Passive to **POSITIVE**
PASSIVE HOUSE AND LOW IMPACT DESIGN

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PHIUS
Passive House Institute US

PASSIVE HOUSE ALLIANCE UNITED STATES

Quality and Quantity SINGLE FAMILY PROJECT COMPARISON

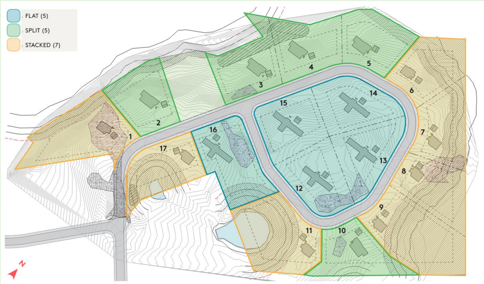
EAGLE ROCK

DEVELOPER / BUILDER: DMITRY BASKIN
ARCHITECT: RODE
STRUCTURAL: TLH CONSULTING
MEP: TBD - DESIGN/BUILD
CPHC: PASSIVE TO POSITIVE

RODE

Passive to **POSITIVE**
PASSIVE HOUSE AND LOW IMPACT DESIGN

SINGLE FAMILY DEVELOPMENT - **3** BUILDING TYPES ACROSS **17** SITES



PROJECT PRIORITIES:
CONSISTENCY OF CONSTRUCTION ACROSS BUILDING TYPES
Variety of building form aesthetic within standardization

PASSIVE HOUSE INTEGRATION
Passive House consultants included from the beginning

INTEGRATED DESIGN & CONSTRUCTION TEAM
Experienced architect & developer with immediate past project experience

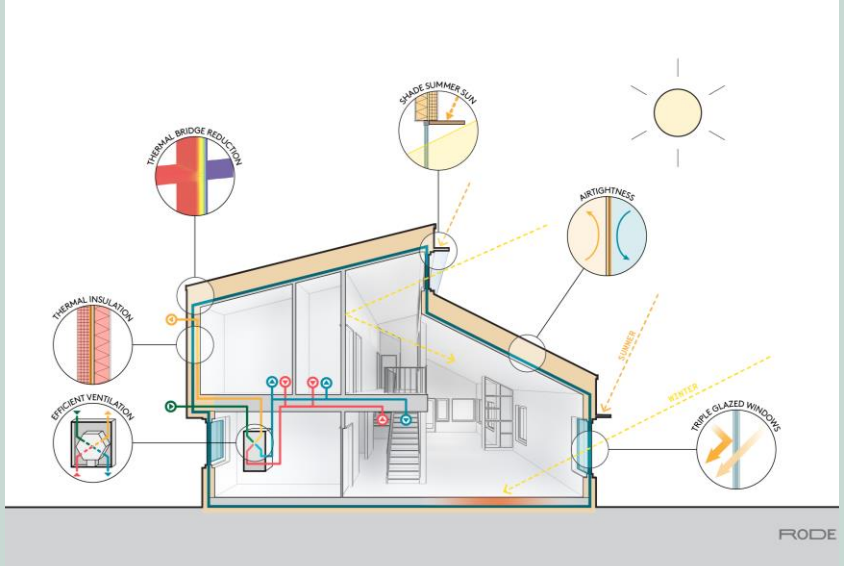
INTEGRATION BONUS!
Low Embodied Carbon, Resilience, Community Creation

