BUILDINGENERGY BOSTON

Historic Buildings, Modern Solutions: Decarbonization Strategies for Multifamily Landmarks

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Northeast Sustainable Energy Association (NESEA) | March 21, 2025

Historic Buildings, Modern Solutions

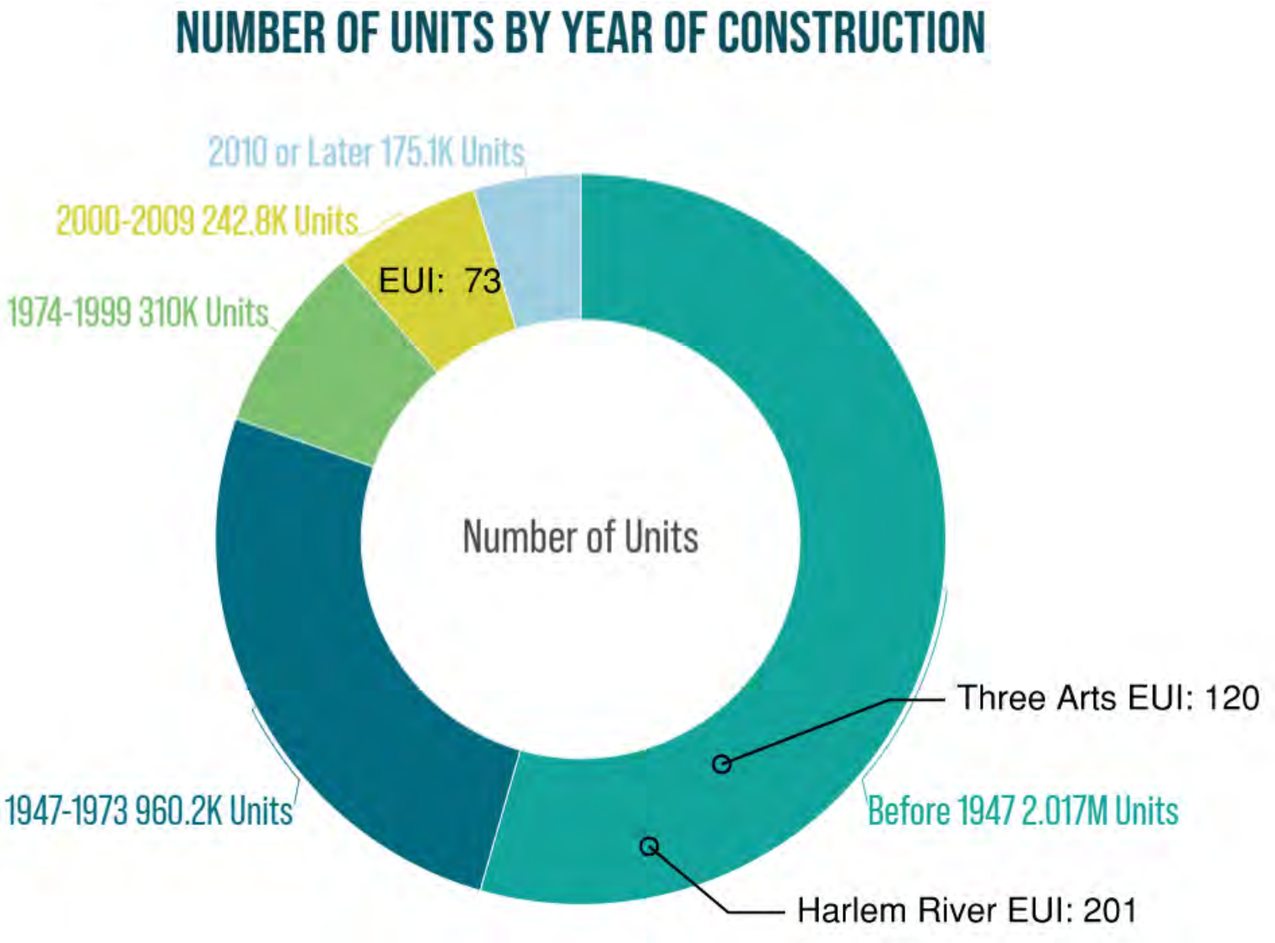
Decarbonization Strategies for Multifamily Landmarks

Steven Winter Associates, Inc.

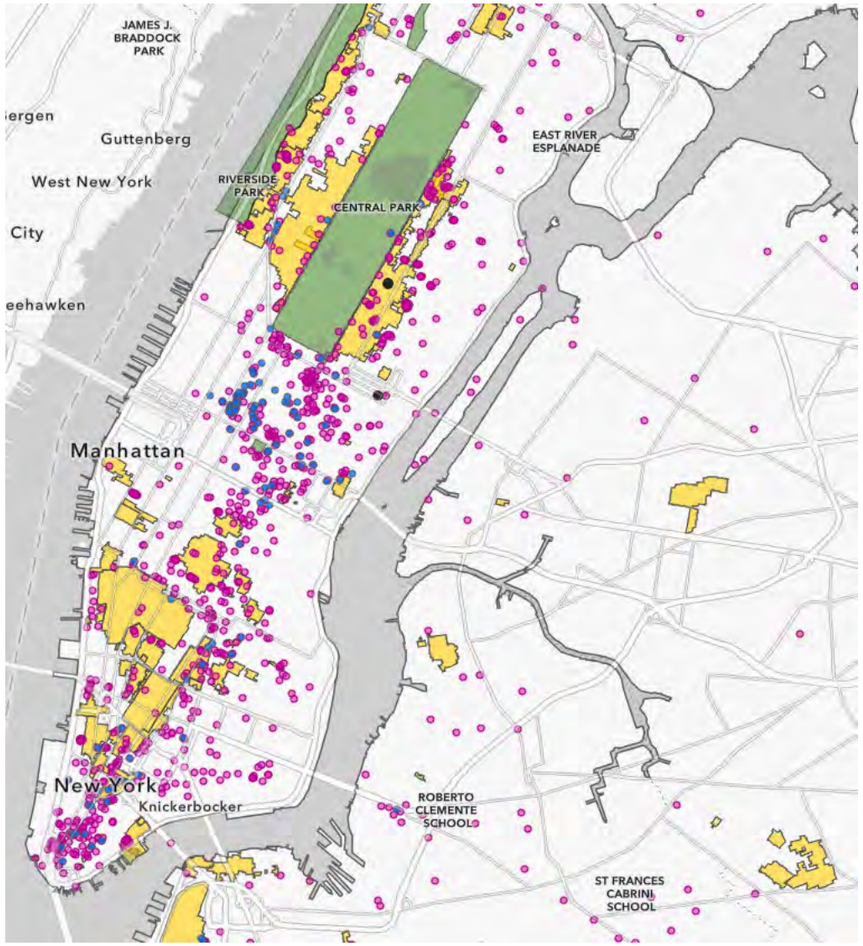
Curtis + Ginsberg Architects

Existing Dense Urban Environments

80% of NYC Housing stock is over 50 years old

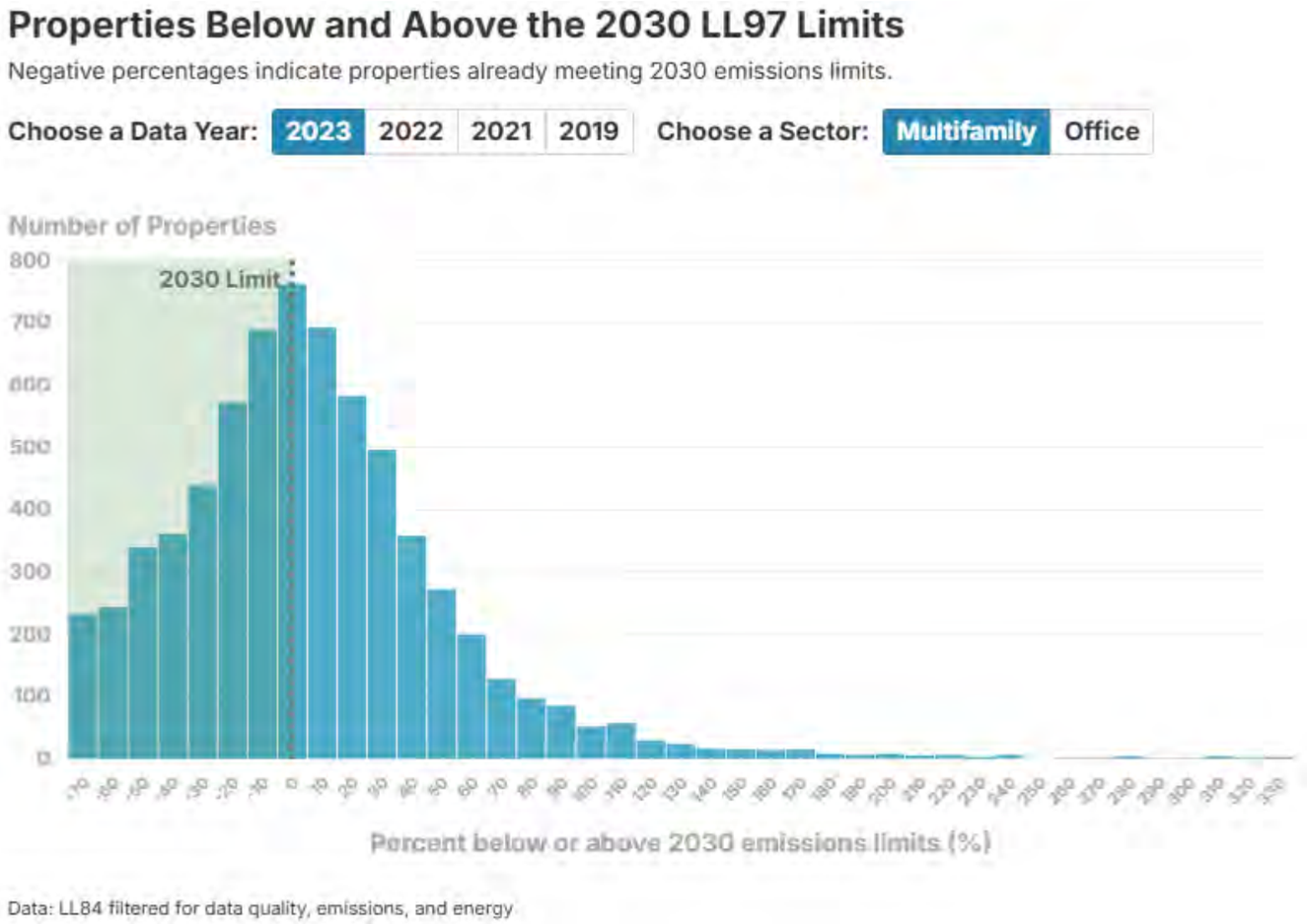


Credit: CHPC



Landmark Properties > Vacant Properties

Energy Landscape



Source: Urban Green

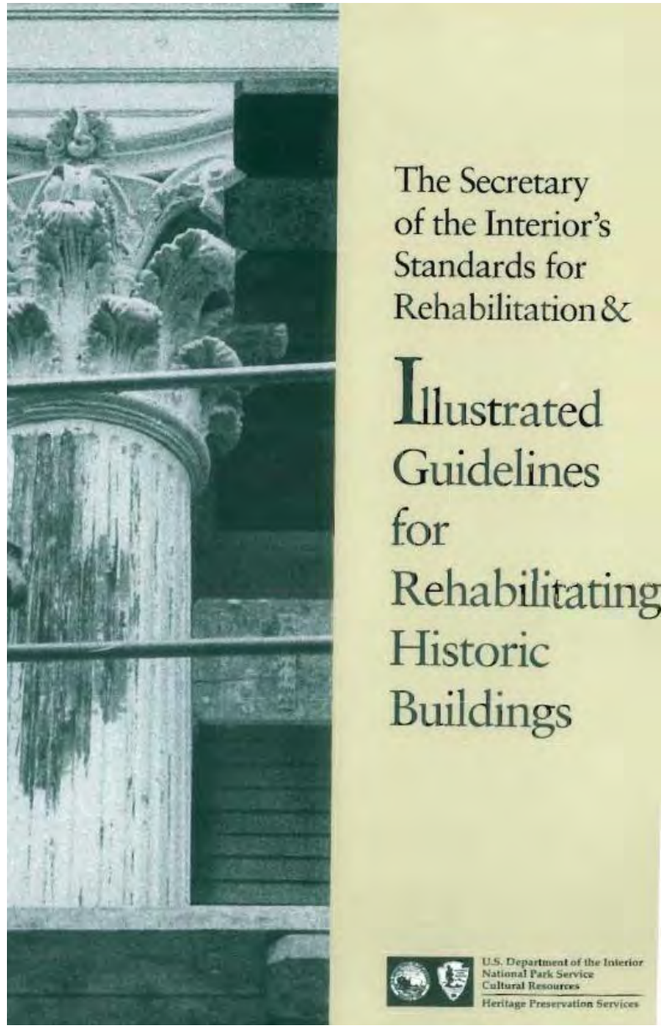
- **Landmark Projects Exempted from NYC Energy Conservation Code**
- **Affordable Housing allowed to follow prescriptive vs calculated path for LL97**

<u>Sustainability Goals</u>

NYCHA Operational Carbon Cap
Enterprise Green Communities
Voluntary application of Energy Code
Passive House Certification

From Urban Green

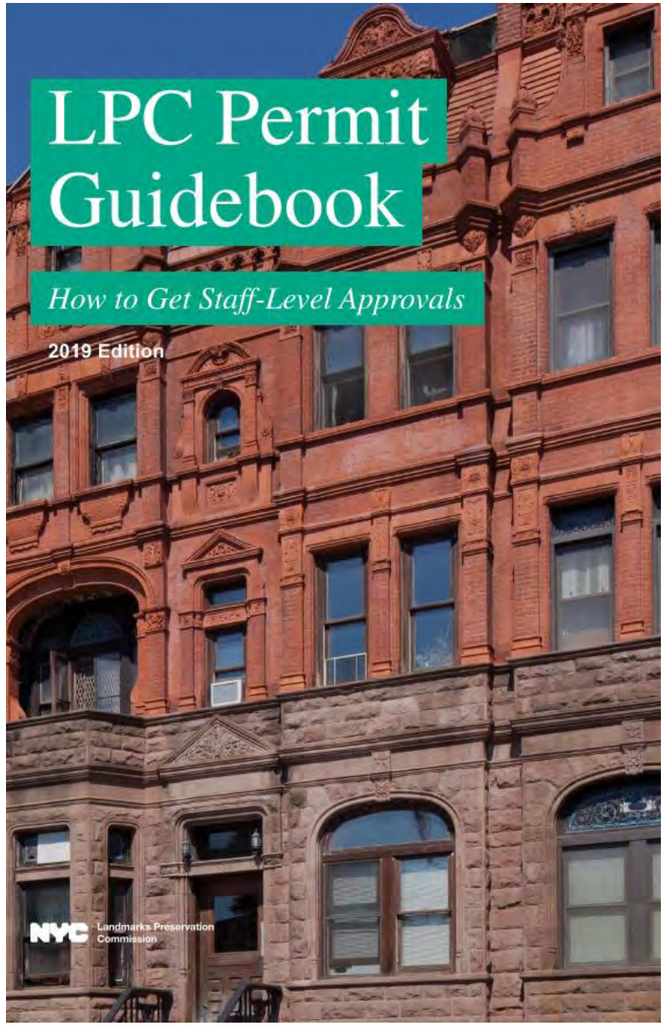
Historic Regulations



National Park Service

Secretary of the Interior's Standards for Rehabilitation

- Exterior and Interior
- Primary vs Secondary Facades
- Exterior Wall Thickness
- Interior Material Restoration and Replacement
- Public vs Private Layout Changes



