9 Bancroft Rd — Calculations & Specifications

Design Basis — 9 Bancroft Rd Ranch

Living spec. Every downstream drawing, schedule, and calc derives from the values here and from `model/`. Change a value here → regenerate. Status tags: **[DECIDED]**, **[ASSUMED]** (needs field/official confirmation), **[OPEN]**.

1. Program [DECIDED]

- One-story ranch, 3 bedrooms / 2 full baths, full unfinished basement with east-end exterior door (graded areaway / partial walkout).
- Footprint 28'-0" × 52'-0" to outside face of wall framing (1,456 sf main floor). Long axis east–west; front (entry) faces south toward Bancroft Rd → south glazing for passive gain.
- Rooms: primary suite (bedroom, walk-in closet, bath) at east end; bedrooms 2 & 3 + hall bath at west end; open kitchen / dining / living in the middle; laundry on main floor; coat closet at entry.
- No garage (driveway + 20x20 parking pad). Exterior landings (IRC R318.3): front — precast concrete landing 5'×4' at 7-1/4" below threshold + 3 risers @ 7-1/8"/11" treads to grade; rear slider — precast landing 8'×4' + 2 steps. Free-standing on 8" compacted crushed stone, 1/2" gap to house, flashing/drip cap over. Attic access 22-1/2"×30" in hall ceiling (R807.1), R-49 insulated, weatherstripped hatch (IECC R402.2.4).

2. Codes [DECIDED]

Discipline	Code
Building / structural	IRC 2024 with NH amendments; NDS 2024 + WFCM 2024 + ASCE 7-22 where IRC prescriptive limits are exceeded
Electrical	NEC 2023 (NFPA 70)
Plumbing	IRC 2024 Part VII (NH admin 101.2.4: 1&2-family may use IPC or IRC) + NH amendments (P2603.5.1, P2801, P3103.1.1 18" vent above roof, etc.)
Mechanical	IMC 2024 / IRC Ch. 12-24
Energy	IECC 2018 residential, climate zone 5A
Septic	NHDES Env-Wq 1000
Well	NHDES We 600 / Env-Wq 2100 (verify chapter)
Zoning	Londonderry ZO §4.2.1.3 (AR-I)
Utility	Eversource NH "Requirements for Electric Service Connections"

Code text access: free read-only (ICC Digital Codes, UpCodes, NFPA free account). Every requirement in the deliverables cites a section number; anything cited from memory rather than read is tagged **[UNVERIFIED-CITE]** until checked.

3. Design loads (site-specific) — see `site/SITE.md`

Load	Value	Basis
Ground snow p_g(asd)	65 psf	NH amendment → CRREL TR-02-6 Table 1 (Londonderry)
Roof snow p_f	0.7·Ce·Ct·Is·p_g → computed in structural calcs	ASCE 7-22 §7.3
Basic wind V	112 mph, Exposure B (wooded, suburban) [ASSUMED B]	ASCE 7-22
Seismic	S_DS 0.27 → SDC B (IRC: SDC A/B exempt from most seismic provisions)	USGS
Floor live	40 psf living, 30 psf sleeping (IRC Table R301.5)	IRC
Attic	10 psf uninhabitable without storage (truss bottom chord)	IRC
Frost depth	48 in [ASSUMED — confirm with Londonderry Building Div.]	local
Soil bearing	2,000 psf presumptive (Canton fsl ≈ sandy loam, IRC Table R401.4.1 class SM)	IRC

Consequence: p_g(asd) = 65 ≤ 70 psf → IRC prescriptive Chapters 5/6/8 apply (R301.2.3); use 70 psf snow columns. Trusses are still manufacturer-engineered per R802.10 (TPI 1) — we specify design criteria and independently check them with a frame model (PyNite) using ASCE 7 roof snow p_f = 0.7·Ce·Ct·Is·p_g.

4. Structure [DECIDED unless noted]

- Footings: cast-in-place concrete, 3,000 psi min (IRC R402.2, weathering "severe"), continuous strip, bottom ≥ 48" below finish grade.
- Foundation walls: 8" cast-in-place concrete, 8'-0" tall (basement clear ≈ 7'-7" to joists), per IRC R404.1 tables or engineered. Damp-proofing + perimeter drain to daylight east (slope permits gravity outlet — no sump).
- Basement slab: 4" concrete on 6 mil vapor retarder on 4" crushed stone; sub-slab radon rough-in (passive stack; NH is Zone 1 for radon [UNVERIFIED-CITE]).
- Main floor: 2x10 SPF #2 @16" (sawn ≥2x10 → NH R302.13 exc.4, no membrane) lapped 12" over a dropped 3-2x12 SPF #2 girder on six 3" Sch 40 steel columns on 30x30x12 pads (calcs/structural.md).
- Walls: 2x6 SPF No.2 @16" o.c., 92-5/8" precut studs (8'-1 1/8" plate height → 8'-0" finished ceiling), double top plate, single bottom plate, 7/16" OSB sheathing, house wrap. Interior partitions 2x4 @16".
- Roof: engineered trusses @24" o.c., 6:12 pitch, 12" overhangs (eave & rake), 5/8" OSB/plywood roof sheathing (thicker for snow) with H-clips, ice & water shield 24" inside the exterior wall line + valleys, synthetic underlayment, architectural asphalt shingles.
- Fastener basis: IRC Table R602.3(1) + engineered connection schedule for snow/uplift path; nails specified as type × pennyweight × length × shank diameter (e.g. 10d common = 3" × 0.148").

5. Envelope (IECC 2018 CZ5 prescriptive, Table R402.1.2) [DECIDED]

Element	Requirement	Design
Ceiling	R-49	R-49 blown cellulose (raised-heel trusses for full depth over plates)
Wood frame wall	R-20 or R-13+5	R-21 high-density fiberglass batt in 2x6
Basement wall	R-15 ci / R-19 cavity / 13+5	2" XPS (R-10) + 2x4@24 R-13 + 1/2" gyp, full height (U 0.042)
Fenestration	U ≤ 0.30 (verify table value)	U-0.27 double-pane low-e argon vinyl

Element	Requirement	Design
Air leakage	≤ 3 ACH50	target 2.0 ACH50, blower-door tested
Ventilation	mechanical required (tight house)	ERV, balanced, ~ 60 cfm continuous (ASHRAE 62.2 / IRC M1505)

6. Mechanical / plumbing [DECIDED, sized in calcs]

- Heating/cooling: ducted cold-climate air-source heat pump, air handler in basement, duct trunk in basement with floor registers at exterior walls. Sized by Manual-J-style load calc cross-checked with EnergyPlus.
- Domestic hot water: 50-gal heat-pump water heater in basement.
- Water: drilled bedrock well, submersible pump, pressure tank in basement. Well located ≥ 75 ft from leach field.
- Waste: 450 GPD design flow (3 BR × 150, Env-Wq 1008.04(k)); **1,250 gal** two-compartment precast tank (Env-Wq 1010.01(b)); 825 sf stone-and-pipe bed (Table 1016-1 @ assumed 10 min/in — confirm by test pit/perc by NH permitted designer); gravity, 2.6 ft fall (site/out/siteplan.json).
- Plumbing: PEX-A supply with manifold, PVC Sch 40 DWV, vents through roof.

7. Electrical [DECIDED, sized in calcs]

- 200 A, 120/240 V single-phase, underground service from Eversource pole on Bancroft Rd in customer-installed conduit; meter socket on house per Eversource spec; 40-space main panel in basement.
- Every circuit listed with: load, breaker (AFCI/GFCI/dual), conductor (Cu NM-B gauge), length, voltage drop, box fill, device locations per NEC 210.52 spacing.
- Load calc: NEC 220 standard method + optional method comparison.
- Smoke/CO: interconnected, hardwired with battery backup (IRC R314/R315).

8. Deliverables

1. `model/` — single parametric source of truth (Python) → IFC with every member and fastener.
2. Drawings (PDF/DXF): site plan, foundation plan, floor plan, framing plans (floor, walls/elevations per wall, roof), building sections, wall section details, electrical plan, plumbing riser + plan, HVAC plan.
3. Schedules: lumber cut list, fastener schedule (count & location for every connection), door/window schedule, circuit schedule, fixture/pipe schedule, material takeoff.
4. Calcs: structural (loads, members, connections), energy (loads, IECC compliance, EnergyPlus), electrical (load calc, voltage drop, box fill), plumbing (DFU, pipe sizing, septic).
5. Renders (Blender).
6. Independent review pass per discipline.

9. Open items

- [OPEN] Confirm frost depth / design criteria table with Londonderry Building Division.
- [RESOLVED] NH amendments read: snow from CRREL; plumbing may follow IRC.
- Section numbering note: IRC 2024 renumbered — emergency escape is R319 (was R310), means of egress/stairs R318 (was R311).
- [RESOLVED] No public water/sewer assumed: private well (75' radius 100% on-lot) + ISDS. Site layout: site/out/C-101_site_plan.png.
- [OPEN] Frontage 149.5 ft in GIS vs 150 ft min — treat as existing lot of record.

Site — 9 Bancroft Rd, Londonderry NH 03053

Hypothetical design site. Real parcel, vacant per the town assessor (building value $0). Not owned by or affiliated with this project.