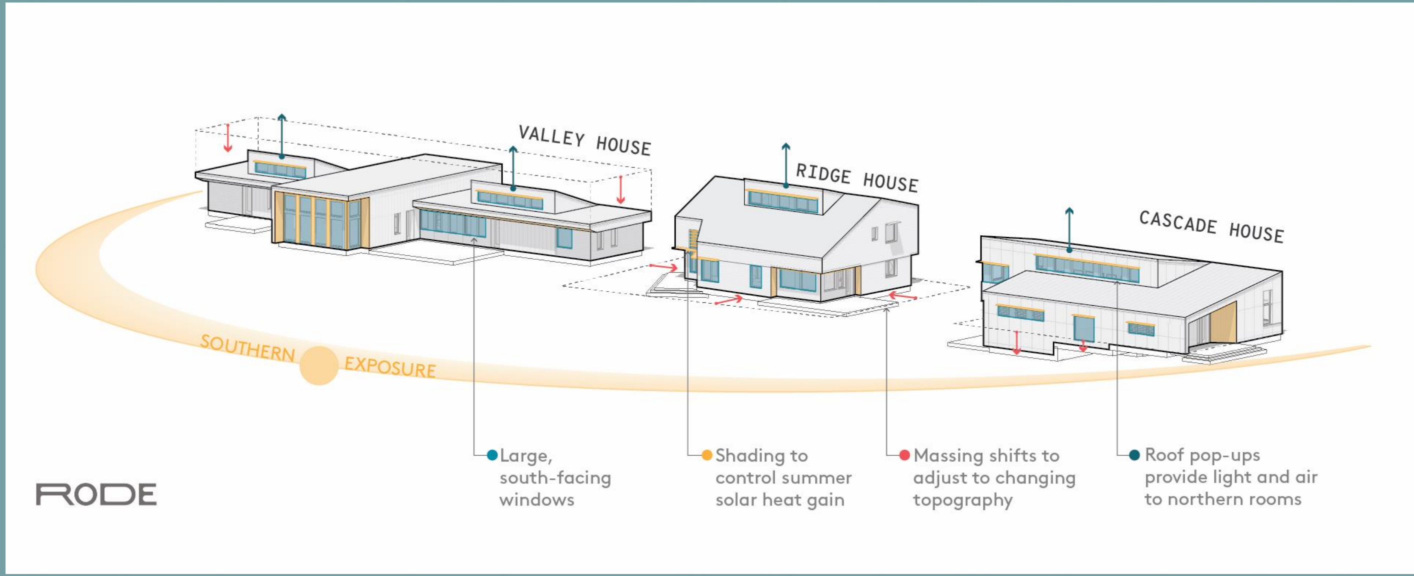
PUT THE PASSIVE BACK IN PASSIVE HOUSE

Early CPHC integration starting at site planning

Passive House Experienced Developer & Architectural team

Optimized site orientation determined design for Passive measures





PUT THE <u>PASSIVE</u> BACK IN PASSIVE HOUSE

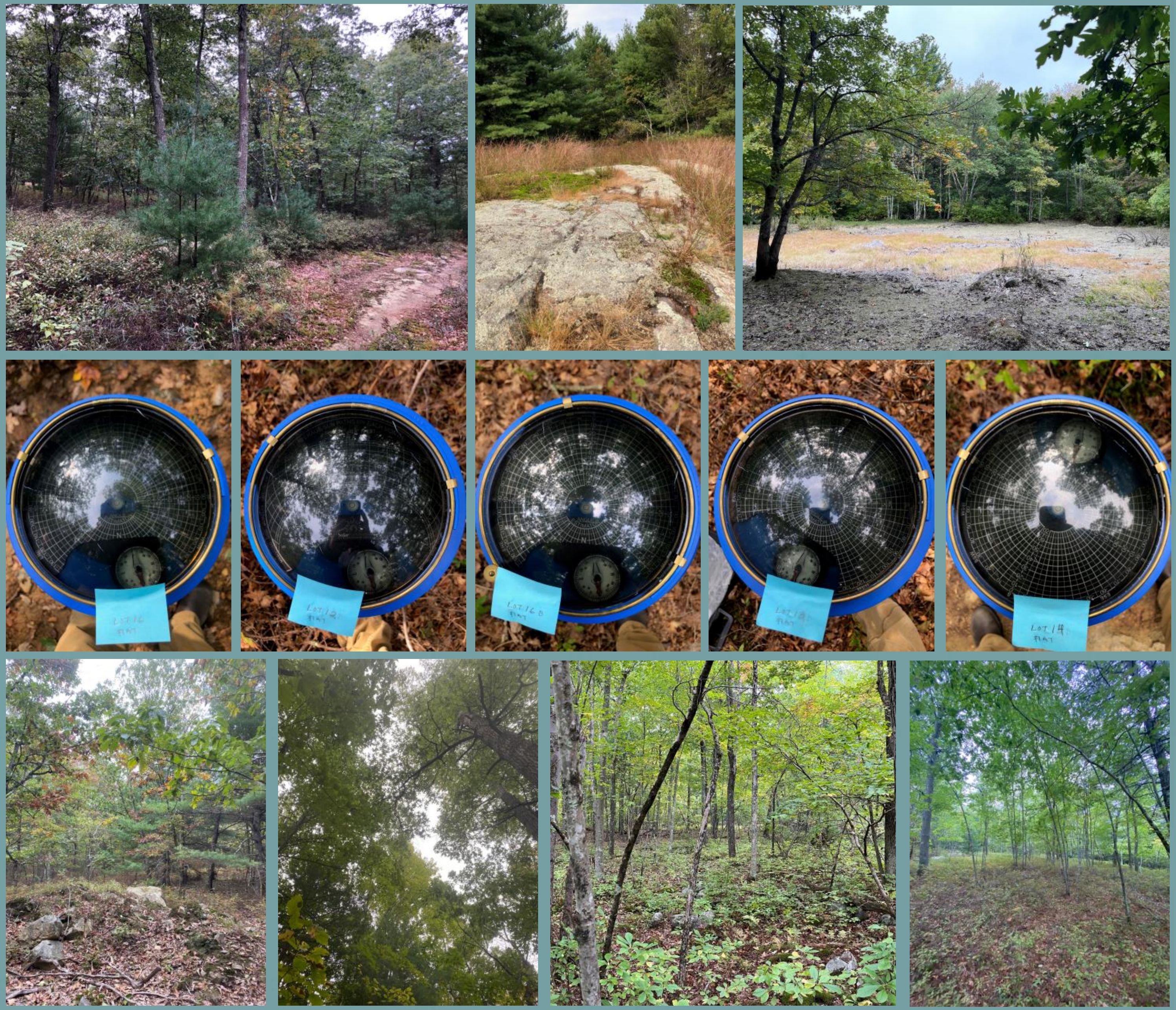
Site Design Challenges

Variable Landscape per Site
Passive design w/o consistent site shading

Site Orientation
All instances of the building are oriented within 15° of south

Variable Topography per Site
Building forms reflect the 'optimized compromise' between site topo and solar orientation (stack house vs split house)

Glazing Ratios & Shading
Reviews built into Architect's design process



EAGLE ROCK FLAT HOUSE

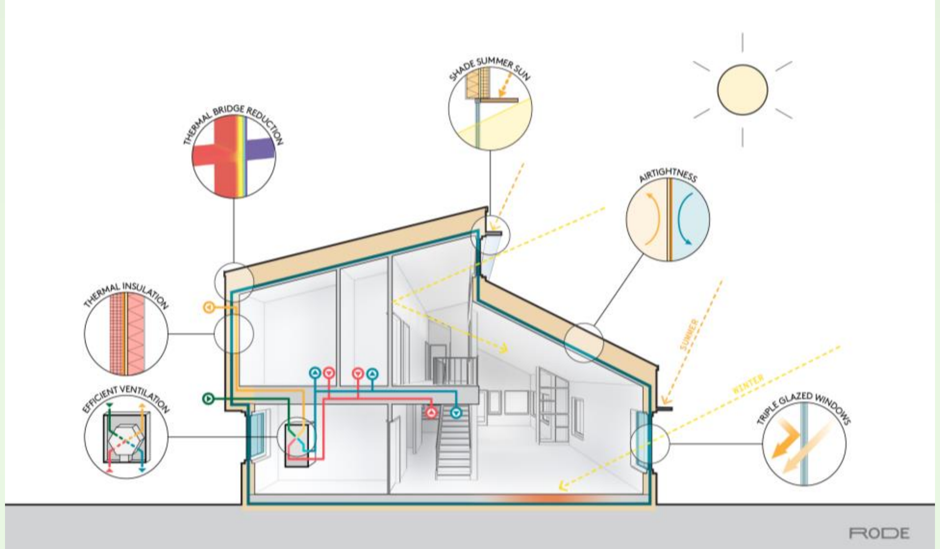
DEVELOPER / BUILDER: DMITRY BASKIN
ARCHITECT: RODE
STRUCTURAL: TLH CONSULTING
MEP: TBD - DESIGN/BUILD
CPHC: PASSIVE TO POSITIVE

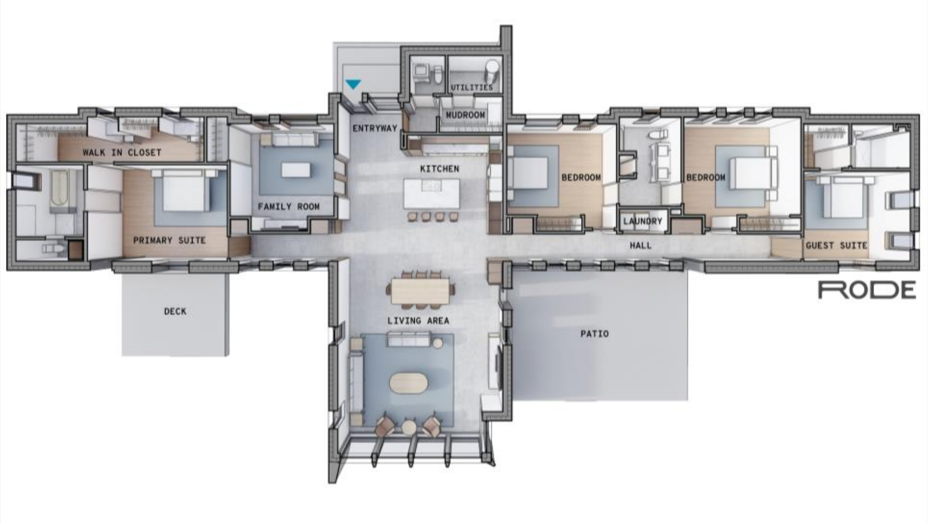
RODE

Passive to **POSITIVE**
PASSIVE HOUSE AND LOW IMPACT DESIGN

MODELED ALL THREE HOUSES TO FEASIBILITY LEVEL TO DETERMINE WORST CASE SCENARIO

DESIGN TO THE WORST CASE SCENARIO
- **Long Linear Layout**
- **Largest iCFA/Occupant**
- **Large Southern Glass Wall**
- **Architecturally open interiors – cathedral ceilings**
- **Hidden systems**

