



# LARGE SCALE PASSIVE HOUSE

APPLYING LESSONS LEARNED

SPEAKERS

**Lois Arena PE**

Director, Passive House Services, Steven Winter Associates, Inc.

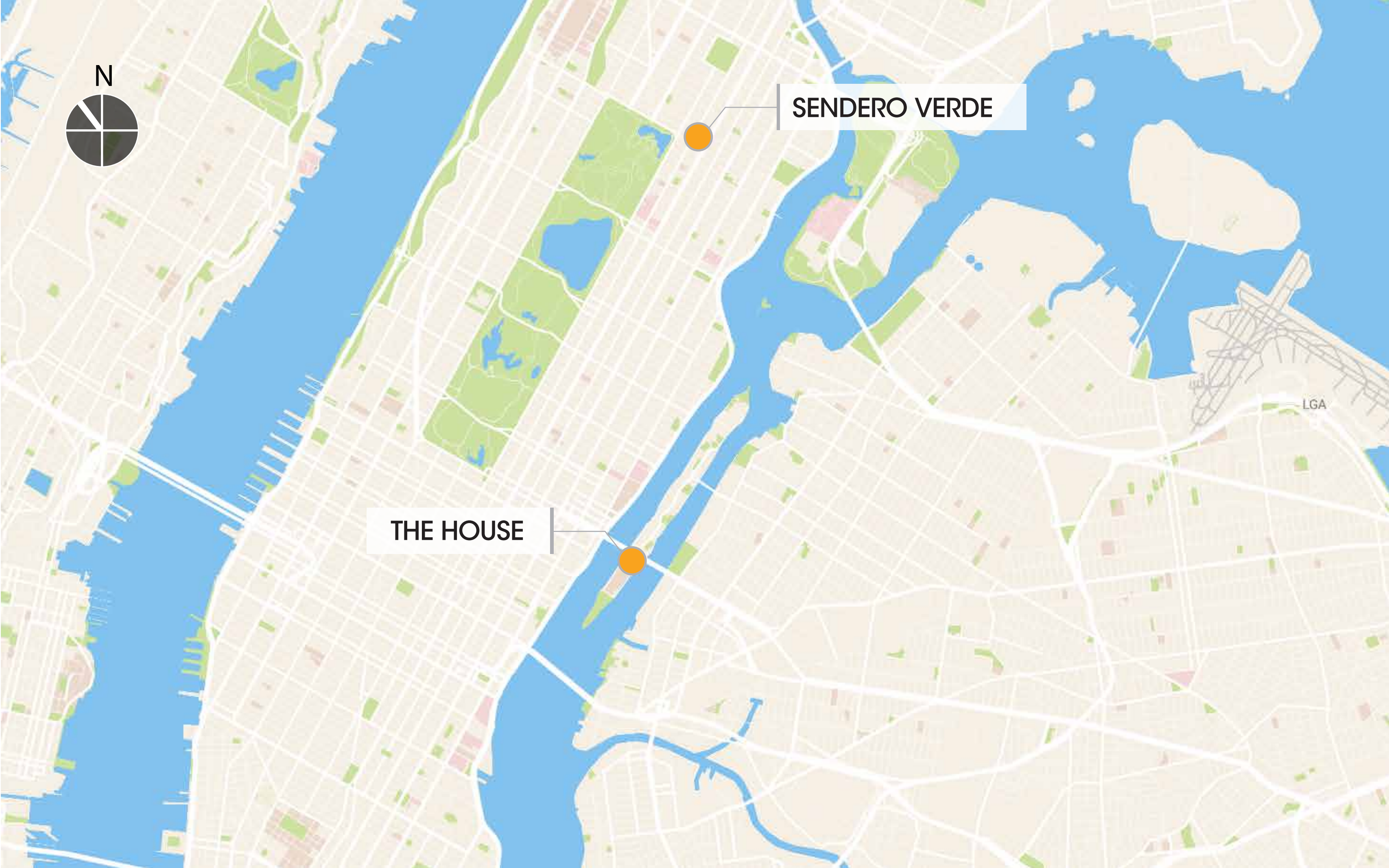
All images and diagrams of The House and Sendero courtesy of Handel Architects



SENDERO VERDE

THE HOUSE

LGA





## TEAM

Cornell University | Hudson Companies | Related Companies  
Handel Architects | Steven Winter Associates | Buro Happold  
Vidaris | Monadnock Construction



## TEAM

Jonathan Rose Companies | L+M Development Partners | Acacia  
Network | Handel Architects | Steven Winter Associates  
Cosentini | DeSimone Consulting Engineers | Vidaris

# Cornell Tech

**THE HOUSE**  
STUDENT / FACULTY  
RESIDENCES

**EXECUTIVE  
EDUCATION  
CENTER**

**FIRST  
ACADEMIC  
BUILDING**

**THE BRIDGE:  
CORPORATE  
CO-LOCATION**



# The House Project Goals



## EXTREME SUSTAINABILITY

- Reduce energy consumption
- Reduce Greenhouse Gas (GHG) emissions
- Reduce dependance on fossil fuels



## ELEVATE THE UNIVERSITY

- Position University at the forefront of innovation



## BETTER LIVING QUALITY

- Improve indoor air quality and comfort
- Provide acoustic separation from the surrounding environment
- Allow individual control of heating & cooling



## SAVE MONEY

- Provide affordable student housing
- Reduce energy costs for users

## PROJECT SUMMARY

Area: 270,000 GSF

26 Stories

270' to Roof

352 Units, 500 Beds

10,600 GSF/Floor

## USERS



Graduate Students



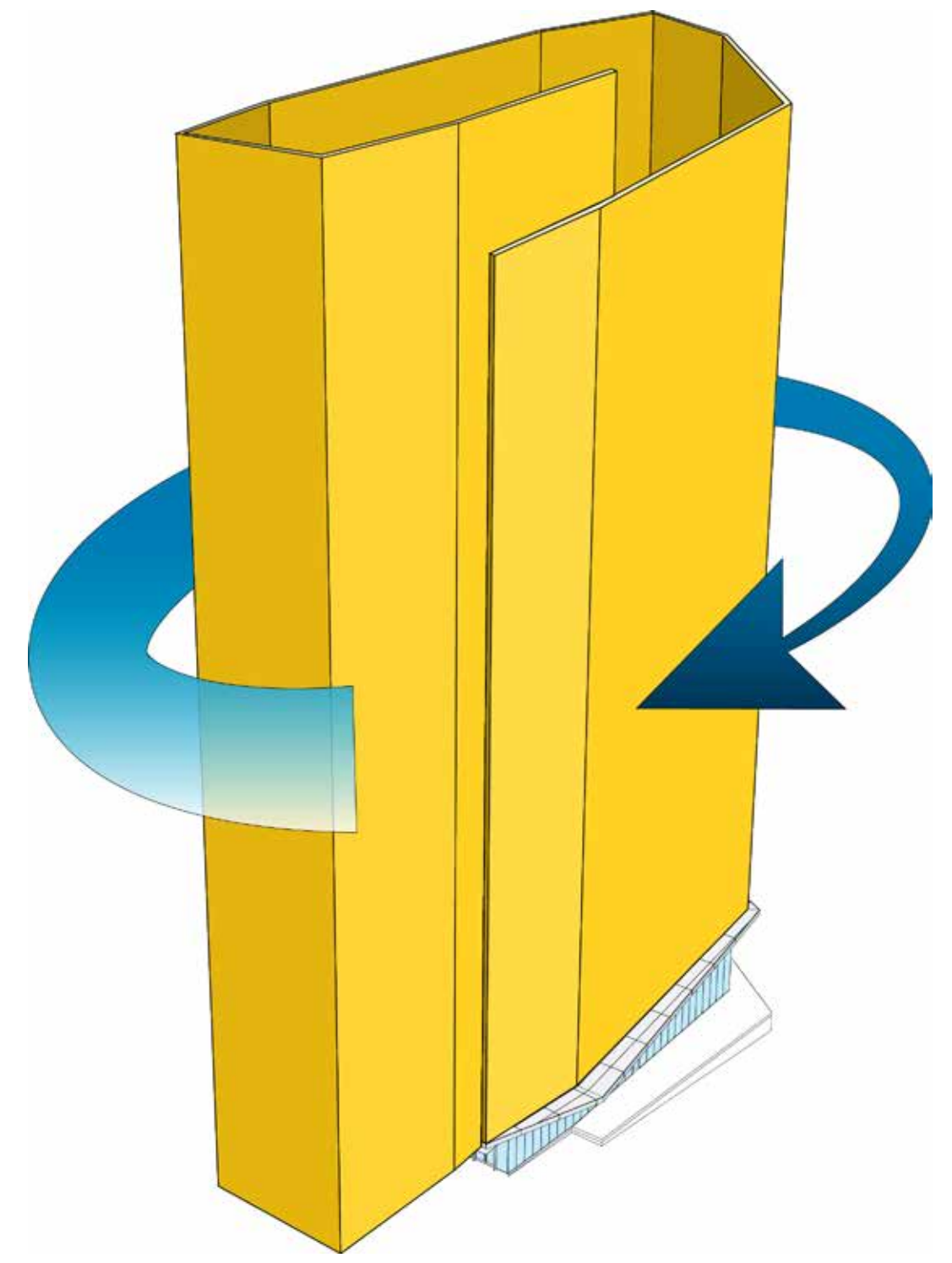
PhD Candidates



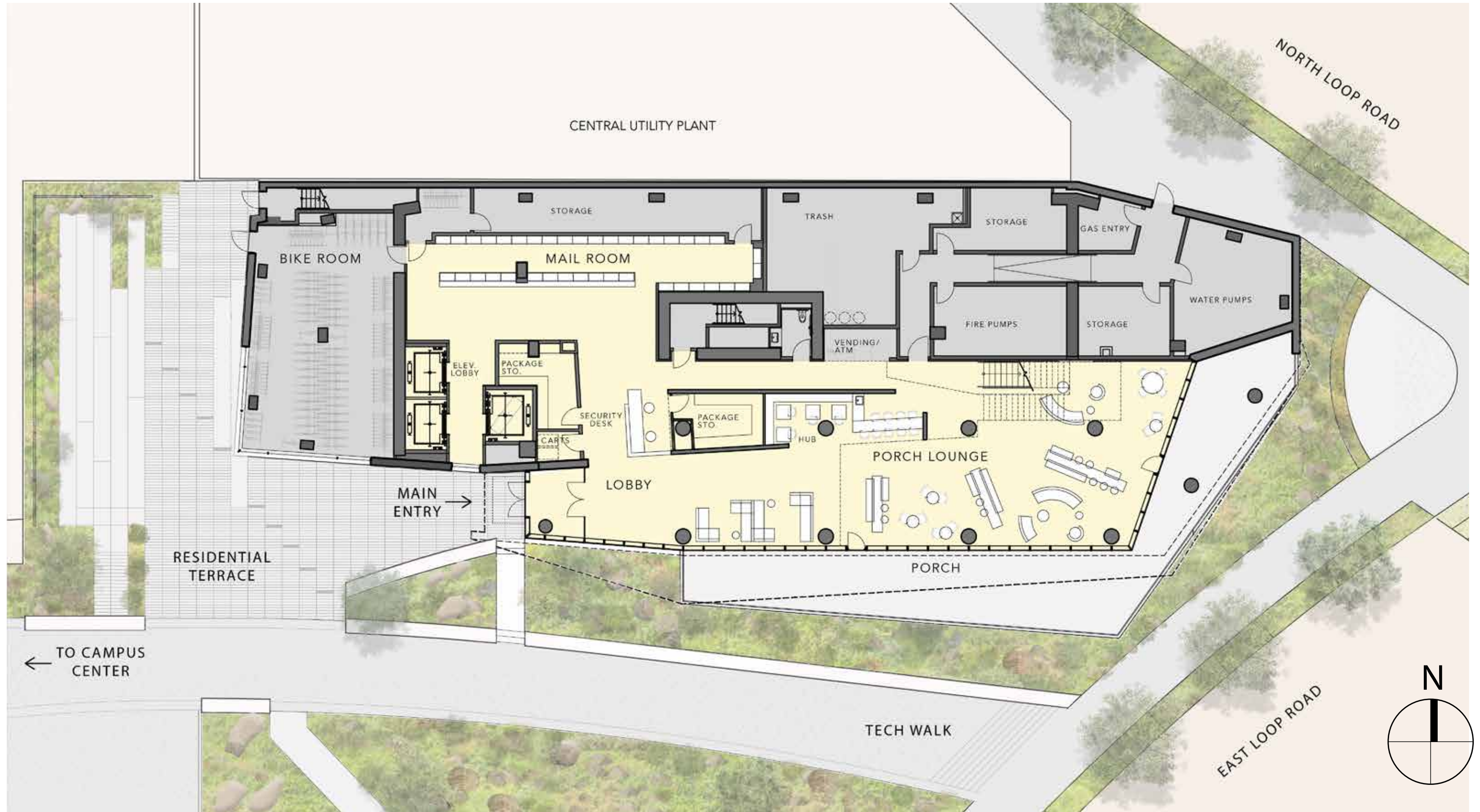
Post Doctoral



Faculty

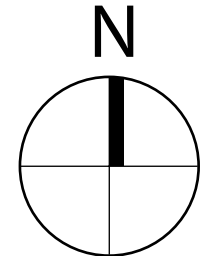


# Ground Floor Plan



# Typical Floor

16 Units per Floor





# Sendero Verde

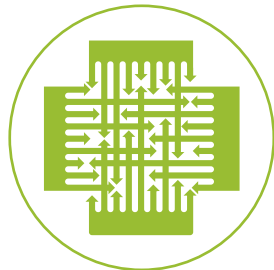


# Sendero Verde Project Goals



## EXTREME SUSTAINABILITY

- Reduce energy consumption
- Reduce Greenhouse Gas (GHG) emissions
- Reduce dependance on fossil fuels



## COMMUNITY OF OPPORTUNITY

- Collaborative community services
- Mt. Sinai / YMCA / DREAM / Union Settlement
- Neighborhood Open Space



## BETTER LIVING QUALITY

- Improve indoor air quality and comfort
- Provide acoustic separation from the surrounding environment
- Superior thermal comfort



## 100% AFFORDABLE RESIDENCES

- Varied levels of affordability
- Studio to 3BR Apartments
- Reduce energy costs for users

## PROJECT SUMMARY

Overall: 812,250 GSF  
Residential: 627,646 GSF  
Community Facilities: 150,110 GSF  
Commercial: 34,494 GSF  
674 Affordable Units

