



IN THE WOODS-  
**ALEX CARVER**  
NORTHERN TIMBERS  
CONSTRUCTION



RIVER VIEW-  
**TOM LEBOEUF**  
NORTHEAST CRAFTSMEN GROUP  
AND H.J. LEBOEUF INC.



LAKE DUNMORE-  
**JARED MOATS**  
STRUCTURAL ENERGY  
CORPORATION

**JEAN TERWILLIGER, ARCHITECT**  
VERMONT INTEGRATED ARCHITECTURE, P.C., MIDDLEBURY, VT

**THREE HIGH-PERFORMANCE HOMES, THREE APPROACHES**

# PRESENTATION GOALS

BASIC PERFORMANCE TARGETS OF HIGH PERFORMANCE HOME DESIGN

ELEMENTS OF A HIGH PERFORMANCE ENVELOPE SYSTEM

- COMPARE PERFORMANCE, COST AND CONSTRUCTABILITY
- CONSTRUCTION CHALLENGES AND TRADE-OFFS

DESIGN ELEMENTS FOR UNIQUE HIGH PERFORMANCE HOMES

- FITTING SITES
- MEETING CLIENTS' NEEDS, PERSONALITIES AND LIFESTYLES



## COMMON FEATURES & GOALS

SMALL LOTS WITH NEIGHBORS

INDOOR/ OUTDOOR CONNECTION TO LAND

FULL TIME RESIDENCES FOR EMPTY  
NESTERS OR RETIREES

DESIRE FOR OPEN LIVING SPACE

NEED FOR OFFICE/STUDY/STUDIO ENTRY/  
MUDROOM

POTENTIAL FOR SINGLE LEVEL LIVING

MINIMIZE ENERGY AND MAINTENANCE COSTS

HELP COMBAT CLIMATE CHANGE



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## COMMON FEATURES

# EFFICIENCY VERMONT HIGH PERFORMANCE HOME SUMMARY

## ENVELOPE:

R-30 BASEMENT WALLS AND UNDER SLAB

R-40 WALLS

R-40 EXPOSED FLOORS

R-60 CEILINGS- FLAT OR SLOPED

R-5 WINDOWS (MAX U= .21)

R-4 DOORS

1 ACH50 MAX. BLOWER DOOR RESULT

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## HIGH PERFORMANCE HOME ELEMENTS

# EFFICIENCY VERMONT HIGH PERFORMANCE HOME SUMMARY

## SYSTEMS:

- EFFICIENT HEAT RECOVERY VENTILATION
- HEAT PUMP or ENERGY STAR RATED HEATING SYSTEM
- HEAT PUMP HOT WATER HEATER or ELECTRIC HOT WATER WITH DRAIN WATER HEAT RECOVERY
- ENERGY STAR APPLIANCES
- 95% ENERGY STAR LED AND/OR CFL LIGHTING

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## **HIGH PERFORMANCE HOME ELEMENTS**

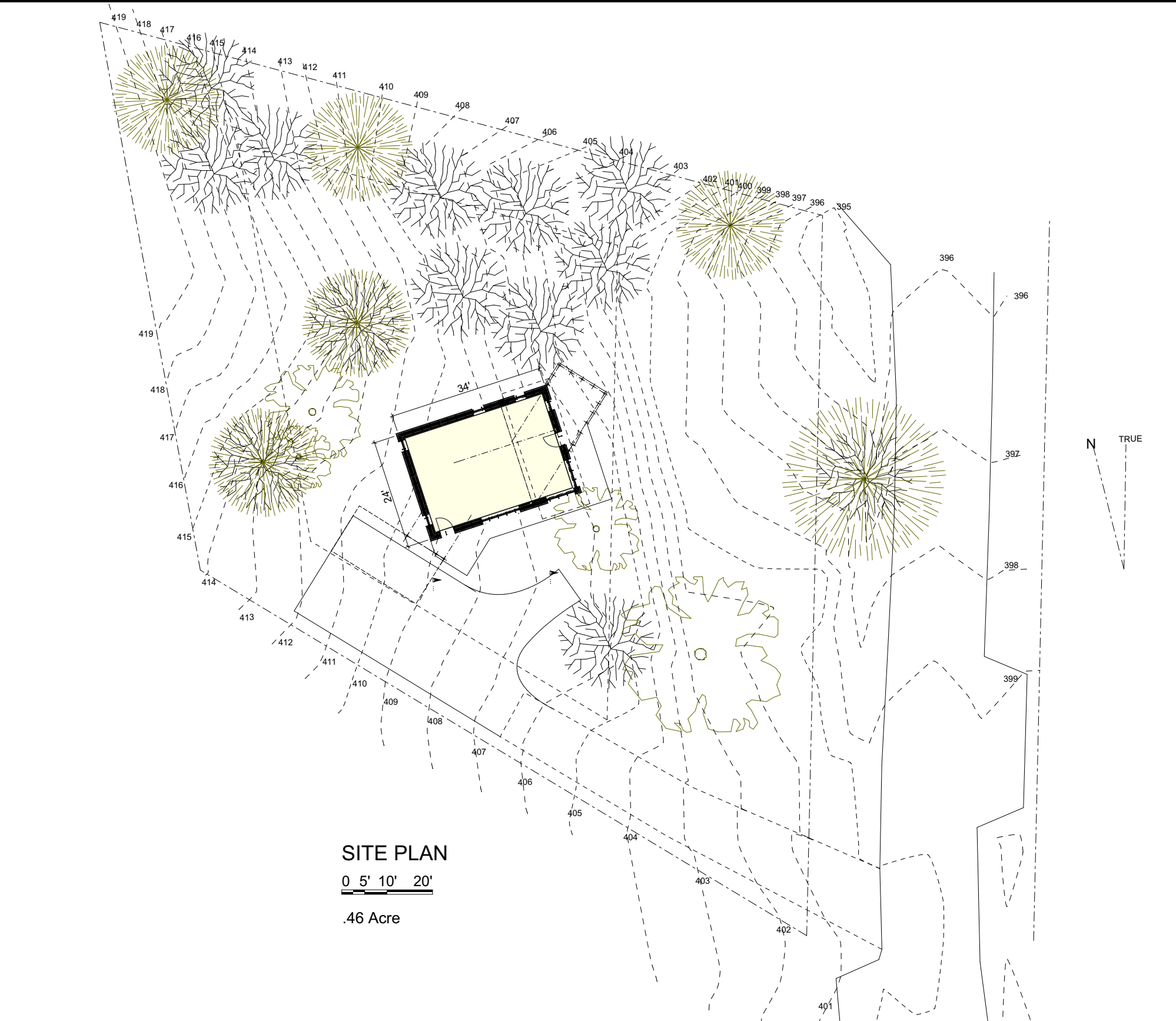




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**IN THE WOODS - DESIGN**





IN THE WOODS  
**SITE AND SITE PLAN**



Program:

