Good Enough – Hitting the Energy Jackpot at Wentworth Community Housing

Presenters:

Samantha Dunn
Housing Vermont

Gregg Gossens
gbA Architecture & Planning

Jon Haehnel
BVH Integrated Services, P.C.

Steve Poole
VHV Company

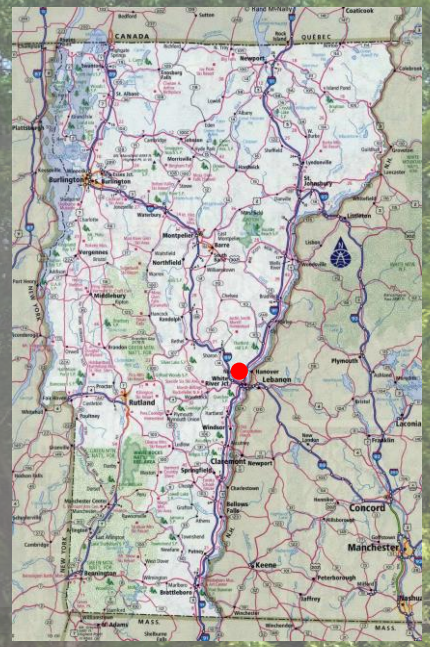
Efficiency Vermont
BETTER BUILDINGS BY DESIGN

CONTENT

- **Project Overview**
- **The Building**
- **How Did We Decide What To Build?**
- **Decision Time**
- **Design Coordination**
- **Building the Building**
- **Did it Work??**
- **What’s Next?**

Project Overview

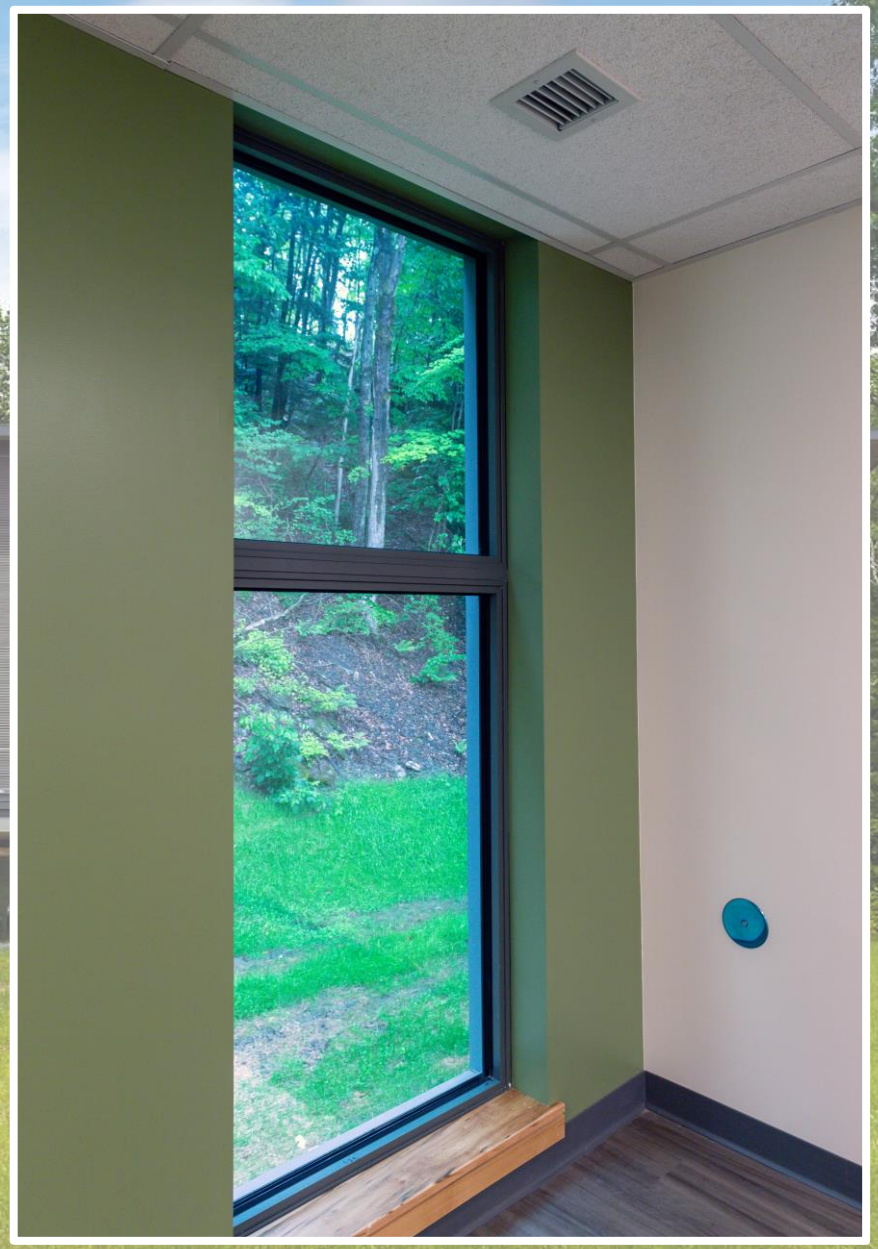
- Project Owners
  - Twin Pines Housing
  - Housing Vermont
- Building occupants
- Owner goals



30 YEARS
TWIN PINES HOUSING

HOUSINGVERMONT
Building possibilities.

Project Overview

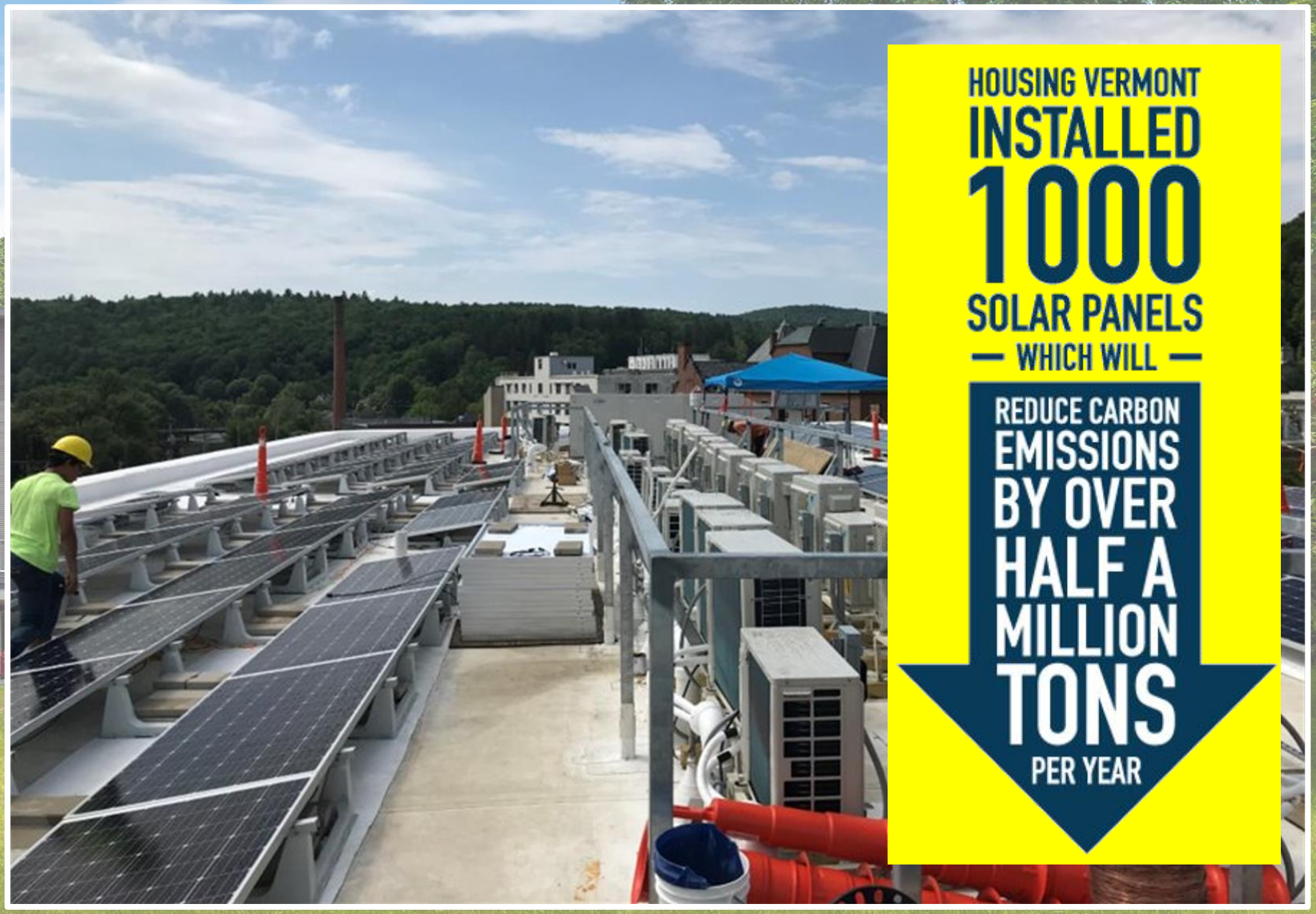


Housing Vermont

- 121 Buildings
- 3304 Units
- $3.1 million on energy!