## USERS



High School Students



Residents

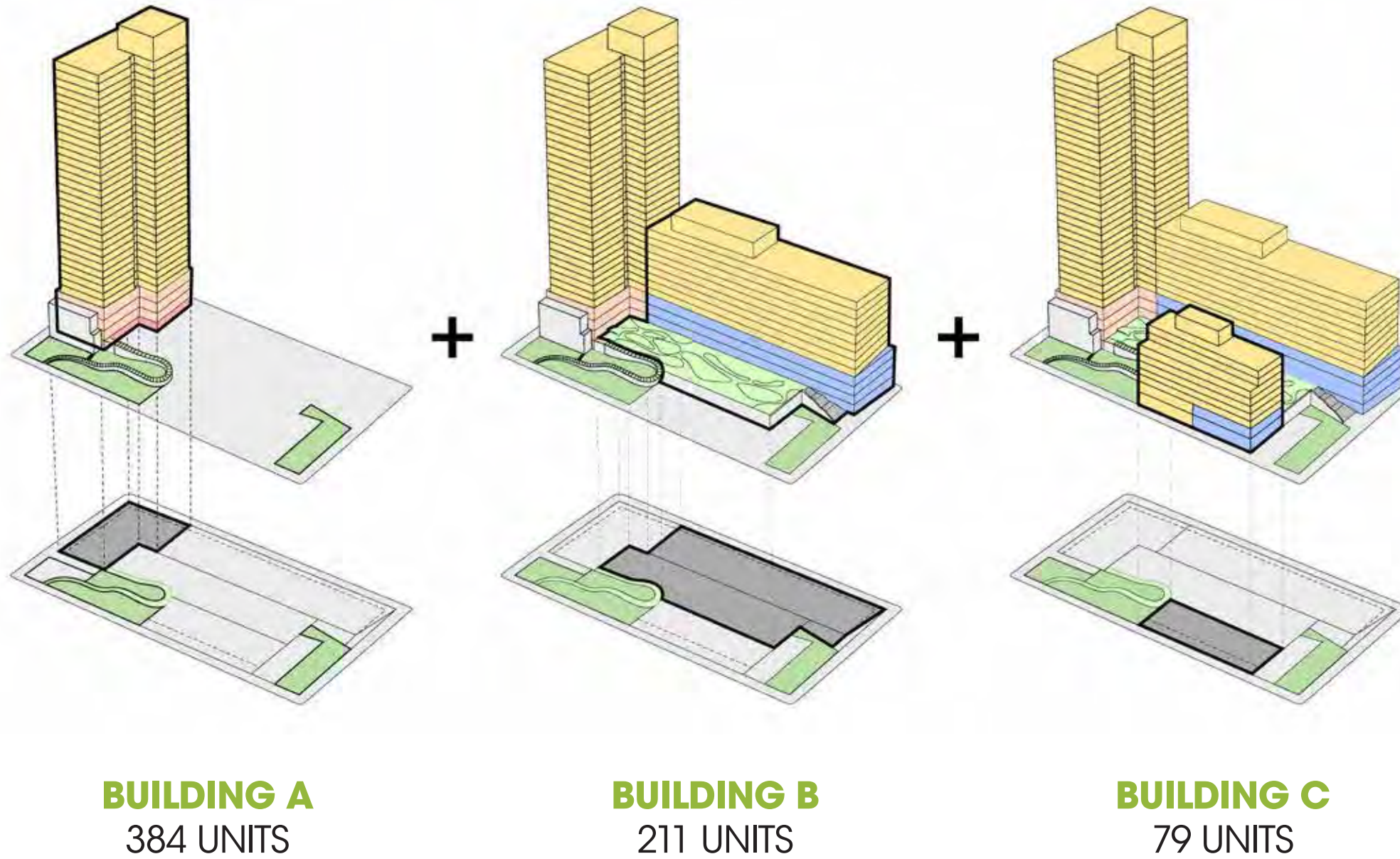


Seniors



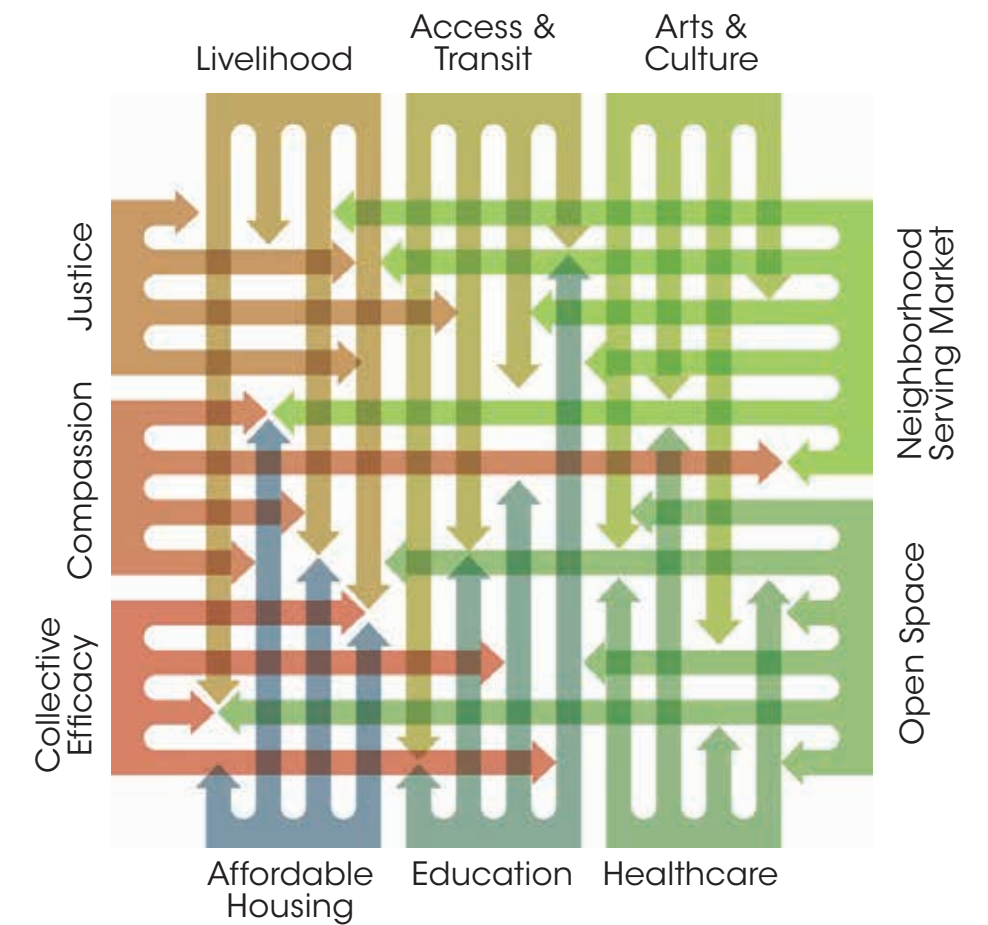
Health Clinic Users

# Affordable Housing for East Harlem



Sendero  
verde

## Community of Opportunity

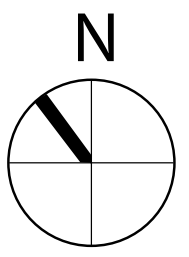
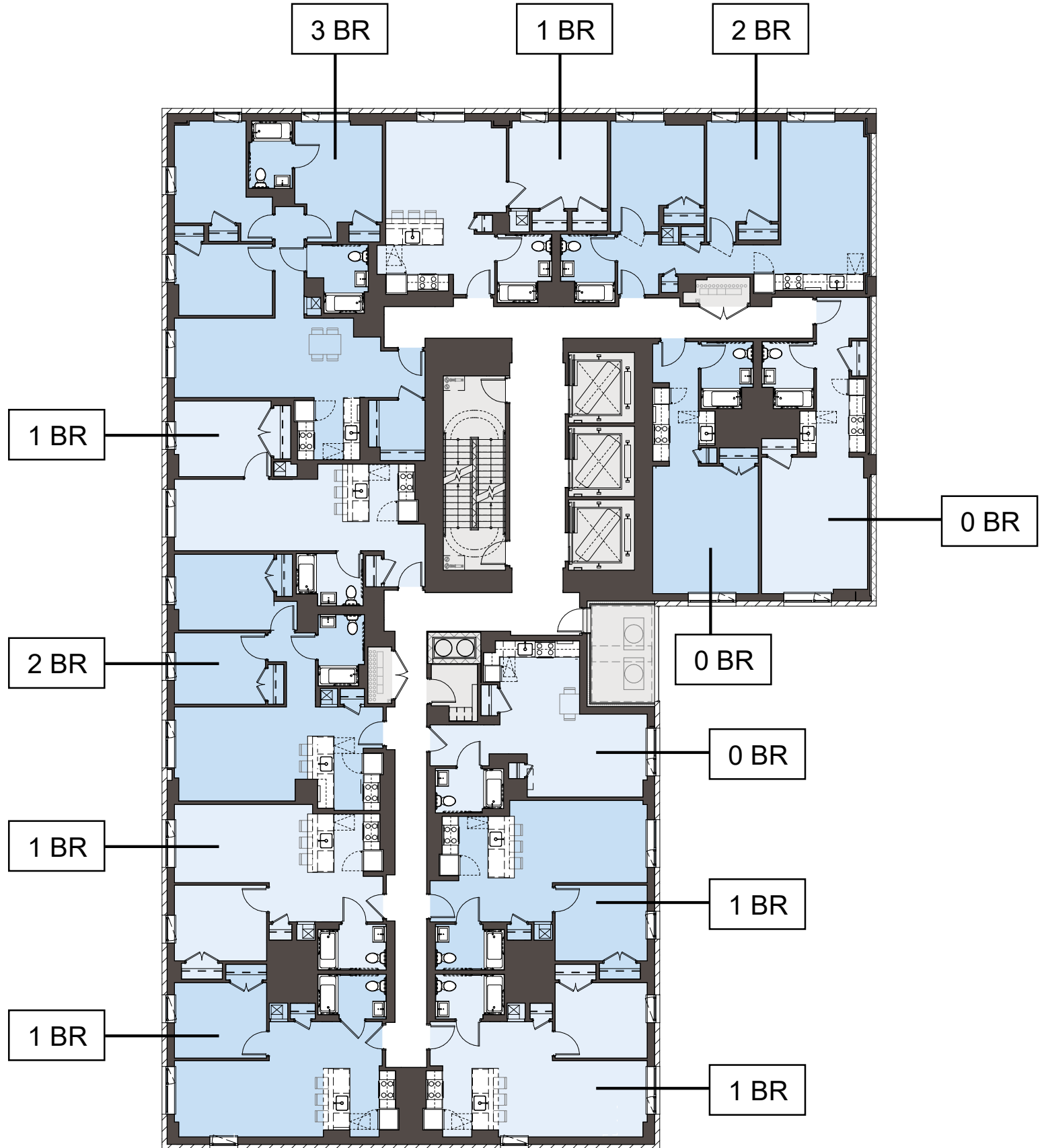


