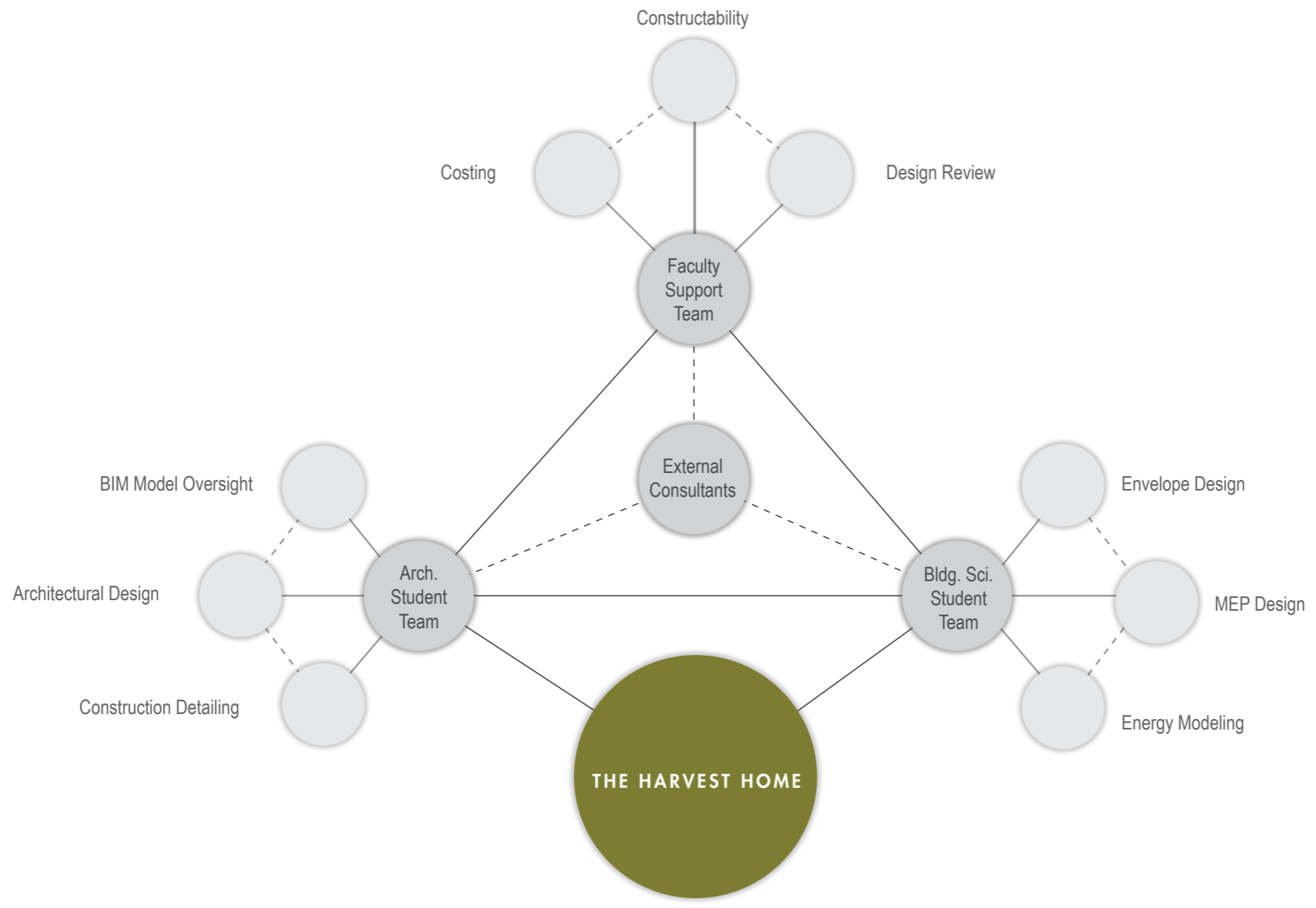




# THE HARVEST HOME

U.S. DEPARTMENT OF ENERGY  
CHALLENGE HOME STUDENT DESIGN COMPETITION

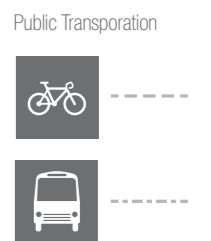




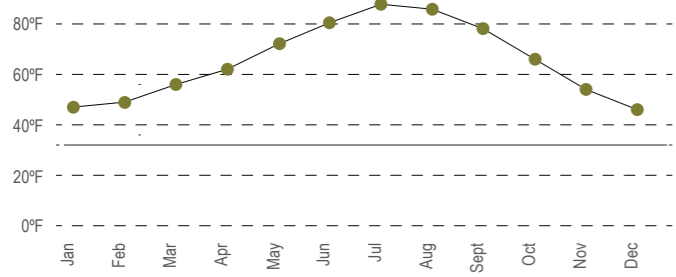
Aerial View to South West



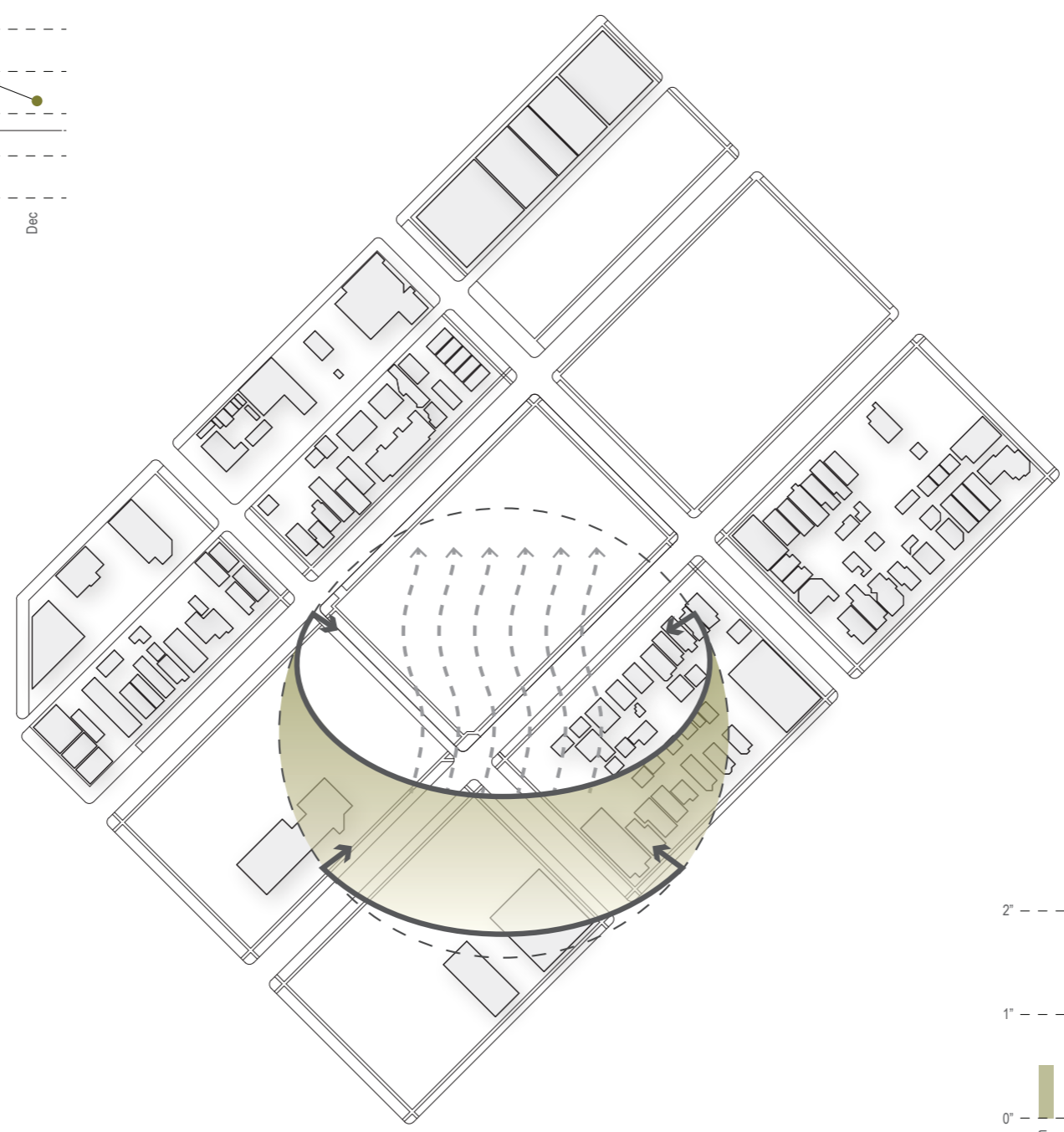
- Fire Station
- Urban Garden
- Place of Worship
- Restaurant & Bar
- Educational Facilities
- Gym & Fitness Center
- Arts & Entertainment Complex
- Employment and Office Centers
- Supermarket & Convenience Store



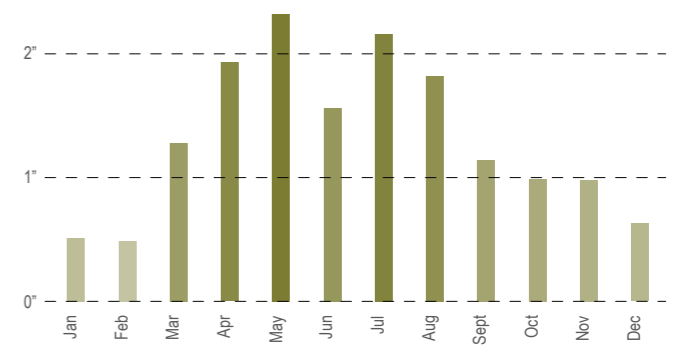
Area Plan - Existing



Monthly Average Temperature



Area Plan - Solar Orientation & Prevailing Winds



Monthly Average Precipitation



Design a **cost-effective** response allowing the average Denver family to purchase, operate and maintain a sustainable home.



Incorporate **flexible** interior and exterior spaces capable of accommodating a variety of familial scenarios.



Meet or exceed the requirements and standards outlined for certification by the **Passive House** Institute United States (PHIUS+).



Create a **net-zero ready** home with the potential of operating completely independent of municipal servicing.



Employ **traditional construction methods** coupled with readily available on-the-market materials, finishes, equipment and appliances..



Incorporate **open concept space planning** capable of hosting a variety of functions within the modest sized floor plate.



Design the **building envelope** to be air-tight and thermal bridge free throughout.



Consider the building as a **direct derivative of the natural context** allowing for rain water collection and optimal passive solar gains.