NYC Landmarks Preservation Commission

Rules of the NYC Landmarks Preservation Commission

- Exterior Only
- Primary vs Secondary Facades
- Historic Window Replication
  - Casement
  - Simulated Double-Hung
- Rooftop Equipment Visibility

Harlem River Houses

Light Energy Retrofit

Harlem River: History

Central Courtyard

Central Pedestrian Path

Sculpture and Mural at South Passageway

7 buildings | 328,000 SF | Manhattan, NY

- 1937 Public Housing for NYCHA
- Designed by Archibald Manning Brown
- Landmarked by NYC LPC in 1975
- Listed on State and National Register of Historic Places in 1980
- First Federally-Funded, Federally-Built, and Federally-Owned Housing Project in NYC

Opening Day Dedication

Opening Day Dedication

Harlem River: Existing Conditions

Central Gas Boiler Plant

Steam Radiator Heating

Inefficient Lighting

7 buildings | 328,000 SF | Manhattan, NY

- Central Gas Boiler for Steam Heating and DHW
- Steam Radiator Heating
- Inefficient Appliances and Plumbing Fixtures

Inefficient Kitchen Appliances

Inefficient Plumbing Fixtures

Harlem River: Current Energy Use

Harlem River: Energy Retrofit Recommendations

Recommendation		Applicable Property	Cost and Savings				Financial Performance		
ECM	Measure Description		Initial Investment	Annual Savings	Utility Cost Savings	Carbon Reduction	Simple Payback (Yrs)	Return on Investment	Net Present Value
1	Install New VRF System at Harlem River	HR I	($11,207,000)	$292,000	12.5%	25.2%	>25	3%	($6,876,100)
2	Install Low-Flow Faucet Aerators and Showerheads	HR I & II	($236,250)	$110,700	4.7%	8.1%	2.1	47%	$706,500
3	Install New Energy-Efficient Windows	HR I & II	($10,129,000)	$65,400	2.8%	4.5%	>25	1%	($9,158,600)
4	Insulate Roof Deck	HR I & II	($3,847,000)	$65,000	2.8%	4.5%	>25	2%	($2,577,500)
5	Upgrade Common Area Lighting	HR I & II	($160,500)	$38,400	1.6%	1.4%	4.2	24%	$166,600
6	Install Exterior Insulation and Finishing System	HR II	($1,029,500)	$12,900	0.6%	0.9%	>25	1%	($777,900)
7	Install Domestic Hot Water Recirculation Flow Control	HR II	($140,500)	$10,900	0.5%	0.8%	12.9	8%	($47,900)
8	Upgrade Apartment Lighting	HR I & II	($253,500)	$16,500	0.7%	0.6%	15.4	6%	($57,400)
9	Overhaul the Building Ventilation System	HR II	($102,500)	$5,900	0.3%	0.3%	17.3	6%	($32,000)
10	Install Exhaust Fan Controls	HR II	($12,750)	$3,400	0.1%	0.2%	3.7	27%	$28,100
11	Install New Energy Star Refrigerators	HR I & II	($638,500)	$5,700	0.2%	0.2%	>25	1%	($554,700)
12	Install PTHPs at Harlem River II	HR II	TBD	$33,400	1.4%	4.2%	NA	NA	NA
13	Install High Efficiency DHW Heaters	HR I & II	TBD	$55,400	2.4%	4.0%	NA	NA	NA
Total: Project Summary		-	**($27,757,000)**	**$715,600**	**30.6%**	**55%**	**>25**	**2%**	**($19,180,900)**

Net present values take into account a discount rate of 7.00% and an energy escalation rate of 3.85%.

Harlem River: Light Energy Retrofit Scope

LEGEND

ENERGY EFFECIENCY

CONTINUOUS ROOF INSULATION

HIGH PERFORMANCE DOORS AND WINDOWS
Increase thermal and acoustic comfort and energy saving

ALL LED LIGHTING & ENERGY STAR APPLIANCES

ALL ELECTRIC HEATING AND COOLING
Variable Refrigerant Volume units

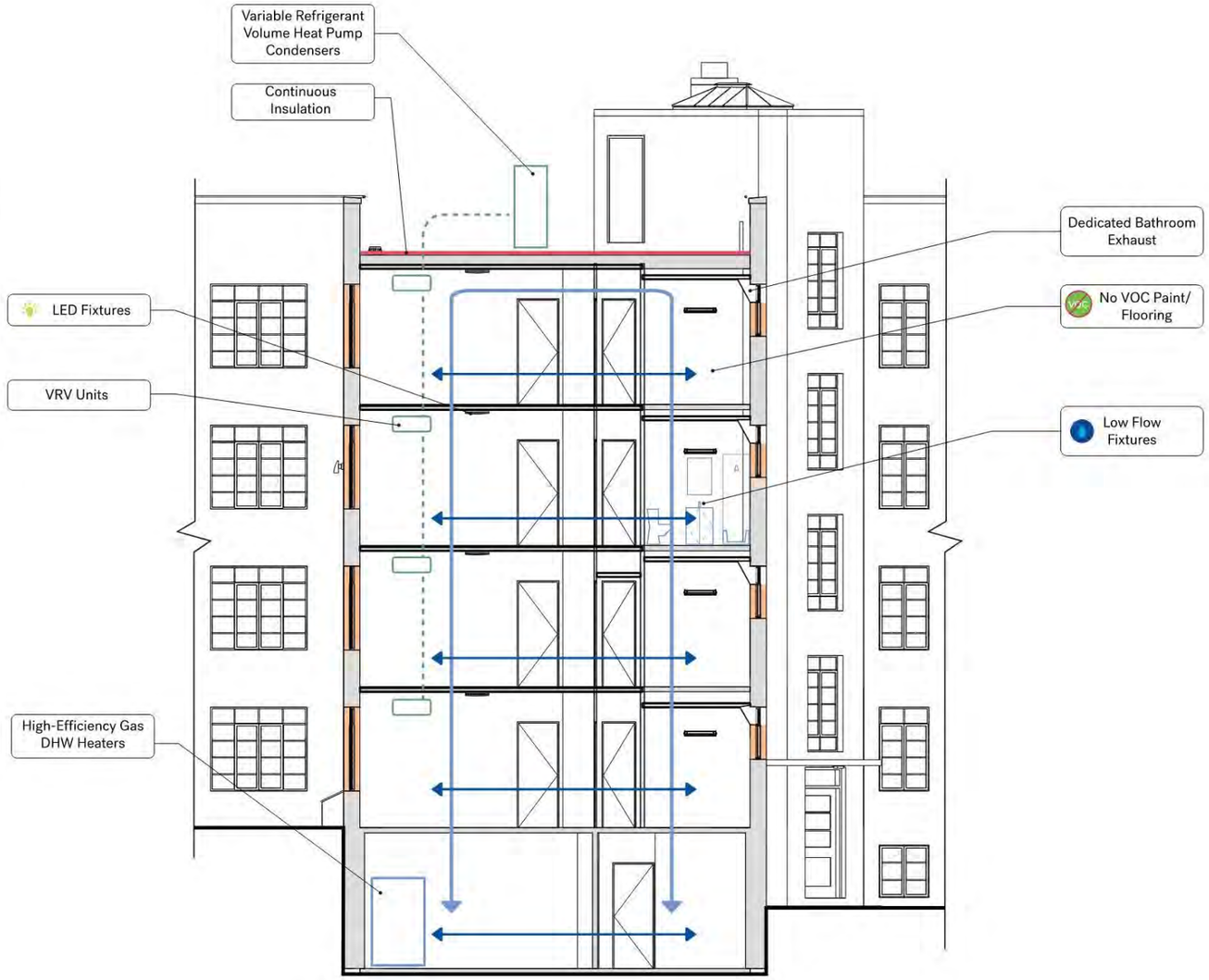
WATER EFFECIENCY

WATER SAVING
Low flow fixtures.

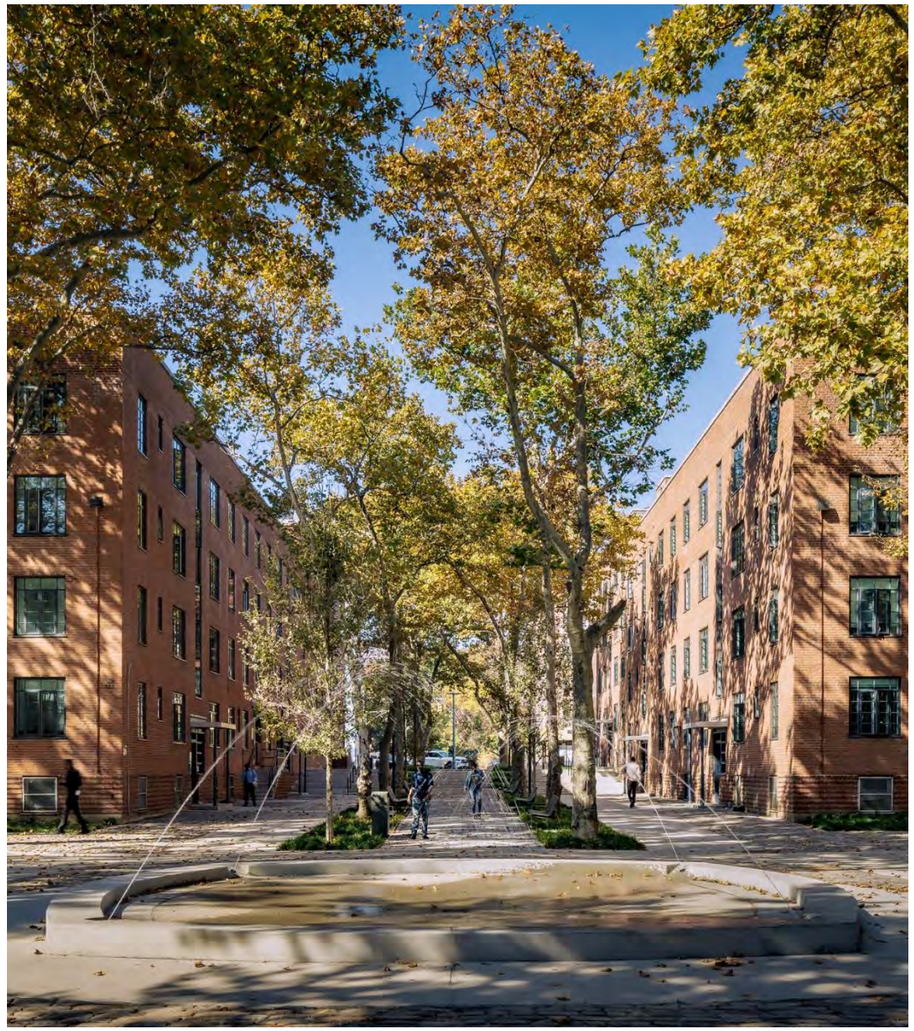
High-Efficiency Gas Domestic Hot Water Heaters
Central plant decoupling by introducing local heating plants.

RESPONSIBLE MATERIAL SELECTION

LOW OR NO-VOC PAINT / SEALANTS / FLOORING
For healthier air quality.



Harlem River: Rehab + Partial Electrification



Rehabilitated Central Fountain and Pedestrian Path

Rehabilitated Apartment Living Area

Rehabilitated Apartment Kitchen

7 buildings | 328,000 SF | Manhattan, NY

- 577 Fully Renovated Apartments
- New or Renovated Resident On-Site Amenities:
  - Three Playgrounds
  - Two Laundry Rooms
  - Tenant Meeting Room and TA Office
  - Management Office
  - Daycare Center
- New Landscaping and Pavement
- Façade Maintenance and Upgrades with Replacement Windows and Roofs
- Electrified Heating and Cooling
- Decentralized Domestic Hot Water

Harlem River: Envelope Upgrades

Existing Windows

Replacement Windows

Existing Roof

Replacement Roof

Thermally Broken Aluminum Casement Windows

- U-Factor = 0.38
- SHGC = 0.30

2016 NYC ECC Requirements (Operable Fenestration)

- U-Factor = 0.45 max.
- SHGC = 0.40 max.

Insulated SBS Roofing Assembly

- R-Value = 34.8ci

2016 NYC ECC Requirements (Insulation Above Deck)

- R-Value = 30.0ci min

Harlem River: Systems Upgrades

Ducted VRF (Indoor Unit)

Bathroom Exhaust

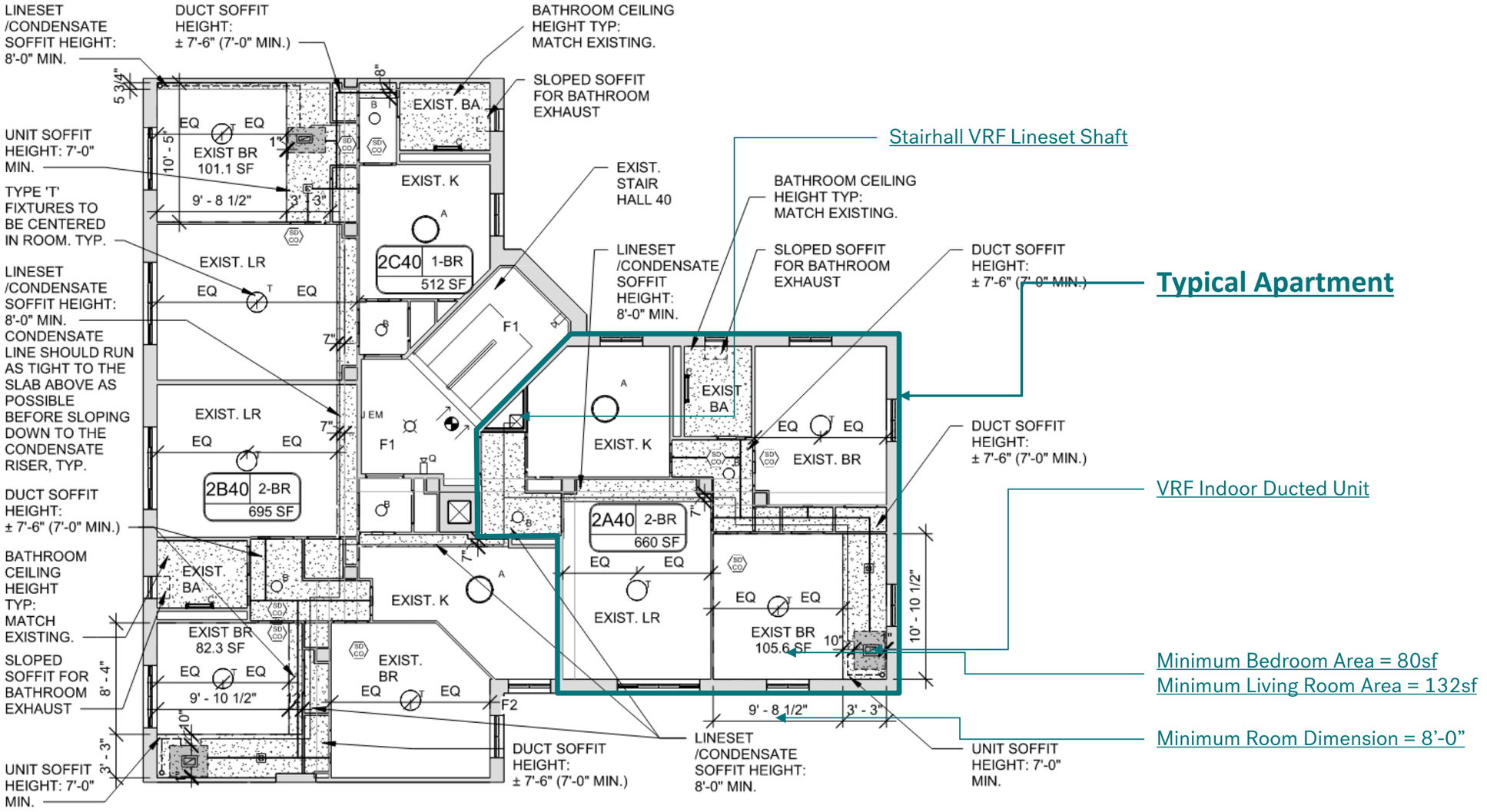
VRF (Rooftop Condenser)