# Sendero Verde: Ground Floor Plan



# Sendero Verde: Typical Floor

12 Units per Floor



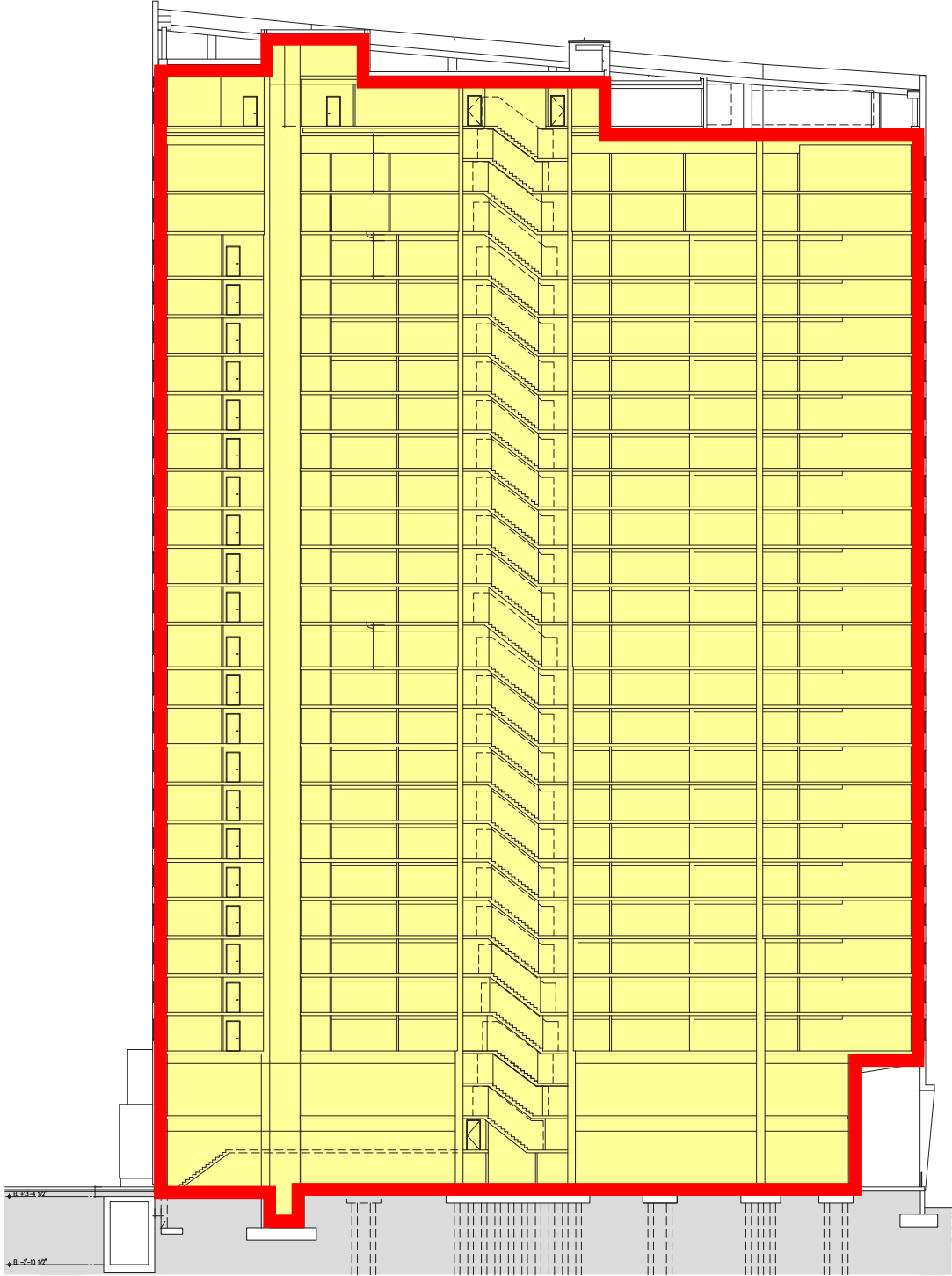


DREAM

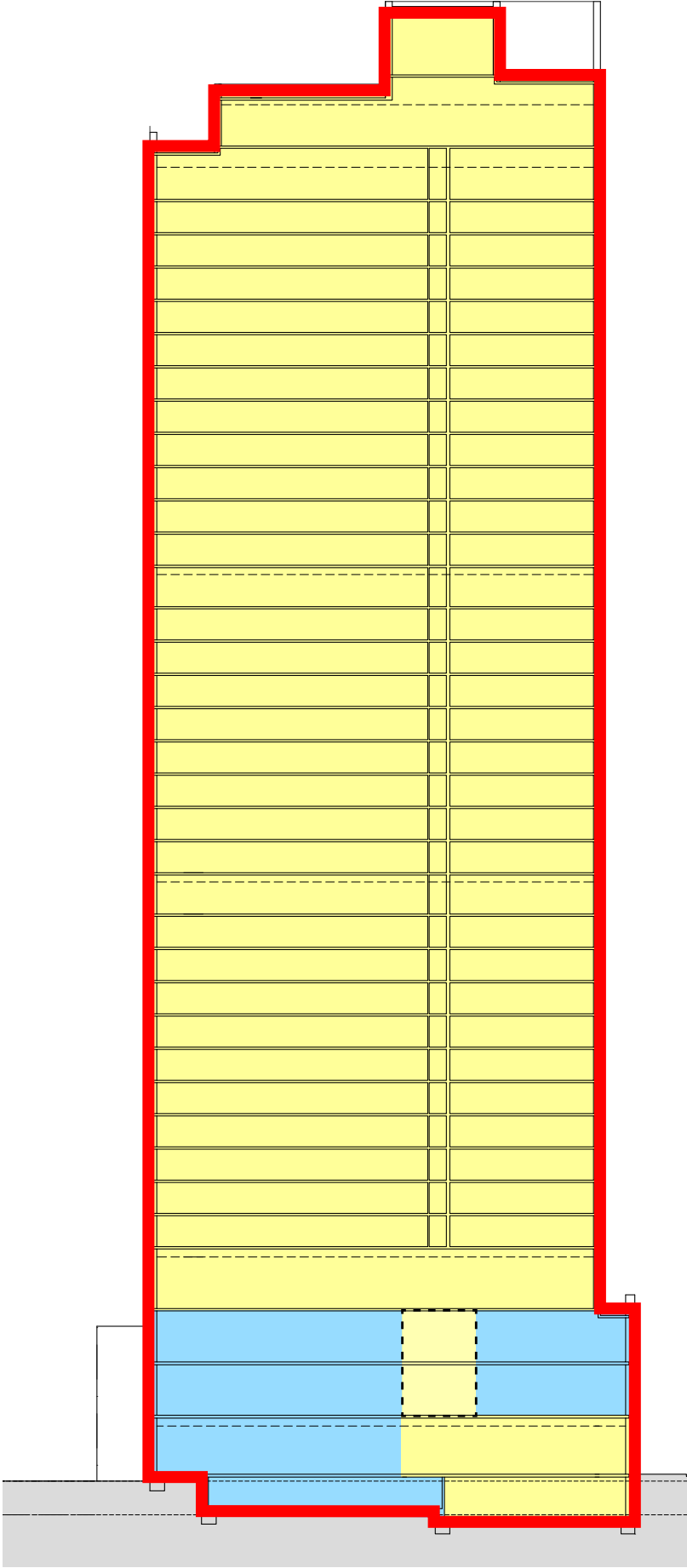
DREAM  
LEARN GROW

# Passive House Envelope & Certified Area

- PH AIRTIGHT LAYER
- PH CERTIFIED AREA
- NON-CERTIFIED AREA



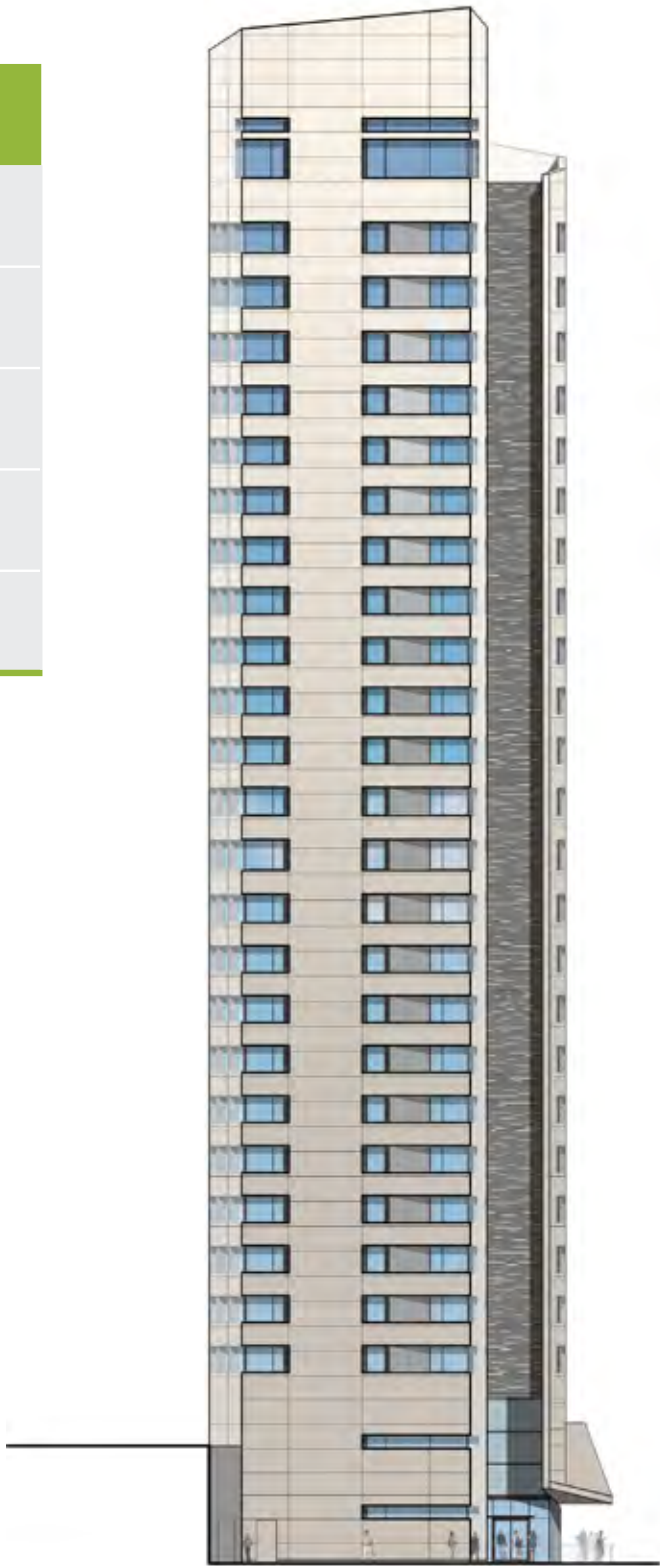
THE HOUSE



SENDERO VERDE

# The House: Enclosure

Component	Efficiency
Roof	R-50
Walls	R-19 Average
Windows	U-0.18
Slabe Edge	R-10+
Cantilevered Floors	R-40



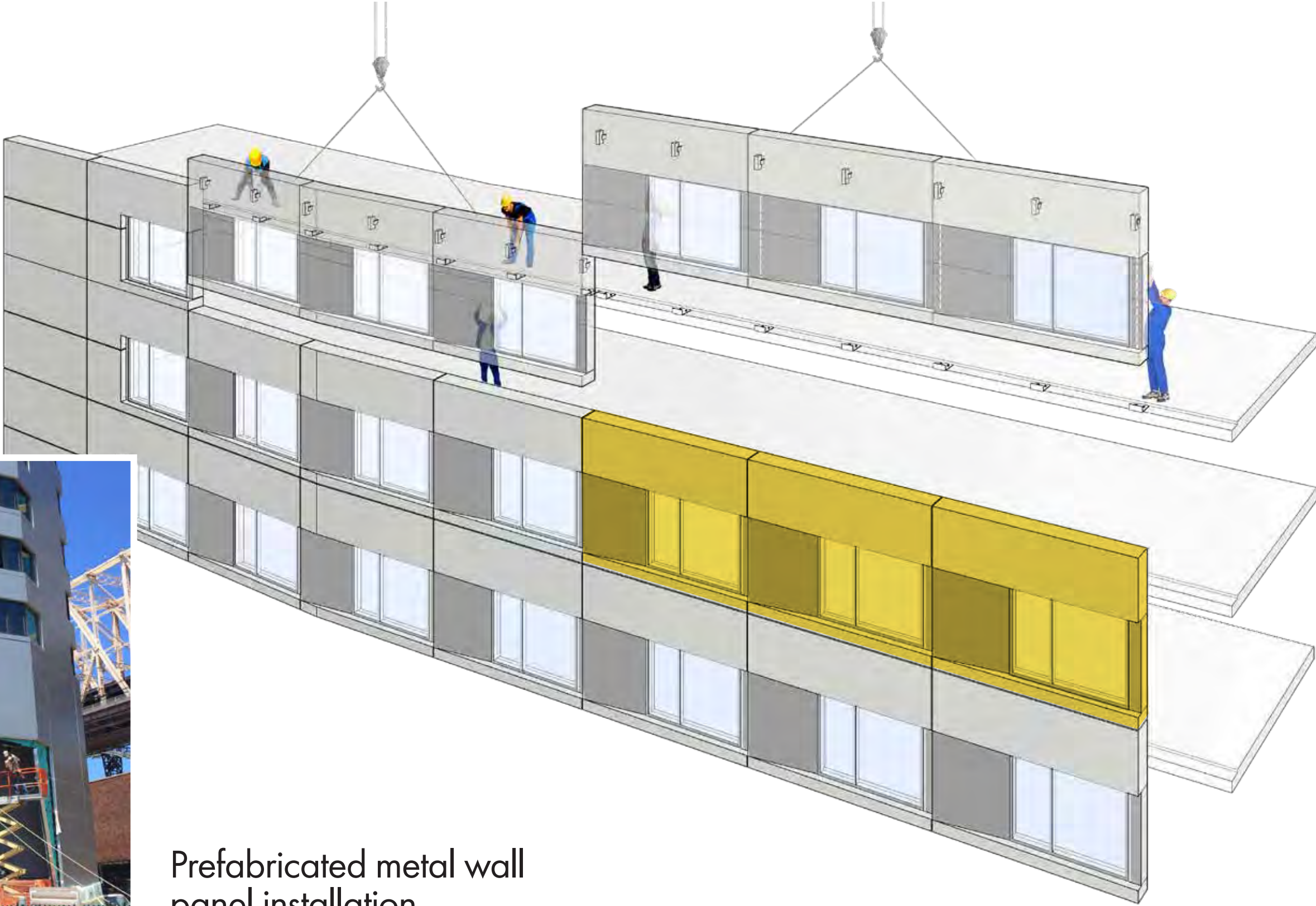
WEST



SOUTH



# The House: Panelized Wall System



Prefabricated metal wall panel installation

# The House: Panel Installation

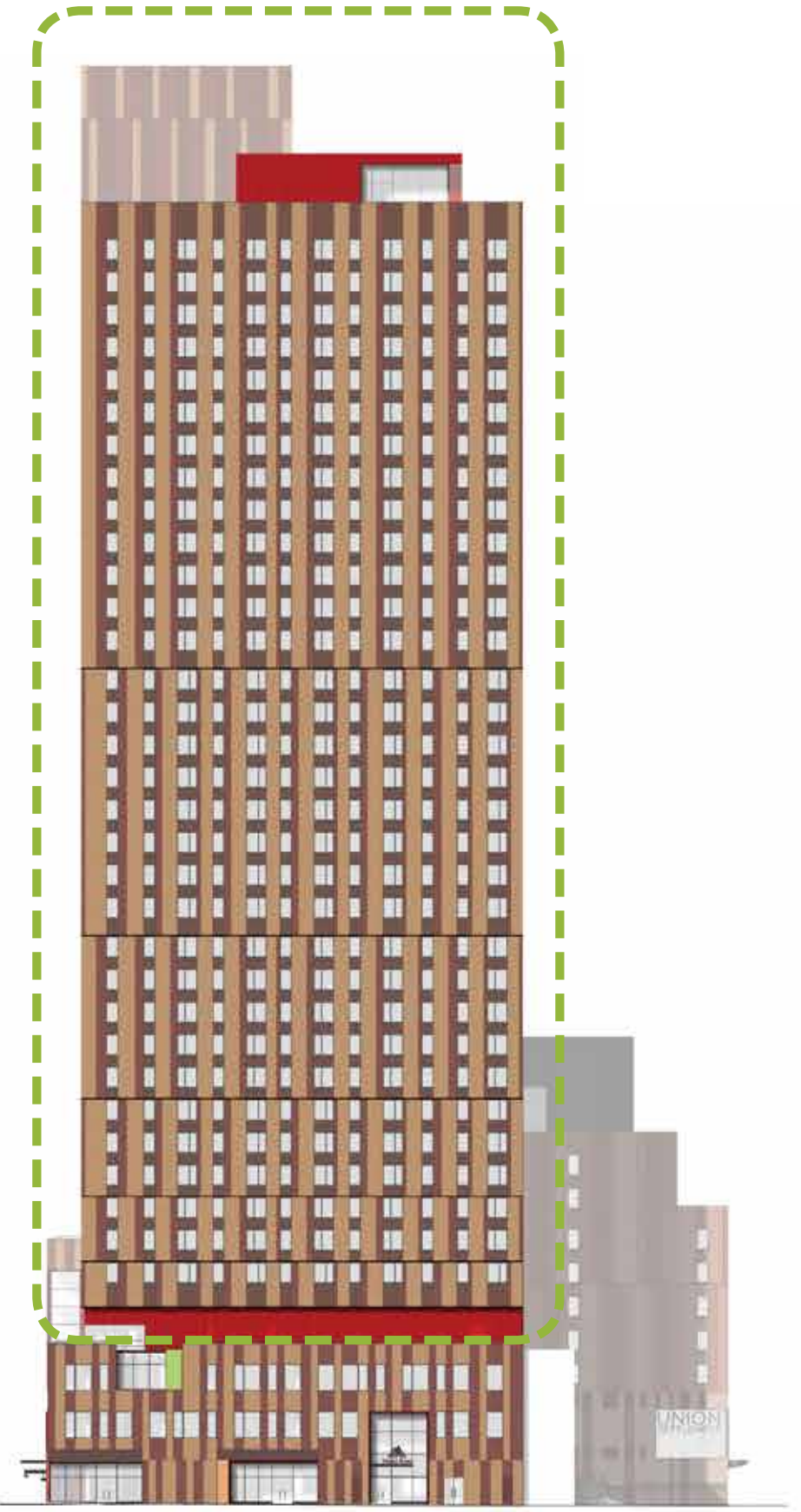


# Sendero Verde: Enclosure

COMPONENT	EFFICIENCY
Roof	R-40
Walls	R-20 Effective
Windows	Operable - U: 0.149 Fixed U: 0.134
Slab Edge	R11



NORTH ELEVATION

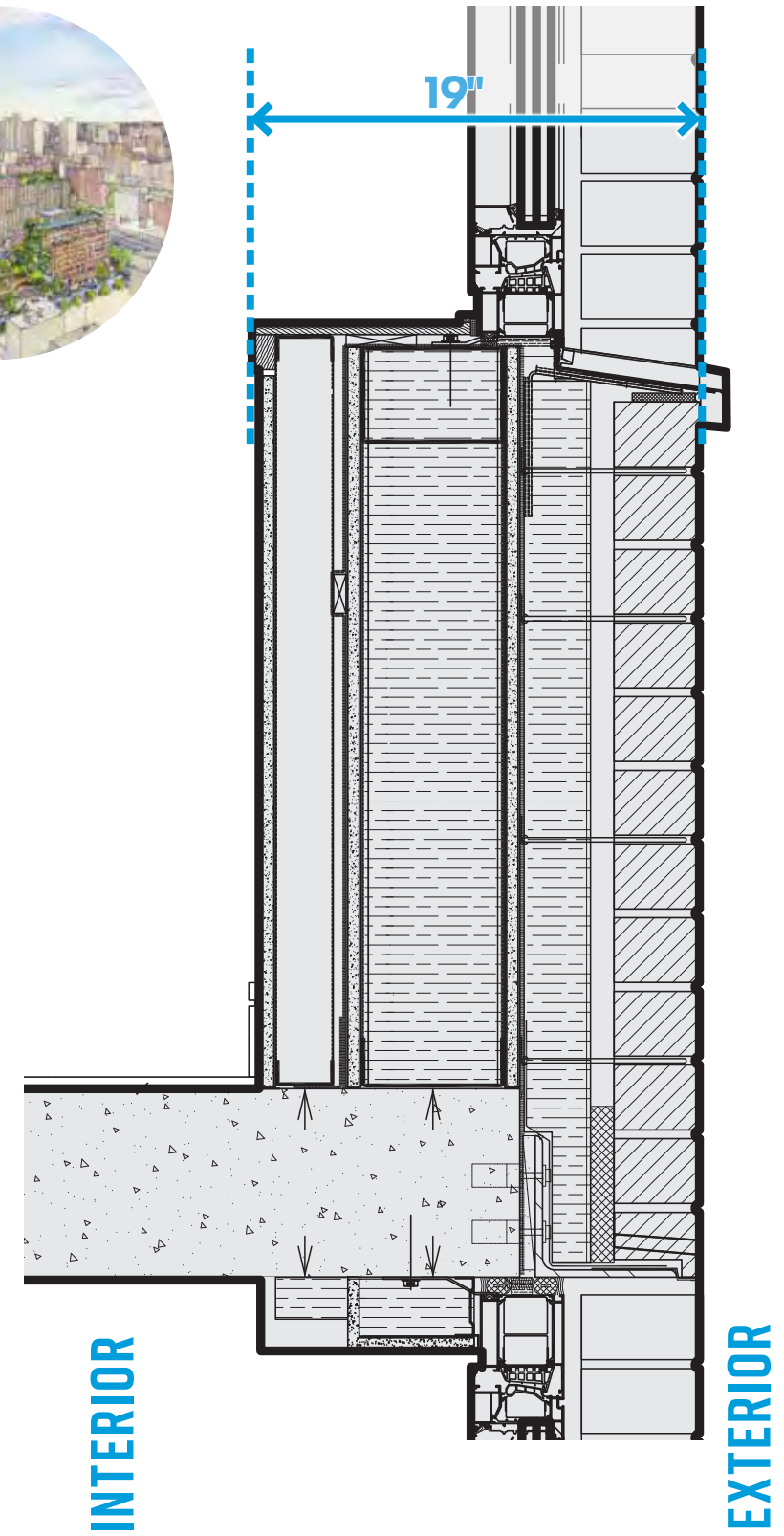
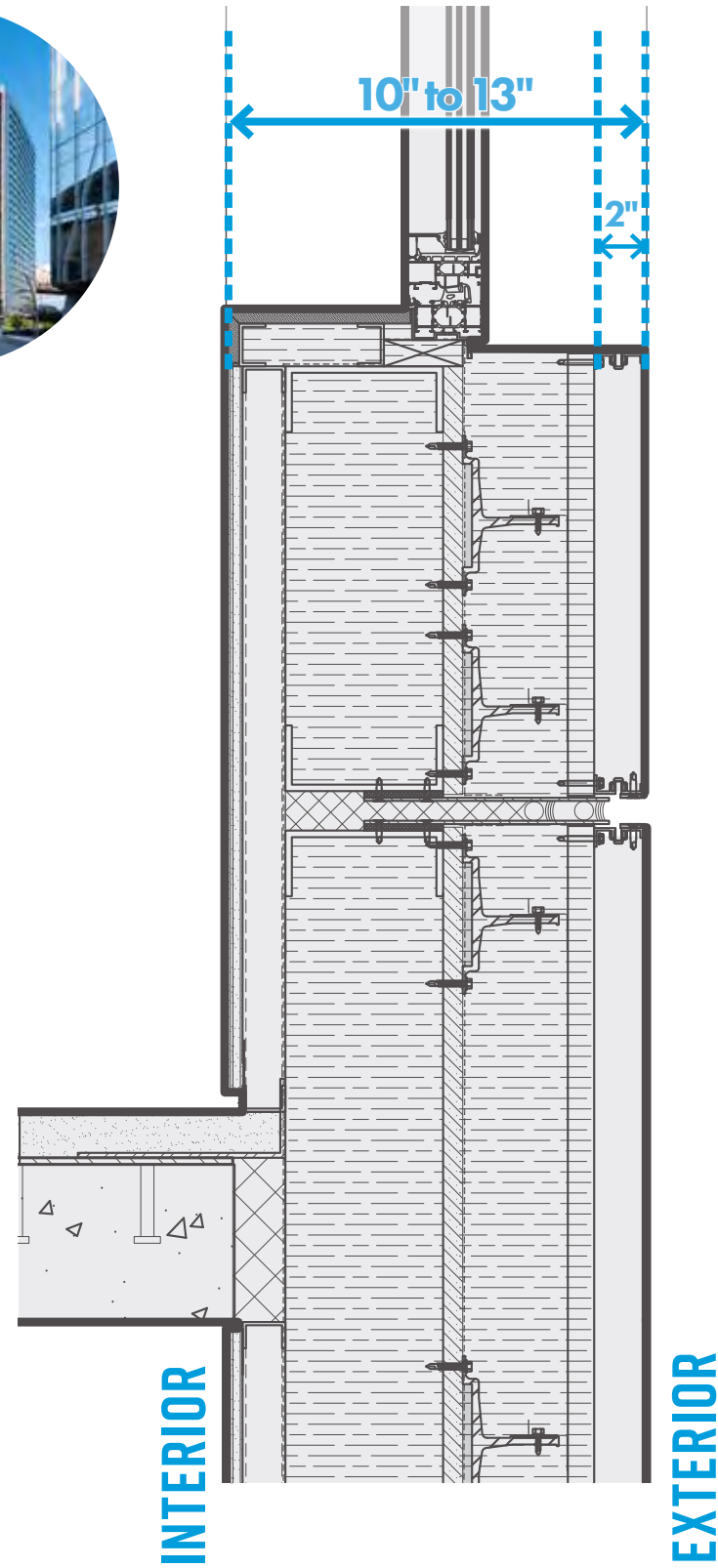