Item	Value	Source
Parcel ID	012-047-2	Londonderry MapGeo (`site/data/parcel_mapgeo.json`)
Area	2.20 ac (95,756 sf) computed; assessor 2.15 ac	parcel polygon, UTM 19N
Zoning	AR-I (Agricultural-Residential)	MapGeo
Dimensional rules (AR-I)	front 40 ft, side 15 ft, rear 15 ft; frontage 150 ft min; max height 35 ft; min lot 43,560 sf + soil-based sizing (Table 4-4, needs high-intensity soil map)	LZO §4.2.1.3 (amended thru 2025-08-18), `refs/local/londonderry-zoning-ordinance.pdf`
Centroid	42.886525 N, -71.379678 W	MapGeo
Ground elevation	351–374 ft (22.8 ft relief), median slope 8.6%	USGS 3DEP 1 m lidar (`site/data/dem_3dep_1m_utm19n.tif`)
Soil	Canton fine sandy loam 42B, 3–8%, well drained, HSG B, no shallow bedrock or water table	USDA SSURGO via Soil Data Access
Wetlands (NWI)	none mapped on parcel	USFWS NWI
Flood zone	X — minimal flood hazard	FEMA NFHL
Ground snow load p_g(asd)	**65 psf** (Londonderry P0=65 psf @ E0=500 ft; elevation correction 2.1 psf/100 ft would give 62.1 psf at 362 ft — NOT taken, conservative)	NH amendment to IRC Table R301.2 note o → CRREL TR-02-6 Table 1 (value via Medeek KML transcription; primary PDF blocked to automated download)
(for reference) ASCE 7-22 p_g	85.8 psf RC II — NOT governing in NH	ASCE GIS
Basic wind speed V	112 mph (RC II, 700-yr); 119 mph RC III	ASCE GIS `w2022_mri700/1700`
Ice	1.23 in, 50 mph concurrent gust (500-yr)	ASCE GIS `i2022_*`
Seismic (Site Class D)	S_DS 0.27, S_D1 per USGS → SDC B	USGS designmaps ASCE 7-22
Climate	IECC zone 5A (Rockingham Co.); 99.6% heating DB -16.3 °C (2.7 °F)	Manchester AP TMYx 2011-2025 `.ddy`
Frost depth	48 in (typical southern NH local value — confirm with Londonderry Building Div.)	Durham NH table as proxy

Governing codes (NH State Building Code)

- IRC 2024 (incl. Part VII plumbing — NH 101.2.4 allows IPC *or* IRC for 1&2-family) + IMC 2024 (mandatory for permits from 2027-01-01; 2021/2024 concurrency through 2026-12-31)
- NEC 2023 (NFPA 70)
- IECC 2018 (energy) — NH kept 2018

- NH amendments (`refs/state/nh-building-code-amendments-2026-07-01.*`): CRREL snow loads; R302.13 floor protection (exempt for ≥2x10 sawn joists); R309 sprinklers NOT required; R319.1 basements require an emergency escape opening
- Local amendments limited to administrative matters from 2026-07-01

Flags

- p_g(asd) = 65 psf ≤ 70 psf → IRC prescriptive Chapters 5, 6, 8 apply (IRC 2024 R301.2.3). Use the 70 psf ground-snow columns of IRC tables.
- Wooded lot → clearing, stumping, erosion control in scope.
- No public sewer assumed → NHDES Env-Wq 1000 septic design (test pit + perc) and private well. Verify water/sewer availability on Bancroft Rd.

Structural Calculations — 9 Bancroft Rd, Londonderry NH

Generated from `model/` + `calcs/`. Code basis: IRC 2024 w/ NH amendments (2026-07-01); NDS 2024; ASCE 7 snow formulas with NH/CRREL ground snow. Prescriptive IRC tables govern wherever applicable; NDS checks are supplementary or fill gaps (marked **ENG**).

1. Design loads

Load	Value	Basis
Ground snow p_g(asd)	65 psf	NH amend. Table R301.2 note o → CRREL TR-02-6 (Londonderry P0=65 @ 500 ft); no elevation reduction taken
Flat-roof snow p_f	50.1 psf	0.7·Ce(1.0)·Ct(1.1)·Is(1.0)·p_g
Sloped-roof snow p_s	50.1 psf	Cs = 1.0 (6:12, cold, non-slippery)
Unbalanced snow (leeward)	65.0 psf	W = 14 ft ≤ 20 ft → Is·p_g leeward, 0 windward
Roof DL (TC)	10 psf	shingles 3, 19/32 OSB 2, truss 3, misc 2
Ceiling DL (BC)	10 psf	5/8 gyp 2.8, R-49 cellulose ≈ 13.5" @ 1.6 pcf = 1.8, truss, misc
Attic LL (BC)	10 psf	IRC Table R301.5 uninhabitable attic w/o storage
Floor LL	40 psf living / 30 psf sleeping	IRC Table R301.5 — 40 psf used throughout
Floor DL	10 psf (15 psf at tile)	IRC span tables at 10 psf; checked at 20 psf column
Wind	V_ult 112 mph, Exp B	ASCE 7-22 RC II map (ASCE GIS); IRC Fig R301.2(2) ≤ 115 row used
Seismic	SDC B (S_DS 0.27)	USGS ASCE 7-22 Site Class D; IRC R301.2.2: SDC A/B exempt from seismic provisions for detached 1&2 family

2. Roof

System: Prefabricated metal-plate-connected wood trusses, raised-heel Fink, 24" o.c.. Span 28'-0", 6:12, eave overhang 16", rake 12", energy heel 16". **Truss design criteria for manufacturer (IRC R802.10.1):** TCLL (snow) 50 psf + unbalanced per ASCE 7 §7.6.1 (leeward 65 psf), TCDL 10, BCLL 10, BCDL 10 psf; wind 112 mph Exp B; deflection L/360 LL, L/240 TL; CD = 1.15 snow. **Independent frame check (calcs/truss.py, PyNite, NDS 2024 combined axial + bending):** | Case | Reaction L / R (lb) | Max defl (in) | Governing member | Ratio | | --- | --- | --- | --- | --- | | D+S | 2158 / 2158 | 0.178 | W0L (2x4 SPF #2, T) | 0.637 | | UNBAL-L | 1074 / 2165 | 0.15 | W5 (2x4 SPF #2, C) | 0.671 | | UNBAL-R | 2165 / 1074 | 0.15 | W2 (2x4 SPF #2, C) | 0.671 | | D+0.75L+0.75S | 1984 / 1984 | 0.166 | BC1 (2x4 MSR 2100f-1.8E, T) | 0.591 |

Max truss reaction **2165 lb** → bearing on 2x6 SPF top plate: 2165 / (5.5 × 1.5) = 262 psi ≤ Fc⊥ = 425 psi (CD n/a).

Sheathing: 19/32" (40/20) APA-rated OSB Exposure 1, strength axis ⊥ trusses, H-clips mid-span at unsupported edges (IRC Table R503.2.1.1(1): 40/20 @24" w/ edge support, allowable live 130 psf ≥ 50.1). **Uplift:** 153 lb/truss (IRC Table R802.11 (24" o.c., 28 ft, Exp B, ≥5:12; interpolated 110→115 mph for 112 mph)). IRC R802.11 Exception 2 applies (≤115 mph, Exp B, ≥5:12, span ≤32 ft, ≤24" o.c.) → toe-nailing per Table R602.3(1) permitted. **Upgrade:** Simpson H2.5A hurricane tie each truss each end (upgrade; IRC R802.11 Exc. 2 permits toe-nails): 5-SD9112 to truss + 5-SD9112 to plates, SPF uplift 540 lb (Simpson, refs/structural/simpson/H2.5A.txt) ≥ 153 lb.

3. Walls

Exterior: 2x6 SPF #2 @ 16" o.c., 92-5/8" precut; single 2x6 bottom plate, double 2x6 top plate, laps ≥ 24" at splices/corners. IRC Table R602.3(5): 2x6 @16, ≤ 10 ft, supporting roof+ceiling only. **ENG stud check (axial, snow):** roof line load 1082 plf → 1443 lb/stud @16". Le/d = 16.8 (weak axis braced by sheathing+drywall), Fc' = 1013 psi → capacity 8359 lb.

Headers — 16 exterior openings. Rough-opening top = 82.875" above subfloor (2x12 header tight to double top plate). | Opening | Wall | RO W x H | Header | Jacks/end | Kings/end | Bearing wall? | Reference | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | D01 | EXT-S | 38 x 82.875 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | D02 | EXT-N | 72 x 82.875 | 3-2x12 + 3 plies tight (outboard), 1" XPS inboard | 3 | 2 | yes | R602.7(1): 7-9 @24w, 6-6 @36w → 7-4.7 @28w; NJ 2 → use 3 (conservative) | | W01 | EXT-S | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W02 | EXT-W | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | no (gable) | R602.7(1) used anyway (gable truss bears on wall) | | W03 | EXT-W | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | no (gable) | R602.7(1) used anyway (gable truss bears on wall) | | W04 | EXT-N | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W05 | EXT-N | 26 x 38 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W06 | EXT-S | 26 x 38 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W07 | EXT-S | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W08 | EXT-S | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W09 | EXT-S | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W10 | EXT-N | 50 x 38 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 2 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W11 | EXT-N | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W12 | EXT-E | 38 x 62 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | no (gable) | R602.7(1) used anyway (gable truss bears on wall) | | W13 | EXT-S | 26 x 38 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) | | W14 | EXT-S | 26 x 38 | 2-2x12 + 1/2" OSB spacer between plies (outboard), 2" XPS inboard | 2 | 1 | yes | R602.7(1): 6-2 @24w, 5-2 @36w → 5-10 @28w; NJ 2 @24w/3 @36w → use 2 (span ≤ 3'-2" actual) |

Interior openings: all interior walls are nonbearing (trusses clear-span 28 ft) → R602.7.4: single flat 2x4 header (2x6 in wet walls) permitted up to 8 ft; flat 2x header + cripples used.

4. Wall bracing (IRC R602.10, Method CS-WSP)

Table R602.10.3(1) (≤115 mph, one story, CS-WSP): E-W lines spaced 28 ft → 4.30 ft; N-S lines spaced 52 ft → 7.80 ft (interpolated). Adjustments Table R602.10.3(2): Exp B 1.00; eave-to-ridge 8.33 ft → 0.900; wall height 8.09 ft → 0.905; 2 braced lines → 1.00; gypsum present → 1.00; no horizontal joints (9 ft sheets vertical) → 1.00. | Wall line | Required (ft) | Qualifying panels (in) | Provided (ft) | End panels ≤10 ft from ends | OK | | — | — | — | — | — | — | | EXT-N | 3.50 | 60, 52, 120, 108, 46 | 32.2 | yes | ✔ | | EXT-S | 3.50 | 42, 94, 55, 46, 78 | 26.2 | yes | ✔ | | EXT-W | 6.35 | 84, 118, 58 | 21.7 | yes | ✔ | | EXT-E | 6.35 | 228, 70 | 24.8 | yes | ✔ | CS-WSP: 7/16” OSB on all exterior wall areas incl. above/below openings; 8d common (0.131 x 2.5) @ 6” edges / 12” field (Table R602.3(3)); corners per R602.10.7 end condition 1 (≥ 24” full-height panel each side of corner — satisfied at all 4 corners, see table).