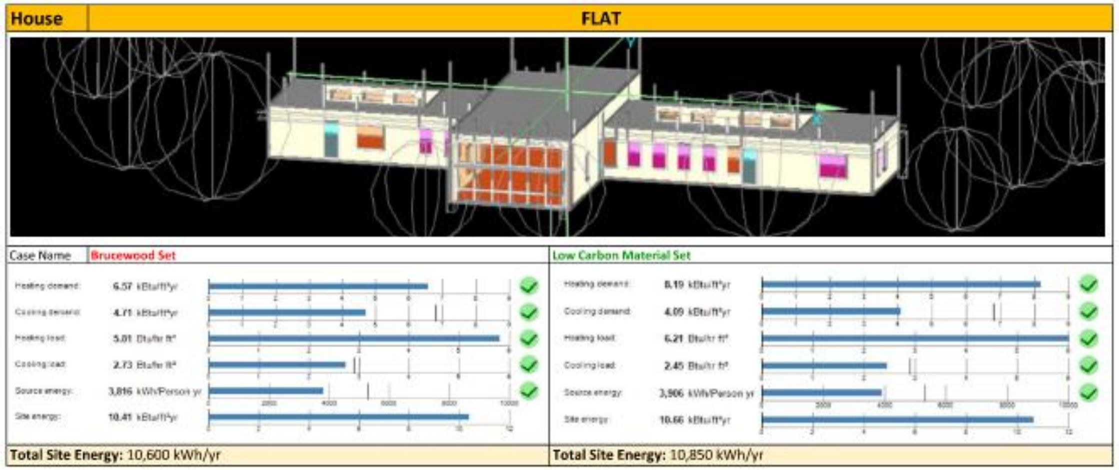


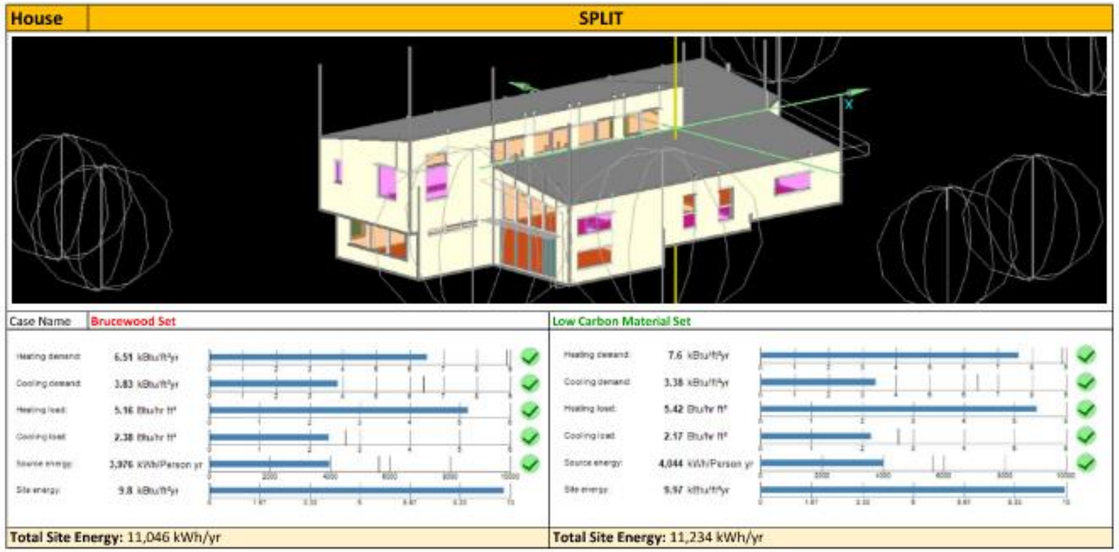


ASSEMBLIES OPTIONS AND ANALYSIS: SELECTION

Simplification by designing for the worst case

Criteria: Thermal and Airtight Performance – Constructability – Team Familiarity – Product Availability – Embodied Carbon





Passive House Results

PHIUS Passive House Criteria	Units	Split Target*	Split Results	Stacked Target*	Stacked Results	Flat Target*	Flat Results
ICFA	sf	n/a	3,845.50	n/a	3,042.30	n/a	3,473.30
Occupant Quantity	occ	n/a	5	n/a	5	n/a	5
Envelope Area	sf	n/a	11,466.10	n/a	8657.9	n/a	13367.4
Heating demand	kBtu/sf.yr	8.9	8.32	8.4	7.42	9.2	8.91
Cooling demand	kBtu/sf.yr	6.4	2.70	6.1	2.81	6.8	2.89
Heating load	Btu/hr.sf	6.4	5.60	6.1	5.37	6.7	6.36
Cooling load	Btu/hr.sf	2.7	1.83	2.6	1.90	2.9	1.95
Source energy before Solar PV**	kWh/person.yr	5600.0	4,010	4850.0	3,340	5300.0	3,810
Site energy before Solar PV	kWhr/yr		11,139.80		9,276.40		10,582.90

Assemblies

Assembly Type	Split: Effective R-Values	Stacked: Effective R-Values	Flat: Effective R-Values
Walls	R-50	R-50	R-55
Foundation Wall	R-30	n/a	n/a
Soffit	R-60	R-50	n/a
Slab on Grade	R-30	R-30	R-35
Roof	R-60	R-60	R-79
Windows	U-Glass: 0.088, Frame U-Value: 0.176, SHGC: 0.35		
Door	U-Glass: 0.088, Frame U-Value: 0.211, SHGC: 0.35		

System Assumptions

	System Type	Location Served and Parameters		
HVAC	Energy Recovery Ventilator	All spaces are ventilated by an ERV with a 80% sensible recovery efficiency and 68% humidity efficiency.		
HVAC	Space Conditioning	Whole building is assumed to be served by a heat pump with placeholder values. The placeholders are the following: COP of 3.2 at 17 degrees and COP of 4.25 at 47 degrees. Cooling COP is 4.79.		
DHW	Heat Pump Water Heater	The building is currently using a HPWH with the following placeholder values: COP of 3.2 and HPWH EF of 4.25. The DHW consumption is 6.6 gal/Person/day.		
VENTILATION	Room Ventilation	Total supply air rate: 143 cfm	Total supply air rate: 119 cfm	Total supply air rate: 119 cfm
VENTILATION		Total exhaust air rate: 143 cfm	Total exhaust air rate: 119 cfm	Total exhaust air rate: 119 cfm
VENTILATION	Exhaust Ventilation	No exhaust ventilation; however, all models would **still pass** with a range hood that has an exhaust volume air flow rate of 150 cfm.		
PV	Photovoltaic Array	All models reflect no PV production.		

Envelope Airtightness

Envelope Airtightness at 50 Pa (cfm/sqft)	0.06 cfm/sqft

Notes

* The provided PHIUS targets were created based on the envelope area, ICFA, dwelling units and total bedrooms

** These results reflect no PV input

ASSEMBLIES

ROOF OPTIONS

Various roof forms on the project:

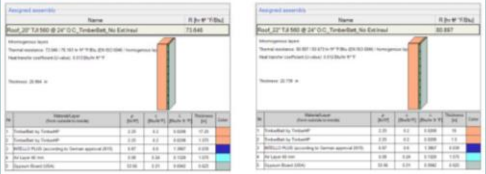
- Shed
- Gable
- Dormers
- Flat roof

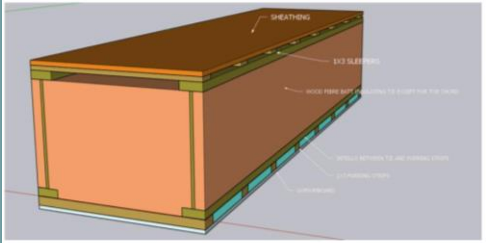
Attempt to use one roof assembly concept

Low slope vented roof is cost savings that we can leverage.

Roof Option #1 (Joists 24" O.C): Insulate TJI with wood fibre batt except for top chord and NO exterior insulation

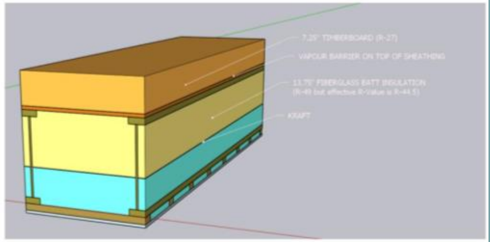
	Wall Assembly	Heating Demand	Cooling Demand	Heating Load	Cooling Load
Targets		9.2	6.8	6.7	2.9
1	2x8 Stud @ 16 OC w/ Cellulose	9.04	4.04	6.55	2.47
2	2x8 Stud @ 24 OC w/ Cellulose	8.92	4.05	6.5	2.46
3	2x6 Stud @ 16 OC w/ Cellulose	8.76	4.06	6.44	2.46
4	2x6 Stud @ 24 OC w/ Cellulose	8.9	4.05	6.49	2.47
5	2x10 Stud @ 16 OC w/ Cellulose	9.19	4.03	6.61	2.47
6	2x10 Stud @ 24 OC w/ Cellulose	9.01	4.04	6.54	2.47
7	2x12 Stud @ 16 OC w/ Cellulose	9.4	4.02	6.69	2.47
8	2x12 Stud @ 24 OC w/ Cellulose	9.15	4.04	6.6	2.47





Roof Option #2 (Joists 24" O.C): Insulate a portion of the TJI with batt and add exterior insulation

	Wall Assembly	Heating Demand	Cooling Demand	Heating Load	Cooling Load
Targets		9.2	6.8	6.7	2.9
1	2x8 Stud @ 16 OC w/ Cellulose	9.02	4.04	6.55	2.47
2	2x8 Stud @ 24 OC w/ Cellulose	8.9	4.05	6.5	2.46
3	2x6 Stud @ 16 OC w/ Cellulose	8.83	4.05	6.47	2.46
4	2x6 Stud @ 24 OC w/ Cellulose	8.74	4.06	6.43	2.46
5	2x10 Stud @ 16 OC w/ Cellulose	9.17	4.04	6.6	2.47
6	2x10 Stud @ 24 OC w/ Cellulose	8.99	4.04	6.53	2.47
7	2x12 Stud @ 16 OC w/ Cellulose	9.38	4.03	6.69	2.47
8	2x12 Stud @ 24 OC w/ Cellulose	9.13	4.04	6.59	2.47



Roof Option #3 (Joists 24" O.C): Insulate entire TJI cavity with Dense cellulose and thicker sleeper