WEST ELEVATION

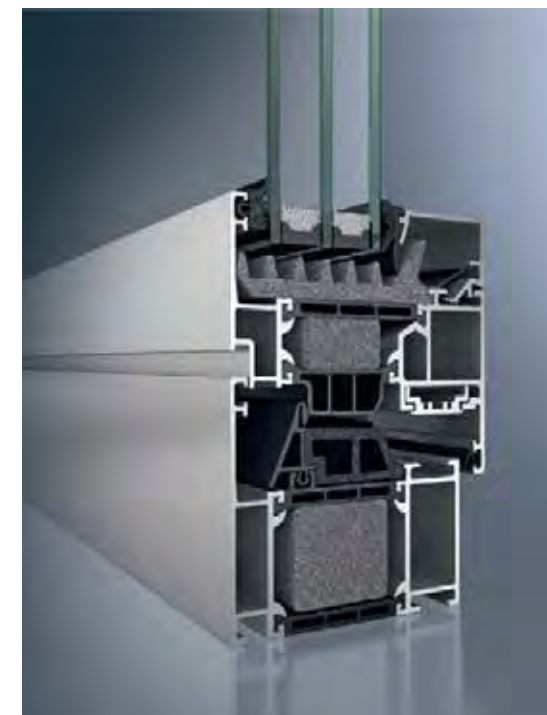
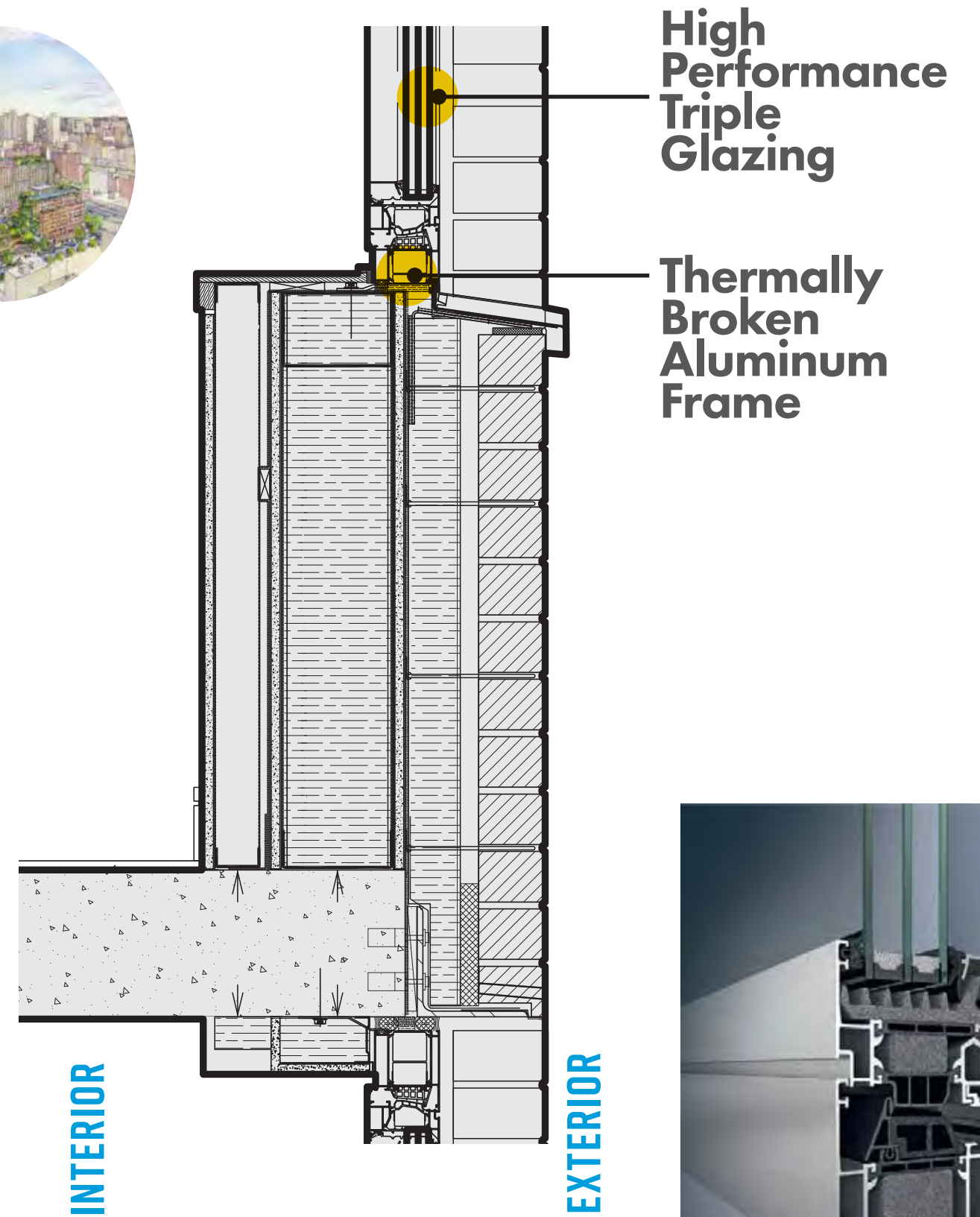
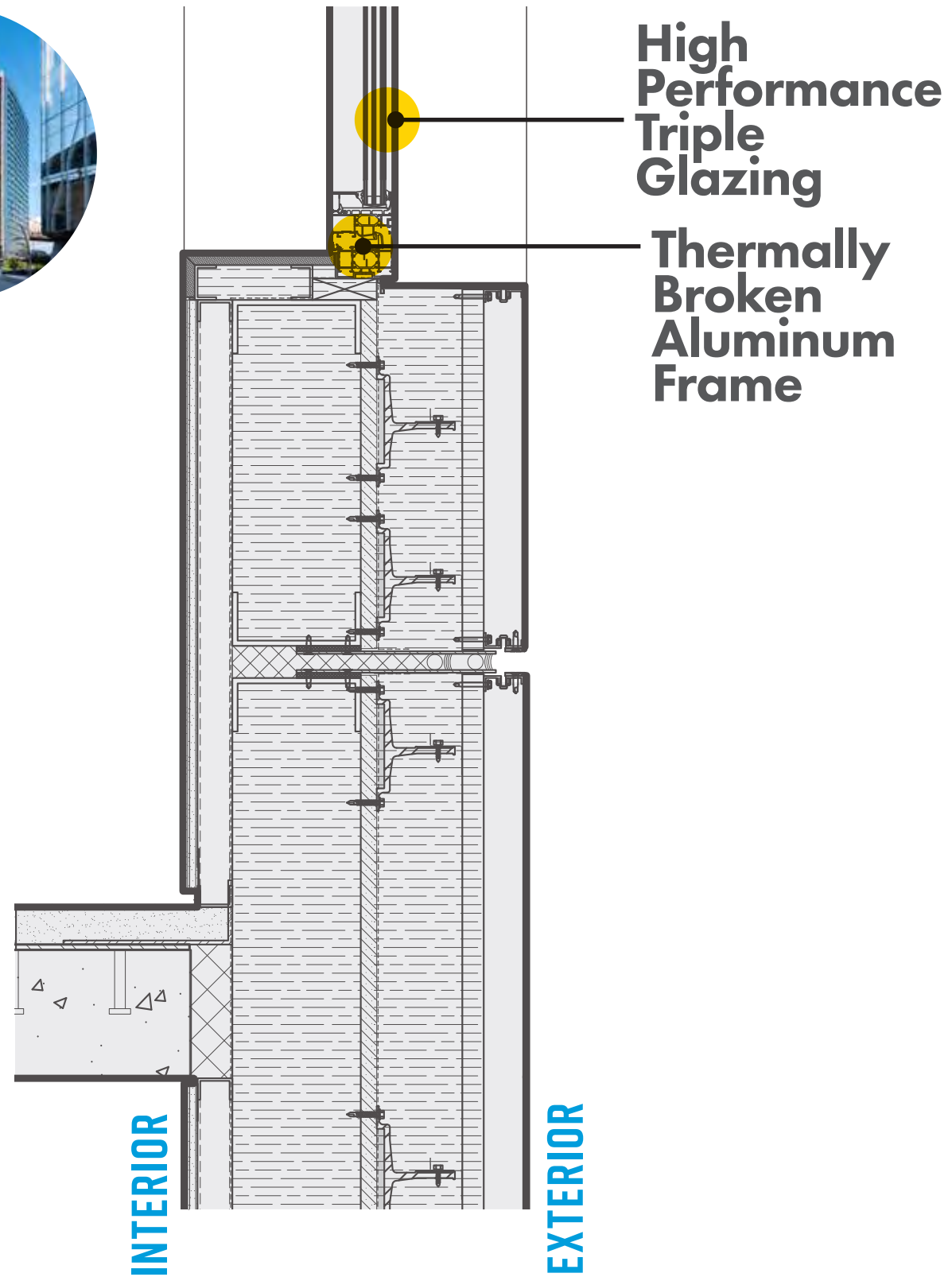
# Sendero Verde: Metal Stud & Masonry Enclosure