5. Floor system

Joists 2x10 SPF #2 @ 16” o.c. bearing on PT sill (outside face flush with foundation) and lapped 12” over dropped girder at y = 168”. Clear spans: south 13’-1.75”, north 13’-1.75”. IRC Table R502.3.1(2): 40 psf LL, 10 psf DL → 15-5; 20 psf DL → 14-1. Subfloor: 23/32” (24 o.c.) T&G OSB, glued (APA AFG-01) + nailed — IRC Table R503.2.1.1(1) 24 o.c. Sturd-I-Floor on 16” joists ✔. NH amendment R302.13 exception 4: sawn 2x10 floor framing → no membrane required on basement ceiling.

Girder: 3-2x12 SPF #2 built-up, dropped; 6 columns → 7 spans of 7’-2.875”. IRC Table R602.7(2) one floor only: 9-6 @24w, 7-9 @36w → 8-11 @28w; actual spans 7’-2.9”. ENG column load: trib width 13.52 ft × 7.24 ft × 55 psf + girder self-wt = **5,472 lb**. Column pad 30x30: bearing = (5,472 + pad wt 938) / 6.25 sf = 1,025 psf ≤ 2,000 psf presumptive (Table R401.4.1(1), SM). ENG girder check (continuous, M ≈ wL²/10): w = 756 plf, M = 3,960 ft-lb, fb = 501 psi ≤ Fb’ = 875 psi (CF 1.0 for 2x12, CD 1.0 floor, no Cr — conservative). Shear fv = 81 psi ≤ 135 psi. Bearing on column cap (1/4” x 5” x 8” plate; girder 4.5” x 8”): 152 psi ≤ 425 psi. Column: 3-1/2” OD Sch 40 steel pipe column (ASTM A53 Gr B), welded 1/4” x 5” x 8” cap plate and 1/4” x 8” x 8” base plate (IRC R407.3 (steel columns ≥ 3” dia Sch 40, restrained top & bottom)). 3” nominal Sch 40 (OD 3.5”, A = 2.23 in², I = 3.02 in⁴, r = 1.16”), KL = 82” → KL/r = 70; AISC 360 ASD (Fy 35 ksi A53 Gr B) Fcr/Ω ≈ 16.8 ksi × 2.23 ≈ 37 kips ≫ 5.5 kips.

6. Stair opening framing

Stair opening 140-1/2” x 37-1/2” between trimmers/headers. South edge: 2x6 SPF #2 bearing wall @16” in basement under W-STAIRS line, on 20x10 thickened-slab footing; carries 2-2x10 flush header. North: 2-2x10 header, tails hung w/ LUS28 hangers. Trimmers: double 2x10 each end (x≈146, x≈286). North tail joists: 17.5” long → reaction 53 lb each; LUS210 w/ 8-SD9112 + 4-SD9212: SPF floor 1,235 lb (Simpson LUS page) ≫. Stair: 40 LL + 10 DL over 3.04 x 11.38 ft = 1,730 lb; top reaction 865 lb; center stringer ≈ 50% = 432 lb. ENG stringer support: 2x6 SPF ledger on east trimmer face, stringers notched to bear on ledger. Ledger nailing: Z(10d common, 1.5” side, SPF) = 100 lb (NDS 12.3) × CD 1.0 → need 5; provide 10-10d common staggered + 2 x 1/4” x 3-1/2” SDWS screws.

7. Foundation

Footing: 20” x 10” continuous, 3,000 psi, 2 x #4 continuous bottom, 3” cover (IRC Table R403.1(1): 70 psf snow, 1 story + basement, 2,000 psf soil → 14 x 6 min). Wall: 8” flat cast-in-place concrete, 3,000 psi air-entrained 5–7%, height 8’-0”; vertical #5 Gr 60 @ 40” o.c., 1-1/4” clear from inside face (IRC Table R404.1.3.2(8): 8 ft wall, 7 ft unbalanced backfill, SM (45 pcf), 8” → #5 @ 41); horizontal #4 within 12” of top + #4 at mid-height (IRC Table R404.1.3.2(1)). ENG bearing (bearing walls N/S): roof 1082 + wall 97 + floor 389 + fdn wall 800 + footing 208 = 2,577 plf → q = 1,546 psf ≤ 2,000 psf. Anchorage: 1/2” x 10” J-bolts, 7” embed, ≤ 6’-0” o.c., ≤ 12” and ≥ 3-1/2” from each plate end, 2 min per plate piece, 3” sq x 0.229” plate washers (IRC R403.1.6). Sill: PT 2x6 SYP #2 (UC2) on closed-cell foam sill gasket. Dampproofing: Bituminous dampproofing (R406.1) + dimple drainage mat. Drain: 4” perforated PVC in 12”+ washed stone wrapped in filter fabric, footing level, gravity outlet to daylight east (R405.1). Slab: 4” 3,000 psi on 10 mil vapor retarder (R506.2.3) on 4” 3/4” crushed stone; control joints ≤ 10 ft. Radon: Passive sub-slab: 3” PVC riser from perforated tee in stone, through roof (IRC App. AF). Column pads: 30” x 30” x 12” 3,000 psi, 3 x #4 each way bottom. Frost: footing bottom at 14” below slab; exterior grade ≥ 48” above footing bottom everywhere except the east basement door areaway → stepped footing at door: bottom ≥ 48” below areaway grade (see foundation plan).

8. Check summary

Check	Result	Detail
Truss D+S	PASS	max ratio 0.637
Truss D+S deflection ≤ L/360 (0.93”)	PASS	0.178”
Truss UNBAL-L	PASS	max ratio 0.671
Truss UNBAL-L deflection ≤ L/360 (0.93”)	PASS	0.15”
Truss UNBAL-R	PASS	max ratio 0.671
Truss UNBAL-R deflection ≤ L/360 (0.93”)	PASS	0.15”
Truss D+0.75L+0.75S	PASS	max ratio 0.591
Truss D+0.75L+0.75S deflection ≤ L/360 (0.93”)	PASS	0.166”
Truss bearing on plate	PASS	262 psi
Truss uplift tie	PASS	540 ≥ 153
2x6 stud axial	PASS	1443 ≤ 8359 lb
Header D01	PASS	38 ≤ 70.0
Header D02	PASS	72 ≤ 88.7
Header W01	PASS	38 ≤ 70.0
Header W02	PASS	38 ≤ 70.0
Header W03	PASS	38 ≤ 70.0
Header W04	PASS	38 ≤ 70.0
Header W05	PASS	26 ≤ 70.0
Header W06	PASS	26 ≤ 70.0
Header W07	PASS	38 ≤ 70.0
Header W08	PASS	38 ≤ 70.0
Header W09	PASS	38 ≤ 70.0
Header W10	PASS	50 ≤ 70.0
Header W11	PASS	38 ≤ 70.0
Header W12	PASS	38 ≤ 70.0
Header W13	PASS	26 ≤ 70.0
Header W14	PASS	26 ≤ 70.0
Bracing EXT-N	PASS	32.2 ≥ 3.50 ft
Bracing EXT-S	PASS	26.2 ≥ 3.50 ft
Bracing EXT-W	PASS	21.7 ≥ 6.35 ft
Bracing EXT-E	PASS	24.8 ≥ 6.35 ft

Check	Result	Detail
Joist span (10 psf DL)	PASS	13'-1.75" ≤ 15'-5"
Joist span (20 psf DL, tile)	PASS	13'-1.75" ≤ 14'-1"
Girder span	PASS	7'-2.875" ≤ 8'-11"
Column pad bearing	PASS	1025 psf
Girder bending (NDS)	PASS	501 ≤ 875
Girder shear (NDS)	PASS	81 ≤ 135 psi
Girder bearing on cap	PASS	152 psi
Stair ledger nails	PASS	1000 ≥ 865 lb (whole top reaction)
Footing bearing	PASS	1546 psf

Thermal envelope & IECC 2018 (NH) compliance

Climate zone 5A (Rockingham Co., IECC Table R301.1). Path: **prescriptive R-value (Table R402.1.2)**, verified also by **Total UA alternative (R402.1.5)**.

Component	Area (sf)	Proposed U	Code U (R402.1.4)	Proposed UA	Code UA	Spec
Ceiling	1,384	0.0199	0.026	27.6	36.0	R-49 blown cellulose (settled), raised heel: full depth over top plate
Frame wall	1,049	0.0594	0.060	62.3	62.9	R-21 HD batt in 2x6 @16 (measured framing fraction 25.0%, headers 5.4%)
Rim joist	153	0.0426	0.060	6.5	9.2	3" ccSPF R-19.5 on rim
Basement wall	1,207	0.0422	0.050	50.9	60.3	2" XPS (R-10) + 2x4@24 R-13 batt + 1/2" gyp (exceeds 15/19 note c)
Windows	184	0.2700	0.300	49.6	55.1	double-pane low-e (heat-mirror class 'high-solar-gain' coating), argon, warm-edge spacer, vinyl frame; NFRC-rated
Glass door (slider)	41	0.2700	0.300	11.0	12.3	vinyl patio slider, low-e argon
Opaque doors	41	0.1700	0.300	7.0	12.4	R402.3.4: one opaque door ≤24 sf exempt; U-0.17 anyway
Total				**215.0**	**248.2**	PASS (13.4% better)

Window-to-wall ratio 17.3%. Measured wall framing fraction (studs, kings, jacks, cripples, plates) by wall: EXT-S 30.6%, EXT-N 25.9%, EXT-W 21.9%, EXT-E 17.9%.