	Wall Assembly	Heating Demand	Cooling Demand	Heating Load	Cooling Load
Targets		9.2	6.8	6.7	2.9
1	2x8 Stud @ 16 OC w/ Cellulose	9.02	4.04	6.54	2.47
2	2x8 Stud @ 24 OC w/ Cellulose	8.89	4.05	6.49	2.46
3	2x6 Stud @ 16 OC w/ Cellulose	8.82	4.05	6.46	2.46
4	2x6 Stud @ 24 OC w/ Cellulose	8.74	4.06	6.43	2.46
5	2x10 Stud @ 16 OC w/ Cellulose	9.16	4.03	6.6	2.47
6	2x10 Stud @ 24 OC w/ Cellulose	8.99	4.04	6.53	2.46
7	2x12 Stud @ 16 OC w/ Cellulose	9.37	4.02	6.68	2.47
8	2x12 Stud @ 24 OC w/ Cellulose	9.13	4.04	6.59	2.47

Assigned assembly

Name	R [hr ft² °F/Btu]
Roof_20" TJI 560 @ 24" O.C_DENSE Cellulose Insulation_No ext. Insul_	74.522

Inhomogenous layers
Thermal resistance: 74.522 / 77.68 hr ft² °F/Btu (EN ISO 6946 / homogenous laye
Heat transfer coefficient (U-value): 0.013 Btu/hr ft² °F
Thickness: 22.278 in

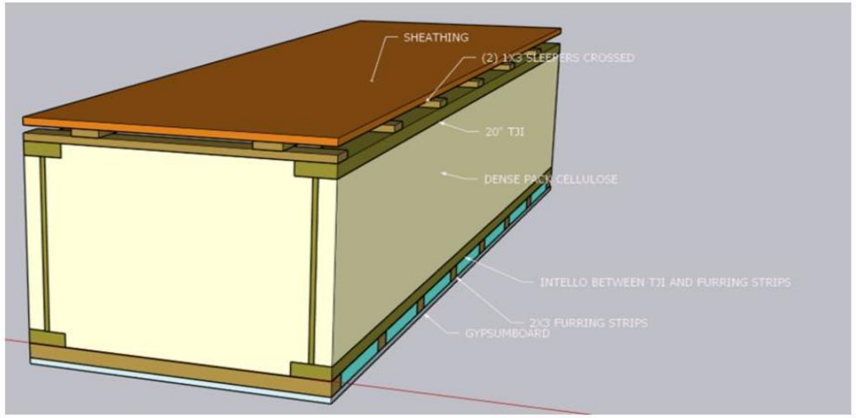
Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Mento Plus-P2P generated from Intello	2.14	0.6	0.0982	0.039	
2	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	1.375	
3	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	17.25	
4	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	1.375	
5	INTELLO PLUS (according to German approval 2015)	6.87	0.6	1.3867	0.039	
6	Air Layer 40 mm	0.08	0.24	0.1329	1.575	
7	Gypsum Board (USA)	53.06	0.21	0.0942	0.625	

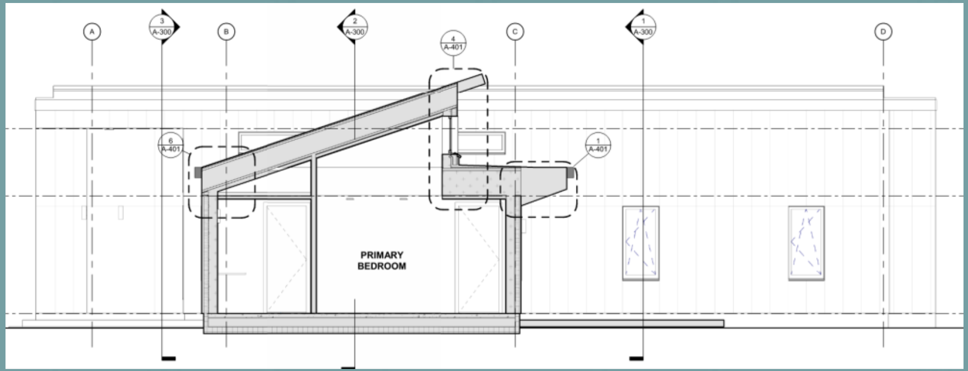
Assigned assembly

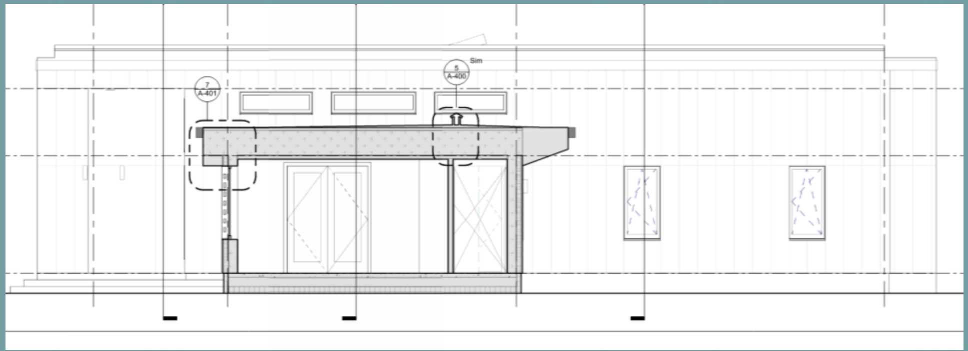
Name	R [hr ft² °F/Btu]
Roof_22" TJI 560 @ 24" O.C_DENSE Cellulose Insulation_No ext. Insul_	81.817

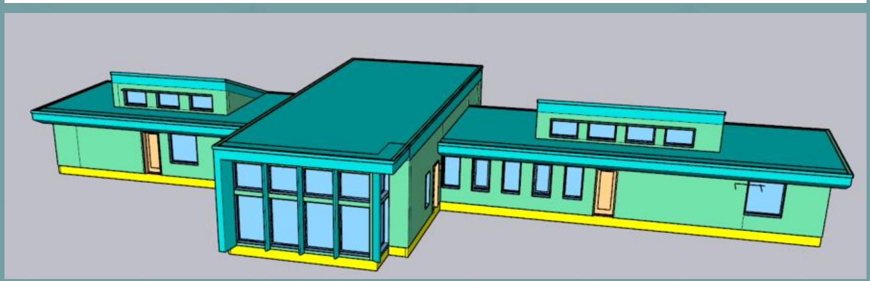
Inhomogenous layers
Thermal resistance: 81.817 / 85.29 hr ft² °F/Btu (EN ISO 6946 / homogenous laye
Heat transfer coefficient (U-value): 0.012 Btu/hr ft² °F
Thickness: 24.278 in

Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Mento Plus-P2P generated from Intello	2.14	0.6	0.0982	0.039	
2	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	1.5	
3	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	19	
4	Cellulose Fiber Dense Pack GreenFiber specs	4.37	0.33	0.0219	1.5	
5	INTELLO PLUS (according to German approval 2015)	6.87	0.6	1.3867	0.039	
6	Air Layer 40 mm	0.08	0.24	0.1329	1.575	
7	Gypsum Board (USA)	53.06	0.21	0.0942	0.625	