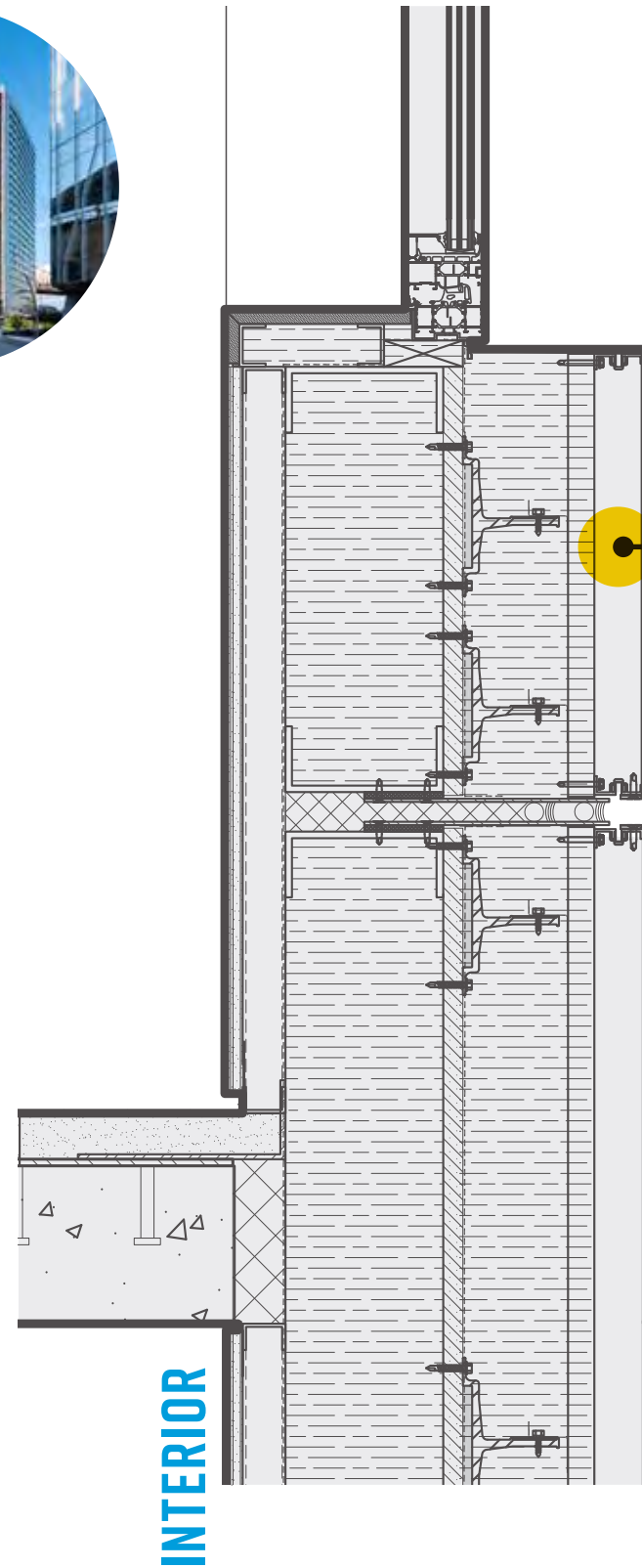
# Exterior Wall Section Comparison



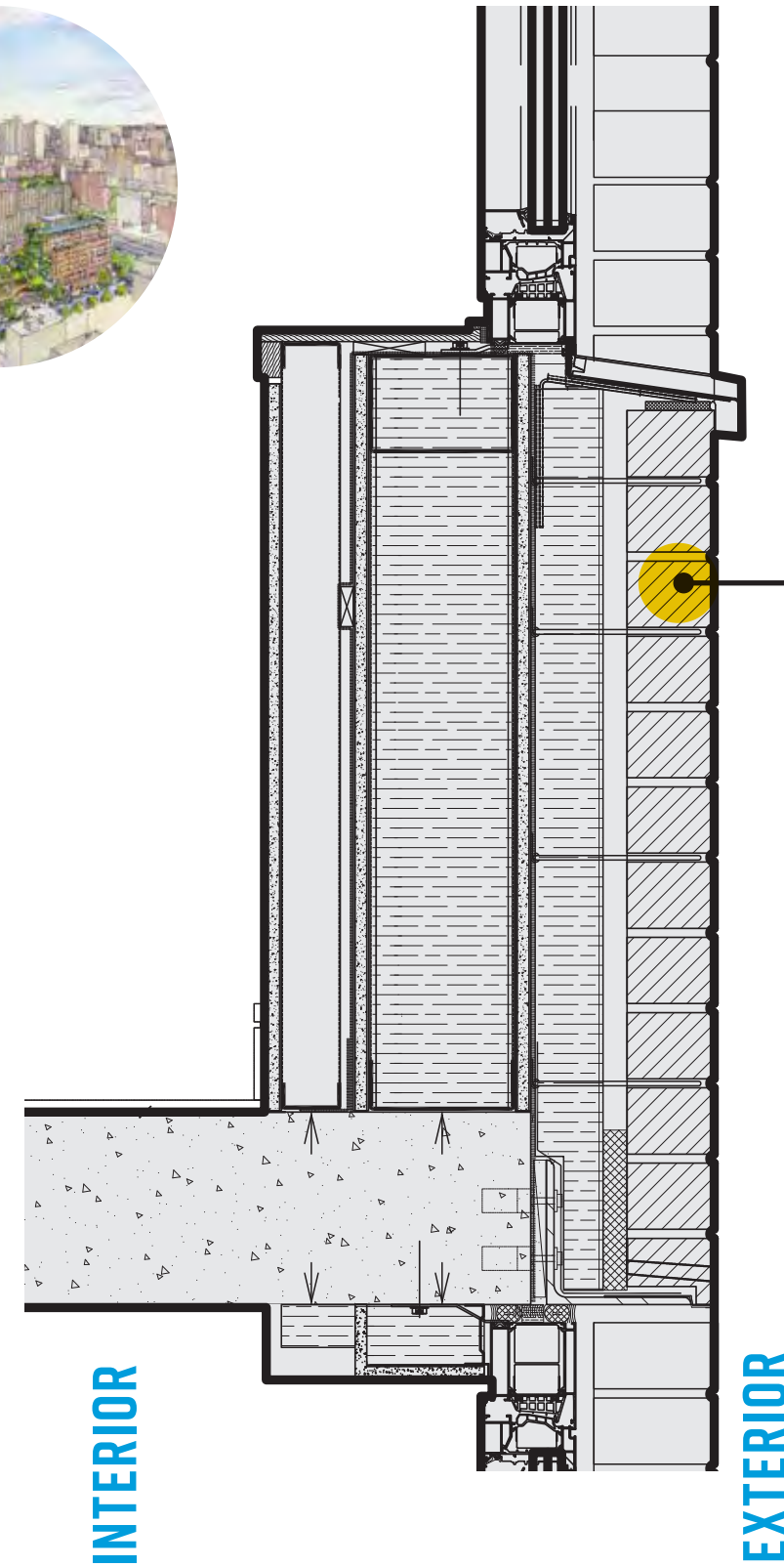
# Exterior Wall Section Comparison



# Exterior Wall Section Comparison

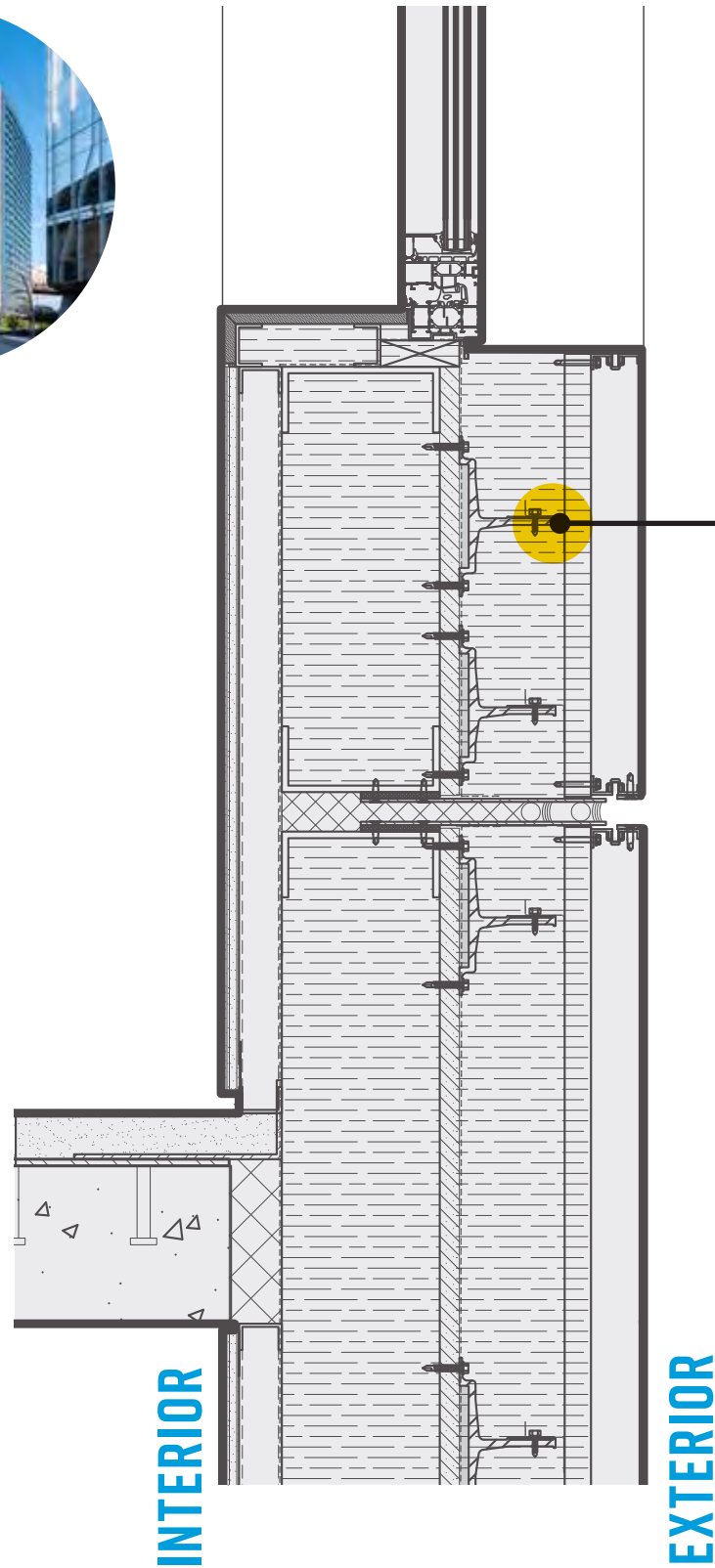


Rainscreen Metal Cladding System



Face Brick, Jumbo Norman

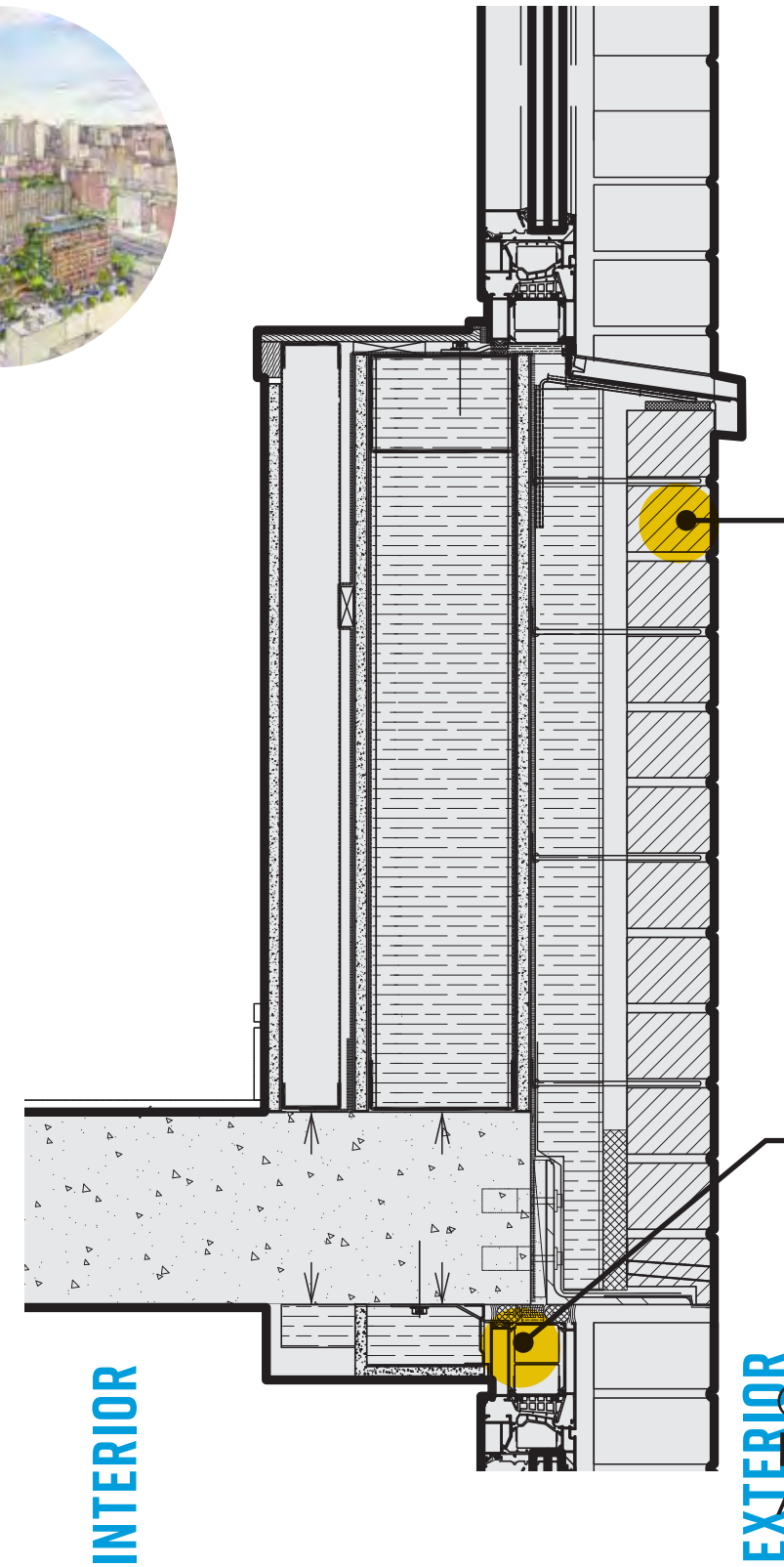
# Exterior Wall Section Comparison



## Thermally Broken Support Clip

Thermal clip assembly with thermal studs/isolators.

Improves performance by 60 - 90%.



