Orchards at Orenco Phase II

More Units…Less Cost…Still Passive

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NAPHC
September 2016

Outline

- Orchards at Orenco – Background & Context
- Orchards Ph. I vs. Orchards Ph. II
  - Design
  - Passive House Process
  - Construction
  - Feedback / Monitoring / Measured Performance
  - Challenges and Lessons Learned
  - Costs
- Orchards at Orenco – Proof of Concept?

Learning Objectives

- Demonstrate how the Passive House standard has been applied successfully to affordable housing development, serving as a model for future developments in North America, and serving as a primary path to achieving net zero energy affordable housing
- Describe the key design measures incorporated in the overall building design, enclosure and mechanical systems to achieve Passive House certification
- Describe the integrated teamwork / process used by the project team in the design, construction and operation of high performance affordable housing
- Demonstrate how efficient design and cost optimization can be used to reduce the overall development and operating costs of affordable housing

The Orchards at Orenco

- Affordable housing community in Hillsboro, OR
  - Phase I: 57 units of workforce housing (completed 6/2015)
  - Phase II: 58 units of workforce housing (completed 7/2016)
  - Phase III: 52 units of family/workforce housing (2018?)

- Developer/Owner:
  REACH Community Development

REACH Community Development

- REACH's goal is to provide **Healthy**, **Safe** and **Affordable** living

- Affordability not only includes low rents but also close proximity to work and schools, and low **monthly utility bills**

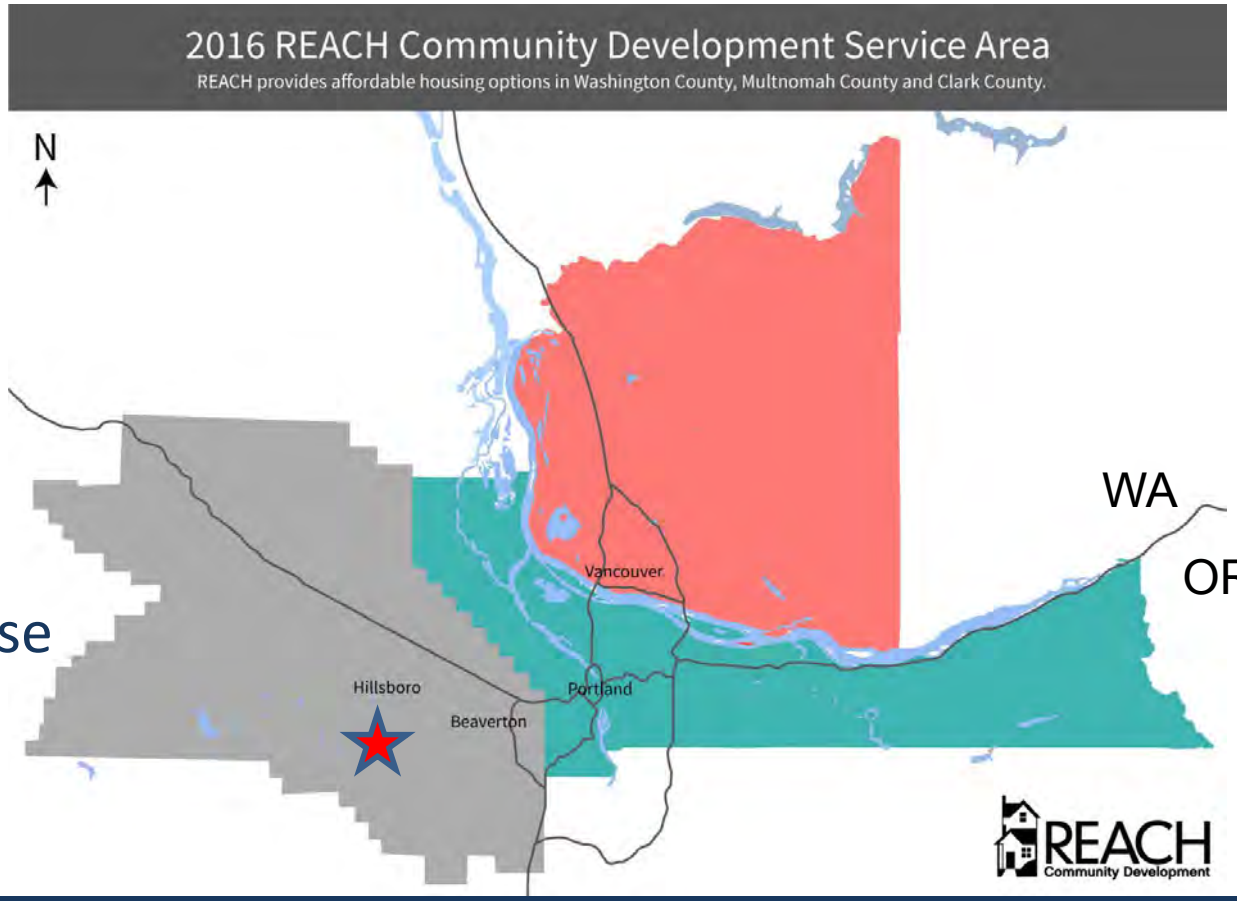
- REACH set a goal in their 2010 Strategic Plan to have a Passive House project in their portfolio by 2015

Why Passive House?

- Most rigorous building energy efficiency standard in world
- Achieve significant reductions of utility costs to residents, while improving comfort and durability
- The right path to net zero…

Orchards at Orenco - Background

- Site history
- Suburban location
- Growing community
- High-tech employer base
- Light rail

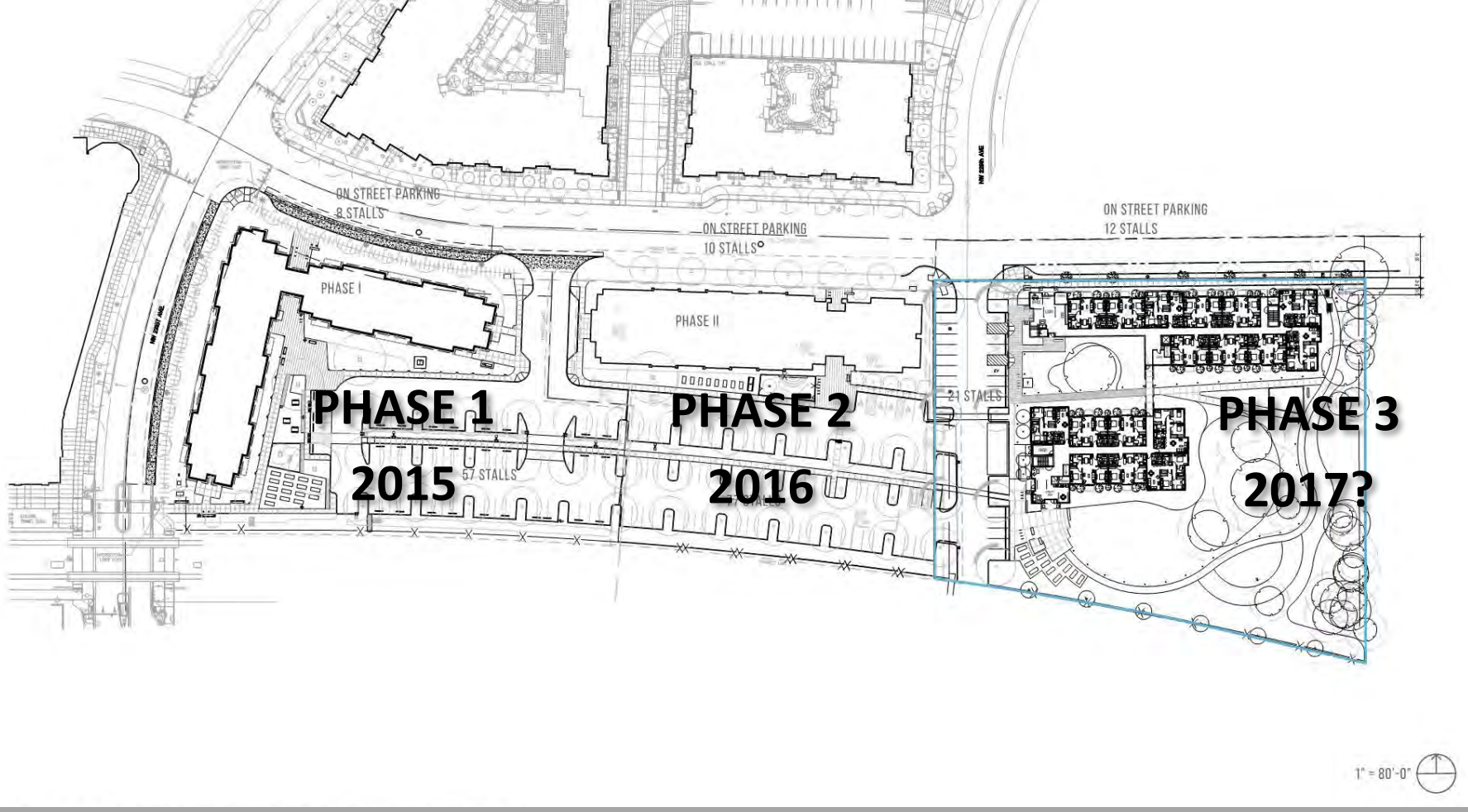


Location


INTEL
Central Park
N
N
Retail District
Neighborhood Center
Bus Line (48) and Stop
NE Cornell Rd
4 Acre Park
Sonrise Church
and Community
Gardens
Quatama
Elementary
School
Orenco Station
NE 231st Ave
High Density
Residential
(HDR)
The Platform District
Senior Affordable
Housing
(HDR)
(HDR)
Trimet
Park and Ride
REACH
Phase 1
REACH
Phase 2
REACH
Phase 3
Orenco/NW 231st Ave MAX Stop
Bus Line (47) and Stop
Farmers Market at
Plaza Park

Orchards at Orenco - Context

- Affordable living
- Amenity-rich
- Workforce
- Inclusive community
- Significant need



The Orchards at Orenco

REACH COMMUNITY DEVELOPMENT | ANKROM MOISAN ARCHITECTS | WALSH CONSTRUCTION CO.

Project Team

REACH Community Development — *Owner/Developer*

Housing Development Center — *Owner's Representative*

Ankrom Moisan — *Architect of Record*

WALSH Construction Co. — *General Contractor*

green hammer — Designed for People. Built for Life.™ — *Passive House Consultant*

william wilson architects pc — *Design Architect*

PAE — *Mechanical Engineer*

STONEWOOD DESIGN — *Structural Engineer*

Humber Design Group, Inc. — *Civil Engineer*

WALKER | MACY — *Landscape Architect*

earth advantage. — *PHIUS+ Rater*

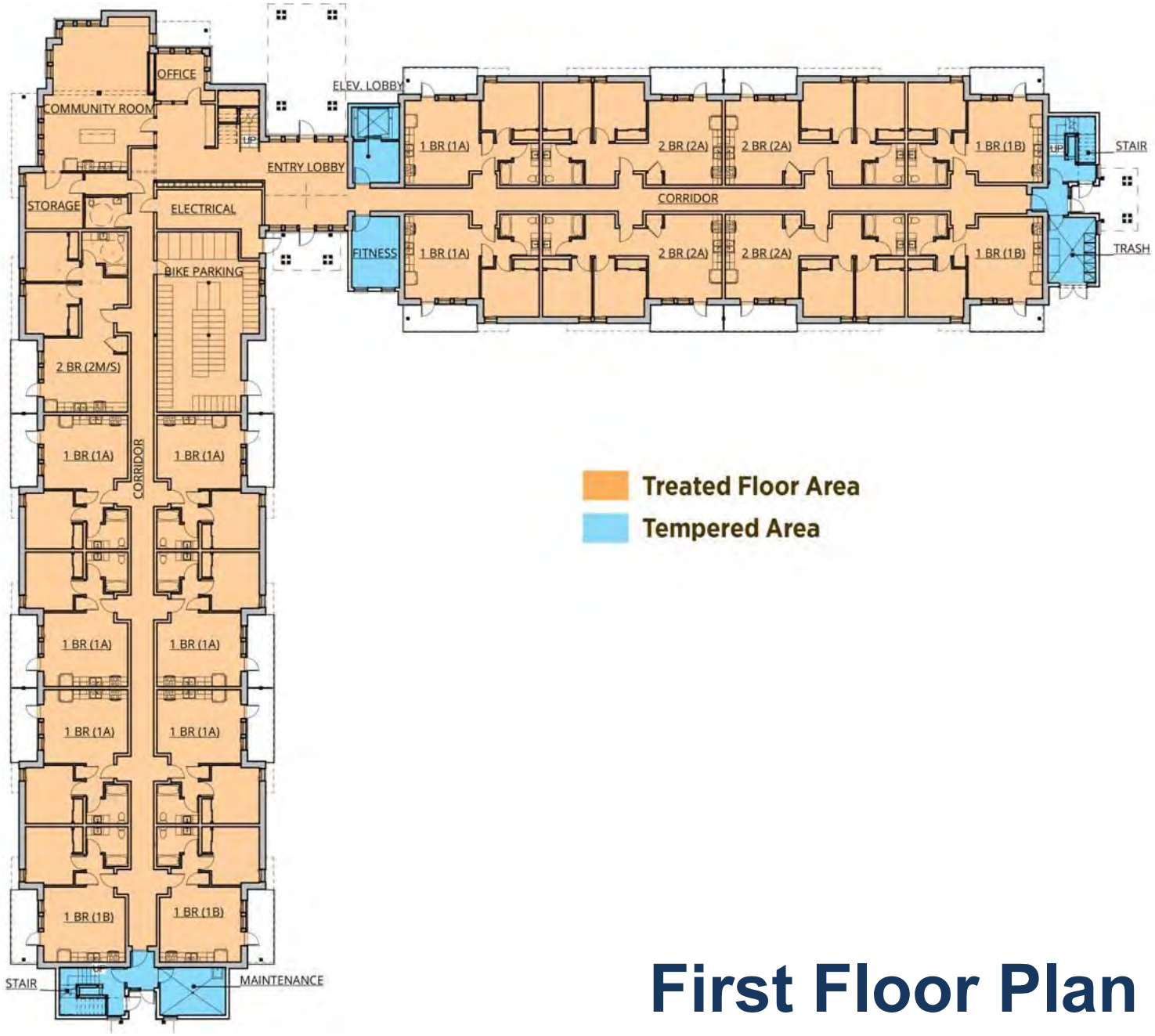
Phase I Basics

- 57 units of affordable workforce housing
- 57,750 square feet
- 3-story, wood frame construction on concrete slab-on-grade foundation

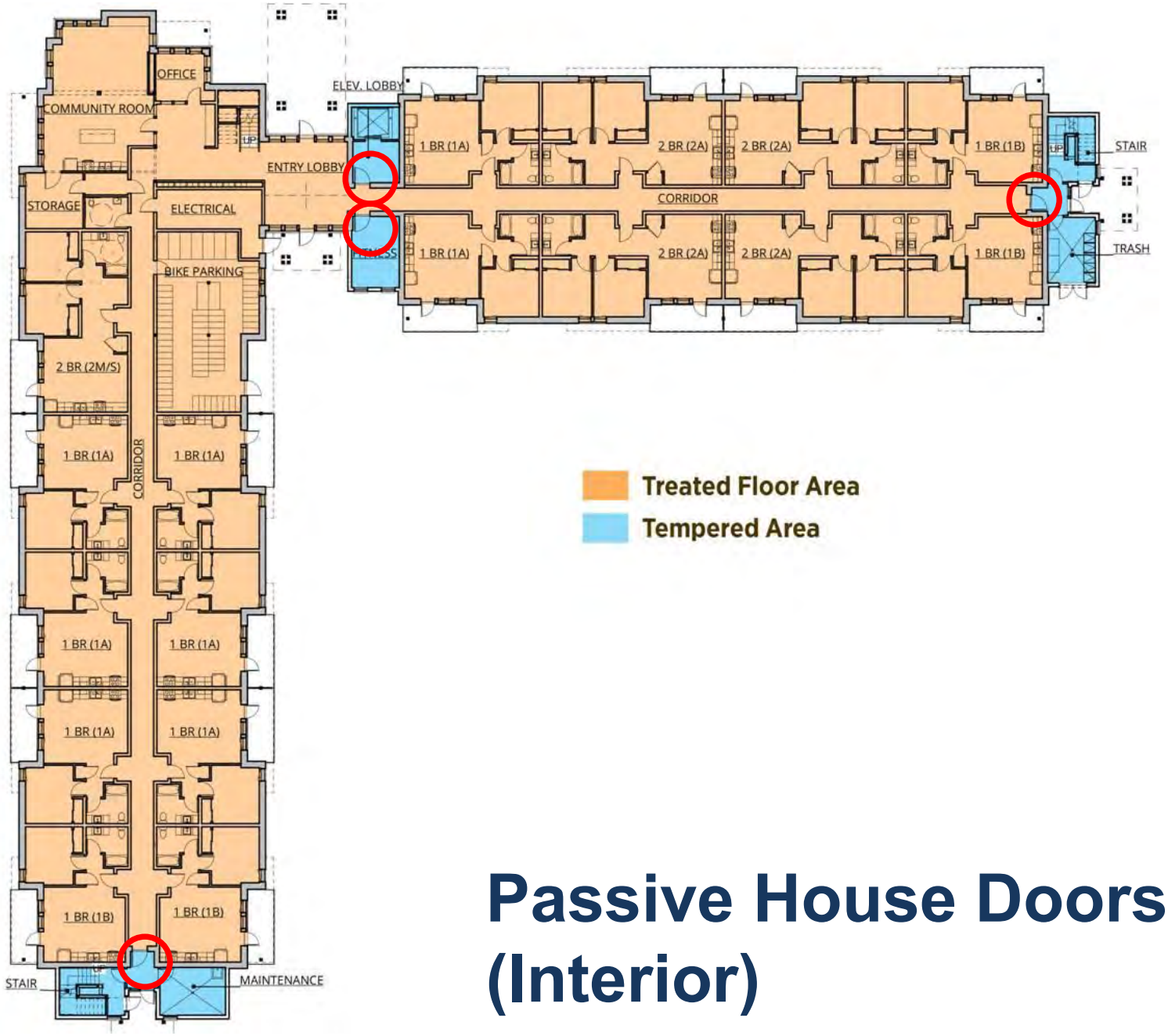
Design Overview

Photo Credit: Casey Braunger

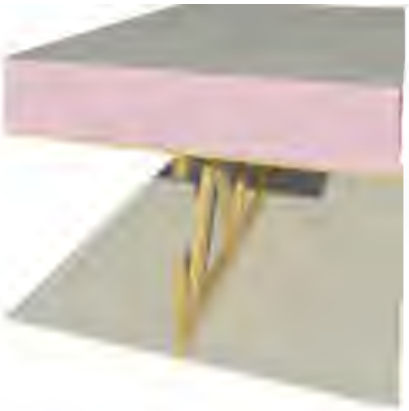
Aerial View from South



First Floor Plan

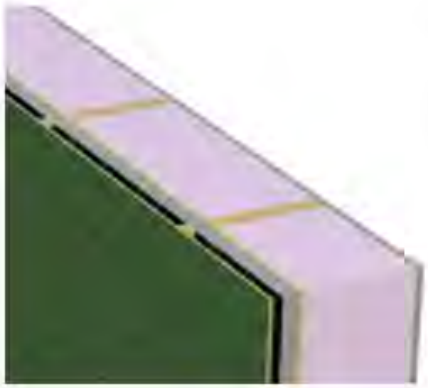


Passive House Doors (Interior)



Typical Roof Assembly: R-81

- 80 mil TPO roof membrane (fully adhered, white)
- 1/2" coverboard
- 12" polyisocyanurate insulation
- Self-adhered rubberized asphalt membrane vapor barrier (serves also as temp. roof)
- 3/4" plywood
- Prefabricated wood truss framing (trusses @ 24"o.c.)
- 5/8" gypsum wall board (2 layers)