Project Overview

Project Overview



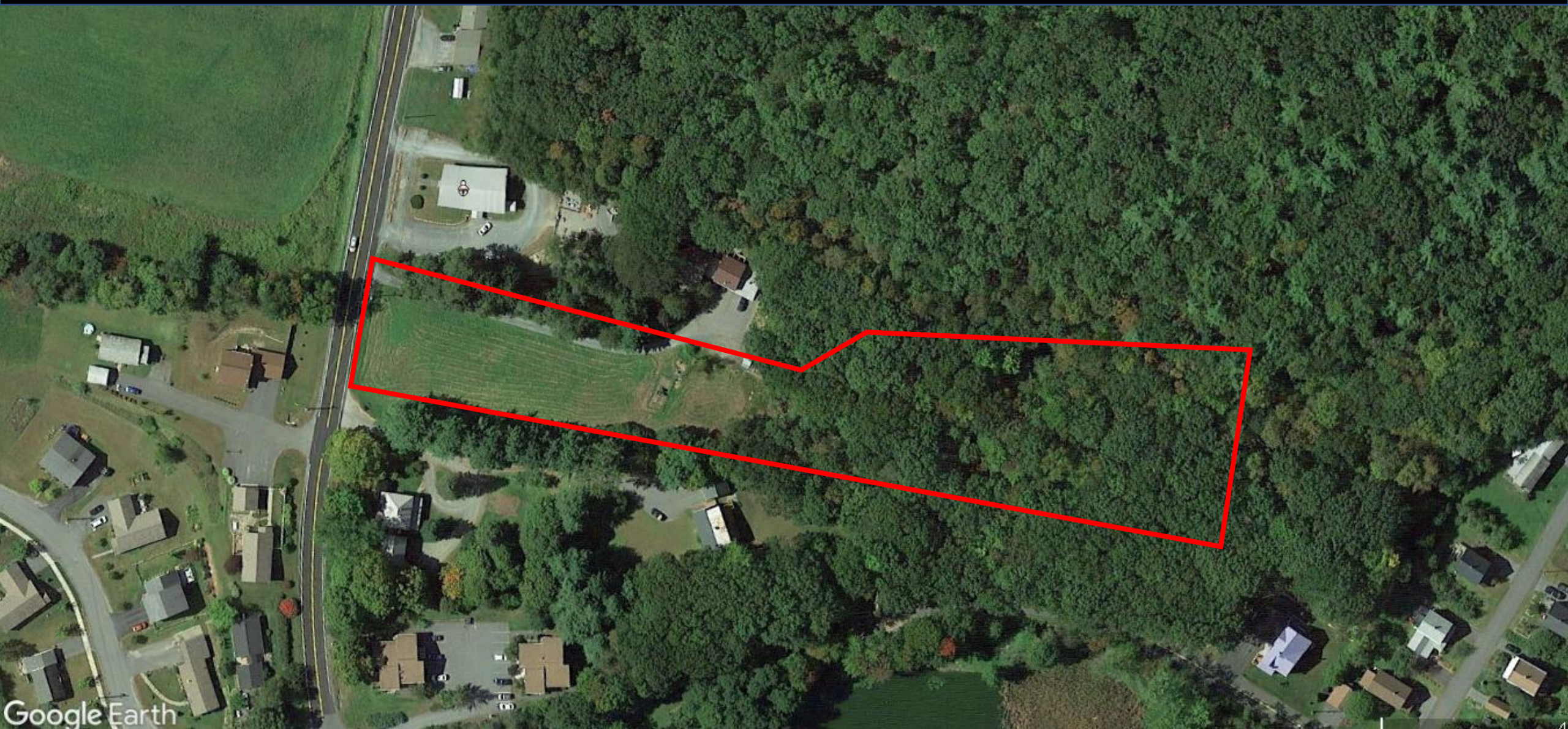
Project Overview

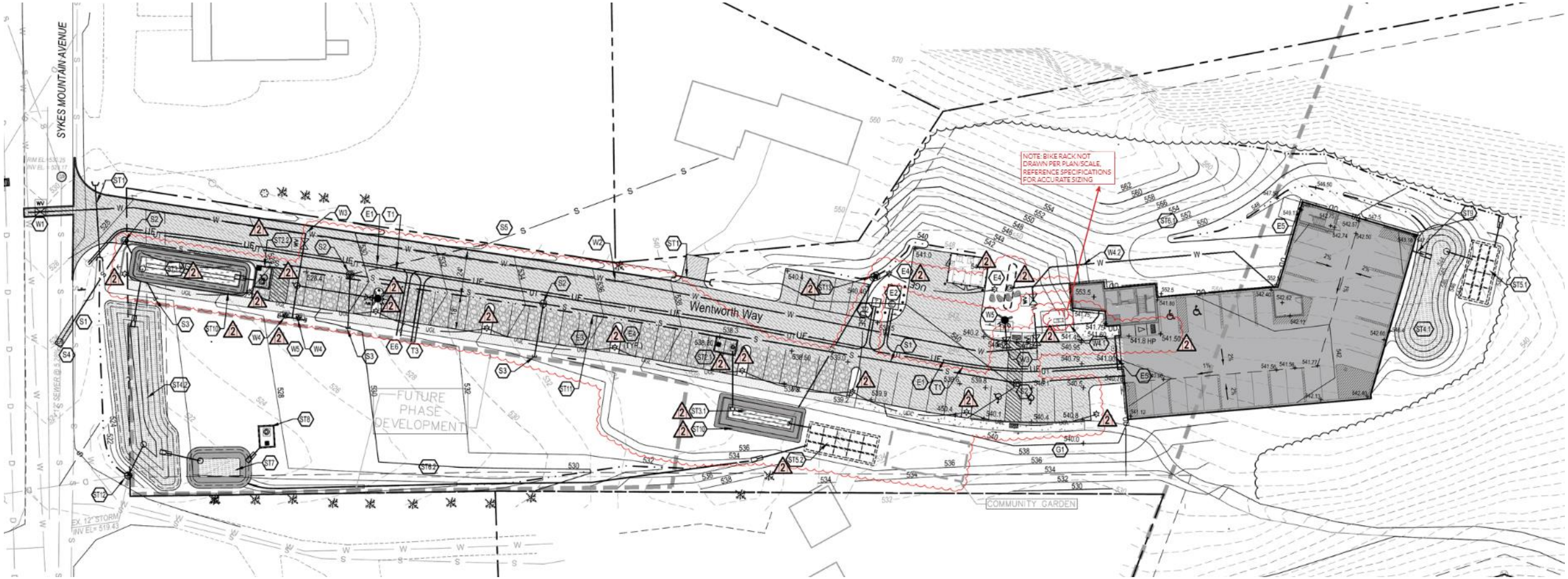
- The Team
  - Architect – gbA Architects
  - Civil Engineer – Engineering Ventures
  - Structural Engineer – Sellers Treybal
  - Construction Manager – ReArch Company
  - Design-Build MEP – VHV and MEI
  - Fire Protection – Alpine Sprinkler
- Why this Team?

CONTENT

- Project Overview
- **The Building**
- How Did We Decide What To Build?
- Decision Time
- Design Coordination
- Building the Building
- Did it Work??
- What’s Next?

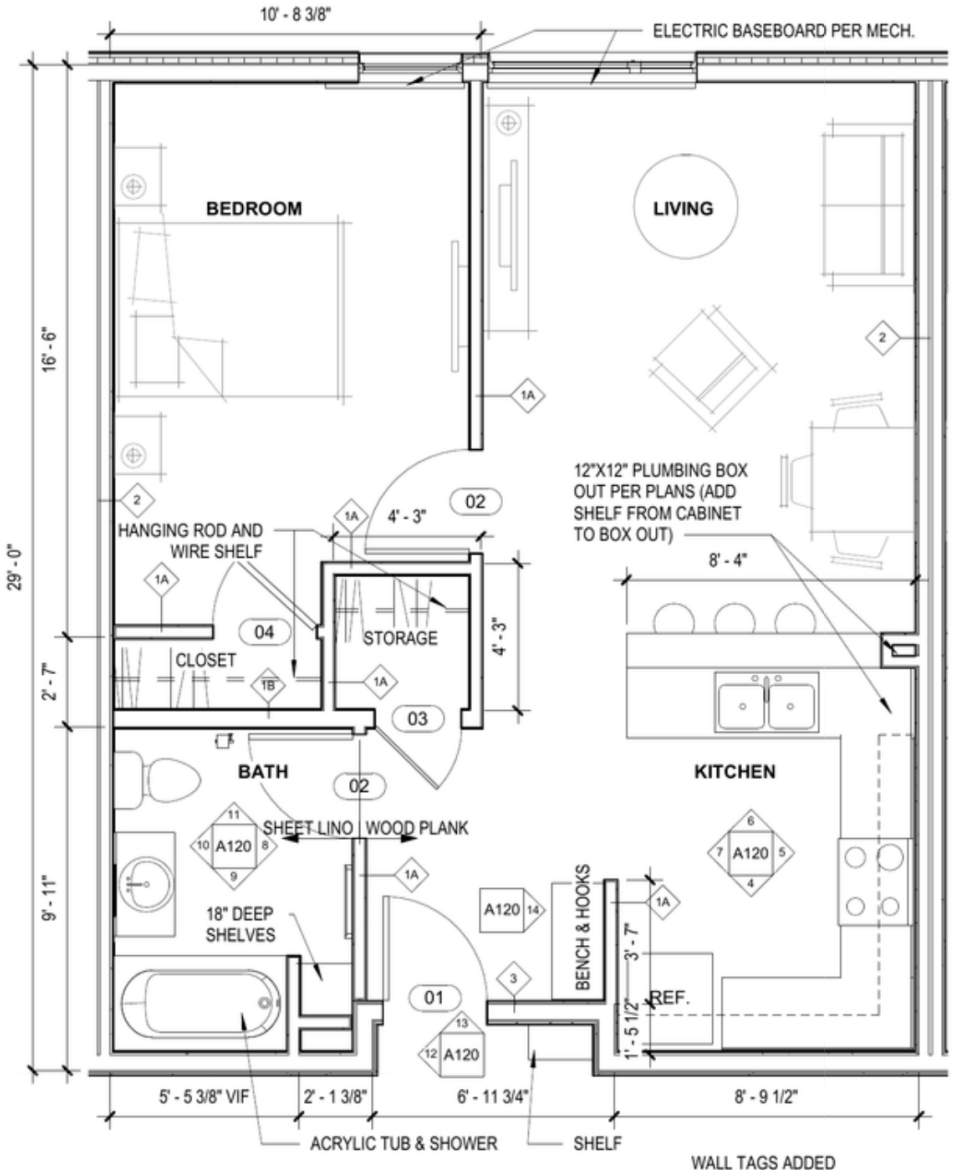
PROJECT SITE BEFORE CONSTRUCTION

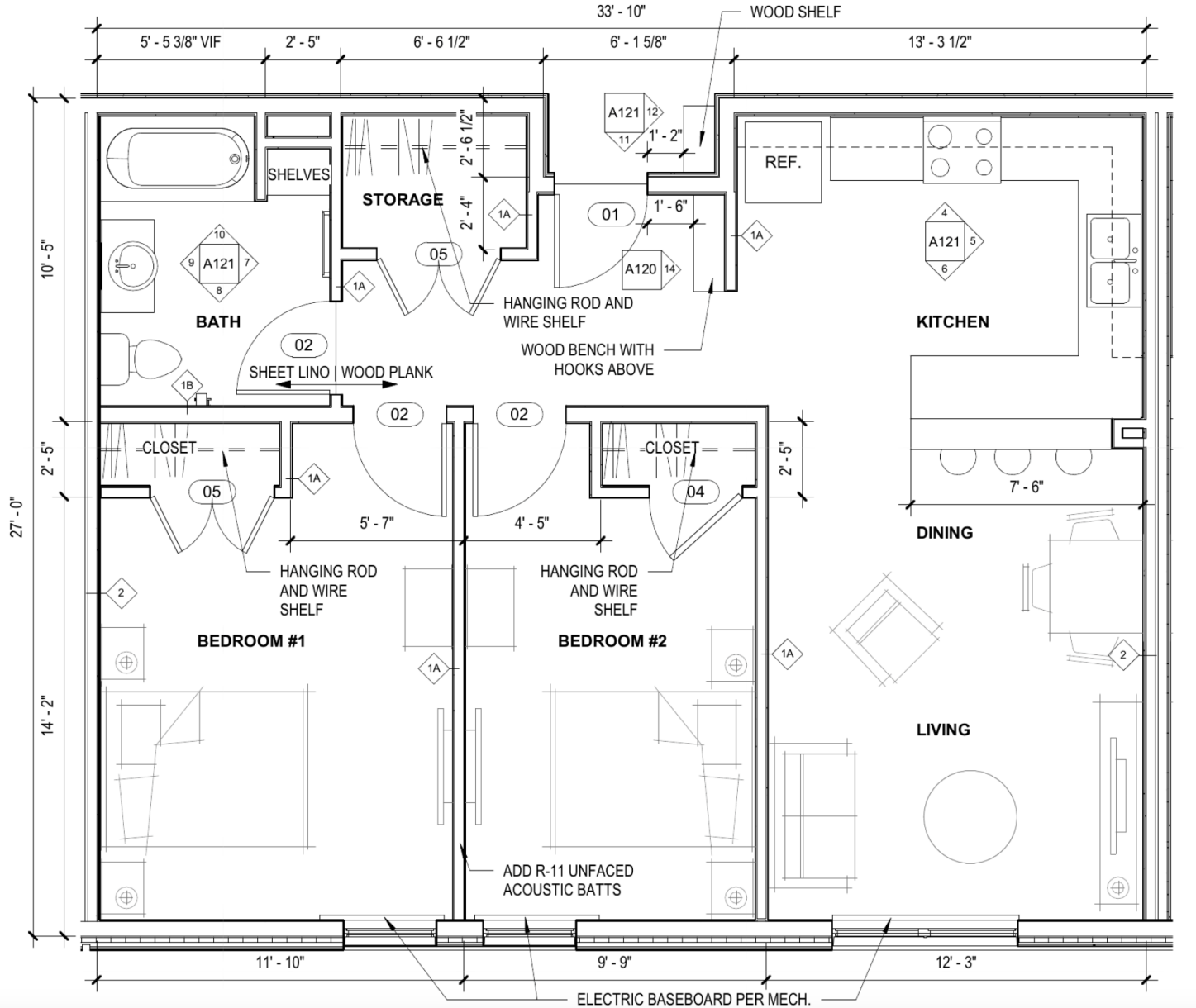


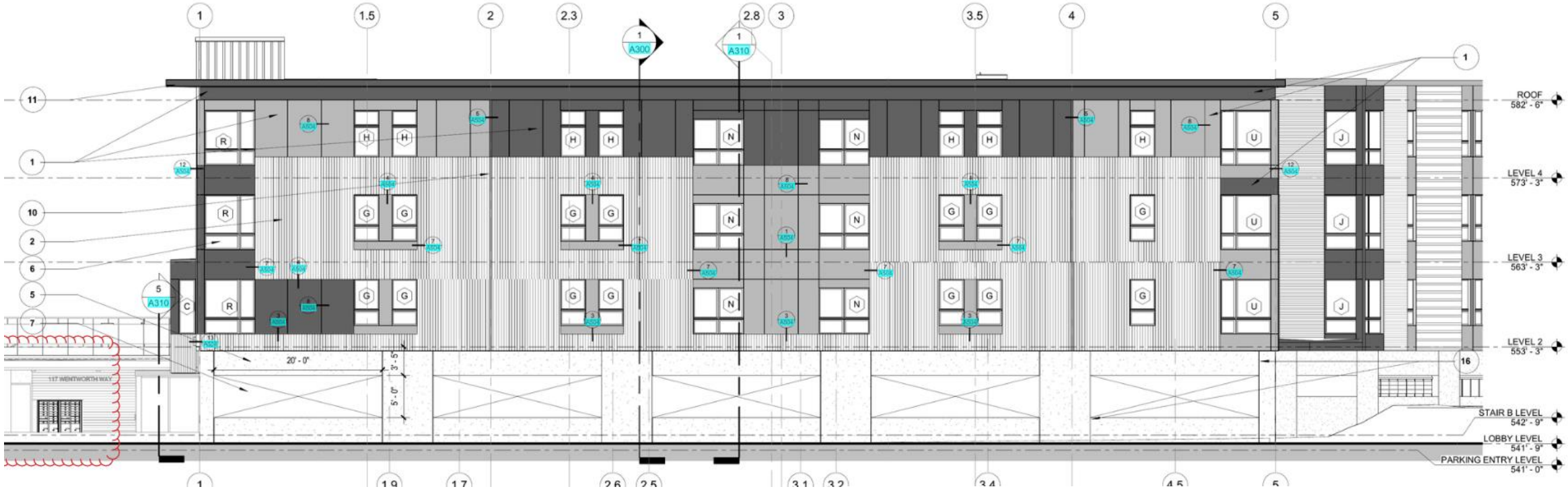

SYKES MOUNTAIN AVENUE
Wentworth Way
NOTE: BIKE RACK NOT DRAWN PER PLAN/SCALE, REFERENCE SPECIFICATIONS FOR ACCURATE SIZING
FUTURE PHASE DEVELOPMENT
COMMUNITY GARDEN
EX. 12" STORM
INV EL= 519.43
541.8 HP