Mandatory items (IECC 2018 R402.4, R403)

- Air leakage: test ≤ 5.0 ACH50 (NH-amended R402.4.1.2); **design target 2.5 ACH50** (sealed sill gasket, taped OSB seams as air barrier, ccSPF rim, gasketed top plates, airtight electrical boxes on exterior walls & ceiling, sealed attic hatch R-49 weatherstripped).
- Mechanical ventilation required (R403.6; IRC M1505.4): ERV 60 cfm continuous (IRC Table M1505.4.3(1), 1,501–3,000 sf incl. conditioned basement, 2–3 BR), fan efficacy ≥ 1.2 cfm/W (Table R403.6.1, HRV/ERV).
- Ducts entirely within conditioned space (basement + interior) → R403.3.5/R403.3.2 duct insulation not required in conditioned space; duct leakage test exempt where all ducts inside the envelope (R403.3.4 exception) — test anyway, target ≤ 4 cfm25/100 sf.
- Hot-water pipe insulation R-3 per R403.5.3 on 3/4" mains & piping to kitchen (prescriptive).
- Lighting: 100% high-efficacy (LED) fixtures (R404.1 requires ≥ 90%).
- Programmable thermostat (R403.1.1); heat-pump supplementary heat lockout control (R403.1.2).
- Basement wall foam (2" XPS) covered by 1/2" gypsum thermal barrier (IRC R303.4); rim ccSPF ≤ 3-1/4" thick permitted exposed at band joist (IRC R303.5.11) — covered anyway by basement ceiling edge drywall strip.

Assembly layer build-ups (parallel path, ASHRAE HOF ch.27)

- Wall cavity path R = 23.53; framing path R = 9.41; header path R = 16.91 → U = 0.0594 (R-16.8 effective)
- Ceiling cavity R = 50.78; framing path R = 42.21 → U = 0.0199 (R-50.1)
- Basement wall U = 0.0422 (R-23.7) excluding soil; rim U = 0.0426

Heating/cooling loads, equipment & annual energy

Design conditions

	Heating	Cooling
Outdoor	99% DB −13.5 °C (7.7 °F)	1% DB 31.4 °C (88.5 °F) / MCWB 21.4 °C (70.5 °F), range 12.2 °C
Indoor	70 °F	75 °F, 50% RH
Source	Manchester-Boston Rgnl AP TMYx 2011–2025 `.ddy` (ASHRAE 2021 conditions)	same

Design loads

Method: **EnergyPlus 26.2 heat-balance zone sizing** (3-zone model: Kiva-coupled basement, main floor, vented attic; actual window positions/sizes, 16" eaves & 12" rakes, 4 occupants) + ventilation (60 cfm ERV, 70% sensible / 60% latent recovery) added outside zone sizing.

Component	Btu/h
Main floor heating (E+)	10,752
Basement heating (E+, Kiva)	8,546
Ventilation heating (60 cfm × 1.08 × 62.3 °F × (1−0.70))	1,211
Total heating	**20,510**
Hand check (UA 164 Btu/h·°F × ΔT + infiltration 68 cfm + below-grade + vent)	19,041
Main floor sensible cooling (E+, peak 7/21 18:00:00)	8,284
Ventilation sensible cooling	262
Latent (basement 630 + vent 783 + 4 people 800 + misc 300)	2,513
Total cooling	**11,060** (SHR 0.77)

E+ heating exceeds the steady-state hand check by 8% — E+ applies the BLAST infiltration temperature/wind coefficients at a 62 °F ΔT (effective ACH ≈ 0.24 vs 0.17 hand) and transient basement losses; **the larger E+ value governs sizing.**

Equipment selection

- **Heat pump:** Ducted cold-climate variable-speed air-source heat pump, nominal 2 ton (24,000 Btu/h cooling AHRI), NEEP ccASHP-listed: heating capacity ≥ 22,000 Btu/h at 5°F (≥ 90% of 47°F rating), COP@5°F ≥ 1.75, HSPF2 ≥ 8.5 (region V), SEER2 ≥ 16, inverter compressor, 1/2" & 3/8" refrigerant lines. Required at 7.7 °F: 20,510 Btu/h → specified ≥ 22,000 Btu/h at 5 °F (≥ design load ✔). Cooling total 11,060 Btu/h → 2-ton unit at minimum speed ≈ 8–9 kBtu/h modulates down to the part-load range (no short-cycling). Annual-simulation peak (TMYx extreme hour): heating 24.9 kBtu/h, cooling 15.2 kBtu/h → covered by heat pump + 5 kW strip (17,060 Btu/h).
- **Air handler:** Variable-speed ECM air handler in basement mechanical area, 800 cfm max, MERV-11 filter, 5 kW electric backup strip (emergency/defrost only, locked out above 25°F per IECC R403.1.2).
- **ERV:** Balanced ERV, 60 cfm continuous (boost 120 cfm), sensible recovery ≥ 70%, latent ≥ 55% @32°F, efficacy ≥ 1.2 cfm/W, stand-alone ducting: exhaust from 2 baths + laundry, supply to bedrooms + living.
- **Water heater:** 50-gal heat-pump water heater, UEF ≥ 3.75 (NEEA Tier 3+), 4,500 W backup element, in basement (≥ 700 ft³ space ✓), condensate to floor drain.
- Sizing per IRC M1401.3 (ACCA Manual S principles): cooling capacity ≤ 115% of load not achievable with smallest ducted ccASHP at full speed; variable-speed modulation (turndown ~ 30%) satisfies Manual S intent for inverter equipment.

Annual energy (TMYx 2011–2025, EnergyPlus annual run)

End use	Load / energy
Space heating load	35,775 kBtu (10,485 kWh_th) → HP electricity @ seasonal COP 2.7 = **3,883 kWh**
Space cooling load	14,766 kBtu (4,328 kWh_th; constant 75 °F setpoint, no window opening — upper bound) → **1,030 kWh**
ERV (50 W continuous)	438 kWh
Heat-pump water heater	1,100 kWh
Lighting (LED)	2,234 kWh
Plug + appliances	4,874 kWh
Total site electricity	**13,560 kWh/yr** (4.7 kWh/sf conditioned)

Unmet hours (heating/cooling, occupied): 0 / 0.

HVAC distribution — ducted ccASHP, ERV, exhaust

Design airflow: main floor 384 cfm (max of heating 369 @ ΔT 30 °F, cooling 384 @ ΔT 20 °F), basement 264 cfm → total 642 cfm (2-ton air handler, ≤ 800 cfm high stage). Friction rate 0.08 in. w.c./100 ft (ESP 0.50 − coil 0.18 − filter 0.10 − registers 0.03 − grilles 0.03 = 0.16 available over ≈ 200 ft TEL). Round-duct diameter from ASHRAE friction equation Δp/100 = 0.109136 q^1.9 / D^5.02.

All ductwork inside the thermal envelope (basement + floor joist bays) — IECC R403.3: no duct insulation required; seal all seams with UL 181 mastic; leakage test ≤ 4 cfm25/100 sf.

Room loads & airflow

Room	Heating (Btu/h)	Sensible cooling (Btu/h)	Supply cfm
BR2	1,566	1,209	50
BR3	1,534	1,045	44
HALL	176	59	5
BATH2	603	187	17
LAUN	507	446	19
GREAT	2,344	2,005	83
KIT	1,886	1,664	69
BR1	1,941	1,149	56
WIC	539	236	15
BATH1	868	284	25
BASEMENT	8,546	—	264

Supply outlets

Room	Location (x,y in)	cfm	Branch Ø	Register	Route
BR2	(56.0, 14)	50	5"	4x10 floor register	trunk → 3-1/4"x10" low-profile under girder → 5" round in joist bay → boot → floor
BR3	(13.5, 259)	44	5"	4x10 floor register	trunk → 5" round in joist bay → boot → floor
BATH2	(169.5, 322)	17	4"	4x10 floor register	trunk → 4" round in joist bay → boot → floor

Room	Location (x,y in)	cfm	Branch Ø	Register	Route
LAUN	(184.0, 14)	19	4”	4x10 floor register	trunk → 3-1/4”x10” low-profile under girder → 4” round in joist bay → boot → floor
GREAT	(328.0, 14)	83	6”	4x12 floor register	trunk → 3-1/4”x10” low-profile under girder → 6” round in joist bay → boot → floor
KIT	(313.5, 322)	69	6”	4x10 floor register	trunk → 6” round in joist bay → boot → floor
BR1	(553.5, 322)	56	5”	4x10 floor register	trunk → 5” round in joist bay → boot → floor
WIC	(504.0, 14)	15	4”	4x10 floor register	trunk → 3-1/4”x10” low-profile under girder → 4” round in joist bay → boot → floor
BATH1	(600.0, 14)	25	4”	4x10 floor register	trunk → 3-1/4”x10” low-profile under girder → 4” round in joist bay → boot → floor
BASEMENT	(100, 100)	66	6”	10x6 ceiling diffuser (side-wall of trunk / short drop)	trunk takeoff
BASEMENT	(100, 260)	66	6”	10x6 ceiling diffuser (side-wall of trunk / short drop)	trunk takeoff
BASEMENT	(330, 260)	66	6”	10x6 ceiling diffuser (side-wall of trunk / short drop)	trunk takeoff
BASEMENT	(560, 100)	66	6”	10x6 ceiling diffuser (side-wall of trunk / short drop)	trunk takeoff

Supply trunk (extended reducing plenum, 8” deep, hung under joists N of girder, bottom ≥ 6’-4” AFF)

Section starting at x (in)	cfm	Size (in)	Equivalent Ø
504.0	495	14x8	11.5
330	480	14x8	11.5
328.0	414	12x8	10.7
313.5	331	10x8	9.8
184.0	262	10x8	9.8
169.5	243	8x8	8.7
100	226	8x8	8.7
100	160	8x8	8.7
56.0	94	8x8	8.7
13.5	44	8x8	8.7

Returns

Location	cfm	Grille	Duct
Great room floor grille (x 297, y 190; 12” across joist bay)	289	24x12 floor return	10” round
Hall floor grille (x 200.75, y 186; N of girder)	193	20x10 floor return	9” round
Basement high-wall grille at AH	160	16x8 sidewall return	direct to return plenum