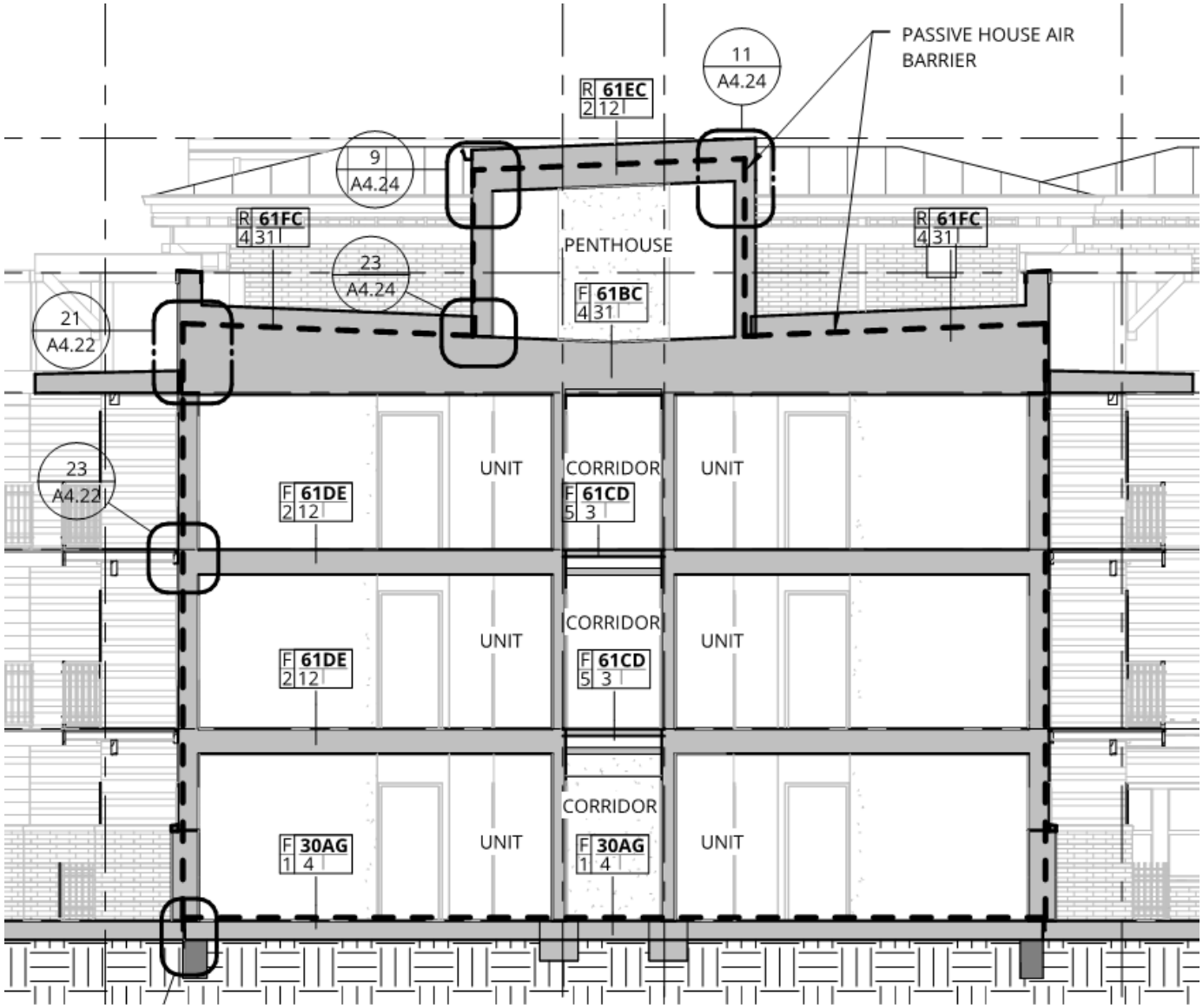
Typical Exterior Wall Assembly: R-39

- Fiber cement siding w/ treated 1x wood furring @ 24" o.c.
- 1-1/2" rigid mineral wool insulation (8 lb. density)
- Spun-bonded polyolefin sheet water-resistive barrier
- 1/2" plywood with air sealing tape at all seams
- 2x10 wood framing (studs at 24" o.c.)
- 9 1/4" blown fiberglass insulation at all framing cavities
- Polyamide sheet vapor barrier
- 5/8" gypsum wall board

Typical Slab Assembly: R-19

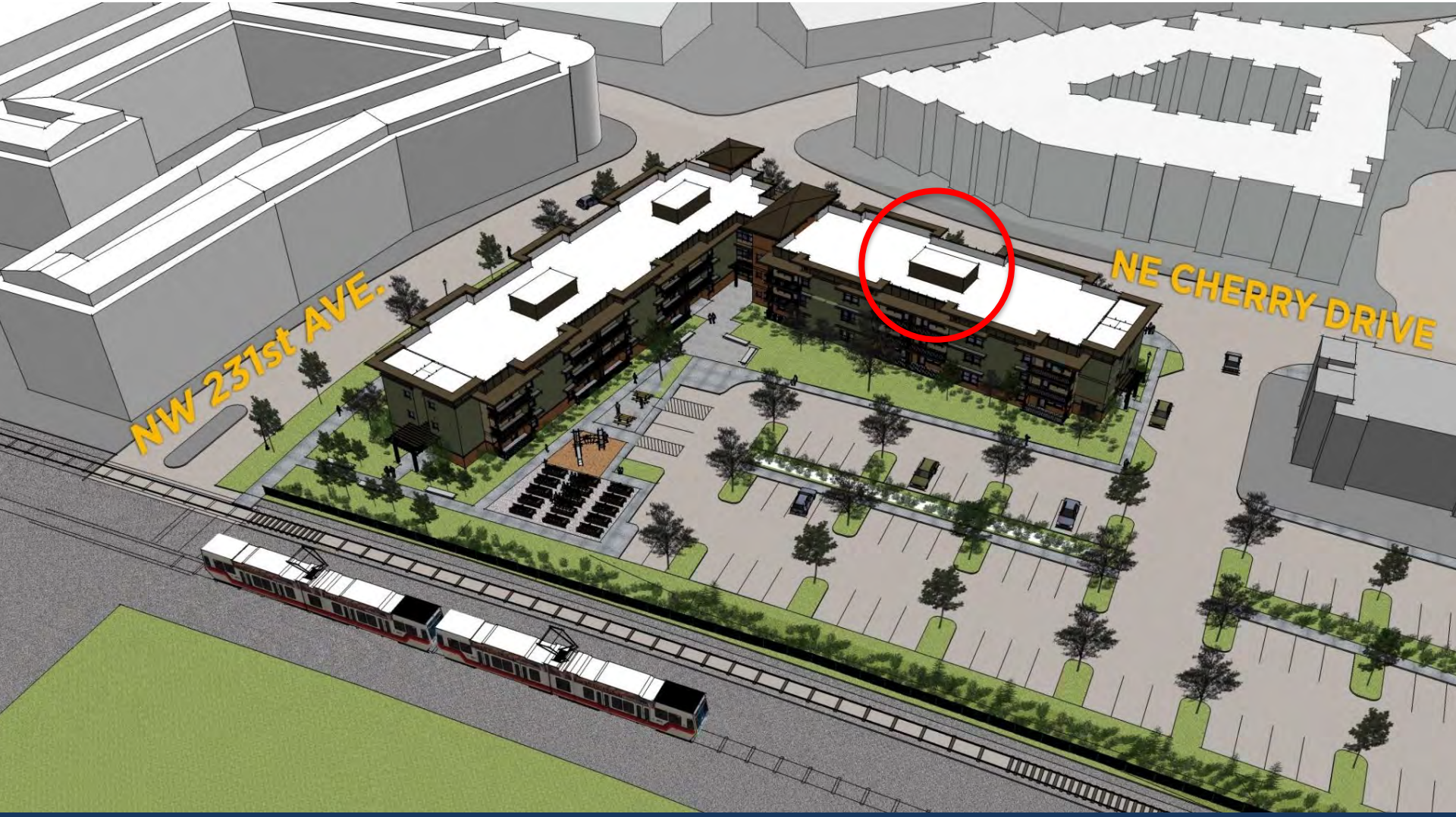
- 4" concrete slab
- 15 mil polymer sheet vapor barrier
- 4" Type II expanded polystyrene insulation
- Gravel base with radon mitigation system piping

Enclosure Assemblies



Phase I Building Section

HVAC Design



HVAC Design

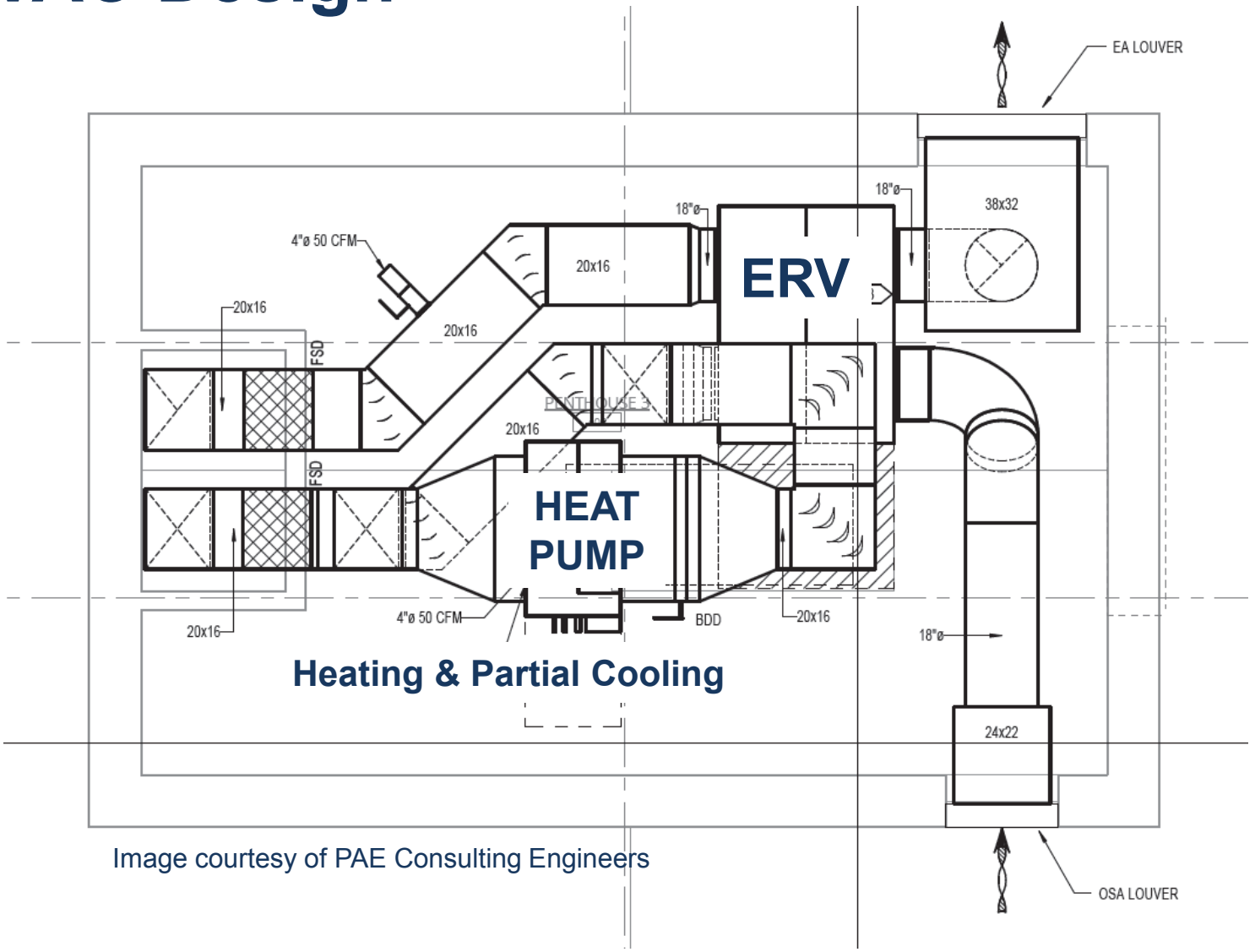
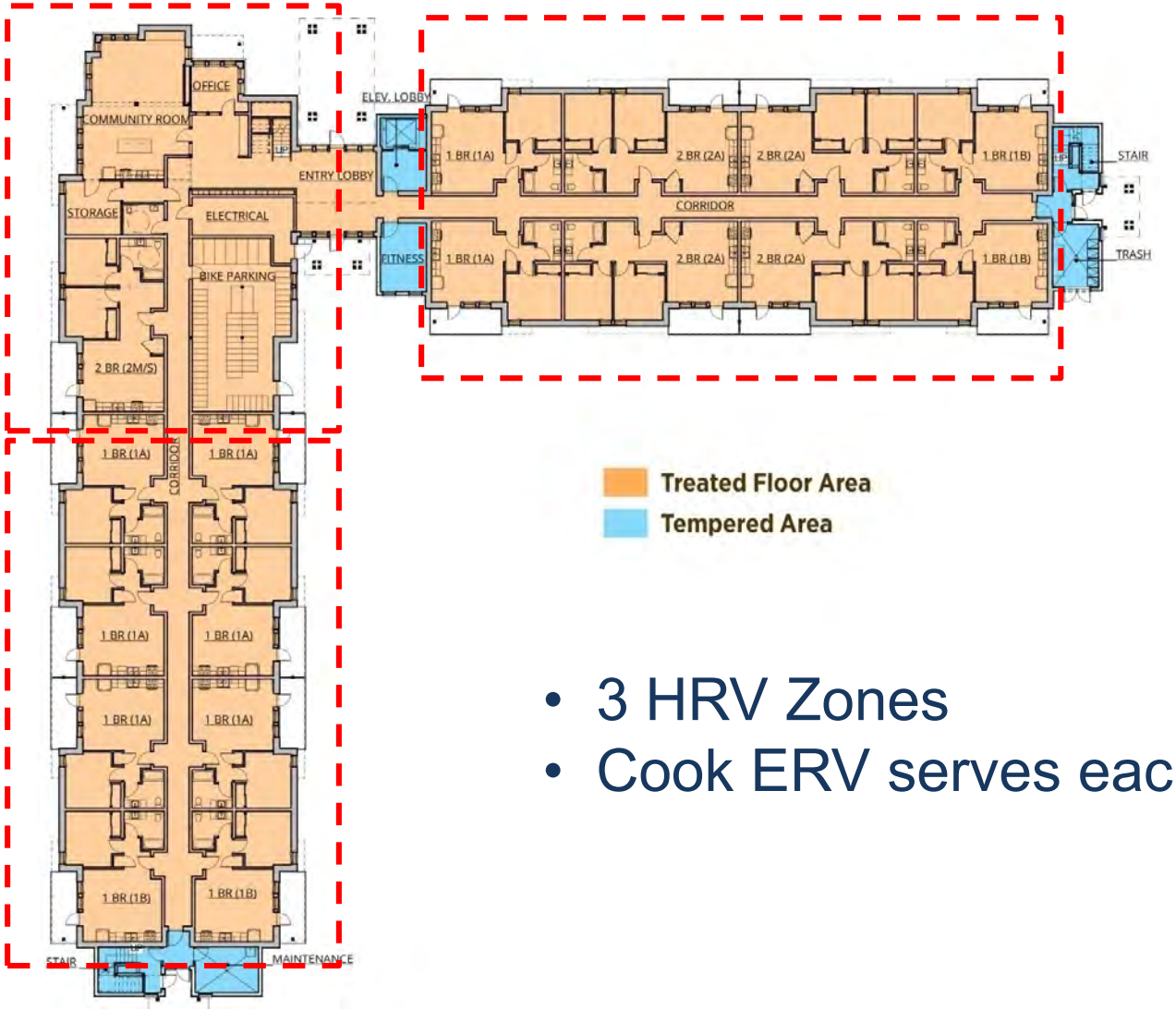


Image courtesy of PAE Consulting Engineers

Mechanical Penthouse

HVAC Design



- 3 HRV Zones
- Cook ERV serves each zone

HVAC Design

- Continuous 50cfm supply air per bedroom
- Continuous exhaust at kitchen and bath
- Electric cove heater in living room for user control & backup heat
  - Estimated at 20% of building heating load
- No active cooling at apartments

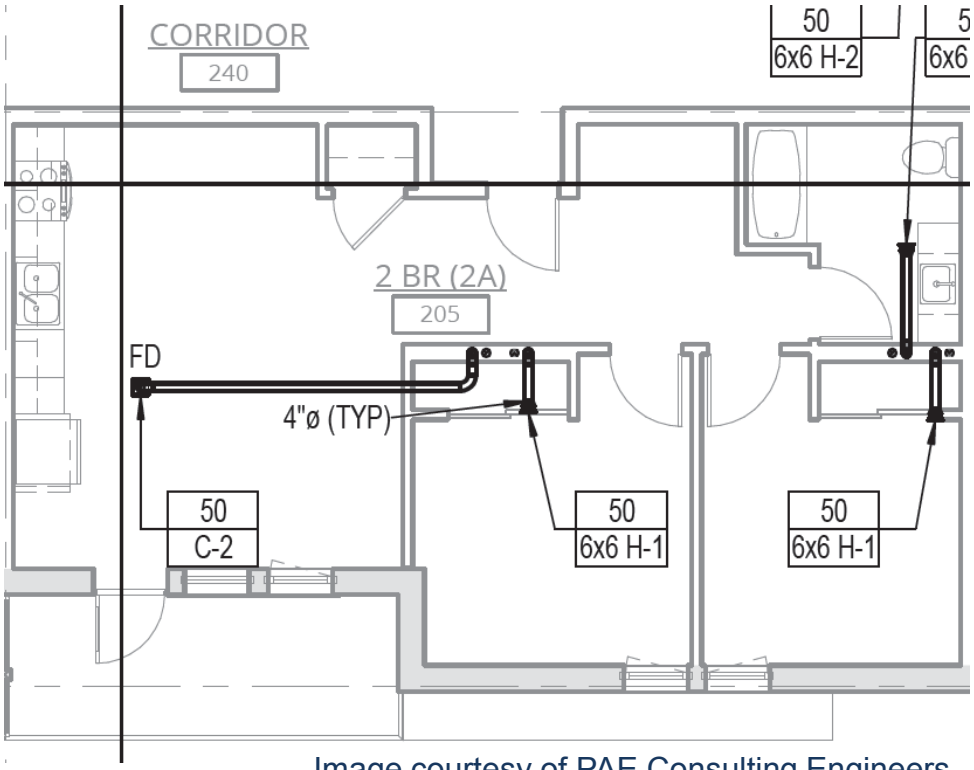
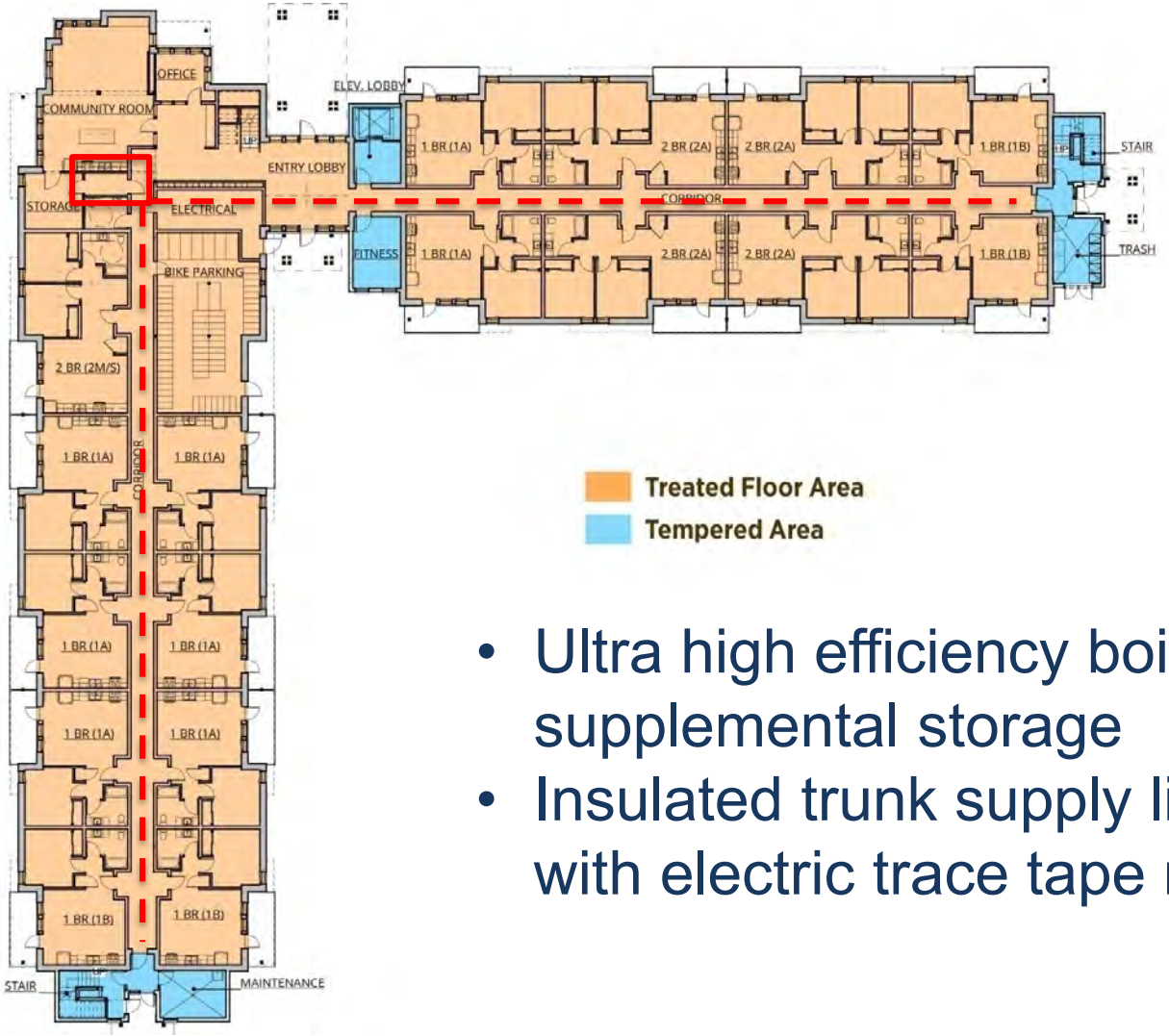


Image courtesy of PAE Consulting Engineers

Overheating?