The Building

- **33,930 SF**
- **Common area: 11,530 SF**
- **Three story with parking garage**
- **(15) 1 bedroom; (15) 2 bedroom**
- **Average unit size: 745 SF**
- **Site designed for Phase II Building**


10' - 8 3/8"
ELECTRIC BASEBOARD PER MECH.
BEDROOM
LIVING
HANGING ROD AND WIRE SHELF
4' - 3"
02
04
STORAGE
CLOSET
03
BATH
02
SHEET LINO | WOOD PLANK
18" DEEP SHELVES
01
12"X12" PLUMBING BOX OUT PER PLANS (ADD SHELF FROM CABINET TO BOX OUT)
8' - 4"
KITCHEN
BENCH & HOOKS
3' - 7"
1' - 5 1/2"
REF.
A120
29' - 0"
16' - 6"
2' - 7"
9' - 11"
5' - 5 3/8" VIF
2' - 1 3/8"
6' - 11 3/4"
8' - 9 1/2"
ACRYLIC TUB & SHOWER
SHELF
WALL TAGS ADDED


33' - 10"
WOOD SHELF
5' - 5 3/8" VIF
2' - 5"
6' - 6 1/2"
6' - 1 5/8"
13' - 3 1/2"
SHELVES
STORAGE
2' - 6 1/2"
2' - 4"
A121
1' - 2"
01
1' - 6"
REF.
BATH
05
HANGING ROD AND WIRE SHELF
A120
KITCHEN
02
SHEET LINO | WOOD PLANK
WOOD BENCH WITH HOOKS ABOVE
CLOSET
04
7' - 6"
DINING
5' - 7"
4' - 5"
HANGING ROD AND WIRE SHELF
BEDROOM #1
BEDROOM #2
LIVING
ADD R-11 UNFACED ACOUSTIC BATTS
10' - 5"
2' - 5"
14' - 2"
27' - 0"
11' - 10"
9' - 9"
12' - 3"
ELECTRIC BASEBOARD PER MECH.


ROOF
582' - 6"
LEVEL 4
573' - 3"
LEVEL 3
563' - 3"
LEVEL 2
553' - 3"
STAIR B LEVEL
542' - 9"
LOBBY LEVEL
541' - 9"
PARKING ENTRY LEVEL
541' - 0"
117 WENTWORTH WAY
20' - 0"
3' - 5"
5' - 0"


20' - 0"
3' - 5"
2' - 6"


80920.pdf
SK14
SMA - AD-039 - 190507.pdf
117 WENTWORTH WAY


GMC

Commissioning Field Report

206 West Newberry Road
Bloomfield, CT 06002
Tel: (860) 286-9171
Fax: (860) 242-0236
www.bvhis.com

BVH integrated services

Status:	**New**
Location:	2nd floor
Location Description:	Cellulose
Test Type:	Visual inspection

Results: Overall the cellulose insulation is looking good. The bays that are filled are densely packed with cellulose as it should. A few areas on the first floor were marked with red spray paint which represent bays missing insulation. The majority of them are known by the insulator such as the bays where interior walls meet exterior walls. The plan for them is to drill and fill the bays with cellulose. Along with this, bays that are too narrow to fill with cellulose should be filled with can foam instead.

The bays where an interior wall meets the exterior wall wrap behind a turned stud making access to the bay difficult. Because of this the plan is to drill and fill the bays with cellulose.

The arrows above point to a bay missing insulation at the intersection of column lines 5 and 6 on the 2nd level. Fill the bay with either cellulose or foam.

Comments:

Next Steps in Commissioning:

1.) Continued 1st instance testing on critical air barrier details (examples: sealed window installations, parking garage air barrier details, Zip roof to CMU wall, etc.).
2.) Continued visual inspections (example: Cellulose insulation).
3.) Compartmentalization preliminary test on mock-up unit.

End of Report - See the BVH Portal for any outstanding items from previous reports

Commissioning Field Report

206 West Newberry Road
Bloomfield, CT 06002
Tel: (860) 286-9171
Fax: (860) 242-0236
www.bvhis.com

BVH integrated services

The installed window from outside. Locations where leaks were found are shown and described further below.

The installed window from inside.

The test setup from inside.

Fog wisped out at the lower corner of the sash even though the cam lock was engaged. This is not a major concern but highlights the importance of making sure the frames are installed square so the sashes close as they were designed to.

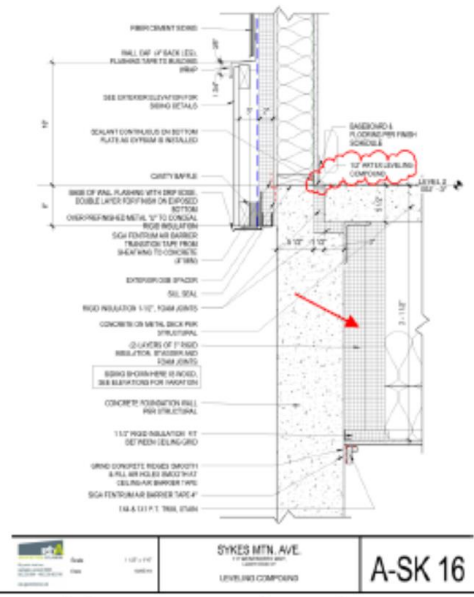
Commissioning Field Report

206 West Newberry Road
Bloomfield, CT 06002
Tel: (860) 286-9171
Fax: (860) 242-0236
www.bvhis.com

BVH integrated services

Status:	**New:**
Location:	A-SK16 , and/or 3/A500
Location Description:	Parking Garage Drywall to Foundation Transition
Test Type:	Visual Inspection

Results: Mark Selig from ReArch was concerned with the drywall seal to the foundation in the parking garage. In speaking with Mark, he stated that the interior rigid insulation in Drawing A-SK16 is being replaced with closed cell spray foam. If this is true, then we recommend the drywall be installed along the perimeter first, only one (1) sheet wide. This will allow the insulators to spray from the foundation directly to the top of the sheetrock. This transition, if done properly, will last longer and create a better seal to the foundation. The spray foam will also help seal penetrations through the foundation such as the roof drain pipes. Please also indicate where this switch to foam was approved.



If the rigid insulation indicated ultimately becomes spray foam, then we recommend the drywall around the perimeter of the garage be installed first for the foam to spray against. Please indicate where this change was

Commissioning Field Report

206 West Newberry Road
Bloomfield, CT 06002
Tel: (860) 286-9171
Fax: (860) 242-0236
www.bvhis.com

BVH integrated services

Fog leaked at the foam in the corner when introduced at the clip shown at the right. See related recommendation above.

The rest of the comments are based on visual observations.

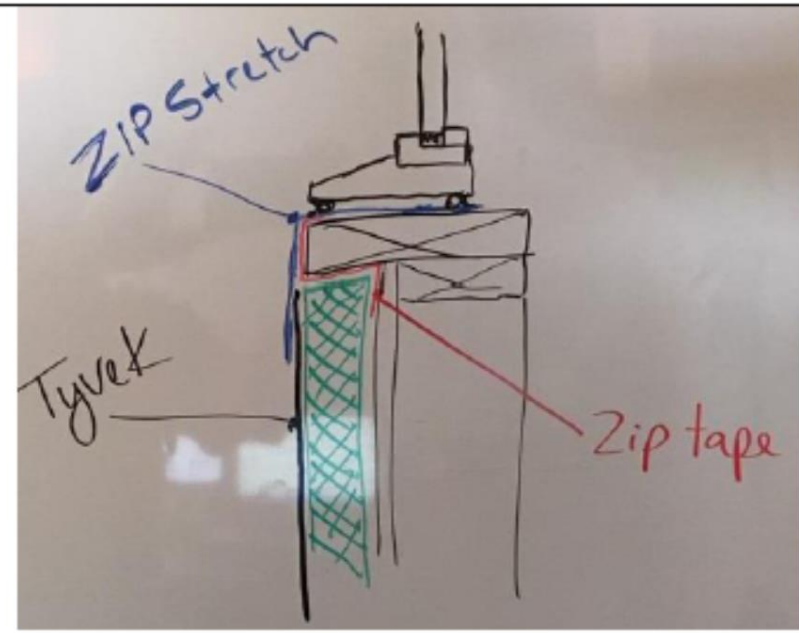
Make sure the ZIP stretch is stretched all the way into the corners. This opening was later infilled with more tape.

Hopefully the rough openings are not too tight. The window could tear the tape as it is pushed in.

Commissioning Field Report

206 West Newberry Road
Bloomfield, CT 06002
Tel: (860) 286-9171
Fax: (860) 242-0236
www.bvhis.com

BVH integrated services

	
The Tyvek has to be cut back in a square at the outer edge of the window buck so that the zip tape at the sheathing (the air barrier) can connect with the Zip Stretch tape at the rough opening. The Tyvek should not lap into the opening as seen above (blue arrows). The red lines show where the Tyvek should be cut to.	As discussed in the kick off meeting on 9-25-18, the Zip tape at the sheathing has to wrap the nose of the wood buck and the Tyvek has to be cut back to leave the buck exposed so the Stretch tape can connect to the Zip tape and then connect to the Tyvek. This is important for air barrier continuity. Also, make sure the Stretch tape comes into the rough opening far enough that the inner caulk bead will seal to the Stretch tape, not to wood.
It was done correctly at the mockup but a reminder to start at the bottom of the window and work up for proper shingling. This applies to all taped seams on the building.	

Blower Door Test Results:

The whole building leakage rate was 0.037 cubic feet per minute (CFM) at 50 Pascals of pressure (1.04 lbs./sq. ft.) per SF of exterior shell. The maximum air leakage rate allowed was 0.05 CFM at 50 pascals per SF of exterior shell so this building meets the standard. Adjusted CFM50 accounts for the change in air density due to temperature differences from inside and outside. Adjusted CFM50 is a more accurate measure of air flow under test conditions.

Field Measured CFM @ 50 Pascals	Temperature Adjusted CFM @ 50 Pascals	Square Feet of Building Shell	CFM50/SF
1,497	1,513	40,892	0.037

CONTENT

- Project Overview
- The Building
- **How Did We Decide What To Build?**
- Decision Time
- Design Coordination
- Building the Building
- Did it Work??
- What's Next?

How do we decide what to build??

- **Added Efficiency VT and Commons Energy to Design Team**
- **Design Charrette with Team**
- **Determine variables and Options to be considered**

WENTWORTH - ENVELOPE ANALYSIS					
Envelope	RBES	High Performance - A	High Performance - B	High Performance - C	Passive
Total Square Footage	33,613	33,613	33,613	33,613	33,613
Roof (const./R-value)	60	66.6	66.6	66.6	83.6
Exterior Wall / Above Grade Wall (R-value)	20	31	31	31	40
Total Window Area	2729	2,729	2,729	2,729	2,729
Window U Value	0.28	0.28	0.28	0.15	0.15
Window SHGC	0.3	0.4	0.4	0.4	0.4
Rim Joists / perimeter slab edge (R-value)	20	31	31	31	40
Parking Garage Ceiling/Floor over unheated	30	30	30	50	50
Slab on Grade (const./R-value)	15	15	15	15	20
Air infiltration - CFM50/sf	0.3	0.1	0.05	0.05	0.05

How do we decide what to build??

- **Out-of-Box thinking!**
- **Developed envelope and systems options Matrix**
- **Optionitis!**

Envelope				
	Base	High Performance A	High Performance B	Passive
Total Square Footage	32,579	32,579	32,579	32,579
Roof (const./R-value)	60	60	60	76
Exterior Wall (R-value)	20	25	25	40
Total Window Area	2,438	2,438	2,438	2,438
Window U Value	0.28	0.15	0.28	0.15
Window SHGC	0.3	0.4	0.3	0.4
Rim Joists (R-value)	20	25	25	40
Parking Garage Ceiling (R-value)	30	38	38	40
Slab on Grade (const./R-value)	15	15	15	20
Air infiltration - CFM50/sf	0.3	0.05	0.05	0.05

HVAC OPTIONS	Option 1	Option 2	Option 2A	option 3	option 3B
Heat	base board hot water higher temp water, non condensing boiler, 80% eff	1. hydronic baseboard with condensing LP gas heat 2. low temp water	1. radiant floor heat with condensing LP gas heat 2. low temp water	ERV with heating boost off of gas boiler, electric baseboard suppliment	ERV with tempered air, electric baseboard suppliment

How do we decide what to build??