Frontage at Lawrence Street

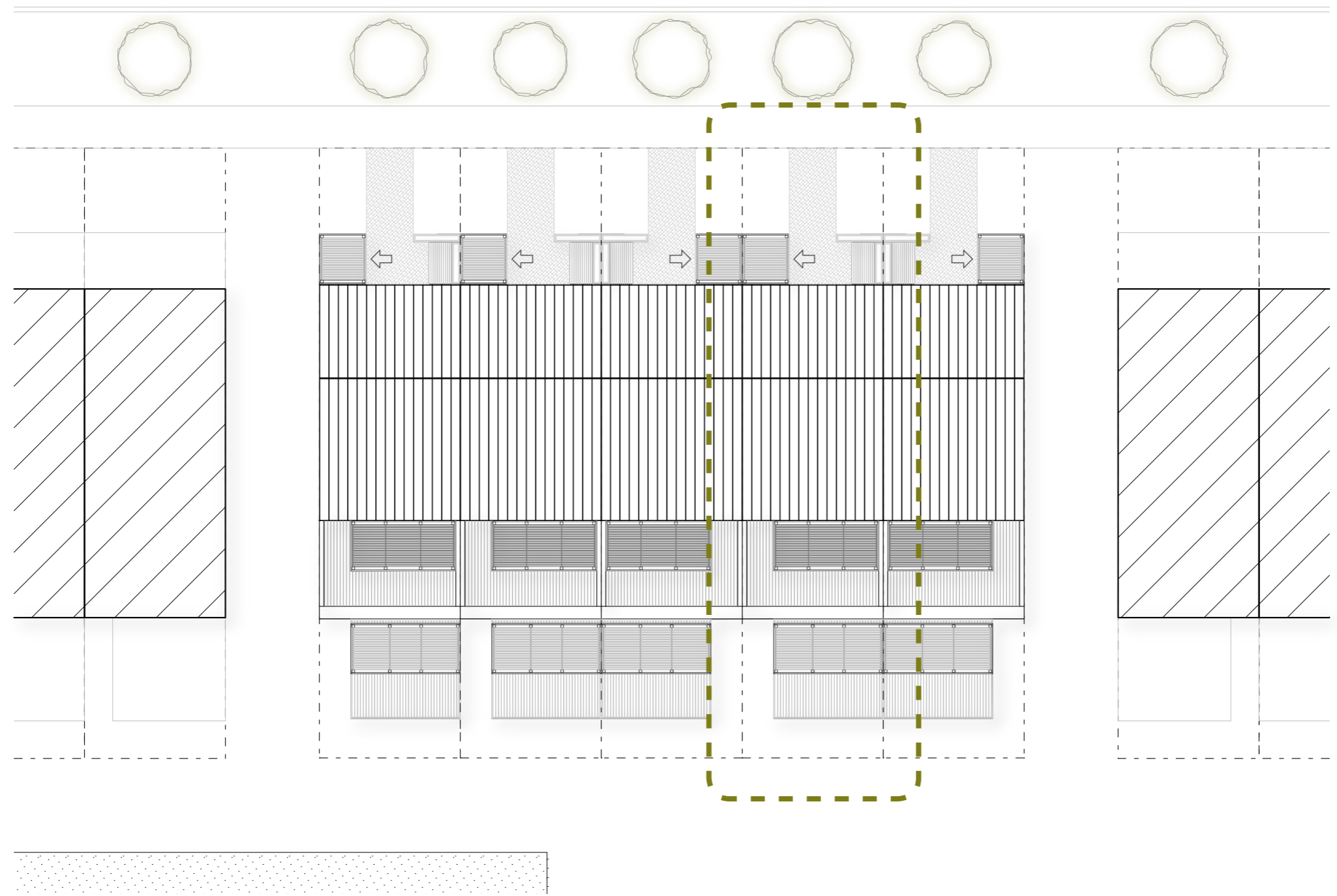




Area Plan - Proposed



# Lawrence Street

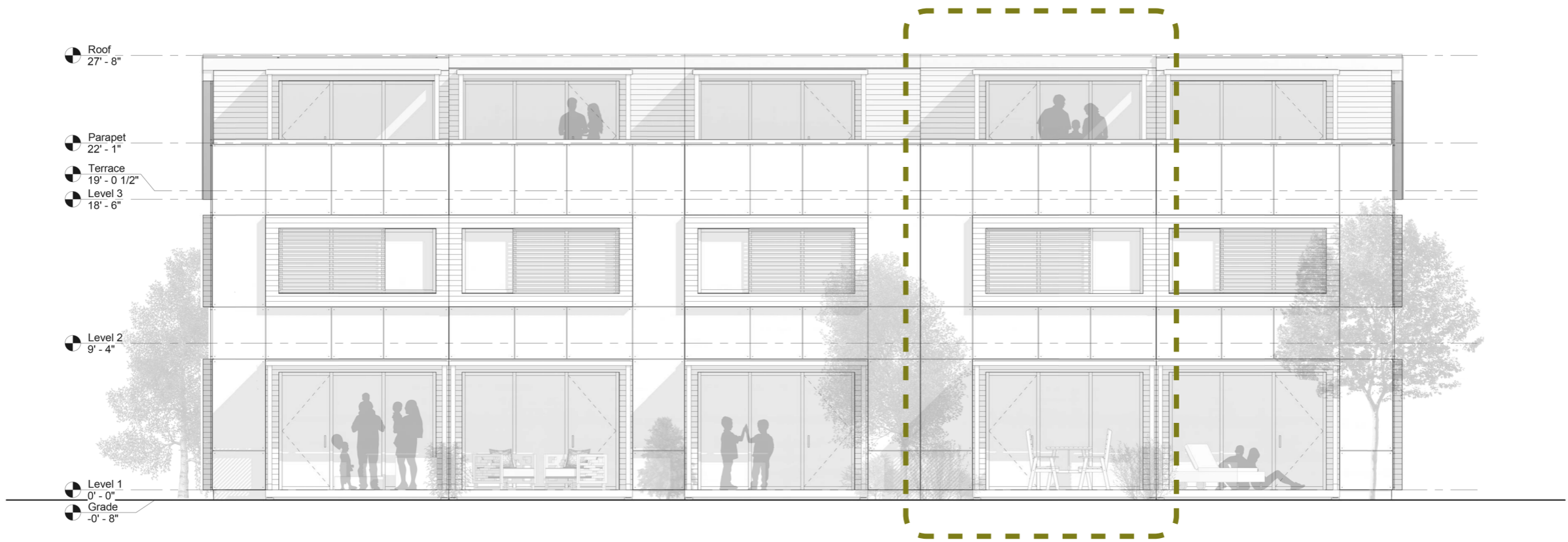


Site Plan - Proposed





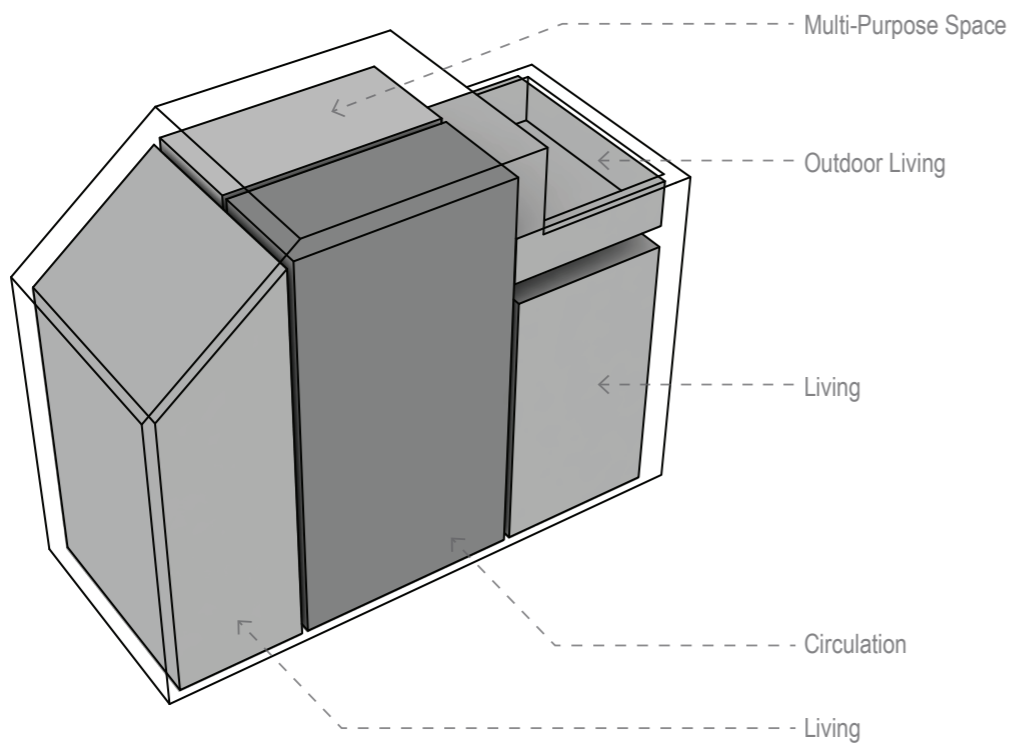
Row Elevation - North



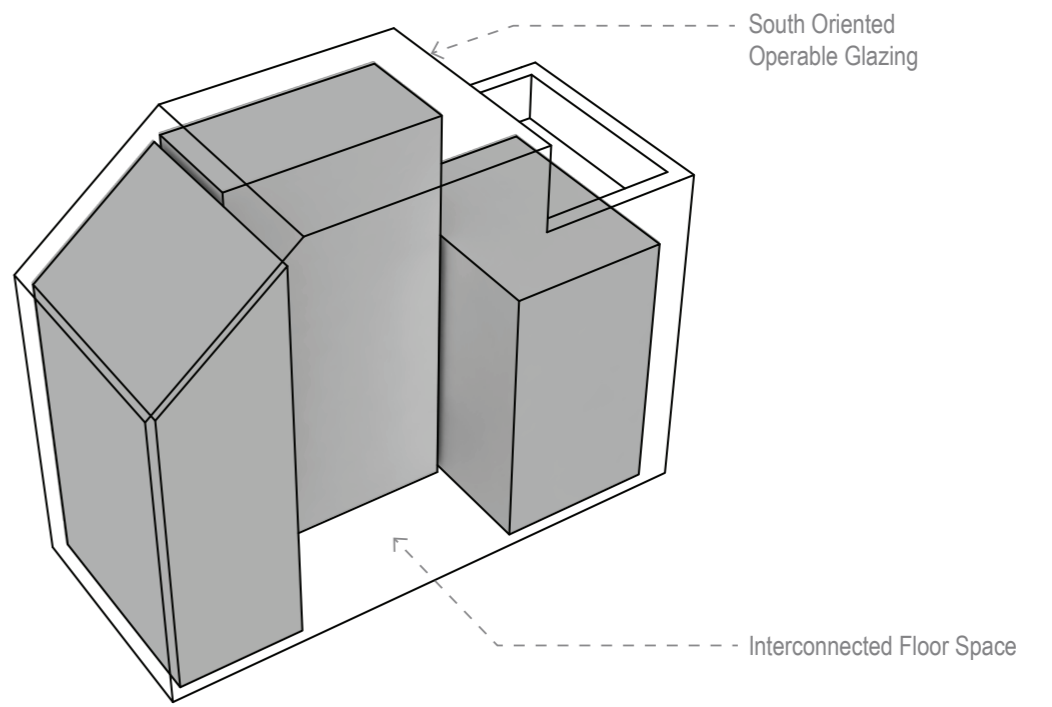
Row Elevation - South



### CONCEPTUAL MASSING

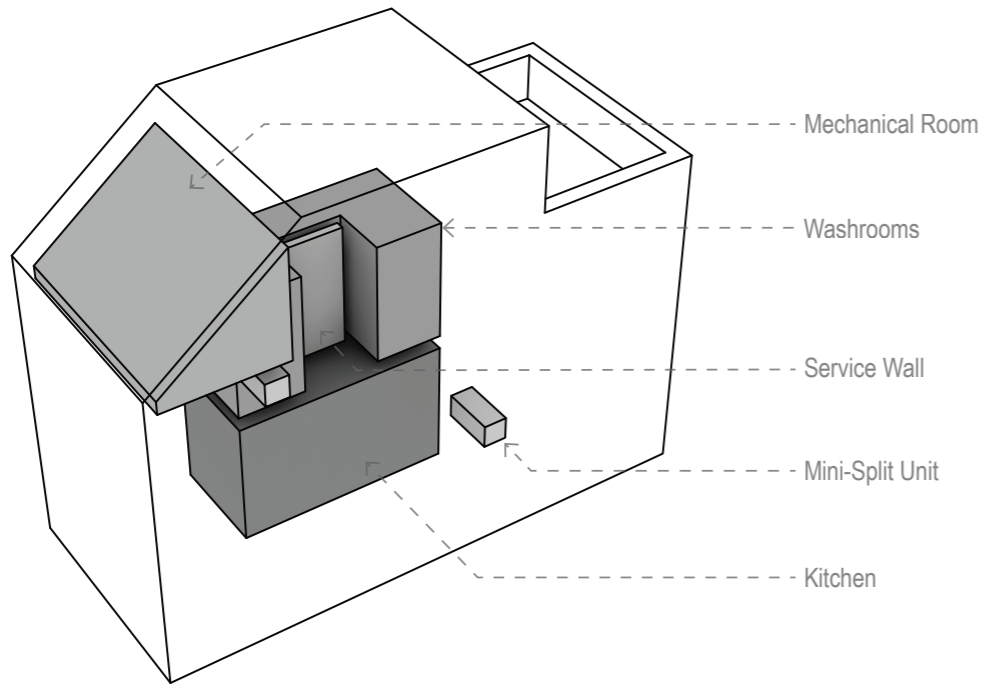


Interior Program Massing

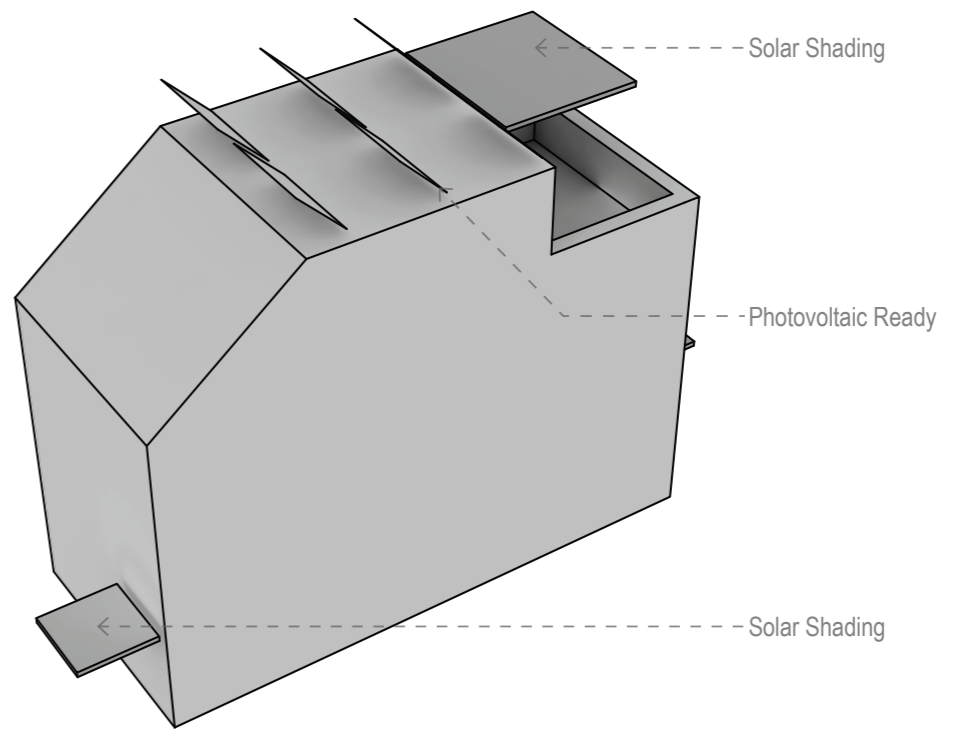


Central Stair

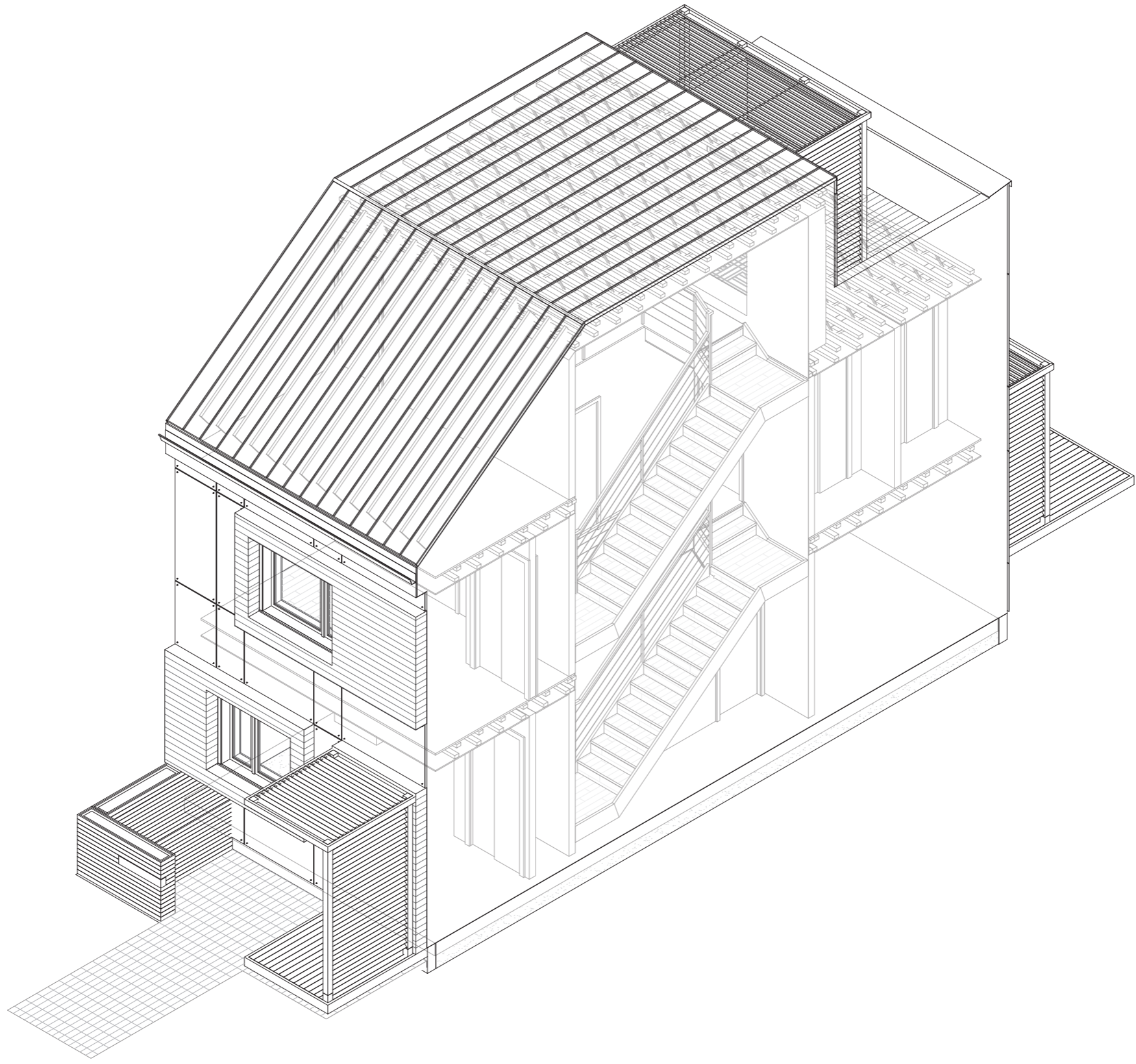
### CONCEPTUAL MASSING



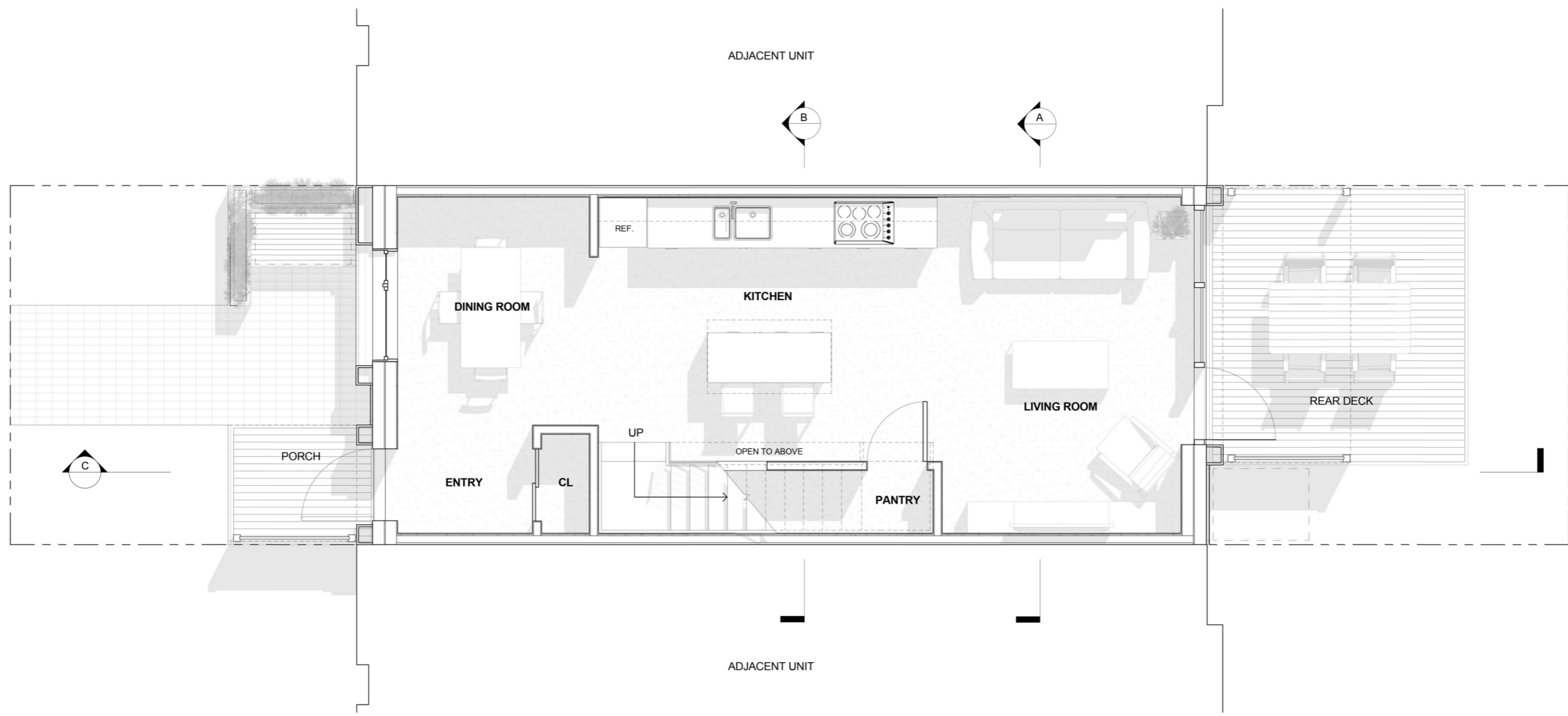
Building Services



Polar Shading & PV Orientation



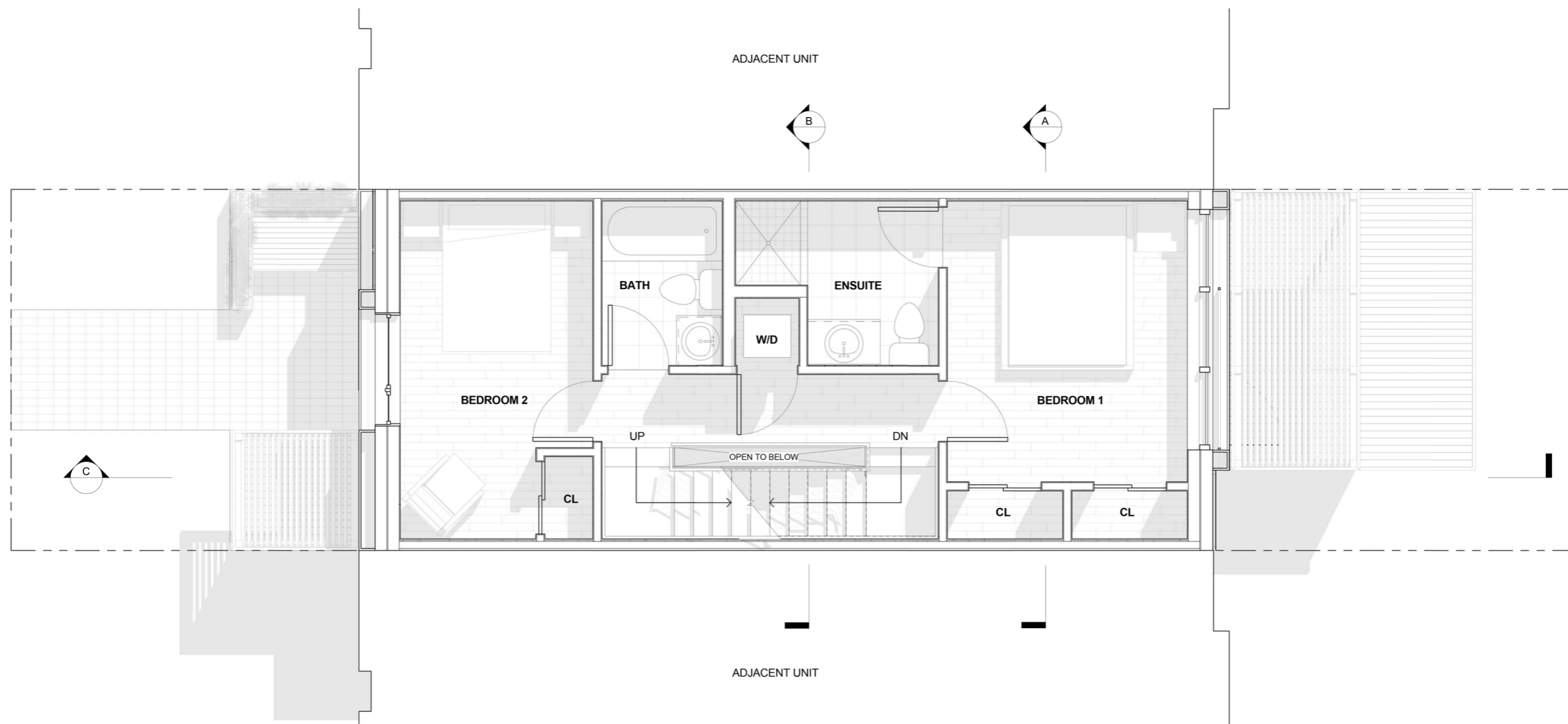
Building Axonometric



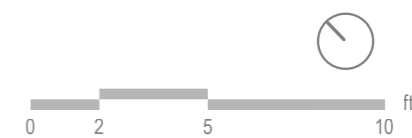
Floor Plan - Level One

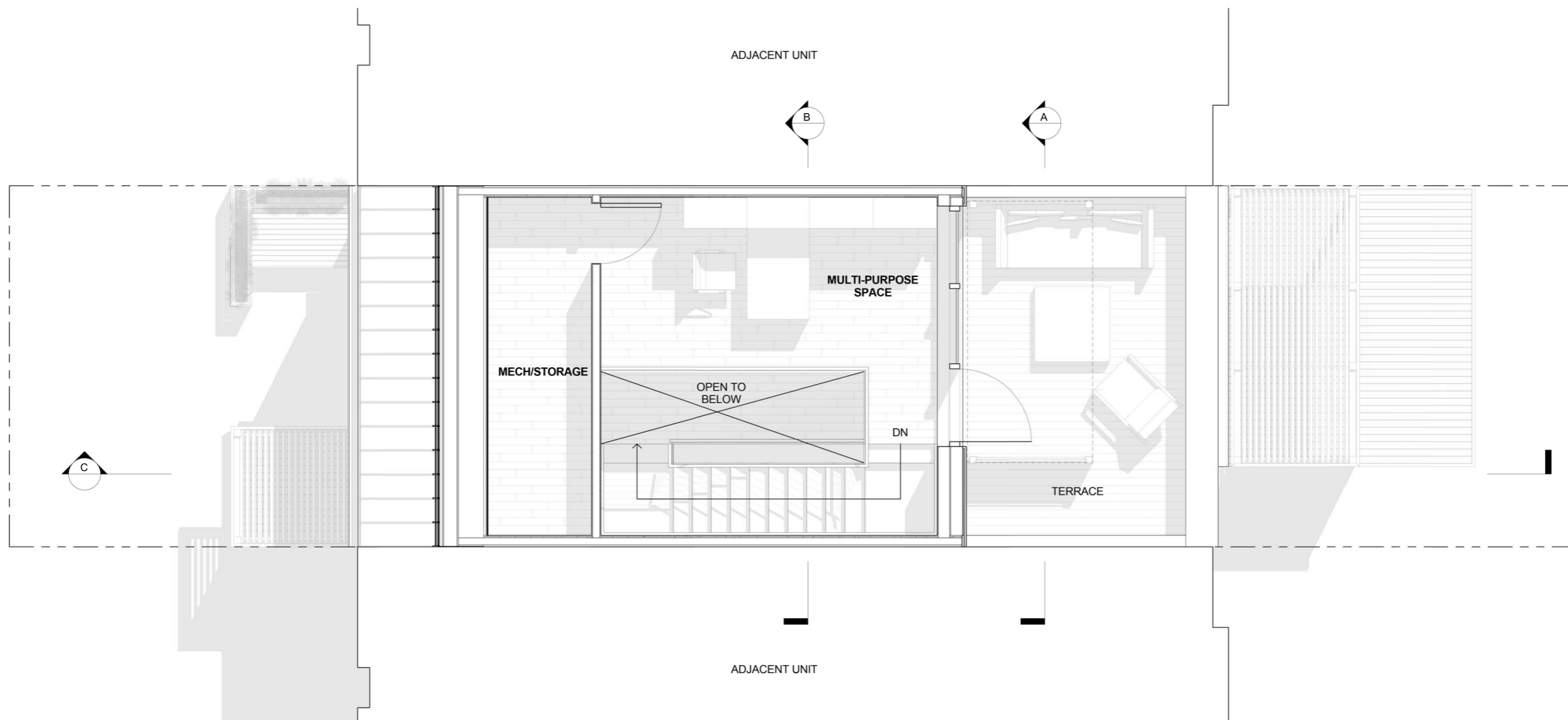






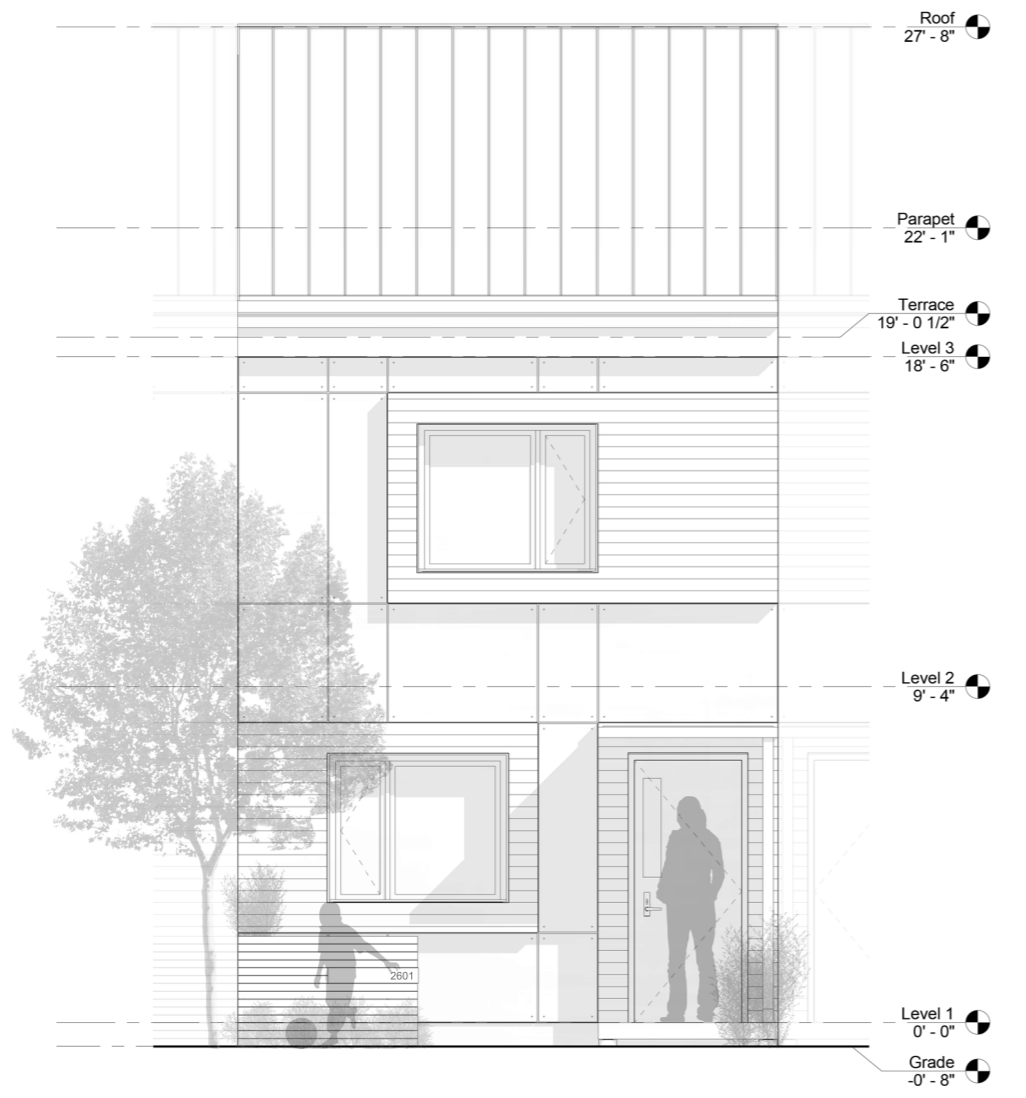