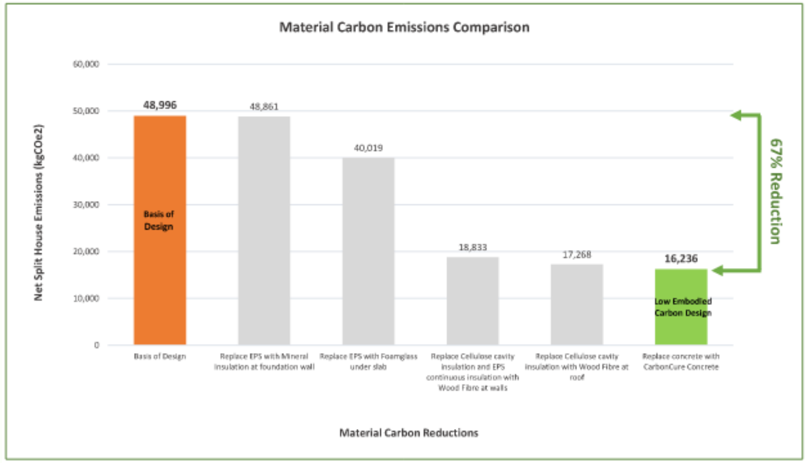


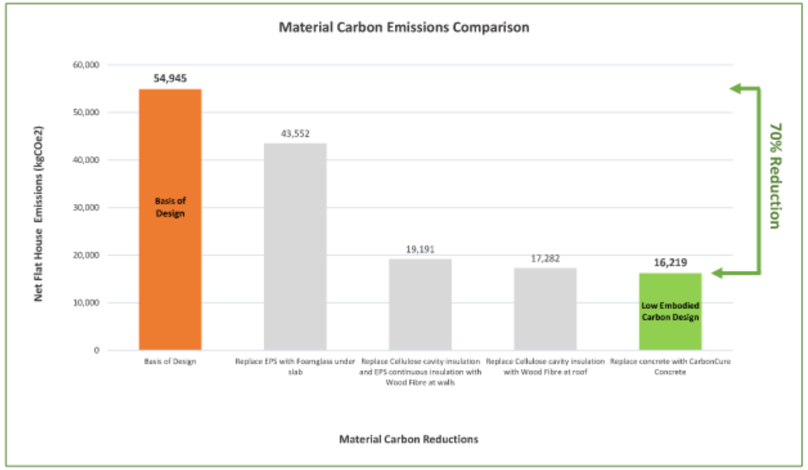


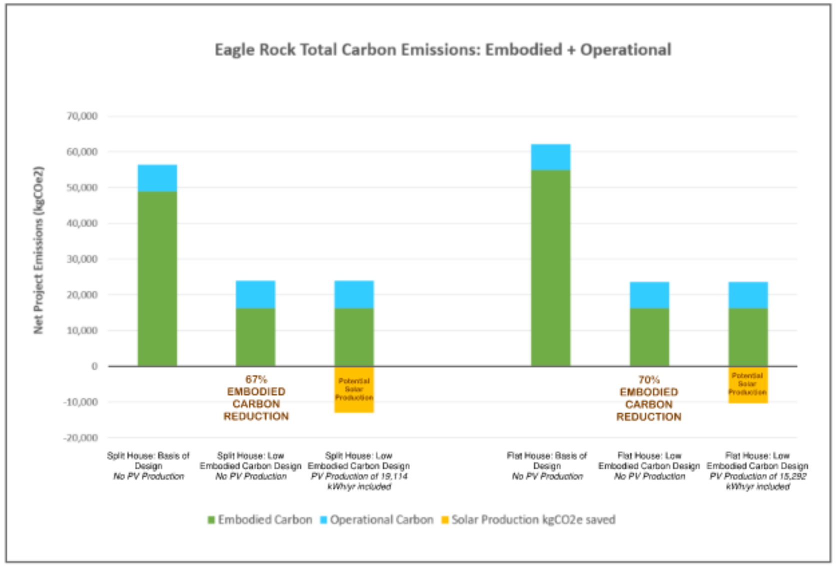
ASSEMBLIES OPTIONS AND ANALYSIS: **EMBODIED CARBON**

Information as **Power** and **Leverage.**

Early iterative studies of **Embodied Carbon** research and analysis led to new opportunities and added project goals.







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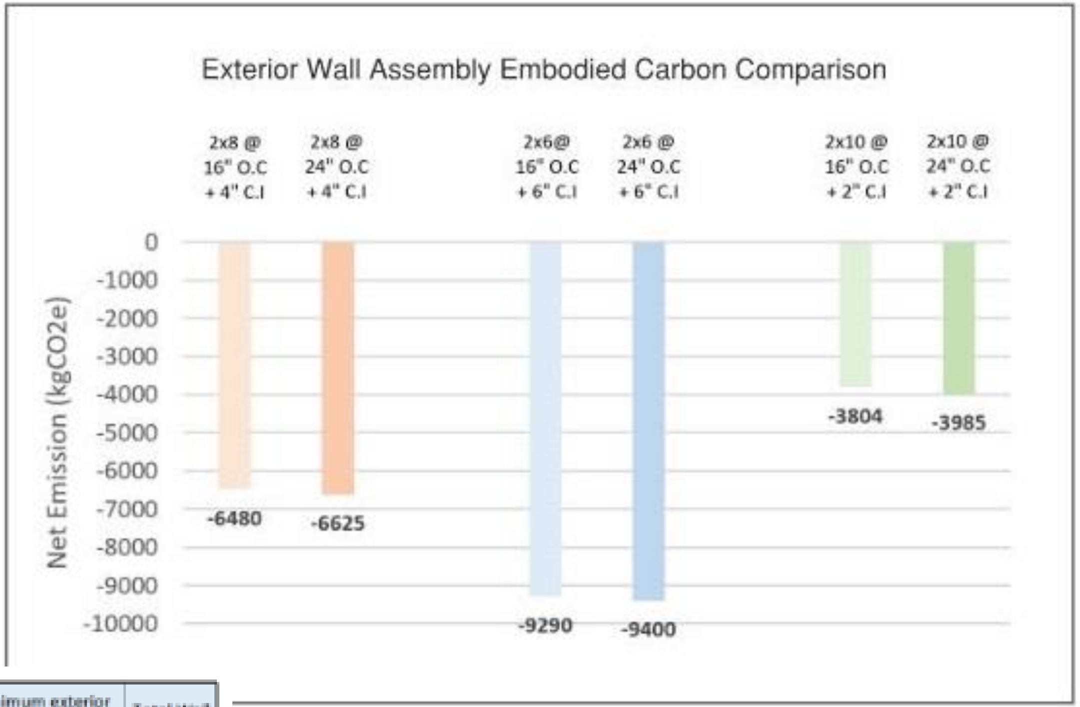
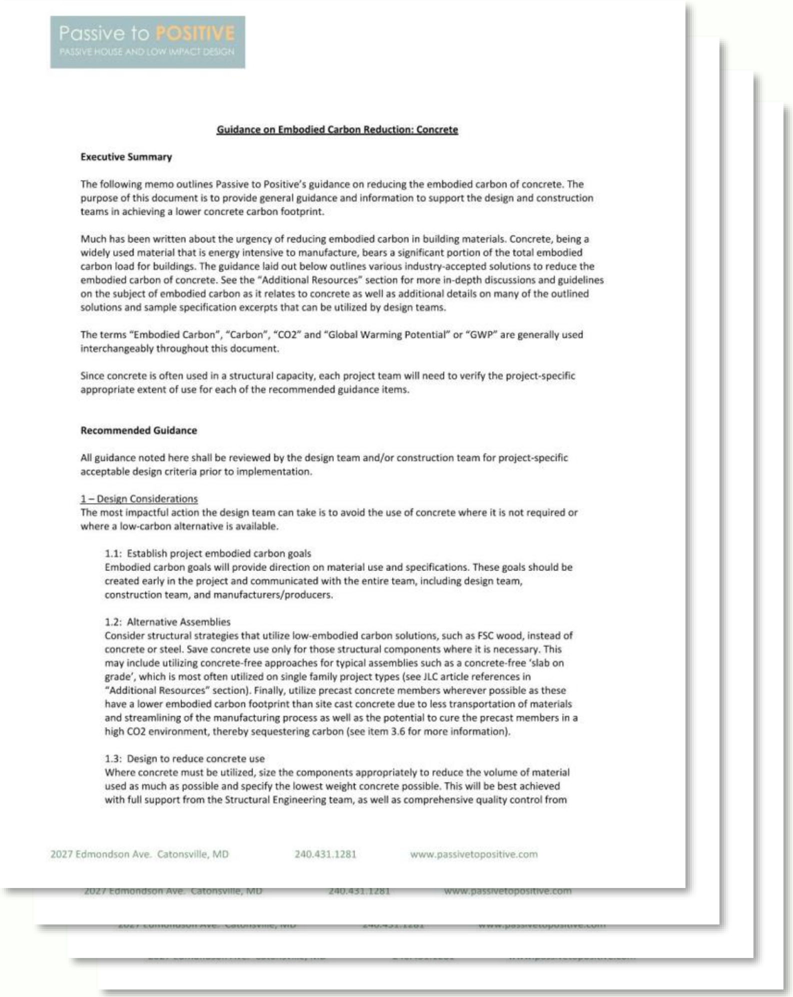


	Wall Assembly	Minimum exterior insulation needed to Pass PHIUS (inches)	Total Wall R-Value
1	2x8 Stud @ 16 OC w/ Cellulose	4	38.485
2	2x8 Stud @ 24 OC w/ Cellulose	4	39.529
3	2x6 Stud @ 16 OC w/ Cellulose	6	40.207
4	2x6 Stud @ 24 OC w/ Cellulose	6	40.961
5	2x10 Stud @ 16 OC w/ Cellulose	2	37.294
6	2x10 Stud @ 24 OC w/ Cellulose	2	38.712


Passive to POSITIVE
PASSIVE HOUSE AND LOW IMPACT DESIGN

Guidance on Embodied Carbon Reduction: Concrete

Executive Summary

The following memo outlines Passive to Positive's guidance on reducing the embodied carbon of concrete. The purpose of this document is to provide general guidance and information to support the design and construction teams in achieving a lower concrete carbon footprint.

