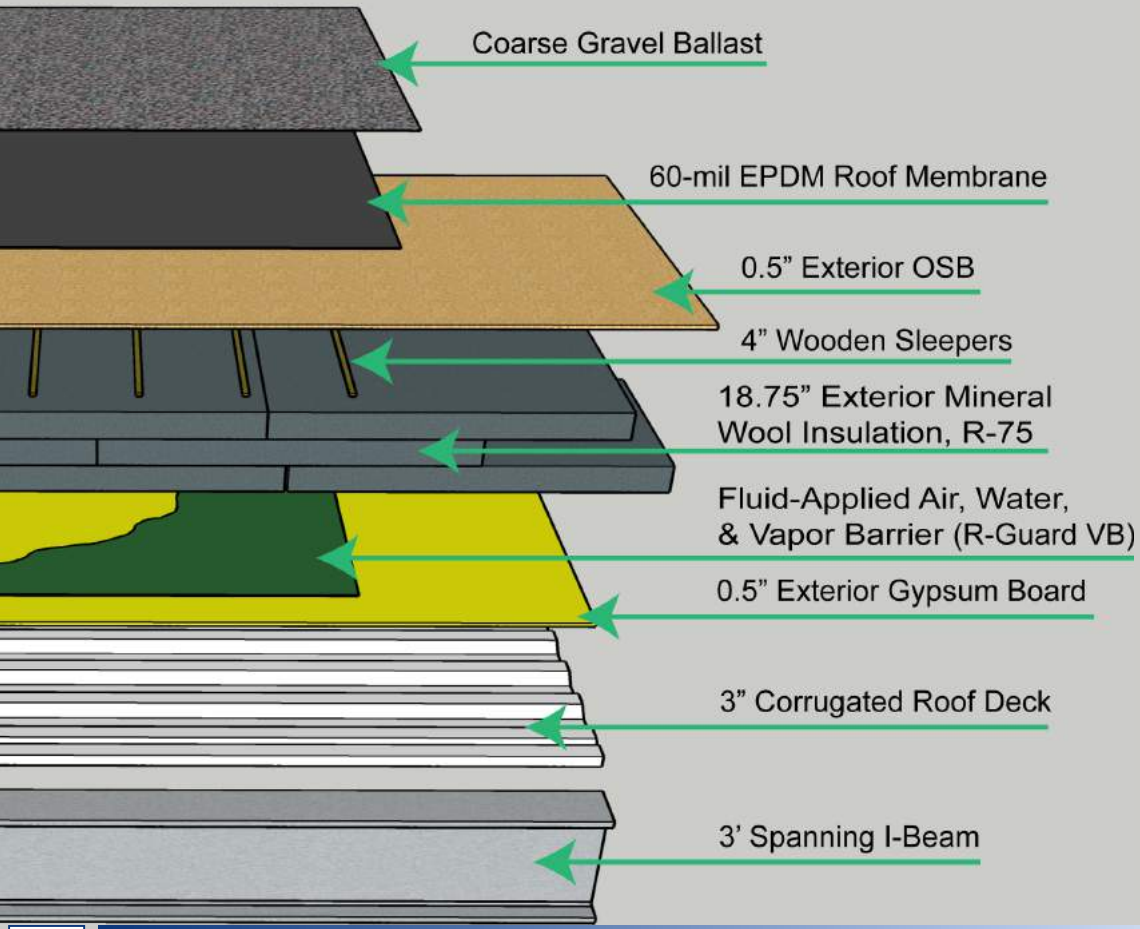


Envelope: Wall Assembly



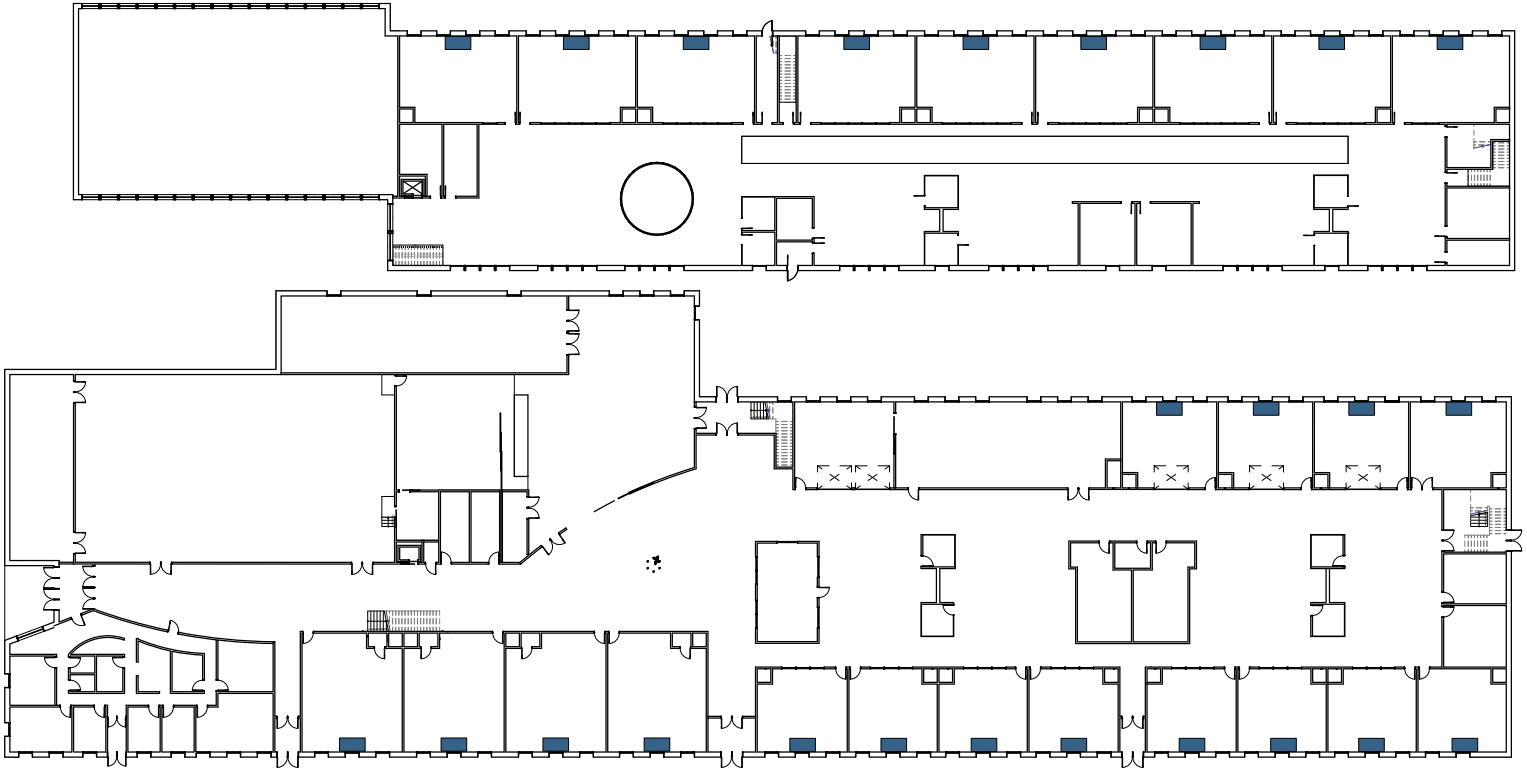
Resilient Design

Envelope: Slab-to-Wall



Resilient Design

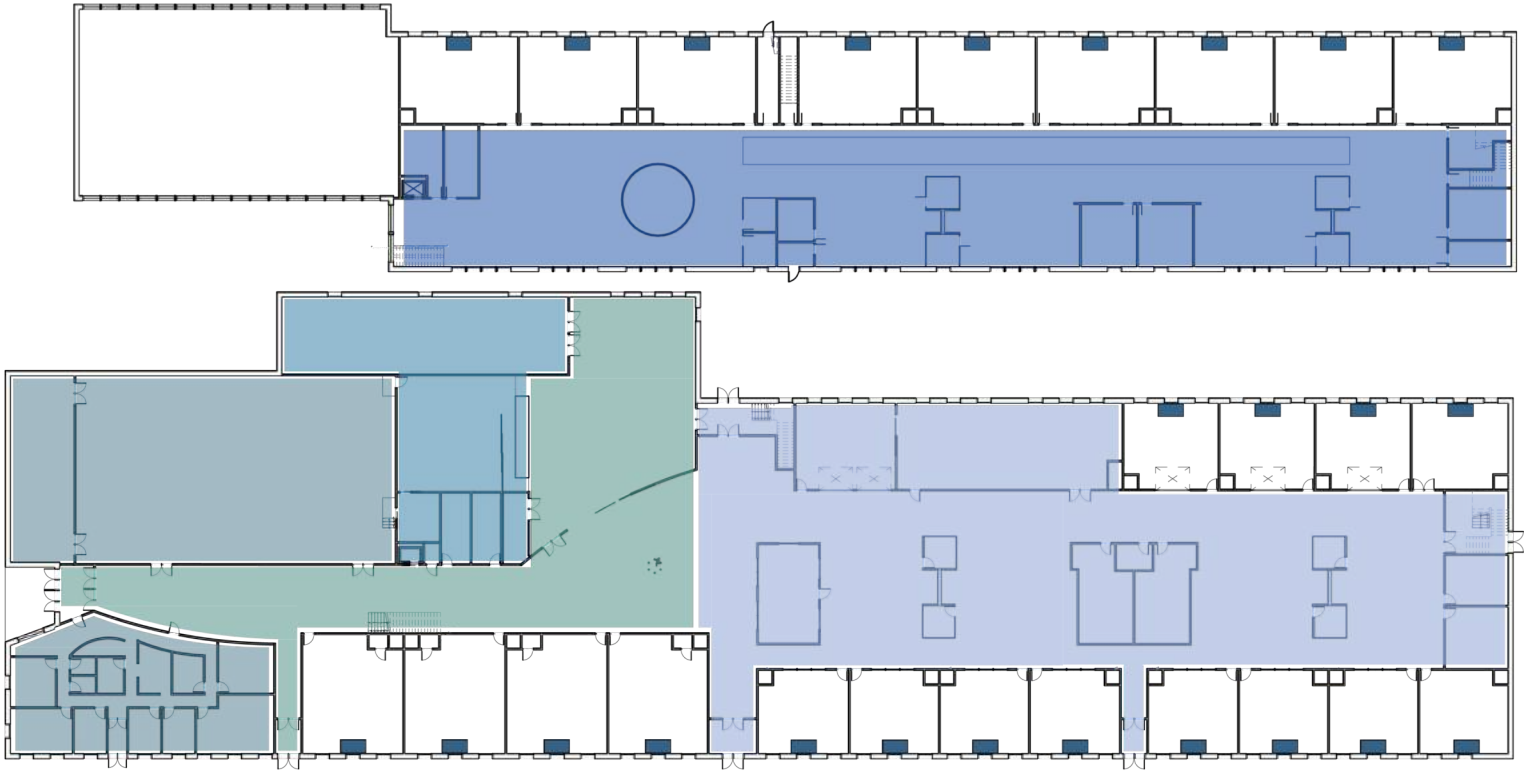
Envelope: Roof



Visible Engineering

Legend
– Ventacity VS 500 SQ

Ventilation

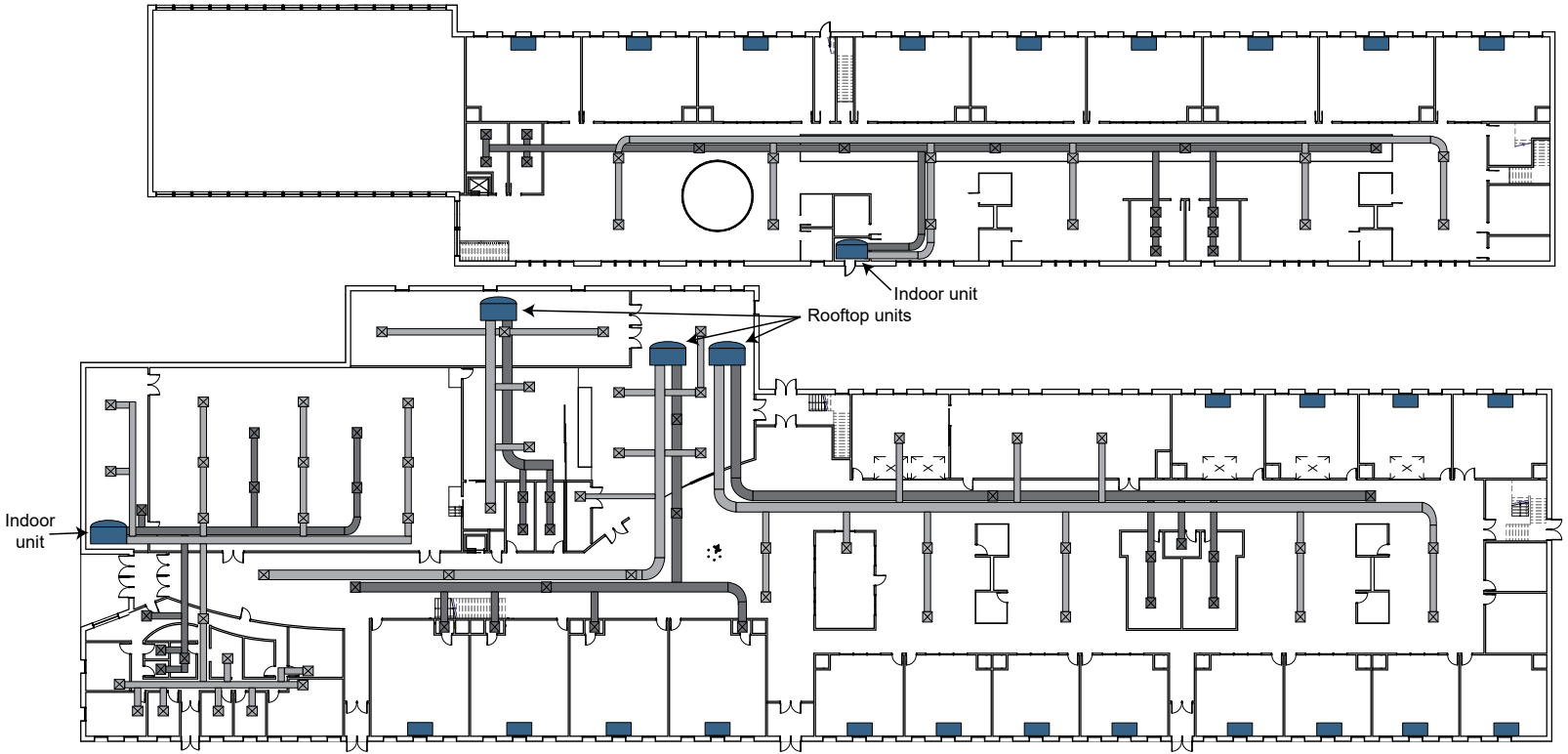


Visible Engineering

Legend
– Ventacity VS 500 SQ

Ventilation

Visible Engineering



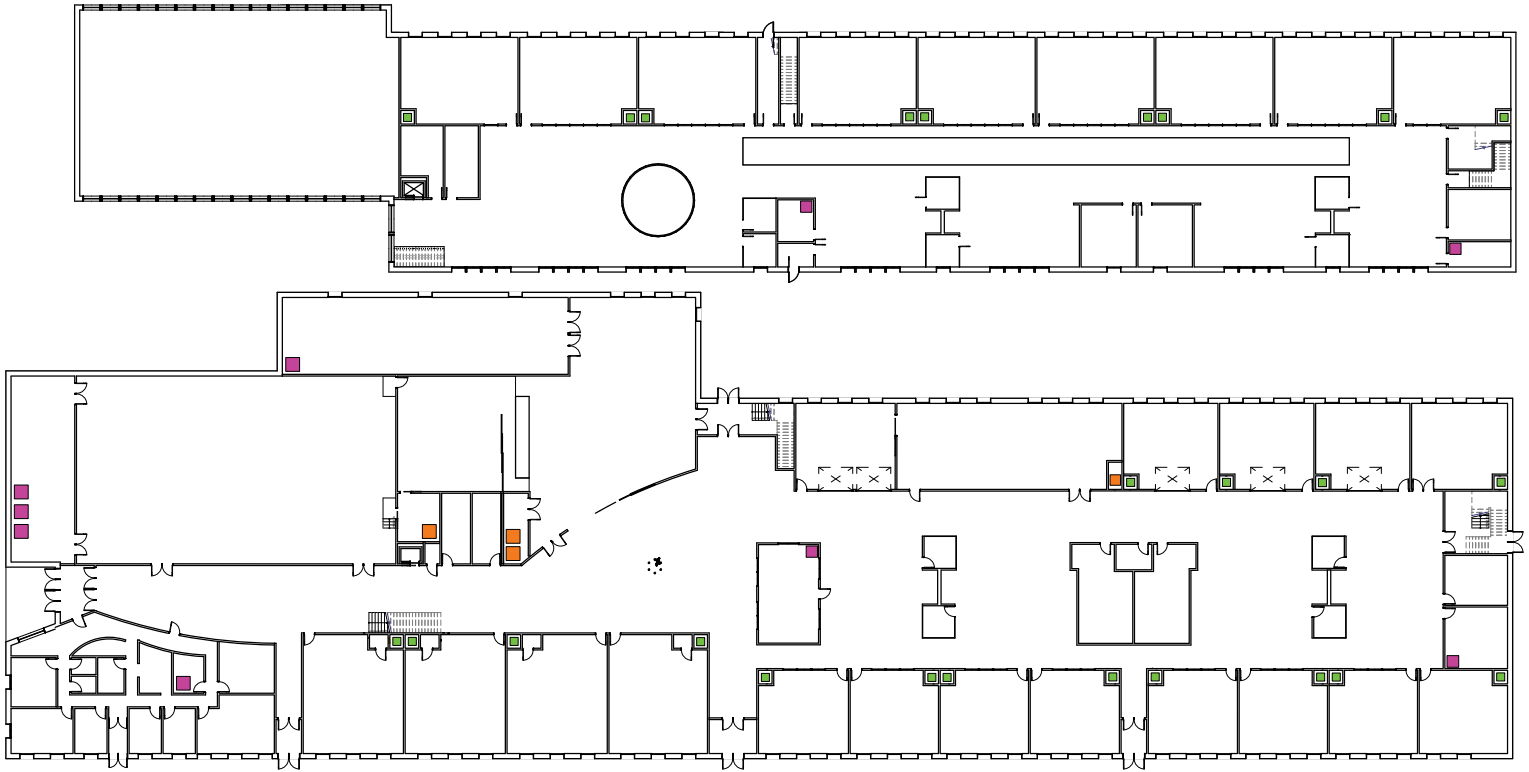
Legend
- Ventacity VS 500 SQ
- Ventacity VS 3000 RT
- Supply Ductwork
- Return Ductwork
- Supply Vent
- Return Vent

Ventilation

Resilient Design

Heating and Cooling