Floor Plan - Level Two



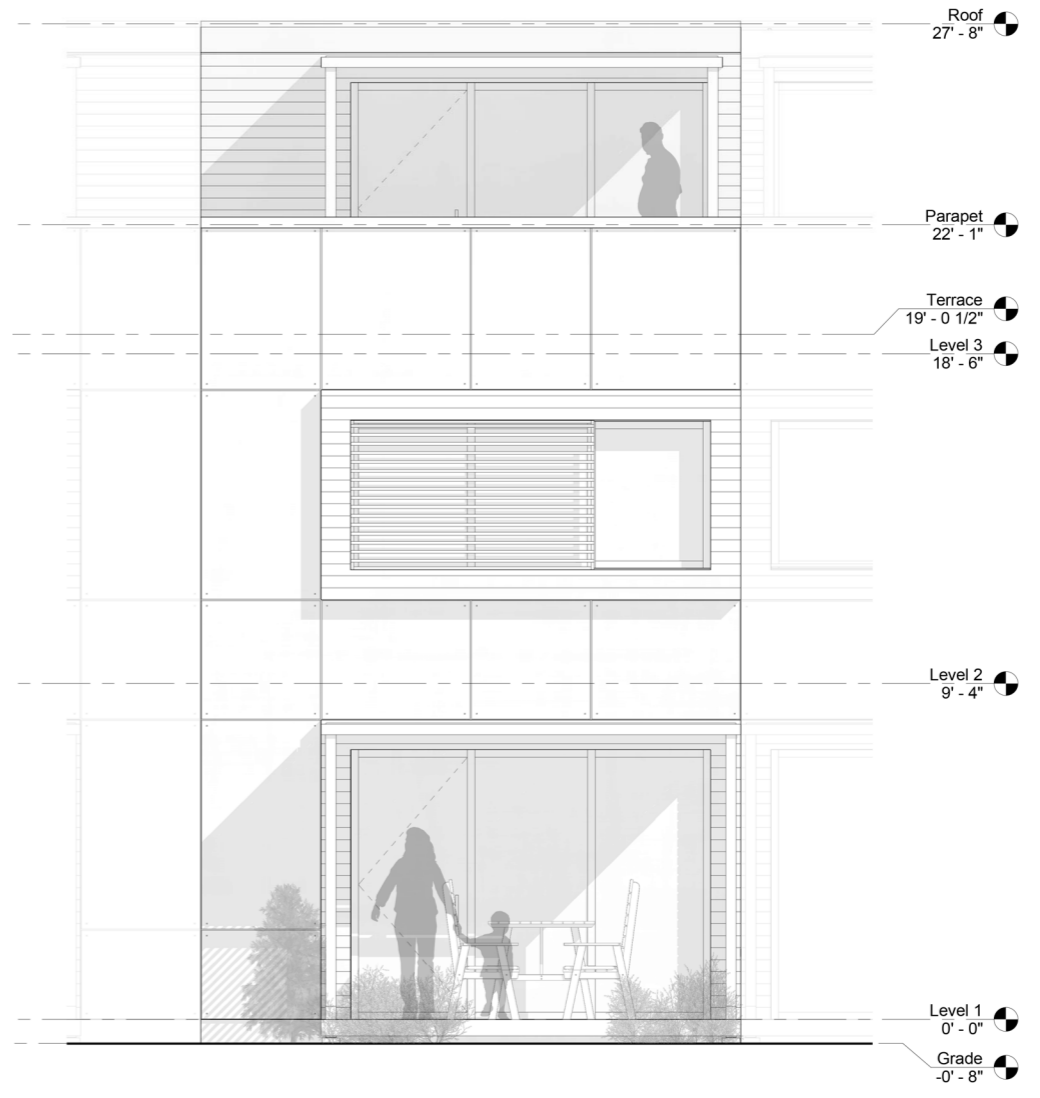


Floor Plan - Level Three



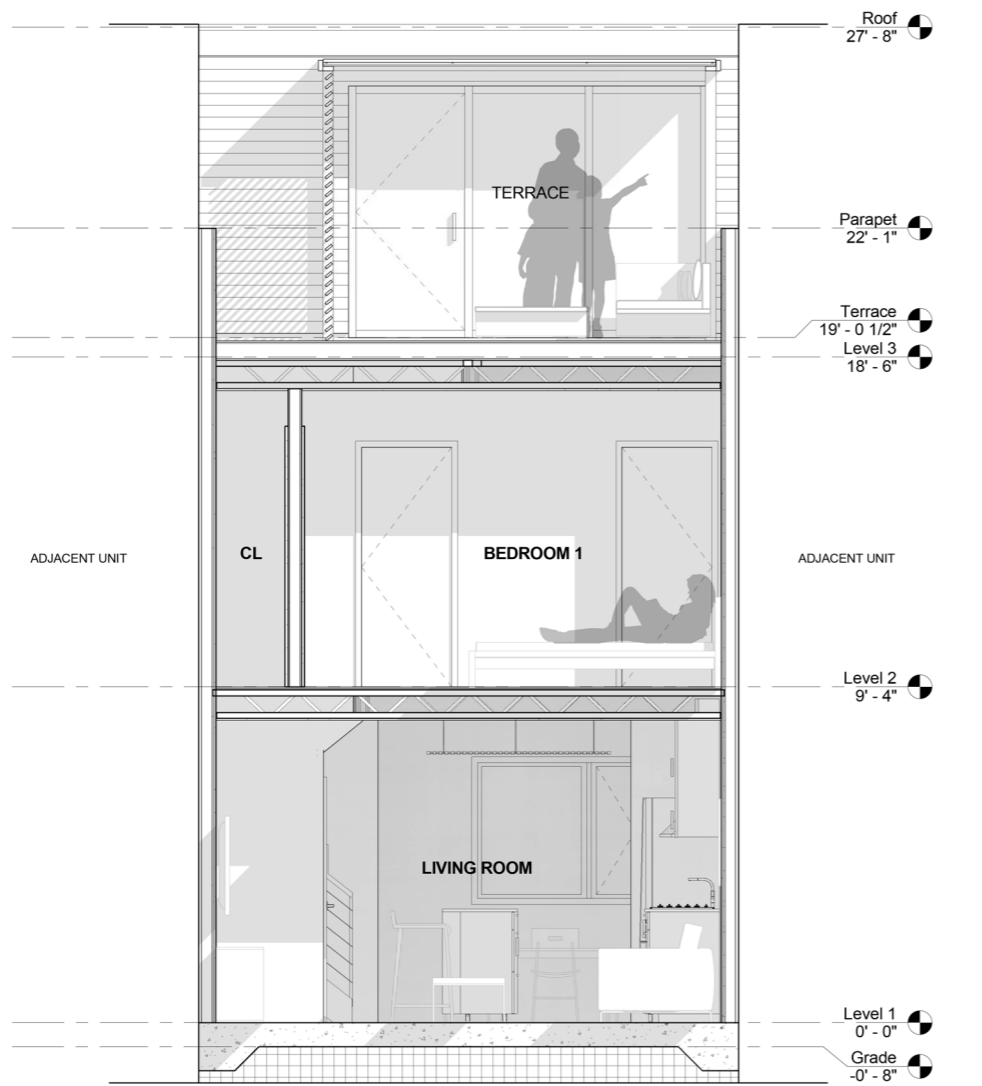


Unit Elevation - North

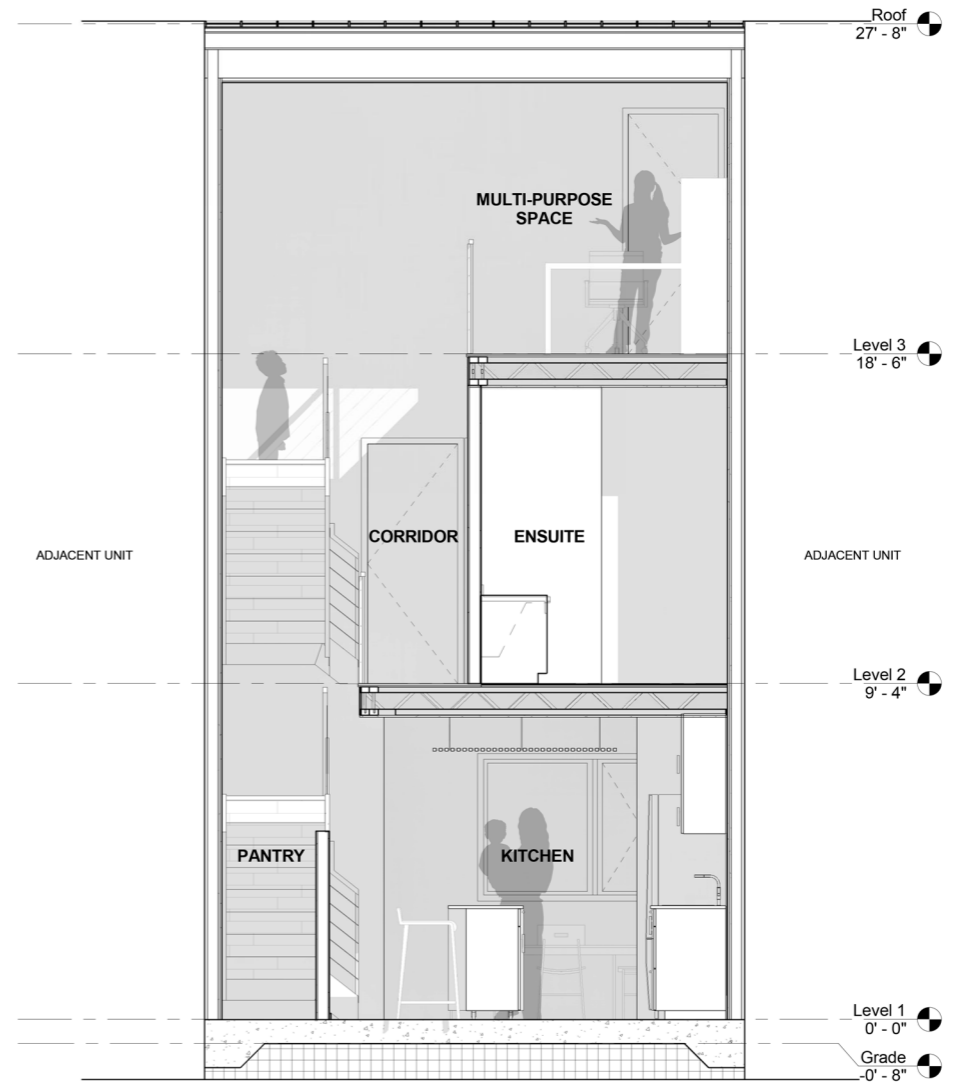


Unit Elevation - South

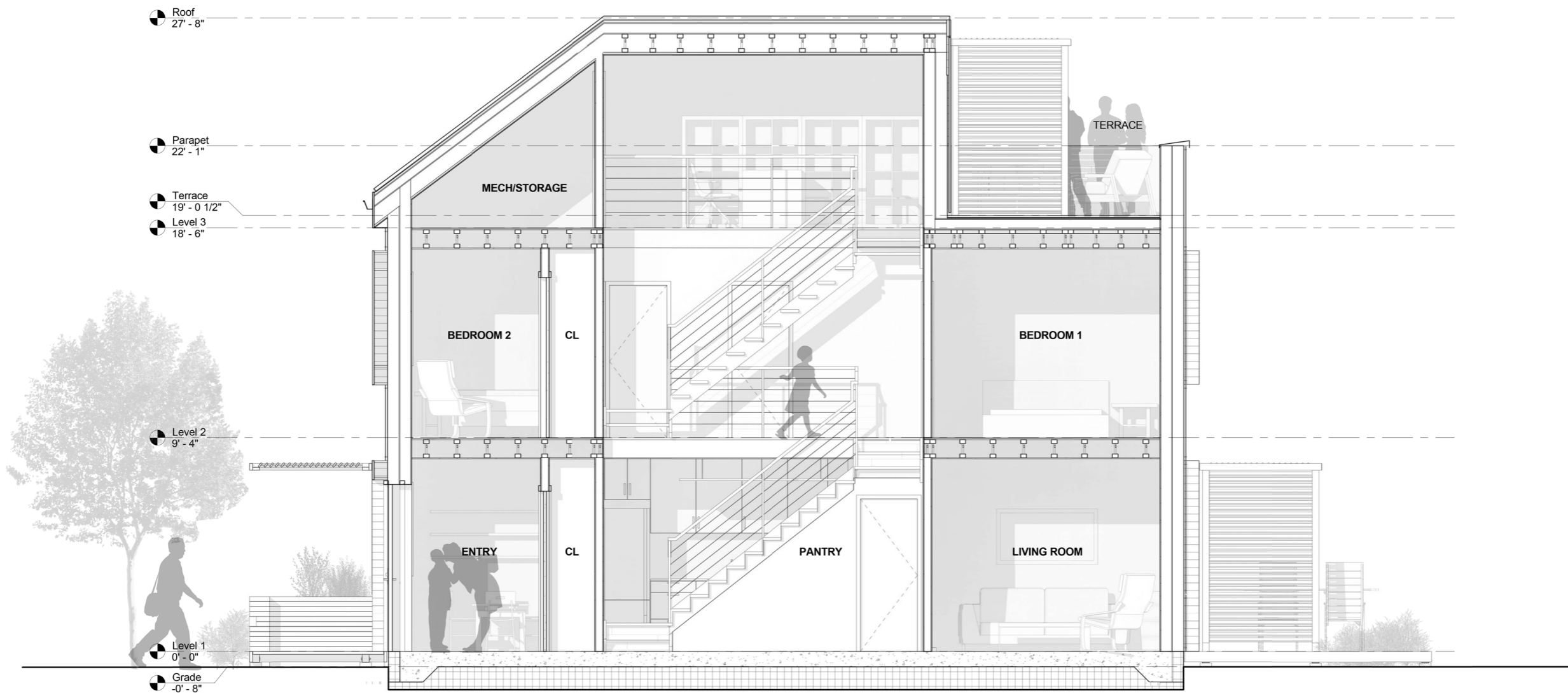




Building Section - A



Building Section - B

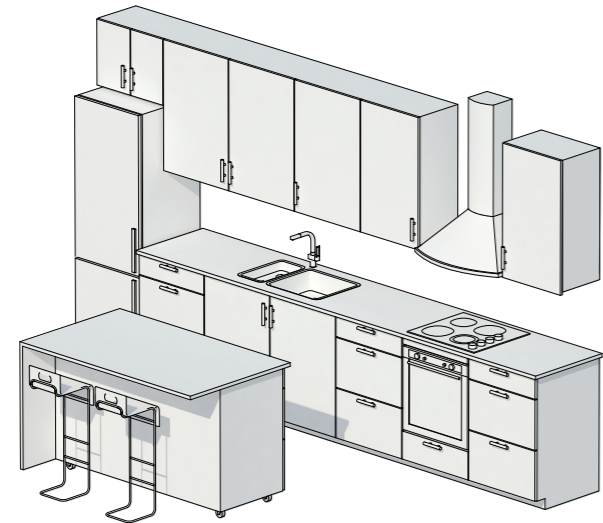


Building Section - C

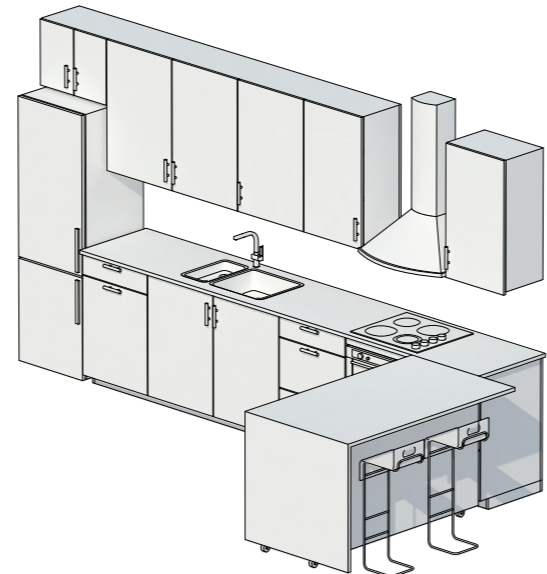




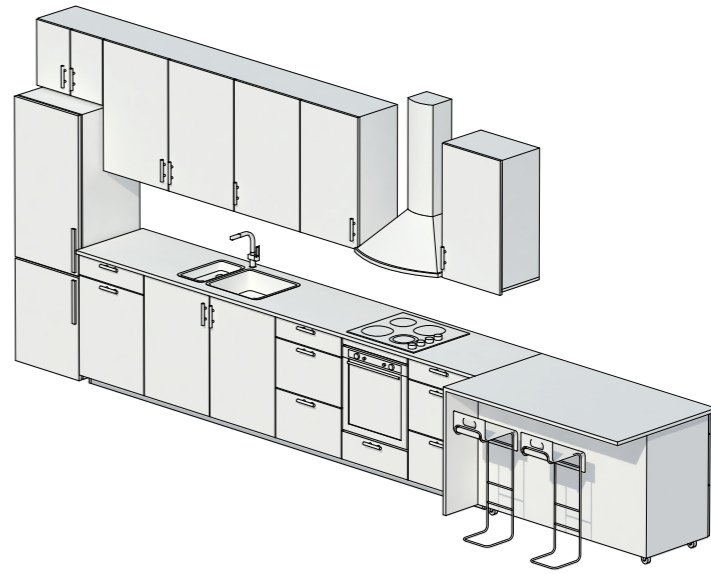
### THE FLEXIBLE WORKSPACE



Centralized Island



Peninsula Counter

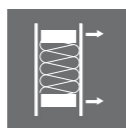


Work Surface Extension





## ENVELOPE DESIGN STRATEGIES



Eliminate **thermal bridging** across the entire envelope through external insulation.



Ensure an **air tight** envelope to limit undesired air infiltration.



Employ a **rain screen** approach to drain bulk water and ventilate envelope layers.