- **Building load calculations**
-
-

t)

Life Cycle Cost Analysis			
	Hydronic	Electric Baseboard	Electric Baseboard w/Solar
First Cost	1,353,944	1,215,944	1,335,994
Energy Costs	678,934	693,722	508,436
Maintenance	39,144	23,486	53,486
Total	2,090,065	1,944,823	1,909,587

CONTENT

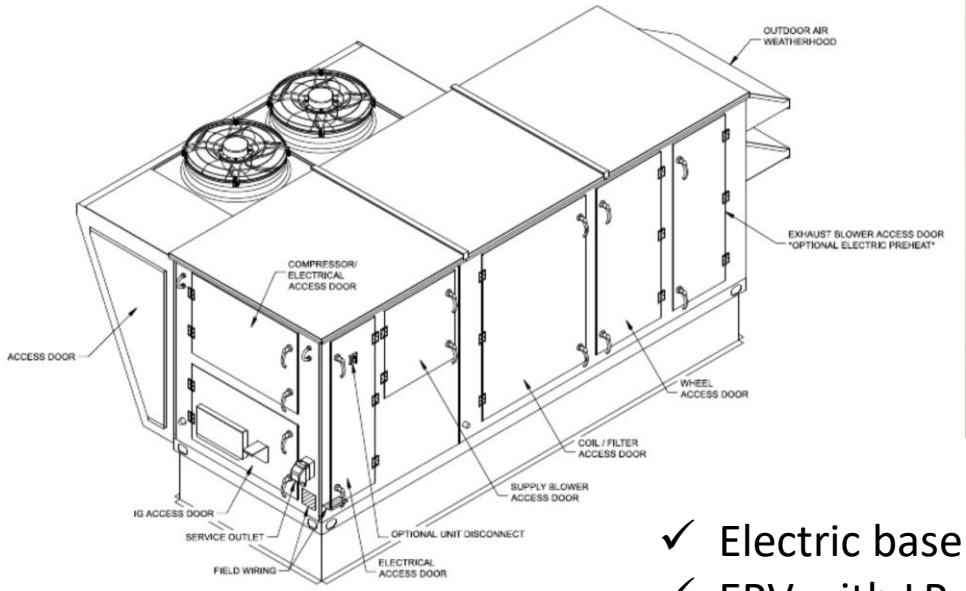
- Project Overview
- The Building
- How Did We Decide What To Build?
- **Decision Time**
- Design Coordination
- Building the Building
- Did it Work??
- What's Next?

Envelope	RBES	A	B	C	Passive	Final Design	Final Design
Total Square Footage	33,613	33,613	33,613	33,613	33,613	33,930	33,930
Roof (const./R-value)	60	66.6	66.6	66.6	83.6	66	66
Exterior Wall / Above Grade Wall (R-value)	20	31	31	31	40	32.4	32.4
Total Window Area	2729	2,729	2,729	2,729	2,729	2,729	2,729
Window U Value	0.28	0.28	0.28	0.15	0.15	0.2	0.2
Window SHGC	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Slab edge (R-value)	20	31	31	31	40	21	21
Parking Garage Ceiling/Floor over unheated space (R-value)	30	30	30	50	50	50	50
Slab on Grade (const./R-value)	15	15	15	15	20	15	15
Air infiltration - CFM50/sf	0.3	0.1	0.05	0.05	0.05	0.035	0.035

- **Construction Cost Differential (envelope): $181,347 ($5.34/sf)**
- **Operating Cost Savings: $8,337/yr**

Code Compliant

Our Building
(without high cost of a Yeti!)

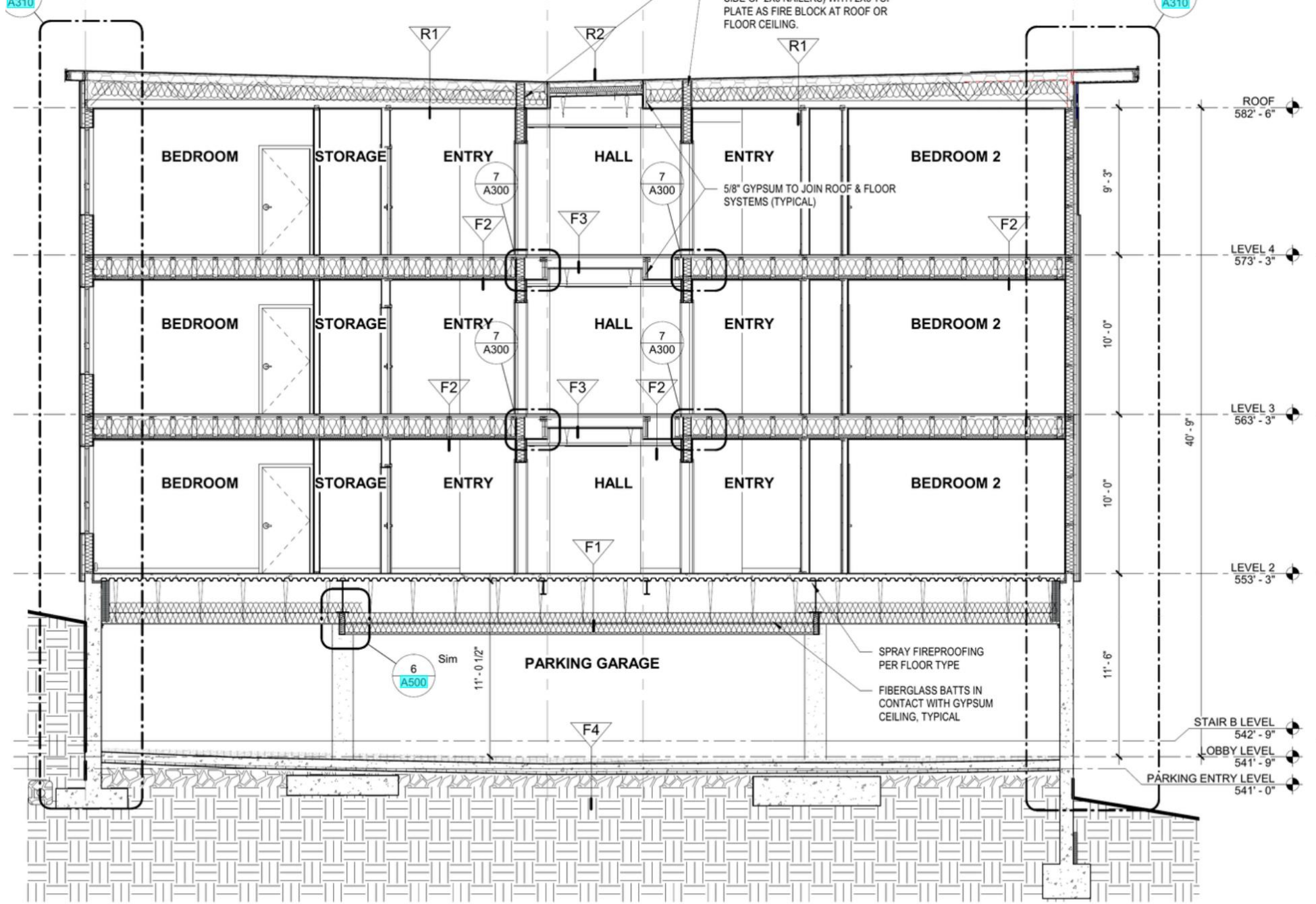


- ✓ Electric baseboard heat
- ✓ ERV with LP gas heat and cooling
- ✓ Condensing water heaters (LP)
- ✓ WiFi thermostats

	kwH Produced
July	9,152
August	7,877
September	6,484
October	3,548
November	1,511
December	812

CONTENT

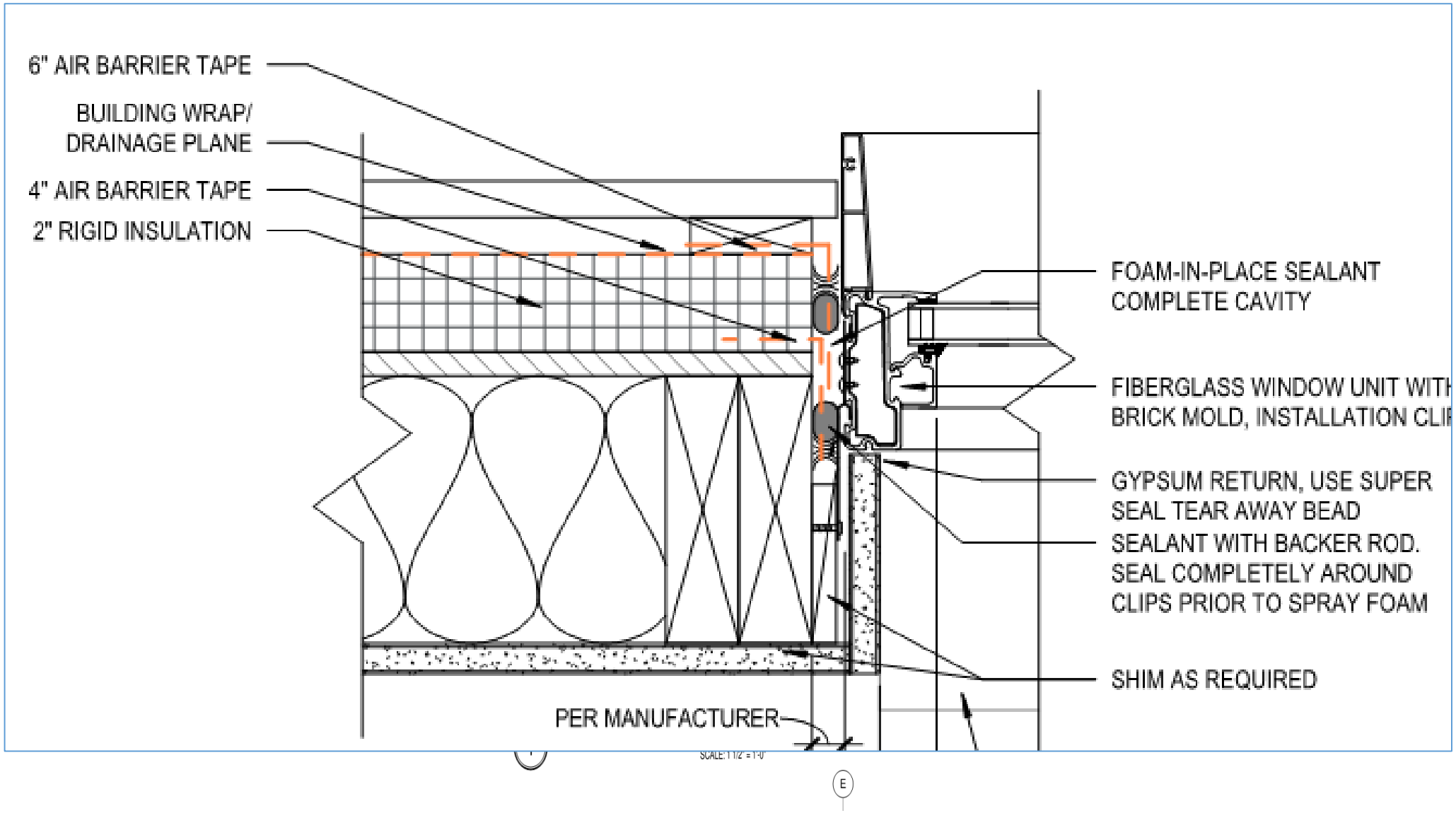
- Project Overview
- The Building
- How Did We Decide What To Build?
- Decision Time
- **Design Coordination**
- Building the Building
- Did it Work??
- What's Next?