Home and yoga studio

Small lot .4 acres

Sun and Privacy

2 BR

Place to write

Desire for angle in design

Cathedral ceiling

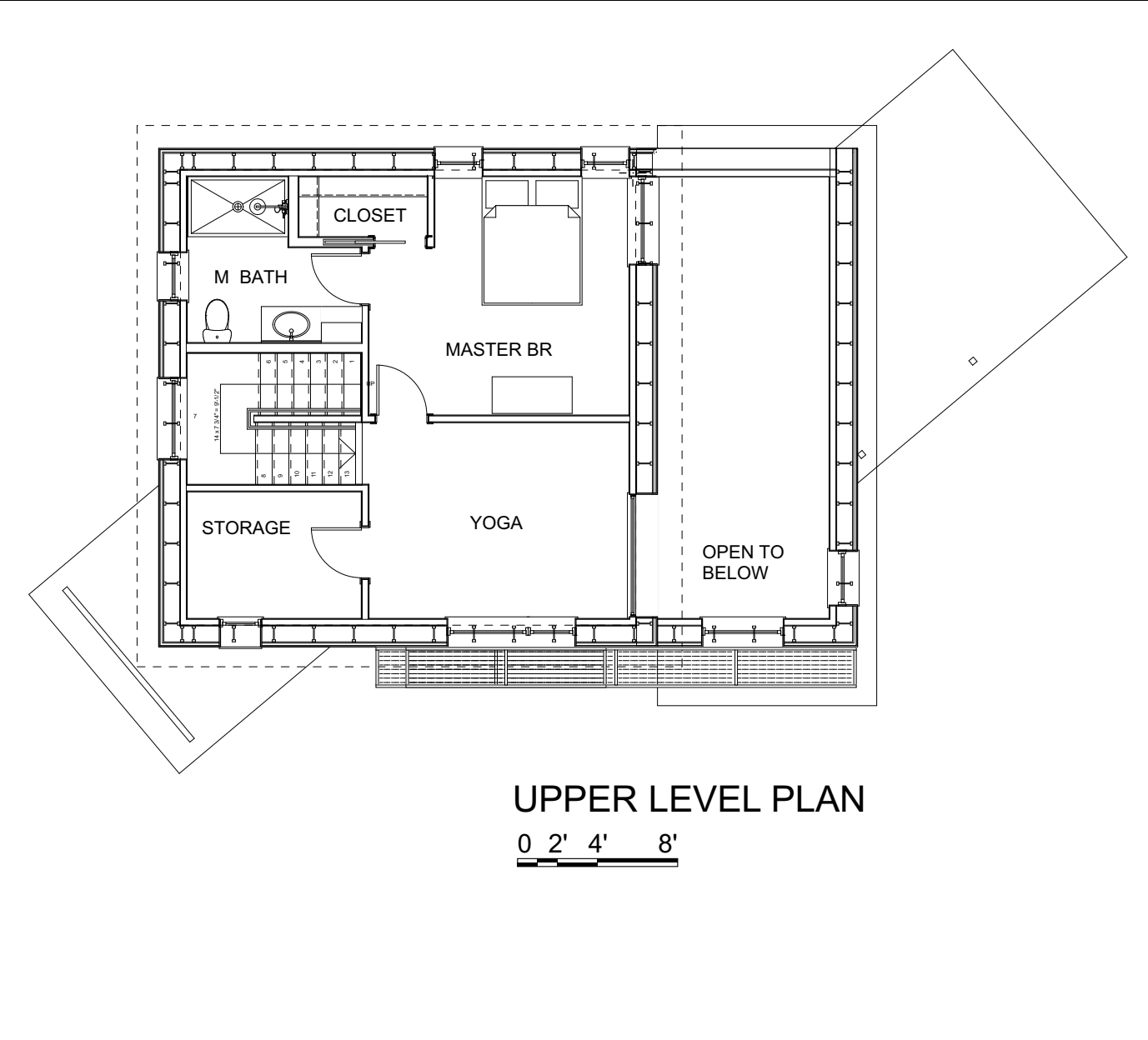
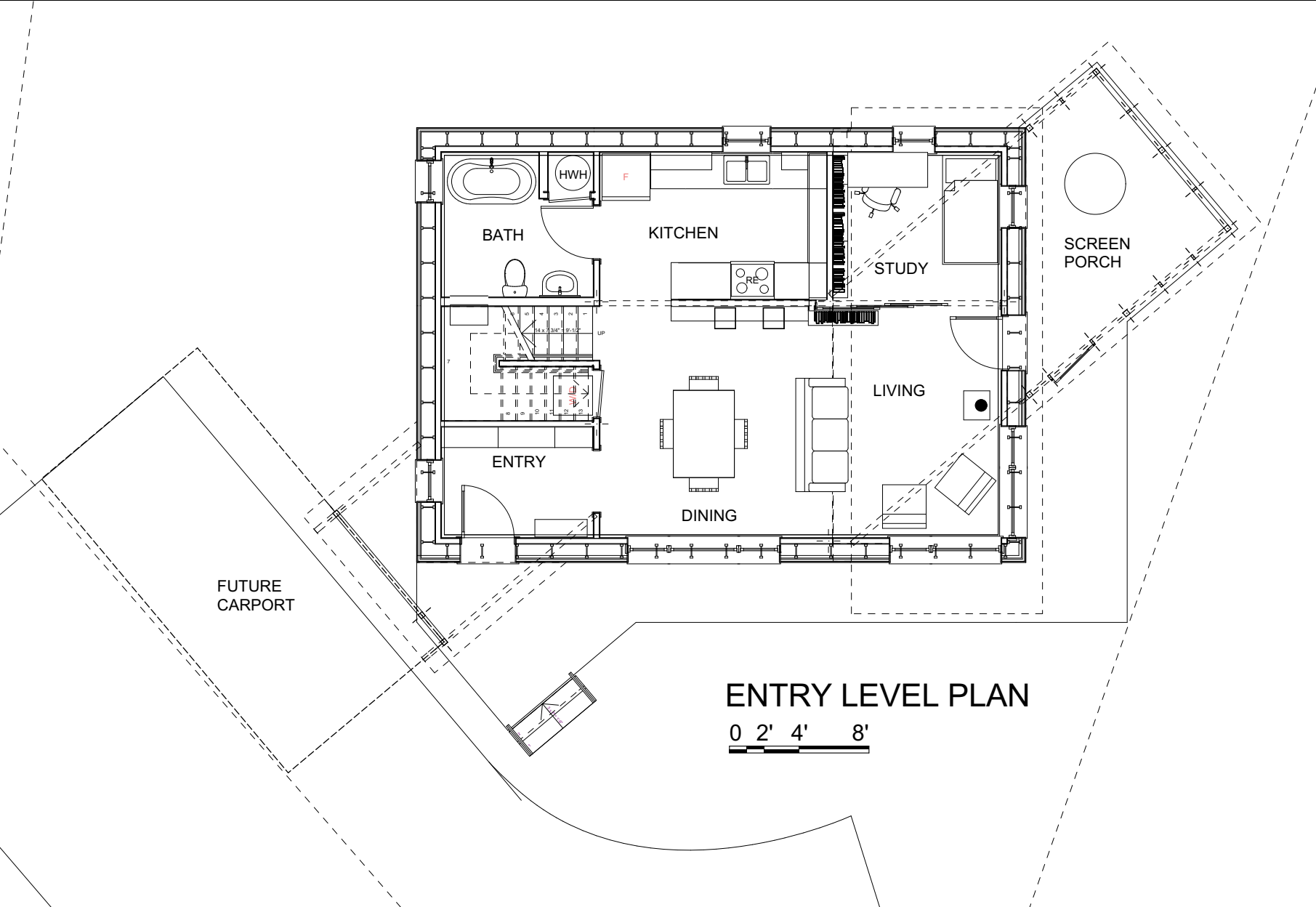


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IN THE WOODS

**GOALS, INSPIRATION & CONSTRAINTS**







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IN THE WOODS  
**ENTRANCE - INTERIOR**





IN THE WOODS  
**INTERIOR**



## HVAC:

2 pair Lunos E2 and bathroom fans

2 heat pump heads

Small woodstove with dedicated outdoor air

Electric hot water heater with drainwater heat recovery



# HERS: 42

(Home Energy Rating System)

Square Feet: 1254 sf. Volume: 12645 cu. ft.  
Blower Door: 155 cfm50, .74 ACH50

Predicted Energy Use:  
31.2 MMBtu,  
5.9 MMBtu heating, \$1500

Energy Use:  
26 MMBtu,  
20.7 kbtu/sf/yr,  
\$1260, 6905 kwh/yr electric,  
1/10 cord wood



## EVELOPE SYSTEMS:

### Foundation:

Concrete footing and ICF frost wall for 4' grade change  
Extra interior insulation  
Slab on grade- 8" EPS under 4" concrete