Transfer air: - BR1, BR2, BR3, WIC: 1” door undercut + through-wall transfer grille 12x6 pair (high/low offset) sized ≤ 1 Pa (0.004” w.c.) at room cfm - Baths: door undercut 3/4” (exhaust make-up)

ERV

- cfm: 60
- connection: Simplified (HVI/CMHC ‘fully integrated’): fresh air → AH return plenum, stale air ← return trunk ≥ 10 ft upstream; AH fan interlocked to low speed (≈ 250 cfm) whenever ERV runs
- ducts: 6” insulated flex (R-6, vapor jacket) to exterior hoods on E wall ≥ 6 ft apart (intake ≥ 10 ft from bath/dryer/vent terminals, R325.4.1)
- balance: balanced ±10% w/ flow hood at commissioning

Exhaust

- Hall bath fan 80 cfm: 4” rigid galvanized, R-8 insulated sleeve in attic, sloped to roof cap w/ damper (M1501.1, M1504)
- Primary bath fan 80 cfm: 4” rigid galvanized, R-8 sleeve, roof cap
- Range hood 250 cfm: 6” rigid smooth galvanized (M1503.2), sealed, R-8 in attic, roof jack w/ backdraft damper; < 400 cfm → no makeup air (M1503.6)
- Dryer: 4” rigid galvanized, joints in direction of flow, no screws into airstream (M1502.4.2), down through floor → joist bay N→S → S rim hood w/ damper, no screen; equiv. length ≈ 21 ft ≤ 35 ft (M1502.4.5.1)

Equipment & controls

- Outdoor unit on 4” composite pad on 18” galvanized wall-mount/stand (snow clearance), E side; line set 3/8” liquid / 5/8” suction (per mfr), insulated, through E rim w/ sealed sleeve; condensate/defrost drains to gravel.
- Air handler: upflow, basement at (520, 192); MERV-11 filter rack; condensate trap → sump; secondary pan + float switch.
- Controls: communicating thermostat in hall (x 200, y 190, 54” AFF) with outdoor sensor, strip-heat lockout above 25 °F (IECC R403.1.2), ERV interlock.

Plumbing design — IRC 2024 Part VII (NH amended), NHDES Env-Wq 1000

Fixture schedule (IRC values)

Fixture	IRC type	WSFU H/C/comb (T.P2903.7)	DFU (T.P3004.1)	Trap (T.P3201.7)	Outlet gpm/psi (T.P2903.1)	Location (x,y in)
B2-TUB	Bathtub w/ shower (pressure-balance)	1.0/1.0/1.4	2	1.5”	4.0 / 20	(234, 315) E wet wall x=240
B2-WC	Water closet tank 1.28 gpf (≤1.6)	0.0/2.2/2.2	3	3.0”	3.0 / 20	(224, 282) floor, 12-1/2” rough
B2-LAV	Lavatory	0.5/0.5/0.7	1	1.25”	0.8 / 8	(226, 218) E wet wall x=240
B1-SHWR	Shower stall (pressure-balance, ≤ 1.8 gpm head)	1.0/1.0/1.4	2	2.0”	2.5 / 20	(552, 36) W wet wall x=540
B1-WC	Water closet tank 1.28 gpf (≤1.6)	0.0/2.2/2.2	3	3.0”	3.0 / 20	(556, 84) floor, 12-1/2” rough
B1-LAV	Lavatory	0.5/0.5/0.7	1	1.25”	0.8 / 8	(553, 120) W wet wall x=540
K-SINK	Kitchen sink (double bowl) + dishwasher = kitchen group	1.9/1.0/2.5	2	1.5”	1.75 / 8	(321, 318) N ext wall (in sink base)
K-REF	Refrigerator ice maker (1/4”)	0.0/0.2/0.2	0	—”	0.5 / 20	(258, 213) recessed valve box W wall
L-WASH	Clothes washer (standpipe)	1.0/1.0/1.4	2	2.0”	4.0 / 8	(164, 104) N wet wall y=108
HB-S	Hose bibb frost-free (front)	0.0/2.5/2.5	0	—”	5.0 / 8	(240, 0) S wall, through rim joist
HB-N	Hose bibb frost-free (rear)	0.0/2.5/2.5	0	—”	5.0 / 8	(440, 336) N wall, through rim joist

Total WSFU 17.7 (hot 5.9, cold 14.6) → peak demand **18.7 gpm** (Table P2903.7(1), flush-tank column, interpolated). DFU: multiple-bath group (2 baths) 8 + kitchen group 2 + clothes washer 2 = **12 dfu**.

Water source — private drilled well (NHDES / We 600; driller’s log governs)

- Well 6” steel casing ≥ 20 ft and ≥ 10 ft into competent bedrock, grouted; cap ≥ 18” above grade, vermin-proof vented; located 36 ft NW of house (site plan), 75 ft protective radius 100% on lot, ≥ 75 ft from tank & bed.
- Assumed static WL 50 ft, pumping WL 150 ft, pump set 200 ft [ASSUMED — revise with driller’s yield test].
- Pump: 4” submersible, **12 gpm @ TDH 329 ft** (pumping level + 70 psi cut-out × 2.31 + friction) → 1-1/2 hp, 230 V, 3-wire w/ control box (FLA 10 A per NEC Table 430.248); torque arrestor; 1-1/4” Sch 120 PVC drop pipe; check valves at pump + every 100 ft; pitless adapter below frost (≥ 5 ft).
- Water service: 1-1/4” HDPE SIDR-7 (160 psi, NSF 61, Table P2906.4), 5 ft cover, sleeved through foundation (NW, x=0, y≈300”), 50 ft developed.
- Pressure switch 50/70 psi; pressure tank 62 gal (precharge 48 psi) drawdown ≈ 13.6 gal ≥ 12 gal (1-min run).
- Treatment train (in order): 1” sediment filter (5 µm) → space + bypass for softener/neutralizer pending lab test (NH DES standard analysis + arsenic/uranium/radon — common in Londonderry bedrock) → UV (if bacteria).
- Main shutoff full-port ball valve + drain at entry (P2903.10.1); pressure gauge; boiler drain.

Distribution — home-run PEX-A manifold

Manifold at (330.0, 296.0, 84.0) (basement, beside water heater). Cold manifold 1” (17.3 gpm), hot manifold 3/4” (10.6 gpm) — Table P2903.9.1 (plastic). Individual lines per P2903.9.2.

Fixture	Side	Size	Dev. length (ft)	Flow (gpm)	Friction (psi)	Residual at outlet (psi)	Required	Velocity (fps)	OK
B2-TUB	C	1/2”	23.0	2.4	1.84	30.6	20	4.3	✔
B2-TUB	H	1/2”	23.0	2.4	1.84	30.6	20	4.3	✔
B2-WC	C	1/2”	16.0	3.0	1.93	33.1	20	5.4	✔
B2-LAV	C	3/8”	23.7	0.48	0.43	34.1	8	1.6	✔
B2-LAV	H	3/8”	23.7	0.48	0.43	34.1	8	1.6	✔
B1-SHWR	C	1/2”	61.2	1.5	2.05	30.4	20	2.7	✔
B1-SHWR	H	1/2”	61.2	1.5	2.05	30.4	20	2.7	✔
B1-WC	C	1/2”	49.1	3.0	5.94	29.1	20	5.4	✔
B1-LAV	C	3/8”	46.3	0.48	0.83	33.7	8	1.6	✔
B1-LAV	H	3/8”	46.3	0.48	0.83	33.7	8	1.6	✔
K-SINK	C	1/2”	7.9	1.05	0.14	34.4	8	1.9	✔
K-SINK	H	1/2”	7.9	1.05	0.14	34.4	8	1.9	✔
K-REF	C	3/8”	20.1	0.5	0.39	34.5	20	1.7	✔
L-WASH	C	1/2”	44.4	2.4	3.55	30.2	8	4.3	✔
L-WASH	H	1/2”	44.4	2.4	3.55	30.2	8	4.3	✔
HB-S	C	3/4”	44.7	5.0	2.59	32.1	8	4.5	✔
HB-N	C	3/4”	20.2	5.0	1.17	33.5	8	4.5	✔

Residual = cut-in 50 psi − filter 3 − softener 8 − UV 1 − manifold 2 − elevation − friction (Hazen-Williams C=150, +25% fittings). Worst case at pump cut-in. Water-hammer arrestors (ASSE 1010, size A) at washer box and dishwasher (quick-closing valves, P2903.5). Hose bibbs: frost-free, stem into heated space → no separate stop required (NH P2903.11 exception), vacuum breaker (P2902.3).

Water heater

- type: Heat-pump water heater, 50 gal, UEF ≥ 3.75, 240 V 30 A (4.5 kW element)
- setpoint_F: 140
- mixing: ASSE 1017 thermostatic mixing valve at heater outlet set 120 °F (NH P2801.2.1)
- expansion_tank: 2.1 gal potable thermal expansion tank on cold inlet, precharged to 50 psi (P2903.4.2 — well check valve makes system closed)
- tpr: 3/4” T&P relief discharge, full size, to within 6” of floor over floor drain/sump (P2804.6.1)
- pan: drain pan + 3/4” to sump
- location: (330, 300)