Much has been written about the urgency of reducing embodied carbon in building materials. Concrete, being a widely used material that is energy intensive to manufacture, bears a significant portion of the total embodied carbon load for buildings. The guidance laid out below outlines various industry-accepted solutions to reduce the embodied carbon of concrete. See the "Additional Resources" section for more in-depth discussions and guidelines on the subject of embodied carbon as it relates to concrete as well as additional details on many of the outlined solutions and sample specification excerpts that can be utilized by design teams.

The terms "Embodied Carbon", "Carbon", "CO2" and "Global Warming Potential" or "GWP" are generally used interchangeably throughout this document.

Since concrete is often used in a structural capacity, each project team will need to verify the project-specific appropriate extent of use for each of the recommended guidance items.

Recommended Guidance

All guidance noted here shall be reviewed by the design team and/or construction team for project-specific acceptable design criteria prior to implementation.

1 – Design Considerations
The most impactful action the design team can take is to avoid the use of concrete where it is not required or where a low-carbon alternative is available.

1.1: Establish project embodied carbon goals
Embodied carbon goals will provide direction on material use and specifications. These goals should be created early in the project and communicated with the entire team, including design team, construction team, and manufacturers/producers.

1.2: Alternative Assemblies
Consider structural strategies that utilize low-embodied carbon solutions, such as FSC wood, instead of concrete or steel. Save concrete use only for those structural components where it is necessary. This may include utilizing concrete-free approaches for typical assemblies such as a concrete-free 'slab on grade', which is most often utilized on single family project types (see JLC article references in "Additional Resources" section). Finally, utilize precast concrete members wherever possible as these have a lower embodied carbon footprint than site cast concrete due to less transportation of materials and streamlining of the manufacturing process as well as the potential to cure the precast members in a high CO2 environment, thereby sequestering carbon (see item 3.6 for more information).

1.3: Design to reduce concrete use
Where concrete must be utilized, size the components appropriately to reduce the volume of material used as much as possible and specify the lowest weight concrete possible. This will be best achieved with full support from the Structural Engineering team, as well as comprehensive quality control from

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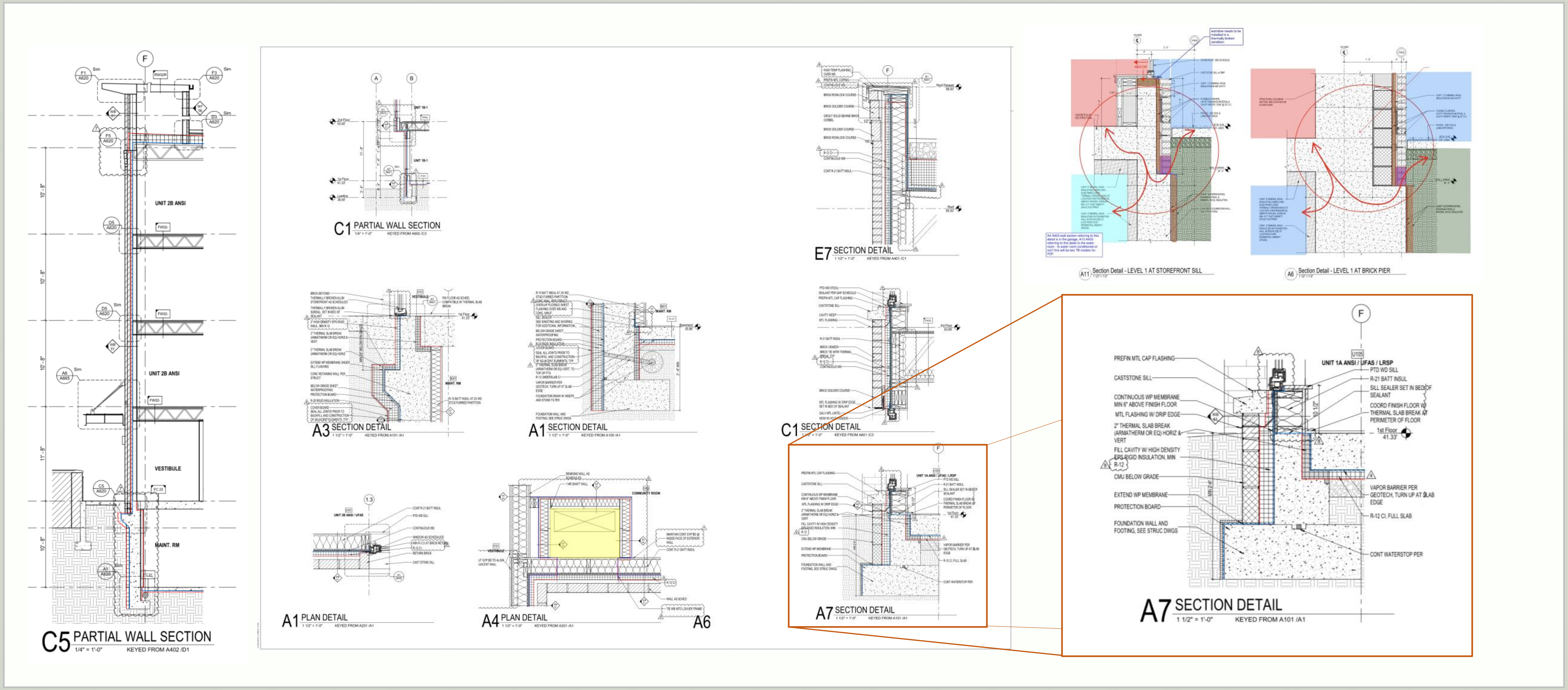
THERMAL BRIDGING ANALYSIS

Varying house types and topography = Unique conditions for each house => Quick analysis of thermal bridge worst case scenarios.

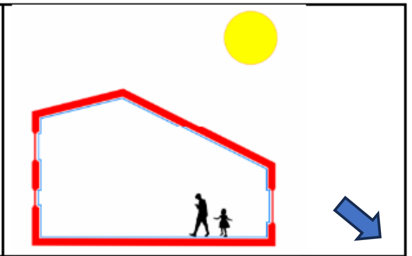
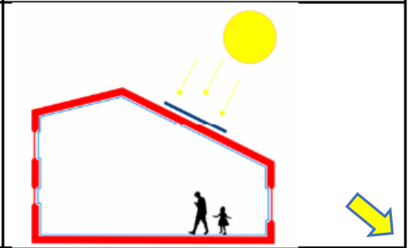
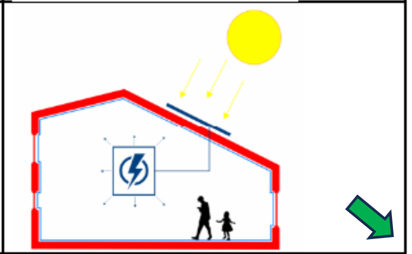
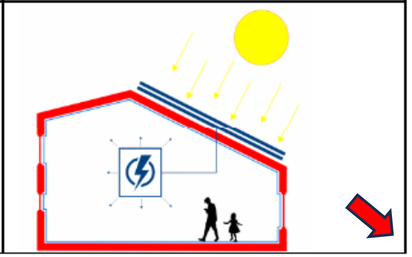
Design team buy-in meant early conversations with the architectural and structural teams.