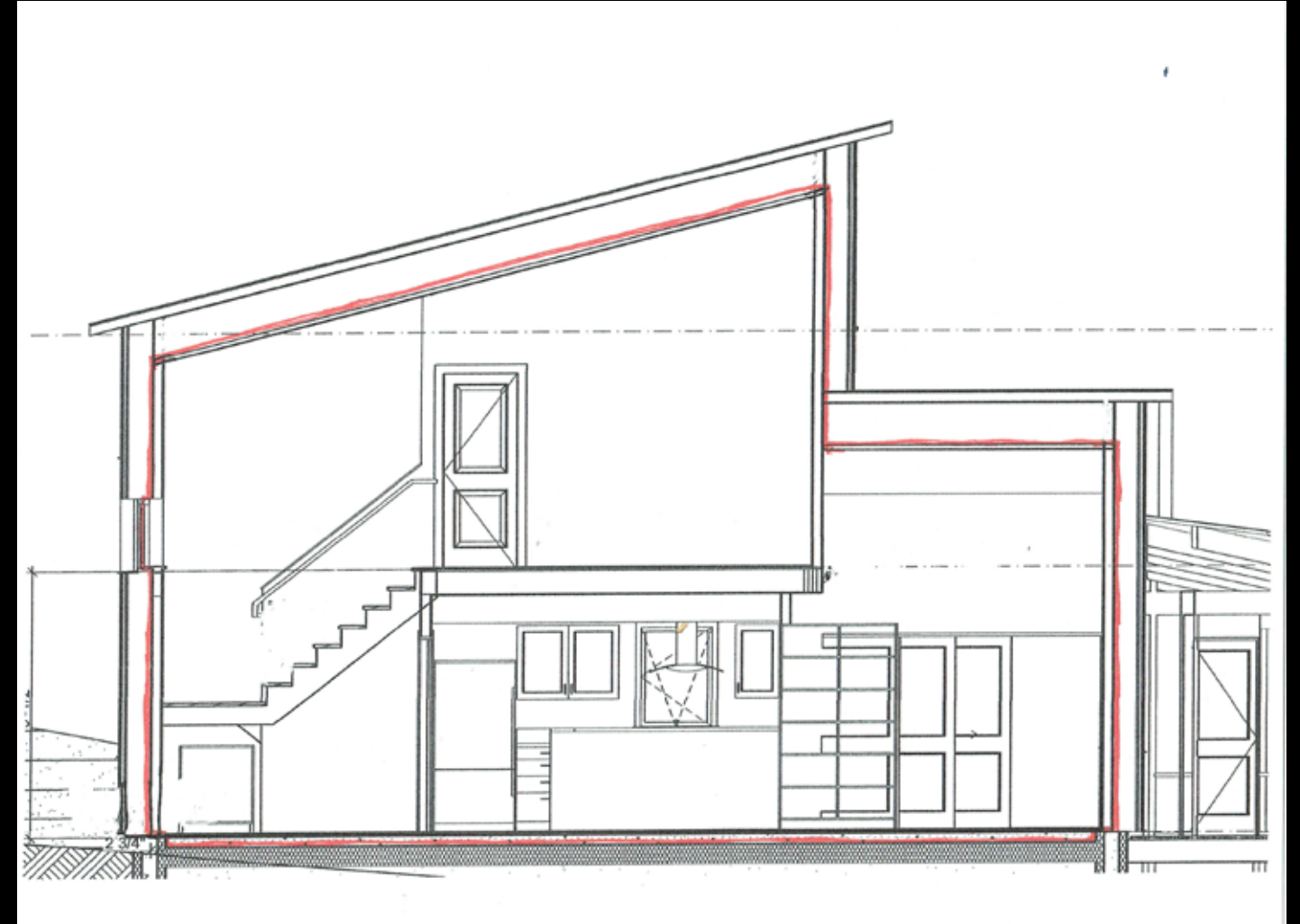
### Arctic wall:

2x4 at 24" oc  
OSB sheathing (taped as air barrier)  
9 1/2" continuous I-joists  
Cellulose outer contained by Mento Plus water barrier  
Mineral wool in mechanical cavity  
Corrugated metal siding

### Roof:

16" I-joist with dense pack cellulose  
Intello inner vapor/ air control layer  
1 1/2" strapping with mineral wool batt,  
2x4 framing above sheathing for vent cavity and eaves;  
Standing seam metal roof

Stick framed entry and screen porch







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**IN THE WOODS - CONSTRUCTION**



# ARCTIC WALL COMPONENTS

2 x 4 frame  
OSB Sheathing  
2x for Bucks





Double wall spans several floors

Bulk of insulation outside the air barrier

Vented siding





Interior Roxul insulation or Damp spray

External & Internal chase and mechanicals

Expedites building process





- R-60 Roof
- Continuous vapor barrier
- Cold roof assembly
- Overhangs





- Inbound/Outbound window placement
- Window buck & air sealing
- Weep holes







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## RIVER VIEW - DESIGN





RIVER VIEW  
**PRE-EXISTING SITE**



## Program:

- Traditional farmhouse
- Single level living potential
- Garage connection
- River views
- Walk-out basement to accommodate slope



RIVER VIEW

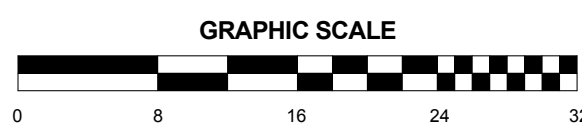
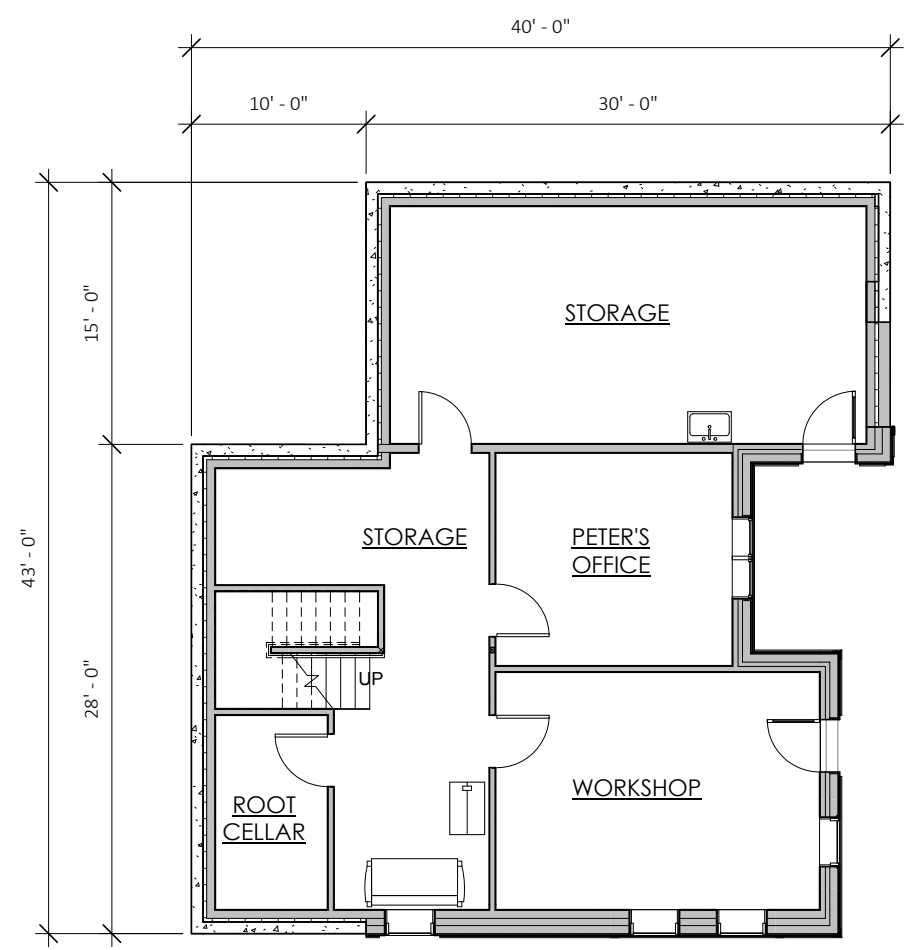
**GOALS, INSPIRATION & CONSTRAINTS**