Drain, waste & vent

Segment	Size	Slope (in/ft)	DFU	Note
B2-LAV drain → 2” horizontal wet vent	1-1/2” trap arm, 2” wet vent	1/4	1	lav dry vent 1-1/2” rises in E wet wall to attic
B2-TUB drain into 2” wet vent	1-1/2” trap, 2” drain	1/4	2	trap-to-vent ≤ 6 ft (Table P3105.1) ✓ ~3 ft
Hall-bath wet vent load	2”	1/4	3	Table P3108.3: 2” ≤ 4 dfu ✓
B2-WC → 3” bath drain (connects to wet vent within 12 ft)	3”	1/4	3	closet bend 3” (4x3 closet flange)
Hall-bath drain to basement (drops through floor at x=228,y=290)	3”	—	6	Table P3005.4.1 vertical 3” ≤ 48 dfu
K-SINK (+DW) trap arm	1-1/2” trap, 2” arm	1/4	2	vent 1-1/2” in N ext wall (insulation outboard of pipe) → attic; DW via high loop to sink tailpiece/air gap
L-WASH standpipe	2” standpipe & trap (P3201.7)	1/4	2	standpipe 18–42” above trap weir; vent 1-1/2” in 2x6 stair wall
B1-LAV → 2” wet vent	1-1/2” trap, 2” wet vent	1/4	1	dry vent 1-1/2” in W wet wall x=540
B1-SHWR into wet vent	2” trap & drain	1/4	2	trap-to-vent ≤ 8 ft ✓
B1-WC → 3”	3”	1/4	3	
Primary-bath drain to basement (x=548,y=60)	3”	—	6	
Building drain (hung, basement)	3” PVC Sch40 DWV	1/8 min (1/4 used)	12	Table P3005.4.2: 3” @ 1/4 ≤ 42 dfu ✓ (12 dfu)
Building sewer (from 30” outside wall) → tank	4” PVC SDR-35 (Env-Wq 1009.01)	1/4 (≥ 1/8)	12	exit S foundation wall at x≈570”, invert 36” above slab (el. 358.04’); sleeve + link seal; 2” XPS over pipe where cover < 48”

Vents

Vent	Size	Route
Hall-bath dry vent	1-1/2”	rises in 2x6 wet wall x=240 → attic
Kitchen sink vent	1-1/2”	N ext wall → attic
Laundry vent	1-1/2”	2x6 stair wall → attic
Primary-bath dry vent	1-1/2”	2x6 wet wall x=540 → attic
Attic vent header (W)	2”	hall bath + kitchen + laundry vents tie in attic ≥ 6” above flood rim of highest fixture (P3104.5), sloped back to drain
Attic vent header → roof	3” (main vent through roof)	one penetration, N roof face near ridge, terminates 18” above roof (NH P3103.1.1); ≥ 10 ft from ERV/HP intakes & openable windows or 3 ft above (P3103.5)
Primary bath vent	2” → ties to 3” header in attic	header runs E-W in attic above BC, insulated by cellulose

Frost closure (P3103.2): 97.5% heating design temp for Manchester ≈ 12 °F > 0 °F → 3” upsizing not required; 3” used anyway.

Cleanouts (P3005.2)

- Base of each 3” drop (hall bath, primary bath) — 3” CO tee
- Building drain at upstream end (W) and at each change of direction > 45°
- Building drain at foundation exit (inside, 3” two-way CO)
- Building sewer every 100 ft and at septic tank inlet tee (riser to grade)

Sump / foundation drainage

- pit: 18” dia × 24” deep basin, sealed lid w/ gasket (radon), at NE basement corner (x 592, y 304)
- pump: 1/3 hp submersible effluent pump, vertical float, 1-1/2” PVC discharge + check valve, through E wall above grade to splash block/rock outlet ≥ 25 ft from leach bed (Table 1008-2 foundation drain outfall)
- receives: footing drains (both sides), AH condensate, HPWH condensate, ERV condensate

Septic (ISDS) — Env-Wq 1000 (design by NH permitted designer required; this is the design intent)

- Design flow 450 GPD (3 BR × 150). Tank: 1,250 gal two-compartment precast concrete, watertight (ASTM C990 joints), risers to grade on both lids, effluent filter on outlet tee, 4” SDR-35 inlet/outlet.
- Bed: conventional stone & pipe 33’ × 25’ (825 sf, Table 1016-1 @ 10 min/in [ASSUMED pending perc]), 12” washed 3/4–1-1/2” stone, 4” perforated SDR-35 laterals @ 6 ft o.c., 0 slope, capped ends; distribution box (level, on stone base); 2” hay/fabric over stone; 6–12” cover.
- Separations met (site/out/siteplan.json): bed–well 113 ft, tank–well 84 ft, bed–foundation 44 ft (≥15 w/ drains), bed–lot line ≥ 10 ft, sump outfall ≥ 25 ft from bed.
- Building sewer: 4” PVC SDR-35, 1/4”/ft, invert at foundation 358.04’; insulate with 2” XPS 24” wide where cover < 48” (NH P2603.5.1 intent).

Electrical design — NEC 2023 (NH amended) / IRC 2024 Part VIII

Service

- 200 A, 120/240 V, 1-phase 3-wire, **underground** from Eversource pole on Bancroft Rd (~250 ft along driveway). Customer: 3” Sch 40 PVC conduit, rigid galvanized steel 90° sweeps (grounded if within 18” of grade), caution tape 12” below grade, ≥ 24” cover (NEC 300.5 T. col. 4/residential), pull string; meter socket (Eversource-furnished) on E wall SE corner at 5’-0” above finished grade (Eversource NH I&R 2021 §54.116). Eversource furnishes/installs cable; may require service enclosure ≤ 10 ft from meter due to elevation change (item 7).
- Meter → panel: 4/0-4/0-2/0-4 Al SER (service-entrance cable) through foundation-wall sleeve, ≤ 10 ft inside to main breaker (230.70 nearest point of entrance).
- Panel: 200 A main-breaker loadcenter, 40 spaces / 40 circuits, Cu bus, basement inside E wall at SE; working space 30” W × 36” D × 6.5 ft H clear (110.26); 3/4” plywood backboard; dedicated equipment space above (110.26(E)).
- Grounding electrode system (250.50/250.52, Eversource requires 2 electrodes): (1) concrete-encased electrode — 20 ft of #4 footing rebar, #4 Cu GEC (250.66(B)); (2) two 5/8” × 8 ft ground rods ≥ 6 ft apart, #6 Cu GEC (250.66(A)). Bond: metal water piping at HPWH / pressure tank tee with #4 Cu (250.104(A)), well casing bonded via pump-cable EGC (250.112(L)); intersystem bonding termination at meter (250.94).

- Surge protection: NH deleted NEC 230.67 (EL-23-11-24) → not required; Type 2 SPD in panel specified as an upgrade. Emergency disconnect: main breaker outdoors not required — NEC 2023 230.85 requires an outdoor emergency disconnect for 1&2-family: **provide meter-main combo or outdoor 200 A disconnect at meter** → spec: 200 A meter-main (Eversource-approved) with indoor 200 A main-lug panel fed by 4/0 Al SER feeder (4-wire, neutral isolated in panel).

Load calculation

- **Optional method (220.82):** general lighting 3 VA × 1456 sf + 2 SA + laundry = 8,868 VA; appliances 28,820 VA → other loads 37,688 VA → 10 kVA @100% + rest @40% = 21,075 VA; heat (220.82(C)(4)): HP 4,300 + 65% × 5 kW strip = 7,550 VA; **total 28,625 VA = 119 A @ 240 V**.
- Standard method (Art. 220 Part III) cross-check: 36,919 VA = 154 A.
- 200 A service: 1.7× optional-method demand; capacity reserved for future EV charger (spaces 39–40).

Circuit schedule

Ckt	Description	Breaker	Wire	Devices	Run (ft)	Design I (A)	VD %	Protection notes
1	Kitchen small-appliance #1 (N counter + island)	20 A 1P	12/2 NM-B	5	73	12.5	2.57	AFCI+GFCI; 210.11(C)(1), 210.52(B); dual-function breaker
2	Kitchen small-appliance #2 (W counter + dining wall)	20 A 1P	12/2 NM-B	4	71	12.5	2.56	AFCI+GFCI; 210.11(C)(1)
3	Refrigerator	20 A 1P	12/2 NM-B	1	63	6.7	1.39	AFCI+GFCI; individual circuit 210.52(B)(1) Exc.2; kitchen receptacle → GFCI (NH 210.8(A))
4	Dishwasher (hardwired j-box)	20 A 1P	12/2 NM-B	1	64	10.0	2.11	AFCI; NH deleted 210.8(D)(7) DW GFCI; AFCI 210.12 kitchen
5	Microwave drawer (island)	20 A 1P	12/2 NM-B	1	49	12.5	2.02	AFCI+GFCI;
6	Range 12 kW	50 A 2P	6/3 NM-B (Cu)	1	64	50.0	1.32	GFCI; NEMA 14-50R; 2-pole GFCI (kitchen receptacle, NH 210.8(A) still lists kitchens)
7	Kitchen lighting + range hood	15 A 1P	14/2 NM-B	11	75	7.5	2.62	AFCI;
8	Laundry receptacle (washer)	20 A 1P	12/2 NM-B	1	60	12.5	2.48	AFCI+GFCI; 210.11(C)(2); laundry area → GFCI + AFCI (dual-function)
9	Dryer 5 kW	30 A 2P	10/3 NM-B	1	56	20.8	1.22	GFCI; NEMA 14-30R; 2-pole GFCI (laundry area 250 V receptacle)
10	Bathroom receptacles (both baths)	20 A 1P	12/2 NM-B	2	66	12.5	1.91	GFCI; 210.11(C)(3): 20 A serving bath receptacles only
11	Living / foyer / hall receptacles	20 A 1P	12/2 NM-B	6	66	10.0	1.37	AFCI;
12	Living / dining / foyer / hall lighting + exterior front & rear door lights	15 A 1P	14/2 NM-B	13	74	7.5	1.99	AFCI;
13	Primary bedroom + WIC receptacles & lighting	15 A 1P	14/2 NM-B	12	46	10.0	1.72	AFCI;
14	Bedroom 2 receptacles	20 A 1P	12/2 NM-B	4	75	10.0	2.15	AFCI;
26	Bedroom 3 receptacles	20 A 1P	12/2 NM-B	4	94	10.0	2.72	AFCI;
15	Bedrooms 2/3, linen, hall-bath, laundry lights & fans + smoke alarms (interconnected)	15 A 1P	14/3 NM-B (interconnect)	16	89	5.8	2.09	AFCI; R310.5 interconnect via red conductor
16	Primary bath light/fan + stair & basement lighting	15 A 1P	14/2 NM-B	15	75	5.0	1.11	AFCI;
17	Outdoor receptacles (front, rear, east @ HP)	20 A 1P	12/2 NM-B	3	51	8.0	1.03	GFCI; 210.52(E); 210.63 HVAC service receptacle ≤ 25 ft; in-use (bubble) covers, WR
18	Basement receptacles (general)	20 A 1P	12/2 NM-B	4	76	8.0	1.26	GFCI; NH 210.8(A)(5) unfinished basement GFCI; 210.63 service receptacle at AH
19	Sump pump	20 A 1P	12/2 NM-B	1	37	6.7	0.8	GFCI; single receptacle; GFCI (unfinished