- Exterior overhangs at all windows
- Solar blocking window screens for west facing units
- Residents need to open windows at night and close during the day…

Water Heating

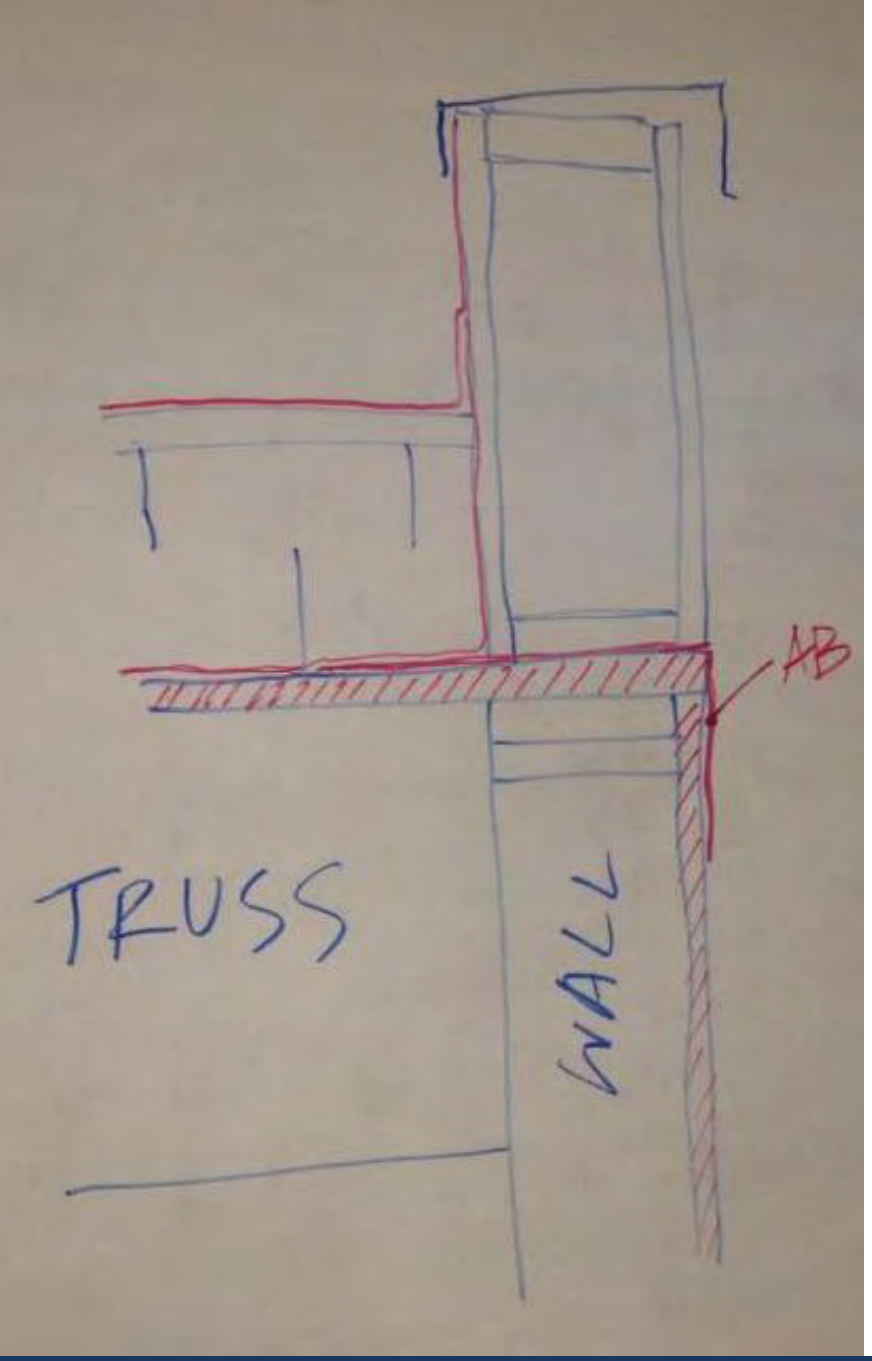


- Ultra high efficiency boiler with supplemental storage
- Insulated trunk supply lines with electric trace tape reheat

Integrated Process

- Integrated team / collaborative approach
  - Owner + design team + construction team

- Design Charrette, leading to early concepts…

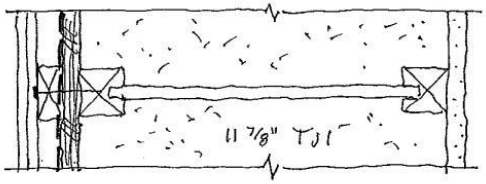


ORCHARDS @ ORENCO — EXT. WALL OPTIONS

2/29/12

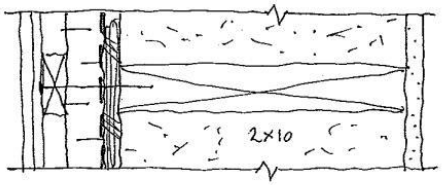
WALL (A)
- 11 7/8" TJI WALL FRAMING
- 11 7/8" BLOWN FG INSUL.

WWR-VALUE = R-39
MOISTURE: FAIR



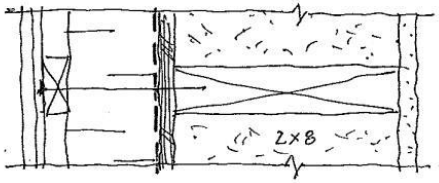
WALL (B)
- 2x10 WALL FRAMING
- 9 1/4" BLOWN FG INSUL.
- 1 1/4" MINERAL WOOL EXT. INSUL.

WWR-VALUE =
MOISTURE: GOOD



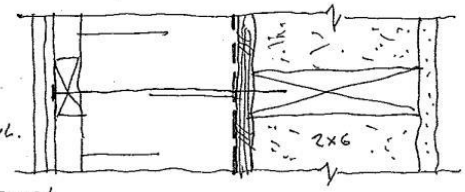
WALL (C)
- 2x8 WALL FRAMING
- 7 1/4" BLOWN FG INSUL.
- 3" MINERAL WOOL EXT. INSUL.

WWR-VALUE =
MOISTURE: BETTER R-40



WALL (D)
- 2x6 WALL FRAMING
- 5 1/2" BLOWN FG INSUL.
- 5" MINERAL WOOL EXT. INSUL.

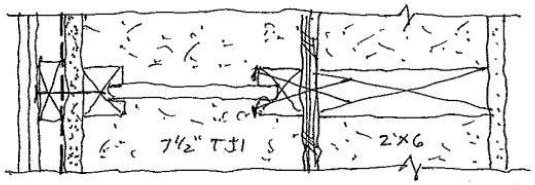
WWR-VALUE =
MOISTURE: BEST! R-41



WALL (E)
- 2x6 WALL FRAMING
- 5 1/2" BLOWN FG INSUL.
- 7 1/2" BLOWN FG INSUL. w/ 7 1/2" TJI TRUSS.

WWR-VALUE =

MOISTURE: ?



Integrated Process

- Integrated team / collaborative approach
  - Owner + design team + construction team
- Design Charrette, leading to early concepts…
- Highly iterative process
  - Design work → modeling work → cost analysis → constructability review
  - Repeat…

The Orchards at Orenco - Phase I
Passivhaus Energy Modeling

PHPP Schematic Design Results - CFC Application Iterations

3/14/2012

green hammer
DESIGN | BUILD | ENERGY
1323 SE 6th Avenue, Portland, Oregon 97214
503-804-1746

Iteration / Item	#7 Thick Windows (New Window Schedule)	R-value	#8 Thick Wall (New Window Schedule)	R-value		#9a CFC App Iterations Wall B,C,D + Cascadia + 80cfm	R-value	#9b CFC App Iterations Wall B,C,D + Cascadia + 60cfm	R-value	#9c CFC App Iterations Wall B,C,D + Zola + 60cfm	R-value	#10a CFC App Iterations Wall E + Cascadia + 80cfm	R-value	#10b CFC App Iterations Wall E + Cascadia + 60cfm	R-value	#10c CFC App Iterations Wall E + Zola + 60cfm	R-value
Walls	2x8 w/ Spray FG	28	2x6 w 5" Mineral Wool	43	UPDATED CLIMATE DATA, ENVELOPE, & FLOOR AREA, THERMAL MASS, APPLIANCE & LIGHTING CALCULATIONS	Wall C: 2x8 + 3" Mineral Wool	42	Wall C: 2x8 + 3" Mineral Wool	42	Wall C: 2x8 + 3" Mineral Wool	42	Wall E: 2x6 + 9.5" TJI	61	Wall E: 2x6 + 9.5" TJI	61	Wall E: 2x6 + 9.5" TJI	61
Window - typ size, apts	3x5 ft T/T & Fixed		3x5 ft T/T & Fixed			3x5 ft T/T & Fixed		3x5 ft T/T & Fixed		3x5 ft T/T & Fixed		3x5 ft T/T & Fixed		3x5 ft T/T & Fixed		3x5 ft T/T & Fixed	
Window - typ size, lobby	Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T			Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T	
Window - typ size, corridor end	(2) 3x5 ft		(2) 3x5 ft			(2) 3x5 ft		(2) 3x5 ft		(2) 3x5 ft		(2) 3x5 ft		(2) 3x5 ft		(2) 3x5 ft	
Window:Wall Ratio, average	18%		18%			18%		18%		18%		18%		18%		18%	
Window - frame, apts	uPVC T/T	6.0	Casc 300 T/T overinsulated	4.5		Casc 300 T/T overinsulated	4.5	Casc 300 T/T overinsulated	4.5	uPVC T/T overinsulated	6.0	Casc 300 T/T overinsulated	4.5	Casc 300 T/T overinsulated	4.5	uPVC T/T overinsulated	6.0
Window - frame, lobby	uPVC T/T	6.0	Casc 400+300 overinsulated	4.2		Casc 300 T/T overinsulated	4.5	Casc 300 T/T overinsulated	4.5	uPVC T/T overinsulated	6.0	Casc 300 T/T overinsulated	4.5	Casc 300 T/T overinsulated	4.5	uPVC T/T overinsulated	6.0
Window - glass south	EU IGU 0.5/0.5	11.4	LoE 180/180 Argon	7.5		LoE 180/180 Argon	7.5	LoE 180/180 Argon	7.5	EU IGU 0.5/0.5	11.4	LoE 180/180 Argon	7.5	LoE 180/180 Argon	7.5	EU IGU 0.5/0.5	11.4
Window - glass north	EU IGU 0.5/0.5	11.4	LoE 366/180 Argon	8.2		LoE 180/180 Argon	7.5	LoE 180/180 Argon	7.5	EU IGU 0.5/0.5	11.4	LoE 180/180 Argon	7.5	LoE 180/180 Argon	7.5	EU IGU 0.5/0.5	11.4
Window - glass east	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2		LoE 366/180 Argon	8.2	LoE 366/180 Argon	8.2	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2	LoE 366/180 Argon	8.2	EU IGU 0.5 solar control	11.4
Window - glass west	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2		LoE 366/180 Argon	8.2	LoE 366/180 Argon	8.2	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2	LoE 366/180 Argon	8.2	EU IGU 0.5 solar control	11.4
Doors - frame	uPVC T/T Door	5.9	Casc 301 T/T Door overinsul	4.7		Casc 301 T/T Door overinsul	4.7	Casc 301 T/T Door overinsul	4.7	uPVC T/T Door overinsulated	5.9	Casc 301 T/T Door overinsul	4.7	Casc 301 T/T Door overinsul	4.7	uPVC T/T Door overinsulated	5.9
Roof	10" EPS over Sheathing	49	10" EPS over Sheathing	49		10" EPS over Sheathing	49	10" EPS over Sheathing	49	10" EPS over Sheathing	49	10" EPS over Sheathing	49	10" EPS over Sheathing	49	10" EPS over Sheathing	49
Slab-field	Slab w 4" EPS	19	Slab w 4" EPS	19		Slab w 4" EPS	19	Slab w 4" EPS	19	Slab w 4" EPS	19	Slab w 4" EPS	19	Slab w 4" EPS	19	Slab w 4" EPS	19
Slab-footer	Slab w 2" EPS	10	Slab w 2" EPS	10		Slab w 2" EPS	10	Slab w 2" EPS	10	Slab w 2" EPS	10	Slab w 2" EPS	10	Slab w 2" EPS	10	Slab w 2" EPS	10
Slab-edge	Slab w 6" EPS	29	Slab w 6" EPS	29		Slab w 6" EPS	29	Slab w 6" EPS	29	Slab w 6" EPS	29	Slab w 6" EPS	29	Slab w 6" EPS	29	Slab w 6" EPS	29
Thermal Mass	Dbl Drywall Walls & Ceilings Gypcrete flr w/o carpet		Dbl Drywall Walls & Ceilings Gypcrete flr w/o carpet			Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet		Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet		Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet		Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet		Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet		Dbl 5/8" Drywall Walls & Ceilings 1 1/2" Gypcrete flr w/o carpet	
Ventilation Rate (ACH)	0.32		0.32			0.87 ACH		0.65 ACH		0.65 ACH		0.87 ACH		0.65 ACH		0.65 ACH	
Ventilation Rate (cfm per apt)						80 cfm/apt		60 cfm/apt		60 cfm/apt		80 cfm/apt		60 cfm/apt		60 cfm/apt	
HRV recovery efficiency	88% (Zehnder HRVs)		83% (Ultimate Air ERV)			83% (Ultimate Air ERV)		83% (Ultimate Air ERV)		83% (Ultimate Air ERV)		83% (Ultimate Air ERV)		83% (Ultimate Air ERV)		83% (Ultimate Air ERV)	
HRV electrical efficiency (W/cfm)	0.75		0.75			0.75 W/cfm		0.75 W/cfm		0.75 W/cfm		0.75 W/cfm		0.75 W/cfm		0.75 W/cfm	
Space Heating						80% Heat Pump, COP = 4.2 20% Direct Electric		80% Heat Pump, COP = 4.2 20% Direct Electric		80% Heat Pump, COP = 4.2 20% Direct Electric		80% Heat Pump, COP = 4.2 20% Direct Electric		80% Heat Pump, COP = 4.2 20% Direct Electric		80% Heat Pump, COP = 4.2 20% Direct Electric	
Water Heating						Gas Boiler, 93% eff. Tank loss 250 BTU/hr		Gas Boiler, 93% eff. Tank loss 250 BTU/hr		Gas Boiler, 93% eff. Tank loss 250 BTU/hr		Gas Boiler, 93% eff. Tank loss 250 BTU/hr		Gas Boiler, 93% eff. Tank loss 250 BTU/hr		Gas Boiler, 93% eff. Tank loss 250 BTU/hr	
Other	SPF in Plumbing Stack		SPF in Plumbing Stack			Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF		Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF		Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF		Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF		Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF		Plumbing/Downspout Stacks: (8) 2x12, 24" stud bays filled with SPF	
Heat Demand, Annual (kBTU/sf) Passivhaus Limit = 4.75 Recommend at this Stage = 3.8	**3.83**		**3.82**			**5.51 kBTU/sf.yr**		**4.88 kBTU/sf.yr**		**4.08 kBTU/sf.yr**		**4.92 kBTU/sf.yr**		**4.30 kBTU/sf.yr**		**3.52 kBTU/sf.yr**	
Heat Load, Whole Bldg (BTU/hr)	104395		103183			112789 BTU/hr		105356 BTU/hr		95652 BTU/hr		105549 BTU/hr		98117 BTU/hr		88412 BTU/hr	
% Htg Deilverable w/ Ventilation Air	116%		121%			287%		230%		254%		307%		247%		275%	
Cooling Strategy	HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only			HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only		HRV w/o heat recovery Windows open night only	
Frequency of Overheating (>77°F) Recommend 0% for whole bldg	0.0%		0.0%			0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	
Primary Energy, Annual* (kWh/sf.yr) With Solar Thermal Collectors Passivhaus Limit = 11.1 Recommend at this Stage = 8.9						**11.1 kWh/sf.yr** 9.9 kWh/sf.yr		**10.3 kWh/sf.yr** 9.1 kWh/sf.yr		**10.1 kWh/sf.yr** 8.9 kWh/sf.yr		**10.9 kWh/sf.yr** 9.7 kWh/sf.yr		**10.1 kWh/sf.yr** 9.0 kWh/sf.yr		**9.9 kWh/sf.yr** 8.7 kWh/sf.yr	
												Annual Heat Demand with 12" Polyiso Roof: **4.47 kBTU/sf.yr**		Annual Heat Demand with 12" Polyiso Roof: **3.86 kBTU/sf.yr**			

* Data assumes PHPP default values for lighting, appliance and plug loads. Actual anticipated loads are over twice these values and will not meet the Primary Energy standard.