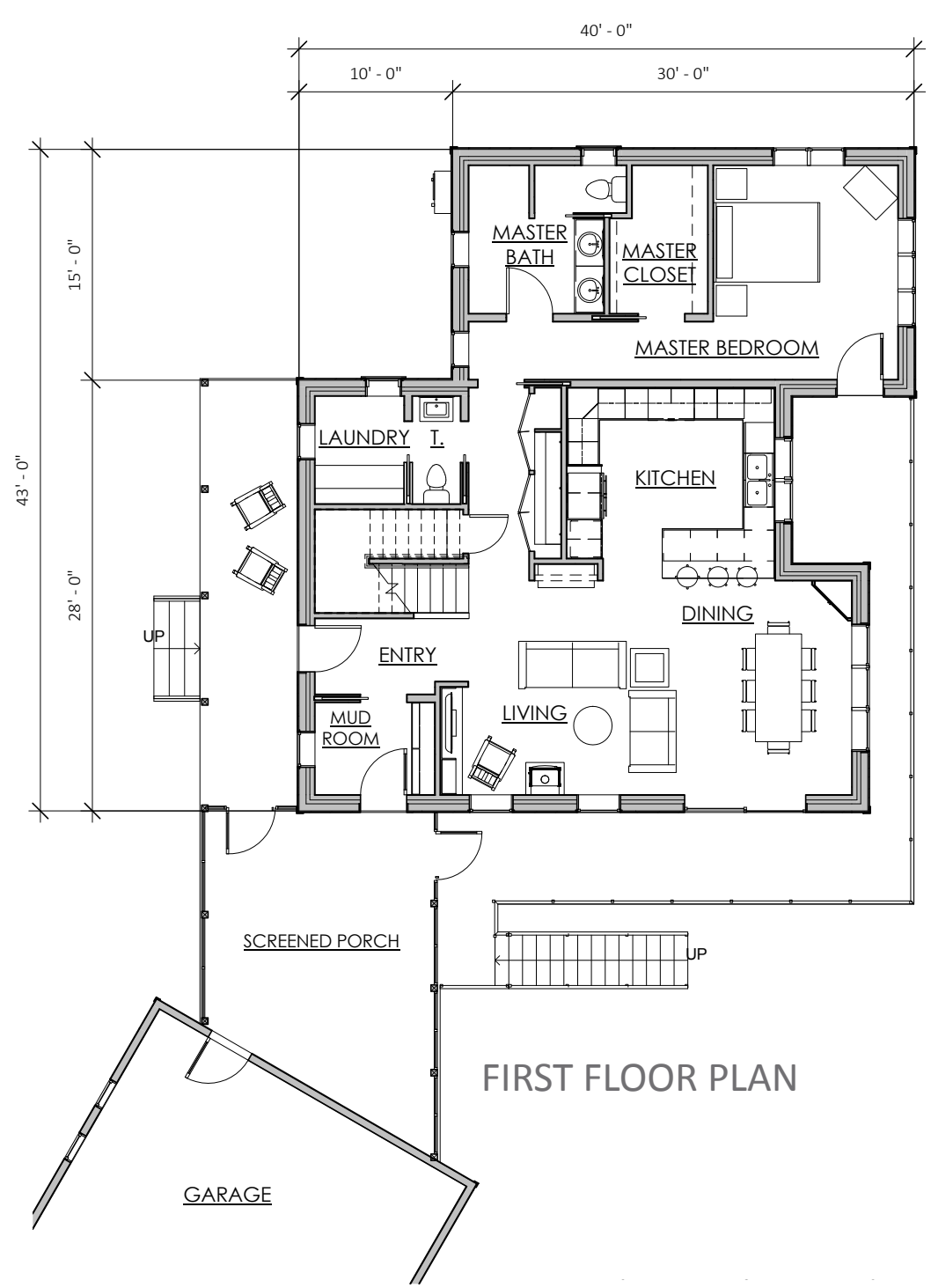


RIVER VIEW  
**SITE PLAN**

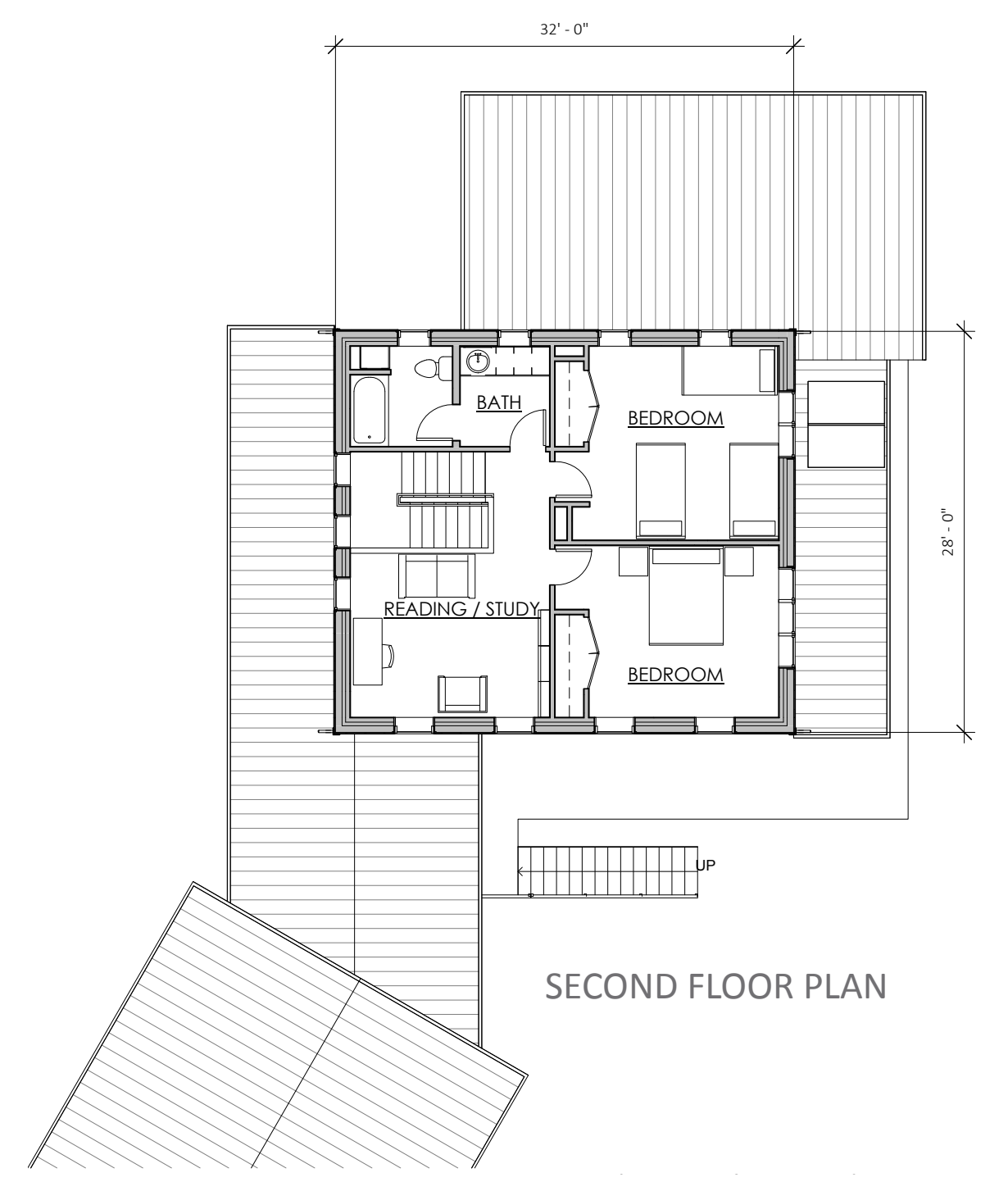




BASEMENT FLOOR PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN





RIVER VIEW  
**MAIN LIVING SPACE**





RIVER VIEW  
**KITCHEN**





RIVER VIEW  
**UPPER LEVEL**



ENVELOPE SYSTEMS:

Foundation:

- 8” (R-30) EPS under 4” concrete slab
- Concrete footing/ foundation wall with 2” XPS

Wall:

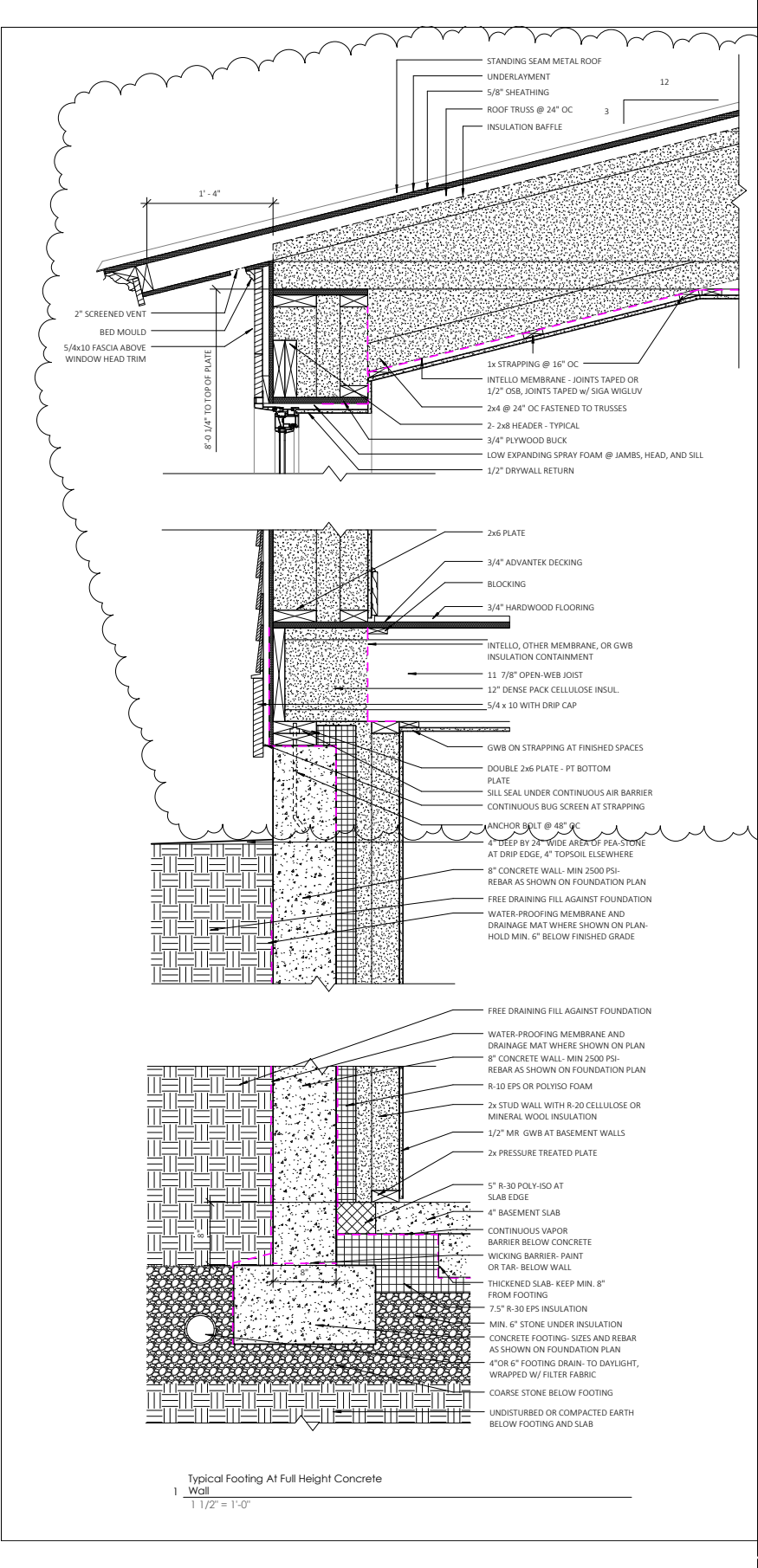
- 2x4 stud with R-20 batt insulation
- Double stud wall with airtight drywall
- Dense pack cellulose
- Rigid insulation w/ spray foam at rim joists
- Taped plywood sheathing with Mento membrane WRB
- Strapping
- Hardi prefinished clapboard siding