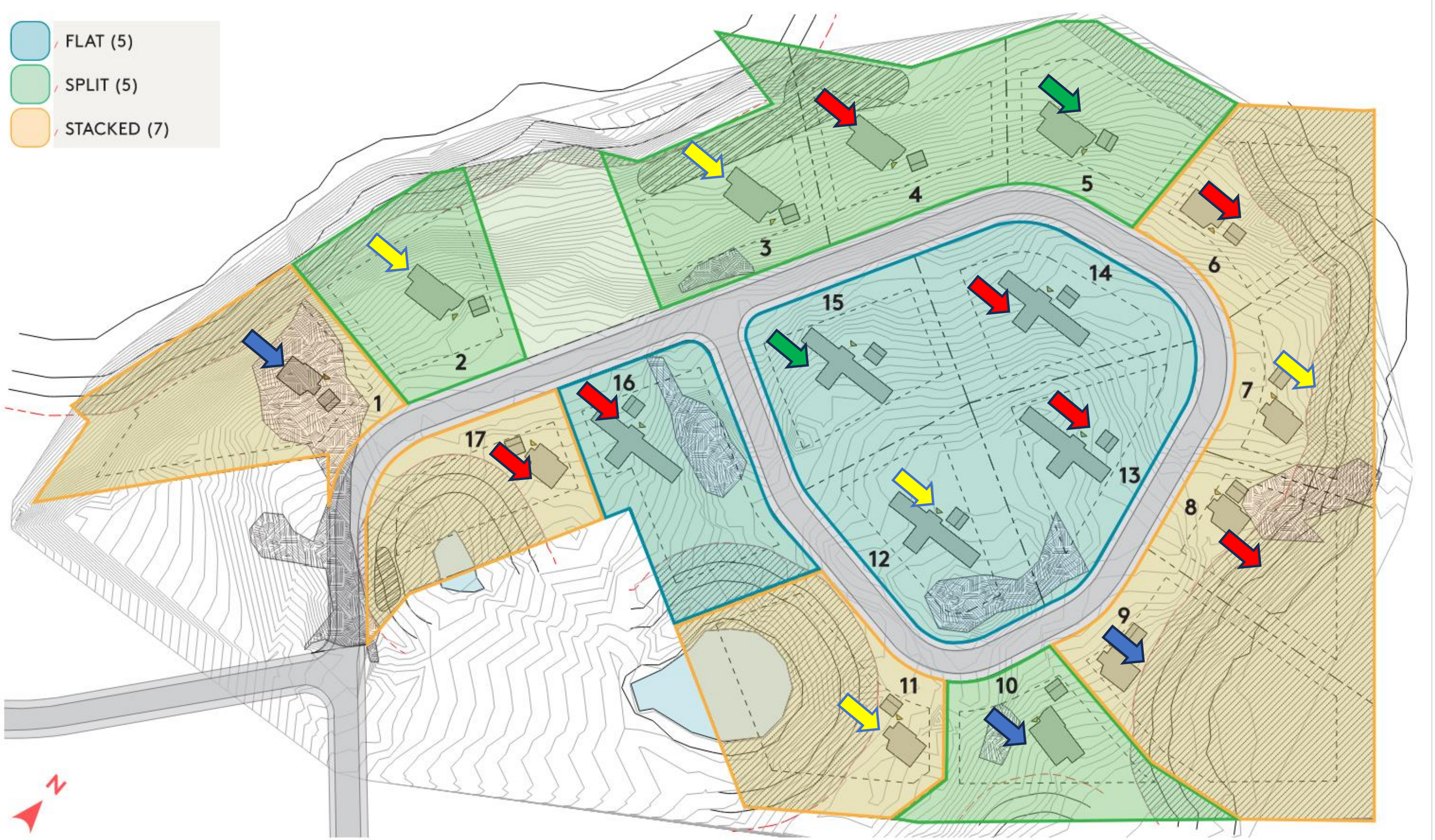


RESILIENCE CONCEPTS

- CPHC led conversation – potential for 'Resilience Upgrade' Packages.
- Can be an easy add-on for the developer – 3 solar/battery studies, 17 possible upgrades.

Eagle Rock 'Resiliency Packages'

Basis of Design: Passive Survivability: High Performance Building Envelope & Systems - Passive House design principles provide a house that will maintain comfort and occupant safety year-round, with minimal energy inputs. - Deep and meaningful energy use reductions. - Robust thermal and airtight envelope, controlled ventilation and use of efficient MEP systems.	
Package 1: Net Zero - Solar PV provided on the roof to meet Net Zero Energy target.	
Package 2: Balanced PV and Energy Storage (Resilience) - Solar PV provided on the roof. - PV power production is balanced between everyday use and battery storage. - Includes critical loads review for storage system sizing.	
Package 3: Full Zero Energy and Resilience - Solar PV provided on the roof to meet Net Zero Energy target. - Additional PV for battery storage. - Includes critical loads review for storage system sizing. - Includes possible bi-directional EV charging / EV as house battery system.	



Building COMMUNITY

MORE THAN A DEVELOPMENT – PLACEMAKING

What makes this community unique?

What ties these houses together?

How is this place marketable?

Building COMMUNITY

MORE THAN A DEVELOPMENT – PLACEMAKING

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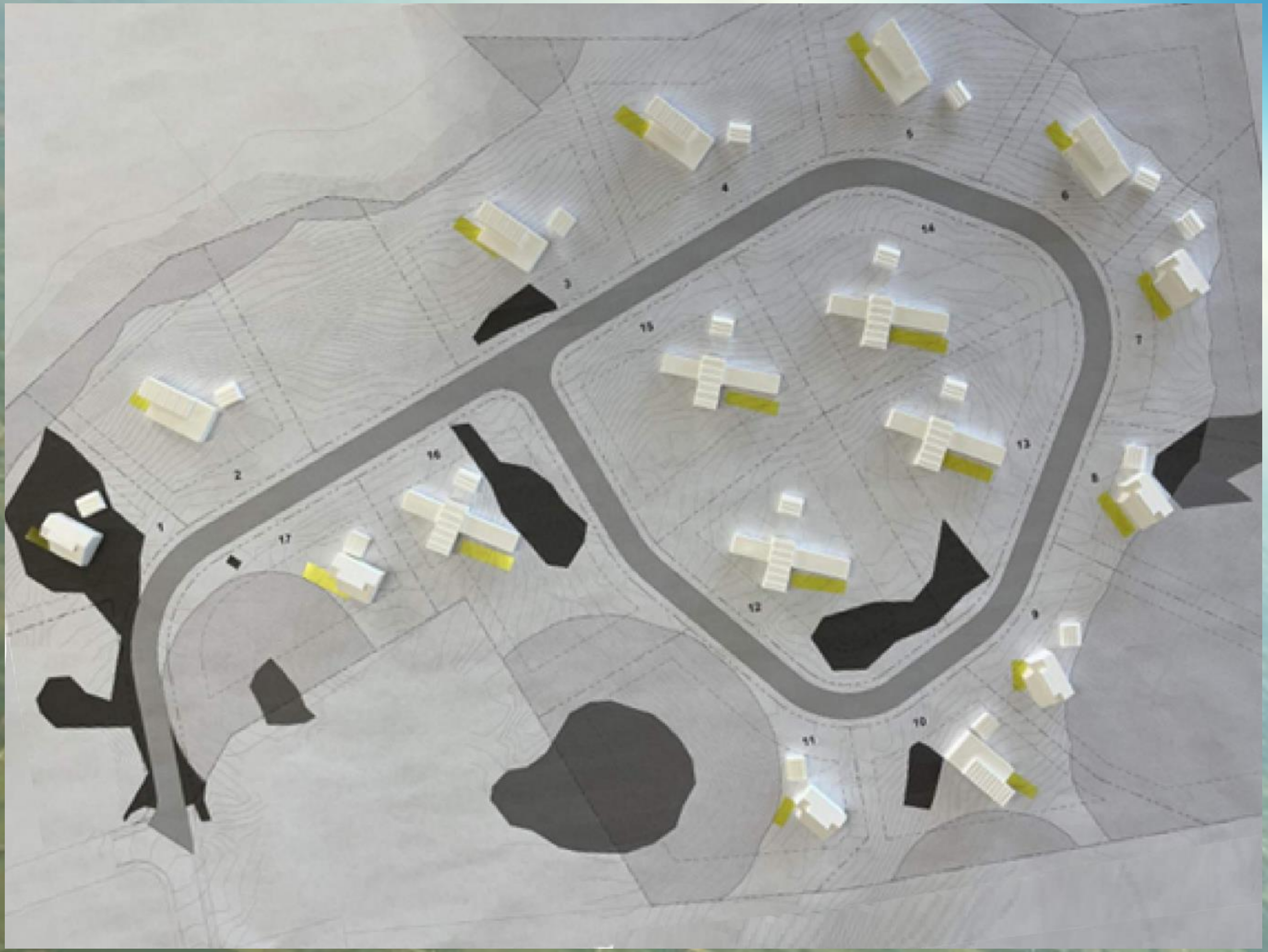
SHARED DESIGN AESTHETIC