Image courtesy of Green Hammer

Item	Iteration #7 Thick Windows (New Window Schedule)	R-value	#8 Thick Wall (New Window Schedule)	R-value
Walls	2x8 w/ Spray FG	28	2x6 w 5" Mineral Wool	43
Window - typ size, apts	3x5 ft T/T & Fixed		3x5 ft T/T & Fixed	
Window - typ size, lobby	Ribbon of 3x5 ft T/T		Ribbon of 3x5 ft T/T	
Window - typ size, corridor end	(2) 3x5 ft		(2) 3x5 ft	
Window:Wall Ratio, average	18%		18%	
Window - frame, apts	uPVC T/T	6.0	Casc 300 T/T overinsulated	4.5
Window - frame, lobby	uPVC T/T	6.0	Casc 400+300 overinsulated	4.2
Window - glass south	EU IGU 0.5/0.5	11.4	LoE 180/180 Argon	7.5
Window - glass north	EU IGU 0.5/0.5	11.4	LoE 366/180 Argon	8.2
Window - glass east	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2
Window - glass west	EU IGU 0.5 solar control	11.4	LoE 366/180 Argon	8.2
Doors - frame	uPVC T/T Door	5.9	Casc 301 T/T Door overinsul	4.7
Roof	10" EPS over Sheathing	49	10" EPS over Sheathing	49
Slab-field	Slab w 4" EPS	19	Slab w 4" EPS	19
Slab-footer	Slab w 2" EPS	10	Slab w 2" EPS	10
Slab-edge	Slab w 6" EPS	29	Slab w 6" EPS	29
Thermal Mass	Dbl Drywall Walls & Ceilings Gypcrete flr w/o carpet		Dbl Drywall Walls & Ceilings Gypcrete flr w/o carpet	
Ventilation Rate (ACH)	0.32		0.32	
Ventilation Rate (cfm per apt)				
HRV recovery efficiency	88% (Zehnder HRVs)		83% (Ultimate Air ERV)	
HRV electrical efficiency (W/cfm)	0.75		0.75	

E, & FLOOR AREA, THERMAL MASS, APPLIANCE & LIGHTING CALCULATIONS

The Orchards at Orenco - Phase I

Passive House Energy Analysis Summary

Euroline Scenario (50% CD Set)

12/24/2013

Holiday Edition!

green hammer
Designed for People. Built for Life.
1323 SE 6th Avenue, Portland, OR. 503-804-1746

RESULTS:

Space Heating EUI:	4.24	kBTU/sf.yr	Total Source Energy EUI:	34.4	kBTU/sf.yr
Passive House Standard:	4.75	kBTU/sf.yr	Passive House Standard:	38.0	kBTU/sf.yr
Percent of Limit:	89%		Percent of Limit:	91%	

ASSUMPTIONS:

Envelope:

		R-value	
Walls:	2x10 + 1.5" mineral wool	39	
	advanced framed, 15% framing factor		
	solid blocking @ exterior structural supports		
Windows:	EuroLine T/T uPVC overinsulated	7.2	R-frame
Glazing N/S:	LoE 180/180 Ar, SHGC=0.54	7.5	
Glazing E/W:	LoE 366/180 Ar, SHGC=0.24	8.2	
Residential Doors:	Euroline T/T Door uPVC overinsul.	4.3	R-frame
	ADA sill (assumed 4600 Series)		
Glazing:	same as above		
Commercial Doors:	TBD Wood Fire-Rated Door	4.5	R-frame
Glazing:	LoE 366/180 Ar, SHGC=0.24	8.2	
Roof:	12" Polyiso over Sheathing	81	
Slab: Field:	4" EPS II	19	
Interior Footings:	1" EPS IX	6	
Perimeter Footings:	4" EPS IX	20	
Vertical Perimeter:	4" EPS II	19	
Airtightness:	0.60 ACH @ 50 Pa		

Other:

Thermal Mass:	Standard drywall
	1 inch gypcrete floor topping w/o carpet
	Carpet in bedrooms only
Cold Stacks:	Downspouts, Plumbing, Radon vents aggregated in:
	(8) 2x12, 24" stud bays filled with Dense-pack Cellulose

Heating System:

80% Heat Pump, COP = 4.15 (average all systems)
delivered via HRV supply & indoor heads
20% Electric-Resistance (in apartments)
window watcher shut-off

Ventilation System:

Ultimate Air ERV, 83% eff, 0.75 W/cfm
Apartment Ventilation: 50 cfm/apt
Comm. Rm. Ventilation: 0.06 cfm/sf baseline
CO2 sensor steps to code max req't
Circulation Ventilation: 0.06 cfm/sf
Whole-Building Ave: 0.58 ACH
Duct Insulation, HRV to Exterior: 4" FG w/ vapor barrier
Fitness/Trash Exhaust: 900 cfm direct exhaust
make-up air inlet provided from exterior to exhausted space
24 hr/day operation
0.3 W/cfm fan efficiency

DHW System:

Central Gas Heater w/ Trace Htg on Lines
Water Heater efficiency = 94%
Hot Water Line Insulation:
(11) hot water riser lines as min. 3/4" continuous
Low-flow fixtures throughout

Appliances:

Refrigerator/Freezers:	370 kWh/yr ES rating or better
Dishwashers:	275 kWh/yr ES rating or better
Clotheswashers:	184 kWh/yr ES rating or better
Clothesdryers:	gas (moisture sensing recommended)
Range/Oven:	electric (convection recommended)
Range Hood:	recirculating; charcoal filter
Elevator:	1800 kWh/yr
	i.e. Kone Ecospace, MRL Traction

Lighting:

Residential:	100% fluorescent/LED
Non-residential:	0.8 W/sf occupied areas
	0.4 W/sf storage/circulation areas
	occupancy sensing all non-residential areas

Cooling Strategy:

Windows open night only, closed during day
"Hold-opens" recommended for windows' Turn position
HRV supply air tempered by heat pump; supply temp ~50F
HRV heat recovery bypass automated by thermostat

Image courtesy of Green Hammer

Integrated Process

- Integrated team / collaborative approach
  - Owner + design team + construction team
- Design Charrette, leading to early concepts…
- Highly iterative process
  - Design work → modeling work → cost analysis → constructability review
  - Repeat…
- Coordinating the work…

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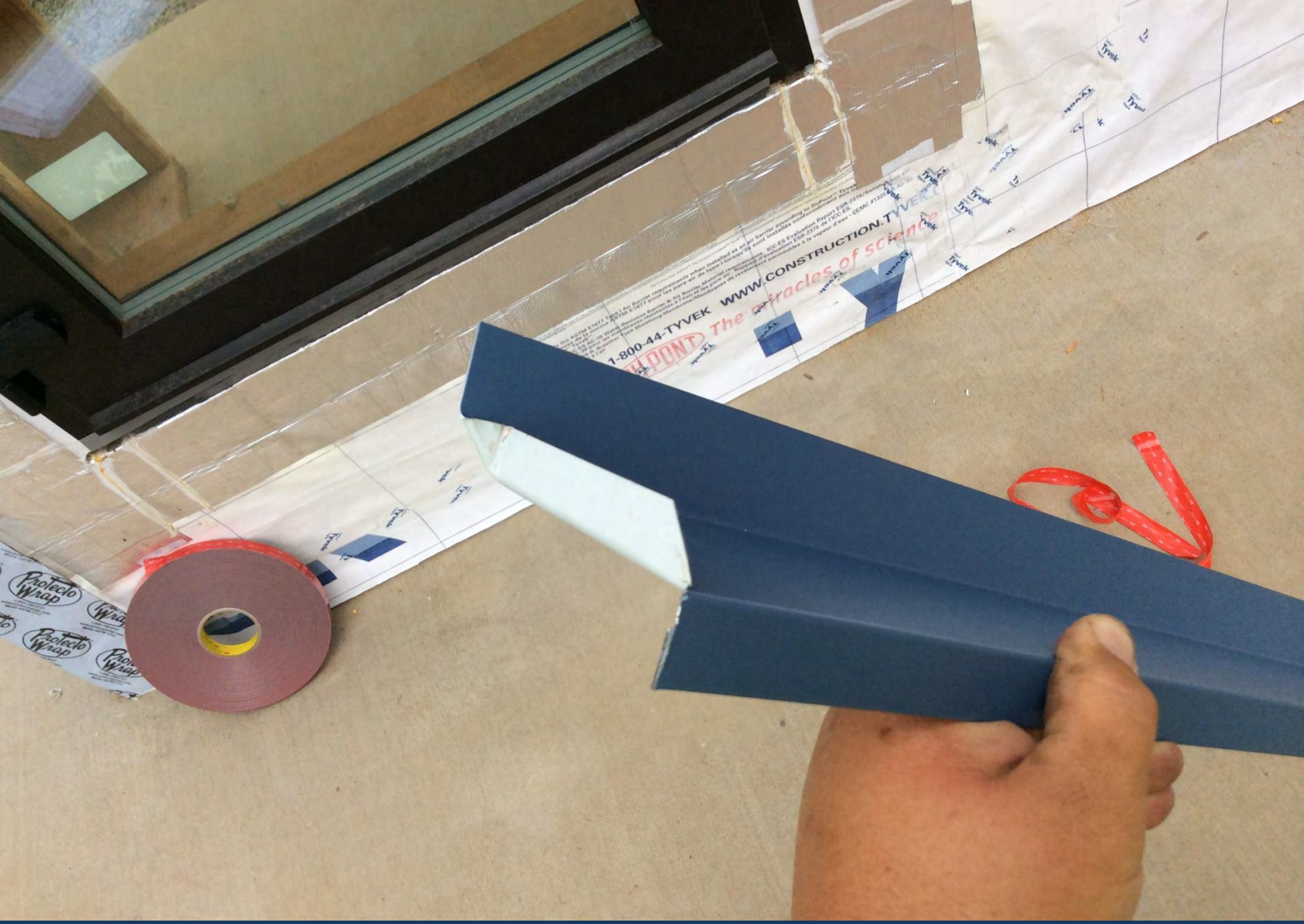
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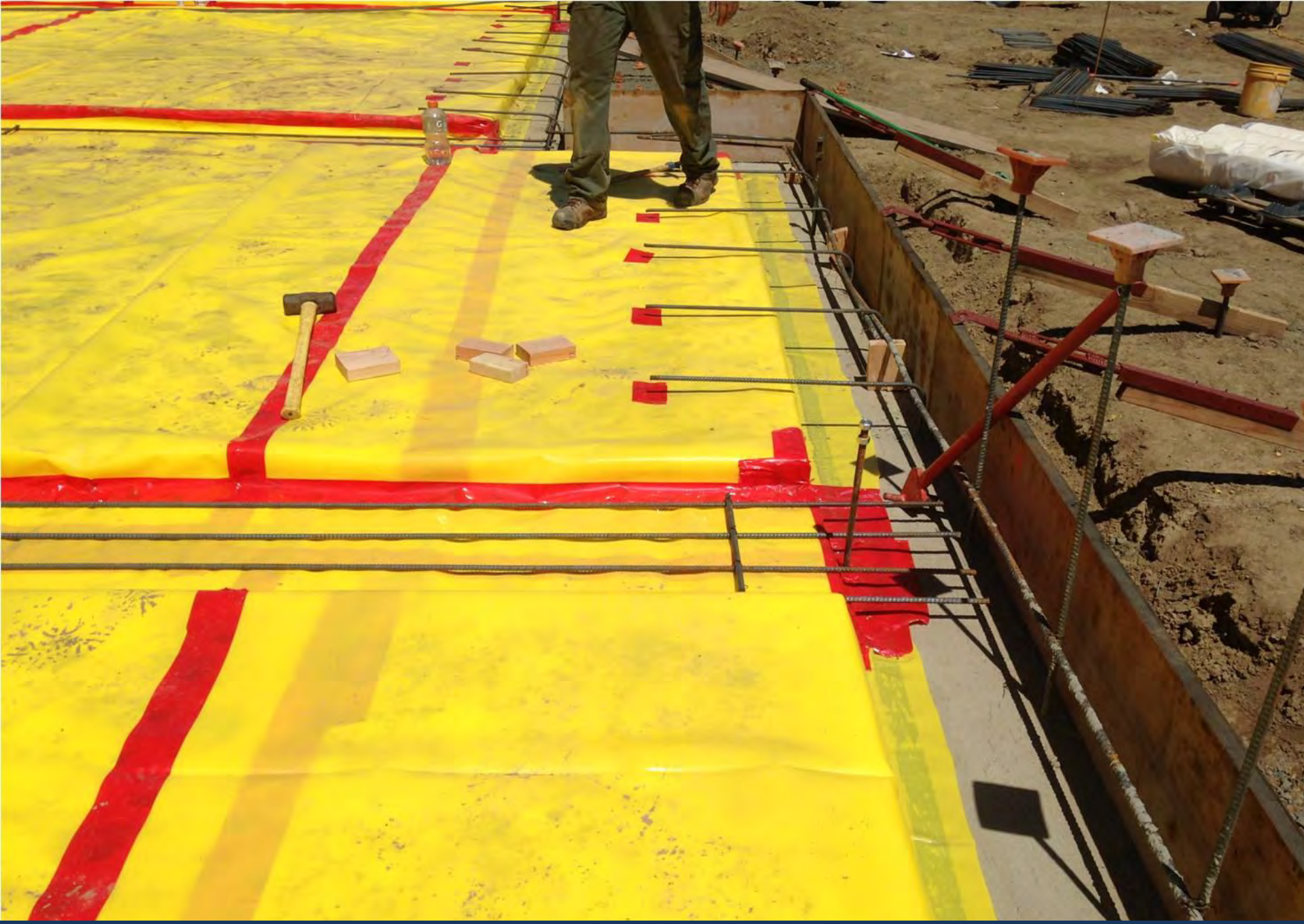

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WCC
PFG
Orchards at Orenco R1A
Location or Type
A2 ew OPP
28"1/8 x 46"1/8


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Photo Credit: Bygghouse

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Phase I - Challenges & Lessons Learned

- Architectural design interface with PHPP
- Product availability
- Airtightness
- Managing subcontractors
- Resident engagement


Do Not Enter
Door Closed for Air Testing


°F
52.0
43.6
FLIR

Preliminary Airtightness Test Result: 0.0875 ACH_{50}


EXIT

Final Airtightness Test Result: 0.133 ACH_{50}

Phase I - Lessons Learned

- Owner vision - and commitment - is pivotal

Phase I - Lessons Learned

- Owner vision - and commitment - is pivotal

- It takes a team…working collaboratively, with everyone pulling in the same direction

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Phase I - Lessons Learned

- Owner vision - and commitment - is pivotal
- It takes a team…working collaboratively, with everyone pulling in the same direction
- Early team integration pays off

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Phase I - Lessons Learned

- Owner vision - and commitment - is pivotal
- It takes a team…working collaboratively, with everyone pulling in the same direction
- Early team integration pays off
- Proactive coordination and QC is essential
- Keep it simple

Photo Credit: Casey Braunger

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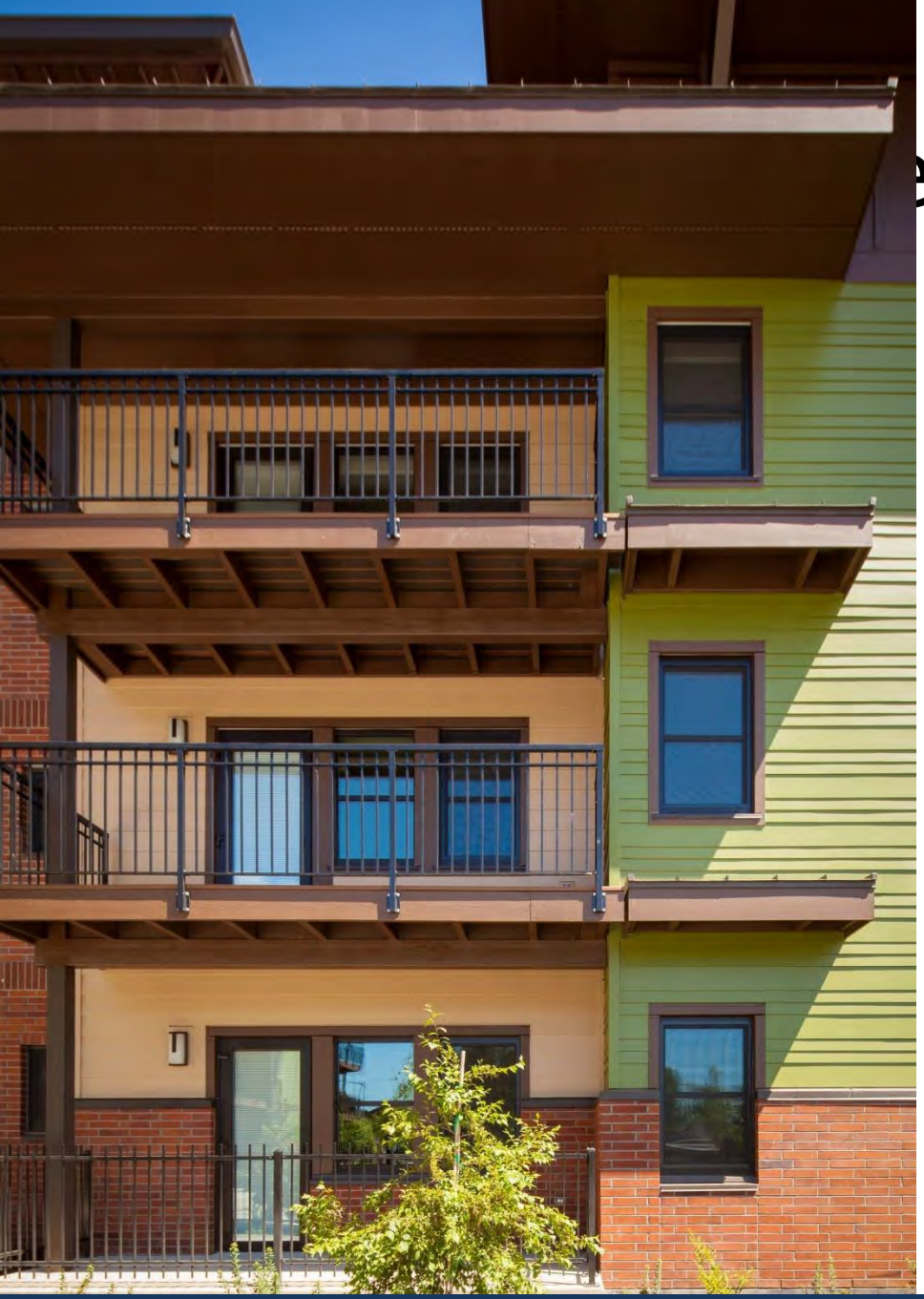