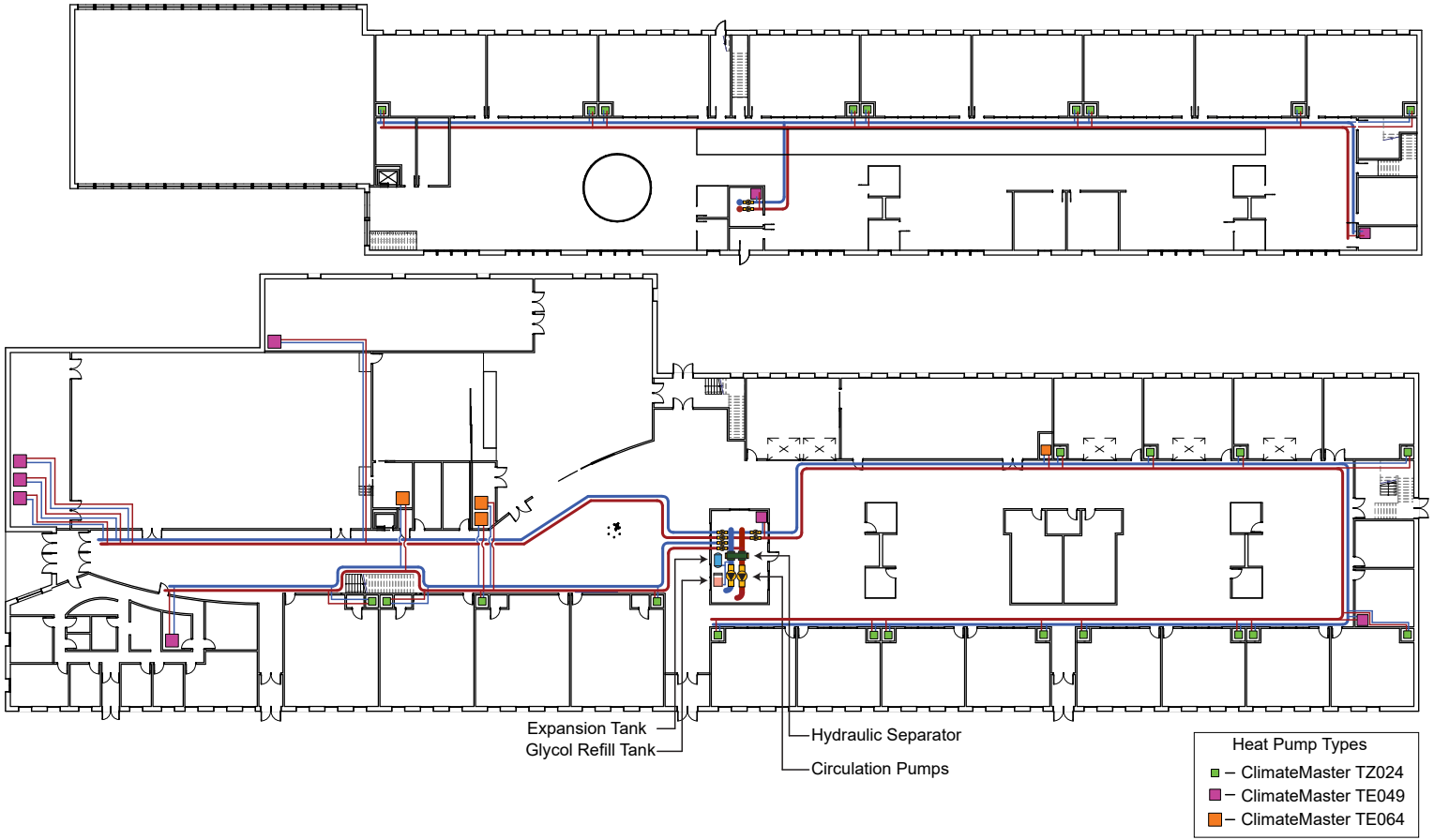
Resilient Design



Most Efficient 2018
www.energystar.gov

Heating and Cooling

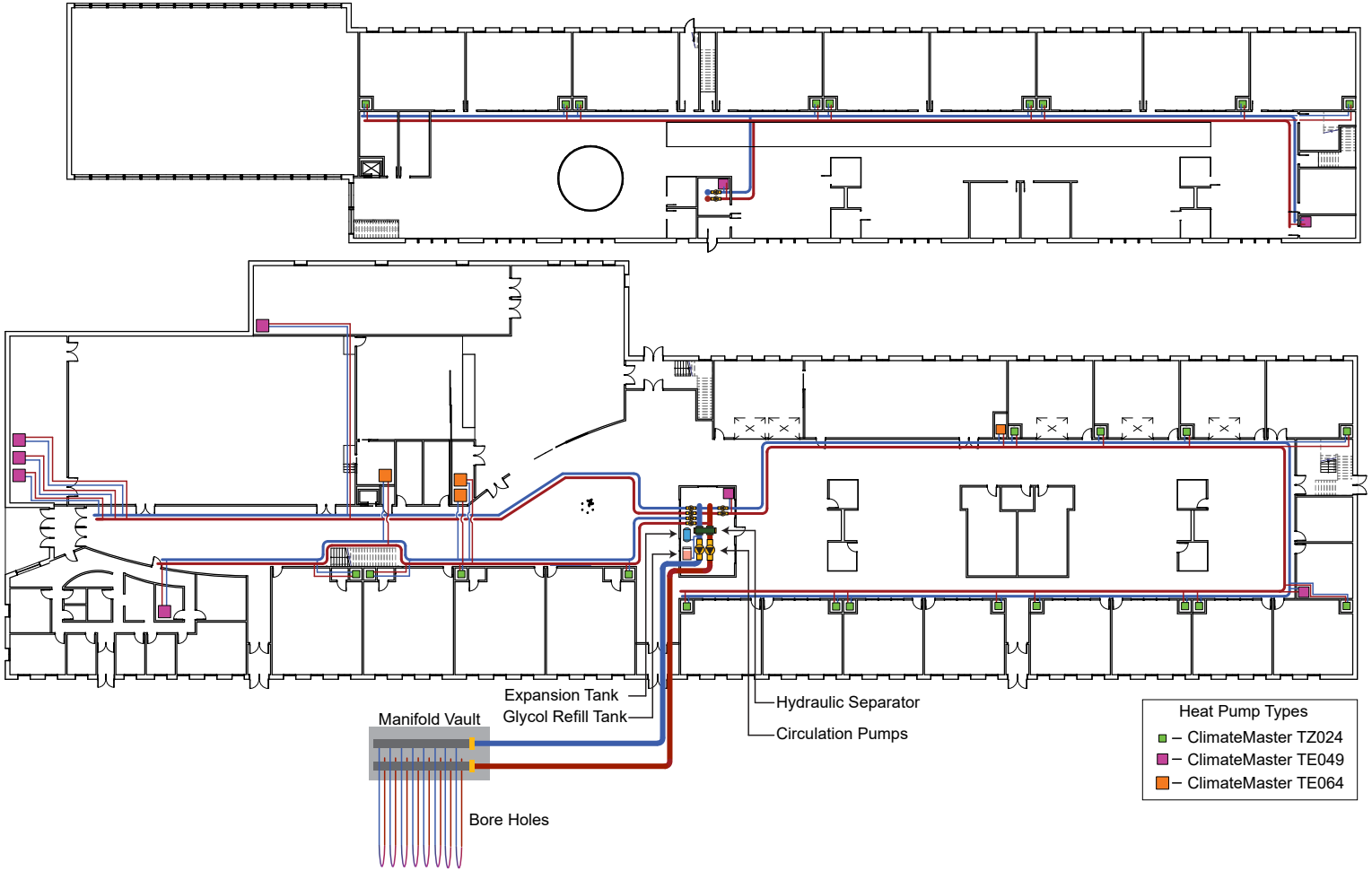
Resilient Design



Most Efficient 2018
ENERGY STAR
www.energystar.gov

Heating and Cooling

Resilient Design



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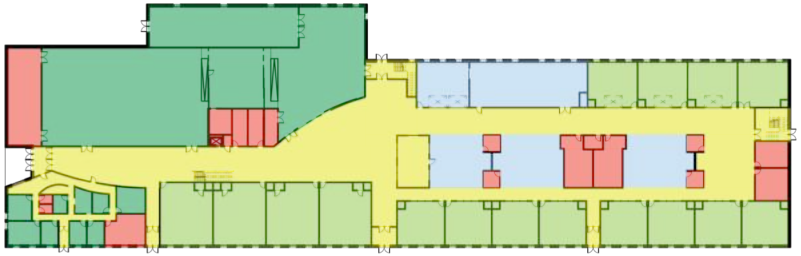
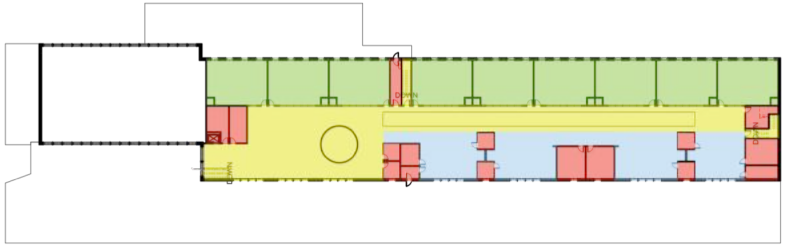
Heating and Cooling

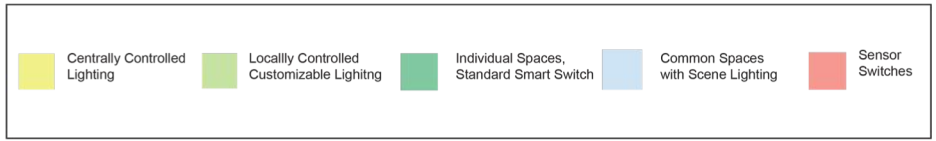
Reduce Electrical Loads

Visible Engineering

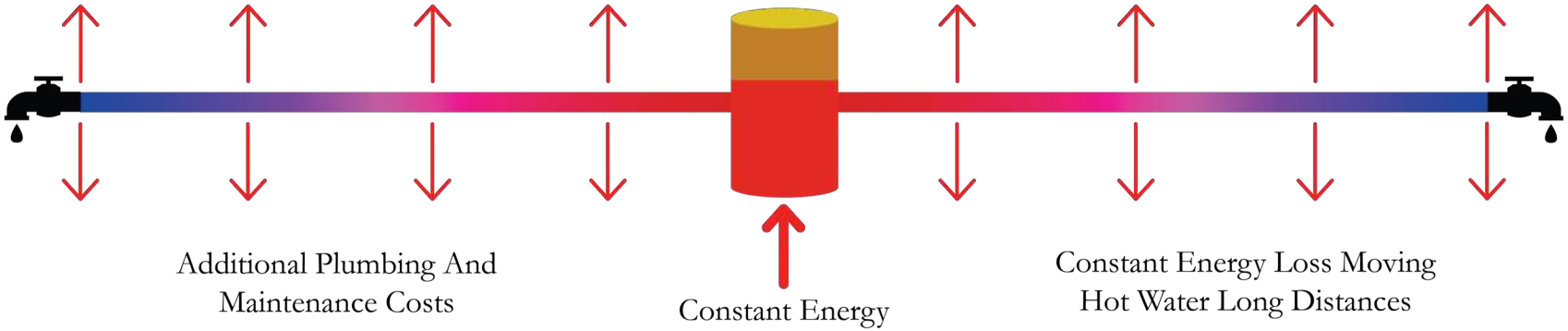
- Thoughtful Daylighting
- Efficient Light Fixtures
- An Intelligent Control System
- Centralized Appliances