Volume Water Heaters and Storage Tanks

MEP Systems Upgrades

- Replace Steam Heating with Ducted VRF
- Replace Central Boiler with High-Efficiency Volume Water Heaters and Storage Tanks
- Replace Incandescent Lighting with High-Efficacy LEDs
- Replace Appliances with Energy Star Appliances
- Replace Kitchen and Bathroom Fixtures with Low-Flow Fixtures
- Install Dedicated Bathroom Exhaust

Harlem River: VRF Layout



Typical Stairhall Reflected Ceiling Plan

Harlem River: Energy Savings and Use Predictions

Energy Retrofit Savings

Recommendation		Utility Savings			
ECM	Measure Description	Electricity (kWh)	Gas (Therm)	Source EUI Reduction	Site EUI Reduction
1	Install New VRF System at Harlem River	-1,959,905	446,363	47.3	60.5
2	Install Low-Flow Faucet Aerators and Showerheads	0	108,717	18.1	17.3
3	Install New Energy-Efficient Windows	56,482	58,180	10.5	9.6
4	Insulate Roof Deck	61,996	57,216	10.4	9.5
5	Upgrade Common Area Lighting	350,956	0	4.9	1.9
6	Install Exterior Insulation and Finishing System	0	12,660	2.1	2.0
7	Install Domestic Hot Water Recirculation Flow Control	0	10,680	1.8	1.7
8	Upgrade Apartment Lighting	154,913	-484	2.1	0.8
9	Overhaul the Building Ventilation System	24,673	3,163	0.9	0.6
10	Install Exhaust Fan Controls	4,997	2,833	0.5	0.5
11	Install New Energy Star Refrigerators	51,643	0	0.7	0.3
12	Install PTHPs at Harlem River II	-458,313	82,045	7.3	10.6
13	Install High Efficiency DHW Heaters	0	54,367	9.1	8.7
Total: Project Summary		**-1,712,558**	**835,740**	**115.7**	**123.9**

Energy Use Intensity (EUI) Predictions

EUI	Baseline	Post Retrofit	Difference
Site EUI	201	77	62%
Source EUI	246	130	47%

Harlem River: Carbon Emissions

NYCHA Carbon Emission Caps (per SF)

Year	Cap
Carbon Cap 2030	5.08 tC02e/ksqft
Carbon Cap 2050	1.69 tC02e/ksqft

Carbon Emissions Analysis – Existing vs Post-Retrofit

Item	Current	Energy Conservation Measure Scope
Calculated Carbon Emissions (mtCO2e)	7,160	3,216
Carbon Cap 2030 (mtCO2e)	3,272	
Percent Over 2030 Cap	119%	-2%
Carbon Cap 2050 (mtCO2e)	1,090	
Percent Over 2050 Cap	557%	195%

Harlem River: Campus Map

HR-II: Non-Historic Building

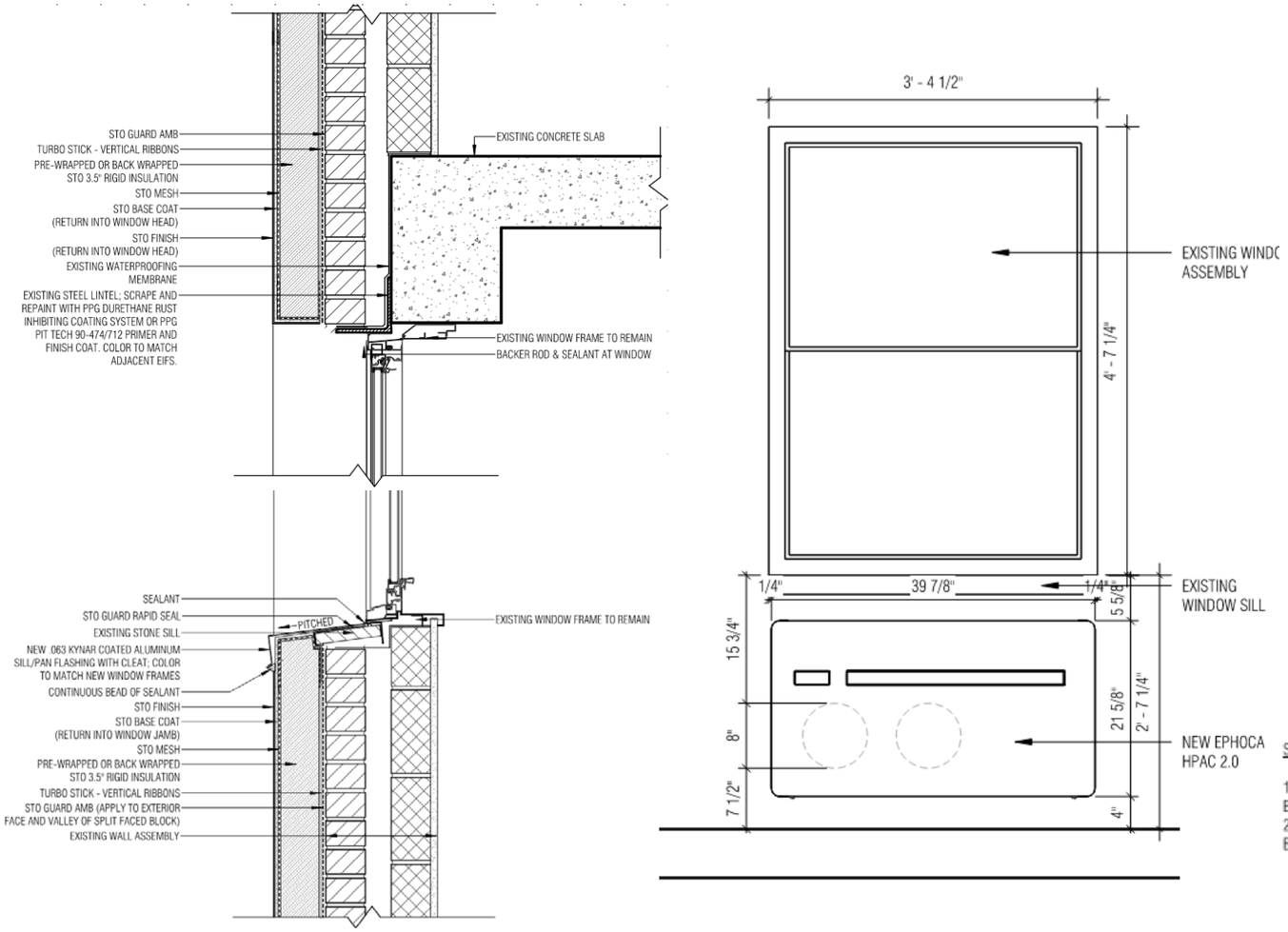
Harlem River: Non-Historic HR-II

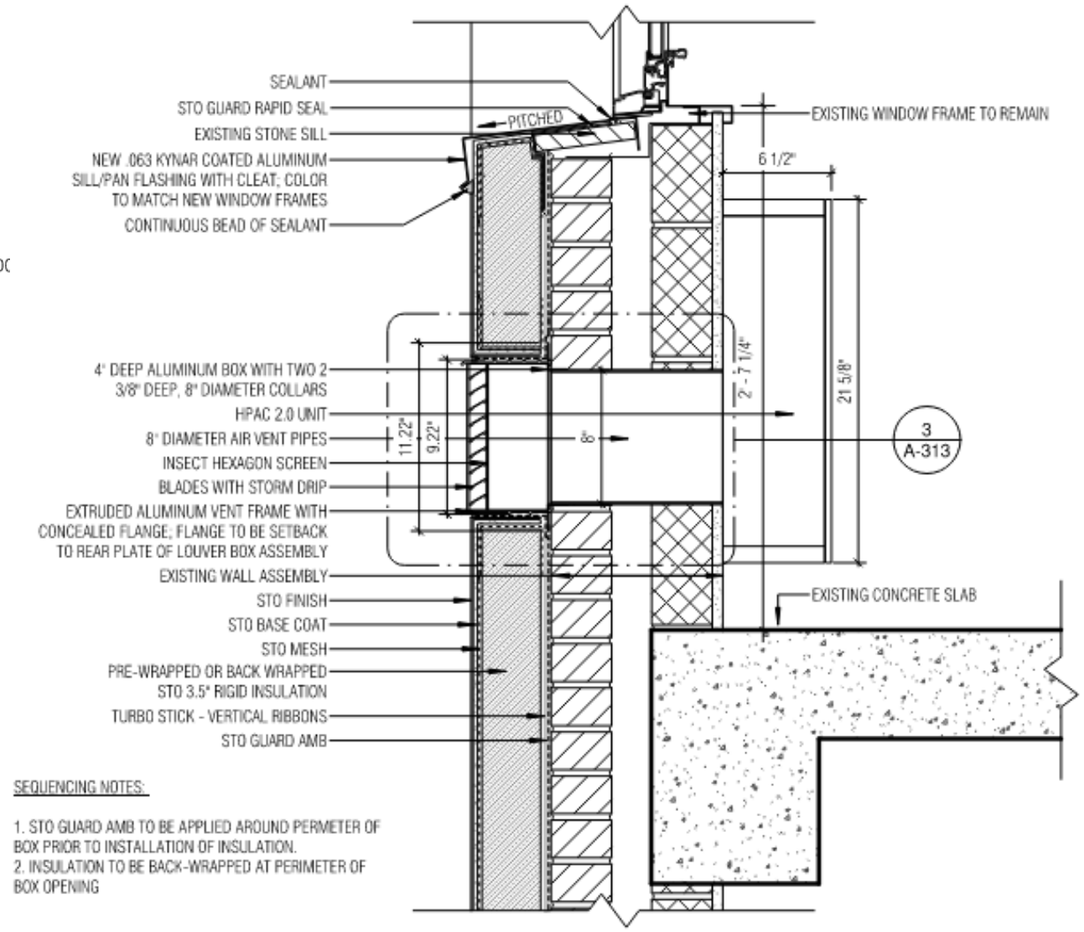
Harlem River II from HRH Building 7 Rooftop

Deep Energy Retrofit Upgrades

- Replace Roofing with R-34.8ci Insulated SBS Roofing Assembly
- Replace Windows with Thermally-Broken Aluminum Double-Hung Windows
- Install R-13.5ci Exterior Insulation and Finish System
- Replace Steam Heating with Ducted VRF
- Replace Central Boiler with High-Efficiency Volume Water Heaters and Storage Tanks
- Replace Incandescent Lighting with High-Efficacy LEDs
- Replace Appliances with Energy Star Appliances
- Replace Kitchen and Bathroom Fixtures with Low-Flow Fixtures
- Install Dedicated Bathroom Exhaust

Harlem River: Overcladding Details





Typical EIFS and PTHP Details

Three Arts Club

Deep Energy Retrofit

Three Arts Club: History

West 85th Street Façade

Tea Garden in the Rear Yard

Penthouse Art Studio

8 stories | 60,000 SF | Manhattan, NY

- 1927 residence for women in drama, music, and fine arts
- Designed by George Bruno de Gersdorff
- Nominated for State and National Register of Historic Places in 2024
- Masonry building with stone trim and ironwork detailing designed in the Colonial Revival style

Library

Music Room

Three Arts Club: Existing Conditions

Central Gas Boiler

Steam Radiator Heating

Inefficient Plumbing Fixtures

8 stories | 60,000 SF | Manhattan, NY

- Central Gas Boiler for Steam Heating and DHW
- Steam Radiator Heating
- Inefficient Appliances and Plumbing Fixtures
- Low-Efficiency Skylights

Gas Laundry Equipment

Low-Efficiency Skylights

Three Arts Club: Early Feasibility

Round Four Winning Demonstration Projects

Demonstration Projects

Project: Three Arts
City, State: New York, New York
Construction Type: New Construction
Market Sector: High-Rise Multifamily
Developed by: West Side Federation for Senior and Supportive Housing
Designed by: Curtis + Ginsberg Architects
Award: $1,000,000

nyserda.ny.gov/boe

Early Feasibility + Funding Support from NYSERDA

- NYSERDA Buildings of Excellence Round 4 Winner
- Early Design Feasibility Study
  - EnerPHit compliance
  - Established envelope performance requirements
  - Able to identify challenges associated w/ historical designations
  - Allows for early engagement with suppliers (ie. Windows)
  - Set minimum HVAC performance targets

Three Arts Club: Deep Energy Retrofit Scope

LEGEND

RENEWABLE ENERGY

SOLAR ENERGY
Reduce solar heat gain and support energy demands.