Photo Credit: Casey Braunger

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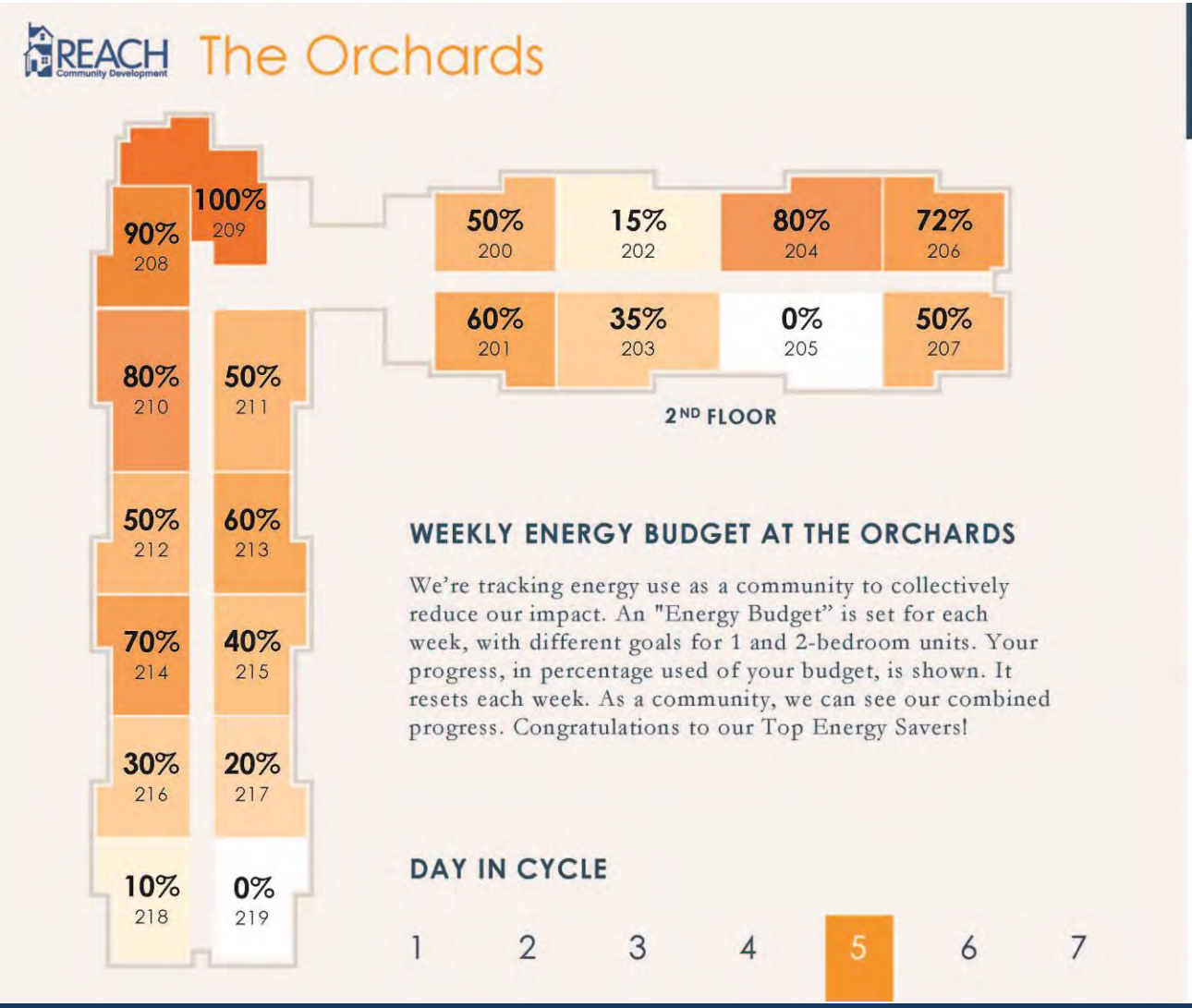
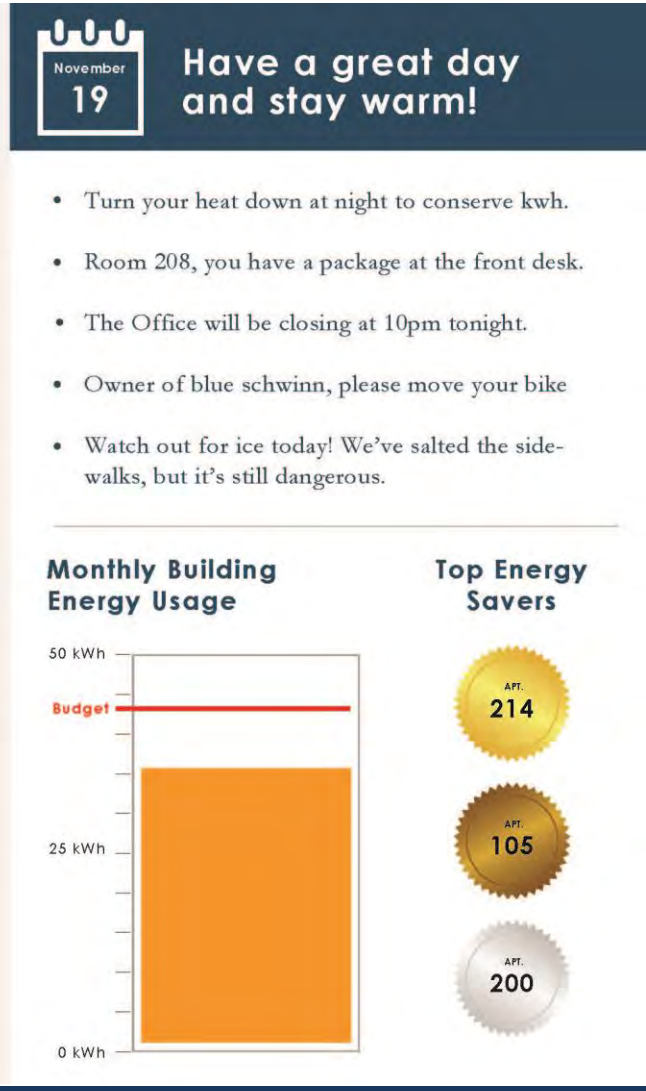
Photo Credit: Casey Braunger

The Building in Use

Photo Credit: Casey Braunger

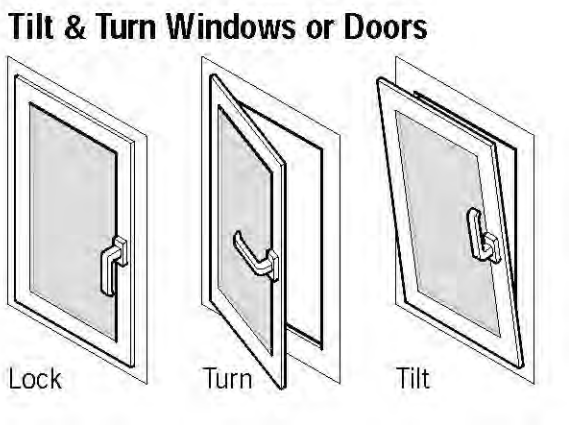
Energy Monitoring





Education

- Building Owner
  - More upfront preparation/coordination required
  - Property management & maintenance staff
  - Owner's training at turnover
  - Internal bucket meetings
- Building Tenants
  - Lease up
  - Move in
  - Ongoing



Benefits to Residents

- Utility savings estimated at $30-40/month
- Improved acoustics – can't hear the MAX train…
- IEQ – continuous fresh air
- High degree of thermal comfort

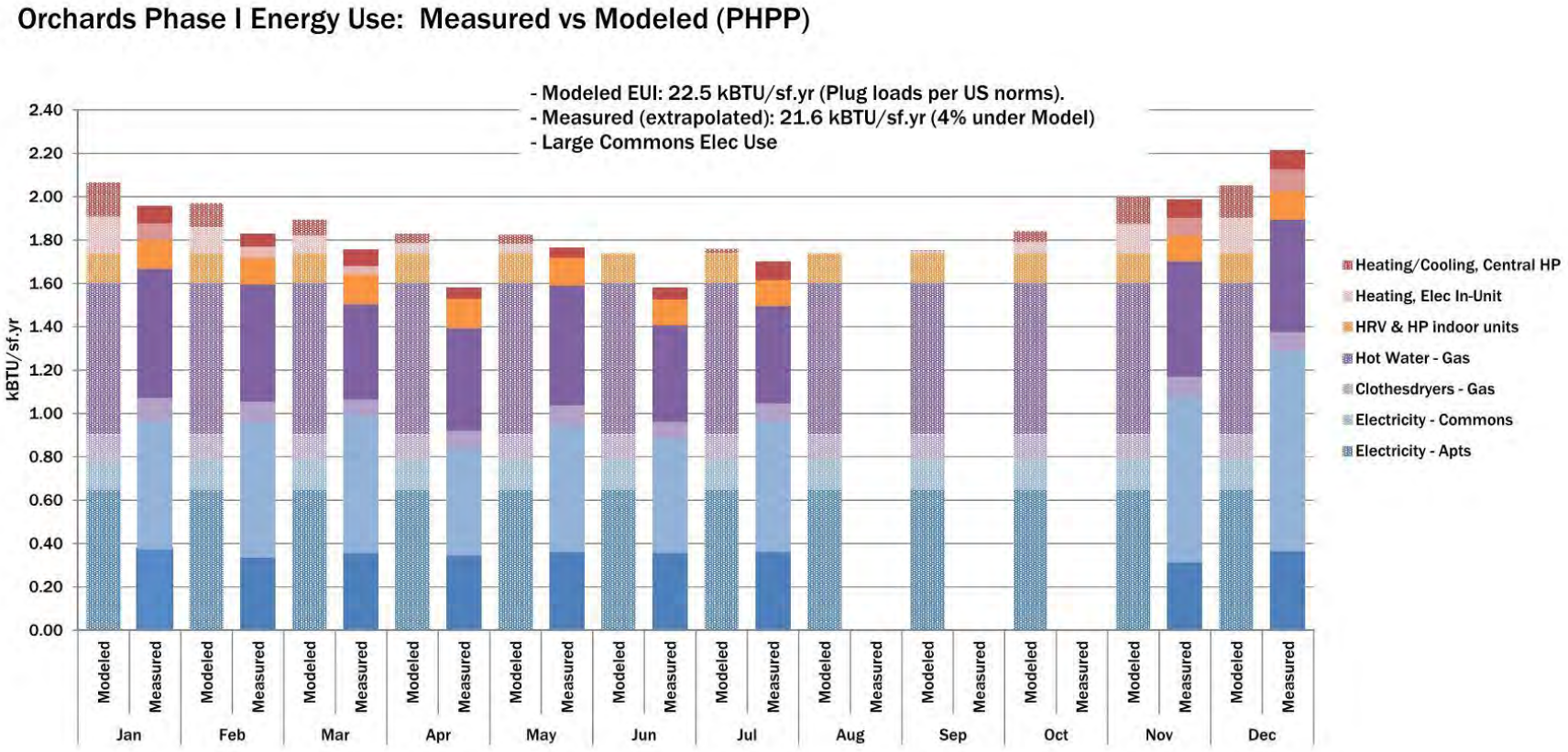
Photo Credit: Casey Braunger

Resident Satisfaction

"Every day I find a new reason to love it. It's cool, it's quiet, and I don't even hear the train. During the heat wave, my girlfriend came over to sleep because it was so cool. Yay for German engineering!"

Georgye Hamlin quoted in POLITICO

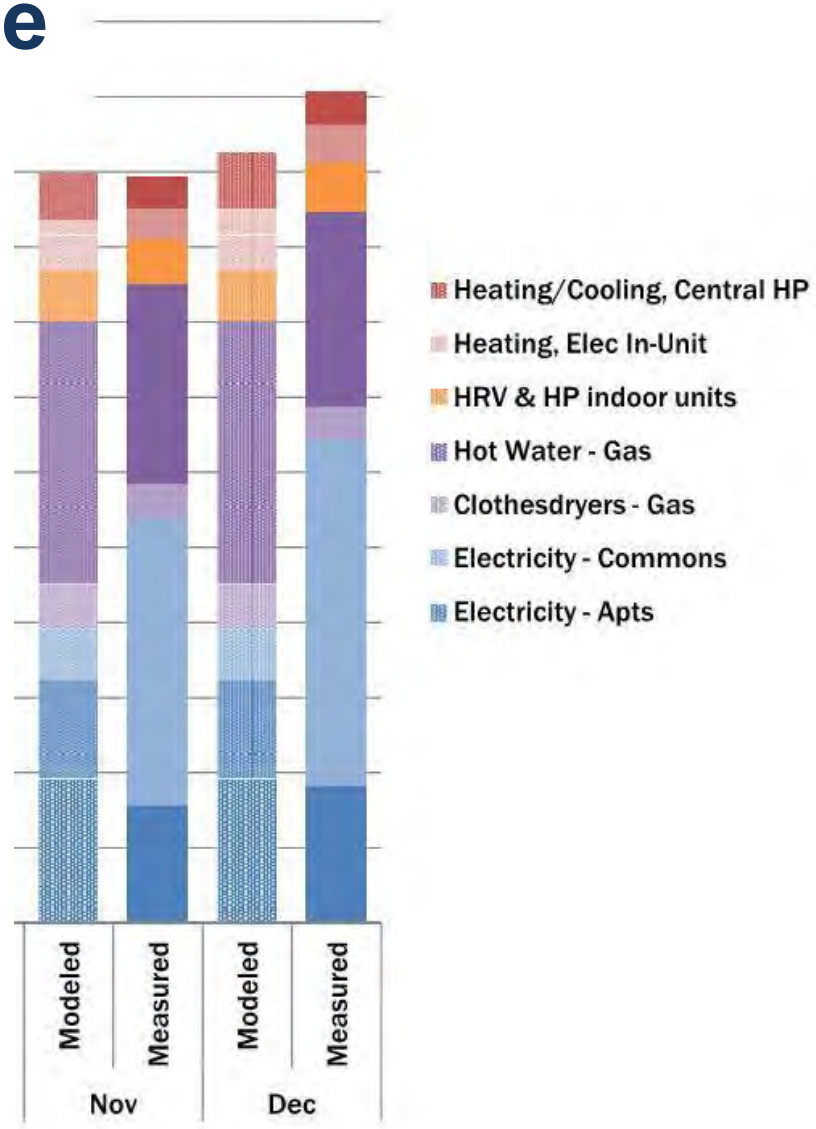
Measured Performance



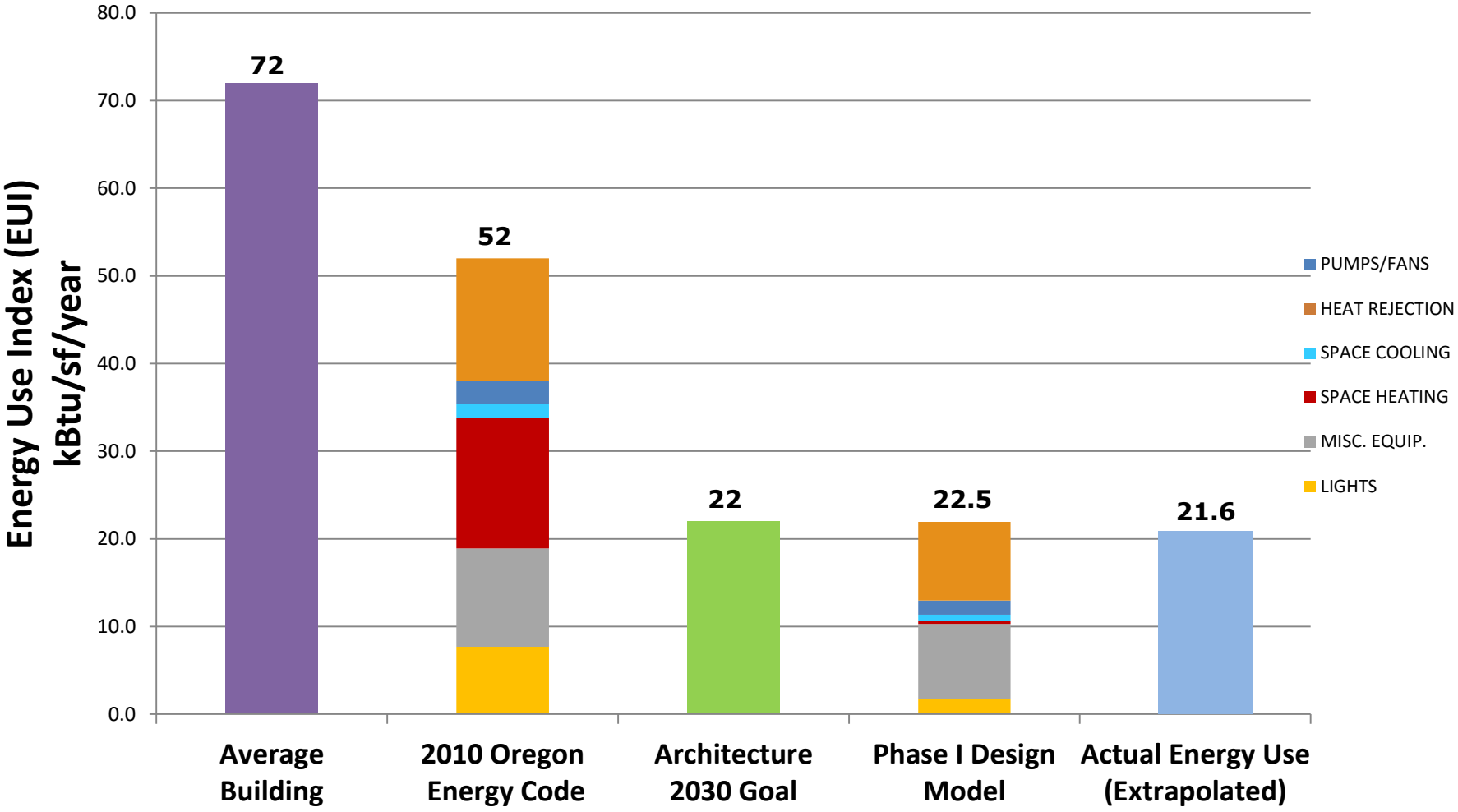
Graph courtesy of REACH Community Development / Housing Development Center

Measured Performance

- Apartments energy use lower than modeled
- Common area electricity use much higher than modeled
  - Causes have been investigated and troubleshooting is underway…
  - Fan at 3rd floor storage room that should be on timer is running continuously
  - Elevator usage higher than anticipated
  - Thermostats at freeze protection heaters in stairwells had been set at 70 degrees, have now been set to 45 degrees
  - DAS system added late during construction was not in original model (increasing site EUI slightly: approx. 0.2 kBTU/sf/yr)