Ckt	Description	Breaker	Wire	Devices	Run (ft)	Design I (A)	VD %	Protection notes
								basement) + high-water alarm
20	ERV + water treatment (UV)	15 A 1P	14/2 NM-B	2	87	1.7	0.76	GFCI;
21	Well pump 1-1/2 hp 230 V (via control box + pressure switch)	20 A 2P	12/2 NM-B	1	89	10.0	1.47	—; FLC 10 A (NEC T.430.248); conductors ≥125% = 12.5 A; OCPD ≤ 250% (430.52); to well: 12-3+G submersible pump cable
22	Heat-pump water heater (4.5 kW)	30 A 2P	10/2 NM-B	1	59	18.8	1.15	—; 422.13: 125% → 23.4 A → 30 A
23	Air handler + 5 kW strip	30 A 2P	10/2 NM-B	1	33	23.8	0.81	—; MCA ≈ 29 A (nameplate governs, 440.4/424.3)
24	Heat pump outdoor unit (2 ton)	25 A 2P	10/2 UF-B / THWN in conduit	1	22	17.9	0.41	—; MCA 18 A, MOCP 25 A [nameplate governs]; 440.14 disconnect within sight; NH 210.8(F) exc. for listed HVAC through 2026-09-01 and NH amended 20 A limit → no GFCI
25	Spare — future EV / generator inlet (2-pole space reserved)	— A 2P	—	0	0		—	—;

Voltage drop: VD = 2·K·I·L / CM (K = 12.9 Ω·cmil/ft Cu); all branch circuits ≤ 3% (210.19(A) Informational Note) ✔ — see table. Conductors: NM-B 60 °C ampacity (334.80): 14 AWG 15 A, 12 AWG 20 A, 10 AWG 30 A, 6 AWG 55 A; small-conductor rule 240.4(D); HVAC per 440 nameplate MCA/MOCP.

Device schedule (count by type)

Device	Qty	Mounting
DISCONNECT_AH	1	
DISCONNECT_HP_60A_NF	1	
FAN_BATH_80	2	
JBOX_DW	1	
JBOX_ERV	1	
JBOX_HPWH	1	
LIGHT_BSMT_LED	8	
LIGHT_CAN_4in_IC_AT	12	
LIGHT_CEILING_LED	10	
LIGHT_EXT_WALL	3	
LIGHT_HOOD	1	
LIGHT_PENDANT	3	
LIGHT_STAIR	1	
LIGHT_UNDERCAB_LED	1	
NOTE	1	
PRESSURE_SWITCH_BOX	1	
RECEPT_14-30	1	
RECEPT_14-50	1	
RECEPT_DUPLEX_TR	32	16” AFF to center (42” at counters)
RECEPT_DUPLEX_TR_GFCI	5	
RECEPT_DUPLEX_WR_GFCI	3	
RECEPT_SINGLE	1	
RECEPT_SINGLE_20	2	
RECEPT_SINGLE_20_GFCI	1	
RECEPT_SINGLE_GFCI	1	
SMOKE_ALARM	6	ceiling ≥ 4” from wall, ≥ 3 ft from bath doors/supply registers (R310.3.3)
SWITCH_3W	2	48” AFF
SWITCH_SP	10	48” AFF, latch side, 6” from casing

All 125 V 15/20 A receptacles tamper-resistant (406.12). Exterior & basement walls/ceilings: airtight gasketed boxes (IECC R402.4.1.1).

Box fill (314.16) — every device box

Device	Ckt	AWG	Conductor count (incl. 1 EGC, 2× device yoke)	Required in³	Box
RE008 RECEPT_DUPLEX_TR	1	12	7	15.75	1-gang 18.0 in³
RE007 RECEPT_DUPLEX_TR	1	12	7	15.75	1-gang 18.0 in³
RE003 RECEPT_DUPLEX_TR	1	12	7	15.75	1-gang 18.0 in³
RE002 RECEPT_DUPLEX_TR	1	12	7	15.75	1-gang 18.0 in³
RE001 RECEPT_DUPLEX_TR_GFCI	1	12	5	11.25	1-gang 18.0 in³

Device	Ckt	AWG	Conductor count (incl. 1 EGC, 2× device yoke)	Required in³	Box
RE023 RECEPT_DUPLEX_TR	2	12	7	15.75	1-gang 18.0 in³
RE006 RECEPT_DUPLEX_TR	2	12	7	15.75	1-gang 18.0 in³
RE005 RECEPT_DUPLEX_TR	2	12	7	15.75	1-gang 18.0 in³
RE004 RECEPT_DUPLEX_TR_GFCI	2	12	5	11.25	1-gang 18.0 in³
RE009 RECEPT_SINGLE_20	3	12	5	11.25	1-gang 18.0 in³
JB010 JBOX_DW	4	12	3	6.75	1-gang 18.0 in³
RE011 RECEPT_SINGLE_20	5	12	5	11.25	1-gang 18.0 in³
RE012 RECEPT_14-50	6	6	6	30.0	2-gang 32 in³
LI021 LIGHT_PENDANT	7	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI020 LIGHT_PENDANT	7	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI016 LIGHT_CAN_4in_IC_AT	7	14	6	12.0	integral j-box (listed fixture)
SW103 SWITCH_SP	7	14	7	14.0	1-gang 18.0 in³
LI015 LIGHT_CAN_4in_IC_AT	7	14	6	12.0	integral j-box (listed fixture)
LI019 LIGHT_CAN_4in_IC_AT	7	14	6	12.0	integral j-box (listed fixture)
LI022 LIGHT_UNDERCAB_LED	7	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI013 LIGHT_HOOD	7	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI014 LIGHT_CAN_4in_IC_AT	7	14	6	12.0	integral j-box (listed fixture)
LI018 LIGHT_CAN_4in_IC_AT	7	14	6	12.0	integral j-box (listed fixture)
LI017 LIGHT_CAN_4in_IC_AT	7	14	4	8.0	integral j-box (listed fixture)
RE026 RECEPT_DUPLEX_TR	11	12	7	15.75	1-gang 18.0 in³
RE027 RECEPT_DUPLEX_TR	11	12	7	15.75	1-gang 18.0 in³
RE025 RECEPT_DUPLEX_TR	11	12	7	15.75	1-gang 18.0 in³
RE024 RECEPT_DUPLEX_TR	11	12	7	15.75	1-gang 18.0 in³
RE028 RECEPT_DUPLEX_TR	11	12	7	15.75	1-gang 18.0 in³
RE045 RECEPT_DUPLEX_TR	11	12	5	11.25	1-gang 18.0 in³
RE043 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
RE044 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
RE030 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
RE029 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
RE042 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
LI053 LIGHT_CEILING_LED	13	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW110 SWITCH_SP	13	14	7	14.0	1-gang 18.0 in³
RE031 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
SW109 SWITCH_SP	13	14	7	14.0	1-gang 18.0 in³
LI050 LIGHT_CEILING_LED	13	14	6	12.0	fan-rated listed ceiling box (NH 314.27(C)), 4” x 2-1/8” 21 in³, airtight
RE033 RECEPT_DUPLEX_TR	13	14	7	14.0	1-gang 18.0 in³
RE032 RECEPT_DUPLEX_TR	13	14	5	10.0	1-gang 18.0 in³
RE036 RECEPT_DUPLEX_TR	14	12	7	15.75	1-gang 18.0 in³
RE037 RECEPT_DUPLEX_TR	14	12	7	15.75	1-gang 18.0 in³
RE035 RECEPT_DUPLEX_TR	14	12	7	15.75	1-gang 18.0 in³
RE034 RECEPT_DUPLEX_TR	14	12	5	11.25	1-gang 18.0 in³
RE038 RECEPT_DUPLEX_TR	26	12	7	15.75	1-gang 18.0 in³
RE039 RECEPT_DUPLEX_TR	26	12	7	15.75	1-gang 18.0 in³
RE041 RECEPT_DUPLEX_TR	26	12	7	15.75	1-gang 18.0 in³
RE040 RECEPT_DUPLEX_TR	26	12	5	11.25	1-gang 18.0 in³
RE047 RECEPT_DUPLEX_TR_GFCI	10	12	7	15.75	1-gang 18.0 in³
RE046 RECEPT_DUPLEX_TR_GFCI	10	12	5	11.25	1-gang 18.0 in³
RE048 RECEPT_SINGLE_20_GFCI	8	12	5	11.25	1-gang 18.0 in³
RE049 RECEPT_14-30	9	10	6	15.0	1-gang 18.0 in³
SM081 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
SM085 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
SM086 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW107 SWITCH_SP	15	14	9	18.0	1-gang 18.0 in³
LI057 LIGHT_CEILING_LED	15	14	8	16.0	4” oct x 2-1/8” 21 in³ (airtight)
SM082 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW106 SWITCH_SP	15	14	9	18.0	1-gang 18.0 in³
LI051 LIGHT_CEILING_LED	15	14	8	16.0	fan-rated listed ceiling box (NH 314.27(C)), 4” x 2-1/8” 21 in³, airtight
SW104 SWITCH_SP	15	14	9	18.0	1-gang 18.0 in³
SW105 SWITCH_SP	15	14	9	18.0	1-gang 18.0 in³