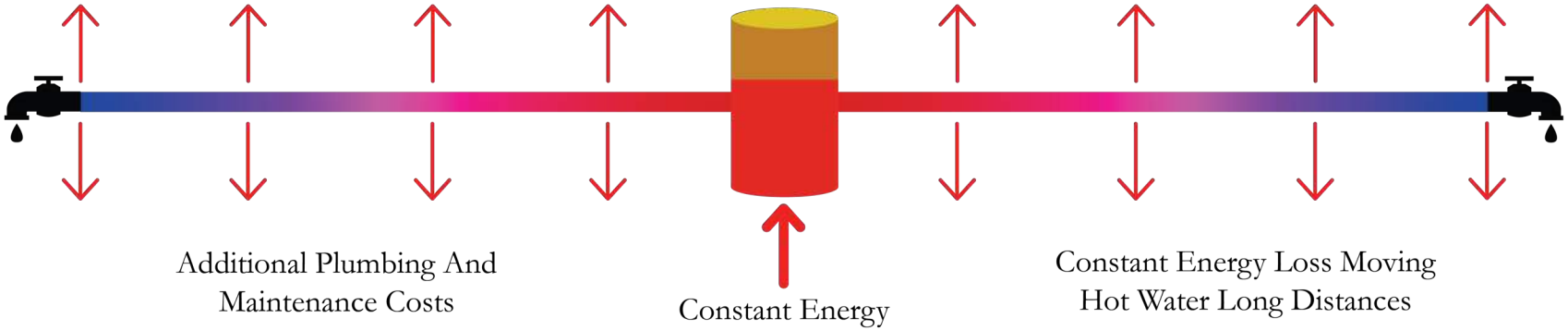




Traditional Tank Based Hot Water



Traditional Tank Based Hot Water



Decentralized Point Source Hot Water

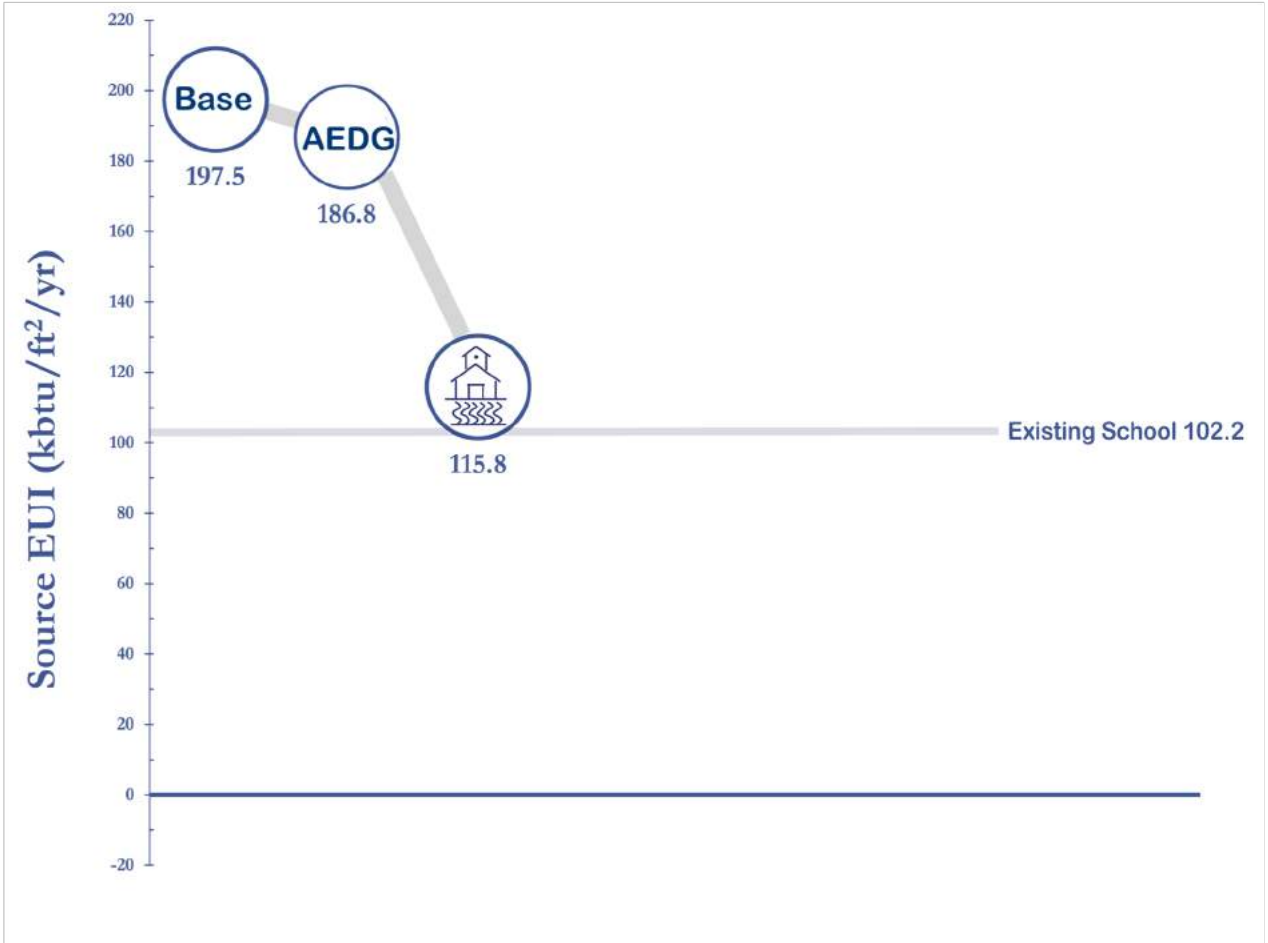
Demand Based Energy Use

Minimal Energy Loss In Hot Water Delivery

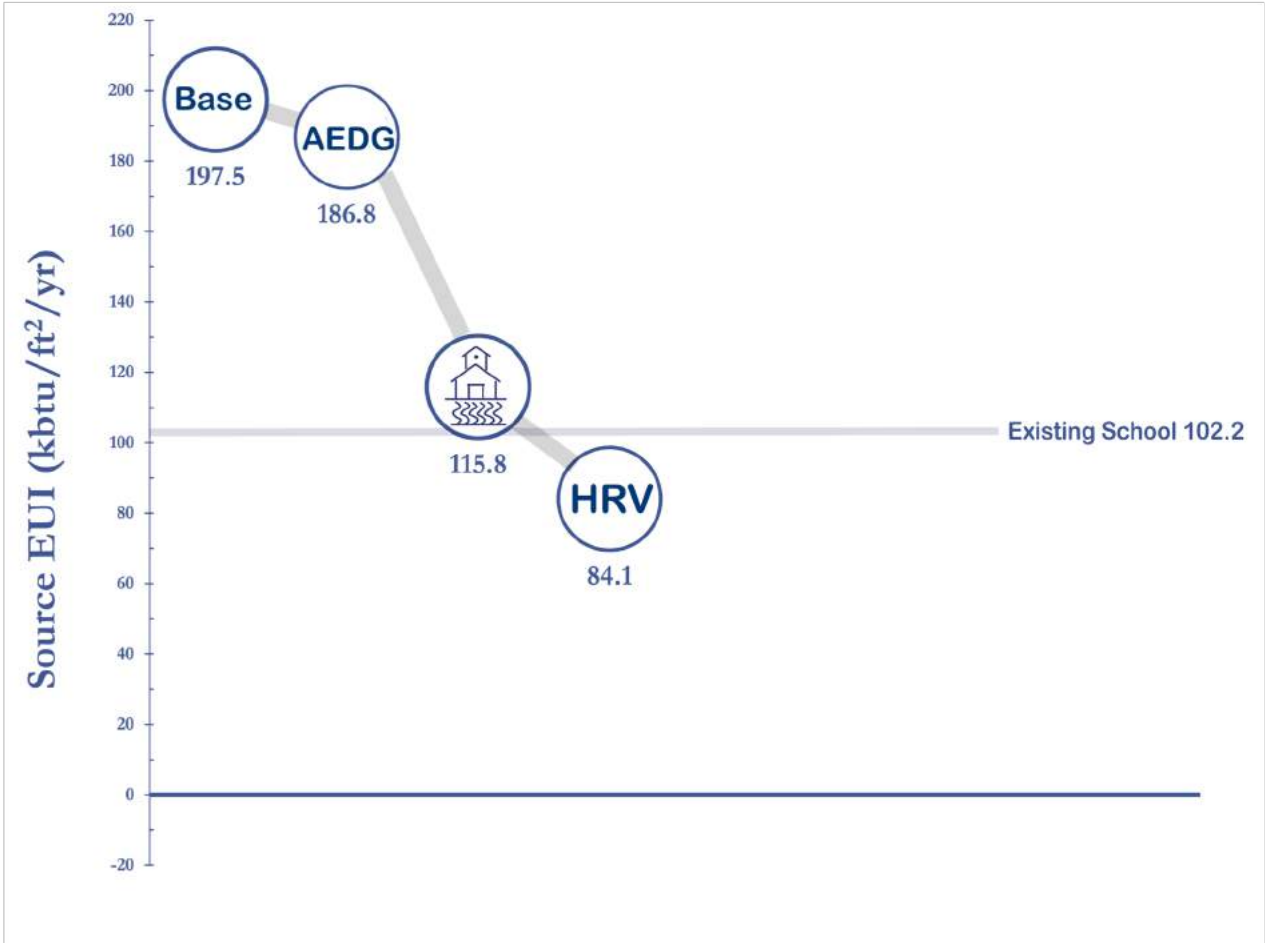
Longer Lifespan

Energy Efficiency Measures