ENERGY EFFECIENCY

AIRTIGHTNESS

CONTINUOUS INSULATION

HIGH PERFORMANCE DOORS AND WINDOWS
Increase thermal and acoustic comfort and energy saving

ERV & APPROPRIATELY SIZED HVAC
Improved air quality and all-electric heating and cooling to reduce energy

ALL ELECTRIC BUILDING
LED fixtures and Energy Star Appliances

HEATING AND COOLING
Variant Refrigerant Flow units and Packaged Terminal Heat Pumps

WATER EFFECIENCY

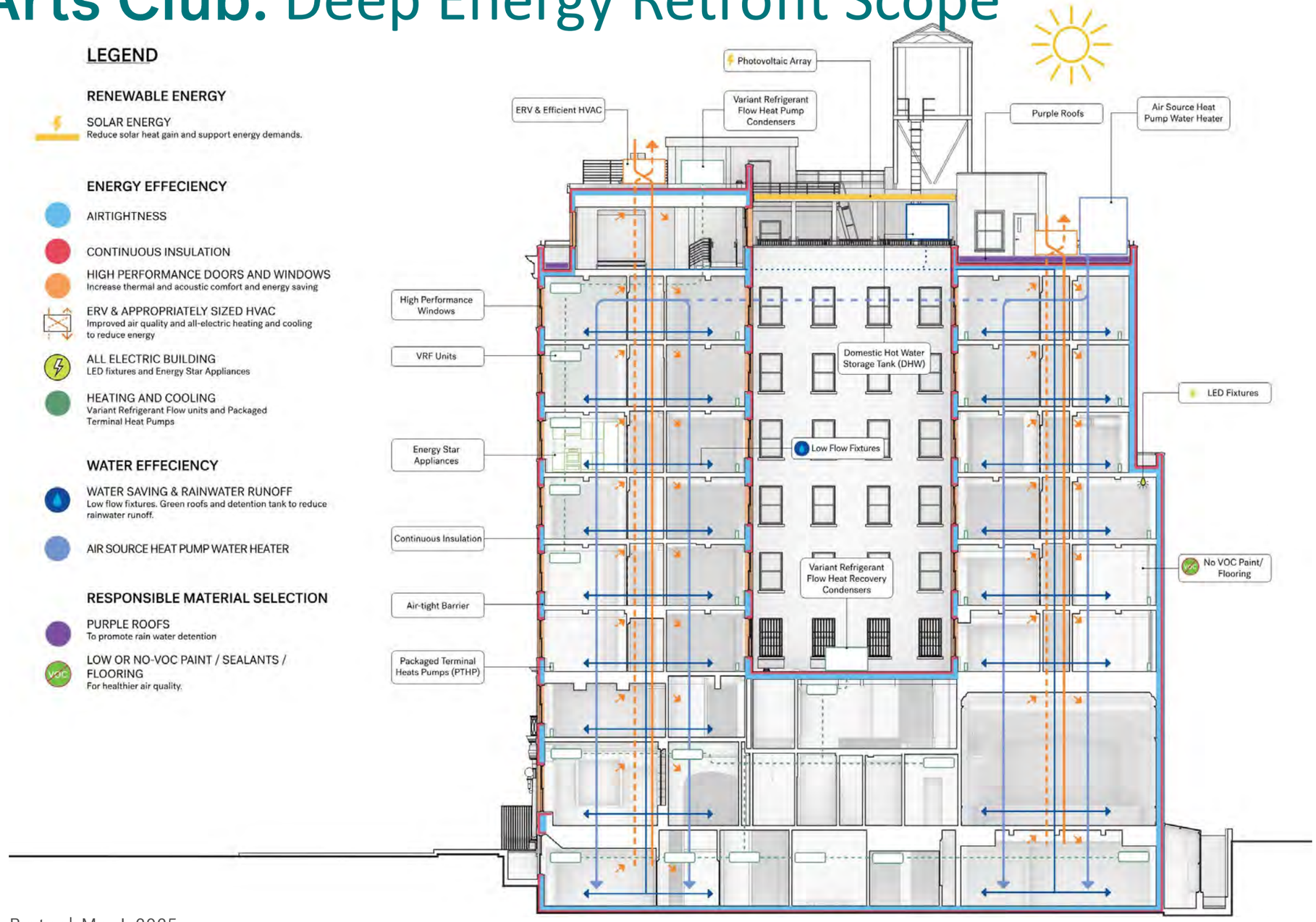
WATER SAVING & RAINWATER RUNOFF
Low flow fixtures. Green roofs and detention tank to reduce rainwater runoff.

AIR SOURCE HEAT PUMP WATER HEATER

RESPONSIBLE MATERIAL SELECTION

PURPLE ROOFS
To promote rain water detention

LOW OR NO-VOC PAINT / SEALANTS / FLOORING
For healthier air quality.



Three Arts Club: Rehab + Full Electrification

Rehabilitated Primary Façade

Rehabilitated Foyer

New Apartment Kitchen

8 stories | 60,000 SF | Manhattan, NY

- 61 Efficiency Senior Apartments and 1 Super's Apartment
- New or Restored Resident and Community Amenities:
  - Music Room with Stage and Balcony (Cooling Center)
  - Library & Computer Room
  - Resident Lounge and Rooftop Terrace
  - Typical Floor Laundry Rooms
  - Social Services Office Suite
  - Commercial Kitchen and Dining Room
- Façade Maintenance and Upgrades with Replacement Windows and Roofs
- Interior Insulation and Air Barrier
- Full Electrification of HVAC and DHW

Three Arts Club: Passive House

What is Passive House?

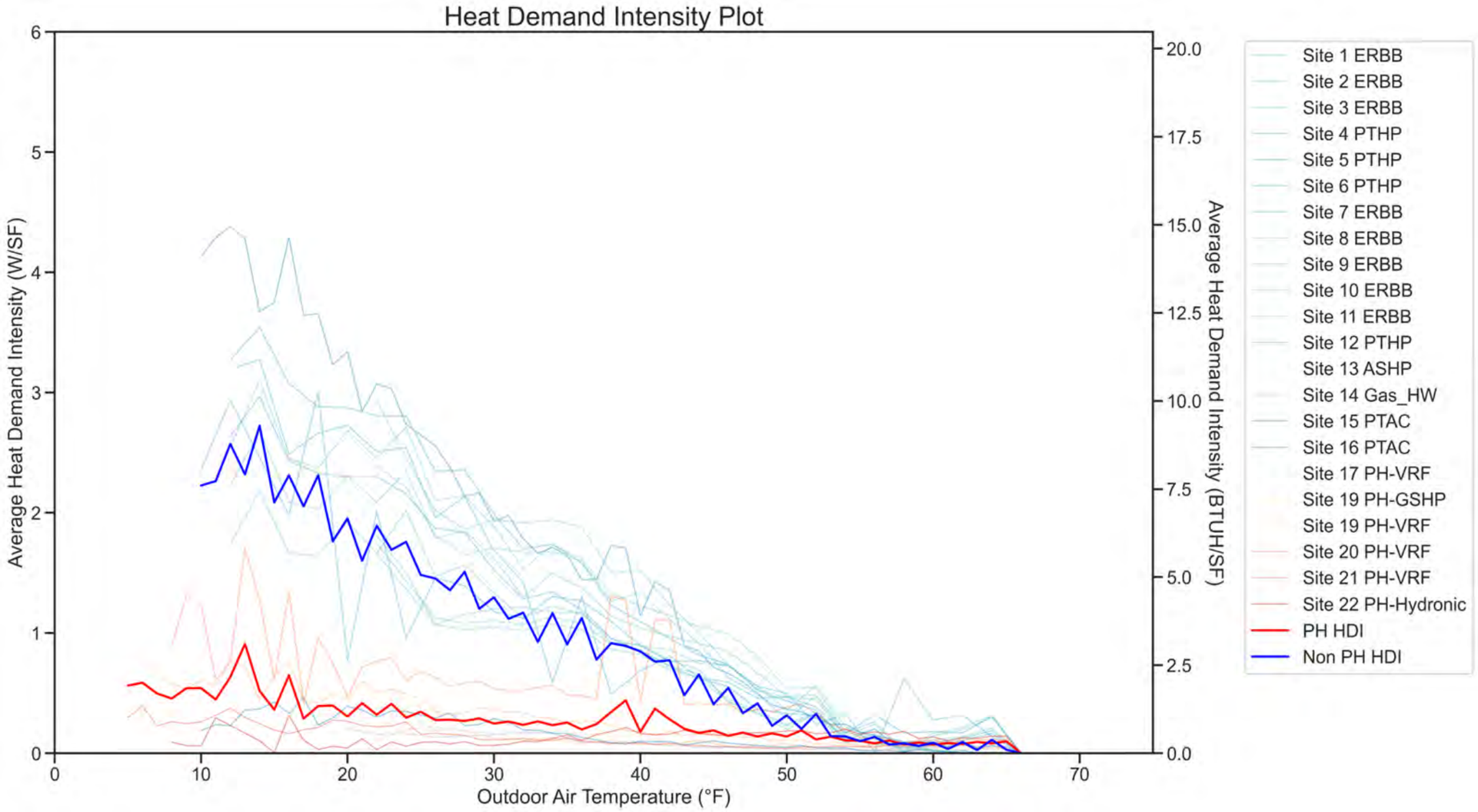
- **Most rigorous building energy standard in the world**
- Two certification standards available:
  - Passive House Institute (PHI)
  - PHIUS
- **Design and Verification** with focus on:
  - Continuous thermal envelope
  - Airtight construction + operable windows
  - Balanced ventilation system w/ heat recovery efficiency ~75% +
  - Right-sized and highly-efficient HVAC and water heating systems

Goals of Passive House

- **Steep energy / carbon savings**
- **Superior occupant comfort and air quality**
- **Building durability**

Three Arts Club: Passive House Multifamily Buildings

Peak Heating vs. Outdoor Air Temperature



Three Arts Club: EnerPHit Compliance Paths

What is EnerPHit?

- **EnerPHit = retrofit standard from Passive House Institute (PHI)**

Two Options for Compliance

- Performance Path – similar to new construction PHI standard
- Component Path – more tailored towards more challenging retrofits, particularly those that can only insulate from the interior.

Three Arts Club: EnerPHit Component Compliance Path

EnerPHit (retrofit): Component characteristics

		Current Model		Threshold	
Building envelope to exterior air[1] (R-value)	hr.ft^2.°F/BTU	**38.0**	≥	18.9	**yes**
Building envelope to ground[1] (R-value)	hr.ft^2.°F/BTU	**1.9**	≥	1.1	**yes**
Wall w/int. insulation in contact w/exterior air (R-value)	hr.ft^2.°F/BTU	**11.9**	≥	11.4	**yes**
Wall w/interior insulation in contact w/ground (R-value)	hr.ft^2.°F/BTU	**6.6**	≥	1.1	**yes**
Flat roof (SRI)	-	**45.2**	≥	-	**-**
Inclined and vertical external surface (SRI)	-	**45**	≥	-	**-**
Windows/Entrance doors ($U_{W/D,installed}$)	BTU/hr.ft^2°F	**0.18**	≤	0.19	**yes**
Windows ($U_{W,installed}$)	BTU/hr.ft^2°F	**-**	≤	0.19	**-**
Windows ($U_{W,installed}$)	BTU/hr.ft^2°F	**-**	≤	0.21	**-**
Glazing (SHGC)	-	**0.30**	≥	0.18	**yes**
Glazing/sun protection (max. solar load)	kBTU/(ft²yr)	**40.0**	≤	-	**-**
Ventilation (effective heat recovery efficiency)	%	**77**	≥	75	**yes**
Ventilation (humidity recovery efficiency)	%	**59**	≥	-	**-**

[1] Without windows, doors and external walls with interior insulation

[2] Empty field: Data missing; '-': No requirement

Three Arts Club: EnerPHit Component Compliance Path

EnerPHit (retrofit): Component characteristics

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Ventilation (effective heat recovery efficiency)	%	**77**	≥	75	**yes**
Ventilation (humidity recovery efficiency)	%	**59**	≥	-	**-**

[1] Without windows, doors and external walls with interior insulation

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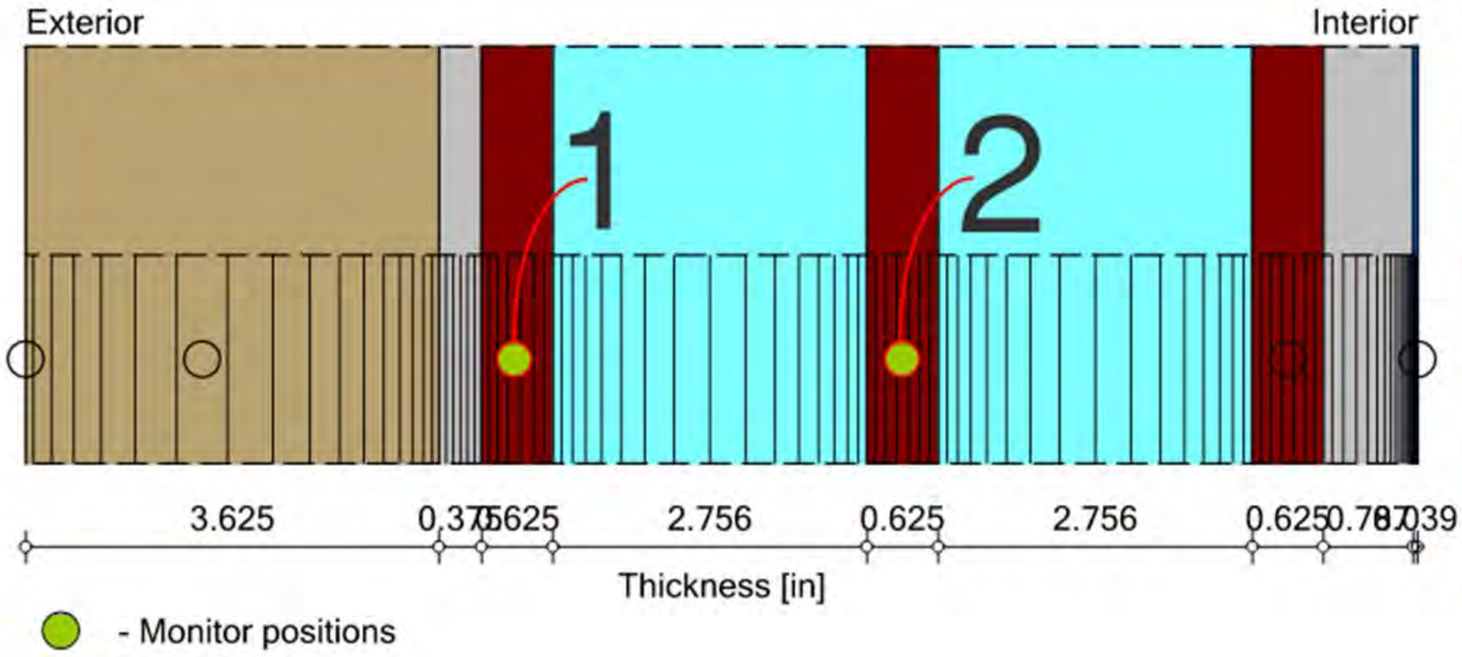
Three Arts Club: Total Water Content (Long-term Drying)

Existing Wall Assembly

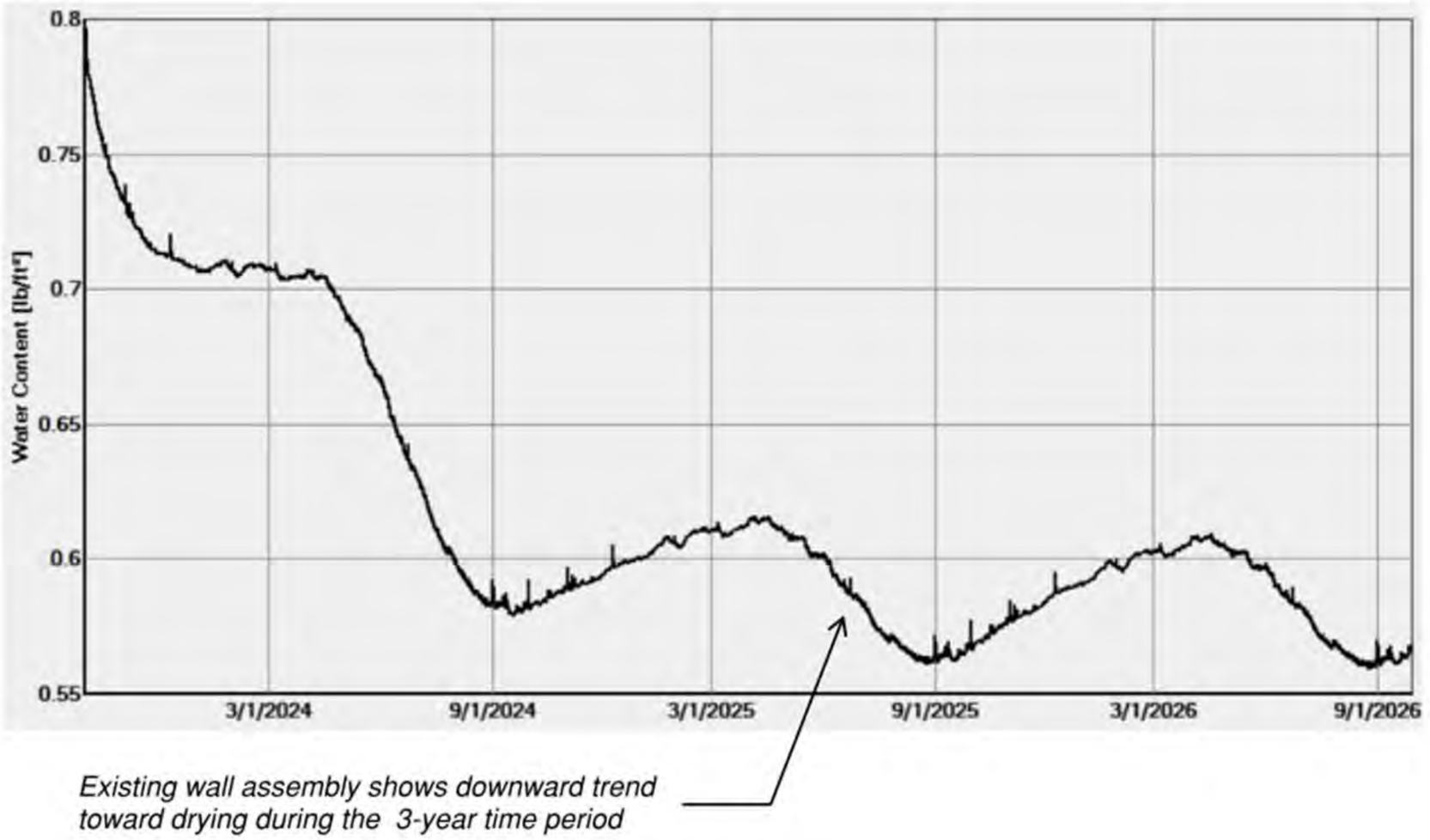


Materials:

- Red Matt Clay Brick	3.625 in
- Portland Cement-Lime Mortar - Type N	0.375 in
- Brick (old)	0.625 in
- Air Layer 70 mm; without additional moisture capacity	2.756 in
- Brick (old)	0.625 in
- Air Layer 70 mm; without additional moisture capacity	2.756 in
- Brick (old)	0.625 in
- Regular Lime Stucco	0.787 in
- vapor retarder (10perm)	0.039 in

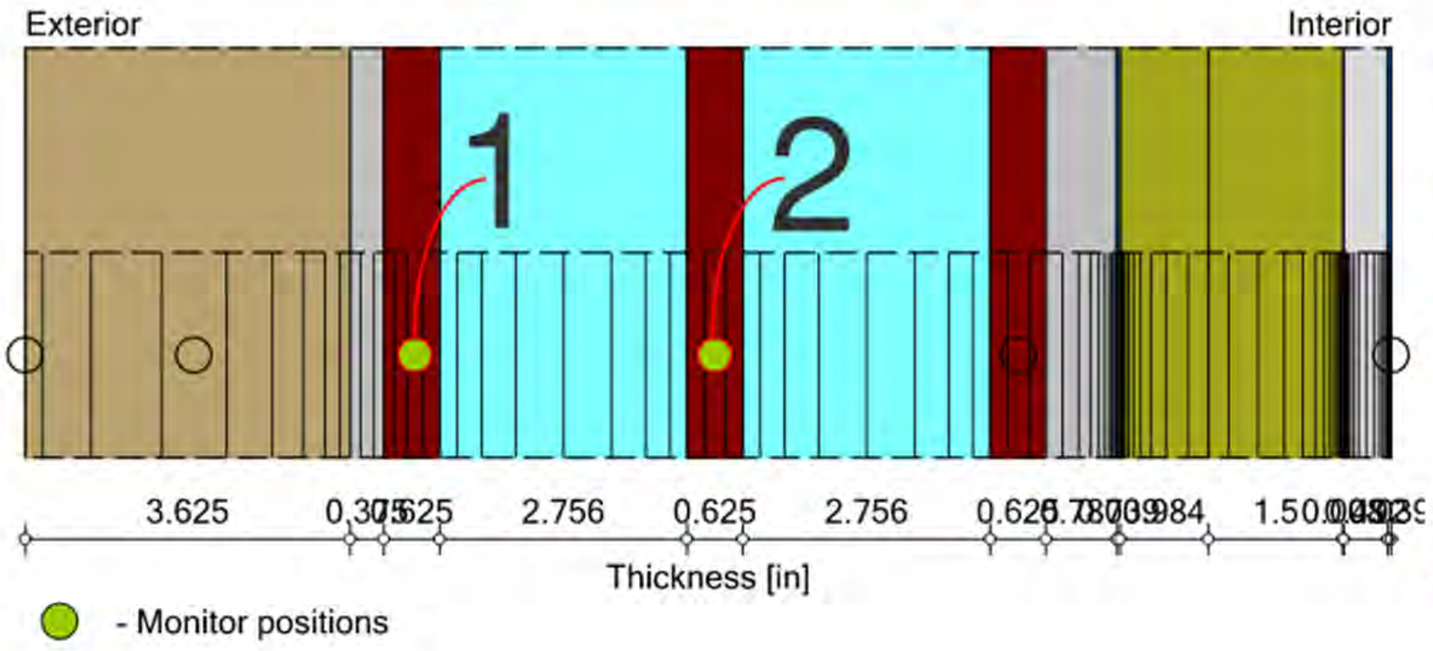
Three Arts Club: Total Water Content (Long-term Drying)

Existing Wall Assembly



Three Arts Club: Total Water Content (Long-term Drying)

Proposed Wall Assembly



Materials:

- Red Matt Clay Brick	3.625 in
- Portland Cement-Lime Mortar - Type N	0.375 in
- Brick (old)	0.625 in
- Air Layer 70 mm; without additional moisture capacity	2.756 in
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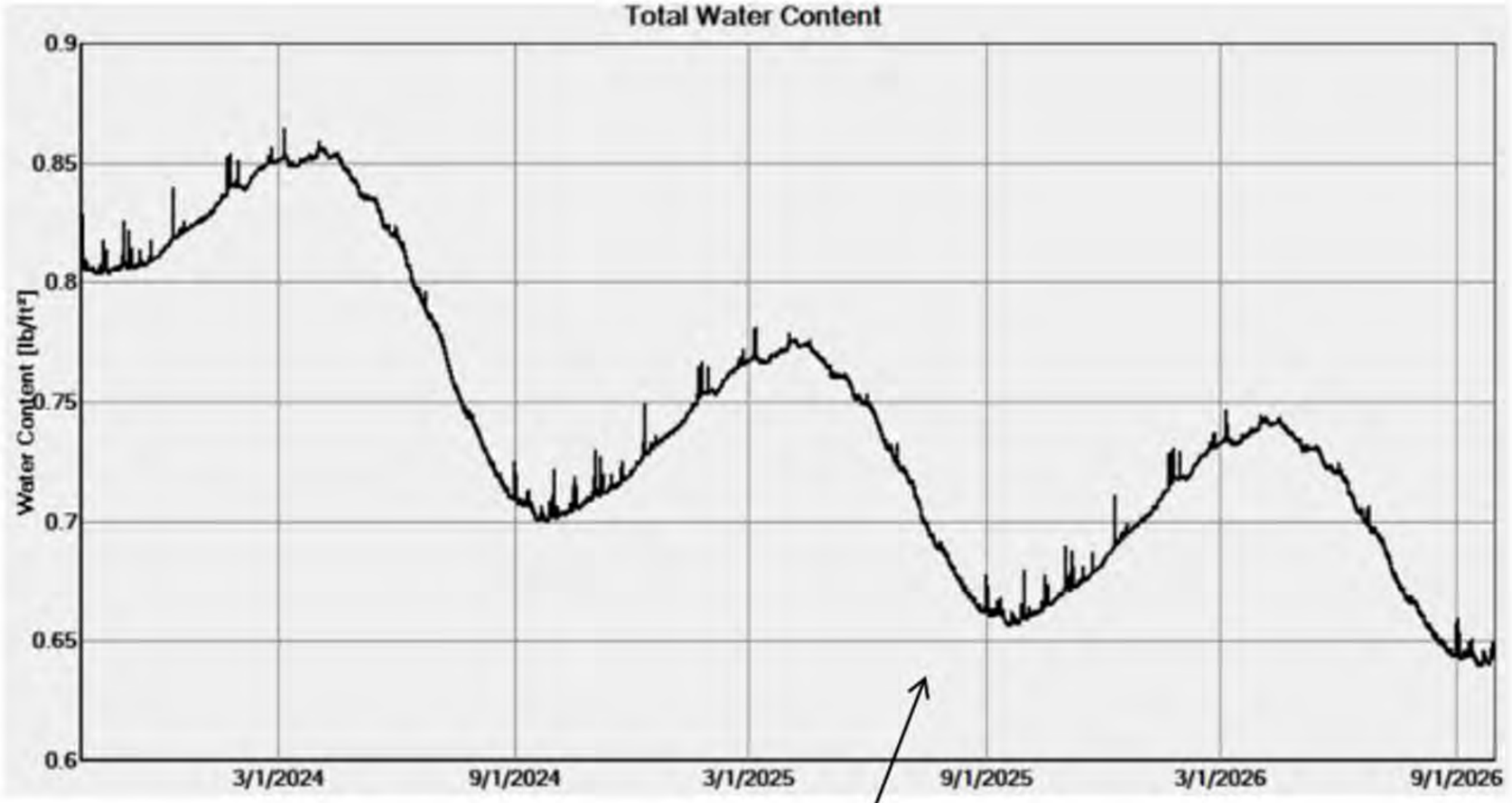
- Brick (old)	0.625 in
- Regular Lime Stucco	0.787 in
- vapor retarder (10perm)	0.039 in
- Roxul CavityRock	0.984 in
- Roxul ComfortBatt	1.5 in
- Metal Deck, unperforated	0.008 in
- Interior Gypsum Board	0.492 in
- vapor retarder (10perm)	0.039 in

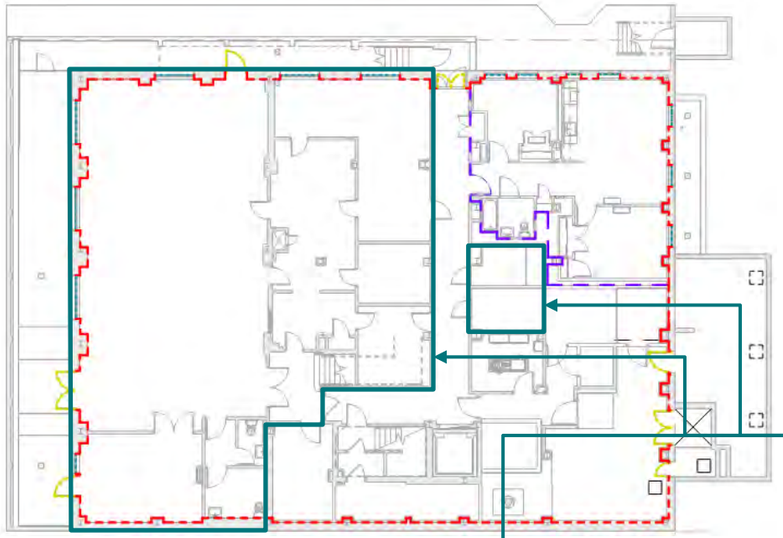
Three Arts Club: Total Water Content (Long-term Drying)

Proposed Wall Assembly



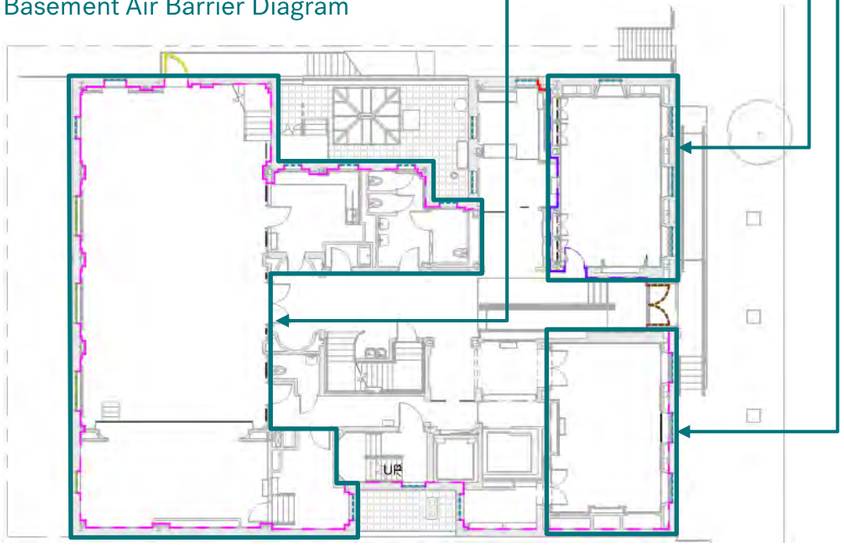
Proposed wall assembly shows downward trend toward drying during the 3-year time period

Three Arts Club: Whole Building Airtightness

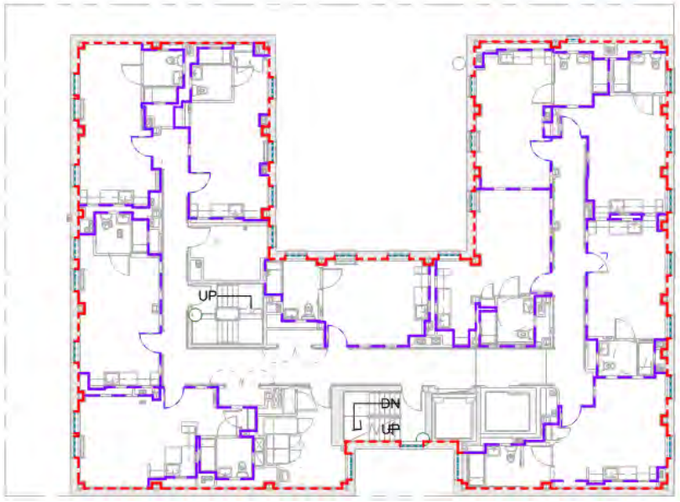


Basement Air Barrier Diagram

Areas Outside the Passive House Envelope



First Floor Air Barrier Diagram



Typical Floor Air Barrier Diagram

EnerPHit Airtightness Requirement:

- Whole Building Air Changes per hour ≤ 1.0 @ 50 Pascals pressure differential.