Roof:

- Raised heel truss with 6’ or 9’ plate height
- Intello vapor/air control layer
- Loose blown cellulose
- Stick framed screen porch

HVAC:

- Venmar HRV (156 cfm) with 6” metal duct
- 5 heat pump heads w/ 1 outdoor compressor
- Woodstove
- Heat pump hot water heater
- Bathroom electric radiant floors under tile





# HERS: 33, 12 after PV

(Home Energy Rating System)

Net-Zero operation predicted.

Square Feet: 3756 sf w/basement, Volume: 31021 cu ft

Blower Door: 203 cfm50, .4 ACH50

Predicted energy use:

48.8MMBtu/yr w/o PV production (\$2237),

20.2 MMBtu (\$1000) with 6.6kw PV production

Actual Energy Use:

51 MMBtu/yr, 15-17 kbtu/sf/yr,

Electric: 5070\* kwh, \$1200

1.5-2 cord wood (20 MMBtu/cord),

\*Estimated Electrical use and PV production. Less than 1yr of use.







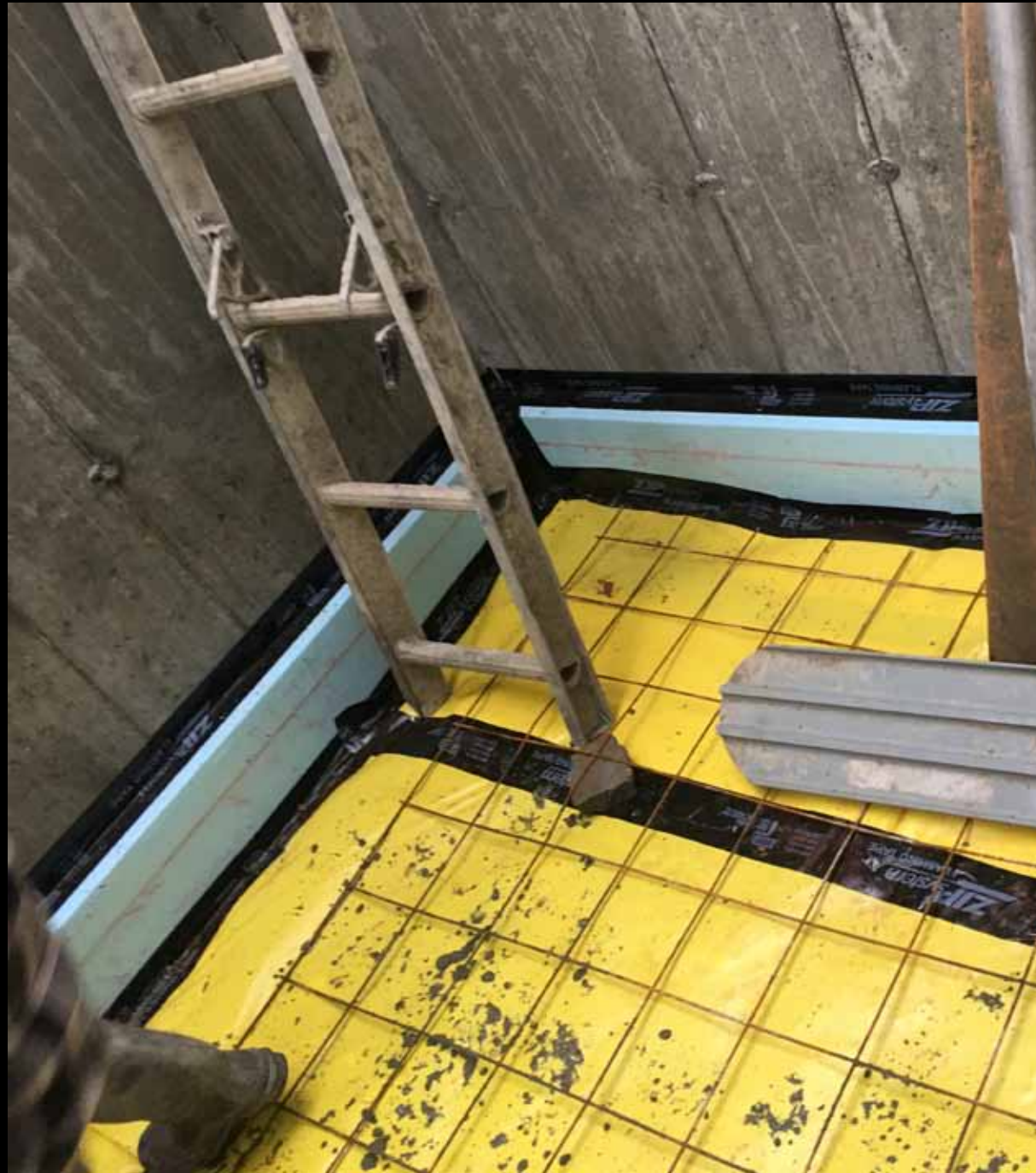
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**RIVER VIEW - CONSTRUCTION**