Device	Ckt	AWG	Conductor count (incl. 1 EGC, 2× device yoke)	Required in³	Box
FA067 FAN_BATH_80	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI055 LIGHT_CEILING_LED	15	14	8	16.0	4” oct x 2-1/8” 21 in³ (airtight)
SM084 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI054 LIGHT_CEILING_LED	15	14	8	16.0	4” oct x 2-1/8” 21 in³ (airtight)
SM083 SMOKE_ALARM	15	14	7	14.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI052 LIGHT_CEILING_LED	15	14	5	10.0	fan-rated listed ceiling box (NH 314.27(C)), 4” x 2-1/8” 21 in³, airtight
LI079 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI071 LIGHT_EXT_WALL	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
FA068 FAN_BATH_80	16	14	5	10.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW111 SWITCH_SP	16	14	7	14.0	1-gang 18.0 in³
LI056 LIGHT_CEILING_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI078 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI076 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI077 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW112 SWITCH_3W	16	14	7	14.0	1-gang 18.0 in³
LI080 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI073 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI075 LIGHT_BSMT_LED	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW113 SWITCH_3W	16	14	7	14.0	1-gang 18.0 in³
LI072 LIGHT_STAIR	16	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI074 LIGHT_BSMT_LED	16	14	4	8.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI062 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
LI061 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
LI065 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
SW102 SWITCH_SP	12	14	7	14.0	1-gang 18.0 in³
LI060 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
LI064 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
LI066 LIGHT_PENDANT	12	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI069 LIGHT_EXT_WALL	12	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
SW108 SWITCH_SP	12	14	7	14.0	1-gang 18.0 in³
LI063 LIGHT_CAN_4in_IC_AT	12	14	6	12.0	integral j-box (listed fixture)
LI058 LIGHT_CEILING_LED	12	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI070 LIGHT_EXT_WALL	12	14	6	12.0	4” round/oct ceiling box 15.5 in³ (airtight)
LI059 LIGHT_CEILING_LED	12	14	4	8.0	4” round/oct ceiling box 15.5 in³ (airtight)
RE090 RECEPT_DUPLEX_WR_GFCI	17	12	7	15.75	1-gang 18.0 in³
RE088 RECEPT_DUPLEX_WR_GFCI	17	12	7	15.75	1-gang 18.0 in³
RE089 RECEPT_DUPLEX_WR_GFCI	17	12	5	11.25	1-gang 18.0 in³
RE095 RECEPT_DUPLEX_TR	18	12	7	15.75	1-gang 18.0 in³
RE093 RECEPT_DUPLEX_TR	18	12	7	15.75	1-gang 18.0 in³
RE094 RECEPT_DUPLEX_TR	18	12	7	15.75	1-gang 18.0 in³
RE092 RECEPT_DUPLEX_TR_GFCI	18	12	5	11.25	1-gang 18.0 in³
RE096 RECEPT_SINGLE_GFCI	19	12	5	11.25	1-gang 18.0 in³
JB097 JBOX_ERV	20	14	5	10.0	1-gang 18.0 in³
RE098 RECEPT_SINGLE	20	14	5	10.0	1-gang 18.0 in³
PR099 PRESSURE_SWITCH_BOX	21	12	3	6.75	1-gang 18.0 in³
JB100 JBOX_HPWH	22	10	3	7.5	1-gang 18.0 in³

Panel schedule

Spaces	Ckt	Breaker	Wire	Load
1-2	6	50 A 2P GFCI	6/3 NM-B (Cu)	Range 12 kW

Spaces	Ckt	Breaker	Wire	Load
3-4	9	30 A 2P GFCI	10/3 NM-B	Dryer 5 kW
5-6	21	20 A 2P standard	12/2 NM-B	Well pump 1-1/2 hp 230 V (via control box + pressure switch)
7-8	22	30 A 2P standard	10/2 NM-B	Heat-pump water heater (4.5 kW)
9-10	23	30 A 2P standard	10/2 NM-B	Air handler + 5 kW strip
11-12	24	25 A 2P standard	10/2 UF-B / THWN in conduit	Heat pump outdoor unit (2 ton)
13-14	25	space	—	Spare — future EV / generator inlet (2-pole space reserved)
15	1	20 A 1P DF (AFCI+GFCI)	12/2 NM-B	Kitchen small-appliance #1 (N counter + island)
16	2	20 A 1P DF (AFCI+GFCI)	12/2 NM-B	Kitchen small-appliance #2 (W counter + dining wall)
17	3	20 A 1P DF (AFCI+GFCI)	12/2 NM-B	Refrigerator
18	4	20 A 1P AFCI	12/2 NM-B	Dishwasher (hardwired j-box)
19	5	20 A 1P DF (AFCI+GFCI)	12/2 NM-B	Microwave drawer (island)
20	7	15 A 1P AFCI	14/2 NM-B	Kitchen lighting + range hood
21	8	20 A 1P DF (AFCI+GFCI)	12/2 NM-B	Laundry receptacle (washer)
22	10	20 A 1P GFCI	12/2 NM-B	Bathroom receptacles (both baths)
23	11	20 A 1P AFCI	12/2 NM-B	Living / foyer / hall receptacles
24	12	15 A 1P AFCI	14/2 NM-B	Living / dining / foyer / hall lighting + exterior front & rear door lights
25	13	15 A 1P AFCI	14/2 NM-B	Primary bedroom + WIC receptacles & lighting
26	14	20 A 1P AFCI	12/2 NM-B	Bedroom 2 receptacles
27	15	15 A 1P AFCI	14/3 NM-B (interconnect)	Bedrooms 2/3, linen, hall-bath, laundry lights & fans + smoke alarms (interconnected)
28	16	15 A 1P AFCI	14/2 NM-B	Primary bath light/fan + stair & basement lighting
29	17	20 A 1P GFCI	12/2 NM-B	Outdoor receptacles (front, rear, east @ HP)
30	18	20 A 1P GFCI	12/2 NM-B	Basement receptacles (general)
31	19	20 A 1P GFCI	12/2 NM-B	Sump pump
32	20	15 A 1P GFCI	14/2 NM-B	ERV + water treatment (UV)
33	26	20 A 1P AFCI	12/2 NM-B	Bedroom 3 receptacles

Lumber, sheet goods & fastener order

Generated by schedules/lumber.py from the framing model. Includes +8% on sheets; stock optimized first-fit-decreasing.

Dimension lumber

Size	Grade	Stock	Qty
2x10	SPF #2	10’	8
2x10	SPF #2	12’	4
2x10	SPF #2	16’	80
2x10	SPF #2	8’	4
2x12	SPF #2	16’	9
2x12	SPF #2	8’	21
2x12	SYP #2	16’	3
2x4	PT SYP #2 UC4A	12’	1
2x4	SPF #2	10’	3
2x4	SPF #2	12’	7
2x4	SPF #2	14’	6
2x4	SPF #2	16’	6
2x4	SPF #2	8’	73
2x4	SPF #2	92-5/8” precut stud	116
2x6	PT SYP #2 UC2 (ACQ)	14’	2
2x6	PT SYP #2 UC2 (ACQ)	16’	8
2x6	PT SYP #2 UC2 (ACQ)	8’	2
2x6	PT SYP #2 UC4A	12’	1
2x6	SPF #2	10’	3
2x6	SPF #2	12’	13
2x6	SPF #2	14’	6
2x6	SPF #2	16’	28
2x6	SPF #2	18’	4
2x6	SPF #2	8’	119
2x6	SPF #2	92-5/8” precut stud	151

Cut-off waste in stock allocation: 380 lf

Sheet goods

Product	Net area (sf)	Sheets ordered
1/2” OSB	49	2

Product	Net area (sf)	Sheets ordered
19/32” OSB 4x8	1,852	63
23/32” T&G OSB 4x8	1,456	50
7/16” OSB 15” strip	131	5
7/16” OSB 4x9	1,441	44

Engineered / purchased components

Item	Qty
GABLE_TRUSS 2x6 TC / 2x4 BC (MSR 2100f-1.8E chords, SPF #2 webs)	2
HEADER_INSUL 1.00” XPS (XPS R-5/in)	1
HEADER_INSUL 2.00” XPS (XPS R-5/in)	15
STAIR_TREAD 5/4x12 (1-1/16” x 11-1/4”) red oak (tread stock)	13
STEEL_COLUMN 3” Sch40 pipe (ASTM A53 Gr B)	6
TRUSS 2x6 TC / 2x4 BC (MSR 2100f-1.8E chords, SPF #2 webs)	25
Simpson H2.5A hurricane tie (G90)	50
APA H-clip 19/32”	208
Simpson LUS210 face-mount hanger	16
Simpson LUS210-2 face-mount hanger	4
Foam sill gasket 5-1/2” x 50 ft roll	4
Construction adhesive APA AFG-01, 28 oz	25

Structural fasteners (exact counts from model)

Type	Spec	Count	Approx. lb / boxes
AB	1/2” x 10” J anchor bolt + nut + 3x3x0.229 plate washer	42	
LAG	1/4” x 3” lag screw	24	
N10	10d common 3” x 0.148”	286	4.6 lb (+10%)
N16	16d common 3-1/2” x 0.162”	4,328	97.2 lb (+10%)
N20	20d common 4” x 0.192”	178	6.3 lb (+10%)
N8	8d common 2-1/2” x 0.131”	12,714	131.9 lb (+10%)
SD9112	Simpson SD9112 #9 x 1-1/2” connector screw	660	100-ct boxes: 8
SD9212	Simpson SD9212 #9 x 2-1/2” connector screw	88	100-ct boxes: 1
SDWS6	Simpson SDWS22600 0.22” x 6” structural wood screw	2	100-ct boxes: 1
WEDGE	1/2” x 4-1/4” wedge anchor (3” embed)	21	

Finish fasteners (quantities; pattern-located per spec, not individually modeled)

Item	Pattern / spec	Qty
Drywall screws 1-1/4” Type W (1/2” walls)	@16” o.c. edges & field into 16” studs (IRC T.R702.3.5)	3,420
Drywall screws 1-5/8” Type W (5/8” ceiling)	@12” o.c. on 24” trusses (T.R702.3.5), adhesive optional	1,729
Drywall screws 1-1/4” (basement thermal-barrier gyp)	@16” o.c. into 2x4 @24” (12” o.c. edges)	1,056
Roofing nails 1-1/4” galv. ring-shank	4 per shingle at mfr nail line; 18.5 squares + 10%	5,214
Vinyl siding nails 1-1/2” galv. roofing, 3/8” head	center of nail slots @16” into studs, 1/32” loose (ASTM D4756)	1,694
Cap staples / plastic-cap nails (WRB)	12” o.c. edges & 24” field per housewrap mfr	2,878