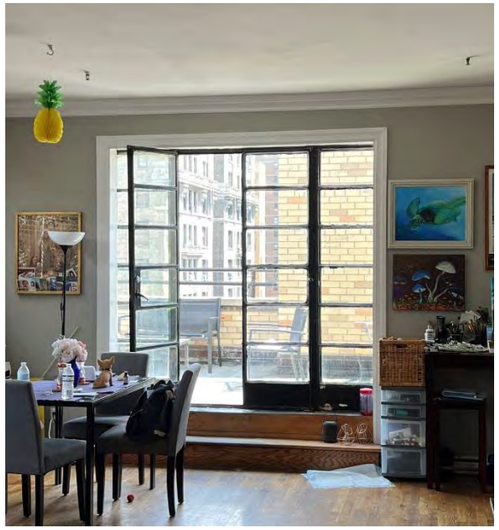
AIR BARRIER LEGEND:

- EXTERIOR WALLS AIR BARRIER
- STOREFRONT DOOR TO BE PROVIDED WITH WEATHER STRIPPING. USE HENRY SA BLUE SKIN ON VERTICAL OPENINGS AND HENRY PWF FOR HORIZONTAL OPENINGS (HEAD/SILL)
- HM DOOR W/ WEATHER STRIPPING.
- SOLID WOOD DOOR AND TRANSOM W/ WEATHER STRIPPING.
- WINDOW IN PUNCHED OPENING W/ AIR BARRIER AT HEAD, SILL AND JAMBS.
- EXISTING HISTORIC WINDOW SEALED SHUT IN PUNCHED OPENING.
- INTERIOR AIR BARRIERS—AIRTIGHT DRYWALL APPROACH DETAILS IN A-602
- INTERIOR DOOR W/ WEATHER STRIPPING
- EXISTING WALL W/ PAINT OR PLASTER FINISH

Three Arts Club: Whole Building Airtightness

First Floor Music Room Windows

First Floor Library Paneling

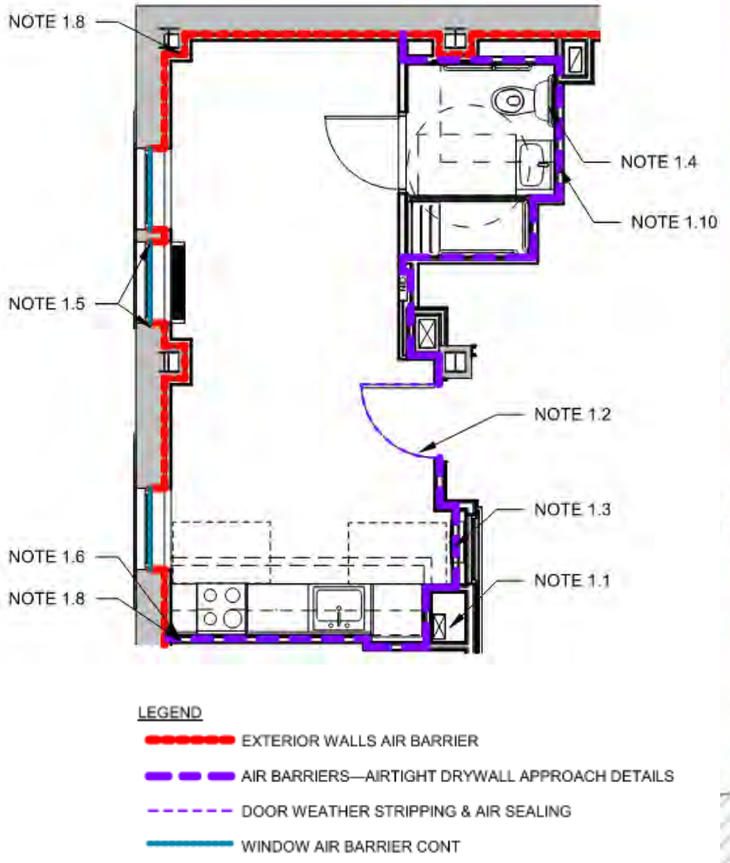


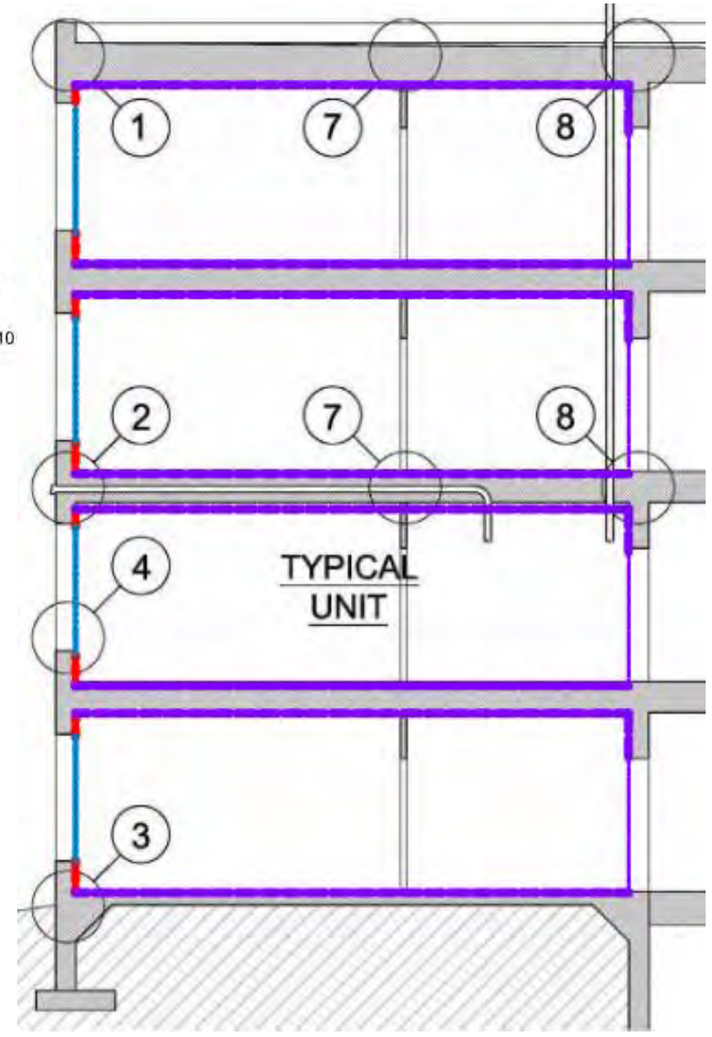
Penthouse Steel Casement Doors

Challenges with Historic Buildings:

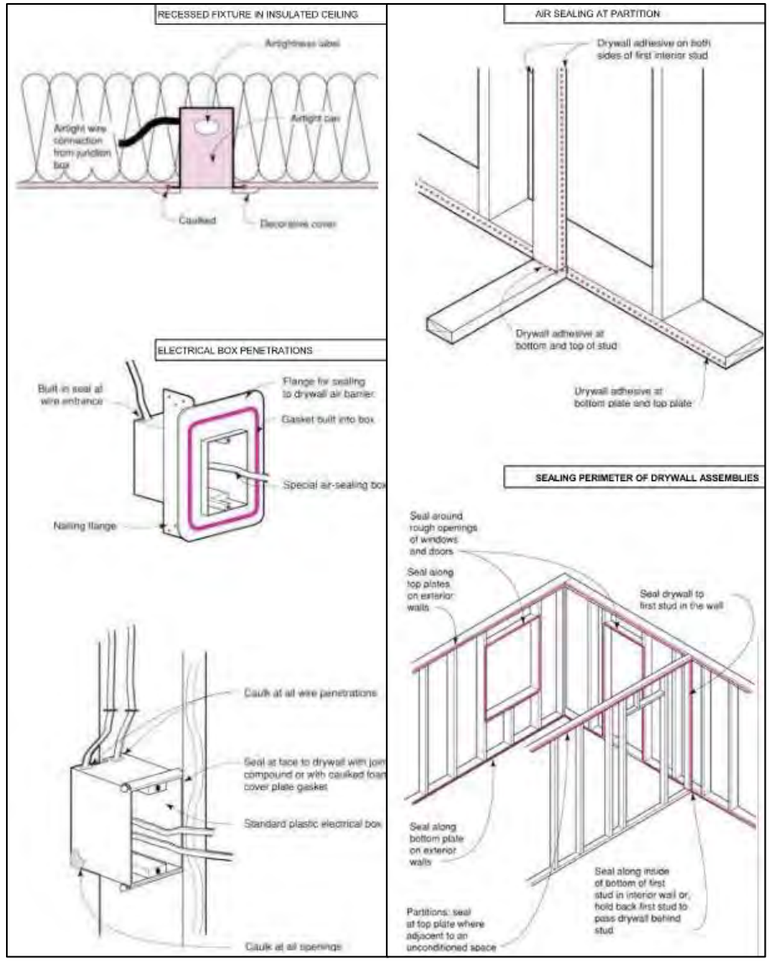
- Historic windows and doors are often very leaky.
- Existing wood paneling, or similar interior finishes, require alternate approaches.

Three Arts Club: Whole Building Airtightness

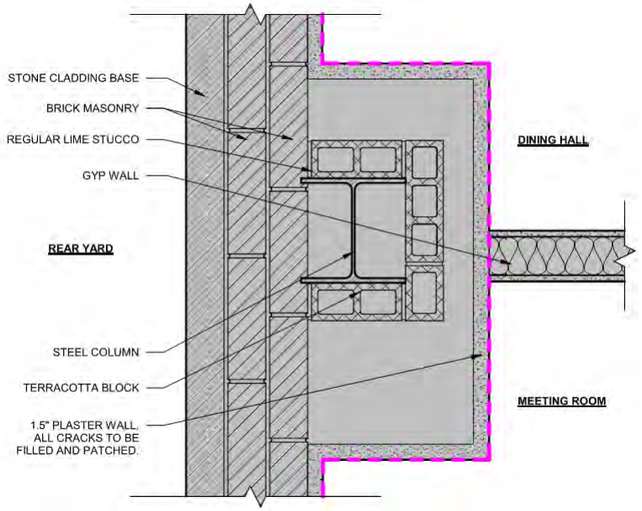


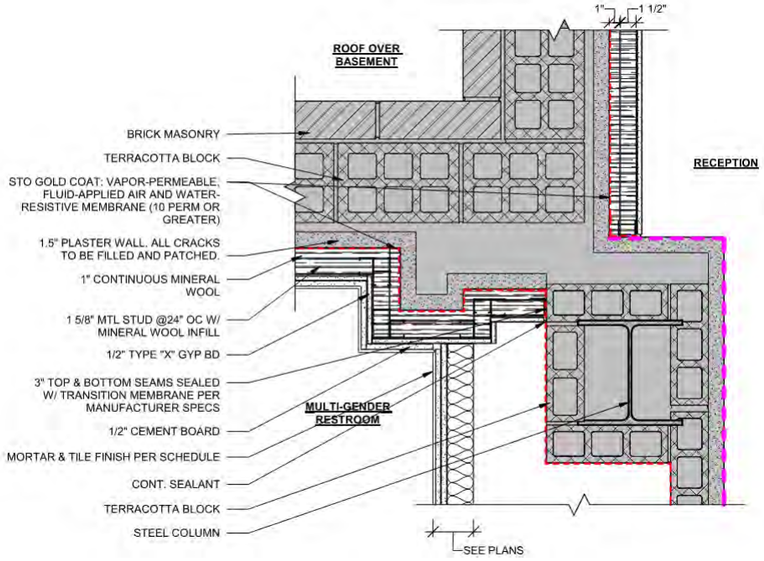


Get Airtightness into the Contract Documents!!



Three Arts Club: Whole Building Airtightness





Get Airtightness into the Contract Documents!!

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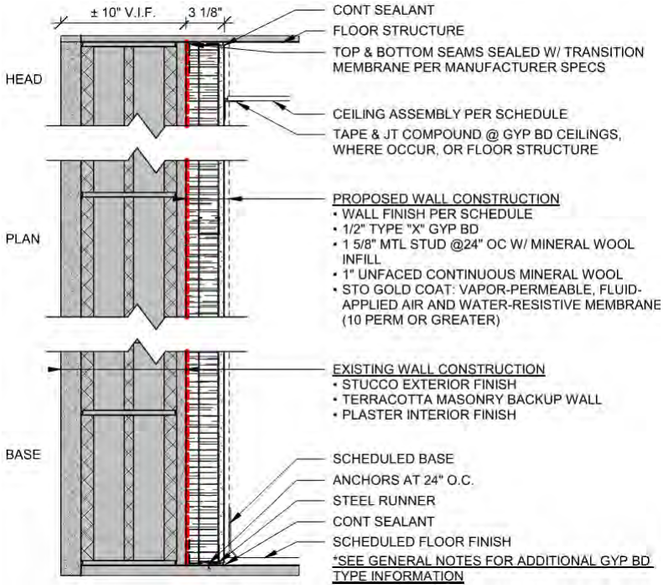
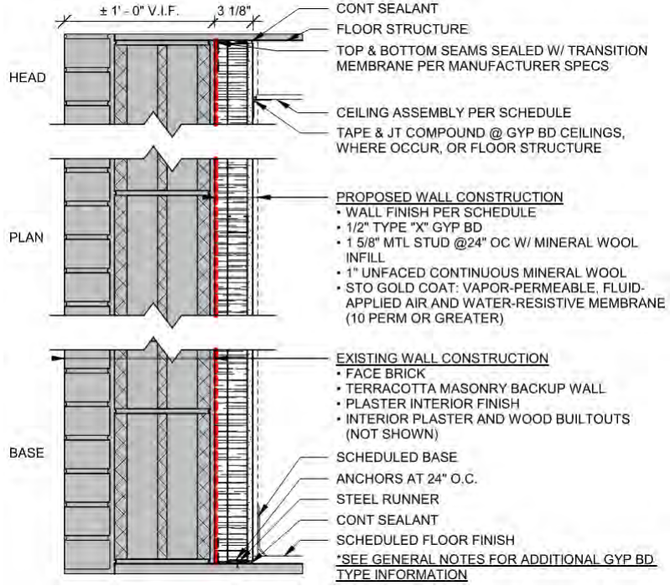
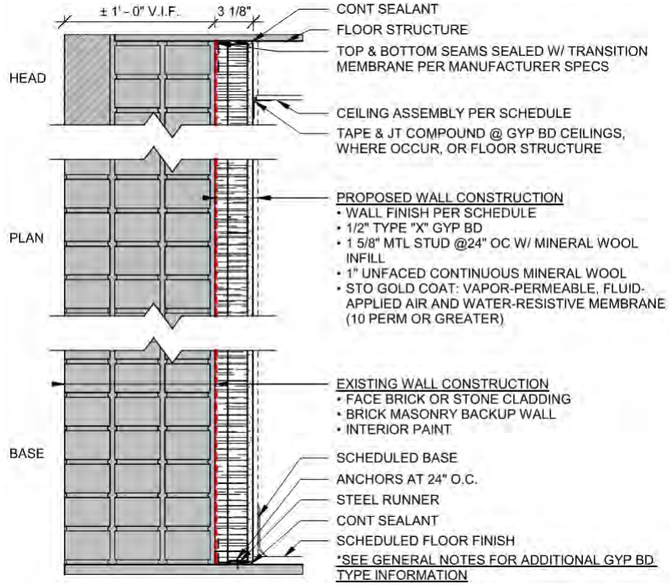
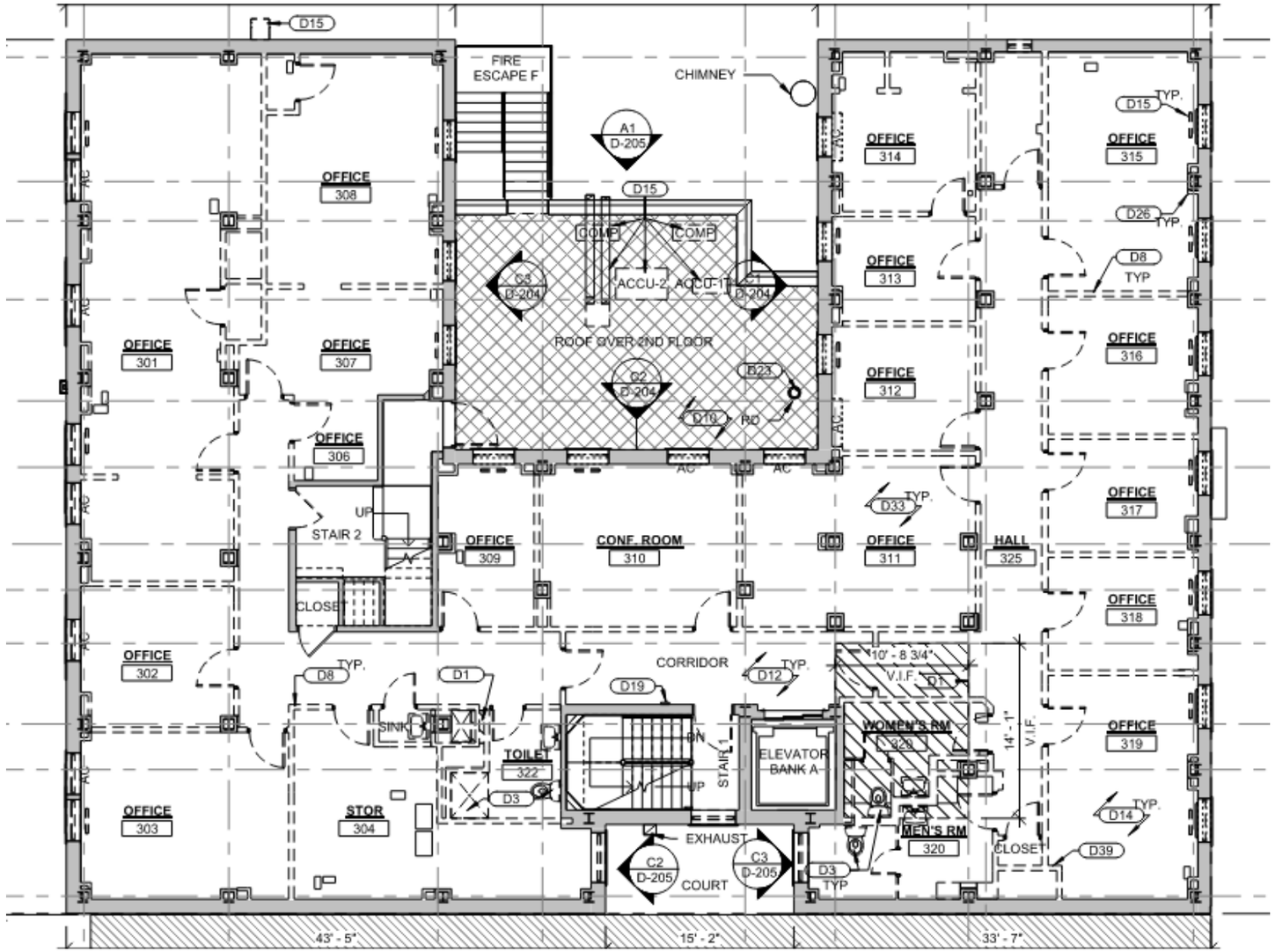