## Galvanized Steel Brick Tie

## Armatherm Thermal Break Pad

@ Connections w/Spray Foam @ Typical 6x6 Angle

INTERIOR

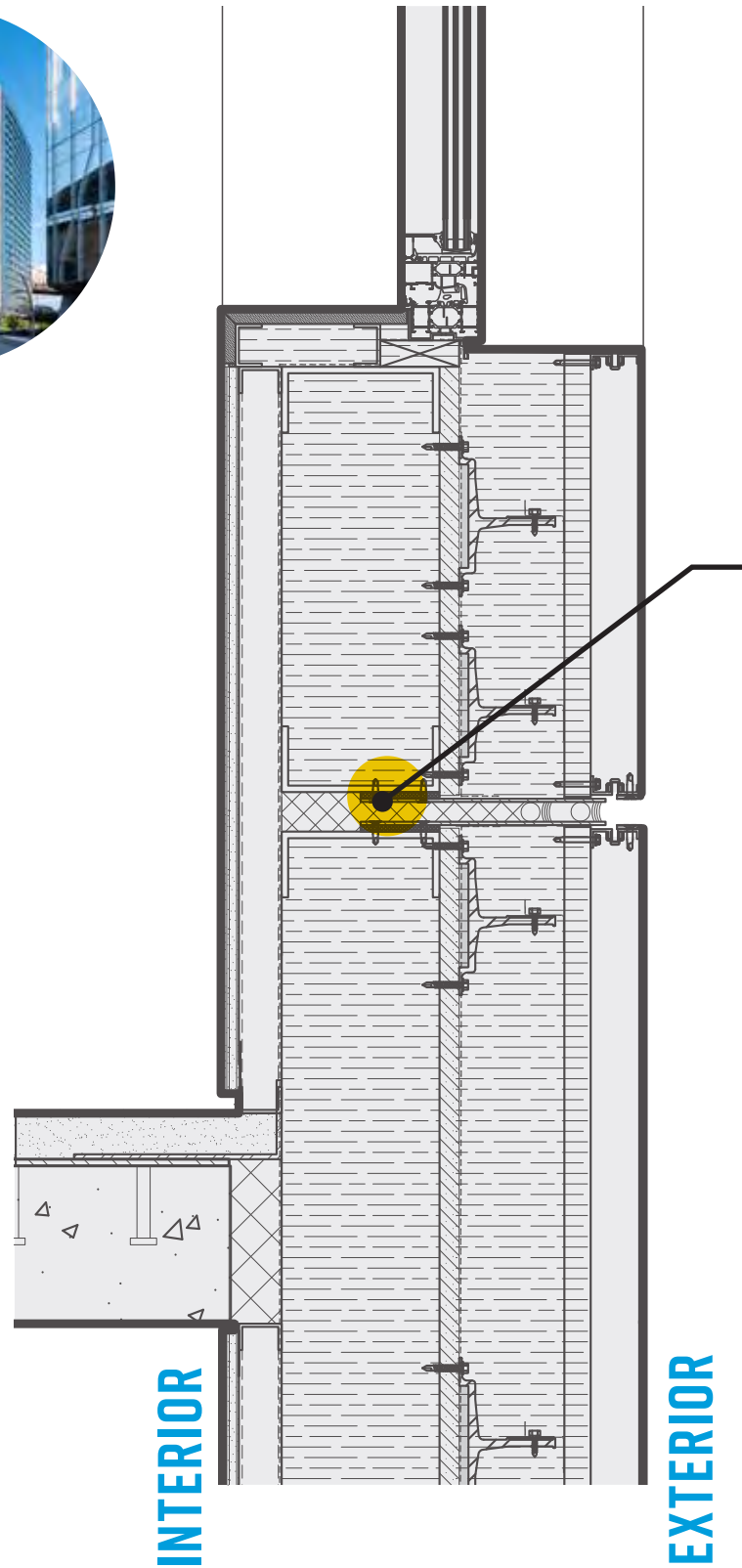
EXTERIOR

INTERIOR

EXTERIOR

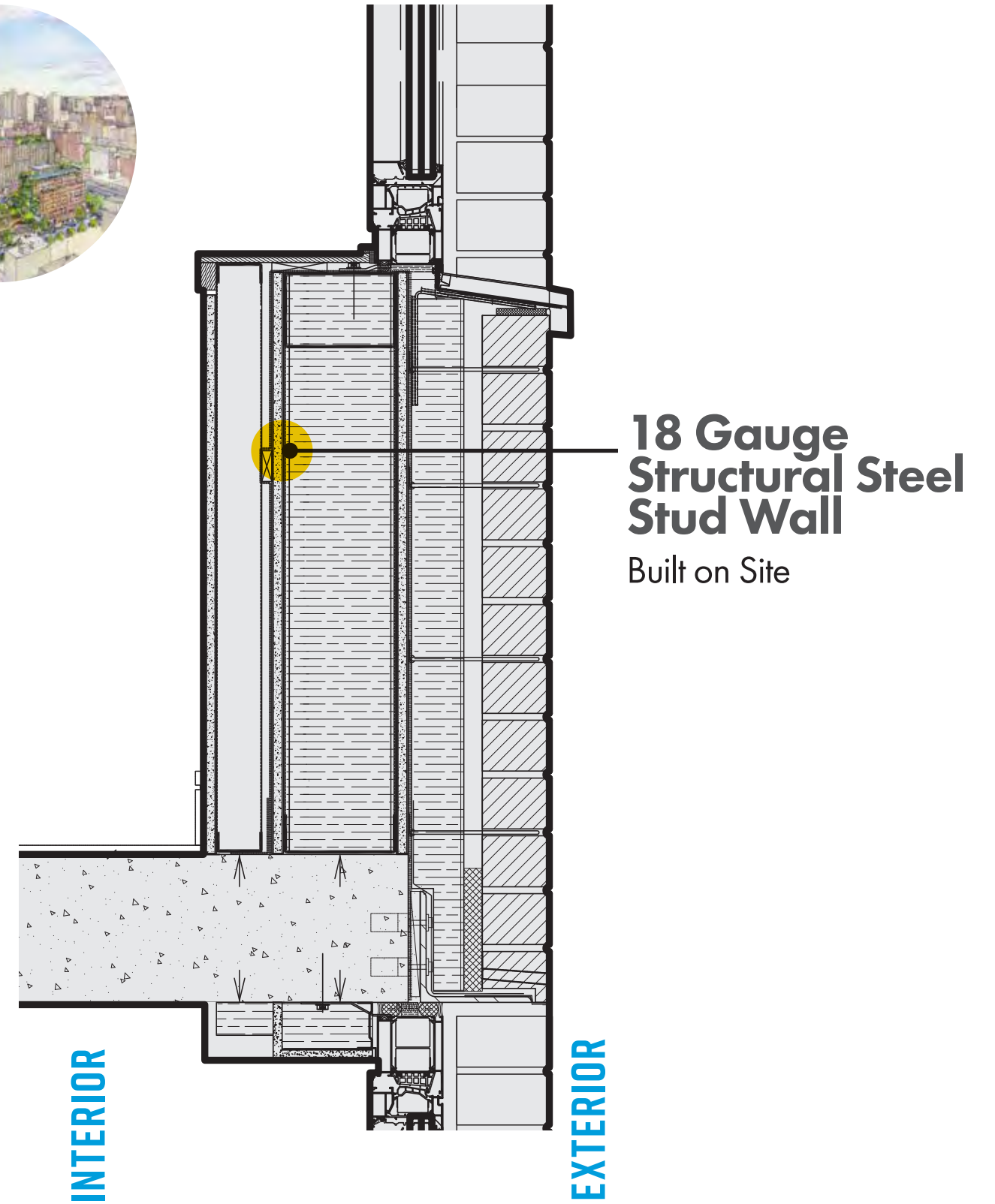


# Exterior Wall Section Comparison



**6" Structural Steel Stud**

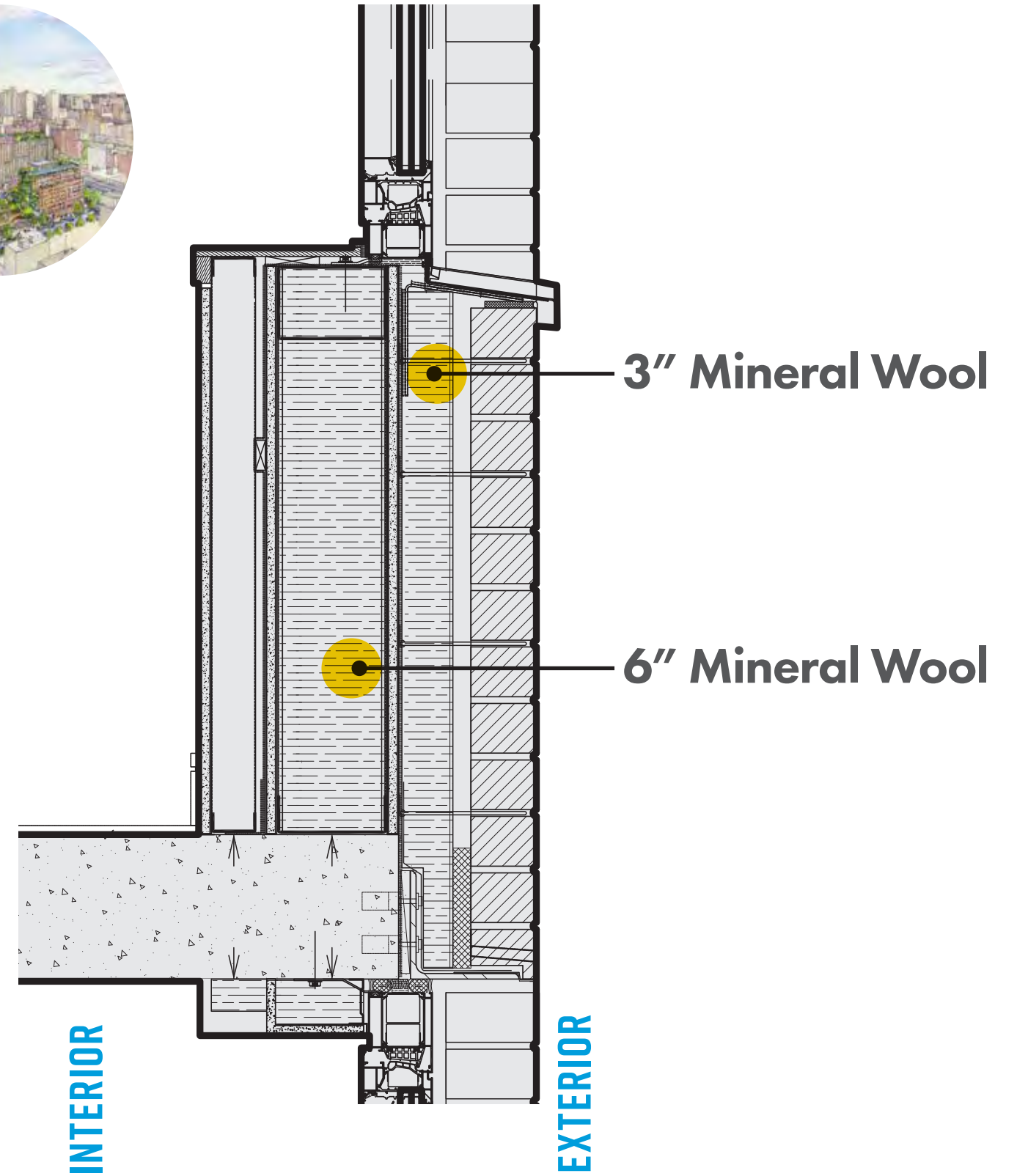
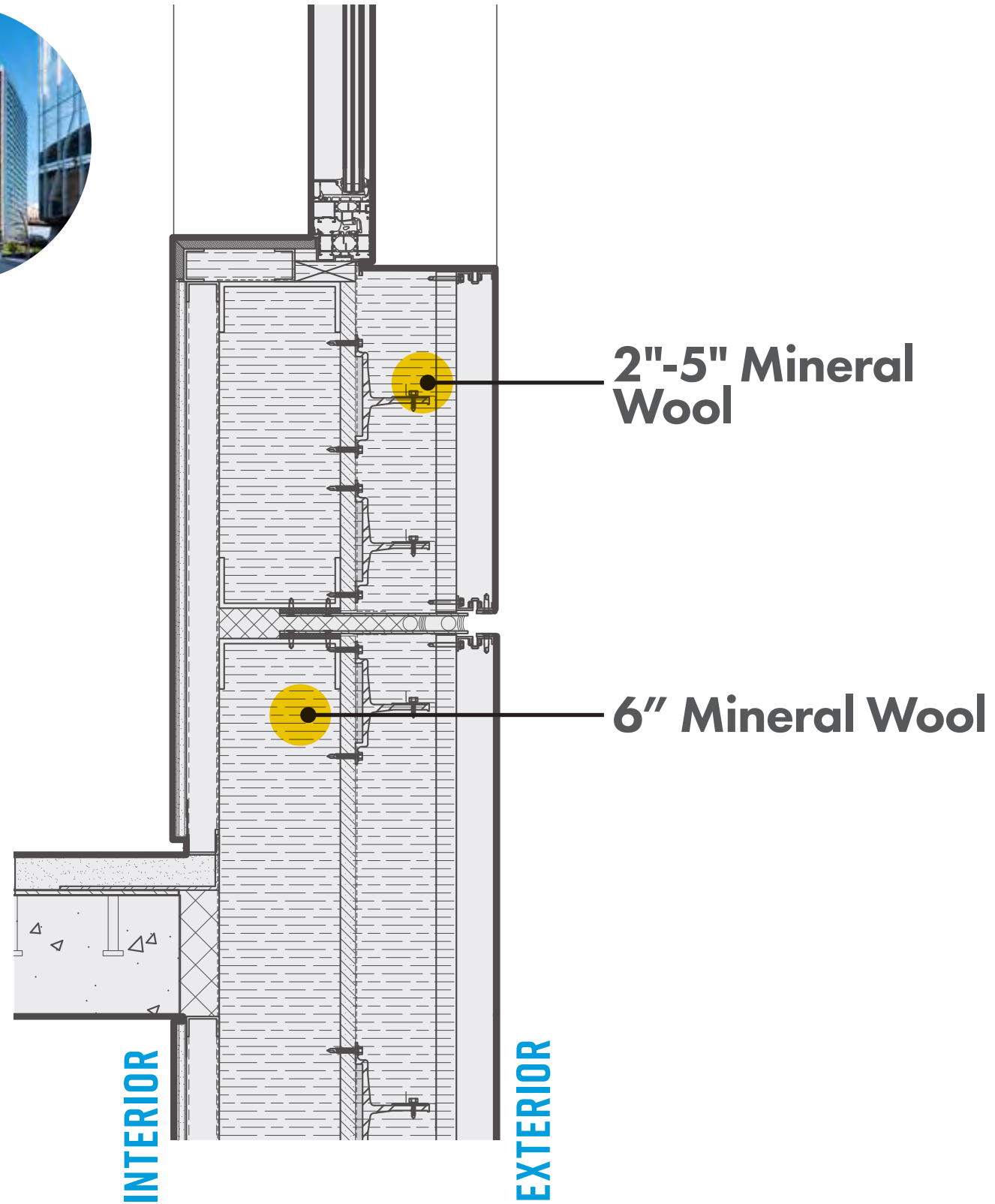
Panelized Built in Shop,  
Set on Anchors



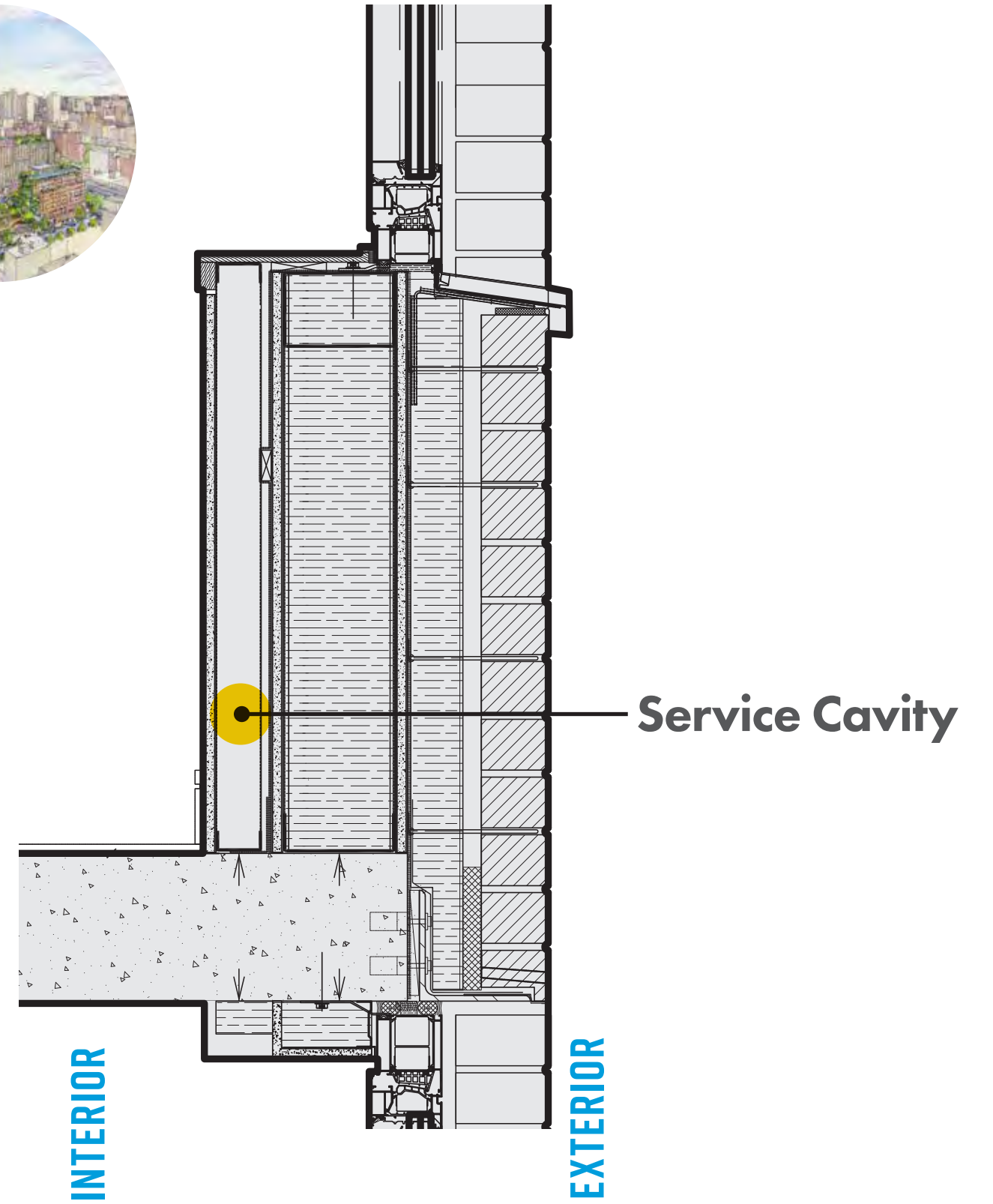
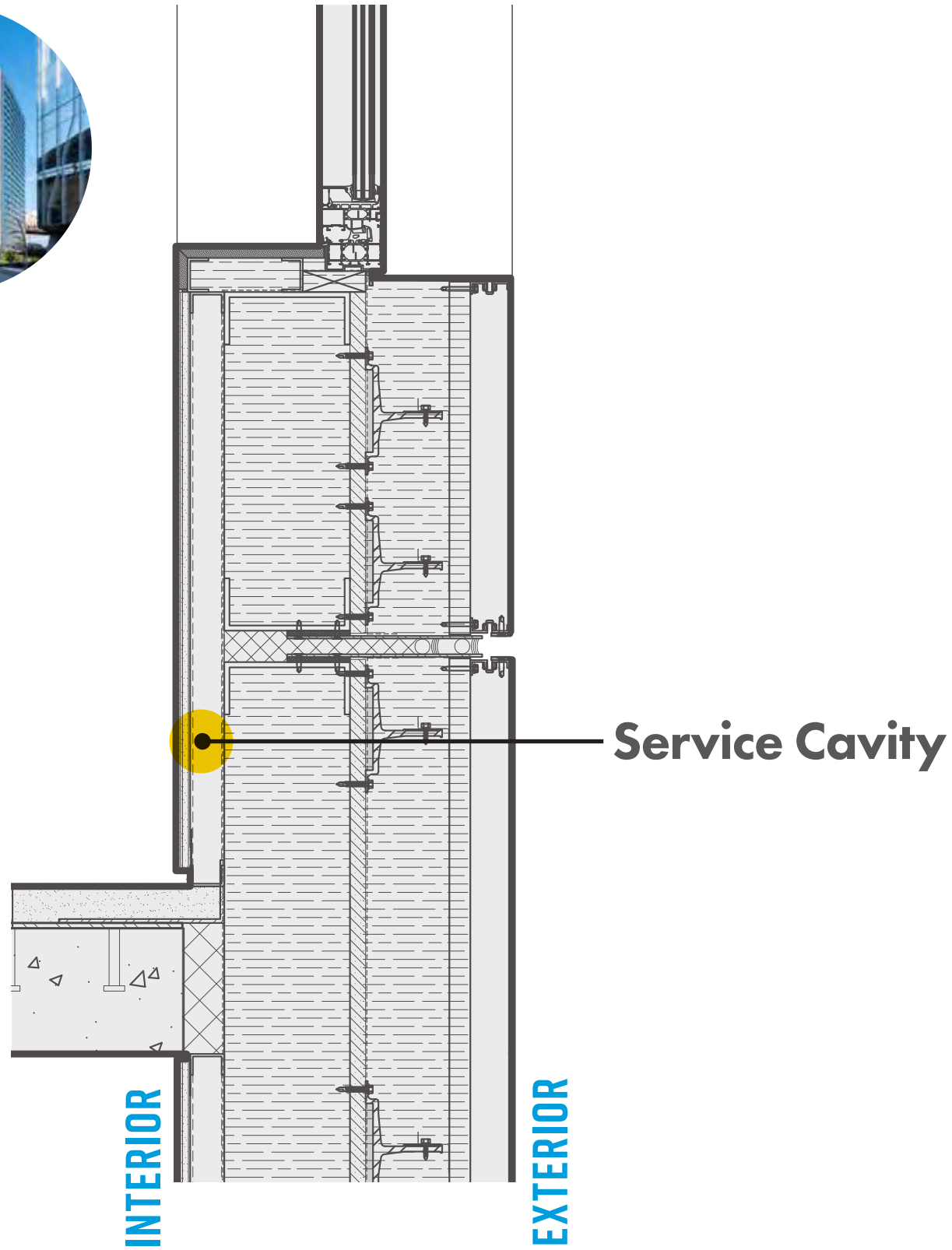
**18 Gauge Structural Steel Stud Wall**