USONION CONCEPT



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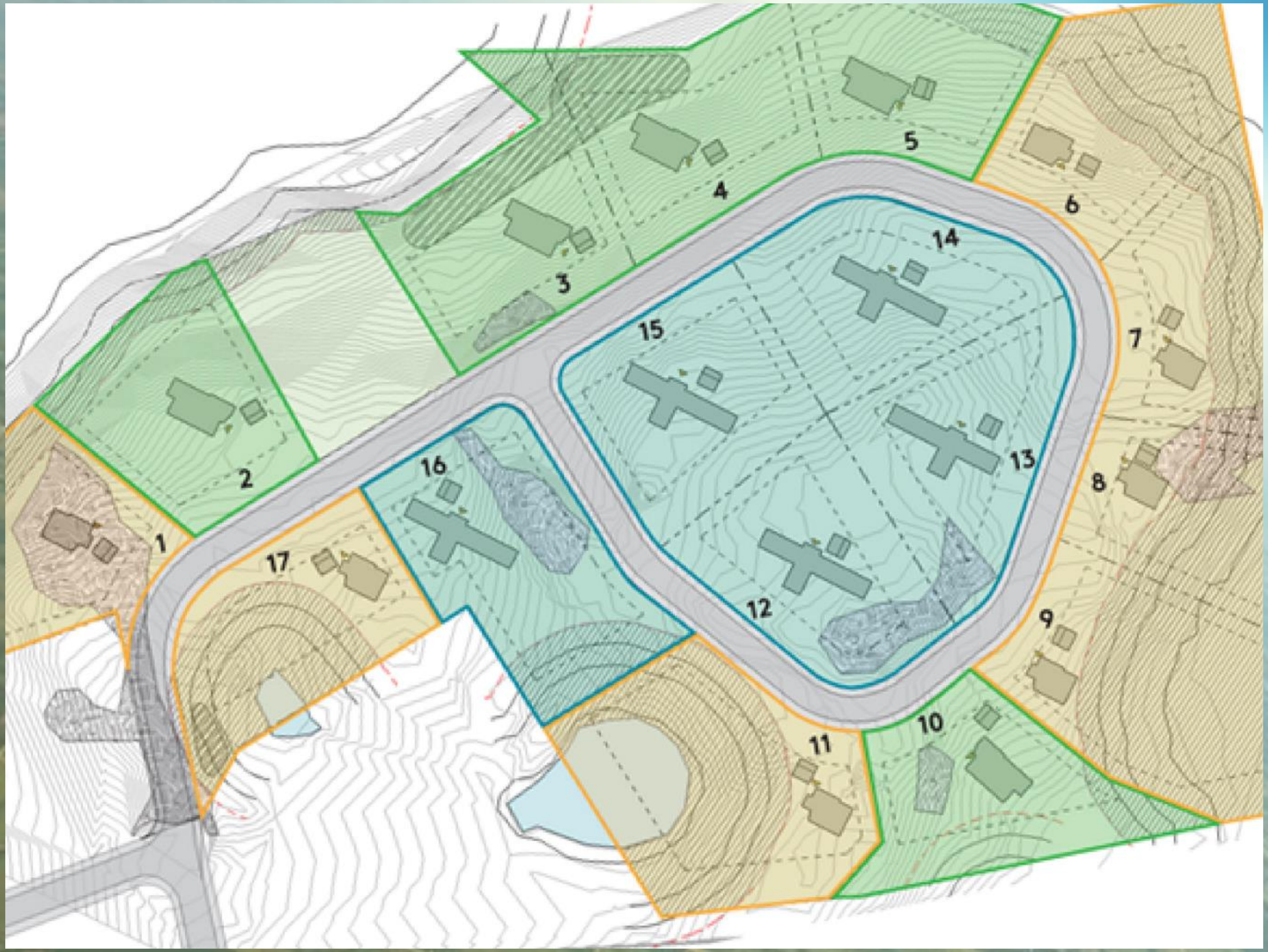
USONION CONCEPT

LOW-IMPACT ETHIC

CONSERVATION FIRST – DO NO HARM

EMBODIED CARBON REDUCTION



Building COMMUNITY

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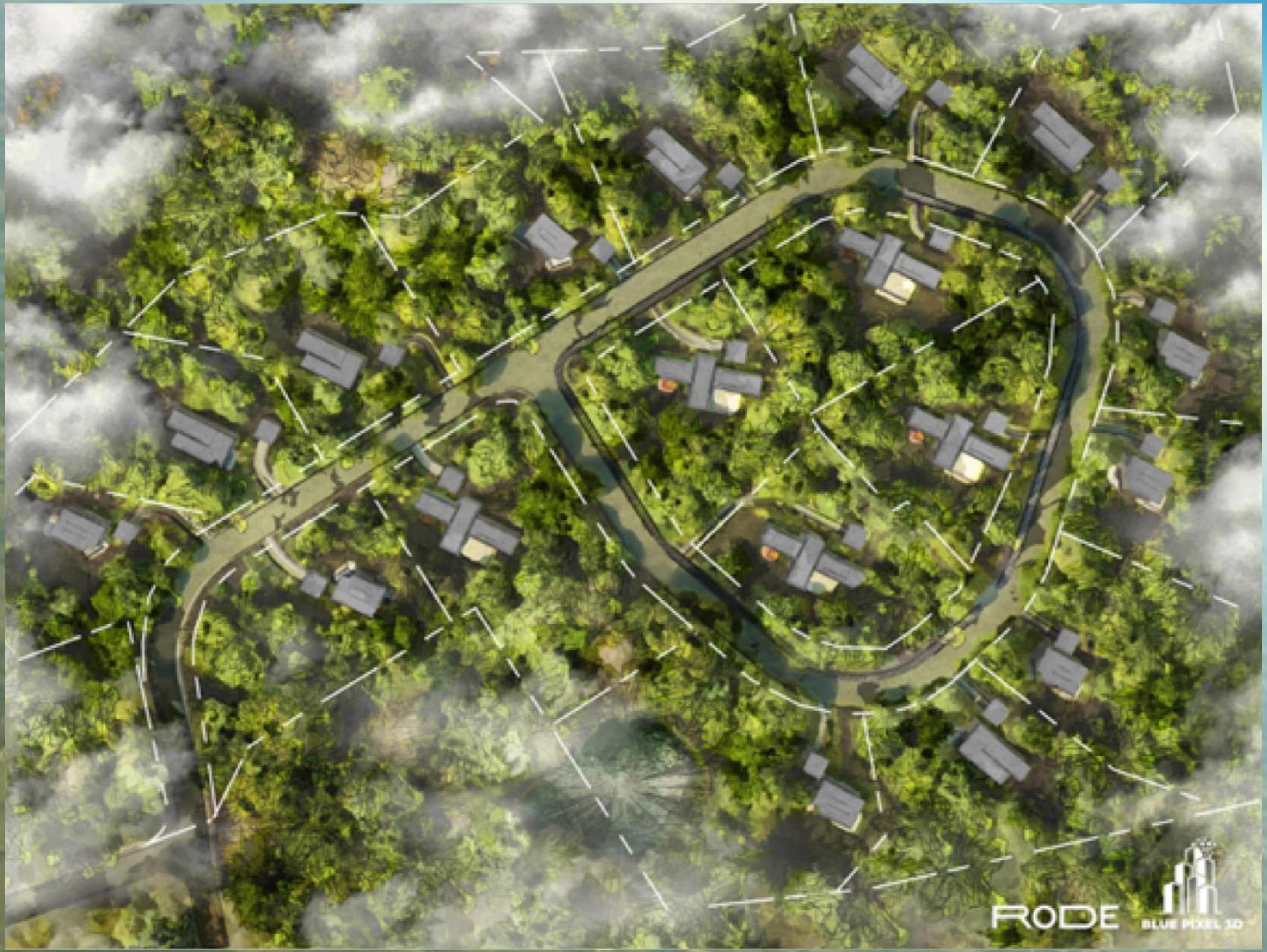

SHARED DESIGN AESTHETIC

USONION CONCEPT

LOW-IMPACT ETHIC

CONSERVATION FIRST – DO NO HARM

EMBODIED CARBON REDUCTION

HEALTH AND COMFORT

RESILIENT HOMES, RESILIENT COMMUNITY

SHARED RESOURCES

SHARED PURPOSE

Passive to POSITIVE

PASSIVE HOUSE AND LOW IMPACT DESIGN

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