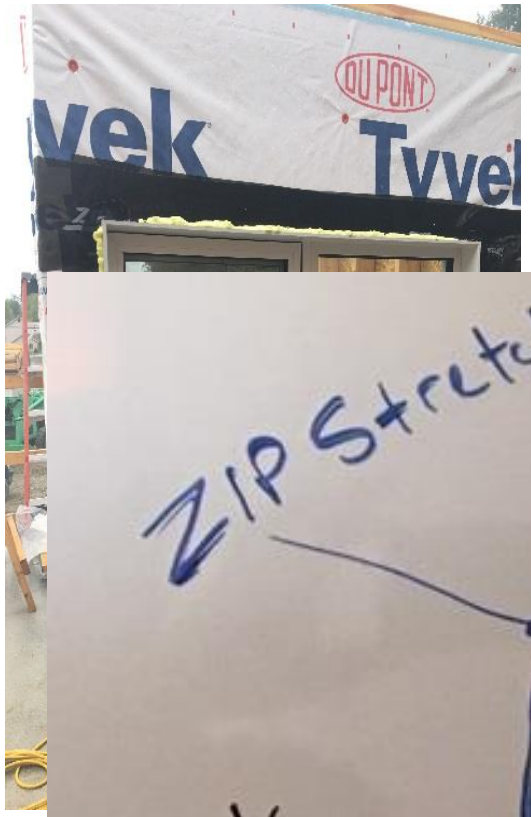
1 BUILDING SECTION

SCALE: 3/16" = 1'-0"

Envelope Kick Off Meeting



Mock Up Tests




DUPONT
Tyvek
HomeWrap


Tyvek
ESTIRABLE
ZIP
USA

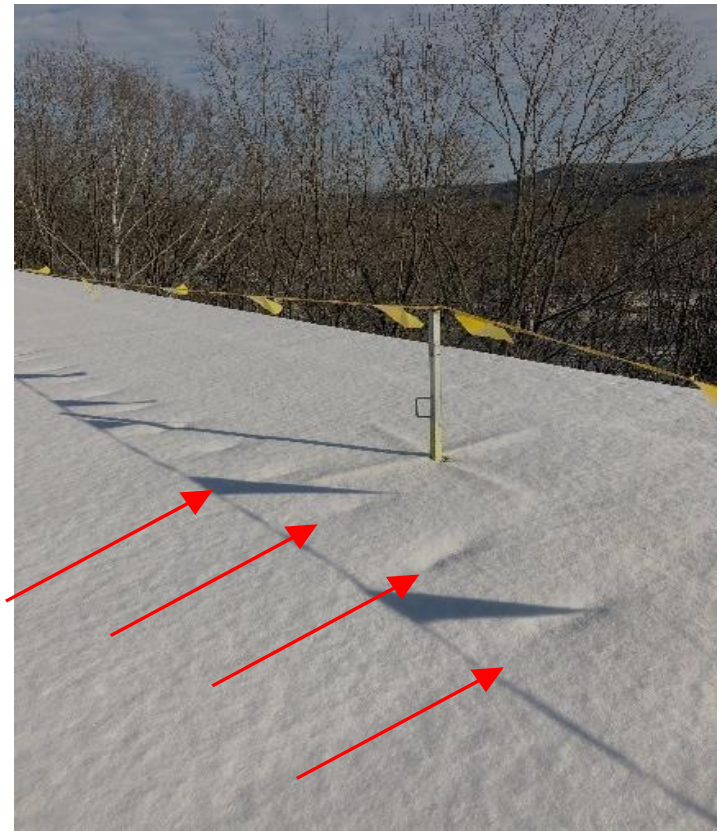
CONTENT

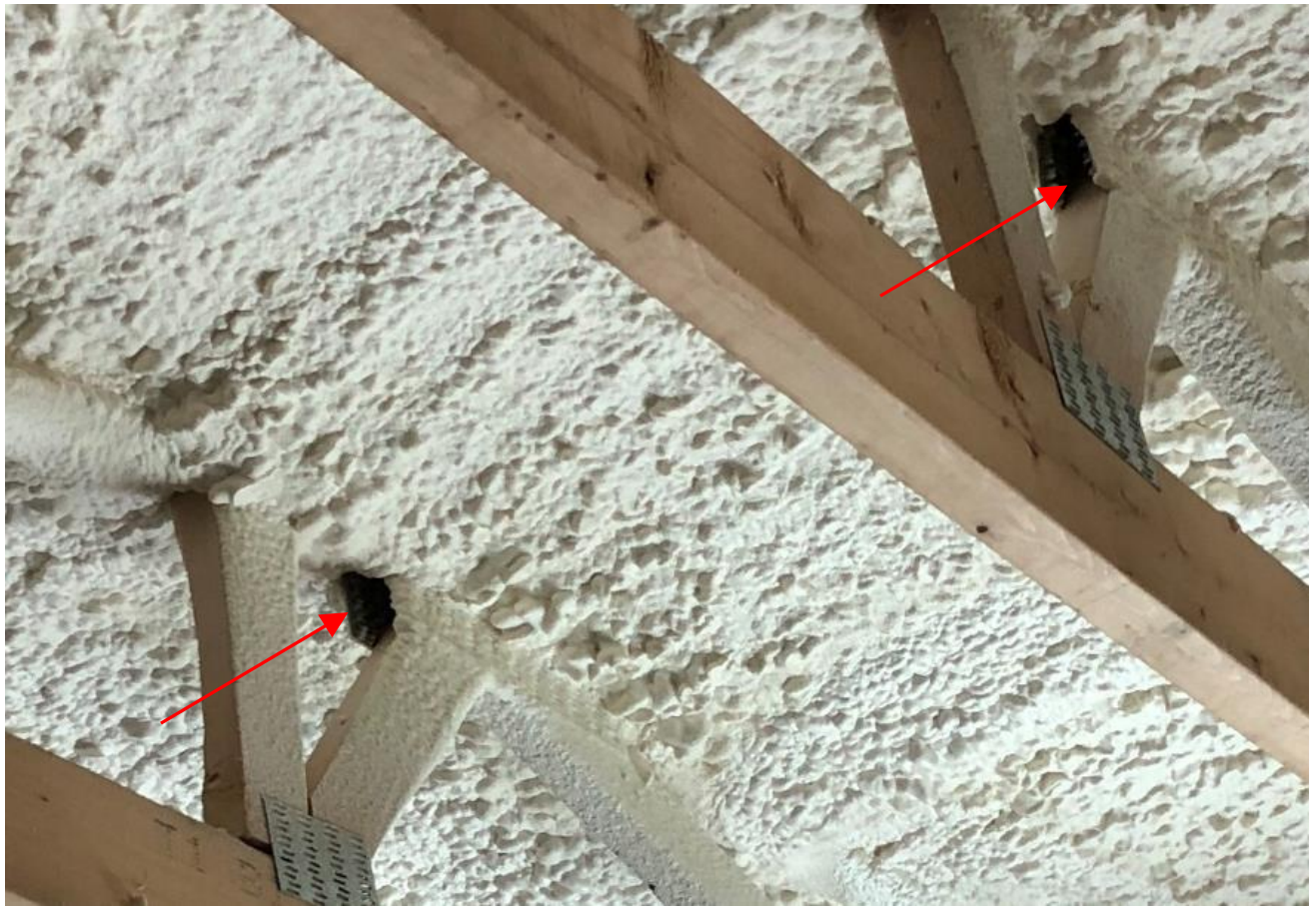
- Project Overview
- The Building
- How Did We Decide What To Build?
- Decision Time
- Design Coordination
- **Building the Building**
- Did it Work??
- What’s Next?

Visual Inspections

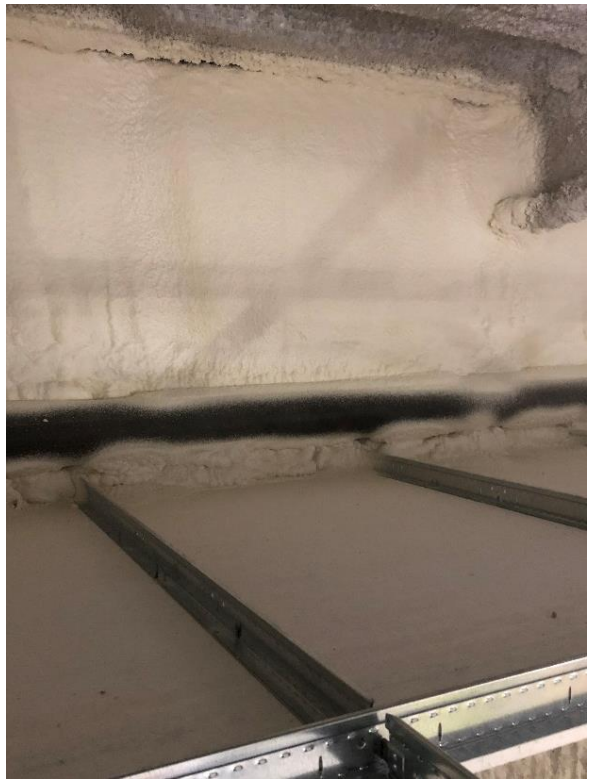
Fog Tests

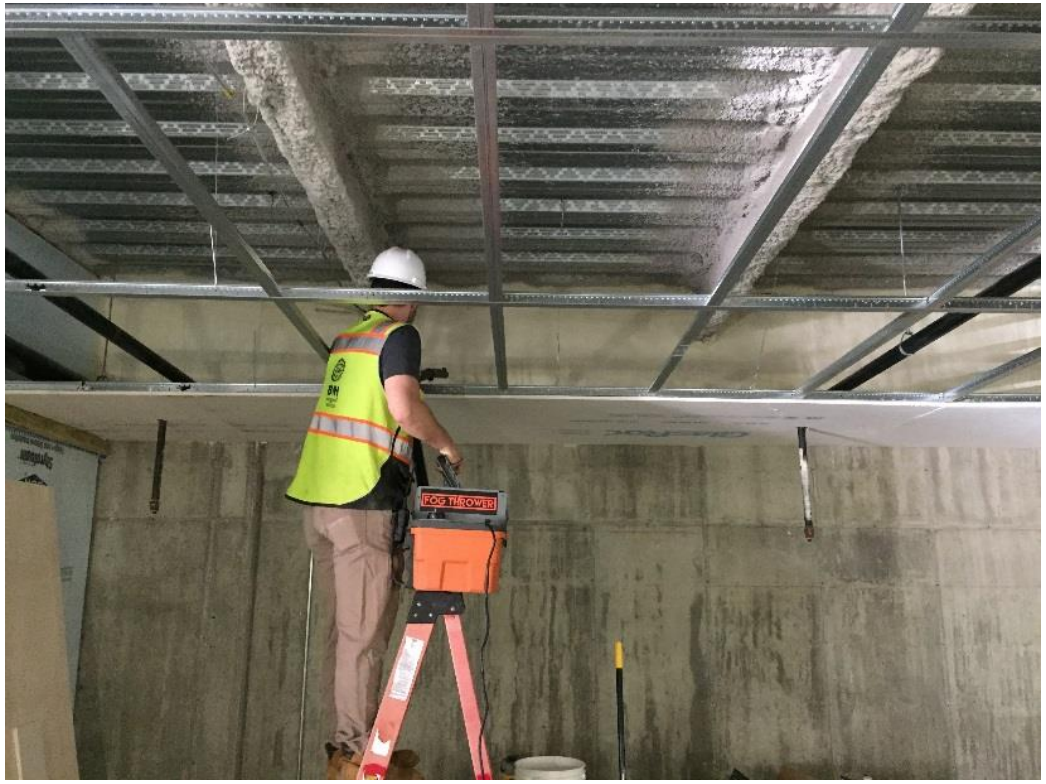
Snow Melt on Roof





Parking garage ceiling as air barrier

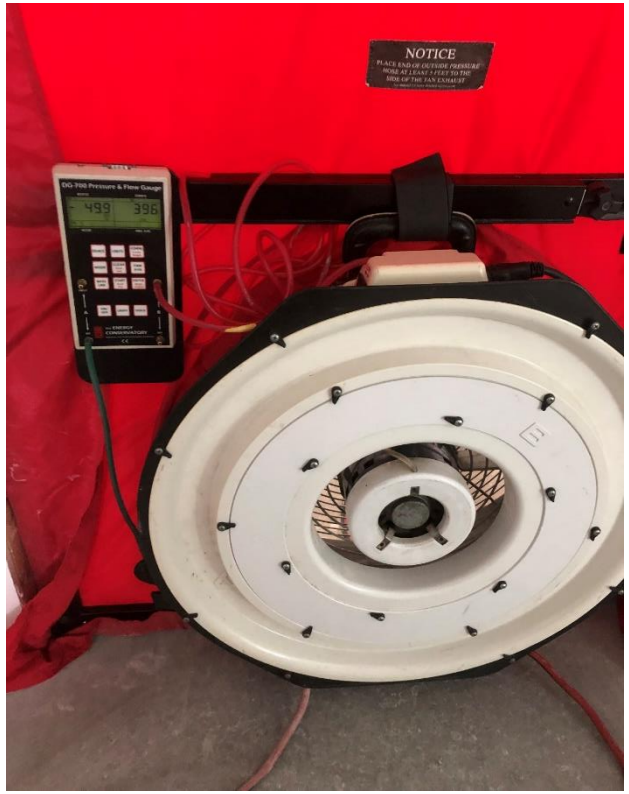




Rafter Tails

Compartmentalization Tests

The Unit 110 leakage rate was 369 CFM at 50 Pascals which equates to 0.12 cubic feet per minute (CFM) at 50 Pascals of pressure (1.04 lbs./sq. ft) per SF of the exterior shell. The maximum air leakage rate allowed was .10 CFM at 50 Pascals per SF of exterior shell and 0.20 CFM at 50 Pascals per SF of interior shell equating to 448.2 CFM at 50 Pascals. This result means the unit has met the air tightness standard.