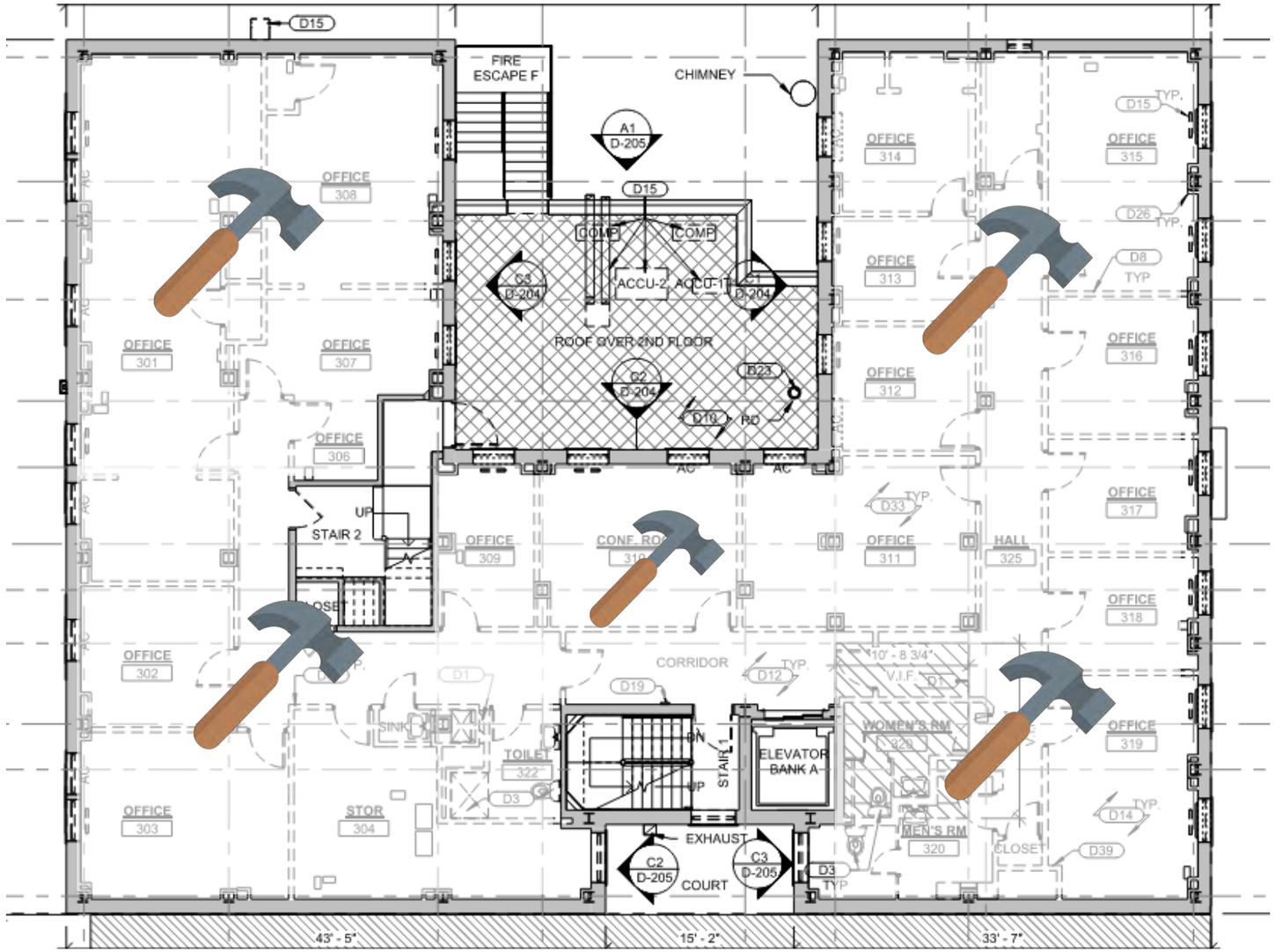
Three Arts Club: Whole Building Airtightness



A Key Sequencing & Scope Detail...

- Existing interior partitions that intersect with exterior wall.

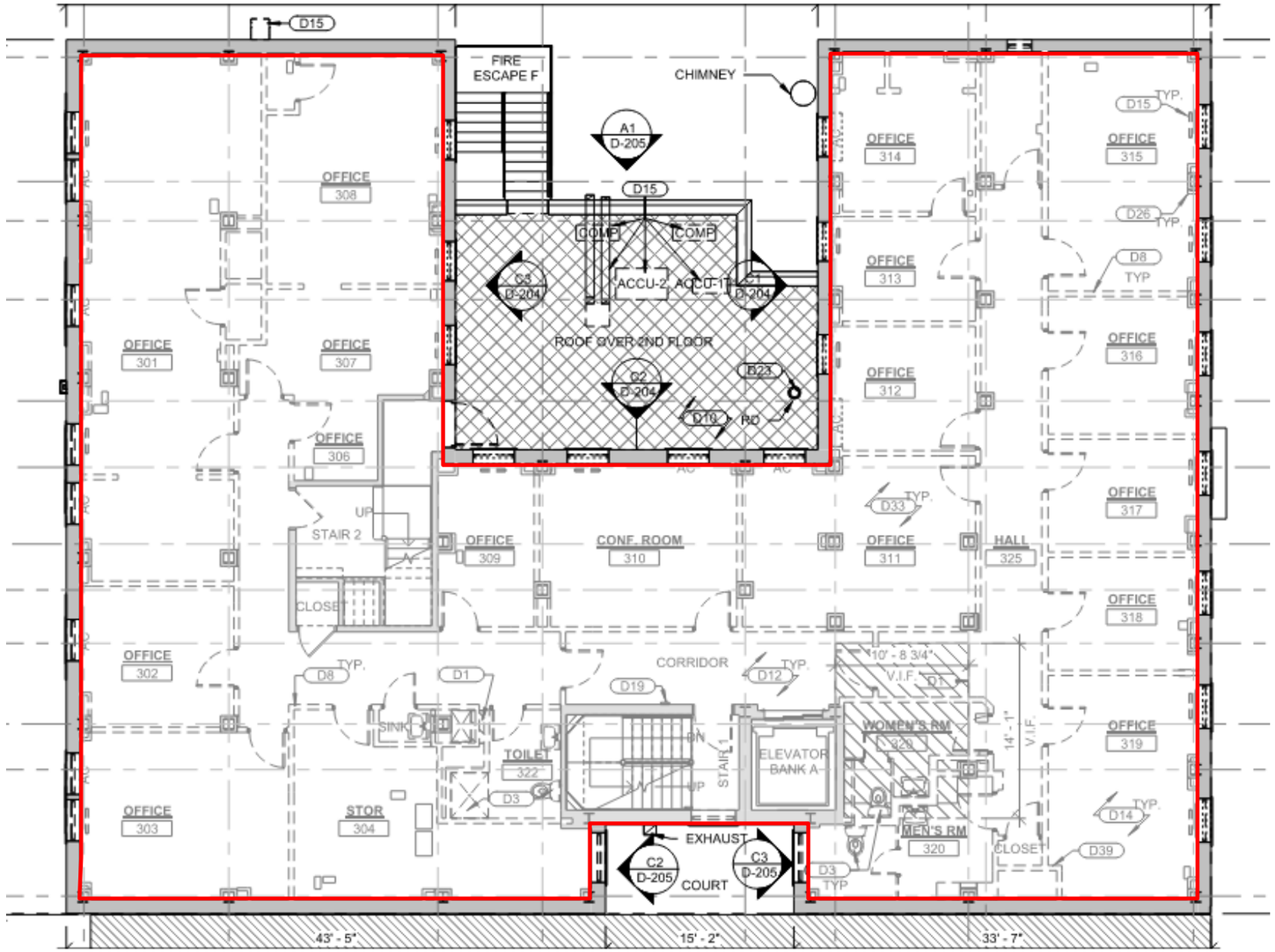
Three Arts Club: Whole Building Airtightness



A Key Sequencing & Scope Detail…

- Existing interior partitions that intersect with exterior wall.
  - Ideally these can be demo-ed.

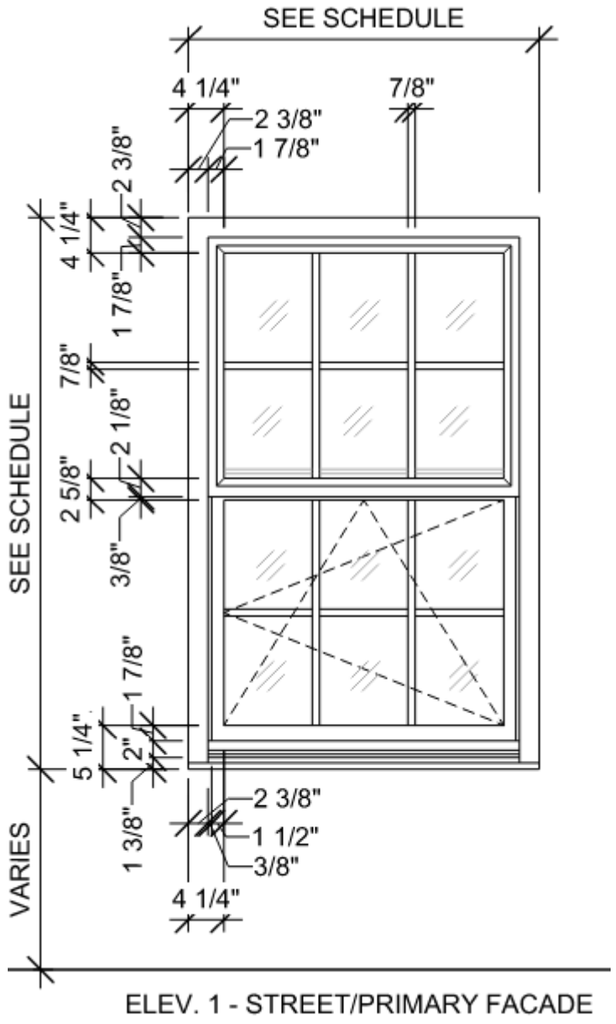
Three Arts Club: Whole Building Airtightness

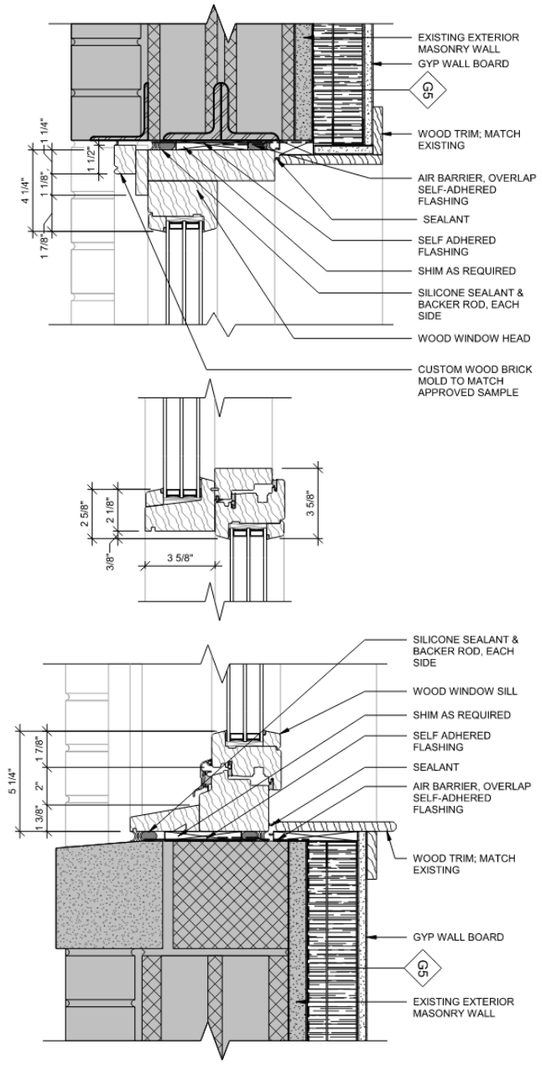


A Key Sequencing & Scope Detail...

- Existing interior partitions that intersect with exterior wall.
  - Ideally these can be demo-ed.
  - Allowing for clean(er) installation of an interior air barrier.