Control **solar gains** through optimized glazing distribution.

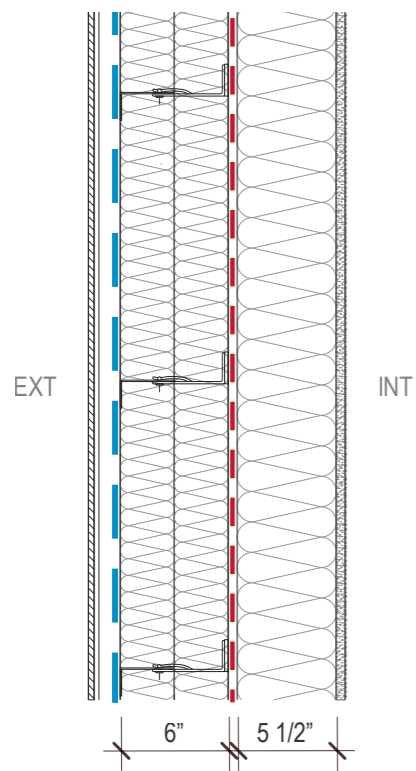


Design envelope to be **highly durable** using simplistic construction materials and methods.



Optimize **interior thermal comfort** through appropriate insulation and air sealing details.

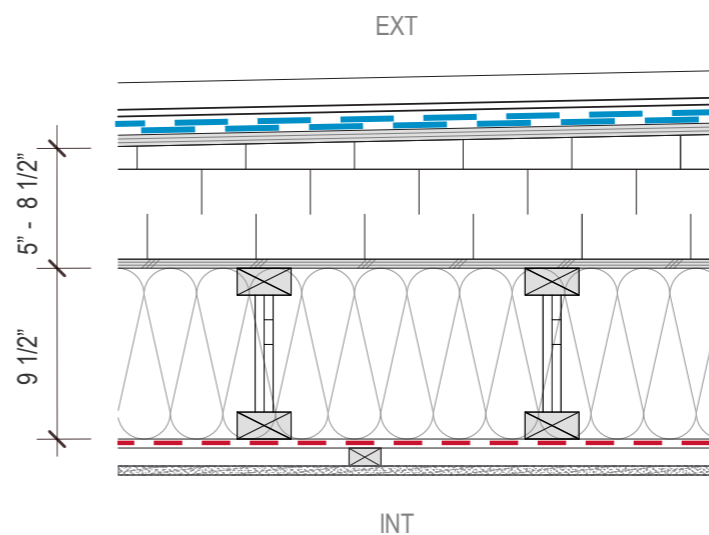
## ENVELOPE ASSEMBLIES



### Vertical Wall Assembly (R-44)

- Fibre Cement "Ecoclad" Panel
- 1" Air Cavity
- Tyvek Weather Barrier
- 2 Layers - 3" Roxul Rigid Insulation (R-25.8)
- 1/2" Zip System Air Barrier / Vapor Retarder
- 2 x 6" Structural Stud Wall (16" O/C)
- 5-1/2" Blown Cellulose Insulation (R-21)
- 1/2" Gypsum Wall Board
- Zero VOC Paint Finish

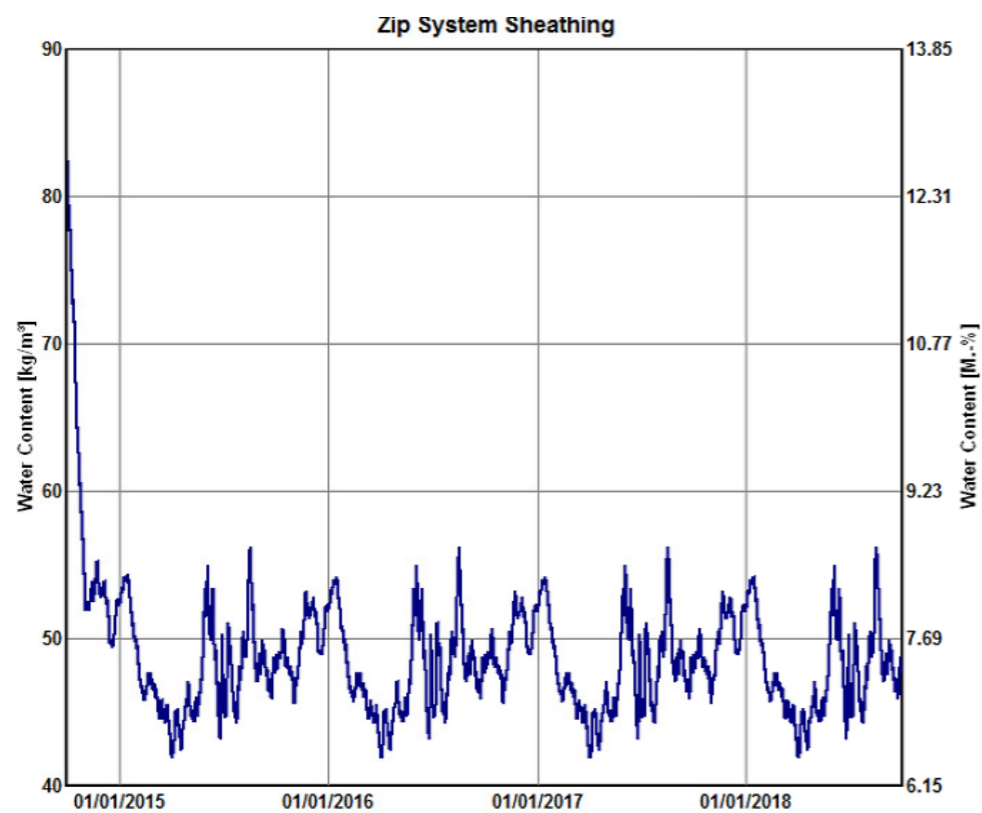
- - - - - Moisture Barrier
- - - - - Air Barrier / Vapor Retarder