Built on Site

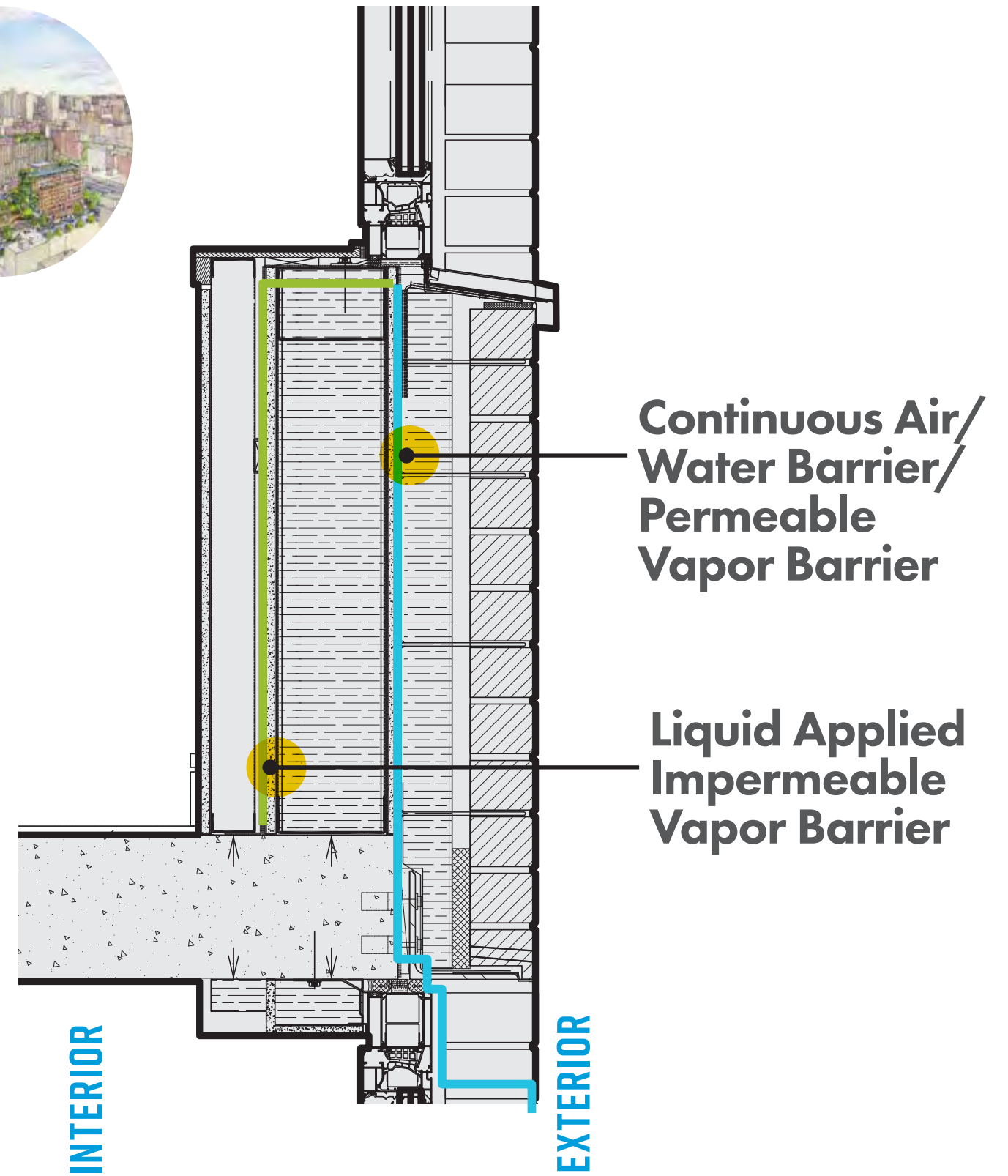
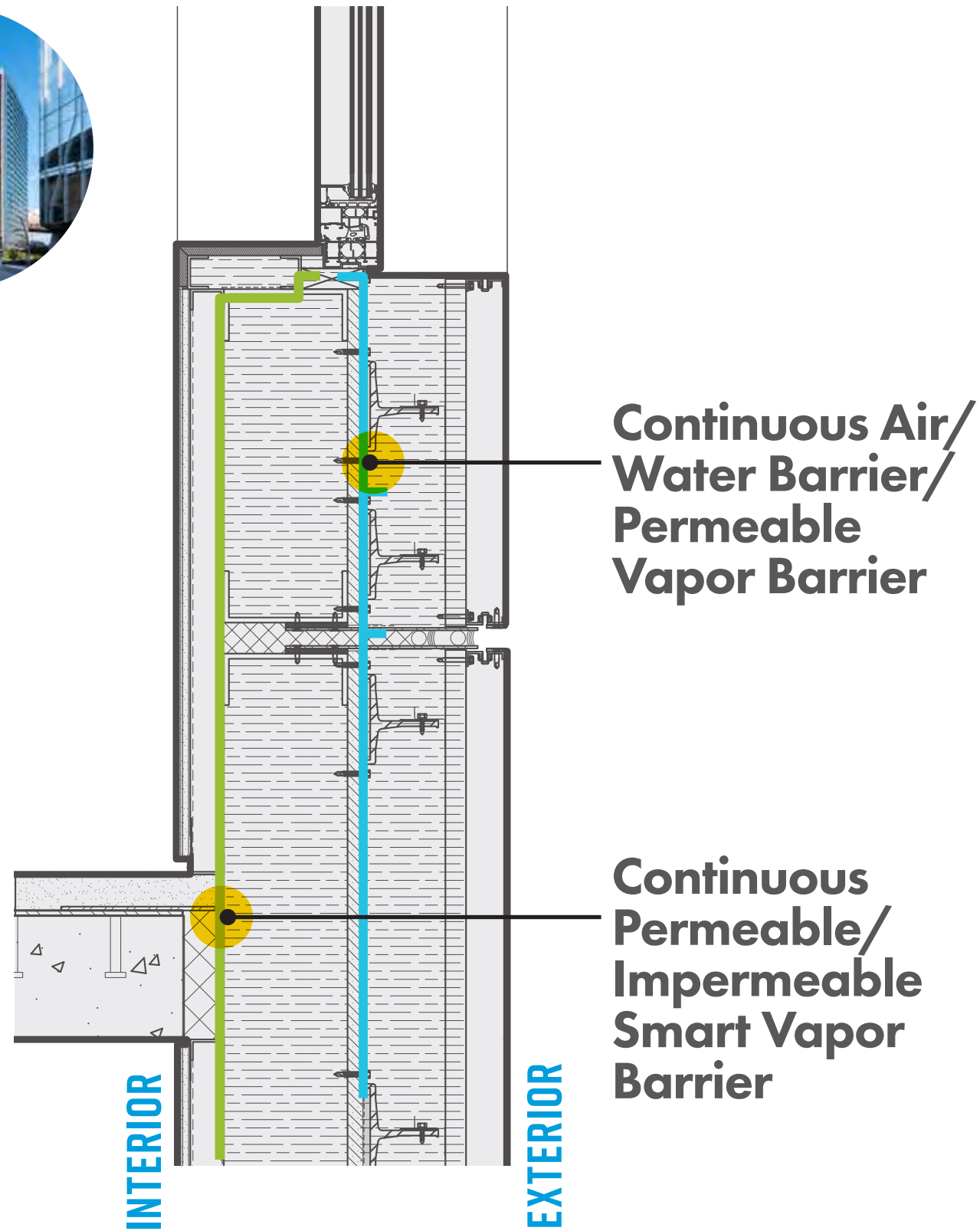
# Exterior Wall Section Comparison



# Exterior Wall Section Comparison



# Exterior Wall Section Comparison



# Prefab Metal Panel Wall Specification

## b. Air/Water Performance

- 1). Air Infiltration – Fixed Wall: 0.06 CFM/SF of wall area at 6.24 psf per ASTM E283,  
Operable Vents and Terrace Doors: 0.10 CFM/SF of crack at 6.24 psf per ASTM E283

Continuous Air and vapor barriers shall be provided.

- 2). Water Infiltration – No water infiltration shall occur under a differential static pressure of 12 lb/ft<sup>2</sup> after 15 minutes of exposure in accordance with ASTM E 331.

## c. Thermal Performance:

- 1). Thermal component of joint movement shall be based on minimum material temperature increase of 200 degrees F and decrease of 180 degrees F relative to nominal condition. Assume entire cross section has uniform temperature. Components including adhesives and sealant shall be capable of withstanding, without failure, design temperatures with simultaneous specified loads. For thermal design other than joint movement, design winter surface temperature is -20 degrees F. Design summer surface temperature shall be at least 180 degrees F. All components including adhesives and sealants shall be capable of withstanding (and remain durable) without failure design temperatures with simultaneous specified loads.

- 2). Opaque Wall Areas: Overall **R-30/R-18** as per locations indicated on Architectural drawings. Modeling using an accepted software tool showing compliance with these thermal performance levels is required.

- 3). There shall be no interior condensation on visible surfaces or those that would wet insulation when the wall is subjected to 0° F exterior, 68° F interior (+/-2 °F), 30% interior relative humidity, 15 mph exterior wind.

Air Tightness

Thermal Performance

# Window Performance

**U-VALUE  
GLASS**

**U-VALUE  
WHOLE WINDOW**

**SHGC**  
SOLAR HEAT GAIN  
COEFFICIENT

## STANDARD WINDOW

Double-glazed  
Low-E Glass  
Argon Gas  
Metal Spacer  
Metal Frame

**0.27**

**0.45**

**0.31**

## THE HOUSE

Triple-glazed  
Low-E Glass  
Warm Edge Spacer  
Thermally Broken Metal Frame

**0.11**

**0.17**

**0.28**

## SENDERO VERDE

Triple-glazed  
Low-E Glass  
Warm Edge Spacer  
Thermally Broken Metal Frame

**0.105**

**OPERABLE: 0.149**  
**FIXED: 0.134**

**0.34-0.36**

# The House: Exterior Wall

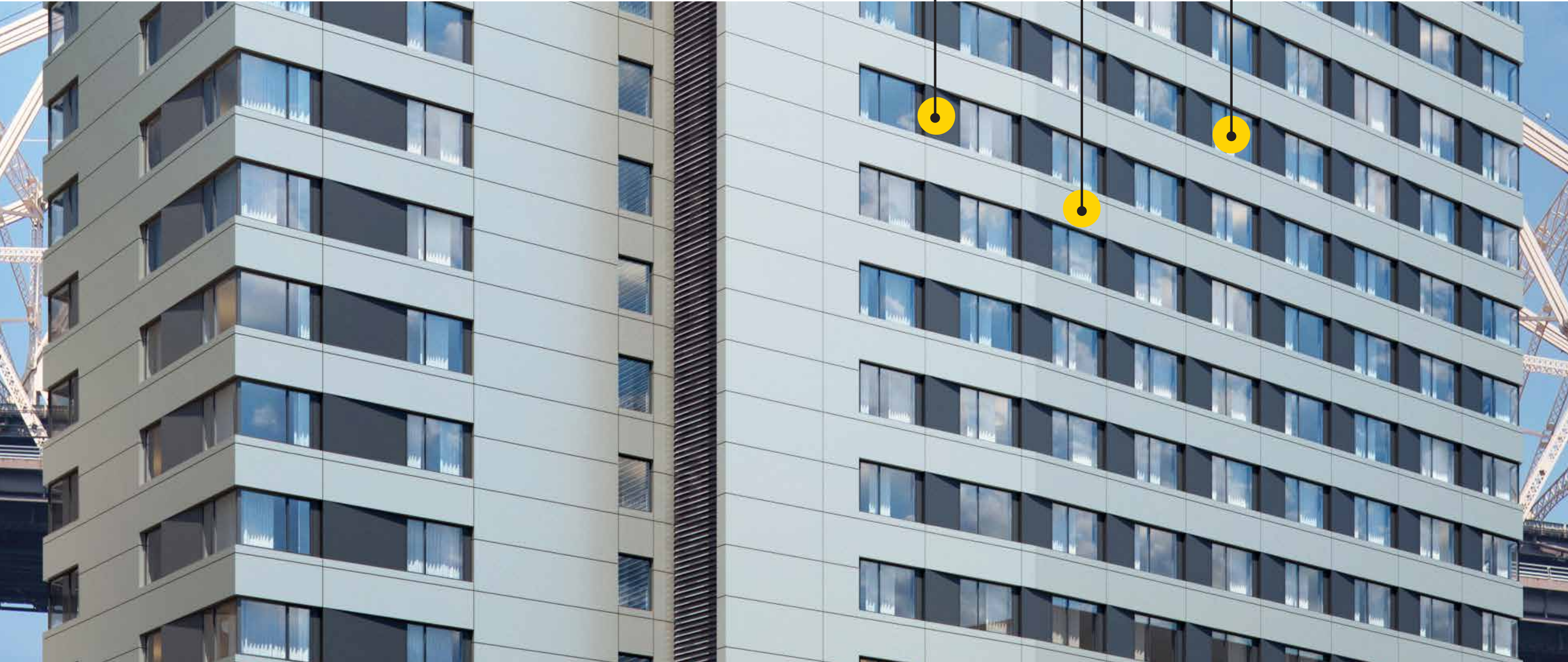
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23% Window to Wall Ratio