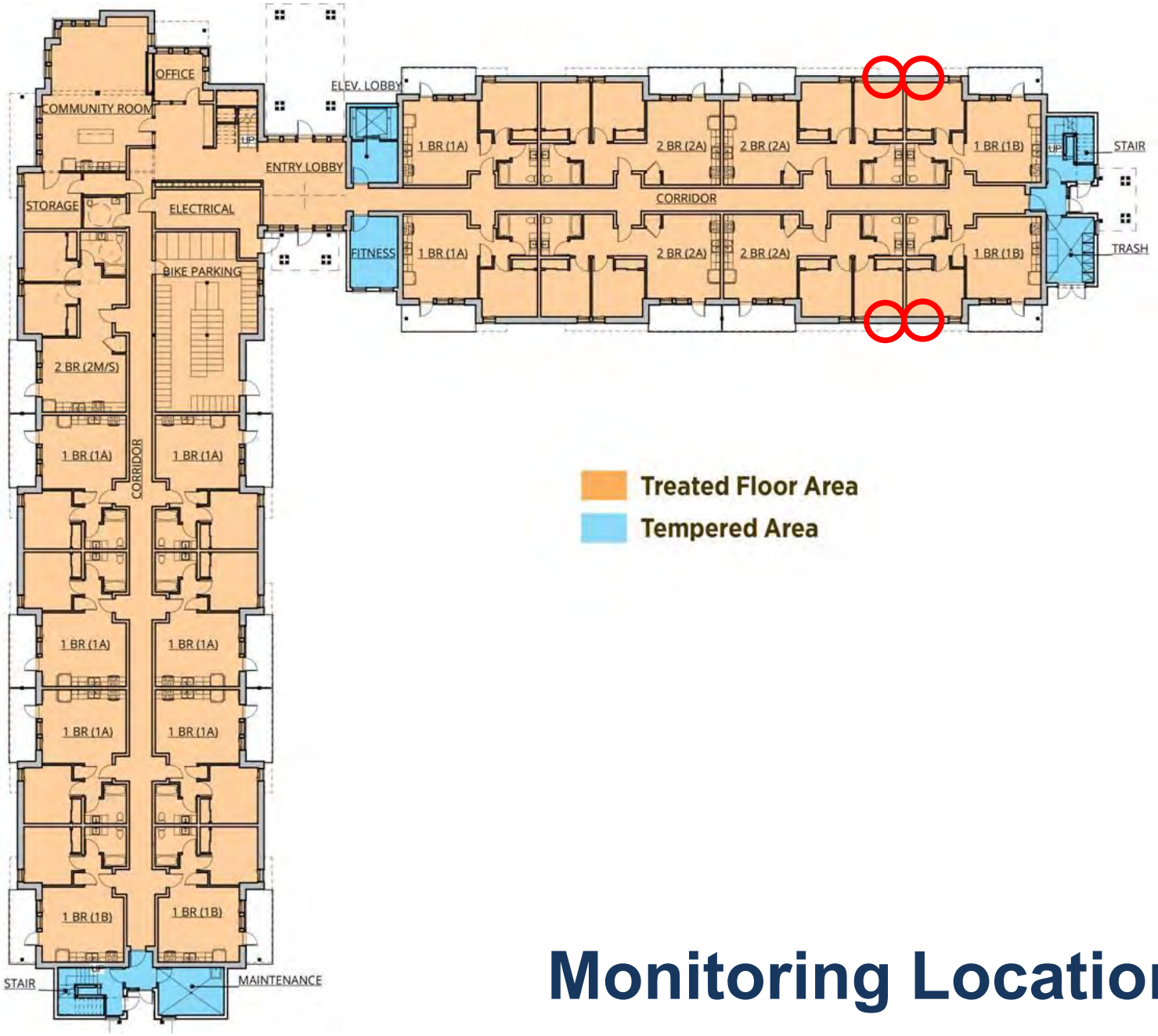
Measured Performance



Graph courtesy of PAE Consulting Engineers

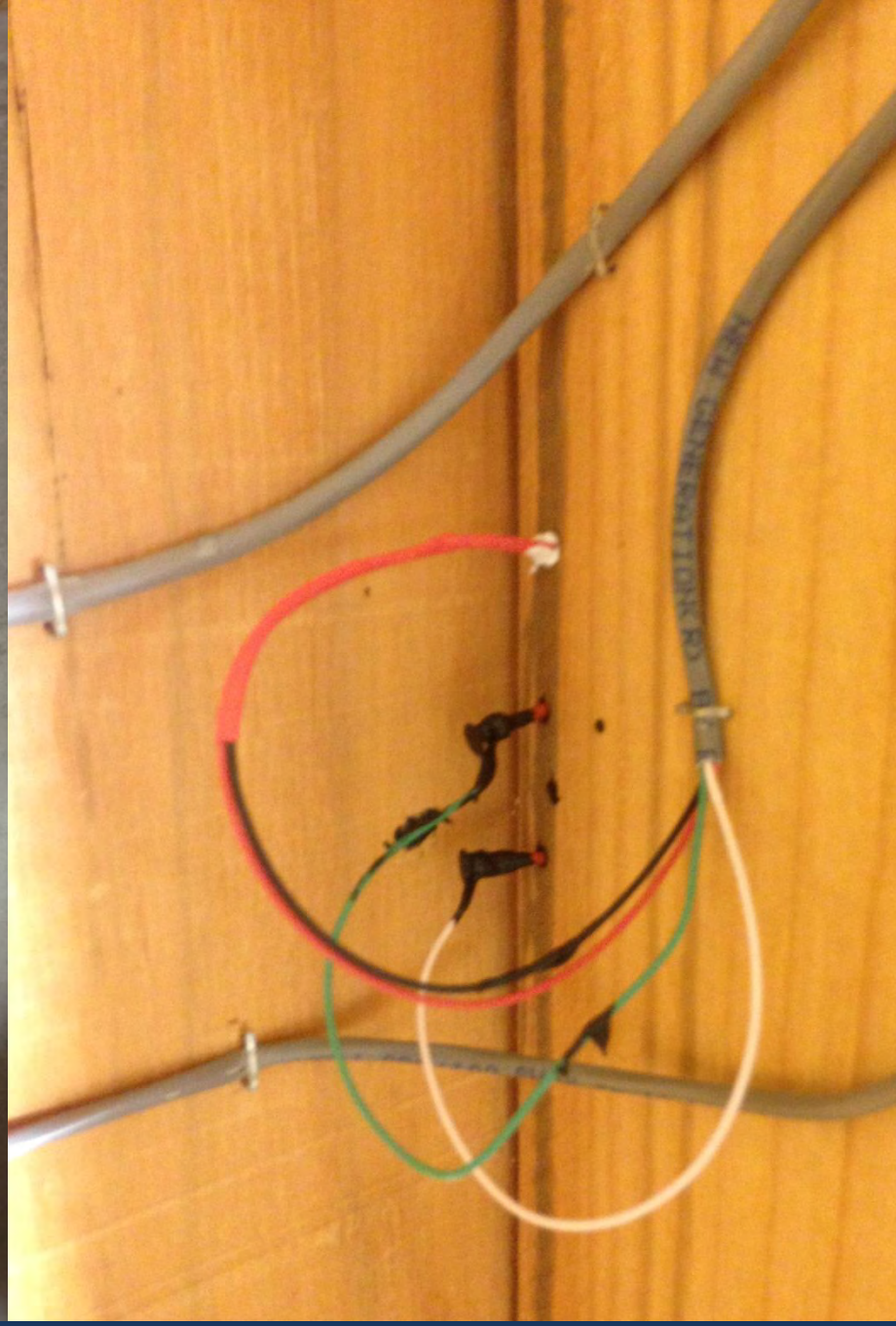
Enclosure Monitoring

- Monitoring performance of exterior wall assembly
- Study designed by RDH Building Science Laboratories
- Funded by ROXUL
- Will collect data for 2 years at least



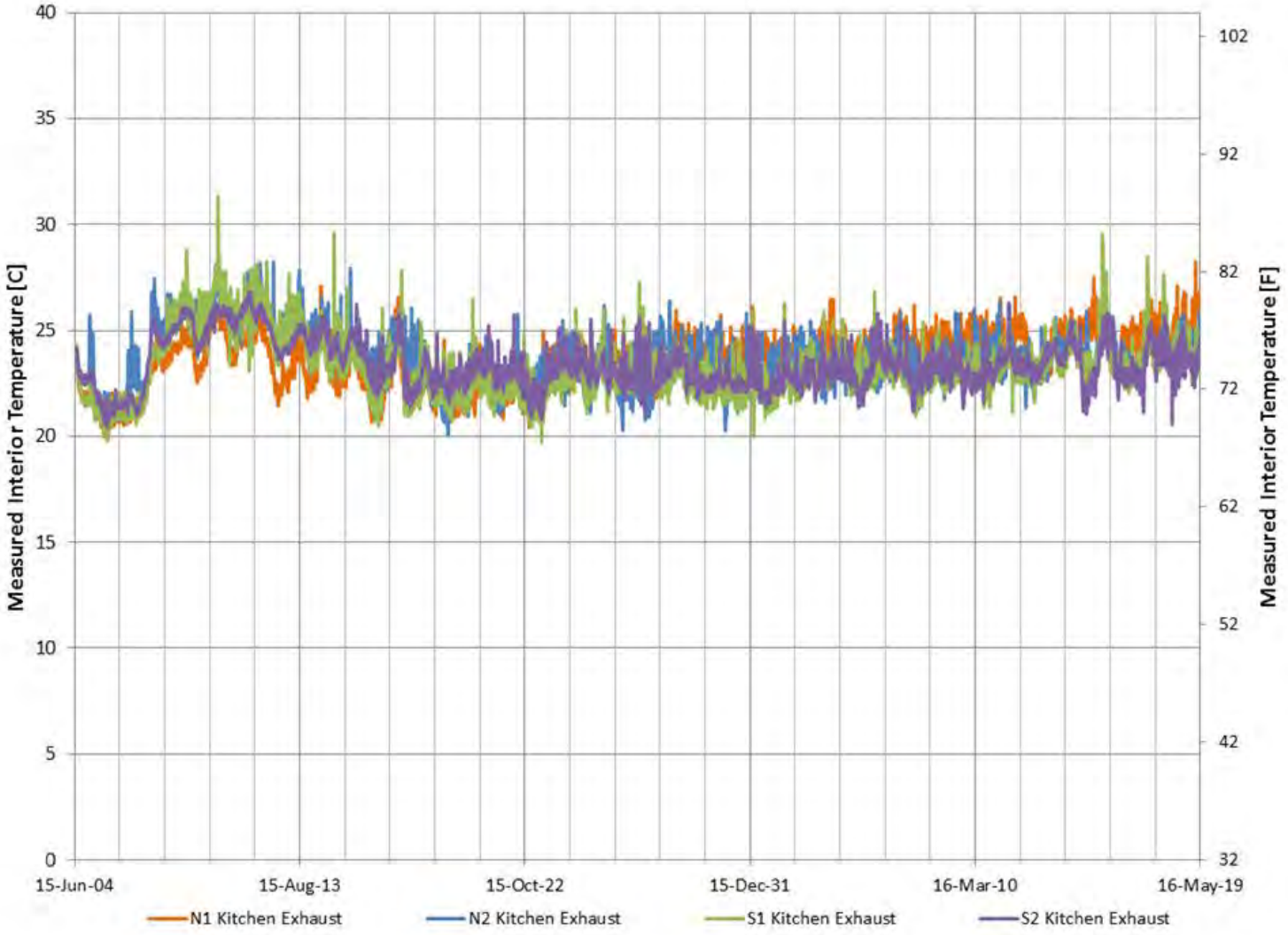
Monitoring Locations


N1



N1
RH

Enclosure Monitoring – Interior Temp



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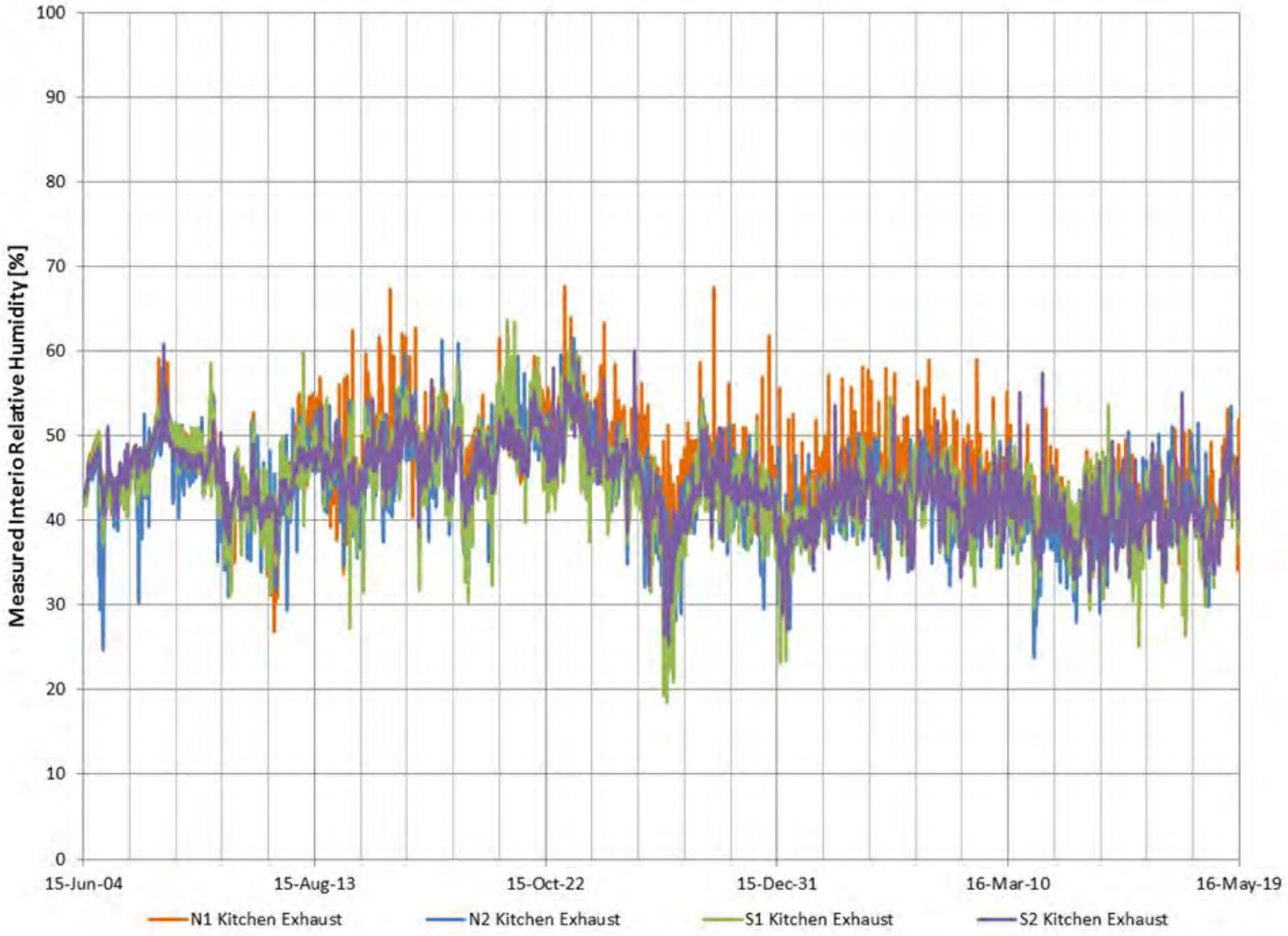
Enclosure Monitoring – Interior RH



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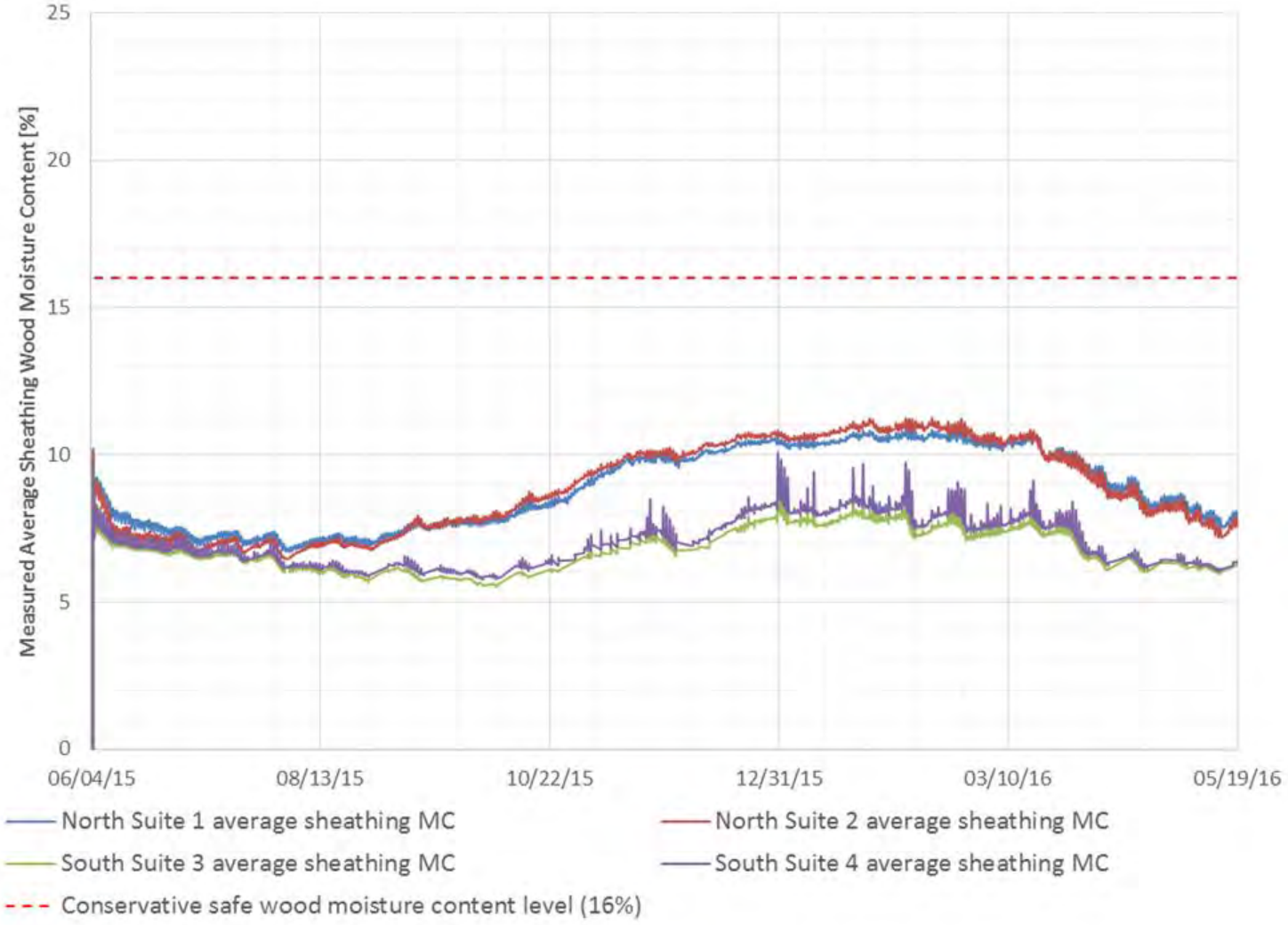
Enclosure Monitoring – Sheathing MC



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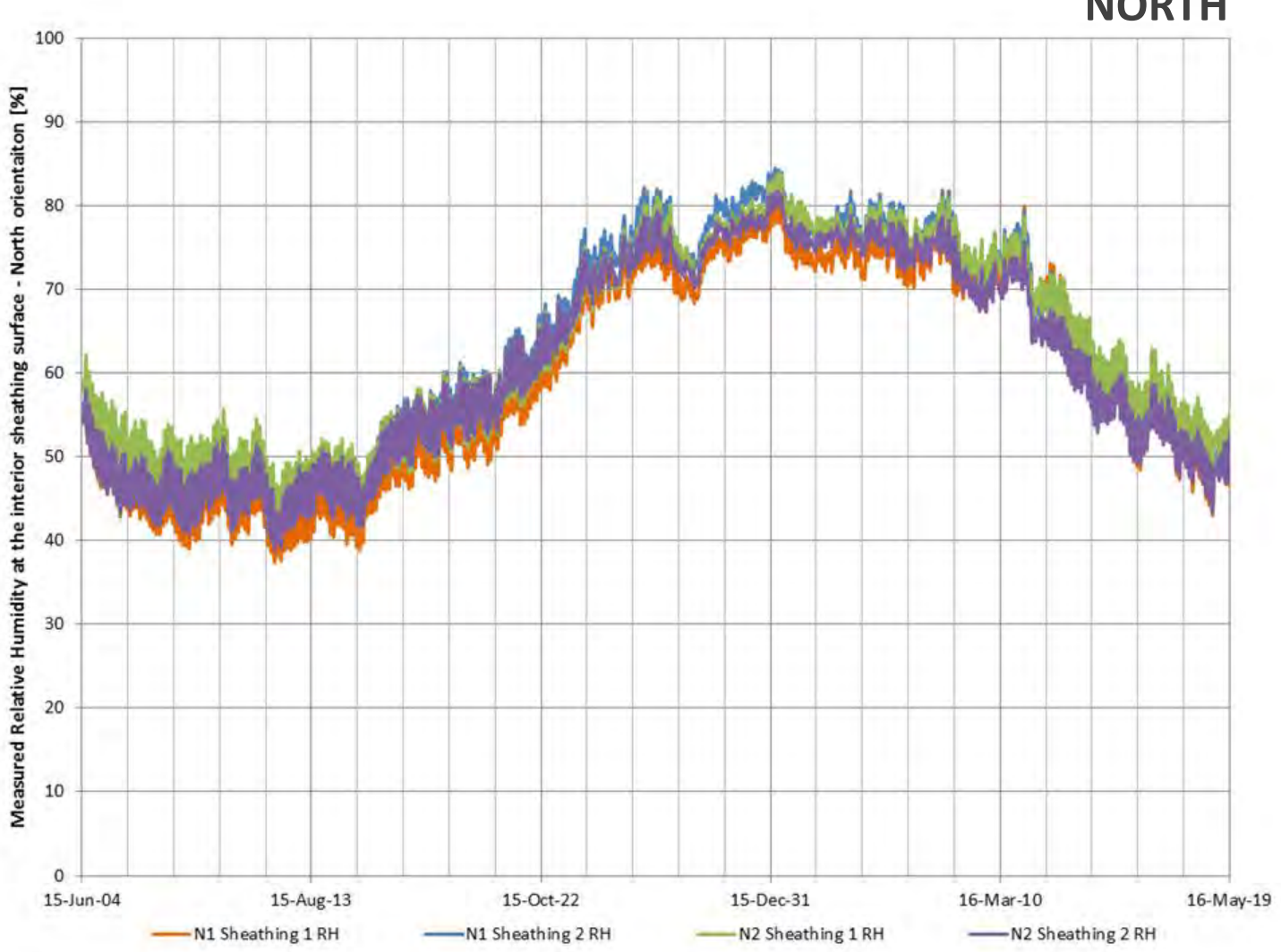
Enclosure Monitoring – Sheathing RH