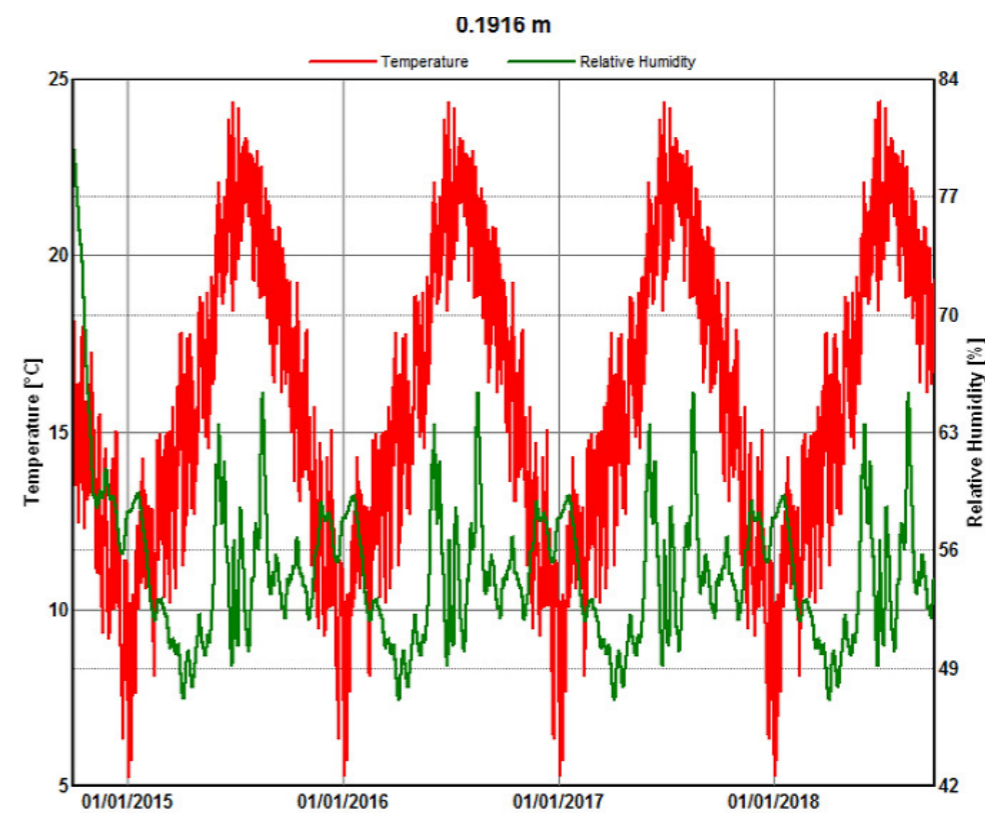
### Roof Assembly (R-56)

- Standing Seam Metal Roof
- 1" Air Cavity
- 2 Layers - 15lb. Roofing Felt
- 5/8" Plywood Sheathing
- EPS Rigid Insulation (R-20)
- 1/2" Plywood Sheathing
- 2 x 10" Wood Joists (16" O/C)
- 9-1/2" Blown Cellulose Insulation (R-33.25)
- 1/2" Zip System Air Barrier / Vapor Retarder
- 1" Wood Furring
- 5/8" Gypsum Wall Board Type X
- Zero VOC Paint Finish

## HYGROTHERMAL ANALYSIS

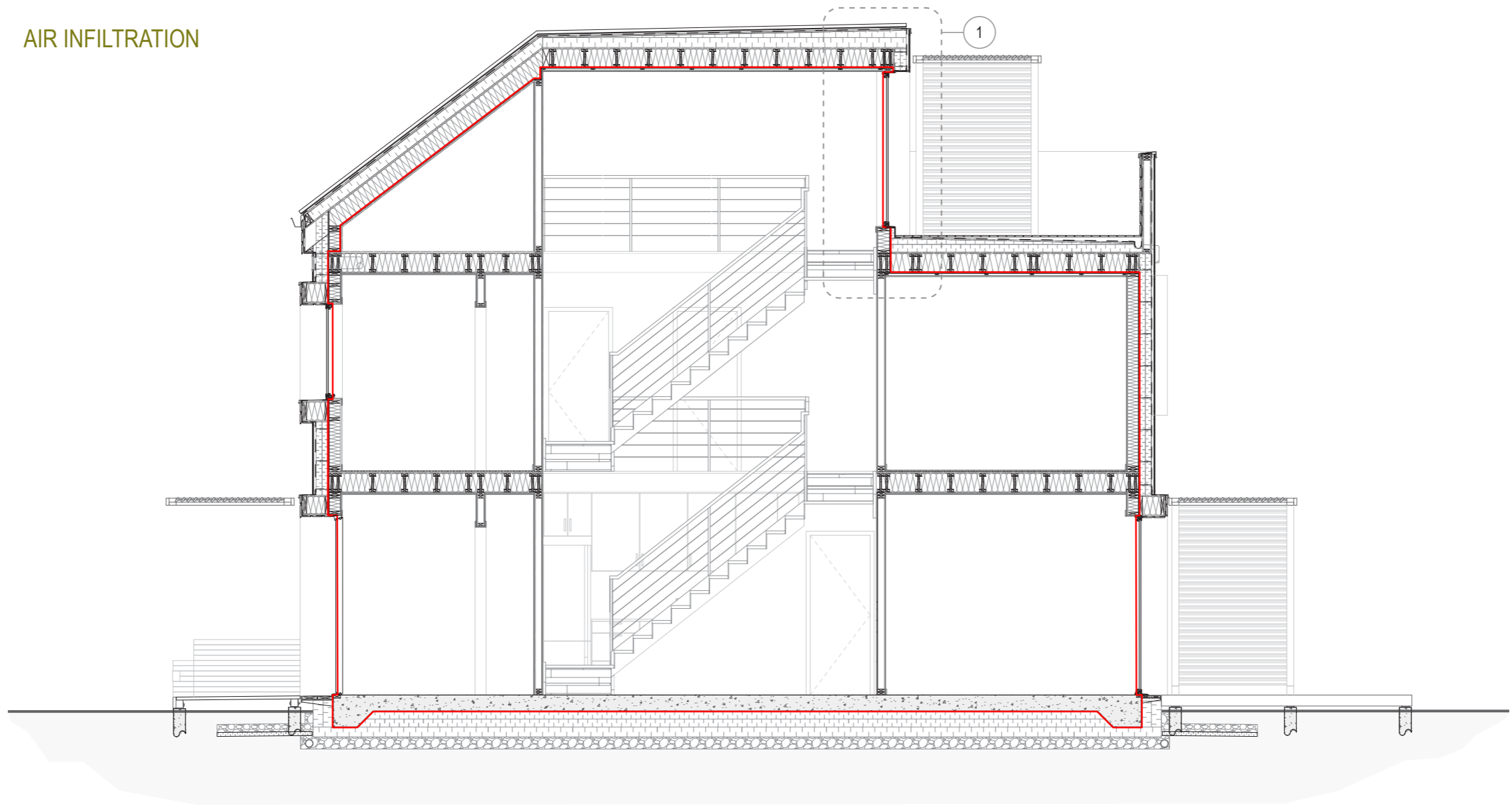


Exterior Sheathing Moisture Content



Exterior Sheathing Temperature & Relative Humidity

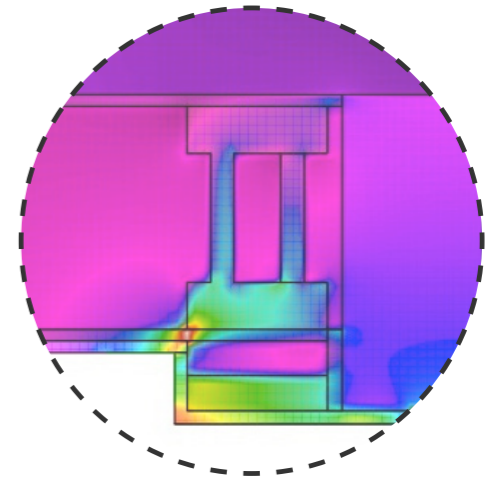
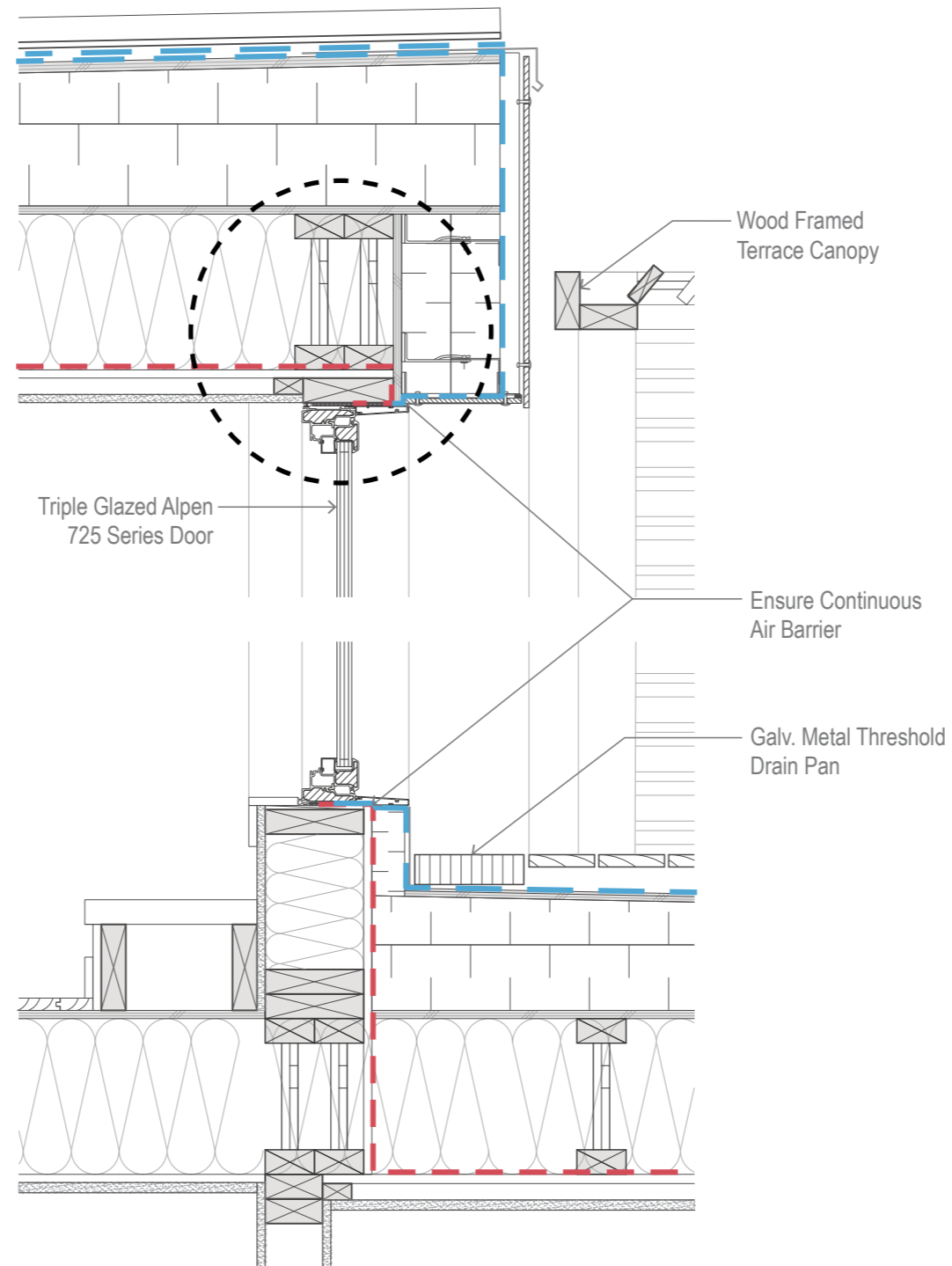
# AIR INFILTRATION



Detail Section



# THERMAL BRIDGING



THERM Analysis

Section Detail - Third Level Terrace Door

- - - - - Moisture Barrier
- - - - - Air Barrier / Vapor Retarder

## INDOOR AIR QUALITY & VENTILATION STRATEGIES



Eliminate airborne pollutants within through **exceptional filtration** of circulated and fresh air supply.



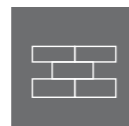
Incorporate **mechanical ventilation systems** to circulate and ventilate interior air.



Minimize noise generation and travel throughout the home.



Reduce, drain and **control moisture** within the building envelope.



Specify materials and finishes with low volatile organic compounds (VOCs).



**Control supply and exhaust air** to and from the home to ensure superior quality interior air.



**Mitigate radon infiltration** from surrounding soil.

### SPACE CONDITIONING STRATEGIES



Appropriately size the mechanical system to meet the volumetric heating requirements.



Minimize operational costs throughout the mechanical system's entire life cycle.



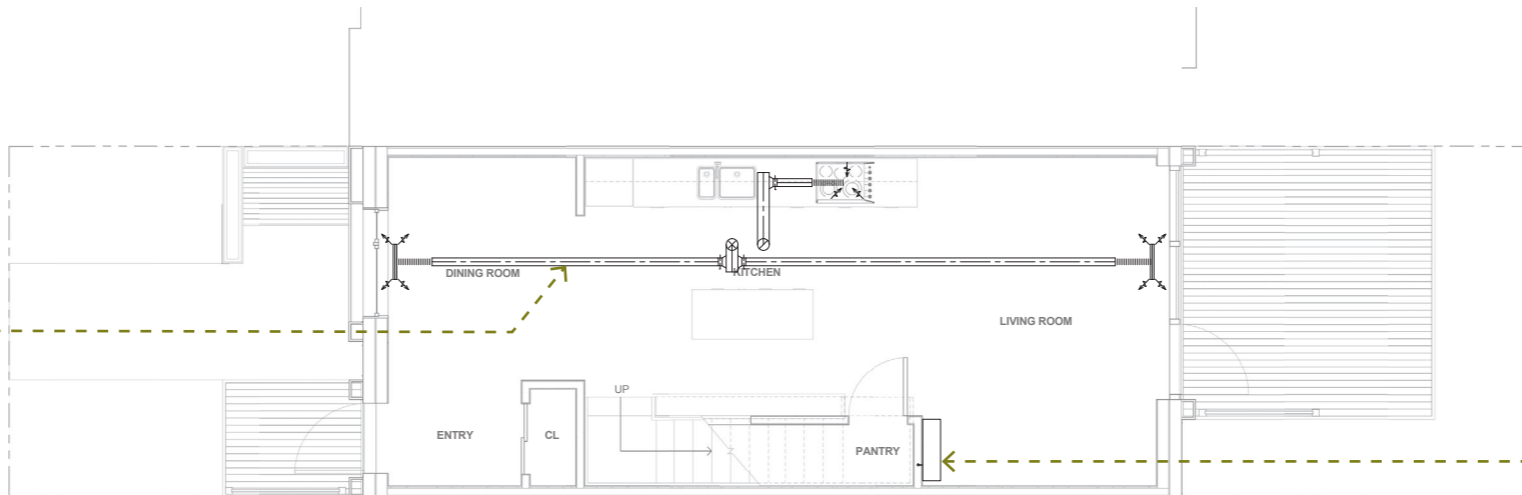
Employ a consistent energy supply source throughout all home systems.



Minimize residual heat loss in duct runs and exhaust air.