Angled Metal Spanrel

Rainscreen Cladding System

Triple Pane IGU's



# Windows

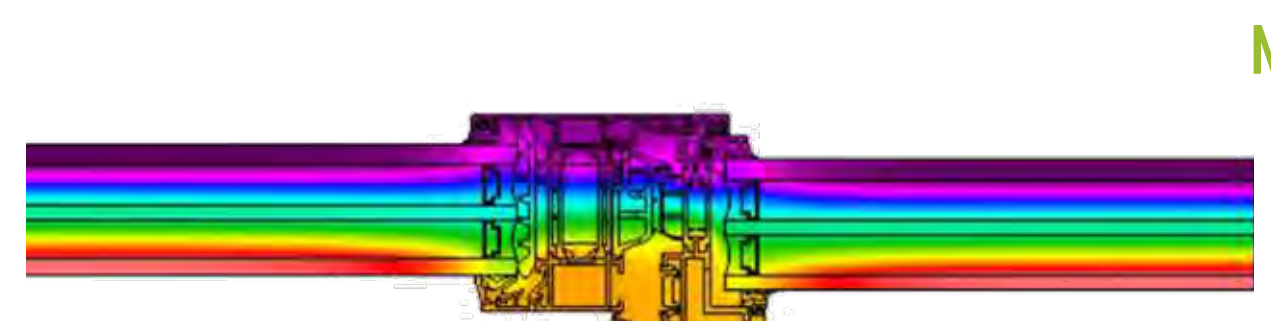
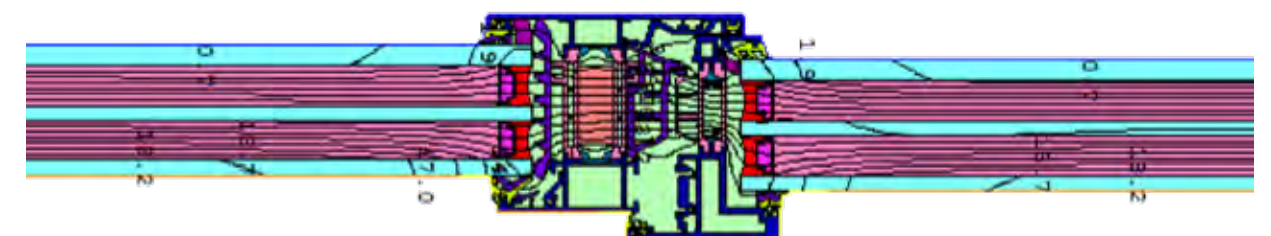
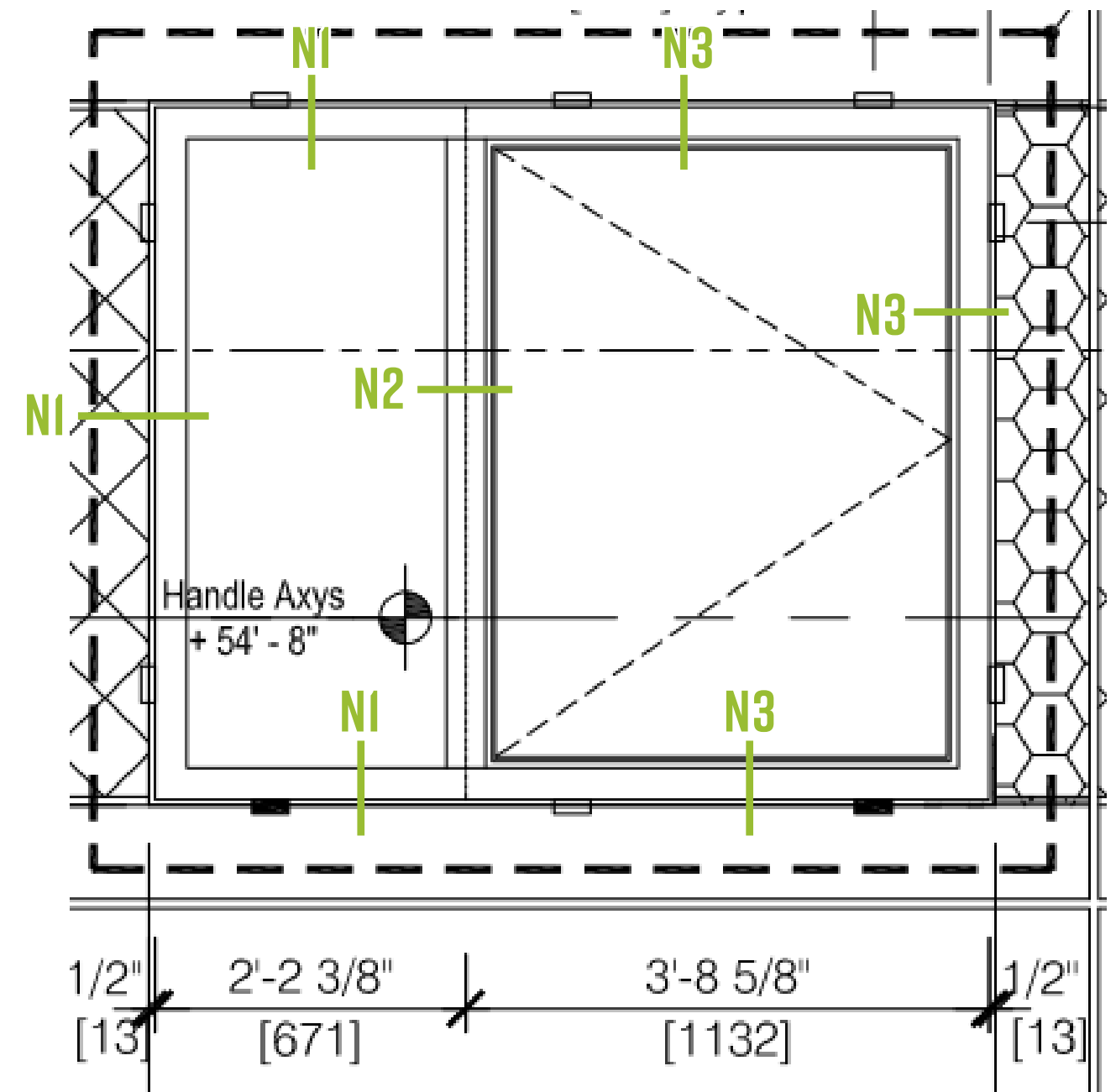
- **Testing Standards: European (EN) vs. US (NFRC)**

The centre-of-glazing U-value ( $U_g$ ), according to standard EN 673.

The frame U-value ( $U_f$ ), calculated with THERM, according EN ISO 10077-2

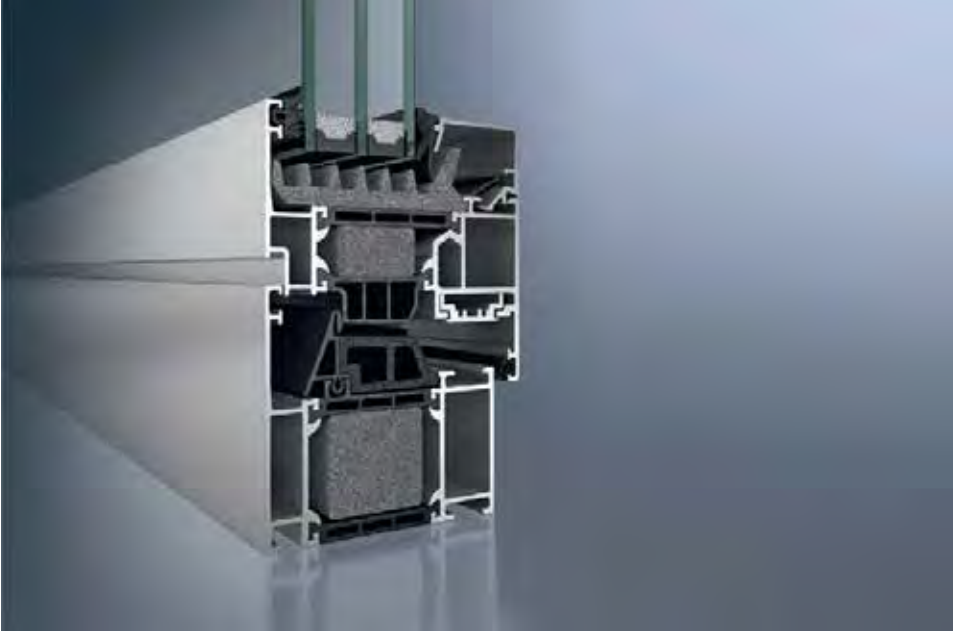
The linear thermal transmittance through the glass edge ( $\Psi$ -value)

- **Unit conversion US to Metric**
- **Condensation analysis**
- **Third party analysis**
- **Impact to specifications and bid process**





# The House: Factory Installed Windows



 Continuity of Thermal Separation

Triple glazing with warm edge spacers

Thermal break at support for metal panel wall

Insulation

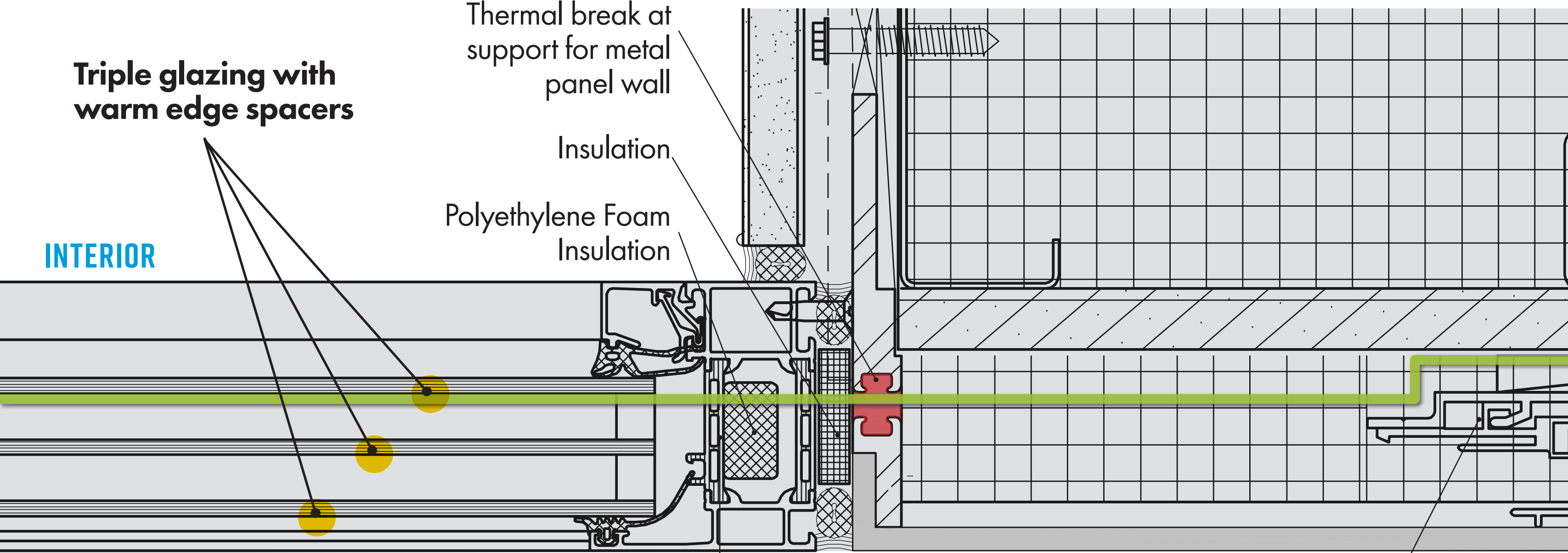
Polyethylene Foam Insulation

INTERIOR

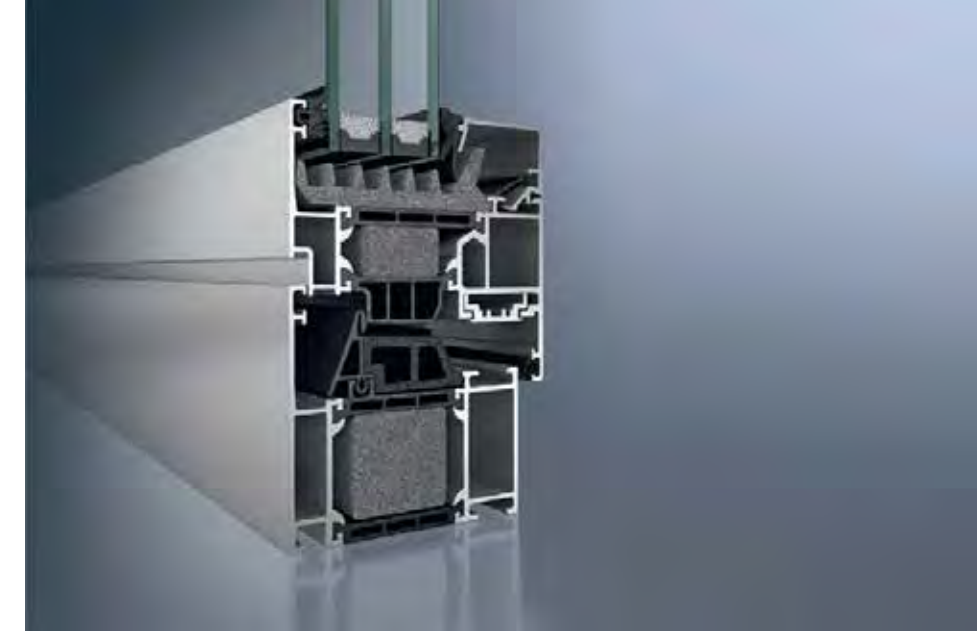
EXTERIOR

Polythermid thermal break

Knight clip



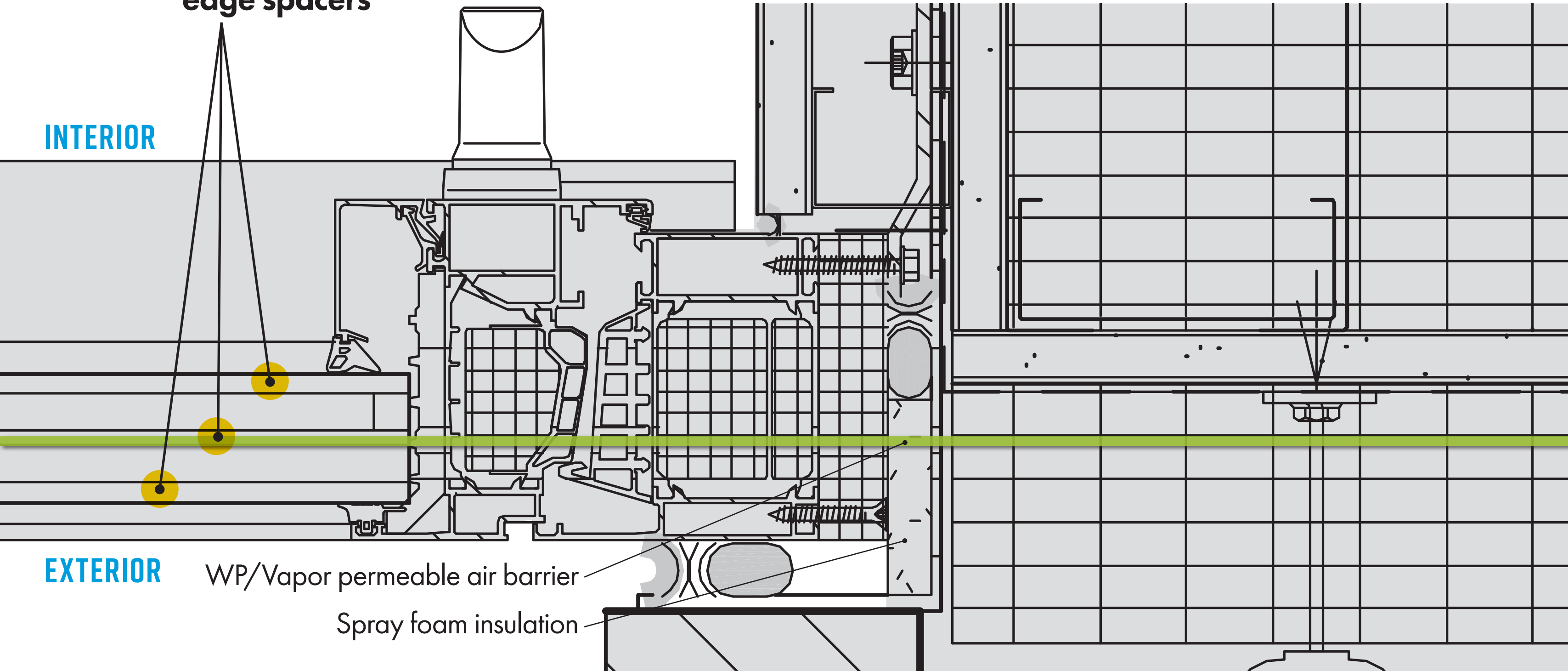
# Sendero Verde: Field Installed Windows



## Continuity of Thermal Separation

Triple glazing with warm edge spacers

INTERIOR



EXTERIOR

WP/Vapor permeable air barrier

Spray foam insulation

# The House: Theory vs. Practice