Field Measured CFM @ 50 Pascals	Square Feet of Unit Shell	CFM50/SF	Weighted Target CFM
369	2,962	0.12	448.2

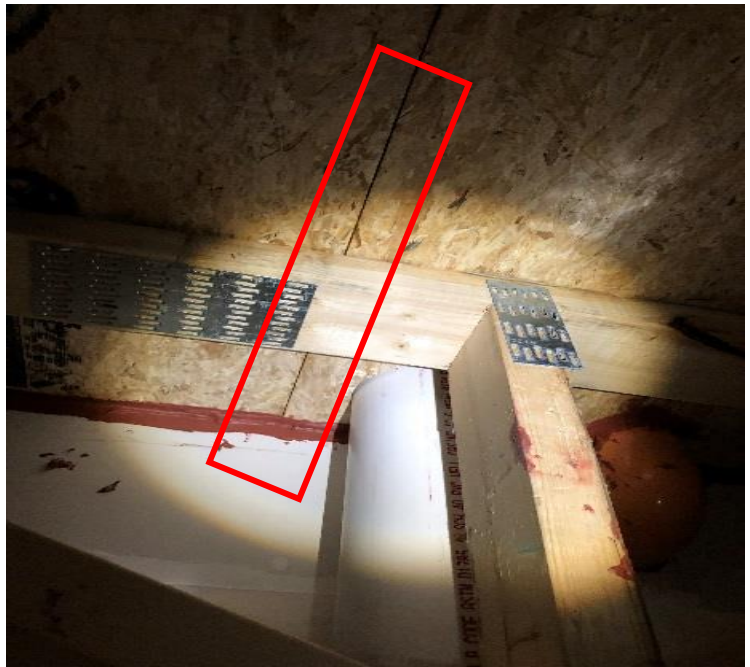
Note* photo was take before repairs were made.

Test Unit

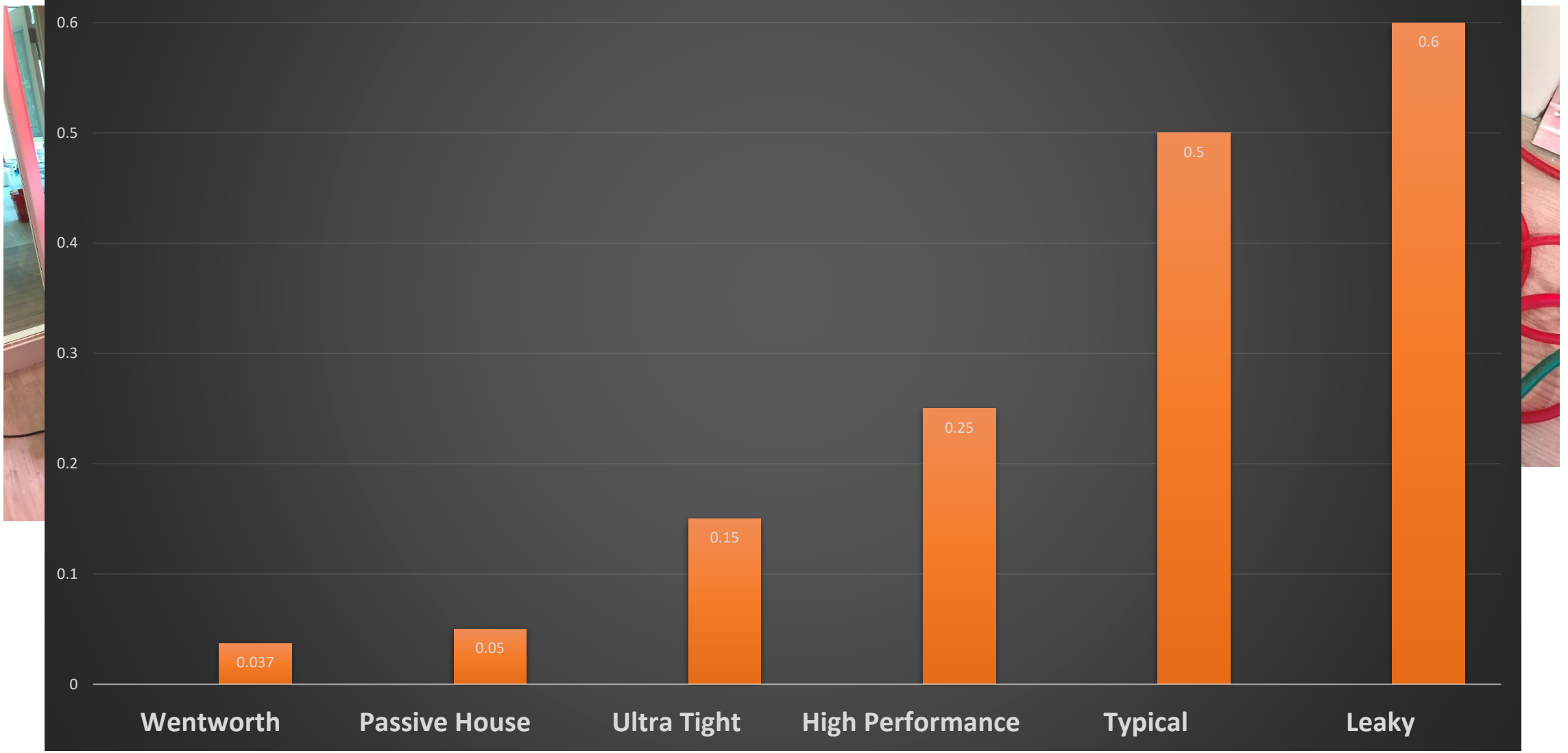
Wall to floor

Drywall is not continuous behind interior partitions, resulting in leaks.

Pipe chase with seam missing tape

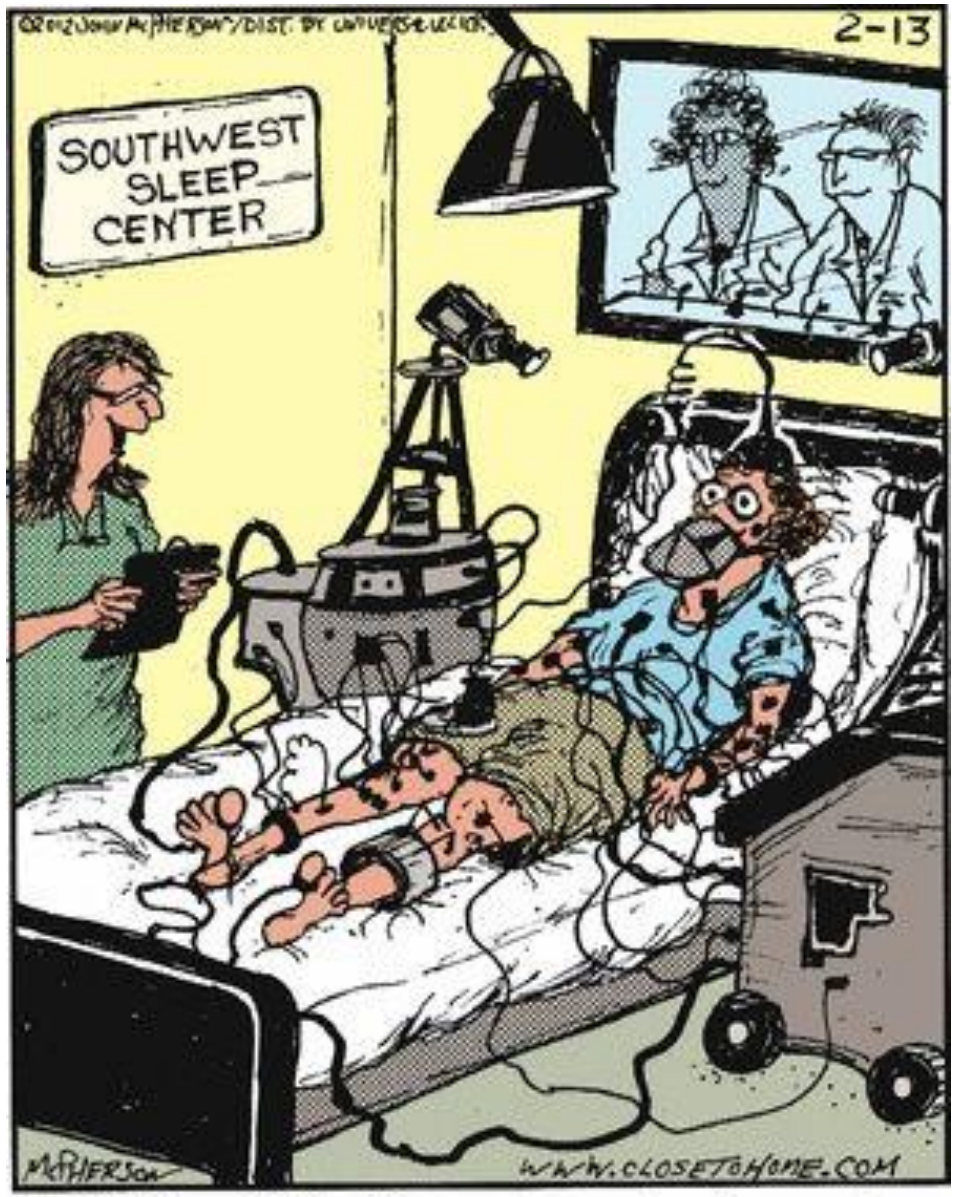


Plumbing penetrations
OSB Seams in the ceiling
Interior outlets-around 50 CFM at first

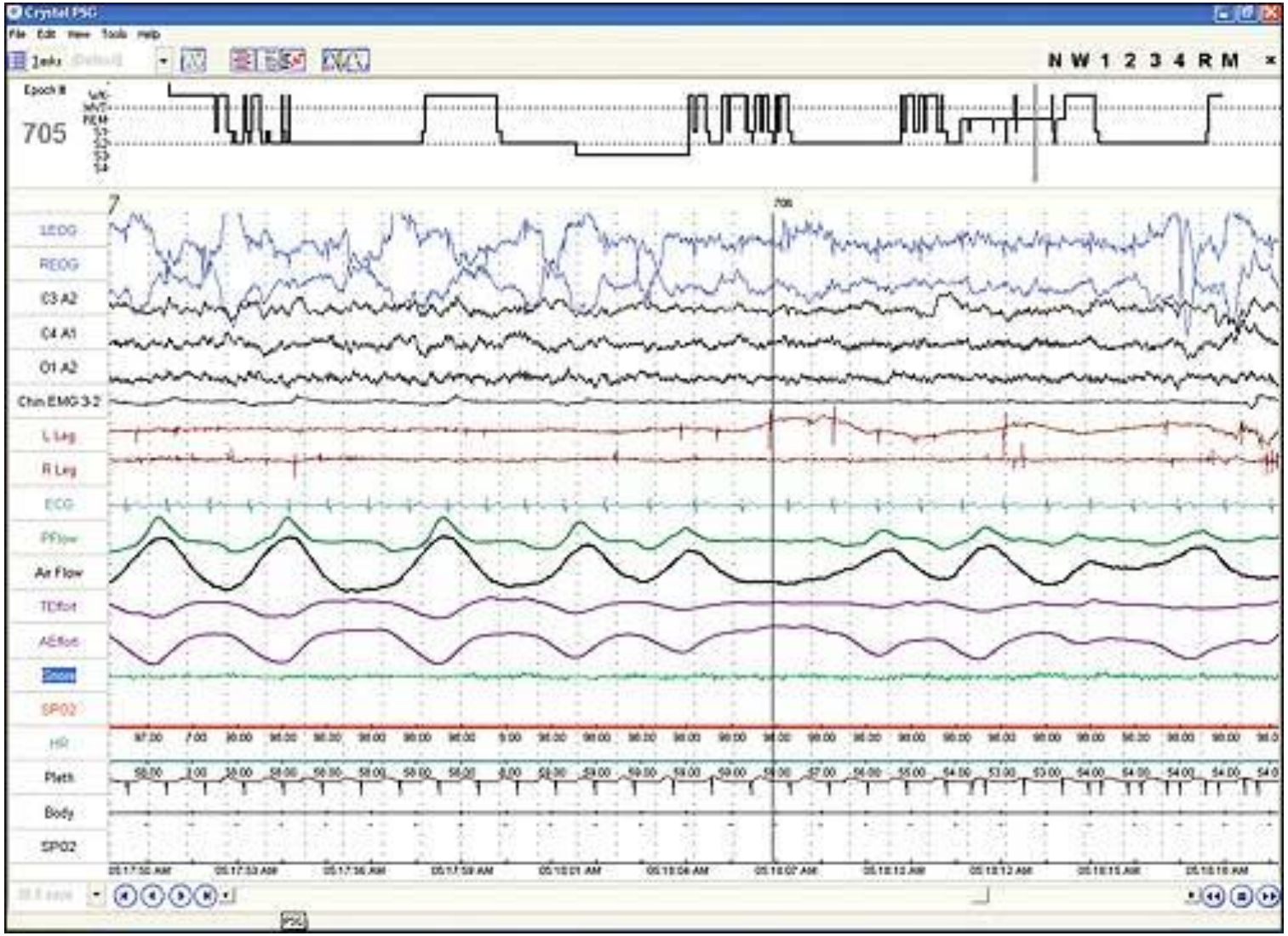

Air Tightness (CFM50/sf)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.037
0.05
0.15
0.25
0.5
0.6
Wentworth
Passive House
Ultra Tight
High Performance
Typical
Leaky

RESULTS

- Project Overview
- The Building
- How Did We Decide What To Build?
- Decision Time
- Design Coordination
- Building the Building
- **Did it Work??**
- What's Next?