Ventilation Ductwork



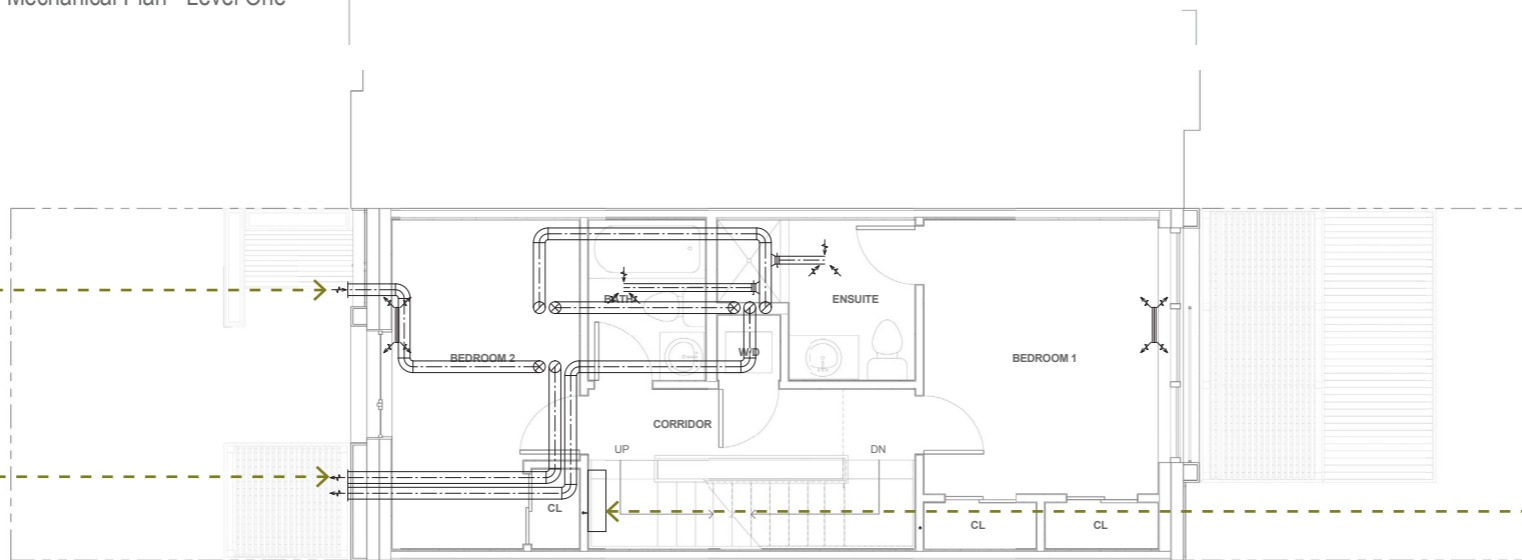
Mechanical Plan - Level One



Mitsubishi Mini-Split Heat Pump

Supply Air

Exhaust Air



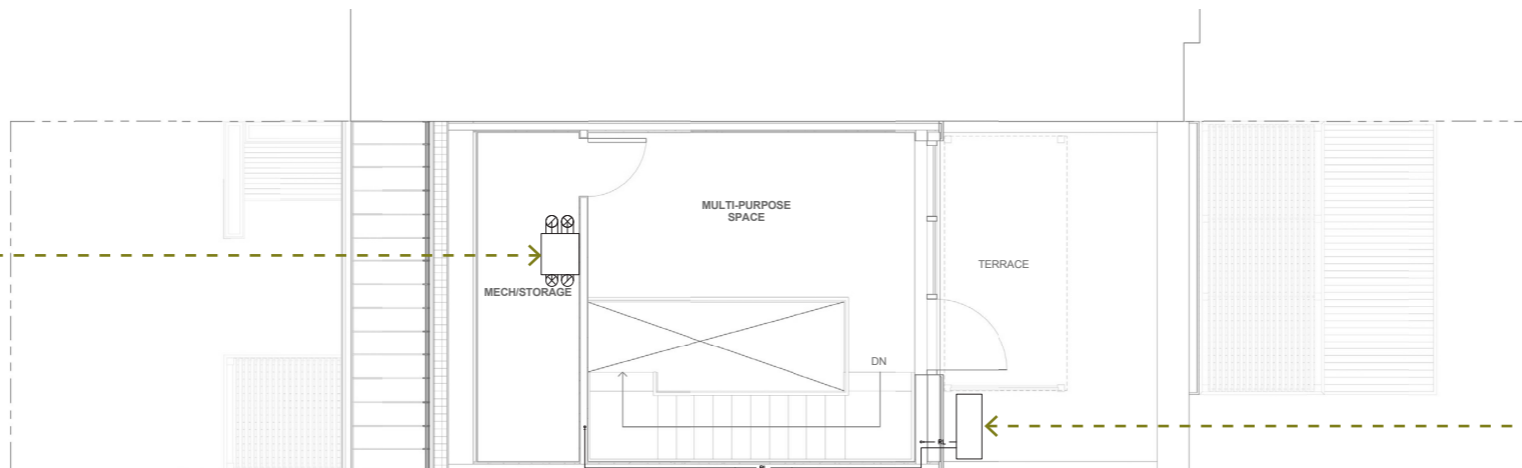
Mechanical Plan - Level Two



Mitsubishi Mini-Split Heat Pump



UltimateAir RecoupAerator ERV



Mechanical Plan - Level Three



Condensing Unit



## DOMESTIC HOT WATER STRATEGIES



Utilize the same **energy source** as the HVAC system.

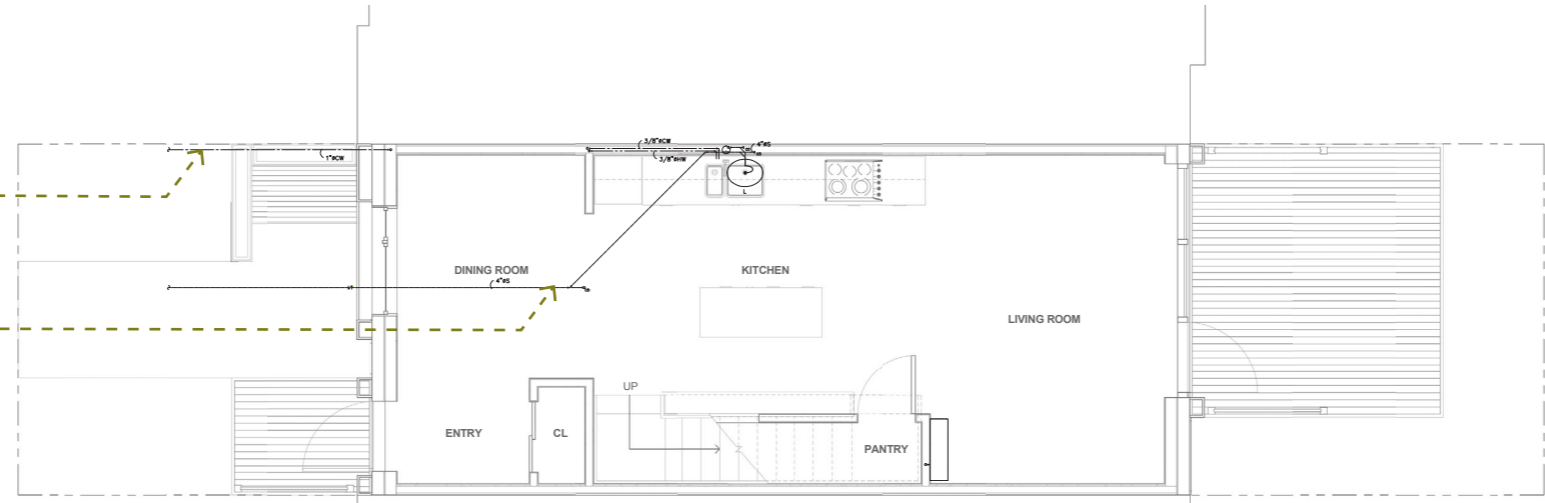


**Minimize operational costs** throughout the mechanical system's entire life cycle.

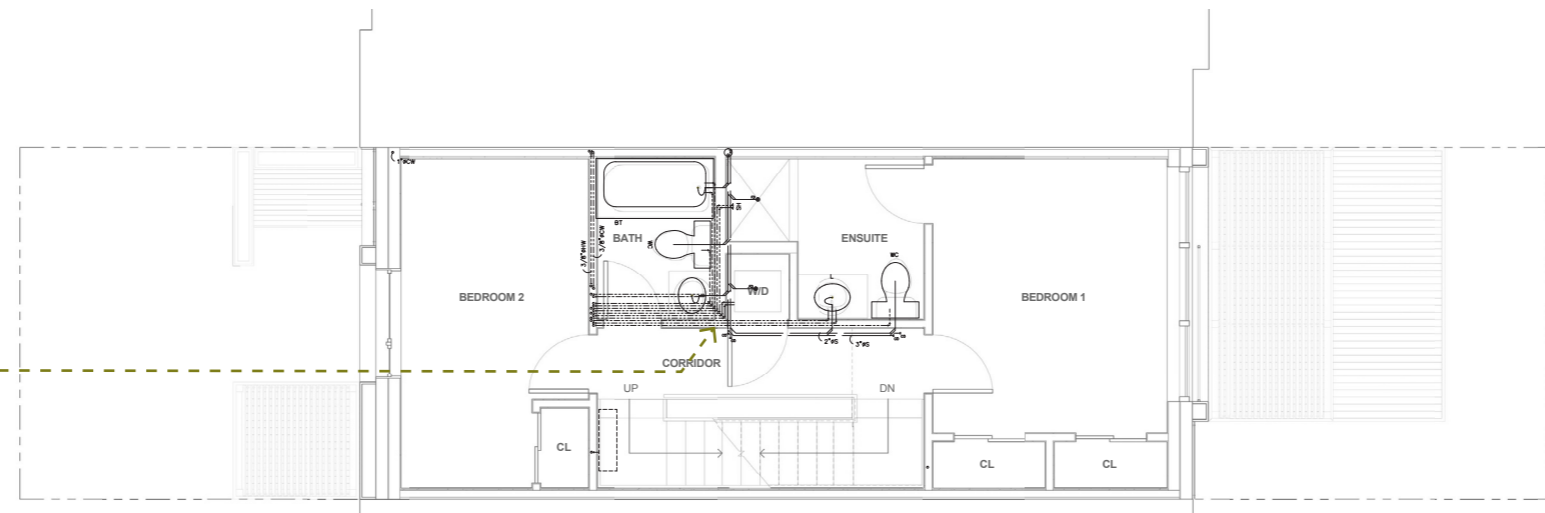


Eliminate the potential for **standing water heat loss**.

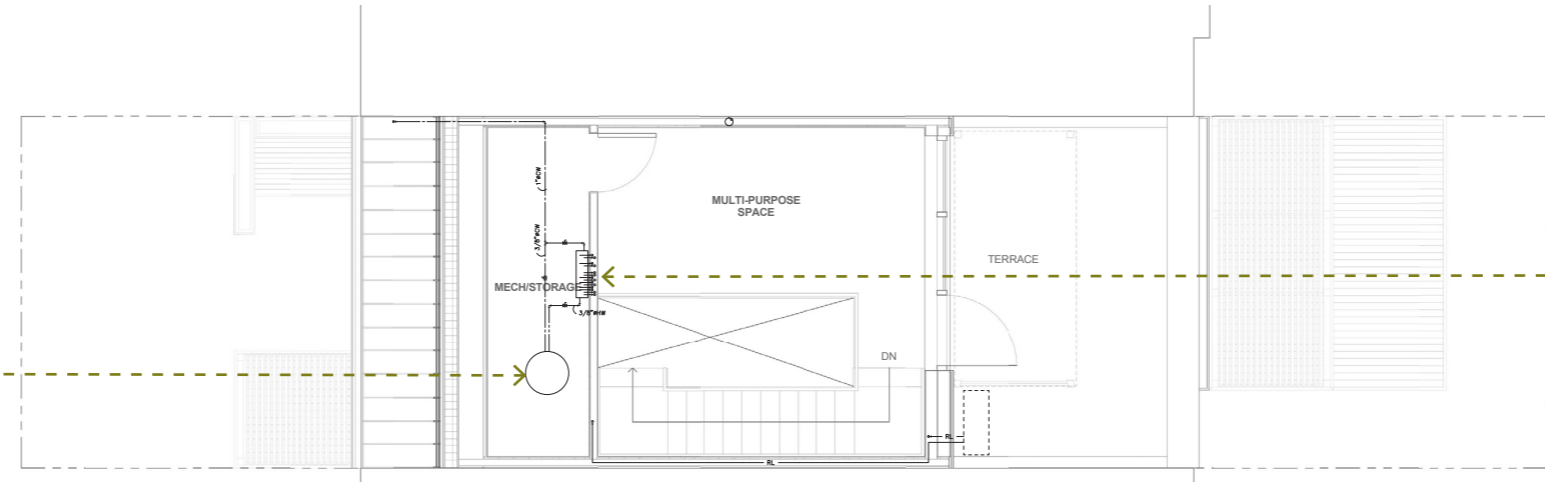
Sanitary Connection  
Water Main Connection



Centralized Plumbing Stack



Hybrid Hot Water Heater



Home Run Manifold

## ELECTRICAL, LIGHTING & APPLIANCE STRATEGIES



Specify **high efficiency fixtures and equipment** to reduce annual energy consumption.



**Minimize operational costs** throughout the mechanical system's entire life cycle.



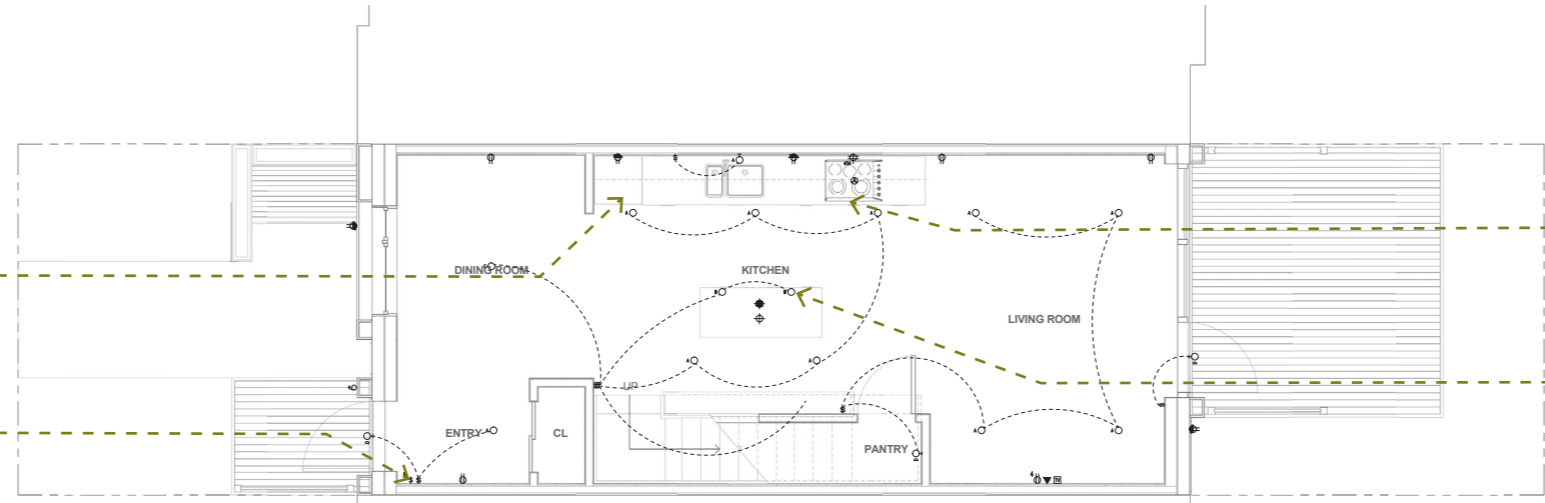
Specify **compact appliances and equipment** to alleviate space within the modest floor plate.