Keep poly flat to ensure tape adherence

Find the easiest method





Keep poly down until roof is on

Cut poly as close to sheathing as possible



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RIVER VIEW

**AIR SEALING AT FOUNDATION**



Try to create flat surfaces for ease of taping



RIVER VIEW

**AIR SEALING AT ROOF TO WALL CONNECTIONS**





RIVER VIEW  
**AIR SEALING AT ROOF TO WALL CONNECTIONS**



Go over install procedures thoroughly





Air tight drywall method can work well  
Caulking  
Can spray foam

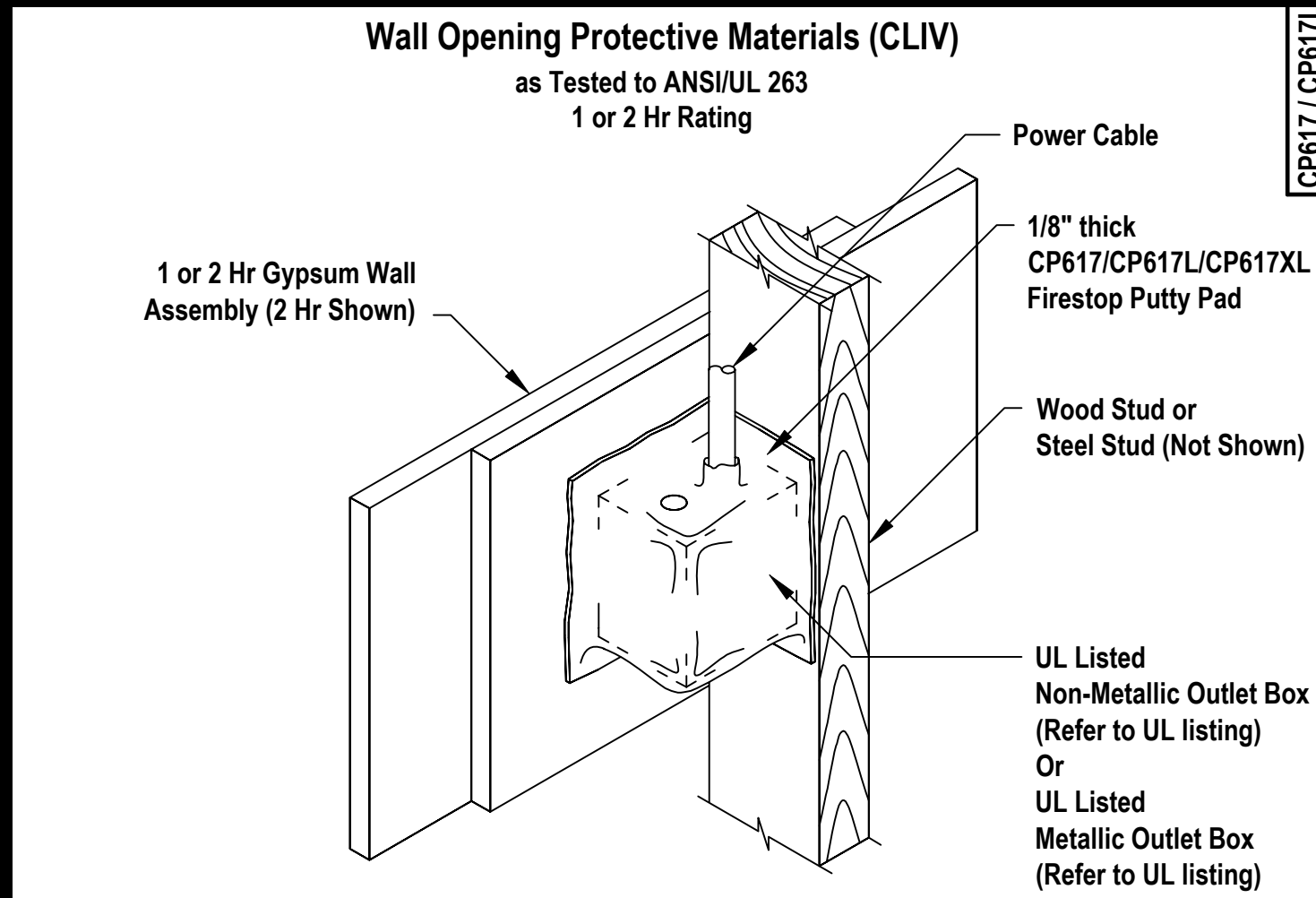




Figure out roof panel layout with pv layout/roof penetrations in advance





Help out mechanical/plumbing contractors

Options on duct work







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## LAKE DUNMORE - DESIGN





LAKE DUNMORE  
**SITE**





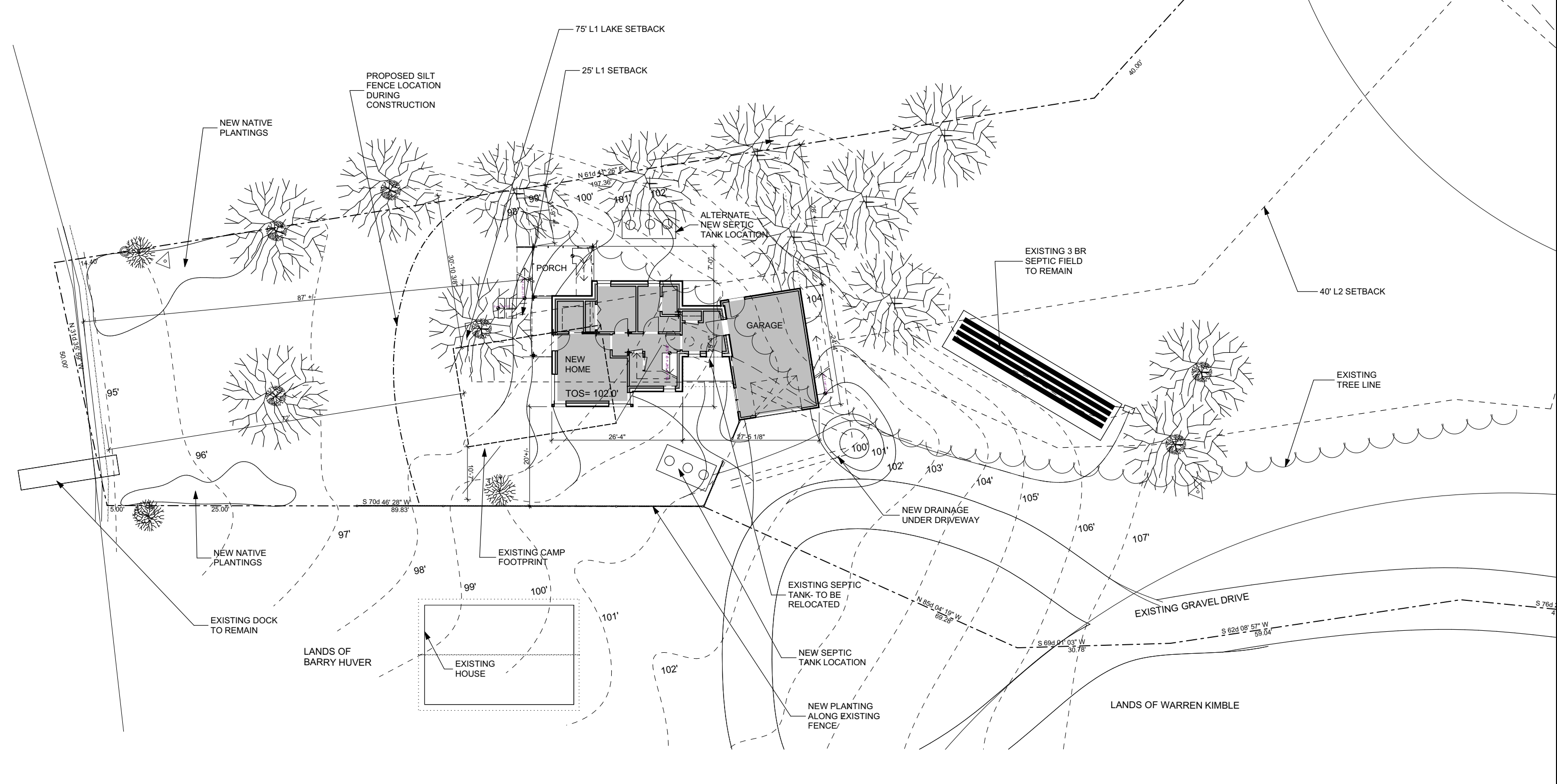
Program:  
Home and professional studio  
Option for air b-n-b rental  
Living space on upper level to improve lake views  
Desire for cathedral ceiling space