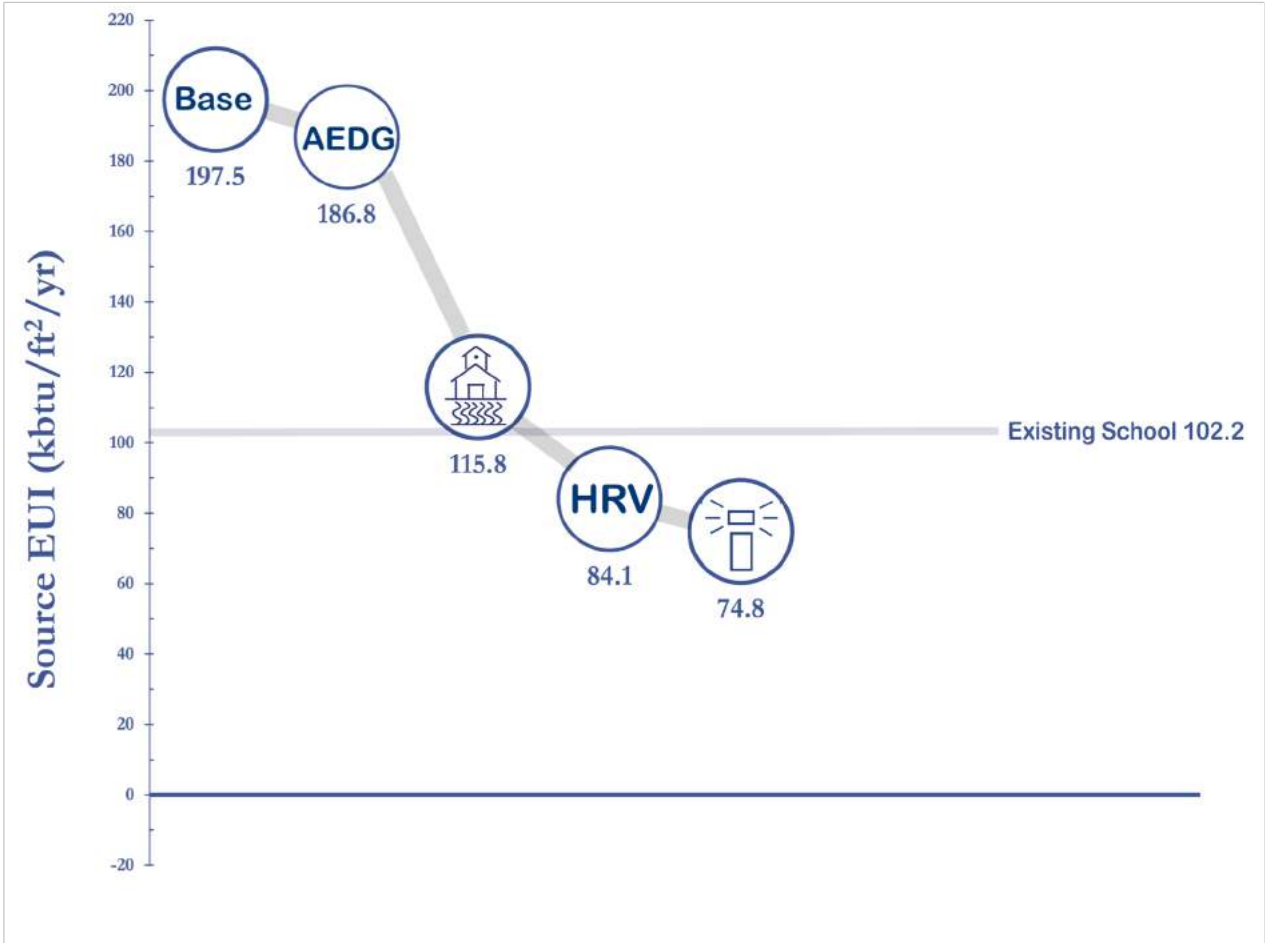
Energy Efficiency Measures



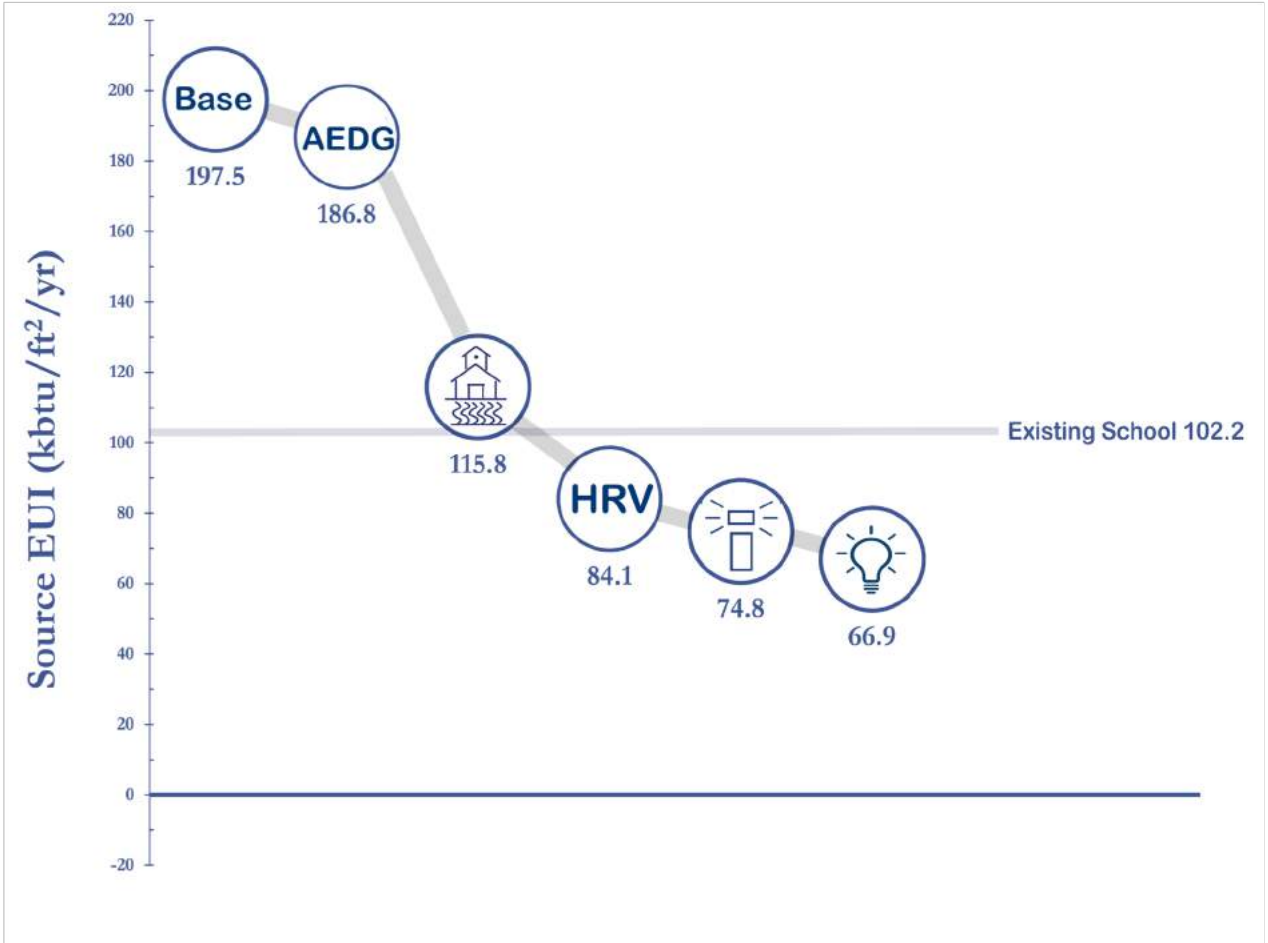
Energy Efficiency Measures



Energy Efficiency Measures



Energy Efficiency Measures



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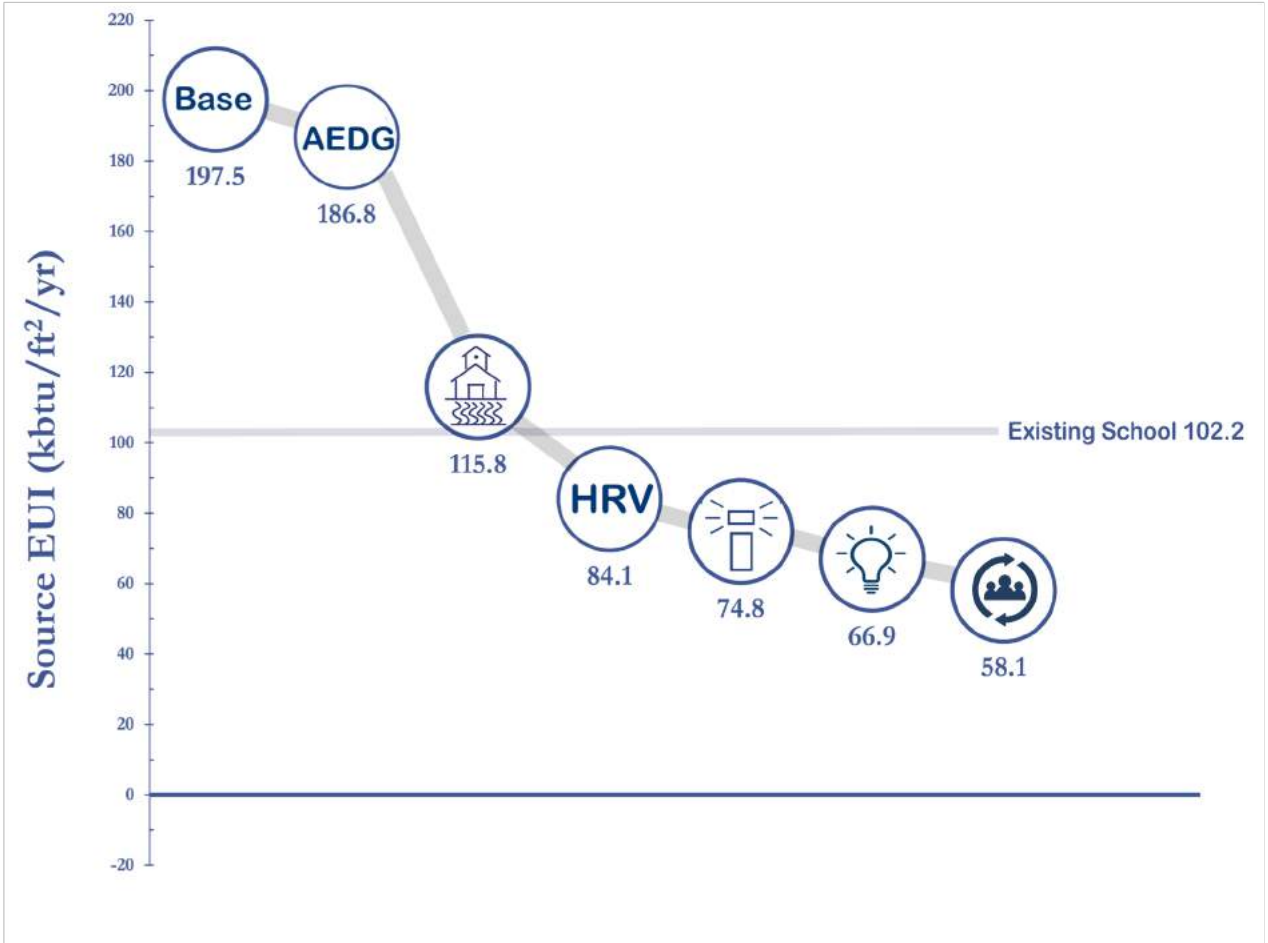
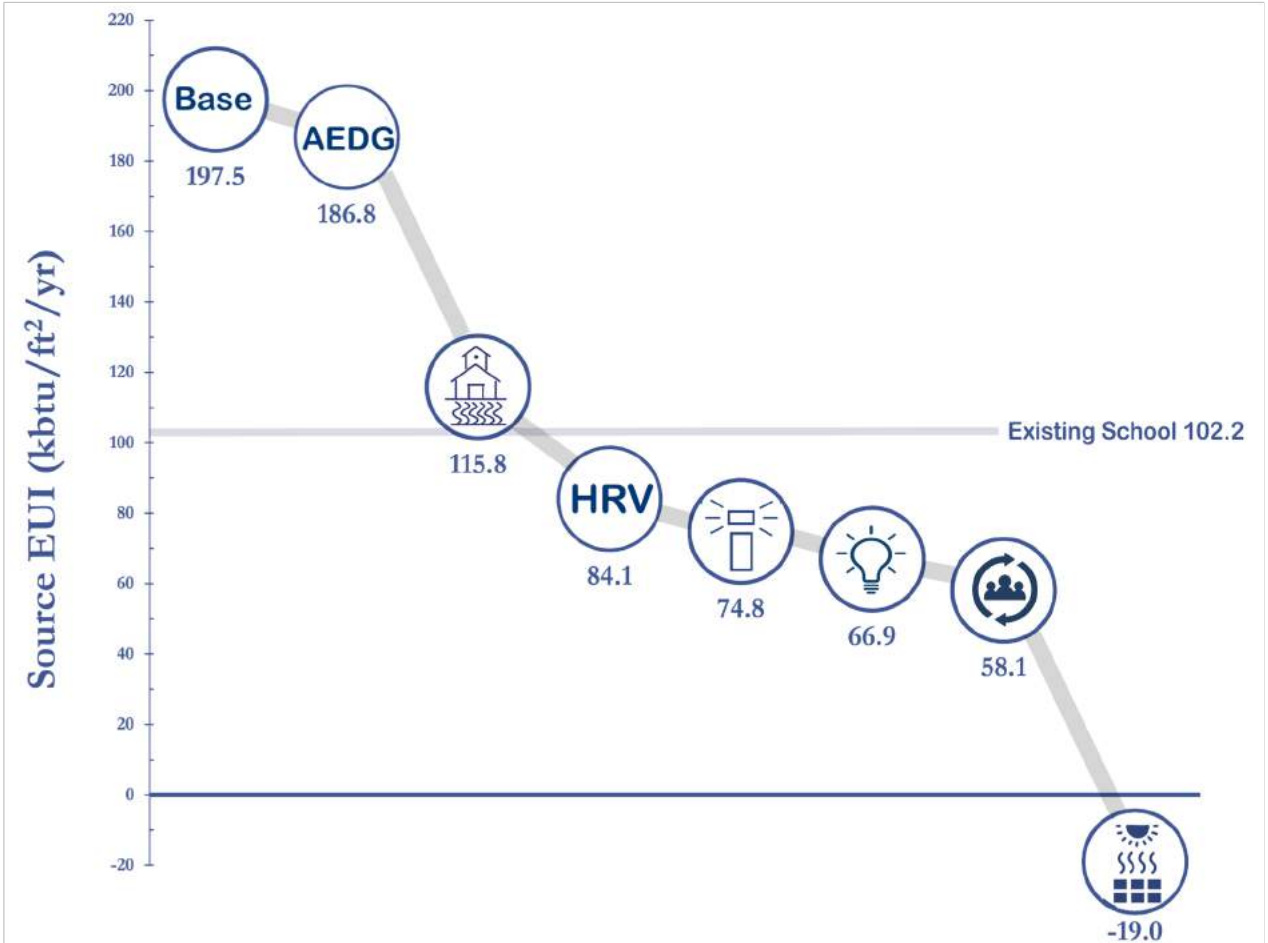
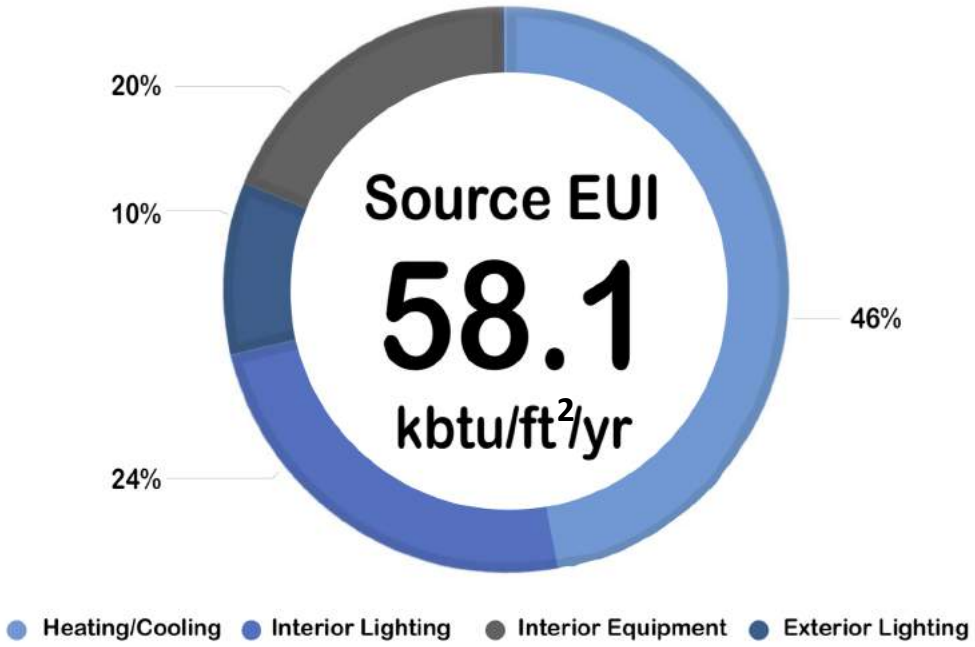