**Maximize daylighting** potential through the use of solar optimized glazing distribution.

\$ ☆ 🚪  
 Compact Refrigerator

\$  
 Master On/Off Switch

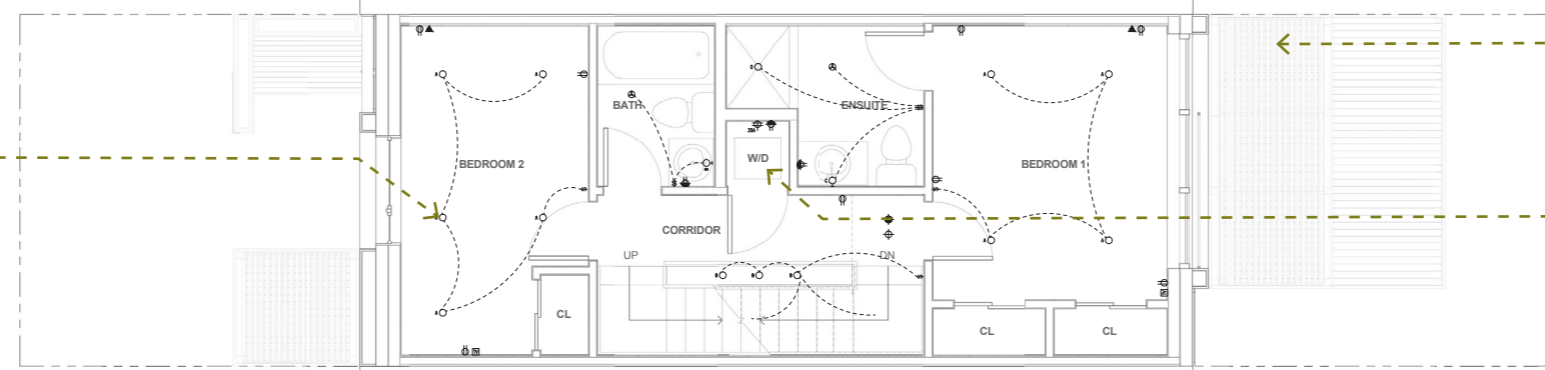


Electrical Plan - Level One

\$ ☆ 🚪  
 Built-in Oven & Cooktop

\$ ☆  
 Task Lighting

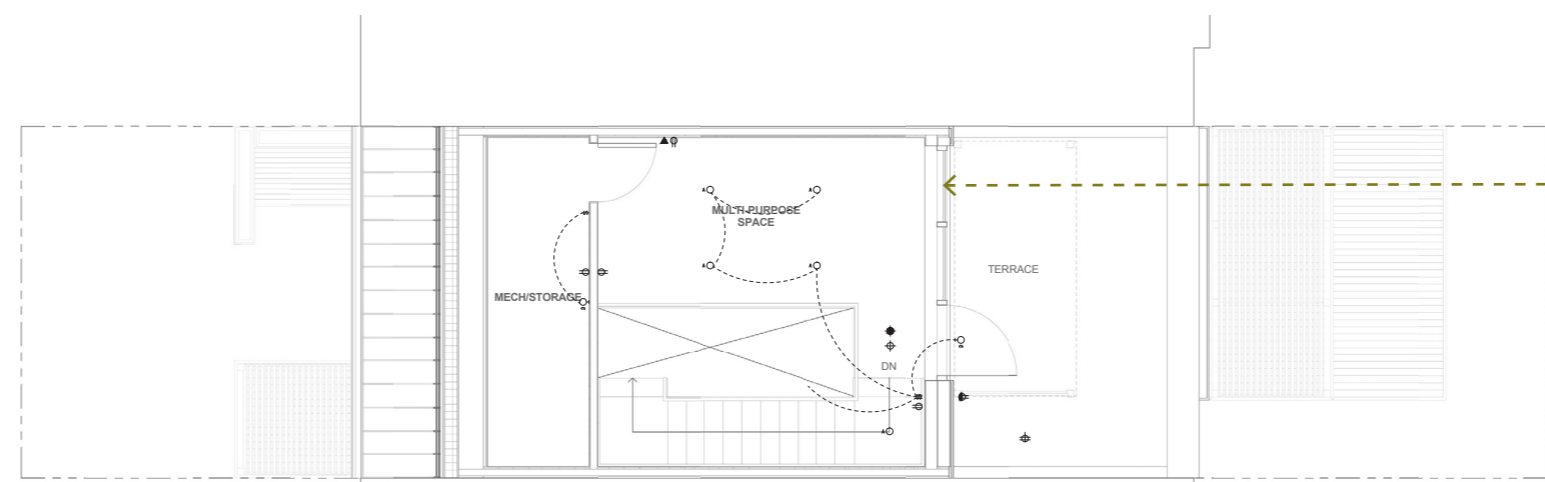
\$ ☆  
 LED Pot Lighting



Electrical Plan - Level Two

\$ ☀️  
 Shading Structure

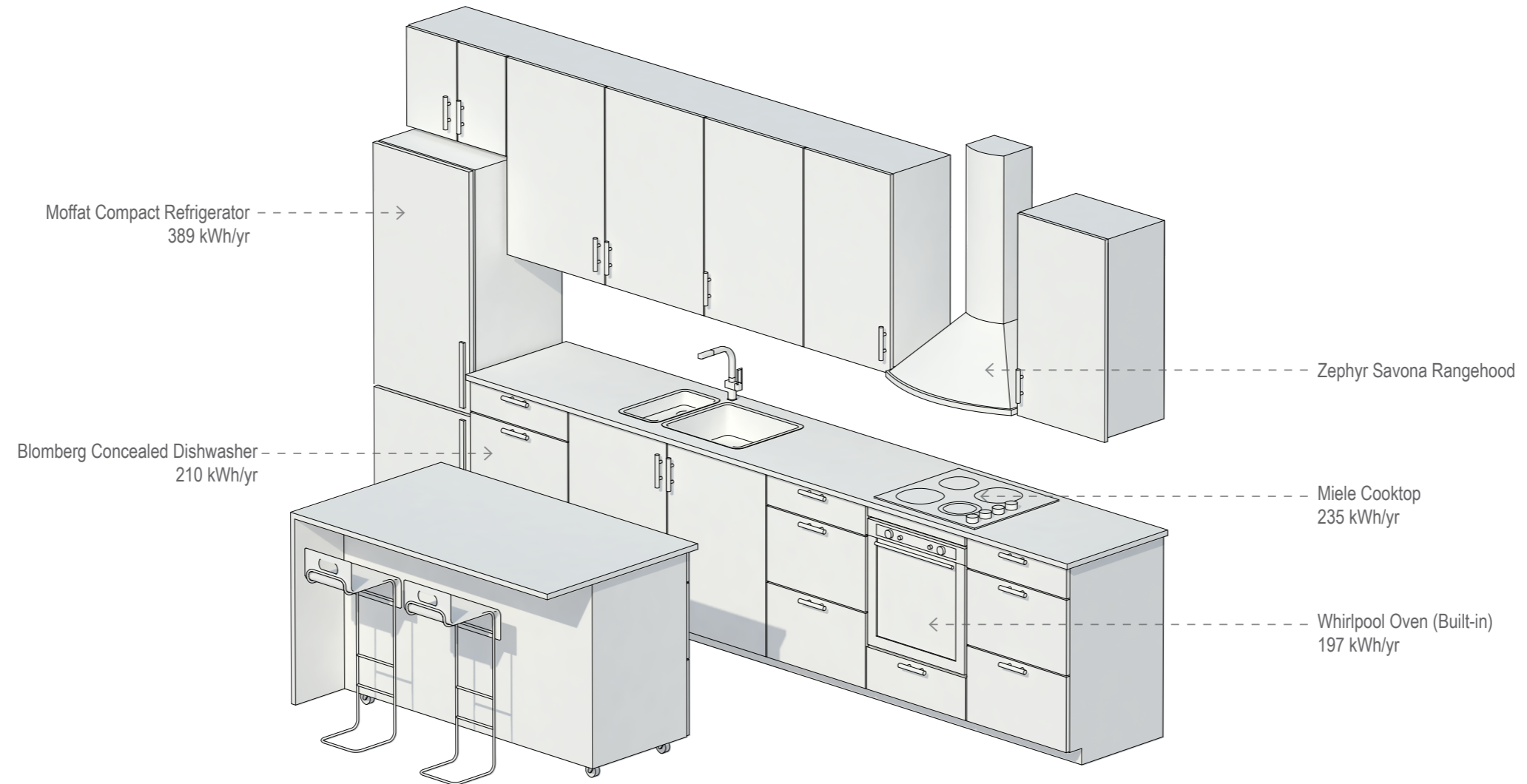
\$ ☆ 🚪  
 Stacked Washer & Dryer



Electrical Plan - Level Three

\$ ☀️  
 South Terrace Glazing

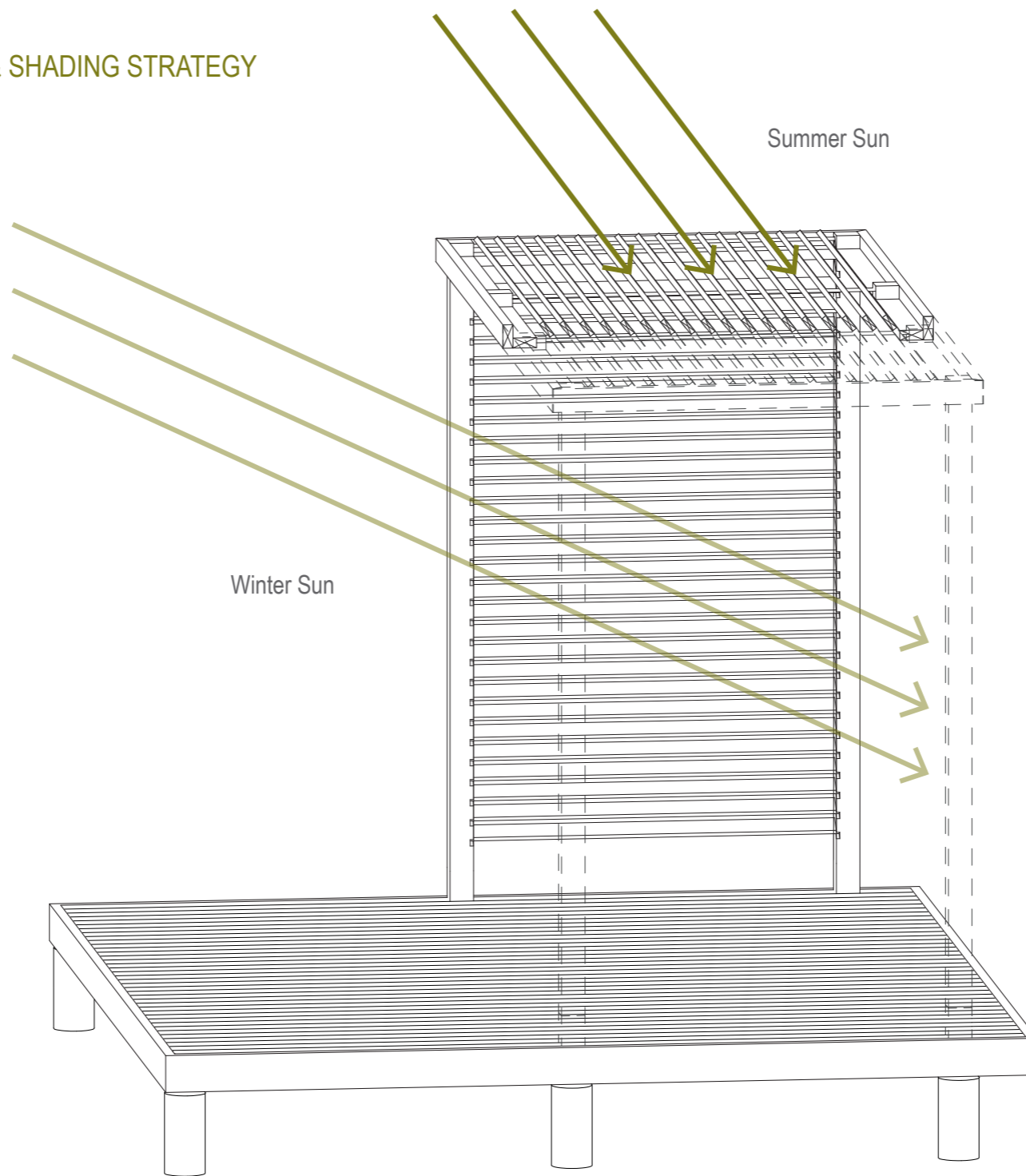
## KITCHEN APPLIANCES



Annual Primary Energy Consumption **36.1 kWh/m<sup>2</sup> - yr**

Passive House Recommended **50.0 kWh/m<sup>2</sup> - yr**

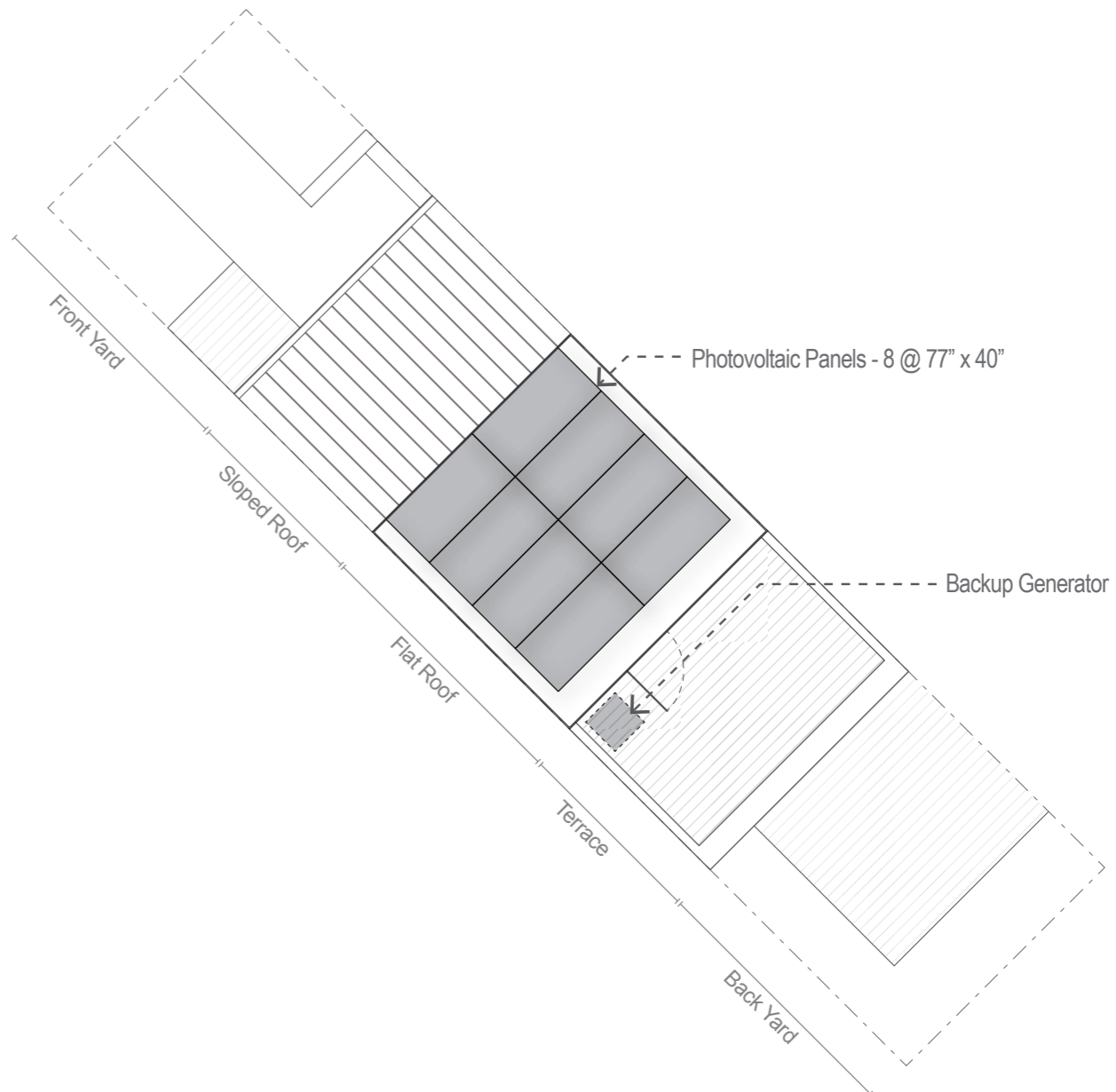
### DAYLIGHTING & SHADING STRATEGY



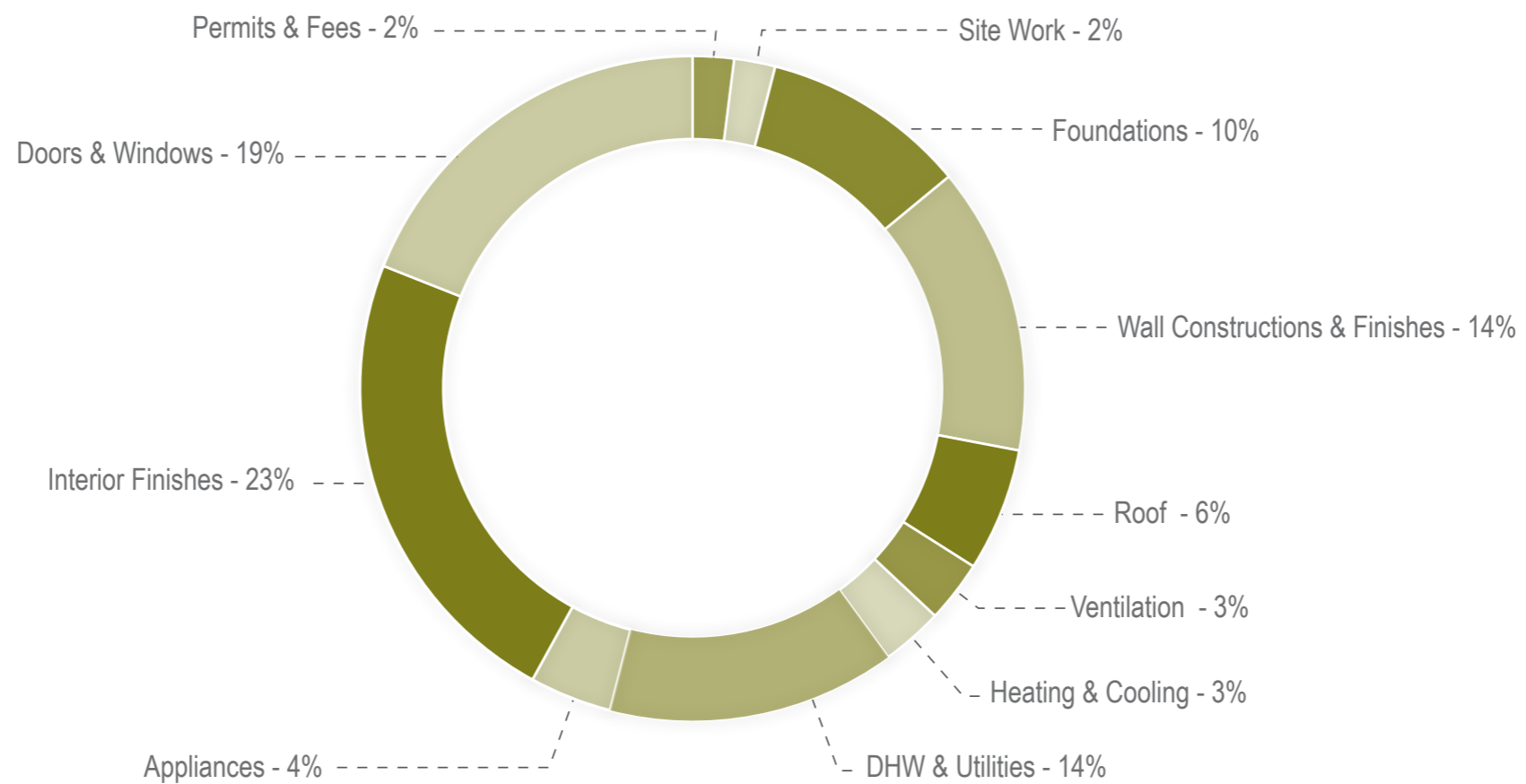
Solar Optimized Shading Canopies

## PHOTOVOLTAIC INTEGRATION

Total Energy Consumption	<b>3,800 kWh/yr</b>
Total Energy Generation	<b>3,010 kWh/yr</b>
Total PV Capacity	<b>2.4 kW</b>
Gross Cost (Incl. Install & Tax Credit)	<b>\$7,622</b>
Pay Back Period	<b>10 yrs</b>
Net Cash Flow - 25 yrs	<b>\$15,500</b>