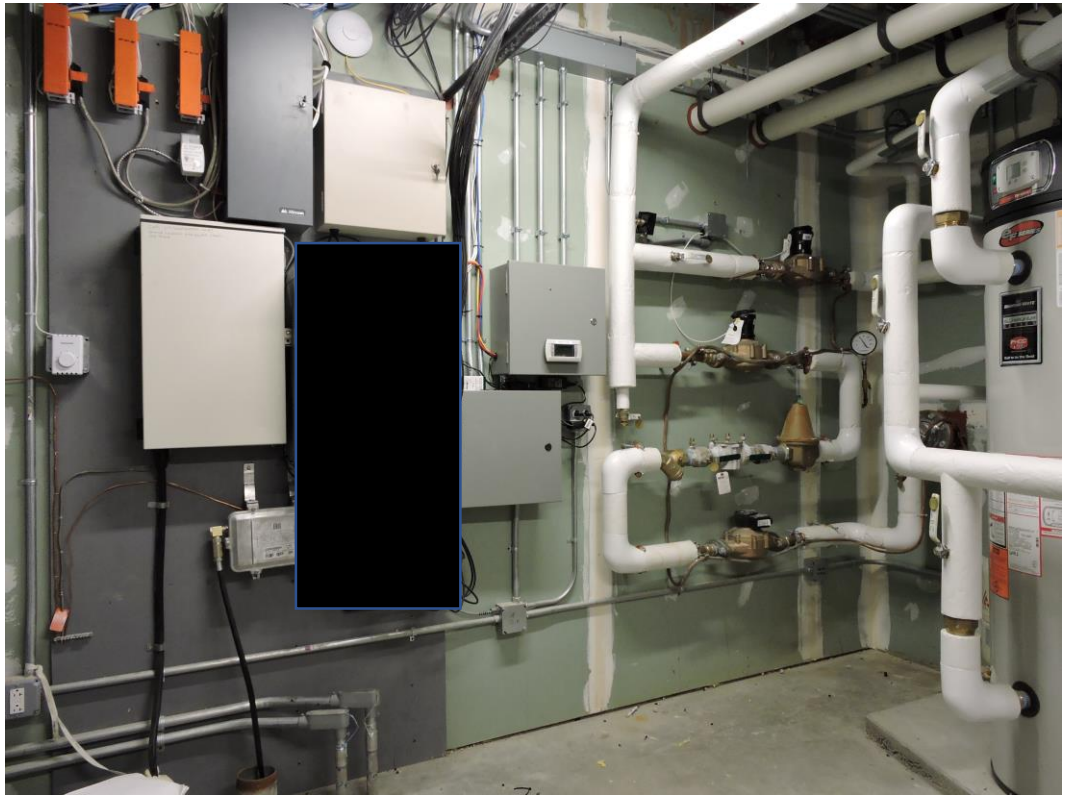


"OK, Mrs. Tully. We want you to relax, get a good night's sleep, and we'll evaluate any sleep issues that you have."




BRADFORD WHITE
Built to be the Best


OFF
68
73 and holding
ecobee



August 4, 2019
7:15 PM

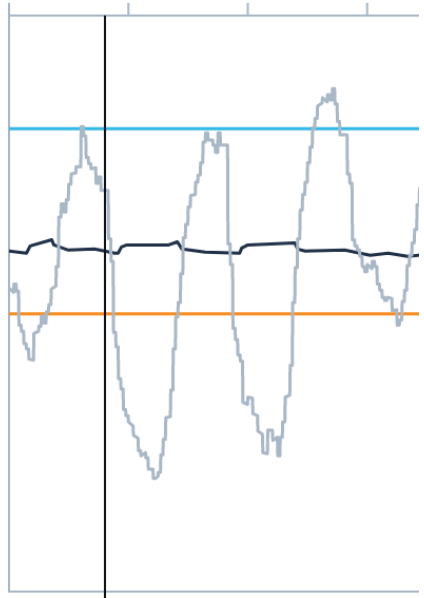
Aug 4, 2019 - Aug

Sun Mon Tue Wed

Temperature

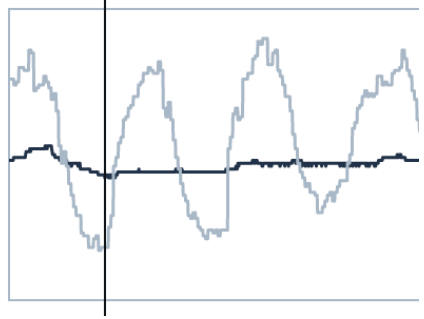
Outdoor	76°
Indoor	70°
Cool	82°
Heat	64°

Sensors



Humidity

Outdoor	28%
Indoor	52%



August 5, 2019
4:05 PM

Temperature

Outdoor	81°
Indoor	75°
Cool	70°
Heat	70°

Sensors

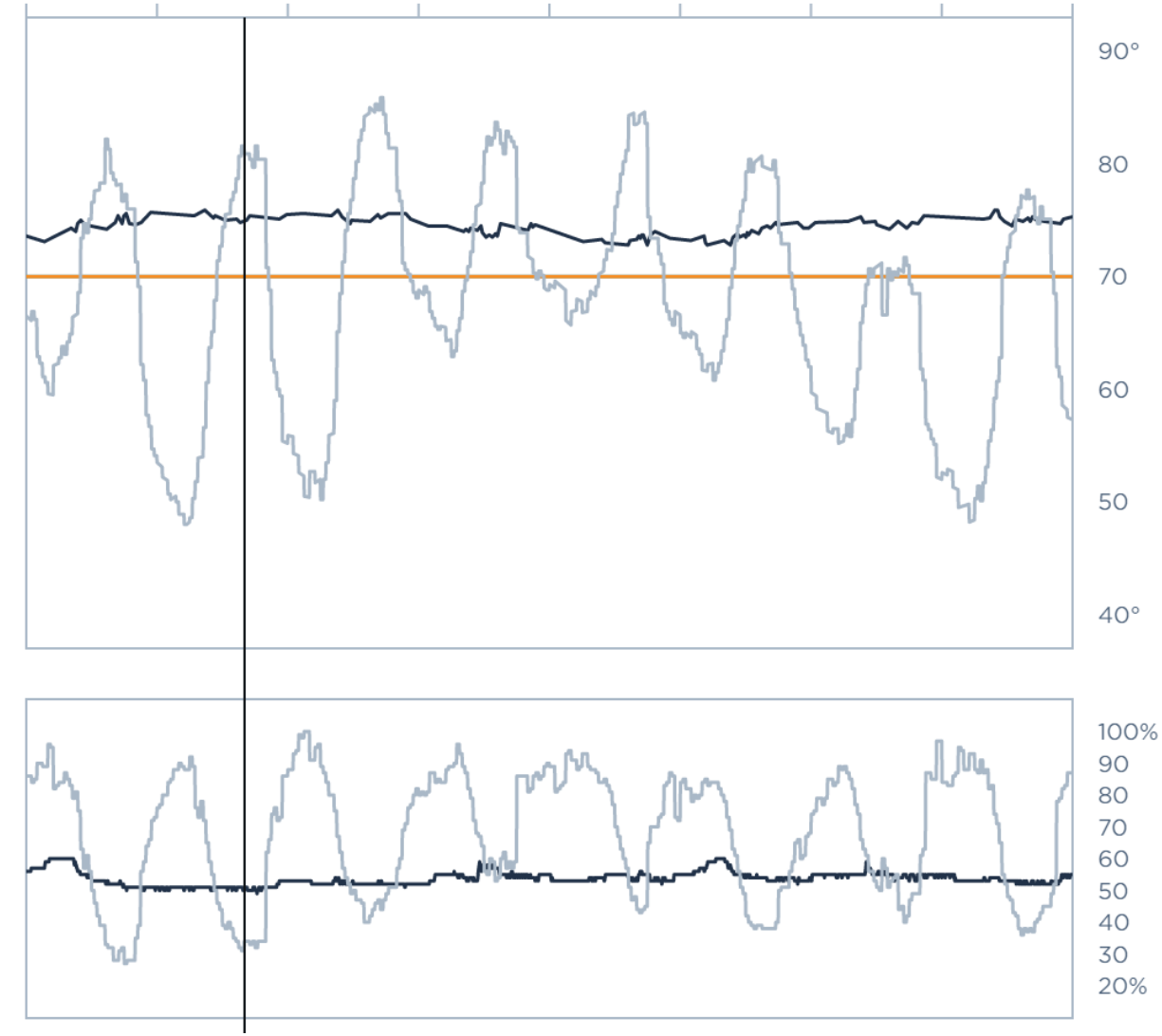
Humidity

Outdoor	34%
Indoor	51%

Aug 4, 2019 - Aug 11, 2019

Export

Sun Mon Tue Wed Thu Fri Sat Sun Mon



January 25, 2020
6:55 PM

Jan 25, 2020 - Jan 31, 2020

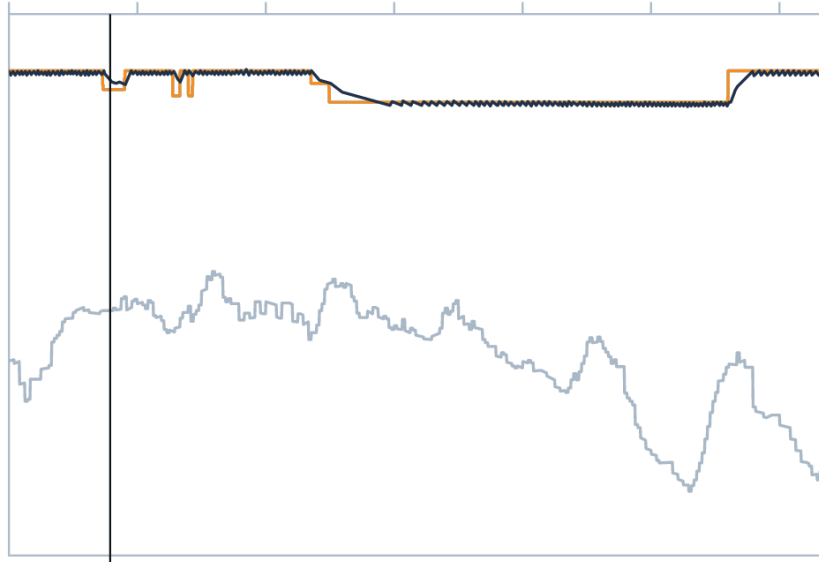
E

Sat Sun Mon Tue Wed Thu Fri

Temperature

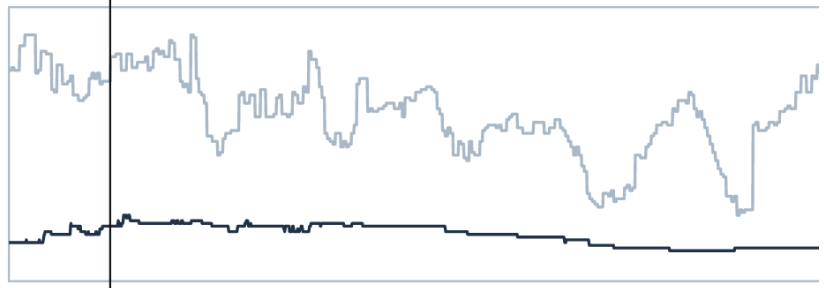
Outdoor	36°
Indoor	73°
Cool	71°
Heat	71°