Energy Efficiency Measures



Energy Efficiency Measures



Affordable Efficiency

Design Parameters

Climate Zone **6A**

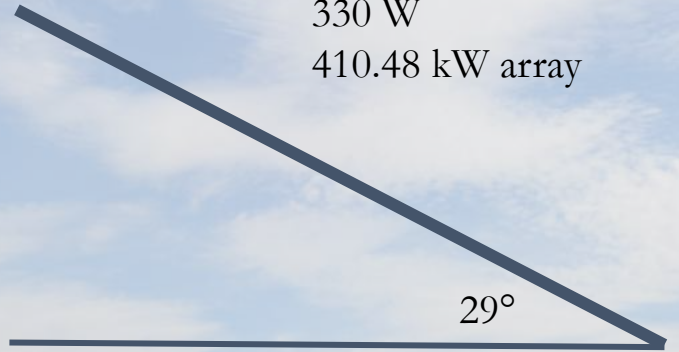
7,186 Heating Degree Days

677 Cooling Degree Days

Annual Energy Usage

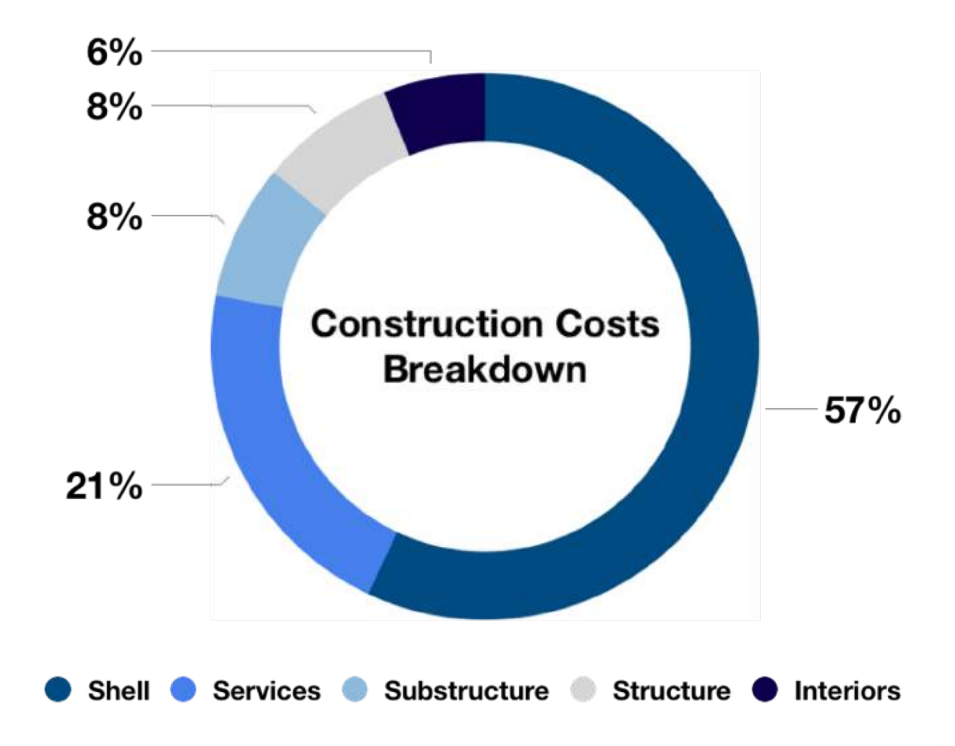
Panasonic HIT N330
19.7%

1,244 panels
330 W
410.48 kW array



Visible Engineering

Energy Production

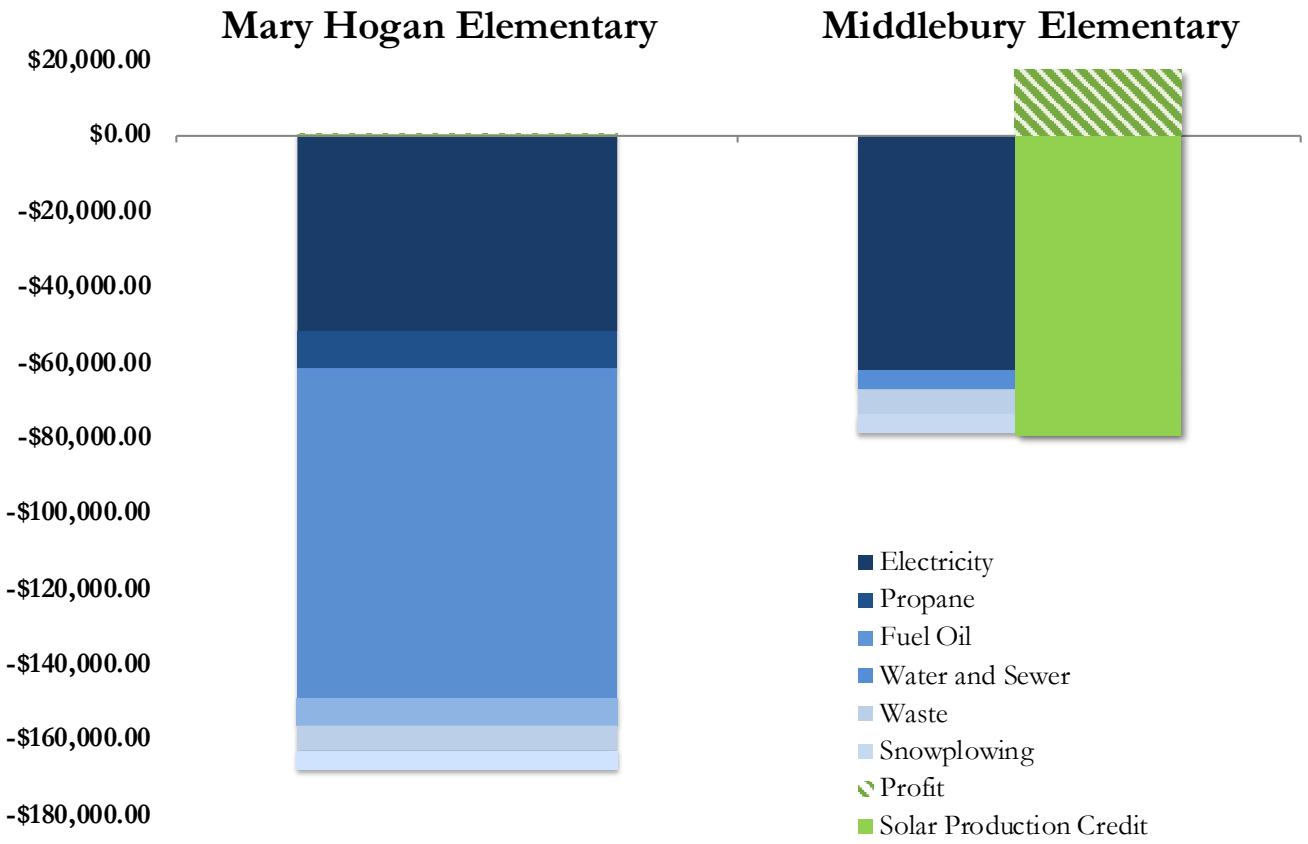


Total Construction Costs:
$17.8 Million

Median New England Elementary School Cost[1]:
$400/ft^2

Middlebury Elementary Cost:
$250/ft^2

Affordable Efficiency



Affordable Efficiency

Financial Analysis

Zach Berzolla
Physics '18
Team Lead and Project Manager

Amanda Kirkeby
Physics '19
Energy Model

Bennett Doherty
Physics '18
MEP

Alex Browne
Physics '18
Building Codes,
MEP

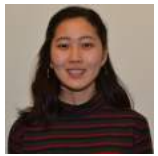
Ben Belinski English '18.5
MEP

Priyanjali Sinha
SOAN '18
Envelope & Landscape Design

Max Lutzius
Economics & Physics '20.5
Envelope

Jack Allnut
HARC '20.5
Envelope & Architecture

Evan Weinman
HARC '18
Architecture



Karen Kobayashi
HARC '18.5
Architecture

Elliott Friedman
HARC '19
Architecture

Emma McDonagh
HARC '19
Architecture & Interior Design

Thomas Wentworth
ES/Psych '18
PV & Interior Design

Olivia Ryder
HARC & Studio Art '19
Architecture & Interior Design

Maria Abragan
ES/Geography '18
Interior Design

Gigi Miller
Comp. Sci. & Studio Art '18
Interior Design

Katie Aman
SOAN '19
Deliverables

Ry Storey-Fisher
ES/Policy '18
Deliverables

ALPEN

Alpen High Performance Windows provided guidance in choosing windows and tuning glazing.

ACSD

Tom Buzzell, principal of Mary Hogan, provided guidance on programmatic design and current operating costs.

sts

Greg Sellers provided insight on the structural systems required to support our building.

LN CONSULTING

Wayne Nelson and Derek Siegler provided guidance on choosing our HVAC system and how to create a system layout.

kmc

Jack Kerby-Miler '14.5 provided envelope design reviews.

1800

Myron Selleck and Spencer Clark of Middlebury's Facilities provided electrical and HVAC design reviews.

J.W. & D.E. RYAN

Dennis Senesac provided guidance on selecting the GSHP equipment.

SOLATUBE
Innovation in Daylighting.

Solatube provided design guidance for using their product to daylight interior spaces.

CADWELL COLLABORATIVE

Ashley Cadwell '80 is our consultant for sustainable school design that supports inquiry project-based intra-disciplinary curricula.

VIA VERMONT INTEGRATED ARCHITECTURE, P.C.

Andrea Kerz-Murray, Sam Ostrow, and Ashar Nelson provided architecture critiques and design reviews.

THE STONE HOUSE GROUP
BUILDING STEWARDSHIP

Larson Lovdal '15.5, provided design suggestions on the lighting, BMS,

Vermont Energy Investment Corporation

Peter Schneider '97 provided design review and contacts with other industry experts.

CREATING YOUR SCENE
SUSAN POTTER DAVIS
Landscape

Susan Davis, Landscape design consultation

VENTACITY SYSTEMS
ALWAYS HEALTHY • ALWAYS EFFICIENT

Aubrey Gewehr, DOAS ventilation system design

LTM Environmental Services

Liam Murphy reviewed the radon management plan.

Team & Advisors

Funding Provided By:

- Middlebury Undergraduate Research Office
- Middlebury's President
- Middlebury's Office of Sustainability Integration
- Middlebury's Environmental Affairs Department

Works Cited

1. School Planning & Management. 2015. Annual School Construction Report.

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- Green engine by Attilio Baghino from the Noun Project
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- Faucet by Georgiana Ionescu from the Noun Project
- Dollar coin by Musmellow from the Noun Project
- School by Ayub Irawan from the Noun Project

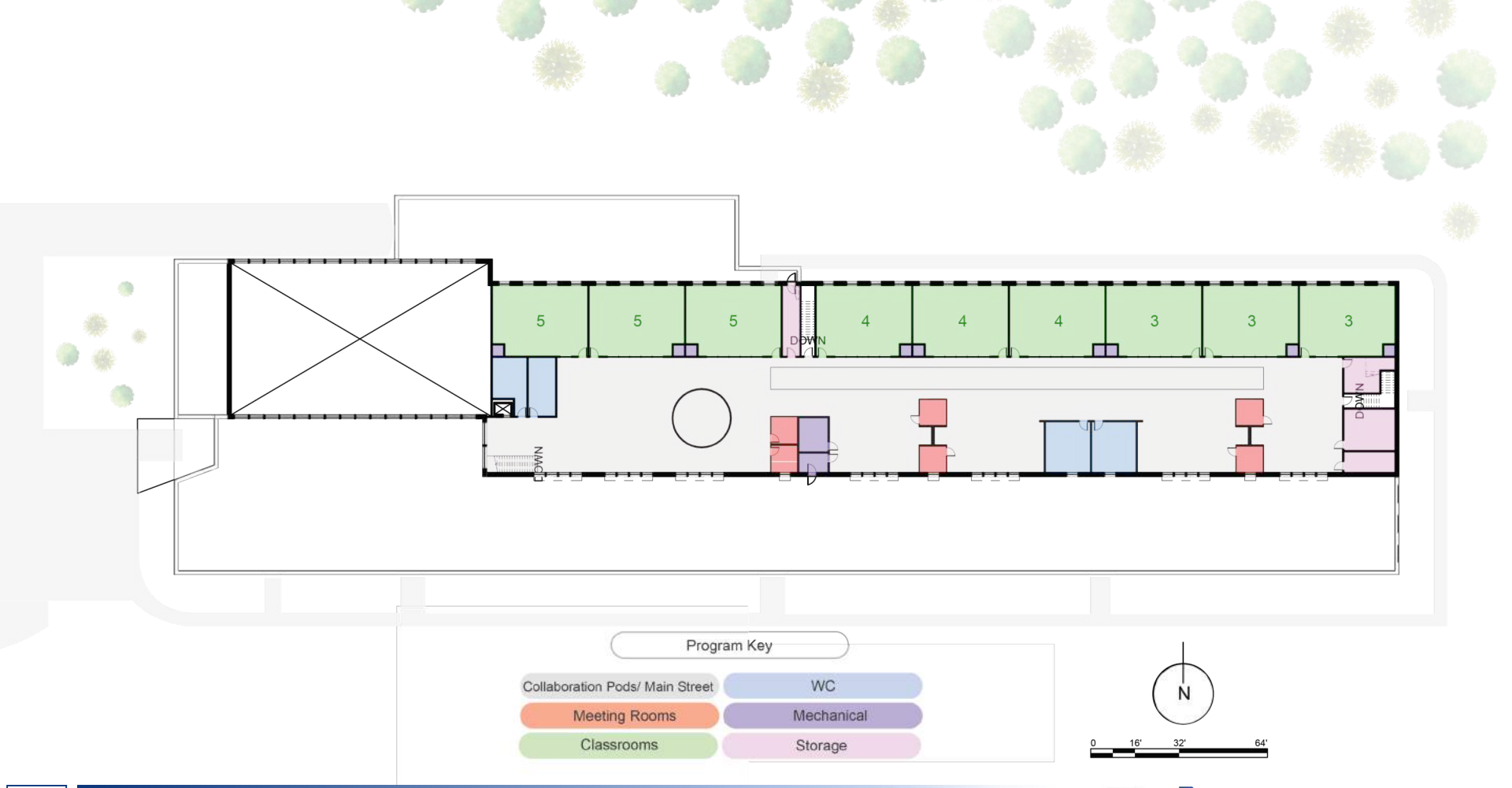
Acknowledgements

Middlebury Elementary

By MiddZEST

Thank You!

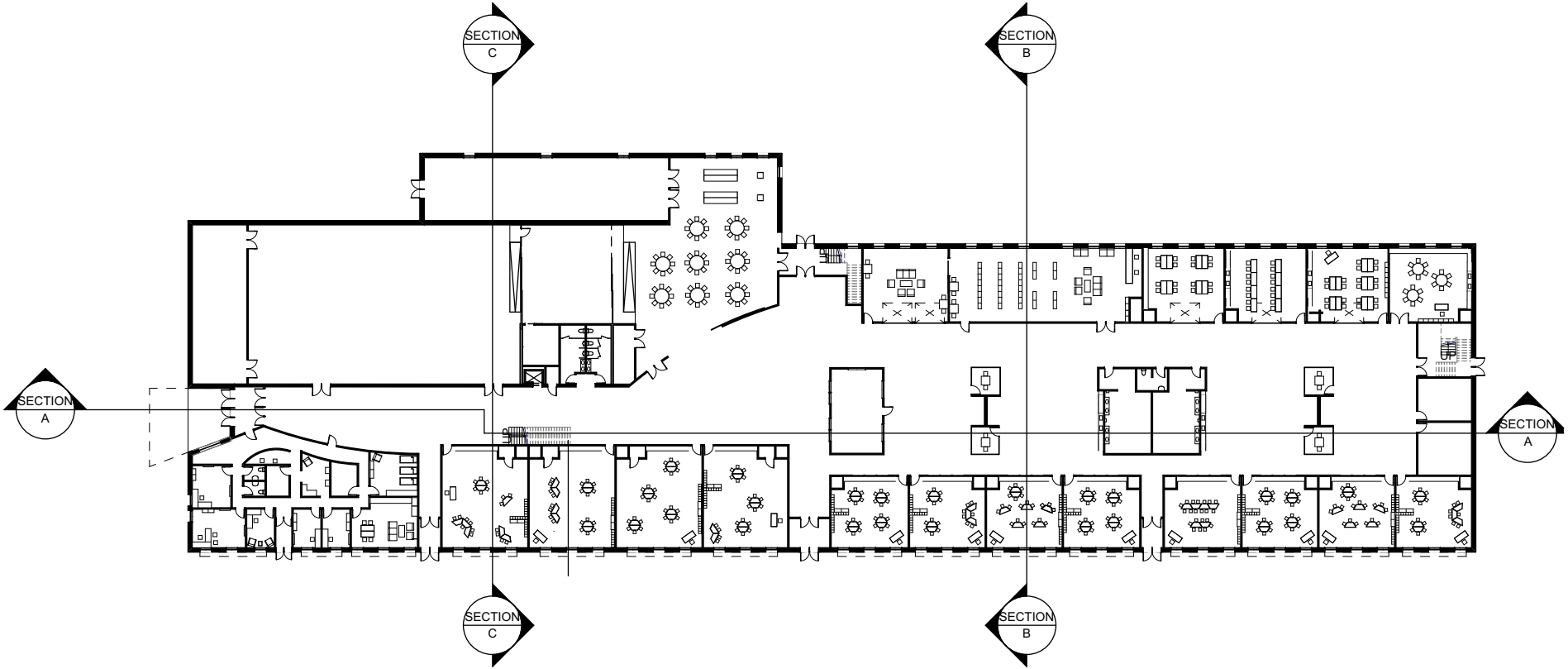
Appendix: Floor Plan



Appendix: Floor Plan

	Specification	Size (l x h)	Quantity	Remarks
South-Facing	Fixed	4' x 4'	43	Center windows in each South-facing classroom. All windows on the 2nd story South-facing wall.
	Operable Tilt Turn/Hopper	4' x 4'	32	Two outer-most windows in each South-facing classroom, all exterior windows in the Administration neighborhood.
	Fixed Daylighting	4'x 2'	77	Above all view windows. One additional window in each South-facing bathroom on the 2nd floor.
North-Facing	Fixed	4' x 4'	29	Two center windows in each North-facing 2nd floor classroom. Central window in groups of 3 on the 1st floor.
	Operable Tilt Turn/Hopper	4' x 4'	34	Outer-most windows in each North-facing classroom on the 2nd floor. Outer-most windows on the first floor groups of 3.
	Fixed Daylighting	4'x 2'	63	Above all view windows.
	Fixed	2' x 4'	2	Stairwell
East-Facing	Fixed	4' x 4'	1	Multipurpose Room
	Fixed Daylighting	4'x 2'	1	Multipurpose Room
	Fixed	2' x 4'	2	Stairwell
West-Facing	Fixed	4' 2" x 8' 2"	2	2nd floor above the main staircase to view the PV array
	Operable Tilt Turn/Hopper	4' x 4'	2	Administration neighborhood
	Fixed Daylighting	4'x 2'	2	Above view windows in Administration neighborhood