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LAKE DUNMORE

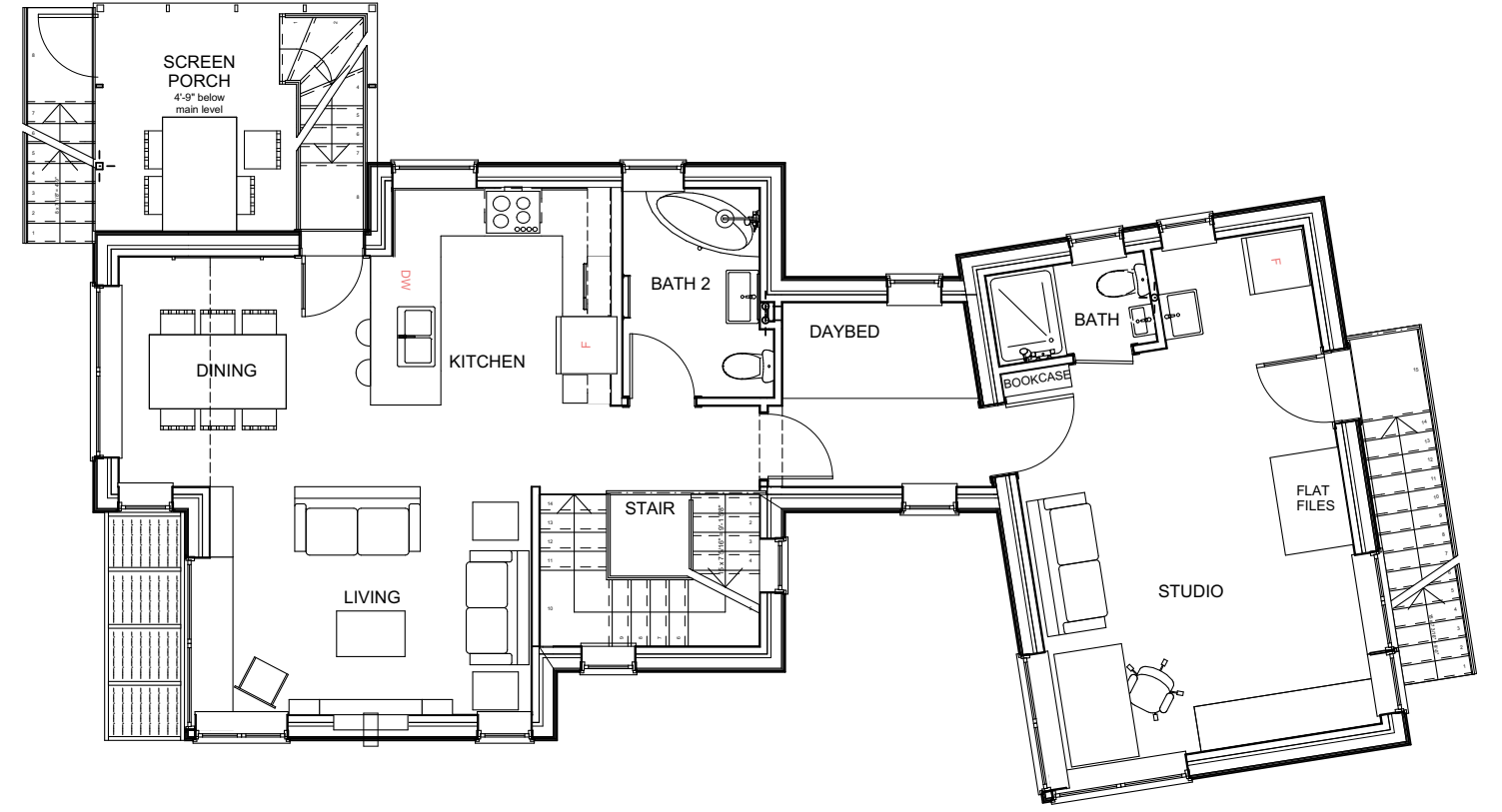
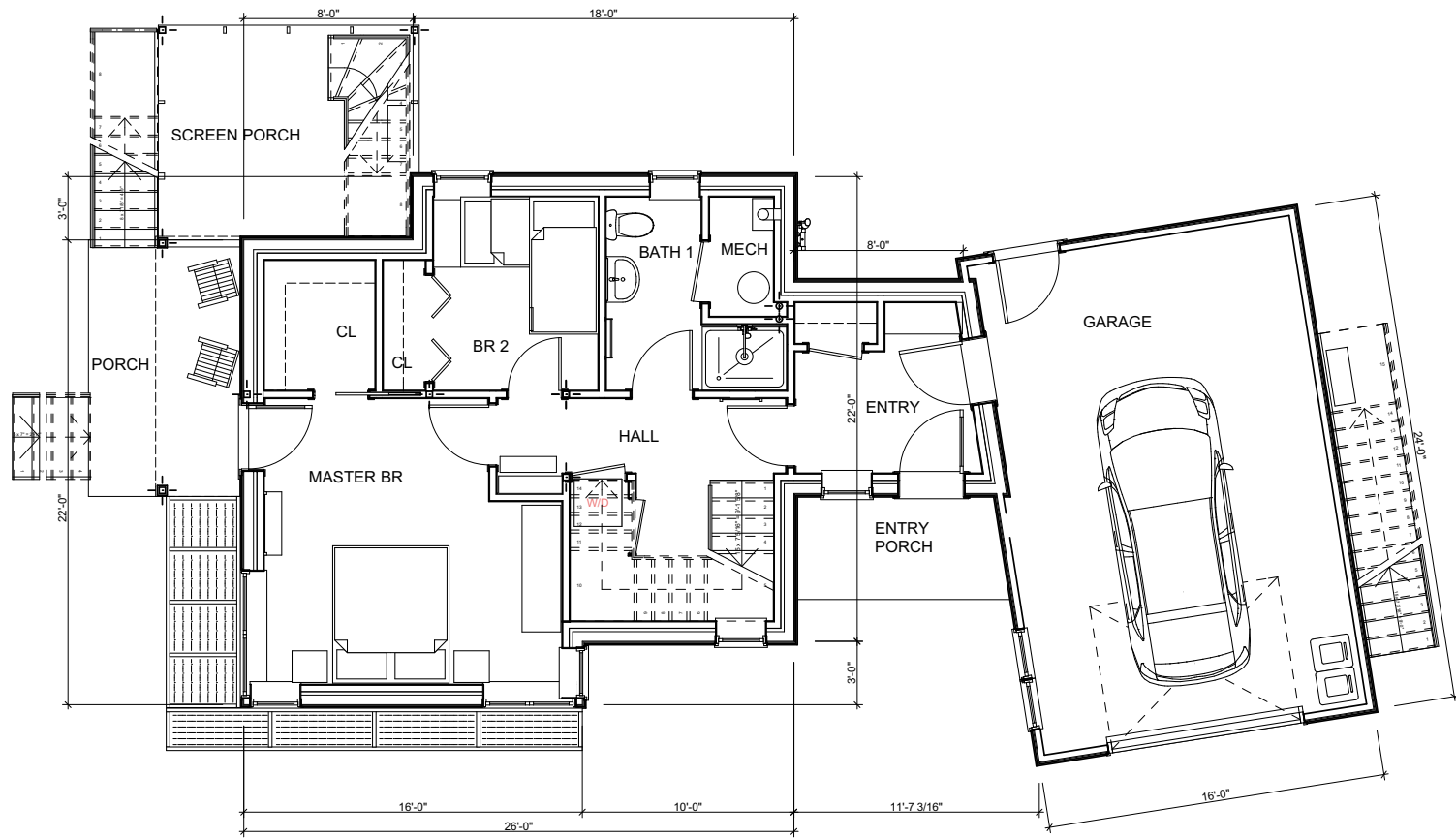
**GOALS, INSPIRATION & CONSTRAINTS**





LAKE DUNMORE  
**SITE PLAN**









LAKE DUNMORE  
**ENTRY**





LAKE DUNMORE  
**LIVING SPACE**





LAKE DUNMORE  
**PRIVATE SPACES**



# ENVELOPE SYSTEMS:

## Foundation:

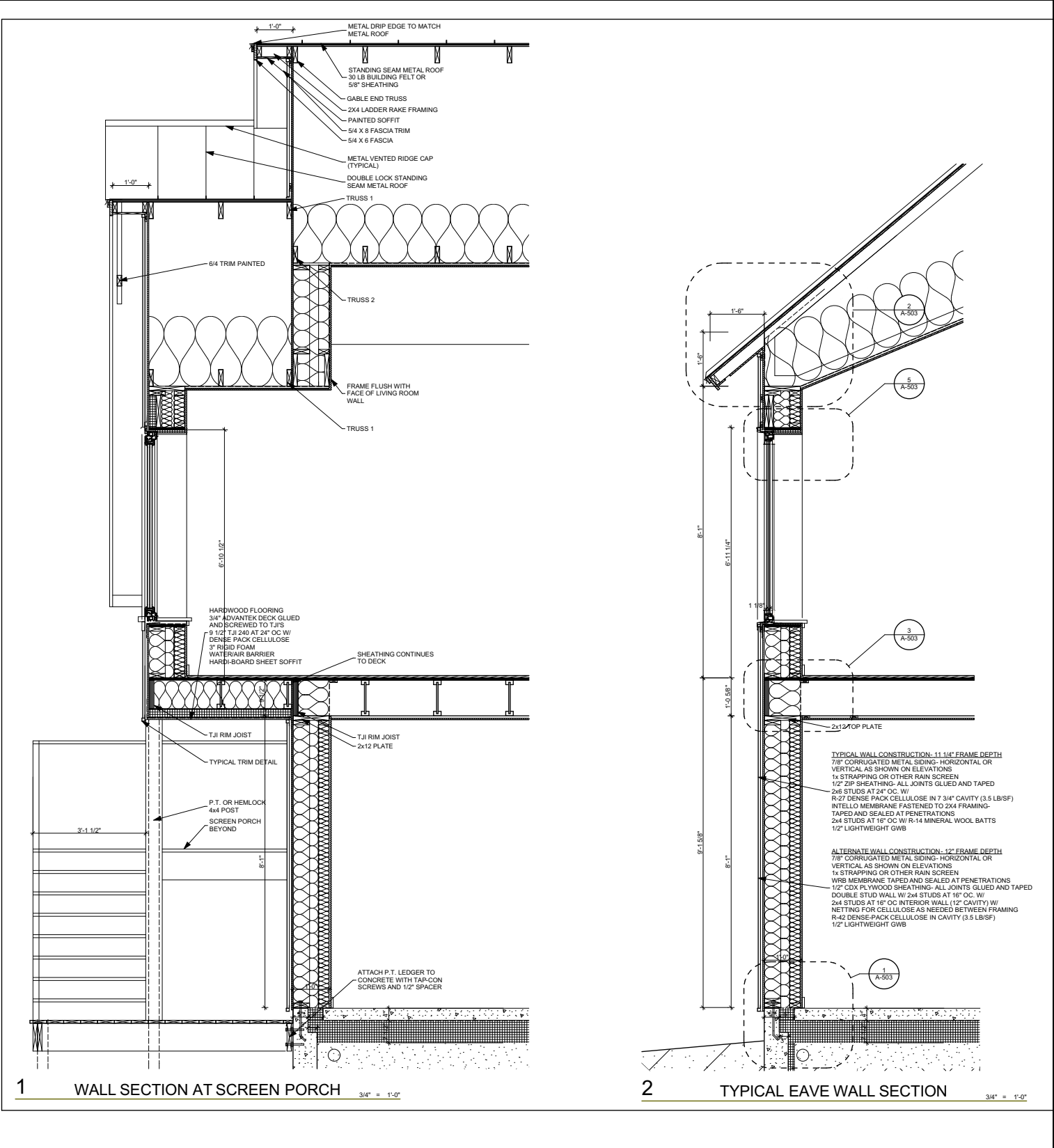
Concrete footing/ foundation wall with 2” XPS  
2x4 stud batt insulation,  
8” EPS under 4” concrete slab