Sensors



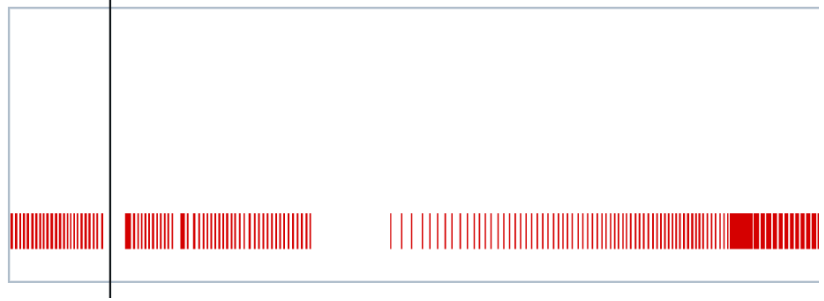
Humidity

Outdoor	83%
Indoor	30%



System Runtime

Fan	Off
Cool	Off
Heat	Off
Aux	Off



January 29, 2020
8:10 PM

Jan 25, 2020 - Jan 30, 2020

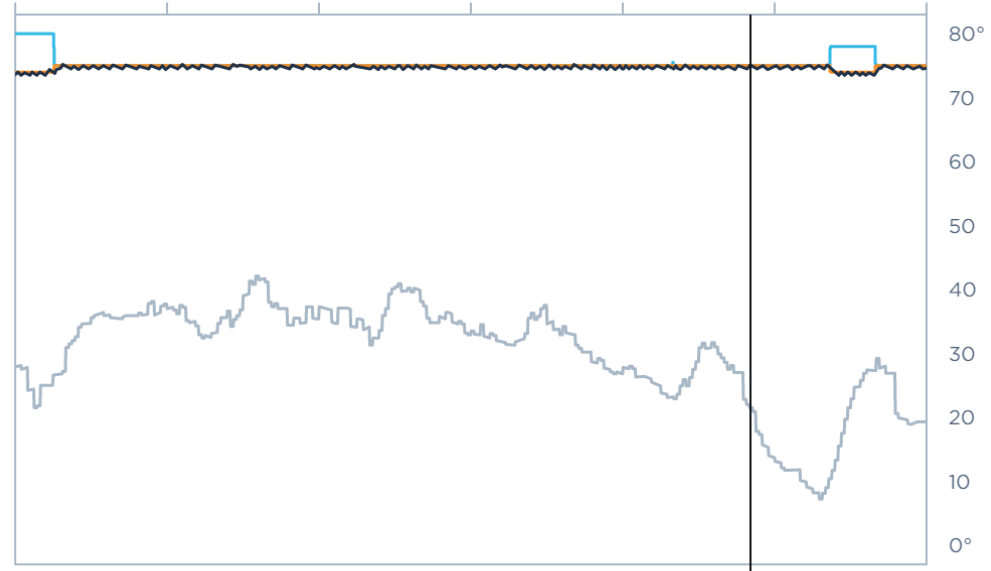
Export

Sat Sun Mon Tue Wed Thu Fri

Temperature

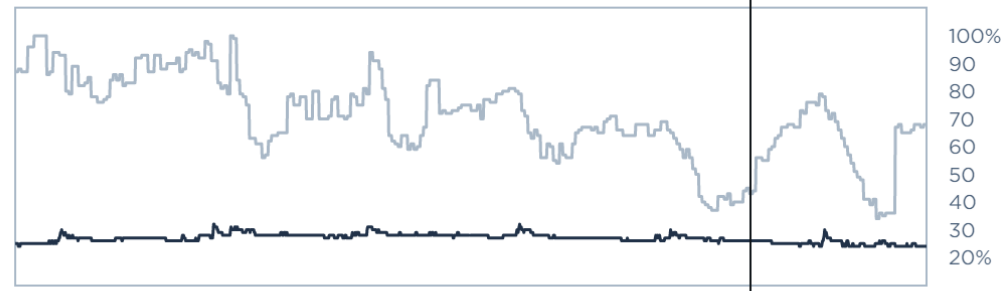
Outdoor	22°
Indoor	75°
Cool	75°
Heat	75°

Sensors



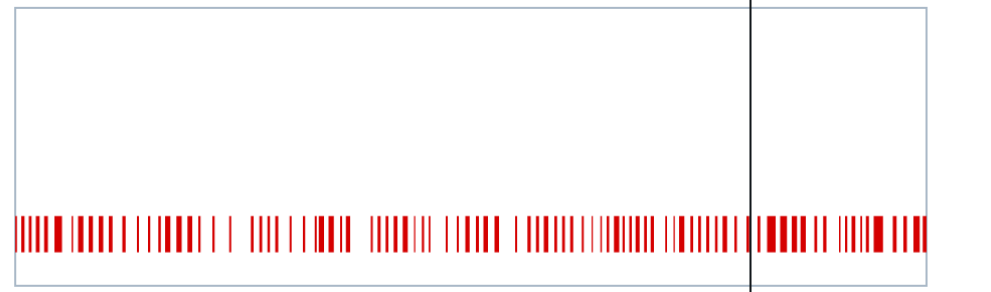
Humidity

Outdoor	43%
Indoor	26%



System Runtime

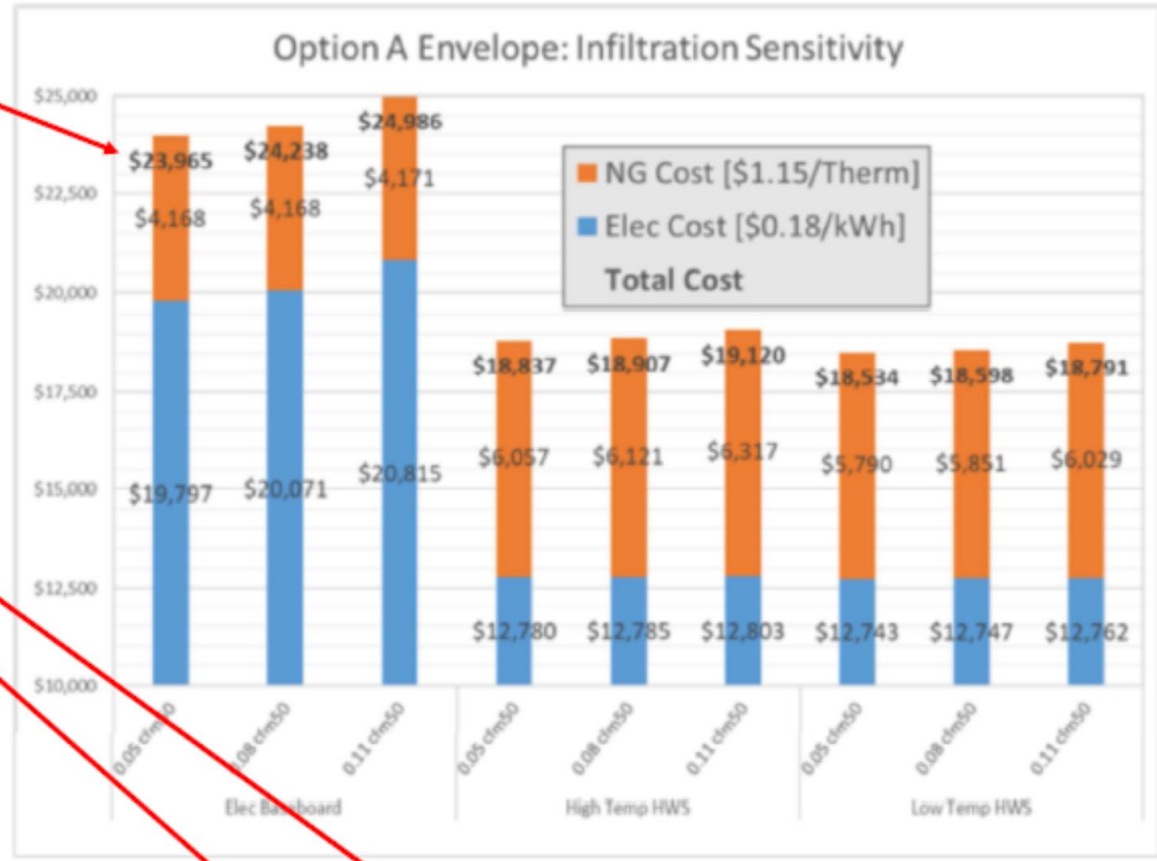
Fan	Off
Cool	Off
Heat	Off
Aux	Off



$15,033 △

$8,932

In 4 months, the electric heat and ventilation have consumed $8,932 of energy. The numbers below look to me like the ERV is providing more heat than anticipated and the electric heat is using much less than predicted.



Wentworth Heating kbtu (electric and propane)

				Electric 1 kwh	kbtu 3.412		Propane 1 gal	kbtu 91				
					$ 0.053	kbtu		$ 0.024	kbtu			
	Modeled			*Actual*								
	Electric kbtu	Propane kbtu	**Total Heat kbtu**	Electric kbtu	Propane kbtu	**Total kbtu**	kbtu per unit	Electric cost @ $0.18/kwh	Propane Cost @ $2.15/gal	Total Cost	Cost per unit	
September	0	0	**0**	3,596	11,265	**24,724**	824	$ 190	$ 266	$ 456	$ 15	
October	-	416	**416**	10,567	21,128	**35,678**	1,189	$ 557	$ 499	$ 1,057	$ 35	
November	82	2,982	**3064**	25,856	25,111	**57,465**	1,916	$ 1,364	$ 593	$ 1,957	$ 65	
December	996	8,050	**9047**	24,689	31,609	**24,689**	823	$ 1,302	$ 747	$ 2,049	$ 68	
								$3,413		**$5,519**		

- Not enough data collected yet
- Analyzing building performance data
- Use this information planning future buildings
- Information used for troubleshooting issues
- Enlightening energy usage data!

CONTENT

- Project Overview
- The Building
- How Did We Decide What To Build?
- Decision Time
- Design Coordination
- Building the Building
- Did it Work??
- **What's Next?**


✓ Building Commissioning and Fine-tuning performance with monitoring (Parson Platform)
✓ Sizing of domestic hot water system
✓ Using real time data to inform energy models and system sizing
✓ Provision for electric resistance heating for high performance buildings in updated energy code! (<6 btu/sf)

ENERGY STAR® PortfolioManager®

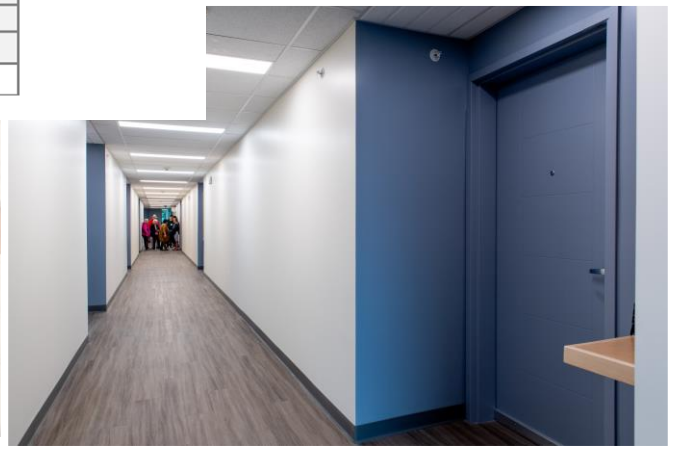
Technical Reference

Broad Category	Primary Function	Further Breakdown (where needed)	Source EUI (kBtu/ft²)	Site EUI (kBtu/ft²)	Reference Data Source - Peer Group Comparison
Healthcare	Ambulatory Surgical Center		138.3	62.0	CBECS - Outpatient Healthcare
	Hospital	Hospital (General Medical & Surgical)*	426.9	234.3	Industry Survey
		Other/Specialty Hospital	433.9	206.7	CBECS - Inpatient Healthcare
	Medical Office*		121.7	51.2	CBECS - Medical Office
	Outpatient Rehabilitation/Physical Therapy		138.3	62.0	CBECS - Outpatient Healthcare
	Residential Care Facility		213.2	99.0	I
	Senior Care Community*		213.2	99.0	I
	Urgent Care/Clinic/Other Outpatient		145.8	64.5	CBEC
Lodging/Residential	Barracks*		107.5	57.9	CBECS - Dormitory
	Hotel*		146.7	63.0	CBECS - Hotel & Motel/Inn
	Multifamily Housing*		118.1	59.6	Fannie Mae Industry Survey
	Prison/Incarceration		156.4	69.9	CBECS - Public Order and Safety
	Residence Hall/Dormitory*		107.5	57.9	CBECS - Dormitory
	Residential Care Facility		213.2	99.0	Industry Survey
	Senior Care Community*		213.2	99.0	
	Single Family Home		N/A	N/A	
	Other - Lodging/Residential		143.6	63.6	
Manufacturing/Industrial	Manufacturing/Industrial Plant		N/A	N/A	
Mixed Use	Mixed Use Property		89.3	40.1	
Office	Medical Office*		121.7	51.2	CBECS - Medical Office
	Office*		116.4	52.9	CBECS - Office & Bank/Financial
	Veterinary Office		145.8	64.5	CBECS - Clinic/Outpatient
Parking	Parking		N/A	N/A	None Available

59.6

Wentworth Community Housing

23



Good Enough – Hitting the Energy Jackpot at Wentworth Community Housing

Presenters:

Samantha Dunn
Housing Vermont

Gregg Gossens
gbA Architecture & Planning

Jon Haehnel
BVH Integrated Services, P.C.

Steve Poole
VHV Company

Efficiency Vermont
BETTER BUILDINGS BY DESIGN