Appendix: Windows

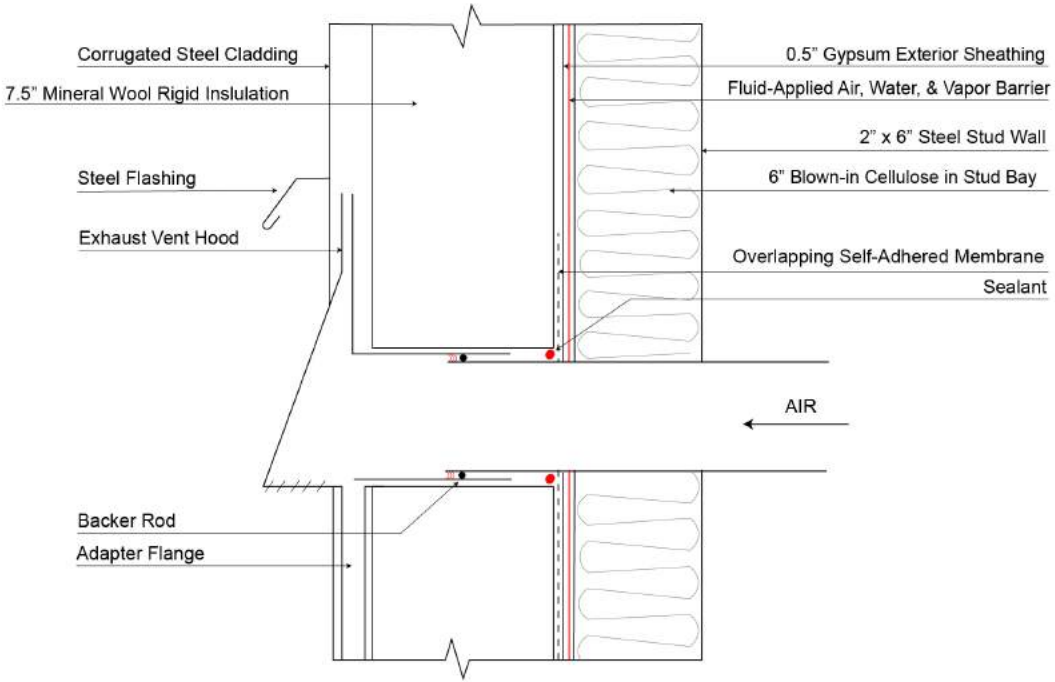


1st FLOOR PLAN

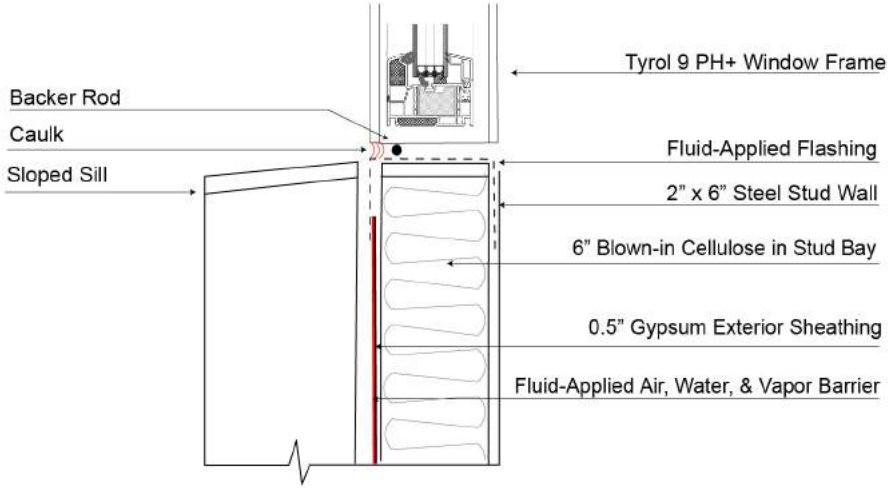
SCALE: 1/32" = 1'-0"

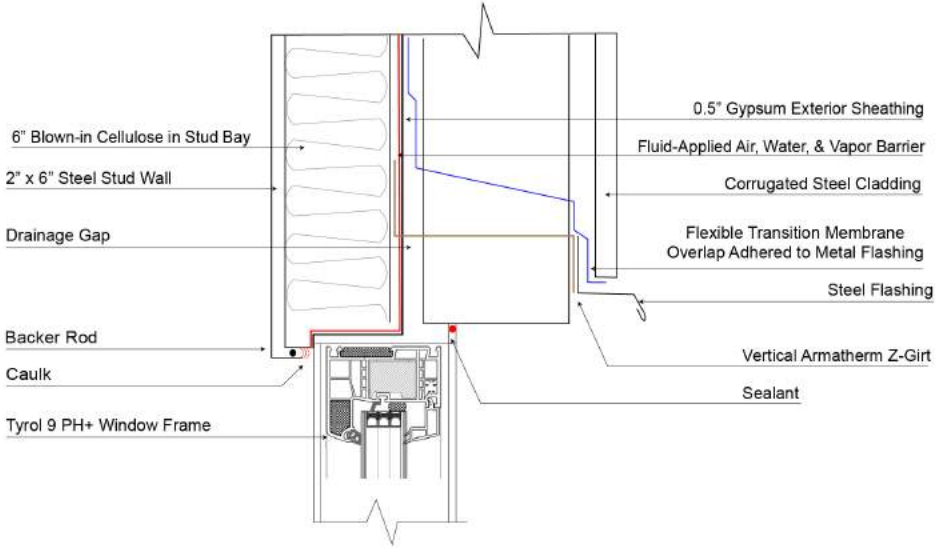
0 16' 32' 64'

Appendix: Furniture Layout

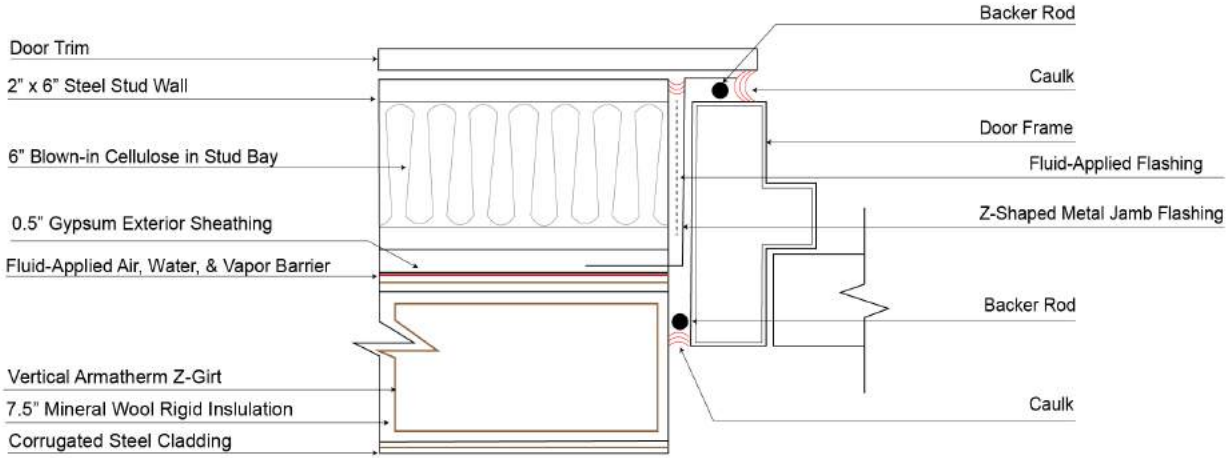


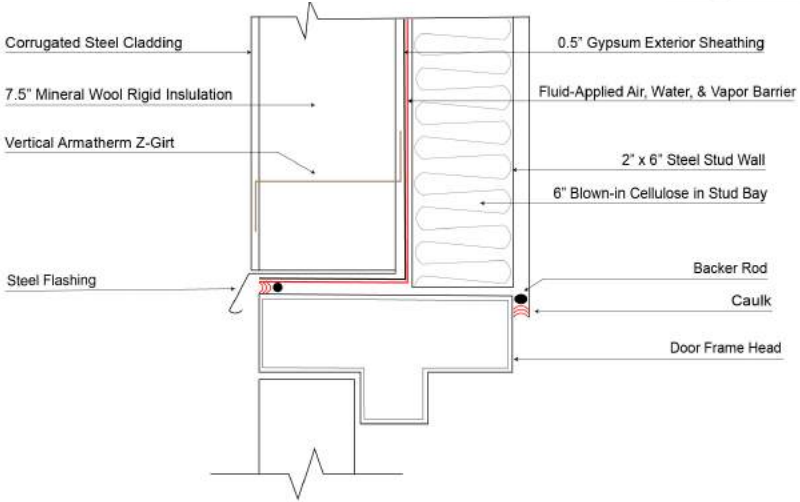
Appendix: Envelope Details

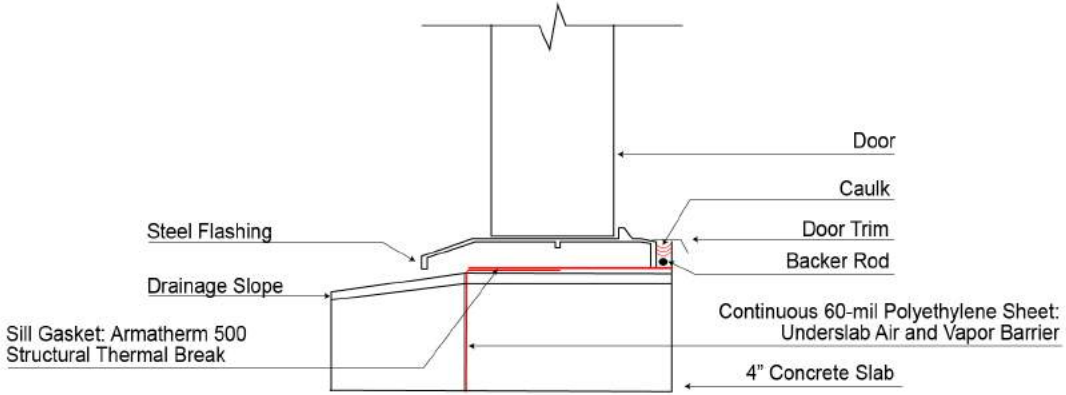




Appendix: Envelope Details



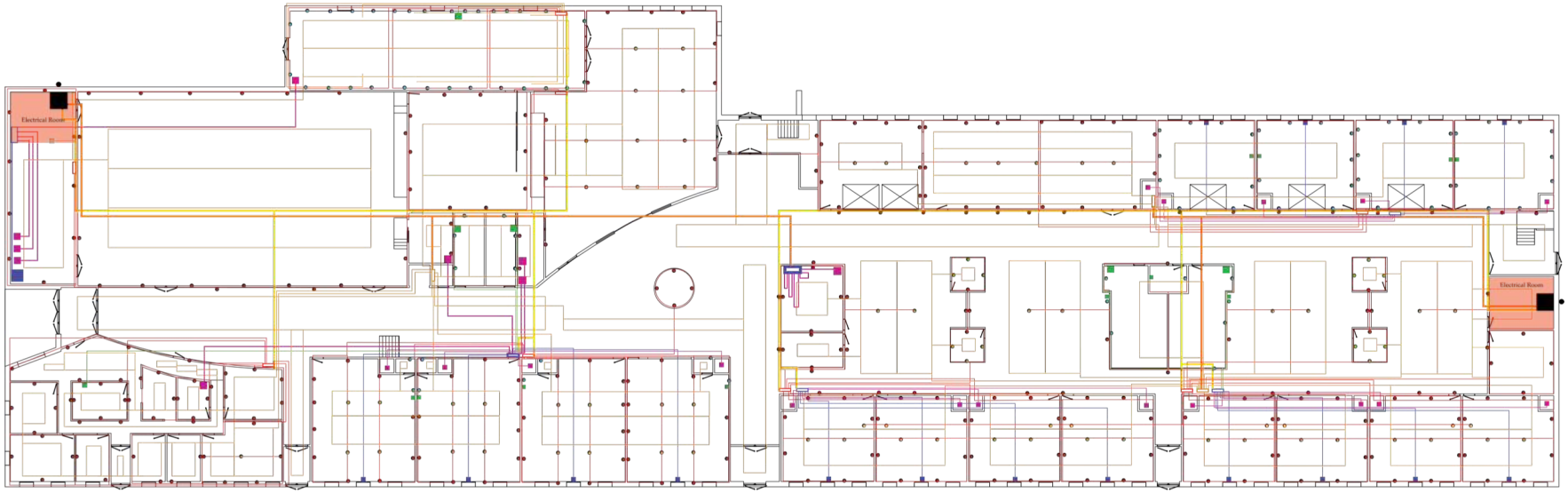


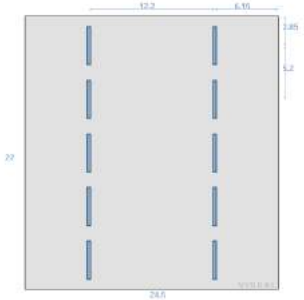


Appendix: Envelope Details

	Electricity (Site to Source Multiplication Factor 3.15)	+	#2 Fuel Oil (Site to Source Multiplication Factor 1.19)	+	Propane (Site to Source Multiplication Factor 1.15)	=	Total Energy Consumption	—	Renewable Energy Production	=	Net Energy Consumption
Site Energy	15.64 kBtu/ft²/yr.	+	38.33 kBtu/ft²/yr.	+	6.39 kBtu/ft²/yr.	=	60.36 kBtu/ft²/yr.			=	60.36 kBtu/ft²/yr.
Existing School											
Source Energy	49.26 kBtu/ft²/yr.		45.62 kBtu/ft²/yr.		7.35 kBtu/ft²/yr.		102.2 kBtu/ft²/yr.				102.2 kBtu/ft²/yr.
Site Energy	18.46 kBtu/ft²/yr.					=	18.46 kBtu/ft²/yr.	—	24.5 kBtu/ft²/yr.	=	-6.04 kBtu/ft²/yr.
Proposed Middlebury Elementary School											
Source Energy	58.15 kBtu/ft²/yr.						58.15 kBtu/ft²/yr.		77.18 kBtu/ft²/yr.		- 19.03 kBtu/ft²/yr.