Three Arts Club: Primary Facade Windows





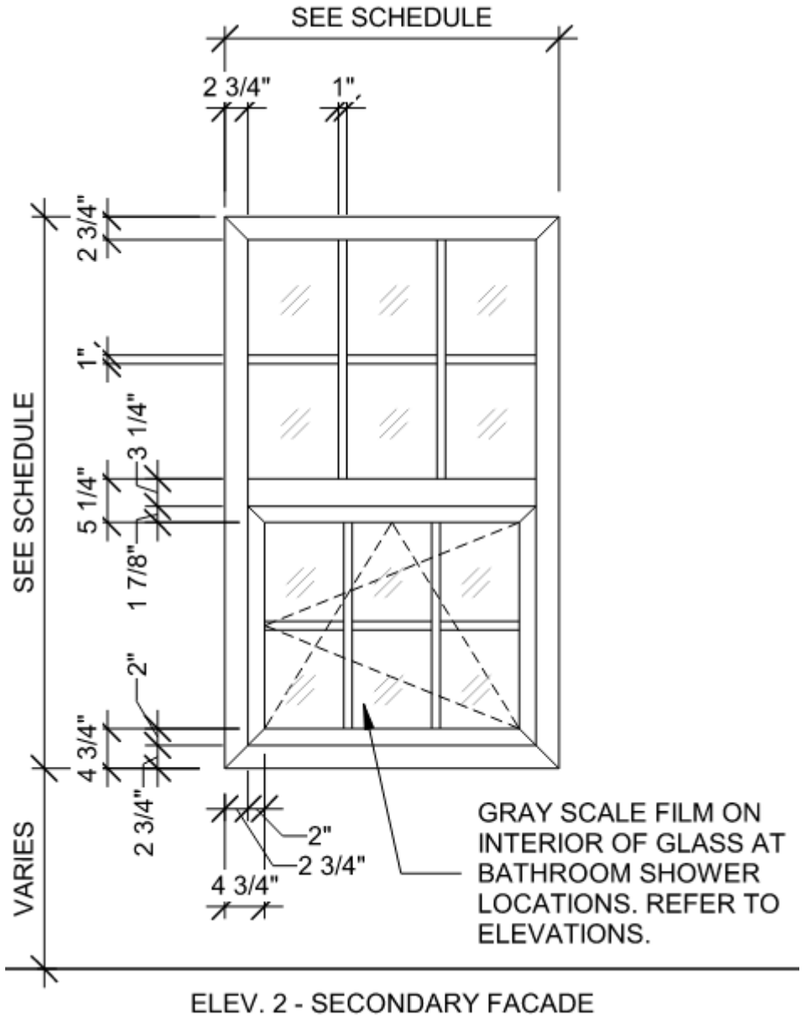
High Performance & Airtight Triple Pane Wood

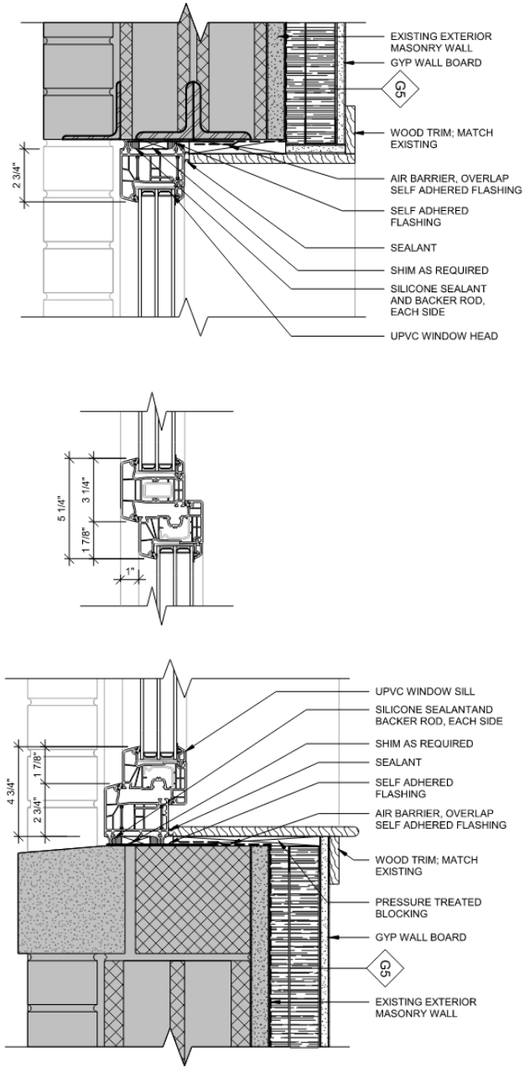
- U-Factor = 0.15
- SHGC = 0.385

2020 NYC ECC Requirements (Nonmetal)

- U-Factor = 0.28 max.
- SHGC = 0.36-0.58 max.

Three Arts Club: Secondary Facade Windows





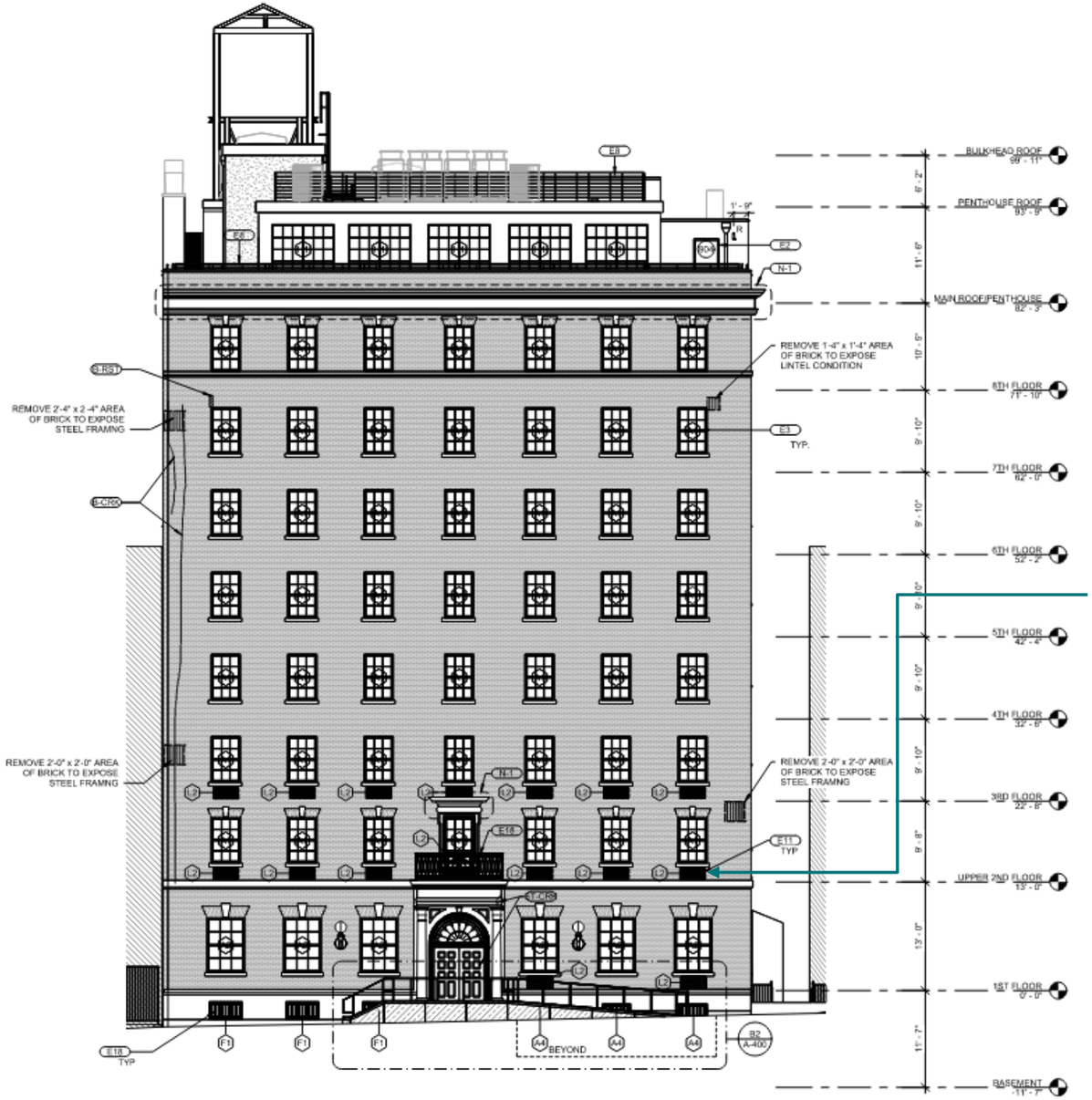
High Performance & Airtight Triple Pane uPVC

- U-Factor = 0.16
- SHGC = 0.375

2020 NYC ECC Requirements (Nonmetal)

- U-Factor = 0.28 max.
- SHGC = 0.36-0.58 max.

Three Arts Club: Heating and Cooling Systems

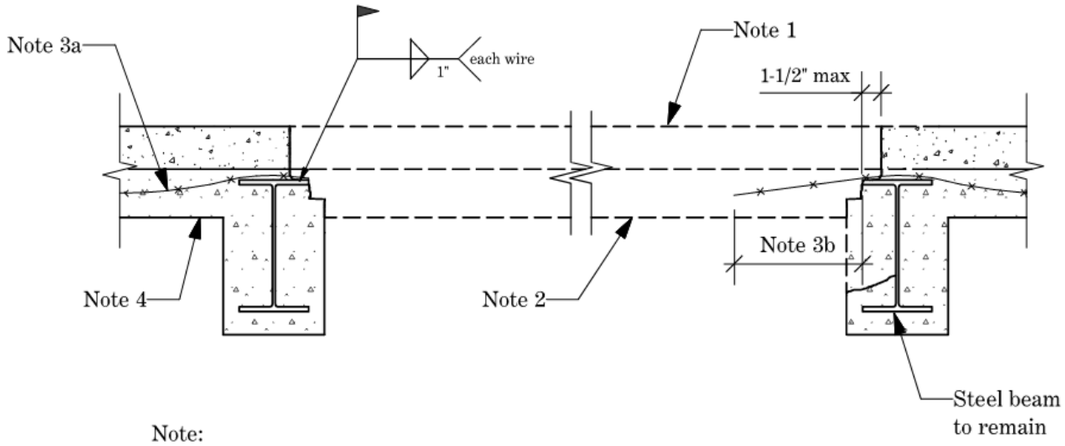


PTHPs and VRFs

- Existing PTAC louvered openings at Primary Façade to be reused for cold-climate, airtight packaged terminal heat pumps (PTHPs). New louvered openings to be added at secondary facades for PTHPs.
- Variable refrigerant flow (VRFs) to be used at all other locations.

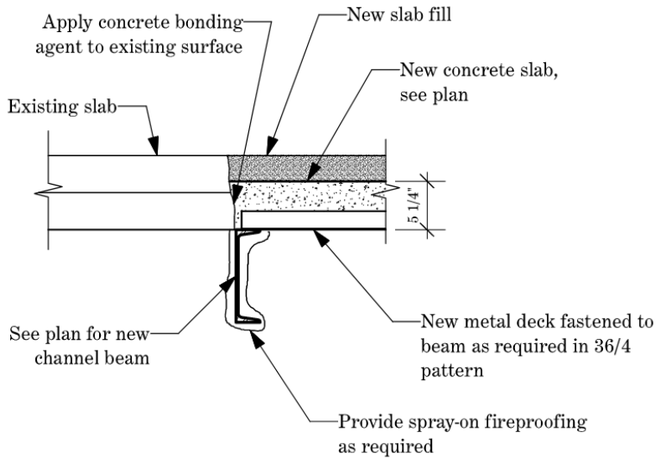
Existing Louvered Openings

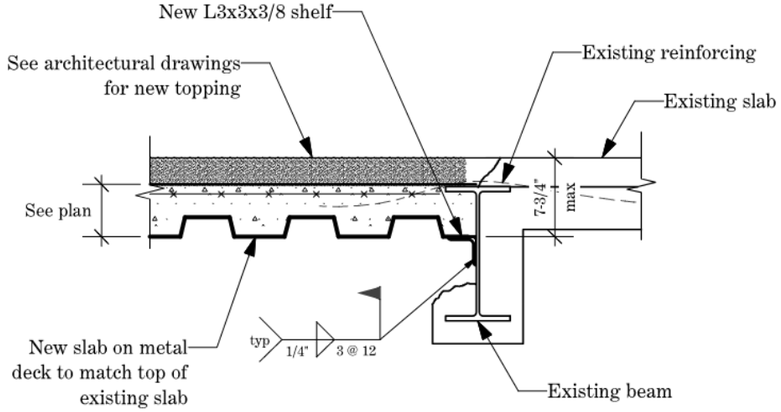
Three Arts Club: Structural Implications



Note:

1. Existing topping slab to be removed.
2. Existing slab to be removed. Do not saw cut at edges. Retain wire mesh as shown.
3. Existing wire mesh reinforcing to remain.
   a. At new opening cut at beam edge and weld as shown.
   b. At areas to be infilled reinforcing to remain minimum 12" from beam edge.
4. Existing slab to remain. If damaged during demolition, contact engineer of record.





Steel Frame with Draped Mesh Slab

- Unreinforced penetration limitations.
- Slab bay replacement options.

Three Arts Club: Site Energy & Carbon Savings

Operational Carbon

- **Existing Conditions:**
  - Site EUI between 100-120 kBtu/gsf.yr
  - Operational Carbon: ~380-500 tons CO2-e per year

    *using NYC Local Law 97 carbon coefficients for years 2024-2029
- **Proposed Retrofit:**
  - Site EUI between 40-45 kBtu/gsf.yr **(55-67% savings)**
  - Operational Carbon: ~150-200 tons CO2-e per year **(60-70% savings)**

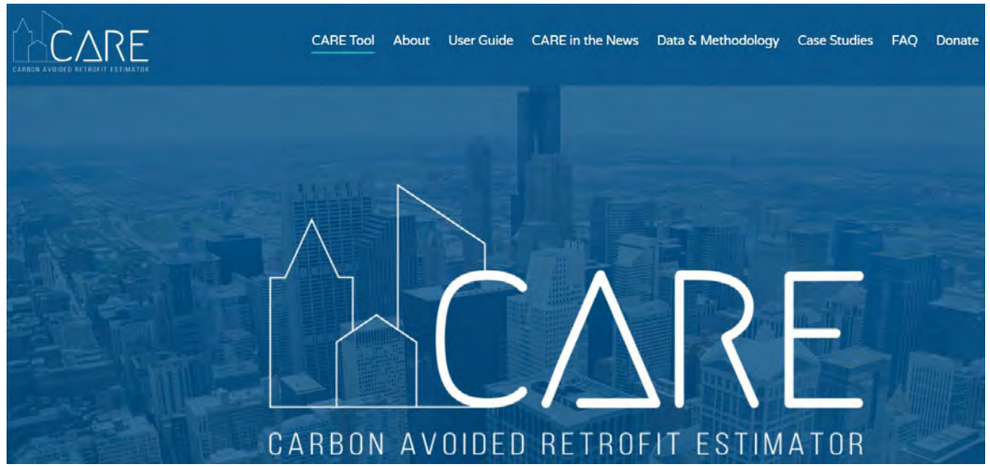
    **using NYC Local Law 97 carbon coefficients for years 2024-2029*

Three Arts Club: Site Energy & Carbon Savings

Embodied Carbon

- **If we built new to a similar level of performance:**
  - Embodied Carbon Emissions Intensity: 38.1 kg CO2-e/sf.yr
- **By reusing the existing structure instead:**
  - Embodied Carbon Emissions Intensity: 10.0 kg CO2-e/sf.yr (74% savings)

*Analysis performed using Cabron Avoided: Retrofit Estimator (CARE TOOL)



Questions?