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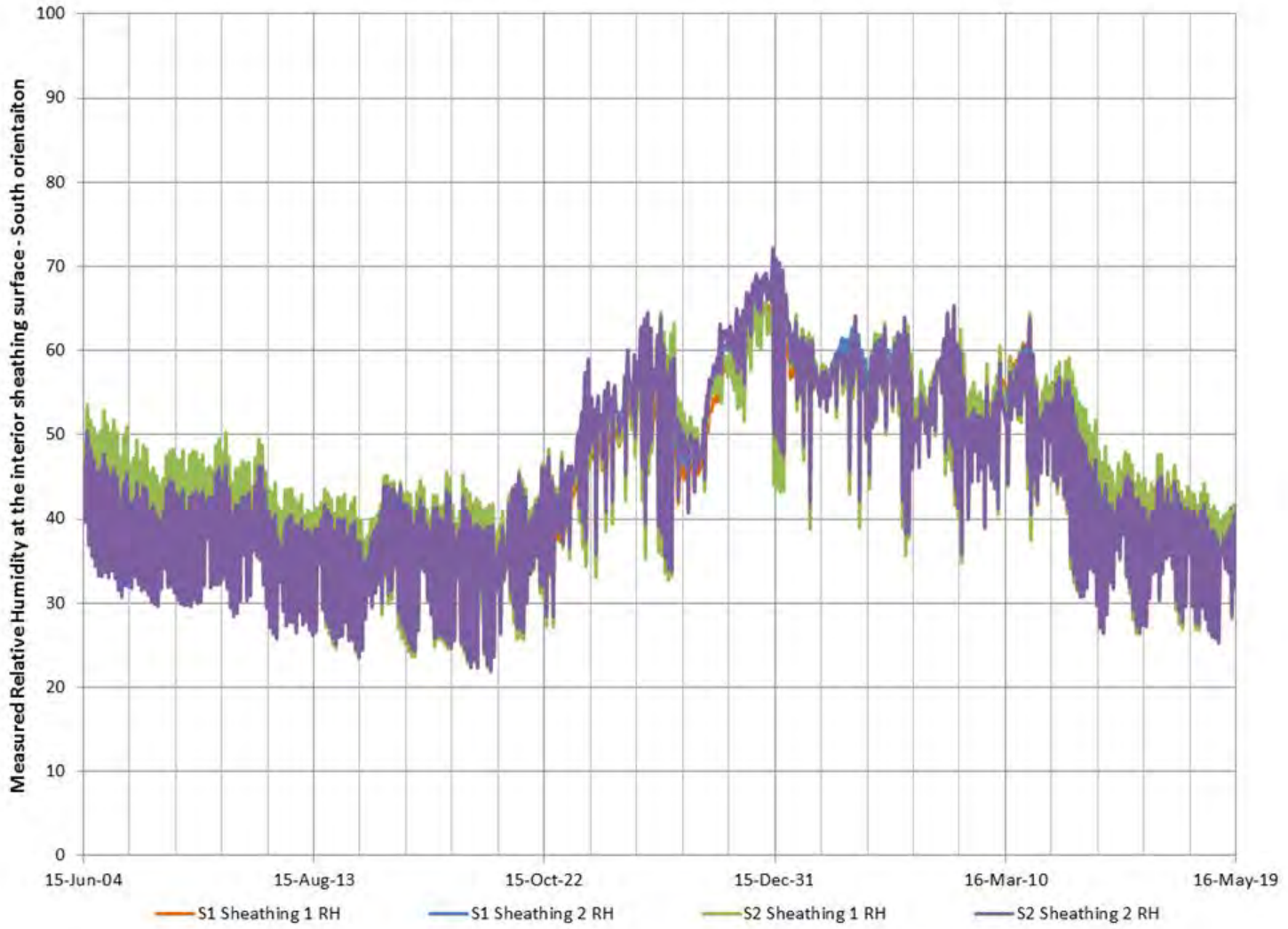
Enclosure Monitoring – Sheathing RH

SOUTH



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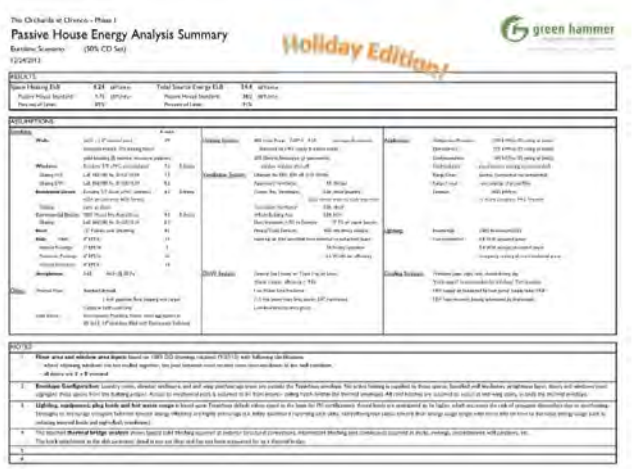
Cost?

Soft Costs - Premium

Incremental Soft Costs		
Design	Amount	Scope
Architecture	37,260	Additional coordination/research
Mechanical	19,600	PAE - Full Design for mechanical system
Energy Modeling	24,000	PAE - Energy Modeling & Incentives
PH consultant	38,720	Green Hammer
Certification	8,000	PHIUS
	21,000	Earth Advantage PHIUS on site review
Total soft costs	**$ 148,580**	

Analysis courtesy of Housing Development Center


Passive House Energy Analysis Summary

Holiday Edition!

green hammer

Hard Costs - Premium

Description	Amount	
Additional construction duration	$	31,500
Additional supervision/QC	$	25,000
Overexcavation for underslab insulation	$	10,000
2x10 stud wall - additional material cost	$	60,000
Fero clips/brick detailing	$	20,000
Detailing/material for separating interior PH spaces	$	10,000
Siding return detail for overinsulation	$	20,000
Additional flashing details	$	20,000
Roofing insulation	$	50,000
Wall insulation	$	53,907
Slab on grade insulation	$	55,711
Windows and Deck Doors	$	176,217
Commercial doors, including interior PH doors	$	38,443
HVAC	$	-
Infiltration costs	$	83,886
Hot water heater	$	2,000
Low flow fixtures	$	3,480
Temp maintenance system	$	15,000
Lighting	$	-
Appliances	$	6,256
Energy monitoring system	$	87,000
Elevator	$	-
Siding/rain screen	$	20,000
Blocking, Hold offs, SAM	$	25,000
Air Testing	$	10,000
Other misc. costs	$	50,000
Subtotal	$	873,400
Markup	$	37,120
Total hard costs	$	910,520

Analysis courtesy of
Housing Development Center

Cost Premium & Financing

Uses

Incremental Soft Costs	$ 148,580	
Incremental Hard Costs	$ 910,520	
Total incremental Cost	$ 1,059,100	
Premium over "typical Orenco"		11.0%

Sources		
REACH Equity	$ 300,000	
Meyer Memorial Trust grant	$ 500,000	
Neighborworks grant	$ 260,000	
OHCS Weatherization	$ 100,000	
Energy Trust of Oregon	$ 65,000	
Enterprise charrette grant	$ 4,000	
Total additional Sources	**$ 1,229,000**	

Analysis courtesy of
Housing Development Center

Would We Do It Again?

Orchards at Orenco Phase II

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Innovation Towards Replication

- Best Overall Project and Best Affordable Project, 2015, PHIUS
- Sustainable Project of the Year, 2015, Portland Business Journal
- Golden Hammer Award for Best Project, 2015, Oregon Opportunity Network
- Energy Efficiency Project of the Year & People's Choice Award, 2016, Daily Journal of Commerce
- Best Green Project, 2016, Affordable Housing Finance Magazine's Reader's Choice Award
- Featured in Dwell, Portland Monthly, Politico, Alaska Airlines' in-flight magazine, and local newspapers

Orchards at Orenco Phase II - Context

- Rental Housing Crisis
- Cost Containment
- Market Demand
- Soft Cost Impacts

Orchards Phase I vs. Phase II

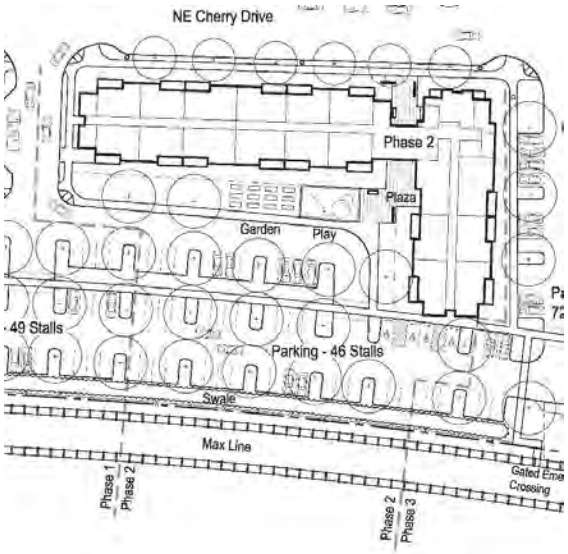
Phase I
(PHIUS+ Certified)

- Innovate to meet REACH strategic goal of building Passive House
- REACH brought significant private investment for this innovation

Phase II
(Passive House Inspired)

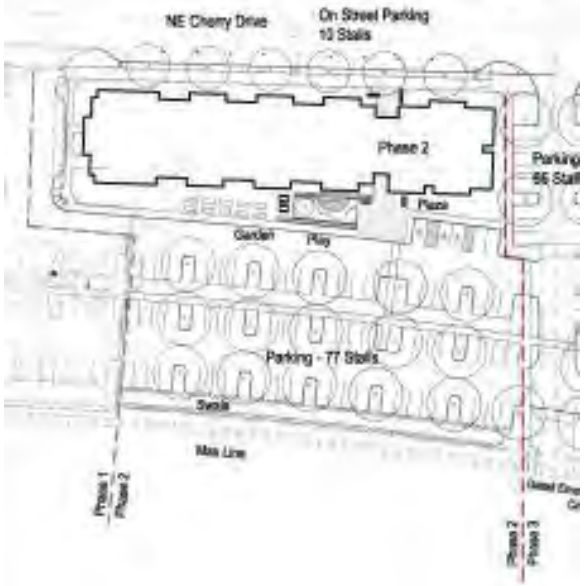
- Reduce costs to meet OHCS cost containment limits
- Additional private resources not available
- Take lessons learned & best practices from Phase I

Design Response to Cost Containment



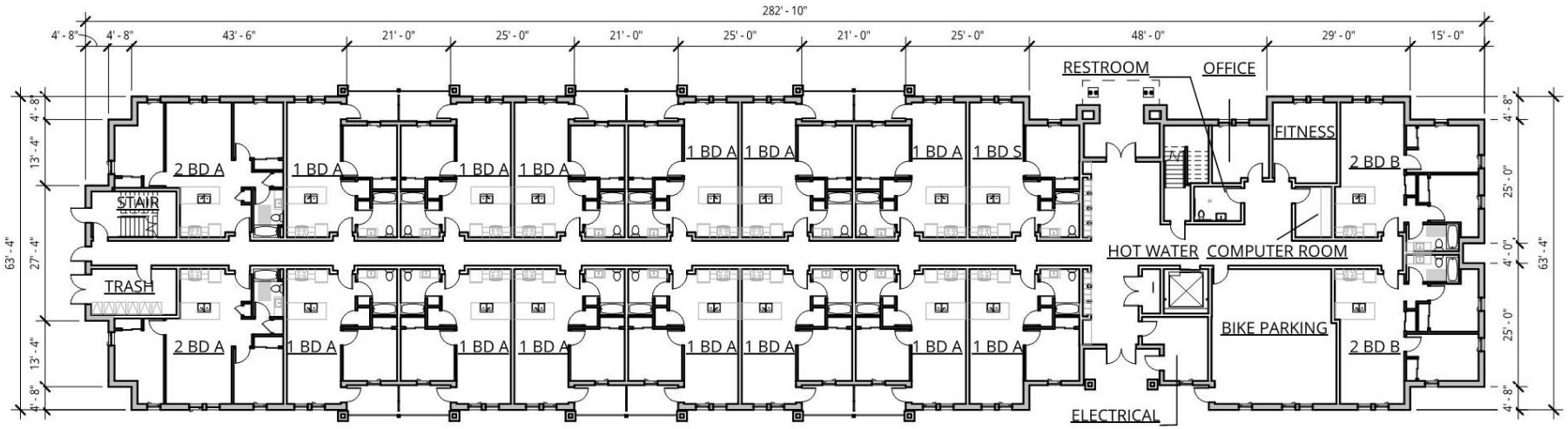
Phase II (original design)

- L-shaped building with 46 parking stalls
- 57 units in 57,750 SF
- Shallow units to increase daylight
- Community room, office



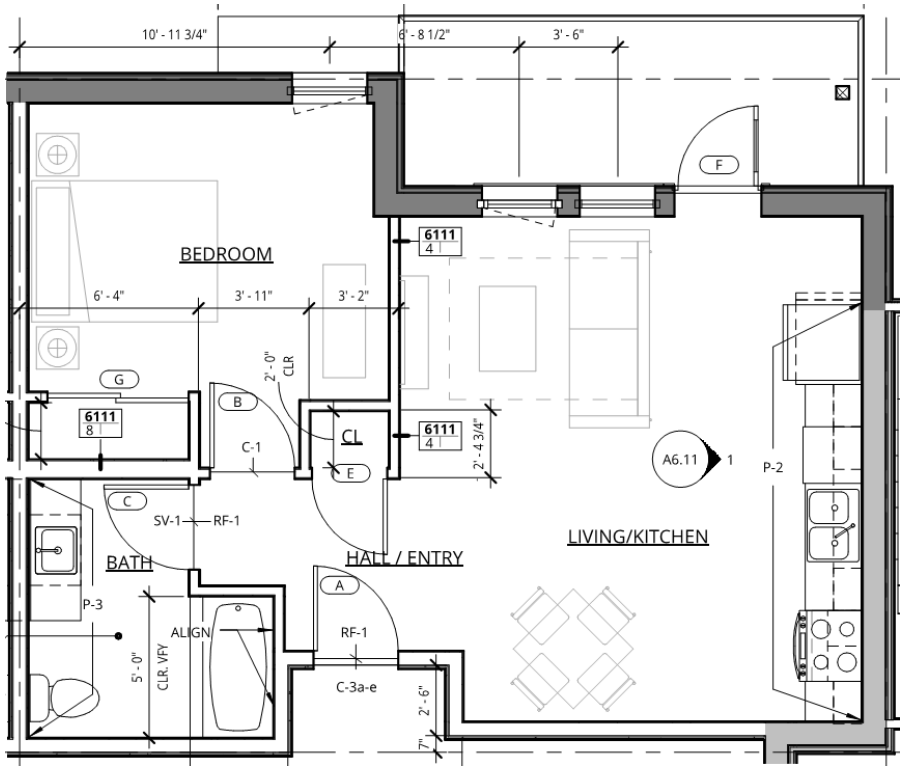
Phase II (after design revisions)

- Bar building with 77 parking stalls
- 58 units in 49,900 SF
- Deeper, narrower units
- Reduced number of balconies
- Reduced amenity space



First Floor Plan

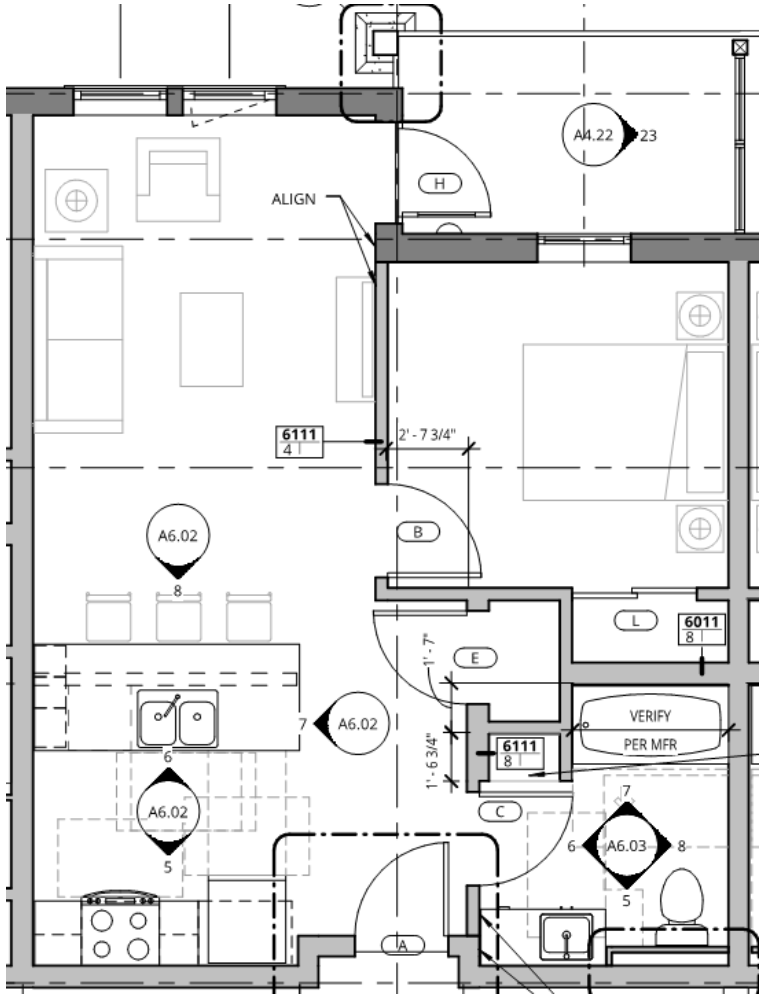
Wide and Shallow…



CORRIDOR

Phase I Typ. 1 BR

Narrow and Deep…



CORRIDOR

Phase II Typ. 1 BR

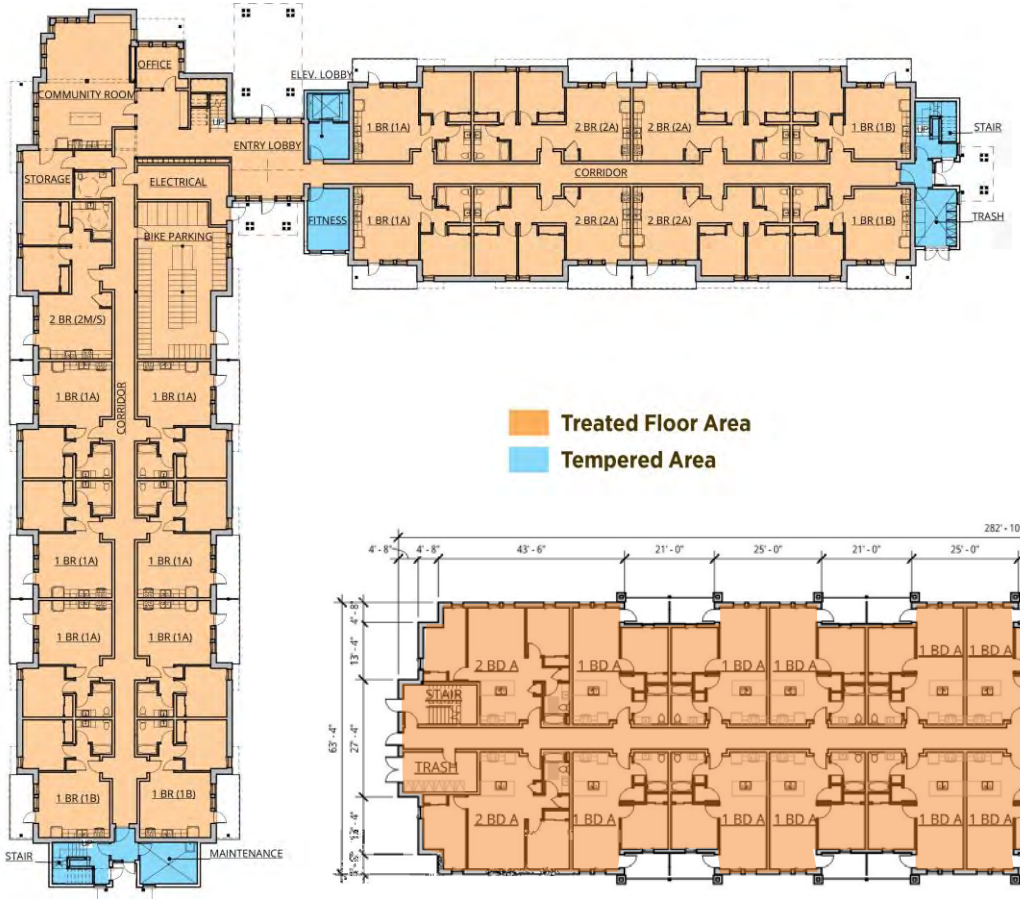
Orchards Phase I & II

Phase I
(PHIUS+ Certified)