Appendix: Energy Analysis



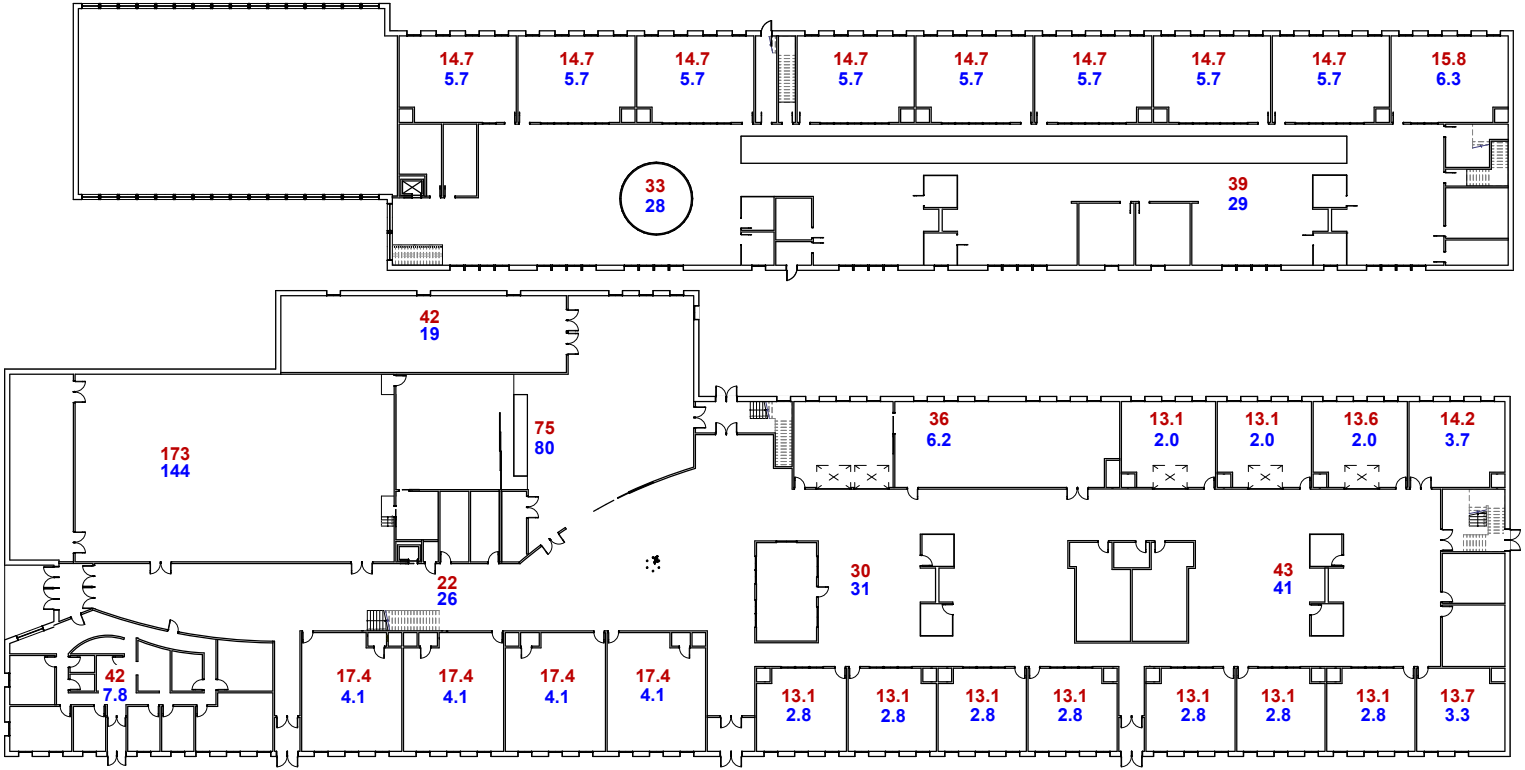


- 480/277 Feeder Lines to Breaker Panels
- 120/208 Feeder Lines to Breaker Panels
- 20 Amp Lighting Circuit, 10-Guage Wire
- 20 Amp General Purpose 1 Pole Circuit, 10-Gauge Wire, AFCI Protected
- Dedicated 20 Amp 2 Pole Heat Pump Circuit, 12-Gauge Wire, with Fuse
- Dedicated 40 Amp Heat Pump Circuit, 6-Gauge Wire, with Fuse
- Dedicated 20 Amp Ventilation 2 Pole Circuit, 10-Gauge Wire, with Fuse
- Dedicated 60 Amp Ventilation 3 Pole Circuit, 4-Gauge Wire, with Fuse
- Dedicated 30/40/60 Amp Point Source Water Heating Circuit, 8/6/4 Gauge Wire
- Dedicated 20 Amp Kitchen Circuit, 10-Gauge Wire
- Dedicated 20 Amp Air Compressor / Sprinkler System Circuit, 10-Gauge Wire, with Fuse

- 3 phase power transformer
- 100 Amp 3 Phase Power 120/208 General Purpose Breaker Panel (each circuit single pole)
- 100 Amp 3 Phase Power 480/277 Lighting Breaker
- 100 Amp 3 Phase Power 120/208 Small Mechanical System Breaker Panel
- 150 Amp 3 Phase Power 120/208 Small Mechanical System Breaker Panel
- 300 Amp 3 Phase Power 480/277 Large Mechanical System Breaker Panel

- 40 Amp Ground Source Heat Pump
- 20 Amp Ground Source Heat Pump
- 40 Amp Point Source Water Heater
- 20 Amp Point Source Water Heater
- Ventacity VS 3000 Ventilation System
- Ventacity VS 500 Ventilation System
- Leviton 20 Amp Duplex Tamper Resistant Outlet
- Leviton 20 Amp Duplex Ceiling Outlet
- Leviton 20 Amp Commercial Grade Self Grounding Duplex Outlet Floor Box
- Leviton 20 Amp 125-Volt Duplex Self-Test Tamper Resistant GFCI Outlet

Appendix: Electrical and Light Fixtures



Appendix: Heating and Cooling

Appendix: Heating and Cooling

Assemblies Category - Name	RS Means Line No.	Quantity (units)	Unit	Estimated Cost per Unit 2014	per Unit - Adjusted for escalation and location	RSMeans Estimated Subtotal	Team Estimate Cost Per Unit		Notes Required?	Justification/Notes (Required for values different than RSMeans Estimate)
Substructure				**$3,984.94**	**$3,931.78**	**$1,376,916.40**	**$3,931.78**	**$1,376,916.40**		
Footings: Concrete in place, including forms (40 uses), grade 60 rebar, concrete (Portland cement Type	03 30 53.40 0300	62.51	C.Y.	$1,325.00	$1,307.33	$81,720.94	$1,307.33	$81,720.94	NO	
Footings: Rigid insulation, Extruded polystyrene, 25 PSI compressive strength, 2" thick R10	07 21 13.10 1940	846	S.F.	$1.94	$1.91	$1,619.35	$1.91	$1,619.35	NO	
Footings: Armathon 500 thermal break	-	47	Ea.	-	-	-	-	-	-	
Underslab: Rigid insulation, Extruded polystyrene, 25 PSI compressive strength, 4" thick R20	07 21 13.10 1940	51570	S.F.	$3.88	$3.83	$197,422.58	$3.83	$197,422.58	NO	
Footings: Stormwater collection, polyvinyl chloride pipe, 20' lengths, SDR 35, B&S, 4" diameter	33 31 13.25 0200	2540	L.F.	$0.28	$0.28	$707.98	$0.28	$707.98	NO	
Slab: Concrete in place, including forms (40 uses), grade 60 rebar, concrete (Portland cement Type I), p	03 30 53.40 0300	636	C.Y.	$1,325.00	$1,307.33	$831,459.22	$1,307.33	$831,459.22	NO	
Slab Thick Edge: Concrete in place, including forms (40 uses), grade 60 rebar, concrete (Portland cemer	03 30 53.40 0300	63.44	C.Y.	$1,325.00	$1,307.33	$82,936.75	$1,307.33	$82,936.75	NO	
Slab: General fill, gravel fill, compacted, under floor slabs, 4" deep	31 23 23.17 0500	51570	S.F.	$0.77	$0.76	$39,179.22	$0.76	$39,179.22	NO	
Underslab: Stormwater collection, polyvinyl chloride pipe, 20' lengths, SDR 35, B&S, 4" diameter	33 31 13.25 0200	1500	L.F.	$0.28	$0.28	$418.10	$0.28	$418.10	NO	
Slab: Polyethelene Sheet, 60-mil	07 13 53.10 2200	51570	S.F.	$2.78	$2.74	$141,452.26	$2.74	$141,452.26		
Shells				**$4,608.86**	**$4,547.38**	**$9,953,698.35**	**$13,058.44**	**$10,260,294.15**		
Roof: EPDM, 60 mils, 0.40 psf, loose-laid & ballasted with stone (10psf)	07 53 23.20 4600	51425	S.F.	$160.00	$157.87	$8,118,246.71	$157.87	$8,118,246.71	NO	
Roof: Roof decking, made from recycled materials, open type, 3" deep, type N, 22 ga., 50-500 squares	05 31 23.50 3250	51425	S.F.	$3.36	$3.32	$170,483.18	$3.32	$170,483.18	NO	
Roof: Gypsum sheathing, gypsum, weatherproof, 1/2" thick	06 16 43.10 0020	51425	S.F.	$1.49	$1.47	$75,601.17	$1.47	$75,601.17	NO	
Roof: Mineral wool insulation (18.75")	-	51425	S.F.	$5.06	$4.99	$256,739.55	$4.99	$256,739.55	NO	
Roof: Fluid-applied membrane air barrier, spray applied vapor barrier, 25 S.F./gallon	07 27 26.10 0100	51425	S.F.	$0.37	$0.37	$18,773.45	$0.37	$18,773.45	NO	
Roof: Sheet metal flashing and counter flashing, including up to 4 bends, steel sheets, galvanized, 26 ga	07 65 10.10 9326	2463.75	S.F.	$4.56	$4.50	$11,084.84	$4.50	$11,084.84	NO	
Roof: Oriented Strand Board factory laminated WR Barrier 1/2" thick, on roof	06 16 36.10 4700	51425	S.F.	$1.49	$1.47	$75,601.17	$1.47	$75,601.17	NO	
Roof: Sleepers treated 2" x 4"	06 11 10.34 0340	10	M.B.F	$2,100.00	$2,071.99	$20,719.88	$2,071.99	$20,719.88	NO	
Windows, doors, and vents: Sheet metal flashing and counter flashing, including up to 4 bends, steel sh	07 65 10.10 9328	4000	S.F.	$4.20	$4.14	$16,575.90	$4.14	$16,575.90	NO	
Roof: Backer rod, polyethylene, 1" diameter	07 91 23.10 0090	1314	L.F.	$1.31	$1.29	$1,698.38	$1.29	$1,698.38	NO	
Roof: Solatube	-	30	Ea.	-	-	-	$1,126.06	$33,781.80	YES	Quote from manufacturer.
Exterior walls: Partition wall, stud wall, 8' to 12' high; exterior, 1/2" gypsum sheathing, 1/2" gypsum fir	09 21 16.33 9400	52045.8	S.F.	$6.35	$6.27	$326,082.41	$6.27	$326,082.41	NO	
Exterior walls: Poured loose-fill insulation, cellulose fiber, R3.8 per inch, 6" thick	07 21 23.10 0022	52045.8	S.F.	$1.02	$1.01	$52,378.59	$1.01	$52,378.59	NO	
Exterior walls: Fluid-applied membrane air barrier, spray applied vapor barrier, 25 S.F./gallon	07 27 26.10 0100	52045.8	S.F.	$0.37	$0.37	$19,000.08	$0.37	$19,000.08	NO	
Exterior walls: Mineral wool insulation (7.5")	07 21 23.10 0100	52045.8	S.F.	$2.03	$2.00	$104,243.67	$2.00	$104,243.67	NO	
Exterior walls: Steel siding, galv, corrugated or ribbed, on steel frame, 30 ga.	07 42 13.30 0080	52045.8	S.F.	$4.24	$4.18	$217,730.62	$4.18	$217,730.62	NO	
Exterior walls: Furring, wood strips, 1" X 2", on walls, on wood	06 11 10.42 0012	7435	L.F.	$1.29	$1.27	$9,463.21	$1.27	$9,463.21	NO	
Exterior walls: Steel louvers, 18 gauge, fixed blade, 12" X 12", galvanized	08 91 26.10 0100	25	Ea.	$100.00	$98.67	$2,466.65	$98.67	$2,466.65	NO	
Parapet: Partition wall, stud wall, 8' to 12' high; exterior, 1/2" gypsum sheathing, 1/2" gypsum finished	09 21 16.33 9400	6680	S.F.	$6.35	$6.27	$41,852.19	$6.27	$41,852.19	NO	
Parapet: Fluid-applied membrane air barrier, spray applied vapor barrier, 25 S.F./gallon	07 27 26.10 0100	6680	S.F.	$0.37	$0.37	$2,438.63	$0.37	$2,438.63	NO	
Parapet: Poured loose-fill insulation, cellulose fiber, R3.8 per inch, 6" thick	07 21 23.10 0022	6680	S.F	$1.02	$1.01	$6,722.71	$1.01	$6,722.71	NO	
Parapet: Steel siding, galv, corrugated or ribbed, on steel frame, 30 ga.	07 42 13.30 0080	6680	S.F.	$4.24	$4.18	$27,945.40	$4.18	$27,945.40	NO	
Parapet: Fluid-applied membrane air barrier, spray applied vapor barrier, 25 S.F./gallon	07 27 26.10 0100	4600	S.F.	$0.37	$0.37	$1,679.30	$0.37	$1,679.30	NO	
Parapet cap: Poured loose-fill insulation, cellulose fiber, R3.8 per inch, 6" thick	07 21 23.10 0022	2956.5	S.F	$1.02	$1.01	$2,975.40	$1.01	$2,975.40	NO	
Exterior Doors: Standard hollow metal doors, insulated, 1-3/4" thick, full panel, 18 ga. 3'-0" X 7'-0"	08 13 13.13 1760	33	Ea.	$615.00	$606.80	$20,024.28	$606.80	$20,024.28	NO	
Exterior Doors: Standard hollow metal doors, vision lite	08 13 13.13 2000	33	Ea.	$104.00	$102.61	$3,386.22	$102.61	$3,386.22	NO	
Expansion control: Expansion joint assemblies, floor cover assemblies, 1" space, aluminum	07 95 13.50 0200	114	L.F.	$43.00	$42.43	$4,836.61	$42.43	$4,836.61	NO	
Expansion control: Expansion joint assemblies, wall and ceiling assemblies, 1" space, aluminum	07 95 13.50 0800	170	L.F.	$33.00	$32.56	$5,535.17	$32.56	$5,535.17	NO	
Exterior Windows: Alpen Tyrol TR-9 PH+ Balanced, Fixed 4' X 8', R-9.1, SHGC = 0.24	-	2	Ea.	-	-	-	$2,000.00	$4,000.00	YES	Quote from manufacturer.
Exterior Windows: Alpen Tyrol TR-9 PH+ HighGain, Tilt Turn/Hopper 4' X 4', R-7.7, SHGC = 0.30	-	32	Ea.	-	-	-	$1,250.00	$40,000.00	YES	Quote from manufacturer.
Exterior Windows: Alpen Tyrol TR-9 PH+ HighGain, Fixed 4' X 4', R-8.3, SHGC = 0.35	-	43	Ea.	-	-	-	$1,084.00	$46,612.00	YES	Quote from manufacturer.
Exterior Windows: Alpen Tyrol TR-9 PH+ Balanced, Tilt Turn/Hopper 4' X 4', R-7.7, SHGC = 0.31	-	36	Ea.	-	-	-	$1,250.00	$45,000.00	YES	Quote from manufacturer.
Exterior Windows: Alpen Tyrol TR-9 PH+ Balanced, Fixed 4' X 4', R-9.1, SHGC = 0.24	-	30	Ea.	-	-	-	$1,084.00	$32,520.00	YES	Quote from manufacturer.
Exterior Windows: Alpen Tyrol TR-9 PH+ Balanced, Fixed Non-Tempered 2' X 4', R-9.1, SHGC = 0.24	-	146	Ea.	-	-	-	$717.00	$104,682.00	YES	Quote from manufacturer.
Exterior Windows: Skyroofs, translucent panels, 2-3/4" thick, ridge and furrow units, over 4' O.C., doub	08 45 10.10 2750	128	SF Hor.	$75.50	$74.49	$9,535.09	$74.49	$9,535.09	NO	
Floor: Floor decking, made from recycled materials, non-cellular composite decking, galvanized, 2" dee	05 31 13.50 5200	22116	S.F.	$2.85	$2.81	$62,189.83	$2.81	$62,189.83	NO	
2nd Floor Slab: Concrete in place, including forms (40 uses), grade 60 rebar, concrete (Portland cement	03 30 53.40 0300	204.76	C.Y.	$1,325.00	$1,307.33	$267,688.04	$1,307.33	$267,688.04	NO	
Interiors				**$8,928.85**	**$8,809.75**	**$911,517.13**	**$43,095.35**	**$1,006,913.13**		
Interior walls: Partition wall, stud wall, 8' to 12' high, 1/2", interior, gypsum board, stg, tape & finish 2	09 21 16.33 1200	82066.28	S.F.	$4.75	$4.69	$384,615.09	$4.69	$384,615.09	NO	
Interior fire doors: Metal fire doors, flush, "A" label 3 hour, egress core, 18 ga., 3'-0" X 7'-0"	08 13 13.15 0680	8	Ea.	$890.00	$878.13	$7,025.03	$878.13	$7,025.03	NO	
Interior doors: Smooth wood doors, flush, interior, hollow core, lauan face, 1-3/4", 3'-0" X 7'-0"	08 14 16.09 0108	72	Ea.	$206.00	$203.25	$14,634.16	$203.25	$14,634.16	NO	
Interior doors: Smooth wood doors, flush, interior, hollow core, lauan face, 1-3/4", pair of 3'-0" X 7'-0"	08 14 16.09 0112	10	Pr.	$240.00	$236.80	$2,367.99	$236.80	$2,367.99	NO	
Interior doors: Wood doors, vision lite	08 14 16.09 5000	92	Ea.	$104.00	$102.61	$9,440.37	$102.61	$9,440.37	NO	
Interior metal frames: Standard hollow metal frames, 16 ga., up to 5-3/4" jamb dept, 3'-0" X 7'-0" singl	08 12 13.13 0100	77	Ea.	$236.00	$232.85	$17,929.60	$232.85	$17,929.60	NO	
Interior metal frames: Standard hollow metal frames, 16 ga., up to 5-3/4" jamb dept, 6'-0" wide, doubl	08 12 13.13 0140	28	Ea.	$295.00	$291.06	$8,149.82	$291.06	$8,149.82	NO	
Garage doors: Residential garage doors, overhead, sectional, incl. hardware, fiberglass, 9' X 7', standar	08 36 13.20 0200	5	Ea.	$1,250.00	$1,233.33	$6,166.63	$1,233.33	$6,166.63	NO	
Classrooms: Whiteboards	-	21	Ea.	-	-	-	$750.00	$15,750.00	YES	https://tinyurl.com/y7zondzs
Classrooms: PowerLite 680 XGA 3LCD Presentation Display	-	21	Ea.	-	-	-	$1,517.00	$31,857.00	YES	https://tinyurl.com/yb6eqtlo
Classrooms: 3.5" wooden peg	-	420	Ea.	-	-	-	$0.60	$252.00	YES	https://tinyurl.com/y7dfvtnd
Classrooms: Plywood, 3/4" thick with lumber edge, 12" wide	-	1575	L.F.	$9.50	$9.37	$14,762.92	$9.37	$14,762.92	NO	
Art room: Whiteboards (4' X 20')	-	1	Ea.	-	-	-	$750.00	$750.00	YES	https://tinyurl.com/y7zondzs
Art room: PowerLite 680 XGA 3LCD Presentation Display	-	1	Ea.	-	-	-	$1,517.00	$1,517.00	YES	https://tinyurl.com/yb6eqtlo
Art room: Multi-Section Cabinet w/ 15 Bins	-	2	Ea.	-	-	-	$602.00	$1,204.00	YES	https://tinyurl.com/yb8rgove
Music room: Partitions, sliding, acoustic air wall, 1-5/8" thick	10 22 43.10 0020	1576	S.F.	$52.50	$51.80	$81,636.33	$51.80	$81,636.33	NO	
Cafeteria: Crathco D25-3 Triple 5 Gallon Bowl Stainless Steel Refrigerated Beverage Dispenser		1	Ea.							