## CONSTRUCTION COST ESTIMATE



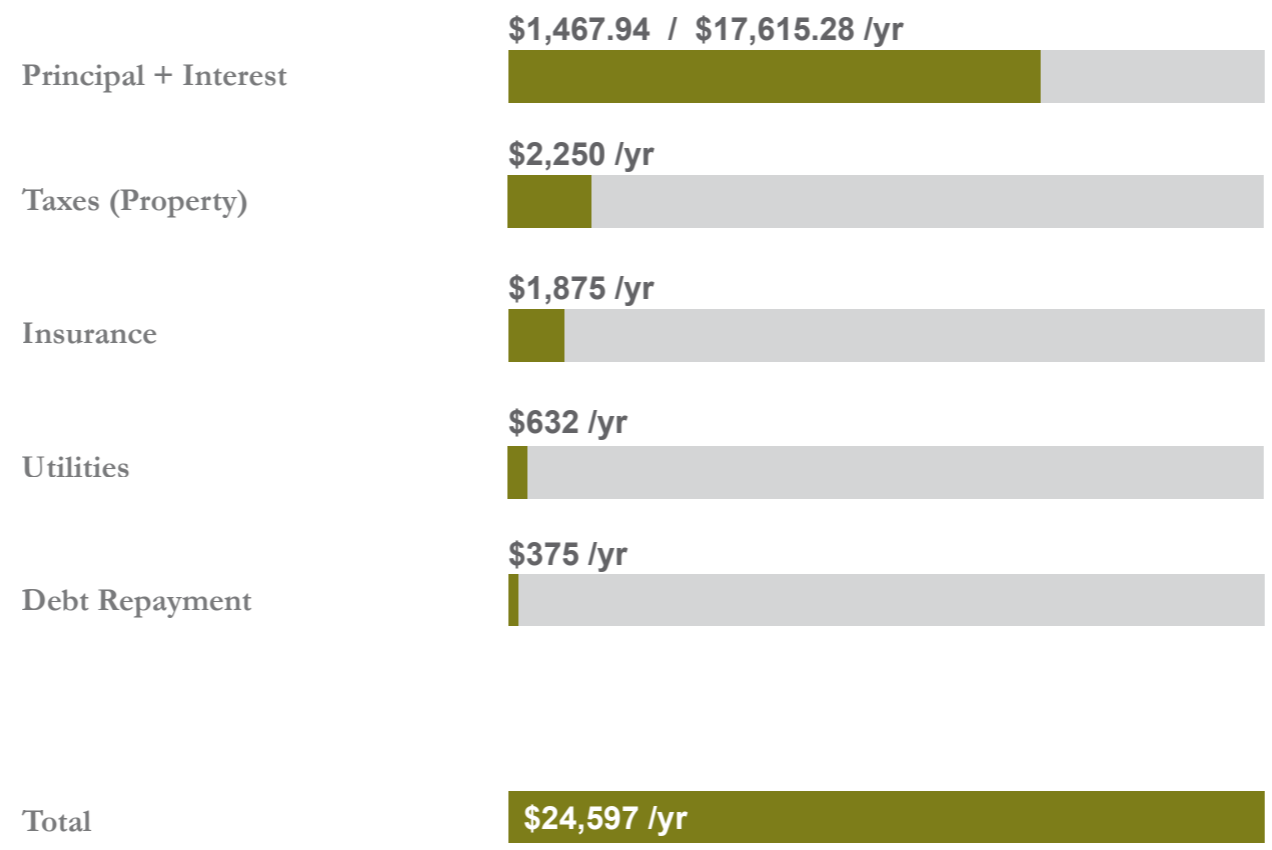
Total Construction Cost **\$181,000**

Cost / ft<sup>2</sup> **\$145**

High Performance Premium **9.0%**



### AFFORDABILITY ANALYSIS - PITIU METHOD



### AFFORDABILITY ANALYSIS - ANNUAL HOUSING EXPENSES

<b>Median Family Income (MFI)</b> City of Denver	<b>\$75,000</b>
<b>Typical Housing Expenses (33%)</b>	<b>\$25,000 /yr</b>
<b>Harvest Home</b>	<b>\$24,597 /yr</b>
<b>Critical Components Replaced Twice in 30 years</b>	<b>\$403 Net Annual Cash Flow</b>

## RATING SYSTEMS



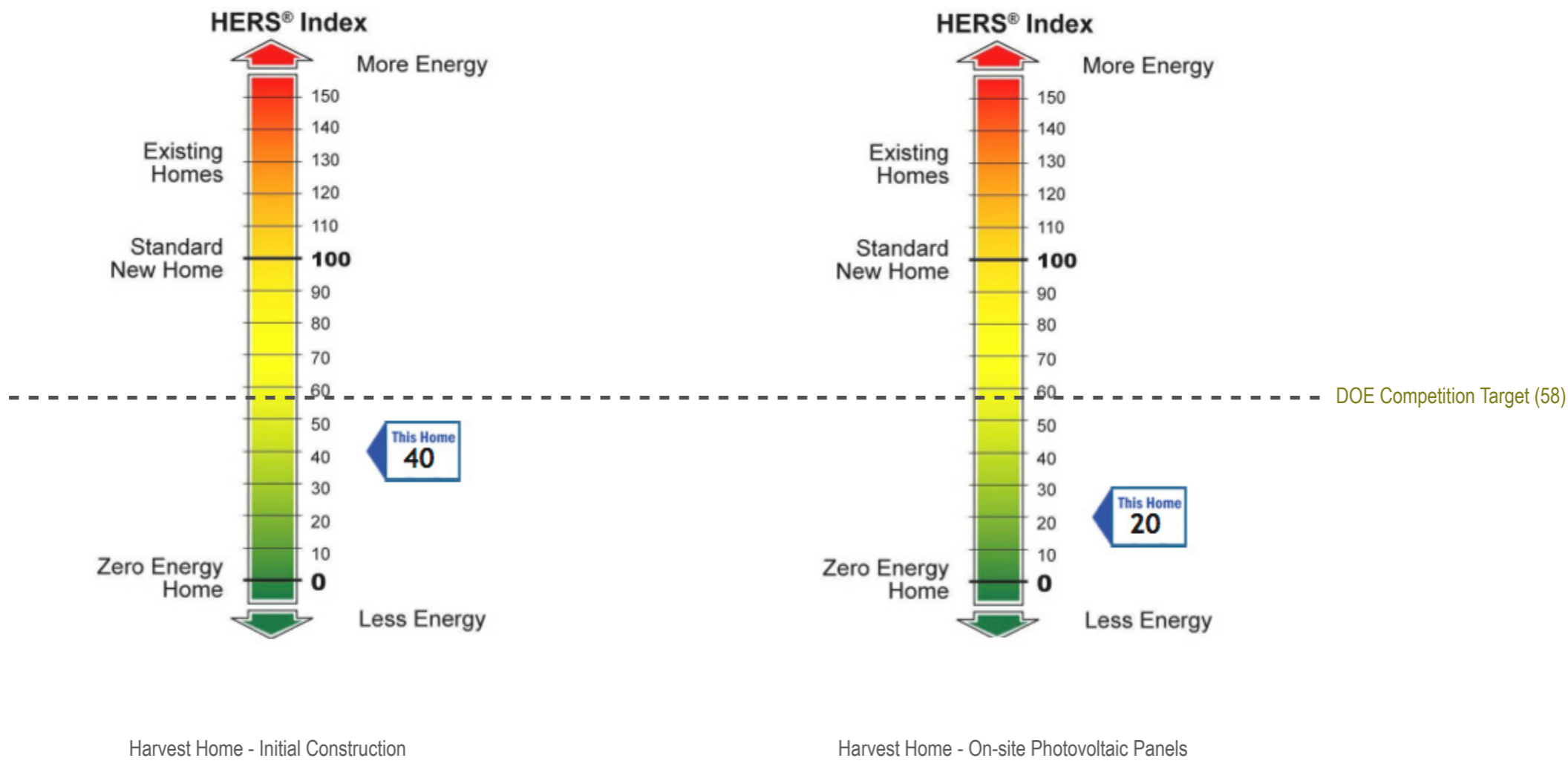
Passive House Institute US



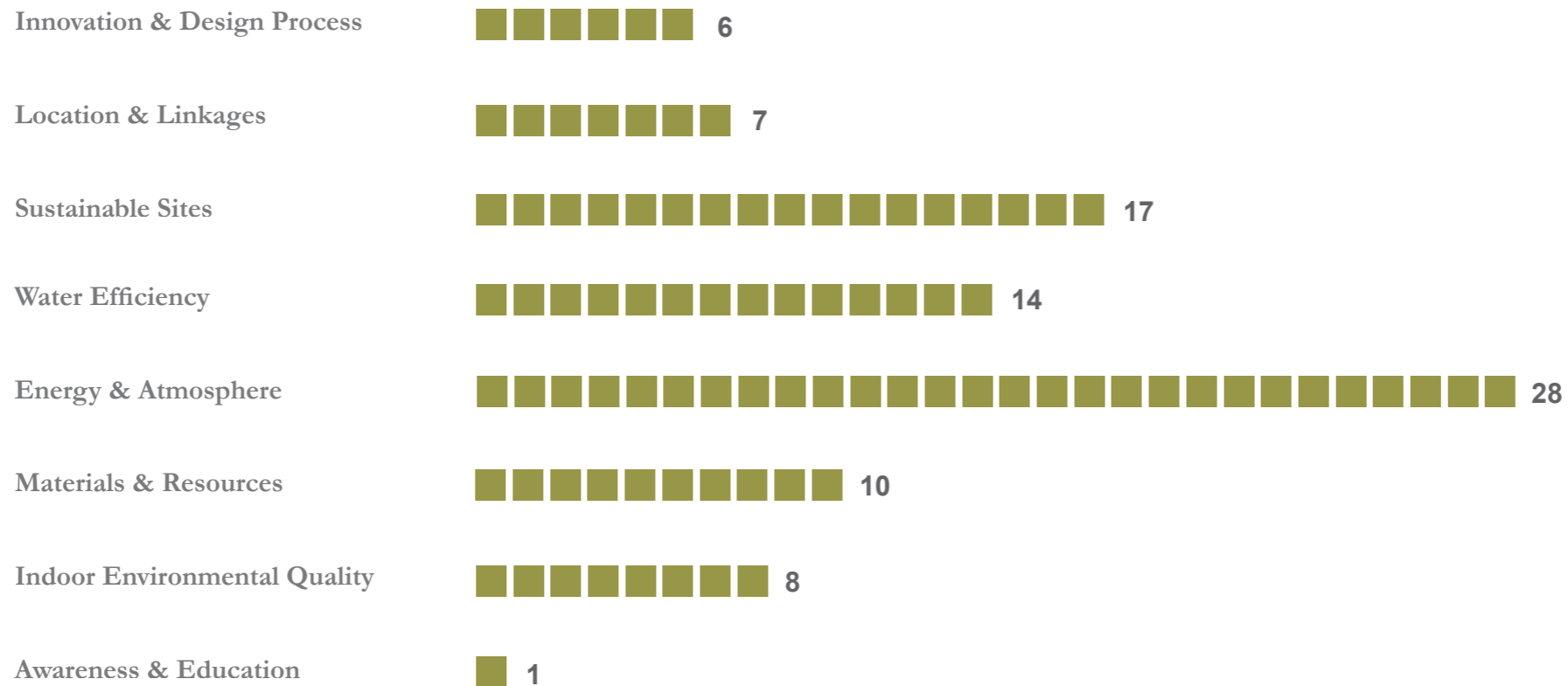
### THE PASSIVE HOUSE STANDARD

	Heat Demand kBTU/ft <sup>2</sup> - yr	Cooling Demand kBTU/ft <sup>2</sup> - yr	Primary Energy Demand kBTU/ft <sup>2</sup> - yr
Passive House Standard	4.75	4.75	38
Harvest Home	2.4	1.74	37.82

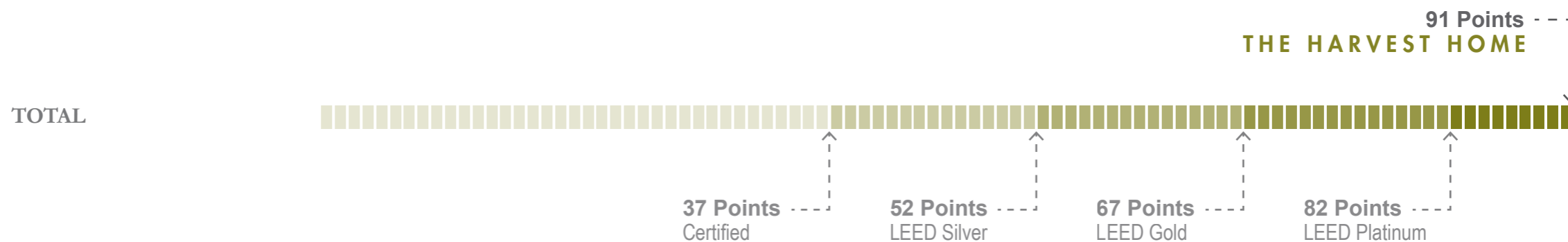
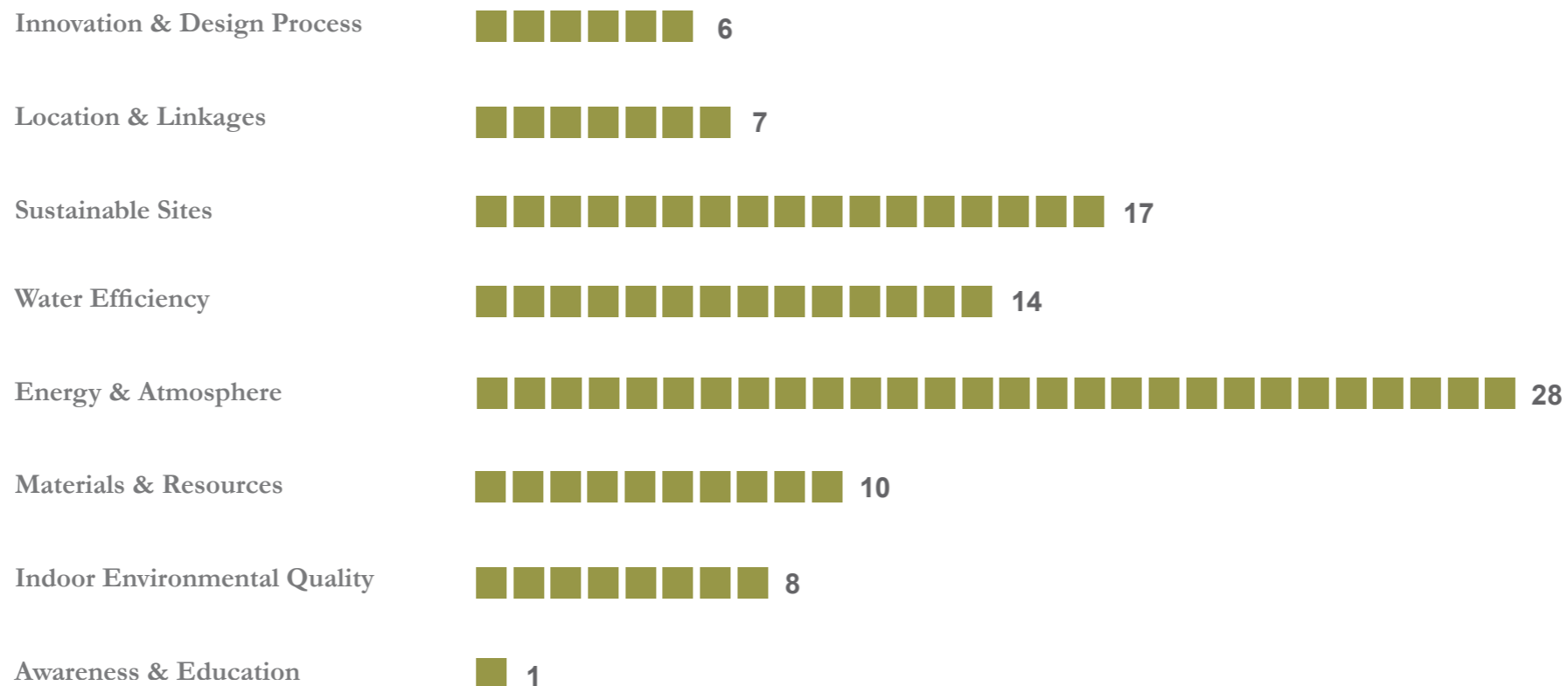
### HERS RATING - REM/RATE SOFTWARE



## LEED FOR HOMES



## LEED FOR HOMES



	AVERAGE COLORADO RESIDENCE	THE HARVEST HOME
HERS Rating	100	40
Passive House U.S.	N/A	Certified
LEED Certification	N/A	Platinum - 91 pts
Annual Energy Consumption	102,000 kBTU/yr	23,600 kBTU/yr
Annual Heating + Cooling Cost	\$1,551 /yr	\$632 /yr
Gross Area	2,082 sf	1,175 sf
Construction Cost / ft <sup>2</sup>	\$120 - \$300 /sf	\$146 /sf







Third Level South Terrace

# THE HARVEST HOME

RYERSON UNIVERSITY | TORONTO, CANADA