## Wall:

Double stud wall with airtight drywall  
Dense pack cellulose outer  
Mineral wool in inner stud bay  
Rigid insulation spray foam rim joists  
Zip sheathing, taped  
Corrugated metal siding

## Roof:

Scissors trusses, various plate heights  
Intello vapor/air control layer  
Loose blown cellulose  
  
Stick framed screen porch





# HERS: 44

(Home Energy Rating System)

Square Feet: 1790 sf w/studio, Volume: 15987 cu. ft.

Blower Door: 155 cfm50, .58 ACH50

Predicted energy use:

45.4 MMBtu, 21.9 MMbtu heating  
\$2172

Actual Energy Use:

Electric: 9580 kwh/yr, \$1683

Propane: 200 gal., \$650

32.84 MMBtu, 18.4 kbtu/sf/yr

Moisture monitoring- 5 locations, recorded  
very stable at 8-16% moisture







**LAKE DUNMORE - CONSTRUCTION**





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LAKE DUNMORE  
**FOUNDATION, FRAMING AND WINTER CONDITIONS**





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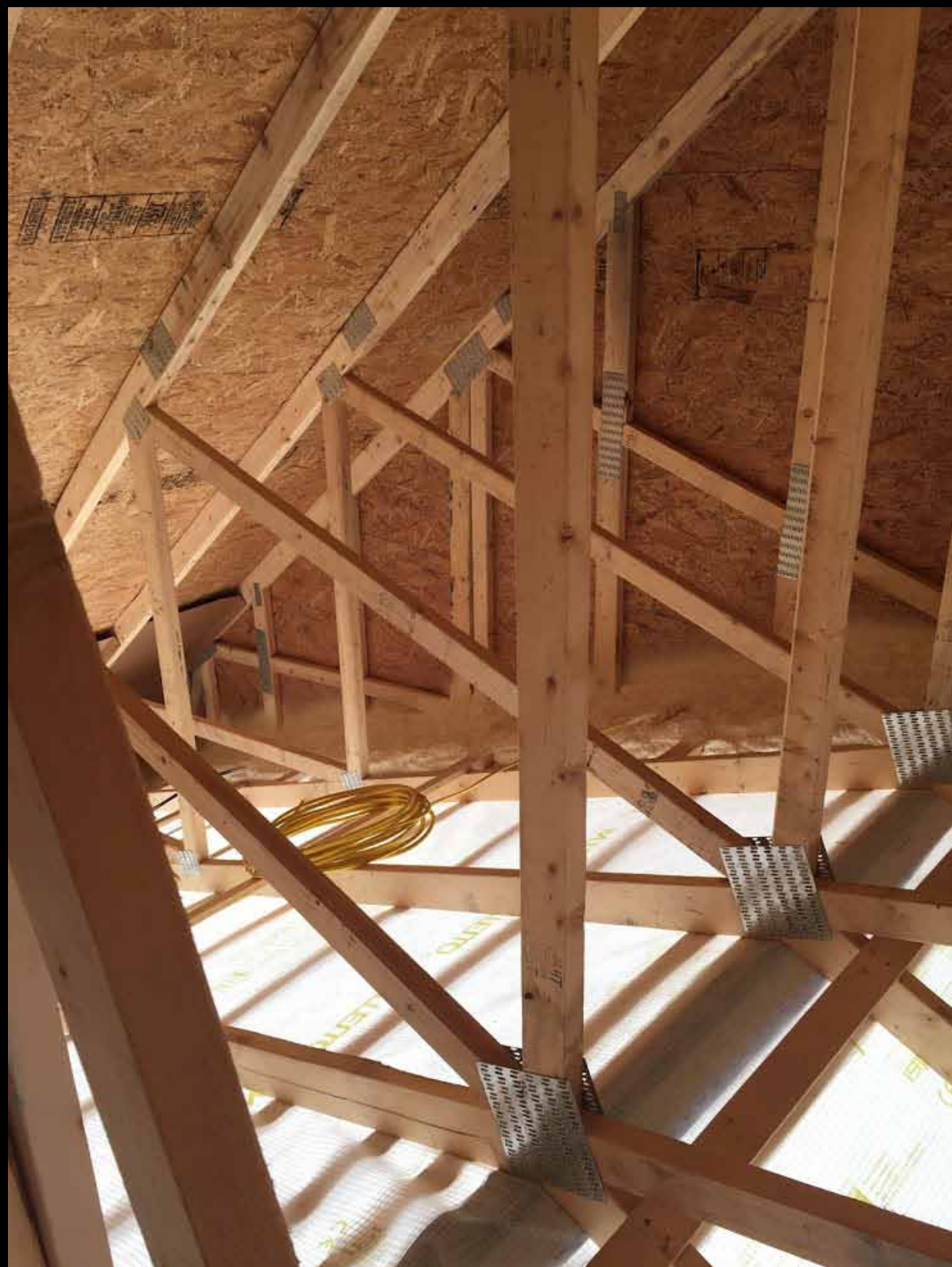
LAKE DUNMORE  
**SCISSOR TRUSSES**





LAKE DUNMORE  
**INNER STUD WALL WITH MECHANICAL CHASE**





LAKE DUNMORE  
**AIR SEALING STRATEGIES**





LAKE DUNMORE  
**WINDOW INSTALLATION**



## HVAC:

3 pair Lunos E2 HRV (60 cfm max.)  
Bath fans  
3 heat pump heads  
Master bathroom electric towel warmer,  
Gas fireplace  
Heat pump hot water heater





WALL ASSEMBLY COST COMPARISON

Arctic Wall- R-48			Double stud wall- R-43			Double stud w/ service cavity- R-44				
2x4 wall w/ 9 1/2" I-joists			2x4 wall		2x6 wall(30% increase)	2x4 wall		2x6 wall(30% increase)		
Plates	\$	315.20	\$	315.20	\$	409.76	\$	315.20	\$	409.76
Studs	\$	1,255.50	\$	1,255.50	\$	1,632.15	\$	1,255.50	\$	1,632.15
Headers	\$	419.00	\$	-	\$	419.00	\$	-	\$	419.00
Window and door bucks	\$	449.65	\$	250.00	\$	-	\$	450.00	\$	-
Insulation at window jamb	\$	450.00	\$	-			\$	-		
Sheathing	\$	1,125.00			\$	1,867.50			\$	1,867.50
Strapping	\$	1,012.00	\$	-	\$	1,012.00	\$	-	\$	1,012.00
Insulation	\$	7,741.00			\$	6,780.00	\$	7,741.00		
Air sealing- membrane and tape	\$	4,200.00	\$	4,200.00			\$	4,200.00		
TJI	\$	2,024.00								
			\$	6,020.70	\$	12,120.41	\$	13,961.70	\$	5,340.41
Total	\$	18,991.35			\$	18,141.11			\$	19,302.11

Note: Numbers do not include framing or air sealing labor



## CLOSING THOUGHTS:

- HIGH PERFORMANCE BUILDINGS MAKE BEAUTIFUL HOMES! THEY DO TAKE MORE PLANNING.
- ONE PERSON SHOULD TAKE RESPONSIBILITY FOR AIR SEALING!
- YES, DO TRY THESE IDEAS IN YOUR OWN PROJECTS!
- WE SHAPE OUR BUILDINGS, THEREAFTER THEY SHAPE US.- WINSTON CHURCHILL
- USE HIGH PERFORMANCE CONSTRUCTION, YOUR CLIENTS WILL BE WARM AND HAPPY CUSTOMERS!





# THANK YOU!      QUESTIONS?



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## THREE HIGH-PERFORMANCE HOMES, THREE APPROACHES







- R-30 at slab edge
- Kerf in Blueboard
- Visible reference line for slab pour