Appendix: Finance

Cafeteria: Crathco D35-3 Triple 5 Gallon Bowl Stainless Steel Refrigerated Beverage Dispenser	-	1	Ea.	-	-	-	$2,194.00	$2,194.00	YES	https://tinyurl.com/ya22cbff
Kitchen: 23 Cu Ft Super Deluxe 1 Section Solid Door Reach In Refrigerator	-	2	Ea.	-	-	-	$3,460.00	$6,920.00	YES	https://tinyurl.com/y7922gzd
Kitchen: Maxx Cold 49-cu ft Frost-Free Freestanding Commercial Upright Freezer (Stainless Steel)	-	2	Ea.	-	-	-	$6,417.00	$12,834.00	YES	https://tinyurl.com/ybpr2nml
Kitchen: Hoshizaki CR2S-FS 55" 2 Solid Door Reach-In Refrigerator, Commercial Series	-	2	Ea.	-	-	-	$5,040.00	$10,080.00	YES	https://tinyurl.com/yb4jqjvl
Kitchen: Bakers Pride BCO-E1 Cyclone Series Single Deck Full Size Electric Convection Oven - 208V, 1 Ph	-	1	Ea.	-	-	-	$5,327.00	$5,327.00	YES	https://tinyurl.com/ybl7x2ce
Kitchen: Avantco MX10 10 Qt. Gear Driven Commercial Planetary Stand Mixer with Guard - 110V, 3/4 h	-	1	Ea.	-	-	-	$949.00	$949.00	YES	https://tinyurl.com/ycygzenf
Kitchen: Vitamix 62826 Vita-Prep 3 Food Blender - 64 oz. Capacity - 3 HP	-	1	Ea.	-	-	-	$932.00	$932.00	YES	https://tinyurl.com/ydzxhndf
Administration: Appliance Cabinet w/ Hutch Set	-	1	Ea.	-	-	-	$1,915.00	$1,915.00	YES	https://tinyurl.com/y8nwbxz7
Administration: Cabinet With Right Hand Sink & Wall Cabinet	-	1	Ea.	-	-	-	$2,915.00	$2,915.00	YES	https://tinyurl.com/y8nwbxz7
Multi-purpose room: Partitions, sliding, acoustic air wall, 1-5/8" thick	10 22 43.10 0020	299	S.F.	$52.50	$51.80	$15,488.11	$51.80	$15,488.11	NO	
Interior glass: Sheet glass, 3/16" thick, tempered	08 81 55.10 0700	5085	S.F.	$12.35	$12.19	$61,962.06	$12.19	$61,962.06	NO	
Cabinetry: Manufactured wood casework frames, base cabinets, counter storage, 36" high, two bay, 3(	12 32 23.15 0400	180	Ea.	530	$522.93	$94,127.46	$522.93	$94,127.46	NO	
Cabinetry: Manufactured wood casework frames, wall mounted cabinet, two bay, 24" high, 54" wide	12 32 23.15 6800	180	Ea.	425	$419.33	$75,479.57	$419.33	$75,479.57	NO	
Cabinetry: Manufactured wood casework frames, wall mounted cabinet, two bay, 30" high, 36" wide	12 32 23.15 9000	60	Ea.	430	$424.26	$25,455.85	$424.26	$25,455.85	NO	
Stairs: Floor plate stairs, shop fabricated, steel stringers, custom steel stairs, 4' wide, medium priced	05 51 16.50 0810	48	Risers	$871.50	$859.88	$41,274.00	$859.88	$41,274.00	NO	
Stairs: Floor plate stairs, shop fabricated, steel stringers, custom steel stairs, 6' wide, deluxe	05 51 16.50 0900	24	Risers	$1,236.25	$1,219.76	$29,274.23	$1,219.76	$29,274.23	NO	
Railing: Railings, Pipe, shop fab'd, 3'6" high, posts @ 5' O.C., aluminum, 2 rail, satin finish, 1-1/4" diame	05 52 13.50 0020	64.9	L.F.	$58.50	$57.72	$3,746.01	$57.72	$3,746.01	NO	
Air barrier curtains, incl. motor starters, transformers, and door switches, environmental separation, d	23 34 33.10 3150	9	Ea.	$2,025.00	$1,997.99	$17,981.90	$1,997.99	$17,981.90	NO	
Services				**$60,880.00**	**$60,067.92**	**$64,567.10**	**$183,584.92**	**$3,720,996.10**		
Plumbing: Toto Ultramax II toilets	-	39	Ea.	-	-	-	$1,309.00	$51,051.00	YES	https://tinyurl.com/y8u2ul44
Plumbing: Sloan WES-1000 waterless urinals	-	7	Ea.	-	-	-	$854.00	$5,978.00	YES	https://tinyurl.com/yb7k5gzm
Plumbing: Elkay EDF 15R Non-Refrigerated Drinking Fountains	-	3	Ea.	-	-	-	$677.00	$2,031.00	YES	https://tinyurl.com/ydgktcoh
Plumbing: EcoSmart Pou 6	-	13	Ea.	-	-	-	$265.00	$3,445.00	YES	https://tinyurl.com/y9df8tq3
Plumbing: EcoSmart Eco 18 (0160 on page 498)	-	1	Ea.	-	-	-	$715.00	$715.00	YES	https://tinyurl.com/ybxnyhjs
Plumbing: EcoSmart Eco 27	-	9	Ea.	-	-	-	$842.00	$7,578.00	YES	https://tinyurl.com/yd48d2ah
Plumbing: American Standard 6055.205.002 0.5 GPM Innsbrook Electronic Proximity Faucet	-	25	Ea.	-	-	-	$865.00	$21,625.00	YES	https://tinyurl.com/y8d9huz4
Plumbing: Lucerne wall mounted sink right faucet hole	-	25	Ea.	-	-	-	$217.00	$5,425.00	YES	https://tinyurl.com/y98qagzc
Plumbing: American Standard Monterrey 4" Centerset Gooseneck Faucet	-	8	Ea.	-	-	-	$344.00	$2,752.00	YES	https://tinyurl.com/yc5txe6y
Plumbing: High Sierra 1.5 GPM High Efficiency Low Flow Shower Head	-	1	Ea.	-	-	-	$67.00	$67.00	YES	https://tinyurl.com/y7gxdjft
Plumbing: Commercial Kitchen Sink NSFB-345 3 Compartment	-	2	Ea.	-	-	-	$6,875.00	$13,750.00	YES	https://tinyurl.com/ybdtvc9q
Plumbing: ARB-2435-A-GR-T	-	4	Ea.	-	-	-	$2,690.00	$10,760.00	YES	https://tinyurl.com/ybk42ncr
Electrical: Insteon 6 button dimmable switch	-	33	Ea.	-	-	-	$127.00	$4,191.00	YES	https://tinyurl.com/y8dn8663
Electrical: Insteon Wireless Motion Sensor	-	25	Ea.	-	-	-	$63.00	$1,575.00	YES	https://tinyurl.com/yarxej3q
Electrical: Lutron Maestro Sensor Switch	-	32	Ea.	-	-	-	$30.00	$960.00	YES	https://tinyurl.com/y7uko9bu
Electrical: Insteon Garage door kit	-	5	Ea.	-	-	-	$113.00	$565.00	YES	https://tinyurl.com/yd4s9j3n
Electrical: Insteon Hub	-	1	Ea.	-	-	-	$134.00	$134.00	YES	https://tinyurl.com/y8e7uopn
Electrical: Leviton 20 Amp 125-Volt Duplex Self-Test Tamper Resistant/Weather Resistant GFCI Outlet,	-	104	Ea.	-	-	-	$42.00	$4,368.00	YES	https://tinyurl.com/yba6g6f3
Electrical: 20 Amp Tamper Resistant Duplex Outlet, White	-	488	Ea.	-	-	-	$6.00	$2,928.00	YES	https://tinyurl.com/yas6bdr4
Electrical: Homeline 100 Amp 20-Space 40-Circuit Indoor Main Breaker Plug-On Neutral Load Center wi	-	25	Ea.	-	-	-	$114.00	$2,850.00	YES	https://tinyurl.com/y8cfzwnn
Electrical: Leviton 88003 Electrical Wall Plate, Duplex Receptacle, 1-Gang - White (10-pack)	-	60	Ea.	-	-	-	$4.00	$240.00	YES	https://tinyurl.com/yaws6dtd
Electrical: 20 Amp Commercial Grade Self Grounding Duplex Outlet Floor Box Brass	-	110	Ea.	-	-	-	$99.00	$10,890.00	YES	https://tinyurl.com/y7v3lg6f
Electrical: Homeline 40 Amp Single Pole GFCI Circuit Breaker	-	1	Ea.	-	-	-	$163.00	$163.00	YES	https://tinyurl.com/yawags9q
Electrical: Transformer, 240V, 480V Wye/277V, 15kVA	-	1	Ea.	-	-	-	$2,324.00	$2,324.00	YES	https://tinyurl.com/ybqhrt2j
Electrical: Homeline 20 Amp AFCI Single Pole Circuit Breaker	-	1	Ea.	-	-	-	$74.00	$74.00	YES	https://tinyurl.com/ycqz5csu
Elevator: Hydraulic passenger elevators and options, hyd. pass, base unit, 1500 lb., 100 fpm, 2 stop, std	14 24 23.10 2050	1	Ea.	$60,500.00	$59,692.99	$59,692.99	$59,692.99	$59,692.99	NO	
Mechanical: Ductwork	-	4000	L.F.	-	-	-	$35.00	$140,000.00	YES	based on quote from J.W. and D.E. Ryan
Mechanical: Piping	-	-	-	-	-	-	-	$105,100.00	YES	based on quote from J.W. and D.E. Ryan
Mechanical: Piping insulation	-	-	-	-	-	-	-	$48,515.00	YES	based on quote from J.W. and D.E. Ryan
Mechanical: Equipment costs	-	-	-	-	-	-	-	$263,020.00	YES	based on quote from J.W. and D.E. Ryan
Mechanical: Condensate drains	-	-	-	-	-	-	-	$18,450.00	YES	based on quote from J.W. and D.E. Ryan
Mechanical: Bore hole excavation and installation	-	-	-	-	-	-	-	$446,250.00	YES	based on quote from J.W. and D.E. Ryan, 35 bore holes at 500 ft. deep
Mechanical: Startup and comissioning services for 1 year	-	-	-	-	-	-		$20,400	YES	based on quote from J.W. and D.E. Ryan
Fire protection: Portable fire extinguishers, CO2, with hose and "H" horn, 15 lb.	10 44 16.13 0160	13	Ea.	$380.00	$374.93	$4,874.11	$374.93	$4,874.11	NO	
Fire protection: Fire panel system	-	71595	S.F.	-	-	-	$6.00	$429,570.00	YES	based on national averages
Fire protection: Automatic sprinkler system	-	71595	S.F.	-	-	-	$3.00	$214,785.00	YES	based on national averages
Fire protection: Smoke and CO2 detectors	-	65	-	-	-	-	$60.00	$3,900.00	YES	https://tinyurl.com/y6uwzw58
Ventillation: Ventacity VS 500 SQ Equipment + Install	-	25	Ea.	-	-	-	$14,400.00	$360,000.00	YES	based on quote from J.W. and D.E. Ryan
Ventillation: Ventacity VS 3000 Equipment + Install	-	5	Ea.	-	-	-	$90,000.00	$450,000.00	YES	based on quote from J.W. and D.E. Ryan
Contingency for lighting, wiring, and plumbing	-	-	-	-	-	-	-	$1,000,000.00	YES	We added this line to include items that are outside of the scope of our design
Structure				**$265.95**	**$262.40**	**$1,457,969.44**	**$262.40**	**$1,457,969.44**		
Structure: Bracing, shear wall X-bracing, per 10' x 10' bay, one face, metal strap, 20 ga. X 6" wide	05 41 13.05	30	Ea.	$95.00	$93.73	$2,811.98	$93.73	$2,811.98	NO	
Structure: Columns, structural, steel, concrete filled, extra strong pipe, 8" diameter	05 12 23.17 0940	8122	L.F.	$90.50	$89.29	$725,236.29	$89.29	$725,236.29	NO	
Structure: Structural steel members, shop fab'd for 100-ton, 1-2 story project, bolted connections, bea	05 12 23.75 1520	11179.25	L.F.	$64.00	$63.15	$705,928.32	$63.15	$705,928.32	NO	
Structure: Open web joists, K series, 30' to 50' spans, 26K10, 13.8 lb./L.F.	05 21 19.10 0640	1478.25	L.F.	$16.45	$16.23	$23,992.85	$16.23	$23,992.85	NO	

Appendix: Finance