- Envelope
  - Fully insulated slab & footings
  - 2x10 walls with 1 ½” exterior insulation
  - Triple-glazed windows
  - Low-slope roof with R-81 insulation
- Whole building ERV with heat pump
- Spaces outside conditioned envelope = very expensive doors & detailing
- Ultra airtight: 0.13 ACH50
- Extended sequencing / duration

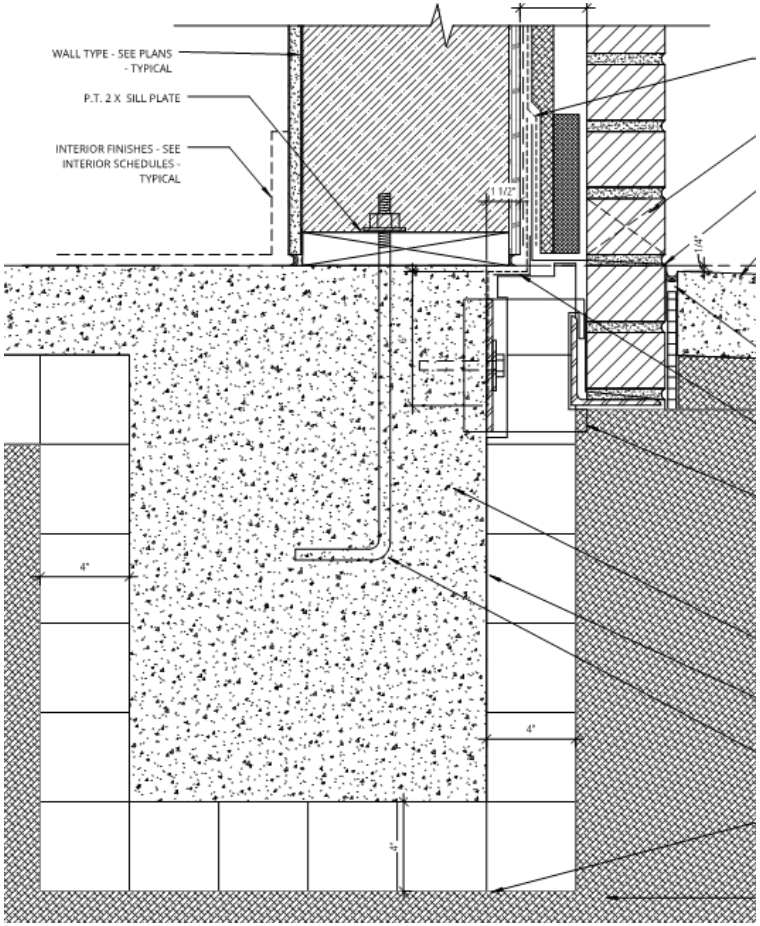
Phase II
(pursuing PHIUS+ Certification)

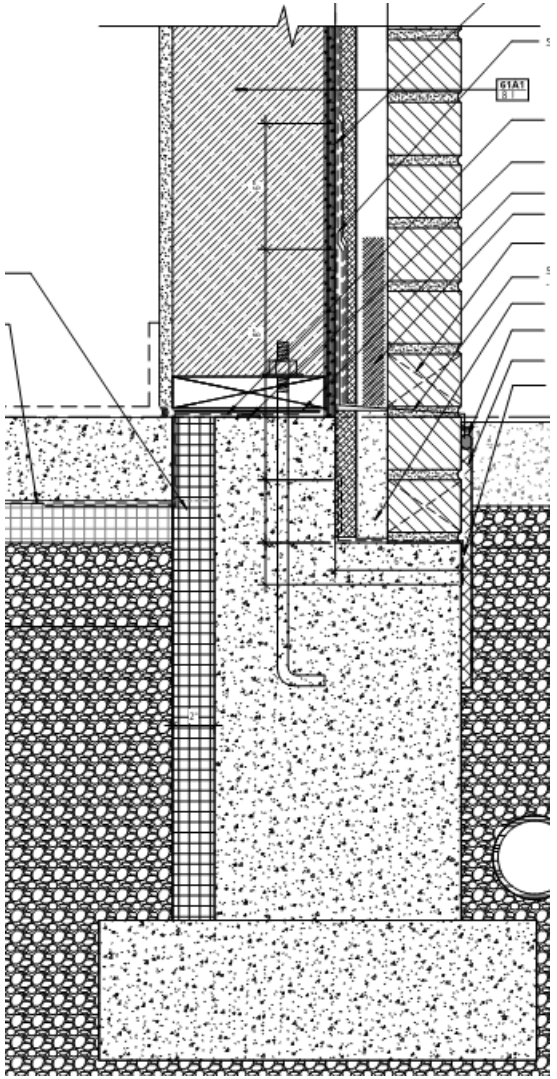
- Envelope
  - Insulated slab. No insulation under footings
  - 2x8 walls with 1” exterior insulation
  - Triple-glazed windows
  - Steep-slope roof with R-60 insulation
  - Vented attic
- Reduced vertical envelope area
  - 35,000 SF → 27,700 SF
- Same HVAC as Phase I, but with better zoning due to orientation of building
- All spaces inside conditioned envelope
- Airtight??????



Phase I – Areas Outside PH Envelope

Phase II – All Areas Inside PH Envelope

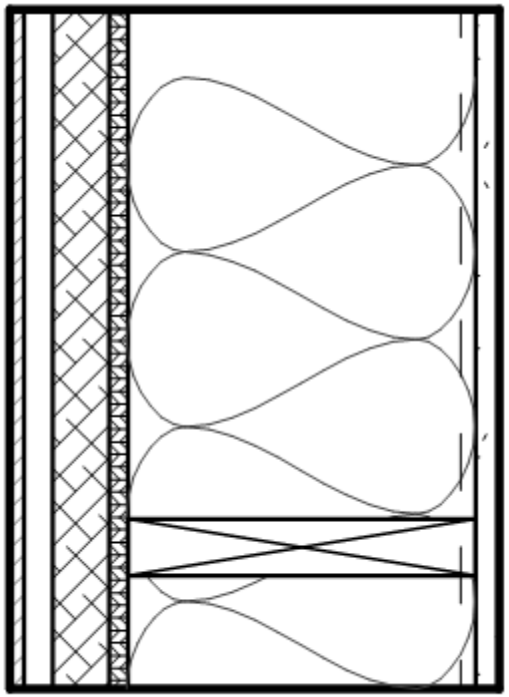




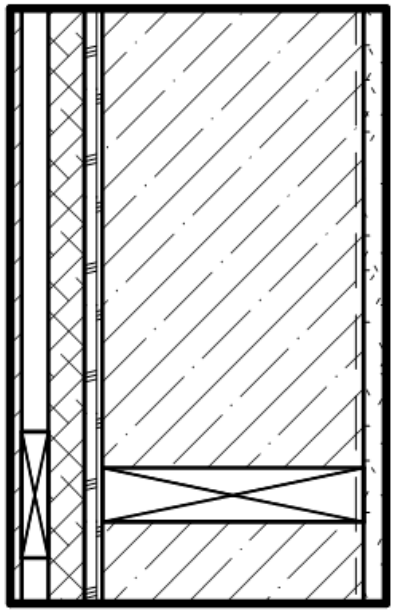
Phase I Foundation

Phase II Foundation

1 ½” Exterior Insulation
2 x 10 Wall Framing

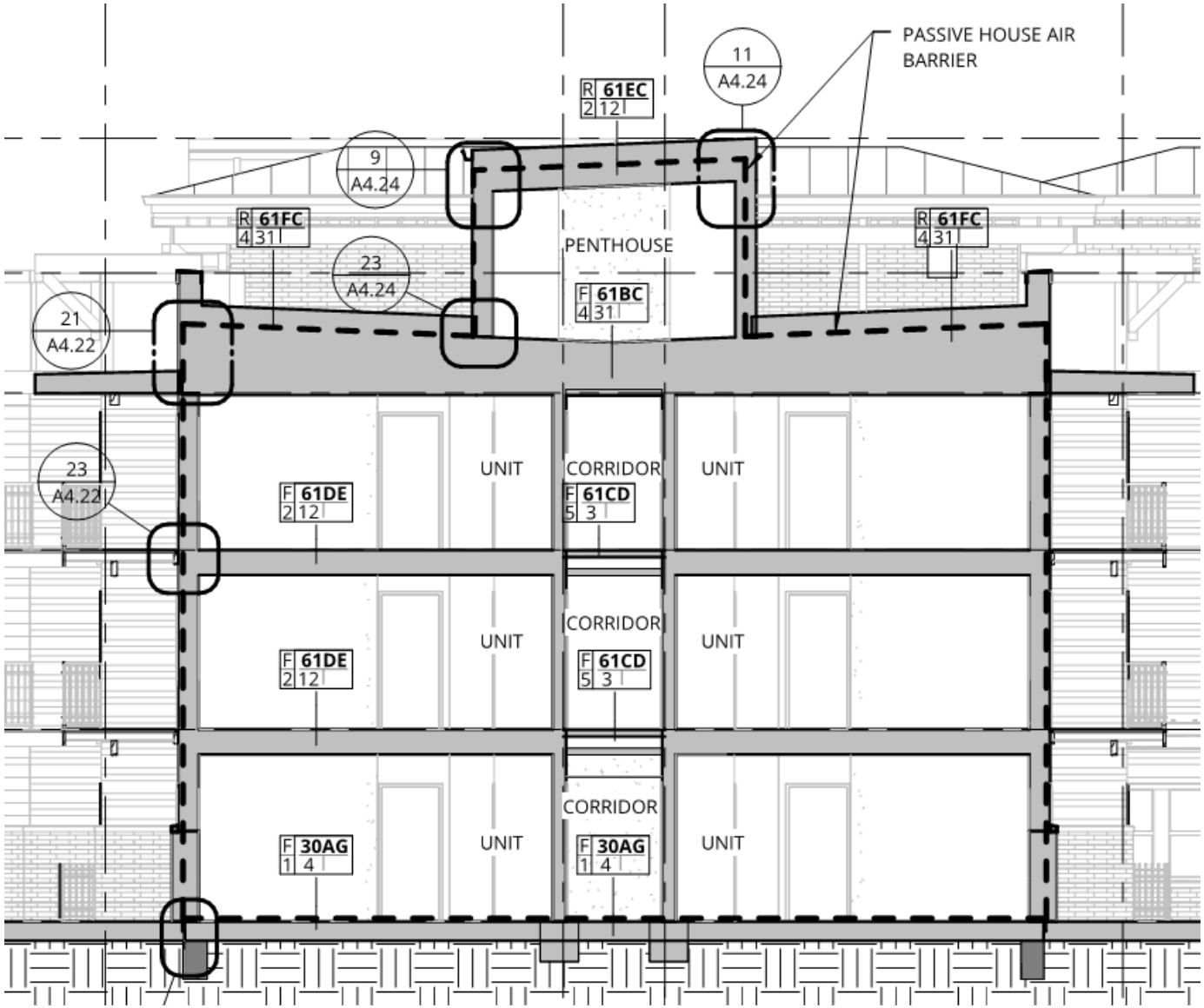


1” Exterior Insulation
2 x 8 Wall Framing

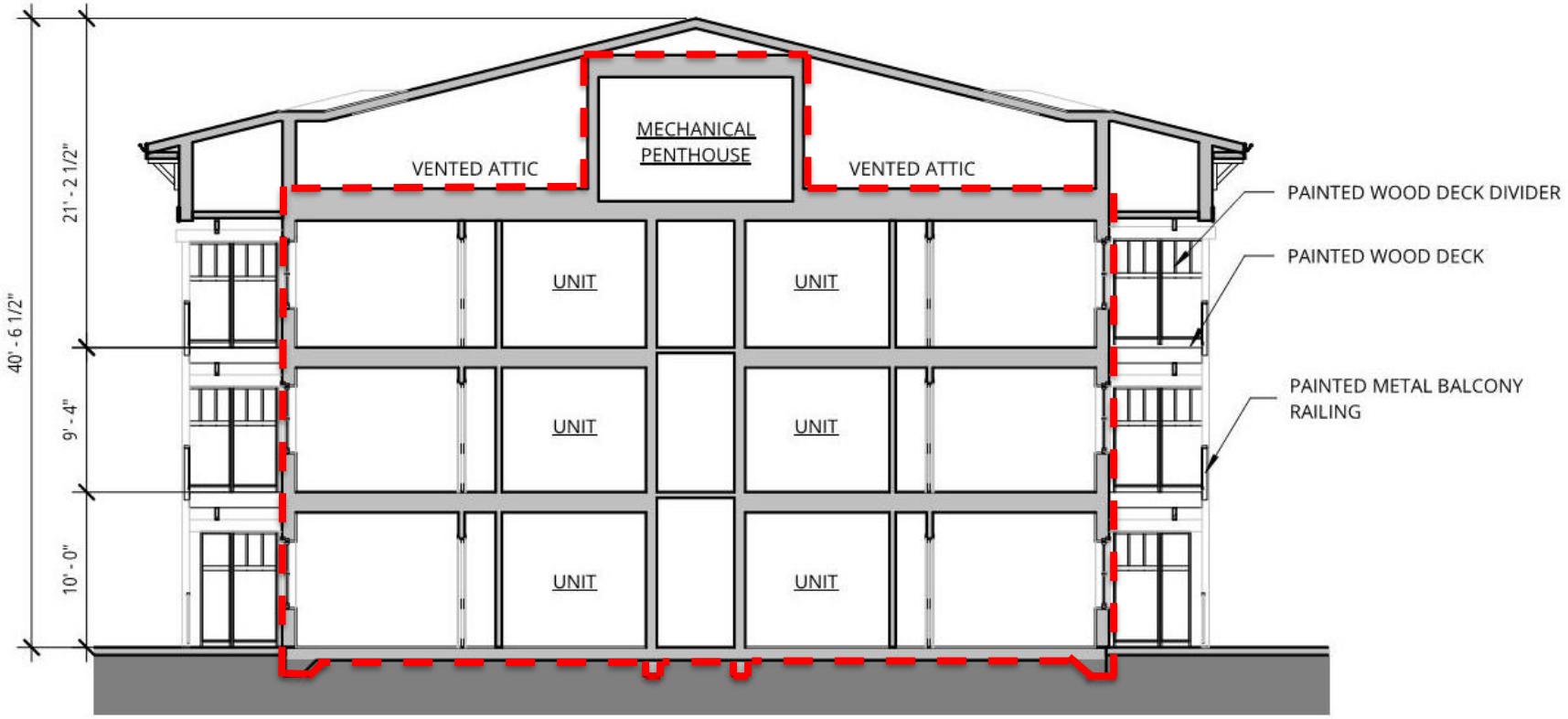


Phase I Ext. Wall

Phase II Ext. Wall



Phase I Building Section



Phase II Building Section

PHIUS+ Certification

- As design began, REACH called for Phase II to use lessons learned and best practices from Phase I while reducing costs to keep within cost containment limits set by state's housing agency
- As construction began, building design was modeled in both PHPP and WUFI Passive
- Determined that design complied with requirements of PHIUS+ 2015 Passive Building Standard
- REACH decided to pursue certification for Phase II

REACH COMMUNITY DEVELOPMENT | ANKROM MOISAN ARCHITECTS | WALSH CONSTRUCTION CO.


Genie S-60


GP
GP
Sheathing


EXIT


PARR

REACH COMMUNITY DEVELOPMENT | ANKROM MOISAN ARCHITECTS | WALSH CONSTRUCTION CO.


94.6
73.1
FLIR

Final Airtightness Test Results: 0.42 ACH_{50} (taped)
0.59 ACH_{50} (untaped)

Phase II - Performance

- Modeled Performance: EUI = 22.2

- Measured Performance: Available Aug. 2017

Phase II - Lessons Learned

- Airtightness
  - A major challenge at steep slope roof with vented attic…

Phase II - Lessons Learned

- Airtightness
  - A major challenge at steep slope roof with vented attic…
- Cost premium to achieve Passive House certification can be effectively reduced through more inherently efficient design
- Construction cost: $173/SF, $147k/unit)
  - 8% cost/unit reduction from Phase I
  - 15%+ cost reduction if factoring in market escalation…
  - Negligible cost premium to achieve Passive House

Passive Measures - Incremental Costs

- Foundation insulation
- Wall framing
- Exterior insulation at cladding
- Triple-glazed windows (if required)
- Heat recovery at ventilation system
- Materials and labor to achieve airtightness
- Traction elevator
- Certification
- Quality assurance / verification

Orchards Phase I & II - Costs

Phase I
(PHIUS+ Certified)

- TDC of $14.5M
- $255K/unit
- Construction cost: $9,093,040
- $158/SF
- $159,527/unit
- Energy performance:
  - 5 energy models
  - 31-71% better than code
  - Actual data available now

Phase II
(pursuing PHIUS+ Certification)

- TDC of $13.6M
- $234K/unit
- Construction cost: $8,531,624
- $173/SF
- $147,097/unit
- Energy performance:
  - 3 energy models
  - 29-67% better than code
  - Actual data available in 2017

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Orchards at Orenco - Proof of Concept

- When implemented with knowledge and skill, passive building measures are cost effective AND provide substantial benefits:
  - Enhanced comfort, health and durability
  - Energy use reduction, leading to operational cost savings
- Orchards at Orenco demonstrates that passive building measures can be implemented at multifamily housing for little additional first cost
- **Life cycle cost & quality benefits likely to far exceed the additional investment at project inception**

ORCHARDS AT ORENCO, PHASE I

ORCHARDS AT ORENCO, PHASE II

WHY?

- WHY are we not doing this on ALL affordable housing moving forward?
- WHY are we not doing this on ALL multifamily housing moving forward?
- “Split incentive” is potential issue for market-rate housing…shouldn’t be for affordable housing
- Construction market cost escalation IS an issue…

More Information & Insights

- REACH Community Development:
  - http://reachcdc.org/main/docs/housing_development/Orchards_PH_Case_Study.pdf
  - http://reachcdc.org/main/docs/housing_development/Orchards_at_Orenco_I_Development_Profile_update_Aug_2015.pdf
- Housing Development Center:
  - http://www.housingdevelopmentcenter.org/our-work/buildings/orchards-at-orenco/
- Ankrom Moisan Architects:
  - https://www.youtube.com/watch?v=ewJUCWI6dqM
- PHIUS Case Study:
  - http://www.phius.org/phius-certification-for-buildings-and-products/case-studies/orchards-at-orenco-phase-i
- BEST 4 Conference Paper:
  - http://walshconstructionco.com/2015/04/walsh-presents-at-best-4-building-enclosure-science-and-technology-conference/
- Guest Blog on Green Building Advisor:
  - http://www.greenbuildingadvisor.com/blogs/dept/guest-blogs/largest-passivhaus-building-us

Q & A